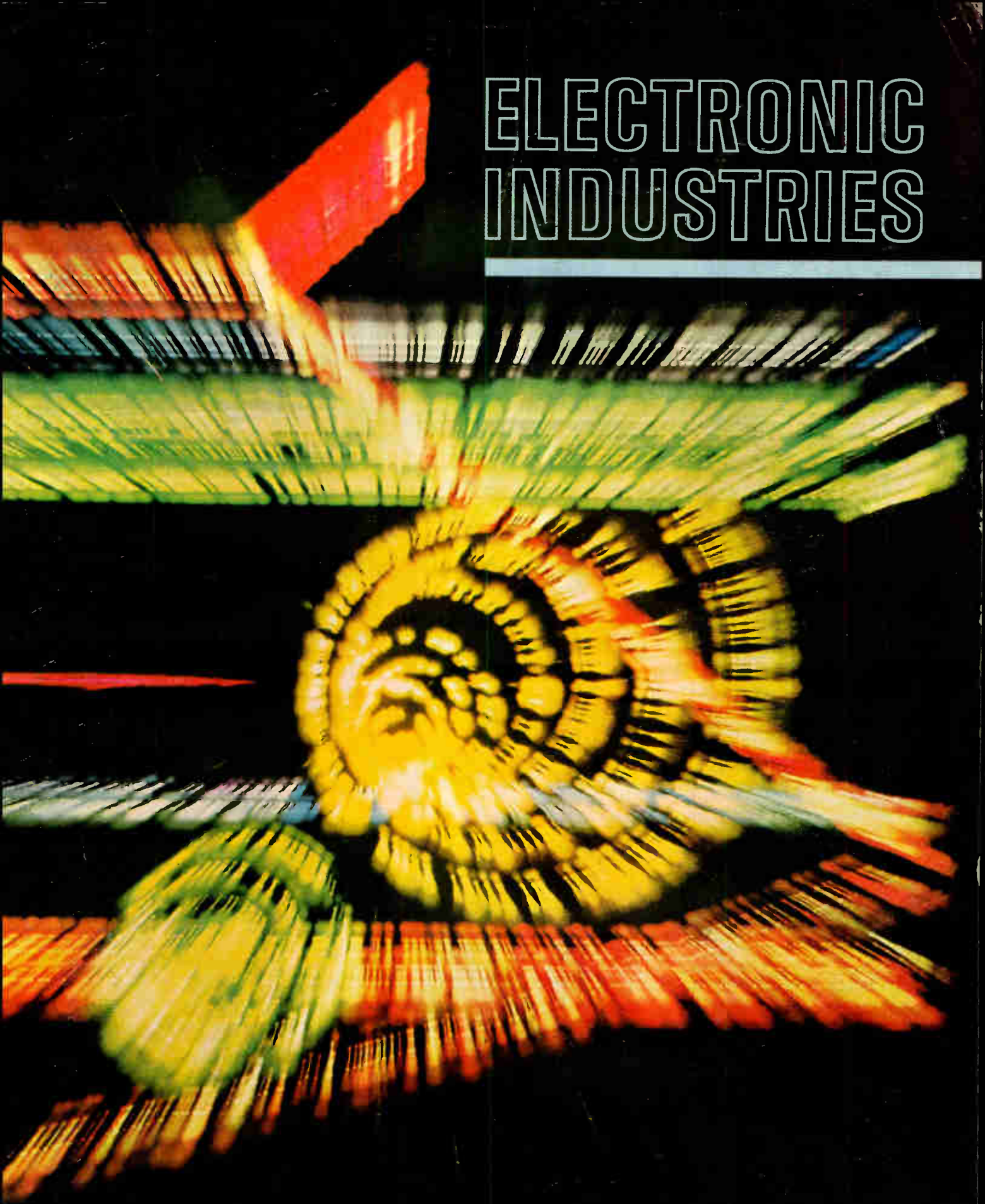
ELECTRONIC INDUSTRIES

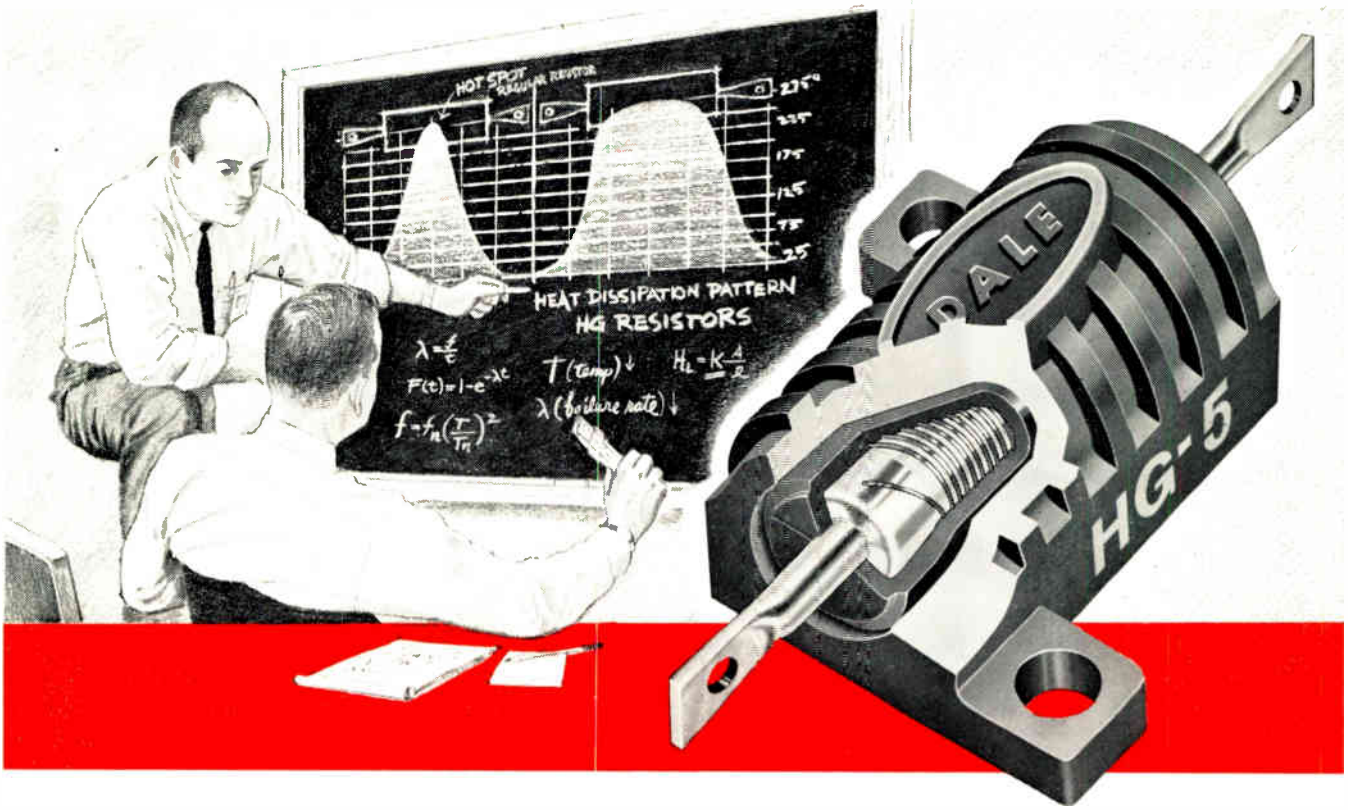


THE STATE OF THE ART REFERENCE ISSUE

JUNE 1963

DALE RELIABILITY

Put more power in less space with new HG Series Precision Power Resistors



Dale HG precision power resistors are a breakthrough in meeting the challenge of miniaturization where high power and precision tolerance are required. Dale uses an exclusive molding process to incorporate a precision wirewound resistance element into an aluminum radiator housing. The result is a solid unit from which heat is dissipated evenly and efficiently along the entire length of the resistance element. This eliminates the performance-cutting central "hot spot" and assures maximum reliability in minimum size. When derated to Mil. Rating, HG Resistors have unprecedented stability. The rigid quality control procedures and materials procurement standards used in the production of all Dale resistors have reached new levels of achievement as a result of Dale participation in the **MINUTEMAN** High Reliability Component Development Program.

SPECIFICATIONS

Three sizes: HG-25 (35 watts) and HG-10 (20 watts) meet requirements of MIL-R-18546C (RE-70 and RE-65 respectively) HG-5 (15 watts) meets functional requirements. Resistance range: .1 ohm to 60K ohms, depending on type and tolerance. Tolerances: 0.5%, 1%, 3%. Continuous operating temperatures: -55° to 275° C. Temperature coefficient: 0.00002/degree C.

Here's how Dale "builds in" reliability

1. RESISTANCE ELEMENT consists of high purity ceramic core wound with resistance wire procured to rigid standards. Precise control of winding tension over centerless ground core assures that wire lays firmly and uniformly. This produces even power dissipation and eliminates local "hot spots". Element is untouched by human hands or foreign materials.

2. COMPLETE WELDED CONSTRUCTION from terminal to terminal. Welds tested to destruction on sample basis. Non-corrosive stainless steel end caps assure good weldability and ideal mechanical properties. Standard terminals gold-plated copper. Also available with tin-plated copper terminals and 6-32 studs.

3. EXCLUSIVE DALE PROCESS (patent pending) completely surrounds resistance element with high density jacket which bonds itself to the outer housing. The result is a solid, void-free mass which gives maximum heat conduction and affords complete environmental protection. Possibility of high voltage breakdown is eliminated by precise centering of resistance element within radiator housing.

4. RADIATOR HOUSING of anodized aluminum mounts on chassis for maximum thermal transfer.

DALE

DALE ELECTRONICS, INC.
1304 28th Avenue, Columbus, Nebraska
A subsidiary of THE LIONEL CORPORATION
Also Made and Sold by Dale Electronics Canada, Ltd., Toronto, Ontario, Canada

SEE OUR SPECIFICATIONS IN VSMF THE MICROFILM CATALOG FILE

Circle 98 on Inquiry Card

1963/64 ALL REFERENCE & DIRECTORY ISSUE

ELECTRONIC INDUSTRIES

ELECTRONIC INDUSTRIES

SHELBY A. McMILLION,
Publisher
BERNARD F. OSBAHR,
Editor

Your 1963 State of the Art Reference Issue

THIS IS YOUR 1963 STATE OF THE ART REFERENCE issue. It contains 34 survey or round-up type articles. Each of these has been written exclusively for ELECTRONIC INDUSTRIES by an outstanding industry authority. Our objective is to provide an up-to-the-minute review of the many technical fronts of our industry.

There are many new and interesting ideas expressed by our authors in these articles. For example:

On page C-38 Robert E. Moe describes how the vacuum tube industry has met the challenge of today's changing technology. This industry still remains a healthy and vigorous supplier of electron controlled devices in the entertainment, industrial, military and space fields.

General Bernard A. Schriever, commenting on national security, page B-6, writes that although we passed a major milestone when the first Minuteman squadron become operational, Minuteman is still not the ultimate weapon system. Technology is not standing still and new systems will always be developed on the basis of new requirements.

Of all basic parameters used in science and engineering, frequency continues to be the one that can be measured to the greatest precision and accuracy. So writes Ivan E. Easton, page E-2. He also points out that today modern molecular oscillators are better time keepers than astronomical movements. You might also wish to read about the discovery of a fundamental new theorem in electrostatics.

Dr. John Bardeen, Nobel prize winner, writing on semiconductor research, page C-12, states "Progress in transistors can be characterized by increasing frequencies, power, reliability, smaller size and lower prices." He predicts truly integrated blocks which will give desired overall circuit functions.

Robert C. Sprague discusses microelectronics, page B-10, and discloses that the development of semiconductor integrated devices has progressed to the point where it appears that they will make possible the smallest electronic circuits which are likely to be made by any technique in the future.

Circuit design, according to Dr. Daniel Noble, page C-2, has become progressively complex because of the advent of integrated circuitry. Involved now for each circuit are circuit theory, mathematics, physics, metallurgy, chemistry, electronics, semiconductor processing, thin-film processing and photography.

Admiral Charles F. Horne, on page B-2 states, "After more than a decade of defense and later space programs the consumer products industry has dropped from a quarter of a century of leadership to less than 20% of total electronics production. The government (thus) has become . . . the biggest buyer of electronic equipment and components."

Dr. Robert Johnson points out, page K-2, the trend toward more economical computers through multiple programming techniques—the interlacing of portions of different simultaneous programs in various computer elements. Such new developments as thin films forecast still greater economies and performance.

This issue, in addition, contains our 21st Annual Directory. Names and addresses of more than 6000 electronic manufacturing plants are provided, as well as information on the more than 3000 products manufactured at these locations.

We think you will agree that this month's cover design is quite a startling and interesting creation. Our cover designer developed it as an answer to our question, "How can you depict the world of the electron?"

Developing and producing your State-of-the-Art Reference issue has been a fascinating challenge for us. We enjoyed it greatly. It is our hope that you will obtain many immediate benefits and find it a useful year-round reference. Your written comments are always welcome.

SECTION A

IN THIS ISSUE...

ELECTRONIC INDUSTRIES

Vol. 22, No. 6 June 1963

1963/64 STATE OF THE ART REFERENCE & DIRECTORY ISSUE

SECTION A: IN THIS ISSUE . . .

SECTION B: OUR ELECTRONIC INDUSTRY—TODAY AND TOMORROW

SECTION C: SEMICONDUCTORS & TUBES

SECTION D: CIRCUIT COMPONENTS

SECTION E: MEASUREMENT & TEST

SECTION F: ELECTROMECHANICAL COMPONENTS

SECTION G: MATERIALS & HARDWARE

SECTION H: MILITARY ELECTRONICS

SECTION I: SPACE SYSTEMS

SECTION J: MICROWAVE

SECTION K: DATA PROCESSING & AUTOMATION

SECTION L: MANUFACTURERS & PRODUCTS

SHELBY A. McMILLION, Publisher

BERNARD F. OSBAHR, Editor

CREIGHTON M. MARCOTT
Executive Editor

JOHN E. HICKEY, Jr.
Senior Technical Editor

SMEDLEY B. RUTH
ANDREW MITCHELL
Associate Editors

CHARLES W. WEBB
JOHN J. HUNTER
ROBERT J. BRAMLETT
Assistant Editors

DR. ALBERT F. MURRAY
Consulting Editor

SIDNEY FELDMAN
Contributing Editor

EDITORIAL PRODUCTION

EDWARD J. RICHTER, Copy Editor
ELMER KETTERER, Art Director
SOL MEDNICK, Cover Design
ANNE AXE, Editorial Assistant
MAE MOYER, Reader Service
IDA GOOD, Editorial Secy.

EDITORS-AT-LARGE

Eastern Region

ELMER T. EBERSOL,
100 East 42nd St.,
New York 17, N. Y.
(Area Code 212) OXford 7-3400

Western Region

J. PHILIP GEDDES,
198 S. Alvarado St.,
Los Angeles 57, Calif.
(Area Code 213) DUnkirk 7-1271

WASHINGTON NEWS BUREAU

1093 National Press Bldg.
(Area Code 202) 393-3474
TWX—202 965-0675
GEORGE BAKER, Mgr.
NEIL R. REGEIMBAL
DAVID R. HEINLY

BUSINESS DEPARTMENT

ELMER DALTON
Advertising Promotion
& Circulation Manager

DONALD J. MORAN
Marketing Manager

GORDON HERNDON
Production Manager

See Advertisers Index on page A-8 for Regional Sales Managers.

Chilton Company—G. C. BUZBY, President Executive Vice Presidents: R. E. McKenna, G. T. Hook. Vice Presidents: P. M. Fahrendorf, L. V. Rowlands, M. E. Cox, E. B. Terhune, Jr., R. W. Case, Jr., J. H. Kofron. Treasurer: Stanley Appleby. Secretary: J. A. Montgomery. Other Directors: C. A. S. Heinle, G. E. Cameron, T. C. Campbell, H. W. Barclay, W. A. Phair; Assistant Treasurer: J. Miades; Assistant Secretary: I. C. Holloway.

JOHN H. KOFRON
Chilton Research Director

ELECTRONIC INDUSTRIES, June, 1963. Vol. 22, No. 6. A monthly publication of Chilton Company. Executive Editorial & Advertising offices at Chestnut & 56th Sts., Phila. 39, Pa. (Area Code 215) SHerwood 8-2000. Controlled circulation postage paid at Philadelphia, Pa. $1 a copy; Directory issue (June), $5.00 a copy. Subscription rates U. S. and U. S. Possessions; 1 yr. $10.00; 2 yrs. $18.00. Canada 1 year, $12.00; 2 yrs. $20.00. All other countries 1 yr., $18; 2 yrs. $30.00.

Products Advertised

In This Issue . . .

(Continued on page A6)

Products (Continued)

RELAYS (Continued)

Time Delay & Quick-Acting Relays—The Adams & Westlake Co.—p. F31

Multiple-Relay Group—Automatic Electric—p. F15

RESISTORS

Trimmer Potentiometers, Resistors — Dale Electronics—p. D18, 19

Fixed Composition Resistors — Stackpole Carbon Co.—p. D61

Wire-Wound Resistors and Rheostat — Clarostat Mfg. Co., Inc.—p. D20

Infinite-Resolution Potentiometers — Bourns Inc.—p. D43

Potentiometers—Spectrol Electronics Corp. —p. D73

Power Resistors—Dole Electronics, Inc.—p. Inside front cover

Fixed Resistors—Allen-Bradley Co.—p. D69

Silicon Epitaxial Varactors—Sylvania Electric Prod., Semiconductor Div.—p. C14, 15

Precision Potentiometers—Borg Equipment, Div. of Amphenol-Borg Electronics Corp. —p. D64

Resistance Network—Kelvin Electric Co.—p. D40

Metal Film Resistors—Electra Mfg. Co.—p. D47

Precision Metal Film Resistors—Weston Instruments & Electronics—p. D54

Variable Resistors—CTS Corp.—p. D28

Power Resistors—Sale Electric Corp.—p. D75

SEMICONDUCTORS

High Current Transistors—Delco Radio, div. of General Motors—p. C27

Automated Packaging — Sylvania Electric Products Inc.—p. C19

Silicon Transistor—Bendix Semiconductor Div.—p. C29

Semiconductor Materials—Monsanto Chemical Co.—p. G27

TC Zener Diodes—Dickson Electronics Corp. p. C33

Thin-Film Microcircuits—Sprague Electric Co.—p. D22

Amplifier Transistors—Sperry Semiconductor, div. of Sperry Rond Corp.—p. C23

Memory Circuits—Radio Corp. of America —p. Back cover

Microelectronics — Hughes Semiconductor Div.—p. C16

Integrated Circuits — Signetics Integrated Circuits—p. C31

Hall Effect Substrates—Beckman Instruments, Inc.—p. C34

Field-Effect Transistors—Texas Instruments Incorporated—p. C24, 25

Silicon Planar Transistors—Transitron Electronic Corp.—p. C21

Integrated Circuits—Centralab—p. D45

Transistors—G. E. Co., Semiconductar Products Div.—p. C32

Silicon Transistors — General Instrument Corp.—Insert following p. B22

SHIELDING

Heat Dissipating Tube Shields—International Electronic Research Corp.—p. G54

Magnetic Shielding—Magnetic Shield Div. Perfection Mica Co.—p. G53

SWITCHES

Pushbutton Switches—Groyhill Inc.—p. D77

Switches—Radio Switch Corp.—p. D66

Thumbwheel Switches—Chicogo Dynomic Industries, Inc.—p. D75

Concentric Shaft Switch—Groyhill Inc.—p. D77

Rotary Switches—Chicago Dynomic Industries, Inc.—p. D75

Thermostats—Stevens Mfg. Co., Inc.—p. D37

Standard & Custom Switches—Controls Co. of America—p. F24

TEST EQUIPMENT

Display Scanner Plug-in—Hewlett Pockard Co.—p. Inside back cover

Capacitance Bridge—Sprague Electric Co. —p. D39

Resistance Measuring System—Electro Scientific Industries—p. E34, 25

RF Sweep Equipment—Jerrold Electronics—p. E29

Dual-Trace Oscilloscope—Analab Instrument Corp.—p. E30

DC Amplifier and Electrometer—General Radio Co.—p. E15

Frequency Standard—Motorola Communications & Electronics, Inc.—p. E36

Bolometers—PRD Electronics, Inc.—p. J12

Test Equipment Cart—Northeastern Engineering Inc.—p. E32

Spectrum Analyzer—Singer Metrics Div., The Singer Co.—p. E16, 17

Frequency Standards, Crystals, Ovens, Filters —Reeves-Hoffman—p. D72

Differential Voltmeter—John Fluke Mfg. Co., Inc.—p. E21

RF Standards—Sensitive Research—p. E25

Tuning Fork Oscillators—Fork Standards, Inc.—p. E36

Taut-Band Meters—Assembly Products, Inc. p. F34

Frequency Distribution Amplifier—Montronics Inc.—p. E35

Digital Voltmeter—United Systems Corp.—p. E24

Vacuum Thermocouples—Vacuum Products, Inc.—p. D79

Voltage Spike Analyzer—Leland Airborne Products—p. E26

Megohmmeter—Associated Research, Inc. p. E32

General-Purpose Oscilloscope — Tektronix, Inc.—p. E19

Oscilloscope—Fairchild Dumont Laboratories—p. D80

High Accuracy Synchro/Resolver Testing — Gertsch Products, Inc.—p. E22

Ultra-Precise Temperature Testing—Stathom Instruments, Inc.—p. E24

Transistorized Frequency Standard—Jomes Knights Co.—p. E26

Differential Voltmeter—Keithley Instruments —p. E38

TOOLS

Pliers—Mathias Klein & Sons Inc —p. G28

Insulated Wire Stripper—Ideol Industries, Inc.—p. G38

Crimping Tools—Buchanon Electricol Products Corp.—p. B19

Pocket Tools—Xcelite, Inc.—p. G57

TUBES

Tube Grids—Anton Mochine Works—p. C50

Industrial Electron Tubes—Western Engineers—p. L2

Tubes—The Victoreen Instrument Co.—p. D58

Storage Tube—Hughes Vacuum Products Div.—p. C36

Power Tubes—RCA Electron Tube Div.—p. C46

Recording Storage Tube—Image Instruments, Inc.—p. C50

Vacuum and Gas-Filled Tubes—Tung-Sol Electric Inc.—p. C49

WIRE & CABLE

Radio Frequency Cable—Boston Insulated Wire & Coble Co.—p. G55

Wire & Cable Catalog—Alpha Wire Corp. —p. G39

Delay Lines—ESC Electronics Corp.—p. D34, 35

Special-Purpose Cable Systems—Scintilla Div., Bendix Corp.—p. G49

Wire Markers—W. H. Brody Co.—p. G51

Thermocouple Extension Wires — Samuel Moore—p. K20

Coaxial Cables—Times Wire & Cable—p. G56

ELECTRONIC INDUSTRIES Advertisers – June 1963

This index is published as a convenience. No liability is assumed for errors or omissions.

Advertisers (continued)

ELECTRONIC INDUSTRIES REGIONAL SALES MANAGERS

Philadelphia (39)—56th & Chestnut Sts.
(Area Code 215) SHerwood 8-2000
JOSEPH DRUCKER
ROBERT Q. HINCKLE, Jr.
HERMANN W. BOZARTH
(Classified Advertising)

New York 17—100 East 42nd St.
(Area Code 212) OXford 7-3400
GERRY PELISSIER
HUGH ROBINSON

W. Hartford, Conn.—62 LaSalle Rd.
(Area Code 203) 236-4237
AL KAISER

Boston (10), Mass.—10 High St.
(Area Code 617) Liberty 2-4460
ROBERT G. SMITH

Chicago (1)—540 N. Michigan Ave.
(Area Code 312) 467-9660
JOHN W. BERNHARDT
PHILIP T. CLARK

Cleveland (15)—930 Keith Bldg.
(Area Code 216) SUperior 1-2860
ROBERT COBURN

Los Angeles (57)—198 S. Alvarado St.
(Area Code 213) DUnkirk 7-1271
GEORGE F. KELLEY
BURT UNDERWOOD

San Francisco (3)—1355 Market St.
(Area Code 415) 861-7107
DON MAY

Atlanta (9)—1776 Peachtree St., N.W.
(Area Code 404) 875-1255
JOHN W. SANGSTON

Dallas (6)—Meadows Bldg.
Expressway at Milton
(Area Code 214) EMerson 3-6426
HAROLD E. MOTT

EUROPEAN SALES OFFICES

London, S. W. (1)—67/68 Jermyn St.
St. James
MAX F. HOLSINGER

Dusseldorf—Huttenstrasse 17
Am Ernst-Reuter-Platz
MAX F. HOLSINGER

FAR EAST SALES OFFICE

Tokio Marunouchi, Japan
C. P. O. Box #1572, Room 814
Tel: 211-3506-3509
Togin Bldg.
CLARENCE T. SAKAGUCHI

SECTION B

OUR ELECTRONIC INDUSTRY— TODAY AND TOMORROW

Except for a few problems and rabbit holes here and there, electronic industries appear to have a rosy future. The electronics "industrial revolution," sired by World War II, and fed by the war in Korea, has taken giant steps —and the steps get bigger as R&D accelerates. Declining profits, increasing costs and import competition are causing headaches in the industry, but larger, diversified firms are learning the cures.

PREDICTIONS FOR THE FUTURE OF THE ELECTRONIC INDUSTRY

AN INDUSTRIAL REVOLUTION HAS OCCURRED in this country during the last 13 years. In this relatively brief span of time, what was once known as the radio industry has become the electronics industry. Perhaps there is need for an explanation.

When World War II ended on V-J day, radio manufacturers joined in the public rejoicing with enthusiasm. The fifty-odd radio producers and their component suppliers were eager to return to the free enterprise market where the consumer calls the shots.

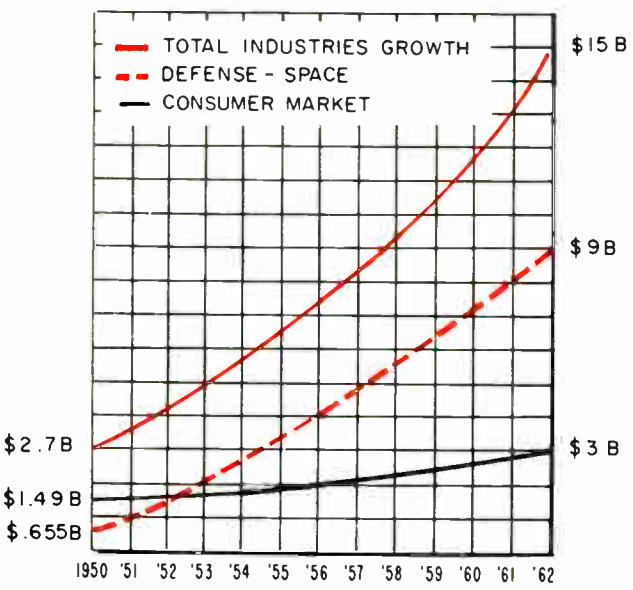
As soon as price and material controls could be discarded, the radio industry set about fulfilling the pent-up wartime demand for new radios for the home and the new car—when you could get it. As a consequence, 20 million radios were produced in 1947 to set a numerical record that has not been matched since.

The radio industry, it seemed, had returned to "normalcy" and was glad of it. But this "normalcy" was not to last; television was beginning to crowd into the living-rooms of America.

By the end of 1950, TV set sales had skyrocketed to 7.5 million, and a new industry boom was in full swing. The big customer was still the American family.

GROWTH OF ELECTRONIC INDUSTRY: 1950 TO 1963
Consumer and Government Markets

Government's defense-space electronics rose from 24% of industries total in 1950 to about 60% in 1963. The consumers' market, which held at 55% in 1950, fell below 20% by 1963.



Korean War Expands Industry

It was on this scene of industrial tranquility that the North Korean invasion of South Korea and the subsequent American intervention came with a rude shock. What the radio-TV manufacturers — and hardly anyone else—did not realize in 1950 was that a new industry was being born even though the radio industry of World War II was its father.

Today, after more than a decade of defense and later space programs, the consumer products industry has dropped from a quarter of a century of leadership to less than 20% of total electronics production. The Government has become without question the biggest buyer of electronic equipment and components. By taking about 60% of the electronic industry's output, the Government's purchases in 1963 will exceed the total volume of the radio industry's sales to the Government throughout World War II.

This metamorphosis was much more significant

By ADM. CHARLES F. HORNE
President
Electronic Industries Association

Today's electronics industry, born out of the debris of World War II, and nurtured by the needs of the war in Korea (above) is "firmly established in the national economy and will continue to grow with it, if not ahead of it."

than the tremendous increase in the dollar volume. It brought vast forward strides in technology, a reorientation of marketing objectives, and a new kind of manufacturer who was a stranger to the pre-1950 radio manufacturer.

A favorite quip of the old radio days was that anyone with a screw driver, a loft, and a set of blue prints could get into radio manufacturing. Today, it not only requires substantial capital, but also a technical capability which surpasses that of the old-time radio engineer to about the same degree as a Ph.D. does a high school diploma. The number of engineers required in any company likewise has multiplied at about the same rate. Today the industry has about 130,000 engineers and scientists.

Dissimilar Firms, Similar Interests

The electronic industries are a heterogenous group of manufacturers held together by their use of similar techniques and components in the development and production of equipment and systems. These products range from the highly complex for military and space and some industrial uses to the relatively simple radio for the home or car.

The Electronic Industries Association, which grew out of the Radio Manufacturers Association into the Radio-Television Manufacturers Association and the Radio-Electronic-Television Manufacturers Association, has defined this new assembly of industries thus:

"Electronic industries comprise industrial organizations engaged in the manufacture, design and development, and/or substantial assembly of electronic equipment, systems, assemblies, or the components thereof."

Some, but not all, of the industries which have entered the electronic field since 1950 are: aircraft, watch, business machine, auto, chemical, camera, glass, and food. Other industries have merely bought into the electronic industries for the purpose of diversifying their products and markets.

Despite the seeming incongruity of industrial background, the electronic industries break down into four major categories of manufacturers:

(*Continued on following page*)

1. Consumer goods (radio, TV, phonographs, tape recorders, etc.).
2. Military and space equipment and systems.
3. Industrial and commercial equipment.
4. Components of all types including microelectronic units.

Number of Producers Varies

There are varying estimates of the number of producers, and the figures depend upon the definition of a company. A conservative estimate of 4,000 companies would be made up approximately of the following groups:

1,300 equipment manufacturers and major assemblers.
2,000 component producers.
700 hardware manufacturers (switches, wire, cabinets, etc.).

Many companies have divisions or subsidiaries which fall within several or all categories of electronic manufacturing. A diversified producer may make radio and television receivers, military and space systems, industrial and commercial equipment, and a variety of components. A less diversified company may choose to produce only one category of products. Many small firms are one-product specialists.

By reason of a wide dispersion of plants, the industry is truly national in character. There are, however, heavy concentrations in a few areas and a thin scattering in others. The heaviest concentrations are in what may be loosely called the Atlantic-Coast Northeast region and the Southwest-Coast area. The former runs from Washington, D. C., to Maine, while the second include Southern California, Arizona, and San Francisco and its environs.

The Chicago-Indiana area remains the stronghold of the older radio industry-manufacturers of radio-TV-phono equipment and standard components. Among the newer zones of electronic industrial development are Florida, Texas, and North Carolina.

Employee Figures Estimated

Employment figures are of necessity estimated due to the over-lapping of electronic manufacturing with other related industries. The Business and Defense Services Administration, Department of Commerce, earlier this year said: "Employment in the electronic industries is expected to pass the million mark in 1963, up almost 10% from the estimated 1962 figure."

This figure, of course, applies only to employees in manufacturing and R&D companies. Thousands more are employed in merchandising outlets, servicing, and broadcasting.

Factory sales, calculated by EIA Marketing Services Department, amounted to just under $13 billion in 1962 and are expected to approach $15 billion in 1963. They may be classified in four general categories:

	1962	*1963*
	(add 000,000)	
Government	$7,600 (1)	$9,000
Consumer	$2,340	$2,400
Industrial	$2,400	$2,700
Replacement Components	$ 620	$ 650
	$12,960	$14,750

(1) Gross Government sales are estimated by EIA as $500 million greater than this, but as they are included in the industrial category as standard commercial products they are not repeated here.

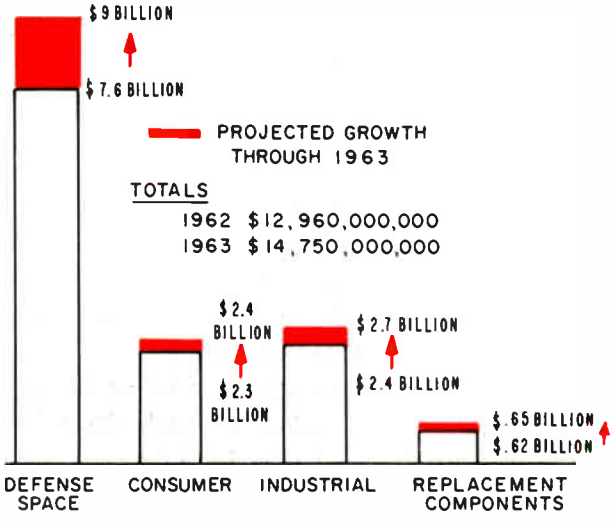
The electronic industry, now fifth largest on the nation's industrial scene, may move into fourth place by the end of 1963. By the close of 1970, annual factory sales could climb to about $20 billion—perhaps even to $25 billion or more.

Indicative of changes in electronic industries since 1950 are the shifts in dollar volume among the above categories. In 1950 consumer goods accounted for about 55% of total electronic production, whereas in 1962 Government sales—a mere $655 million in 1950—represented about 60% of the dollar volume.

FACTORY SALES FROM 1962 TO 1963 FORECAST

Growth comparisons in defense-space, consumer, industrial and replacement component markets.

Factory sales in four general categories neared $13 billion in 1962; are expected to bring $15 billion in 1963. Defense-space still holds 60% line; consumer market is less than 20%.



During the same period industrial electronic products rose from $350 million to $2.4 billion to surpass consumer goods. Component replacement sales, as might be expected, closely paralleled industry growth by almost tripling in volume.

Greatest Gov't Market Change

Perhaps the greatest change occurring in the Government market is the rapid growth in space requirements. The National Aeronautics and Space Administration (NASA) request for fiscal year 1964, which begins July 1, 1963, was for $5.7 billion, which is $2 billion above the previous year. Military requirements, on the other hand, showed a slight decline in categories heavily electronic so far as production is concerned; but R&D programs, which increasingly involve electronics, are up $521 million to $7.1 billion.

During the fiscal year 1963, and for several years thereafter, the Department of Defense will concentrate on building up American capacity for limited warfare. The command and control requirements of this program rely heavily on the electronic industries.

The total dollar value of factory sales for consumer products increased 12% in 1962 somewhat to the surprise of everyone. It had been generally accepted by 1960 that the television market was leveling off and could be expected to grow only as the population expands. As for radios, just as the book salesman discovered on his first house calls, everyone has a radio. The only market seems to be for extra sets and replacements.

But these forecasts failed to anticipate the impact of stereophonic FM Broadcasting which has made remarkable strides since it was authorized by the Federal Communications Commission in June, 1961. More than 225 FM stations have converted to stereo, and sales of stereo FM receivers may reach a million units in 1963.

Just what effect the All-Channel Receiver Act—effective April 30, 1964—will have on TV set sales is open for conjecture. The television industry has joined with the FCC in preparing the retail and servicing trade, broadcasters, and the public for the change-over. If successful, this program eventually should expand television broadcasting services in many areas where the scarcity of VHF channels has limited the number of stations and hasten the consumer's conversion to the all-channel receiver.

Military Needs Slowed Market Down

It is universally conceded that the industrial and commercial markets offer the greatest growth potential for electronic industries. That sales of industrial electronic products have multiplied seven times since

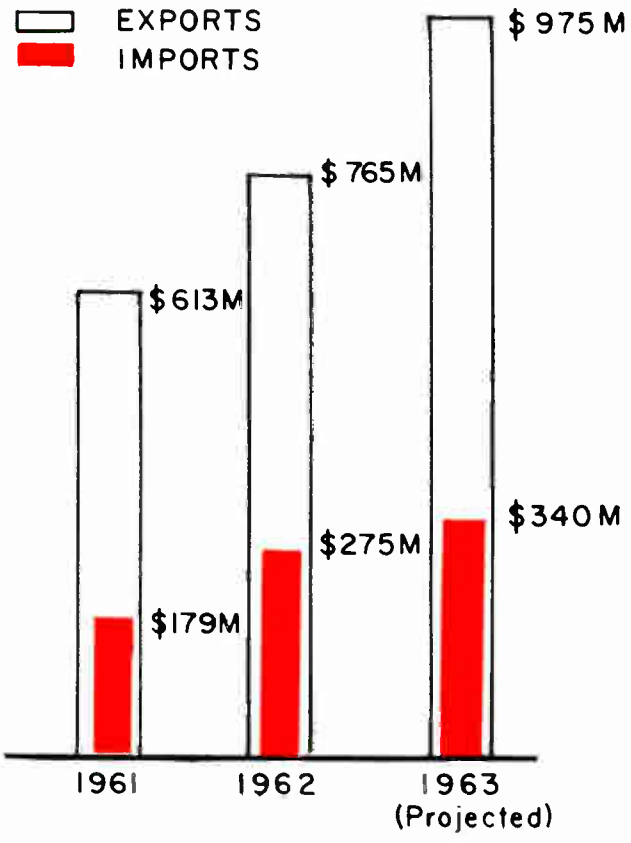
"Government's purchases in 1963 will exceed total volume of radio industry sales to Government throughout World War II."

1950 is indicative of the future. The priority of military requirements undoubtedly has slowed the growth of the market. However, the development and improvement of many industrial - commercial devices

(Continued on page B16)

EXPORT-IMPORT GROWTH AND FORECAST: 1961-1963

U.S. exports of electronic systems, equipment and components may reach $975 million in 1963. Imports also are rising but at a faster rate to an estimated $340 million total in 1963.



The continuing threat to our national security puts increasing demands on electronic-aerospace technology. Gen. Schriever spells out here the current and future requirements for more effective striking forces and defensive systems, on earth and in space. He suggests components and systems that may be developed to fit those needs, with accent on reliability.

NATIONAL SECURITY AND ITS TECHNOLOGICAL REQUIREMENTS

THE SECURITY OF THE UNITED STATES depends heavily on our possession and application of superior technology. Throughout military history, technology has made vital contributions to victory in battle. Its role is paramount today. Our national survival hinges on a vast array of highly complex and sophisticated systems that have been created by the joint efforts of the armed services, science, and industry.

Continued advance in every area of technology is essential to maintain our national security in the face of a wide-ranging threat. We must be prepared for aggression on any scale—in the jungles of Southeast Asia, in the emptiness of space, or anywhere in between. Wherever freedom is threatened by military action at any level, we must have the capability to make the appropriate response. As President Kennedy said shortly after the Cuban crisis last fall, "Regardless of how persistent our diplomacy may be in activities stretching all around the globe, in the final analysis it rests upon the power of the United States."

Many of the systems we depend on today—advanced manned aircraft, intercontinental and intermediate range ballistic missiles, electronic early warning systems, and rapid and reliable communications systems—were not even invented twenty years ago. A number of them were dismissed as "fantastic" or "impractical" when they were first suggested. Serious development of intercontinental ballistic missiles did not begin until we had obtained solid evidence that the Soviets were building similar weapons.

Ballistic Missile Progress

The rapid progress of the ballistic missile program has been due to the close partnership between science, industry, and the armed forces. New methods of management enabled us to cut lead times and surpass the most optimistic predictions made at the start of the ICBM program in 1954. In December 1962 we passed a major milestone when the first operational Minuteman squadron was turned over to the Strategic Air Command. The national inventory of operational missiles will greatly increase during 1963.

These new weapons are greatly augmenting the Nation's deterrent strength, but it would be a mistake to regard any system—even the most advanced—as "the ultimate weapon." Technology is not standing still. New systems will always be developed on the basis of new technology and new requirements.

If we are not the first to develop them, we must expect that another nation will be. This is a major problem. How do we insure that the Soviets will not achieve superiority in a decisive area of technology? There are no easy answers. When we attempt to evaluate Soviet technical capabilities or specific weapon developments, we are dealing either with estimates or with virtual unknowns.

Three Facts About the Soviet

However, there are three things we know for certain about the Soviet Union, and these indicate the general developments that are likely to occur in military technology. First of all we know the basic Communist hostility toward the Free World. Events of the past several months have shown this very clearly. They talk of "peaceful co-existence" until they are blue in the face—while their actions continue

By GEN. BERNARD A. SCHRIEVER
Commander, Air Force Systems Command
Andrews Air Force Base, Md.

"There is a great and immediate need for improved technology in limited war activity. In many areas we are already late."

"We sometimes neglect military technology advancement, misjudging capabilities and intentions of potential aggressors."

"Technology is not standing still. New systems will always be developed based on new technology, new requirements."

"The Soviets are fully aware of the importance of technology in their drive for world domination. Education is stressed."

"It would be a mistake to relax efforts in any area of technology. Space calls for our best thinking and best efforts."

to be anything but peaceful. As Chancellor Adenauer told the National Press Club last November, "When anybody talks to me about 'co-existence,' I think of Cuba."

Secondly, we know that the Soviets are fully aware of the importance of science and technology in their drive for world domination. They place great emphasis on technical education, and they reward their scientists and engineers with both pay and prestige.

Third, we know that the Soviets have made significant achievements in some aspects of space technology. They have shown clearly that they are aware of both the military and the psychological possibilities of space vehicles. In 1961, they launched Major Titov in a 17-orbit flight. Last summer they launched concurrent multi-orbital flights. We have yet to duplicate these two feats.

Consider those three factors—the basic Soviet hostility, their emphasis on technology and education, and their achievements in space. It would be a mistake to relax our efforts in any area of technology.

Space is certainly one area that calls for our best thinking and our best efforts.

New Environments—Many Problems

Space activities pose many problems for our technology today. We will be operating in a completely new environment that has many unique characteristics. For instance the hard vacuum of space, radiation, and extreme changes in temperature affect the properties of many materials. New materials must be developed to withstand these conditions for prolonged periods of space flight.

All space systems demand an extremely high standard of reliability. In most cases normal maintenance will be extremely difficult, if not impossible. Limitations on payloads weights will make it difficult to provide adequate spare parts or to compensate for failures through redundancy. The reliability problem is complicated by the fact that space systems will be operating in new and largely unknown environments at progressively greater distances from the earth.

Many requirements apply equally to military and civilian aspects of the national space program. But for military space operations, there will be several unique requirements. These include the capability for fast reaction and repeated operations, the ability to conduct missions at times and places dictated by mission objectives, and the capability to inspect uncooperative objects in space. Other needs are the ability to survive in a hostile environment, and in general, the same kind of flexibility we have in present aerospace operations.

Specific Electronics Needs

In addition, there are specific military requirements in electronics. One of these is for reliable and secure communications systems between the earth and points in space, and between two or more points in space. These systems should be able to function during natural or man-made interference.

Extensive development is needed in this area to meet the unique requirements of the space environment.

Space communications systems may need to make use of infrared and visible light frequencies in order to provide high-volume capacity and high reliability over long distances. We must continue to explore the possibility of new ways to transmit energy and signals in space.

We will need systems that are capable of detecting, tracking, identifying, and cataloging all space traffic. These may include new ground-based radars, which could be supplemented later by satellite-borne instruments. This is an area in which many technical advances are needed.

As space operations increase, another function will be needed. This is a system for programming and controlling launch, flight, and recovery operations through special electronic facilities. At the heart of the system would be a central control facility that would program the re-entry flight paths for space vehicles. It would be fed data continuously by tracking stations and would use computers on the ground and in the vehicles to insure that ground and air control systems were perfectly synchronized.

Special Weapons Controls

We may also need a special space weapon control system, integrated with other space systems. Such a system would analyze and evaluate vast amounts of information, in somewhat the same manner as SAC and NORAD Operations Centers now use information fed to them by the Ballistic Missile Early Warning Systems (BMEWS) and the Space Detection and Tracking System (SPADATS). This control system would play a key role in our defense against possible aggression which might be launched through space.

Our needs are equally great in other areas. In spite of the great potential in ballistic missile and space technology, we have no intention of neglecting developments in aerodynamic flight. In terms of technical feasibility, military aircraft definitely have a future. During the next ten years it will be possible to provide significant improvements in aircraft range, speed, and versatility. Development and use of boundary layer control, improved engine inlet designs, and advanced combustion technology are all feasible in this period.

A great variety of advanced aircraft types, including conventional design, V/STOL, variable geometry, and paraglider configurations, could afford many new mission capabilities. That such aircraft may be feasible does not guarantee their development, but at least there seem to be no technical barriers. These advanced aircraft can be developed if they are needed to meet military requirements.

Limited War Technology

There is also a great and immediate need for improved technology in limited war and counterinsurgency operations. In a number of areas we are already late. We need methods of finding people from the air when they are hidden by jungle cover. We need weapons that are effective through trees and brush.

There are logistic problems, such as the need to pinpoint drop zones securely and deliver material to the exact spot.

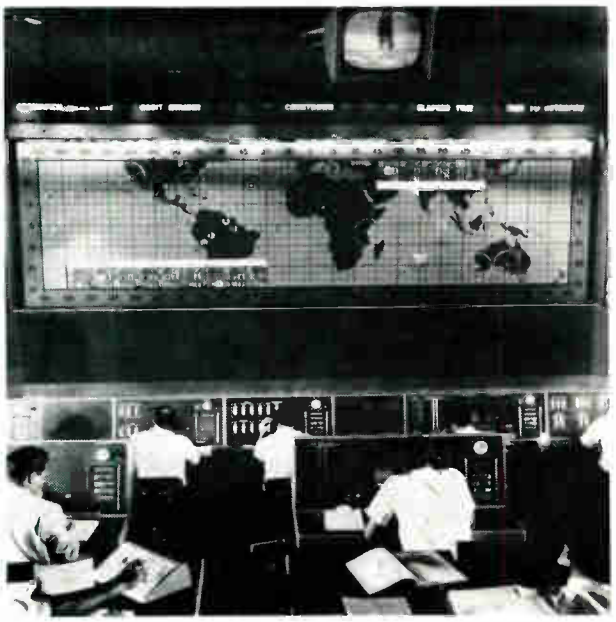
We would also like to have a practical means of securing large areas from the air, particularly at night, so that we can detect the movement of troops and preferably be able to tag them for identification. In addition, we need to improve command and control systems required in these types of operations.

Our nation has sometimes tended to neglect the advancement of military technology. We have been guided by our own peaceful intentions and have either misjudged or ignored the intentions and capabilities of potential aggressors. We can no longer afford this. If the Soviets should attain a commanding lead in military technology, we might have little chance of catching up.

In recent years, we have been surprised more than once by Soviet technical achievements.

We must not underestimate the capabilities of Soviet technology. It is equally important that we do not underestimate our own capabilities. We have vast natural resources, a broad and diversified industrial base, and an immense pool of scientific talent and experience. In all of these we are far more than a match for the Soviets. We must use all these capabilities wisely, and continue to stimulate the advance of technology in operational systems.

"There are specific military requirements in space electronics. One is for reliable and secure communications systems between earth and space, and between points in space. They should be able to function during natural or man-made interference."



Air Force Strengthening Labs

The Air Force is making a maximum effort to strengthen its in-house laboratories, an important source for the initiation and evaluation of new technical efforts. Through the Research and Technology Division of the Air Force Systems Command, formed in July, 1962, the direction of Air Force applied research effort is being improved and centralized. Applied research and advanced technology programs will be compiled in seven major areas: electromagnetics, rocket propulsion, flight dynamics, aero propulsion, avionics, weapons, and materials. The laboratories working in these seven areas will be the principal Air Force points of contact with other government agencies and with industry.

The Air Force will continue to look to industry as a primary source of new ideas and proposals. The imagination, initiative, and creative efforts of American industry are vital to the direction and rate of technological progress. That technological progress, in turn, may play a determining role in our future.

Our opponents are confident they can use technology to destroy freedom and spread their system throughout the world. We must be dedicated to the use of technology to defend freedom wherever it is attacked. I am convinced that we have both the resources and the dedication to meet the challenge that confronts us.

While some designers envision a distant "ideal circuit," industry finds that it cannot wait. Custom circuits is the trend, and engineers have their choice of three approaches in microcircuit design, each with its own advantages. There are too many innovations and requirements in circuitry; the search for the "ideal" may be an endless one, and the author presents reasons why.

MICROELECTRONICS: IN SEARCH OF THE IDEAL CIRCUIT

THE WORD "MICROELECTRONICS" conjures different images to many of us associated with the electronics industry. These images are so diverse that this word, and its associated term "integrated circuits," are good words to start a controversial discussion whenever electronics people, in industry or in government, get together.

About a year ago, I pointed out that the new concepts in circuit fabrication that have stimulated this widespread interest represent not a revolution but a continuing evolution of electronic technology in its search for the ideal circuit. This ideal circuit will occupy virtually no space, cost practically nothing, and be readily available to perform a wide variety of functions with almost perfect reliability.

In the ensuing year this evolution has proceeded apace, but despite rapid gains in technical knowledge and skill in applying new techniques, the ideal circuit remains largely a vision of the future. This is not to say, however, that the effort has been in vain. Good progress has been made: microelectronic techniques are on the verge of providing the designer with a powerful tool in the further miniaturization of his circuits.

"At this time, the trend seems definitely toward custom circuits . . . the day of standardized, off-the-shelf "ideal" circuits will be a long time coming, if ever," says Bob Sprague.

Microelectronics Has Advantages

A variety of advantages are usually cited for microelectronics, and in using the term here I include both microcircuits and microcomponent assemblies. I am aware that in talking about microelectronics, some people exclude microcomponent assemblies on the ground that they do not employ "integral" processing techniques. However, there are today, and in all probability will continue to be, many applications in which microassemblies of miniaturized components in disciplined geometries offer significant advantages. It seems to me, therefore, that the frequent use of the phrase "integrated circuits" as a synonym for microelectronics is both inaccurate and misleading.

Regardless of terminology, the microelectronics field appears to be settling down into three general circuit design approaches which often appear to be competitive, but which will probably prove in the long run to be more complementary than competitive.

At this time the two major microelectronic circuits receiving industry attention are semiconductor-substrate microcircuits, and passive-substrate, thin-film hybrid circuits. The latter are called "hybrid" because they employ discrete active devices, which can not easily be made by thin-film methods in today's state of the art.

By ROBERT C. SPRAGUE
Chairman and Chief Executive Officer
Sprague Electric Company
North Adams, Mass.

Use of Discrete Components

A third approach is miniaturized discrete components in a variety of packaging schemes of which the cordwood, "swiss cheese" substrate, and the Micro-Module are the best known. Let us look briefly at these three approaches in terms of the advantages usually claimed for microelectronics—size, cost, versatility, and reliability. Each of the three design approaches excels in one or more advantages but there is no solid evidence that any one excels in all.

As to reductions in size and weight, the development of semiconductor integrated circuits has already progressed to the point where it seems safe to say that this type makes possible the smallest electronic circuits which are likely to be made by any technique in the future. As for costs, these have been coming down, which would be expected as technical competence is gained by companies, including my own, who have extensive development efforts underway on silicon-based integrated microcircuits.

Thus, there is reason to be optimistic that the cost of these devices, when produced in substantial quantities, will ultimately be competitive with circuits assembled by any other means. There is, however, one important qualification to be kept in mind. Namely, costs become favorable only after sizable initial tooling charges have been absorbed.

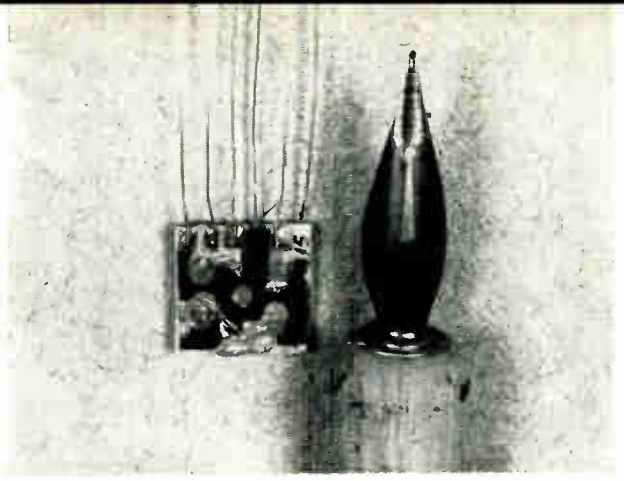
Moderate Supply—Premium Cost

Companies interested in moderate quantities of non-standard modules are now beginning to realize that a substantial premium must be paid to have their circuits transformed into semiconductor integrated circuits; quotations ranging from $5,000 for the simplest circuits up to $30,000 where moderate amounts of development work are required are not unusual.

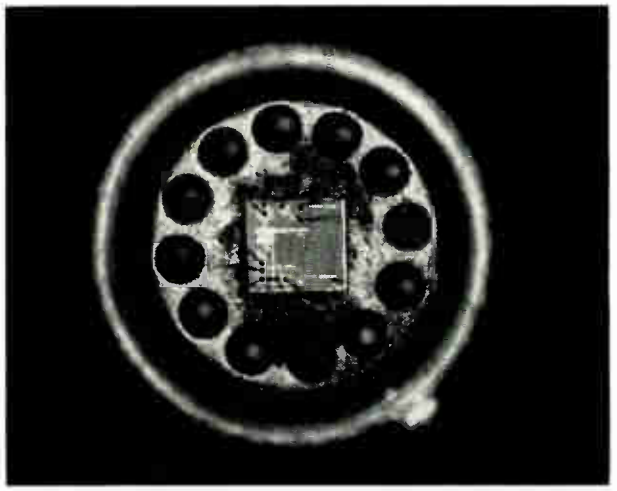
Whether these changes are absorbed by the producer or the user makes little difference. In either case, they are bound to affect the price of the circuits for any but very large quantities of identical circuits.

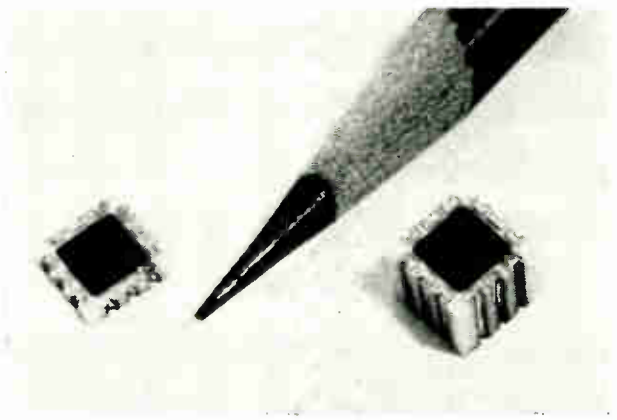
As to versatility, pure diffused semiconductor-based circuits still suffer from severe limitations on component types and tolerances. Active devices can be produced with relative ease, and diffused resistors are practical within certain limits of temperature coefficients. Large values of capacitance are very difficult to produce, and inductances virtually impossible.

For these reasons, presently available devices are suitable in the main for digital circuits. These are undoubtedly a very important class of circuit, but they can not perform all of the critical functions in

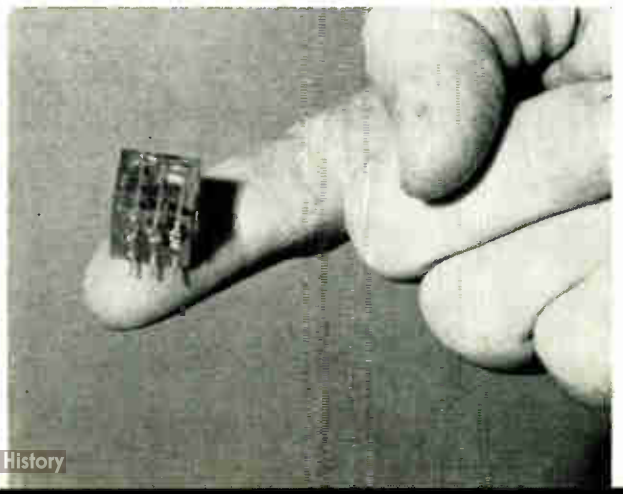


"The two major microelectronic circuits receiving attention from industry at this time are semiconductor-substrate circuits (below), passive-substrate, thin-film hybrids (above)."





"Another approach is miniature discrete components in varied packaging schemes of which the cordwood "swiss cheese" substrate (below) and micro-modules (above) are the best known."



either military or commercial electronic systems, or else can perform them only at the sacrifice of efficiency. However, thin-film components deposited on the silicon-chip surfaces promise increased versatility for diffused-base semiconductor surfaces.

Reduced Power Advantage

It is often said that in addition to size and weight reductions, semiconductor integrated circuits offer the advantage of reduced power consumption. This is a relative matter. When compared to the numerous transistorized circuits which operate in the 100-500 milliwatt power range, an integrated circuit operating at 5 milliwatts does have considerable advantage.

For some applications, however, where their small size would otherwise strongly recommend them, they are at an equally serious disadvantage. For example, digital logic circuits assembled from discrete components for NASA typically operate at a power drain of less than 1 milliwatt and some at less than 0.1 milliwatt. Thus, there is something like a 5-to-1 advantage in favor of discrete components for these critical applications.

I am told that NASA ranks size but third after reliability and power consumption in evaluating circuit techniques.

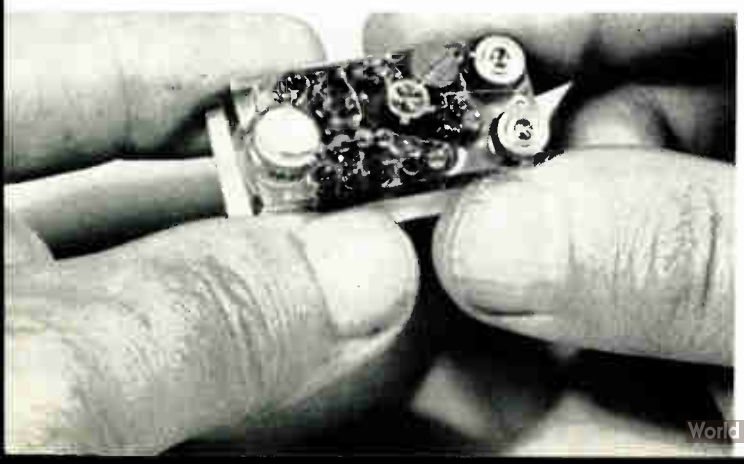
Thin-Film Hybrid Circuits

Before turning to reliability, let us look at thin-film hybrid circuits. Thin layers of metal are deposited by various means on an insulating substrate to comprise most of the passive elements of the circuit, including more precise values of resistance and larger capacitance values than are attainable with semiconductor-based circuits.

In the thin-film circuits presently being manufactured, uncased semiconductor elements are usually inlaid in recesses in the substrate. This present production inability to fabricate active elements using thin-film techniques is the only thing which prevents these devices from being true integrated circuits.

Thin-film hybrid circuits also are not capable of the extremes of size reduction possible with semiconductor microcircuits, and it appears unlikely that they will ever be entirely competitive in this respect.

Ultra-high component density semiconductor logic module has honeycomb body, inserted components, and welded connections.



Greater Design Freedom

Nevertheless, I believe thin-film circuits will play a somewhat more important role, for some years at least, than they have generally been credited with. For one thing, they allow the designer greater freedom in balancing circuit values to produce highly precise circuits, including a number in the important linear class as well as the digital class.

It also seems possible that the closer control of tolerances which they afford will enable them to more closely approximate the very low power levels for which it is possible to design circuits with conventional discrete components. As to cost, while they may not be as economical in the long run in very large quantity production, they will probably be available at a significantly lower cost for many short-run to medium-run applications, where high initial design and tooling costs work against the semiconductor microcircuit.

Although I am inclined to agree with prevalent estimates that in the long run the volume of semiconductor circuits will be considerably greater than for thin-film circuits, I nevertheless believe the latter have been underestimated by many. After all, there is no magic in the use of integrated techniques, and there seems to be an increasingly widespread recognition among users that thin-film hybrids have a great deal to offer in the proper place.

For the longer term, it seems possible, even probable, that semiconductor and thin-film circuits may be used side by side in "hybrid-hybrid" circuits which take advantage of the strong points of both.

The Question of Reliability

Turning now to reliability, the first few equipments made in substantial quantities from semiconductor-based microcircuits are yet to be built. The tens of millions of unit hours of life test to prove their reliability are yet to be clocked off. Much improvement in reliability claimed for these circuits is based on the reduction of the number of internal connections they make possible, and indeed it seems probable that this may turn out to be a major advantage.

It would be dangerous, however, to rely on this reliability until it is proved by statistically valid tests,

and there are as yet unresolved questions as to what constitutes such tests.

Reliability expectations for thin-film circuits are also good, and because they have already been in regular production for a number of years, more complete field data are available today for the less complicated of such devices than for the semiconductor microcircuits.

Thus, I believe that for the present the thin films have the edge in proven reliability. For the longer term, with more development work and extensive testing, both types will probably prove to be capable of sufficiently high reliability to meet virtually any practical requirement.

Can't Wait for Ideal Circuit

From the standpoint of versatility and proven reliability, no microcircuit can yet equal the assemblies of discrete microcomponents, including the many new form factors available today to the systems designer who can not wait for the ideal microcircuit to come along. Where extreme miniaturization is not necessary, they offer great flexibility and a much wider range of circuit values than are attainable with microelectronic circuits.

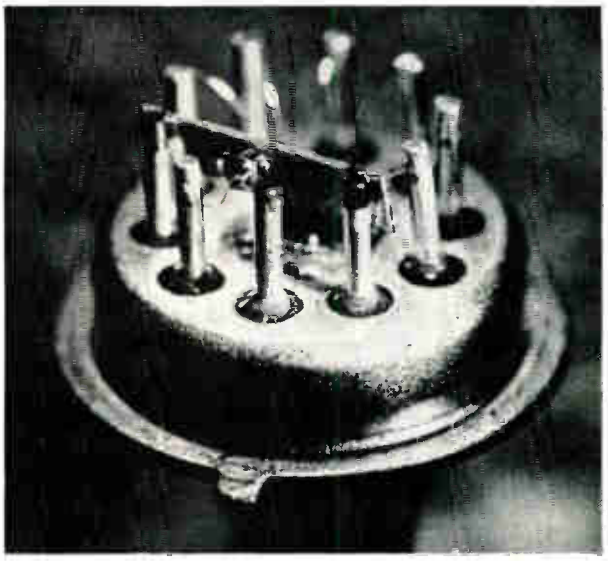
Millions of miniaturized assemblies have been in operation long enough to demonstrate that very high orders of reliability are possible with them. A trip around the recent IEEE Show revealed the wide variety of discrete components available for microassemblies. With initial tooling costs even lower than for thin-film circuits, it seems entirely possible that for many applications, especially in commercial and industrial electronics, microassemblies will continue to be used in growing volume for many years to come.

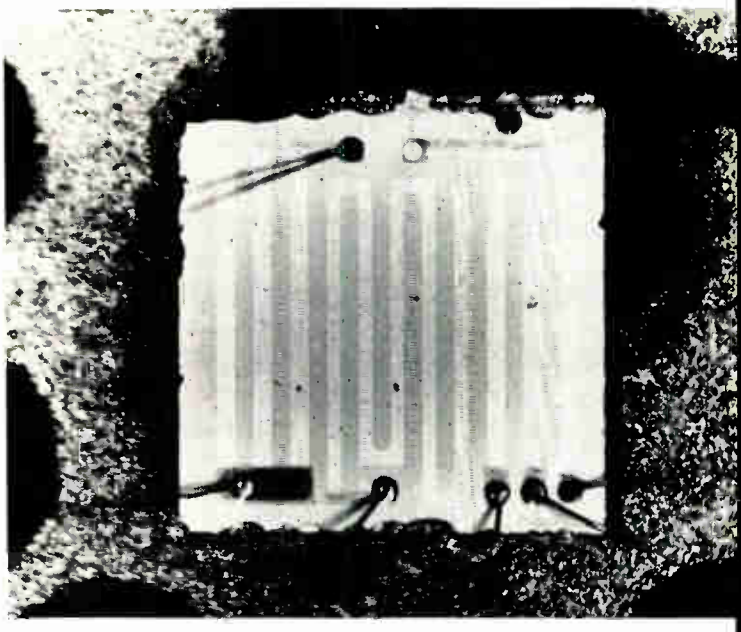
In using this approach, the designer of equipment will find that if he chooses carefully the proper components, from suppliers who have technical competence, production capability and quality integrity, that his equipment will be functioning on schedule and with impressive reliability.

Choice Up to Designer

Which of these approaches or combinations of them the designer should use in quest for the ideal circuit is up to him. The choice will surely be wide enough that he need concern himself less with the possible surrender of his prerogatives as a designer, than with the difficult task of evaluating the alternatives from the standpoint of his overall objectives of availability, cost and proven reliability.

My own company, Sprague Electric, has intensive development work underway in all three major types of microelectronic circuits, and is a major producer





Hybrid microcircuit (above) on a transistor includes silicon epitaxial planar transistor bridge-mounted on pins and silicon chip with 5 thin-film resistors fixed to header (below).

of microcomponents and assemblies, as well as of thin-film circuits. I do not pretend to know which of these approaches, or perhaps others not yet developed, will be the most widely used in the long run.

One thing which seems to be increasingly clear is that the manufacturer of electronic systems will not be content to assemble his products from a relatively small number of stock microcircuits, whether made by outside suppliers or by his own in-house facilities.

There is still too much room for circuit innovation and too much of a proprietary nature at stake for the systems designer to make such an outcome likely.

At this time, the trend seems definitely to be toward custom circuits, which is perhaps another way of saying that the day of the standardized off-the-shelf "ideal circuit" will be a long time in coming, if ever.

have been expedited by Government-financed R&D aimed at military and space objectives.

The industrial market, like the industries which serve it, covers a wide diversity of products. Computers, communications equipment, navigation aids, test equipment, and closed circuit television are perhaps the best known, there are many more. The EIA Marketing Service Department estimates that more than 2,000 companies produced a thousand different types of industrial-commercial electronic products in 1962.

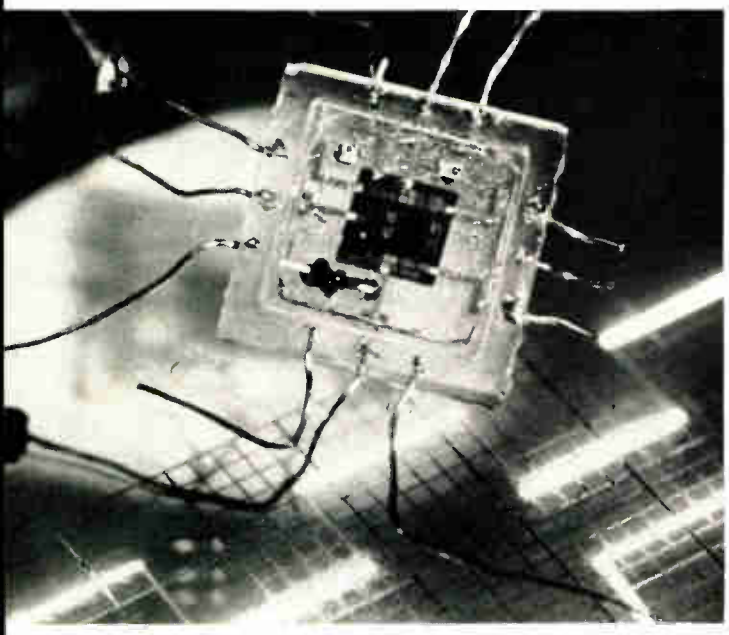
One of the chief attractions of electronic devices to industry and commerce is their promise of cost cutting and the speeding of production processes. While many electronic devices are initially very expensive, they open the way for cost-cutting automation techniques which more than offset original investment.

The electronic components industry has grown with the equipment markets, as might be expected, but it also has been forced to change as the complexity and sophistication of end products have increased. It also is the electronic area most likely to undergo even more drastic transformations.

Micro-Miniaturization One Reason

One reason for the expected changes may be found in the remarkable technological developments of micro-miniature components and integrated circuitry. By combining the functions of many standard components into one consolidated device with resulting economies in space requirements, these new components are understandingly attractive to equipment manufacturers.

"Microelectronics will make possible within a few years many consumer products once a dream of science-fiction writers."



Microelectronics, or micro-miniaturization processes will surely make possible within the next few years numerous consumer products that were once a mere glint in the eyes of science fiction story-tellers.

The EIA Marketing Services Department and the Engineering Department are both engaged in activities designed to define and standardize this new electronic component market. The former estimates that by 1965 about 10% of the dollar value of component sales will be in this category.

Many parts and semiconductor manufacturers are in microelectronic research from which a new component market may be developing. While some persons see this development as a threat to existing parts manufacturers, I believe that it rather represents a challenge which will be accepted by the more alert and resourceful component producers. It also would appear that most of today's standard components will be in demand for some years to come.

The dollar volume of electronic components in 1962 exceeded $3.5 billion and is expected to reach $3.7 billion in 1963. Transistor sales have increased in unit production but declined in dollar volume due to intense competition among the large number of producers. Total semiconductor output rose $63 million in 1962 to reach $628 million and is expected to approach $780 million in 1963.

Component Sales Increases

Receiving and picture tube sales declined in 1962, while special purpose tubes—used heavily in military and space programs—rose 14% to $325 million. All other parts sales rose about $200 million to $2.3 billion in 1962 and are expected to increase to at least $2.4 billion in 1963.

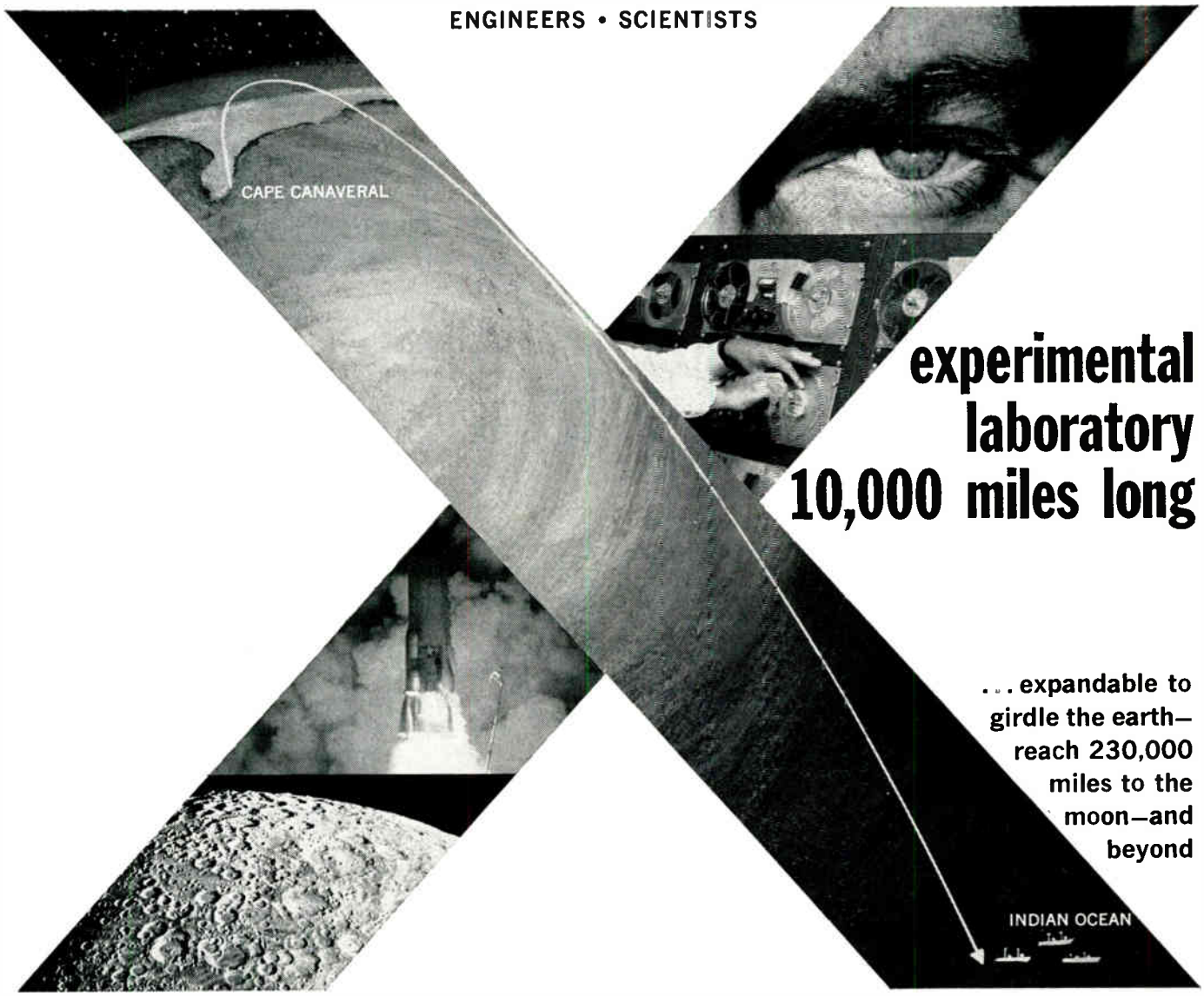
With so many encouraging sales reports, it would appear that the electronic industries have few problems and need have no apprehension about their future.

Unfortunately, this is not true.

While I have no doubts as to the economic soundness of the electronic industries and their prospects for continuing growth, I am concerned over the following: (1) declining profits and increasing costs, particularly in Government business; and (2) increasing competition of imports, especially from Japan, and their effect on the consumer industry.

The EIA, by providing a national forum for these industries, offers a mechanism for solving some of these problems by means of a united attack on them. It must be admitted, however, that the Government probably holds the trump card. (*Continued on* B18)

ENGINEERS • SCIENTISTS



experimental laboratory 10,000 miles long

. . . expandable to girdle the earth—reach 230,000 miles to the moon—and beyond

ENGINEERS and SCIENTISTS LOOKING FOR "BIG-SYSTEM" CHALLENGES will find them with PAN AM at the Atlantic Missile Range.

This is the giant laboratory where the nation's major missile systems and space vehicles come for their crucial flight tests, research, and development, under a true operating environment. It's more than hemisphere long, for ballistic missiles. Linked with other national ranges, it provides orbital coverage and impact location, as in recent Mercury launches. Right now, Advanced Planning Groups are working to raise its capabilities to encompass recording all relevant data from lunar flights, including voice communications. Already solutions for problems of data acquisition from the interplanetary missions of the 70's are under study. ☐ Taken all together—this is a task of great magnitude in which PAN AM's Guided Missiles Range Division is by no means alone. In carrying out the triple responsibilities assigned the Division by the USAF for range planning, engineering, and operation, PAN AM cooperates with many segments of American industry:

- **GMRD,** by designing individual range instrumentation systems to match the requirements of each new program, collaborates with Range Users, who create the new vehicles and spacecraft.
- **GMRD** works closely with the radar, telemetry, computer and communication industries providing specifications and technical direction for the development of new equipment.
- **GMRD** and its subcontractors operate and service the tracking and other electronic equipment of the range.

In addition, PAN AM provides launch and operations support at Cape Canaveral and Down Range.

IF YOU ARE INTERESTED IN CONTRIBUTING TO THE NEW RANGE TECHNOLOGY, INQUIRE ABOUT THE FOLLOWING POSITIONS:

Systems Engineers & Program Managers, EE, Physicists with specialized knowledge in any major area of range instrumentation
Instrumentation Planning Engineers, EE, Physicists with specialized knowledge in advanced instrumentation systems
Technical Staff & Advance Planning Groups MS, PhD—Physics • Electronics • Mathematics • Celestial Mechanics • Astronomy

Why not write us today, describing your interests and qualifications in any of the areas above. Address Dr. Charles Carroll, Dept. 32-F, Pan American World Airways, Incorporated, P.O. Box 4465, Patrick Air Force Base, Florida.

*Carrying on Range Planning, Engineering and Operation of Atlantic Missile Range for the USAF since 1953.

An equal opportunity employer.

PAN AM

GUIDED MISSILES RANGE DIVISION

PATRICK AIR FORCE BASE, FLORIDA

"Defense Department will concentrate on building up capacity for limited war. Program needs rely heavily on electronics."

Gov't Relies on Industries

The Government's progress in the space race, as well as maintenance of its dominant position in national defense, is dependent on the ability of the industries.

The electronic industries have a creditable record in meeting U. S. requirements and hope to continue. But they will be severely handicapped if they can't make reasonable profits for stockholders and capitalize on their technical ingenuity. No one will gain if the Government supplier is denied free enterprise benefits.

The extent of foreign competition in the domestic electronic market also is a problem. The electronic industries, especially component manufacturers, are learning to meet this competition in some cases by concentrating on technical advances. But American manufacturers often find themselves on a treadmill—running just to stay where they are in the domestic market.

EIA has never followed a "protectionist" policy in international trade. In fact, the electronic industries benefit from increasing exports and hope to make further gains from contemplated negotiations under the Trade Expansion Act.

Exports May Hit $975 Million

The Department of Commerce has reported that the total value of U. S. exports of electronic systems, equipment, and components may reach $975 million in 1963 compared with $765 million in 1962 and $613 million in 1961. However, it candidly admits that "imports of these products are rising even faster: $179 million in 1961, $275 million in 1962, and an estimated $340 million in 1963."

"It is universally conceded that the industrial commercial markets offer the greatest growth potential for electronics."

A factor that Congress and the Executive Establishments should not overlook in their comparisons of exports and imports is that the larger diversified company usually benefits most from exports and suffers least from imports, while the smaller manufacturer is the first victim of the invading importer because of his inability to shift his marketing emphasis. This effect would seem to run contrary to the American pattern under which the smallest business organization has an opportunity to become larger.

Yet, despite these and other problems, the electronic industries are firmly established in the national economy and will continue to grow with it if not ahead of it. These markets—both civilian and Government—are certain to grow as new uses for electronic techniques develop.

The contributions of the electronic industries to national defense are widely recognized. Their increasingly important role in space exploration is becoming more apparent as the nation's program expands.

Electronic engineers, manufacturers and workers will all help to put our astronauts on the moon and other points in outer space. And yet, many examples of new products and industrial processes—spin-off benefits—for the consumer market can be traced directly to some part of our massive aerospace and defense effort.

The time may not be too far distant when electronic technology will perform many current jobs. Electronic developments could range from devices that would design and build other electronic devices—such as computers and picture-frame TV sets—to the simple task of shopping for groceries through community-wide automation.

The greatest days of the electronic industries are still ahead.

BUCHANAN CYCLE-CONTROLLED CRIMPING TOOLS

HAND • AUTOMATIC FEED • MANUAL FEED

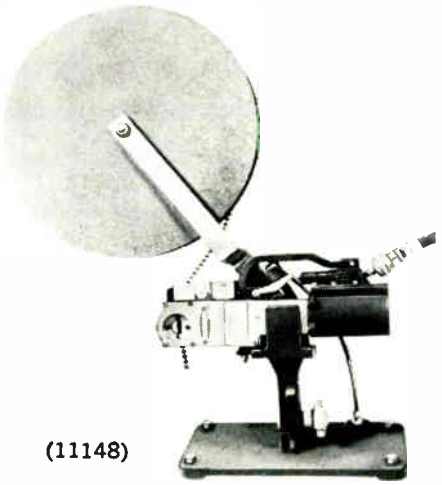
No matter what your production volume or specialized application is, one cycle-controlled Buchanan tool will handle almost any electrical connector contact size — MS or proprietary contacts. The MS 3191-A cycle-controlled hand tool is ideal for low volume production, the manual feed for medium size runs, and the automatic feed for high volume production runs. There are no operator adjustments — ever! Buchanan tools are available for electrical, electronic and mechanical applications to meet various military specs . . .

(MS 3191-A)

CYCLE-CONTROLLED HAND TOOL

This one tool and inexpensive positioners can crimp almost any proprietary or MIL-Spec contact — in wire sizes from #12 thru #30. By selecting the positioner, you program the tool to provide crimp depth, crimp location, and point of ratchet release. **And there are no operator adjustments.** Meets all requirements of MIL-T-22520A, Class I.

Write today for catalog and the new manual on crimping pin and socket connectors.



(11148)

CYCLE-CONTROLLED AUTOMATIC FEED TOOL
Portable or Bench Mounted

The speed of this automatic feed tool is limited only by the operator's ability to insert contacts and wires. There are **no operator adjustments.** Tool automatically feeds contacts in disposable, inexpensive carriers. Carriers can be modified to accommodate almost any contact size thru #30 (also protect contacts from mechanical damage). Tool meets performance requirements of MIL-T-22520A.

In bench mounted units (shown above) carriers in reel hold up to 2000 contacts. Crimp depth is automatically controlled by interchangeable snap-in blocks. Tool accommodates foot valve control.

This tool can be used for portable application. Carriers in self-positioning "see-thru" magazine hold up to 102 contacts. The magazine automatically selects the proper crimp depth.

(10967)

CYCLE-CONTROLLED MANUAL FEED TOOL

This pneumatic tool and associated types can accommodate most contacts #12 thru #30, screw machine and stamped. Crimp depth can be adjusted by qualified personnel for a specific job. Speed is limited only by operator's ability to operate contacts and wires. Replaceable inexpensive contact locator properly positions crimp on contacts and can be drilled to accommodate specific contact sizes and types. Indenter configuration conforms to MS-3191 Geometry. Meets performance requirements of MIL-T-22520A.

BUCHANAN
ELECTRICAL PRODUCTS CORPORATION

a subsidiary of Elastic Stop Nut Corporation of America
HILLSIDE, NEW JERSEY (201) WA 3-7474

NEW TECH DATA

for Engineers.

Portable Standards

"Weston Portable Standards," a 12-page brochure which describes in detail a line of light-beam portable wattmeter, ammeter and voltmeter standards, is available. Complete specs., photos, schematics, cross-section views, etc., are provided. Specs. include accuracies and ranges of the various instrument models and descriptions of accessories which are available for special measurement requirements. Weston Instruments and Electronics Div., Daystrom, Inc., 614 Frelinghuysen Ave., Newark 14, N. J.

Circle 609 on Inquiry Card

Differential Pressure Cell

Bulletin PD-4381 gives data on Type MM differential pressure cell for aerospace wind-tunnel research. Cell is a low-capacity, low-line, bellows unit to measure static and low-freq. differential, absolute or gauge pressures of gases. Bulletin illustrates unit, including a dimensional drawing, describes features, specs., dynamic characteristics and prices for available capacities from 5 through 100psi. Electronics Div., Baldwin-Lima-Hamilton Corp., 42 4th Ave., Waltham 54, Mass.

Circle 610 on Inquiry Card

Program Timers

Cramer types 511 and 521 field-adjustable program timers are described in a new bulletin. Complete specs., operating description and schematics are included in the bulletin, describing the units, which are designed to control a series of operations in any desired sequence. Bulletin No. 511/521. Publications Dept., Cramer Div., Giannini Controls Corp., Old Saybrook, Conn.

Circle 611 on Inquiry Card

P-Channel Transistor

The 2N2386 P-channel planar-diffused unipolar field-effect transistor is contained in a TO-5 package. Designed for low-cost industrial uses, it offers 1000μmho min. g_m and a typical pinch-off voltage of 4v. Applications include high-impedance voltmeters, operational amplifiers, sample and hold circuits, choppers, commutators, and other circuits requiring high-input impedance devices. Siliconix Inc., 1140 W. Evelyn Ave., Sunnyvale, Calif.

Circle 612 on Inquiry Card

Pulse Height Analyzer

Tech. data is available on the 400-channel transistorized Model ST-400K pulse height analyzer. The Model ST-400K is tailored to fit restricted budget needs yet retain all the features needed for research uses. Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Circle 613 on Inquiry Card

Magnetic Field Regulator

Brochure describes new laboratory magnet systems featuring Fieldial® magnetic field regulator. With direct readout feature, any desired field intensity can be set and maintained in a magnet air gap without the need for more measuring equipment. Included are charts of tests made to show the improved sweep linearity of field-regulated magnet systems compared with ordinary current-regulated systems. Condensed product specs. are also included. Instrument Div., Varian Associates, 611 Hansen Way, Palo Alto 5, Calif.

Circle 614 on Inquiry Card

Geophysical Instruments

Revised catalog on geophysical instruments describes, illustrates latest test gear in the line. Details are given on sensitive, rugged battery-operated ac microvoltmeters for resistivity surveys with base lines up to 5 miles long. All weather, battery-operated dc potentiometers without standard cells or suspension galvanometers are also shown. A complete line of accessories, including stakes, electrodes, and wire reels is described. Canadian Research Institute, 85 Curlew Dr., Don Mills, Ont., Canada.

Circle 615 on Inquiry Card

Zener Diode Chart

A third edition of the zener reference publication which lists all types presently registered under EIA numbers is available. The publication lists specs., package dimensions and other pertinent information for all zener diode types. Request on company letterhead to Dickson Electronics Corp., 248 So. Wells Fargo, Scottsdale, Ariz.

Integrated Circuits

The 8-page 2-color Condensed Catalog gives specs. of 26 Signetics integrated circuits 14 of them new. Also described are DTL elements; NAND/NOR gates, diodes and gates, power gates, binary elements, line drivers, 1-shot multivibrator, and several buffer circuits. Catalog has articles on Signetics' quality control and R&D programs. Signetics Corp., 680 W. Maude Ave., Sunnyvale, Calif.

Circle 617 on Inquiry Card

Test Instruments

This 97-page catalog lists a line of sweeping oscillators, audio spectrum analyzers, noise generators, attenuators, oscillators, etc. Accompanying each component is a photo, description, specs., and price. Kay Electronic Co., Maple Ave., Pine Brook, Morris County, N. J.

Circle 618 on Inquiry Card

Deep-Sea Testing

Comprehensive illustrated 20-page brochure describes the facilities and capabilities of Daystrom's Electric Div. in the development of deep-sea oceanographic instrumentation and in anti-submarine warfare work. Brochure describes the extensive background of Daystrom in research, oceanography, ASW, circuit techniques, component design, ordnance components, and electro-mechanical and mechanical systems. Many ordnance items are shown. Electric Div., Daystrom, Inc., Manchester Rd., Poughkeepsie, N. Y.

Circle 619 on Inquiry Card

Transistor Guide

How to choose the best field-effect transistors for ac amplifiers is the theme of this bulletin. Included in this comprehensive article are schematics and equations that will help solve many problems encountered in amplifier design. Siliconix Inc., 1140 W. Evelyn Ave., Sunnyvale, Calif.

Circle 620 on Inquiry Card

Transistorized Readouts

Two data sheets (270 and 292) describe 12 models of the Tec-Lite TNR Series transistorized readouts. They are designed to control Nixie tube numeral displays from signals down to 2v. Self-contained driver circuitry is packaged behind rectangular Nixie tube and allows mounting on 1 in. centers. Both sheets contain outline drawings, panel mounting hole dimensions and electrical and terminal connection diagrams. Applicable military and environmental data is also included. Tec-Lite Dept., Transistor Electronics Corp., Box 6191, Minneapolis 24, Minn.

Circle 621 on Inquiry Card

Ceramic Capacitors

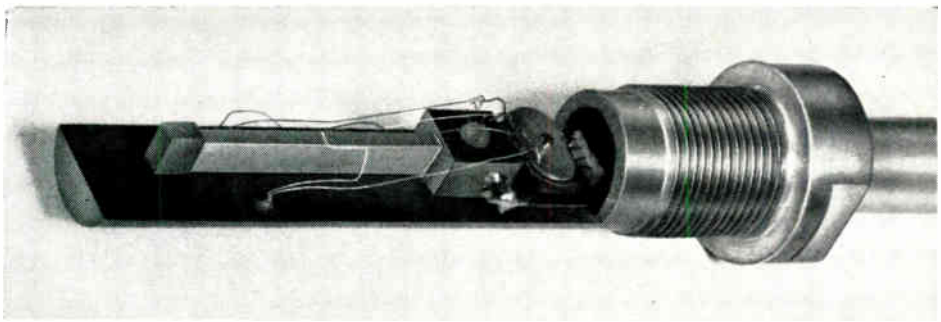
Data available on capacitors includes 36-page catalog on new fixed, ceramic dielectric dc capacitors, 47-page catalog on fixed, porcelain dielectric capacitors, separate photos of them, "Reliability Calculator," a facilities brochure and other information on the manufacturing firm. Vitramon, Inc., P.O. Box 544, Bridgeport, Conn.

Circle 622 on Inquiry Card

Flame Detectors

A 12-page illustrated brochure, "Capabilities for Defense and Industry" is available from Pyrotector, Inc., Hingham, Mass. Brochure gives information on optical flame and smoke detectors for the aerospace industry, on commercial and industrial products, including home and industrial smoke detectors, battery chargers, emergency lights and marker beacons. It describes the concept of "putting light to work."

Circle 623 on Inquiry Card



An elegant, but tiny refrigerator, utilizing the Nernst-Ettingshausen effect, has been demonstrated in the Solid State Physics Laboratories at Lockheed Missiles & Space Company. This type of cooling is applicable below 200° Kelvin, where thermoelectric cooling is no longer efficient. It shows particular promise for space application because of the reliability inherent in its all-solid state construction.

In the Nernst-Ettingshausen effect, heat is pumped as a result of an electrical current flowing in a magnetic field. The heart of the present device is a bismuth antimony single crystal. Other crystal systems are also being investigated.

This thermomagnetic cooling device is one of the results of the Lockheed research program in transport phenomena in solids.

Another investigation concerns the quantum theory of the electronic structure of crystals. An ingenious computer program has been devised for determining the essential features of the energy band structure of a wide variety of crystals. Results for a given case can be obtained in an hour or less. Conclusions drawn from the theoretical solution elucidate many of the electronic properties of crystals, and have widespread significance.

Lockheed scientists and engineers are also studying: Electron spin echo phenomena; the interaction of electrons with microwave phonons; coupled traveling waves in crystals; semiconductor lasers; antiserromagnetic resonance; various theoretical and experimental aspects of superconductivity.

LOOK AT LOCKHEED...AS A CAREER

Consider Lockheed's leadership in space technology. Evaluate its accomplishments —such as the Polaris missile, the Agena vehicle's superb record of space missions. Examine its outstanding advantages—location, advancement policies, creative climate, opportunity for recognition.

Then write for a brochure that gives you a more complete Look at Lockheed. Address: Research & Development Staff, Dept. M-45C, P.O. Box 504, Sunnyvale, California. Lockheed is an equal opportunity employer.

SCIENTISTS & ENGINEERS: In addition to solid state physicists and chemists, other important openings exist for specialists in: Inertial guidance • Orbit thermodynamics • Electromagnetics • Mission & trajectory analysis • Gas dynamics • Chemical & nuclear propulsion • Systems engineering • Computer research

LOCKHEED

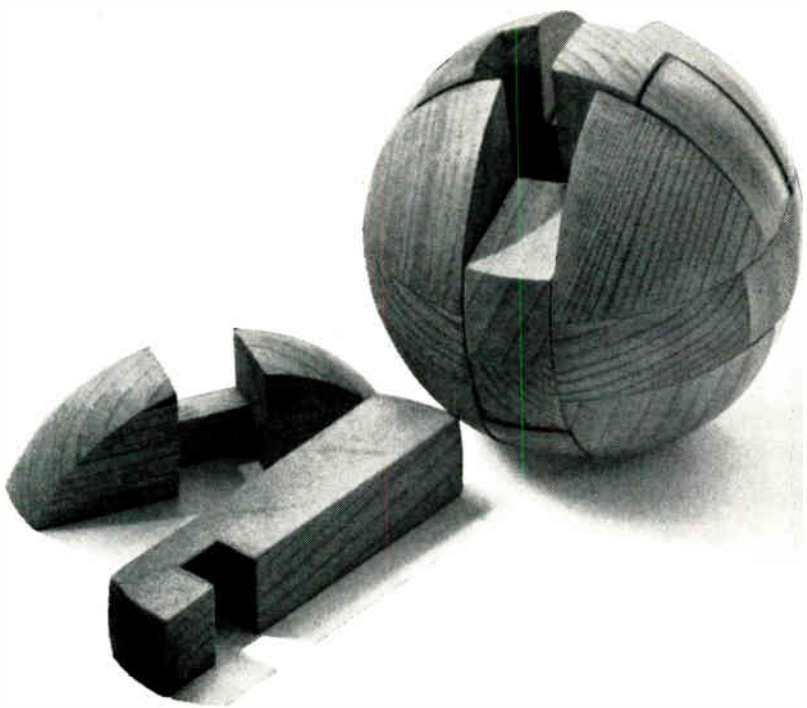
MISSILES & SPACE COMPANY

A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION

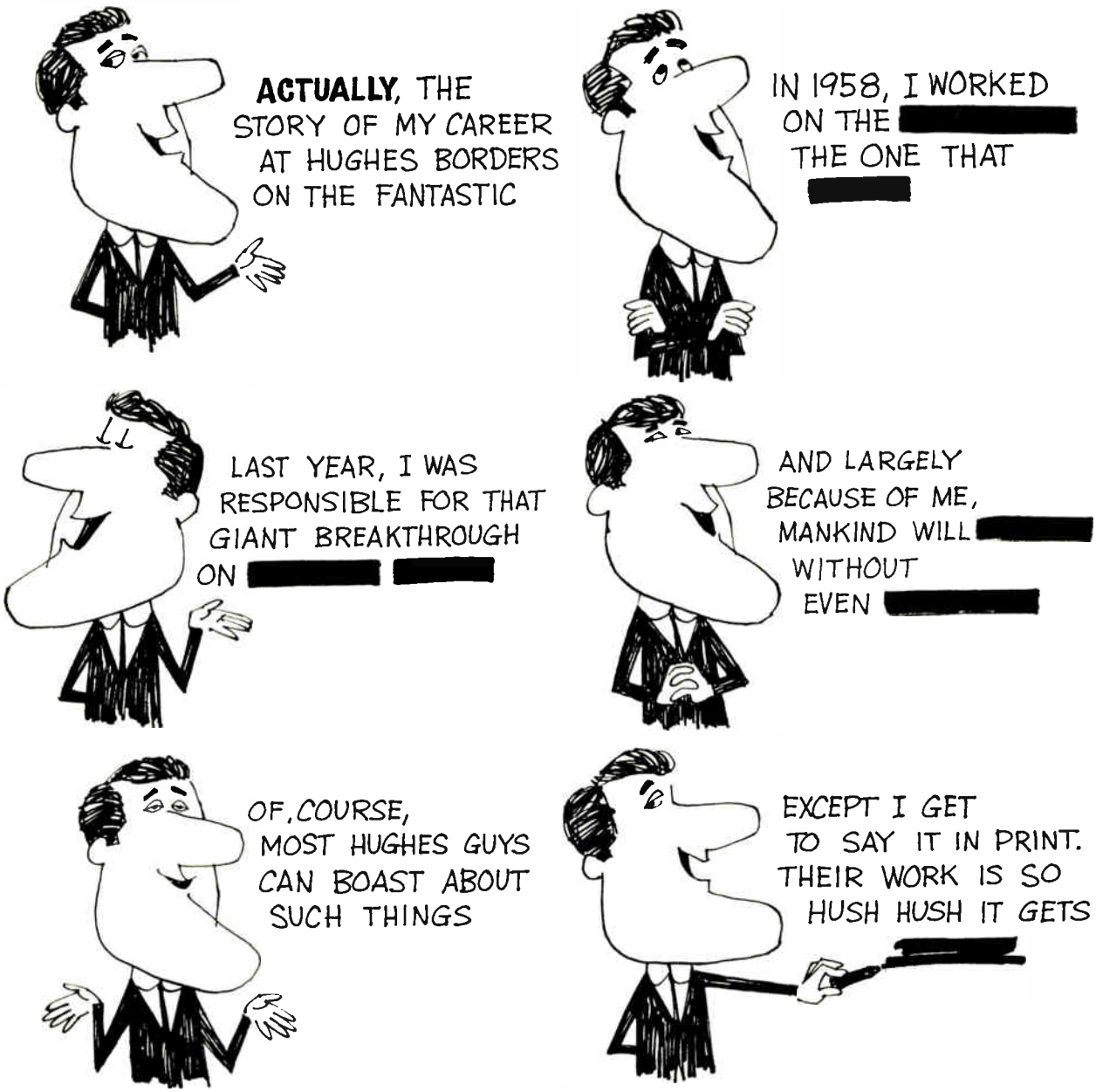
Sunnyvale, Palo Alto, Van Nuys, Santa Cruz, Santa Maria, California • Cape Canaveral, Florida • Huntsville, Alabama • Hawaii

LOOK AT LOCKHEED IN SOLID STATE PHYSICS:

Basic and applied research on the properties of solids



THE CLASSIFIED ENGINEER



You work on more of the [redacted] jobs at Hughes! Plus a great many projects we can mention. Like **F-111B** PHOENIX Missile System, **MMRBM** Integration, Assembly & Checkout, **TOW** Anti-Tank Missile, **SURVEYOR** Lunar Landing Vehicle, **SYNCOM** Synchronous-Orbit Communications Satellite, **ARPAT, VATE** Automatic Test Equipment, Advanced **POLARIS** Guidance, Advanced **ICBM** Defense Systems ...and many others. Positions are open for specialists with professional experience, degrees from accredited universities and U.S. citizenship.

CONTROLS ENGINEERS. Concerns airborne computers and other controls—related areas for: missiles and space vehicles, satellites, radar tracking, control circuitry, control systems, control techniques, transistorized equalization networks and control servomechanisms.

FIRE CONTROL ENGINEERS. Determine systems requirements for manned airborne electronic systems and supporting ground equipment to carry out necessary technical direction to assure system integrity. Responsibilities include logical design, signal flow designs and circuit interface requirements between portions of the systems.

CIRCUIT DESIGNERS. Involves analysis and synthesis of systems for: telemetering and command circuits for space vehicles, high efficiency power supplies for airborne and space electronic systems, space command, space television, guidance and control systems, and many others.

MISSILE ENGINEERS. Determine functional design requirements for advanced air-launched missiles; the design of such systems to meet customer requirements and theoretical analysis of system performance; coordinate and assist engineering departments in the development of equipment to fulfill the system requirements.

For immediate consideration please airmail your resume to:

Mr. Robert A. Martin
Head of Employment
Hughes Aerospace Divisions
11940 W. Jefferson Blvd.
Culver City 55, California

Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY
AEROSPACE DIVISIONS

An equal opportunity employer.

Circle 9 on Inquiry Card →

ARE YOU KEEPING INFORMED ABOUT THE LATEST DEVELOPMENTS IN SEMICONDUCTOR PRODUCTS AND TECHNOLOGY?

To help you do so, General Instrument makes this new *R.S.V.P.* postcard service available. Simply designate those products about which you would want the very latest information. Mail the postcard and data will be sent to you posthaste.

GENERAL INSTRUMENT CORPORATION
Semiconductor Products Group

65 Gouverneur Street
Newark 4, New Jersey

EASTERN AREA HEADQUARTERS
256 Passaic Street
Newark 4, New Jersey
Code 201 — HU 5-0072

CENTRAL AREA HEADQUARTERS
5232 West Diversey Avenue
Chicago 39, Illinois
Code 312 — AV 2-6700

WESTERN AREA HEADQUARTERS
3030 Temple Street
Los Angeles 26, California
Code 213 — DU 5-5371

Represented in Europe by:
Bay & C.S.p.A.
Centro Pirelli
Via Fabio Filzi 24
Milano, Italy

Bay & Co. (U.K.) Ltd.
c/o Pirelli House
343/5 Euston Road
London, N.W. 1, England

General Instrument France
3 Rue Scribe
Paris 9e, France

1

R.S.V.P. Please send me the latest data on the following:

- ☐ Silicon Transistors
- ☐ Microcircuits
- ☐ Darlington Amplifiers
- ☐ Differential Amplifiers
- ☐ Video Amplifiers
- ☐ Choppers
- ☐ High Voltage Nixie Transistors
- ☐ Microdiodes
- ☐ Germanium Transistors
- ☐ Silicon Rectifiers
- ☐ Silicon Controlled Rectifiers
- ☐ Controlled Avalanche Rectifiers
- ☐ Selenium Rectifiers & Stacks
- ☐ Zener Diodes & Regulators
- ☐ Silicon Diodes
- ☐ Germanium Diodes
- ☐ Precision Wire Wound Resistors
- ☐ "CAP-SIL®" Voltage Variable Diodes
- ☐ UHF Mixer Diodes
- ☐ High Power Diodes
- ☐ Encapsulated Assemblies
- ☐ Special Products
- ☐ Other_____

NAME _____

COMPANY _____

TITLE _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

2

R.S.V.P. Please send me the latest data on the following:

- ☐ Silicon Transistors
- ☐ Microcircuits
- ☐ Darlington Amplifiers
- ☐ Differential Amplifiers
- ☐ Video Amplifiers
- ☐ Choppers
- ☐ High Voltage Nixie Transistors
- ☐ Microdiodes
- ☐ Germanium Transistors
- ☐ Silicon Rectifiers
- ☐ Silicon Controlled Rectifiers
- ☐ Controlled Avalanche Rectifiers
- ☐ Selenium Rectifiers & Stacks
- ☐ Zener Diodes & Regulators
- ☐ Silicon Diodes
- ☐ Germanium Diodes
- ☐ Precision Wire Wound Resistors
- ☐ "CAP-SIL®" Voltage Variable Diodes
- ☐ UHF Mixer Diodes
- ☐ High Power Diodes
- ☐ Encapsulated Assemblies
- ☐ Special Products
- ☐ Other_____

NAME _____

COMPANY _____

TITLE _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

3

R.S.V.P. Please send me the latest data on the following:

- ☐ Silicon Transistors
- ☐ Microcircuits
- ☐ Darlington Amplifiers
- ☐ Differential Amplifiers
- ☐ Video Amplifiers
- ☐ Choppers
- ☐ High Voltage Nixie Transistors
- ☐ Microdiodes
- ☐ Germanium Transistors
- ☐ Silicon Rectifiers
- ☐ Silicon Controlled Rectifiers
- ☐ Controlled Avalanche Rectifiers
- ☐ Selenium Rectifiers & Stacks
- ☐ Zener Diodes & Regulators
- ☐ Silicon Diodes
- ☐ Germanium Diodes
- ☐ Precision Wire Wound Resistors
- ☐ "CAP-SIL®" Voltage Variable Diodes
- ☐ UHF Mixer Diodes
- ☐ High Power Diodes
- ☐ Encapsulated Assemblies
- ☐ Special Products
- ☐ Other_____

NAME _____

COMPANY _____

TITLE _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

First Class
Permit No. 6114
SECTION 34.9 P. L. & R.
Newark 4, N. J.

BUSINESS REPLY CARD

NO POSTAGE NECESSARY IF MAILED IN THE U. S. A.

GENERAL INSTRUMENT CORPORATION
Semiconductor Products Group
65 Gouverneur Street
Newark 4, New Jersey

First Class
Permit No. 6114
SECTION 34.9 P. L. & R.
Newark 4, N. J.

BUSINESS REPLY CARD
NO POSTAGE NECESSARY IF MAILED IN THE U. S. A.

GENERAL INSTRUMENT CORPORATION
Semiconductor Products Group
65 Gouverneur Street
Newark 4, New Jersey

First Class
Permit No. 6114
SECTION 34.9 P. L. & R.
Newark 4, N. J.

BUSINESS REPLY CARD
NO POSTAGE NECESSARY IF MAILED IN THE U. S. A.

GENERAL INSTRUMENT CORPORATION
Semiconductor Products Group
65 Gouverneur Street
Newark 4, New Jersey

DISTRIBUTORS

ALABAMA—BIRMINGHAM
M. G. Electronics
ARIZONA—PHOENIX
Astronics, Inc.
CALIFORNIA—NORTHERN
PALO ALTO— Zack Electronics
SAN FRANCISCO—
Fortune Electronics Corp.
CALIFORNIA—SOUTHERN
BURBANK—
Valley Electronic Supply Co.
HOLLYWOOD—
Hollywood Radio & Electronics, Inc.
INGLEWOOD— Liberty Electronics Corp.
LOS ANGELES— Fortune of Los Angeles
SAN DIEGO— Radio Parts Company
COLORADO—DENVER
Fortune Electronics of Denver
CONNECTICUT—STAMFORD
Sun Radio & Electronics Co., Inc.
FLORIDA
MELBOURNE–Electronic Wholesalers, Inc.
MIAMI— Electronic Wholesalers, Inc.
GEORGIA—ATLANTA
Southeastern Radio Parts Company
ILLINOIS—CHICAGO
Newark Electronics Corp.
Solid State Electronics
INDIANA—INDIANAPOLIS
Graham Electronic Supply, Inc.
IOWA—CEDAR RAPIDS
Iowa Radio Supply Co., Inc.
LOUISIANA—NEW ORLEANS
Southern Radio Supply Co.
MARYLAND—WASHINGTON, D. C.
BALTIMORE—
Radio Electric Service Co.
of Baltimore, Inc.
BETHESDA—
Empire Electronics Supply Co.
HYATTSVILLE—
Milgray Washington, Inc.
MASSACHUSETTS
CAMBRIDGE—
R&D Electronic Supply Co., Inc.
NEWTON— The Greene-Shaw Company
MICHIGAN—BATTLE CREEK
Electronic Supply Corp.
MINNESOTA—ST. PAUL
Gopher Electronics
MISSOURI
KANSAS CITY—
Walters Radio Supply Co., Inc.
UNIVERSITY CITY—
Olive Industrial Electronics, Inc.
NEW JERSEY—PRINCETON
Sun Radio & Electronics Co., Inc.
NEW MEXICO—ALBUQUERQUE
Electronic Parts Co., Inc.
NEW YORK (METROPOLITAN AREA)
Milgray Electronics, Inc.
Sun Radio & Electronics Co., Inc.
Terminal-Hudson Electronics, Inc.
NEW YORK STATE
BINGHAMTON—
Stack Industries, Inc.
BUFFALO— Summit Distributors
OHIO
CINCINNATI—
The Mytronic Company
CLEVELAND—
Mainline Cleveland, Inc.
OKLAHOMA
OKLAHOMA CITY—
Trice Wholesalers
TULSA— Radio, Inc.
PENNSYLVANIA—S. JERSEY
PHILADELPHIA—
Herbach & Rademan
TENNESSEE
KNOXVILLE—
McClung Appliances
NASHVILLE—
Electra Distributing Co.
TEXAS
DALLAS—
Adleta Company
FORT WORTH—
Scooter's Radio Supply Co.
HOUSTON—
Busacker Electronic Equipment Co., Inc.
UTAH—SALT LAKE CITY
S. R. Ross, Inc.
VIRGINIA
CHARLOTTESVILLE—
Virginia Radio Supply Co., Inc.
NORFOLK—
Priest Electronics, Inc.
WASHINGTON—OREGON
SEATTLE—
F. B. Connelly Co.
Seattle Radio Supply, Inc.
WISCONSIN—MILWAUKEE
Electronic Expeditors, Inc.

SECTION C

SEMICONDUCTORS & TUBES

Part One—Semiconductors

Not since the introduction of transistors has the industry experienced an impact like that caused by integrated circuits. Although a relatively new art, integrated circuits have made startling advances in circuit miniaturization, and promise even greater advances in the future.

THE FUTURE OF INTEGRATED CIRCUITS

IN ABOUT TWELVE YEARS, a revolutionary, brashly vigorous, new solid-state electronics technology has been developed. Only a few years ago the great transition from vacuum-tube circuitry to transistor circuitry was begun; and now, before we have fully digested the new approaches offered by transistors, electronic ceramics, and the other solid-state devices and materials, we find ourselves faced with additional changes wrought by the future widespread use of integrated circuits. Integrated circuits which use materials in *inseparable* association (as contrasted to interconnected components) form a radical departure from former fabrication techniques. This is a change from component orientation to materials orientation.

Coordination

Heretofore, the circuit engineer's concern with materials was secondary. By blending theory and experience, they developed circuit configurations of interconnected components to perform the needed functions. Although a number of disciplines were involved in component preparation, they were developed independently by specialists who were not concerned with the daily problems of each circuit designer. Now, with integrated circuits, there is a coordination and synthesis problem. For each circuit we must include circuit theory, mathematics, physics, metallurgy, chemistry, electronics, semiconductor processing, thin-film processing, and photography. The successful development of integrated circuits requires a high level of intensely coordinated, sophisticated engineering; but much work must be done before the necessary levels of experience and maturity are reached. Although progress has been made in the fabrication of digital-logic integrated circuits, only a few of the estimated thirty functions performed in modern airborne electronic equipment subsystems can be done with mature, integrated-circuit modules. Although the use of integrated circuits will help support a continuing rise of electronic-systems complexity without approaching unacceptable reliability limits, the sensational claims (however understandable) associated with the introduction of integrated circuits have exceeded the performance and the production-and-price availability of useful integrated-circuit components. These poorly timed claims are a natural result of the infection of marketing managers by enthusiastic engineers who have limited equipment experience. Eventually disciplined engineering approaches will fulfill the optimism and the amplification factor of the marketing managers. Digital-circuit logic components are rapidly approaching expectations.

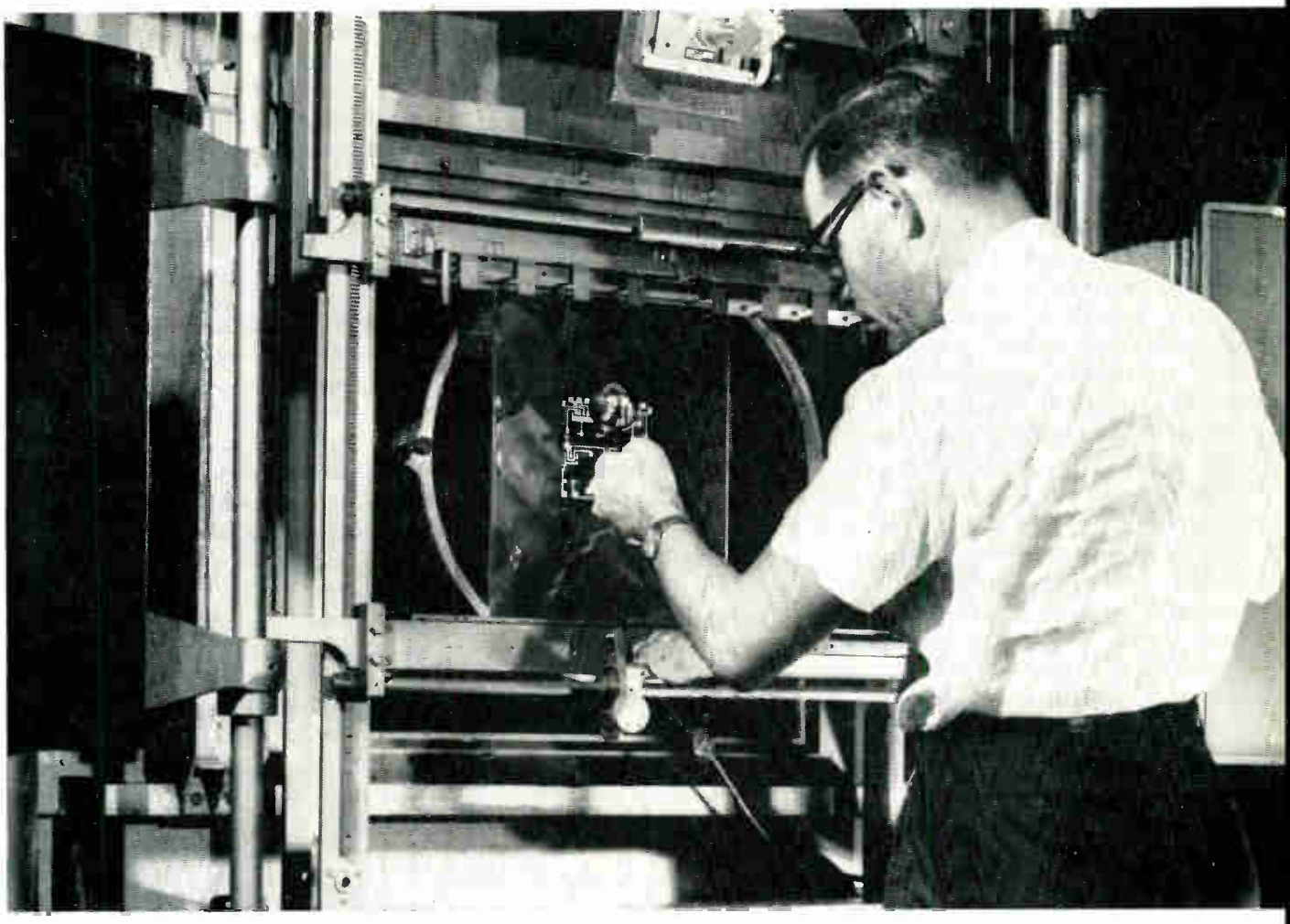
There are three major steps which must be taken before we graduate from the highly promising but still experimental pattern of integrated-circuit technology.

1. Integrated-circuit engineers must develop methods of eliminating, controlling, or compensating for the stray couplings which are frustratingly "integrated" in integrated circuits. These couplings are far more difficult to control than those associated with component circuitry.

2. There must be an effective merger of the skills of the experienced equipment engineers with those of semiconductor and integrated-circuit specialists. Operating integrated circuits have been produced under ideal laboratory conditions, but design maturity, which must include means for controlling reproducibility, circuit-element parameters, and environmental performance within acceptable specifications limits,

By DANIEL E. NOBLE

Executive Vice President
in Charge of Communications,
Semiconductor, Solid State
and Military Electronics Division,
Motorola, Inc.
5005 E. McDowell Ave.
Phoenix 8, Ariz.



Fabrication is an important step in the manufacture of an integrated circuit. Here, a photomasking technique is inspected.

will be accomplished only when the integrated-circuit engineers and equipment systems specialists understand each others problems. Thus an exchange of ideas between the two groups is essential to progress.

3. Processing techniques must be developed that would allow fast circuit-parameters adjustments while the circuit is being developed. Processing must be refined to allow mass production of the prototype circuits at acceptable levels of yield within reasonable performance limits. Despite general optimism, the fact remains that the production of integrated circuits other than comparatively simple switching digital networks is costly and the yield is low. Extensive production experience must illuminate the major problem areas, and research must find practical solutions to the problems.

Chips

The chipped semiconductor circuitry seems to be a practical, effective means for developing microelectronics, and it should provide a necessary and highly desirable interim step leading from microelectronics to the final, single-chip integrated circuit form. With chips, the stray coupling problem can be minimized and individual component chips can be selected to meet component tolerances. The chips allow traditional component circuit design approaches, and it affords a means for gaining experience with equilvalent resistance, capacitance and active elements in forms comparable with those to be used in the single-block integrated circuits. The path from chips to single-module "integrated" construction involves the solution of the stray couplings problem introduced by the "inseparable association." Chip circuits allow the exploration of patterns of reliability, reproducibility, and parameter control. Transistor cans provide protection and connection while the work on new packaging forms is progressing. While some digital circuits may progress without the intermediate step, the chipped approach can speed the evolution toward more and more single-chip or single-module analog integrated-circuit designs.

When experienced equipment engineers get involved, the best of the available circuit approaches will be selected for use in optimum combinations. Equipment reliability, performance, reproducibility, and cost will be some of the guidlines for selection. There is no virtue in the use of "pure" integrated circuits if the equipment performance is not acceptable. During the transition period, mature integrated circuits should not be used in combination with immature integrated circuits to produce an overall inelegant solution. It is better to use a hybrid approach which uses the mature integrated circuits in association with conventional component circuitry. "Trade-offs" will always be necessary. It may be necessary to trade off tight performance specifications in favor of substantial improvements in reliability, size and weight reduction, and power requirements when many integrated circuits are used.

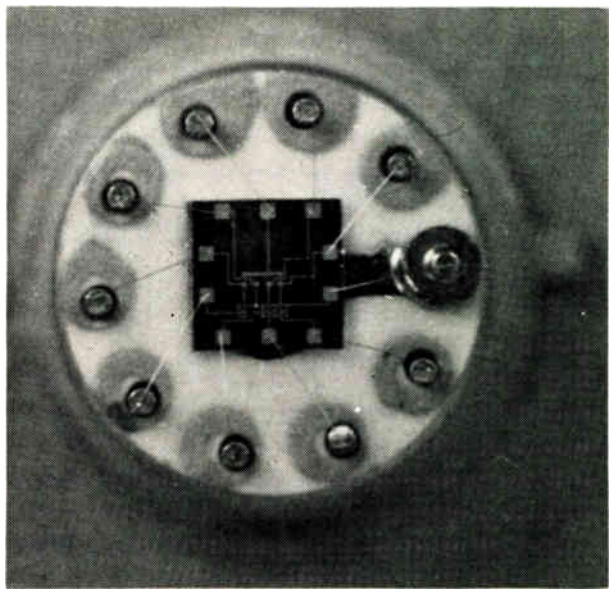
Cooperation

Progress in integrated-circuit applications needs, at this time, the joint, effective cooperative efforts of the integrated-circuit specialist and equipment engineers. Since most integrated-circuit specialists are isolated in thin-film or semiconductor research or development laboratories, and the equipment men are designing component configurations to satisfy their customers' needs, there exists a rather large gap which is not easily closed. Many equipment engineers are reluctant to use radically new components without extensive testing and knowledge about reliability, costs, and production availability. But adequate information in these categories will not be generated until the interaction between the equipment engineers and the integrated circuit designers is effective and continuous. The job cannot be done rapidly without the help of the equipment engineers. The rather slow process of developing and fabricating experimental integrated-circuit designs; the delays incurred in testing and modifying; and the slow interaction between equipment and integrated-circuit engineers when they are not in the same laboratory present barriers to rapid progress. We need only look at the ten or more years of transition from tube to transistor applications to understand the delays inherent in the change from transistor component circuitry to integrated circuitry.

Conclusion

As is the case with most complex industry approaches, there will be several working solutions to the total integrated-circuit problem. No doubt standard supplier-proprietary integrated circuits will be developed and sold to customers for use in equipment. It is also true that many equipment organizations will work closely with the integrated-circuit suppliers to custom design and develop the unique integrated circuits required. After the circuits are developed through the cooperative efforts of both groups of engineers, the production run of the customer-proprietary circuit will be accomplished under contract with the supplier. No doubt some preliminary circuit design work will be hastened by using either component circuit prototypes or chipped-up module circuitry to establish circuit performance parameters.

As the processing equipment is developed and the procedures approach an easily controlled automatic-equipment routine, the larger equipment manufacturers will use integrated-circuit laboratory equipment to develop their own prototypes. When these are finalized, the full specifications can then be passed to the integrated-circuit supplier who will process the circuit for mass production.



Advanced techniques can produce either digital circuits or, as shown by this high-frequency integrated amplifier, linear devices.

Ultimately, some of the larger equipment manufactuers will equip themselves for both the circuit development and production of integrated-circuit modules, but the stage may not be reached until push-button processing equipment is marketed.

The final pattern will include all four approaches to integrated circuits: the sale of standard modules; the joint custom development of proprietary units which will be mass produced by the supplier; the equipment manufacturers in-house development of the integrated-circuit prototypes, which will then be

vended for mass production by the semiconductor manufacturer; and eventually the in-house development and production of integrated circuits by some of the larger equipment manufacturers.

During the next five years the industry will be concerned with the refinement of the diffusion, epitaxial growth, and thin-film processing techniques. The refinement of all processes will add new degrees of freedom to both the designs and control of integrated-circuit parameters.

If the art is to be speedily developed, integrated circuits must be used immediately in all possible practical equipment applications. The refinement of integrated-circuit technology is not only important to the continuing growth of the electronic industry, it is essential to the achievement of the necessary substantial reliability improvement for all military electronics equipment.

Massive engineering and quality-control efforts will cause every art to mature to an asymptotic relationship which, in the final analysis, yields only slight improvements in reliability or performance. This asymptotic relationship has been reached for traditional component circuitry in complex systems, and substantial efforts directed to quality-control improvements will produce only minor reliability improvements. When results of refinement of techniques are no longer significant, a *radical* change in the performance and reliability can be achieved only through a *radical* change in the art itself. For the electronic industry, this radical change appears to be the material-oriented integrated-circuit approach. Hopefully, this discontinuity or step function in the electronic-industry development curve may provide a new steep slope of potential advance before it levels off to its ultimate asymptotic relationship. Nevertheless, the integrated-circuit approach is the only promising "step-function" technique on the horizon, and if the problems of yield can be solved, the extrapolation of transistor experience promises that circuits produced will be both more reliable and less costly than those made by the traditional methods.

The next five years should produce a turmoil of activity in the industry which, hopefully, will yield practical and economical solutions to encourage the wide use of integrated-circuit modules in new equipment designs. In continuing this most important work we should not be pessimistic, but we should also avoid unwarranted high levels of optimism which confuse the realities of the reproducibility, production, and cost problems. We move faster when we accept the obvious need for the old reliable, successive approximation pattern of progress. No doubt integrated-circuitry technology will revolutionize the electronic industry; the only question is "when?"

Some Views On . . .

RELIABILITY

The reliability of all forms of microminiaturization depends greatly on the interconnections. The advantages that integrated circuits offer over all the other approaches is that there are fewer interconnecting wires. The great majority of the interconnections are achieved by using evaporated thin-aluminum films over the top of the circuit itself. These, in turn, become an integral part of the block and are completely stable. They adhere to the silicon-dioxide covering, and there appears to be no serious mode of failure of these aluminum interconnecting films except, of course, gross overload which could fuse them. The interconnections from the circuit to external components are usually made by conventional thermocompression bonding techniques. But again, these are so greatly reduced in number over the number that would be used if the circuit were assembled from conventional transistors and diodes, resistors and capacitors, that the probability of failure is correspondingly reduced.

FABRICATION

One of the major problems in fabrication is the control of contamination and foreign material in the process itself. Another major problem in construction is the control of the diffusion processes. With the present diffusion techniques, there are many variables in the process. Therefore the control of as many of these variables as possible is essential. Photo masking is another area of concern. Accurate photo-masking processes and techniques are required to eliminate variations in the components that can be produced by variations in the photographic masks or in the way they're applied.

A prevalent problem is the design of the components. Here the circuit designer must be familiar with the process, diffusion, the masking and the assembly processes in order to better design a circuit that is compatible with the process. A close relationship between the circuit-design group and the process group will encourage a lot of cross training and education in both groups.

The semiconductor industry has grown from an annual business of a few million dollars to one of nearly half a billion dollars in less than a decade. This article discusses the technological revolution in the semiconductor field which brought about this rapid growth. It covers the present status of this technology and tries to forecast the near future.

THE FUTURE OF SEMICONDUCTOR DEVICES

By DR. A.M. GLOVER
Vice Pres. & Gen. Mgr.
Semiconductor and Materials Div.
Radio Corp. of America
Somerville, N.J.

TODAY, THERE ARE TWO DIVERGENT TRENDS in semiconductors. One is the rapid change in certain areas [e.g., high-speed silicon (S_i) transistors for switching]. The other is the ability of many of the oldest devices to hold on tenaciously. Even the point-contact transistor is still being used in certain equipments (but not in modern designs). In this case, cost of re-engineering to adapt newer types cannot be justified.

This same pattern of long use life is true for S_i grown-junction and germanium (G_e) alloy-junction transistors. These types are built into a wide range of both military and commercial equipment. As long as these equipments are made, a market will exist, even though both types are technically obsolete by today's standards. In both cases, it is hard to substitute a more modern type directly without a good deal of redesign. In the case of the G_e alloy types there are other factors. These types have reached peaks of refinement in characteristics and reliability. Circuit designers know what to expect from them under every operating condition. Also, many circuits have been developed whose performance and reliability have been proven over the years. Where speed or frequency is not a factor, the G_e alloy transistor will continue to be used for years to come.

Low-Power Transistors

In the area of low-power transistors having frequency responses greater than 5 or 10 MC, the situation is more fluid. In G_e the first attempt to provide a low-power r-f device consisted of the so-called micro-alloy types. In this approach the base width is carefully controlled to obtain a narrow base width and, thus, an h-f response. The micro-alloy type was for a long time the only h-f transistor available, but it is now nearly obsolete.

Drift Types: Development of drift transistors was the next step towards higher frequencies. This approach uses a graded region in the base just below the emitter, plus an intrinsic region near the collector. For use as an amplifier, where low output capacitances and low base resistance are needed, the resultant characteristics are nearly ideal. If the drift approach is combined with that of the micro-alloy types, the resultant micro-alloy diffused transistor (MADT) is useful as an amplifier up to frequencies in the GC range. For a period these types dominated the h-f and the high-speed switching fields. They will probably continue to be widely used in many entertainment and commercial equipments at frequencies in the low MC range. However, for fast switching and for very high frequencies they are being superseded by mesa and planar types. Smaller geometries can be used in mesa or planar transistors without serious sacrifice of power capability and mechanical reliability. Recent advances in mesa and planar methods, particularly the use of epitaxial material, permit these types to compete both technically and economically with the MADT in all respects.

Mesa Transistors: Mesa transistors differ from alloy and alloy-drift types in that the starting material is the collector rather than the base. The base of the mesa is diffused into the collector, and the emitter is either diffused or alloyed into the base. A mesa is then etched to reduce the collector area at the base-collector region.

The mesa structure has several advantages. The base width can be closely controlled, especially when shallow emitter alloying or emitter diffusion is used. With this narrow base width, there is no loss of mechanical strength or power dissipation, as in the

MADT. The diffused base-collector junction allows a higher voltage breakdown with a given collector resistance. This feature has made the mesa method invaluable in making high-voltage transistors.

There are, however, some drawbacks. Because of the need for a base contact, the collector capacitance is larger than that of an MADT having the same emitter size. Also, the collector thickness needed for mechanical handling produces a voltage drop across the collector and increases the stored charge in saturation. However, recent developments have made the mesa transistor competitive with the MADT in every way and have placed it in a power and reliability class by itself.

Geometry Control of Mesas: Some of the geometry control that permits the collector area and capacitance to be reduced has been done by brute force. The alloyed dots have been made smaller for mesas that use alloyed emitters and base contacts. Because the mesa has no lineup problem between the emitter and collector dot, dot sizes are limited only by the need for making contacts to them. Present limits for dot diameters are 3 or 4 mils. The mesas are etched right to the edge of these dots to keep the collector capacitance to a minimum. Mesa types having gains up to 20 db at 200 MC have been made for amplifier uses. Further advances are being pursued by the possible use of smaller dots.

With special methods such as that of "split dots," transistors have been made with useful gains at 800 MC. Because of the low-cost possibilities, alloy-dot mesas will continue to have commercial use. This type has had even wider acceptance in the European market.

Mesas using evaporated emitters and base contacts are limited in area only by the lead-attachment problem. Emitters as small as 1 by 2 mils are possible when ½-mil connector wires are used. These mesas provide gains of 20 db at 200 MC. Laboratory units with small areas have shown much gain in the GC region. These types are being used in two areas—amplifiers at UHF's, and high-speed switches. They are the most popular types for high-speed computers. However, in the future they will receive strong competition from S_i planar types.

Double Diffusion: A more elegant method of controlling base and emitter areas is by masking and double diffusion. To date, this method has been carried further with S_i than with G_e. The oxide deposit formed by heating S_i to a high temperature masks the transistor against either an n-type or a p-type impurity. The oxide can be removed by the usual photoetching methods in areas where diffusion is

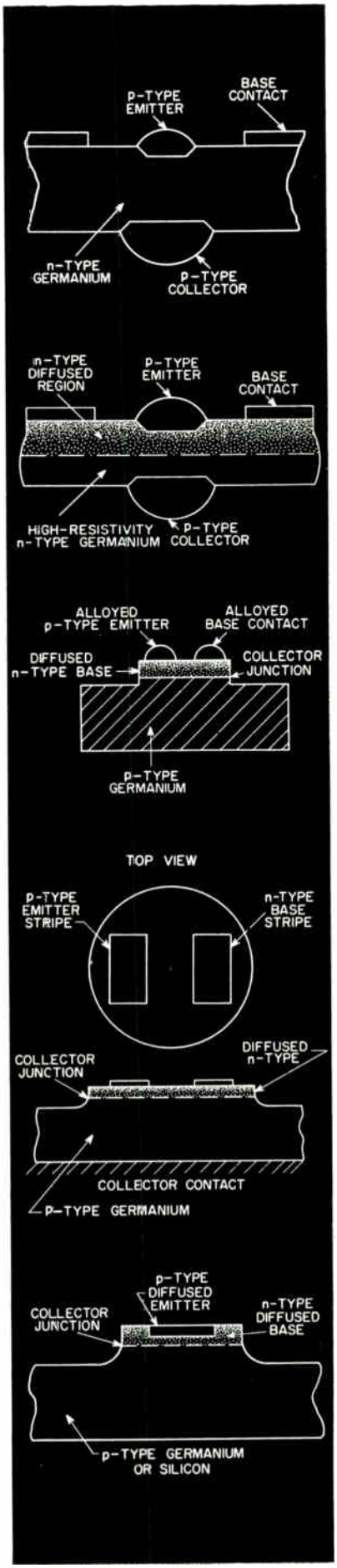


Fig. 1: The germanium alloy - junction type transistor has a pattern of long use life.

Fig. 2: Drift transistor approach uses a graded region in the base just below the emitter, plus an intrinsic region near the collector.

Fig. 3: Mesa types differ from alloy and alloy-drift types in that the starting material is the collector rather than the base.

Fig. 4: Mesas using evaporated emitters and base contacts are limited in area only by the lead-attachment problem. They are now the most popular types for present-day high-speed computers.

Fig. 5: A method of controlling base and emitter areas is by masking and double diffusion — a typical p-n-p device is shown.

needed in a base or an emitter. These methods have been so well refined that lines 0.1 mil wide can be etched in the oxide. This permits emitters and base-contact areas as small as the wires that can be attached to them. Amplifier transistors with 1-mil-dia. emitters and base areas of about 2 mils dia. have been made. Performance in the GC range appears possible.

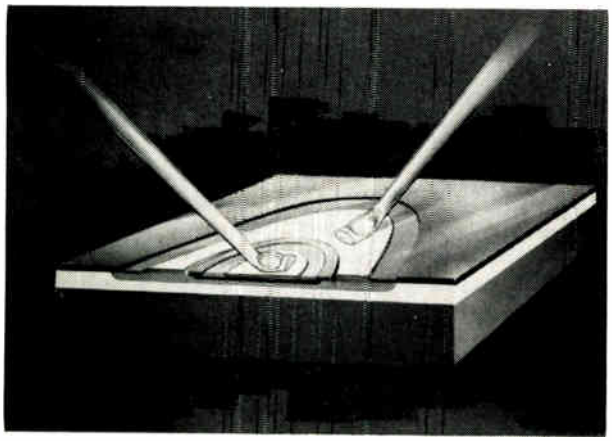


Fig. 6: The planar type is the method which the entire industry is currently adopting. An advantage is greater stability.

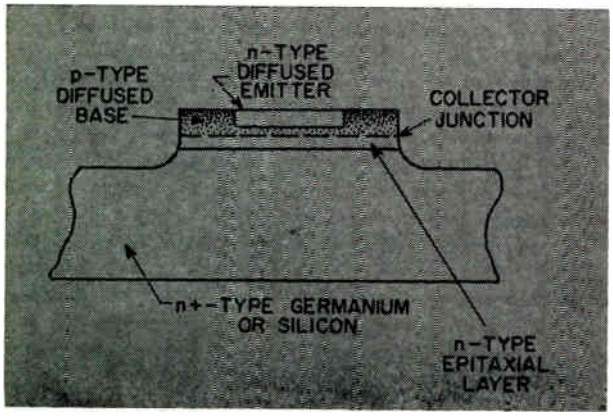
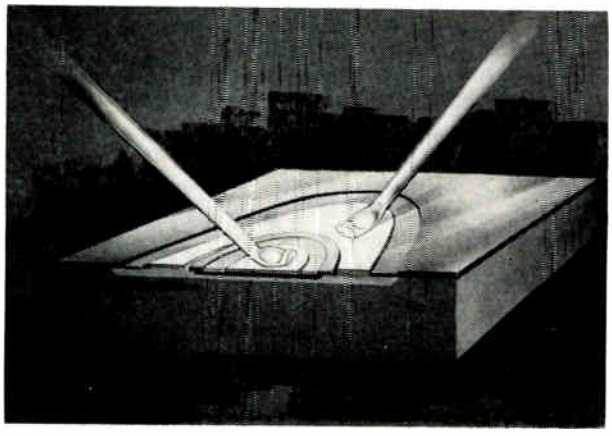


Fig. 7: The epitaxial approach to a mesa transistor is shown.

Fig. 8: Triple diffusion approach as applied to a planar structure.



The Planar Approach: The approach which the entire industry is now adopting is the planar type. In this method, base diffusion as well as emitter diffusion is from a limited-area source. Main advantages are greater stability during life, a more constant beta with current, and a low I_{cbo}. Planar types have been found to have low noise at very low frequencies (1/f noise) consistent with low I_{cbo}. These features are probably inherent because of the oxide coating of all junctions—something not possible in mesa types. Another advantage of the planar construction is that the metallic coating from the emitter or base-contact area can be extended onto the oxide where connections can be made. This permits small active areas with larger areas for the wire contact—a useful feature for integrated devices.

The planar device, however, has two drawbacks. First, for a given base area, the collector capacitance is larger; this can be compensated for with a slightly reduced geometry. Second, although the low-voltage I_{cbo} is an order of magnitude or more lower with the planar structure, voltage breakdown figures have not been as good as those obtained with mesas having the same crystal resistivity. Processing refinements should dispel this problem.

Silicon vs. Germanium: Use of masking and photoetching has been carried further with S_i than G_e; however, a great deal of work is being done to apply the same approaches to G_e. The planar approach appears to be applicable to both p-n-p and n-p-n germanium structures. Because of the greater mobility in G_e, it is thought that G_e would be used for the very highest frequencies. In VHF structures, however, the input and output capacitances are as important as the mobilities. This fact, along with the better temperature capability of S_i, may make S_i the logical choice.

Gains of 20 db at 200 MC are achieved with both S_i and G_e. The noise figure at 200 MC for G_e is as low as 2 or 3 db; for S_i, it has so far been slightly higher. G_e has been pushed faster than S_i into the GC ranges, but S_i may overtake G_e. In the next few years, transistors having gains of 20 db at 1 GC appear feasible in both G_e and S_i. The noise levels obtained may be the determining factor as to which material is used for VHF low-level amplifiers. For switching, this is not a consideration.

Epitaxial Layers: The second development which has improved the mesa (or planar) approach is the use of epitaxial material. This idea is an old one,

but its use in semiconductors is recent. Epitaxial construction permits the growth of a thin layer of semiconductor material of the desired resistivity. The epitaxial layer need only be thick enough for the needed design parameters of the transistor. The layer thickness is usually in the range of 0.1 to 0.5 mil. The carrier material, which serves only as a holder, is of such low resistivity that the voltage drop across it and the charge storage in it are negligible. Improvement in the performance of mesa or planar devices with the epitaxial approach makes them completely competitive with the MADT.

Triple Diffusion: Another approach is to use triple diffusion instead of the epitaxial method. The collector side of the wafer is diffused to provide a low resistivity. The triple-diffused method has one drawback; in diffusing into the collector, it is difficult to control the top-layer thickness of original resistivity. However, triple diffusion has the advantage of producing a top layer with any desired value of resistivity; the epitaxial approach is at present limited to a few ohm-centimeters. The triple diffused structure, therefore, is applicable for high-voltage transistors, especially for nonsaturated use.

Planar Types in the Future: Except for certain areas where G_e alloy and drift types and G_e mesas will continue to be widely used, it appears that epitaxial or triple-diffused S_i planar types will become the low-power type of the future. This field is just beginning to settle down because much of the use in the past has been in prototype equipment. There has been a race to obtain faster and faster transistors in order to show a continued improvement, especially in computer speed. However, the older slower types are now being used in production equipments and there is some sign of stabilization of types. The n-p-n structure has been the favored type because of the higher mobility of electrons in S_i; however, the p-n-p type is now finding wider use. The p-n-p type can be used in complement with an n-p-n type where low power consumption is useful (such as for satellite use); it is also easier to use as a replacement for a p-n-p germanium type. Because of the effects of the oxide of S_i on the S_i surface, it has proven to be much more difficult to obtain stability in a p-n-p type. However, increasing knowledge of surface effects (which can be controlled more readily in S_i than in G_e) promises high reliability for both p-n-p and n-p-n S_i planar types. The reliability level is becoming so high that it is hard to measure.

Field-Effect Transistors: An outgrowth of improved S_i technology is the development of useful S_i field-effect transistors. A bipolar transistor has

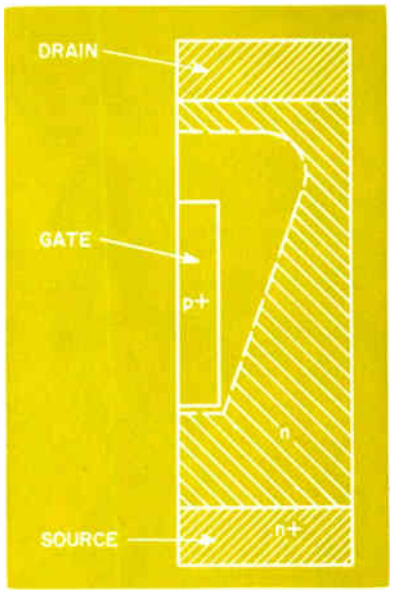
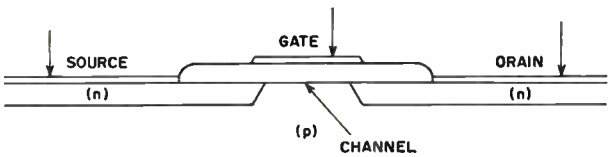


Fig. 9: One of two forms that field-effect types have taken is that of a back-biased junction to control the channel current.

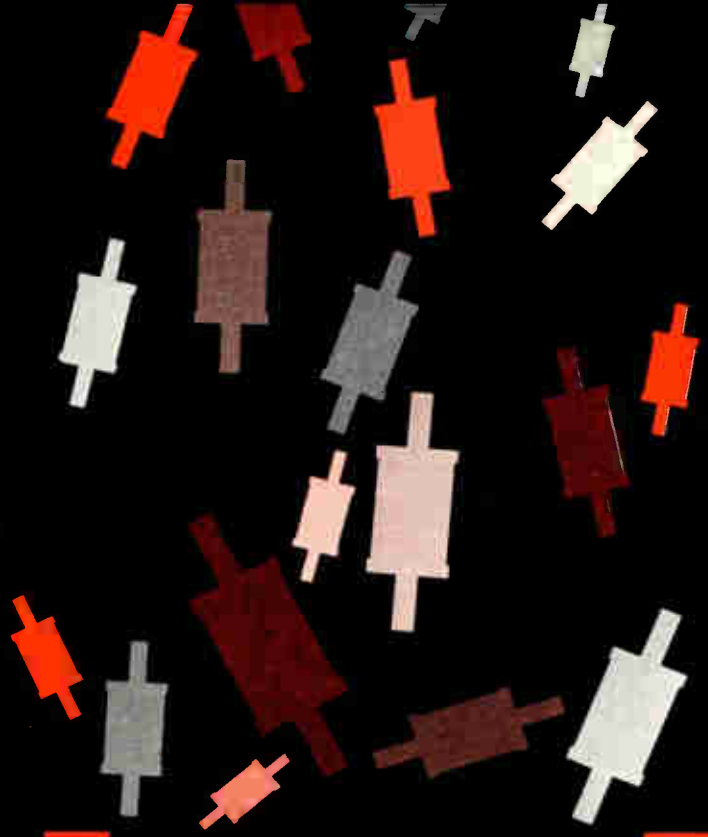
many advantages, but it has suffered from three major disadvantages: (1) a low and variable input impedance which has made matching to high-impedance sources difficult (this also makes design of high-gain tuned stages difficult); (2) an exponential dependence of the collector current on input voltage which can result in severe cross-talk and has limited the use of transistors in high-performance communication receivers; (3) difficulty of automatic gain control (AGC). The field-effect transistor has none of these disadvantages because of its high input impedance and its square-law dependence of output current on input voltage. Field-effect types have taken two forms: (a) that of a back-biased junction to control the channel current; and (b) the metal-oxide semiconductor (MOS), in which the channel current is controlled by the voltage on a metal gate which is separated from the channel by an oxide. Both have

Fig. 10: Another form that field-effect types have taken is the MOS, in which channel current is controlled by the voltage on a metal gate which is separated from the channel by an oxide.



the advantages discussed above, but the MOS has further improved characteristics: (1) Input impedance is entirely capacitive, with the resistive component greater than 10^{12} ohms (in general limited by the enclosure used). This feature makes the MOS useful as an electrometer. (2) Because the gate is insulated from the channel by an oxide it can be made negative or positive. This permits many circuit in-

(*Continued on page* C11)



HOW TO CHOOSE VARACTORS

**For V_b to 140 v with P_d to 5 w—
Philco L4200 series Epitaxial Silicon Varactors.**

**For Industry's Highest Varactor Efficiency
(and lowest prices)—Philco L4600
series Germanium Varactors.**

Now you can choose the optimum combination of efficiency, power, and price for your varactor requirements.

If you want voltage capability to 140 volts V_b with power dissipation to 5 watts, and the extra ruggedness of thermally bonded contacts (including junction contacts), evaluate Philco L4200 series Epitaxial Silicon Varactors. They enable you to build harmonic generators with higher output powers at higher output frequencies. The L4200 series is designed to meet MIL-S-19500/C requirements.

If you require medium power devices, get industry's highest varactor efficiency and lowest varactor prices—with Philco L4600 series germanium varactors. The low contact potential inherent in germanium enables these types to have maximum capacitance variation (highest harmonic generation efficiency).

There's a Philco varactor for every frequency multiplier and solid-state power source. Get the optimum type for your application—now in stock at COMPAR and at your Philco Industrial Semiconductor Distributor. For complete data, write COMPAR, or Dept. EI663S.

CHECK THESE TYPICAL PHILCO VARACTORS

Type	P_d	V_b	C_j @ −6 v	f_c @ −6 v
L4633 J	0.3 w	40 v	0.8-1.6 pf	70 Gc
L4243 J	0.5 w	60 v	0.8-1.6 pf	70 Gc
L4244 F	1.0 w	60 v	1.6-3.0 pf	40 Gc
L4277 B	5.0 w	140 v	12-20 pf	10 Gc

Many other types available for your specific needs.

SPECIAL PRODUCTS OPERATION

PHILCO®

A SUBSIDIARY OF *Ford Motor Company*

LANSDALE DIVISION, LANSDALE, PA.

In Europe: Avenue de Beauregard 3, Fribourg, Switzerland
In Canada: Don Mills Road, Don Mills, Ontario, Canada

SOLID-STATE CENTER U.S.A.™

Circle 1 on Inquiry Card

novations not even possible with vacuum tubes. (3) Frequency responses will probably always be higher for an MOS. (4) Small change of its characteristics with temperature.

Insulation of the gate has another advantage. Instead of having conductivity in the channel which can be cut off by making the gate negative, the MOS can be designed to conduct current only when the gate is positive. At low positive voltages (2 to 4 v) the current can be made small, while large currents flow with gate voltages of 8 to 10 v. Such a transistor permits direct-coupled switching circuits, in fact, the circuits can be the same as for DCTL with bipolar

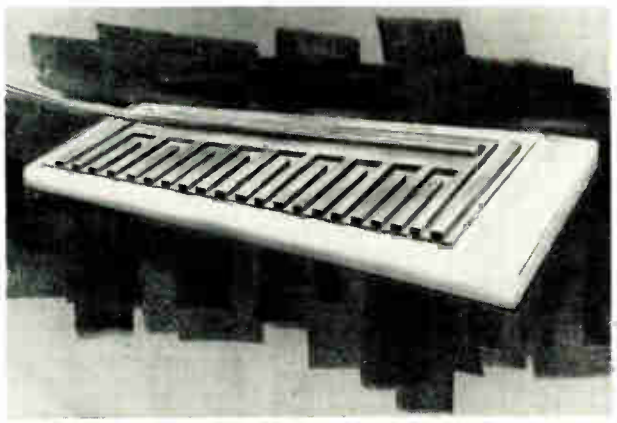


Fig. 11: An interdigitated emitter design is depicted here.

types. MOS circuits have the advantages of no "base hogging" and better s/n ratios. By combining n-channel MOS transistors with p-channel types, switching circuits can be built which use no stand-by power (current flows only during switching). Such circuits are attractive where low power is essential, e.g., in satellites.

It appears that the next breakthrough in transistors will be in the field-effect types. Such transistors have all the advantages of tubes, plus most of the advantages of bipolar types. Frequency response up to the GC region and switching speeds which provide stage delays of 50 to 100 nsecs should be possible.

High-Power Transistors

It is not clear whether S_i or G_e will dominate the small-signal and low-power switching fields. However, in most areas of the high-power transistor field, S_i is becoming the preferred material. Audio-output-amplifier and power-supply-regulator transistors are an exception because of the low cost of G_e audio power types. The initial problem with S_i power transistors was the poor saturation voltage, which made the usual mesa approach unattractive. This problem was solved by designs in which the collector and emitter are simultaneously diffused from opposite sides and part of the emitter is etched off to obtain a base contact.

Triple-Diffusion and Epitaxial: The single-diffused approach has given good S_i power transistors with low saturation resistances and good reliability. Because of the low saturation resistance, this approach will be used for a long time. Diffusion from both sides, however, makes control of the base width difficult. The frequency response, therefore, is limited to the single-diffused device. With the advent of triple diffusion and epitaxial layers, it is now possible to make power devices using the mesa or planar approach, and to obtain low saturation resistance and higher frequency response. Transistors having power outputs of nearly 100 w. at 50 MC have been designed using triple diffusion. There will be a place both for these and for the older single-diffused designs.

Geometry Considerations: Another factor in the design of h-f, high-power devices is the tendency for the emitter to emit only at its edges at high currents, especially in S_i types. Best h-f results are obtained with the largest emitter perimeter for the smallest emitter area. Shape of the base with respect to the emitter must also be considered in order to keep the base area, and consequently, the base collector capacitance small, and at the same time keep $r_{bb'}$ low. Good results can be obtained with a variety of geometries, including a ring emitter, a star emitter, and interdigitated emitters and base contacts.

The Future: The field of high-power, h-f devices is only beginning to open up. Today, devices are available that will provide 3 w. at 200 MC, 10 w. at 100 MC, 50 to 100 w. at 50 MC, and several hundred watts at 5 MC. In the next few years, devices capable of several watts at 1 GC, 50 to 100 w. at 100 to 200 MC, and several kw at a few MC appear to be possible. This area is one of the most exciting in transistor design. In general, planar technology is used unless the high collector voltages obtained at present only with mesas are needed. With further study of surfaces, the voltage limitations of planars will be removed. Also, a serious problem in power types, that of "second breakdown," must either be solved or designed around.

TRENDS IN SEMICONDUCTOR RESEARCH

Semiconductor research has progressed at a rapid pace over the past fifteen years. This progress is reviewed and areas of active research interest are indicated in this article.

By Dr. JOHN BARDEEN
University of Illinois
Urbana, Ill.

IN SEMICONDUCTOR RESEARCH, there has been a close connection between basic science and applications. Scientific discoveries have often been translated rapidly into practical devices. Applied research due to interest in applications has often led to advances in understanding. Probably in no other field has invention followed so closely after scientific discovery. Every year or two a new breakthrough seems to come along to give new impetus to the field. Latest is the junction laser. Certainly the results achieved during the past fifteen years have been tremendous, and we do not appear to be anywhere near the end of the road.

Progress in transistors can be characterized by increasing frequencies, power, and reliability; and smaller size and lower prices.

As transistors are designed to go to higher frequencies, dimensions become smaller and base layers thinner. Conductivity of the base layer material must be increased in order to get enough lateral conduction. In lab models, conductivity is getting into the metallic range. Many labs are in fact experimenting with metals for base layers as well as with other active thin film devices.

Integrated Circuits

Transistors are usually put in a package larger than the working volume, to have something big enough to see and handle. To take advantage of the inherently small size, to simplify the problems of interconnections and to increase reliability, the trend is toward integrated circuits or functional blocks. While it now appears that computers of the future will use integrated circuits, it is uncertain just how far the technology will go into other branches of electronics. It is certain, however, that a new technology with large potential remains to be exploited. Problems of design of these circuits and of the economics are quite different from those of normal circuits. Just how these will be worked out remains to be seen. There must be a compromise between a number of factors. The design engineer knows best what sort of compromise suits his purpose. Some semiconductor producers are using the master slice principle in which redundancy is built into the basic unit. This allows flexibility in circuit design, but has limitations. I do not know what the solution will be.

Present integrated circuits are assemblies of indi-

Dr. John Bardeen (left) shows a design of the junction laser to Paul Carroll, president of Semiconductor Specialists, Inc., Chicago.

vidual components built into a small package. In the future are truly integrated blocks in which a semiconductor or thin layer device will give a desired overall function. Shockley's 4-layer diode and its close cousin, the controlled rectifier, are examples. Another is the Esaki tunnel diode. We may expect further advances in such devices, but because of difficulties in fabrication as well as the ingenuity which must go into their design, progress probably will be slow.

With the increased packing density made possible by integrated circuits, heat dissipation becomes a problem. Partly for this reason, there is increasing interest in field effect devices which have a high impedance input and lower standby power.

Shockley suggested the field effect transistor prior to the invention of point contact and junction types; but, it took a long time for the state-of-the-art to advance to working models. It was not until 1952 that Shockley published his detailed theory and not until 1955 that Dacey and Ross published their classic paper on experimental devices. However, even after it was shown what could be done with field effect devices, they were neglected until quite recently.

The present state of the semiconductor art is the result of a large effort by many people. In 1948, the year the point-contact transistor was announced, I underestimated the time it would take to get transistors into commercial production and use, and did not appreciate the large scale effort needed to make useful and reliable devices. On the other hand, I did not foresee the success that has been gained in overcoming frequency, power and other limitations. This shows that patience is needed in a research program and that our sights should not be set too low.

Major Steps

Some major steps have been the production of single crystals of germanium and silicon, starting in 1950 and 1951; zone refining, 1952; grown junction diodes and transistors, 1951; alloy junctions, 1952; surface barrier transistors, 1953; diffused base transistors, 1957; oxide masking a little later; and epitaxial growth and the planar design in 1961. Maximum frequency of transistors increased by more than a factor of a thousand between 1948 and 1962. Progress in diodes and rectifiers has also been impressive. Some of the important advances have been in power rectifiers, Zener reference diodes, Shockley's 4-layer diodes, tunnel diodes and junction lasers.

Largely through the efforts of Welker of Siemens-Schekert, an intensive study of the 3-5 compounds started in the mid-fifties. They appear to be quite valuable for a number of purposes, including the junction laser.

Laser junctions of gallium arsenide convert dc power from a battery into light with high efficiency. By replacing some of the arsenic with phosphorous the wavelength of the light can be varied from about 8400Å to 6400Å. Perhaps with use of other compounds, the frequency can be pushed further into the visible. Possibilities here are great.

It has long been known that a junction laser is a theoretical possibility, but its practical realization came sooner than expected. As early as 1953, John von Neuman suggested it and made theoretical calculations of what might be needed.

There is now much (both basic and applied) research on luminescence, photo-conductivity, and other problems involving interaction of light and matter, including lasers. It seems that this is a broad area of great potential.

This article is based on a talk given in Chicago, Illinois at a seminar on semi-conductor devices sponsored by Semiconductor Specialists, Inc.

Basic Research

Progress on basic research has paralleled that on device uses. Perhaps the most important step for both uses and basic science has been the development of methods for making nearly perfect single crystals. Measurements have given an understanding of what is going on in terms of the electronic structure and composition of the material. Composition control has allowed one to design devices on paper and then make them in the lab and expect them to perform as anticipated. There has been a change from empirical art to engineering design.

Basic research in semiconductors covers a broad front. Only two areas of current interest will be mentioned. One is on surface properties. It is now becoming possible to determine the atomic structure of the surface and to see what impurities or surface defects affect electrical properties. Another is the study of plasma effects in semiconductors. One can observe plasma pinch effects as well as magneto-hydrodynamical waves of various sorts.

Innovation

Innovation or invention needs two factors: seeing a need and providing the technical means for fulfilling the need. In some cases one predominates, in some the other. Often elements of both are important. It is possible that the need can be met within

(*Continued on page* C17)

New: Sylvania silicon epitaxial varactors offer widest

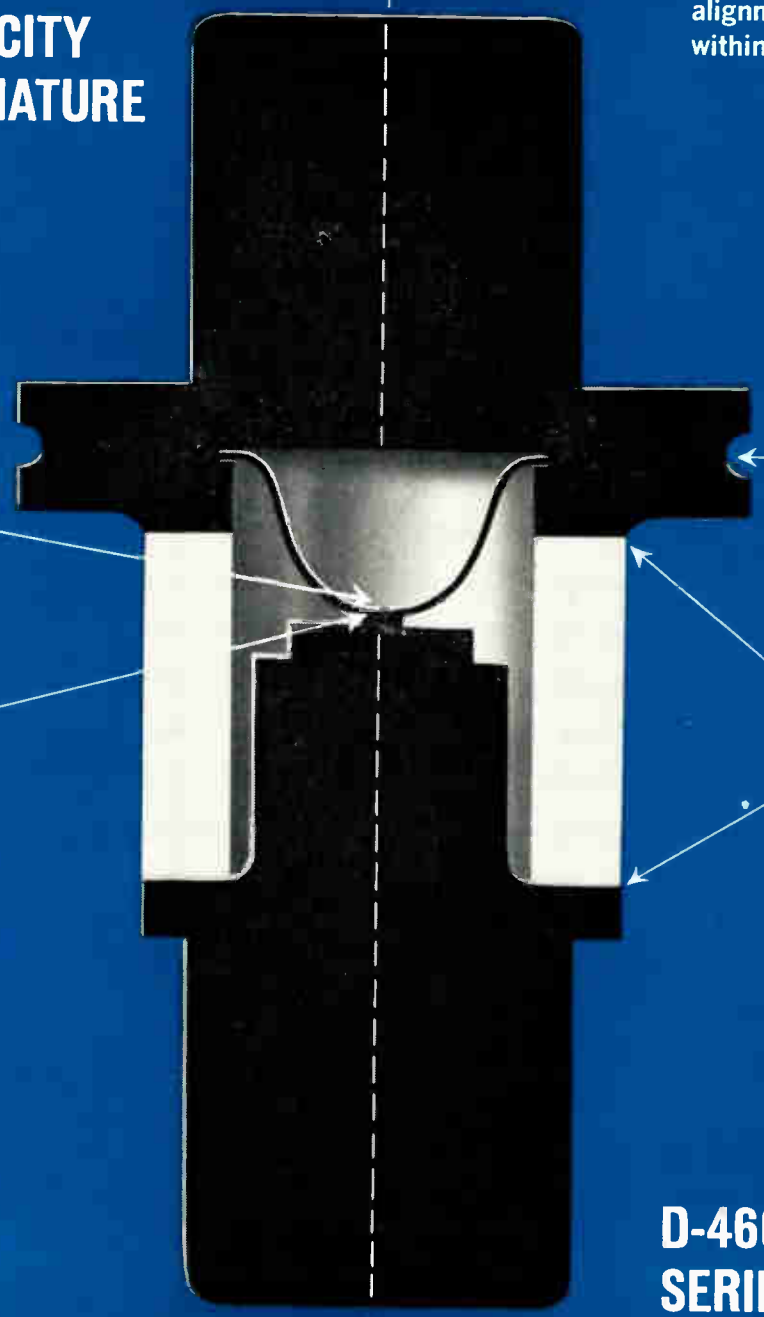
ACTUAL SIZE

For parametric amplifier and harmonic generator applications, the D-4600 varactor series offers the advantages of both a thermally bonded junction and a microminiature welded ceramic package.

Superior Performance. Refined epitaxial techniques give lower series resistance at high breakdown voltages—which results in better conversion efficiencies at high frequencies. And these techniques also permit tight capacity tolerance control, resulting in a high degree of uniformity among units of the same type. Because of the low-inductance, low-capacity construction, this series is capable of self-resonant frequencies in the mid-X-Band region, assuring maximum operating efficiencies in higher-frequency applications.

Extreme reliability is another dividend of the rugged package and bonded-junction design. Before final elec-

LOW-CAPACITY MICROMINIATURE PACKAGE



D-4600 SERIES

trical testing, varactors are vacuum baked at 200°C and immediately welded in a controlled dry atmosphere to insure that there is no moisture inside the true hermetic seal. And they are subjected to the exacting tests of MIL-S-19500.

For more information on D-4600 series varactors see your Sylvania Salesman or Franchised Semiconductor Distributor. Semiconductor Division, Sylvania Electric Products Inc., Woburn, Massachusetts.

bonded-junction choice in

cutoff frequency

... up to 200 Gc

breakdown voltage

... 6 V to 150 V

junction capacity

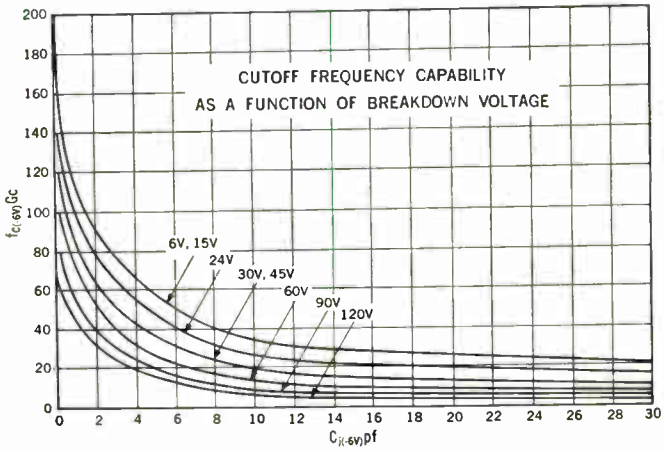
... 0.1 pf to 30 pf

RELIABILITY

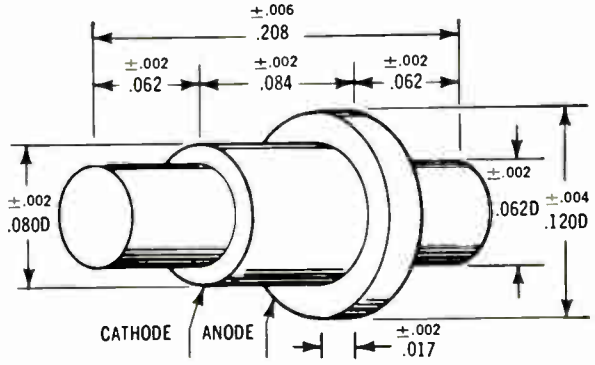
All varactor diodes are subjected to the MIL-S-19500 tests below according to standard military sampling procedures.

Ref. Par. MIL-STD-750	TEST	CONDITION
1052	Temperature Cycle	−65°C to +200°C, 5 cycles
1056	Thermal Shock	100°C to 0°C
1021	Moisture Resistance	95% R.H. 10 cycles 10°C to 65°C
2016	Shock	1500 G, 0.5 millisecond. 5 blows in each of 3 planes
2056	Vibration	20 G from 100 to 2000 cps. Four 5-minute cycles in each of 3 orientations
2006	Constant Acceleration	20,000 G for one minute in each of 3 planes
2036	Terminal Strength	5 pounds
1031	Storage Life	200°C for 1000 hours

PERFORMANCE



OUTLINE



SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

SYLVANIA SALES OFFICES

ATLANTA, GA. 2115 Sylvan Road, S.W., phone 404—PO 6-3633 • **BALTIMORE, MD.** 31 Allegheny Ave., Towson 4, phone 301—VA 3-2550 • **CHICAGO, ILL.** 2001 No. Cornell Ave., Melrose Park, phone 312—ES 9-2525 • **DALLAS 2, TEX.** 100 Fordyce St., phone 214—RI 1-4836 • **DAYTON 2, OHIO** 333 W. First St., phone 513—BA 3-6227 • **FLORIDA** 1520 Edgewater Drive, Suite "C," Orlando, phone CH 1-9681 • **FORT WAYNE, IND.** 4740 Coldwater Rd., phone T3-1145 • **LOS ANGELES 54, CALIF.** 6505 E. Gayhart St., phone 213—RA 3-5371 • **MASS.** 100 Sylvan Rd., Woburn, phone 617—WE 3-4784 • **N. Y.** 1000 Huyler St., Teterboro, N. J., phone 201—AT 8-9484; in N.Y.C., CH 4-8820 • **N. Y. UPSTATE** Seneca Falls, N. Y., phone LO 8-5881 • **PHILADELPHIA 31, PENNA.** 4700 Parkside Ave., phone 215—GR 7-5000 • **SAN FRANCISCO, CALIF.** 1811 Adrian Rd., Burlingame, phone 415—OX 7-3500 • **WASHINGTON 6, D. C.** 1120 Connecticut Avenue, N. W., phone 202—FEderal 7-6600 • **INTERNATIONAL** 730 Third Ave., New York 17, N. Y., phone 212—551-1000 • **MONTREAL 9, QUEBEC** 6233 Cote de Liesse Road, phone 514—ME 1-4201 • **GENEVA** 40 Rue Du Rhone.

Circle 12 on Inquiry Card

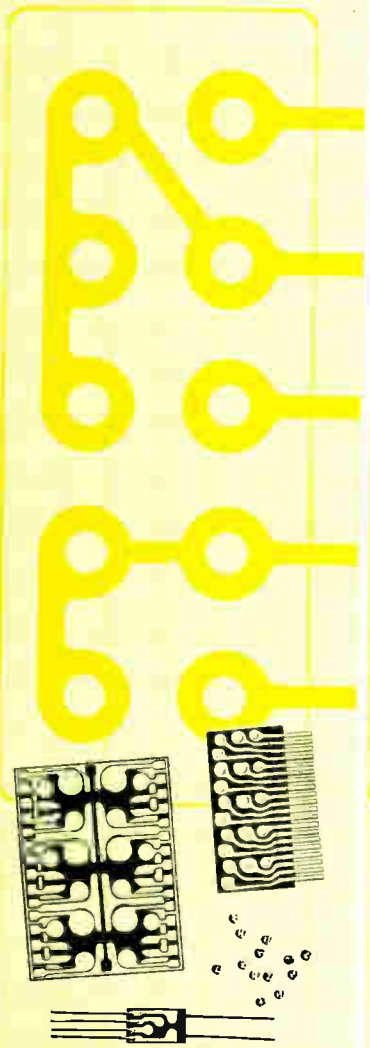
Total microelectronics capability

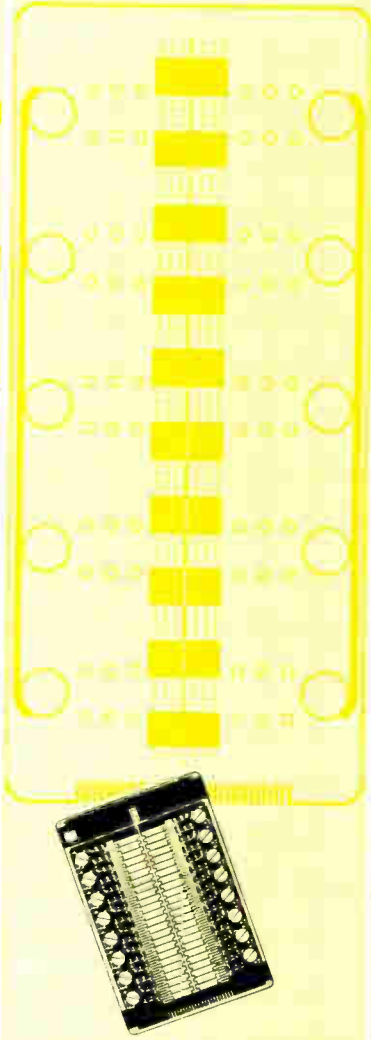
MICROSEAL* CIRCUITS
Active
and passive
pellet
components

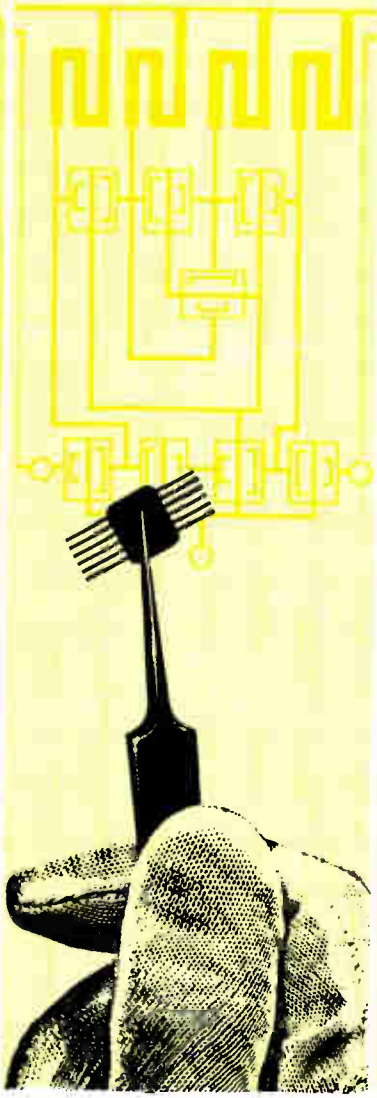
THIN FILM/MICROSEAL CIRCUITS
Passive
thin films
Active pellet
components

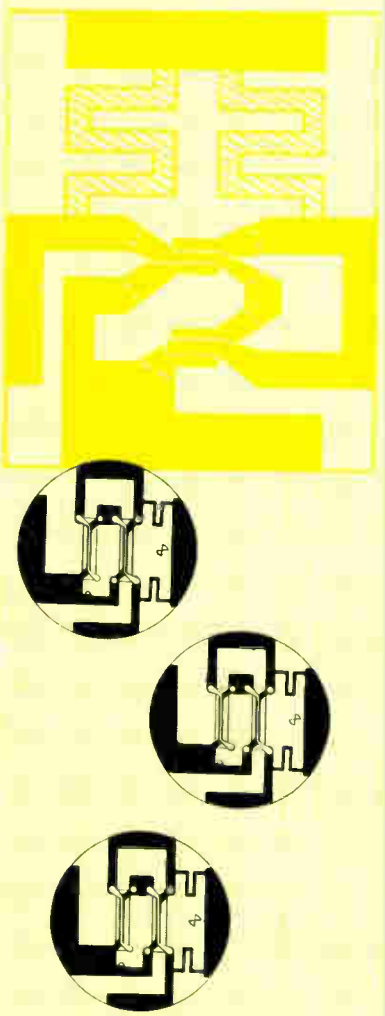
INTEGRATED SILICON/THIN FILM CIRCUITS
Monolithic
silicon actives
Passive
thin films

INTEGRATED THIN FILM CIRCUITS
Thin film
active and passive
component
functions









*Trademark, Hughes Aircraft Company

"ALL EXCELLENT THINGS ARE AS DIFFICULT AS THEY ARE RARE." Spinoza

The best ideas are common property. However, it is the dedicated pursuit and practical application of ideas that is uncommon. □ Six years ago we set our sights on today. Theory through research has yielded today's prototypes—the models for tomorrow's production.

HUGHES MICROELECTRONICS, SEMICONDUCTOR DIVISION, NEWPORT BEACH, CALIFORNIA

Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY
SEMICONDUCTOR DIVISION

Circle 218 on Inquiry Card

SEMICONDUCTOR RESEARCH (Concluded)

existing technology, even though much ingenuity may be involved. In most great inventions of the past century, the genius of the inventors was more in recognizing the need, and of seeing a better way of doing things, than in advances in technology. With the need in mind, they worked out ways to meet it. Edison advanced technology not by increasing basic scientific understanding, but by trying everything he could think of until he found something which satisfied his needs for a use he had in mind. This method is still valuable and is still widely used in areas where there is a gap between scientific understanding and technology.

In other cases the need may be seen, but no one knows how to fulfill it within existing technology. A breakthrough in science or technology then is needed. Invention of the transistor is an example of this. In this case, we knew that if we could make an amplifier which would operate without a heated filament, we would have something. We were ready to exploit anything which turned up in our basic research program which might help us achieve this goal.

Not long after Brattain and I invented the first point contact transistor, Shockley suggested the junction transistor and worked out the current-voltage characteristics to be expected. It took roughly three years for advances in technology to reach the stage where the first junction transistors could be made in the lab. These performed close to what had been predicted. In this case, the need was seen and there was basic understanding of what was needed but there had to be marked advances in the art of processing semiconductor materials before the device could be made.

Sometimes innovation arises from a discovery in basic science. An example: development of atomic energy which came from the discovery of nuclear fission. When a new scientific discovery is made, one may ask: How can it be applied? What can it be used for? How can it be exploited?

The Government has been spending large amounts on basic research. Knowledge is accumulating at an increasing rate. Results of basic research are published freely throughout the world and are available to everyone. The most technologically advanced countries can take best advantage of this vast fund of knowledge. This country being the most advanced has the most to gain from basic research, wherever in the world it is done. A good example is the tunnel diode discovered by Esaki in Japan in 1958. Research on Esaki diodes was taken up rapidly by labs in this country not only for practical uses but also to obtain many results of great scientific interest. It was not long before Esaki diodes were an article of commerce.

What applies to different countries applies to different segments of our own economy. The bulk of semiconductor research is done in support of military and space efforts, with universities playing an important role in basic research. It has been difficult for electronics industries, which are largely civilian based, to support advanced research programs of their own and to attract our best scientists and engineers. There is a danger to the future of the industry if this trend is not reversed. If we are to compete with such advanced countries as West Germany and Japan, we need to get more of our best technical manpower thinking about problems of the civilian economy.

GLOSSARY OF MICRO-CIRCUIT TERMS

Courtesy of Autonetics, A Division of North American Aviation, Inc.

ACTIVE ELEMENT—An element which displays transistance such as gain or control.

ACTIVE SUBSTRATE—A substrate for an integrated circuit in which a portion of the substrate displays transistance.

ARRAY DEVICE—A multitude of similar, basic, complex, or integrated devices without separate enclosures, each having at least one of its electrodes connected to a common conductor or all connected in series.

ARTWORK—Artwork is an accurately scaled configuration which is used to produce the master pattern.

ASSEMBLY—A number of parts or subassemblies or any combination thereof joined together to perform a specific function. (Examples: Audio frequency amplifier, vacuum tube, voltmeter, distance meter, analog-to-digital converter.)

BASE—An insulating support for the printed pattern. It may consist of a flexible or rigid material.

BASIC DEVICE—The simplest useful device exhibiting a basic solid-state phenomenon.

BIONICS—The art which treats of electronic simulation of biological phenomena.

BOND STRENGTH—A measure of the stress required to separate a layer of material from the base to which it is bonded. It is measured in pounds per inch of width (peel strength) obtained by peeling the layer, and in pounds per square inch (pull strength) obtained by a perpendicular pull applied to a surface of the layer.

BOSS—Use TERMINAL AREA.

CERAMIC-BASED MICROMINIATURE CIRCUITRY—Microminiature circuitry printed on a ceramic substrate. Usually consists of combinations of resistive, capacitive, or conductive elements fired on a wafer-like piece of ceramic.

CHARACTERISTICS—Any dimensional, visual, functional, mechanical, electrical, chemical, physical, or material feature or property; and any process-control element which describes and establishes the design, fabrication, and operating requirements of an article.

CHEMICALLY REDUCED PRINTED CIRCUIT—A printed circuit formed by the chemical reduction of a metallic compound.

CHEMICALLY DEPOSITED PRINTED CIRCUIT—A printed circuit formed on a base by the reaction of chemicals.

CHIP—Use SUBSTRATE.

CIRCUIT ELEMENT—A basic constituent of a circuit, exclusive of interconnections.

COLD WELD—The joining together of two metals (without an intermediate material) by the application of pressure only, without an electrical current or elevated temperature.

(Continued on page C 32)

THE STATUS OF MICROELECTRONICS

Microelectronics showed early promise of revolutionizing the industry. But despite the millions spent yearly by both government and industry on R&D, difficulties still hamper the production and widespread acceptance of these new components. These problems and others are frankly discussed.

FROM THE BREADTH OF WORK in techniques and applications of thin-film and single-crystal microelectronics, conservative estimates indicate more is to be discovered than has already been uncovered. The impact in future equipment will rank with the discovery of the transistor.

Semiconductor manufacturers, hopeful that present diffusion, passivation, photomasking and etching, and epitaxial techniques will remain in use, are automating measurement, test, and assembly. Elimination of these areas as bottlenecks in an apparently predictable stable processing period ahead promises a hotly competitive circuit-pricing market in one to three years.

Standardization is expected rapidly only in test and measurement, with some acceptance of certain package configurations. Major emphasis may be applied to controlling and standardizing process steps, with less emphasis on circuit configurations and transfer function.

Integration of thin-film and semiconductor techniques is expected, but metallic thin-film active devices have not reached the development maturity necessary to assay a predictable future.

Military and aerospace equipment manufacturers are rapidly applying thin-film and single crystal microelectronic circuits to their products. Military contracts, expected to total $100 million dollars in 1963, are aimed at developing the potential microelectronic advantages of improved cost, reliability, weight, lower power, quick reaction time and maintainability in selected applications. Although com-

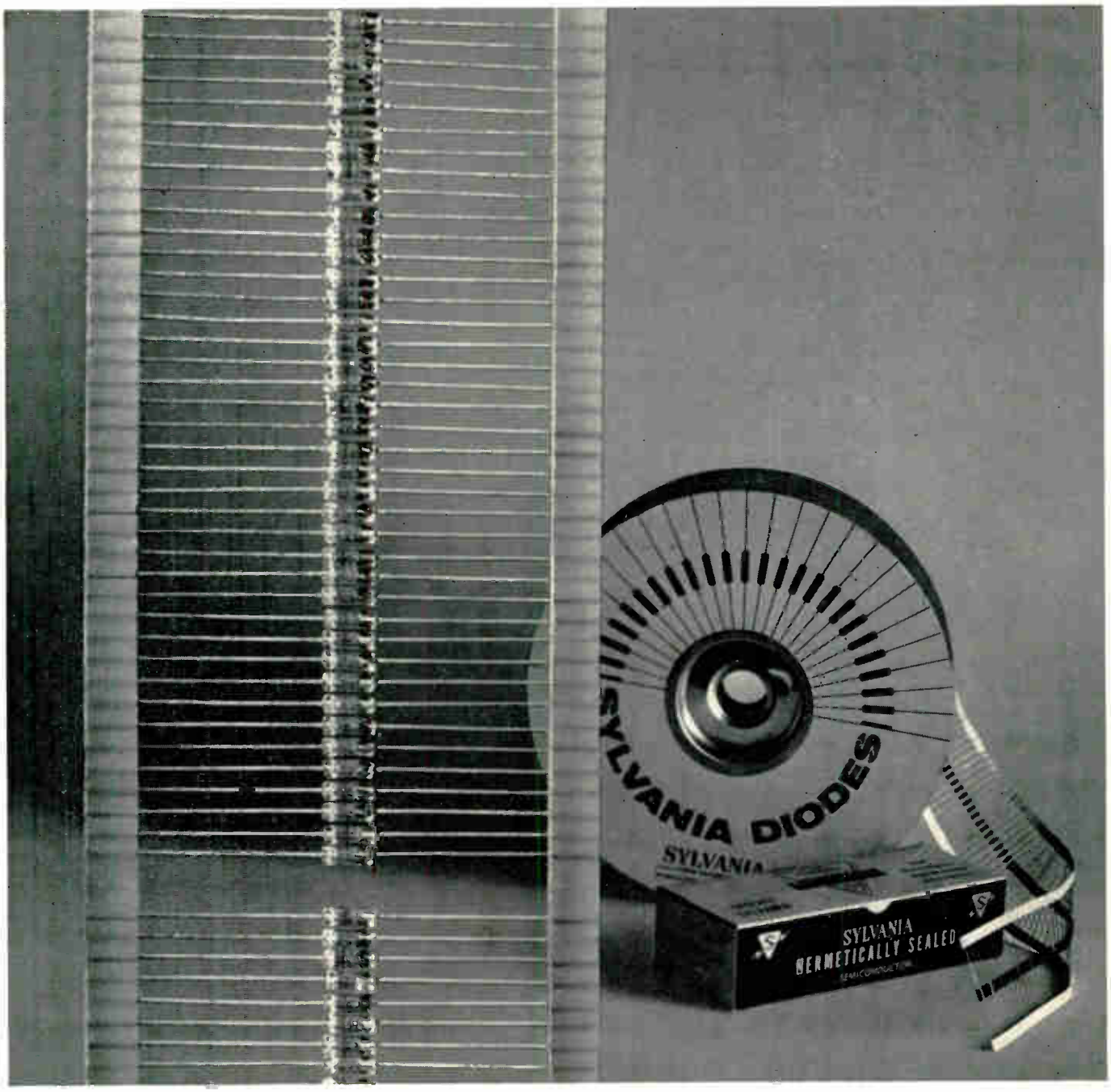
(*Continued on page* C20)

Fig. 1: Typical Characteristics of Microelectronic Techniques.

THIN FILM CIRCUITS	RESISTORS	CAPACITORS	ACTIVE DEVICES
Value	200-400 ohm/sq	30,000 Pf to 2μf/inch²	—
Tolerance	±5%, ±1%	±50%, ±10%, ±5%	None (1962)
Stability	±0.1%	±1%	*
Ratio	±1%, ±0.1%	±1%	—
Temperature Coefficient	±50 PPM/°C	±1000 PPM/°C	—
Voltage Stability	Too low to measure	—	—
SINGLE CRYSTAL CIRCUITS			
Value	200-400 ohm/sq	20,000 to 50,000 Pf/in²	Transistor Diodes
Tolerance	±30%, ±20%	±30%	Field effect devices
Stability	±0.1%	±1%	SCR'S
Ratio	±0.1%	±0.1%	—
Temperature Coefficient	≈ +1000 PPM/°C	Diode	—
Voltage Stability	—	Δ 30% (0.1 to 10 v)	—

*Production feasibility of thin film active films not at present demonstrated.

By E. Q. CARR
Technical Director,
Microelectronics Development Engineering,
General Electric Co.,
Utica, N.Y.



This "diode gap" saved our customer money

Along with controlled manufacture, another benefit of the high degree of automation at Sylvania's diode plant is the packaging flexibility we can offer.

For example, the unusual packaging shown above came about when one customer asked us to deliver his diodes taped in tight groups of 50, with a gap between groups. This made it easy to pick up 50 at a time for insertion into lead-bending machines, with a considerable saving in girl-hours. Another customer asked for leads already bent at the ends, with the diodes inserted into blocks of foam plastic. We were able to oblige in both cases.

Neither of these "specials" caused any great problem or expense, thanks to the versatility of Sylvania's automated packaging equipment. It can be programmed to meet your needs, whether the requirement is reels, boxes, or some other form of packaging. One more reason to consider Sylvania for your diode requirements, germanium or silicon.

Semiconductor Division, Sylvania Electric Products Inc., Woburn, Mass.

SYLVANIA

SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS

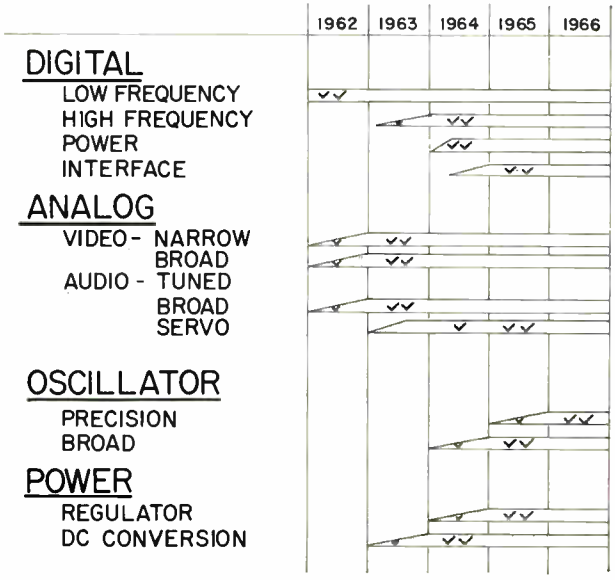
NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS • MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

mercial and industrial uses are expected at a slower rate, some appearances are expected in 1963. The major impact year for the military applications should be 1966; commercial applications should be 1968.

Single-Crystal Circuits

Semiconductor component manufacturers are pressing vacuum tube and germanium transistor radio and TV markets with low-cost, high-performance, plastic-packaged, planar-passivated silicon transistors, which are produced by process techniques used to manufacture microelectronic single-crystal circuits. While the demise of germanium-alloy signal transistors is thus foreshadowed, equipment now capable of producing fifty thousand planar-epitaxial passivated transistors a day can be converted with little or no modification into a five thousand single-crystal circuit-a-day operation. A circuit can average ten components ranging through high-frequency transistors, fast diodes, zener diodes, tens-of-picofarad capacitors and closely ratioed, high-toleranced resistors with large predictable negative temperature coefficients. Although only five or six semiconductor manufacturers reportedly have conquered both initial development and production yield problems, many have a one hundred to two hundred a week circuit pilot production-run stage. This quantity pilot run normally precedes a full thousands-a-week capability within six to nine months.

Fig. 2: Industry Circuit Availability.



Semiconductor manufacturers are relying on present processing techniques to carry them through the coming microelectronic era without revolutionary manufacturing changes. Present keys to low-cost manufacturing are:

—Precision control batch gaseous diffusion processing;
—Photo-resist etching;
—Fully or partially automated wafer/dice testing, die assembly, and packaging;
—In-process or post-passivation junction protection from moisture and other contaminants (permitting epoxy encasements for at least commercial environments);
—Epitaxial depositions; and
—In-house mask-making capability.

In the past, such measures obsoleted costly, automated, alloy type production lines before a profit was realized.

Established semiconductor and some equipment companies have programs involving from ten to one hundred professional contributors. Their goals range from in-house engineering development and application to several thousand circuits a month; but expansion plans call for production well into the tens of thousands of circuits a month if the demand warrants it. Last year a dozen or more military equipment firms have established in-house thin-film and/or semiconductor process engineering laboratories. Although they are not openly competing with semiconductor suppliers, equipment builders are seeking to establish a profitable future position in the single-crystal and thin-film circuits area, in addition to solving the problems of specifying, designing, and testing new circuit types. Consequently, semiconductor vendors are reacting with a barrage of services which include:

—Multiple device chip assemblies in a single package;
—Converting a circuit breadboard of conventional parts into a single-crystal circuit on a two-to-five week quick-reaction basis;
—Selling at any point in the semiconductor production line—from an epitaxial wafer to a fully diffused wafer without intraconnection and up to individual micropackaged device and circuit dice;
—Do-it-yourself kits which result in a hybrid assembly of flying-lead intraconnected device chips soldered in microelectronic packages; universal or custom matrices of limited range. The process-selectable standardized components are dif-

(*Continued on page* C22)

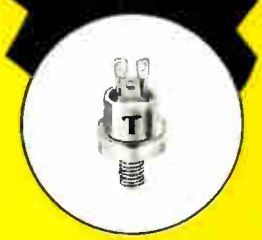
SILICON PLANAR POWER TRANSISTORS

PNP 2N2875

Features remarkably high beta linearity over wide range of collector currents. Dissipates up to 15 Watts of power at 100°C case.

Type	DC Current Gain @ I_C= 500mA (β)	Typical Collector Saturation Voltage @ I_C= 500mA (Volts)	Minimum Sustaining Voltage @ I_C= 50mA (Volts)	Typical Cut-Off Frequency @ I_C= 100mA (Mc)	Power Dissipation Rating @ 100°C Case (Watts)
2N2875	20-60	1.0	50	30	15

IN A 7/16" STUD-MOUNTED PACKAGE



NPN 2N2866-7

Features extremely low RCS of 0.75 Ohms Max. Dissipates up to 20 Watts of power at 100°C case. High beta linearity.

Type	DC Current Gain @ I_C= 500mA (β)	Typical Collector Saturation Voltage @ I_C= 1 Amp (Volts)	Minimum Sustaining Voltage @ I_C= 50mA (Volts)	Typical Cut-Off Frequency @ I_C= 100mA (Mc)	Power Dissipation Rating @ 100°C Case (Watts)
2N2866	20-60	0.4	80	15	20
2N2867	40-120	0.4	80	15	20

TRANSITRON'S NEW STATE-OF-THE-ART SILICON PLANAR TRANSISTORS FEATURE GREATER RELIABILITY, LOWER RCS, AND PERMIT FURTHER CIRCUIT SIMPLIFICATION IN DEMANDING POWER CATEGORIES.

Drawing heavily upon its broad experience in silicon power transistor development and stud-mounted packaging, Transitron introduces its new PNP 2N2875 and NPN 2N2866-7 intermediate power silicon transistors. They combine all the recognized advantages of planar construction with the efficiency of 7/16" hex base stud-mounted packaging, which solves a variety of annoying mounting problems. And, because they complement each other, extensive circuit simplification is now practical within power applications.

These highly reliable silicon planar power transistors are the product of the same intensive Transitron Total Reliability Program that produced the popular 7/16" NPN 2N1647-50 and 2N2018-21 series for modern military ICBM systems. Continuous lot control from ingot stage, thorough product improvement documentation, and comprehensive failure analysis have enabled Transitron Product Engineering to develop units which will satisfy the strictest requirements.

The 2N2875 and the 2N2866-7, and other complementing PNP and NPN silicon power transistors, are available through your Transitron Distributor.

For complete information, write Transitron's Wakefield, Mass. installation.

Transitron electronic corporation
wakefield, melrose, boston, mass.

SALES OFFICES IN PRINCIPAL CITIES THROUGHOUT THE U. S. A. AND EUROPE • CABLE ADDRESS TRELCO

Circle 2 on Inquiry Card

fused in batches of stockpiled wafers convertible to fifty to two hundred circuits by two additional mask and process steps.

Competition between the component and equipment groups continues. With much significant growth still to be achieved in the technique areas, leading semiconductor firms continue to garner the high volume production runs.

Opinions vary but more widespread application, particularly in linear circuits, is hampered only by high initial mask cost. The industry, however, is plagued by a lack of definitive reliability criteria, reluctance of semiconductor vendors to discuss problems, and a tendency of these vendors to emphasize the merits of their individual approaches. Factors contributing to the situation are: only recent, lethargic, investigation into new associated circuit problems by equipment circuit designers; lack of detailed component-drift data and worst-case analyses; and definition of limits acceptable to reliability engineers long nurtured in component-oriented calculations. In addition, there are premature standardization conflicts caused by a plethora of different logic-block circuit types from each manufacturing source entering the field.

High-powered, hard oversells to upper management give rise to misconceptions on how much can be done—and how soon. In one instance, a request was made to micro and make redundant a wide-band multi-channel amplifier to achieve two-year unmaintained operation, thus solving a particular reliability problem in military field use. The findings of a cursory engineering investigation showed the present weighty thirty-two vacuum tube, small-quantity-use amplifier operated from a few hundred kc to the gc frequency range and, in field use, was lashed to a trembling sheetmetal support. Aside from requiring a costly and superb engineering achievement based on some blithe assumptions concerning an all-semiconductor problem solution, a low-budget cost-sharing arrangement was expected. Suggestions for non-redundant conventional alternative solutions to establish feasibility were ignored.

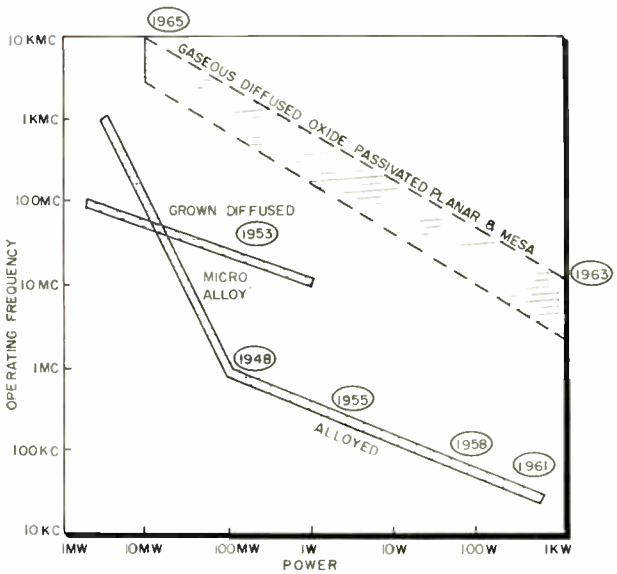
Single-Crystal Circuit Applications

Considerable mixing of micro and conventional components, circuits, and techniques will prevail in the foreseeable future (Fig. 6). Digital computer designs and data processing with 90 to 100 per cent fully integrated, single-crystal circuits in arithmetic and control sections is feasible. Remotely alterable memory, memory drive, and amplifiers are less amenable to micro techniques for reasons of per bit cost, low usage, high power, and large size. Techniques discussed later offer hopeful solutions in some areas, but progress lags in circuit availability by several years. The work of six firms engaged in military computers demonstrates size, power and weight advantages gained with micro techniques (Fig. 7).

Second-level interconnection of single-crystal circuits is accomplished in a wild, nearly chaotic, exploration of multilayer stacked, eyeletted, etched wireboards; multilevel electrodeposited epoxy-coated leveled board structures; cordwood stacking with welded risers; epoxy potted and unpotted, welded matrix interconnections with and without additional soldering, etc. So far all approaches are costly and, in some cases, still require significant amounts of handwork. A seven to eleven multiply stacked etched board in small quantities can cost a thousand dollars or more because of artwork and photomask tooling charges necessary even in small quantities. At least two military development contracts have been let to study and solve the problems, but the findings have not been generally accepted by industry. A number of techniques employing optical-laser welding at atmospheric pressure; programmed, kilowatt-power, precision-deflected, electron-beams welding at low pressure; small single-piece welding probes; and thin-film interconnection methods are being inves-

(*Continued on page* C26)

Fig. 3: Semiconductor Process Explosions. Improved manufacturing techniques has increased both the quality and quantity of the components, but they have also outdated process before a profit can be realized.



NEWEST
MICROELECTRONIC

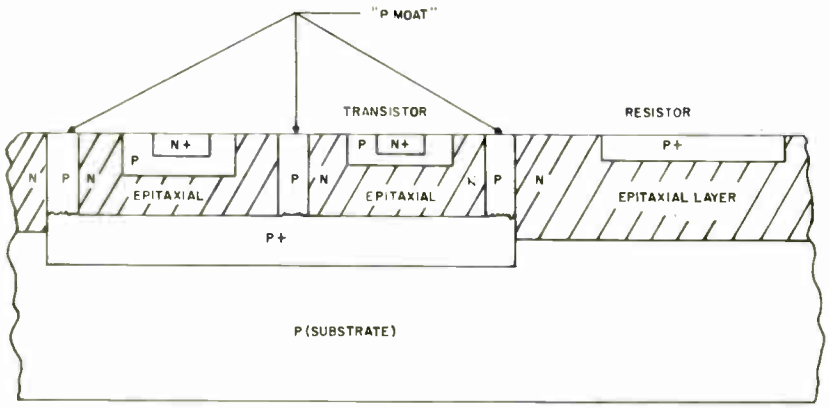
close matching

9 New Differential Amplifier Transistors feature close matching of characteristics: $\triangle V_{BE}$ as low as 5 mV maximum. ☐ Other features include: temperature tracking of V_{BE} — $\triangle (V_{BE_1} - V_{BE_2}) / \triangle T$ as low as $10\mu V/°C$.; extremely high beta — up to 50 min. at $1\mu A$ matched to within 10%; and low noise typically 2db. Extremely low leakage — as low as 1nA max. at 30 volts. ☐ Because these devices eliminate common-mode signals and allow use of balanced inputs to minimize input drift, they find application in low drift DC amplifiers, operational amplifiers, telemetry, comparators and analog-digital converters. These new microelectronic devices have two closely matched low-level NPN silicon planar transistors, electrically isolated but thermally connected, in a single 6-lead TO-5 package. Production quantities are presently available. ☐ Sales Offices: Chicago, Illinois; Los Angeles, California; Oakland, New Jersey; Medford, Massachusetts; Sykesville, Maryland; Bethpage, L. I., New York. ☐ Write today for technical bulletin. *SPERRY SEMICONDUCTOR, Norwalk, Connecticut.*

SPERRY
DIVISIONS OF SPERRY RAND CORPORATION

Circle 3 on Inquiry Card

Fig. 5: Formation of thin-film, single-crystal layers on an insulating substrate could solve the parasitic problem with respect to junctions. However, this type of single-crystal film may not meet production process standards.

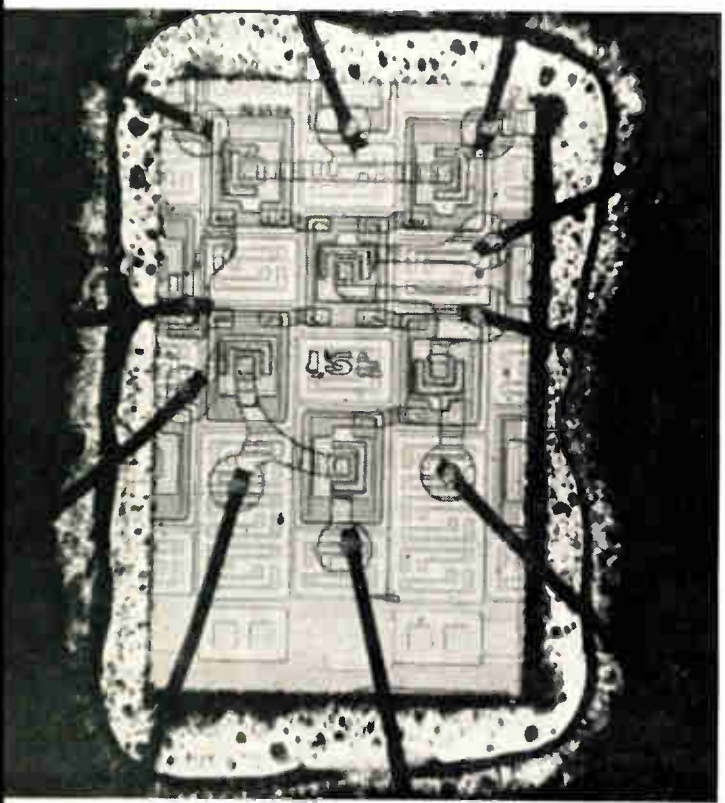


MICROELECTRONICS (Continued)

tigated in an effort to improve reliability within reasonable cost.

Interconnection problems involving large intercoupling capacity between cable-bundle leads, low-drive logic, small fanout, low clock speeds, plus uncertainty about power and ground bus noise at low power levels in semiconductor single-crystal circuits have caused computer manufacturers not to react rapidly to present microelectronic logic circuits. In a business in which 80 per cent is software and 20 per cent hardware there is little enthusiasm despite tantalizingly low-cost production proposals by semiconductor vendors. Commercial computer firms that are hard pressed to expand or keep their share of computer markets have followed a pattern of increasing clock speeds and living on tumbling semiconductor prices, while increasing computer complexity to handle more and more difficult customer tasks.

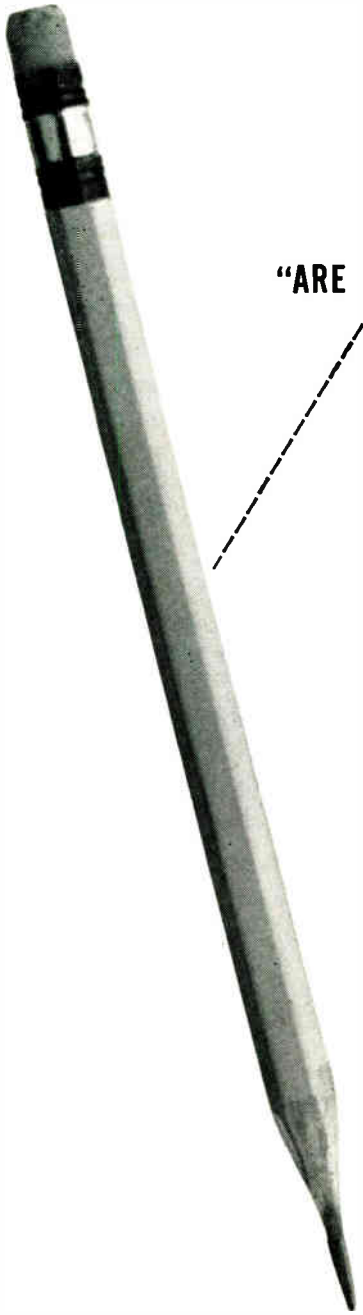
Fig. 4: GE's 12F is an example of a current integrated circuit. It is a 5 gate NOR circuit consisting of transistors, 6-v zener diodes, fast signal diodes, and resistors.



Computer firms that have made developments in superconducting cryogenic microelectronics have aimed at an elusive target of low-cost, high-speed computation, and now are experiencing delays in converting laboratory work into production procedures. Production problems in yield, photoetching, intraconnection, precision mask alignment, and thermal shock are found when multiple-layer deposited thin films on large thinly-insulated metal substrates are being made.

Should delays in cryogenic production continue, manufacturers may take advantage of the cryogenic vacuum-evaporating, photomasking, and camera facilities to produce their own microcircuits. Additional equipment needed to perform this function would cost between $300 to $600 thousand dollars. This would be a successful venture because it would supply a wide second source of components for industry, and it would also open potential low-cost markets in small industry, machine tools, etc. The main stumbling blocks are a dearth of proven top-talent semiconductor personnel and necessary redesign in logic, interconnection and computer repackaging (and, whimsically, perhaps, "image unselling," if microelectronics shrinks the now commonplace showboat computer installations). The brilliant VonNeumann, who could not envision more than a few giant electronic computers in the late 1940's, might be startled at the number in use today—and perhaps shocked at future floods of computer-controlled micro-

(*Continued on page* C28)



"ARE YOU SURE YOU CAN GIVE HIGH EFFICIENCY IN HIGH CURRENT SATURATED OPERATION?"

Type	V_{CEO} @ I_C Volts @ Amps	V_{CBO} @ I_{CBO} Volts @ ma	h_{FE} @ I_C Amps	$V_{CE(sat)}$ @ I_C Volts @ Amp	Thermal Resistance
2N1518	40 1.0	50 4	15/60 15	0.7 25	0.8° C/watt
2N1519	60 1.0	80 4	15/60 15	0.7 25	0.8° C/watt
2N1520	40 1.0	50 4	17/68 15	0.6 35	0.8° C/watt
2N1521	60 1.0	80 4	17/68 15	0.6 35	0.8° C/watt
2N1522	40 1.0	50 4	25/100 15	0.5 50	0.8° C/watt
2N1523	60 1.0	80 4	25/100 15	0.5 50	0.8° C/watt

NOW AVAILABLE AT HALF-PRICE: A family of high current transistors that offers low saturation resistance for improved efficiency. You use fewer components in a circuit, get better reliability.

For additional information or applications assistance, write your nearest Delco Radio Semiconductor distributor or one of our sales offices listed below. Better yet, phone.

DELCO RADIO
DEPENDABILITY
RELIABILITY

Division of General Motors, Kokomo, Indiana

Union, New Jersey
324 Chestnut Street
MUrdock 7-3770
AREA CODE 201

Detroit, Michigan
57 Harper Avenue
TRinity 3-6560
AREA CODE 313

Palo Alto, California
201 Town & Country Village
DAvenport 6-0365
AREA CODE 415

Santa Monica, California
726 Santa Monica Blvd.
UPton 0-8807
AREA CODE 213

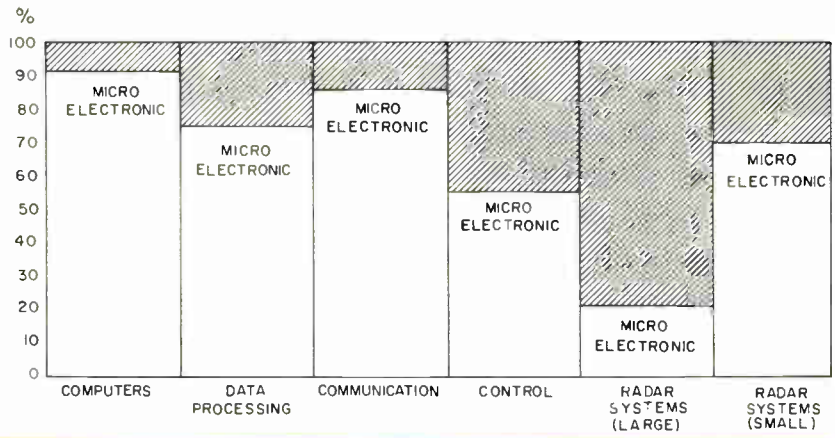
Syracuse, New York
1054 James Street
GRanite 2-2668
AREA CODE 315

Chicago, Illinois
5151 N. Harlem Ave.
775-5411
AREA CODE 312

Kokomo, Indiana
700 E. Firmin St.
GLadstone 2-8211, Ext. 500
AREA CODE 317

Circle 4 on Inquiry Card

Fig. 6: Estimated Conventional vs Microelectronic Circuits in Military Equipment by 1966.

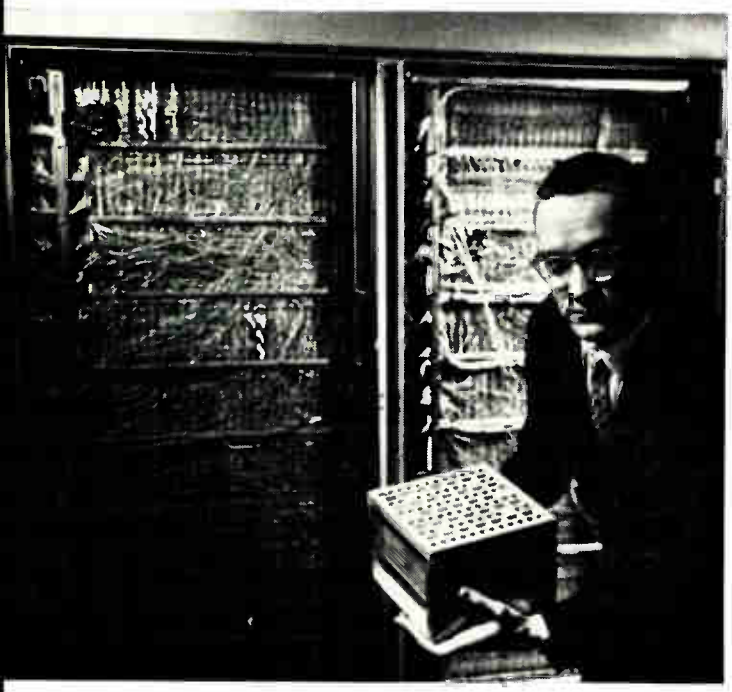


MICROELECTRONICS (Continued)

electronic computers gleaming in the eyes of American marketing men.

The envisioned fifty-cent to a dollar circuit has caused cost-conscious, import-sore, radio manufacturers, already converted to germanium transistors in most home radios, to consider competitively-priced, higher-performance, low-collector capacitance individual silicon devices. Silicon-transistor breadboard receivers are operating already, and micro-techniques may soon be introduced. Production radio engineers design radios to operate on a bewildering variety of one, two, three or a dozen transistors for an r-f range of 200 KC to over a 108 MC. However, portable radio manufacturers exist on cheap transistors (those that do not meet specifications) from commercial computer quality transistor production lines. Challenging implications arise when a decreasing volume of the germanium transistors shrinks this transistor supply. Limited engineering staffs have caused many manufacturers to skimp on long-range development, thus causing a dependence on semiconductor vendors for advanced microelectronic innovations. This dependence may stay introduction of microelectronics for the years it takes to saturate the military market.

Fig. 7: The A-236 is a microversion of the M-236 shown in background. The A-236 airborne central computer will be used in early warning and control systems, aircraft and weapon control systems, etc.



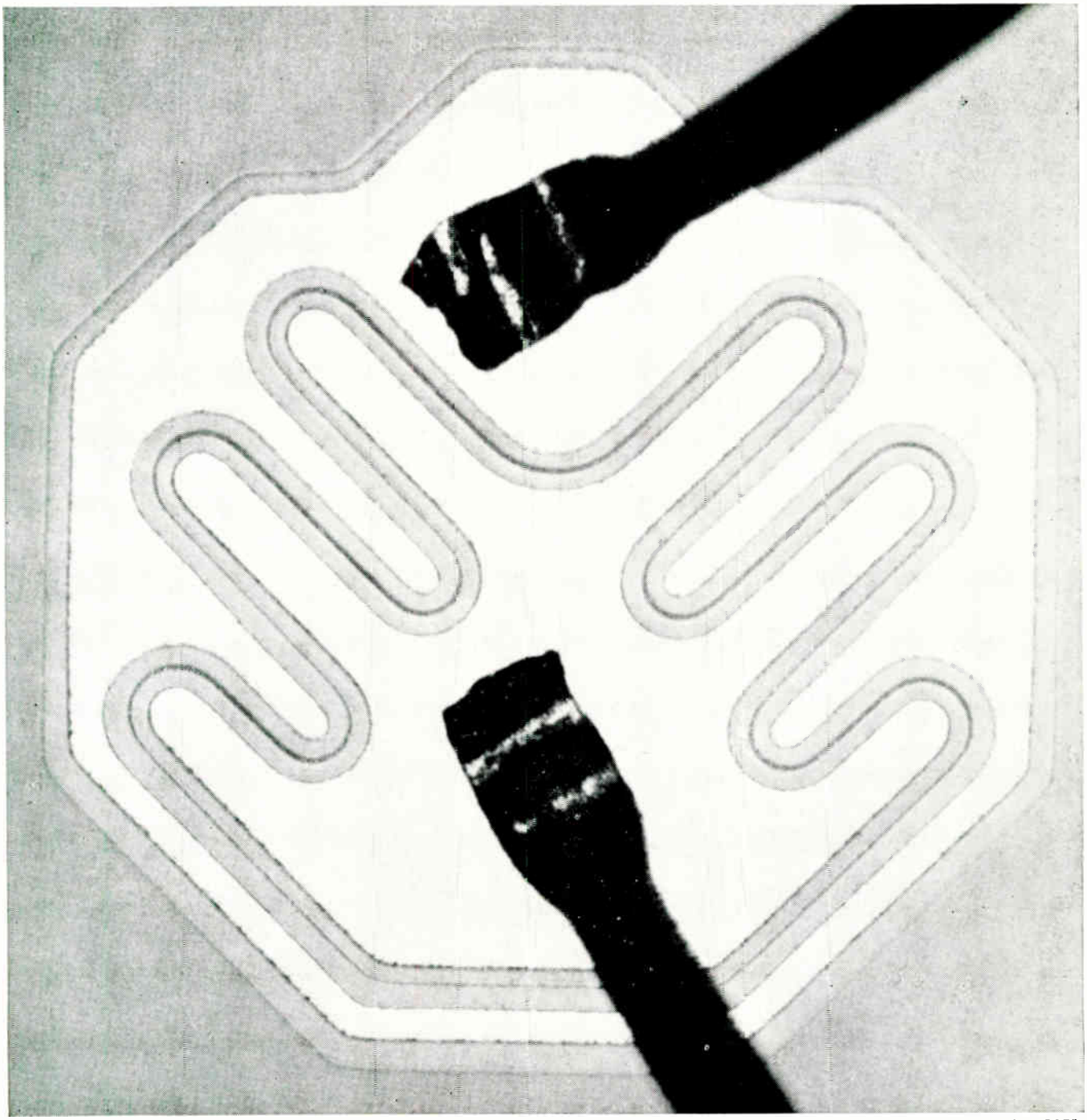
Raw materials for breakthroughs exist, and efforts may be directed towards low-collector capacity silicon transistors, characterized for linear class-A operation well below 1 ma collector current; that are below a fifty-cent transistor price; that have 3 to 10 kc bandwidth, low-insertion loss, 455 kc center-frequency filters to team with a three to five stage 50 to 65 db wideband video amplifier for i-f strips; potentiometer tuned oscillator/converter circuits; precision wide-capacity, swing-voltage variable PN junction tuning capacitors; R-C Q multipliers; combinations of field-effect devices and transistors; NPN and PNP transistors in one chip for high-efficiency audio stages; and, perhaps, cheap current regulators which permit half battery voltage operation in low-voltage portables. High-volume, auto radios, which have a greater margin in pricing, have more to gain by intrinsic silicon circuit advantages (easier wide temperature operation), and the opportunity to move some of the profit in-house now going outside to vendors will likely lead portables in the field.

Thin-Film Microelectronics

Thin films are a paradox. Many equipment manufacturers enter microelectronics with thin films for the following reasons: lower initial investment; similarity of circuit design techniques to conventional components; less stringent photomasking, etching

(*Continued on page* C30)

Bendix "Leaf"* Silicon Transistor



*Patent applied for.

Magrified 265 times—actual size .025".

BENDIX SILICON PLANAR EPITAXIAL TRANSISTORS OFFER THESE ADVANTAGES:

MECHANICAL	ELECTRICAL
"Leaf" Configuration	Lower Saturation Voltage
Larger Emitter Area	Higher Gain
Larger Emitter Periphery	Improved Beta Linearity
Larger Bonding Area	Higher Reliability
TO-5 and TO-18 Packages	81 Types

Write us in Holmdel, New Jersey, soon.

Bendix Semiconductor Division

THE Bendix CORPORATION

and artwork; straightforward evolution from etched wireboard work; high-speed circuits with minimum parasitic problems; design flexibility; relatively low cost in small quantities; and the future potential of compatible process for thin-film active devices. But vacuum-evaporated metal thin films, recorded over a hundred years ago, have less than ten years experience in control of precision sheet resistance, temperature coefficient, substrate finish, source shapes, multiple element alloy compositions and effects of hydrocarbons, water vapor, oxide formations in the vacuum systems. Manufacturers find few experts in the composition of thin films below 1000Å thick. Cleaning procedures, materials specification and control, heater design, etc., as in semiconductor process, are presently more art than science.

Present processes use singly or in combination elements and oxides of aluminum, chrome, gold, copper, tantalum, niobium, silicon, nickel, titanium, barium, cadmium sulfide, tungsten, etc. Materials are evaporated by electron beams, metal ribbon and filament resistance heaters, r-f fields, and radiation heating. Laboratory uses include sputtering, glow discharge, ion transport, optical laser heating at pressures of 10 to 100 microns in atmospheres of nitrogen, argon, and helium with controlled leak systems of oxygen, nitrogen, etc. Deposition areas are controlled with precision-registered metal, glass and ceramic masks, or by controlled etch-back techniques in "maskless" deposition systems. "Maskless" systems actually use photographic masks rather than etched metal masks to overcome tolerance and etching problems which, so far, limit minimum metal mask apertures to the 1 to 5 mil range.

Deposition substrate materials include fire-polished glass, chemically insulated oxidized or anodized metals, oxidized silicon, plastics and glazed ceramics of aluminum and beryllium oxide. Ceramics offer high thermal conductivity with present problems of controlling flatness, surface finish and thickness. Active devices are thermocompression bonded, welded, soldered or ultrasonically bonded to the deposited substrates of passive components.

Circuit design procedures are similar to normal component approaches; the circuits have less severe resistor and capacitor tolerances than single-crystal circuits, but they lack adjustable resistor, capacitor or any usable inductance. The variety of methods being investigated indicate an open field but without a clearly defined path. As such, it is difficult to assess the future. However, thin-film approaches could well represent the ultimate in microelectronic techniques.

Thin-Film Applications

Development applications already explored are digital and linear circuits in military radio receivers, missile instrumentation, auto pilots, test equipment, and high-powered, large-fanout, digital circuits. Four stage, R-C coupled, 50 to 60 db gain, wideband video amplifiers centered at 4.5, 30 and 120 MC are operating and under military test.

High cost of microsized semiconductors, improved quality of silicon-dioxide passivated device junctions, and improved chip-bonding techniques indicate the new paths of interconnection by thin films now in development. Fig. 8 shows the feasibility of direct-device dice bond-

(*Continued on page* C34)

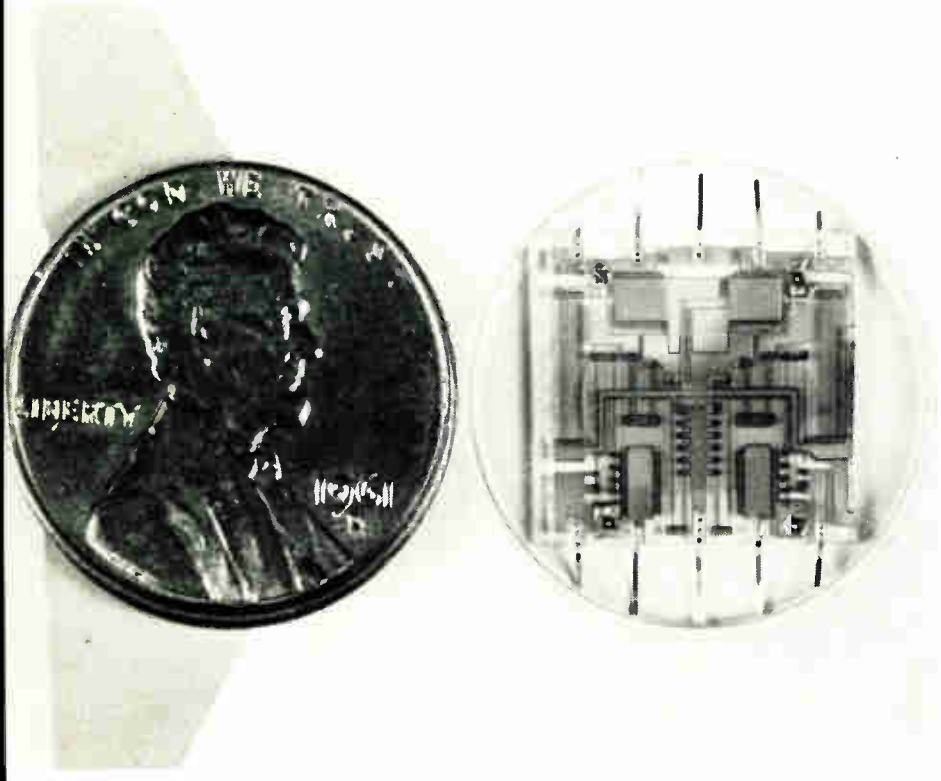
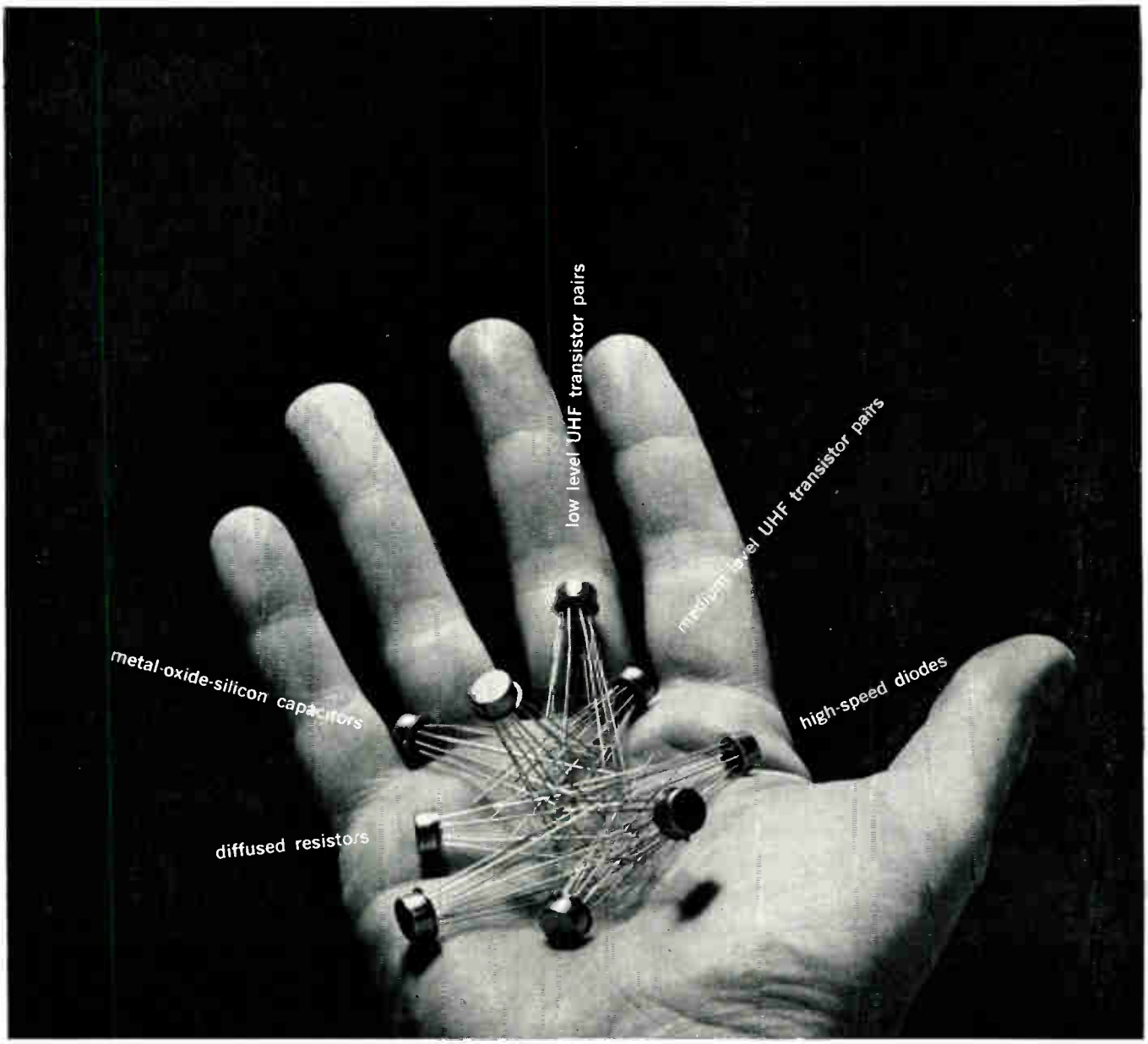


Fig. 8: Device Chips Bonded to Thin-Film Substrate. The individual device chips are thermocompressed to a thin-film glass substrate.

THE BEST WAY TO GET THE FEEL FOR INTEGRATED CIRCUITS:



USE INTEGRATED COMPONENTS

Signetics calls these integrated components preFEBS®. With them, the circuit designer can observe, first hand, the performance characteristics of his design as it would behave when completely integrated. That's because each preFEB is fabricated with its characteristic isolation junction and has the same leakage current and isolation diode effects as that particular component would have in a completely integrated circuit. With preFEBS, the reliability engineer can study the reliability of each integrated circuit component. And with preFEBS, management has a low cost assurance that integrated circuit decisions are sound. There are 9 preFEB combinations – all housed in 8 lead TO-5 cans including PF800T, PF801T Transistor Pairs; PF830T, PF831T, PF832T Diodes; PF860T, PF861T Diffused Resistors; PF880T, PF881T Metal-oxide-silicon Capacitors. For more information about preFEBS, write to SIGNETICS INTEGRATED CIRCUITS, 680 West Maude Avenue, Sunnyvale, California.

SIGNETICS INTEGRATED CIRCUITS

CALL YOUR NEAREST SIGNETICS REPRESENTATIVE: **ALA.** Compar Southern, Huntsville, 539-4294 □ **ARIZ.** Compar Rocky Mountain, Scottsdale, 947-4336 □ **SO CALIF.** Compar Los Angeles, 877-9781 □ **NO. CALIF.** Eng. Liaison Assoc., Redwood City, 369-5515 □ **COLO.** Compar Rocky Mountain, Denver, 758-4873 □ **CONN.** Compar N.E. Hamden, 288-8296 □ **FLA.** Compar Southern, Orlando, 293-5202 □ **ILL.** Compar Chicagoland, 774-1500 □ **MD.** Compar Chesapeake, Baltimore, 523-7700; Hyattsville, 927-7222 □ **MASS.** Compar New England, Newtonville, 332-6975 □ **MICH.** Compar Michigan, Detroit, 865-5550 □ **MINN.** Compar Twin Cities, St. Paul, 646-6461 □ **MO.** Compar St. Louis, St. Louis, 721-6403 □ **N.J.** Compar Philadelphia, Haddonfield, 429-4013 □ **N.M.** Compar Rocky Mountain, 265-1020 □ **N.Y.** Compar New York, Little Neck, 225-3820; Compar Albany, 436-9649; Buffalo, NT 4-5731 □ **N.C.** Compar Southern, Charlotte, 333-7743 □ **ORE.** Eng. Liaison Assoc , Redwood City, Calif., 369-5515 □ **OHIO** Compar Ohio, Fairborn, 879-2631 □ **TEX.** Compar Southwest, Dallas, 327-3944 □ **VA.** Compar Southern, Richmond, 266 2060 □ **WASH.** Eng. Liaison Assoc., Redwood City, Calif., 369-5515 □ **CANADA** Aero Sales Eng., Rexdale, Ont., 249-9139

MICRO-CIRCUIT TERMS (Continued)

(Continued from page C 17)

COMPONENT PARTS DENSITY — Use PARTS DENSITY.

CONDUCTIVE PATTERN—A design formed from an electrically conductive material on an insulating base.

CONDUCTOR — A single conductive line forming an electrical connection between terminal areas.

CONTROLLED PART—An item which requires the application of specialized manufacturing and procurement techniques.

CORDWOOD—The technique of producing modules by bundling parts as closely as possible and interconnecting them into circuits by welding or soldering leads together.

CRITICAL ITEM—An item whose failure could result in hazardous or unsafe conditions or prevent performance of the tactical function of the end item.

DEFINITION—The fidelity of reproduction of pattern edges in the printed circuit relative to the original master pattern.

DEGRADATION—A gradual deterioration in performance. The synonym—DRIFT—is often used for electronic equipment.

DEPOSITION—The process of applying a material to a base by means of vacuum, electrical, chemical, screening, or vapor methods

DEVICE—A combination of physical material to form a part comprised of one or more active elements. (Examples: Transistor, diode.)

ELECTRON BEAM MACHINING—The process of using a controlled electron beam to weld or shape a piece of material.

ELEMENT—Increment of volume of a part that displays an electrical phenomenon. (Examples: Transistor fabrication within a silicon substrate using diffused structures, resistor formed by fusing metal oxide onto a glass base or conductor screened on a ceramic substrate.)

EMISSIVITY—The relative power (of a surface or a material composing a surface) to emit heat by radiation.

ENVELOPE DIAMETER—A dimension of an opening or hole, as in a tube or missile airframe, that describes the extent to which an object irregularly shaped can be accommodated as it rests in the opening or as it slides into the opening either at an angle or straight. The term is used especially in reference to accommodating electronic equipment within the airframe of a missile.

ETCHANT—A solution used, by chemical reaction, to remove the unwanted portion of a conductive material bonded to a base

ETCHED WIRING SUBSTRATE—A printed conductive pattern formed by chemical, or chemical and electrolytic, removal of the unwanted portion of conductive material bonded to a base.

FABRICATION TOLERANCE—In the construction and assembly of an equipment or portion thereof, the maximum variation in the characteristics of a part which, when related to the defined variations of the other part comprising this equipment, will permit operation of the equipment within specified limits.

FEEDTHROUGH—Use INTERFACIAL CONNECTION.

FINGER—Use PRINTED CONTACT.

GRID—A two-dimensional network consisting of a set of equally spaced parallel lines superimposed upon another set of equally spaced parallel lines so that the lines of one set are perpendicular to the lines of the other, thereby forming square areas. The intersections of the lines provide the basis for an incremental location system.

GUARD BAND—The unused area which serves to isolate elements in a printed circuit. (Examples: Area between printed contacts, area between an element and the edge of the mounting base.)

INTERFACE—The junction point or surface between two different media.

INTERFACIAL CONNECTION—A conductor which connects conductive patterns on opposite sides of the base.

LAND—Use TERMINAL AREA.

MASK—An implement, usually a thin sheet of metal containing an open pattern, which shields selected portions of a base during a deposition process. Also, an implement used to shield selected portions of photosensitive material during photo processing.

MASTER DRAWING—A drawing showing the dimensional limits or grid location applicable to any or all parts of a printed circuit, including the base.

MASTER PATTERN—A 1-to-1 scale pattern which is used to produce the printed circuit within the accuracy specified in the master drawing.

MATRIX—Use GRID.

MECHANIZED ASSEMBLY—The joining together of parts and/or subassemblies with the aid of operators and semiautomatic equipment.

MICROMINIATURIZATION — The technique of packaging a microminiature part or assembly composed of elements radically different in shape and form factor. Electronic parts are replaced by active and passive elements, through use of fabrication processes such as screening, vapor deposition, diffusion, and photoetching.

MINIATURIZATION — The technique of packaging by reducing size and weight of electronic parts in step with the change from vacuum tubes to transistors and diodes.

PAD—Use TERMINAL AREA.

PARTS DENSITY—The number of parts per unit volume.

PASSIVE SUBSTRATE—A substrate which exhibits no effects of transistance. (Examples: Glass, ceramic.)

PEEL STRENGTH—See definition for BOND STRENGTH.

PRINTED CONTACT—That portion of a printed circuit used to connect the circuit to a plug-in receptacle and to perform the function of a pin in a male plug.

PRINTED ELEMENT—An element in printed form, such as a printed inductor, resistor, capacitor, or transmission line.

PRINTED-WIRING SUBSTRATE—A conductor pattern printed on a substrate.

PRINTING—The act or art of reproducing a pattern on a surface by any of various processes, such as vapor deposition, photoetching, embossing, or diffusion.

PULL STRENGTH—See BOND STRENGTH.

REDUNDANCY—That design which makes additional electrical paths available to a function.

REGISTER MARK—A register mark is a mark used to establish the relative position of one or more printed-wiring patterns or portions thereof, with respect to their desired locations on one or both sides of a printed-wiring base.

RESIST—Resist is a material such as ink, paint, metallic plating, etc., used to protect the desired portions of the printed conductive pattern from the action of the etchant, solder, or plating.

SEPARABLE PART—A replaceable part, the body of which is not chemically bonded to the base, excluding the effects of protective coatings, solder, and potting materials.

SUBMINIATURIZATION—The technique of packaging miniaturized parts using unusual assembly techniques for increased volumetric efficiency. (Example: Cordwood.)

SUBSTRATE—A wafer-like piece of insulating material which may serve as a physical support or base and thermal sink for a printed pattern (Examples: Ceramic, glass, silicon, quartz.)

TAB—Use PRINTED CONTACT.

TERMINAL AREA—A portion of a printed circuit used for making electrical connections to the conductive pattern, such as the enlarged portion of conductor material.

TERMINAL PAD—Use TERMINAL AREA.

THERMOCOMPRESSION BONDING — The joining together of two materials without an intermediate material by the application of pressure and heat in the absence of electrical current.

THIN FILM CIRCUIT—The combination on a single passive substrate, such as glass or ceramic, of a number of elements entirely in the form of deposited films of conducting, semiconducting, or insulating materials. The method and sequence of deposition, physical location, and shape of the film provide the interconnections on the common physical support. (Example: Vaporized tin oxide on glass.)

TRANSISTANCE—An electronic characteristic exhibited in the form of voltage or current gain or in the ability to control voltages or currents in a precise and nonlinear manner. (Examples of parts showing transistance: Transistors, diodes, vacuum tubes.)

UNDERCUT—The reduction of the cross section of a metal-foil conductor caused by the etchant's removal of metal from beneath the edge of the resist.

WAFER—Use SUBSTRATE.

WIRING PATTERN — Use CONDUCTIVE PATTERN.

MICROELECTRONICS (Concluded)

ing to metal films on glass substrates using a gold-silicon eutectic solder. This technique now includes complete single-crystal circuit dice assemblies used in shift-registers (Fig. 9).

Integrating thin-film techniques with single-crystal circuits should simplify interconnection, and allow the use of cheap glass substrates for large capacitors, precision, low-temperature coefficient resistors in certain linear circuits, and precision ladder-divider networks for A/D convertors.

Thin-film passive circuits will be in low-quantity special circuits where high-speed or frequency operation and power levels greater than those obtainable from single-crystal circuit are needed. These circuits have larger substrate sizes, low parasitic values and favorable cost differential.

The paradox of thin films is that although it may be an advanced technique compared with the single-crystal diffusion process, continued integration of both technologies is already evident. Depositing isolated single-crystal platelets at scratches, pits and other surface anomalies in quartz, glass and semiconductors from gaseous reduction reactions has been observed for years. Large continuous single-crystal films proved difficult until recent work demonstrated that one-inch diameter patches of almost uniform silicon single-crystal film could be deposited on a molten layer of glassy oxides between the silicon and the final alumina substrate. Although laboratory work continues, transistor production-line quality films are not yet available. In the past six months,

A REPRINT OF THIS ARTICLE CAN BE OBTAINED BY WRITING on company letterhead to The Editor ELECTRONIC INDUSTRIES Chestnut & 56th Sts., Phila. 39, Pa.

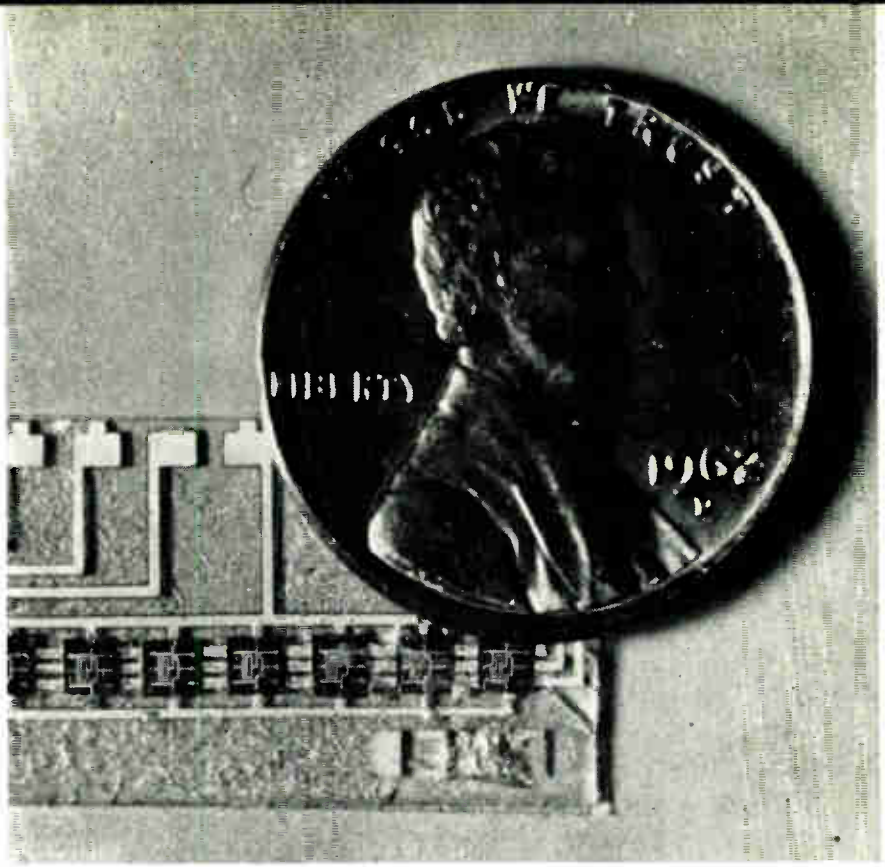


Fig. 9: The use of a cheap glass substrate instead of a more expensive silicon chip is demonstrated with this 4-bit shift register. Future progress in this field will reduce cost, size, and weight of the microcircuits.

military contracts for improvements have been awarded. The main technique attractions are large substrates (12 in. x 12 in. solar cells), continued utilization of present semiconductor device and circuit fabrication technology, almost complete elimination of parasitics by a passive substrate, and potential cost reductions. Every major research laboratory in the country has a thin-film single-crystal program in a technique which could prove a new industry departure point.

Thin-film active devices based on tunnelling phenomena, "hot" electron room temperature emission or field effects (Fig. 10) are intensively pursued in industry. Significant progress, short of the production line, however, has been made in field-effect devices employing polycrystalline cadmium sulfide and cadmium telluride. Production delays apparently stem from control and stability of semiconducting materials, film thicknesses, and fine line or gap and multilayer registration problems. As one researcher mumbled, "cadmium sulfide is a chemical mess!" But so were silicon and germanium in 1948.

Electron emission devices may be stymied in the only recently explored requirements of continuous, hole-free, high-dielectric constant insulators in the 50 to 100Å thickness range. The use of multiple metal and oxide film will eventually allow these devices to have higher nuclear radiation resistance than semiconductors.

The continuing advantage of passive thin films in frequency response, plus the future discoveries which may be ahead in thin films, have led several semiconductor firms to maintain more than token programs in passive thin-film elements, looking to possible future merging of the major techniques.

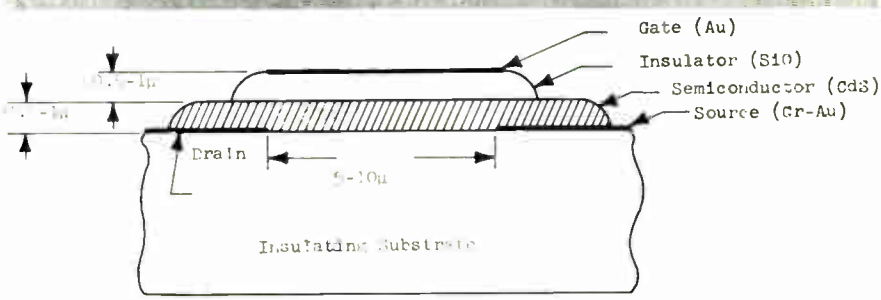
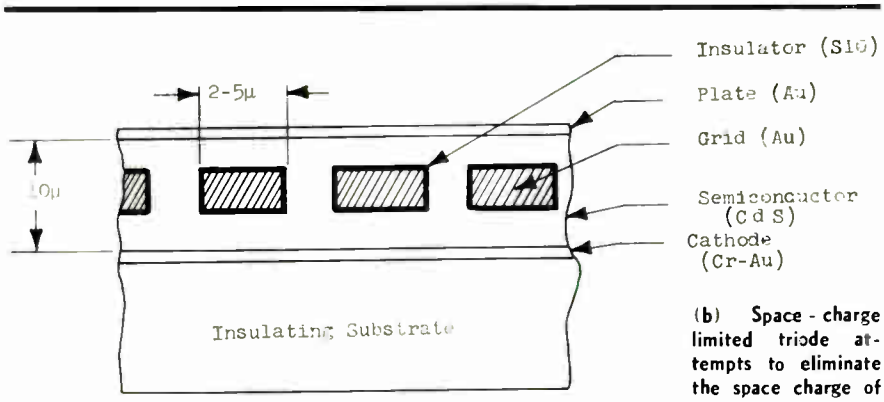
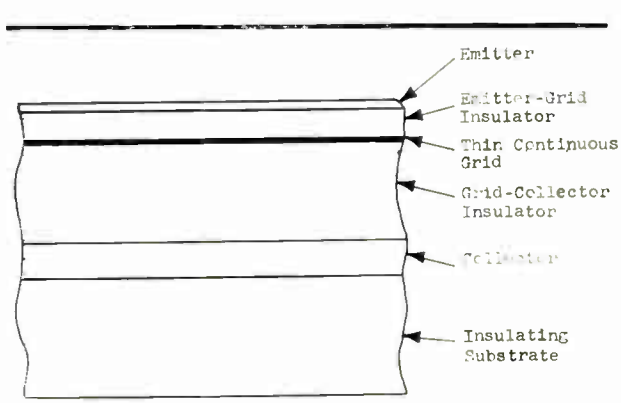


Fig. 10: (a) Field-Effect Triode. The gate-electrode voltage modulates the carriers in the volume between source and drain electrodes.



(b) Space-charge limited triode attempts to eliminate the space charge of the conventional triode by allowing the electrons to move through a perfect crystal lattice.



(c) Nontunneling hot electron triode operates at ambient temperatures if there's spontaneous electron emission, ultra-thin insulation layers, and energy level differences in sandwich metals.

New compact storage tube for airborne applications

Hughes has developed a 5″ diameter direct view storage tube with an overall length of 8″ (tube envelope length – 4″). The Hughes H-1076AP20 TONOTRON* tube overcomes the severe size limitations inherent in airborne equipment.

Designed with weather radar and terrain avoidance radar in mind, the H-1076AP20 has both original design and retrofit applications. It is now feasible to realize the advantages of high light output direct view halftone storage tubes where before only standard cathode ray tubes could be used.

While much smaller in size, the average performance characteristics of the Hughes compact TONOTRON* tube are equal to or better than many larger 5″ diameter storage tubes:

H-1076AP20 5″ TONOTRON* direct view halftone storage tube with electrostatic focus and magnetic deflection. 4″ minimum useful screen diameter. On-axis construction.

STORED RESOLUTION 50 lines/in (shrinking raster) for 5μa beam current and 80% of equilibrium brightness.

BRIGHTNESS 2000 ft. L equilibrium brightness at 10,000 volts.

WRITING SPEED 60,000 in/sec for 5μa beam currents, from 0% to 80% of equilibrium brightness.

ERASE TIME 200 milliseconds (length of single pulse to reduce brightness from 100% to 20%).

VIEWING TIME** 30 secs.—0% to 20% of equilibrium brightness.

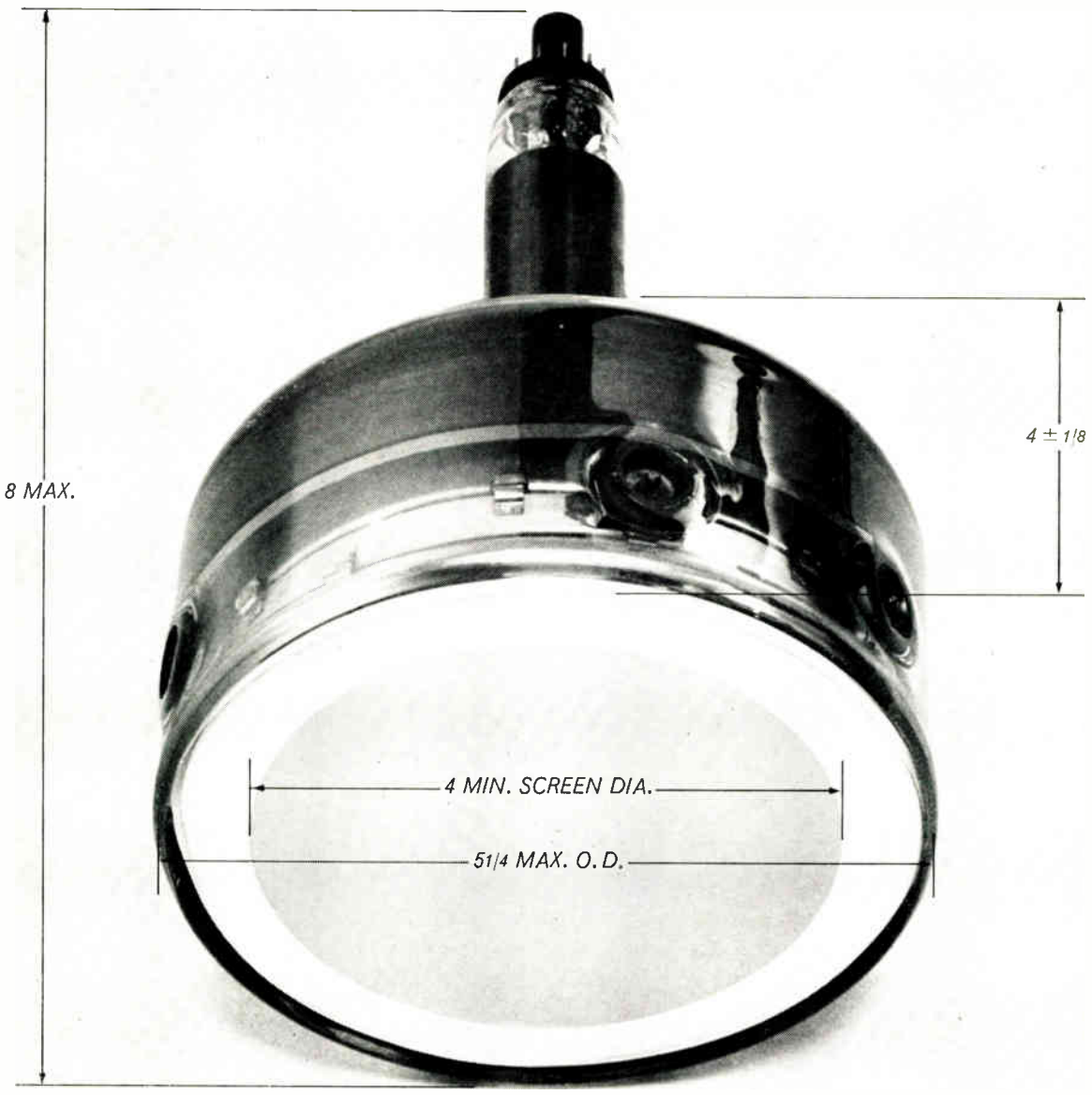
For additional information and answers for your specific display problems, call, wire or write today: Hughes Storage Tubes, 2020 Short Street, Oceanside, California—Area Code 714, 722-2101, Ext. 273 or 280. Hughes Storage Tubes, 1 Bala Ave., Bala Cynwyd, Pennsylvania, Area Code 215, MO. 4-3950. For export, write Hughes International, Culver City, California.

Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY
VACUUM TUBE PRODUCTS DIV.

*Trademark Hughes Aircraft Company **By means of pulsing techniques, unneeded light output can be traded for extended viewing time.



SECTION C

SEMICONDUCTORS & TUBES

Part Two–Tubes

TUBES— TODAY AND TOMORROW

In spite of the gloomy prediction
of a few years ago,
vacuum tubes are very much "alive" today.
The dollar volume remains high,
better than $300 million.
Many improvements have been made
that are obvious only to tube designers.

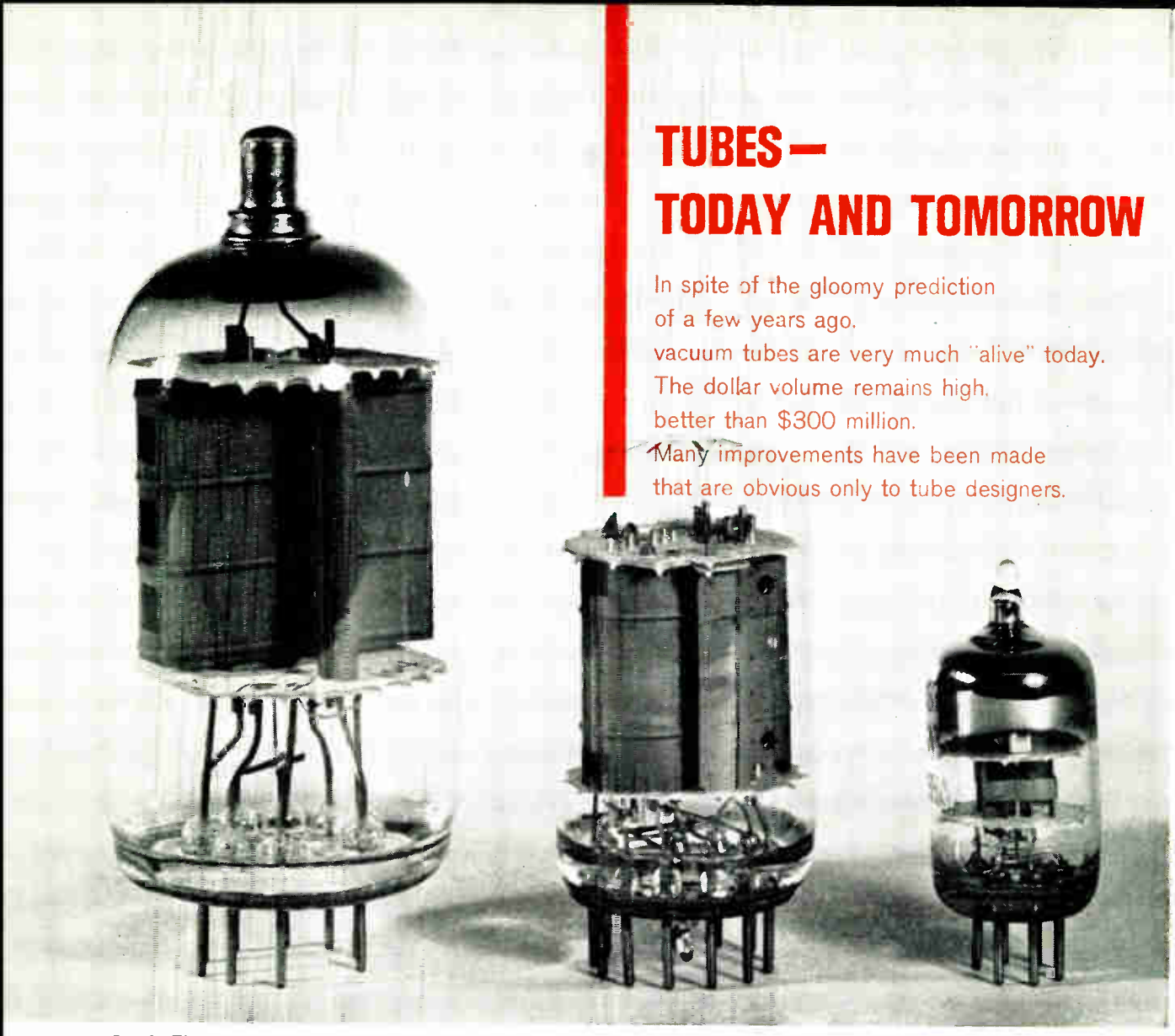


Fig. 1: The novar, compactron, and frame-grid constructions represent some of the newest types of tubes used today.

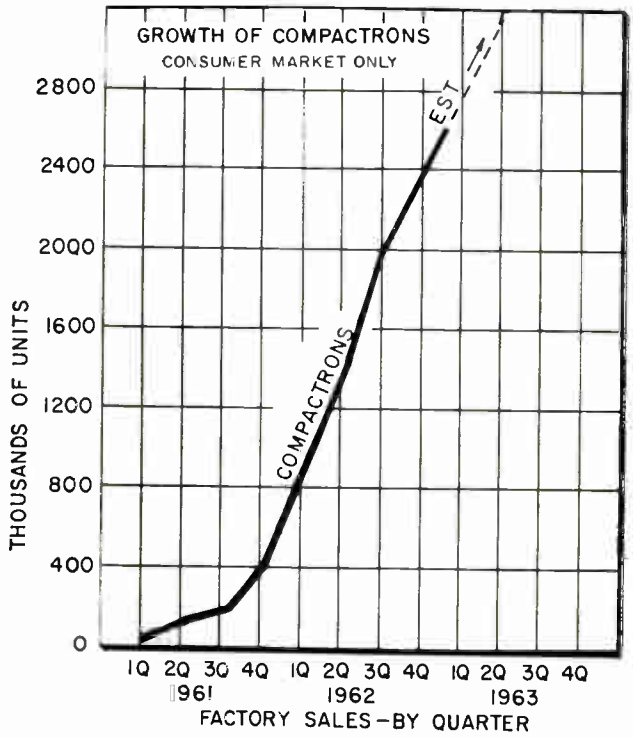


Fig. 2: Compactron sales have been increasing at a fast rate.

LIKE MARK TWAIN, the electron tube industry can say: "Reports of my death are highly exaggerated."

For despite the oft-repeated dire predictions of the past decade, this industry today remains a healthy and vigorous supplier of electron control devices in all four major areas of application—entertainment, industrial, military and space.

Behind the scenes, screened by successive flurries of popular interest in scores of other developments, tube makers and users have quietly continued to place hundreds of millions of these devices in the bread-and-butter circuitry that has been the backbone of the

By ROBERT E. MOE
Manager of Engineering
Receiving Tube Dept.
General Electric Company
Owensboro, Kentucky

electronics industry. In addition, tubes play an important role in the more glamorous Space Age electronics.

Recently the continuing progress in tube design and usage has brought this work to public view sufficiently to cause some comment that tubes are "coming back." One knowledgeable tube man, when confronted with this comment, quietly smiled: "Well, really you know, they never went away."

Significant technical advances, particularly in materials usage, have been spurred by competition within the tube industry and from other devices—both in the United States and throughout the world. Research and development in basic techniques, as well as materials, will continue to provide advances in tube structures, efficiency and characteristics.

Recent progress, in the face of both new electronic circuit needs and competition, has been pointed toward the circuit functions and areas where the electrical advantages of electron tubes, their established predictable operation, and their economy outweigh those of other devices.

As a whole, the tube industry remains large both in dollars (more than $300 million in domestic receiving tube manufacturers' sales alone last year) and in unit-functions. Though actual sales of tube *units* have decreased somewhat in recent years, tube *functions* have, in effect, increased because of multi-function units like compactrons, because of more sophisticated circuitry which needs fewer units, and in a sense also because increased tube reliability has necessitated fewer replacements. All this adds up to added value in the present-day products of the tube industry.

Here are some of the high points of present and future developments in the major areas of tube use:

Entertainment

The most significant development in the entertainment area is the mushrooming usage of the 12-pin compactron in television receivers (Fig. 1). A glance at the current service manuals shows that compactrons are used now in the majority of TV chassis—and it is safe to say that their usage will become even more general. There are 60 types of compactrons registered which serve any and all present TV purposes. Some, the hard-working power types remain single-function units; but the majority are two, three, and four-function types.

Incidentally, there has been some rather shallow criticism, particularly in the consumer press, to the effect that compactronized circuits make maintenance more costly. This argument is built on the seemingly logical assumption that if one section of a multi-function tube fails, the whole unit must be replaced. However, those who voice such criticism are not aware of two facts: First, tests and field experience have proved that, with less points of possible breakdown, a compactron can and does rack up a better reliability record than the 2 or 3 tubes it replaces. Secondly, years of experience have proven that the only significant concentration of tube failures in sets lies in the small group of usually-over-worked *single-function* tubes—the vertical and horizontal outputs, dampers, high-voltage rectifiers, and UHF oscillators.

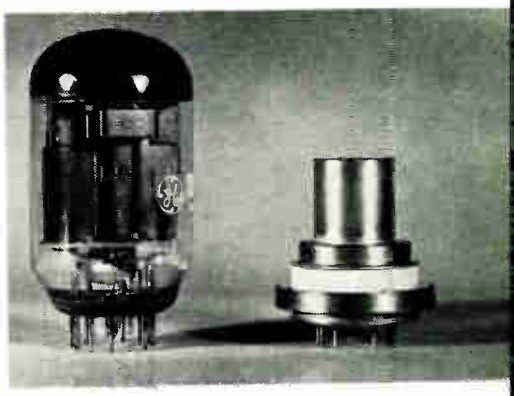


Fig. 3: The compactron (left) and the metal-ceramic power tetrodes provide high power at 175 mc and 450 mc respectively for mobile communications.

In TV, tubes' ability to handle high power and high voltage continues to dictate their use in the deflection and picture tube circuits for a good many years to come. This is particularly true in color TV, still a growing infant, where the HV rectifier, shunt regulator, and damper tubes are the only devices which can handle the severe power needs in feeding a 90° deflection picture tube using 3 guns. In addition, the color matrix demodulation function in some circuits can be performed best by beam deflection tubes like the recent 6AR8 and 6JH8. For here the capability of generating a specific transfer function from input beam deflection plate to output collector current is unique to tube techniques.

The new frame grid tubes and, to a lesser extent volume-wise, the magnoval-based tubes and nuvistors of recent years are examples of the tube industry's ingenuity in tailoring products to fit the needs of equipment manufacturers and, in the end, consumers.

The second-largest entertainment market, AM broadcast receivers, still largely uses tubes in clock and table radios where extremely small size, portability and power consumption are not major considerations. Tubes continue to excel in this area because of quality of operation, lower price, and simpler and

less costly maintenance. The most influential of these factors is, of course, price—a pressure to which styling and various other factors have knuckled under.

One might wonder why no manufacturer has come out with a one- or two-compactron table radio. The answer lies in a peculiar combination of psychology and economics. Manufacturers firmly believe the public is deeply rooted in the philosophy that the more components a radio has, the better it is. So, none is willing to risk a "one-tube" or "two-tube" radio manufacturing schedule. Complementing this factor, and perhaps even more over-riding, is the fact that the standard four- and five-tube AM "kits"—long tried, trusted and proven—can be turned out by tube manufacturers just about as cheaply as the comparable compactrons.

The ability of tubes to handle high radio frequencies efficiently—both from the viewpoint of economics and electrical operation—assures their continued large volume use in FM radio and stereo multiplex. In the foreseeable future, only a small portion of this market will turn from tubes to meet the demands of the relatively few consumers who demand the latest in "gadgetry"—a factor which also is affecting, in a small degree, the continuing use of tubes in hi-fi equipment.

A heretofore "hidden" advantage of using tubes in circuits connected to household and commercial ac power lines recently has come to light. Seeking to solve a problem plaguing modern tubeless entertainment and industrial circuitry, application engineers have found that transients as high as several thousand volts, lasting several microseconds apparently are quite prevalent on 60 cycle power lines —both from atmospheric and man-made electrical disturbances. Tubes apparently have taken such pulses in their stride for many years.

Among the recent developments in tube materials and construction are the use of welded top caps (instead of soldered), rhenium tungsten heaters, 3- and 5-ply plate materials, and many detailed structural improvements which have passed unnoticed by all but the working tube designers. These have yielded significant improvements in performance, reliability, life and cost. Progress has been so steady and sound there can be no doubt that it will continue at the same or even a faster rate. This progress is rooted deeply in materials and techniques studies, most of which are clothed in proprietary interests and remain unheralded for obvious reasons.

Industrial

Although solid-state devices have been adopted in the large-volume applications of the computer industry, tubes still serve the specialty functions in the industrial field, such as industrial TV systems and high-voltage thyratron applications. This is particularly true where some of the newer devices have caused sharp current rises, producing line transients and severe radio noise which must be shielded and filtered — situations more easily and economically solved by using tubes.

In the growing radio communications equipment field, receiving functions are shared with solid-state devices in mobile equipment as higher performance and more predictable transistors become available. Yet even in these low power functions the most economical installations employ tubes where a high degree of miniaturization is not demanded. The output stages of transmitters, even relatively low power, will continue to use tubes for the foreseeable future.

Fig. 4: Starting on left are nuvistor, TIMM and ceramic triode.

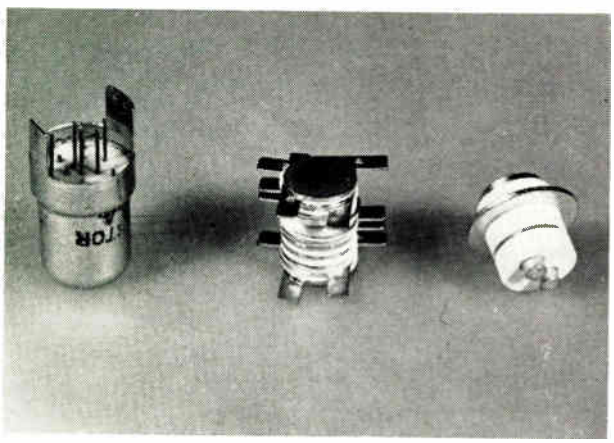
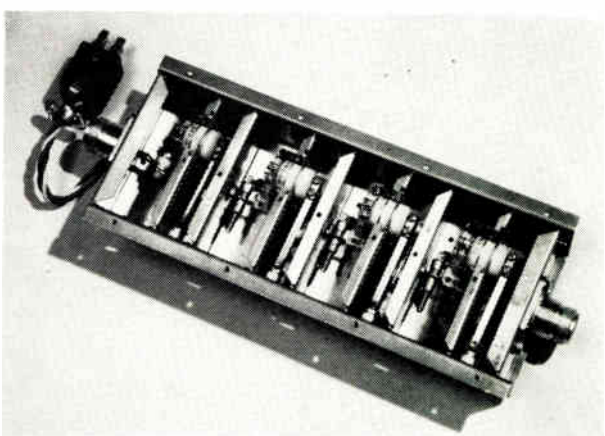


Fig. 5: Ceramic tubes provide 40db gain in an i-f at 1300mc.



This includes the new power tetrodes at 175 MC. and metal-ceramic triodes and tetrodes at 450 MC. (Fig. 3). Except for additional emphasis on the use of transistors, which can competently serve the more critical size and power factors, airborne communications and navigation equipment will follow this same pattern.

Another large field, the instrument market, provides a healthy and growing body of applications for tubes in such items as oscilloscopes, spectrum analyzers, gas-tube counters, RFI detectors, vacuum tube voltmeters and many others.

Military

While it appears at this point that both transistors and tubes will be succeeded in the large volume military uses by integrated circuitry—either semiconductor or thin-film—such devices still are severely limited by intolerance to both high temperature and nuclear radiation, and by application techniques. Design choice may be severely limited.

The presently-available devices which most easily tolerate these difficult environments are the new, small metal-ceramic tubes (Fig. 4). Their tolerance is inherent in the characteristics of the ceramic and metal materials used—which have been carefully developed with this purpose in mind.

Such tubes can, and are, providing top electrical performance in military equipment where low cost, reliability and performance are the key factors. No other devices of comparable size and weight can attain the combination of power, high frequency, low noise and bandwidth possible with small ceramic-metal receiving tubes. (Fig. 5)

Small transmitting tubes, too, will continue to supply those applications where a few kilowatts of peak pulse output are needed for radar, beacon transponders, altimeters, and telemetry equipment. (Fig. 6) The same is true of receiver local oscillators in these applications, where ceramic triodes will save weight and space.

In phased-array radar, where linearity and freedom from phase-shift are vital, tubes will see use in the output stages and in beam-deflection phase comparison circuits.

Even in battery-pack field transceivers, where the low-level stages are transistorized, filamentary tubes are used in the power output stages for better uniformity, gain and power at high frequencies.

Present miniature and subminiature tubes in the "reliable" series will continue in use for many years, as equipment still is being designed around them, and they enjoy a good replacement market.

Space

Recent work on high-current ceramic triodes has shown their feasibility for C- or X-band work where these frequencies must be used to transmit through the plasma sheath formed around a space vehicle during re-entry. Useful power from triodes has been obtained at 10,000 MC. and upwards—a significant "raising-of-the-sights" on the part of the tube industry. (Fig. 7)

This work has shown the feasibility of using triodes for such super-high frequency operation in both pulsed transmitters or receiver local oscillators. Performance-to-weight and cost is far more favorable with triodes, as compared to present microwave klystrons, magnetrons, or TWTs. These new triodes are no larger than the eraser on the head of a pencil.

As shown by the Telstar experience, radiation damage can pose a serious threat in space electronics. There metal-ceramic tubes have a tolerance 10,000

Fig. 6: Triodes generate high peak pulse power up to 3.5gc.

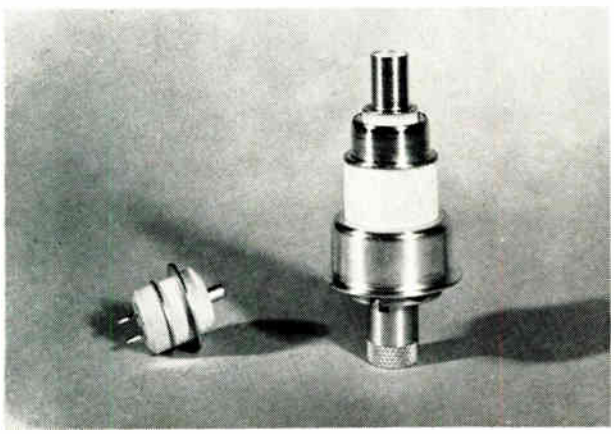
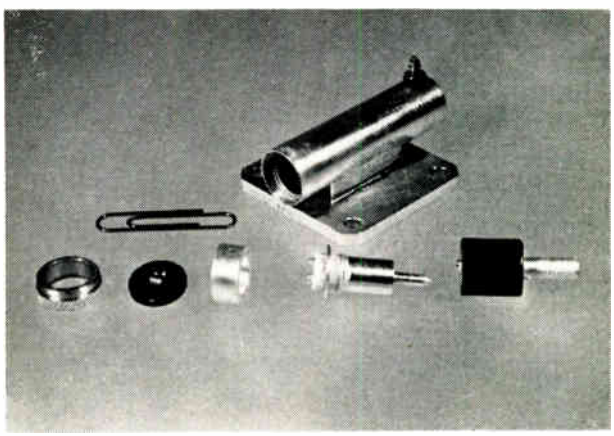


Fig. 7: A special metal-ceramic tube provides 20mw at 10gc.



times higher than the active components in most presently-designed space electronics. Although perhaps more costly from the viewpoint of space and power consumption, it may be that ceramic tubes will provide the necessary reliability in facing radiation in space.

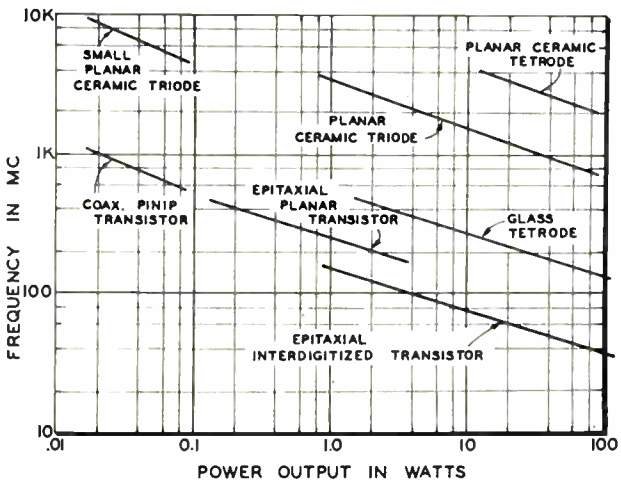
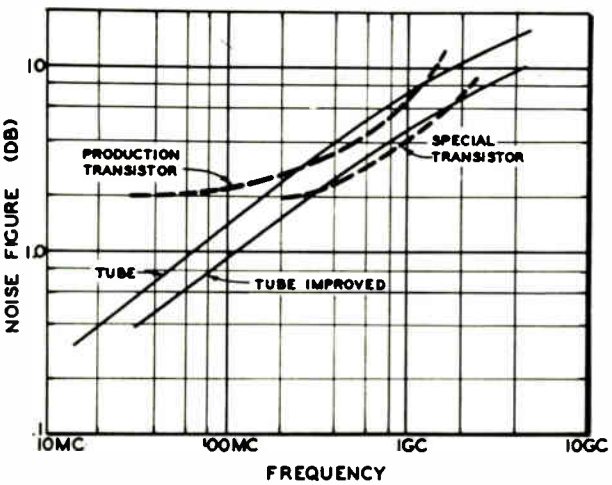


Fig. 8: CW power output vs. frequency for available devices.

Fig. 9: Noise figure versus frequency for current state-of-the-art (devices not used as parametric amplifiers).



A REPRINT OF THIS ARTICLE CAN BE OBTAINED
by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

In fact, both ceramic tubes and heaterless ceramic diodes and triodes combined in the integrated circuitry known as Thermionic Integrated Micro Modules (TIMM circuits) have been tested in the core of a reactor. Results indicate that they could be used for control, navigation or communication purposes in a nuclear-powered missile or space ship without the need of radiation shielding, which adds weight. Needless to say, they also can withstand a much wider range of temperature than any other active electronic component. Ceramic tubes have operated while glowing red-hot; and TIMM circuits operate normally at 580° C.

Using tube-derived technology, TIMM circuits have been successfully produced in a wide variety of circuit modules which have scores of resistors and capacitors—passive components—as well as diodes and triode control elements. These modules now are being evaluated for use in advanced air-borne and space electronics systems. They are competitive in size and weight with all other modular approaches to miniaturization.

Although not a tube in the normal sense, the thermionic converter—either vacuum or gas-filled, will be a strong contender in space applications for converting nuclear heat to useful power. Most of these will be of metal and ceramic to withstand the temperatures involved. And here, again, tube technology can be put to profitable use.

Special Devices

The broad subject of tubes covers things like multiplier phototubes, which will continue to have many applications because of their exceptionally high speed of response.

The extremely high input impedance of electrometer tubes at present continues to maintain the significance of these devices in specialized functions.

Cold-cathode thyratrons and trigger tubes also still hold special fields of application where low stand-by power and the ability to hold off high voltages is combined with high peak-current capability.

Feasibility studies are being conducted on the development of tunnel cathodes, which if successful, could advantageously apply thin-film technique to produce "heaterless" receiving tubes.

A specialized version of a cathode ray tube, the so-called "tuning-eye" tube, will continue to be both necessary and useful in tape recorders as level indicators, in FM sets for tuning accuracy, and in other visual control applications.

Photoconductive cells of high quality are now being born of tube-derived techniques. Now available as single units, they will, in the future, be made in many specialized multiple arrays, such as for reading data from punched cards.

Trends

In general, tubes will continue to improve in cathode current density, higher efficiency, higher frequency capability, warm-up time, and cost-per-function. Size per unit of output will decrease slightly as more efficient cathode and plate materials are developed. With the advent of more automatic assembly techniques and the consequent reduction in the human error factor, reliability will improve by two or three to one in most fields—continuing the steady progress which necessarily is slow as the figure nears 100%.

In the high-frequency region—above 1 gc.— ceramic tubes will improve in power output, gain-bandwidth product, and noise figure, by significant amounts. This will be directly related to the improvements in cathode current density mentioned above. Figs. 8 and 9 show the current state-of-the-art.

Conclusion

While no one can predict anything with certainty in this fast-moving industry (as witness the fate of the many predictions periodically expressed for a short life for the tube industry since 1950), it is quite safe to suggest there is a very strong possibility that electronic tubes will still be used in large volumes at the turn of the next century—the year 2000.

This thought appears conservative when one examines the record. Available figures for receiving tubes alone show that nearly two generations were needed to build this portion of the tube industry from its inception in the early 1920's to the peak dollar volume of domestic manufacturers' sales in 1957. Since then the curve has leveled, and there is no indication that it will drop faster than it rose in the first 33 years. In fact, the electron control device market still rises rapidly so that the net effect on domestic tubes appears to be a slight decline resulting from imports, increased reliability and other devices.

But even if the receiving tube volume were to drop at the same rate as it rose, an extension of the curve shows that this one section of the industry would continue until past 1990!

Finally, consider the so-called "battle" between tubes and transistors. Engineering-wise, no such strife ever has existed. For facts are facts; and at any one point in time the respective states-of-the-arts have dictated that tubes serve best in certain functions and transistors in others. (Any overlap has been quickly settled by economics or technical reasons.)

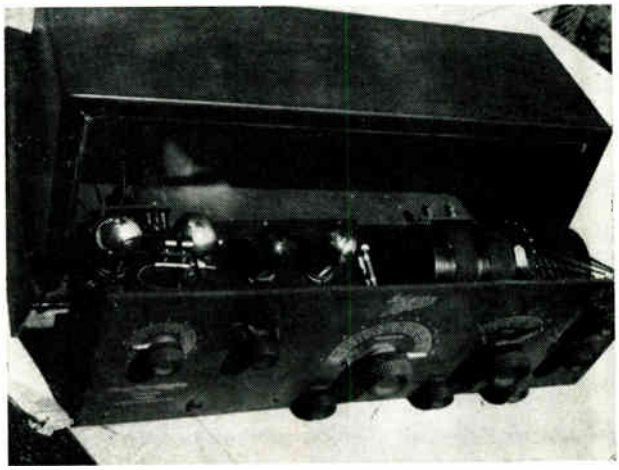
The only "battle" has been one of human minds—battles waged with words, too often the wrong ones, derived from what knowledge (or lack of it) the person speaking at the moment enjoyed. Such battles have raged hottest in the market-place—a rutted no-man's land singularly unfertile for the growth of engineering sanity. And this situation may continue for some time.

Periodically, however, the equalizing forces of economics and engineering will swing the scales into balance. And such a situation may well be approaching right now—which perhaps has led some observers into expressing the fallacy that tubes which never went away are "coming back."

Actually, the ideal sought by serious engineers in both fields is a reasonable situation in which the semiconductor and the tube each complement the other—each serving where its characteristics (including cost) are superior. But inasmuch as human endeavors and desires move more on the order of the oscillating pendulum, it may be unrealistic to hope that such a steady, logical and scientific balance ever will be maintained for any length of time. One can only hope that competent equipment designers will enjoy the freedom, knowledge and components necessary to accomplish their objectives within the limits of the state-of-the-arts at the time.

AN OLD SOLDIER

Anyone remember this one? A 1925 Model 3R Zenith radio receiver that was to the Charleston as color-TV is to the twist.



The industrial segment of the electronic industry is among the most fertile at the present time. Tubes are playing an important role in this growing area. Latest developments, availability and new applications of major industrial tubes are covered in this article.

INDUSTRIAL TUBES TODAY

ELECTRON TUBES are used for many manufacturing and industrial applications. A number of switching functions are done by gas-filled tubes such as ignitrons and thyratrons. Rectification of high voltage is usually done by vacuum rectifiers and low-voltage rectification by gas-filled rectifiers. Induction heating requires generation of higher frequencies than normal power frequencies and uses high-vacuum triodes.

Some of these functions can be performed by semiconductor diodes which promise greater life and reliability than tubes. Semiconductor equipment has, in some fields, displaced tubes; but in other fields tubes are superior in performance and reliability.

Ignitrons

The ignitron is a mercury-pool cathode, single-anode tube. It is triggered every conduction pulse by a current of about 20a. flowing into the mercury pool through a resistance rod, one end of which is submerged in the mercury. This rod is called an ignitor.

The two ignitrons shown here are both rated at 56 amperes.

Most of the tubes are water cooled. Vacuum envelopes and water jackets are of stainless steel to minimize corrosion. Electrical insulating bushings are of glass-kovar design. Connection to the anode is by a flexible cable and to the cathode by a strap projecting from the cathode of the tube for bolting to a buss-bar connection.

Recent design changes are a new cathode mounting at the top of the metal envelope that simplifies connection to the circuit. This reduces the cost of the massive conductors involved and provides a reduction of the magnetic field interacting with the mercury arc, reducing the tendency of the arc to contact the tube walls.

Now we will look at some of the current uses of ignitrons.

Power Conversion: For power rectification, several sizes of ignitrons are available. Many of the lower voltage and power uses are now being filled by stacks of semi-conductor diodes. However, uses for variable-speed motor drives and others where the phase shift control of output voltage is convenient are being filled by ignitron rectifiers.

Capacitor Discharging: In recent years, ignitrons have become of interest in connection with fast discharging of capacitor banks to obtain large currents. A new use is metal forming by hydraulic or magnetic impact. Several sizes of ignitrons are available for this work. Table 3.

Resistance Welding Control: Most ignitrons are used in the resistance-welding field. Two ignitrons connected in reverse parallel in series with a single-phase welding transformer is the common type used.

By D. MARSHALL
Engr'g. Supervisor of Special Purpose Tubes
and JAMES A. HALL
Advisory Engineer
Image Tube Dept.
Westinghouse Electric Corp.
Elmira, N.Y.

The ignitron acts in a switching capacity. Current to the welding transformer can be started and stopped. It can be controlled in magnitude and synchronized with the frequency of the power supply, reducing unwanted transients, or can be non-synchronized where transients can be ignored.

The three-phase welder circuits have additional features of reduced frequency output at the welding electrodes. This results in reduced secondary reactance and, therefore, improved primary power factor, and the primary current is distributed over the three phases, resulting in reduced phase unbalance.

Ratings and outline drawings have been registered by the EIA (Electronic Industries Association) for a series of six sizes of resistance-welding-service ignitrons. Data on these ratings are enough to show capabilities of the tubes for single-phase welding control, Table 1.

Thyratrons

Thyratrons are grid-controlled, hot-cathode, gas-filled rectifiers. The gas filling may be mercury vapor or inert gases such as argon, neon, hydrogen, or xenon. Most thyratrons are made in glass envelopes. Method of mounting in the circuit may be by a pin base and socket, flexible leads, or lug bases. The latter two methods usually provide more reliable connections to the cathode heaters. This is important since the heater voltage may be 2.5v. and the heater current near 20a. A small resistance in the socket-to-base pin connection may be the cause of reduced cathode temperature. This results in reduced electron emission and thus reduced life.

They are used for voltage-controlled rectifiers, and for controlling the speed of dc motors, either by controlling the field currents or the armature current. There are many control situations where they are used as fast-acting relays and many small thyratrons are used in relaxation inverter timing circuits.

Thyratrons are used in large quantities in the ignitor circuits of ignitrons. Control of the ignitron is through the grid of the thyratron. Combining the two provides the needed control of the thyratron and the high current capability of the ignitron.

Authors:
D. Marshall (l.) and J. A. Hall (right)

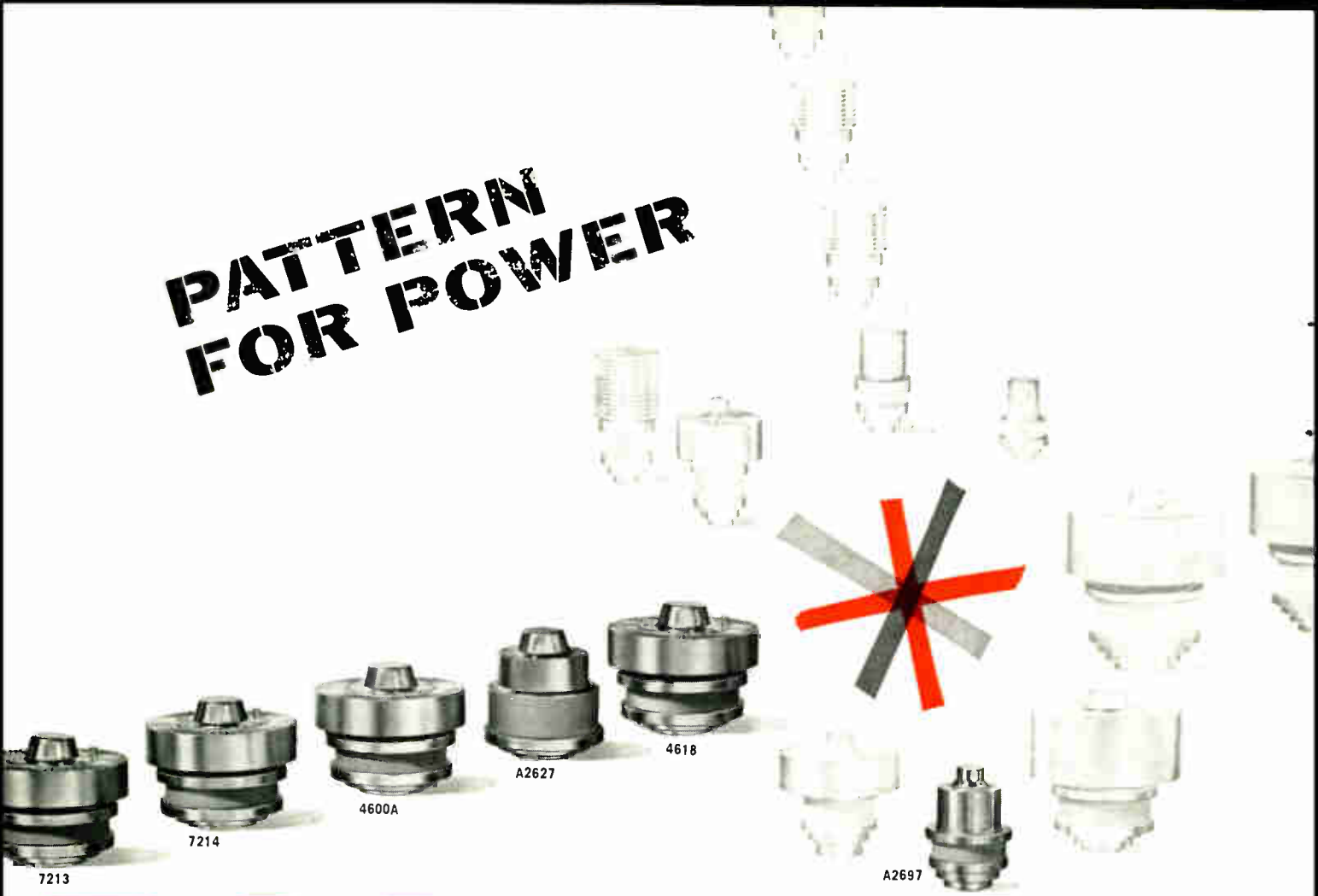
High vacuum transmitting tube rated 75 kw output with attached water jacket.

High-Vacuum Tubes

Radio-Frequency Heating: Heating of metal parts by induction at KC and MC frequencies provides a method of annealing, hardening, melting, brazing, cleaning materials, parts and assemblies.

Source of the high-frequency power is often an oscillator circuit containing one or more high-vac-

PATTERN FOR POWER



RCA CERMOLOX FAMILY

Just five years ago RCA introduced the first members of the CERMOLOX "family," a new concept in power tubes incorporating precision-aligned grids, and ceramic-metal construction. Today, "second generation" types are emerging and forming individual "type-families." Highlighted here are just two of these "type-families:" RCA-7650 and RCA-7213. These rugged beam power designs provide the power required for virtually every type of electronic application. They are easily tailored to a variety of air-cooled or conduction-cooled techniques for communications, control, radar, UHF-TV, phased array, and distributed amplifier applications. CERMOLOX design is adaptable in power and size from watts to megawatts, and in frequency from kilocycles to gigacycles.

For technical information and assistance, consult your RCA Industrial Tube Representative or for technical data on specific tube types write: Section: F - 50 - Q. Commercial Engineering, RCA Electron Tube Division, Harrison, N. J.

Tube Type	Capabilities	Applications	Cooling
7650	800 watts power output	CW Amplifier	Forced-Air
7651	39,000 watts peak power output	RF-Pulse Amplifier	Forced-Air
4614	2,500 max. plate volts 0.5 max. plate amperes	Voltage Regulator	Forced-Air
A2697	3,000 max. plate volts 1.25 min. peak plate amperes at zero bias	Hard-Tube Modulator	Conduction
7213	1,350 watts power output	CW Amplifier	Forced-Air
7214	65,000 watts peak power output	RF-Pulse Amplifier	Forced-Air
4600A	3,500 max. plate volts 1.0 max. plate amperes	Voltage Regulator	Forced-Air
A2627	15,000 max. plate volts 20 max. peak plate amperes	Hard-Tube Modulator	Conduction
4618	1,350 watts power output	CW Amplifier	Forced-Air

INDUSTRIAL TUBE PRODUCTS FIELD OFFICES – OEM SALES: Newark 2, N. J., 32-36 Green St., (201) 485-3900. Chicago 54, Ill., Suite 1154, Merchandise Mart Plaza, (312) 527-2900. Los Angeles 22, Calif., 6801 E. Washington Blvd., (213) RA 3-8361. **GOVERNMENT SALES:** Harrison, N. J., 415 South Fifth St., (201) 485-3900. Dayton 2, Ohio, 224 N. Wilkinson St., (513) BA 6-2366. Washington 6, D. C., 1725 "K" St., N.W., (202) FE 7-8500. **INTERNATIONAL SALES:** RCA International Div., Clark, N. J., (201) 382-1000.

The Most Trusted Name in Electronics

Circle 17 on Inquiry Card.

uum triodes. These tubes are adapted from designs originally used in radio communications.

Basic principles are much the same as in earlier days. However, many improvements in materials, design and processing have resulted in improved efficiency and life.

Design improvements consist of shorter and lower inductance connections, giving better performance at the higher frequencies; stronger vacuum-envelope design; coated grid wires to reduce secondary grid emission; placement of cathode and grid to reduce the electron current to the grid on positive grid drive, thus reducing grid heating and permitting higher power outputs per tube.

Thoriated-tungsten cathodes are being used in many of the tubes. This gives greater cathode electron-emission, resulting in less heating energy needed for the cathode.

For tubes handling large power, cooling becomes important. As a result of analysis, efficient water jackets and air-cooled radiators have been developed.

A recent development has been cooling by evaporation. In the past, the cooling water had to be held to temperatures below boiling because of the insulating effect of the vapor bubbles which formed on the cooling surfaces. The new method uses carefully designed roughness of the cooling surface. This promotes release of the bubbles and increases the surface area. Evaporative cooling reduces water consumption and is important when cost of water is a factor.

Tubes are available in nearly uniform steps from 10 to 300kw power-output with operating frequency at full rating up to 22MC. These larger sizes are cooled by water flow or water evaporation. In sizes below 50kw, radiator-cooled tubes for use with fan-driven, forced-air cooling are available.

High-Vacuum Rectifiers

High-vacuum rectifiers, up to 150kv. inverse-voltage rating and 2.5a. peak-current, are in general use. These are large glass-envelope tubes. They are used in smoke precipitators, capacitor charging and high-voltage testing equipment. Higher current and voltage ratings are available.

These tubes are designed for minimum X-ray output and minimum probability of cathode breakage. Their processing benefits from the recent improvement in high-vacuum methods.

Smaller vacuum rectifiers, in the 20kv. range with 250ma. rating, are also available for use with smaller equipment.

Vacuum Gauges

As part of the improvement in high-vacuum methods, vacuum-measuring tubes of special design permit direct reading of pressure from 10^{-1} to 10^{-5}mm. of mercury in a "high-pressure" type, and 10^{-3} to 10^{-9}mm. in a "low-pressure" type. These are used in research, space environment simulation, electron tube factories, and industries engaged in high-vacuum work.

Mercury Vapor Rectifier Tubes

The 857B hot-cathode, mercury vapor rectifier tube, rated at 20kv. inverse and 10a. average and the 869B, rated at 20 kv. inverse and 2.5a. average, are standard for medium voltage, fairly high-current uses. Many are used in the power-supply circuits of induction heaters. These tubes have shown ability to withstand voltage surges and short circuits. This is true even though used often with unreliable protective circuitry.

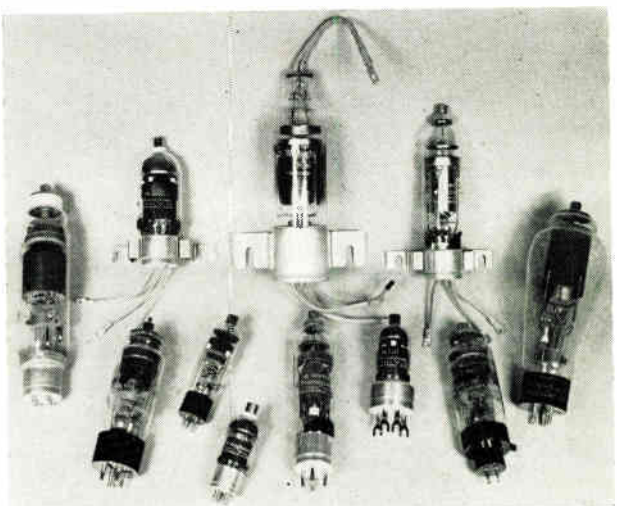
These are fairly large tubes. The 857B, for example, is 20 in. high and 7 in. in diameter.

Smaller rectifier tubes for lower voltages are the 575 at 15kv. inverse, 2.5a. average and the 872A at 10kv. inverse, 1.25a. average. These tubes are about 10 in. high and 3 in. diameter.

Imaging and Camera Tubes

Light sensitive tubes in industry are used mainly for inspection, measurement, and control, and more recently for surveillance or observation of areas which are remote, inconvenient or hazardous. Although the tubes themselves use little power, they are classed as power tubes. They are normally made by the power tube departments of the major tube manufacturers. (*Continued on page* 48)

Assortment of thyratrons with various basing arrangements.



The Westinghouse WL-5997 X-ray image intensifier tube.

Three types of TV camera tubes are in industrial use today. Most widely used is the Vidicon, a one inch diameter tube which operates in compact equipment. It is designed to use camera lenses manufactured for 16mm. motion picture cameras. These tubes produce high quality pictures with 10 to 100 foot-candles illumination on the objects being viewed (normal factory or office area illumination levels). They have operating lives of 3000 to 8000 hrs. Present uses include remote viewing in connection with servo controlled manipulators for handling radioactive materials. TV cameras using vidicons are being used in many monitoring and surveillance applications.

Vidicons designed for operation under either standard broadcast or slow-scan conditions are also available to permit scanning pictures, diagrams, or orders and sending this information to another plant location over telephone lines.

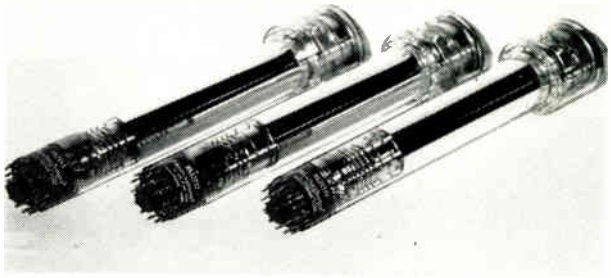
A special purpose TV tube, the Permachon camera storage tube, operates in a standard vidicon camera and can take flash exposure pictures and display them on a standard TV monitor, for times up to several minutes. This device is useful for detailed studies of rapidly moving parts in a high speed production process.

Another TV camera tube in industrial use is the image dissector which needs much light but is simple and long lived. It is used by some electric power companies for functions like the remote monitoring of boiler water levels. The image orthicon, a very sensitive tube used in entertainment broadcasting, is also used. Although expensive, $1000 to $3000 for the tube alone, and needing camera circuitry costing from $4000 to $20,000, and despite its short life of 500 to 2000 hrs., it will come closest to seeing in the dark of any tube in production today. They are good where illumination is critically low, including TV microscopy in the ultra-violet, inspection of photo-sensitive materials by low level and infrared radiation, and remote viewing uses. Most startling of these image orthicon uses is the installing of a water cooled TV camera within a blast furnace in a German steel mill to observe the ore reduction process as it happens.

X-Ray Sensitive Tubes

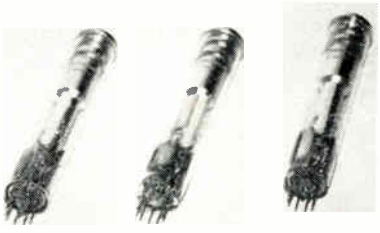
A second major use for photo-sensitive tubes is in the X-ray examination of industrial products. The tire industry is using automated high speed X-ray inspection as a quality control measure. To cut ex-

Image orthicon camera tubes—WL 7611, WL 22722 and WL 22724.



penses for photographic supplies, they use an X-ray image converter like the WL5997 to visually inspect for defects in the tire carcass. The X-ray image intensifier tube is used rather than direct viewing of a fluorescent screen to present a bright, readily visible image to the operator and because the X-ray tube voltage and current can then be set for high resolution, high contrast, and longer tube life.

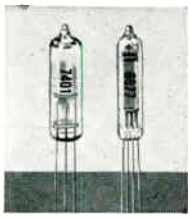
A similar arrangement has been used for inspection of welds and castings, which, because of their X-ray opacity, need both high intensity and intensi-



Vidicon-like devices used in industrial applications are (l to r), the WL 7290, WX 4887 and WL 7383.

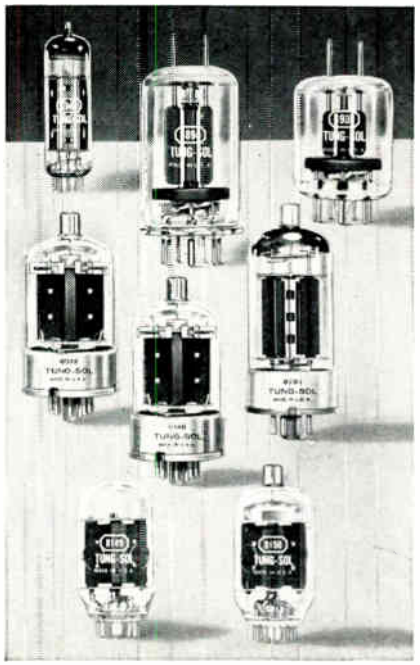
fication of the output image to give a directly visible picture of flaws. For small items like transistors and complete solid state microcircuits, high resolution X-ray sources and X-ray sensitive vidicon type camera tubes are used to give a magnified TV picture of connections or of desired density variations within the device.

The method is important for a small number of high reliability items in which control cannot be assured by destructively testing samples from a large production run. (*See Rating tables on page* C50)



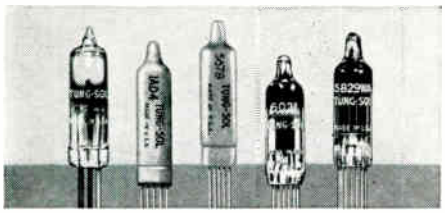
INDICATOR TUBES

PHOTO TUBES

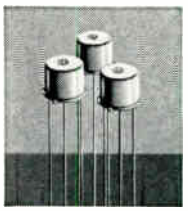


TRANSMITTING TUBES, INCLUDING COMPACTRON TYPES

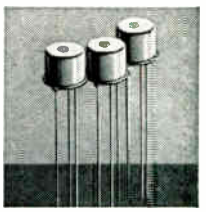
GERMANIUM POWER TRANSISTORS



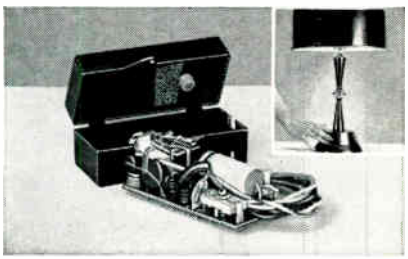
SUBMINIATURE TUBES



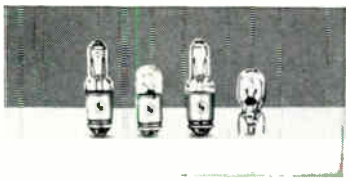
DYNAQUADS



SILICON DIFFUSED AND FIELD EFFECT TRANSISTORS

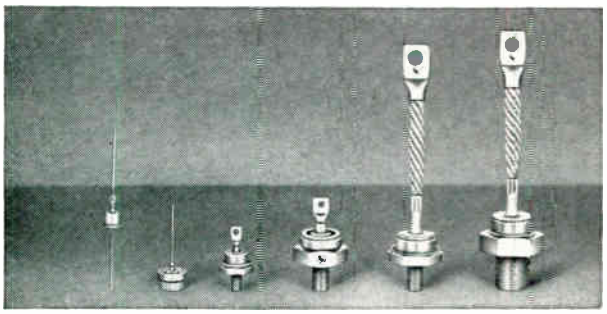


DYNAQUAD II TOUCH CONTROL MODULES



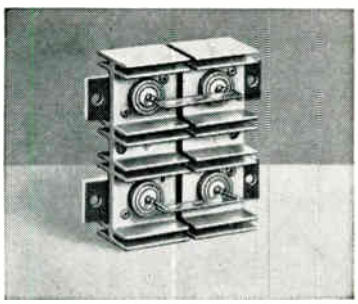
SUBMINIATURE LAMPS

GLASS HYDROGEN DIODES AND THYRATRONS



SILICON RECTIFIERS TO 250 AMPS, INCLUDING NEW REVERSE POWER RATED TYPES

CERAMIC HYDROGEN DIODES AND THYRATRONS



SILICON RECTIFIER STACKS

REGULATED POWER SUPPLIES

Tung-Sol is the one independent domestic manufacturer of vacuum and gas-filled tubes and solid state devices with the capability to supply volume requirements of so many popular-demand types. Tung-Sol components span the whole frequency spectrum. For more than sixty years, Tung-Sol has served America's largest-producing industries. Year after year the confidence of companies of all sizes has been merited by the performance-to-cost ratio of Tung-Sol products, the competence of Tung-Sol engineering and the dependability of Tung-Sol service. You may find it profitable to discuss your component requirements with Tung-Sol, particularly in the design stage. Tung-Sol Electric Inc., Newark 4, New Jersey. TWX: 201-621-7977

Technical assistance is available through: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Tex.; Denver, Colo.; Detroit, Mich.; Melrose Park, Ill.; Newark, N. J.; Seattle, Wash. In Canada: Abbey Electronics, Toronto, Ont.

CENTER LINE QUALITY

TUNG-SOL

Circle Numbers on Inquiry Card: Tubes—70, Transistors—71, Subminiature Lamps—72, Rectifiers—73, Power Supplies—74, Control Modules—75.

INDUSTRIAL TUBES (Concluded)

Table 1

EIA REGISTERED IGNITRON RATINGS*

Type Number	Max. Ave. Current Per Tube (amp.)	Max. Pk. Current (amp.)	Max. Averaging Time (sec.)	Tube Dimensions Diameter (in.)	Tube Dimensions Height (in.)
5550	22.4	850	11	2 1/8	9 7/8
5551	56.0	1,700	9	2 3/4	13
5552	140.0	3,400	7.1	4 1/4	14
7681	210.0	5,100	7.1	4 1/4	17 1/2
5553	355.0	6,800	5.6	5 5/8	19 1/2
7151	900.00	13,600	4.5	9	22 3/8

*Data listed are for 400 to 500 volt RMS, 25 to 60 CPS supply.

Table 2

RECTIFIER IGNITRON REGISTERED RATINGS

Type Number	Max. Ave. Amps/Tube (amp.)	Max. Inverse Voltage (v.)	Tube Dimensions Diameter (in.)	Tube Dimensions Height (in.)
5554	100	2,000	4	16
5555	200	2,000	5 3/4	19 1/4
5630	50	20,000	5 3/4	22
6228	150	20,000	9	41 1/2

Table 3

CAPACITOR DISCHARGE IGNITRONS

Type Number	Peak Current (amp.)	Max. Ave. Current (amp.)	Peak Voltage (v.)	Tube Dimensions Diameter (in.)	Tube Dimensions Height (in.)
7703	100,000	0.6	20.000	2 1/8	7 1/4
8306	35,000	0.6	15,000	2 1/8	7 1/4

Table 4

TYPICAL THYRATRON RATINGS*

Ave. Current (amp.)	Peak Current (amp.)	Peak Voltage (v.)	Max. Averaging Time (sec.)
0.1	1	1300	30
1.0	8	1300	—
1.6	20	1500	15
3.2	40	2500	15
6.4	80	2500	15
16.0	160	1250	—

*Formal standardization of thyratrons is not effective. Type numbers, therefore, are not universal and are not given.

NEW TECH DATA

Corona Stabilizer

Type SC5 is a new double-ended tube. Its double top cap facilitates easy fitting and greatly improves reliability by reducing the possibility of internal flashing or accidental mechanical damage to the glass envelope. It is available at output voltages of 5,000, 6,000 and 6,800v. operating over a current range of 25μa to 1ma. The M-O Valve Co. Ltd., Brook Green Works, London W.6, England.

Circle 563 on Inquiry Card

Silicon Rectifiers

Eight hermetically-sealed silicon rectifiers covering the current range from 25 to 250a. are available. Each is available in a choice of 6 voltages: 100 to 600 PIV and 70 to 420 max. RMS input volts. All units feature hard solder at every junction interface and oversized junctions that hold a max. forward voltage drop to 1.2v. Semiconductor Div., Sarkes Tarzian, Inc., 415 N. College, Bloomington, Ind.

Circle 564 on Inquiry Card

NEW TECH DATA

Tube Brochure

More than 600 different tubes are cross-indexed by type number, function, and operating characteristics in this 16-page brochure. Tubes include diodes, twin diodes, triodes, dual triodes, multi-section types, thyratrons, decade counters, radiation counters, etc. Industrial Components Div., Raytheon Co., 55 Chapel St., Newton 58, Mass.

Circle 328 on Inquiry Card

Magnetron Design Aid

"Magnetron Application Notes," 21 pages, is an 8 section report to aid in designing circuits that use magnetrons. Included are sections on magnetron test specs., effect of system on tube, measurements of system and tubes as a unit, and application notes for testing. Graph, tables, and equations are also included. Sylvania Electronic Tube Div., Seneca Falls, N. Y.

Circle 329 on Inquiry Card

Cooling-Water Repurifying

Bulletin #149-B describes cooling-water repurifying system which adds to life of UHF transmitting tubes. System consists of mixed-bed and oxygen-removal cartridge holders, Submicron® filter and purity meter. It comes completely assembled, ready for operation. Bulletin tells why pure water is needed to safeguard life of transmitting tubes. Barnstead Still & Sterilizer Co., 201 Lanesville Terrace, Boston 31, Mass.

Circle 330 on Inquiry Card

Backward-Wave Oscillator

SYB-4403 features packaging which makes external cooling unnecessary. The tube is tunable over the 2.0Gc to 4.0Gc range, with a power output of 100mw. and a power variation of less than 2db. from a straight line. The Microwave Device Div., Sylvania Electric Products Inc., 730 Third Ave., New York 17, N. Y.

Circle 331 on Inquiry Card

Phototubes

Three low-noise multiplier phototubes, differing basically in their photo-cathode spectral responses, are available from ITT Industrial Laboratories, Div. of International Telephone and Telegraph Corp., Ft. Wayne, Ind. All are 16-stage units; they withstand 25g's of vibration and 50g's of shock. Uses include star tracking, guidance, field uses in laser receivers, and unambiguous photon counting.

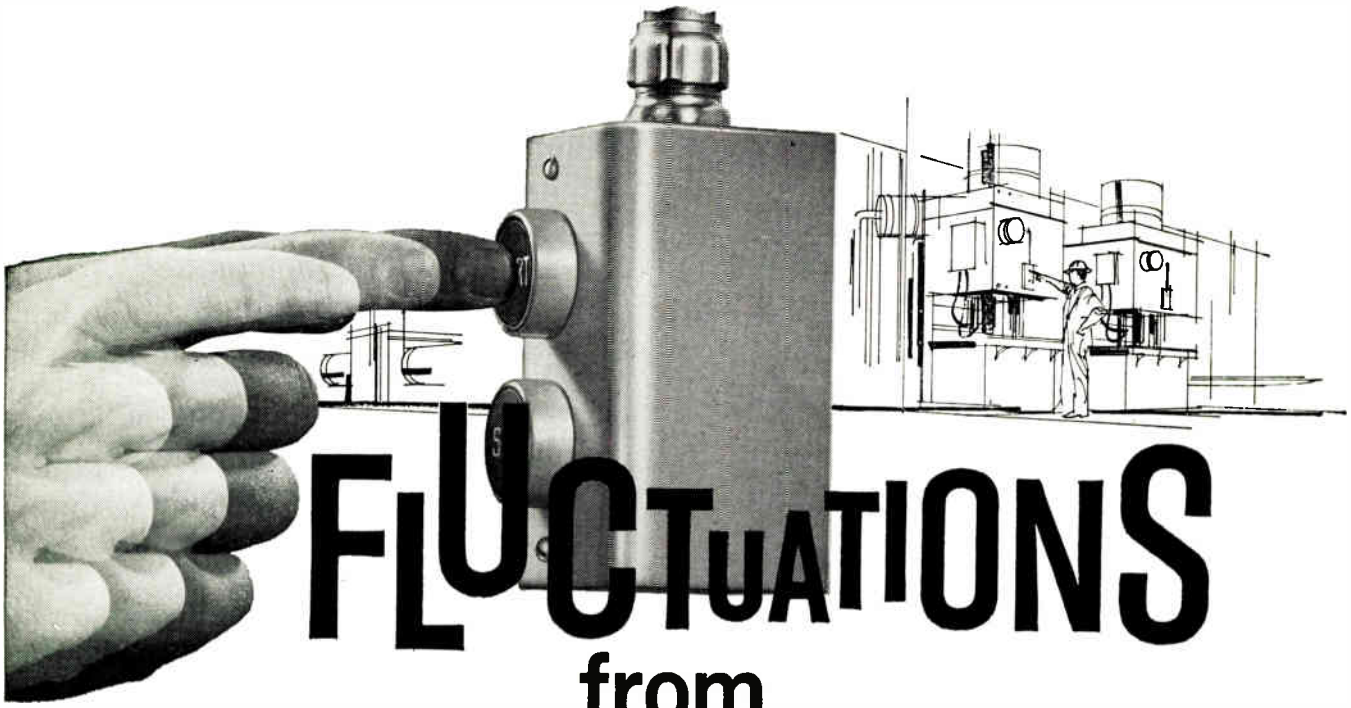
Circle 332 on Inquiry Card

Orthicon Selector

This quick selector publication gives sensitivity and spectral response for Westinghouse tubes. Included in the operating characteristics are the min. illumination ratings for 200 and 400 TV lines. Westinghouse Electronic Tube Div., Elmira, N. Y.

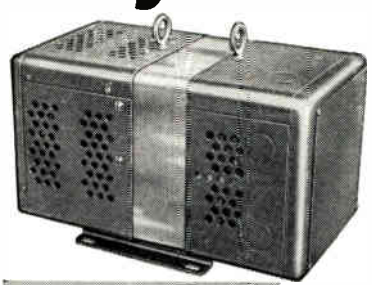
Circle 333 on Inquiry Card

SOLAtron LINE VOLTAGE REGULATOR corrects



FLUCTUATIONS from the very first cycle

Responds up to 10 times faster than electromechanical devices . . . irons out fluctuations due to both line and load changes! Voltage correction is practically *concurrent* with every disturbance; starts long before output voltage nears the boundaries of the regulation envelope. Even under extreme conditions, correction never takes more than one-sixth second. And *talk about reliability!* Solatron line voltage regulators eliminate moving parts; rule out mechanical wear and tear. Complete maintenance-free operation. Solid-state sensor monitors actual output . . . then regulates the transformer *flux* to automatically maintain correct nominal voltage.



SOLA

S-7-63

BPC

Division of Basic Products Corporation

SOLA ELECTRIC CO., 1711 Busse Road, Elk Grove Village, Illinois, HEmpstead 9-2800

IN CANADA, SOLA BASIC PRODUCTS, LTD., 377 Evans Avenue, Toronto 18, Ontario

Compare the advantages:

Superior performance — regulation ±1% for line and load variations, zero to full load.

High efficiency — 95% or better at full load.

"Lifeguard circuitry" — withstands momentary overloads many times rated current.

Input PF — 90% minimum on unity PF loads.

Smaller, lighter—considerably more compact than other standard regulators.

Solatron line voltage regulators are offered in ratings from 3 to 100 kva, for 120 and 240 vac, 60 and 400 cycles. For more information contact your local Sola distributor or call us direct.

SECTION D

CIRCUIT COMPONENTS

RESISTORS: THEN AND NOW

In 80 years since carbon film resistors first made their appearance the construction and materials of these devices have changed radically to meet new demands. The most challenging demands are being made today. Here are comments on the evolution of resistors and on changes expected in the next few years.

THE USE OF A CARBON COMPOSITION FOR RESISTORS dates back to about 1885. In this first era, scientists and investigators working in electromagnetic wave propagation and electrical power utilization often had to devise their own methods of inserting resistances, such as carbon blocks or pieces of wire, in their experimental circuitry. Then World War I provided the impetus to use radio communications on a large scale. This led to both commercial and military demand for resistors.

In the second major era of component history, continuing through the 1920's, the first commercial radio transmitters went on the air. Thousands of experimenters demanded that the industry produce devices for home-built receivers. Fig. 1 shows some of the resistive components of this era; the acknowledgement contains names of these antique components. With this development came a new terminology for dealing with these devices. For example, resistors began having uniformity of case sizes, wattage rat-

Fig. 1: The early resistors shown below were used in the 1920's. They are a far cry from the sophisticated units in use today.

ing, ambient temperature ratings and purchase tolerances. Many varieties of carbon composition and wirewound resistors became available.

Carbon Film Resistors Appear

In the 1930's, the mass manufacture of radio receivers became a major industry. The importance of improving and standardizing resistors and other components was more evident. A new type of resistor, the carbon film, was marketed during this period. This invention was significant, because it completed the 3 families of discrete resistor components as we know them today: wirewound, composition and film types. Fig. 3 shows some samples and their cross sections.

Changes in construction, encapsulation and identification of these 3 basic groups provide a huge variety of choices today. For instance, insulation may be provided by molding, conformal coating or sleeving. Common lead terminations materials are copper, Dumet and nickel. Complete immunity to environmental conditions can be achieved by hermetically sealing the resistive element in an enclosure, such as shown in Fig. 4. Marking for part identification is done either with printed characters or color bands.

With development of the 3 basic types, the stage was set for the third era of components. World War II equipment, circuit designs and applications needed major strides in understanding and documenting resistor capability in such areas as temperature coefficient, temperature cycling, shock, vibration, load life, moisture resistance, voltage coefficient and high temperature endurance. Many methods of testing and performance levels for these parameters were evaluated during this period, and basic concepts for full scale industry and military standard specifications were set.

Another key factor was recognized and dealt with at this time: the use of statistical quality control concepts to resistor performance and test evaluation. Tables of sampling plans defining test lot sizes, degrees of statistical confidence levels, and associated risks were developed. These were to assure designers of the validity of performance claims and guarantees of component manufacturers.

By LYMAN S. KING

Supervisor-Market Development-Resistors
Corning Electronic Components
Corning Glass Works
Bradford, Pa.

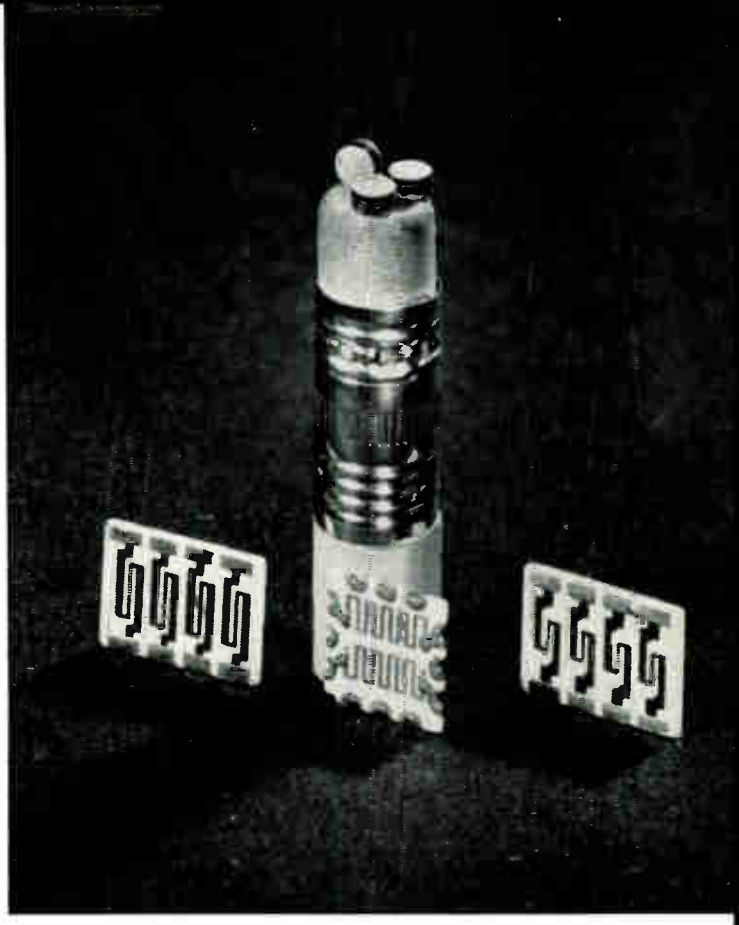


Fig. 2: The latest stage of resistor development is in the wafer and pellet film resistors for greater miniaturization.

Generating Military Specifications

The desire for standardized resistor quality and performance continued through the 1940's and into the 1950's. Military and industrial groups worked closely together, generating a series of military specs for fixed resistive components. This was accompanied by the development of two significant and parallel specifications that were aimed as much at all components as they were at resistors. These are Mil-Std-105 (Sampling Procedures and Tables for Inspection by Attributes) and Mil-Std-202 (Test Methods for Electronic and Electrical Component Parts). The use of these documents, along with standard product descriptions, such as those found in specs listed in

TABLE 1

Early Fixed Resistor Military Specifications

Description of Resistor	Component Designations	Specification	Date of Basic Spec.
Fixed composition (insulated)	RC	Mil-R-11	Feb. '53
Fixed film (high stability)	RN	Mil-R-10509	Sept. '52
Fixed wirewound (power type)	RW	Mil-R-26	Dec. '52
Fixed film (power type)	RD	Mil-R-11804	Mar. '53
Fixed film (insulated)	RL	Mil-R-22684, (Navy)	Apr. '61
Fixed wirewound (accurate)	RB	Mil-R-93	Mar. '52

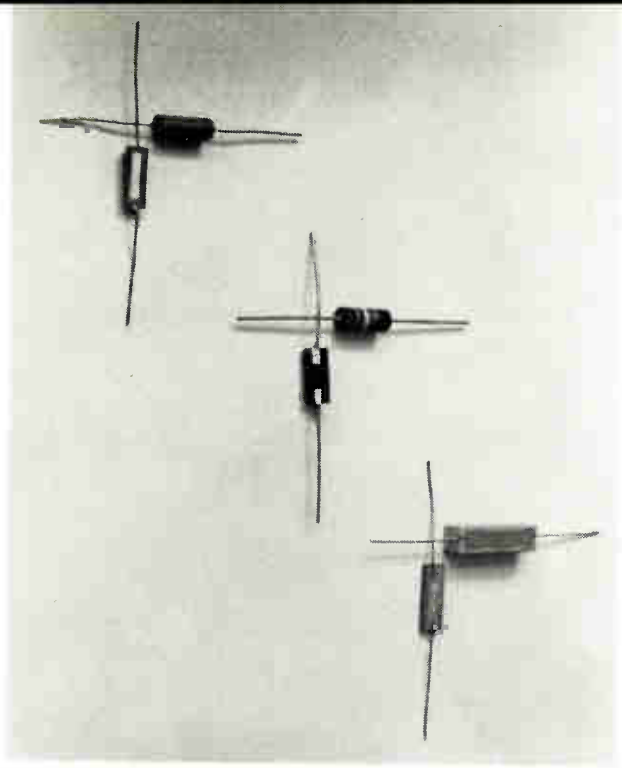


Fig. 3: Three general types of resistors and their cross sections are shown. They are the film, composition and wirewound.

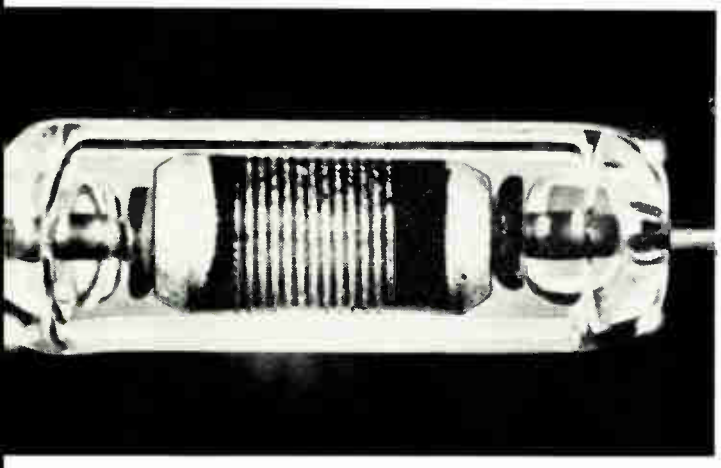
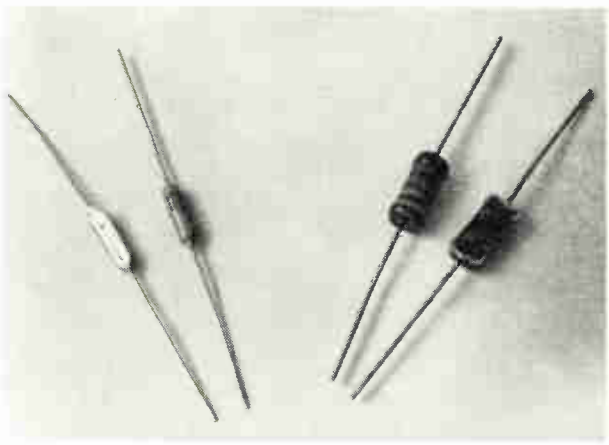


Fig. 4: Immunity to environmental conditions can be achieved by hermetically sealing the element in an enclosure.

Fig. 5: Samples and longitudinal sections of metal alloy and metal oxide types of resistors are shown in photo below.



RESISTORS (Continued)

Table 1, helped assure quality resistors at a low cost. They also paved the way for improvements in size, materials and electrical performance.

Here it should be noted that not only resistors, but also other components were undergoing much the same general pattern of standardization and advancement during this period.

A classic example of advancement in the resistor industry is shown by the evolution of Mil-R-10509. The original issue of this spec. in September 1952 contained five wattage ratings from ¼ watt through 2 watts. Each had two temperature coefficient characteristics. Since then, the spec. has been revised 3 times and is currently undergoing a fourth review. The original 10 resistor combinations have been obsoleted and replaced by 27 resistor combinations that include five temperature coefficient characteristics, one hermeticity characteristic, and wattage ratings from 1/10 watt through 2 watts.

During this period, the original carbon film resistors were modified and improved. Also, the metal alloy film resistor and the tin oxide film resistor were qualified to the basic standards in the specification. These, too, now are major factors in the film resistor market. Fig. 5 shows samples and longitudinal sections of metal alloy and metal oxide types.

Establishing Reliability

Since the late 1950's, there has been a fourth major phase in the history of resistors. This phase results from industrial and military needs for components having established reliability. Modern systems made it necessary for circuit designers to have access to resistors and other components with proven minimum failure rates within specified performance limits. The first systems using this concept of established reliability achieved proof of reliability in many forms. Each resistor supplier and each equipment manufacturer had opinions and ways for both obtaining and proving component failure rates. However, in the case of standard components, it became apparent that standardization of these "reliability techniques" would be the only way to obtain the economies and availability of parts necessary to support system usage over the years.

Again, industry and military study groups worked together to find philosophies and techniques to guide this standardization. Many of the earlier concepts were applicable to established reliability needs, but it soon became evident that these concepts were much more complex when implemented in standard reli-

ability specifications. Basic materials and manufacturing processes needed detailed analysis to "build in" reliability. Previous "proof of quality" testing had to be upgraded in quantity by many orders of magnitude.

The culmination of this effort was reached in 1962 when the first coordinated military spec. Mil-R-55182 (Resistors, Fixed, Film, Established Reliability), was issued as a procurement document. Missile and space equipment designers now had a standard document specifying that parameter of reliability that had been so elusive. Since the issuance of the document, several other components types have achieved, or are in the process of achieving, this status. They include fixed capacitors, composition resistors, connectors and wirewound resistors.

As work in the established reliability phase continues, it is of interest to note the appearance of several technical concepts that simplify the understanding of reliability for resistors. Becoming accepted practices in the industry are tests such as power burn-in to eliminate early life failures, high voltage stresses to detect product or manufacturing deficiencies, and resistor current noise to evaluate degrees of individual product alikeness. Much of the information obtained through studies can be applied to standard part manufacture and usage with resultant upgrading of the entire industry.

Accumulation of resistor performance data through established reliability testing has permitted acceptance of the validity of "worst-case design." Statistically proved performance parameters often reduces the circuit design effort significantly. Knowing accurate resistor design and tolerances permits engineers to optimize circuit performance and reduce cost of the overall system. Component reduction can be accomplished with this technique, resulting in decreased power consumption and heat dissipation, and increased reliability and overall economy.

The established reliability phase will continue at least through the foreseeable future of discrete resistor components. This phase is being complemented by major efforts toward reduction of size and weight. Also, improvements are expected in the areas of reliability, electrical performance, increases in usable ambient temperatures, determination of long-term performance under conditions of radiation and hard vacuum, adaptations of multiple performance ratings for single components, and modification of circuitry to take full advantage of presently unused resistor performance capability.

Future Aspects

A fifth and still embryonic phase for the resistor is being created, along with other components, by changes in shapes. Resistive elements deposited in various patterns on flat substrates comprise one kind of modification. Small pelletized elements that can be inserted in a three-dimensional matrix have proved themselves an alternative. Fig. 2 shows both wafer and pellet film resistors. Combining passive elements with active transistor elements to create a functional electronic block, as in Fig. 6, is another approach. Many advantages of miniaturization are available through these new approaches.

Despite successes to date, major investigations will be needed to provide direction and balances for the inherent performance compromises that will face circuit and system designers as they adopt these new component forms. Such parameters as life stability, temperature coefficient, tolerance and reliability must follow the same rigorous path as that traveled by the discrete component. Also, industrial capability to supply vast quantities at low cost must be developed.

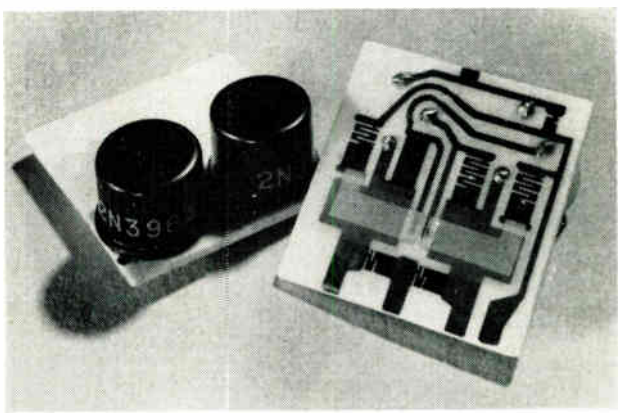


Fig. 6: Combining passive elements with active transistors is one approach being used to create a functional block.

The resistor today is a precise and sophisticated component. Its capabilities and limitations are known and documented to a very high degree. Though there are new and exotic resistor forms, the success of most circuit and system applications in the practical future will depend on the high performance and low cost of available products.

Acknowledgment

The author is grateful to Mr. C. H. Daykin of Geneva, N. Y., for supplying the components shown in Fig. 1. Names on these components are as follows: Dejur, Bosch, Radiall Company (Amperite), Arthur H. Lynch, Inc. (Lynch Equalizer), Pilotohm, Allen Bradley (Bradley-unit) International Resistance Co., and Daven Co. (Glastor and Resisto-Coupler).

Bibliography

Dummer, G. W. A.: "Modern Electronic Components," *Philosophical Library, Inc.*, New York 1959.
Henry, K. and Walsh, C.: "Electronic Components Handbook," *McGraw-Hill Book Co.*, New York 1957.

Thermoelectrics are introducing significant new trends in heating and cooling. These include infrared detection and cold-probe electronic measurements. Other devices in the field are shown and their effect on future products is predicted.

THE OUTLOOK FOR THERMOELECTRIC DEVICES

RECENT ADVANCES IN THE AREAS of development and cost reduction are speeding the pace at which thermoelectric devices are reaching the point of commercial usage.

Currently, a number of manufacturers are making feasibility studies, checking prototype designs, or planning production of equipment for these classes of use:

Film Storage
Parametric Amplifier Coolers
Incubators
Dew Point Equipment
Gas Chromotography
Guidance Control Systems
Constant Temperature Baths
Controlled Environment Chamber
Film Developing Tanks
Liquid Circulators
Drug Storage
Food Storage
Reference Chambers
Cooling Electronic Components
Cooling Electronic Circuits
Melting Point Apparatus
Microscope Stages
Electronic Measurement
Food Serving Equipment

Heat Pumps

To stimulate application development activity, there are system-oriented thermoelectric units which appreciably reduce both the time and cost of developing prototype equipment. Introduced this year, these consist of assembled heat pumps of various ratings with matched power supplies, ready to be installed in many consumer products and commercial equipment.

The units are designed as a complete package with a cold plate to mount to the load, a thermoelectric module to do the heat pumping, and an integral fin-fan combination to efficiently and conveniently dissipate heat to the ambient. (See photograph.) With them, engineering and fabrication time is reduced to a minimum. The application problem is reduced to the selection of the proper unit, mounting the electrically insulated cold plate to the load, and connecting the unit electrically.

Heating and cooling are done by varying the amount and direction of device current. With the right control system, the units can be used to cool loads over wide ambient ranges or to hold a desired temperature.

The integral fin-fan combination on the units allows ratings to be given in terms of specific cold-side temperature when the ambient temperature is known. The cold-side temperature is the actual information needed. The current necessary to produce the desired cold-side temperature can be found by reference to technical data.

As an application example, consider an infrared detector with preamplifier that is located in the roof trusses of a plant. The device is used to position large equipment, and in operation the ambient is 50° C (122° F). The detector has its maximum chassis, with its 5.5 w load, at this temperature.

The chassis is bolted to the cold plate of the module and a foam insulation placed about the chassis to reduce the ambient thermal loading. The total heat load from ambient is 2 w, so the total load is 7.5 w. Fig. 1 shows a plot of the characteristics of a Westinghouse W832G01 cooler in an ambient of 23.9°C. This plot give a cold-side temperature for various device currents and thermal loading. However, the present ambient is 50°C, so it becomes necessary to refer to Fig. 2, which is a plot of the algebraic cold-side correction temperature vs. ambient temperature. From these, a projected cold-side temperature can be found as follows:

$$T_{projected} = T_{desired} - T_{correction}$$

$$T_{projected} = 10°C - (19°C) = -9°C$$

Referring again to the 23.9°C curve on Fig. 1, a −9°C cold side temperature with a 7.5 w load is obtained with a device current of 20 a.

By ROBERT L. BRICKLEY
Mgr., Special Prod. Dept.
Semiconductor Div.
Westinghouse Electric Corp.
Youngwood, Pa.

Cascaded Units

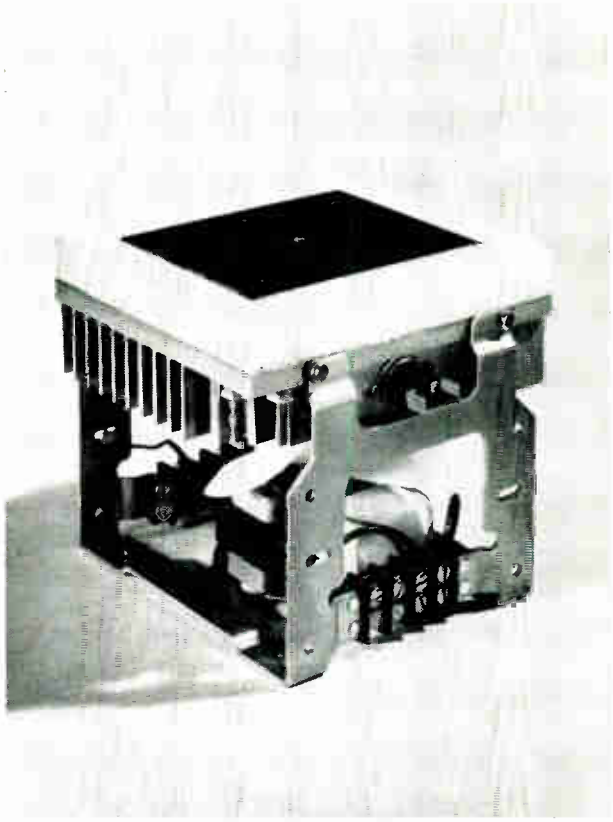
A cascade model provides a −50°C (−58°F) cold-side temperature while cooling a 400 mw load. See photograph of this type unit. Designed to operate with 24 a. of dc current, the cascade effect is achieved by cooling the hot side of one thermoelectric module with the cold side of a larger one.

The cascade unit (type W832G03) can be used in the building of apparatus for freezing point measurements, dew point meters, freezing traps, photomultiplier tube coolers and many other low temperature uses.

Ratings of each of the units are based on an ambient temperature of 23.9°C (75°F). Cooling capacities are increased when operating under conditions wherein the temperature difference between ambient and cold side is lowered.

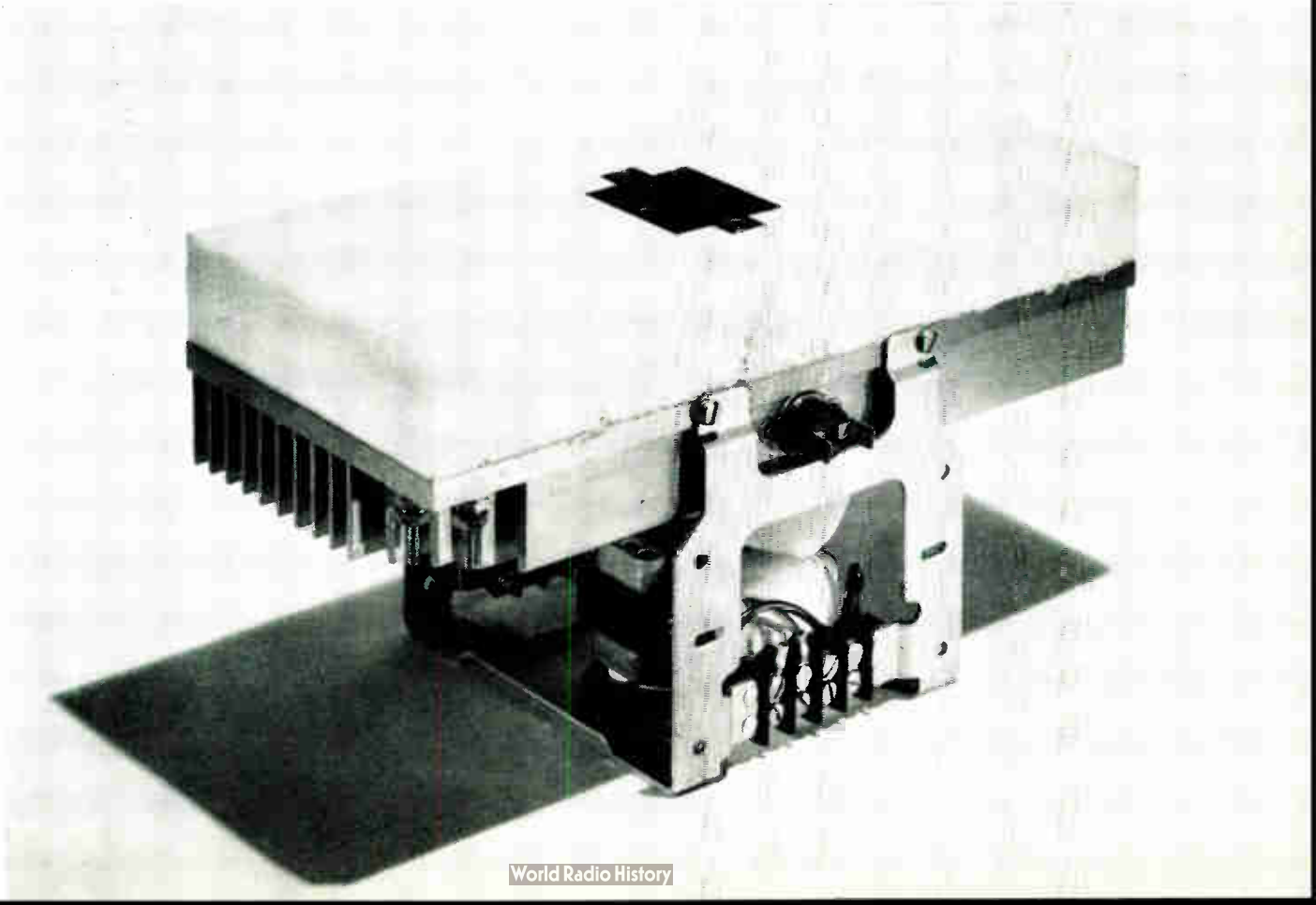
To speed mounting of the units, a set of tapped holes is provided in the cold plate. This helps to reduce the cold-side interface thermal drops, and hence increases pumping capacity. In those cases involving higher heat loads or difficult mounting geometry, several units can be applied to increase the heat pumping capabilities and use whatever mounting areas are available. The units also can be used to cool a chamber by placing one or more units into the chamber wall.

To enhance unit dependability, features such as



Thermoelectric heat pumps, like the assembly seen equipped with cold plate and integral fin-fan combination, facilitate application design. Matched power supplies are also available.

A cold side temperature of —50°C is provided by this two-stage cooler. The cascade effect is achieved by cooling the hot side of one thermoelectric module with the cold side of a larger one.



"impedance-protected" fans rated for ambient temperatures to 125°F, a thermostatic cutout switch placed into the fin to prevent excessive temperature rises, and wide spaces between fins to prevent clogging from industrial atmospheres, have been made part of the standard design.

The units are completely wired and tested. Each has terminals for the 115 v ac 60 cps power for the fan, current terminals for the thermoelectric device, spare terminals for a temperature sensor or controller, and output terminals from two copper-constantan thermocouples imbedded in the hot and cold plates, which permits temperature monitoring for inspection or evaluation.

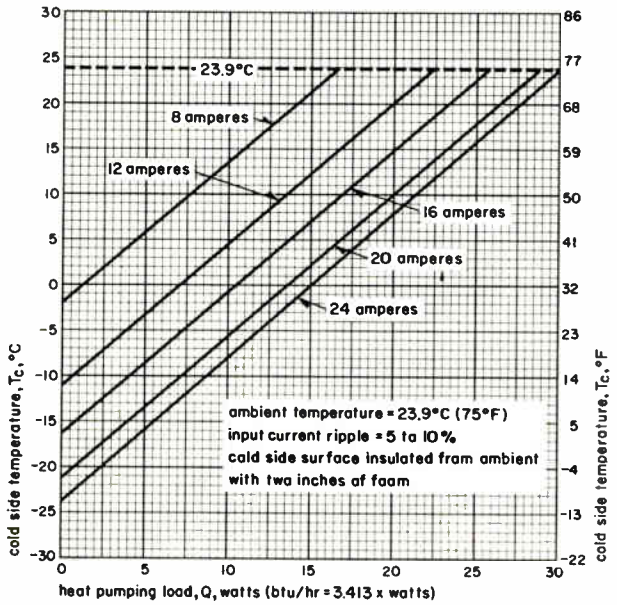
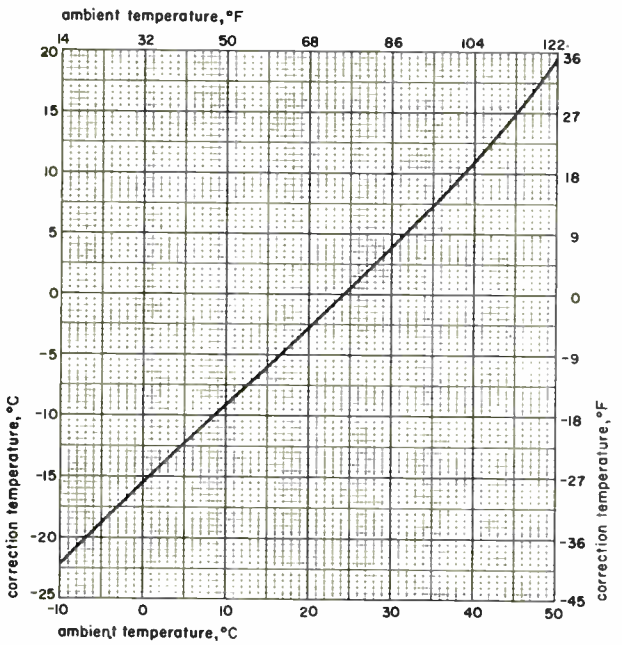


Fig. 1: Characteristics of W832C01 cooler showing temperature difference versus heat pumping load for constant currents.

Fig. 2: From this graph, correction is added algebraically to the cold-side temperature from Fig. 1, for other ambients.



Optional designs are available in the event a standard unit will not meet a need. These are designed to give maximum flexibility so that many special design needs can be handled with minimum effort. Mil-type fans, units without fans, and other special changes are included in this classification.

Proper operation of thermoelectric heat pumps requires a low-voltage, high-current, low-ripple source of dc power. Various sizes of power supplies provide outputs matched to the assembled heat pumps with which they operate.

Thermoelectric Devices for Lab Use

A number of thermoelectric devices for laboratory use have been placed on the market. Indicative of the current state of the art of thermoelectrics, they include a controlled temperature chamber, a controlled temperature bath, and a cold probe.

The controlled temperature chamber is designed for various "below ambient" uses, including temperature control of frequency reference quartz crystals, crystal oscillators, reference thermocouples, and reference diodes. The Westinghouse unit is equipped with control circuit, power supply and mercury thermostat, and controls temperature to ±1°C at 30°C over an ambient range of −40°C to +55°C. The chamber, which has a diameter of 2½ in. and stands 6 in. high, is mounted on a 4 x 4⅛ x 1 in. power package.

The controlled temperature bath is designed to permit determination of physical properties of materials as a function of temperature, chemical kinetics studies, and other laboratory uses. One model of the units made provides ±0.02°C control of bath temperature at any point from −20°C to +40°C. It is equipped with mercury thermostat, electronic relay and Dewar flask. Although bath capacity is 4½ gal. of appropriate fluid, the unit is designed as a compact, table model measuring only 15 in. wide by 23 in. deep by 21 in. high.

The Westinghouse cold probe is designed to permit checking the conductivity type of very thin epitaxial layers, about 2 microns, and high resistivity layers on low resistivity substrates. The method of use is shown in picture. It is of value in uses where hot probes and/or room temperature probes are inade-

quate, since it eliminates the need for liquid refrigerants. The probe resembles a low-wattage soldering iron in appearance. A thermoelectric module, a cold-probe point, and heat-rejection fins are mounted on the head of a balanced handle. Two current leads and a potential lead are integral with the probe. A room-temperature probe which acts as the second potential lead of the unit is also furnished, along with a power supply that operates from 110 v ac.

Other laboratory uses for thermoelectric devices that could lead to specialized products within the next several years include:

Blood sample coolers	Microtome sample coolers
Freezing traps	Distillation coolers
Incubators	Controlled humidity chambers
Thermocouple reference baths	

Military Uses

Military uses for thermoelectrics will deal with problems raised by putting both equipment and men in ambient conditions beyond their endurance limit. Thermoelectric devices expressly will be used because of their ease of control, static operation and freedom from noise. While it is not possible to predict when various types of equipment might be procured by the military, there is little question of their current feasibility. Examples include:

Navigational equipment—Shipboard and aircraft use of temperature control chambers for sensitive reference components.

Infrared detectors—Sensors for missile guidance can often be cooled thermoelectrically to meet the needs, eliminating the complexity of cryogenic devices.

Air conditioned electronic equipment vehicles—Thermoelectric devices can provide noise and vibration-free temperature and humidity control for vehicles containing sensitive components and equipment.

Submarine air conditioning — Thermoelectrics makes possible silent and diversified air conditioning. It also minimizes maintenance needs, and needs no refrigerants which can pollute the air over extended submerged periods.

Air conditioned mobile field hospitals—Modular construction of thermoelectric units provides the portability and flexibility required of air conditioning systems for field hospitals which must function under widely-varying climatic conditions.

Dehumidification of enclosed personnel chambers —Bathyscaphs, space craft, test chambers, etc.

The thermoelectric cold probe eliminates liquid coolants in uses such as this checking of conductivity type of very thin epitaxial layers.

Industrial Uses

Industrial uses feasible within the current state of the thermoelectric art are too numerous to mention. Refrigerated trucks, printing ink containers, fluorescent lamp coolers, and dehumidifiers show the broad range of industrial uses which will take advantage of the compactness and light weight of thermoelectric devices within the next 2 to 4 years.

The extensive effort placed on application development in 1962, and the reduction in the cost of materials ranging from 30 to 50% during the same period, have had their effect in stimulating new systems design. It is correspondingly true, however, that further cost reduction and application development is required before widespread introduction of products using thermoelectrics materializes.

For the immediate future, design engineers and product planners alike, should appraise the cost in terms of the entire system, rather than in the thermoelectric component alone. As an example, it should be realized that a complete 200 BTU/hr. refrigeration system with the necessary controls has less than 25% of the total cost tied up in the basic thermoelectric module.

In many heating/cooling systems, the cost of the modules is less than 20% of that of the entire system.

When complete original equipment utilizing thermoelectrics is considered as the base, the cost falls as low as 5 to 10%.

These figures suggest that widespread thermoelectric use depends on cost reductions in power supplies, control equipment, and system design, as well as on further cost reductions in thermoelectric materials and modules.

In this connection, it is also interesting to note that more substantial extension of the operating capabilities of thermoelectrics was achieved in 1962 via improved systems design and specific application effort than through improvements in thermoelectric materials. This may well prove to be a pattern which will govern the growth of the thermoelectric industry in the foreseeable future.

These light-dependent resistors provide circuits of increased simplicity and lower cost. They give non-arcing, "spike-free" switching for inductive loads. They provide the reliability of solid-state devices including high gain, plus the ability to handle power.

PHOTOCONDUCTIVE DEVICES IN CONTROL CIRCUITS

ELECTRO-OPTICS AND OPTOELECTRONICS have drawn much attention lately, due to some extent to the laser. However, there is a part of the broad field of electro-optics that got relatively little notice until last year, but which has grown steadily—chiefly in breadth of applications. This is the area of those photosensitive devices which do not use photovoltaic or photoelectric properties in their operation.

A photosensitive device can be defined as one in which the number of available charge carriers changes due to incident light. The term photo implies visible light, but one usually includes infrared detectors in the definition.

Photosensitive devices are of 3 major types:* photovoltaic (selenium barrier layers, silicon or germanium solar cells); photoelectric (the emission of electrons due to light striking a cathode, as with phototubes and photomultipliers); and photoconductive devices. Other than to compare with, we will discuss only the latter type from which we will leave out those devices whose properties do not vary much with light intensity (e.g., light-triggered silicon controlled rectifiers).

*Misunderstanding in regard to the similarities and differences among these three types is great, even within the industry.

Fig. 1: Sketch shows make-up and is used to help explain the meaning of gain in a typical photoconductive device (see text).

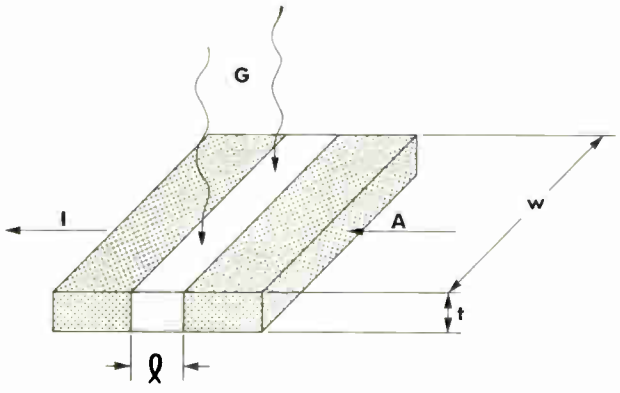


Table 1 lists several photosensitive devices with certain properties of each. Photoelectric devices are included for comparison since they are similar to the photoconductive devices in that their output is roughly linear with light intensity. A photomultiplier tube is really a "stack" of simple phototubes. Photoelectric devices are defined by the emission of electrons from a cathode and are described by their use of a vacuum and need of high voltages.

On the other hand, photoelectric devices have a higher speed of response than the photoconductive devices, although they are seldom used for other than as detectors. Photoconductive devices have the advantages of the glamour and reliability of solid-state devices plus the ability to handle power.

Only the CdS photocells can handle much power. This power capability is a new development for commercial use. Where applicable, these cells offer advantages in performance and cost.

Basic Principles

The important properties of photoconductive devices and also photovoltaic devices depend upon generation of charge carriers in them due to light striking the material. In a normal conducting solid, such as copper or silver, there are many "free" electrons which can move under the stress of the applied voltage and thus, permit current to flow. In a nonconductor, either insulator or semiconductor under proper conditions, the electrons or charge carriers are bound to the ions or atoms which make up the crystal lattice.

By Dr. FRANK E. JAUMOT JR. and ROGER W. BECK

Delco Radio Div.
General Motors Corp.
Kokomo, Indiana

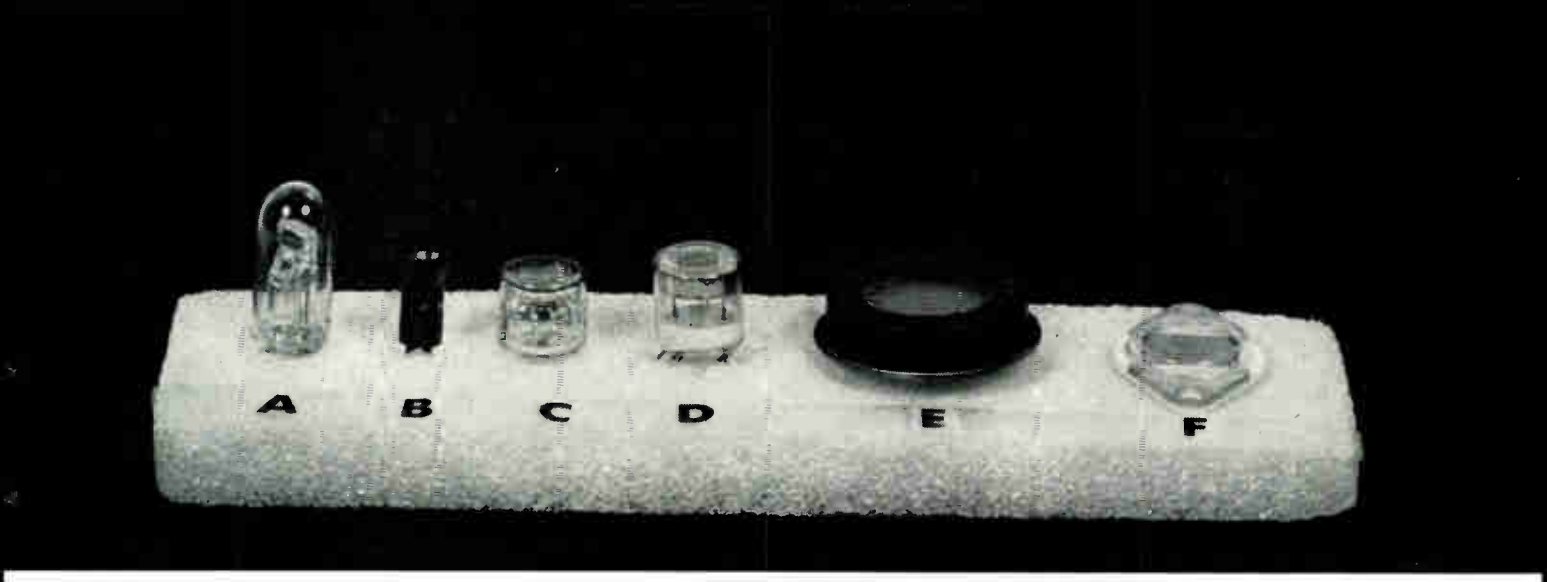


Fig. 2: Some available photoconductive devices: A is a single crystal cell; B is a small area sintered cell; C is a pressed-powder pellet; D, E, and F are all sintered powder on ceramic substrate with dissipation ratings of 0.5, 2, and 25 watts, respectively.

Free electrons, such as in conductors, are absent or sparse. Moderate applied voltages do not cause these bound charge carriers to move and so no current flows. Photoconductive materials fall into this category at least when not exposed to radiation. When radiation strikes the crystal, much of its energy is absorbed by the lattice. Apart from a totally reflecting surface, this is mostly true of all materials.

In photoconductors, an incident light photon (the basic energy particle of light having a specific energy for a given wavelength) will cause the production of one hole-electron pair. (The hole is defined as the absence of the bound electron and since this vacancy is free to move it too can carry current.) However, since the hole is immediately "trapped" (i.e., bound again) in either CdS or CdSe, conduction in these materials is purely by electrons.

Fundamental Properties

Of importance in photoconductor devices are (a) gain, (b) gain-bandwidth product, (c) frequency response, (d) voltage capability and (e) power handling. For example, we would like to use available "line" voltages, avoid intermediate amplification, etc.: these are precisely the advantages of the CdS and CdSe cells.

To understand the meaning of gain in a photoconductive device refer to Fig. 1. The shaded areas are the electrodes or metallic contacts, the white area is the active photoconductor material, G is the number of light photons striking per cm^3 per sec., t is the thickness of the device, l is the distance between electrodes, w is the width of the device ($tw = A$, the cross-sectional area) and I is the current. Assuming that each photon generates 1 hole-electron pair or, since holes are immediately trapped, 1 charge carrier, the added number of carriers in the photoconductor per cm^3 will be, $n = G\tau$, where τ is the effective lifetime of the electron or the average time an electron will live in the material before it is once again trapped by the lattice. Then if we assume there is no conductivity in the absence of light (in practice dark resistances are of the order of megohms), the conductivity is given by the usual expression, $\sigma = n\mu q = G\tau\mu q$, where μ is the mobility of the charge carriers and q is the charge on the electron.

Then, since the current is given by, $I = \sigma EA = (\sigma AV)/l$, where E is the electric field equal to V/l and V is the applied voltage, we find the current to be $I = (G\tau\mu qAV)/l$.

Now we are more interested in the current for the number of light photons incident per sec. rather than per volume per sec. Thus, defining $Q = GAl$, we have, $I = (\mu\tau VqQ)/l^2$ (1)

We see immediately that the current, instead of being qQ, the charge times the number of photons creating electrons per sec. is larger by a factor $M = (\mu\tau V)/l^2 =$ gain (2)

This gain may be of the order of 10^3 or 10^4 in CdS or CdSe cells whereas it is near unity in other photoconductive devices. Thus, these cells have gains as much as 1000 times greater than the other devices.

Although the gain is "real," how is it possible for more electrons to leave the crystal than are released by the incident light? The simple fact is that there is nothing to stop free electrons entering from the negative electrode. This, in turn, may permit an electron liberated from the lattice to effectively pass around the circuit many times before it is recaptured by the lattice. Without radiation, free electrons are not generated within the crystal. Therefore, any appreciable number of electrons cannot enter the crystal from the electrode. Their entry is restrained by a space-charge effect.

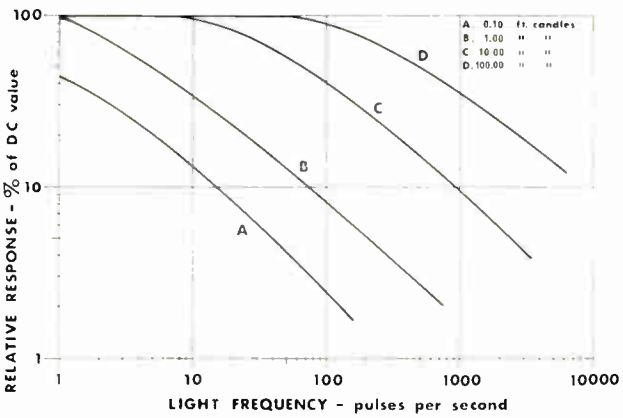


Fig. 3: The above graph shows how the speed of response of a typical photoconductor depends on the level of light intensity.

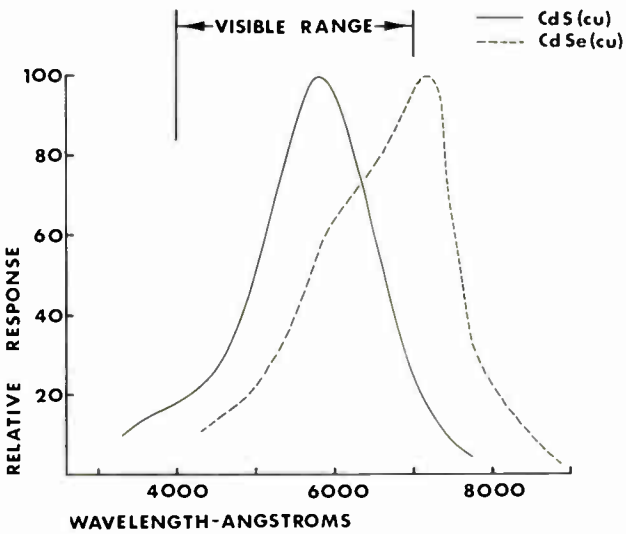
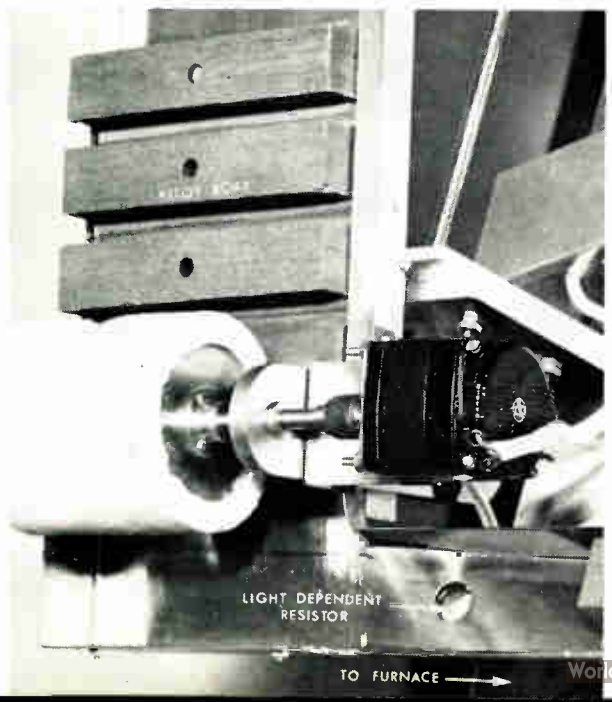


Fig. 4 (above): Graph shows typical spectral response of Cds and CdSe photocells. The Angstrom unit is equal to 10^{-8} cm.

Fig. 5 (below): A process use of power photocells: the LDR controls motorized feeding and detects each boat for loading.



Gain-Bandwidth

A purer definition of gain which leads to the same result but is somewhat more useful when talking about the gain-bandwidth product is

$$\text{gain} = M = \textit{lifetime/transit time} = \tau/T \quad (3)$$

The gain bandwidth product R is the gain divided by the lifetime, $R = M/\tau = 1/T$, (4)
or the reciprocal of the transit time, which is defined as the time for a charge carrier to traverse the distance between electrodes. In CdS cells T is of the order of 10 μsec. so the gain-bandwidth product is of the order of 100 kc per sec. Since gain is of the order of 1000, the bandwidth which is roughly equal to the frequency at which the photoconductor can cycle from dark to light to dark resistance conditions, is of the order of 100 cps. Actually this is only at high light intensities as shown in Fig. 3; at low light intensities these cells are much slower.

Since the voltage appears directly in our gain expression (Eq. 2), the gain-bandwidth product should increase indefinitely as the voltage across the device increases, at least to the point of dielectric breakdown. However, in practice a saturation effect occurs, since the current is space-charge limited.

Dielectric Strength

It is desirable to have a device which could "stand-off" high voltages. In CdS or CdSe cells, this property is a function of the dielectric breakdown strength and the spacing between electrodes. These materials have dielectric breakdowns high enough to enable relatively narrow regions to withstand fairly high electric fields, E $(= V/l)$. Typical electrode spacings of 0.010 in. will stand off 400 v. and easily 200 v. However, since the current (Eq. 1) varies inversely, or the resistance varies directly, as the square of the electrode spacing, it is preferred, at least in power devices, to keep this spacing small. In practice conservative voltage ratings above 400 v. are not practical to handle significant power.

Photoconductive devices have great advantage in switching inductive loads. Since their response is quite slow, they do not get voltage spikes from the usual inductive "kicks" and thus do not need protective circuitry. This freedom from spike trouble is aided by the normal thermal inertia of the average lamp used to activate them. We are inclined to regard slow response as a significant deficit in a device. However, the major use of these cells is the activation of power relays, motors or mechanical devices, all of which are very slow by modern speed standards.

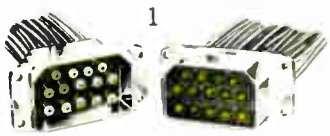
(*Continued on page* D17)

AMP PUTS AN END TO EVERY CIRCUIT PROBLEM

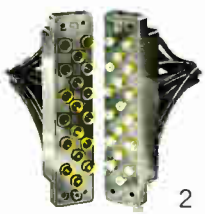
A patented Compression-Crimp Technique . . . the finest research and testing facilities in the industry . . . an exclusive plating process . . . a sales and service organization that spans the world . . . all these are factors contributing to AMP's recognition as the undisputed leader in the field of Solderless Wire Termination. Shown here is a representative sampling of the more than 15,000 electrical/electronics products we design and manufacture. All are designed to provide you with more reliable circuitry. All are available for immediate delivery. From basic ring tongue terminals to intricate programming systems . . . from one-crimp coaxial connectors to compression-crimp fine wire splices . . . whenever a circuit needs completion, AMP delivers the best, fastest and most economical answer.

COAXIAL CABLE AND SHIELDED WIRE PRODUCTS

COAXICON® CONNECTORS—Quick connect/disconnect for coaxial wire with one crimp termination of inner conductor, outer braid and cable support . . . an exclusive AMP feature. Multiple and single-in-line types, in standard, miniature and subminiature models. RG/U sizes .075 to .250". Gold over nickel contact plating . . . standard with AMP.



MINIATURE—(TYPE IV CONTACT)
—12 and 20 positions.



STANDARD—18, 24 and 34 positions. Special configurations available on request.

COAXICON Connectors
and Pin and Socket mix.

TNC—Standard and miniature sizes. Plus hardware version of COAXICON Contacts for through panel installations.

BNC — Bayonet coaxial connector for a quick connect/disconnect of maximum reliability. Noise free because of exclusive A-MP® crimp. Meets requirements of MIL-C-3608.

TERMASHIELD® SPLICES AND FERRULES — both pre- and-post insulated, for single and multiple conductors with nylon or TEFLON insulation. Line includes special heat-resistant ferrules and a new pre-insulated ferrule for printed circuit boards.

PIN AND SOCKET MULTIPLE CONNECTORS

AMPin-cert* Pin and Socket connectors satisfy and exceed applicable Military and commercial requirements. Complete range of sizes and configurations. Feature crimp, snap-in contacts. Available in stamped and formed and screw-machine processed types, in single-piece or strip form for application with A-MP* hand, semi-automatic or fully automatic crimping tools. Gold over nickel contact plating . . . standard with AMP!

Connectors conforming to MIL-C-8384

7

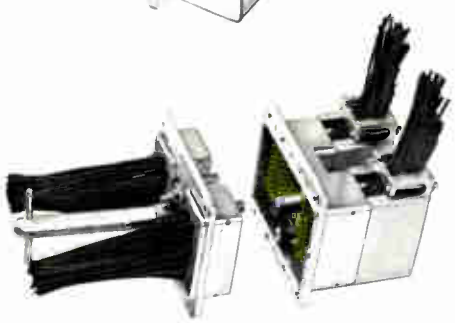
TIER BLOCK
—10 position
modular stacking unit

8

SERIES "M"—14, 20, 21, 26, 34, 41, 50, 75 and 104 position.

9

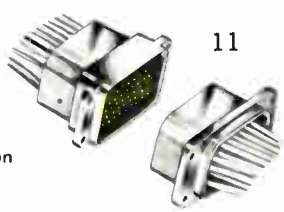
SERIES "D"—78 position



10

SERIES "DD"—156 position

11



SERIES "W"
26 and 40 position

12

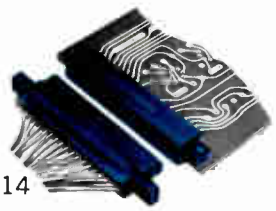
SERIES "A"
Meets electrical and environmental requirements of MIL-C-26518. Metallic shell . . . sealed or unsealed . . . 50 and 100 positions. Rack and panel or bulkhead mounting. Screw-machine contacts exclusively. Center to center spacing of .150".

SUBMINIATURE
High density, 50 position connector. Center contact spacing of .060". Wire range 26-32. Insulation support.

13

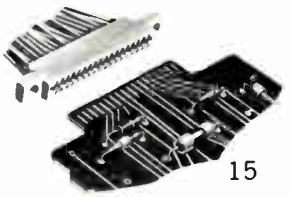
PRINTED CIRCUIT CONNECTORS

AMPin-cert one and two piece printed circuit connectors, available in a wide variety of sizes and configurations. Utilize crimp, snap-in contacts. Unique design insures controlled contact pressures for reduced surface wear. Exceed requirements of all applicable MIL specifications. Connectors are alpha-numerically coded, not pre-loaded and feature gold over nickel contact plating . . . standard with AMP! Complete range of hand, semi-automatic and fully automatic application tooling.



14

RIGHT ANGLE CONNECTOR
Pin and Socket contacts . . . 19 positions sealed and/or unsealed.



15

AMP-LEAF* CONNECTORS
8, 15, 18, 22 and 30 positions. Conforms to MIL-C-21097A.

16

AMP-BLADE* CONNECTORS
17, 23, 29, 35, 41 and 47 positions. Conforms to MIL-C-21097A.

DUO-TYNE* FLAG CONNECTORS
One piece right angle connector. 3 to 22 positions.

17

18

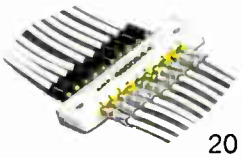
CIRCUITIP* TERMINALS — component tip for improved solder dip attachments. Can be applied at rates up to 7,200 tips per hour with A-MP Component Tipping Machine.

TAPER TECHNIQUE

Miniaturized components for high density applications. Both pre-and-post insulated, stamped and formed and solid type taper pins to mate with a variety of one or two piece stackable nylon taper blocks. Pins are self-cleaning and self-locking and compression-crimped to the conductor for insured uniformity of connections. Newest addition to the line, TAYP-AIR* Pins, feature elongated pins which provide extreme vibration resistance.

19

TAYP-AIR ASSEMBLY



20

STANDARD ASSEMBLY

INSULATED and NON-INSULATED

STACKED TAPER BLOCKS

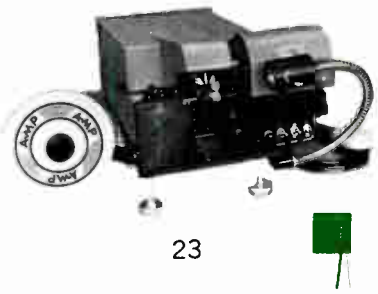
*Trademark of AMP INCORPORATED.

21

TERMINALS AND SPLICES
Industry's most complete line of pre-and-post insulated compression-crimp terminals and splices. Accommodate solid, stranded and irregularly shaped conductors in all AWG wire sizes. Single-piece or strip form for application with AMP hand, semi-automatic or fully automatic crimping tools.

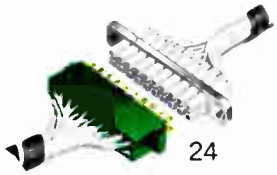
22

TERMI-BLOK® CONNECTORS — modular design terminal block connector for high density circuitry. Permits infinite variation in wiring logic and stack configurations. No need for insertion/extraction tools.



23

AMP-FINE-Y-R® SPLICE TECHNIQUE—compression-crimp method for joining 34 to 44 gage magnet wire to lead wires of 26 AWG or finer. Special air and electric crimping machine strips the wire and applies the splice. Takes just 12 seconds. Up to 300 finished splices per hour.

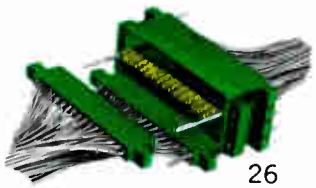


24

DUO-TYNE® LEAF CONNECTOR—new modular design connector with virtually unlimited application possibilities. Individually housed crimp contacts snaplock into aluminum mounting plates which can be designed to any size or configuration desired.

25

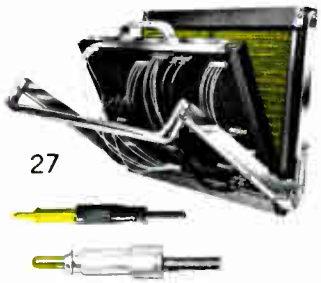
200 CONTACT CABLE CONNECTOR — crimp, snap-in contacts. Connector can be electrically disengaged without mechanical uncoupling. Cable outlet positioned at either 45° or 90°.



26

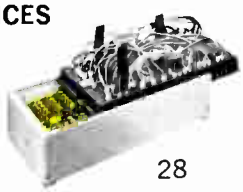
AMP-BLADE® MULTI-CIRCUIT FEED-THRU CONNECTOR—commoning block for rack-mounted systems. Density potential of 192 connections in a cubic area of 3.375". Crimp, snap-in contacts.

PROGRAMMING DEVICES



27

PATCHCORD—both universal and shielded construction. Standard rack mounted types and a new "space-saver" model which mounts into rather than onto the panel. Double-wiping action of crimped contacts. New double-detent patchcord. Spring retention member makes accidental dislodgement next to impossible.



28

"240" PATCHCORD — compact, lightweight programming system. Permits in-flight programming of electrical/electronic circuits in a matter of seconds.

29

PINBOARD — ideal for matrix programming. Factory pre-wired with standard or special silk screen legends.

ENVIRONMENTAL TERMINALS AND SPLICES

30

STRATOTHERM® — terminals and splices—for high temperature applications. Conform to MIL-T-7928.

31

TERMINYL® — pre-insulated terminals and splices for large wire sizes (8-4/0). Conform to MIL-T-7928.

32

SEALED HELICON® DISCONNECT — pre-insulated and environmentally sealed disconnect for all high-reliability circuits. Wire range 22-10. Exceeds requirements of MIL-T-7928.

33

CERTI-SEAL® SPLICE — prevents moisture breathing in aircraft and missile applications. Wire range 22-10. Exceeds requirements of MIL-T-7928.

GENTLEMEN: I would like additional information on:

EI

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	

NAME _____ POSITION _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

TOOLING

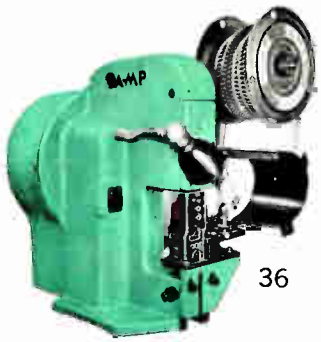
A complete range of compression-crimp tooling to handle the most diverse wire application problems. Matching tool and terminal design insures reliable, uniform terminations of maximum tensile strength and electrical conductivity. Resistant to heat, vibration and corrosion.

34

"T"-HEAD* HAND TOOLS—lightweight, compact, hand crimping tools designed to handle a wide range of AMP Products in wire sizes 26-14 AWG. Color and numerical assembly coding. Ratchet-in prevents opening of crimping dies until complete crimp has been made.

35

AMP-TAPEMATIC* TOOLS—highly versatile, portable, semi-automatic crimping tools featuring tape-fed application of terminals and splices. Combine the speed and power of a bench-press with the compactness and light weight of a hand tool.



36

AMP-O-LECTRIC* AUTOMATIC MACHINE—up to 4,000 uniform connections per hour are possible with this automatic, electrically powered crimping machine. Bench-mounted, easily moved. Handles a variety of AMP tape and strip mounted terminals, splices and connector contacts.

CAPITRON* PRODUCTS

Over 2,500 specially designed power supplies, pulse units, transformers, capacitors, etc. available as off-the-shelf items. Exceed requirements of all applicable military and commercial specifications.

37

PULSE NETWORKS — designed to specifications covering all combinations of pulse widths, impedances and charging voltages with exact compliance to pulse shape, rise time and ripple tolerances.

38

RADAR PULSE NETWORKS—quadrupled power in the same cube. Charging choke, pulse forming networks, supply, and pulse transformers combined in one balanced unit.

39

CAPACITORS—a variety of special high voltage capacitors in oil-filled hermetically sealed cases, encapsulated in epoxy resin, of openframe construction and of other special types.

U.S. POSTAGE
FIRST CLASS
PERMIT NO. 279
Harrisburg, Pa.

BUSINESS REPLY MAIL
No postage necessary if mailed in the United States.

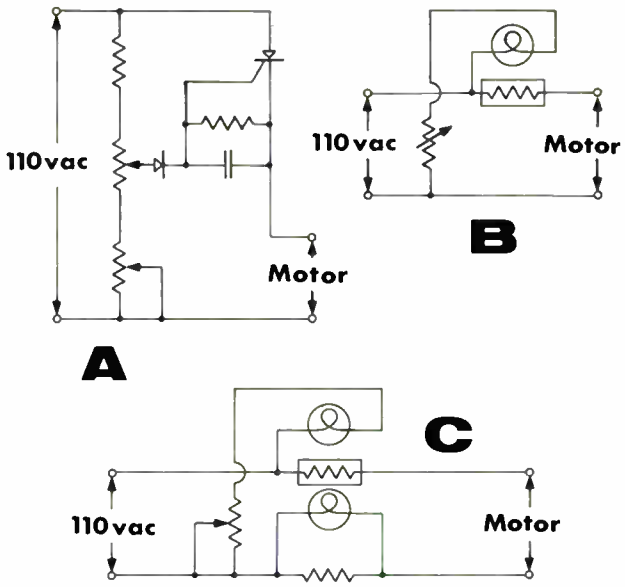
AMP INCORPORATED
Eisenhower Boulevard
Harrisburg, Pa.
Attn.: Reader Service Dept. (Adv.)

AMP®

AMP INCORPORATED
Harrisburg, Pa.

For complete information on the products shown, circle keyed numbers on the reply card on page 3.

Fig. 6: Motor speed control circuits: "Standard" SCR type (A); LDR types are (B) simple, less feedback, and (C) with feedback.



Types of CdS and CdSe Cells

Table 2 gives the main types of CdS and CdSe cells used, their general construction and their properties. Fig. 4 gives typical spectral responses of these materials and Fig. 2 shows some typical commercially available units.

Of the types shown in Table 2, the "powder" type is not seen on the market and this may be due to its low sensitivity and somewhat low power capability. However, it was able to withstand the highest voltages. Of the others, note that the sintered layer on ceramic has high sensitivity and by far the greatest power handling ability. (*Continued on page* K20)

Table 1

CLASSES OF PHOTOCONDUCTIVE DEVICES

Two photoelectric devices, the phototube and photomultiplier. are included.

Type	Sensitivity (per lumen)	Approx. Max. Frequency Response	Approximate Wavelength of Max. Sensitivity	Remarks
Vacuum phototube	100 μa	100 MC	4000 to 4500 Å	Requires approx. 100 volts.
Ge junction photojunction	30 ma	100 KC	1.9 microns	Used mainly in computer equipment.
Ge point-contact diode	100 ma	200 KC	1.9 microns	Detector and computer equipment
Si planar photodiode	200 ma	100 KC	1.1 microns	Same as Ge diode but better sensitivity.
CdS and CdSe photocells	Up to 50A	100 CPS (CdS) 1000 CPS (CdSe)	5500 to 6500 Å (CdS) 7000 to 7500 Å (CdSe)	Very slow at low light levels, can handle power.
Photomultiplier tubes	Up to 1000 A	100 MC	4000 to 4500 Å	Requires up to 2500 volts.

Table 2

TYPES of CdS and CdSe PHOTOCELLS

Type and Method of Assembly	Comments	Current, Voltage, Dissipation	Distinguishing Feature	Type of Encapsulation	General Electrical Char.
Single Crystal, small crystal with ohmic contacts.	Earliest types difficult to fabricate and mount.	Few ma. 200 v. Few mw.	Active area generally very small.	All glass assembly.	Ohmic with proper contacts—very low power dissipation.
Powder, sintered powder in binder	Simple construction adapts to any size. Not marketed.	> 10 ma/cm² To 1000 v. ?	Scant information but fairly high dissipation should be possible.	Glass-metal or plastic-metal sandwich.	Current increases with up to 4th power of the voltage at low light levels due to particle boundary limit on conductivity.
Sintered, thin layer sintered on ceramic substrates	Can be made rugged mechanically. About 10 times the sensitivity of powder version and ½ the sensitivity of pressed and sintered.	Up to 1 Amp. To 400 v. To 25w.	Very high dissipation when substrate becomes part of package.	Glass-ceramic, all glass or metal package with glass window.	Can be made quite ohmic. High power types not strictly ohmic because high conductivity metals yield poor ohmic contacts.
Pressed and Sintered, sintered powder pressed into "pill"	Very high sensivitity though not as rugged or easy to fabricate. Dissipation limited by mounting scheme.	To 100 ma. To 400 v. To 500 mw.	Relatively thick active body shifts spectral response to the near infrared.	All glass assembly.	Can be made very ohmic.

DALE

Better things in smaller packages

Resistors, Trimmer Potentiometers, Precision Potentiometers – no matter how exacting your specifications – Dale can meet them. This ability stems from unmatched experience in winding the smallest diameter resistance wires as well as superiority in producing resistance devices with improved metallurgical and performance characteristics. If your needs are not listed here, contact Dale at once.

WIREWOUND PRECISION RESISTORS *(Write for Catalog A)*

TYPE	RANGE	SIZES	WATTAGES	TOLERANCE	FEATURES
 TYPE **ARS**	0.1 ohm to 16K ohms	3	2, 5, 10	1%	Ultra-high reliability, failure rate less than .001% at 1000 hours of operation at 50% of rated power at 25° C. Ask for Bulletin R-66.
 TYPE **RS**	1 ohm to 240K ohms	11	¼, ½, 1, 2, 2½, 3, 5, 7, 10	0.05% to 3%	Meets functional requirements of MIL-R-26C. Silicone coating. Weldable leads available.
 TYPE **RLS**	10 ohms to 240K ohms	9	1, 2, 2½, 3, 5, 7, 10	0.05% to 3%	Radial leads. Meets functional requirements MIL-R-26C. Silicone coating. Weldable leads available.
 TYPE **HS**	.1 ohm to 240K ohms	9	1¼, 3, 3¼, 3¾, 4¼, 6½, 9, 13	0.05% to 3%	Replaces vitreous enamel resistors in high temperature applications. Silicone coating. Meets functional requirements of MIL-R-26C, Characteristic V. Weldable leads available.
 TYPE **NS, NLS**	.1 ohm to 37K ohms	7	2, 2½, 3, 5, 7, 10	0.05% to 3%	Silicone coated, non-inductive winding. Type NLS has radial leads. Weldable leads available.
 TYPE **RSE**	.1 ohm to 240K ohms	7	2, 3, 5, 7,10	0.05% to 3%	Resistance element suspended in metal tube meets toughest environmental conditions. Lead or clip mounted. Weldable leads available.
 TYPE **HL**	.1 ohm to 200K ohms	5	5, 6, 7, 11	0.05% to 3%	Replaces vitreous enamel resistors in high temperature applications. Multi-layer silicone coating. Meets requirements of MIL-R-26C. Terminal or through-bolt mounted.
TYPE **MRS**	1 ohm to 4.6K ohms	2	¼, ½	0.05% to 3%	Molded coating offers superior protection. Weldable leads available.
 TYPE **G**	.05 ohm to 175K ohms	7	1, 1½, 2¼, 4, 6, 7, 15	0.05% to 3%	Decreased size with increased heat dissipation. Silicone coated. Exceeds functional requirements of MIL-R-26C. Weldable leads standard.
 TYPE **HG**	.1 ohm to 60K ohms	3	15, 20, 35	0.5% to 3%	Maximum heat dissipation at no increase in size. Meets or exceeds requirements of MIL-R-18546C. Chassis mounted molded radiator housing.
 TYPE **RH**	.1 ohm to 240K ohms	6	5, 10, 25, 50, 100, 250	0.05% to 3%	Resistance unit molded into radiator housing. Meets requirements of MIL-R-18546C. Mounts on chassis.
 TYPE **NH**	.1 ohm to 37K ohms	5	10, 25, 50, 100, 250	0.05% to 3%	Non-inductive winding. Silicone-sealed resistance unit in radiator housing. Mounts on chassis.
 TYPE **PH**	.1 ohm to 75K ohms	3	10, 25, 100	0.05% to 3%	Silicone-sealed resistance unit in radiator housing. Mounts through hole in chassis.
 TYPE **WWA**	.1 ohm to 4 megohms	7	.1, .15, .2, .25, .33, .5	0.05% to 1%	Bobbin type design with patented Dale features. Non-inductive winding, epoxy encapsulated. Meets requirements of MIL-R-93C, Char. C.
 TYPE **MWA**	1 ohm to 160K ohms	2	.100, .125	0.05% to 1%	Sub-miniature bobbin type with molded coating for excellent environmental protection.
 TYPE **CWR**	1 ohm to 12 megohms	7	.15, ¼, ⅓, ½, 1	0.5% to 1%	Ceramic bobbin type. Non-inductively wound. Radial tinned copperweld leads. Unencapsulated.

For detailed information on the resistors listed here, write for Catalog A. Complete data on Trimmer Potentiometers will be found in Catalog B. Catalog E contains specifications on Precision Potentiometers.

DALE

Better things in smaller packages

DEPOSITED CARBON RESISTORS *(Write for Catalog A)*

TYPE	RANGE	SIZES	WATTAGES	TOLERANCE	FEATURES
 TYPE **DC**	1 ohm to 200 megohms	10	1/10, ⅛, ¼, ½, 1, 2, 5	1%	Miniature size. 3 layer silicone-base varnish coating protects against moisture and salt spray. Weldable leads available.
 TYPE **DCF**	1 ohm to 200 megohms	10	1/10, ⅛, ¼, ½, 1, 2, 5	1%	Epoxy coating gives complete insulation and environmental protection in miniature size. Weldable leads available.
 TYPE **DCH**	1 ohm to 200 megohms	10	1/10, ⅛, ¼, ½, 1, 2, 5	1%	Hermetically sealed in non-hygroscopic envelope. Can endure severe mechanical shock. Can be clip mounted. Weldable leads available.
 TYPE **MC**	1 ohm to 50 megohms	5	⅛, ¼, ½, 1, 2	1%	Molded housing completely insulates and protects against environmental and mechanical damage. Weldable leads available.

METAL FILM RESISTORS *(Write for Catalog A)*

 TYPE **MF**	100 ohms to 4 megohms	5	⅛, ¼, ½, 1, 2	.25% to 1%	Molded housing gives complete environmental and mechanical protection. Low temperature coefficient. Weldable leads available.

WIREWOUND TRIMMER POTENTIOMETERS HUMIDITY-PROOF - PRECISION *(Write for Catalog B)*

1200 SERIES

Three different terminal configurations, standard or printed circuit mounting; 10 to 50K ohms; 5% tolerance; 1 watt up to 85° C, derating to 0 at 150° C.

900 SERIES

High temperature. Three different terminal configurations, standard or printed circuit mounting; 10 to 30K ohms; 5% tolerance; 1 watt up to 70° C. derating to 0 at 175° C.

600 SERIES

Eight different terminal configurations, standard, panel and printed circuit mounting; 10 to 30K ohms; 5% tolerance; 1 watt up to 70° C, derating to 0 at 175° C.

1500 SERIES

Nine terminal configurations, standard, panel and printed circuit mounting; 10 to 50K ohms; 5% tolerance; 1 watt up to 70° C, derating to 0 at 175° C.

5000 SERIES

New space saving square configuration; 100 to 50K ohms; 5% tolerance; 1 watt up to 70° C, derating to 0 at 150° C.

WIREWOUND TRIMMER POTENTIOMETERS-LOW COST *(Write for Catalog B)*

100 SERIES

Five terminal configurations; 10 to 50K ohms; 5% tolerance; .8 watt to 70° C, derating to 0 at 135° C.

200 SERIES

Five terminal configurations; 10 to 50K ohms; 10% tolerance; .5 watt to 70° C, derating to 0 at 105° C.

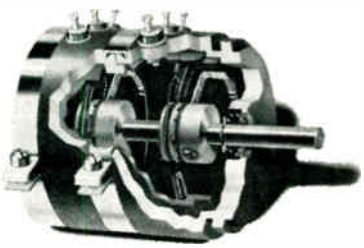
300 SERIES

Two terminal configurations; 100 to 20K ohms; 15% tolerance; .25 watt to 70° C, derating to 0 at 85° C.

1100 SERIES

High temperature. Three terminal configurations; standard or printed circuit mounting; 10 to 50K ohms; 10% tolerance; 1 watt to 70° C, derating to 0 at 175° C.

PRECISION POTENTIOMETERS - SINGLE TURN - WIREWOUND *(Write for Catalog E)*



- Precision machined anodized aluminum cups • Molded Diallyl Pthalate liners • Welded Tap and terminal construction • Precious metal wipers and slip rings • Flush clamp bands • Gold plated terminals • Precision sleeve or ball bearings • Centerless ground stainless steel shafts • Single or ganged units

SPECIFICATIONS:

- Meet requirements of MIL-R-12934B and NAS-710
- Eight physical sizes, ⅞" to 3" diameter
- Electrical angles and functions to specification
- Special mechanical configurations available

DALE

DALE ELECTRONICS, INC.

1304 28th Avenue, COLUMBUS, NEBRASKA

A subsidiary of THE LIONEL CORPORATION

There is increasing demand for reliability in capacitors with more exact properties. Mylar has been the best all-purpose, reliable plastic dielectric material for capacitor design. But other and new plastics have challenging properties. All of these are discussed in this article along with reasons for their importance.

Trends Toward Higher Reliability...

PLASTIC DIELECTRICS IN CAPACITORS

TRENDS IN USING PLASTIC DIELECTRIC are toward higher reliability in smaller capacitors and better capacitors and better capacitor properties. After a good look at the plastic dielectric capacitor of today and of the near future, one may feel that plastics for capacitor dielectrics have "arrived." But new designs pop up more frequently. New ideas and techniques are put into use as our knowledge of plastics grows, and a great many films are "just around the corner" with new properties to use in supplying capacitors to meet the more exacting needs of today's sophisticated circuits.

Plastics for Reliability in Capacitors

As electronic circuitry becomes more involved in the space age and its vehicles, polyethylene teraphthalate (Dupont's Mylar), is being recognized as one of the most reliable dielectrics for capacitors. Mylar is received in the capacitor plant as a complete dielectric. It does not require impregnation to make it useful as all paper dielectrics must. It is well known that reliability increases with less handling because there are fewer chances of error.

Many of the steps that are needed to develop electrical properties of paper dielectric capacitors are excluded in production of dry Mylar units. Not having to impregnate a capacitor, helps to preclude chance of errors in temperature, vacuum, time cycles, and purity of the impregnant.

Mylar has excellent dielectric breakdown strength, good stability and long term life properties. It therefore requires minimum handling to be used in capacitors that become highly reliable components.

Great strides have been made in producing Mylar film over the years. Uniformity of thickness and electrical properties of the film are improved.

Experience in manufacturing capacitors from film and continuing tests of these capacitors have shown the extent to which controls of handling these dielectrics improves the quality and reliability of finished parts.

Mylar capacitors are recognized to be reliable for space applications. In part this is due to the outstanding performance of these capacitors in fields of intensive radiation. In several of the articles written about the testing of dielectrics in radiation, it has been pointed out that Mylar ranks among the highest in resistance to such exposure. (Good-All has an information booklet available which contains data and information from most of these articles.) For example, after similar radiation exposure, the following figures are shown in comparing temporary capacitance change on 3 different dielectrics:

Mica—changed from +7% to −11%
Paper—changed from 0% to −90%
Mylar—changed from +1% to −8%

With respect to transient capacitance change, one can see that Mylar is affected no more than mica and much less than paper by exposure to radiation. Space-age electronics requires reliability for obvious reasons besides the radiation problem. Plastic dielectrics certainly are playing a major role in capacitor design for reasons stated above.

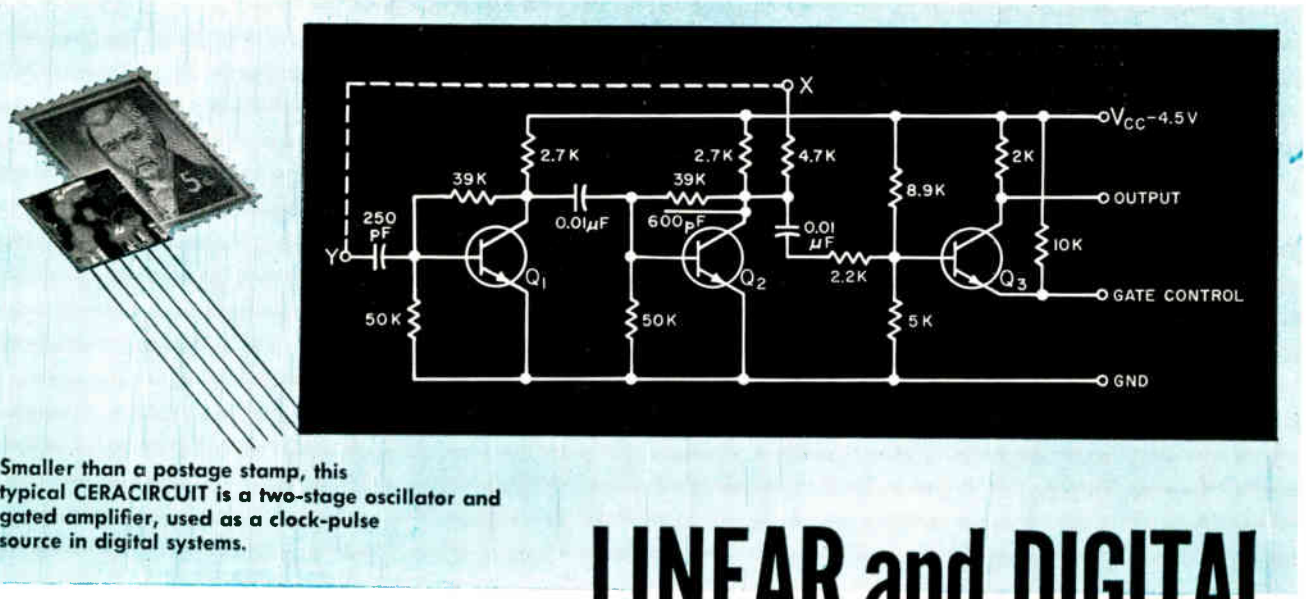
Control Process Is Important

Good-All places emphasis on cleanliness of capacitor manufacturing areas. Their High Reliability

(Continued on page D23)

By TROY L. PESTEL
Chief Engineer
Good-All Elec. Mfg. Co.
Div. of TRW Electronics
112 W. 1st St.
Ogallala, Nebr.

THIN-FILM MICROCIRCUITS NOW AVAILABLE FROM SPRAGUE!



Smaller than a postage stamp, this typical CERACIRCUIT is a two-stage oscillator and gated amplifier, used as a clock-pulse source in digital systems.

LINEAR and DIGITAL

CERACIRCUITS*

FOR GREATER DESIGN FLEXIBILITY...INCREASED RELIABILITY...CIRCUIT ECONOMY!

Thin-film CERACIRCUITS allow great flexibility in the choice of components and types of circuits. Chopping size, weight, and cost, while boosting reliability and power utilization, these revolutionary microcircuits are being used by alert design engineers in ever-increasing numbers. Their ease of usability is remarkable. Containing familiar circuit elements such as capacitors, inductors, resistors, diodes, and transistors, CERACIRCUITS offer precision components with a wider choice of tighter parameters, assuring greater design freedom.

*Trademark

Custom thin-film CERACIRCUITS are here . . . Now! A Sprague microcircuit specialist will be glad to discuss the transition of *your* circuits to thin-film. He can also supply CERACIRCUITS such as linear amplifiers, oscillators, NOR gates and drivers, indicators, binary counters, and clocks for evaluation of Ceramic-base CERACIRCUITS in *your* equipment. For complete information, write to Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

SPRAGUE COMPONENTS

MICROCIRCUITS
CAPACITORS
TRANSISTORS
MAGNETIC COMPONENTS
RESISTORS

INTERFERENCE FILTERS
PULSE TRANSFORMERS
PIEZOELECTRIC CERAMICS
PULSE-FORMING NETWORKS
TOROIDAL INDUCTORS

HIGH TEMPERATURE MAGNET WIRE
CERAMIC-BASE PRINTED NETWORKS
PACKAGED COMPONENT ASSEMBLIES
FUNCTIONAL DIGITAL CIRCUITS
ELECTRIC WAVE FILTERS

SPRAGUE®
THE MARK OF RELIABILITY

'Sprague' and '®' are registered trademarks of the Sprague Electric Co.

manufacturing area has controlled atmosphere with electrostatic air filtering. Workers wear lint-free garments and their habits are being continually shaped in reliability-oriented channels. Extensive training is given to High Reliability capacitor workers in work habits as well as production techniques.

Detailed manufacturing specifications are a must to obtain highly reliable capacitors and adequate quality control personnel are needed to insure compliance with the specifications.

The High Reliability material screening process used is a unique system whereby a sample from a log roll of Mylar is used to wind capacitors. Extensive tests are then run to decide whether the material is "qualified" for production. Only after qualification is the entire log roll slit to necessary widths for use. This system has helped to achieve established failure rate of .001% per 1000 hours with dry Mylar constructed capacitors. This leads to the belief that greater reliability can be obtained as material manufacturers continue to improve the basic dielectric and increased knowledge is gained about its qualities.

Miniaturization a Reality

The pressure for smaller capacitors becomes greater with each day as circuit designers are cramped for space. Plastics again are filling this need.

Significant size reduction has been achieved in a plastic dielectric capacitor with Good-All's miniature capacitor called "Microlar" or type 608. This capacitor offers a 75% size reduction over conventional designs in small values and is fully capable of voltage rating over the temperature range of −55°C to 125°C just as other Mylar units are.

The unique design of this capacitor features excellent lead-pull characteristics, even though it is very small (see photograph). A combination of small size and ruggedness are found in this discrete component. The "Microlar" line has only Mylar dielectric, but its design is readily adaptable to other plastics.

Epoxy Dipped Units

Selections of physical shape and case style of capacitors are usually dictated by space available, the need for humidity protection, and physical ruggedness required. Epoxy dipped units are popular since they fill the requirements on most of these points. Although as high a degree of miniaturization of the "Microlar" capacitor is not achieved with type 601PE dipped capacitors, they are small and provide the radial lead styles desired in printed circuit work. They can be made thin to take full advantage of board space and the case of tough epoxy is a very good humidity barrier.

Other Plastics

Up to the present time, Mylar represents the best answer to an all-purpose, reliable plastic dielectric material for capacitor design.

Forward looking work by capacitor manufacturers is largely aimed at providing capacitors with improved properties in such areas as temperature range, temperature coefficient, dielectric absorption, and physical size. When one or possibly two characteristics must be optimized, the selection of a specialty dielectric is much easier today because of the variety of materials available.

The major portion of plastic dielectric capacitors today contain Mylar as the dielectric. Polystyrene is also a very important plastic used in capacitors.

Polystyrene capacitors offer the following advantages:

Extremely high insulation resistance.

Extremely low dissipation factor.

Low capacitance change with temperature change.

Very good stability.

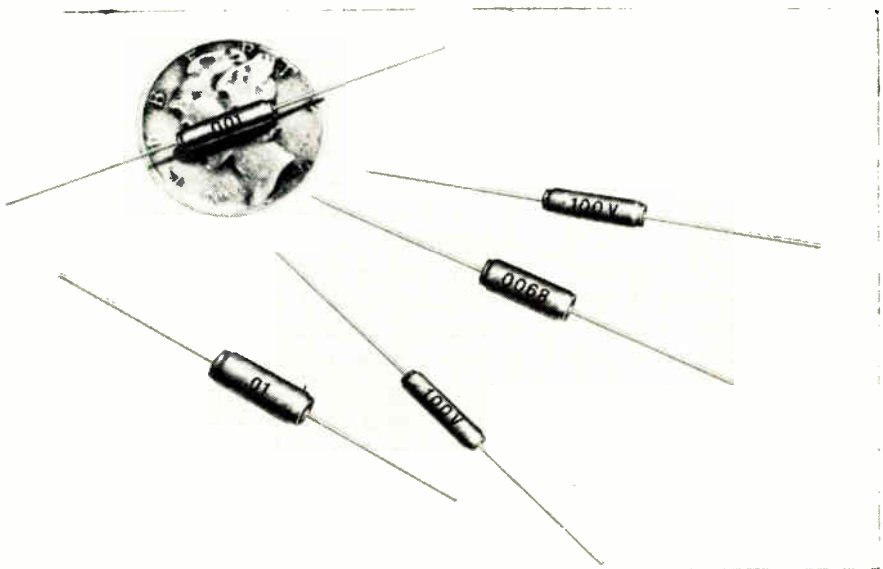
Low dielectric absorption factor.

But the chief drawback is its low melting point which limits its use to a maximum of 85°C.

Teflon overcomes the high temperature limitation of polystyrene

(*Continued on page* D24)

Good-All's "Microlar" Capacitors combine a 75% size reduction with unique lead-pull design.



PLASTIC DIELECTRIC (Concluded)

while offering essentially the same characteristics. Although a few capacitor manufacturers offer lines of Teflon capacitors, it is very difficult to handle and has found only limited use as a capacitor dielectric due to the high costs involved in manufacturing.

There are a few other plastics used in capacitors today but these are of less importance and will not be discussed. New plastics which have been recently available or are expected to be available before long shall now be included.

New Plastics

A relatively new plastic dielectric, polycarbonate, provides properties similar to those of polystyrene but up to at least 125°C operation. As mentioned, Teflon will do this, but has the drawback of being difficult to handle. Polycarbonate handles more easily and will probably find much broader use than Teflon has for capacitor use.

Comparison tests to date have shown polycarbonate imported from Germany to be superior to domestic films. This is unfortunate, but sizeable stocks of the foreign polycarbonate film are being built up in various places in the United States and its use is expected to increase sharply.

Preliminary tests of Kodar (Eastman Kodak's new film) have been very encouraging. This film exhibits a significant improvement in temperature coefficient (capacitance change with temperature change) over DuPont Mylar above 85°C. Although Kodar is not now available in gauges thinner than ½ mil in production quantities, it shows promise to be a popular plastic dielectric of the future.

DuPont's H-Film is currently under study for high temperature use. This is another plastic which is available only in small sample quantities at present. It has good voltage breakdown strength, even above 150°C, and could be of significant value in this temperature range. Since its properties are good, it is fairly certain that this plastic will be an important capacitor dielectric.

Polypropylene may be staging a rally for recognition as a capacitor dielectric. It has been tried in the past with disappointment but recently manufactured film appears to be good. Its chief attraction in the past has been its light weight and accompanying lower cost. It does offer some very good properties, however, and should be watched in the future as a possible contender with polystyrene and polycarbonate.

DuPont's 15-gauge Mylar (.00015 in. thick) is not actually a new film. It does, however, represent somewhat of a breakthrough in the plastic capacitor dielectric field, and should be discussed with new dielectrics. Its primary usage appears to be in metallized capacitors where the maximum in size reduction is realized.

Importance of Combinations

Combinations of plastic capacitor dielectrics have been used for some time to obtain desired capacitor properties. However, when you view the excellent choice of new plastics which will soon be available to capacitor design engineers, the combinations appear to be virtually unlimited and properties can possibly be tailored to meet almost any capacitor application. These many new plastic dielectrics will tend to increase competition between plastic dielectric manufacturers and hopefully will tend to force continual improvement and upgrading of all such dielectrics. This is, of course, a healthy and happy situation for both the capacitor manufacturer and the capacitor user since better capacitors are the inevitable result.

NEW TECH DATA

for Engineers.

Printed-Circuit Booklet

Techniques for producing reliable printed circuits and assemblies are detailed in this 3-color, 10-page booklet. It covers manufacturing methods, advantages and disadvantages of each. Included are charts listing tech. data and performance characteristics of base materials, from phenolic paper to epoxy glass, an easy-to-read table giving uses and properties of plated coatings, cut-away renderings of multi-layer termination alternatives, and other illustrations. Industrial Circuits Co., 99 Main Ave., E. Paterson, N. J.

Circle 581 on Inquiry Card

Wire and Cable

Standard Wire and Cable Co., 3440 Overland Ave., Los Angeles 34, Calif., has published a new aid to aircraft, electronic, space and missile designers, engineers and purchasing personnel who deal with military spec. wires and cables. Publication entitled, "Comparison Chart" shows characteristics of aircraft and electronic wires and cables covered by mil. specs. The brochure shows engineering, physical, and electrical characteristics for 20 most commonly used electronic and aircraft wire types.

Circle 582 on Inquiry Card

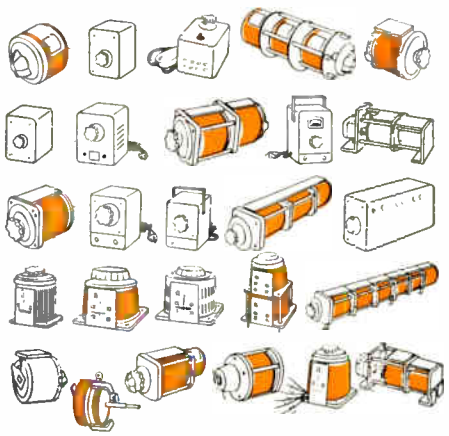
Explosion-Proof Starters

Safety and reliability features of Allis-Chalmers threaded, explosion-proof starters for hazardous locations are described in this literature. Designed for indoor and outdoor use, the enclosures have all-aluminum domes and body and stainless steel exterior hardware. Enclosures are available as complete factory-assembled starters, combination starters, and circuit breaker units. Components for field assembly of starter and circuit breaker units are also available. "TEP Starters for Hazardous Locations," 14C1488. Allis-Chalmers, Milwaukee 1, Wisc.

Circle 583 on Inquiry Card

economy thru variety

a big line that can fill your needs in unique ways



Ohmite *V.t.*® Variable Transformers

Take basic models of variable transformers and develop them intensely with imagination . . . with thoroughness . . . with boldness. And what's the result? A big line of muscular transformers . . . innumerable variations that save you money by close matching of requirements.

OVER-ALL CURRENT RANGE—1.75 to 25 amps (50 and 60 cycles to 400 cycles).

INPUT VOLTAGES—40, 120, 240 Volts.

CASED UNITS—Fixed mounting with knockouts; portable with switch, cord, outlet, and fuse; deluxe portable with on-off overvoltage selection switch, cord, outlet, circuit breaker, and adjustable handle.

TANDEMS (GANGED)—Two and three-unit from stock; special arrangements made to order.

WITH METERS—Portable cased transformers with voltmeter, ammeter, or wattmeter; single or in pairs.

INTERCHANGEABILITY—Practically all models are directly interchangeable with other popular types having comparable current ratings.

STOCK—54 Types and combinations, plus Ohmite's exclusive *motor drive modules*, from distributor and factory stocks.

"STANDARD" SPECIAL FEATURES—Multitaps; double tracks; special terminals; concentric shafts (tandems); special enclosures; special windings; adjustable taps; auxiliary switches; innumerable shaft variations; motor drives; and combinations with rheostats and switches.

UL APPROVED—Series VT4 and VT8 (3.5 to 10 amps). Approvals pending on other sizes. Carried in stock.

CUSTOM ENGINEERED—Whether your special needs are mechanical or electrical, simple or complex, Ohmite can engineer and manufacture the job in any quantity you desire.

Write for General Catalog 500 or call your distributor for Stock Catalog 30

OHMITE

OHMITE MANUFACTURING COMPANY
3662 Howard Street, Skokie, Illinois
Phone: (312) ORchard 5-2600

RHEOSTATS • POWER RESISTORS • PRECISION RESISTORS • VARIABLE TRANSFORMERS
TANTALUM CAPACITORS • TAP SWITCHES • RELAYS • R. F. CHOKES • SEMICONDUCTOR DIODES

JFD

model	type mount	capacitance range mmf measured per JFD 5177 min.	max	D.C. working volts	dielectric strength measured at max. rated cap.	insulation resistance 500 VDC	Q factor measured per JFD 5178	temp. coeff. of capacitance P.P.M. °C 25° to 125° C	material (dielectric-piston)	length (front of panel)
SEALCAP MINIATURE PANEL MOUNT, PRINTED CIRCUIT, GLASS AND QUARTZ										
SC131*, 141 & 151	Prt. Ct.	0.3	4.5	750	1500 VDC	2×10^4 Meg.	500	±50	Glass - Invar	13/32†
SC133*, 143 & 153	Prt. Ct.	0.8	8.5	1250	2500 VDC	10×10^4 Meg.	500	±50	Glass - Invar	21/32†
SC134*	Prt. Ct.	0.7	12.0	1250	2500 VDC	10×10^4 Meg.	500	±75	Glass - Invar	7/8
SC144 & 154	Prt. Ct.	0.8	12.0	1250	2500 VDC	10×10^4 Meg.	500	±75	Glass - Invar	1.053
SC136*, 146 & 156	Prt. Ct.	0.8	18.0	1250	2500 VDC	10×10^4 Meg.	500	±100	Glass - Invar	13/32†
SC139*	Prt. Ct.	1.0	30.0	1250	2500 VDC	10×10^4 Meg.	500	±100	Glass - Invar	1 3/4
SC149 & 159	Prt. Ct.	0.8	30.0	1250	2500 VDC	10×10^4 Meg.	500	±100	Glass - Invar	1.928
QS171*, 181 & 191	Prt. Ct.	0.6	1.8	1000	1500 VDC	2×10^4 Meg.	1500	Approx. Zero	Quartz - Invar	13/32†
QS173*, 183 & 193	Prt. Ct.	0.6	5.5	1250	2500 VDC	10×10^4 Meg.	1500	Approx. Zero	Quartz - Invar	21/32†
QS176*, 186 & 196	Prt. Ct.	0.6	9.5	1250	2500 VDC	10×10^4 Meg.	1500	Approx. Zero	Quartz - Invar	13/32†
QS179*, 189 & 199	Prt. Ct.	0.8	16.0	1250	2500 VDC	10×10^4 Meg.	1500	Approx. Zero	Quartz - Invar	1 3/4†
STANDARD SPLIT-STATOR PANEL MOUNT, GLASS AND QUARTZ										
VC16G	Panel	(A) 0.5 (B) 0.8	5.0 2.5	500	1000 VDC	10^4 Meg.	700	±50	Glass - Invar	11/16
VC17G	Panel	(A) 0.6 (B) 1.1	8.5 4.5	500	1000 VDC	10^4 Meg.	700	±50	Glass - Invar	1 1/32
VC18G	Panel	(A) 0.7 (B) 1.8	14.0 7.5	500	1000 VDC	10^4 Meg.	700	±50	Glass - Invar	1 13/32
VC80	Panel	(A) 0.3 (B) 0.4	2.0 1.0	1000	1500 VDC	10^4 Meg.	1000	Approx. Zero	Quartz - Invar	13/32
VC81	Panel	(A) 0.4 (B) 0.6	3.2 1.6	1000	1500 VDC	10^4 Meg.	1000	Approx. Zero	Quartz - Invar	5/8
VC82	Panel	(A) 0.5 (B) 0.85	5.5 2.8	1000	1500 VDC	10^4 Meg.	1000	Approx. Zero	Quartz - Invar	1 1/32
VC83	Panel	(A) 4.8 (B) 3.0	11.0 6.0	1000	1500 VDC	10^4 Meg.	1000	Approx. Zero	Quartz - Invar	1 3/16
HI-LIFE NVC20G MINIATURE PANEL MOUNT SERIES (May be used to replace VC20G series)										
NVC20G*, NSC133* (Sealcap)	Panel	0.8	8.5	750	1500 VDC	10^4 Meg.	500	±50	Glass-Invar	5/16
NVC21G*, NSC131* (Sealcap)	Panel	0.8	4.5	750	1500 VDC	10^4 Meg.	500	±50	Glass-Invar	5/16
NVC22G*, NSC134* (Sealcap)	Panel	0.7	12.0	750	1500 VDC	10^4 Meg.	500	±75	Glass-Invar	45/64
NVC23G*, NSC134* (Sealcap)	Panel	0.8	18.0	750	1500 VDC	10^4 Meg.	500	±100	Glass-Invar	1
NVC24G*, NSC139* (Sealcap)	Panel	1.0	30.0	750	1500 VDC	10^4 Meg.	500	±100	Glass-Invar	1 5/8
MINIATURE SPLIT-STATOR SEALCAP SERIES										
SPS226G*, 236G & 246G	Prt. Ct.	(A) 0.8 (B) 0.8	4.2 2.0	750	1500 VDC	10^3 Meg.	500	±50	Glass - Invar	11/64†
SPS227G*, 237G & 247G	Prt. Ct.	(A) 0.8 (B) 1.5	9.0 4.5	750	1500 VDC	10^3 Meg.	500	±100	Glass - Invar	1 1/8†
SPS228G*, 238G & 248G	Prt. Ct.	(A) 1.0 (B) 2.0	14.0 7.0	750	1500 VDC	10^3 Meg.	500	±100	Glass - Invar	1 13/32†
SUPER MAX-C SEALCAP SERIES, STANDARD PANEL MOUNT, PRINTED CIRCUIT, GLASS AND QUARTZ**										
MCD641**, MCD661	Prt. Ct.	1.0	14.0	1000	2000 VDC	10^4 Meg.	500	±50	Glass-Invar	11/16†
MCD643**, MCD663	Prt. Ct.	1.0	28.0	1000	2000 VDC	10^4 Meg.	500	±50	Glass-Invar	51/64†
MCD644**, MCD664	Prt. Ct.	1.0	42.0	1000	2000 VDC	10^4 Meg.	500	±50	Glass-Invar	1 7/64†
MCD646**, MCD666	Prt. Ct.	1.0	60.0	1000	2000 VDC	10^4 Meg.	500	±50	Glass-Invar	1 13/32†
MCD649**, MCD669	Prt. Ct.	1.0	90.0	1000	2000 VDC	10^4 Meg.	500	±50	Glass-Invar	1 49/64†
MINIATURE DIFERENTIAL SEALCAP SERIES										
DS441*, 451 & 461	Prt. Ct.	(1) 0.7 (2) 2.0	3.0 3.0	500	1000 VDC	10^4 Meg.	500	±100	Glass - Invar	3/64†
DS443*, 453 & 463	Prt. Ct.	(1) 0.8 (2) 2.5	8.0 8.5	500	1000 VDC	10^4 Meg.	500	±100	Glass - Invar	43/64†
DS444*, 454 & 464	Prt. Ct.	(1) 0.8 (2) 3.0	12.0 12.0	500	1000 VDC	10^4 Meg.	500	±100	Glass - Invar	3/16†
DS446*, 456 & 466	Prt. Ct.	(1) 0.9 (2) 3.0	16.0 16.0	500	1000 VDC	10^4 Meg.	500	±100	Glass - Invar	1 1/64†
DS449*, 459 & 469	Prt. Ct.	(1) 1.0 (2) 4.0	28.0 28.0	500	1000 VDC	10^4 Meg.	500	±100	Glass - Invar	1 11/64†
MAX-C SEALCAP SERIES										
MC601*, 611 & 621	Prt. Ct.	1.0	14.0	1000	2000 VDC	10^4 Meg.	500	±50	Glass - Invar	29/64†
MC603*, 613 & 623	Prt. Ct.	1.0	28.0	1000	2000 VDC	10^4 Meg.	500	±50	Glass - Invar	1 1/64†
MC604*, 614 & 624	Prt. Ct.	1.0	42.0	1000	2000 VDC	10^4 Meg.	500	±50	Glass - Invar	1 13/32†
MC606*, 616 & 626	Prt. Ct.	1.0	60.0	1000	2000 VDC	10^4 Meg.	500	±50	Glass - Invar	1 13/32†
MC609*, 619 & 629	Prt. Ct.	1.0	90.0	1000	2000 VDC	10^4 Meg.	500	±50	Glass - Invar	1 3/4†

LC TUNERS*	self-resonating frequency (MC)	nominal induct (microhenries)	nominal capacitance (MME)	Q factor	operating temperature °C	material	length (front of panel)
LC303* , 313 , 323 & 333**	400 MIN 725 MAX	.0248 MIN .0277 MAX	.54 MIN 6.56 MAX	170-200	—55 to +125	Glass - Invar	43/64
LC304* , 314 , 324 & 334**	275 MIN 550 MAX	.0367 MIN .0396 MAX	.85 MIN 11.66 MAX	150-175	—55 to +125	Glass - Invar	5/8
LC306* , 316 , 326 & 336**	200 MIN 500 MAX	.0507 MIN .0544 MAX	.86 MIN 20.19 MAX	135-170	—55 to +125	Glass - Invar	1 1/4
LC309* , 319 , 329 & 339**	125 MIN 375 MAX	.048 MIN .0798 MAX	.88 MIN 24.49 MAX	145-155	—55 to +125	Glass - Invar	1 13/32

†Other NVC, NMQ and NQS Hi-Life models are also available. All Hi-Life units can be used to replace other corresponding JFD trimmer capacitors without "N" prefix. All are fully described in JFD catalog C-63.

FIXED METALIZED INDUCTORS FOR PANEL MOUNT OR PRINTED CIRCUIT MOUNT

23 values available off the shelf from 0.05μh-Q factor up to 180. High stability over wide operating temperature. Write for our catalog.

**Standard panel mount * miniature panel mount †Length Applicable for Panel Mount Types Only.

JFD THE VARIABLE TRIMMER PISTON CAPACITORS, LC TUNERS AND METALIZED INDUCTORS

AMERICA KNOWS BEST!

model	type mount	capacitance range mmf measured per JFD #5177 min.	max.	D.C. working volts	dielectric strength measured at max. rated cap.	insulation resistance 500 V D C.	Q factor measured per JFD #5178	temp. coeff. of capacitance P.P.M./°C 25° to 125°C	material (dielectric-piston)	length (front of panel)
STANDARD PANEL MOUNT, GLASS AND QUARTZ										
VC1G	Panel	0.7	9.0	1500	2500 VDC	10^4 Meg. Min.	500	−60 to +10	Glass - Invar	21/32
VC4G	Panel	0.8	18.0	1000	1500 VDC	10^4 Meg. Min.	500	+350 to +450	Glass - Brass	1
VC5G	Panel	0.8	18.0	1000	1500 VDC	10^4 Meg. Min.	500	−20 to +40	Glass - Invar	1
VC11G	Panel	0.6	14.0	1000	1500 VDC	10^4 Meg. Min.	500	−30 to +40	Glass - Invar	1
VC11GRA	Panel	0.6	14.0	1000	1500 VDC	10^4 Meg. Min.	500	−40 to +50	Glass - Invar	1
VC11GRB	Panel	0.6	14.0	1000	1500 VDC	10^4 Meg. Min.	500	+450 to +600	Glass - Brass	1
VC11GRC	Panel	0.8	18.0	1000	1500 VDC	10^4 Meg. Min.	500	+20 to +100	Glass - Invar	1
VC30G	Panel	0.8	30.0	1000	1500 VDC	10^4 Meg. Min.	500	−10 to +50	Glass - Invar	1 19/32
VC2	Panel	0.7	4.5	1000	1500 VDC	10^4 Meg. Min.	2000	Approx. Zero	Quartz - Invar	7/16
VC5	Panel	0.6	6.0	1000	1500 VDC	10^4 Meg. Min.	2000	Approx. Zero	Quartz - Invar.	5/8
VC11	Panel	0.8	10.0	1000	1500 VDC	10^4 Meg. Min.	2000	Approx. Zero	Quartz - Invar	1
VC11A	Panel	1.0	10.0	1000	2000 VDC	10^4 Meg. Min.	2000	Approx. Zero	Quartz - Invar	1 1/32
VC12	Panel	9.0	21.0	1000	1500 VDC	10^4 Meg. Min.	2000	Approx. Zero	Quartz - Invar	1 19/32
VC99	Panel	0.8	10.0	3000	5000 VDC	10^4 Meg. Min.	2000	Approx. Zero	Quartz - Invar	1 3/32
SPLIT BUSHING SERIES PANEL MOUNT, PRINTED CIRCUIT, GLASS AND QUARTZ										
VC3G	Panel	0.7	9.0	1500	2500 VDC	10^4 Meg. Min.	650	+350 to +500	Glass - Brass	21/32
VC3GI	Panel	0.7	9.0	1500	2500 VDC	10^4 Meg. Min.	650	+0 to −150	Glass - Invar	21/32.
VC6GA	Panel	0.7	17.0	1000	1500 VDC	10^4 Meg. Min.	750	+400 to +600	Glass - Brass	1 1/32
VC6GC	Panel	0.8	17.0	1000	1500 VDC	10^4 Meg. Min.	650	−100 to +100	Glass - Invar	1 1/32
VC6GI	Panel	0.8	17.0	1000	1500 VDC	10^4 Meg. Min.	600	−100 to +100	Glass - Invar	1 1/32
VC7G	Panel	2.0	30.0	1000	1500 VDC	10^4 Meg. Min.	600	−100 to +100	Glass - Invar	1 5/8
VC13GA	Panel	0.8	13.0	3000	5000 VDC	10^4 Meg. Min.	500	+225 to +375	Glass - Ph. Bronze	1 1/4
VC50C	Panel	5.0	50.0	1250	2500 VDC	10^3 Meg. Min.	450	+250 to +450	Ceram Ph Bronze	1
VC801GW	Prt. Ct.	0.8	4.5	1000	1500 VDC	10^4 Meg.	500	−55 to +125	Glass - Invar	33/64
VC803GW	Prt. Ct.	0.8	8.5	1000	1500 VDC	10^4 Meg.	500	−55 to +125	Glass - Invar	25/32
VC804GW	Prt. Ct.	0.8	12.0	1000	1500 VDC	10^4 Meg.	500	−55 to +125	Glass - Invar	31/32
VC806GW	Prt. Ct.	0.8	18.0	1000	1500 VDC	10^4 Meg.	500	−55 to +125	Glass - Invar	1 1/32
VC809GW	Prt. Ct.	0.8	30.0	1000	1500 VDC	10^4 Meg.	500	−55 to +125	Glass - Invar	1 13/16
VC811QW	Prt. Ct.	0.6	1.8	1000	1500 VDC	10^4 Meg.	2000	−55 to +150	Quartz - Invar	33/64
VC813QW	Prt. Ct.	0.6	5.0	1000	1500 VDC	10^4 Meg.	2000	−55 to +150	Quartz - Invar	3/4
VC816QW	Prt. Ct.	0.6	9.5	1000	1500 VDC	10^4 Meg.	2000	−55 to +150	Quartz - Invar	1 1/32
VC819QW	Prt. Ct.	0.6	16.0	1000	1500 VDC	10^4 Meg.	2000	−55 to +150	Quartz - Invar	1 13/16
MINIATURE PANEL MOUNT, PRINTED CIRCUIT, GLASS AND QUARTZ										
VC20G * VC9G, VC9GW	Prt. Ct.	0.8	8.5	1000	1500 VDC	10^4 Meg. Min.	500	±50	Glass - Invar	9/16
VC21G* VC10G, VC10GW	Prt. Ct.	0.8	4.5	1000	1500 VDC	10^4 Meg. Min.	500	±50	Glass - Invar	5/16
VC22G*	Panel	0.7	12.0	1000	1500 VDC	10^4 Meg. Min.	500	±75	Glass - Invar	49/64
VC23G* VC32G,VC32GW	Prt. Ct.	0.8	18.0	1000	1500 VDC	10^4 Meg. Min.	500	±100	Glass - Invar	1
VC24G *	Panel	1.0	30.0	1000	1500 VDC	10^4 Meg. Min.	500	±100	Glass - Invar	1 5/8
VC31G, VC31GW	Prt. Ct.	0.8	12.0	1000	1500 VDC	10^4 Meg. Min.	500	±75	Glass - Invar	1 1/32
VC42G & VC42GW	Prt. Ct.	1.0	21.0	1000	1500 VDC	10^4 Meg. Min.	500	±100	Glass - Invar	1 1/8
VC43G, VC43GW	Prt. Ct.	0.8	30.0	1000	1500 VDC	10^4 Meg. Min.	500	±100	Glass - Invar	1 5/8
MQ101*, 111 & 121	Prt. Ct.	0.6	1.8	1000	1500 VDC	10^4 Meg. Min.	1500	Approx. Zero	Quartz - Invar	5/16
MQ103*, 113 & 123	Prt. Ct.	0.6	5.5	1000	1500 VDC	10^4 Meg. Min.	1500	Approx. Zero	Quartz - Invar	9/16
MQ106*, 116 & 126	Prt. Ct.	0.6	9.5	1000	1500 VDC	10^4 Meg. Min.	1500	Approx. Zero	Quartz - Invar	1
MQ109*, 119 & 129	Prt. Ct.	0.8	16.0	1000	1500 VDC	10^4 Meg. Min.	1500	Approx. Zero	Quartz - Invar	1 5/8

* Panel Mount

JFD ELECTRONICS CORPORATION

JFD ELECTRONICS CORPORATION
THE AMERICA KNOWS BEST!

Components Division
15th Avenue at 62nd Street, Brooklyn 19, N. Y.; Phone 212 DE 1-1000
TWX212-833-7001 Cable-JEFDEE N. Y.

JFD WESTERN
9 Morlan Place
Arcadia, Calif.
Phone: HIllcrest 6-0312

JFD MIDWESTERN
6330 Hermione St.
Chicago 46, Ill.
Phone: 775-5424

JFD MIDWESTERN-OHIO
P. O. Box 36090
Cincinnati 36, Ohio
Phone: 421-1166

JFD NORTHEASTERN
Ruth Drive, P. O. Box 228
Marlboro, Mass.
Phone: HUntley 5-7311

JFD CANADA
51 McCormack Street
Toronto, Ontario, Canada
Phone: ROger 2-7571

JFD ELECTRONICS (ISRAEL) LTD.
Industrial area B. Bldg. 23
Azur, Israel
Cable Address:
JFD AZUR, ISRAEL

LCC STEAFIX
128 Rue de Paris
Montreuil, Seine, France

STANDARD TELEPHONE & CABLES LTD.
Footscray, Sidcup,
Kent, U. K.

DUCON CONDENSER
PTY. LTD.
Villawood, N.S.W., Australia

Variable Trimmer Piston Capacitors • Metalized Inductors • LC Tuners • Filters • Diplexers • Fixed and Variable Distributed and Lumped Constant Delay Lines • Pulse Forming Networks

Circle 25 on Inquiry Card

VARIABLE RESISTORS

Complete Line. Whatever you need, CTS has it or can make it to your Exact Requirement.

CTS' world-wide sales organization will help solve your variable resistor problems.

	DIAMETER	POWER RATING (watts)	RESISTANCE (ohms)	CTS SERIES	
COMPOSITION VARIABLE RESISTORS					
COMMERCIAL	15/16"	1/4-1	200Ω—10 megs	45	
	15/16"	1/4	250Ω—15 megs	Q	
	3/4"	2/10-3/10	250Ω—5 megs	70	
	5/8"	2/10-1/4	250Ω—2.5 megs	200	
	9/32"	1/10	500Ω—10 megs	M250	
	2 & 3 section side by side	1/4-1/3	250Ω—10 megs	X52 X53 U52	
	2 & 3 section side by side	1/4	500Ω—10 megs	X152* X153*	*Carbon-ceramic
	2"	2	5KΩ—50 megs	HVC	MIL-R-94B
MILITARY	1-1/8"	2	100Ω—10 megs	96	RV4
	1-1/8"	2	100Ω—10 megs	95	
	15/16"	1	100Ω—5 megs	90	RV2
	15/16"	1/4	100Ω—15 megs	45	
	3/4"	1/2	100Ω—2.5 megs	65	RV5
	1/2"	3/4	100Ω—2.5 megs	300*	RV6
WIREWOUND VARIABLE RESISTORS					
COMMERCIAL	1-17/32"	4	3Ω—25K	25	
	1-17/64"	2	3Ω—15K	252	
	1-1/4"	2	1Ω—50K	2W	MIL-R-19
	3/4"	1-1/2 to 3	1/2Ω—5K	110	
MILITARY	1-17/32"	4	3Ω—25K	25	RA30
	1-17/64"	2	3Ω—15K	252	RA20
	1-1/4"	2	3Ω—15K	WP	RA20
CERMET VARIABLE RESISTORS					Request Data Sheet
(with Space Age High Stability 500°C Metal-Ceramic Element)	1-3/64"	3	100Ω—2.5 megs	400†	179
	3/4"	1-1/2	100Ω—2.5 megs	500†	180
	1/2"	3/4	100Ω—5 megs	600	175

*Carbon-ceramic

†Semi-precision

	DIMENSIONS	POWER RATING (watts)	RESISTANCE (ohms)	CTS SERIES	
COMPOSITION TRIMMER RESISTORS					Request Data Sheet
COMMERCIAL	1-1/4x.295x.350	1/4	500Ω—1 meg	140	80
	7/16x5/16x1/2	1/8	250Ω—2.5 megs	220	184
MILITARY	1-1/4x.295x.350	1/4	500Ω—1 meg	140	80
	.344 Dia. x .240	1/10	250Ω—2.5 megs	380*	
CERMET TRIMMER RESISTORS					
	1/2x1/2x.260	1	100Ω—1 meg	170	178
	1-1/4x.295x.335	1	100Ω—1 meg	180	177

*Carbon-ceramic

Only P.C. sizes are shown. Lead sizes are smaller.

CERMET FIXED RESISTORS

CERAFER—Cermet resistance element. Wafers for micromodule systems. Low cost resistor and conductor layouts for printed circuitry on ceramic. 5Ω-300K per square. Request Data Sheet 181.

CERADOT—Solid cermet, .050" dia. x .030" long or as required, 1/10 watt, 50Ω-100K, with or without leads. Request Data Sheet 185.

SELECTOR SWITCHES

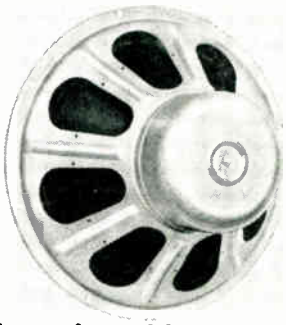
NON-DRIFT, COMPACT

1-1/8" dia., 2 to 12 positions, rotary wafer switches for commercial and military applications. Unprecedented switch uniformity from entirely new automated manufacturing concept. Request Data Sheet 182.

REMOTE OPERATED VARIABLE RESISTORS & SWITCHES

Variable resistors with continuous motor drive or electromagnetic step drive. Also available with attached on-off switch.

HIGH QUALITY LOUDSPEAKERS



Complete Line

From 3" tweeter...through all-purpose round and elliptical . . . to 15" woofer. Precision workmanship produces the closest tolerances between moving coil and magnet. Modern facilities. Request Data sheet P-101 from CTS of Paducah, Inc., Paducah, Ky.

CTS®

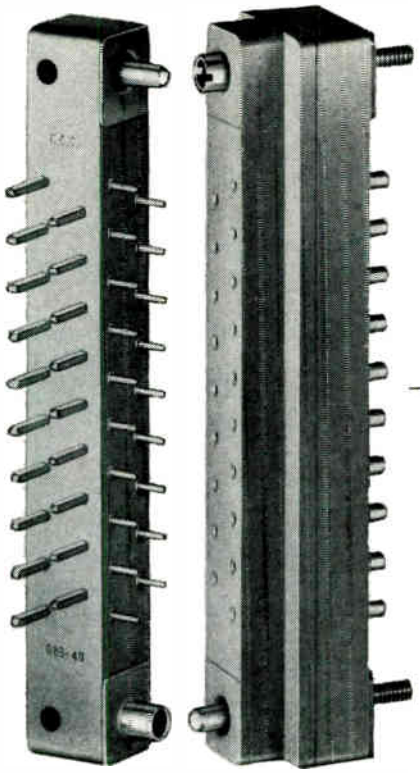
Founded 1896

CTS CORPORATION
Elkhart, Indiana

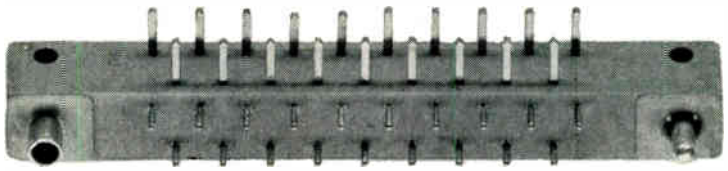
DATA SHEET REQUESTS HONORED PROMPTLY, ASK BY NUMBER

Factories coast-to-coast for your convenience: Elkhart & Berne, Indiana; South Pasadena, California; Asheville, North Carolina; Paducah, Kentucky and Streetsville, Ontario, Canada.

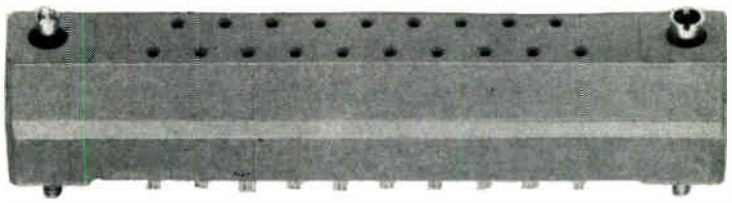
ANOTHER CONTINENTAL CONNECTOR FOR THE POLARIS PROGRAM



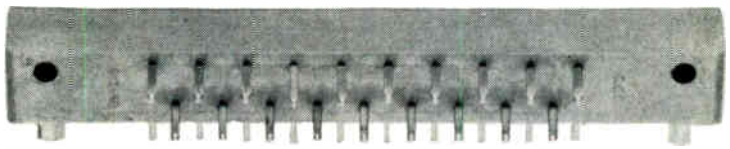
Series 683-40 and 683-41 Right Angle Plug & Socket



Feature Two Taper Receptacles for Each Solderless-



Wrap Connection and .250 Staggered Contact Spacing



...Meet All Requirements for Vibration and Impact.

19 Solderless-Wrap Plug Terminations/38 Taper Pin Socket Terminations
Socket easily secured to PC board or chassis by two threaded mounting studs. Plug has through hole mounting. Guide pins and sockets are polarized to prevent mismating. Molding is flame resistant, high dielectric, glass filled Diallyl Phthalate.

DESIGNER'S DATA FILE. If you're designing for right angle printed circuit applications you'll want to have Continental's Catalog RTA 362, compiled to help you select and specify the type best suited to your needs. For a free copy, write to: *Continental Connector Corporation, 34-63 56th Street, Woodside 77, New York, or call TW 9-4422.*

DISTRIBUTORS FOR OFF-THE-SHELF DELIVERY:

AIRWORK CORP., O.E.M. DIVISION P.O. Box 48-194, International Airport, Miami 48, Fla. • Phone: 885-2401 • TWX 305-821-3720

CONTACT ELECTRONICS, INC. 2403 Farrington, Dallas, Texas Phone: MElrose 1-9530 • TWX 214-631-4993

ESCO ELECTRONICS INC.
3130 Valleywood Drive, Dayton, Ohio • Phone: 298-9816

STAN AUERBACH ELECTRONIC DISTRIBUTORS, INC.
1371 Bridgetown Pike, Feasterville, Pa. • Phone: (215) EL 5-0430

CCC WEST COAST BRANCH
4054 W. Beverly Blvd., Los Angeles 4, Calif. • Phone: 381-2285

CCC MIDWEST BRANCH
2040 W. Wisconsin Ave., Milwaukee, Wisc. • Phone: D1 4-2727

MICRO-MINIATURE • SUB-MINIATURE • MINIATURE • PRINTED CIRCUIT • RIGHT ANGLE PIN & SOCKET • CENTER SCREWLOCK

CONTINENTAL CONNECTORS

CONTINENTAL CONNECTOR CORPORATION • WOODSIDE 77, NEW YORK

50% more capacity per unit volume, 30% more capacity per unit weight than any comparable nickel-cadmium battery — rechargeable thousands of times — these are features you may need now for transistorized field pack radios or radio telephones, rescue beacons, unmanned remote stations, test equipment, low-noise preamps and other long-life, low-rate-discharge applications.

Added to the voltage stability, rechargeability and low-temperature performance of nickel-cadmium, these cells offer exceptional efficiency — made possible by a space-saving rectangular shape and Sylvania's film forming process. Cell plates are made by casting and sintering nickel to form a self-supporting, porous film, and then loading this "sponge" with chemicals. The usual plate backing is thus eliminated, and efficiency is increased.

Cells are hermetically sealed and available in a wide choice of sizes with capacities from 50 mA hrs. to 4 Amp hrs. Easily stacked in a variety of arrangements, they are strapped and jacketed in plastic to form a battery that meets shock and vibration requirements of MIL-B-55118 (Signal Corps).

To crystallize some of the advantages of Sylvania bat-

Design small, design light—new Sylvania are up to 50% more efficient

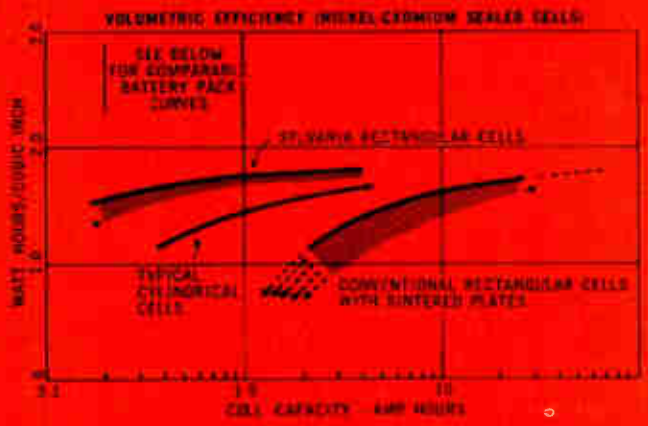
Typical plastic-jacketed 12-volt battery—only 5.5 cubic inches, with 500 mA hr. capacity. High efficiency comes from rectangular cell shape and film formed plates shown in cutaway—sheets of porous nickel impregnated with chemicals.

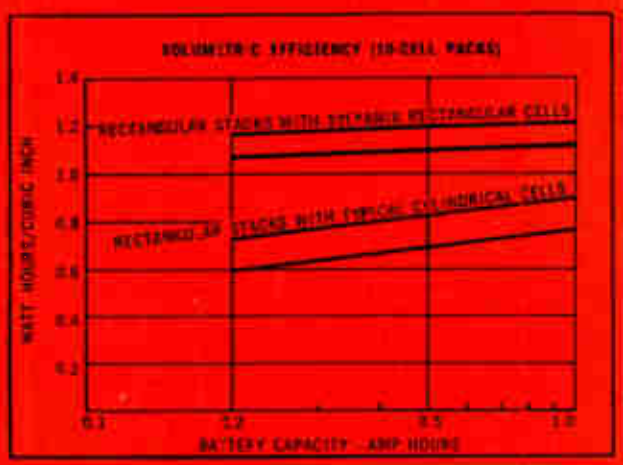
series, here is a partial description of the typical 10-cell pack illustrated below:

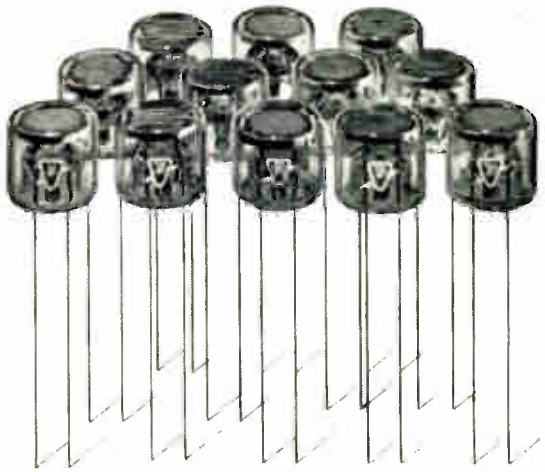
TYPE SRB-3428

Dimensions (approx.)	3⅛ x 2⅛ x 1 5/16 in.
Volume	5.5 cu. in.
Weight	.5 lb.
at .2C$_5$ rate:	
Capacity (nominal)	500 mA hrs.
Average Operating Voltage	12 Volts

Ni-Cd batteries than any others







BROADEST LINE OF T-4 CdS PHOTOCONDUCTORS AVAILABLE

400 V, 300 mW ratings...hermetic seal with blue-dot proof!

Photocell circuit designers can now have cells exactly suited to streetlighting, flame-out alarms, remote control devices and other applications—choosing from the Sylvania line, ranging from 750 ohms to 16,000. Now rated at 400 volts, with 300 mW dissipation, these photoconductors also have reliability insurance—a true hermetic seal verified by a blue dot that immediately signals the presence of as little as .02% water vapor.

Among T-4 cadmium sulfide cells, only Sylvania offers such a broad range plus these high voltage and dissipation ratings. And watch for future developments: smaller size, photoconductors for high power and ultraviolet.

Type	2 Ft.-Candle Resistance (ohms)	Min. Dark Resistance After 10 Sec. in Complete Darkness (ohms)
8345	750	75,000
8142	1,500	200,000
8346	3,000	300,000
8100	5,000	500,000
8143	9,000	900,000
8347	16,000	1,600,000

For more information on these two new developments from Sylvania, write Electronic Tube Division, Sylvania Electric Products Inc., Box 87, Buffalo, N. Y.

SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS
MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

Circle 14 on Inquiry Card

NEW TECH DATA

for Engineers.

Components Catalog

Catalog 32, 44 pages, lists variable resistors, switches and ceramic capacitors. Detailed dimensional drawings and complete electrical, mechanical, and environmental specs. are given. Included are 18 and 24-position phenolic switches, lever-action switches, intercom switches, rotary switch kits, military type ceramic disc capacitors, ac line ceramic disc capacitors, 20v. microminiature Ultra-Kaps, and polystyrene capacitors. Centralab, The Electronics Div. of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc.

Circle 484 on Inquiry Card

Thin-Plate Capacitors

Bulletin NPJ-122 describes subminiature thin-plate capacitors, types TPXPO, TP25, and TP89. Available in a variety of temp. coefficients, their rectangular slim design allows close assembly on printed-wiring boards. Listed are typical properties for each type, physical dimensions, etc. Aerovox Corp., New Bedford, Mass.

Circle 485 on Inquiry Card

Nonlinear Capacitors

This new line of Mylar® dielectric permits any nonlinear function with capacitor rotation. Custom features such as trigonometric, step, discontinuous and circuit-error correcting functions can be accommodated. Total capacitance may be increased, decreased or remain constant with rotation. Western Industrial Research, Rotary Products Div., P. O. Box 404, Beverly Hills, Calif.

Circle 486 on Inquiry Card

Low-Power Amplifier

The SA-112 amplifier gives high-gain and low-drift performance without choppers. It has less than 10mv./day drift and uses 60mw. It can be operated continuously for 1 month from 2 flashlight-size batteries and drives a galvanometer-type recorder. It is ideal for recording thermocouple signals. Self-Organizing Systems, Inc., 6612 Denton Dr., Dallas 35, Tex.

Circle 487 on Inquiry Card

I-F Tubes

Types 6JK6 and 6JL6 are strap-frame, i-f amplifiers designed for use in television receivers. Type 6JK6 is a 7-pin miniature video i-f pentode featuring frame-grid construction, sharp cutoff characteristic, and 18,000μmhos; type JL6, also a 7-pin miniature i-f pentode, features frame-grid, has remote cutoff characteristics, is designed for AGC controlled stages, and has 15,500μmhos. Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y.

Circle 488 on Inquiry Card

Power Supplies

Bulletin Series 4105 presents information on power supplies covering output from 0.7v. to 500v. at 1.0 to 110 amps. Circuits use either conventional or ferroresonant transformers and either magnetic-amplifier, SCR, or transistor regulators. Vickers Inc., 1815 Locust St., St. Louis 3, Mo.

Circle 489 on Inquiry Card

Power Resistors

The Greenohm "V" edge-wound resistors are available in power ratings from 90 to 375w. Temp. rise is 375°C. The units meet or exceed Mil-R-26C for uninsulated resistors. Resistance range is from 0.04 to 25 ohms. Clarostat Mfg. Co., Inc., Dover, N. H.

Circle 490 on Inquiry Card

Voltage Sensors

Voltage hermetically-sealed sensors, consisting of input network, voltage comparator with adjustment if required, amplifier and output relay, are available. These sensors are used where critical amplitude sensing between drop-out and pull-in voltages or low voltages must be sensed. Hi-G Inc., Bradley Field, Windsor Locks, Conn.

Circle 491 on Inquiry Card

Tin Oxide Resistors

Bulletin, "Resistor Reliability" discusses methods of manufacturing and selecting and provides information on performance of high-reliability tin oxide resistors. Two representative graphs illustrate the results of continuous life testing of standard parts for almost 6 years at 60%, and at 140% for almost 4 years. Corning Electronic Components, Corning Glass Works, Raleigh, N. C.

Circle 492 on Inquiry Card

Trimmer Capacitors

Series Bulletin Y-63 describes a new series of low-cost trimmers which exceed Mil-C-14409A. These trimmers feature stability, high Q, ultra-linear tuning, and lack tuning reversals. Information includes physical and electrical specs. JFD Electronics Corp., 15th Ave. at 62nd St., Bklyn. 19, N. Y.

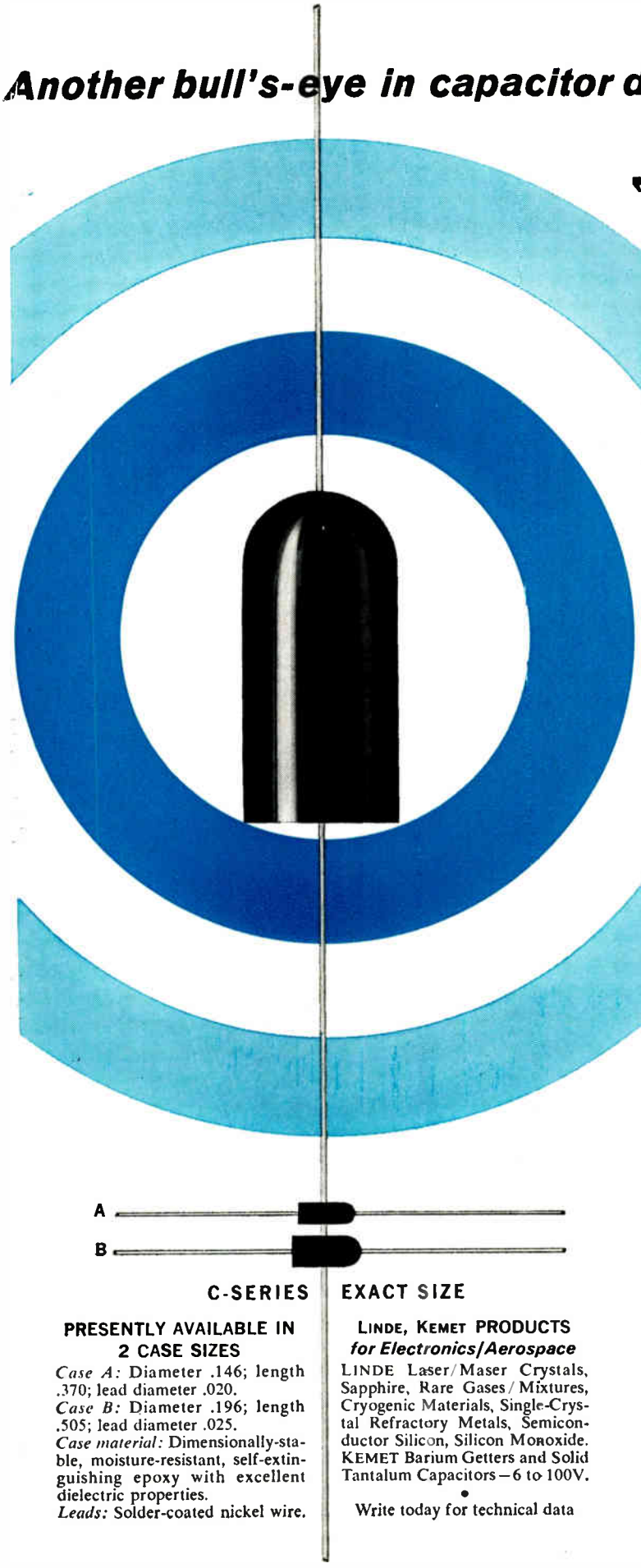
Circle 493 on Inquiry Card

Power Resistors

Type PW wire-wound resistors are available in ratings of 2, 3, 5, 7, 10, 15, and 20w. Min. standard resistance value is 0.1Ω, and tolerances are 5 and 10%. Boone Div., International Resistance Co., P. O. Box 393, Boone, N. C.

Circle 494 on Inquiry Card

Another bull's-eye in capacitor design...!



C-SERIES EXACT SIZE

PRESENTLY AVAILABLE IN 2 CASE SIZES

Case A: Diameter .146; length .370; lead diameter .020.
Case B: Diameter .196; length .505; lead diameter .025.
Case material: Dimensionally-stable, moisture-resistant, self-extinguishing epoxy with excellent dielectric properties.
Leads: Solder-coated nickel wire.

"KEMET"
TRADE MARK

BULLET-SHAPED
C-SERIES
(Polar Type)
SOLID TANTALUM CAPACITORS

Provide peak performance under severe shock/vibration conditions

★ **Molded shape adaptable to welded module construction or conventional point-to-point wiring... also automatic insertion equipment.**

★ **Suitable for better-grade entertainment devices, ship-to-shore and other 2-way radio communications or similar top-quality uses.**

KEMET's complete line of solid tantalum capacitors has a brand new member—the C-Series polar type—designed for highly compact circuitry!

C-Series units consist of a porous tantalum anode encapsulated in an epoxy case with a *bullet-shaped* end for fast polarity identification, easy capacitor orientation, and assembly in close proximity to other components.

DC leakage current is extremely low and dissipation factor is not sacrificed. Capacitance ranges from 0.1 to 56 microfarads in ±5, 10, and 20 per cent tolerances. Working voltages are 6, 10, 15, 20, 35, and 50. Operation is continuous over a temperature range of −55° to +85°C.

For full information on the C-Series and other solid tantalums in KEMET's complete line—from 6 to 100 volts—write to:

"THE SPECIALIST IN SOLID TANTALUM CAPACITORS"

Kemet Department, Linde Company, Division of Union Carbide Corporation, 11901 Madison Avenue, Cleveland 1, Ohio. Telephone 216-221-0600.

LINDE, KEMET PRODUCTS *for Electronics/Aerospace*

LINDE Laser/Maser Crystals, Sapphire, Rare Gases/Mixtures, Cryogenic Materials, Single-Crystal Refractory Metals, Semiconductor Silicon, Silicon Monoxide. KEMET Barium Getters and Solid Tantalum Capacitors—6 to 100V.

•

Write today for technical data

KEMET DEPARTMENT
LINDE COMPANY

UNION CARBIDE

"Kemet," "Linde," and "Union Carbide" are registered trade marks of Union Carbide Corporation.

ESC ELECTRONICS CORP.

534 BERGEN BOULEVARD • PALISADES PARK. N. J.

products are available from stock, or depending on your requirements, will be designed to your exact specifications. For custom requirements, we will produce a prototype and submit a detailed laboratory report on all parameters and test equipment used. When your prototype is ready for production, our rigid Inspection and Quality Control Procedures ensure that each electrical and mechanical characteristic is exactly as specified.

For complete information on the hundreds of different models manufactured by ESC, write or call today for catalog No. 9, or specific technical literature.

*Write for Brochure

*MAGNETOSTRICTIVE DELAY LINES

This new ESC line ranges from 10 μsec to 10,000 μsec; frequency range 200 KC to 1 MC R.Z.; temperature coefficient less than 1 PPM where required; meets MIL environmental requirements. The acoustic wire type of sonic delay line offers the most desired characteristics of a memory line — long delay, wide bandwidth and delay stability in a high density package.

Series No.	Min. Delay	Max. Delay
30M	250 μSEC	1000 μSEC
40M	1000 μSEC	2500 μSEC
50M	2500 μSEC	5000 μSEC
60M	5000 μSEC	10000 μSEC

AUDIO DELAY LINES

Hermetically sealed for most severe environmental applications; delays from 500 μsec to 5000 μsec and greater; bandwidth (3 db); up to 35 KC and greater; delay time/rise time ratios as high as 170/1. Frequency insertion loss less than 4 db.

Other audio delay lines up to 200 milliseconds.

MINIATURE TRANSPONDER DELAY LINE

Occupies only six cubic inches; Impedance: 470 ohms; delay time 20.3 ±.1; rise time: 0.45 (max); attenuation: 4 db; temperature coefficient: 65 ppm or better over a temperature range of −55°C to +125°C. Series 52-44.

For your immediate requirements, ESC carries an extensive stock of encoding or decoding delay lines.

DIRECT READOUT VARIABLE DECADE DELAY LINE

Model 101 — a total delay of 9.99 μsec, resolution $\frac{1}{1000}$ of total delay

Model 102 — a total delay of 9.99 μsec, resolution $\frac{1}{1000}$ of total delay

Model 103 — a total delay of 9.99 μsec, resolution $\frac{1}{1000}$ of total delay

PUSHBUTTON DECADE DELAY LINE

Model	Delay	Rise Time	Impedance	Attenuation (at max. μsec delay)
205 205R	0- 5.075 μsec	0.20 μsec	1000 ohms	25%
210 210R	0-10.05 μsec	0.30 μsec	1000 ohms	40%
220 220R	0-20.05 μsec	0.50 μsec	1000 ohms	50%
250 250R	0-50.1 μsec	2.0 μsec	1000 ohms	50%

CONTINUOUSLY VARIABLE DELAY LINES (6 17/32" X 5/8 X 1 1/4")

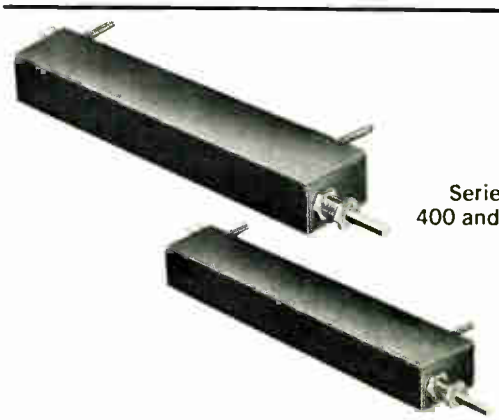
No.	Delay (Max.)	Rise Time (Max.)	Impedance (Ohms)
401	.10 μsec	.025 μsec	100
402	.20 μsec	.030 μsec	200
403	.70 μsec	.090 μsec	500
404	.50 μsec	.055 μsec	750
405	.40 μsec	.040 μsec	1000
406	.25 μsec	.030 μsec	1300
407	.20 μsec	.030 μsec	1500

CONTINUOUSLY VARIABLE VIDEO DELAY LINE (7 1/4" X 1" X 1 5/8")

Model No.	Min. Delay @ Max. Pos.	Impedance (Ohms)	Rise Time (max)	Attenuation
501	0.9 μsec	1,000	0.2 μsec	0.5 db
502	2.0 μsec	470	0.4 μsec	1.2 db
503	4.0 μsec	220	0.8 μsec	2.5 db
504	9.0 μsec	100	1.8 μsec	5.0 db
505	15.0 μsec	56	3.0 μsec	9.0 db

Series 100

Series 200



Series 400 and 500

WORLD'S LEADING PRODUCER OF DELAY LINES

LUMPED CONSTANT DELAY LINES

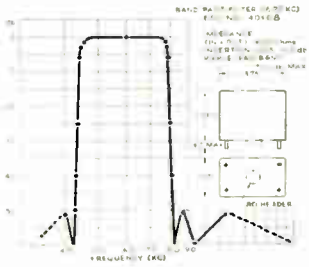
Standard LC Series

Delay time/rise time ratios from 10 to 30 for delays of 0.25 μsec to 50 μsec.

Millisecond Series

Long delay, low attenuation characteristics with delay time/rise time ratios from 20 to 50 for delays of 10 μsec to 5 millisec.

(Custom-built Lumped Constant Delay Lines available with delay time/rise time ratios as high as 170/1.)



CUSTOM DESIGNED FILTERS

Phase distortion problems minimized by ESC's custom-designed low, high and band pass filters. Exacting phase characteristics in small case sizes can be met and at very competitive prices. Ruggedly constructed, these filters meet appropriate MIL and commercial environmental, shock and vibration specs.

DISTRIBUTED CONSTANT DELAY LINES

Cylindrical or rectangular shapes for printed board mounting. Delays varying from 0.02 μsec to 1.2 μsec covering impedance ranges from 100 ohms to 1,800 ohms, exhibiting excellent pulse characteristics, at low cost.

MINIATURE DELAY LINE — SERIES 37-74

This miniature features better than 35 to 1 delay/rise time ratio in a 3½ cubic inch package. Low attenuation — less than 2 db high temperature operation —55°C to 125°C. Delay time 2.5 μsec.

MINIATURE NANOSECOND DELAY LINES

Designed for printed board mounting, delays range from 5 nsec. to 100 nsec. with pulse rise time from 1 nsec. to 10 nsec.

MINIATURIZED FILTER SERIES

Attenuation of less than 3 db at cutoff frequency; greater than 40 db at and beyond $2.5 \times F_{CO}$ (at and below $1/2.5 \times F_{CO}$ for high pass filters.) Insertion loss is less than 2 db. Temperature range: —20°C to +85°C. Hermetically sealed.

Series 600

VARIABLE DELAY LINES (6⅛" x 6⅛" x 1⅝")

Model	Delay	Impedance (Ohms)	Rise Time	Attenuation
602	2.0 μsec	1000	0.17 μsec	1.0 db
603	5.0 μsec	1000	0.40 μsec	3.0 db
604	10.0 μsec	1000	0.70 μsec	5.0 db
605	15.0 μsec	1000	0.90 μsec	5.0 db
606	2.0 μsec	100	0.17 μsec	1.0 db
607	5.0 μsec	100	0.40 μsec	3.0 db
608	10.0 μsec	100	0.70 μsec	5.0 db
609	15.0 μsec	100	0.90 μsec	5.0 db

60 step switch provides resolution 1/120 of total delay.

Series 700

MINIATURE VARIABLE DELAY NETWORKS (4½" x 1½" x ½")

Model No.	Time Delay	Impedance	Pulse Rise Time
701	0.125 μsec	1500 ohms	0.03 μsec (max.)
702	0.25 μsec	1800 ohms	0.06 μsec (max.)
703	0.50 μsec	1000 ohms	0.10 μsec (max.)
704	0.75 μsec	680 ohms	0.15 μsec (max.)
705	1.0 μsec	560 ohms	0.20 μsec (max.)
706	1.25 μsec	470 ohms	0.25 μsec (max.)
707	1.50 μsec	390 ohms	0.30 μsec (max.)
708	0.65 μsec	93 ohms	0.10 μsec (max.)

Pulse Attenuation — 1.0 db (max.) all units DC Working Volts — 500 volts (max.)

Series 800

MINIATURE TRIMMER DELAY LINE "TRIMLINE"™

Model	Delay* (nsec)	Char. Impedance (ohms)	Approximate TD/TR Ratio	Size (inches)	Approx. # of Revolutions
801	50	200	4:1	2.25 x 1.800 x .35	6
802	75	1000	4:1	2.25 x 1.800 x .35	6
803	100	200	7:1	4.00 x 3.500 x .35	12
804	125	500	4:1	2.25 x 1.800 x .35	6
805	150	1000	7:1	4.00 x 3.500 x .35	12
806	250	500	7:1	4.00 x 3.500 x .35	12
807	10	100	4:1	2.25 x 1.800 x .35	6
808	20	100	7:1	4.00 x 3.500 x .35	12

*Min. delay at max. position

Circle 29 on Inquiry Card

NEW TECH DATA

Delay-Line Packages

FWS 18166-1 and 18228 epoxy-encased delay-line packages achieve delays of from 5nsec. to 1425nsec. in 5nsec. increments. Designed for mounting in standard 0.100 in. grid printed-circuit boards, the packages are encased in flame-retardant epoxy, with a raised bearing surface which prevents moisture trapping. General Instrument Corp., F. W. Sickles Div., 165 Front St., Chicopee, Mass.

Circle 495 on Inquiry Card

Power Transistors

This 24-page reliability evaluation brochure contains the results of more than 7 million life-test hours performed on TO-36 pnp power transistors. The report verifies a reliability of 99.9983%/1000 hrs. Included are sections which cover designing for reliability, 1000-hr. stability curves, histograms, and safe operating area curves for pulse applications. Motorola Semiconductor Products Inc., P. O. Box 955, Phoenix 1, Ariz.

Circle 496 on Inquiry Card

Crystal Filters

Bulletin F-101 gives technical specs. on the Hill Electronics 475-000 crystal filters. Center freqs. are approx. 1.75MC; units feature a very steep shape factor while maintaining low insertion loss and ripple in the passband. This series appears to be a vast improvement over current steep-sided filters. Hill Electronics, Inc., Mechanicsburg, Pa.

Circle 497 on Inquiry Card

Voltage Surge Protection

Manual No. KL-601, 20 pages, gives complete data on the protection of silicon rectifiers and other semiconductors through the use of selenium transient-voltage suppressors. Included are charts, graphs, and schematics. International Rectifier Corp., 233 Kansas St., El Segundo, Calif.

Circle 498 on Inquiry Card

Reliability Manual

This manual is designed for personnel engaged in high-reliability projects. It contains product construction details, failure modes, failure analysis, performance characteristics and failure rates. Actual engineering calculations are shown incorporating predetermined Chi-square values. Cornell-Dubilier Electronics Div., Federal Pacific Electric Co., 50 Paris St., Newark 1, N. J.

Circle 499 on Inquiry Card

Instrument Amplifier

Tech. Data 84-B describes Model 840, a new type dc to dc hybrid amplifier which uses only 300mw. supply power. Contained are application and power-supply circuits. Acromag, Inc., Sales Dept., 15360 Telegraph Rd., Detroit 39, Mich.

Circle 500 on Inquiry Card

Circle 30 on Inquiry Card

Circle 31 on Inquiry Card →

STEVENS *Certified* THERMOSTATS
*for electronic and aerospace applications**

■ If smaller size, lighter weight, utmost reliability and realistic costs are part of your product cosmos, take a long, hard look at Stevens *Certified* Thermostats.

■ Because Stevens makes the broadest line of bimetal thermostats in the industry, you can get all the special features to fit your special requirements *exactly* right from a *proven*, standard production-line Stemco thermostat, or from a minor modification thereof. This also gets your product off the ground faster . . . by cutting lead time, slashing engineering and development costs.

■ And we back Stemco Thermostats by Applications Engineering Service that's right out of this world. A card or call will bring our representative on the double.

STEVENS *manufacturing company, inc.*
P. O. Box 1007 • Mansfield, Ohio

® STEMCO THERMOSTATS

Type MX Hermetic
Snap-acting to open on temperature rise only. Copper housing responds more readily than steel types. Standard tolerances ±3°F with 2 to 6°F differentials; 1 to 4°F differentials on special order. Temperature 10° to 260°F. Various terminals and mounting brackets. See Bulletin 6100.

Type AX Hermetic
Similar to Type MX but to close on temperature rise. Wide selection of terminals and mounting provisions, highly responsive non-ferrous metal housing. 2 to 6°F differential. Bulletin 3200.

Type C Hermetic
Field-adjustable, positive-acting. Electrically independent bimetal strip type for operation from —10° to 300°F. Nickel-silver case with or without plating, depending on specifications. Turret terminals or wire leads. For ratings, etc., Bulletin 5000.

Type A Hermetic
Electrically independent bimetal disc and high-response brass case for quick, snap-action control from —10° to 300°F. Various nonferrous metal enclosures, wide variety of terminal arrangements and mounting provisions, including brackets. Bulletin 3000.

*Above Stemco Thermostats are designed and manufactured to meet most requirements of applicable MIL specifications.

NEW TECH DATA

Electromagnetic Compatibility

A tech. bulletin entitled, "Electromagnetic Compatibility" discusses EMC with emphasis on interference spec. compliance requirements. Includes a discussion of EMC problems and a 2-page table comparing the requirements of selected interference specs. White Electromagnetics, Inc., 4903 Auburn Ave., Bethesda 14, Md.

Circle 501 on Inquiry Card

Noise-Source Tube

Publication RT21-13 describes a noise-source tube used in microwave measurements. When used with the RG-50/U waveguide it provides noise in the 5.85 to 8.20GC waveband. Schematics and operating data are included. The Bendix Corp., Red Bank Div., Eatontown, N. J.

Circle 502 on Inquiry Card

Medium Range Supplies

The Series MP Minipacs cover the medium voltage range, beginning at voltage ratings beyond the reliable level for completely transistorized modules. They produce up to 425 VDC at 0.8a. Regulation is less than 0.05% with ripple and noise below 1mv. Deltron Inc., 4th & Cambria Sts., Phila. 33, Pa.

Circle 503 on Inquiry Card

Electromagnetic Catalog

This illustrated catalog describes electromagnetic delay lines, networks, and filters. It covers constant and variable delay lines, magnetrostrictive delay lines, miniature delay lines and networks, etc. Basic performance specs., including delay, rise time, impedance and attenuation are included. ESC Electronics Corp., 534 Bergen Blvd., Palisades Park, N. J.

Circle 504 on Inquiry Card

Technical Abbreviations

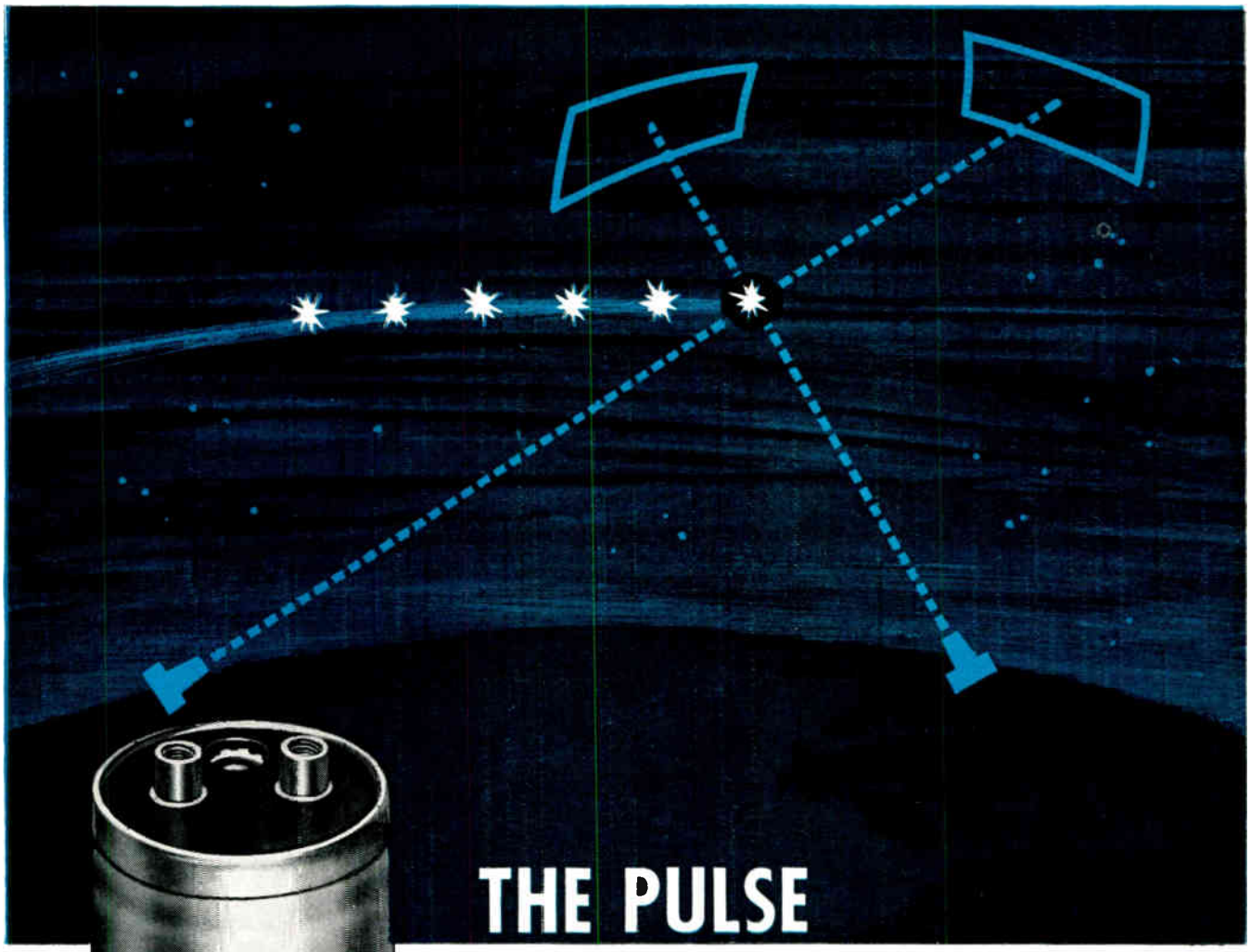
A 32-page booklet entitled, "1,001 Technical and Scientific Abbreviations," is available from Automatic Electric, subs. of General Telephone & Electronics, Northlake, Ill. Three extra sections give frequently used Latin abbreviations, chemical elements with their symbols and atomic numbers, and Greek and Latin numerical prefixes.

Circle 505 on Inquiry Card

Fixed-Delay Line

Data Sheet 63437 describes the Spiradel miniature fixed-delay line. The delay line is a small diameter, distributed-constant fixed-delay line, featuring high delay-to-rise time ratio and good pulse fidelity. Included are specs. and basic configuration drawings on all current models. Helipot Information Service, Fullerton, Calif.

Circle 506 on Inquiry Card



THE PULSE OF ANNA

Now . . . for the first time . . . aluminum electrolytic energy-storage capacitors have been employed in an orbital satellite!

Satellite *Anna* is the world's first all-geodetic satellite. *Anna* opens the door to: more precise location of world-wide target areas; more accurate orbit planning; improvement of surface and air navigation. But perhaps the most useful aspect of *Anna* was the experience gained in developing "spaceworthy" components which can function in the difficult launch and orbital environment.

Anna's optical beacon, developed by Edgerton, Germeshausen & Grier, Inc., flashes sequential strobe signals from satellite to ranging station. *The heart of this beacon is a bank of Sprague Type 36D Powerlytic® Capacitors.* Powerlytics were chosen for their high capacitance, their compact physical size, and their ability to withstand the stringent demands of outer space.

An electrolytic capacitor specialist will be glad to discuss the application of these capacitors to *your* projects. For application engineering assistance without obligation, write to Electrolytic Capacitor Section, Field Engineering Dept. For complete technical data, write for Engineering Bulletin 3421 to Technical Literature Service, Sprague Electric Company, 233 Marshall St., North Adams, Mass.

SPRAGUE COMPONENTS

CAPACITORS	INTERFERENCE FILTERS	HIGH TEMPERATURE MAGNET WIRE
TRANSISTORS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
MAGNETIC COMPONENTS	PIEZOELECTRIC CERAMICS	PACKAGED COMPONENT ASSEMBLIES
RESISTORS	PULSE-FORMING NETWORKS	FUNCTIONAL DIGITAL CIRCUITS
MICROCIRCUITS	TOROIDAL INDUCTORS	ELECTRIC WAVE FILTERS

46C-114-63

SPRAGUE®
THE MARK OF RELIABILITY

'Sprague' and '©' are registered trademarks of the Sprague Electric Co.

NEW TECH DATA

Portable Magnet

Bulletin 45-951 describes a portable superconducting magnet system that produces 20,000 and 30,000 gauss. Designated Cryopak magnet system, it is ideal for laboratory investigations with high magnetic fields. Westinghouse Cryogenic Systems Dept., P. O. Box 10596, Pittsburgh 35, Pa.

Circle 507 on Inquiry Card

Energy Discharge Capacitor

Bulletin 2610 contains reference data for electrical and mechanical design criteria covering energy discharge capacitors. Graphs, tables, and definitions are used to clarify capacitor parameters. Descriptive information and catalog listings are given. Sangamo Electric Co., Springfield, Ill.

Circle 508 on Inquiry Card

Component Insertion Film

A new motion picture film entitled, "Inserting Components with Dynasert" is available from United Shoe Machinery, 140 Federal St., Boston 7, Mass. The 13-min. movie, in full sound and color, shows the high-speed, automatic operation of the Dynasert machine, which handles reels of strip-mounted components, clips off the axial leads, bends them to proper shape and length, inserts them into printed circuit boards, and clinches the protruding ends on the reverse side ready for soldering.

Circle 509 on Inquiry Card

Engineering Chart

A new Nanosecond Data Chart listing 12 tables of parameters useful in the design and use of nsec. circuits is available. In addition, the chart includes condensed data on nsec. instruments. Lumatron Electronics, 116 County Courthouse Rd., New Hyde Park, N. Y.

Circle 510 on Inquiry Card

Welding Power Supply

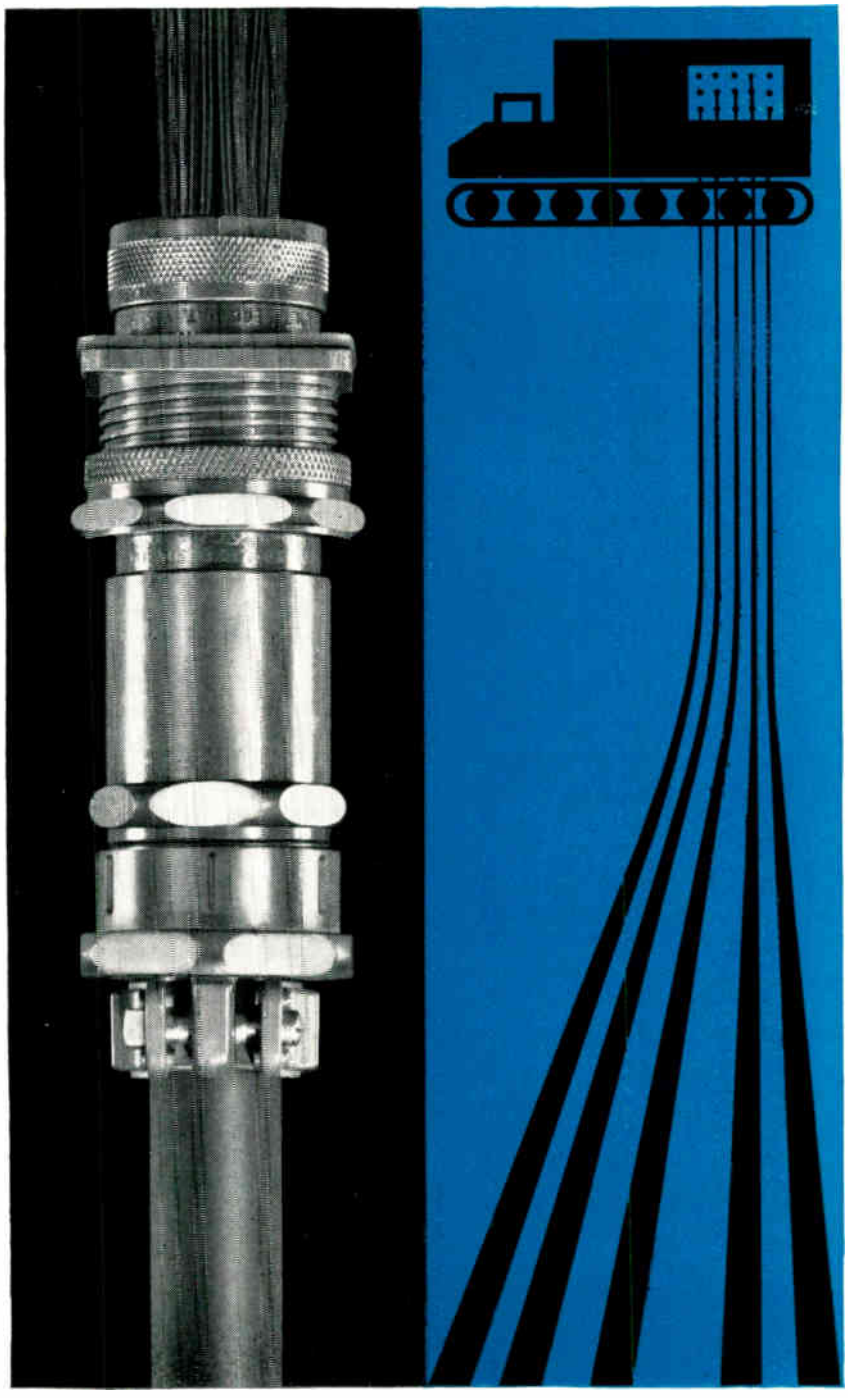
Model 1065 provides 2 pulse widths (discharge times): a long pulse of 0.009 sec. nominal for welding materials of high conductivity, and a normal pulse of 0.0032 sec. nominal for welding materials of high resistance. The unit operates on 2 separate stored energy ranges from a low range of 0.14 to 20 w-sec. through a high range of 0.7 to 100 w-sec. Weldmatic Div./Unitek, 950 Royal Oaks Dr., Monrovia, Calif.

Circle 511 on Inquiry Card

Wall Chart

A 24 x 37 in. wall chart aids in selecting heat sinks, knobs, handles, military knobs, switch guards, etc. Each item is described in detail, and characteristic graphs are provided. Vemaline Products Co., Inc., Franklin Lakes, N. J.

Circle 512 on Inquiry Card



WHERE ENVIRONMENTAL CONDITIONS ARE AT THEIR WORST, PYLE-STAR-LINE® CONNECTORS ARE AT THEIR BEST. Rugged, Neptune Series (ZZM) heavy-duty connectors are designed to withstand the most severe operating conditions . . . to resist shock, vibration, and pressure. These compact, lightweight connectors perform with outstanding reliability under environmental extremes of temperature, humidity, moisture, dust, oil, and corrosive atmospheres.

An extensive variety of contact configurations is offered in MOD I, captive contact, inserts; and MOD II, push-in crimp-type removable contact, inserts.

Now also being offered is MOD III inserts with collet retained, rear entry and release contacts, in sizes No. 18 to No. 4/0.

A wide choice of cable and installation accessories enable these versatile connectors to be easily adaptable for ground support equipment, electronic packaging and cabling, electrical control, power, and communications. Hardware having RFI shielding capabilities is also available.

Design features include: reversible inserts for plug or receptacle shells, positive self-sealing insert construction, closed-entry rigid socket insulators, and closed-entry socket contacts. Power inserts have circuit-breaking capabilities, and are U.L. listed.

Years of field-performance have proven Pyle-Star-Line reliability to provide electrical and mechanical capabilities for the roughest and toughest assignments. Write today for complete technical data, and information on our engineering service.

CONNECTOR DIVISION, THE PYLE-NATIONAL COMPANY, 1334 NORTH KOSTNER AVENUE, CHICAGO 51, ILLINOIS

ALSO MFG. IN CANADA BY: PYLE-NATIONAL (CANADA) LTD., CLARKSON, ONTARIO

Pyle-National

ELECTRICAL CONNECTORS · LIGHTING EQUIPMENT · CONDUIT FITTINGS

NEW TECH DATA

Coaxial Patch Panel

Bulletin 8496 describes Type 27935 10 x 10 patch panel used for 3⅛ in., 50Ω transmission lines. It features a panel layout of terminals in 3 concentric circles and a dummy load connection at the center of the panel. This allows a transmitter to be connected to any of the 10 antenna terminals or the dummy load. The completed patch panel is 67 x 84 x 24 in. Available from Andrew Corp., P. O. Box 807, Chicago 42, Ill.

Circle 513 on Inquiry Card

Carbon Potentiometer

A 12-page engineering catalog, No. 42-1447, describes the RV4 style (Mil-R-94B) hot molded carbon potentiometer, known as Model 12. The catalog fully details the unit's electrical, mechanical and environmental characteristics. Photos and detailed dimensional drawings illustrate single, twin, dual, triple, quad, and front and rear-mounting rotary switch versions. Also included is a derating nomograph for multiple-element types and a listing of units available for immediate delivery. Centralab, The Electronics Div., Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc.

Circle 514 on Inquiry Card

Miniature DC Motor

Bulletin 800 describes a new low-current miniature dc motor, Model 800. Detailed specs. include size, voltage, torque and speeds. Complete schematics and application data are included. Publications Dept., Cramer Div., Giannini Controls Corp., Old Saybrook, Conn.

Circle 515 on Inquiry Card

Voice Coil Winder

This 2-color catalog illustrates and describes Model 62-PM compact, semi-automatic voice coil winder. An experienced operator can produce over 800 finished coils/hr. with it. Geo. Stevens Mfg. Co., Pulaski Rd. at Peterson, Chicago 46, Ill.

Circle 516 on Inquiry Card

High-Vacuum Equipment

Two 4-page illustrated brochures describe high-vacuum equipment, one covering stainless steel gate valves and the other, high-vacuum baffles. Royal Research Corp., 11727 Dublin Blvd., Hayward, Calif.

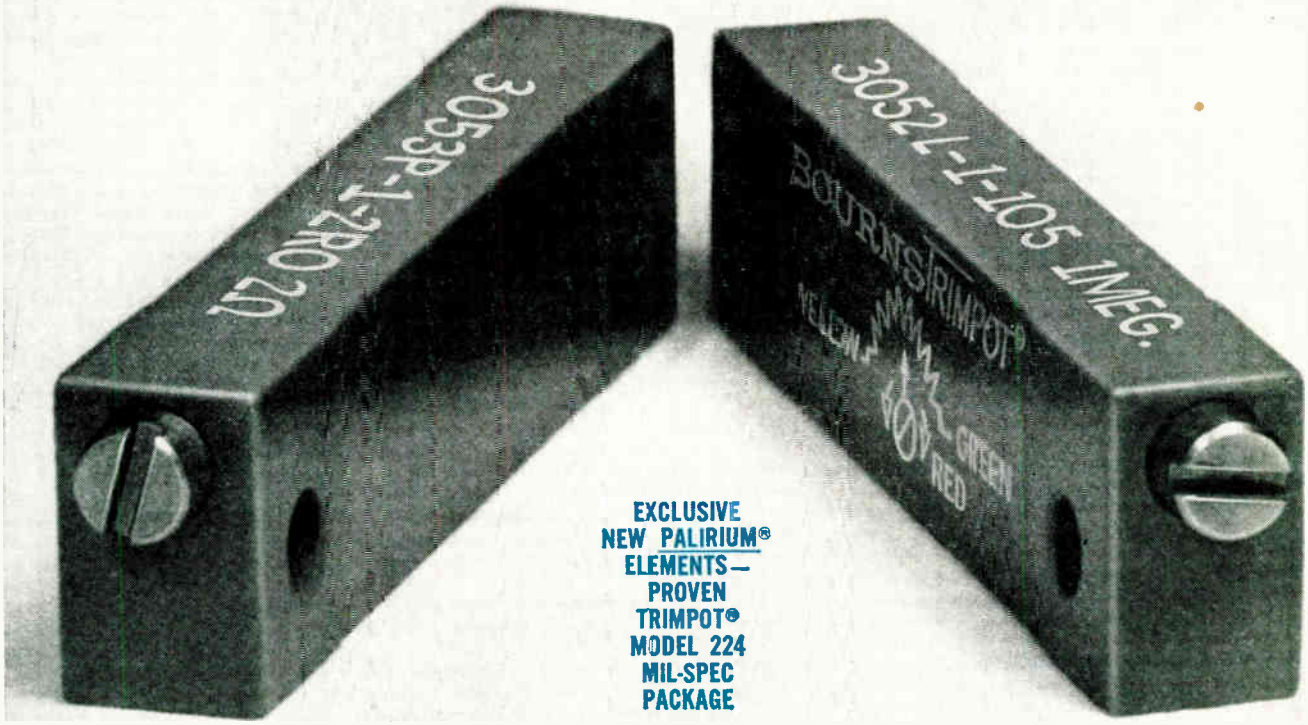
Circle 517 on Inquiry Card

Logic-Operated Relay

The DS-2000 series of Sensireed relays draws a max. of ¼ma from a 6v logic level input, and operates an electrically isolated SPST contact rated at ½a. These units are encapsulated for printed-circuit applications. Relay contacts are rated at 10w dc, 0.5a, 250v. Actuate time is 1ms. Data Systems Corp., Valley Forge Industrial Park, Norristown, Pa.

Circle 518 on Inquiry Card

DOUBLE-BARREL NEWSBREAK IN INFINITE-RESOLUTION POTENTIOMETERS



EXCLUSIVE NEW PALIRIUM® ELEMENTS— PROVEN TRIMPOT® MODEL 224 MIL-SPEC PACKAGE

NOW — INFINITE ADJUSTABILITY IN A 2-OHM POTENTIOMETER!

Now you can bring the convenience of infinite adjustability to applications that have always required an arduous fixed-resistance approach. The new TRIMPOT Model 3053, with its exclusive PALIRIUM film element, overcomes the problems in resolution and contact resistance that heretofore have made a low-resistance unit of this kind impossible. Stability of the infinite-resolution Model 3053 is outstanding, enhanced by an unusually low temperature coefficient and the time-proven Mil-Spec configuration of Bourns' famous TRIMPOT Model 224. This potentiometer should help you develop new circuit-design approaches.

Total resistance range:	2 Ω to 100 Ω
Resolution:	Infinite
Power rating:	½ W @ 70°C
Contact resistance variation:	2% max.
Temperature coefficient (2.5 Ω):	+ 400 PPM/°C max.
Temp. coefficient (10 to 100 Ω):	+ 300 PPM/°C max.
Humidity:	Exceeds MIL-R-22097B
Max. operating temperature:	175°C
Environmental stability:	1% or less
Load life stability:	2% or less

NOW — TWICE THE STABILITY IN RESISTANCES UP TO 1 MEGOHM!

At the other end of the scale, TRIMPOT Model 3052 offers you two to four times the stability of competitive high-performance potentiometers over the resistance range of 100K to 1 megohm. Like the companion low-resistance unit, Model 3052 features the approved Mil-Spec configuration of Bourns' high-temperature, humidity-proof Model 224. Its spec of 500 maximum applied volts is approximately 60 per cent better than that of other available units, and its total resistance tolerance of ±10% cuts the usual competitive figure in half. The new high-resistance, infinite-resolution element is also available in Model 3012 with the popular 1¼"x⅜"x¼" package. The prices? Less than you've been paying!

Total resistance range:	100K to 1 Meg.
Resolution:	Infinite
Power rating:	1 W @ 70°C
Contact resistance variation:	2.5% max.
Temperature coefficient:	Less than 300 PPM/°C
Humidity:	Exceeds MIL-R-22097B
Max. operating temperature:	175°C
Environmental stability:	2% or less
Load life stability:	2% or less

AVAILABLE IMMEDIATELY FROM FACTORY STOCK AT COMPETITIVE PRICES.
Write for latest Trimpot potentiometer summary brochure.

ACTUAL SIZE

BOURNS

BOURNS, INC., TRIMPOT DIVISION
1200 COLUMBIA AVE., RIVERSIDE, CALIF.
PHONE 684-1700 · TWX: 714-682 9582
CABLE: BOURNSINC

Manufacturer: TRIMPOT® potentiometers; transducers for position, pressure, acceleration. Plants: Riverside, Calif.; Ames, Iowa; and Toronto, Canada

NEW TECH DATA

Coaxial Cable

Bulletin PS4, 32 pages, details engineering data, performance curves and mechanical characteristics of Styroflex® semi-flexible, air-dielectric coaxial cable. Curves for each cable dia. indicate attenuation and power ratings in KC and MC for each impedance. Phelps Dodge Electronic Products Corp., 60 Dodge Ave., New Haven, Conn.

Circle 519 on Inquiry Card

Connector Wall Chart

This 34 x 45 in. connector wall chart illustrates a selected line of connectors and tools. Photos and illustrations of each connector accompany physical-characteristic and application information. Deutsch Electronic Components Div., Municipal Airport, Banning, Calif.

Circle 520 on Inquiry Card

Laser Tube

Gas-filled laser tube LT-40 operates in the visible (6328Å) or the infrared (11,530Å) region with suitable mirrors and r-f excitation equipment. This all-quartz tube contains quartz windows at the Brewster angle. It contains a gas mixture of 0.9mm of helium and 0.09mm of neon; other mixtures are available. The tubes are high-temp. processed (above 420°C) to assure cleanliness. Litton Industries, Electron Tube Div., San Carlos, Calif.

Circle 521 on Inquiry Card

Procurement Specs.

Procurement specs. for an entire line of silicon power transistors are available as a series of 5 booklets. These specs. aid the design or component engineer in preparing a military procurement spec. for npn silicon power transistors which meet the requirements of Mil-S-19500C. The electrical and environmental tests and procedures form a comprehensive quality-assurance lot-acceptance program for each of the silicon power transistors. Requests on company letterhead to Westinghouse Semiconductor Div., Youngwood, Pa.

Circle 522 on Inquiry Card

Coax Catalog

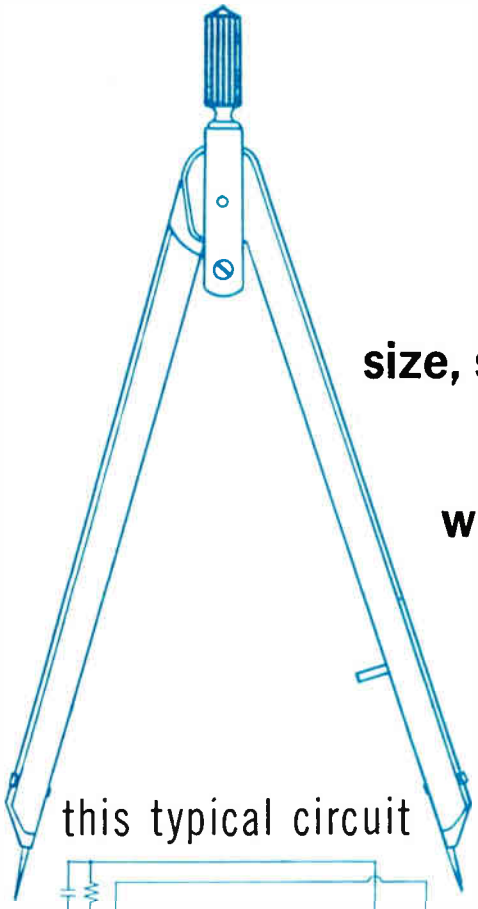
Bulletin FF Issue 3, 33 color pages, presents photos, graphs, and charts pertaining to a wide range of coaxial cable. Accompanying each cable is a general description, applicable equations, temperature and freq. charts. Phelps Dodge Electronic Products Corp., N. Haven, Conn.

Circle 523 on Inquiry Card

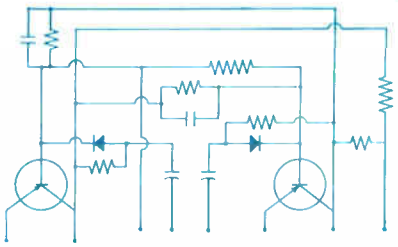
Custom Assemblies

Information is available which describes Renwell's capabilities in custom electronic assemblies, wiring harnesses, and electromechanical assemblies. Renwell Electronic Corp., 755 New Ludlow Rd., So. Hadley Falls, Mass.

Circle 524 on Inquiry Card



this typical circuit



or any comparable circuit, can be supplied to your specifications

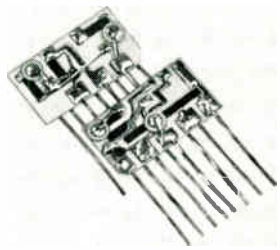
size, shape, and component content to your requirements with

CENTRALAB PEC®

INTEGRATED CIRCUITS

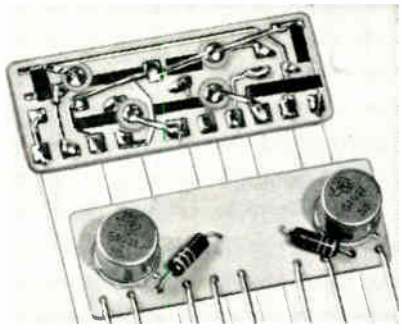
For design flexibility in integrated circuitry specify PEC's. With the Centralab PEC technique, equipment design considerations dictate the package rather than package requirements dictating the design. You have an unlimited choice of sizes, shapes, and component content, in addition to the benefits of uniformity, reliability, and ease of assembly.

Typical of this flexibility is the flip-flop shown here. It, or any comparable circuit can be supplied in a variety of protective encasements and terminations at low cost with delivery in a matter of weeks. For additional information write for Bulletin #42-1281.

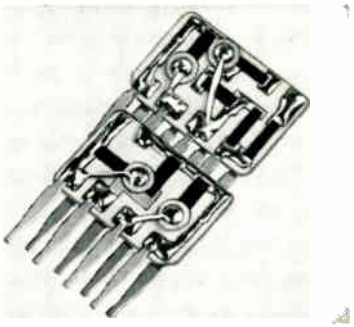


WITH MINIATURE SEMICONDUCTORS— Where size and weight must be kept at a minimum and fast delivery at practical cost is essential. Space requirements are similar but cost is approximately 1/5 to 1/30 of film deposited circuits.

ALL UNITS SHOWN ACTUAL SIZE



OR STANDARD SEMICONDUCTORS— Where space is limited but is secondary to cost, a PEC can be designed whose shape is best suited to your equipment without sacrificing uniformity, reliability, and ease of assembly. Cost is 20-50% of other packaging techniques and 10-30% less space is required.



OR WITHOUT SEMICONDUCTORS— Where space and ease of assembly are important and the user wishes to install his own semiconductors separately. Uniformity and reliability exceeds that of individual components. Cost is generally less than, and units require 20-30% the space of individual components.

Y-6313

Centralab®

THE ELECTRONICS DIVISION OF GLOBE-UNION INC.
938F E. KEEFE AVE. • MILWAUKEE 1, WISCONSIN
In Canada: Centralab Canada Ltd., P. O. Box 400, Ajax, Ontario

NEW TECH DATA

Capacitor Catalog

Catalog N-1, 12 pages, 2 colors, contains complete specs. for a variety of subminiature ceramic capacitors. Information includes capacitances, sizes, tolerances, leads, power factors, temp. characteristics and ranges. Also included is information concerning UHF standoff capacitors, UHF ribbon-lead capacitors, and low-voltage, transistor-circuit capacitors. Requests on company letterhead to Mucon Corp., Dept. B, 9 St. Francis St., Newark 5, N. J.

Circle 525 on Inquiry Card

Connector Brochure

Bulletin 668, 36 pages, provides information on environmental capabilities, design features, the sequence of component selection, and the interchangeability of components. Also included is complete spec. data on contact inserts, barrels, adapters and accessories. The Pyle-National Co., 1334 N. Kostner Ave., Chicago 51, Ill.

Circle 526 on Inquiry Card

Instrument Catalog

The 8-page Quick-Reference Catalog contains capsule descriptions, prices and illustrations of all Sierra products. These include voltmeters, transistor testers, line fault analyzers, signal generators, oscilloscopes, r-f power monitors and amplifiers, precision power measuring instruments, power sources, waveguide and coaxial leads, directional couplers, detectors, and low pass filters. Sierra Electronic Div. of Philco, Marketing Dept., 3839 Bohannon Dr., Menlo Park, Calif.

Circle 527 on Inquiry Card

High-Voltage Rectifiers

Data bulletin gives performance curves and specs. on high-voltage stacked silicon rectifiers. The small, hermetically sealed rectifiers are rated from 1500 to 25,000 peak inverse volts, up to 500ma average rectified current. Diodes, Inc., 9261 Independence Ave., Chatsworth, Calif.

Circle 528 on Inquiry Card

Epitaxial PNPN Switch

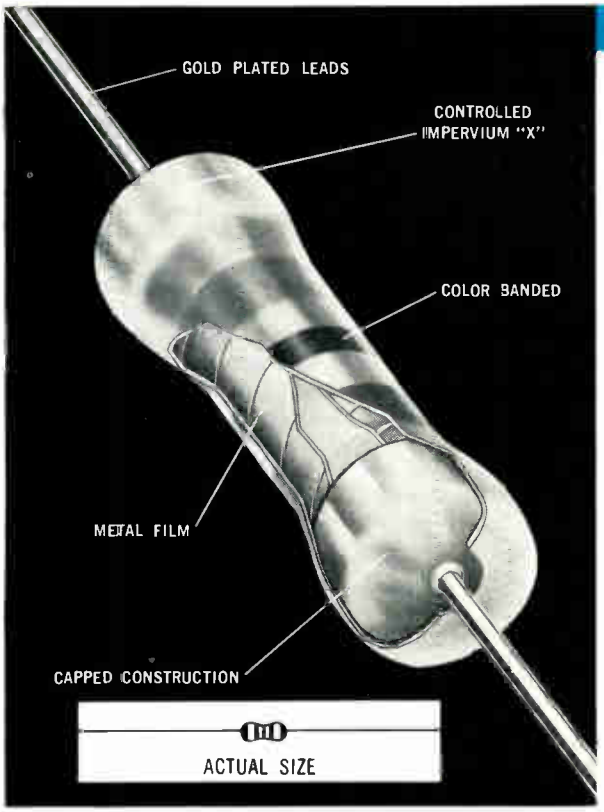
Brochure describes planar epitaxial pnpn switch with gate turn-off gain. It discusses the switch's design and advantages of the planar process. Characteristics of the component and schematics are included. Sylvania Electric Products, Inc., 1100 Main St., Buffalo 9, N. Y.

Circle 529 on Inquiry Card

CRT Image Print-Out

A system which makes possible the direct print-out of images from a fiber optic CRT face to Kalvar film is described in 3 data bulletins available from Display Devices Dept., Litton Industries Electron Tube Div., 960 Industrial Rd., San Carlos, Calif.

Circle 530 on Inquiry Card



ELECTRA X-4C METAL FILM RESISTORS

MULTI-RATED

NEW VERSATILITY AND IMMEDIATE DELIVERY

New Electra X-4C metal film resistors have amazing versatility. Multi-rated, they have rugged resistance to overload, are widely applicable. Example: The 1/10 watt X-4C also handles ⅛, ¼, or ½ watt, depending on temperature.

Indicated for printed circuitry applications, they all connect on ¼" centers. Capped construction for added strength, and "GP-25" gold-plated leads are weldable or solderable. Conformally coated with Electra's exclusive Impervium "X" and color banded for value identification.

Rated from 20-Ohms to 301-K. Controlled meniscus means film never laps over to leads. Write for information about "Proto-Pak", the special designer's selection. And look to Electra for excellence in carbon and metal film resistors, high reliability resistors, tantalum capacitors, integrated circuits and micro-modular packaging.

Electra precision products

ELECTRA MANUFACTURING COMPANY, INDEPENDENCE, KANSAS

PHONE: 316-331-3400 / TWX: 316-331-0210

Circle 40 on Inquiry Card

CONNECTOR DESIGN CRITERIA

by Vip

VISUALLY INSPECTABLE FOR CORRECT ASSEMBLY AND INSTALLATION

(our connectors are visually inspectable too!)

DEUTSCH

Circle 41 on Inquiry Card

New Transistorized DC to AC Power Inverters

- Sine Wave Output
- 50 VA to 1,000 VA
- 400 Cycle Output/ 22-30 VDC Input

DRS SERIES

- 0.5% Frequency Regulation
- 1% Harmonic Distortion
- 0.5% Voltage Regulation

Model	400 Cycle Output		D.C. Input	Dimensions
	VA	Single ø Volts	Volts	HxWxD
DRS-50	50	115	22-30	4"x11"x 4"
DRS-100	100	115	22-30	4"x11"x 4"
DRS-250	250	115	22-30	5"x12"x 9"
DRS-500	500	115	22-30	8"x16"x14"
DRS-1000	1000	115	22-30	10"x16"x17"

Features all solid state components, reliable short circuit protection, light weight, and exceptional temperature stability (voltage: max. 0.005%/°C, frequency: max. 0.05%/°C).

Ideal for powering switching-type loads (no notching in output waveform). Excellent as a versatile power source for airborne or ground support applications.

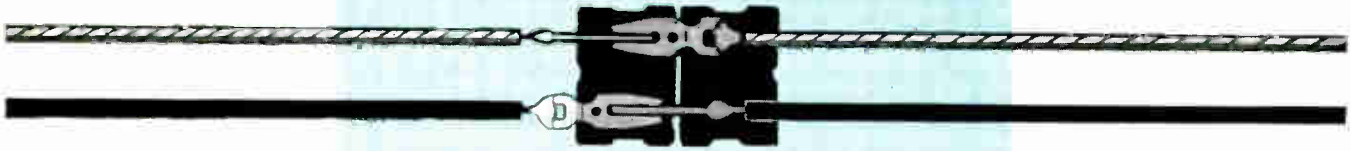
60 CYCLE OUTPUT units also available. Write for complete information on several new series of sine wave and square wave inverters and frequency converters.

CML **COMMUNICATION MEASUREMENTS LABORATORY, INC.**

A Subsidiary of Tenney Engineering, Inc.

350 Leland Avenue, Plainfield, N. J. (201) 754-5502

Circle 42 on Inquiry Card



isn't it time somebody exploded the "just as good as" connector myth?

Don't let anyone tell you his connector is "just as good as" ours. At least, not without making him try to explain how! Does it offer the proven reliability of the ELCO Connector, sold under the trade-mark VARICON? Does it provide equal application versatility? Or production economy? Or the fork-like design with 4 surfaces mating at 90° to allow contacts to engage along their entire length? Don't stop there; press on. Ask him about the additional contact surface provided by a 45° bevel running the full length of the fork. And about the "spring" contacts with wiping action which maintain pressure under all operating conditions. Then startle him with your knowledge of our plating; our next-to-limitless selection of sizes; our variety of tail-end terminations for every wiring technique. Chances are he'll now admit there is nothing "as good as" the ELCO VARICON* Connector except the ELCO VARICON Connector. Send for complete literature on the subject to be forewarned and forearmed when he arrives.

if it's new... if it's news... it's from...

ELCO

ELCO CORPORATION, New Main Plant and Offices: Willow Grove, Pa., OLdfield 9-7000, Area Code 215; TWX 215-659-0494
Also Subsidiaries, Licensees, Importers and Representatives Throughout the World

*TRADE-MARK

FREE! use these cards for:

- Catalogs, Bulletins, Literature
- Design features of advertised products
- Information about new products
- New Tech Data for engineers

YOUR NAME ..... TITLE .....

FIRM .....

FIRM ADDRESS .....

CITY OR TOWN..... ZONE..... STATE .....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112
113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168
169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196
197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224
225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252
253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308
309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336
337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364
365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392
393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420
421	322	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448
449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476
477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504
505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532
533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560
561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588
589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616
617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644
645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672
673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700

Please send me further information on the items I have circled above.

EI-09 JUNE, 1963

FIRST CLASS
PERMIT NO. 2333
CAMDEN, N. J.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

The Computer Center

P. O. Box 1970

Camden 1, New Jersey

FREE! use these cards for:

- Catalogs, Bulletins, Literature
- Design features of advertised products
- Information about new products
- New Tech Data for engineers

FIRST CLASS
PERMIT NO. 2333
CAMDEN, N. J.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

The Computer Center

P. O. Box 1970

Camden 1, New Jersey

YOUR NAME .....TITLE .....

FIRM .....

FIRM ADDRESS .....

CITY OR TOWN.....ZONE.....STATE .....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112
113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168
169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196
197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224
225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252
253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308
309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336
337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364
365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392
393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420
421	322	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448
449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476
477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504
505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532
533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560
561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588
589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616
617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644
645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672
673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700

Please send me further information on the items I have circled above.

EI-09 JUNE, 1963

NEW Subscription Order

I wish a new complimentary Subscription to

ELECTRONIC INDUSTRIES

Company Name _____ Mail Stop or Div./Dept. _____

Name _____ Position/Title _____

Company Address _____

City _____ Zone _____ State _____

IMPORTANT

FOR OUR STATISTICAL RECORDS PLEASE CHECK THE ONE APPROPRIATE CATEGORY THAT BEST DESCRIBES YOUR COMPANY OR DEPARTMENT. Failure to do so will delay your subscription.

- ☐ Mfr. of non-military electronic receiving and transmitting equipment.
- ☐ Mfr. of non-military electronic instruments, measuring, control and test equipment.
- ☐ Mfr. of non-military electronic computers, data processing, analysers, business machine.
- ☐ Mfr. of Guided Missiles and Accessories; Aircraft and Accessories, All Type of Military Products and Equipment.
- ☐ Mfr. of electronic components, parts, tubes and like products.
- ☐ Mfg. Co. (non electronic) using any of the above equip. in mfr., research or development work.
- ☐ Broadcasting or telecasting station.
- ☐ Commercial communication user (Tel & Tel, Police, Airports, Recording Studio, Etc.).
- ☐ Independent research, test, design laboratories and independent consultants—not part of a mfg. Co.
- ☐ Gov't Bureaus, Gov't laboratories, Gov't research center, military installation.
- ☐ Wholesaler, mfg. representative, service firm.
- ☐ University (educational) Public Library.
- ☐ Other (Please explain) .....

CHANGE OF ADDRESS

I wish to continue receiving ELECTRONIC INDUSTRIES
Change my address as indicated.

OLD

Paste wrapper imprint here, or . . .
Write in *complete* old address

NEW

Company _____
Mail Stop or
Div./Dept. _____

Title/Position _____

Company Address _____

City _____ Zone _____ State _____

Signature _____

IMPORTANT

FOR OUR STATISTICAL RECORDS PLEASE CHECK THE ONE APPROPRIATE CATEGORY THAT BEST DESCRIBES YOUR COMPANY OR DEPARTMENT. Failure to do so will delay your address change.

- ☐ Mfr. of non-military electronic receiving and transmitting equipment.
- ☐ Mfr. of non-military electronic instruments, measuring, control and test equipment.
- ☐ Mfr. of non-military electronic computers, data processing, analysers, business machine.
- ☐ Mfr. of Guided Missiles and Accessories; Aircraft and Accessories, All Type of Military Products and Equipment.
- ☐ Mfr. of electronic components, parts, tubes and like products.
- ☐ Mfg. Co. (non electronic) using any of the above equip. in mfr., research or development work.
- ☐ Broadcasting or telecasting station.
- ☐ Commercial communication user (Tel & Tel, Police, Airports, Recording Studio, Etc.).
- ☐ Independent research, test, design laboratories and independent consultants—not part of a mfg. Co.
- ☐ Gov't Bureaus, Gov't laboratories, Gov't research center, military installation.
- ☐ Wholesaler, mfg. representative, service firm.
- ☐ University (educational) Public Library.
- ☐ Other (Please explain) .....

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed In U. S. A.

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES
Chilton Company
Chestnut & 56th Sts
Philadelphia 39, Pa.

Att: Circulation Dept.

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed In U. S. A.

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES
Chilton Company
Chestnut & 56th Sts.
Philadelphia 39, Pa.

Att: Circulation Dept.

Cinch ELECTRONIC COMPONENTS

Eliminate contact damage in Multi-Contact connectors with Cinch

HINGE CONNECTORS*

*U.S. Pat. No. 2,899,699

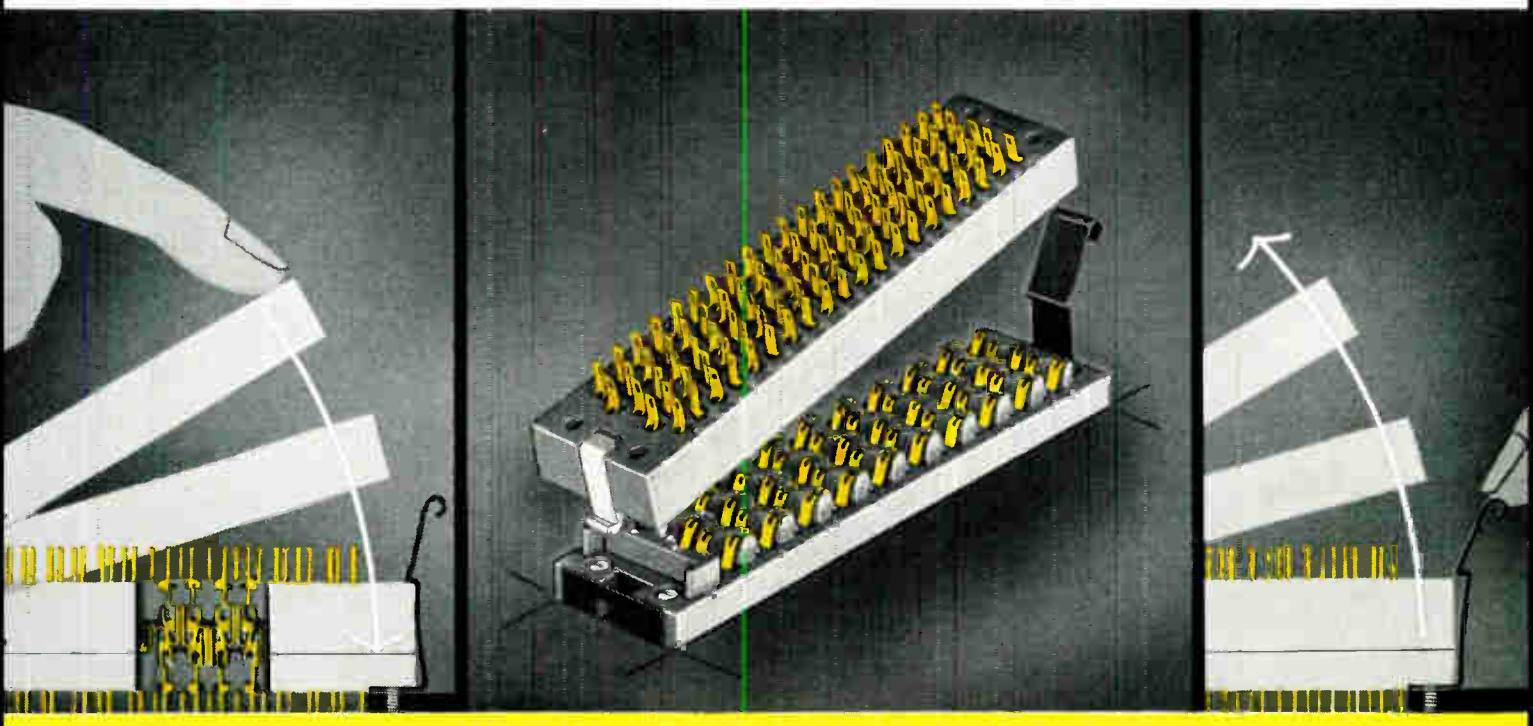
20 *to* 100

contact connectors for high density applications

High insertion and extraction forces that wreak havoc with ordinary multi-contact connectors are no problem at all with the Cinch Hinge Connector. A flexible contact design eliminates the excessive insertion and extraction forces; positive contact is always maintained because of the pressure action of the wiping contacts. An ingenious Hinge and Latch principle permits opening and closing Cinch Hinge Connectors *using only one finger!*

These exclusive features are available in both Standard Cap models (for use with 20 to 100 contact Hinge Connectors) and space saving Shallow Cap models (for use with 20 to 50 contact Hinge Connectors). Both types can be supplied with cable entry holes in top or end, with or without cable clamps.

For detailed information and technical data, write for Catalog CM-16.



CM-6311

CINCH MANUFACTURING COMPANY

1026 South Homan Avenue, Chicago 24, Illinois

Plants located in Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; and St. Louis, Missouri.

Circle 44 on Inquiry Card

DOT

A DIVISION OF UNITED-CARR FASTENER CORPORATION, BOSTON, MASSACHUSETTS

NEW TECH DATA

Capacitor Bulletin

A short form data bulletin describes miniature and plastic dielectric tubular, fixed capacitors meeting the requirements of Mil-C-27287 (USAF) Engineering Data 27287 is available from Dearborn Electronic Laboratories, Inc., Orlando, Fla.

Circle 300 on Inquiry Card

Carbon Resistors

Bulletin NPJ 115-16 Rev., describes Aerovox Carbofilm® Types CPX and CPM precision deposited carbon resistors. Characteristics given include temp. coefficient, moisture resistance and load life. Mil-Bell and commercial stock values are listed. Aerovox, New Bedford, Mass.

Circle 301 on Inquiry Card

Light-Sensing Amplifier

Data is available on a photo-Darlington light-sensing amplifier packaged in a TO-18 can with lens window. Designated RM3002, unit has a light-current sensitivity of 25ma./ft.-C. with a 12v. collector-to-emitter voltage. Raytheon Co., Semiconductor Div., 350 Ellis St., Mountain View, Calif.

Circle 302 on Inquiry Card

Delay Lines

Andersen Labs is offering brochures on electromagnetic, magnetostrictive, digital, and variable delay lines. Each item is fully described by equations, curves, and characteristic tables. Andersen Labs Inc., 501 New Park Ave., West Hartford, Conn.

Circle 303 on Inquiry Card

Commercial Oscillators

Synopsis of 1-1000 MC commercial oscillators details production models to 400 MC and development models to 1000 MC. Each production model will generate 30w. into a 50Ω load. Diagnostic Instrumentation, Inc., 49 Hampshire St., Cambridge, Mass.

Circle 304 on Inquiry Card

Microminiature Connectors

'Catalog MM-1, 24 pages, describes a complete line of microminiature connectors. Specs. for all series and information on Wire-Form Poke-Home® contacts and contact tools are given. Booklet also depicts suggested uses for all series. Amphenol Connector Div., Amphenol-Borg Electronics Corp., 1830 S. 54th Ave., Chicago 50, Ill.

Circle 305 on Inquiry Card

Ceramic Capacitor

The MC-70 ceramic capacitor has capacity ranges from 10μμf to 20,000μμf. Information available includes capacity tolerance, power factor, and physical dimensions. Hi-Q Div., Aerovox Corp., Olean, N. Y.

Circle 306 on Inquiry Card

BTK

Much higher reliability ... slightly higher price

DD

In order to furnish parts with a confidence level acceptable to the user, manufacturers must design beyond nominal or "standard" usage requirements. At Deutsch, this concept is the guideline for all design criteria. We *exceed* the minimums in every applicable specification to assure our customers of continuous performance above and beyond documented requirements. For instance, our DD ball-lock and BTK bayonet-lock connectors exceed, by far, the latest revision to MIL-C-0026482. Here are just a few examples:

- Deutsch-developed silicone materials provide better wire and interfacial seals against altitude and moisture... assure temperature performance above 300°F... guarantee better dielectric characteristics and dimensional stability under exposure to oils and fuels.
- Contact retention of 25# exceeds the 15# specification by more than 60%.
- Fixed coupling rings make sure the connector remains a complete unit throughout assembly... provide grope free engagement... insure proper mating and lock of plug and receptacle.
- Positive visual lock indicators afford inspectability for correct connector assembly and engagement.
- Millivolt drop, measured by the latest specification techniques, is 50% below the minimums before and after corrosion testing. And insulation resistance is at least four to five times higher at 300°F. than the specification's minimum at room temperature.
- Insertable and removable contacts are crimp terminated to military standard geometry, and are held in place by mechanical devices that insure retention, contact alignment and are replaceable if damaged.
- MIL-C-0026482 electrical performance ratings, at altitude, are met and exceeded at 110,000 ft. instead of at the specified 80,000 ft.

These and the many additional advantages of DD and BTK connectors may cost a little more, but in terms of value analysis are priced lower due to assembly time savings, repairability and, perhaps most important, favorable MTTF ratios under actual use. If you are faced with criteria calling for a high confidence level rather than just meeting a specification, we suggest you get all the facts on DD and BTK performance from your local Deutschman, or write for Data File A-6.

DEUTSCH

Electronic Components Division · Municipal Airport · Banning, California

ADVANCED SPECIFICATION MINIATURE ELECTRICAL COMPONENTS

NEW TECH DATA

Lamp Catalog

Catalog L-170 gives information on twin-lamp placard lights, which conform to the environmental and operational needs of Mil-E-5272, ARMA-XPID-1023 and 1064. Discussed are ways of grouping placard lights, methods of mounting, and other optional features. Dialight Corp., 60 Stewart Ave., Bklyn. 37, N. Y.

Circle 307 on Inquiry Card

Inductors Shielded

Information on ultra-reliable, shielded subminiature r-f inductors which range from 0.1μH to 180,000μH in 76 values is available. The WEE-DUCTOR is encapsulated and shielded for min. coupling in high-density packaging. They meet the requirements of Mil-C-15305B, Grade 1, including resistance to moisture and immersion, and operate from −55°C to +125°C. Nytronics, Inc., 550 Springfield Ave., Berkeley Heights, N. J.

Circle 308 on Inquiry Card

Instrumentation

Bulletin GEA-7749 covers GE's line of solid-state electronic instrumentation for process-control uses. Controllers, recorders, transmitters, accessories and computing elements are described and illustrated. General Electric Co., Schenectady 5, N. Y.

Circle 309 on Inquiry Card

HV Zener Diodes

The JEDEC series 1N4057 through 1N4085 operate between 12.4v. and 200v. with a temp. coefficient of 0.005%/°C and nominal voltage tolerances of ±5%. A special series have voltage tolerances as tight as ±1%, and temp. coefficients as low as 0.001%/°C. Dickson Electronics Corp., P. O. Box 1387, Scottsdale, Ariz.

Circle 310 on Inquiry Card

Power Supplies

Specs. on semiconductorized precision power supplies are given in a new short form catalog. The 2-color catalog pictures the units and includes outline drawings of rack panel adapters. A chart lists the specs. of vacuum tube supplies. Power Designs, Inc., 1700 Shames Dr., Westbury, N. Y.

Circle 311 on Inquiry Card

Stretchable Cable

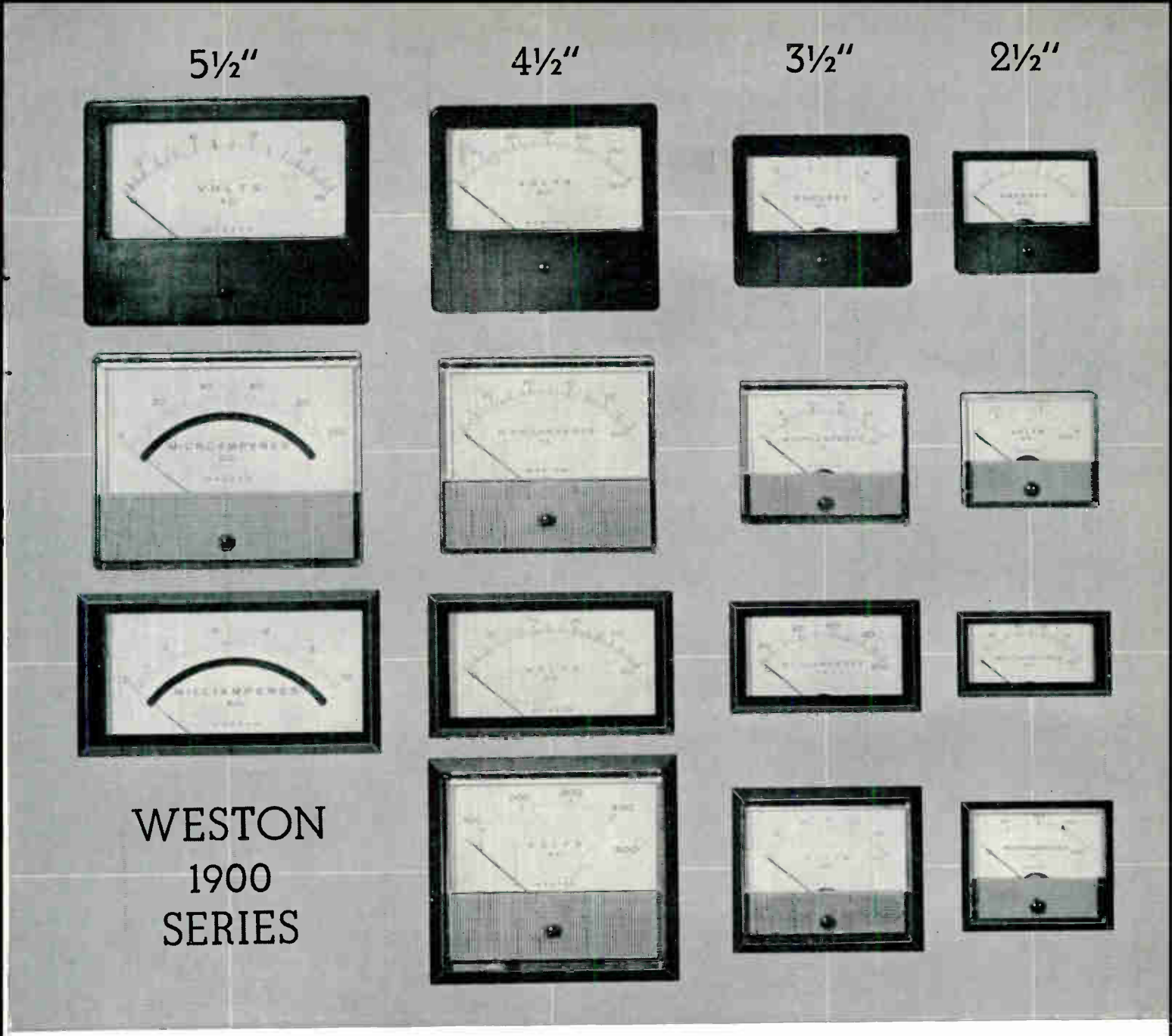
Information on a coaxial, multiconductor cable which stretches up to 400% is available from NRA, Inc., Sales Dept., 35-01 Queens Blvd, Long Island City, N. Y. Suited for underwater uses, cable can be covered with jacket of synthetic fiber, plastic or silicone rubber.

Circle 312 on Inquiry Card

Ceramic Capacitors

A 9-page test report, TR 322, gives acceptance test data on Vitramon "VK" microminiature capacitors per Mil-C-11015C. Vitramon, Inc., P. O. Box 544, Bridgeport 1, Conn.

Circle 313 on Inquiry Card



You choose size, function, accuracy, mounting and style!

Illustrated above are only 15 Weston Series 1900 Panel Meters. The possible combinations of features these instruments offer is almost unlimited. In fact, for any given function and range, you can select from more than 100 possible configurations of size, accuracy, style and type of mounting. Specify the features you want, and you'll see why this line of matching instruments is the broadest and most flexible ever offered!

Size: Weston Series 1900 Panel Meters are available in five sizes: 2½"; 3½"; 4½"; 5½"; and 7½".

Function: d-c; a-c; VU; Thermo; Rectifier; and Log-scale.

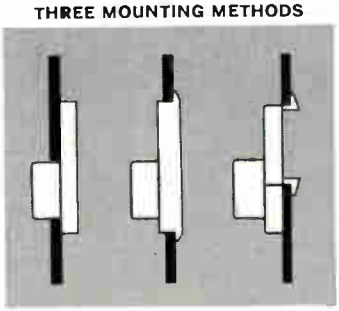
Range, full scale: Ten standard d-c μa ranges (20 to 500); d-c ma in 9 ranges (1 to 500); d-c amps in 7 ranges (100 to 500); d-c volts in 11 ranges (2 to 500). Three standard a-c μa ranges (100 to 500; a-c ma in 9 ranges (1 to 500); a-c amps in 6 ranges (1 to 30); a-c volts in 16 ranges (3 to 500); Thermo amps in 5 ranges (1.5 to 15). Other ranges on request.

Accuracy: ±2%; ±1%; higher on request.

Pointers: Lance pointer, 100° arc scale; knife-edge pointer and mirror scale for highest accuracy.

Movement: Iron vane; external magnet; or Cormag® to protect against external magnetic fields. With proved Weston pivot and jewel movement, or new Weston Taut Band Suspension with Co-planar™ Suspension which provides complete control of ribbon length and movement.

THREE MOUNTING METHODS



Surface Flush Recess

Style: Conventional Bakelite fronts for all except 7½" size; all sizes available with modern clear plastic cases with provision for inserts for color coding or styling.

Mounting method: Only Weston Series 1900 can be mounted in three ways—surface, flush or recess.

Illumination: Available for recess mounting.

No matter what features you've indicated above, layout problems are simplified because all instruments of the same size are **directly interchangeable.**

Full information is contained in our technical bulletin.

WESTON
INSTRUMENTS & ELECTRONICS

614 Frelinghuysen Ave.,
Newark 14, New Jersey
Division of
Daystrom, Incorporated

NEW TECH DATA

DC Power Supplies

Catalog 63 features index-tab selection of dc power supplies by regulation mode: constant-voltage, constant-current or dual mode. Data is presented in tabular format for fast-scan location of operating parameters and prices. Describes Electronic Measurements' new PVC all-silicon constant-voltage/constant-current power supplies, offering more more than a 1kw. of dc power with voltage regulation of 0.01% and current regulation of 0.05%. Electronic Measurements Co., Eatontown, N. J.

Circle 314 on Inquiry Card

Temperature Transducers

Bulletin 100 describes resistance temp. transducers. The 4-page, 2-color bulletin lists transducers, materials used to make them, military specs., operating principles, and calibration methods. It includes photos, an applications drawing and generalized specs. Free applications-engineering service is also described. Nova-Netics Corp., 232 Glasgow Ave., Inglewood 1, Calif.

Circle 315 on Inquiry Card

Coax Connectors

A new 24-page catalog furnishes information on Wirelok and PDE Connectors for air dielectric, semi-flexible cables. Connector design and installation data is given. Bulletin WH 3. Phelps Dodge Electronic Products Corp., 60 Dodge Ave., North Haven, Conn.

Circle 316 on Inquiry Card

Magnetostrictive Delay Lines

Booklet on magnetostrictive delay lines includes technical review, standard case sizes available from stock and discussion of standard specs. For digital circuit engineers. Andersen Laboratories, Inc., 501 New Park Ave., W. Hartford, Conn.

Circle 317 on Inquiry Card

R-F Transformer

Data is available on an r-f transformer designed to operate at 1.85MC with bandwidth of 43KC at 3.0db. Coefficient of coupling is .019. Unit measures 1 x 1 x 2⅜ in., not including terminals. Relcoil Products Corp., Windsor Locks, Conn.

Circle 318 on Inquiry Card

Dipped Capacitors

A 12-page illustrated Bulletin, 2323, entitled "Dipped Mica Capacitors," contains design and manufacture data, including parameters and characteristics. Sangamo Electric Co., Springfield, Ill.

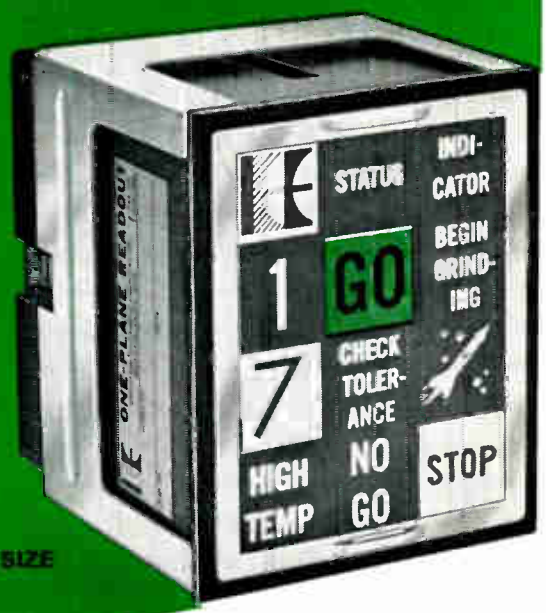
Circle 319 on Inquiry Card

Variable Filters

Bulletin 717, 4 pages, describes the Series 300 Variable Electronic Filters. Specs., characteristics, photos and charts are included. Available from Spencer-Kennedy Laboratories, Inc., 1320 Soldiers Field Rd., Boston 35, Mass.

Circle 320 on Inquiry Card

Circle 51 on Inquiry Card



ACTUAL SIZE

IEE low cost Status Indicators give you up to 12 message displays in 3 square inches

...simultaneously!

SPECIFICATIONS

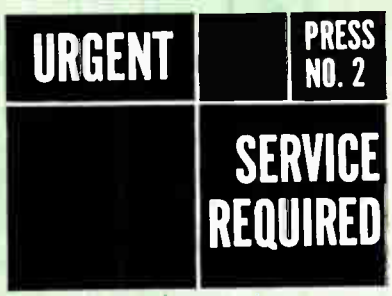
Message Areas: Up to 12 per unit; each 7/16" sq. • **Message Displays:** Numbers, letters, words, symbols, colors • **Input:** Straight decimal system • **Lamps:** Any T3-1/4" bayonet base lamp • **Voltage:** 6 to 28 volts • **Ambient Temp.:** 140° F maximum with all 12 lamps lit • **Unit Price:** $12.50 in 1-9 quantities; engraved screens slightly higher.

You get up to 12 message displays individually, in combination, or all simultaneously... *at costs as low as 80 cents per indication*... with the IEE Status Indicator.

Each of the 12 message positions is back lighted by an individual lamp—easily replaceable from the front.

All messages are displayed on a single-plane viewing screen.

Messages can be engraved on the viewing screen, placed on film, or by use of both methods, you can obtain combination effects.



Larger message displays can be obtained by combining message areas and lighting message with more than one lamp. This unit shows dividing lines engraved on screen, messages on film. Unit can be mounted vertically or horizontally.

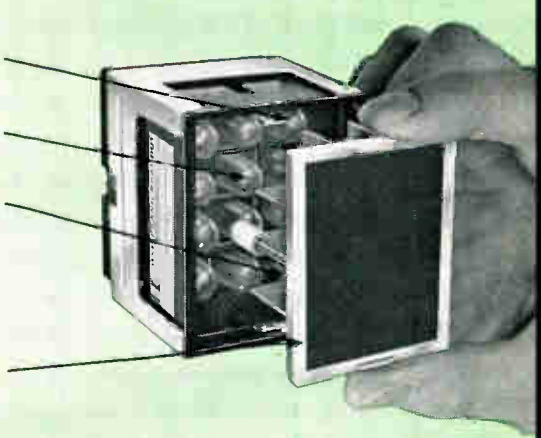
Quick, easy lamp replacement from front of unit.

Redundant lamping available.

Message film behind screen can be replaced easily for field changes.

Messages can be typed or lettered on mylar film or parchment for development jobs.

No mounting screws on face of unit. Two screws inside Status Indicator draw unit tight against front of panel.



Write today for Status Indicator message designer sheet and complete specifications.

INDUSTRIAL ELECTRONIC ENGINEERS, INC.

5528 Vineland Avenue • North Hollywood, California • Phone: (213) 877-1144 • TWX: (213) 769-1636

Circle 52 on Inquiry Card

CONHEX® SUB-MINIATURE R. F. CONNECTORS

Designed and manufactured to meet the industry's demand for a better connector. Real gold-plated, not just flashed. Maximum impedance match, minimum VSWR. Available in Crimp-On or Clamp-On designs.

SCREW-ON
Clamp-On

SNAP-ON
Clamp-On, Crimp-On

PRESS-FIT® TEFLON TERMINALS

Sealectro and only Sealectro makes Press-Fit terminals. Ultra-quality provides optimum reliability and assembly ease. Available in all standard EIA colors.

SUBMINIATURE STANDOFFS
Teflon bushings in diameters from .148" to .218". Choice of lugs, including turrets.

SUBMINIATURE FEEDTHRUS
For connections through chassis or casing. Choice of lug designs including hollow-tube.

MINIATURE STAND-OFFS
For components and assemblies stressing higher voltages. Wide choice of lugs and turret designs.

MINIATURE FEEDTHRUS
For handling voltages up to 4000 VDC. Wide choice of bushing diameters and lengths.

SEALECTRO COMPONENTS OFFER PROVEN RELIABILITY IN ALL INDUSTRIAL AND MILITARY APPLICATIONS

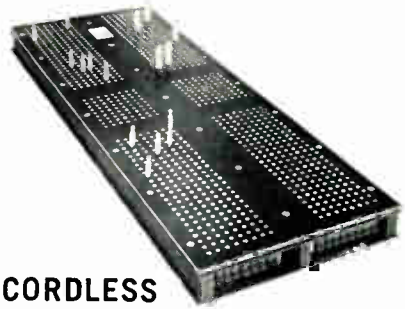
PRESS-FIT® TEST JACKS AND PLUGS

Male and female. Ideal for test instrument probes, jumper plugs and multiple pin plugs. Test jacks for printed circuitry.

DELTIME MAGNETOSTRICTIVE DELAY LINES

Longer delay times utilizing the magnetostrictive principle for maximum stability and mechanical ruggedness. Delay times up to 10 milliseconds at repetition rate of 655 KC with return-to-zero, or 5 millisecond delay at 1 MC with return-to-zero. Suitable for data storage. Completely humidity and magnetically shielded. Many standard fixed and variable models available.

SEALECTOBOARD

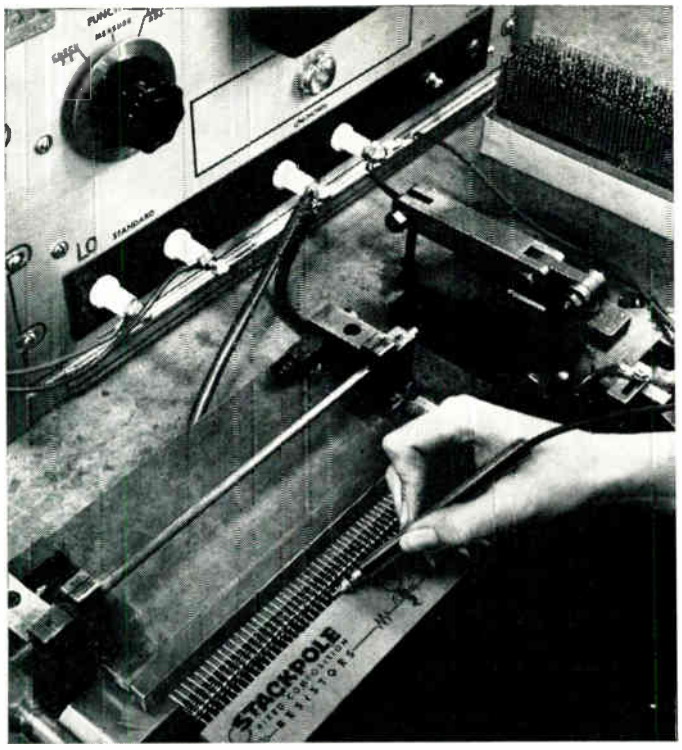


CORDLESS PROGRAM BOARDS

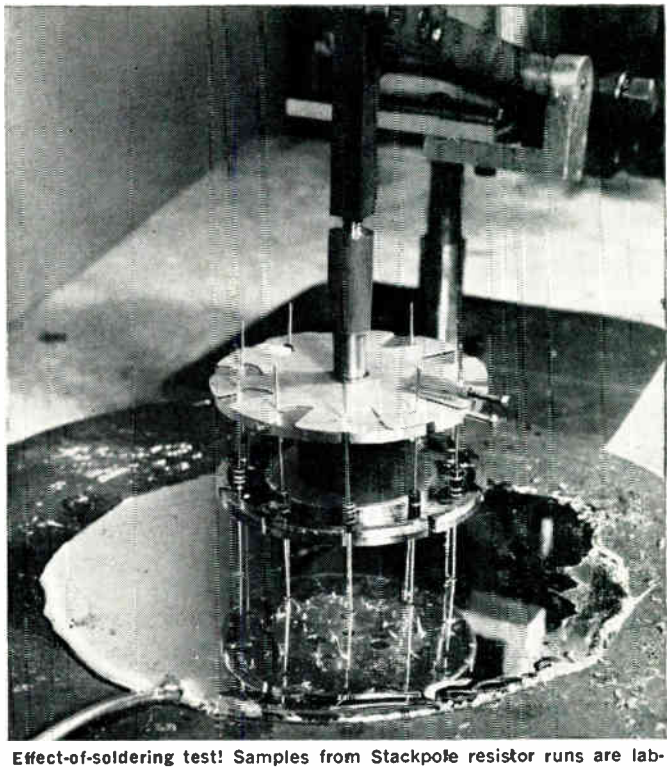
The revolutionary program board. Simplifies multi-channel switching. Provides complete connections with insertion of single pin. No cord clutter. Accessories include component holders for inserting diodes, resistors, or other components at any circuit point. Available in any X- and Y- configuration. Standard Proto-Kits including board, shorting pins and component holders available from distributors.

WRITE FOR CATALOGS . . . STATING PRODUCT INTEREST

Sealectro CORPORATION
139 HOYT STREET • MAMARONECK, N. Y.



Tested 200% plus! Production line machines automatically classify every Stackpole resistor to insure that specified resistance and tolerance are unerringly met. Then, just before packaging, resistors are again tested individually as the final step in a series of critical inspections that start even before production begins.



Effect-of-soldering test! Samples from Stackpole resistor runs are laboratory tested regularly to make certain that soldering heat will have negligible affect on performance. Equally rigid tests at every important stage of production assure quality second to none in every Stackpole COLDITE 70+ resistor you specify.

Some Stackpole resistors are not for you

Stackpole COLDITE 70+® Fixed Composition Resistors roll down our line, and out to customers, by the tens of thousands every day.

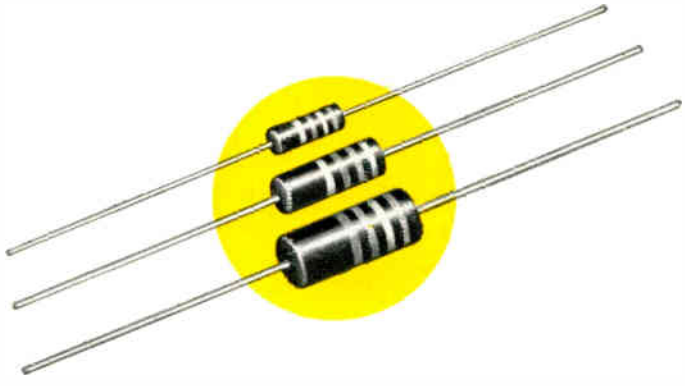
But does this mean sheer volume at the sacrifice of quality?

On the contrary!

It calls for one of the most rigid, comprehensive testing and quality control programs in the resistor industry . . . just to spot the one Stackpole resistor that is not for you (or any other Stackpole customer). Two of the tests are shown above.

This is why you can specify COLDITE 70+ resistors without a second thought about their solderability, load life, humidity and temperature characteristics. And why they exceed every important MIL-R-11 requirement.

If you're ever in our area, drop in and say, "Hello!" We'll be glad to chat about your design problem. Meantime, buzz your Stackpole distributor and prove our point: you get more out of Stackpole resistors because we put more in them. Or write: Electronic Components Division, Stackpole Carbon Company, St. Marys, Pennsylvania.



STACKPOLE

CARBON COMPANY, *Electronic Components Division*

St. Marys, Pennsylvania

NEW TECH DATA

Piezoelectric Accelerometers

High-performance piezoelectric accelerometers and companion amplifiers are described in this 4-page brochure available from Statham Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif. Specs., illustrations and general information are included.

Circle 321 on Inquiry Card

DC Amplifier

Complete specs. are available on Model 260 solid-state wideband potentiometric dc amplifier. These specs. include: bandwidth, down 3db at 200kc minimum; gain accuracy, ±0.002% at dc; input impedance, 1,000 megohms minimum; output, ±10v., ±10ma. Redcor Corp., 7760 Deering Ave., P. O. Box 1031, Canoga Park Calif.

Circle 322 on Inquiry Card

R-F Capacitors

Tech. Bulletin 402 lists low-loss silicone oil-impregnated r-f capacitors with ratings from 2.5kv to 30kv. Capacitance ranges from 0.00005μfd to 0.1μfd. Capacitors are primarily designed for ultrasonic oscillating circuits, r-f and pulse uses. Captronics, Inc., 9 Cricket Terrace, Ardmore, Pa.

Circle 323 on Inquiry Card

Voltage Regulator

"Statex Voltage Regulators," Bulletin 14C1523, has a diagram of the printed-circuit elements of the voltage regulator, and a block diagram of the complete excitation system. Regulator can handle exciter field power requirements up to 5250w., provides regulation of ±1%. Allis-Chalmers, Milwaukee 1, Wisc.

Circle 324 on Inquiry Card

Conveyor Furnaces

An 8-page bulletin, C-1, gives basic design facts for radiant equipment, air-circulated equipment, conveying mechanisms and muffle or chamber arrangements, along with recommended areas of use. Drawings and photos are used, parts labeled, and processes clearly described. Trent, Inc., 201 Leverington Ave., Philadelphia 27, Pa.

Circle 325 on Inquiry Card

DC Power Supply

This 4-page brochure describes Model R2432-100 Regulated DC Power Supply, a portable unit providing 0-100a of current at 24-32vdc. Available from Tung-Sol Electric, Inc., 1 Summer Ave., Newark 4, N. J.

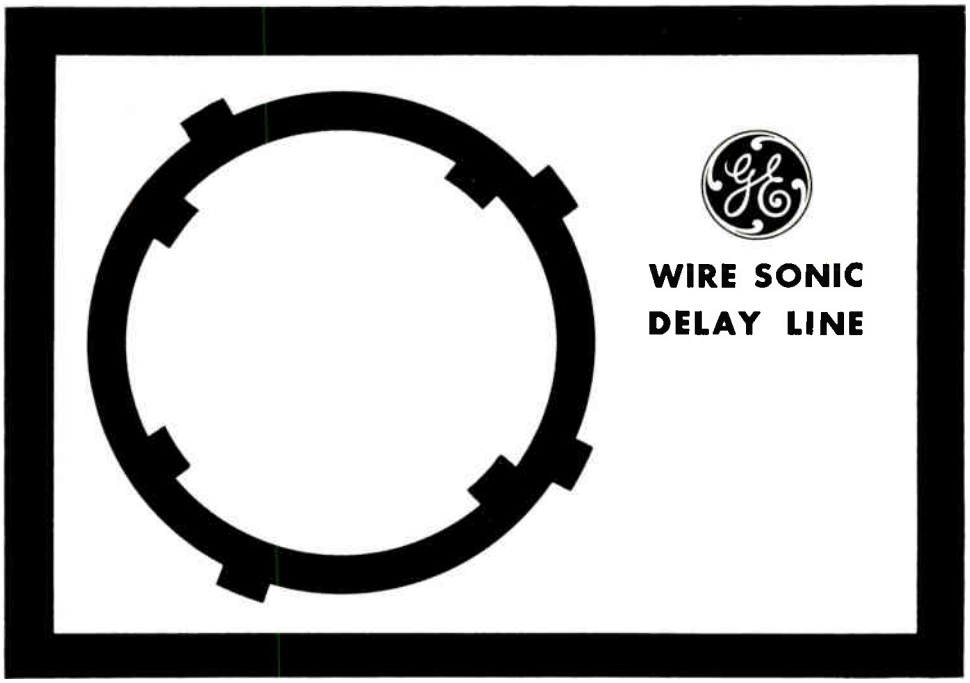
Circle 326 on Inquidy Card

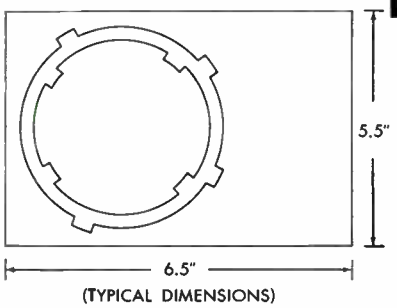
Wire-Wound Resistors

High-temp., wire-wound resistors of fireproof inorganic construction are described in Bulletin P-7b. Units, designated type PW, are available in 2, 3, 5, 7, 10, 15 and 20w ratings. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Circle 327 on Inquiry Card

Provides higher PRF (2.5mc RZ or 5mc NRZ) . . . and satellite flights demonstrate reliability





(TYPICAL DIMENSIONS)

General Electric has achieved an important technical breakthrough in sonic delay lines—devices that operate at 2.5mc and 5mc PRF. These unique G-E delay lines, the only ones in industry capable of such high-frequency operation, give more storage per unit volume, faster access time to data, and enable higher operating frequencies for associated equipment. This continuous-operation performance has been demonstrated in actual satellite flights—from high-vibration launch through in-space operation.

Durable General Electric-developed direct drive torsional delay lines replace delicate mode converters with sturdy piezoelectric transducers. In addition to high vibration tolerance (up to 30Gs 20–2000 cps), these low-loss, completely passive devices withstand shock of 200Gs (11 Msec), and temperature variations from —5°C to +65°C (—55°C to +100°C with special considerations).

IN MISSILES, SATELLITES, AND INDUSTRIAL EQUIPMENT, G-E wire sonic delay lines can perform a variety of functions, including computer serial memories, buffer data storage, signal processing, and pulse timing. Input/-output circuitry is furnished where desired.

To meet the specific requirements of your equipment and systems, General Electric's Specialty Devices Operation will custom-design these reliable, high-frequency devices.

Free, detailed information on G-E sonic delay lines is available. Write to Section 179-14, General Electric Company, Schenectady, New York.

SPECIALTY DEVICES OPERATION

GENERAL ELECTRIC

DEFENSE ELECTRONICS DIVISION

BORG MICROPOT® POTENTIOMETERS

. . . a complete line of single-turn, multi-turn, and trimming potentiometers for commercial and military applications

You can get quick delivery of any potentiometer listed below. If you need a special, take advantage of Borg's Quick Reaction Facility. We can build prototypes to your specs for the fastest possible delivery.

PRECISION MICROPOT® POTENTIOMETERS

	Model	Standard Resistances (Ohms)	Resistance Tolerance	Temperature Range (°C)	Maximum Power Rating (Watts)	Size (Inches) Length	Size (Inches) Diameter	Linearity Tolerance (Standard %)	Number of Turns
205 SERIES	205	1.15 to 100K	±10% to 50 ± 3% over 50	−55 to +105	5	2-1/8	1-3/4	±.1	10
	205-3T	10 to 50K	±3%	−55 to +105	3	1-31/64	1-3/4	±.5	3
900 SERIES	901	25 to 100K	±3%	−55 to +125	5	2-1/16	2	±.1	10
	931	15 to 60K	±3%	−55 to +125	3	1-3/8	2	±.5	3
2100 SERIES	2101	25 to 120K	±10% to 100 ± 3% 100 to 100K ± 5% over 100K	−55 to +125	5	1.573	7/8	±.5	10
	2131	10 to 40K	±10% to 30 ± 3% over 30	−55 to +125	4	1.055	7/8	±.5	3
	2151	100 to 100K	±3%	−55 to +105	3	1.455	7/8	±.25	10
2200 SERIES	2201	25 to 200K	±3% to 100K ±5% over 200K	−55 to +105	5	2-1/8	1-13/16	±.25	10
	2251	25 to 200K	±5% to 100 ±3% 100 to 100K ±5% 100K to 200K	−55 to +105	5	2-1/8	1-13/16	± .5 to 100 ± .25 100 to 100K ± .5 100K to 200K	10
2400 SERIES	2441	500 to 50K	±5% to 10K ±3% over 10K	−55 to +125	3	.781	7/8	±.5	1
	2461	500 to 100K	±5% to 5K ±3% over 5K	−55 to +125	4	.800	1-7/16	±.5	1
	2481	100 to 125K	±5% to 5K ±3% over 5K	−55 to +125	5	1	2	±.5	1
	2491	100 to 200K	±5% to 5K ±3% over 5K	−55 to +125	6	1	3	±.5	1

TRIMMING MICROPOT® POTENTIOMETERS

	Description	Resistance Range	Resistance Tolerance	Temperature Range (°C)	Maximum Power Rating	Size H	Size W	Size L	Turns	Termination*
990 SERIES	High-Temperature Wirewound	10 ohms to 50K	±10% to 100 ohms ± 5% over 100 ohms	−55 to +175	1	.36†	.28	1-1/4	40	L SL PC T
992 SERIES	General Purpose Wirewound	10 ohms to 50K	±10% to 100 ohms ± 5% over 100 ohms	−55 to +105	1	.36†	.28	1-1/4	40	L SL PC
993 SERIES	General Purpose Carbon	20K to 1 meg	±20%	−55 to +105	.5	5/16	.28	1-1/4	25	L SL PC
994 SERIES	General Purpose Humidity-Proof Wirewound	10 ohms to 50K	±10% to 100 ohms ± 5% over 100 ohms	−55 to +105	1	.36†	.28	1-1/4	40	L SL PC
995 SERIES	General Purpose Humidity-Proof Carbon	20K to 1 meg	±20%	−55 to +105	.5	5/16	.28	1-1/4	25	L SL PC
2700 SERIES	Miniature High-Temperature Humidity-Proof Wirewound	100 ohms to 30K	±5%	−55 to +175	1	.315	.18	1	15	L W
2750 SERIES	High-Temperature Humidity-Proof Wirewound	10 ohms to 100K	±5%	−65 to +175	1	.32	.19	1.25	22	L SL PC
2800 SERIES	High-Temperature Humidity-Proof Wirewound	10 ohms to 50K	±10% to 100 ohms ± 5% over 100 ohms	−55 to +175	1	.36†	.28	1-1/4	40	L SL PC

†Except L models: 5/16".

*L: Color-coded wire leads.
T: Solder Terminals.

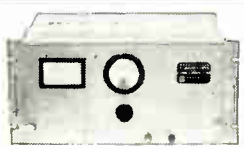
W: Uninsulated tinned copper leads.
PC: Printed circuit pins.
SL: Gold-plated solder lugs.

BORG MICRODIAL® TURNS-COUNTING DIALS

Do you prefer digital or concentric scales? Borg offers you the widest selection of precision dials for potentiometer control. Large, easy-to-read numerals. Thousand-to-one indexing accuracy. Rugged construction unaffected by "panic" handling. Positive braking option. Write for data.

SUB-FRACTIONAL H.P. INSTRUMENT MOTORS

Synchronous, induction, and control models. Two or four pole types. With or without gear trains. Gear trains interchangeable in some models for maximum versatility. Write for data.



FREQUENCY AND TIME STANDARDS

Borg Frequency and Time Standards offer 24-hour stability of up to 5pp 10^{11}. Some models transistorized. Fully militarized and radiation-free. Integral power supply. Fail-safe frequency dividers. Crystal controlled. Time comparator for fast WWV comparisons. Write for complete data.

BORG

BORG EQUIPMENT

A Division of Amphenol-Borg Electronics Corporation
Janesville, Wisconsin

Cool indifference—up to 310°C.

That's the big difference with AMPLIMICA* Capacitors!

This stacked foil capacitor goes right on giving dependable performance in control systems, high voltage power supplies, pulse forming networks, and atomic reactors under temperature ratings up to 310°C. And the big reason for this is our new dielectric—a processed mica which takes all the advantages of raw mica and makes them more readily controllable for today's miniaturization and operational requirements.

In addition to being effectively resistant to high temperatures, our new AMPLIMICA Capacitors are also resistant to radiation . . . even high dosage rates cause no appreciable capacitance loss.

If your requirements call for a capacitor that assures reliable, stable performance under temperatures ranging up to 310°C., we offer AMPLIMICA Capacitors in a complete range of sizes and configurations . . . ready to do the job. Send for complete information today.

*Trademark of AMP INCORPORATED

AMP INCORPORATED | *CAPITRON DIVISION*
155 PARK STREET, ELIZABETHTOWN, PA.

AMP products and engineering assistance available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

NEW TECH DATA

for Engineers.

Multiple Headers

A 4-page bulletin on high-temp., vacuum-sealed multiple pin headers has been released. Fully illustrated with photos and dimensional sketches, Bulletin FT-3 includes headers having from 1 to 8 pins for use from −325°F to +800°F and above. Several types not cataloged before are shown. Catalog Dept., Physical Sciences Corp., 314 E. Live Oak Ave., Arcadia, Calif.

Circle 443 on Inquiry Card

Photoelectric Controls

The 8-page Transistor Photoelectric Control Catalog, in color, describes sensitive, self-contained transistorized photoelectric controls. It covers controls with magnetic amplifiers, tubeless controls, controls with time delays, and light sources for use with the above. Also described are transistorized on-off photoelectric controls and time-delay controls with small and regular size sensing and light source heads, including infrared and flourescent light filter assemblies. Autotron, Inc., 3627 N. Vermilion, Danville, Ill.

Circle 444 on Inquiry Card

Coaxial Cable Bulletin

The 20-page illustrated Bulletin CT-3 describes Spirafil coaxial cable. This air dielectric, semi-flexible cable is used in community TV systems and feed networks for guidance, telemetry, space surveillance and radar. Data covers electrical and mechanical characteristics, average power rating, and atenuation vs. freq. performance curves. Phelps Dodge Electronic Products, 60 Dodge Ave., North Haven, Conn.

Circle 445 on Inquiry Card

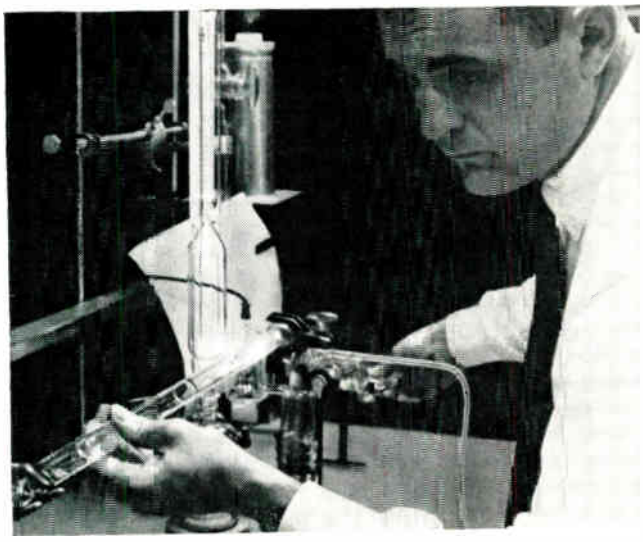
High-Power Amplifiers

Bulletin 1306-1 describes high-power series of magnetic amplifiers. Completely static amplifiers meet medium-power industrial needs and are ideal for ac and dc motor control, electric furnace control, or other power control. Bulletin lists features, specs., dimensions and other physical data of the super-power series, and shows typical connection diagrams. It also charts typical control characteristics and provides a silicon rectifier selection guide. Electric Products Div., Vickers, Inc., 1815 Locust St., St. Louis 3, Mo.

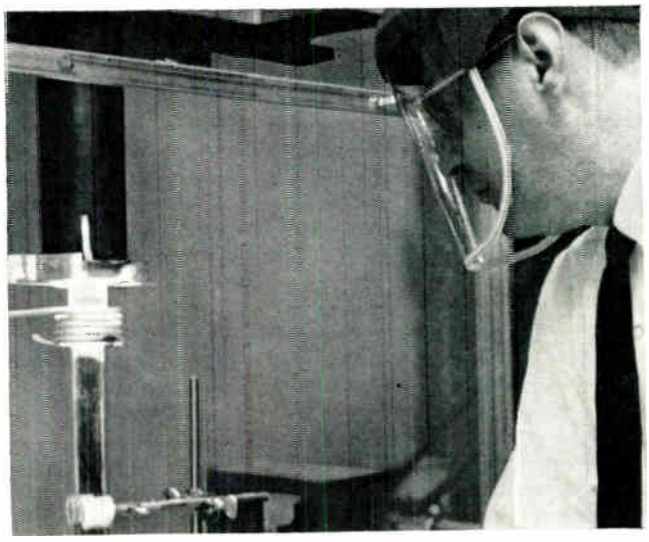
Circle 446 on Inquiry Card

IBM asks basic questions in materials

How can we develop better semiconductors?



In this method of preparing ultrapure gallium arsenide, gallium reacts with arsenic in a quartz tube with oxygen added under pressure to suppress dissociation of SiO_2.



In this alternative method, gallium arsenide crystals are pulled from gallium and arsenic melted in aluminum nitride crucibles, which do not liberate silicon contaminates.

The immense speeds at which computers must operate place stringent requirements on the transistors and diodes which perform calculations. To increase further the speed of semiconductor devices now operating in millionths or even billionths of a second requires not only refinements in present designs and fabrication techniques, but also new materials that are inherently superior to materials presently being used, like germanium and silicon. IBM has been working to transform the great potential of one such new material, gallium arsenide, into useful devices.

Gallium arsenide has a much higher electron mobility than germanium and silicon. Thus it is potentially much faster. It has a larger band gap, permitting operation at higher temperatures. It is chemically and mechanically stable. However, the difficulty of producing gallium arsenide of sufficient purity has, until recently, limited its application.

IBM scientists have developed the reproducible processes, shown above, which greatly improve the purity of the material. Using their new processes, they can produce materials with electron mobilities —an important measure of purity—of about 8,000 cm^2/volt-sec., as compared with previously reported mobilities of about 6,000 cm^2/volt-sec. Mobilities in this high-purity gallium arsenide are about twice those of germanium and four times those of silicon. These mobilities may make it feasible to fabricate semiconductor devices of higher speed than previously available.

The potential of high-purity gallium arsenide was first exploited by IBM scientists in a new gallium arsenide-germanium heterojunction diode. The difference in conduction band energies between gallium arsenide and germanium permits a diode to be made using n-type material on both sides of the junction. In other words, n-type gallium arsenide is used on one side of the junction and n-type germanium on the other. Such a configuration virtually eliminates minority carriers. Since the chief barrier to faster diode switching has been minority-carrier storage time, the heterojunction device has the potential for much faster switching than conventional p-n junction diodes. Its calculated switching time is on the order of a few picoseconds (trillionths of a second). Measurements have shown it to be faster than the fastest available measuring circuits. This configuration had been tried earlier, but was unsuccessful until better gallium arsenide was made by IBM scientists. This is an example of the way in which the development of new materials like gallium arsenide makes it possible to produce components which can keep up with the increasing speeds of new generations of computers.

If you have been searching for an opportunity to make important contributions in materials, space, programming systems, or any of the other fields in which IBM scientists and engineers are finding answers to basic questions, please contact us. IBM is an Equal Opportunity Employer. Write to: Manager of Professional Employment, IBM Corp., Dept. 557F, 590 Madison Avenue, New York 22, N. Y.

FOR EXPERIMENTAL USE

VK®

MICROMINIATURE
CERAMIC CAPACITOR
Labstock Kit

Specially Priced

Wide assortment of over 600 "VK" ceramic capacitors, ranging in value from 39 pf to 10,000 pf in both 10% and 20% tolerances, for prototype and breadboard use. Units are packaged and sorted by value in individual, labeled drawers for fast, easy selection. 32-drawer, enameled metal cabinet is compact, sturdy — takes up less than 1/2 ft. of bench space. VK® Kit #3, as shown, **specially priced at $349.00.**

Contact us for information concerning VK® Kit #4 with 120 **specially selected units priced at $75.00.**

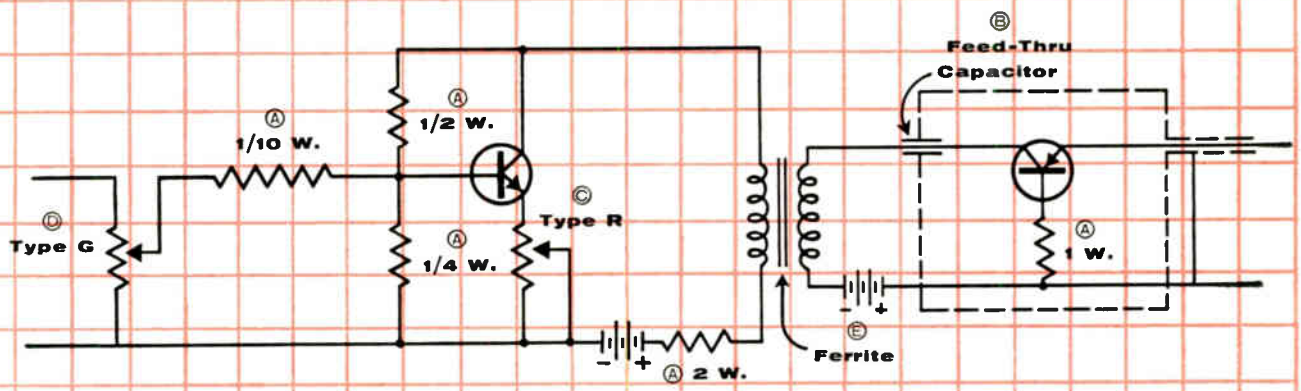
Write for FREE CATALOG of
"VITRAMON" Porcelain and Ceramic Capacitors

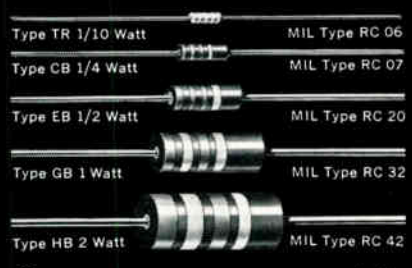
Vitramon
INCORPORATED
BOX 544 • BRIDGEPORT 1, CONNECTICUT

D68

Circle 62 on Inquiry Card

Allen-Bradley's "time-proven" components bring the ultimate in reliability to your circuit design





Ⓐ **HOT MOLDED FIXED RESISTORS** are available in all standard EIA and MIL-R-11 resistance values and tolerances.

Ⓑ **FEED-THRU CAPACITORS**—Available in standard values of 470 mmf ± 20% and 1000 mmf G.M.V. Special values from 6.8 to 1000 mmf. Rated to 500 v DC max.

Ⓒ **HOT MOLDED ADJUSTABLE FIXED RESISTORS**—Rated ¼ watt at 70°C. Values to 2.5 meg. Tol: ± 10 and 20%.

Ⓓ **TYPE G HOT MOLDED POTENTIOMETERS**—Only ½" diam. Rated ½ watt at 70°C. Resistance values to 5 meg. Tol: ± 10 and 20%.

Ⓔ **FERRITES** in a wide range of "items," such as flared rings, quarter rounds, U cores, E cores, cup cores, etc., can be supplied.

With the quality of the components which you select, you automatically establish the "quality" of your product. Consequently, there's no surer way of making certain of optimum performance than by using Allen-Bradley electronic components. Such stable characteristics insure against catastrophic failure, and conservative ratings are way beyond the "promise" of any similar products. Hundreds of customers of many years standing have learned from their experience with Allen-Bradley hot molded resistors, that today's shipments are as uniform in quality as they were ten or twenty years ago—and such uniform quality can always be expected.

Remember also that with billions of A-B resistors in use, there is *not one instance* of catastrophic failure on record! Allen-Bradley's *exclusive* hot molding process results in such uniformity that long term resistor performance can be accurately predicted.

Then there's the compact Type G potentiometer. The solid, hot molded resistance element assures exceptionally smooth control throughout its long life—there are never any abrupt resistance changes during adjustment. The noise factor is remarkably low initially, and it actually decreases with use.

Allen-Bradley's Type R adjustable fixed resistors are also made by this same hot molding process—resistance element, terminals, and insulating base are all molded into a solid unit. Stepless adjustment is provided, and the moving element is self-locking at its "setting."

In the higher frequencies—up to 1,000 mcps—A-B ceramic feed-thru and stand-off capacitors' unique discoidal design eliminates all parallel resonance effects.

Entirely new answers to design problems are possible with A-B's broad line of ferrites . . . reducing product size, weight, or cost, and improving performance. They can be supplied in a wide range of shapes and sizes—while maintaining extremely uniform electrical and mechanical characteristics.

For more details on all A-B quality electronic components—types, ratings, dimensions—please send for Publication 6024: Allen-Bradley Co., 1342 S. Second St., Milwaukee 4, Wisconsin. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.

QUALITY ELECTRONIC COMPONENTS | **ALLEN-BRADLEY**

NEW TECH DATA

Mica Capacitor Chart

The Mica Minder is a 17 x 22 in. wall chart to help circuit designers select mica capacitors. More than 40 types of mica capacitors are listed with line drawings and dimensions. For each type, chart shows capacitance, tolerance, voltage, operating temp., temp. characteristics and insulation resistance. Three smaller charts augment the above information. Cornell-Dubilier Electronics Div., Federal Pacific Electric Co., 50 Paris St., Newark 1, N. J.

Circle 447 on Inquiry Card

Connector Facilities Booklet

Expanded facilities for producing electrical connectors are described in a 19-page illustrated booklet. Bulletin #665 outlines and illustrates the connector manufacturing facilities and capabilities of Pyle-National Co. Areas covered include elastomer compounding and molding, testing, quality control, and cable terminating and molding. The Pyle-National Co., 1334 N. Kostner Ave., Chicago 51, Ill.

Circle 448 on Inquiry Card

Selection Guide

How to specify 1,500 standard infrared detector elements is outlined in a series of Servotherm® detector spec. sheets. A new method for the systematic selection of various component elements simplifies detector procurement to a marked degree. Consequently, Mil-quality infrared detectors can be specified as standard components instead of requiring special designs. Servo Corp. of America, 111 New South Rd., Hicksville, L. I., N. Y.

Circle 449 on Inquiry Card

H-F Rectifier

Technical information and prices on a new h-f diffused-junction rectifier for high-radiation uses are available from TRW Electronics/Pacific Semiconductors, Inc., 14520 Aviation Blvd., Lawndale, Calif. Rectifier Type PS3200 has a top operating freq. of 250KC and a 10kv. rating.

Circle 450 on Inquiry Card

Metallized Paper Capacitors

Bulletin No. 131B8 contains complete specs. on high-temp., metallized paper capacitors, designed to meet critical operating requirements and reliability. Temp. ranges, performance characteristics and case dimensions are included. Aerovox Corp., New Bedford, Mass.

Circle 451 on Inquiry Card

Power Supplies

This 44-page catalog, B-631, describes over 230 dc-regulated power supplies, including programmable voltage/current regulated models. Included are performance features and physical specs. Kepco, Inc., 131-8 Sanford Ave., Flushing 52, N. Y.

Circle 452 on Inquiry Card

Acme Electric ENGINEERED QUALITY

IS ASSURANCE OF BETTER PERFORMANCE

Dependable performance beyond the acceptable average is the result of engineered quality in these Acme Electric products. Our research and engineering staff can apply a wealth of experience, and the facilities of a new, completely equipped, modern engineering laboratory to help resolve the application of electronic and magnetic components.

Acme Electric POWER SUPPLIES

Acme Electric has designed, over the period of 15 years, more than 1000 different types of Power Supplies in ratings from ⅛ watt to 600 KW. This significant experience can be of value to you in the selection of a *standard* Power Supply or *custom built* units to specific applications.

POPULAR STANDARD DESIGNS

Cat. No.	A.C. Input Volts	Watts	Amperes	D.C. Volts	Approx. Regulation	Approx. Efficiency	Shipping Weight
PS-41422	100-130	50	2.08	24	±1%	73%	14
PS-41423	100-130	150	6.25	24	±1%	76%	23
PS-41424	100-130	200	4.15	48	±1%	81%	25
PS-41425	100-130	250	2.0	125	±1%	86%	26
PS-41426	100-130	300	2.0	150	±1%	86%	30
PS-41427	100-130	200	1.0	200	±1%	80%	25
PS-41428	100-130	250	1.0	250	±1%	85%	26
PS-39787	120	.125	0.005	0-25			15
PS-1-6757	95-130	112.5	0-2.5	0-45	±5%		21
PS-39600	120±15%	250	0-5	0-50	±1%		21
PS-39590	115±15%			0-52	±.015		

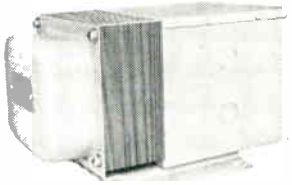
CUSTOM DESIGNS TO SPECIFICATIONS

Custom power supplies are designed with regard to regulation, frequency response, recovery time, transient disturbances, ripple, noise-level, isolation, temperature drift, stability and the most practical physical size consistent with the component and circuitry requirements. Our suggestions on your application may be of considerable value.

Acme Electric MAGNETIC AMPLIFIERS

Solid state electronic components and magnetic reactors of advanced design provide high ratio between power input and power output. Self saturating. Bias control winding and independent gain control circuit are adjustable by independent potentiometers. Operates from extremely low signal source. Isolated signal and load circuits. Write for Bulletin #24.

Acme Electric CONSTANT VOLTAGE STABILIZERS



A standardized line, available from stock shipment in any quantity. Output voltage stabilized ±1% of normal. Bulletin #09.

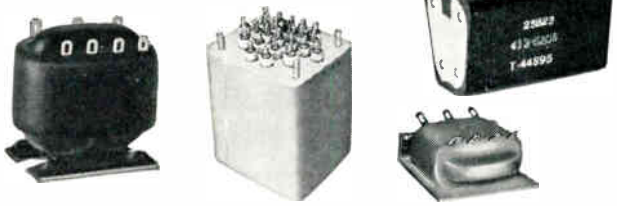
OUTPUT CAPACITY	INPUT VOLTAGE		OUTPUT VOLTAGE	
15	95-130		6.3	120
25	95-130		6.3	120
50	95-130		6.3	120
100	95-130	190-260	120	240
200	95-130	190-260	120	240
300	95-130	190-260	120	240
500	95-130	190-260	120	240
1000	95-130	190-260	120	240
2000	95-130	190-260	120	240
3000	95-130	190-260	120	240
5000	95-130	190-260	120	240

Note: Ratings are available with single output voltage only and only one input voltage range.

Acme Electric TRANSFORMERS

ENCAPSULATED, MOLDED, HERMETICALLY SEALED

Complete facilities for designing, producing and testing transformers for high frequency, high temperature and high performance applications.



Acme Electric STATIC POWER RECTIFIERS

Our production of static, magnetic, rectified DC power supply units have now advanced beyond 600 KW capacity types. Custom engineered rectifiers can be supplied with low level or high level dc output voltages.

SAA 3650/2089

ACME ELECTRIC CORPORATION

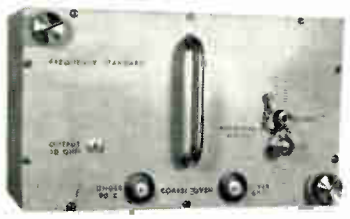
896 Water St. Cuba, New York

In Canada: Acme Electric Corp. Ltd., 50 Northline Rd., Toronto, Ont.

Acme Electric TRANSFORMERS

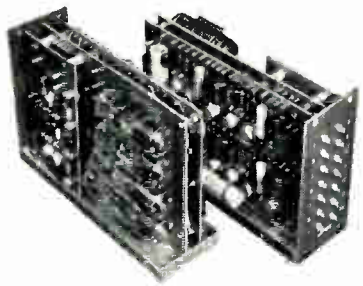
REEVES-HOFFMAN

FREQUENCY STANDARDS, CRYSTALS, OVENS, FILTERS



FREQUENCY STANDARDS

Highly reliable, ultra-stable standards with a basic frequency of 5 mc are available with circuitry for division to 100 kc and 1 mc and doubling up to 10 mc. Stability is up to 1 part in 10^9 per day. Precision standards use crystals of our own manufacture and are packaged to your specifications.

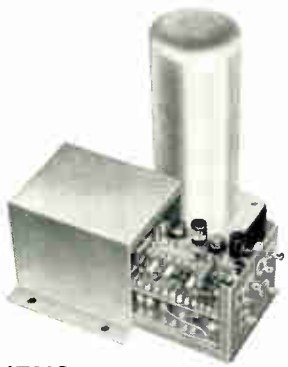


PACKAGED OSCILLATORS

Transistorized and Hard Tube Types of Reeves-Hoffman packaged oscillators are available in a frequency range from 100 cps to 100 mc. Stability is up to 1 part in 10^9. Packaged to your specifications.

CRYSTALS

STANDARD TYPES of Reeves-Hoffman crystals, for all commercial and military applications, are available in a frequency range from 1 kc to 100 mc. Hermetically sealed in metal holders.
PRECISION TYPES of Reeves-Hoffman crystals, for use in high precision oscillators and secondary frequency standards, are available in a frequency range from 1 kc to 5 mc. Hermetically sealed in glass holders with standard radio tube bases.



OVENS

OVENS for precise temperature control are available in three types:
PROPORTIONALLY CONTROLLED, for precise frequency standards, hold within 0.001°C at any fixed ambient.
THERMOSTATICALLY CONTROLLED, for high reliability requirements, hold within 0.005°C at any fixed ambient.
SNAP-ACTION CONTROLLED, for rugged military requirements, hold within 1.0°C at any fixed ambient.

FILTERS

Crystal filters are available in a frequency range of audio to 30 mc. Filters, using crystals of Reeves-Hoffman manufacture, can be packaged to your specifications.

MODEL S2075 2.5 MC FREQUENCY STANDARD

Stability of 2×10^{-11} per day after one year (at a constant ambient). Provides simultaneous output frequencies of 100 kc, 1 mc, 5 mc. Double proportional control oven, transistorized, fits into 5¼-in. rack panel. Crystal is AT-cut, 5th overtone with frequency adjustable to within 1×10^{-11}.

Compact, rugged and highly reliable Reeves-Hoffman components are available in standard types or will be designed and manufactured to your specifications. Units are designed to meet applicable Military specifications for environmental conditions.

Reeves-Hoffman also manufactures fractional horsepower motors and resolvers.

REEVES-HOFFMAN

CARLISLE, PENNSYLVANIA

DIVISION OF DYNAMICS CORPORATION OF AMERICA

OVER 1,000,000 SPECIAL POTS

Which means: (a) we know how (b) we welcome the unusual, including complex non-linears (c) you get quicker delivery; chances are we've already solved the problem (or close to it) for somebody else (d) you save money since minimum design time is required (perhaps none at all) (e) we can meet your specs.

May we make one (or 1,000) for you? It costs you nothing to inquire. Why don't you try us?

SPECTROL ELECTRONICS CORPORATION

1704 South Del Mar Avenue
San Gabriel, California

Adams Court
Plainview, L. I., New York

P. O. Box 130
Brampton, Ontario

Circle 69 on Inquiry Card

NEW TECH DATA

for Engineers.

Toroidal Inductor

An 8-page booklet, entitled "Toroidal Inductor Application Guide," includes specs., curves, construction and operating range, inductance data, reactance nomograph, plus other pertinent information on miniaturized transformers. Microtran Co., Valley Stream, L. I., N. Y.

Circle 437 on Inquiry Card

Transistor Power Supply

Bulletin S-2-37 describes Model 591-H regulated switching transistor power supply for military use (Mil-E-5272A). It converts low-voltage dc to higher voltage dc. Specs., schematics and characteristics are included. Arnold Magnetics Corp., 6050 W. Jefferson Blvd., Los Angeles 16, Calif.

Circle 438 on Inquiry Card

Piezo Components

High-performance piezoelectric accelerometers and companion amplifiers are described in a new 4-page brochure from Statham Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif. Complete specs. are included on AK series piezoelectric accelerometers and SA series piezoelectric amplifiers.

Circle 439 on Inquiry Card

RFI Filter Catalog

This 6-page catalog, Data-Log No. RFI-2000, describes 11 typical categories of RFI filter design solutions, including more than 2,000 different designs. It includes guide for complete design information to specify filters. Hopkins Engineering Co., P. O. Box 191, San Fernando, Calif.

Circle 440 on Inquiry Card

Cable Finder

Electronic Wire Catalog has chart entitled "Cable Finder" referencing conductors and shielding to trade numbers and catalog. By using color coding to separate the different shields, it is easy to find the exact cable required. Catalog describes 3 new instrumentation cables. Belden Mfg. Co., 415 S. Kilpatrick, Chicago 44, Ill.

Circle 441 on Inquiry Card

Printed-Circuit Connectors

Comprehensive 40-page printed-circuit connector catalog lists 210 contacts available with various terminations, including eyelet lug, solderless-wrap, taper tap and dip solder. Continental Connector Corp., 34-63 56th St., Woodside 77, N. Y.

Circle 442 on Inquiry Card

THUMBWHEEL SWITCHES

TABET U.S. Patent 2,841,660

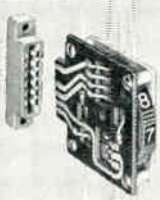
Binary & Digital. **Meet MIL-S-22710**

- **For Critical Reliability Applications.**
- **Available with internal lighting MIL-L-25467A.**

Permanent wafer type, Series TSD-P. Only ½" panel space needed per module. Also available in multi-deck series TM.

Removable wafer type, Series TSD-R. For continuous operation applications where interruptions must be held to an absolute minimum.

Permanent wafer type, Series TSB-P. Available in 8, 10, 12 or 16 positions, up to 36 switches per assembly.



Removable wafer type, Series TSB-R. For applications where maintenance time is valuable and rapid servicing a necessity.

CHICAGO DYNAMIC INDUSTRIES, Inc.

C·D·I PRECISION PRODUCTS DIVISION
1725 Diversey Blvd., Chicago 14, Illinois
Phone: WEllington 5-4600

Circle 78 on Inquiry Card

C·D·I ROTARY SWITCHES

TABET U.S. Patent 2,841,660

- **For Critical Reliability Applications. Meet MIL-S-22710**
- **Quick changing of programs, configurations, circuits.**
- **Maintenance problems completely eliminated by unique 5-second wafer replacement models.**

1¼" x 1½" Rotary Selector Switch, Series RS15. Manually (illustrated), motor or solenoid operated.

2½" x 2⅜" Rotary Selector Switch, Series RS21. Solenoid, manually or motor operated.

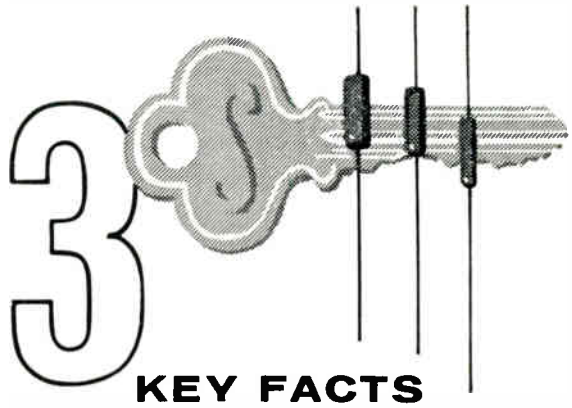
3" x 2⅞" Rotary Selector Switch, Series RS30. Manually (illustrated), solenoid or motor operated.

4" x 4" Rotary Selector Switch, Series RS40. Motor, manually or solenoid operated.

CHICAGO DYNAMIC INDUSTRIES, Inc.

C·D·I PRECISION PRODUCTS DIVISION
1725 Diversey Blvd., Chicago 14, Illinois
Phone: WEllington 5-4600

Circle 79 on Inquiry Card



3 KEY FACTS TO CONSIDER WHEN YOU SPECIFY POWER RESISTORS

FACT 1

PRODUCT SPECIALIZATION

Only Sage Electronics offers 14 years of highly specialized experience in the design, test and application of sophisticated power resistors.

FACT 2

UNSURPASSED PERFORMANCE

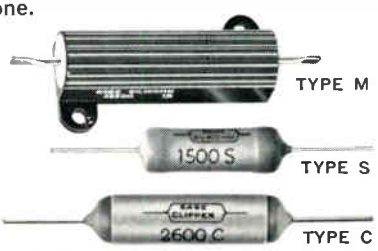
By concentrating exclusively on miniature precision wirewound designs Sage provides the broadest variety of features available from any source.

- 20 axial lead styles; 3 chassis mount styles; ½ to 50 watts
- tolerance and stability as close as .05%
- T.C. 20 ppm/°C
- 1000 volt rms body insulation
- low values not available in other resistors (specials to .01Ω)
- characteristic G or V wattage rating; to 275°C or 350°C
- power load life stability < .5%/1000 hours
- weldable leads when specified
- non-inductive winding when specified
- exceed MIL-R-26C and MIL-R-18546C as well as MIL-R-93C (appropriately derated)

FACT 3

RELIABILITY

Systems contractors such as those supporting Polaris, Titan, Atlas and Minuteman have found Sage product reliability second to none.



For full technical details request catalog R-62

SAGE

SAGE ELECTRONICS CORP.
Country Club Road • East Rochester, N. Y.

Circle 80 on Inquiry Card

NEW TECH DATA

for Engineers.

Mylar Capacitors

This data sheet covers complete specs. for new thin-film metallized mylar capacitors. They are in hermetically sealed rectangular and round tubulars, wrap-and-fill and epoxy-case styles. Electron Products, 1960 Walker Ave., Monrovia, Calif.

Circle 453 on Inquiry Card

Miniature Precision Resistors

Two miniature precision resistors, which feature wirewound stability and tolerances up to 0.05%, are available from International Resistance Co., Boone, N. C. Designated AS-½ and AS-1, they dissipate ½w and 1w respectively at ambient temps. of 125°C.

Circle 454 on Inquiry Card

Miniature Bearings

A 16-page illustrated catalog describes standard RMB miniature bearings. Catalog 5E63 covers radial, angular contact, pivot, miniature roller, and special type bearings. Dimensional data and drawings, including size drawings, are given. Landis & Gyr, Inc., 45 W. 45th St., New York 36, N. Y.

Circle 428 on Inquiry Card

Flangeless Rectifiers

New bulletin, entitled "Double Diffused Avalanche Regulated Silicon Flangeless Rectifiers," covers products with operating characteristics up to 1a., 1,000v. It contains mechanical outlines, plus performance and environmental features. The 1a. flangeless rectifier, available in a general-purpose and in a high-temp. series, has all ratings and characteristics outlined in chart form. Atlantic Semiconductor, Inc., 905 Mattison Ave., Asbury Park, N. J.

Circle 429 on Inquiry Card

Power Supplies

A 16-page illustrated catalog covers standard power supplies, insulation testers and power packs. Catalog gives data on 51 standard high-voltage power supplies ranging from 1kv. to 1,000kv., 9 highly regulated high-voltage dc power supplies, dc, ac and ac/dc insulation testers. Power packs described range from 2 to 150kv. Kilovolt Corp., 238 High St., Hackensack, N. J.

Circle 430 on Inquiry Card

Electrical Integrators

A new 4-page brochure, Technical Data 90A, describes Models 921 and 1201 electrical integrators. Data brochure contains specs., schematics and drawings of basic circuits and uses. Uses shown include strain gauge belt weighing system, gas chromatograph integration, and nuclear dosemeter integrator. Sales Dept., Aeromag, Inc., 15350 Telegraph Rd., Detroit 39, Mich.

Circle 431 on Inquiry Card

RFI/EMI Brochure

This brochure discusses r-f and electromagnetic interference problems in designing and operating electronic and microwave systems. It is divided into the following major sections: Control Programs, Measurements and Corrections, R&D, and RFI/EMI Components. Brochure lists firm's accomplishments and capabilities in the RFI/EMI field. Genistron, Inc., 6320 W. Arizona Circle, Los Angeles, Calif.

Circle 432 on Inquiry Card

NEW TECH DATA

Crystal Filters

A 12-page brochure entitled "What is an IL.o Crystal Filter" describes new class of crystal filters designed by insertion loss, or modern synthesis, methods. Brochure lists differences in characteristics between insertion loss and image parameter filters. List of stock filters is attached. Midland Mfg. Co., 3155 Fiberglas Rd., Kansas City 15, Kans.

Circle 434 on Inquiry Card

Cost Control

"Value Control Design Guide" will help determine lowest cost to reliably accomplish basic and secondary functions. Information is in 3 sections: Classification of Shapes, Comparison of Manufacturing Processes, and Description of Manufacturing Processes. Value Analysis, Inc., 141 N. Broadway, Schenectady 5, N. Y.

Circle 435 on Inquiry Card

AC-DC Power Supplies

Illustrated 23-page catalog, in color, describes solid-state dc power supplies, ac invertrons and plug-in oscillators. Electrical and mechanical specs. are listed. Available to engineers from Behlman-Invar Electronics Corp., 1723 Cloverfield Blvd., Santa Monica, Calif.

Circle 436 on Inquiry Card

NEW TECH DATA

Power Modules

An illustrated, 34-page catalog describing four lines of regulated ac-dc solid-state power modules is available from Technipower, Inc., a Benrus subsidiary, 18 Marshall St., S. Norwalk, Conn. Modules are designed primarily as system components, but can also be supplied in rack mounts for general purpose use in laboratories and production tests.

Circle 418 on Inquiry Card

Capacitor Bulletin

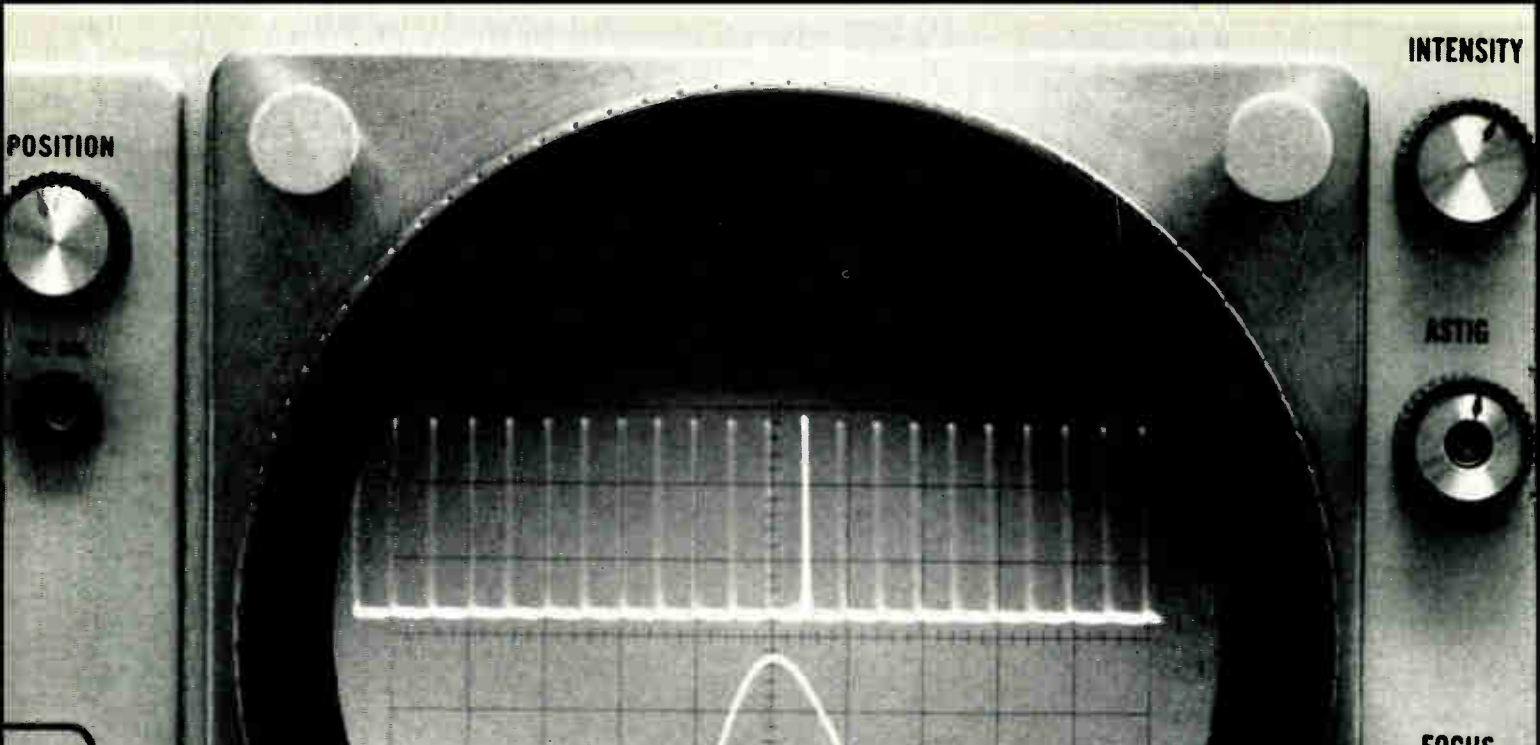
Data on electrical and mechanical design of energy discharge capacitors is included in Bulletin 2610. Graphs, tables, and definitions are used to clarify capacitor parameters. Catalog listings are given. Sangamo Electric Co., Springfield, Ill.

Circle 419 on Inquiry Card

Crystal Catalog

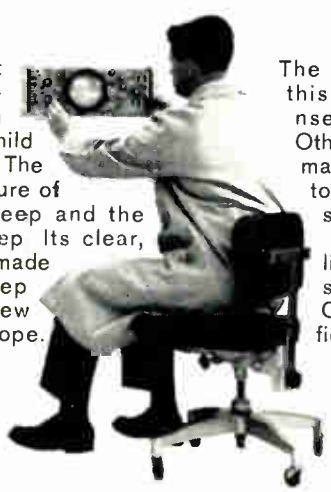
Covered in this catalog are over 11,000 standard crystals, 360 oscillators, 46 freq. standards and 56 filters. For standard crystal units, the purchaser need specify only code number and nominal freq.; for military types, only Mil type number and nominal freq. The standardized crystals range in center freq. from 400cps to 1mc. Hill Electronics, Inc., Mechanicsburg, Pa.

Circle 420 on Inquiry Card



What's the delay here?

The delay here is what happened to a 10-nano-second radar pulse on its way through a Fairchild Type 767H Oscilloscope. The trace is a multiple exposure of a strobed delaying sweep and the magnified delayed sweep. Its clear, "locked in" display was made with the Delaying Sweep Plug-In unit of this new Fairchild solid state scope.



The 50 mc Plug-In used to make this trace has a rise time of 7.5 nsec, sensitivity of 50 mv/cm. Other available plug-ins provide many other capabilities – enough to replace half a dozen or more special purpose scopes.

Investigate the new Fairchild line before you invest in another scope. Write for our Instruments Catalog. Better yet, call in a field sales engineer (offices in 39 principal cities) for a demonstration. Fairchild Scientific Instruments, 750 Bloomfield Avenue, Clifton, N. J.

FAIRCHILD

DU MONT LABORATORIES

DIVISIONS OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

750 BLOOMFIELD AVENUE CLIFTON, NEW JERSEY

Circle 90 on Inquiry Card

SECTION E

MEASUREMENT & TEST

Amplitudes of several thousandths of an inch are being achieved, with accelerations up to 100,000 g. Among the newer developments are transducers using a depletion layer in a piezoelectric semiconductor as a resonant element. The thickness of these layers is well below one micron and new types of transducers may well become possible.

WHERE ULTRASONIC TRANSDUCERS ARE TODAY

As early as 1847 Joule observed that certain ferromagnetic materials changed their dimensions in a magnetic field. In 1880 the Curie brothers discovered that some crystals like quartz, tourmaline, etc., would produce an electrical charge, when squeezed. These effects, termed magnetostriction and piezoelectricity, as well as their inversions, piezomagnetism and electrostriction remained laboratory curiosities until the first World War, when it was realized that sound projectors and hydrophones could be made, using these principles. Thus a military application, submarine detection, caused the ultrasonic transducer to be born.

Sonics (a word coined by Hueter and Bolt as the title of a well-known textbook) comprises the generation and detection of vibration or elastic waves, their properties of propagation and their interaction with solid or fluid matter. Today uses of elastic waves range from subcycle frequencies (infrasonics) used in geological seismic prospecting through the audible range (acoustics) up to, say 15 kc. From there on up, ultrasonics has pushed the frequency limit into the gc range with many applications.

In 1957 a German handbook[1] listed over 7,000 references on ultrasonics, with applications ranging from nondestructive testing to submarine detection systems, from TV-image projectors to liquid level sensors, from medical therapy to ultrasonic cleaners. Whether a device modulates a light beam or prevents deposit formation in steam boilers, it always contains one component—the ultrasonic transducer, the device converting electrical r-f power into vibratory mechanical energy or vice versa.

Transducer Materials Today

An ideal transducer material should combine the following properties:

1. High piezoelectric or piezomagnetic constant
2. High electromechanical coupling factor
3. High electrical quality factor
4. High mechanical quality factor
5. Maximum time and environmental stability of properties
6. High tensile and compressive strength
7. Optimal economies and fabricability

Practical materials usually fall

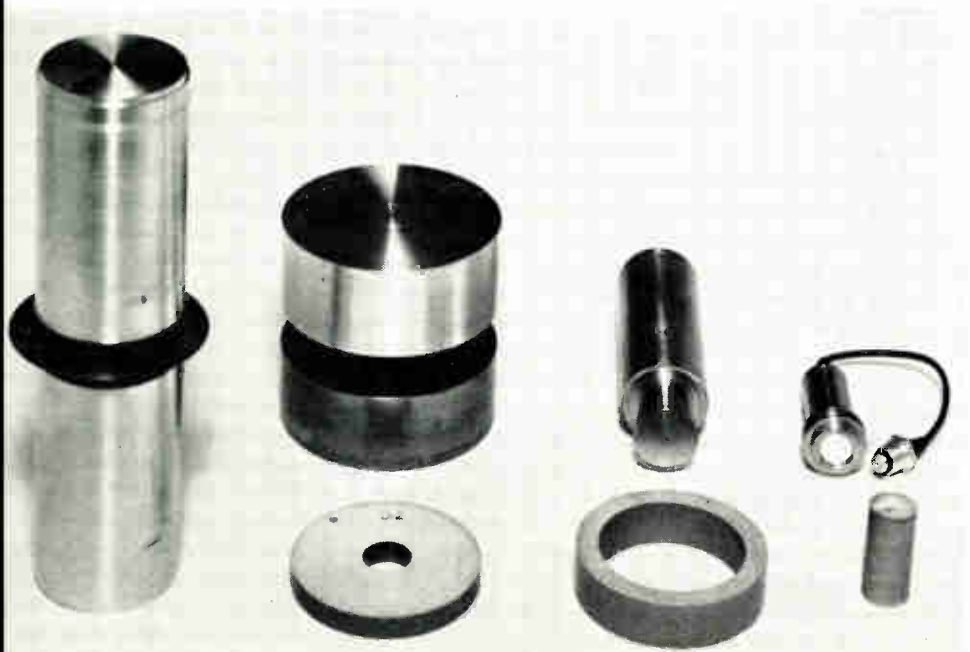


Fig. 1: Several types of transducers are shown along with special items that are used in conjunction with some transducers for vibration pick-up or sonar.

Dr. ERHARD SITTIG
Senior Physicist
Durasonics
Div. of Dura-Bond Bearing Co.
P.O. Box 11085
Palo Alto, Calif.

short in one or more of these listings and must be selected by the application.

Tables 1 and 2 list some data of materials representative of our general classes.[2]

Piezoelectric Single Crystals

Several hundred substances with usable properties are known, but only a few are of importance. They are available as natural or artificially grown crystals from which plates of suitable orientation have to be cut or ground. Available shapes are, therefore, limited. Crystals combine high Q and high time stability with a low to moderate coupling factor and low permittivity. Their use as vibrators is only warranted at high frequencies where other materials are too lossy, and where they do not have to be driven with high voltages.

Quartz has low losses and a high maximum usable operating temperature. This makes it the choice for high stability resonators, vibrators at high frequencies (several thousand megacycles have been reached) or high environmental temperatures. At lower frequencies (< 1 MC) and for high power vibrators, ferroelectric ceramics are much cheaper.

Ferroelectric Electrostrictive Ceramics

Arbitrary shapes may be made from these materials by standard ceramic methods. They are rendered piezoelectric by a polarizing heat treatment in an electrical field. The remanent polarization can be lost by electrical overloading or overheating. Mechanical and dielectric losses are high to moderate and amplitude dependent, but coupling factor and permittivity are very high. Transducers made from these materials may be driven by low voltages. As receivers, they produce voltages from a low source impedance.

Until recently barium titanate compositions were the most used. Now they are being superseded by newer compositions based on lead zirconate. These offer higher usable operating temperatures and, therefore, better power handling. Their coupling factors are indeed high enough to contemplate their applications as static energy converters, e.g., in automotive ignation systems, photographic flash bulb triggers, etc.

Magnetostrictive Metals

This group comprises nickel and alloys containing nickel, iron, and aluminum. Being conductors, they have to be used as thin walled tubes, strips, laminated stacks or scrolls, to avoid excessive eddy current losses, particularly at higher frequencies. Due to internal friction such structures exhibit high losses,

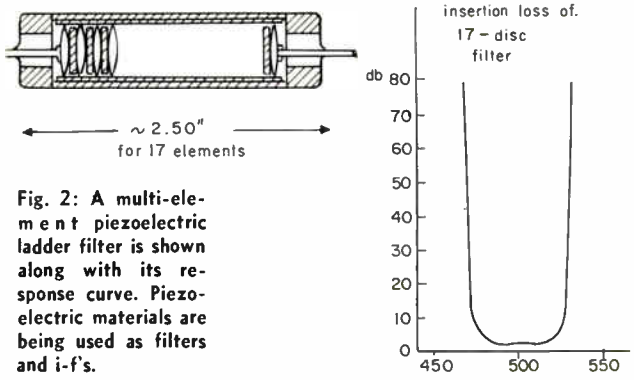


Fig. 2: A multi-element piezoelectric ladder filter is shown along with its response curve. Piezoelectric materials are being used as filters and i-f's.

although the basic metal has a mechanical Q of about 10,000. Because of low coercivity, power vibrators must be polarized by dc-current or permanent magnets to obtain a linear relation between driving field and deformation.

Their inherent ruggedness makes them well suited for high power applications in spite of their low efficiency. Eddy current and hysteresis losses restrict their application to frequencies below 50 KC.

These are nonconducting ceramics and need not be laminated. They combine a moderate coupling factor with a high Q and high usable temperature. Therefore, they can share in most applications with the ferroelectric ceramics, particularly where their higher temperature limit makes up for their somewhat higher price and the necessity for coil windings rather than simple plate electrodes.

Applications of Ultrasonic Transducers

Ultrasonic transducers find their main use in the areas listed below.

Electrical circuit components: A transducer exhibits certain filter characteristics. Unloaded, it constitutes a 2-terminal network having an impedance minimum and maximum near its mechanical resonance frequency. It may also be used as an "adaptor" to connect mechanical structures to electrical circuits. These may have resonating properties. A much higher Q is available from mechanical resonators than from equivalent electrical networks consisting of capacitors and inductors. At frequencies below several MC spectacular space and weight savings may be had from, say, electromechanical i-f filters or multi-element ladder filters.

This also is true for sonic delay lines. These use the fact that the sound velocity is much smaller than the light velocity. By means of suitable transducers an electrical signal is converted into a sonic one, and reconverted into an electrical one after having traveled through a liquid or solid delay medium. Since such media typically produce delays of 0.2 to 3 microsec. per millimeter path length, fixed or con-

Due to the number of connections which must be made, testing complex systems is both costly and time consuming. This situation can be rectified by using the methods described in this article. Sensors are used which respond to external fields — found in electronic components which have been energized. Optical fibers are used to transmit the data.

TESTING WITHOUT DIRECT ELECTRICAL CONNECTIONS

In electronic systems which contain thousands of components failure should be expected which will impair system operation. Much has been said and done to reduce the number of failures. Even so, failures still exist, creating a severe problem. The larger the number of active components, the more severe the problem. Often the time consumed for testing greatly reduces the time left for useful operation. In a complex system this testing sometimes becomes a full time effort. Thus, the elusive goal of 100% reliability often is replaced by the nonelusive goal of 100% testing. To reduce the chance of this happening, test and repair time must be kept at a minimum.

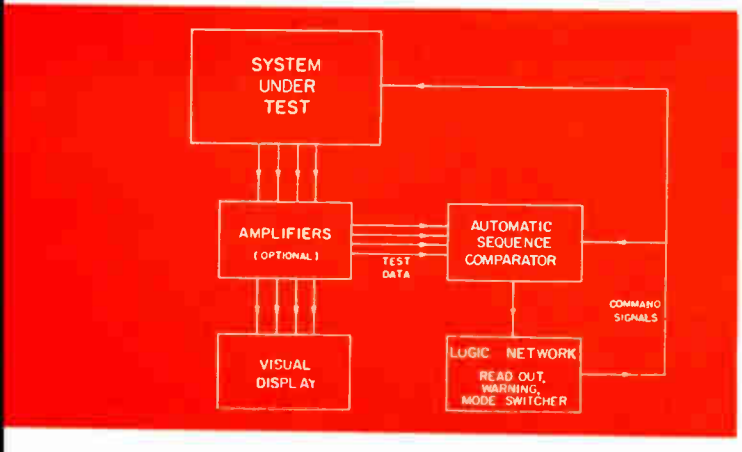
Automatic Test Equipment

Automatic testing methods have been introduced in recent years. First there was the stepping-switch programmed, internally-wired, programmer comparator. This method decreased test time but was inflexible with regard to changes in the system subject to test. To avoid this, and to make more flexible the programming of test stimuli and the measurement of response, the punched-tape sequentially programmed device was introduced to replace the prewired stepping switch. This method of tape programming has improved the situation in certain cases but these devices are large and complex; and programming is difficult and costly. Now being introduced is the computer type of device using magnetic and delay line storage, rapid access and simultaneous test. This type of device increases the complexity of both the test equipment and the programming. The extent to which these methods have been used for maintenance purposes is evident from the literature.

These methods are useful in many applications, but they don't provide the simplicity of test that is desired in operational systems. The programmer-comparator, for example, needs stimuli generators and "adapter carts" before it can be connected to the equipment under test. This assembly of test equipment is complicated since a sequentially operated digital machine process is used to control and measure analog electrical quantities. Often, automation is relied upon to supply test data even though the underlying basic manual measurement methods are unknown. Also, few systems provide, in suitable form and number, the test points which are desired for this test arrangement. Thus, the areas have been limited in which this type of test equipment has proved successful.

Where the above types of test equipment have not proved effective is in the test of operational systems.

Fig. 1: Continuous monitoring of the system under test provides a visual display for detection of intermittent faults and for failure prediction based upon gradual component degradation.



By DAVID M. GOODMAN
Director of Project SETE
Research Div., College of Engineering
New York University
New York, N.Y.

In these systems time needed to connect external stimuli and measurement devices often discourages the user. Equally important, test logic that is needed to trouble-shoot from the outside of a system is hard to work out and set forth. Programming needed to carry out a suitable test sequence is a major consideration. In effect, it is necessary to trouble-shoot the entire system in advance. This is done without benefit of the practical experience normally obtained on a given system. Then, to carry out the requisite tests much external equipment is needed which is complicated and costly. Finally, the logic, programming and external equipment must be reviewed whenever a change is made in the system under test. Net result is that usefulness of this method is doubted. It should have been anticipated that the external stimuli generation and the control and measurement sequence are not needed whenever these means are already contained in the equipment under test. By

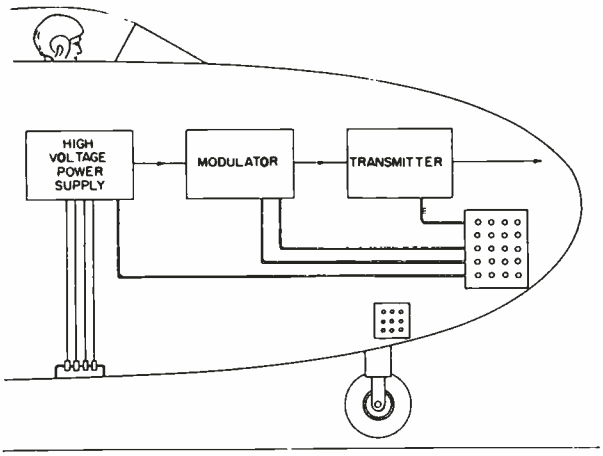


Fig. 2: Representation of three optical test point matrixes which provide test data at the outer surfaces of an aircraft.

using these self-contained means for test purposes as well as for their main purpose, large savings can be achieved. Much confusion has arisen, nevertheless, at this time from all-too-frequent use of the external programmer-comparator for testing of operational systems.

Continuous Monitoring

The disadvantages and uncertainties that exist in the above procedures can be overcome. This can be done by providing many sensors that use long-life, lightweight, and reliable probes made of magnetic materials, semi-conductors and phosphors, and which are used to continuously monitor the components in a system. Simple and reliable means are thus provided which respond to an action of an operative component so that an electrical signal, or preferably electromagnetic radiation, is generated which shows the state of energization of the component. When the electromagnetic radiation is transmitted to provide a test signal, the method of transmission for reasonable distances is via thin, rugged, flexible optical fibers.

Since the sensors respond to external fields, it is not necessary to make circuit connections in the prime equipment, and retrofit of existing systems becomes practical. This method can also be applied to subminiature and microminiature building block assemblies, and to thin film and solid-state assemblies. To trouble-shoot these assemblies a single test set suffices. It is made of an optical probe, a detector, an amplifier, and an oscilloscope connected in tandem. Finally, by combining the foregoing features, large and complex systems can be tested so that the users will have a current and continuously updated display describing the complete status of the system.

To achieve these ends, use is made of the electric or magnetic field that electronic components have when energized. Often this field is intense and external of the component which makes it easy to measure. The field may be static, it may be alternating, or it may comprise electromagnetic radiation. These fields may be detected in many ways. For example, phosphors have the ability to emit light when they are excited by particle or by electromagnetic radiation. Electroluminescent materials and other semiconductors also have the ability to detect the presence of electric and magnetic fields. By placing sensors made of materials of this type at strategic positions, it is possible to trouble-shoot a complex system almost instantaneously. As noted this can be done without making direct electrical connections into the system. Optical fibers are then used to transmit "light" signals representative of the level of energization of the major units in a system under test to where these signals are examined. Checking of the "light" signals is done rapidly and need only locate failure to a replaceable unit or assembly. When desirable, however, the logic of test may be made to pin-point the component or subassembly which has failed. Continuous measurement of the external fields associated with the components within a system, and data transmission by rugged optical fibers, contains elements of simplicity and reliability which have been lacking in prior test arrangements.

The Display and Computer

A hypothetical system under test, in Fig. 1, has many output signal test leads. Test signals contained on these leads are derived from various points within the system. They contain information that shows

the level of energization of many components within the system. Amplifiers are used only when necessary in order to amplify the test signals. Although these signals may be electrical in nature, preferably they consist of electromagnetic radiation in the range from infrared (IR) to ultra-violet (UV) making it possible for them to be transmitted by optical fibers. Signals are split into two parts, with a first set going to a visual display device and a second set going to an automatic sequence-comparator. The visual display is for the benefit of an operator; the sequence-comparator is used for unattended or automatic operation, and for convenient transmission of the test data.

Output test signals which carry visible radiation are arranged in matrix form to provide the display. The visible signals are presented to the operator in a symmetrical pattern so that any change from normality may be noticed rapidly. When the leads carry electrical signals they may be converted to light for display purposes. Signals from the system are also fed into sequence-comparator so that rapid automatic comparison can be made. Signals into the comparator may be normalized so that a single reference may suffice for comparison purposes. Alternatively, a

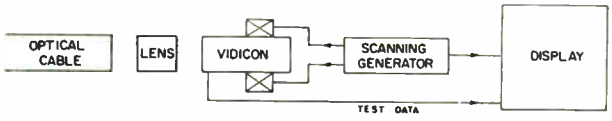


Fig. 3: Closed-circuit television chain for transmission and display of the test data which is provided by the optical cable.

number of different reference signals may be provided. Comparison of the input signals to the reference signal may be sequential, or parallel, or a combination thereof depending upon the system and purpose of test. Departures from normal system operation are detected and suitable corrective action is programmed. For example, when drastic failure is detected the system may revert to an alternate mode of operation. Under these circumstances the command signals to the system also instruct the sequence-comparator to make changes in the test sequence. Desirability of using an alternate mode of operation in this manner depends on system design and the operational needs placed on it. This alternate mode may or may not constitute a degraded mode of operation. Careful consideration of the intended method of operation of the system will dictate the choices available to the equipment designer. Logic networks which are used can be thought of as the computer section of this test system.

Sensors and Transmitters

Some of the test signals are provided by phosphor sensors. These phosphors are long lived and need no electrical connection for their operation. They are merely coated on the optical fibers. This coating provides light energy when excited by UV light or X-rays or by particle radiation. By means of internal reflections the light rays are transmitted for a long distance along the fiber.

Optical fibers may be routed and cabled in a manner akin to electrical wiring. At the termination, junction box, or test point the optical signal may be observed by a technician. Also, since these fibers can be made thin, can be flat or ribbon-like, and since they are chemically inert in most cases, they can be interspersed with assemblies having a high packing density. The analogy with electrical wiring continues since a series of optical test points can be provided in a module much like an electrical connector. Possibilities in this regard are endless.

A Radar Transmitter

In Fig. 2 a typical chain of high-power electronic assemblies is outlined by a power supply, a modulator, and a transmitter such as may be used in an airborne radar set. Each of these packages is sensed by a different phosphor which may be inside or outside the package. During normal operation a certain level of radiation, often in the form of X-rays, will impinge upon each of the phosphors. This radiation will be converted to light by the phosphor. This light will be transmitted through the optical light pipes or fibers and the brightness will be proportional to the radiation intensity. In an aircraft environment the attenuation in the optical fiber will be kept low due to the short cable runs.

Consider the situation where the transmitter contains a klystron amplifier designed to operate at 60kv. with a power output of 1Mw, a pulse width of 0.1μsec., and a duty cycle of 0.001. One sensor monitors average X-ray activity while a second monitors peak X-ray activity. For the first sensor, a phosphor is chosen with a decay time which exceeds 1 msec. so that the X-ray averaging process takes place in the phosphor. For the second sensor, a phosphor is chosen with a decay time which is much less than 0.1 sec. so that the shape of the output pulse may be examined. Many phosphors or scintillators are available which can be used. They are listed and described in standard texts. More recently introduced are the plastic scintillators which offer high conversion effi-

ciency, have a large dynamic range, and are unlimited in size and physical shape. They have decay times as short as 5 x 10^{-9} sec., are rugged, easily machined, and have a long shelf life. Also, the optical fiber itself may comprise the scintillator.

Exact location of these phosphor sensors is not critical since they are small in size, need no electrical connections; and are easily shielded from undesirable radiation. Spatial or directive filtering may be obtained by physical placement, and by surrounding the sensor with simple collimating devices. Wavelength or frequency filtering may be obtained by coating the phosphors to enhance the transmission of particular radiations and to attenuate others. Since the sensors are small and the light pipes flexible, a large number of detectors can be used simultaneously making it possible to monitor each major component within a high voltage assembly. The various test signals can be routed so that each fiber of the cable thus formed carries a signal representative of the level of energization of a different component. These fibers are brought out to a panel in the form of an optical termination where the operator may make observations or measurements. The panel may conform to or be contiguous with the flush surface of the aircraft.

Many such panels may be provided, each supplying test data from a different section of electronics within the aircraft. These panels are best located on the aircraft surface so that tests on each panel can be made simultaneously and independently, a most important consideration. Further, since space often is at a premium it is possible to arrange these panels so that the test signals may be transmitted to a remote location. This may be done for short distances via optical cables, or for greater distances by using optical transmission of the data to a receiving device such as an image-orthican or a vidicon or to a coherent light receiver. Thus, it is possible to speed up the test procedures by having a number of optical test panels, and the testing may be done at a remote location without undue concern for electrical interference and without being subject to electronic countermeasures.

Use of TV Techniques

One method of transmitting and displaying the optical test data is shown in Fig. 3. The optical cable has outside dimensions of 1 x 1 in. Individual fibers contained therein have a diameter of 0.033 in. so that an array, or matrix, is formed made of 30 x 30 optical fibers, or 900 test leads. The optical cable is coupled to a vidicon via a conventional lens, a flat Fresnel lens, or a short optical fiber section. Also, the cable can be placed directly against the vidicon face. The 900 signals are stored on the target within the vidicon on a target which is about 1^2 in. Stored signals are released when the electron beam of the vidicon scans the target. A scaning generator, a deflection assembly, and a display device complete a closed circuit TV chain. The display is arranged to reproduce the 30 x 30 matrix of test points. For a normal system the 900 points cast a uniform pattern. For an abnormal system with a single fault,

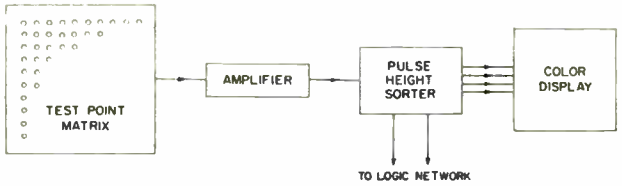


Fig. 4: The pulse height sorter receives the data derived from scanning the test point matrix and also furnishes signals both for the visual color display and for the logic networks.

one point on the matrix will differ from the rest. This point will show on the display. Thus, a maintenance tool is introduced which uses methods of the TV industry. The test data, as well as the analysis thereof, can be collected and displayed at a rapid rate. The data can be viewed directly, transmitted to remote locations, stored and photographed.

To illustrate this point with another example, the target screen of the vidicon in Fig. 4 is illuminated by an optical cable with a 10 x 10 matrix. Using TV scanning practice of 525 lines and 62.5μsec./line, it takes only 0.033 sec to trace out a complete raster. This means that the 100 points of test data are rescanned 30 times/sec. Pulses thus derived are amplified and are sorted so that signals of normal amplitude are displayed in white on a CRT. Signals above a certain tolerance are displayed in red. Signals below this are displayed in green. This color coding assists the observer in interpreting the display. Intermittent faults, for example, which ordinarily are most difficult to recognize and analyze will show up as a red and green flicker in a normally white test point.

No doubt the reader can imagine many variations of the foregoing test setup. Two such variations merit consideration. First: instead of, or in addition to, relaying the data to a remote location these data can be displayed on a CRT already contained in the system under test. A weather radar, for example,

can be time shared to present both cloud formation and the test matrix. Second: storage features of the vidicon, or of the display tube, can be used effectively for the test of systems which are energized only for a short period of time. In these cases, the data is obtained during the brief interval of system energization. The data is stored and the analysis continues after the system is de-energized.

Status Display

Another form of a central display arrangement is shown in Fig. 5. Here a test or status display is provided by optical fibers to yield an output for viewing. The display is arranged to match colors, intensities, flicker rates, etc., as is best decided by a study of the entire system from a human-engineering viewpoint. In this case, however, a test may be made of individual wave shapes. An oscilloscope is provided for this purpose. For each sensing position, a detector is used with response time and decay characteristics suitably matched to the purpose of measurement. For example, high-speed phosphors may be used to transmit video pulses in the microsecond range. They are suitable also for transmitting other signals provided the frequency of the signals is not excessive. Phosphors with a slower decay may be

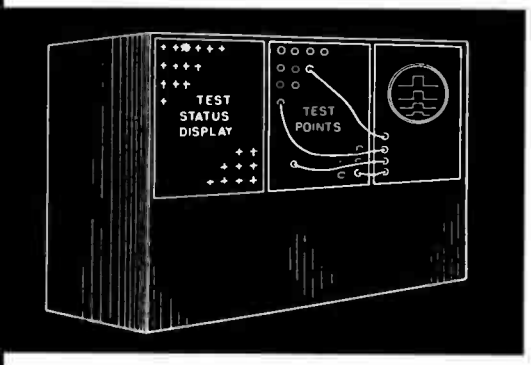


Fig. 5: Central monitoring and status display. An oscilloscope is provided for analyzing a plurality of individual waveshapes.

used to average sinusoids, or pulses, and, therefore, may respond to the envelope thereof. Following considerations of this nature, the test point panel is set up so that the wave shapes of signals may be selected for viewing on the scope. The test point section may be composed of both electrical and optical test points. Waveshape measurements of signals at the electrical test points are made conventionally. The description of Fig. 6 will describe the use of the optical test points for waveshape measurements. It should be appreciated, however, that even without making waveshape measurements, the central monitoring position provides a complete and continuously updated display which gives the operator a rapid view of the status of the entire system. He can determine readiness of the system at a glance.

General Purpose Test Set

In Fig. 6, the optical cable provides a matrix of test points. The sealed unit also provides a matrix of

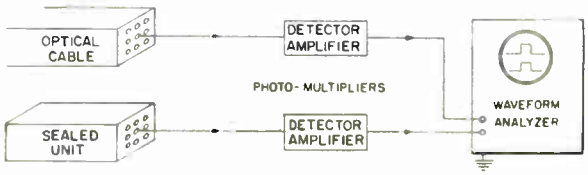


Fig. 6: Flexible optical probes are used to pick up individual test signals in a matrix. These signals are detected and amplified in the photomultipliers for presentation on an oscilloscope.

optical test points. Signals are present at these points which reveal the different levels of component energization. The sealed unit may represent an assembly which is hermetically or vacuum sealed, or it may represent a micromodule or other subminiature circuit. The flexibility, chemical stability, and thinness of the optical fibers allow them to be packaged in many ways. In any event the optical signals represent instantaneous energy levels in some cases. In other instances the optical signals represent time averaged values of energization. To examine the waveshapes of these signals two optical probes are provided. These probes, akin to electrical test prods, are flexible shielded optical fibers and have an exposed optical contact area which is to be positioned against the various test points. The data thus picked up are transmitted along the fiber to detector-amplifiers which provide an electrical output corresponding to the optical signals. These electrical signals are portrayed on the scope. Advantages of this arrangement are numerous. The atmosphere, or lack of it, surrounding the sealed unit will not interfere with the measurements. The optical signals are easier to handle than their electrical counterpart from the point of view of voltage breakdown, electrical interference and countermeasure, and are safer to handle in a hazardous environment. More important though, this arrangement of basic elements provides a versatile wide-band test combination. The optical fibers have an almost unlimited bandwidth. The plastic phosphors are very fast. The detector-amplifier, shown as a photomultiplier, has a wide bandwidth. Suitable scopes are readily available and for the few occasions where these might be inadequate a sampling attachment may be used. Thus, without loading any of the circuits, measurements from dc to 50 MC can be made with a single instrument, and hundreds of optical test points which may be provided in a complex system may be diagnosed.

(continued on bottom of page E14)

Fundamental to all technological progress is the ability to make precise, accurate measurements. This in turn depends on the availability of accurate stable standards. Here is a quick discourse on the current state of electronic measurement standards.

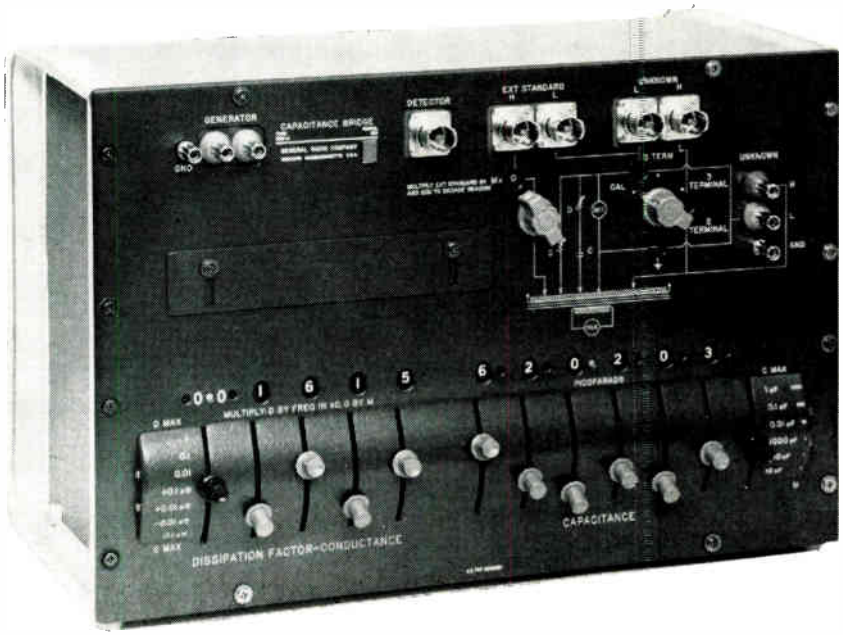
ELECTRONIC MEASUREMENT STANDARDS

To try to discuss the complete state-of-the-art in electromagnetic measurements and standards in a few thousand words would be quite futile, as is well illustrated by the IRE Transactions on Instrumentation, Dec. 1962. This volume consists of the papers given at the International Conference on Precision Electromagnetic Measurements in August 1962. It thus represents some of the highlights of recent advances in the "electronic" measurements art. Even so, the 300-odd pages and ¼ of a million words do not even touch on vast areas of the modern technology. In particular, they give no clue to the enormous outpouring of commercial instruments for the measurement of every imaginable electrical and physical quantity. These comments merely touch on a few highlights of the present and recent art.—I.G.E.

OF ALL BASIC PARAMETERS used in science and engineering, frequency continues to be the one that can be measured to the greatest precision and accuracy (see Fig. 1). So fast, in fact, have improvements been made in stability of frequency standards, that the very definition of frequency needs modification. Frequency was originally defined by international agreement as the reciprocal of time, which in turn was based on astronomical observations. But today, modern molecular oscillators are better timekeepers than the astronomical movements. International intercomparisons of frequency and time have in fact been carried out since 1959 in terms of an atomic time scale based on an atomic cesium resonance. Although the fundamental unit of time has been defined since 1956 in terms of the tropical year 1900, it now seems likely that a new definition of the second, based on some selected atomic transition, will be adopted at the 1966 General Conference on Weights and Measures. Such action would "formally recognize the situation that already exists, namely, that atomic clocks are used to provide the unit of time interval where very high precision is needed."[1]

Production of commercial equipment has followed closely behind the advanced development. Frequency standards based on cesium beams and on rubidium vapor are available, as are a host of good quartz

1. Markowitz W., "The Atomic Time Scale," IRE *Transactions on Instrumentation*, Volume I-11, Dec., 1962, p. 239.



The General Radio Type 1615-A capacitance bridge seen here offers capacitance measurement accuracy of 0.01% routine direct reading, with intercomparison to better than 1 ppm.

By IVAN G. EASTON
Vice-Pres. for Engineering
General Radio Co.
West Concord, Mass.

crystal oscillators. These provide the working standards of frequency, but need to be maintained in terms of the accepted standard. By use of standard frequency transmissions on VLF and of time signals on Loran C, a standards lab. anywhere in the country can find the frequency of local standard oscillators to an accuracy of a few parts in 10^{11}.

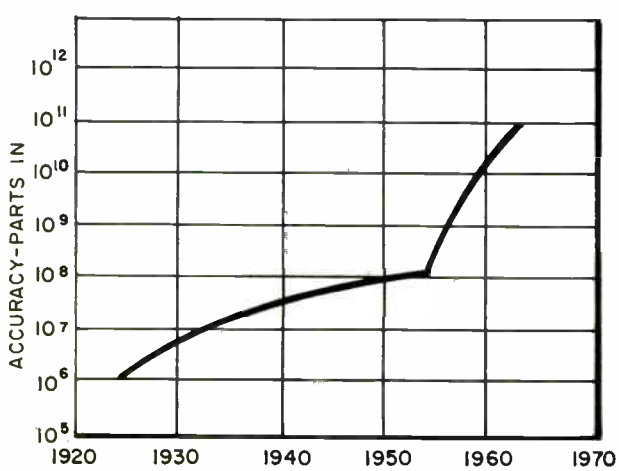
Techniques have long been known and used for subdividing the precisely known frequency of a quartz oscillator by powers of 10 or successively by various integral numbers. Recently there has been intensive development of synthesis techniques for generating any arbitrary frequency from a single standard frequency. Instruments based on such methods have become available, and they may well have the same impact on the art of frequency generation that the electronic counter did on the art of frequency measurement.

Capacitance

In the field of capacitance standards and measurements, progress has been comparable to the strides made in the field of frequency and time. The advances made are based on 1. the discovery of a fundamental new theorem in electrostatics and 2. a recognition of and the exploitation of the advantages of bridge circuits using inductively coupled ratio arms (popularly referred to as "transformer bridges").

The basic work for an order-of-magnitude improvement in the determination of the absolute unit of capacitance was contributed by Thompson and Lampard[2] and their co-workers, in Australia. In their search for an accurately computable capacitor, they recognized a form whose capacitance depends solely upon a single dimension of length. Referring to Fig. 2, the 3-terminal capacitance per unit of length between A and A′, with B-B′ connected to ground, is independent of the form, provided only that certain simple conditions of symmetry are met.

Fig. 1: The improvement in accuracy of the U. S. frequency standard over a period of 4 decades. The sharp break in slope was the result of introduction of atomic standards.



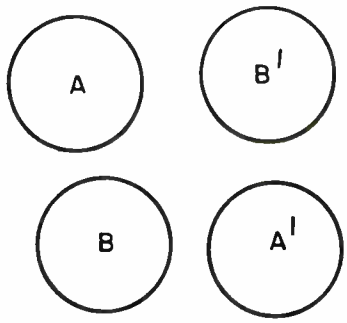


Fig. 2: A cylindrical capacitor with the cross - section shown is accurately computable since it depends solely on a single dimension.

Reference standards, based on this principle, have been built in several labs., and the pf. (10^{-12} farad) is now believed to be known to within a very few parts per million. Continuing work may soon lead to accuracy expressed in parts per 10 million.

The capacitors constructed on the new principle have a capacitance of less than a pf., but the transfer from this low value of reference standard upward to the μf. range is done with very little loss of accuracy using newly developed transformer bridges.

The transfer of capacitance values from the national standardizing labs. to "lower echelon" labs. and, in turn, to the production line can be done with remarkably little loss of accuracy with the newest bridges and standard capacitors. The "transformer bridge" shown in the photograph permits capacitance comparisons to better than 1.0 ppm and routine direct-reading measurements to 0.01%. Fixed, sealed, nitrogen-filled capacitors similar to those used in this bridge show promise of long-term stabilities of the order of 10 ppm.

Whereas a few years ago, the standards laboratory that could be confident of capacitance values to a few hundredths of 1.0% was doing well, accuracies in the order of 50 ppm are now possible.

Resistance

One of the oldest and perhaps most intensively cultivated of the electrical measurement arts is that of resistance. In this mature field, progress tends naturally to be slower, but recent years have seen intensive commercial development work on improved resistors, on highly refined ratio-sets, and on guarded bridges for high-resistance measurements.

On the frontiers of the art, the absolute value of the ohm has been redetermined by new methods. The

2. Thompson, A. M., and Lampard, D. G., *Nature*, Vol. 177, p. 888, May, 1956.

new computable capacitor described above has been the basis for a new evaluation in terms of fundamental units of length and time. The impedance of a capacitor (evaluated in terms of length) is calculated for a given frequency (time) and compared with a resistor. The value obtained in this way checks very well with older findings based on inductance and time, and the ohm is now known with confidence to better than 5 ppm. Available resistance standards are sufficiently stable that the ohm can be known in a well equipped lab. to within a few parts per million of the value maintained by the National Bureau of Standards.

Inductance

No great progress in inductance standards has come to my attention in recent years. Interest in and, presumably, need for better inductance standards and measurement methods do not appear to be very strong. Standard inductors that have been available for a number of years consistently demonstrate long-term stabilities of about 0.01%, and available bridges are more than adequate for intercomparison and maintenance purposes. Conversely, the standards are adequate for the maintenance of the accuracy of the bridges. In the advanced development area, research is under way to find a configuration whose inductance can be found simply and accurately from a single dimension in the manner of the Thompson-Lampard capacitor. As a matter of general scientific interest, if this can be done, it will be possible to determine the speed of light very accurately from the ratio of electrostatic to electromagnetic units. Some interest has developed in the use of commercially available decade ratio-transformers for the intercomparison (or measurement) of inductance, but the extent to which such methods may replace conventional bridge methods is not yet clear.

Voltage Ratio

A very significant development has been the growing use of the decade ratio-transformer. This device can subdivide an audio-frequency voltage with very high accuracy. One ppm (of the input voltage) is quite common, a few parts in 10 million less readily, and parts in 10^8 seem within the reach of most advanced techniques.

Voltage and Current

The saturated cell remains the preferred device for the unit of electromotive force. Highly refined and thoroughly understood after many years of use and development, such cells provide the standardizing lab. with a reference voltage known in the order of 10 ppm.

The Zener diode is coming into its own as a voltage reference in measuring instruments, but does not yet seem to threaten the "standard cell" as a primary reference.

Current-regulated power supplies have been developed to the point where they can be treated as standard current sources, with accuracies of at least a few hundredths of 1.0%. This is an interesting development, since current, being a transitory quantity, has not heretofore been considered as being transportable.

Techniques of transfer from dc to ac have been greatly improved, and ac current and voltage through at least the audio-frequency range can be found from the established dc values without major loss of accuracy.

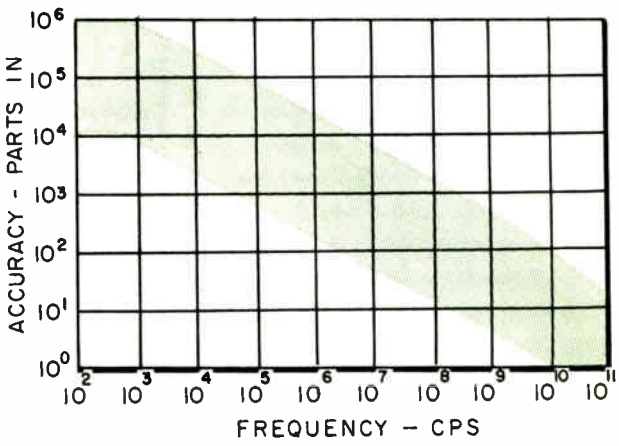
For the basic parameters of voltage, current, resistance, capacitance, inductance, and their ratios, which characterize electric-circuit performance at low frequencies, there has been developed a well integrated, highly consistent, and mutually compatible system of units, reproducible standards, and measurement techniques. Accuracies ranging from a few parts per million to a few hundred parts per million can now be maintained by a well equipped, conscientiously operated standards laboratory in these basic areas of electrical measurement.

Microwave Standards

At higher frequencies, as circuit dimensions become comparable to wavelength, the emphasis gradually shifts from circuit analysis to wave and field concepts, and the parameters of primary interest also

(*Continued on page* E14)

Fig. 3: The graph shows how precision in the measurement of most electrical parameters falls off with increasing frequency.



MEASUREMENT STANDARDS (Concluded)

shift. Voltage, current, inductance, and capacitance give way to characteristic impedance, attenuation, reflection coefficient, and phase shift, for example. Attainable accuracies vary considerably with frequency, but in general we are now dealing in terms of parts per thousand rather than parts per million.

The chart in Fig. 3 indicates the general nature of the degradation of accuracy of electrical measurement with frequency. To supplement this chart, the following examples will indicate the approximate state of the art as realizable in a competent laboratory with commercial equipment.

Microwave Power

In the microwave range of current interest one encounters power levels from microwatts to megawatts. Over the frequency range from a few thousand MC to about 30,000 MC, power levels from 100 μw. to 100 w. can be measured to within 1%. At higher and lower power levels, accuracy falls off sharply. Over the frequency range in which coaxial systems are used (roughly 1 MC to 10,000 MC), 1% accuracy can be achieved for power levels from 1 μw. to 1 kw.

Over the coaxial frequency range just mentioned, attentuation values from 0 to 60 db can be measured to less than 1%.

Voltage

The accuracy of voltage measurement in the range between a few tenths of a volt and a few hundred volts approaches 0.1% at frequencies in the tens of MC, falls to 1% or poorer in the hundreds of MC, and is not much better than 10% at a few thousand MC.

Attention is being directed by many labs. to the problems of improving measurement accuracy in the microwave region. The next few years will undoubtedly see significant improvement in many areas, but the erosion of accuracy at higher frequencies is probably fundamental. Very likely, accuracies at low frequencies will continue to improve and the general relationship between accuracy and frequency of measurement may remain almost as suggested in Fig. 3.

A REPRINT OF THIS ARTICLE CAN BE OBTAINED
by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

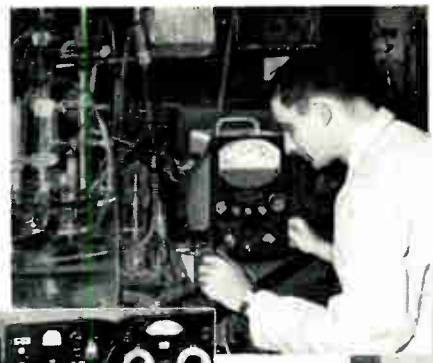
TESTING (Concluded)

Conclusions

At this point it is clear that a sizeable number and variety of sensors are needed for and serve as the basis of this new test method. For high-energy fields, the phosphor detectors are ideal and the examples were restricted to this type of sensor. It is noted, however, that low-energy detectors are available and that often the direct visible radiation, as from heater filaments and cathodes, and from corona, and from arcs in waveguides, etc., are useful in providing the optical test signals. Many radiation sources and sensors are now available, and more can be anticipated, that will respond to or be indicative of the level of energization of the components in an operative system. These sensors provide signals in the optical frequency range which are displayed and analyzed so that a complete picture is presented of the manner in which the system is behaving. By incorporating these sensing devices into the system, and its subassemblies, in the design stage it is almost a necessity that the system be properly instrumented. The function to be performed by the system, the operational environment, the logistic support plan, the predicted failure rates, the anticipated life expectancy of the components, the skill level of the operators and of the maintenance people, are considerations which will all have a bearing on the design of the system and the selection of sensing devices to be provided therein. Likewise, these considerations will determine the method of choice for the collection, analysis, and display of the test data.

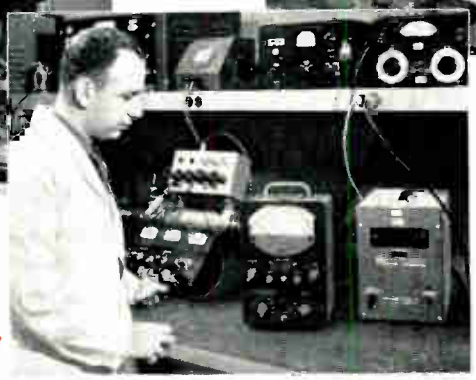
It is my belief that a major breakthrough will be achieved in the electronics art if the considerations of the above teachings are made mandatory in the design of new components and systems. The designer then will be forced to include in his equipment suitable test features and test points which have been so noticeably lacking. It will then be possible to test a complex system rapidly and reliably so that its operational status may be determined with a degree of certainty not now available.

The author appreciates the encouragement given to him by the entire Project SETE Steering Group to release the contents of the article. Also, special credit is extended to V. A. Parks, Bureau of Ships; A. R. Glorioso, Bureau of Weapons; H. Mulkey, Hq. USAF; and W. J. Schlotterbeck of the Electronic Systems Div., Bedford, Mass.

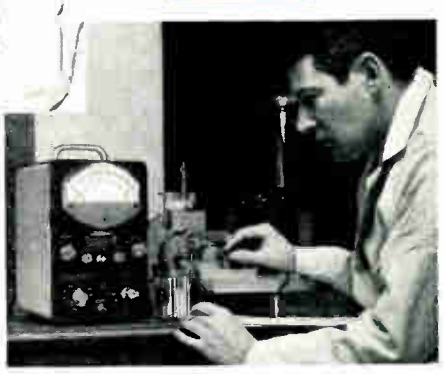


High precision corrosion studies at the Electric Storage Battery Company

Electrical leakage tests at Farnsworth Electronics



Ion-current measurements at Lockheed's Missile and Space Division



Measuring surface potentials of PN junctions on germanium crystal specimens at IBM

MILLIVOLTMETER 0.5 mv to 10v dc

MICRO-MICROAMMETER 0.005μμa to 1ma dc

MEGA-MEGOHMMETER 0.3 MΩ to 500 MMΩ

DC AMPLIFIER Current gain of 16×10^9

in ONE Instrument...

- ★ High Input Resistance — selectable from 10^4 to $10^{11}\Omega$ in 8 steps with an additional "∞" position of the order of $10^{14}\Omega$
- ★ True direct-coupled amplifier design — no choppers, reeds, or vibrators to wear out or go out of adjustment.
- ★ Constant low (9.1v) voltage across unknown, may be increased to 600v dc with external supply — no need for voltage-coefficient corrections when measuring high-resistances.
- ★ Reliable operation even under extreme humidity conditions
- ★ Output for 5-ma recorders

Type 1230-A
DC Amplifier and Electrometer
...$460 (In U.S.A.)

Write for complete information.

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

In EUROPE
General Radio Overseas
Zurich, Switzerland

NEW YORK, N. Y., 964-2722 Ridgefield, N. J., 943-3140 | CHICAGO (Oak Park) 848-9400 | PHILADELPHIA, 424-7419 Abington, 887-8486 | WASHINGTON, D.C. (Rockville, Md.) 946-1600 | SYRACUSE 454-9323 | DALLAS FL 7-4031 | SAN FRANCISCO (Los Altos) 948-8233 | LOS ANGELES 469-6201 | ORLANDO, FLA. 425-4671 | IN CANADA (Toronto) 247-2171

FIRST TRULY UNIVERSAL

Panoramic* solid-state TA-2 goes anywhere, does many jobs!

The TA-2 is the first truly all-purpose spectrum analyzer. Utilizing plug-in modules – 20 cps to 25 mc – it is transistorized, miniaturized, portable (30 lbs.), and battery-operated.

Its operation is "optimized" for universal application. Operable for over four hours on rechargeable silver-cadmium batteries, it is capable of normal operation, while charging, on any line 95-130 and 190-260 volts, 50 to 1000 cps.

With minimum space, installation, power, setup, and adjustment problems, the TA-2 can be taken anywhere in the laboratory, production line, or field. Finding great usefulness on board small ships and aircraft, it brings swept-band convenience to areas where, because of equipment bulk, less satisfactory instruments have been used.

Four modules give the TA-2 wide frequency versatility:

The AR-1 sonic module covers 20 to 35,000 cps. Center frequency is adjustable 0-25 kc. A 20 kc scan permits quick surveillance of the entire sonic spectrum at a glance, and detailed high-resolution analyses are made by the stable narrow-band scans of 5000, 1000, and 200 cps. Preset resolution is automatically at optimum. Internal crystal-controlled markers every 2.5 kc verify frequency calibration. A unique input switching and CRT calibration permits use of the TA-2/AR-1 as a sensitive (30 μv full scale) direct-reading dbm and voltmeter. CRT is calibrated for linear (voltage) and log (40 db) scales.

TA-2/AR-1 applications include vibration and acoustic waveform analysis, filter and transmission line checking, digital and other pulsed signal analysis, distortion measurements, dynamic analysis of digital, speech, and music for channel bandwidth and other studies, geophysical and seismic studies, and a host of others.

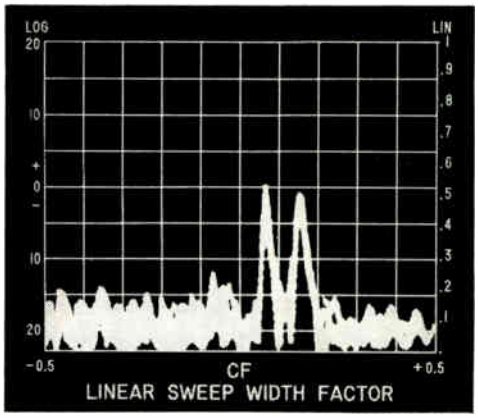
The AL-2 module has the features of the AR-1 plus a logarithmic frequency scan. The UR-3 covers the 100-600,000 cps sonic, ultrasonic, and low rf range, useful for telemetry subcarrier, VLF and wire carrier communications, sonar, and ultrasonic equipment analyses. The VR-4 analyzes 1 kc–25 mc. and is valuable for a wide variety of analyses of communications, including telephone carrier systems for rapid detection and measurement of noise or malfunctioning message channels, and for monitoring and trouble-shooting television video modulation. Other modules covering higher frequencies will be available soon.

The upper right hand space on the front of the TA-2 contains a removable cable and accessory compartment that may also be used for future plug-in accessory modules to even further extend the universality of the TA-2.

Vibration of a motor viewed with 0 to 5 kc sweep, log amplitude scale.

Note resonances and amplitudes are easily read.

Narrow band scans permit detailed observations.



TA-2/AR-1 SPECIFICATIONS

FREQUENCY: Range: 20 (usable to 15) to 35,000 cps./Center Frequency: expanded calibration control 0-20 kc. / Sweep Width: preset scans of 200, 1000, 5000, 20,000 cps. / Resolution: automatic optimum, 25 cps min. / Scale: linear frequency sweep. / Markers: zero and 2.5 kc intervals (built-in). ■ **SCAN RATE:** 1 cps, other rates available. ■ **SENSITIVITY:** 30 μv full LIN scale, –90 dbm full LOG scale. ■ **DYNAMIC RANGE:** harmonic and IM products down 60 db. ■ **CRT:** Size: 3½" square. / Amplitude Scales: linear voltage (accuracy ±10%); linear direct-reading 40 db (±1 db). ■ **POWER:** internal battery, or 95-130 or 190-260 volt 50-1000 cps line. ■ **DIMENSIONS:** TA-2: 8¾" w x 11" h x 18" d. / AR-1 module 8½" w x 6¼" h x 8¾" d. ■ **WEIGHT:** Approximately 30 pounds.

PAN-40-1

*A Trademark of THE SINGER COMPANY

Panoramic INSTRUMENTS

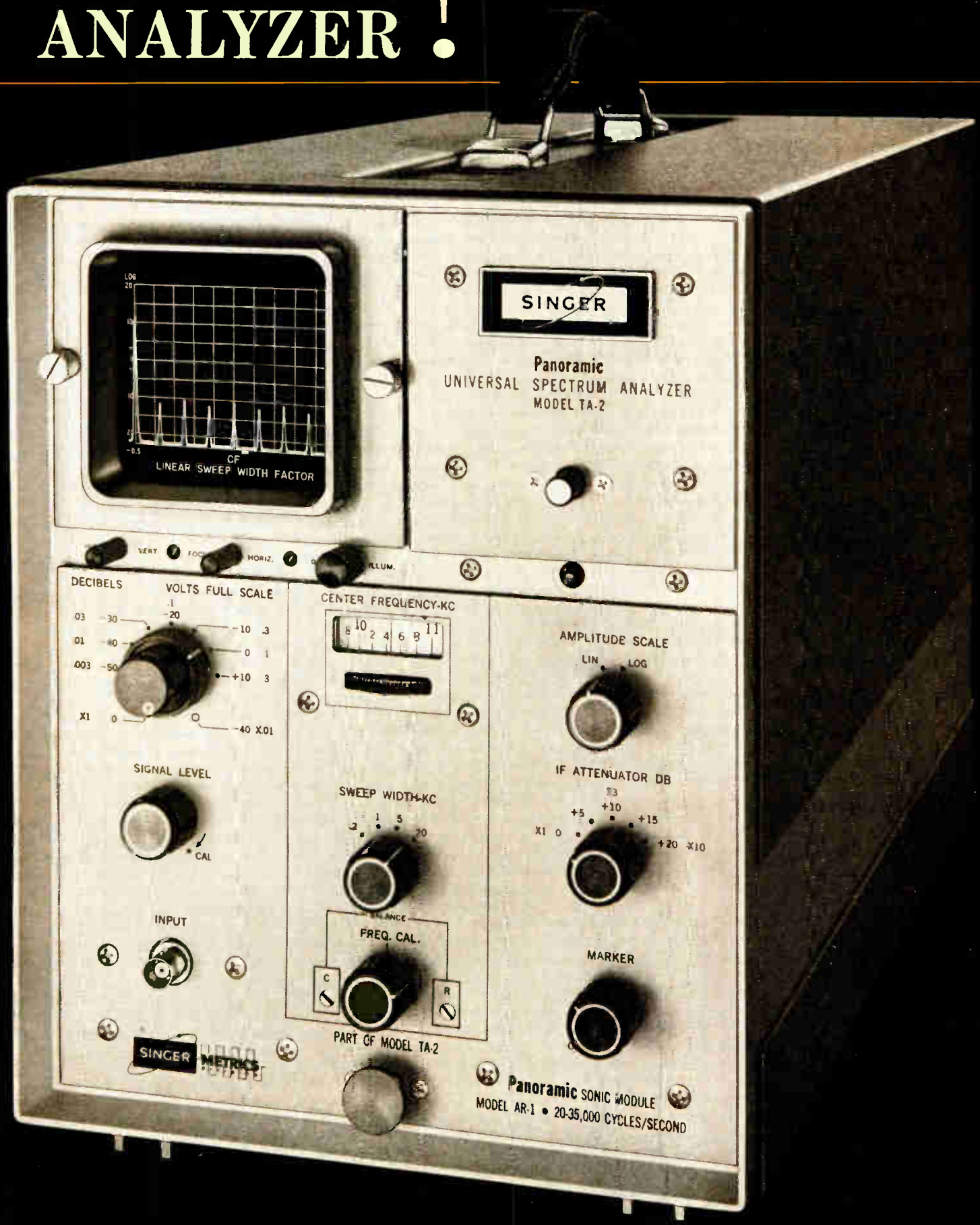
The measure of progress . . .

SINGER METRICS

SINGER METRICS DIVISION
THE SINGER COMPANY
915 PEMBROKE STREET · BRIDGEPORT 8, CONNECTICUT · (203) FOREST 6-3201

SPECTRUM ANALYZER !

The TA-2 with AR-1 sonic module. Display on TA-2 screen shows internal markers at 2.5 kc intervals for checking frequency calibration of 20 kc sweep width.



NEW DESIGNS IN PANEL METERS

A few years ago panel meters
came only in a few shapes,
and a limited number of colors—all black.
Today, along with accuracy,
a prominent factor in meter selection
is the human engineering considerations.
The newer designs also offer more rugged movements,
increased sensitivity and improved accuracy.

A CLASSIC EXAMPLE OF THE TRANSITION which takes place in a product as design considerations become more critical lies in the history of the electrical indicating panel instrument. This transition has been far from a "blockbusting" imposition of new ideas and approaches. Rather, within the last few years a quiet revolution has been going on in the field of panel meters.

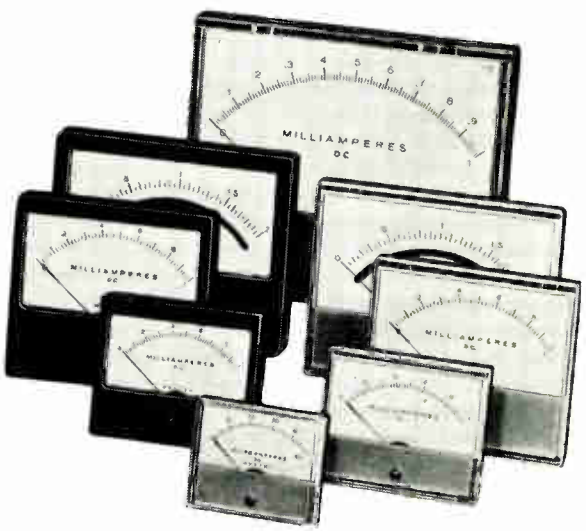
As is usually the case with an item that is with us for many years, their functions and their importance are taken for granted. In fact, a casual examination might lead one to conclude that nothing much has happened in the panel meter field since it started.

This is far from the case. The quiet revolution has completely upset the classical relationship between manufacturer and user of panel meters.

Historically, a user demanding better than 1% accuracies was pretty much limited to a large bulky design intended for switchboards. For reasonable performance and good reliability, there was an automatic restriction to bakelite case construction. For sensitivities less than 20 μa., it was vital to mount the meter in a horizontal position to assure repeatability.

And now, lets look at the changes that have taken place.

By EMIL G. NICHOLS
Mgr. New Product & Market Dev.
Weston Instruments & Electronics Div.
Daystrom, Inc.
614 Frelinhuysen Ave.
Newark 14, N.J.



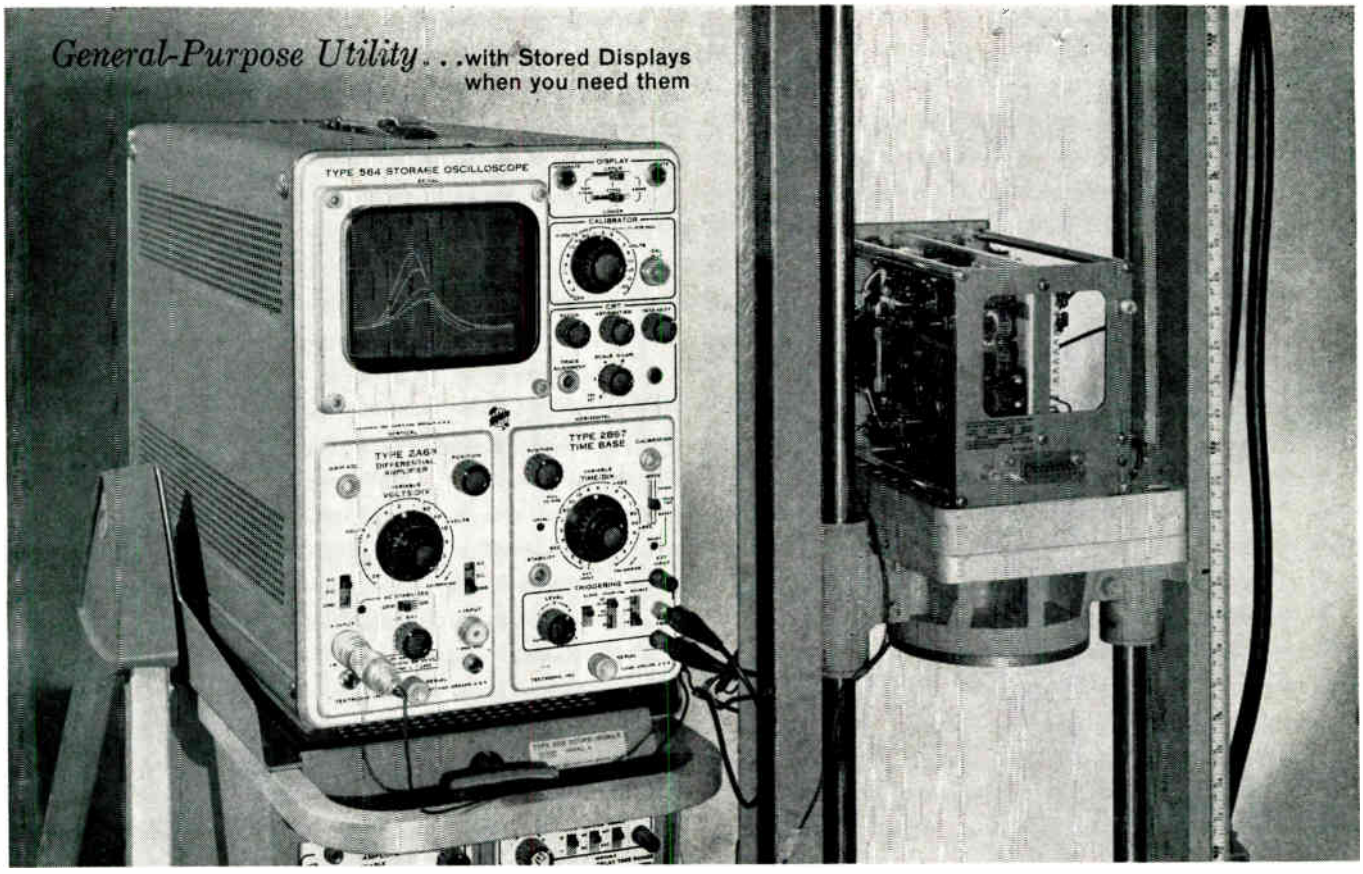
Weston 1900 Series Panel Meters above have design options in sizes ranging from 2½ to 7½ inches.

First and basic was the meter manufacturer's recognition that designs of panel meters should be subservient to the overall design of the product in which meters are used.

Second, the development of taut-band or ribbon suspension in place of the classical pivots and jewels. This obviated the need for any restrictive mounting positions or the need for bulky construction to obtain high accuracy or good repeatability.

Third, the development of anti-static treatments for thermoplastics. This eliminated the collection of electrostatic charges on such plastics. Better grades of thermoplastic materials permitted construction of meters to very close mechanical tolerances and to dimensional stabilities against age, temperature, humidity and other environments.

Fourth, the development of an integrated functional series of panel meters offered greater flexi-



THE NEW TEKTRONIX TYPE 564

The Type 564 in a typical mechanical measurement. Waveforms on screen represent shock imparted on the device under test when dropped from successively increasing heights. Trace is calibrated vertically at 8.6 g/cm and horizontally at 2 msec/cm. Storage facility permits easy analysis of shock data without need for multiple exposure photography.

. . . *As a General-Purpose Oscilloscope*

When you don't need stored displays, the Type 564 operates for you as a conventional oscilloscope, with all the versatility afforded by interchangeable vertical-deflection amplifiers and time-base generators.

Vertical Plug-In Units Offer:

DC to 1 Mc at 50 mv/cm—Type 2A60	$ 105
DC to 4 Mc at 50 mv/cm—Type 3A75	$ 175
0.06 cps to 300 kc at 10 μv/cm—differential input—Type 2A61	$ 385
DC to 300 kc at 1 mv/cm—differential input—Type 2A63	$ 130
Dual-Trace, DC to 650 kc at 10 mv/cm—Type 3A72	$ 250
Dual-Trace, DC to 10 Mc at 10 mv/cm—Type 3A1	$ 410
Four Trace, DC to 2 Mc at 20 mv/cm—Type 3A74	$ 550
0.4-nsec risetime at 2 mv/cm, sampling—Type 3S76	$1100

Time Base Plug-In Units Offer:

1 μsec/cm to 5 sec/cm, 5x magnifier, single sweep—Type 2B67	$ 175
Normal and Delayed Sweeps, 0.5 μsec/cm to 1 sec/cm, calibrated delay from 0.5 μsec to 10 sec, single sweep—Type 3B3	$ 525
Same as Type 3B3 except delay not continuously calibrated and no single sweep—Type 3B1	$ 475
0.2-nsec/cm to 10 μsec/cm equivalent, for sampling—Type 3T77	$ 650

. . . *As a Storage Oscilloscope*

Single traces at low and medium speeds are stored for at least one hour, and erased in ¼ second. A unique split screen permits storage or conventional operation over the whole screen, or storage on either half with conventional operation on the other half.

Type 564 (without plug-in units) $950

U.S. Sales Prices f.o.b. Beaverton, Oregon

For a demonstration and/or complete information, please call your Tektronix Field Engineer.

Tektronix, Inc. / *P. O. BOX 500 · BEAVERTON, OREGON / (Area Code 503) Mitchell 4-0161 · TWX: 503-291-6805 · Telex: 036-691 · Cable: TEKTRONIX · OVERSEAS DISTRIBUTORS IN 27 COUNTRIES*

Tektronix Field Offices are located in principal cities throughout the United States. Please consult your Telephone Directory.
Tektronix Canada Ltd: Montreal, Quebec • Toronto (Willowdale) Ontario • Tektronix Ltd., Guernsey, Channel Islands

PANEL METER (Continued)

bilty as to size, choice of construction materials, colors, mounting methods and operating characteristics.

With the capabilities of present day meters many of the engineering considerations do not have to be compromised to suit the human engineering aspects of the equipment. Nor do the human engineering aspects of the equipment design have to be compromised for the sake of performance dictated by the equipment developer.

Selection of Meter Size

In a given situation, the size of the indicating meter may be unrelated to its technical needs of accuracy, resolution, visibility from a distance, etc. In such a case, the human engineering considerations could be the governing factor. The designer may choose a large size of meter to create a center of interest.

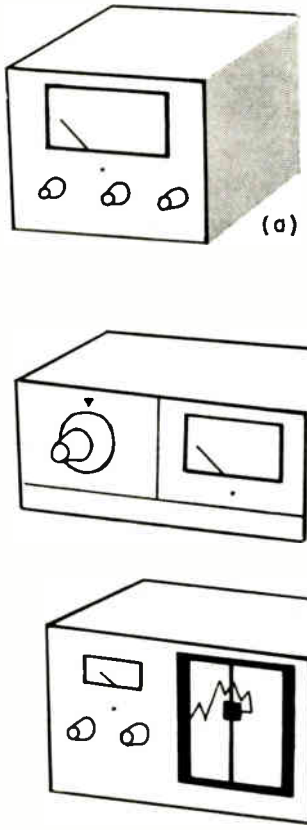


Fig. 1: The size of a meter has, as shown, in (a) more, (b) equal, and (c) less importance due to its function.

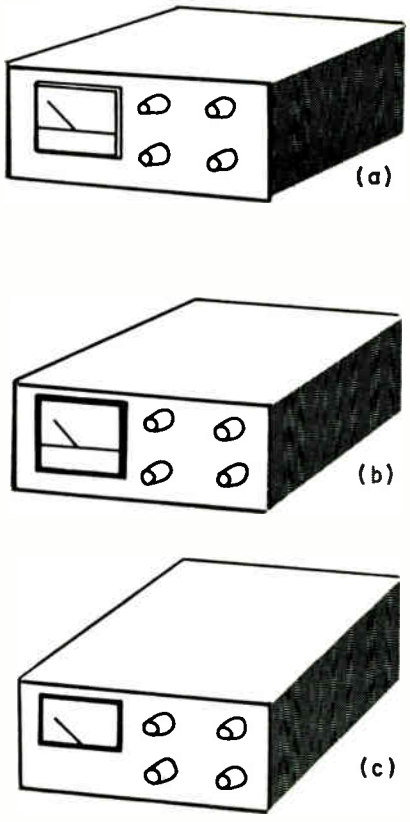
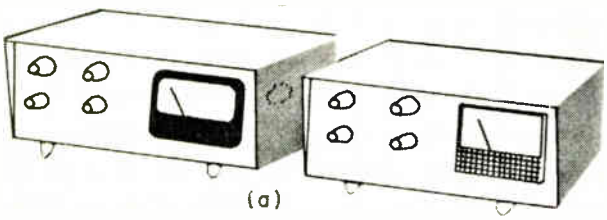
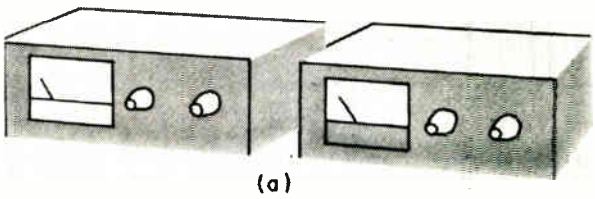


Fig. 2: A meter is usually on the surface as in (a), but, looks larger with a bezel (b) and smaller recessed (c).

See Fig. 1a. This might be especially true in such devices as vacuum tube voltmeters. Here, the range and function selector switches might be quite incidental and subservient to the meter itself since in indication of the meter is the important factor.

(*Continued on page* E22)





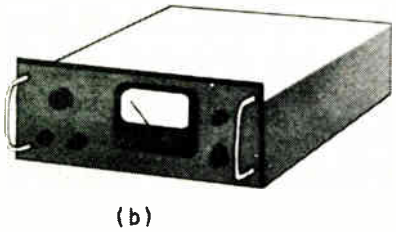
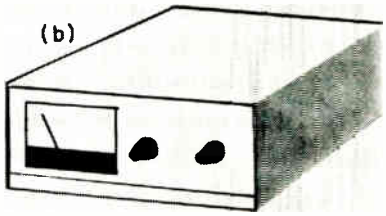


Fig. 3: Thermoplastic is better-looking on panel with light finish, as in (a) but, bakelite is more appropriate for equipment treated roughly, as in (b).



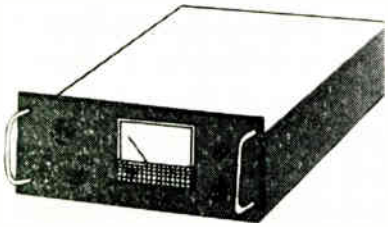
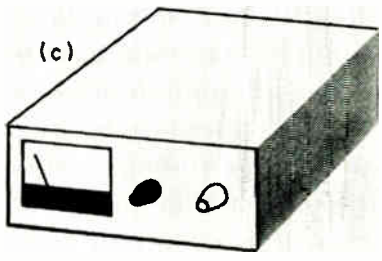


Fig. 4: Use of color in panel meters is meant to (a) change aspect ratio, (b) harmonize with a panel's detail, and (c) associate with a control knob.



Quite a package!

Fluke manufactured, precision wirewound resistors, aged and matched both for resistance and temperature coefficient, guarantee the long term DC accuracy of the voltmeter to be better than 0.01%. Resistors used in critical portions of the Kelvin-Varley divider have temperature coefficients of less than one part per million per degree Centigrade.

Accuracy of 0.01% DC, 0.1% AC

a uniquely useful measuring instrument

The new Fluke Model 823A differential voltmeter provides the highest accuracy obtainable in a portable instrument. In addition, it provides infinite DC input resistance at null (0-500V), divider terminal linearity of 2-20 ppm, DC polarity switch, recorder output, and no zero controls.

Model 823A is designed to perform under severe environmental conditions. It is guaranteed to withstand the shock and vibration requirements of Mil-T-945A. It is guaranteed to perform within specifications from 0-80% humidity and from 55° to 95°F. It's quite a package.

Ask your Fluke representative for a demonstration, or request complete data from John Fluke Mfg. Company, Inc., P.O. Box 7428, Seattle 33, Wash. Tel. PR 6-1171; TWX 206-879-1864, TLX 852.

FLUKE

Brief Specifications:

MODEL 823A

DC ACCURACY
± 0.01% from 0.5V to 500V
± (0.01%+10 uv) below 0.5V

AC ACCURACY
± 0.1% from 30 cps to 5 KC
± 0.15% from 20 cps to 10 KC
overall frequency range 5 cps - 100 KC

CALIBRATION
500V internal reference supply calibrated to better than 20 ppm against built-in standard cell

INPUT POWER
115/230V AC ±10%, 50-400 cps, 80 watts

	CABINET	RACK
SIZE:	13" high x 9¾" wide x 16" deep	7" high x 19" wide x 15½" deep
WT.:	28 pounds	26 pounds
PRICE:	$1300.00	$1320.00

MODEL 803D

New Model 803D, available in either rack or cabinet configuration, offers many of the features of Model 823A. Accuracy—AC, 0.1%; DC, 0.02%. Price—cabinet, $1100.00; rack, $1120.00.

Circle 94 on Inquiry Card

PANEL METER

(*Continued from page* E20)

On the other hand, another piece of equipment might have a calibration or tuning dial whose functional importance is equal to that of the indicating meter associated with such a dial (Fig. 1b). In this case, the human engineering considerations might well dictate an intermediate size of panel meter and a larger sized tuning dial or knob. In still other cases, (Fig. 1c) a meter may be necessary but completely incidental to the main function of the device. Again, this can be implied by choosing a very small panel meter; thereby indicating its lack of relative importance in the overall function of the device.

Of course, the shape and location of the meter in each of the 3 situations above would also have a very profound effect on the human engineering aspects, but of the 3 parameters involved, size is the most important.

Mounting Methods

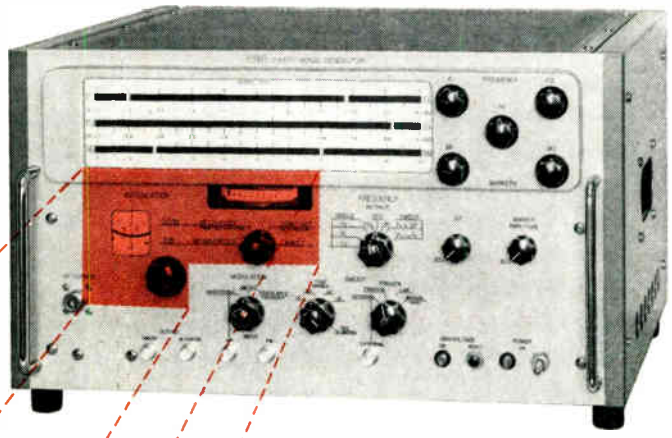
In certain uses, the scale length may dictate a large meter size, but the human engineering aspects may call for a relatively small meter. To a very real degree, these seemingly incompatible factors can be resolved by mounting the meter behind the panel with a half-bezel (Fig. 2c). This technique will frame only the scale-plate area and produce the double advantage of a seemingly small meter and the illusion of an even longer scale.

The opposite may also be true. Economics might dictate a very small meter for minimum cost, but human engineering aspects dictate a larger meter for increased prominence. In this case the smaller meter can be flush-mounted with a bezel (Fig. 2b) which completely surrounds it and thereby adds to its apparent size.

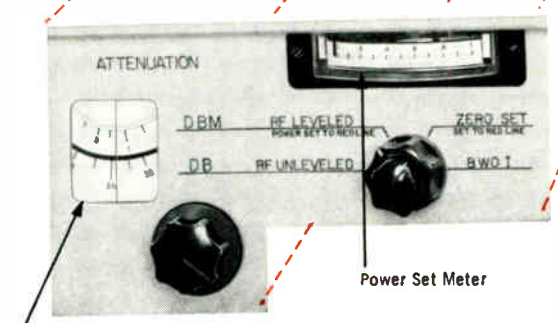
(*Continued on page* E24)

This is not a microwave sweep oscillator

This is the first microwave sweep signal generator



HERE, IN ONE COMPACT PACKAGE, is the microwave industry's first electronically swept signal generator. Alfred's new 630 Series now provides precise frequency tuning **PLUS** known absolute power output over a 60 db range, calibrated in dbm, all during swept or CW operation. Note these special features:



Power Set Meter

60 db Range Attenuator

FLAT OUTPUT—Feedback leveler holds power variation to less than ±0.5 db at rated output over each range. Variation in any 100 Mc range is less than ±0.1 db. Accuracy ±1 db at rated power output.

TRANSISTORIZED — 10½" panel height — lightweight — low power consumption — only five vacuum tubes used.

STABILIZED POWER OUTPUT—Balanced bolometer assures constant power output over wide temperature range.

AVAILABLE IN THREE RANGES—1 to 2, 2 to 4 and 4 to 8 Gc. Frequency is continuously adjustable over entire range with direct calibrated dial (1% accuracy).

ADJUSTABLE FREQUENCY MARKERS—Each unit has two time-saving indicators of band limits and two additional frequency markers.

KEY SPECIFICATIONS FREQUENCY RANGE: Model 631, 1 to 2 Gc; Model 632, 2 to 4 Gc; Model 633, 4 to 8 Gc. RF POWER: At least 1.0 mw. Continuously variable over 60 db range. Greater power output available unleveled. RESIDUAL FM: Less than 0.003% peak of highest frequency. DRIFT: ±0.01% per hour. SWEEP WIDTH: Continuously adjustable from 0 to any part of the entire frequency range. Symmetrical Sweep: 0 to ±5% of range about any center frequency. SWEEP TIME: CW operation, 100 to 0.01 second. Square Wave Operation, 100 to 0.5 second. AMPLITUDE MODULATION: CW, square wave or external.

COMPLETE DATA AVAILABLE—Alfred's policy is to publish complete specifications and guarantee them as stated. For detailed information on Series 630 Sweep Signal Generators, contact your Alfred engineering representative or write to:

ALFRED ELECTRONICS

Stanford Industrial Park • 3176 Porter Drive • Palo Alto, California
Phone: (415) 326-6496

Circle 96 on Inquiry Card

PANEL METER

(*Continued from page* E22)

Of course, the intermediate condition would be the case in which the selected size of meter, mounted in the typical fashion on the surface of the panel as in Fig. 2a, provides the best solution to the technical and human engineering needs.

Case Materials

As mentioned, the current availability of good plastics have contributed to the equipment designer's freedom of choice. Bakelite cases or thermoplastic cases now are simply a matter of preference rather than any technical necessity.

Many of the current designs of lab. instruments are modernistic in appearance and use light pastel colors on their panels and cabinets. In such cases, meters with thermoplastic covers better looking, while meters with bakelite cases might tend to become overwhelming by their prominence. See Fig. 3a.

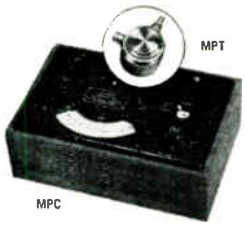
Conversely, certain types of equipment which are designed or built to rugged military specs may look much more homogeneous in overall design when meters with bakelite covers are used (Fig. 3b). Such bakelite-cased meters would enhance the feeling of utility and ruggedness, while meters with thermoplastic covers, even though just as rugged, durable and well sealed, might give the appearance of delicacy which could be out of place. Panel meter designs which provide for complete interchangeability of covers eliminate the need to compromise in either direction.

Use of Color

Certain equipment designs deal almost entirely with human engineering aspects rather than technical aspects. Among such factors are the use of color in panel meters.

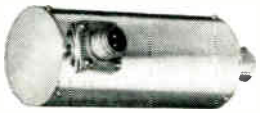
(*Continued on page* E26)

RF STANDARDS



MODEL MPT MICROPOTENTIOMETER

DC — RF calibration standard provides true rms voltages from 1 μv to 660,000 μv. Interchangeable radial resistors supplied in type N connectors. Certifiable by NBS to ±2% up to 100 mc; ±3% to 500 mc; ±5% to 900 mc. Model MPC, Micropot Calibrator, is an instrument for the rapid readout of micropotentiometers and their calibration at time of use.



MODEL CTC COAXIAL THERMAL CONVERTER

DC — RF voltage transfer standards for true rms measurement or calibration. Ranges: 0.5, 1, 2, 5, 10, 20, 50 and 100 volts; usable from 20% to 135% of nominal value. Certifiable by NBS at ±0.02% to 50 kc ±0.1% to 10 mc; ±0.2% to 30 mc; ±1.0% to 100 mc.

MODEL ATV A-T VOLTMETER

RF voltage standard having true rms response. Ranges and frequency: from 0.2 to 20 volts up to 1000 mc; 1 to 300 volts up to 100 mc; 10 to 500 volts up to 10 mc. Accuracy 1% ± of NBS calibration. Features 1¾" diameter micrometer readout with direct resolution of 0.0001" per division.

The comprehensive array of **Sensitive Research*** high accuracy AC/DC electrical instrumentation ranges from portable and panel type indicating instruments to the most sophisticated laboratory standards. The calibration of all **Sensitive Research** instruments is traceable to the National Bureau of Standards.

AC/DC TEST SETS
AMMETERS
AMPLIFIERS
CALIBRATION CONSOLES
CHOPPERS
COAXIAL THERMAL CONVERTERS
COMPENSATING INDUCTORS
CORE LOSS TEST SETS
CORROSION INSTRUMENTS
CONSTANT TEMPERATURE ENCLOSURES
CURRENT CONTROLLERS
DIFFERENTIAL INSTRUMENTS
DUAL CONTACT SWITCHES
ELECTROSTATIC VOLTMETERS
FLUXMETERS
FLUXMETER CALIBRATORS
FORM FACTOR INSTRUMENTS
FREQUENCY METERS
GALVANOMETERS
GAUSSMETERS
HIGH VOLTAGE DIVIDERS
HIGH VOLTAGE PROBES
INCREMETERS
INDUCTERS
ISOLATING POTENTIAL COMPARATORS
KILOVOLTMETERS
LINDECK MICROVOLT SOURCES
LOW THERMAL NOISE SWITCHES
MAGNETIC TEST INSTRUMENTS
MICROAMMETERS
MICROPOTENTIOMETERS
MILLIAMMETERS
MILLIVOLTMETERS
MULTIPLIERS
POLYRANGERS
POTENTIOMETERS
POWER FACTOR INSTRUMENTS
POWER SUPPLIES
RATIOMETERS
REVERSING SWITCHES
SHUNTS
STANDARD CELL ENCLOSURES
STANDARD RESISTORS
TEMPERATURE MEASURING EQUIPMENT
TEST CONSOLES
THERMOCOUPLES
THERMOMETER BRIDGES
THERMAL RESISTORS
TRANSFORMERS
THERMAL COMPENSATORS
VOLT-AMP-MILLIAMMETERS
VOLT-AMP-WATTMETERS
VOLTMETERS
VOLT RATIO BOXES
VOLTAGE REFERENCE SOURCES
WATTMETERS
"Y" BOXES

WRITE FOR DETAILED SPECIFICATIONS OR CATALOG

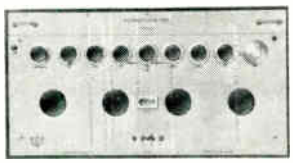
Sensitive Research*

ELECTRICAL MEASURING STANDARDS

SINGER METRICS DIVISION
THE SINGER MANUFACTURING COMPANY

915 PEMBROKE ST., BRIDGEPORT 8, CONN.
(203) FO 6-3201 • TWX 710-453-3483

*A Trademark of THE SINGER MANUFACTURING COMPANY

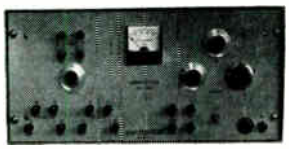


COMMANDER TYPE 9120 POTENTIOMETER

Features 7 figure, single window readout from only 4 dials. Accuracy ± (0.0015% + 0.1 μv). Range: zero to 2.099,999,9 volts. Resolution: 1 part in 20 million (0.1 μv per step). No current is carried through measuring dial switches so contact resistance is not a factor. Thermal emfs 0.1 μv max.

MODEL PARK HIGH VOLTAGE DIVIDER

Precision high voltage measuring or calibration standard. Constructed to a design by Howard Park of the National Bureau of Standards.
Total resistance: 100 megohms.
DC ratio accuracy: 100 kv to 1 v ± .05%
AC ratio accuracy (60 cps): 50 kv to 500 v ± .5%.
Units may be stacked for higher voltage measurements.



COMMANDER TYPE 9800 COMPARATOR

A DC resistance and voltage comparator employing an isolating potential circuit. Thermal noise less than 0.01 μv. Voltages compared to 1 part in 10^7; resistors to 1 part in 10^6. May be used with Dauphinee potentiometer and platinum resistance thermometer for temperature measurements. Resolution 0.0005°C. Ideal for comparison of two thermocouples. Measurements are independent of lead length and current stability.

CONSTANT CURRENT SOURCE

Type 9770A supplies currents from 10 to 100 ma DC that are stable to ± 1 ppm when referenced against an external saturated cell (± 10 ppm when using internal reference). Output is approx: 10 v into 1000 Ω (max.) load. Application is for use with DC potentiometers, accelerometers and all circuits requiring highly stable currents within its output range.

PANEL METER

(Continued from page E24)

One way of obtaining such color is by the use of very low-cost colored plastic inserts (Fig. 4a). These inserts are mounted between the scale plate of the meter and the transparent thermoplastic cover. This permits the user to have very wide selection of color. At the same time he avoids the need and added cost of having the meter manufacturer to custom-paint such covers.

In certain equipment designs, human engineering may dictate a horizontal/rectangular aspect ratio for a meter, while the available meter may be more nearly a square. In such a case, the use of a plastic strip insert in the lower portion of the meter, in a color matching the mounting panel, helps to create the illusion of a rectangular meter.

At times, the panel of the equipment may be finished with an accent color used as a design element (Fig.

(Continued on page E29)

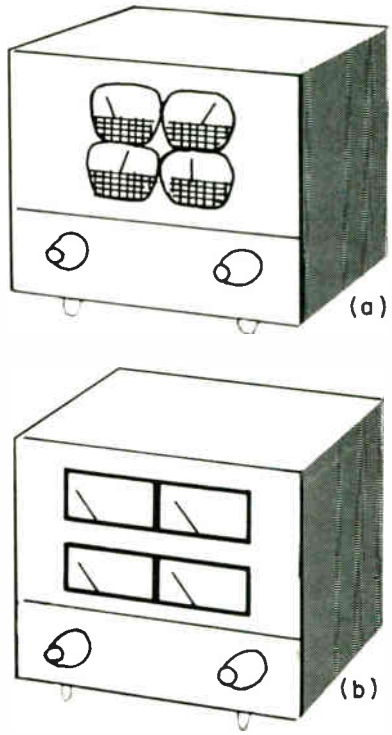
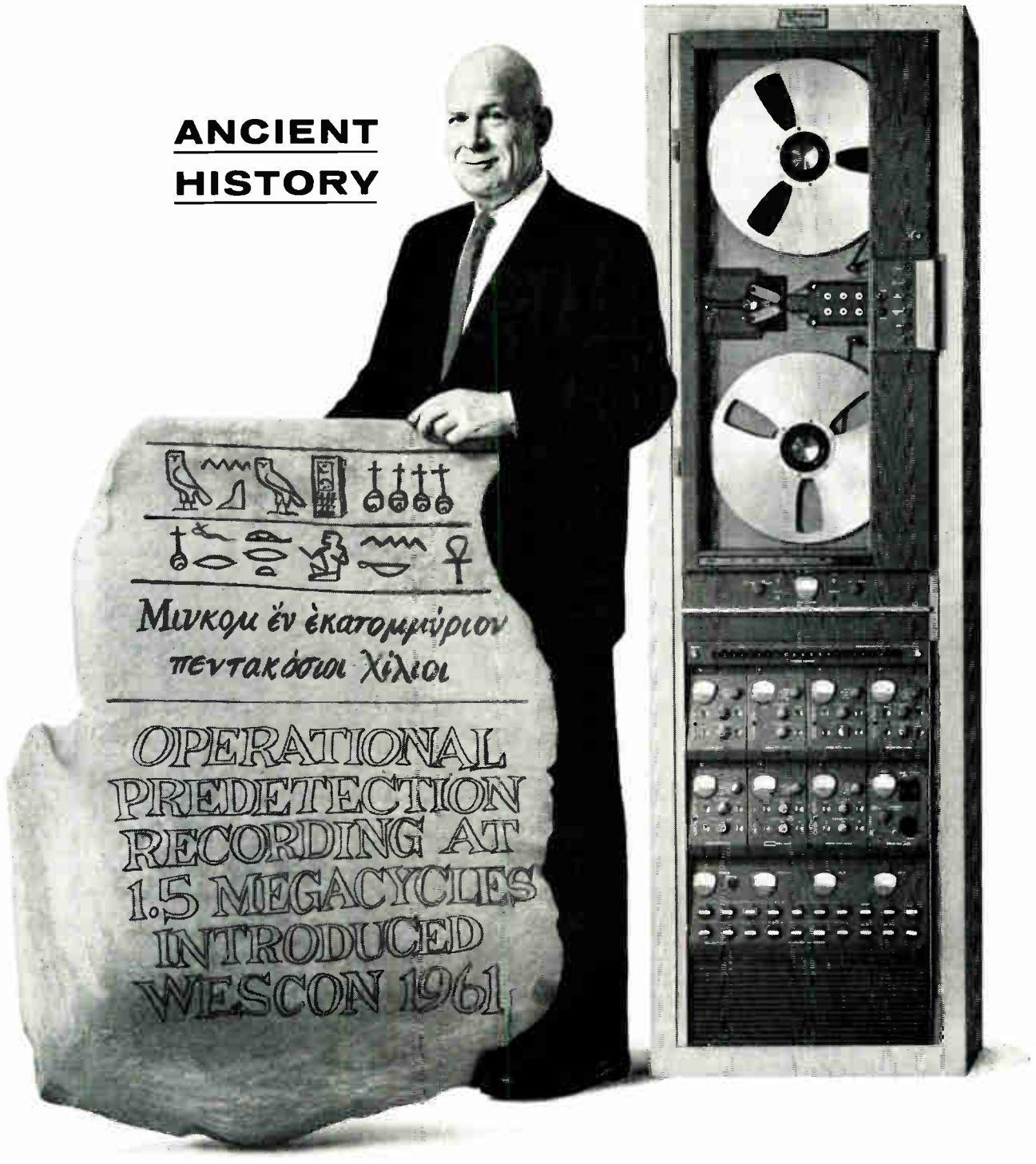


Fig. 5: Odd design shapes, as in (a), which are not square-cornered as in (b) are more pleasing if used singly.



MINCOM CM-100 1.5 MC RECORDER / REPRODUCER

Only the Mincom CM-100 has a field-proven record of predetection performance. Mincom's leadership in this highly complex telemetry technique stems from the CM-100's long-standing and reliable 1.5-mc response. CM-100's versatility and extreme wideband capability have made it the industry's instrumentation standard: 1, 1.2 or 1.5 mc at 120 ips in analog recording/reproducing, or simultaneous post- and pre-detection recording in FM/FM mod, PCM, PCM/FM, PAM/FM, PACM/FM and other FM-type carrier systems. Superior fixed heads and phase-compensating electronics produce better rise time, correcting for phase shift and overshoot. Write today for specifications.

Mincom Division 3M COMPANY
2049 South Barrington Avenue, Los Angeles 25
425 13th Street N.W., Washington 4, D.C.

SHOWN WITH DATAFLASH

This man is looking at a perfect oscillograph record

. . . and you can, too . . . with CEC's direct-writing 5-123

You can't buy an oscillograph that produces better records than CEC's 5-123. It's made by the company with the greatest experience and know-how in the field of oscillography.

The versatile 5-123 can be used in any laboratory environment installation, fitting into a standard RETMA rack. 36- or 52-individual channels of recorded data on 12-inch-wide recording paper are produced without chemical processing of any kind . . . at 12 discrete speeds from .1 to 160 ips — and with trace numbering.

Instant record speed selection is made by pushbuttons. There's complete front access for operation and routine maintenance. All major modules of the 5-123 can be easily removed, replaced or exchanged.

For ultrafast access to data traces, the optional DATAFLASH module is available, providing access time that is up to 60 times faster than any other print-out process.

Need more information? Call CEC, or write for Bulletin CEC 5123-X14.

CEC

Data Recorder Division

CONSOLIDATED ELECTRODYNAMICS

A Subsidiary of Bell & Howell • Pasadena, California

Circle 107 on Inquiry Card

PANEL METER (Concluded)

4b1). To be compatible with such a panel design, plastic strip insert on the meter can repeat this color accent.

Sometimes a specific control knob may be related to a meter (see Fig. 4c). Here, the color used on the knob can be repeated, by means of the colored insert in the meter, and thus imply the necessary relationship.

Group Mounting of Panel Meters

When several meters are mounted in close proximity, another factor becomes apparent—the shape of the meter selected. Panel meter designs which use shapes other than square or rectangular may look very pleasing when used singly. However, when they are grouped or clustered, such odd shapes may not be compatible with the rectangular aspect of a typical instrument panel (Fig. 5a). Furthermore, when meters having the shapes of shields, circles, trapezoids, or other non-rectangular areas are clustered, the odd-shaped areas remaining between the meters are natural dust collectors.

Summary

Increased sensitivities now permit the development engineer to simplify circuitry and in many instances eliminate amplifiers that might have been previously needed. Compatibility of appearance in various instrument sizes and functions enhances the freedom of choice of the designer.

One might well say that the design engineer can now "eat his cake and have it, too." He can design his equipment to be technically superior to anything that was possible previously, and still avoid any compromise that human engineering might have otherwise imposed.

NEW TECH DATA

for Engineers.

Aerosol Photometer

Data on Royco Model 230 Aerosol Photometer, which monitors aerosol concentration in monodisperse aerosols or aerosols with constant size spectra, is available from Royco Instruments, Inc., 440 Olive St., Palo Alto 6, Calif. Photometer measures and indicates total average logarithm of light scattered by large numbers of particles in a sample stream.

Circle 339 on Inquiry Card

High-Resolution CRT

Information on a new 5 in. dia. CRT, SC-3168, for high-resolution photographic recording is available from Sylvania Electric Products, Inc., 1100 Main St., Buffalo 9, N. Y.

Circle 340 on Inquiry Card

Contact Test Set

Details on the Miss Tester®, automatic contact and component test set, are available from Hi-G, Inc., Bradley Field, Windsor Locks, Conn. System is suitable for relay manufacturers and incoming inspection departments.

Circle 341 on Inquiry Card

Instrument Catalog

This 100-page, 2-color catalog lists data on sweeping oscillators, audio spectrum analyzers, noise generators, attenuators, oscillators and other instruments. Illustrations, specs. and characteristics are given in the cross-indexed publication. Kay Electric Co., Dept. E. I., Maple Ave., Pine Brook, Morris County, N. J.

Circle 342 on Inquiry Card

Digital Voltmeter

Bulletin 107 describes a transistorized reed-relay type digital voltmeter which features automatic ranging, manual control selection (if desired), automatic polarity, and 10 megohm input impedance. Sensitivity is 1mv. Princeton Applied Research Corp., Box 565, Princeton, N. J.

Circle 343 on Inquiry Card

Electric Utility Controls

GEA-7571, 16-page brochure, lists instruments available for the electric utility industry. Included are indicators, recorders, sensors, controllers, test instruments, and many other instruments and systems. General Electric Co., Schenectady 5, N. Y.

Circle 344 on Inquiry Card

Tachometer Transducer

Bulletin F-111-1 describes TDS6 self-generating magnetic transducer, which has a linear signal proportional to rotation speed of shaft. Output signal is fed to Tach-Pak which changes frequency to dc for metering, recording or controlling. Seminole Div., Aripax Electronics Inc., Ft. Lauderdale, Fla.

Circle 345 on Inquiry Card

Micro-Manipulators

A 12-page color catalog includes drawings, specs. and photos of micro-manipulators not previously offered. Accessories table is also included. Brinkmann Instruments, Inc., 115 Cutter Mill Rd., Great Neck, N. Y.

Circle 346 on Inquiry Card

Oscilloscope Catalog

The illustrated 15-page "1963 Abridged Catalog," in color, gives complete specs. in tabular form for oscilloscopes and companion instruments. Characteristics, uses, prices and other sales data are included. Tektronix, Inc., P. O. Box 500, Beaverton, Ore.

Circle 347 on Inquiry Card

Sweetest choice in miniatures

Today, you needn't look any further than Honeywell in your move to miniature meters. Honeywell's popular line, broadest in the industry, offers many shapes and models to choose from. Catching on fast is the brand-new, modern-styled MS-1 Square Meter. It has longer scale length, a clean, uncluttered dial and concave cover, stacks flush vertically and horizontally. In addition, there's the HS-1 Ruggedized Meter that shrugs off vibration, is immune to dust and moisture; the MCE-1 Edgewise Meter, for use in cramped areas; and the contemporary-looking MM-1 Medalist®. All Honeywell miniatures are produced in quantity, so you can get immediate delivery. For further information, just write to us at Honeywell, Precision Meter Division, Manchester, New Hampshire. In Canada, Honeywell Controls Ltd., Toronto 17, Ontario. Honeywell International: Sales and service offices in principal cities of the world.

Honeywell

NEW TECH DATA

Atomic Frequency Standard

A solid-state, optically pumped rubidium freq. standard is described in Product Spec. Sheet No. 70. The 4-page brochure keys the theory of operation to a block diagram of the instrument. Performance data at the National Bureau of Standards is plotted to document stated stability. Uses of the standard described include navigation systems, communication systems, and its use for laboratory calibration. STL Products, 139 Illinois St., El Segundo, Calif.

Circle 348 on Inquiry Card

Intervalometer Catalog

A 46-page catalog, AIC 1017, describes standard models of time delay relays, intervalometers and program controls, plus basic units for custom modification. Technical data, outline dimensions and environmental characteristics are given. Abrams Instrument Corp., Dept. 107, 606 E. Shiawassee St., Lansing 1, Mich.

Circle 349 on Inquiry Card

Shock Machine

Data is available on a new shock tower for environmental testing of components under shock or impact. The 15-ft. tower is a vertical drop shock machine, designed to meet the need for a method of testing manufactured units at high "g" levels. Dept. 2A, Livingston Electronic Corp. Montgomeryville, Pa.

Circle 350 on Inquiry Card

Semiconductor Tester

Data is available on a Go/No-go multiparameter tester, Series 250, which conducts tests at the rate of 900 units/hr. This equipment features 16 variable go/no-go tests per unit, is easy to operate. Fairchild Semiconductor Corp., 545 Whisman Rd., Mountain View, Calif.

Circle 351 on Inquiry Card

Magnetic Modulators

Specs. for magnetic and electronic modulators, analog multipliers, solid-state control relays, and dc and ac current sensors are detailed in a 6-page catalog. Theory of magnetic modulator operation is also covered. Transmagnetics, Inc., 134-08 36th Rd., Flushing 54, N. Y.

Circle 352 on Inquiry Card

Underwater Camera Control

A 2-color data sheet gives complete specs. on small pan and tilt control for underwater cameras. Unit features open-frame design which requires no sealing or bulky housings. Also described are its underwater motors and components. Unit, Model #8700-1, is designed for operation in seawater, radioactive liquids and other environmental fluids. Electro-Kinetics Corp., 909 Border Ave., Torrance, Calif.

Circle 353 on Inquiry Card

NEW TECH DATA

for Engineers.

Direct Writing Brochure

This brochure gives a brief description of the high-speed, direct-writing recording instruments. Illustrated and described are Techni-Rite Analog Recorders, and Ana-Vent Recorders. Militarized adaptations of these recorders are available which comply with Mil-E-4158 and Mil-I-6181. Techni-Rite Electronics, Inc., 65 Centerville Rd., Warwick, R. I.

Circle 354 on Inquiry Card

Precision Phase Detectors

Data sheets available from Ad-Yu Electronics, Inc., 249-259 Terhune Ave., Passaic, N. J., include one on millimicrosecond phase detectors. Several types are listed with specs., illustrations, schematics, characteristics, uses and accessories.

Circle 355 on Inquiry Card

Epoxy Spray Tests

A test service to aid electric motor manufacturers in evaluating 1-part epoxy insulation on stators and armatures has been established. Details are available from Dept. W3-201, 3M Co., 2501 Hudson Rd., St. Paul 19, Minn.

Circle 356 on Inquiry Card

Fault Counter

The PHYWE Fault Counter, Model IV, tests defects in enamelled wires. The wires to be tested are run through a solution of NaCL or Hg. The device detects a defect when insulation resistance is 10KΩ or less. Brinkmann Instruments, Inc., 115 Cutter Mill Rd., Great Neck, L. I., N. Y.

Circle 357 on Inquiry Card

Strip-Chart Recorders

Bulletin on strip-chart recorders describes linear/log recorder and high-sensitivity recorder with sensitivity of 1μv. in the 0.5mv. range. An automatic integrator is also described and illustrated. LaPine Scientific Co., 6001 S. Knox Ave., Chicago 29, Ill.

Circle 358 on Inquiry Card

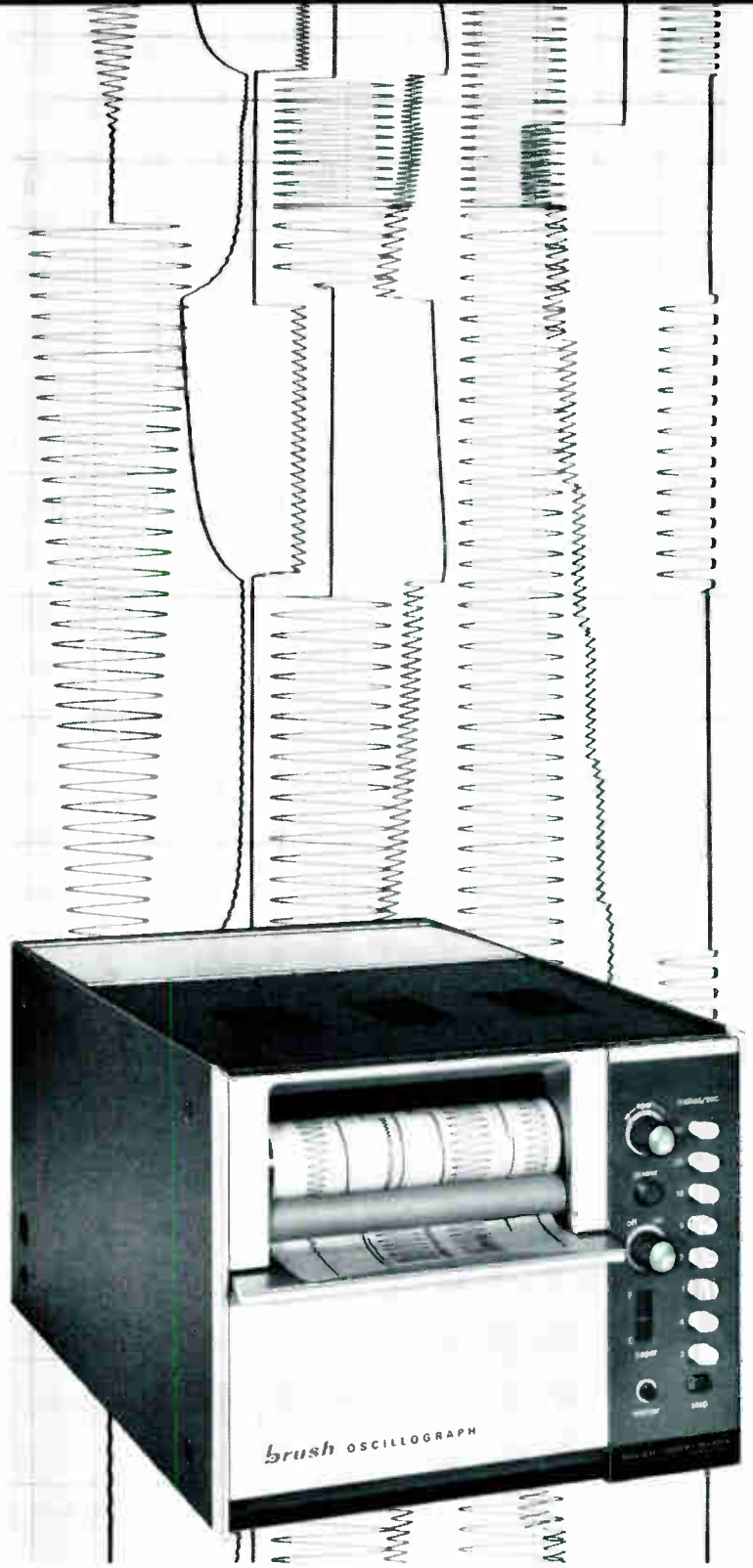
High-Voltage Testing

The 12-page short-form catalog No. 63 on high-voltage test sets and power supplies covers instruments for lab and production tests and industrial processes. Peschel Instruments, Inc., Route 216, Towners, Patterson, N. Y.

Circle 359 on Inquiry Card

Circle 121 on Inquiry Card →

Actual width of record is 6 inches



At Brush it's a matter of record

. . . and *this* record speaks for itself. It was made by the new oscillograph Series 2300 . . . a product of Brush's advanced recording system design. Its unique optical system produces these high contrast traces . . . at all writing speeds. An extremely stable tungsten light source eliminates cluttered records caused by ultra-violet "jitter" or RF interference. The start-up of this low-cost lamp is virtually instantaneous. Overall system linearity is better than 2%. Eight record speeds are controlled by pushbuttons. Paper take-up is built-in. A complete line of accessories accommodates special requirements. So now, you can record over the whole range of most-used frequencies with Brush systems incorporating all the known refinements in oscillography. Write for full details.

brush INSTRUMENTS

DIVISION OF CLEVITE 37TH AND PERKINS, CLEVELAND 14, OHIO

NEW TECH DATA

for Engineers.

Light-Beam Oscillographs

Brochure 2300, 3 colors, describes the Series 2300 8 or 16-channel light-beam oscillographs. It uses an incandescent light source for simple, safe and economical operation. The brochure discusses the advantages offered by an incandescent light source and lists specs. for the oscillograph and its associated amplifiers. Brush Instruments, Div. of Clevite Corp., 37th & Perkins, Cleveland 14, Ohio.

Circle 455 on Inquiry Card

Ion Beam Generator Bulletin

Bulletin IBG-1 describes an ion beam generator which produces a steady, controllable beam of metal ions. The ion beam generator has potential uses in semiconductor technology, image formation and research. Schematic and circuit diagrams, specs., and tables of typical operating conditions are also included. CBS Laboratories, High Ridge Rd., Stamford, Conn.

Circle 456 on Inquiry Card

Light Measuring System

The Hydrophotometer Type HHP is an underwater light-measuring system which allows a means of accurate, sensitive and wavelength-selective measurements of irradiance and radiance in hydrospace. A 16-page booklet describes functions and uses. Hoffman Electronics Corp., 700 Hoffman Dr., Santa Barbara, Calif.

Circle 457 on Inquiry Cord

Nuclear Products

Brochure GET-3127, 12 pages, 2 colors, describes more than 30 nuclear instrumentation components. Included is information on fission counters, ion chambers, integral cable counters and chambers; pulse measuring equipment; current measuring equipment, power supplies and radiation monitors. General Electric Co., Schenectady 5, N. Y.

Circle 458 on Inquiry Card

Pulse Generator

Tech. Bulletin 106 describes the Datapulse 106 pulse generator which offers linear, variable rise and fall times from less than 10nsec. A complete set of oscilloscope photos illustrates the unit's waveform capabilities, and a full listing of specs. is provided. Datapulse Inc., 509 Hindry Ave., Inglewood 1, Calif.

Circle 459 on Inquiry Card

Tachometer Generator

Specs. and data are presented on Vibratac Bearingless Tachometer Generator which has meter and freq.-responsive module to provide a complete speed measuring system. Vibrac Corp., Route 129, Alpha Industrial Park, Chelmsford, Mass.

Circle 460 on Inquiry Card

Resistance Standard Device

This 4-terminal rheostat provides exceptional resistance standards capability. It established 893 reference resistance standard values in 2 digits, in the ranges from 1Ω to 110KΩ. The rheostat enables the use of resistance values at Rosa levels without the need for complex mercury cups. When used as a calibrating device, a conventional 0.1% bridge can be operated at an accuracy with 0.01% or better for all discrete resistance values within the 1Ω to 110KΩ range. Angstrohm Precision Inc., 7341 Greenbush Ave., N. Hollywood, Calif.

Circle 461 on Inquiry Card

Oscilloscope Booklet

This brochure describes 14 types of oscilloscopes designed for rack and console service. Models covered include dual-beam, readout and sampling types with up to sub-nsec. ranges; and amplifier and time-base plug-in units. Instrument dimensions and mounting details are also included. The booklet contains information on plug-in unit storage cabinets and cradle mounts designed for rack-mounting installation. Requests should be made on business letterheads. Tektronic, Inc., Box 500, Beaverton, Ore.

Circle 462 on Inquiry Card

Line Fault Analyzer

The Sierra 371A Line Fault Analyzer, which has a 200 mile range, is described in this report. It features a display of line faults reproduced from photos of an analyzer's scope presentations. The device can pinpoint fault locations remotely, and identify open lines, shorted lines, grounds, taps, and capacitor or transformer banks. Sierra Electronic Div. of Philco, Marketing Dept., 3839A Bohannon Dr., Menlo Park, Calif.

Circle 463 on Inquiry Card

Tantalum Test Unit

This tantalum-capacitor test unit prints out characteristics of a capacitor under test in only 8 sec. The test compares the capacitance and dissipation-factor characteristics of unknown capacitors with the known values of standard capacitors. The results are presented as a percentage difference. RCA Electron Tube Div., Harrison, N. J.

Circle 464 on Inquiry Card

Digital Catalog

A bulletin and price list on the Chronolog digital clocks, digital calendars, digital counters and digital timers is now available from Chrono-log Corp., 2583 West Chester Pike, Broomall, Pa. It includes complete technical details and engineering specs. The price list covers over 50 standard models.

Circle 465 on Inquiry Card

NEW TECH DATA

for Engineers.

Controller Bulletin

This 8-page bulletin, B850, describes Hays Model 850 controllers for control of pH, conductivity, flow, gas analysis, pressure, current, humidity, etc. Four pages are devoted to schematics of basic control systems and principles of operation. The Hays Corp., Michigan City, Ind.

Circle 466 on Inquiry Card

Electromanometer

Bulletin 1547C describes rack-mounted electromanometer systems which provide secondary pressure-standard accuracies for laboratory, field, or automatic process control. The precision pressure balances measure differential, gage, and absolute pressure to 500PSI. Pressure balance may be separated from the servo amplifier by as much as 400 ft. Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Circle 467 on Inquiry Card

Instrument Guide

"NLS Instrument Selection Guide," new 8-page short form catalog, is available from Non-Linear Systems, Inc., Del Mar, Calif. It lists the complete NLS line, including 15 new products. Basic specs., prices are given. The Delta Design, Inc., line of environmental test equipment, now being marketed by NLS, is also listed.

Circle 468 on Inquiry Cord

Precision CRT Display

A 6-page brochure describes Type 30 CRT Display. Digital display converts stored digital data into graphic or tabular form. Requiring only logic level inputs, it easily connects to most digital systems. Technical Publications Dept., Digital Equipment Corp., 146 Main St., Maynard, Mass.

Circle 469 on Inquiry Card

PPI Indicator

An 8-page, 3-color booklet, ED 3-10-2, on new Westinghouse transistorized universal plan position indicator (indicator group AN/UPA-48) is available from Westinghouse Electronics Div., Box 1897, Baltimore 3, Md. It describes the features and gives reference data for the versatile unit.

Circle 470 on Inquiry Cord

True-RMS Voltmeter

This 4-page brochure describes the Ballantine Model 320A, a sensitive wide band true RMS-responding voltmeter with freq. range from 5CPS to 4MC, voltage range of 100μv to 330v and basic accuracy of better than 2%. Ballantine Laboratories, Inc., Boonton, N. J.

Circle 471 on Inquiry Card

Solid-State Counter

Data describes Model 40-80 solid-state counter. Nine standard output frequencies are available in decade steps from 0.1CPS to 10MC. Plug-in components include a unit which counts from dc to 200MC and a 200MC to 1,000MC frequency converter. Northeastern Engineering Co., Inc., Manchester, N. H.

Circle 472 on Inquiry Cord

Instruments and Standards

Catalog No. 75 contains over 160 pages of technical and descriptive information on precision measurement and calibration instruments covering voltage, current, power, frequency and magnetic quantities from dc to 1000MC. The data on uses makes the catalog a useful textbook of precision measurements. Singer Metrics Div., The Singer Mfg. Co., 915 Pembroke St., Bridgeport, Conn.

Circle 473 on Inquiry Cord

Magnetometer

A portable, battery-operated, laboratory magnetometer capable of detecting and measuring magnetic fields from 1 to 100,000 gamma is available from Marshall Laboratories, a sub. of Marshall Industries, 3530 Torrance Blvd., Torrance, Calif. Power requirement is 12v (±10%), and the output is ±160mv. Additional specs. are available.

Circle 474 on Inquiry Card

Test Equipment

The 16-page 1963 Short Form Catalog describes a complete line of X-Y recorders, T-Y recorders and laboratory test equipment. Also described are ac and dc voltmeters, dc amplifiers, ac/dc converters, log freq./dc converters and test calibration units. Houston Instrument Corp., 4950 Terminal Ave., Bellaire 101, Tex.

Circle 475 on Inquiry Card

Transistor Devices

This short-form catalog of transistor devices contains prices and characteristics of approx. 200 new products. These products consist of audio amplifiers, i-f amplifiers, miniature rectifier transformers and tiny power-supply modules. Ferrotran Electronics Co., Inc., 693 Broadway, New York 12, N. Y.

Circle 476 on Inquiry Cord

Instrument Selection Guide

This guide lists the complete line of NLS instruments, accessories and standard systems with basic specs. and prices. Included is a line of environmental test equipment. It lists 15 new instruments and accessories. Non-Linear Systems, Inc., Del Mar, Calif.

Circle 477 on Inquiry Cord

OUR BUSINESS IS AMPLIFIERS

IFI means amplifiers. Good ones. They are the culmination of years of intensive development and manufacture of today's most sophisticated electronic countermeasures and electronic counter-countermeasures systems.

Proof? The thousands of IFI amplifiers...off the shelf and special purpose...performing accurately and reliably throughout the free world.

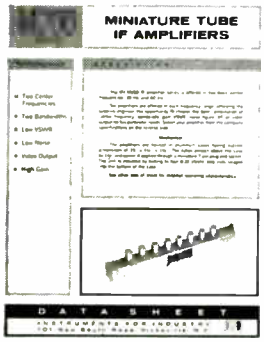
If you are interested in dependable, advanced design amplifiers...Transistorized IF...Log IF...Very Wide Band ...Video...Nuvistor DA...or High Power DA...

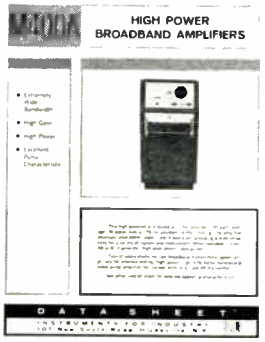
tell us your requirements, or write for data sheets.

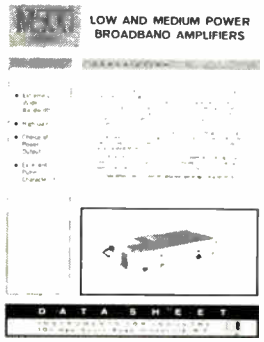
INSTRUMENTS FOR INDUSTRY

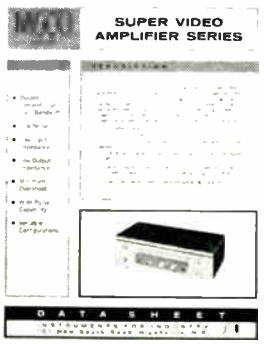
101 New South Road, Hicksville, New York • OVerbrook 1-7100

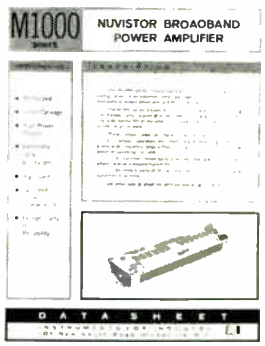
IFI INSTRUMENTS FOR INDUSTRY











SECTION F

ELECTROMECHANICAL COMPONENTS

Rapid advancement of the digital computer has contributed to the widespread use of digital methods. This has in turn brought about an increased demand for shaft position encoders and coded disks. Anyone who recognizes the advantages of digital processing should read this enlightening article. It outlines the types, applications, advances and trends of photoelectric shaft position encoders and coded disks.

A LOOK AT CODED DISKS AND ENCODERS

THERE ARE SEVERAL DIFFERENT TYPES of shaft position encoders but only 2 main categories—contacting and noncontacting. These include, in the contacting types, those using brushes or commutation elements as the sensing means. The noncontacting category includes those operating on principles of magnetic, capacitive, or photoelectric pickup. Recently effort has been directed toward the improvement of high accuracy photoelectric methods. This effort has been concerned with accuracy improvements on coded disks and readout methods. Also as a result of this effort, economical lower-resolution photoelectric encoders have evolved which compete with the contacting types.

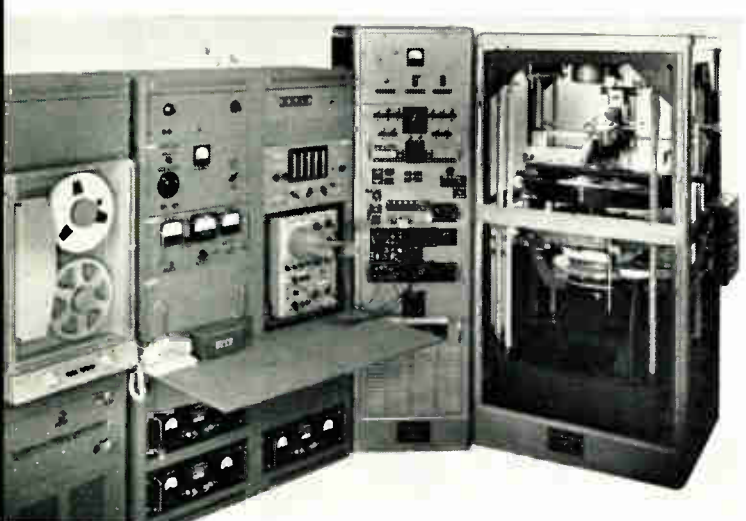
Of the various basic methods of encoding by noncontacting media, photoelectric methods appear to be the most straightforward and advanced for generating digital information from shaft rotation. Among the advantages are the attainment of digital data directly from the coded disk and high accuracy. Only a few elements are needed to comprise a photoelectric shaft position encoder to obtain binary coded information defining the shaft position. These include:

1. A glass disk containing the desired opaque and clear sectioned pattern.
2. Input shaft supported by bearings.
3. A light source.
4. An optical system.
5. Photosensing elements.

Some of the more advanced types need only one low voltage to supply the light source. By using photovoltaic photocells, digital data is obtained directly from the photocell outputs. Thus the photoelectric type affords a simple and direct approach to acquiring digital data. Magnetic and capacitive sensors need excitation supplied by h-f oscillators and some means of detection to resolve digital signals. Usually this results in a more complex and therefore less reliable arrangement compared to photoelectric methods.

Key to the successful performance of the photoelectric encoder centers around the coded glass disk. A machine has been developed to rapidly produce accurate coded disks, which in themselves define the absolute maximum accuracy obtainable from an encoder.

Fig. 1: Divided circle machine consists of two basic sections; a mechanical section (extreme right) comprised mainly of a highly precise turntable and an electronic programming system.



By C. FARRELL WINDER
Baldwin Electronics, Inc.
A Subsidiary of the
D. H. Baldwin Co.
Little Rock, Ark.

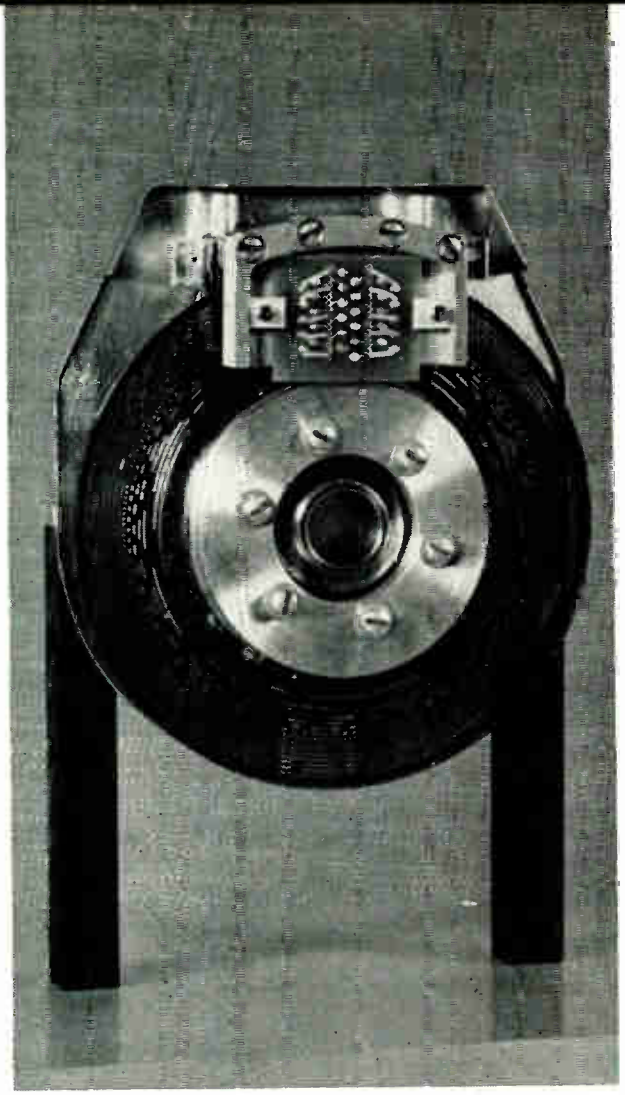


Fig. 2: Small 16-bit absolute reading encoder is only 4.5 in. in dia.

Divided Circle Machine

A machine was designed and developed by Baldwin over a decade ago to make photographic glass disk masters for use in shaft position encoders. By 1959 pattern accuracy of this machine had reached to about one part in 1,048,576 (2^{20}). A Baldwin disk was tested by the Bureau of Standards in Dec., 1959 and certified to 1.6 second positional accuracy.

Recently a fivefold improvement has been attained by use of error reduction methods which were applied to the master reference pattern on the machine. Patterns can now be produced having a positional accuracy of 0.3 seconds of arc and better, i.e., 1 part in better than 4,000,000. An electronic programming section in the machine allows almost any coded pattern to be produced.

Basic Types

The Continuous Lamp Trend: While encoders using gaseous flash lamps have been widely used and are still produced, a scheme using a continuous lamp has been included in a number of new designs. Several advantages are gained by the use of a continuous lamp. One is that only a low voltage is needed to operate the lamps. Usually 6.3 v. or less is enough whereas anode voltages of several hundred volts and trigger voltages of several kw are needed to operate a flash lamp. Also, RFI, which must be carefully shielded in flash lamp designs, is eliminated. Using photovoltaic photocells, only the lamp voltage is needed to operate the basic encoder. Hence the encoder contains a minimum of active elements. This results in high reliability.

Another advantage is that the encoder itself becomes a storage device. Changes in the output occur only when the shaft is rotated. Thus intermediate storage logic to supply related circuitry is unnecessary for some uses. Rate information can also be readily obtained from a continuous-lamp encoder.

Lamp life can be made very long. A slight reduction from rated voltage will increase the lamp life substantially. Generally the lamp is designed to have a life in excess of 5000 hr. at rated voltage. A longer lamp life can be obtained by sacrificing a small amount of encoder output signal.

Amplification is usually needed since the available output direct from photovoltaic photocells is only in the millivolt range. One method, is to use suitable dc amplifiers. Another method is to use a basic R-C coupled amplifier arranged with provisions for pulsed-interrogation of the input. This is generally the preferred method if the encoder and amplifier are to be subjected to wide temperature variations. The pulsed amplifier also serves as a means for interrogation of the encoder position on demand. Some systems operate on an interrogation or sampling basis wherein data is commanded by the system clock signals. The pulsed amplifier permits interrogation rates from any rate greater than zero upwards to several KC. Typical interrogation pulses for Baldwin "TA Series" pulsed amplifiers are 5 v., 5 μsec in magnitude.

"Absolute" or "Full Word" vs "Incremental" Types: For positional data needs, rather than rate data needs, "absolute" or "full word" encoders offer an advantage in reliability over others, such as incremental encoders. Absolute position encoders use a multiple track disk defining the input shaft position in a distinct binary word for each one of the total possible positions definable on a particular disk. The full word disk therefore serves as a permanent storage medium unaffected by the previous history of signals to or from the encoder.

Incremental type encoders are, however, useful for some applications. These usually use a disk having at least one track of equally spaced clear and opaque sections. Another track having at least one narrow

clear section can serve as a zero reference position for the system. These encoders must have a reference position from which to count angular increments as opposed to absolute angular information, which needs no reference position. Since the data is derived in increments, it must be accumulated in some external logic circuitry if it is to represent position. Data on the direction of shaft rotation may be obtained by using the output of a second pickup. Output of this pickup is usually displaced in phase by 90° from the other output. Thus lead-lag data may be resolved through standard methods to feed into a reversible binary counter. One disadvantage of using incremental schemes to determine position is the possibility of incorrect data resulting from false counts being generated by noise transients. Gross errors can also result from power failure.

However, incremental encoders do provide a simple means of generating high accuracy rate data. By taking advantage of the high accuracy disks, which are now being produced, the resultant rate-data accuracy can approach that of the basic disk itself. It should be noted that inherently high accuracy digital data is possible through incremental methods. By using only one track and one or more pickups from the same track, the error that could arise from incorrect relative positionings of multiple tracks, from optics to read such multiple tracks, and from associated radial misalignment of an optical indexing assembly, is eliminated.

High accuracy rate data, which can be obtained from incremental encoders, is finding increased usage in deriving rate information for gyro test tables and gyro gimbal readout.

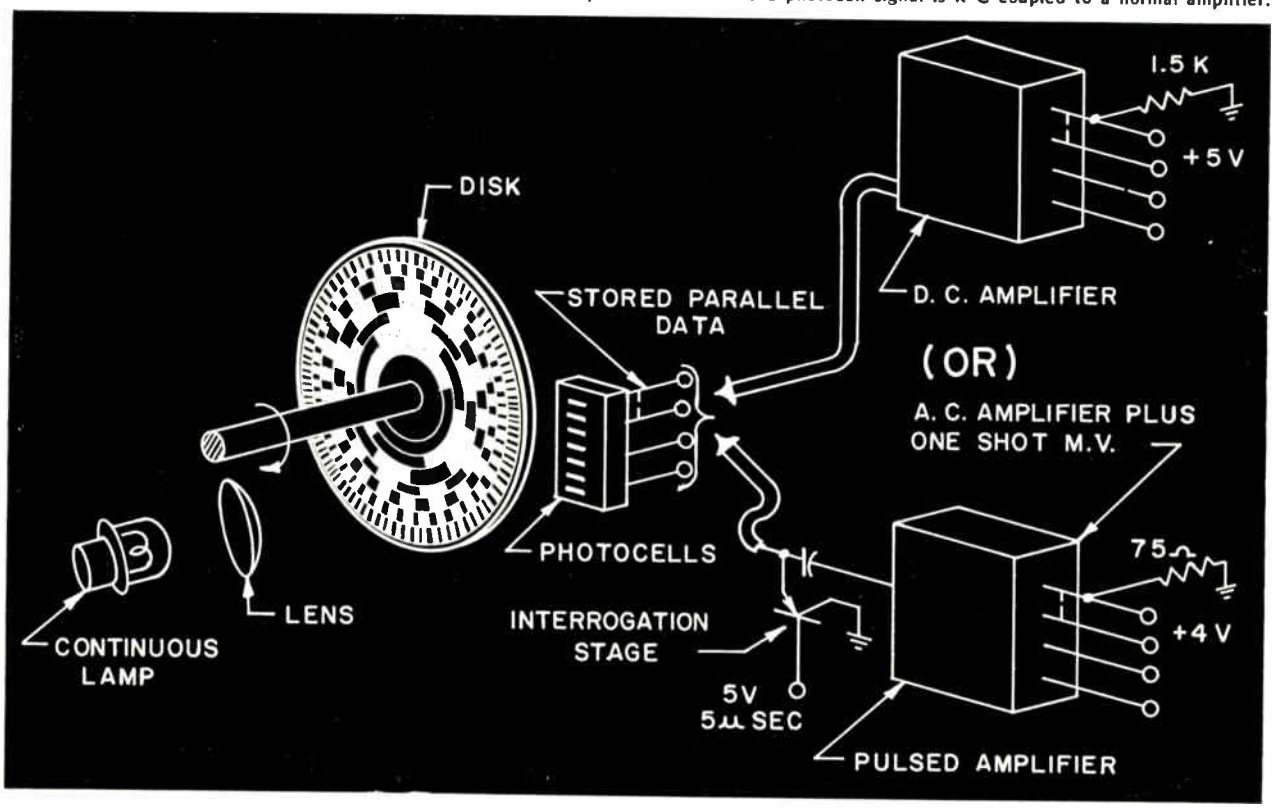
Advanced Models

Prototype One-Inch O.D. 13-Bit Encoder: Within the last year the Baldwin Research group has completed several prototype models of a new type subminiature 13-bit encoder. The effort to develop this design has resulted in a photoelectric encoder with only 1/10 the volume of other models of comparable resolution.

This prototype model is contained in a size 11 synchro package. The package also contains miniature electronics for sequential interrogation[3] of the photocell output signals and a time-shared amplifier. This encoder is provided with a continuous lamp to illuminate the coded disk.

Sequential operation is done through the interrogation of one photocell at a time, in time sequence. Logic within the package performs the function of

Fig. 3: Continuous lamp encoder with optional dc or interrogated amplifier. Operation of the interrogation stage is such that, during interrogation, any signal from the photocell is temporarily reduced to near zero level by the shunting effect of this stage during conduction. When the interrogation pulse is removed the photocell signal is R-C coupled to a normal amplifier.



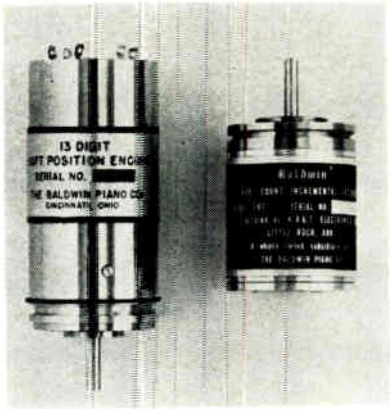


Fig. 4: Unit on the left is a prototype model of a new type subminiature 13-bit encoder. Unit on the right is a new subminiature incremental encoder for gyro rate measurements.

an electronic single-pole, multi-position switch. This switch operates at speeds permitting sample rates up to 1,000,000 digits/sec. Sequential operation of this unit permits the reduction of 13-bit data with only 5 connecting leads to the encoder. These encoders are now undergoing tests and evaluation by a government development lab.

The same packaging and optical methods using high-accuracy subminiature disks have been used to provide a new incremental encoder for gyro rate measurements. This unit features diametrically positioned readouts, direction sensing, cancellation of the dc components of the output signals and provision for increment multiplication. Photocells in this model have been positioned to give two sets of diametrical readouts. This makes possible the elimination of bearing-eccentricity errors.

Solid state circuitry, which provides increment multiplication up to 10 times, can be used with this model. The basic unit provides 600 counts per revolution and multiplication circuitry provides an output of 6000 counts per revolution.

Small 16-Bit Satellite Encoder: A recent advance in compact, high-accuracy, lightweight encoders has been achieved in the design and construction of a 16-bit absolute-reading encoder. This encoder is only 4.5 in. in diameter and is the smallest known photoelectric encoder having this high resolution. It uses an original master code disk to achieve a resolution of 1 part in 65,536.

To meet the needs of space operation, a reliability figure of 97% over a 12,000 hr life was demanded. To meet the severe conditions encountered during launch, a special optical train was devised to function with redundant lamps. Beam splitter optics provides for the light input from the two lamps. Ordinarily only one lamp is operating. If failure should occur in this lamp, the other is turned on by current detection circuitry placed in series with the first lamp.

The encoder weighs less than one lb. The mechanical assembly can serve as an integrated gimbal mounting pivot. This encoder uses a continuous lamp and is operated in the sequential mode. A modified pulsed amplifier arrangement is used wherein 16 interrogation stages operating in sequence are used to feed the common input of a time-shared amplifier. The power consumption of the lamp, the sequential interrogation circuitry and the amplifier is less than 1.7 w. total.

This type package will find increased use on star trackers, attitude reference platforms and inertial systems.

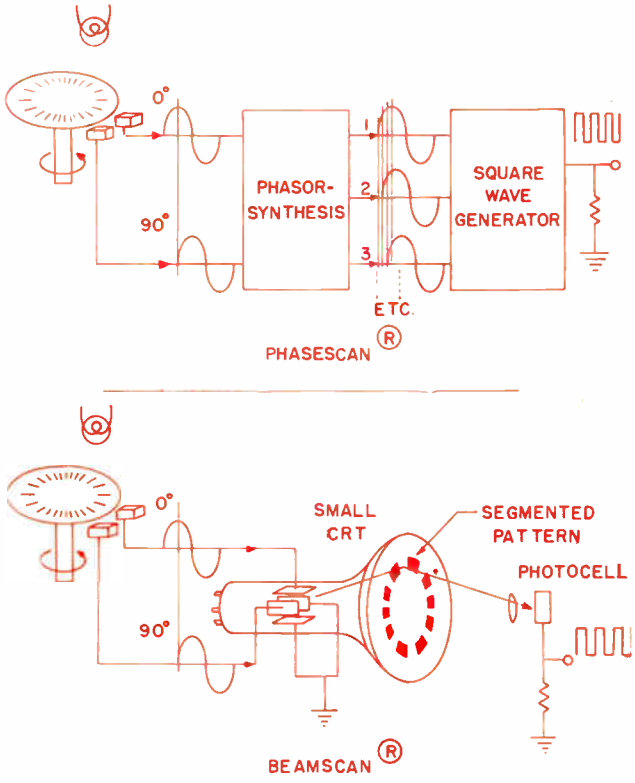
18-Bit Encoder: An achievement made possible only by using the high accuracy disks already discussed is the 18-bit encoder. Its diameter is only 9 7/8 in. and its height only 4 1/16 in.

Its construction is centered around a large dual bearing having a typical runout of only 10 millionths of an inch. This bearing is built to withstand axial loads up to 500 lbs and radial loads up to 6000 lbs. It can therefore serve as a rugged pivot member in a mechanical system.

This encoder uses modular construction throughout with easily replaceable modules for the power supply, amplifiers, and lamp assembly. A hollow shaft version permits a waveguide or optics to pass axially through the center of the encoder.

This encoder has been independently tested using

Fig. 5: Phasescan (upper) and Beamscan (lower) vernier techniques were verified by use of these two test arrangements.



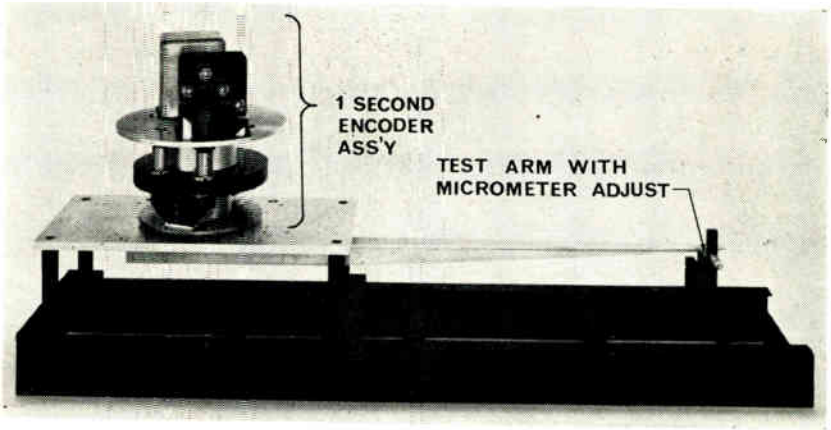


Fig. 6: The one-second encoder is shown on a test stand. In this encoder additional phasors are synthesized to produce a "ten-times" count from a disk having 129,000 increments (ten second-of-arc spacing).

4 autocollimators and an optical polygon having 16 prisms. Absolute accuracy of the prisms was specified as 1.25 secs of arc. Over a 360° positional check maximum deviation was only −3.5 secs of arc from averaged true reference. (Quantum of an 18-bit encoder is 4.94 secs of arc.)

High Resolution Methods: Frequent demands are made for resolutions and accuracies much beyond that now attainable from absolute or full-word coded disks of practical size. Two recent innovations have been used to advance high accuracy readout from photoelectric encoders as described below.

A phasor pickoff method known as Phasescan has been developed to provide outputs with resolution and accuracy in the order of one second of arc over 360° of rotation. This is done with a single disk rotating through only one turn. The basic Phasescan encoder is about 14 in. in diameter by 14 in. deep.

Where very high resolution readout is needed for position measurement such as 1 sec of arc or better, it is desirable to use an absolute reading disk for the coarser reading. Phasescan is then able to provide a vernier reading which is combined with the coarse output of the absolute encoder. Phasescan data is derived from a single track on the disk. The least significant digit (L.S.D.) of the absolute-reading code disk can serve for this purpose. A more ideal arrangement is to provide an added track having a higher multiple of the L.S.D. graduations for derivation of phasescan signals. Phasescan methods can also be used on incremental encoders or tachometers to add vernier readings. The basic principle makes use of photoelectric pickups, which establish an accurate 0° and 90° phase relation from a basic high-accuracy pattern. It should be noted that the resultant vernier data can at best be of only equal accuracy to that of the original disk. Thus the disk accuracy is of paramount importance in the resultant vernier digital output. By composing known encoder outputs to have 90° phase relationships and making these outputs independent of angular velocity, it is possible to synthesize additional phasors.

In the one-second encoder, additional phasors are synthesized to produce a "ten times" count from a disk having 129,600 increments (10 second-of-arc spacing). These phasors, which describe essentially sinusoidal patterns as the disk is rotated, are individually fed into trigger circuits which provide square wave output. For positional data these outputs are combined with the absolute-encoder data to provide a composite output. For tachometer use, the output is applied to a counter. In rate measurements, it is compared to an accurate reference oscillator. Many error compensation features are used so that the output will represent the highest-attainable accuracy. Compensation is applied for errors arising from dc signal shift, variation in lamp voltage, lamp aging, line width variations on the disk, small imperfections on the disk pattern bearing runout, and imperfect disk centering.

Phasescan methods have at the present time an upper limiting factor of about 30-times multiplication. Where still higher resolution data is needed other methods have been successfully shown.

A further innovation of vernier methods, the Beamscan, has been used wherein vernier outputs of up to 100 increments for each input cycle have been realized. A method was described for deriving two waveforms of 90° phase relation. By applying these waveforms to a small CRT, a circular Lissajous pattern is described each time the input waveform completes one cycle. By placing a segmented pattern of alternate opaque and clear sectors over the circular scan, the resultant light output from the CRT represents vernier data of the output. A photocell is used to convert the light output to digital data. By using 129,600 divisions on the encoder disk and a pattern of 100 segments on the CRT, the Beamscan arrangement provides 1/10 sec. of arc increments (one part in 12,960,000 or one part in more than 2^{23}) at the out-

put! These devices have been devised mainly for gyro testing, but the methods are broadly applicable. Experiments with the 1/10 sec. encoder have suggested that the unit would provide very sensitive digital seismometer.

Either the Phasescan or Beamscan methods can be used with coded disks to read out in many ways.

Multiturn Encoders for Numerical Positioning and Control: Digital shaft-position encoders are finding key roles in numerical positioning and control systems. In such uses as machine tool positioning, film readers and X-Y plotters, position data is needed to the order of 0.001 to 0.0001 in. over linear distances up to about 1000 in. maximum. Since rack and pinion arrangements or lead screws can convert linear motion to rotary motion with the required accuracy, then rotary shaft-position encoders are well suited to read out position data.

A typical need might call for readings in thousandths of an inch increments over 100 in. of travel. An encoder arrangement to satisfy this need would be an encoder reading 1000 increments per in. of motion with a rack and pinion converting each linear inch of travel to one turn of rotary motion. A second encoder must then be coupled to the input encoder, e.g., through a gear train, to establish a definite turns ratio between the two. In this example the input encoder would supply 1000 increments per turn and the second encoder would supply 100 increments for a total of 100,000 increments. Since the second encoder is required to supply only 100 increments a 100:1 geared-down arrangement is used to couple the encoders together. This general category of encoders is termed multispeed[7] or multiturn.

Recent improvements in photoelectric encoders have afforded both a decrease in package size and a reduction in manufacturing costs, particularly for the lower-resolution types. Heretofore multiturn encoder arrangements have been provided chiefly by encoders of the contacting type. Some multiturn arrangements using resolvers have been used but they generally need complex logic to derive the desired digital data.

Photoelectric multiturn encoder assemblies offer many outstanding features. Among these advantages, when compared to the contacting types, are the elimination of contacting elements and their attendant problems of wear, bounce, noise and low reliability. With some contacting encoders the brushes or commutating segments must be lifted to prevent severe damage of the sensing elements during high speed slewing or traverse of the machine to which they are attached. Photoelectric encoders obviate this problem. These assemblies can also provide accuracy an

(*Continued on page* F26)

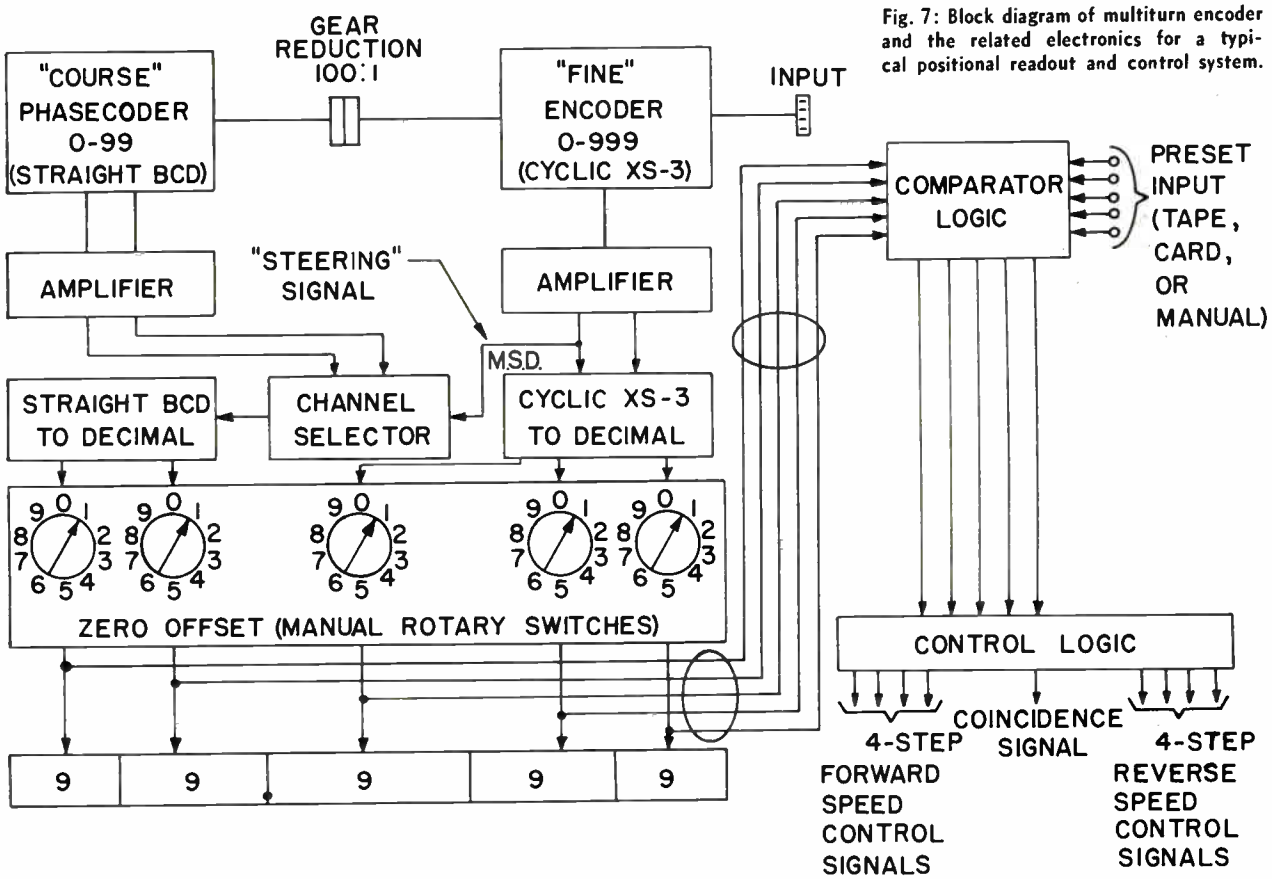
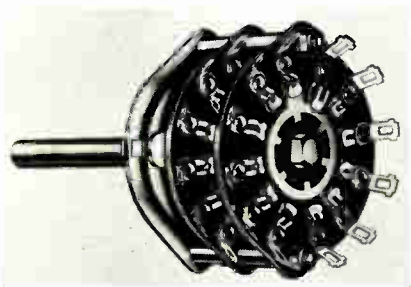


Fig. 7: Block diagram of multiturn encoder and the related electronics for a typical positional readout and control system.

MIL-S-3786A is based on important changes in service needs, availability of new materials and manufacturing techniques. It covers the latest designs in rotary switches. These are shown here so that the equipment engineer can obtain the rotary switch that gives the best performance.

NEW STANDARDS FOR ROTARY SWITCHES

THE EQUIPMENT DESIGNER has many decisions to make when choosing a rotary switch for a specific use. One of the many factors he must consider is to have a switch work under the ambient mechanical stresses imposed. Is size and weight of prime importance; Or is the construction, insulation, or the maximum resistance to adverse environment the governing factor? There are now five types of construction, 3 levels of temperature-life characteristic, 2 basic types of insulation breakdown, 3 grades of vibration, and 2 levels of shock given in revised Specification MIL-S-3786A and Amendment 1. These are indicated in Tables 1 through 5. Each of these characteristics can be interlaced in any combination.



Oak Manufacturing Co. Type 514H.
SR01 Style

Switches designed to meet MIL-S-3786A in the style as indicated are shown.

SR02 Style
Centralab Div./Globe Union Inc. PA-2000 Series.

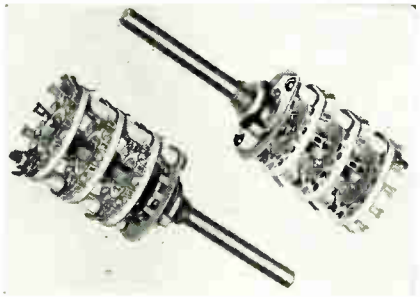


Table 1

Temperature-Life Characteristic.

Symbol	Number of cycles of rotational life	Temperature range (°C)
A	10,000	−65 to +125
B	25,000	−65 to +85
C	25,000	−65 to +125

Table 2

Types of Construction.

Symbol	Construction
B	Closed, without sealed shaft and bushing.
D	Closed, with sealed shaft and bushing.
E	Explosion proof.
N	Open, without sealed shaft or bushing.
S	Open, with sealed shaft and bushing.

SR02 Style
Oak Manufacturing Co. Type N5C.

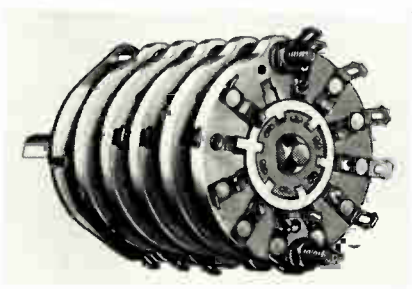


Table 3

Vibration Grades.

Symbol	Frequenc range in CPS
1	10 to 55
2	10 to 500
3	10 to 2,000

Table 4

Shock Types.

Symbol	Type of shock
M	Medium impact
H	High impact

Table 5

Types of Insulation.

Symbol	Insulation material
C	Ceramic
P	Plastic

Present Philosophy

This specification recognizes that it is not practical for the Military to standardize switches to their electrical shape, since rotary switches are one of the last items designed into equipment. The switching circuitry depends on the needs of the particular equipment, in the same way that a transformer is "custom tailored" for special gear. For this reason, no attempt is made to iden-

By IRVING CAROL
Standardization Div.
U.S. Army EMSA
Fort Monmouth, N.J.

tify in the type designation the electrical circuitry, number of poles, positions and type of rotor blade per deck, and number of decks for each style of switch.

Ten detail specifications are presently included in MIL-S-3786A and several more are being processed. Each detail specification covers a widely used style of switch, designated SR01, SR02, etc. The wafer size, front plate and mounting dimensions, and other physical design and construction pertain to that style. The wafers (decks) can be either plastic or ceramic. Any plastic material can be used except cotton-base laminates or wood-flour or cotton-flour filled molding materials. Ceramic material must be grade L422 or a higher grade of Specification MIL-I-10A.

The most prevalent temperature-life available is B (−65° to +85° C for 25,000 cycles of rotation). However, some designs are being made in characteristic A (−65° to +125° C for 10,000 cycles), and C (−65° to +125° C for 25,000 cycles. Also, switches are now available for 50,000 cycles in an ambient of 125° C and a detail specification was recently issued to cover their type in style SR14.

Some manufacturers have already qualified for switches with 2,000 cycles vibration, high-impact shock, or both. As a rule, switches are specified to withstand 2,000 cycles vibration for Air Force use, while for Navy shipboard use, high-impact shock is specified.

The specification takes into account the changing military needs, changes in materials and manufacturing methods, and the increasing new uses for rotary switches. The scope of this specification covers rotary switches for making and breaking current up to 2 a. The specification was formed to be as simple and understandable as possible. The manufacturer's and user's viewpoints were considered in each part of the writing and their opinions were viewed consistent with securing proper quality safeguards.

Centralab, the Electronics Division of Globe Union Inc. Series PA-600.

SR03 Style

The switches seen here are designed to meet MIL-S-3786A in the style indicated for each.

Features in the Specification

The original material to develop MIL-S-3786A was in a prototype specification prepared by the Armour Research Foundation (ARF) for the Wright Air Development Center under contract AF 33(600)—32206. ARF consulted with the various manufacturers of rotary switches while developing a draft. Next, ASESA, acting as agent for the Bureau of Ships, prepared an initial draft from the prototype specification as modified by a services coordination meeting. Comments from circulation of the initial draft were coordinated at a Service-Industry meeting in June 1960. The document was approved for use on 16 Jan. 1961. The subsequent Amendment 1 was likewise coordinated and approved for use on 10 Aug. 1962.

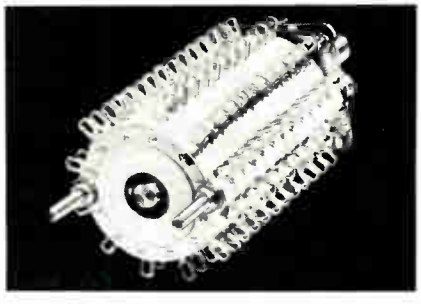
Several new features went into the specification, such as a standard size and location of the nonturn device. Some of the new tests and requirements of this specification include:

1. A solderability test like that now in MIL-STD-202B.

2. A method of terminal identifi-

Oak Manufacturing Co. Type F.

SR03 Style



CTS Corp. military Series 211.

SR03 Style

SR04 Style

Grayhill Inc., 21806 Series.

ROTARY SWITCHES (Concluded)

cation and orientation of deck wafers, as covered in Amendment 1.

3. A standard monitoring method to determine contact opening, if any, under vibration and shock.

4. A method of monitoring contact alignment of the first and last decks during the rotational life test.

During the vibration and medium-impact shock tests, the switches are checked for opening of closed contacts in excess of 10 μsec. For high-impact shock the time allowed is 5 msec.

Monitoring of the first and last decks for alignment during the rotational life test serves to realize the number of decks any switch style can have.

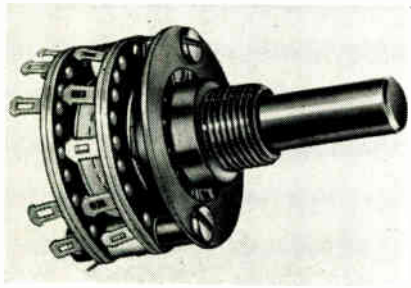
Terminal numbers for open-frame type switches are made visible and arranged CCW when viewed from the rear end of the switch. In addition, each wafer, the front plate, and the terminal identification marking plate (if used), must have a dot near the periphery between terminals 1 and 2 and on the plane facing the view from the rear of the switch. Terminal identification for closed-type switches has numbers, arranged CCW showing rows of the same numbered terminals, and visible from the rear end of the switch.

Discussion of Rotary Switches

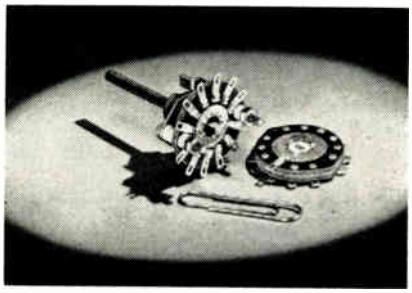
General purpose rotary switches are mostly of the open-construction types. Special needs for enclosed switches but not panel-sealed against moisture are covered by type B construction. Switches to be used where

Seen below are illustrative examples of switches designed to meet MIL-S-3786A in the style which is indicated for each picture.

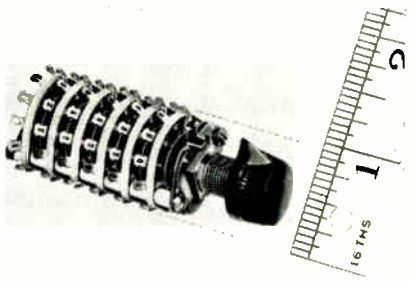
SR05 Style
Oak Manufacturing Co. Type A.



SR05 Style
Centralab Div./Globe Union Inc. Series 100.

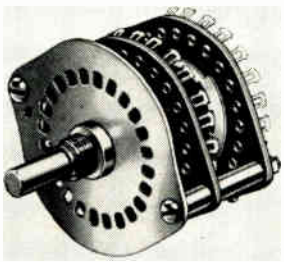


SR05 Style
J-B-T Instruments, Inc. V-7000 & V-5000 Series.

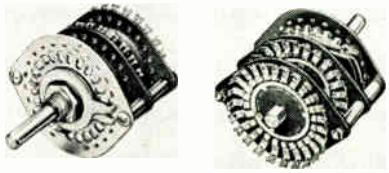


SR08 Style
Electro Switch Corp. Type MAG-12.

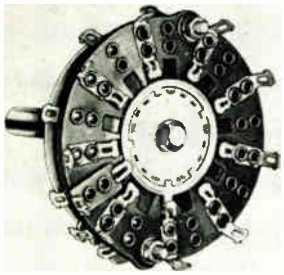
SR09 Style
Oak Manufacturing Co. Type MF.



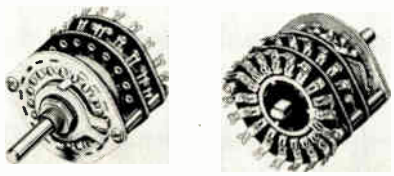
SR09 Style
Centralab Div./Globe Union Inc. Series PA-670



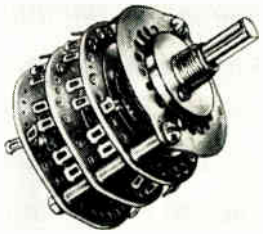
SR10 Style
Oak Manufacturing Co. Type DLX.



SR10 Style
Centralab Div./Globe Union Inc. Series PA-650.



SR11 Style
Oak Manufacturing Co. Type RK.



explosion is a hazard have type E construction. Enclosed panel-sealed switches are covered by type D construction. All switches have requirements for some particular level of vibration and shock as shown in tables 3 and 4.

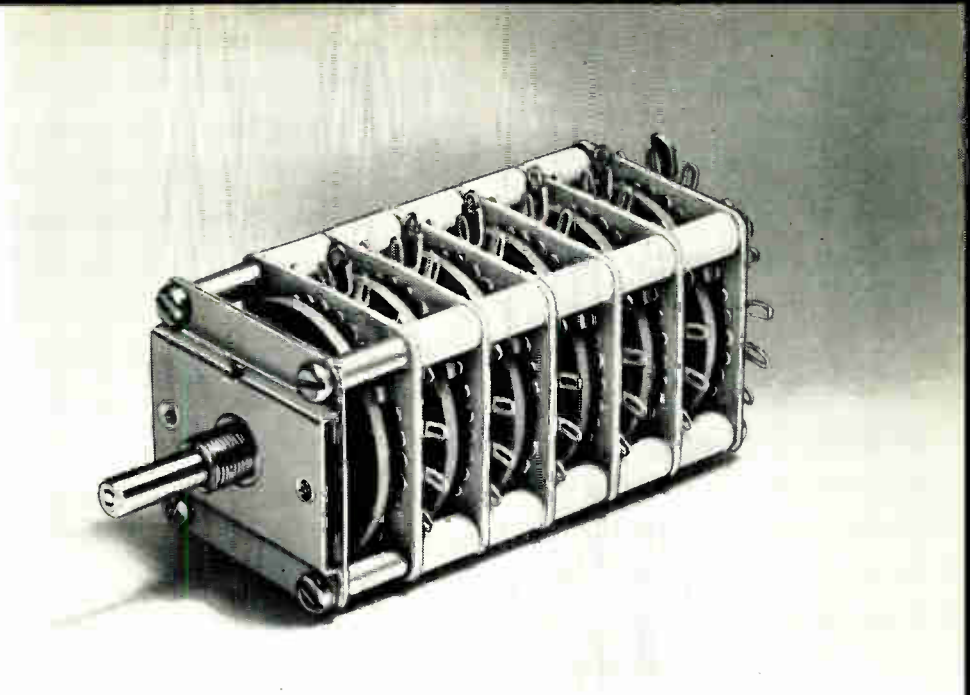
The specification provides for qualification inspection of the styles with detail specifications. For switches without detail specifications, preproduction inspection is allowed, using the same tests and sequence of testing listed for qualification inspection.

For the qualification testing program, several changes were made in the group submission of sample units by Amendment 1. This is to get the greatest coverage by any qualification inspection and thus lower the cost of such testing. By submission and testing extra sample units, qualification can be obtained at the same time for switches rated for medium-impact and high-impact shock, and altitude-rated as well as sea-level-rated switches. In addition, qualification of sealed shaft and bushing switches in turn gives this status to like switches without sealing, also, qualification of higher grade vibration switches covers all switches of lower grade vibration types provided that exactly the same monitoring means is used and the results are the same.

To simplify testing and remove any doubts, the specification lists all environmental conditions, mechanical tests, and check tests and requirements in the specific order in which they are to be performed.

Rotary Switch Specified

It is expected that MIL-S-3786A will have considerable impact on rotary switch design and upon equipment manufacturers. For the standard styles covered by the individual detail specifications, manufacturers of rotary switches are urged to submit their products for qualification, since this will aid the rotary switch market by cutting down on the delay which would normally occur due to constant retesting.



SR14 Style
Shallcross Manufacturing Co. Type SR14-1.

Qualification inspection is the responsibility of the Bureau of Ships. Its administration has been delegated to the Defense Electronic Supply Center, Qualification Division (DESC-EQ), 1507 Wilmington Pike, Dayton 20, Ohio.

To obtain qualification, the rotary switch maker should first write to DESC about the proper procedures and forms. This consists of requesting authority to perform qualification inspection either by a commercial lab approved for testing to MIL-S-3786A by DESC, or in-plant, or a combination of both.

If the in-plant method is used, then an inventory of equipment and facilities needed for the testing is submitted on the proper DESC form. Then the items listed will be physically inspected by an agent of DESC for adequacy and proper calibration.

When the manufacturer receives approval of his in-plant facilities, tests can then be made after authority to test has been obtained from DESC. The tests are monitored by a Government inspector and the data is sent to DESC for study. If the data is satisfactory, DESC will grant qualification for the particular types or styles involved and will list the company on QPL-3786 for those units. Incidentally, this procedure is basically the same for qualification of any electronic component part which is administered by DESC.

Switches with new designs or without a detail specification must have a preproduction inspection. Details relating to the number of samples, place of testing, etc., should be shown in the contractual document. Problems relating to the preproduction inspection, should be discussed with the contracting officer for any information needed.

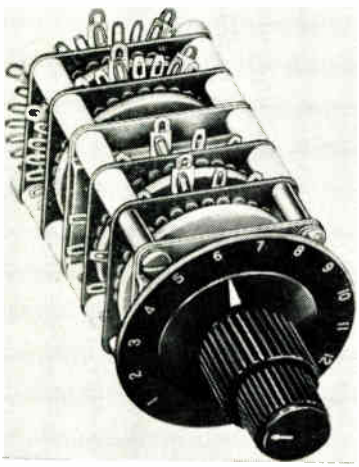
Since rotary switches are generally "custom-tailored" parts, it is necessary, for each switch being procured, that more than one document be used to completely specify the particular switch. Thus, a particular switch design, including the electrical configuration, will be covered by the basic Specification MIL-S-3786A, the particular detail specification for the basic style (e.g., SR03 is covered by MIL-S-3786/3), and ordering data describing the electrical circuitry. For items not covered

ROTARY SWITCHES (Continued)

as a standard style by a detail specification, the ordering data in the basic specification spells out all details normally required to procure a rotary switch to MIL-S-3786A.

Selecting a Switch

Equipment designers are urged to select from rotary switch styles covered by the detail specifications, since most of the widely used ones are included. This will help to omit many of the special designs, which could increase the problems and costs to the Services in stocking them. Special switches, which differ only in minor details from those



Shallcross Manufacturing Co. Type SR14-2.
SR14 Style

covered by the detail specifications, should not be used.

The Services prefer that complete switch assemblies, including the detent and drive, should be normally procured from the switch manufacturer. However, there are uses where equipment manufacturers find a need to procure separate sections for a special switch assembly. In a case like this, it is the responsibility of the user to determine that switching assemblies made from separate sections are capable of passing the rotational life testing listed in Group V of the Qualification Inspection Table VII of MIL-S-3786A.

For added protection of rotary switches, which are to be mounted on panels which will be exposed to moisture or dust, panel seal boots should be installed which are in accordance with Type C of Specification MIL-B-5423B. For watertight switches the Bureau of Ships prefers this method in lieu of having manufacturers undercut and put "O" rings in shafts to meet the watertight test.

The author wishes to acknowledge the efforts of Mr. George Fogleman of the Bureau of Ships in filling in details about the historical background of MIL-S-3786A and his suggestions and comments relative to this article.

GLOSSARY OF ROTARY SWITCH TERMS

Prepared by John M. Kikta, Chief Engineer
Grayhill, Inc., La Grange, Ill.

ROTARY SWITCH—An electromechanical device which is capable of selecting, making or breaking an electrical circuit and is actuated by a rotational torque applied to its shaft.

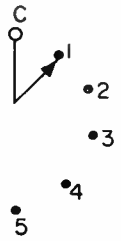
ADJUSTABLE STOPS—Usually the stop mechanism is at the shaft end of the switch, such that once the switch is assembled to a panel, the stops cannot be readjusted unless the switch is removed. Some have adjustable stops at the rear of the switch, so that the total angle of throw between stops can be altered while the switch is mounted. These stops are usually independent of the detent and contact systems, which are not disturbed when the stops are being adjusted.

ANGLE OF THROW — The number of degrees of rotation through which the shaft travels in moving from one position to the next consecutive position. (This term is at times wrongly used conversely with "indexing").

BI-DIRECTIONAL ROTATION — Switch shaft may be rotated either CW or CCW.

BUSHING PROJECTIONS — That portion of the threaded mounting bushing (if the switch is so equipped) which projects beyond the mounting surface.

COMMON, OR COLLECTOR — Also called a "pole terminal." That side of a switch circuit which is common to all other parts through the rotating elements. The diagram below shows a simple single pole, 5-position switch which will suffice as an example. "C" is the common terminal.



CONTACT AGREEMENT—The circuitry of the switch and/or the physical location of terminals and contacts on a switch section, or deck.

CONTACT CLIPS—Many open frame switches use clip type or clam shell contacts wherein the spring portion of the contact and the terminal, or soldering lug, are one piece. Eyeletted to the wafer, or stator portion, they provide a versatile (from the switch circuit standpoint) switching arrangement.

CONTACT FORCE — The amount of force exerted by one side of a pair of closed contacts upon the other side. Sometimes called contact pressure.

CONTACT RESISTANCE — The resistance of a pair of closed contacts.

CONTACT VOLTAGE DROP—That drop measured across a pair of closed contacts.

CONTINUOUS ROTATION — A switch provided without stops so that continuous rotation of 360° in either direction is possible.

CYCLE OF OPERATION — Defined in several ways, but mostly as rotation of a switch from one stop to the other stop and return. In the case of a continuous rotation switch, it would be rotation from position #1 through position #12 and return (for a 12-position switch).

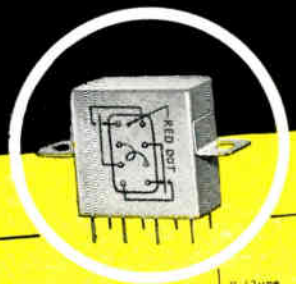
DETENT—This is the quick stop arrangement which enables your hand to feel its way from one position of a switch to another. (A good detent system will have a long life with a minimum torque reduction or loss of feel across its normal life span. It will be positive in that there will be little or no back lash or play on any position. The rate of torque change when rotating from one position to the next should be such that there is no tendency to overrun, i.e., rotate from position #1 to position #3 when you want to be on position #2).

DOUBLE END MOUNTING—Some relatively long switches tend to twist so that it is advisable to use rear end mounting support in addition to the front end support. Switches usually have some means (extended through bolts, etc.) for fastening the rear of the switch to a bracket.

ENCLOSED SWITCHES—Those with all parts of the switch enclosed by some type of housing. (This does not mean hermetically sealed).

FIXED STOPS—Stops which are built into the switch to limit rotation of the switch to a pre-determined number of positions. **(Continued on page F29)**

If you're interested in MILITARY-TYPE RELAY RELIABILITY...



C. P. CLARE & CO.
TYPE F RELAY CONTACT LIFE RELIABILITY
As of February 28, 1963

Test Conditions	Ambient Temp.	Failure Criteria	Relays Tested	Operations Per Relay	Total Relay Operations	Early Failure Period Ends (Estimated Operations)	Wear Out Period Begins (Estimated Operations)	(1) Failure Rate per 10,000 operations (2) Reliability Level per 10,000 operations At 90% Confidence Level
Low Level - 10 mv. open ckt. volt, 10 μa, 3 cps. Contacts in series. Checked each 10^6 operations for electrical parameters.	+25°C	Contact resistance > 100Ω on 4 or more operations	407	Up to 8×10^6	381.5×10^6	5000	8×10^6	(1) .158% (2) 99.8%
1.0 ampere, 28 VDC res. Each leg loaded individually. Checked each 10^6 operations for electrical parameters.	+25°C	Welding. No continuity. Contact resistance > 1Ω after test	62	Up to 10×10^6	218.5×10^6	N/A	10×10^6	(1) .054% (2) 99.9%
2.0 ampere, 28 VDC res. Each leg loaded individually. Checked each 2.5×10^5 operations for electrical parameters.	+25°C	Welding. No continuity. Contact resistance > 1Ω after test	66	Up to 1×10^6	62.1×10^6	N/A	1×10^6	(1) .084% (2) 99.9%
3.0 ampere, 28 VDC res. Each leg loaded individually. Checked each 10^5 operations for electrical parameters.	+25°C	Welding. No continuity. Contact resistance > 1Ω after test	61	Up to 4×10^5	22.8×10^6	N/A	4×10^5	(1) .519% (2) 99.5%
1.0 ampere, 28 VDC res. Each leg loaded individually. Checked after 10^5 operations for electrical parameters.	+125°C	Welding. No continuity. Contact resistance > 1Ω after test	257	Up to 5×10^6	25.4×10^6	N/A	1×10^6	(1) .306% (2) 99.7%
2.0 ampere, 28 VDC res. Each leg loaded individually. Checked after 10^5 operations for electrical parameters.	+125°C	Welding. No continuity. Contact resistance > 1Ω after test	230	Up to 2.5×10^5	22.3×10^6	N/A	2.5×10^5	(1) .834% (2) 99.2%

draw your own conclusions!

This Clare Relay Reliability Report may be different from some other reports you have seen. For example:

***a*—This data covers standard, production-line relays sampled and tested on a weekly basis.**

***b*—This Report gives the results of a formally-defined Quality Assurance Program, details of which are available for the asking.**

***c*—Data is reported in terms of relay operations, not contact operations. Each operation of a dpdt relay requires four contact operations. Relay operations present the most stringent measurement of reliability.**

***d*—Reliability levels reported above are derived by a recognized statistical method which produces reliability figures of assured authenticity.**

What does this Reliability Report mean to the user of Military Type Relays? You'll draw your own conclusions, of course. But here are two comments which will be important to you if you're concerned with reliability:

1—Clare Relay Reliability statements are completely factual—backed by specific data compiled in actual, routine tests on standard Type F Relays.

2—Every Clare Type F Relay—including those you are now using—carries the same assurance of quality and reliability.

Produced on a mature, controlled-process, large-volume production line, Clare Military-Type Relays are available to you at competitive prices and delivery.

Clare Type F Relays provide non-polarized, single side stable, single coil operation.

Operate times: 3.5 ms nominal, 5.0 ms maximum (including bounce), at nominal coil power.

Release times: 1.0 ms nominal, 5.0 ms maximum (including bounce), coil not suppressed.

Sensitivity: Just-operate power 250 mw.

(All ratings at +25°C ambient)

For additional information on Clare Military-Type Relays, circle Reader Service Number below . . . or address Group 6D7, C. P. Clare & Co., 3101 Pratt Boulevard, Chicago 45, Illinois.

TYPE F ENVIRONMENTAL TESTING/Mil-R-5757D
(Summary of Test Results from Clare Quality Assurance Program)

Relays Tested	Temperature Cycling —65°C to +125°C	Mechanical Shock 65g—11ms half sine	Vibration 10-2000 cps .125" da—20g
235	2 failures (at low temp)	0 failures	6 failures (all over 15g at > 1000 cps)

CLARE®

Relays and related control components

There is a general and serious lack of knowledge about these electromechanical devices. This is partly due to the fact that constant advances have been made in the past few years, and in part owing to the requirements of military security. This article is presented to help fill the void.

PROGRESS IN TELEMETERING AND PULSING DEVICES

TELEMETERING DEVICES RECEIVE MULTIPLE SIGNAL INPUTS, scan them at a prescribed time sequence and transfer all of the signals to one output pulse train. Pulsing devices are akin to telemetering devices in internal construction but they take only one input and "chop" it into a pulsed output which can be used for timing or counting. The difference between these devices is shown in Fig. 1.

Since telemetering and pulsing devices are so similar, our discussion will apply to both types.

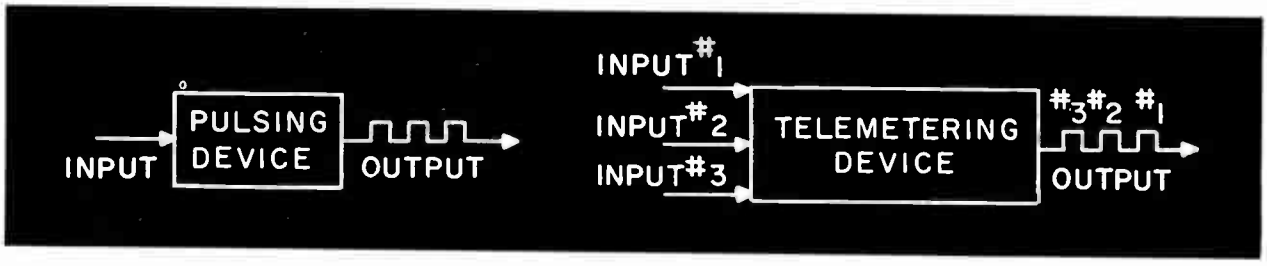
Basic Definitions

Let us review some basic terms used in telemetering and pulsing devices.

Channel: This is the contact of the commutator. It may be shorting (make-before-break) or non-shorting (break-before-make), depending upon which is required.

Sampling Rate: This is the number of times a particular channel is sampled in a second.

Fig. 1: With regard to their function, these diagrams show the difference between the two types of devices named in the blocks.



The systems designer can choose from several types of telemetering and pulsing devices found in one of the following basic categories:

1. Motor driven electromechanical units.
   a. Conventional types (brushes and contacts)
   b. Mercury jet
   c. Ball bearings
   d. Magnetic reeds
2. Stationary devices (electronic solid state).
   a. Conventional solid state
   b. Beam switching tube commutator
   c. Hall effect generator
   d. Magnetic switching of elements immersed in a conducting liquid.

In this discussion, however, we will limit ourselves only to the description and operation of the electromechanical devices.

Duty Cycle: Channel duty cycle is defined as the ratio of the channel on time and the channel period. See Fig. 2.

Noise: Best described as the difference in pulse leading and trailing edges when compared to the theoretical pulse. See Fig. 3.

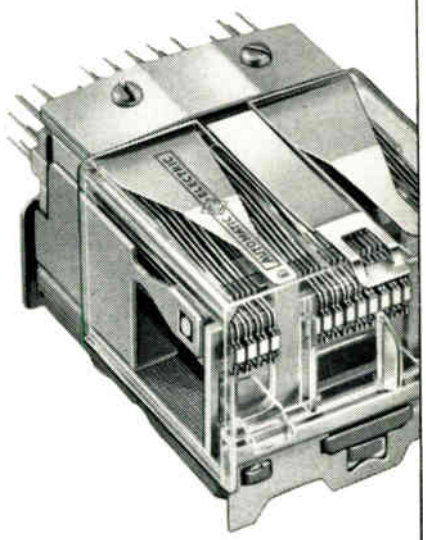
Pole: A pole is one complete circuit of multiple inputs and one output. Most units presently being manufactured are multipole.

Contact Resistance: The actual resistance at

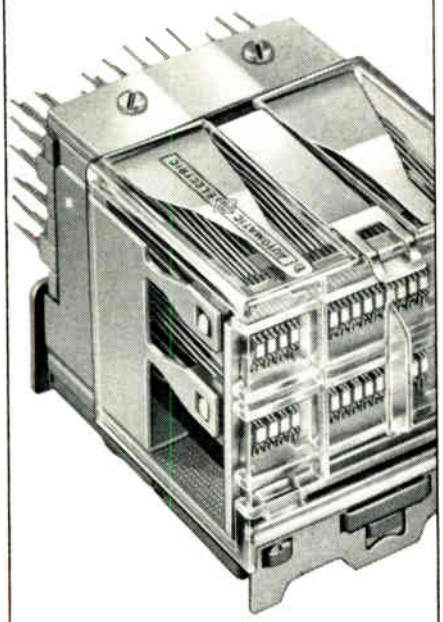
By GEORGE MERKER
Director of Engineering
Gyrex, Inc.
38 Irving Place
Garfield, N.J.

and JOHN J. PIRET
Chief Engineer
Airflyte Electronics Co.
535 Avenue A.
Bayonne, N.J.

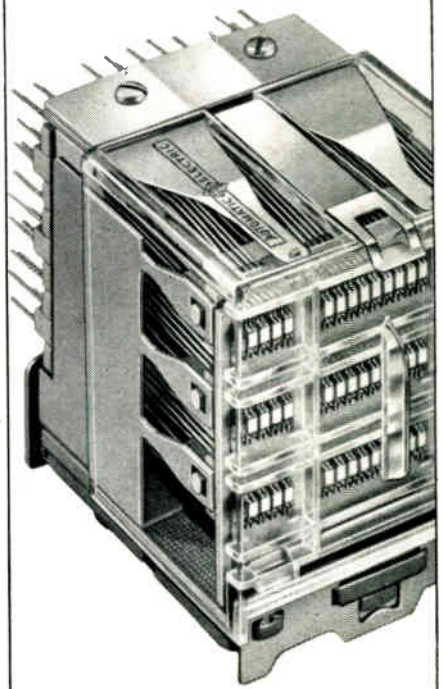
17...



34...



51...shift
in one fast play



Assuring the simultaneous transfer of circuits in a multiple-relay group is one of the trickier problems faced by electrical and electronic engineers. AE's happy solution is the WQA Relay—the first industrial-control component specifically designed for uniform transfer of up to 51 circuits.

The modular construction of the WQA permits one, two or three rows of contact forms, each with a capacity for 17 circuit transfers. Unique, compact design saves valuable mounting space, replacing 4 or more "general-purpose" relays. Remarkably sensitive, even the largest pile-up requires less than 6 watts input. Continuing tests show a life expectancy of over 800 million operations without readjustment.

• • •

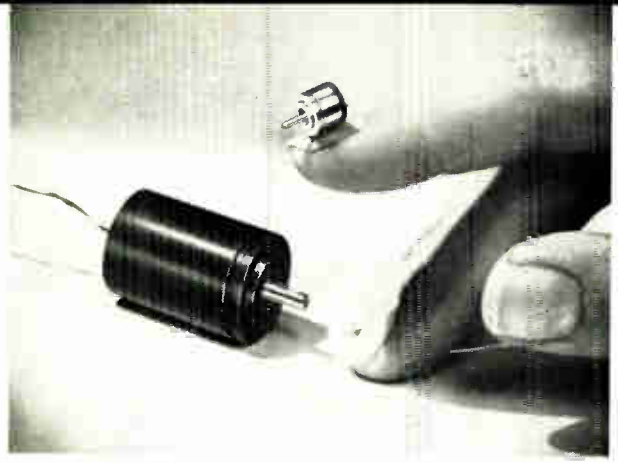
For full information, ask for Circular 1957-B. Write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

AUTOMATIC ELECTRIC

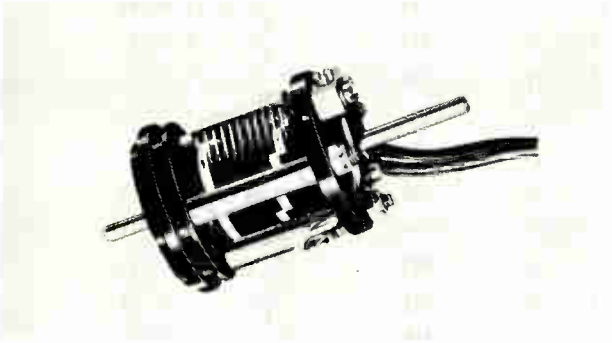
Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

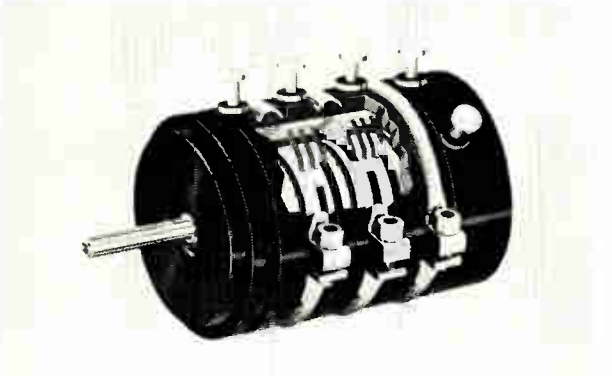
GENERAL SYSTEM



Size 3(0.27 in. OD) and size 8(0.75 in. OD) telemetering switches differ as above. Performance characteristics are similar.



Above is a close-up view of a telemetering switch which is rather small in size. There are 10 channels incorporated in this device.



The device shown in the above cutaway view is called a phase-adjustable switch. Striations in the brushes of the model are seen.

AUTHORS

George Merker

John J. Piret

TELEMETERING DEVICES (Continued)

the contact interface. This is measured with the leads in the circuit but the actual resistance of the leads are subtracted from the total.

Efficiency of Conversion: The conversion efficiency is the nominal incremental output amplitude with respect to the input signal.

Switch Accuracy: This is the maximum allowable deviation of any channel from the nominal switching function.

Phasing: In the case of multi-pole units, phasing is defined as the maximum allowable deviation between corresponding pulses on each pole (Fig. 4).

Design Considerations

In selecting the proper commutator these requirements should be considered:

1. Sampling speed
2. Power required
3. Signal level of input
4. Size
5. Weight
6. Physical requirements
7. Life
8. Accuracy
9. Reliability
10. Cost.

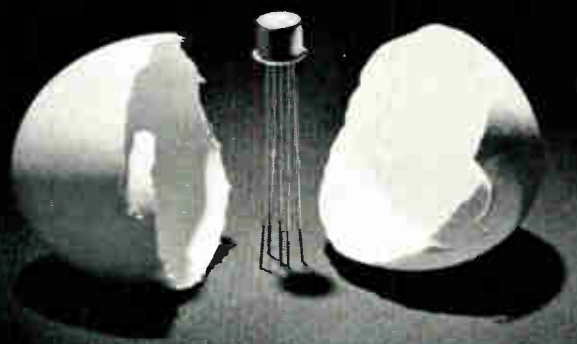
The order in which the above are listed is not a measure of their relative importance since any factor can be in the major area of possible conflict.

1. Sampling Speed: This has been defined as a rate. In mechanical devices the sampling rate should be less than 1000 samples per sec. Above that, an electronic switch should be considered, especially if long life is required. The sampling rate, depending on a fixed-speed motor, is held constant. Since this might be a drawback, it is possible to obtain a variable-speed device by controlling the deviation of the fundamental pulse frequency. The information is then fed into a simple closed loop to control the speed.

2. Power: As a rule, electromechanical devices require more power than electronic systems since there are moving elements which represent frictional losses. The required power is about 2 watts dc, but this is actually determined by the size of the commutator which is related to the number of poles and channels.

3. Signal Level Input: In mechanical commutation the signal level is usually in the low mv. range

(*Continued on page* F18)



RELAY breakthrough !

The smallest SPDT Relay available for immediate delivery.

TC-5 transistor case size.
DC coil voltages: 1.5 to 32 volts.
Operate power: 100 milliwatts at pull-in.
Operate time: 1.5 milliseconds max.
Dissipation: 0.3 watts at rated voltage.

All-welded construction.
1,000,000 operations at 125° C at 0.5 amp.
100,000 operations at 1 amp.
10,000,000 operations at low level.
Continuous duty.

Dry circuit to 1 amp.
Vibration: 30 G's to 3,000 cps.
Shock: 80 G's, 11 milliseconds.
Meets requirements of MIL-R-5757D.

PATENT APPLIED FOR.

Contact: Your local Teledyne Precision Representative or Teledyne Precision, Inc., a subsidiary of Teledyne, Inc., 3155 El Segundo Boulevard, Hawthorne, California. 679-1186.

TELEDYNE
PRECISION, INC.

to keep the commutating noise down. A level of 10 to 15 mv. is about normal with noise in the 50 μv. region. The noise is a function of many variables such as contact material surface condition, speed of rotation and magnetic or capacitive pickup.

4. Size: This is difficult to define. For reliable airborne use, a switching device must meet shock, vibration, acceleration and other physical requirements. Size is directly related to these requirements and is normally in the range of 20 cu. in.

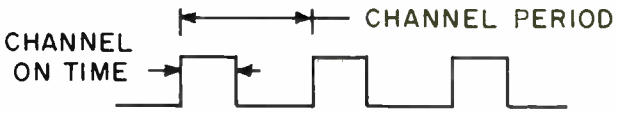


Fig. 2: Duty cycle is defined as ratio of the two terms given.

5. Weight: This is a function of the size and must follow the same steps. By using high-strength alloys and miniaturized components, it is possible to reduce weight. This should not be done at the expense of reliability. Depending on the number of channels and poles, the mechanical units weigh from 0.5 to 5 lbs.

6. Physical Requirements: These must be considered very carefully: Shock, random or sinusoidal vibration, acceleration, humidity and temperature extremes and vacuum (to 10^{-8}mm Hg). All have resultant effects on the performance, life and size of the device. To over-specify is to make the design more precarious, less reliable and quite costly. Often the requirements for a switch are the same as the entire system, although it will only be subjected partially to these tests.

7. Life: Can be defined as the useful life or the point at which the output can no longer serve as the useful signal. As a rule 300 hrs. is a practical duration. The life is not only based on the output of the commutator but also on the life of the motor, bearings, and other mechanical elements. Outside factors such as continuous vibration and shock can further shorten the life.

8. Accuracy: Accuracy in the electromechanical commutator is normally held to ±0.5°. It can easily be converted to a time base accuracy or a percentage, if the speed of rotation and the number of channels is known. If the system designer selects components which require the commutator to have a tolerance less than ±0.25°, it will be difficult and costly to obtain a satisfactory telemetering switch.

9. Reliability, or satellite and missile use reliability is of the prime importance. It can only be achieved by stringent control of materials, assembly by qualified personnel in white room areas and extensive testing of each unit before shipment.

10. Cost: This can become a stumbling block but, to meet all requirements, great care must be given to the design, manufacture and testing of the device. The actual price of the commutating switch is a small part of the cost of the entire system. However, performance should be the determining factor.

Electromechanical Devices

Since we mentioned types of electromechanical devices, it is well to describe these in detail.

The basic electromechanical device (Fig. 5) consists of a circular plate of insulating material having a series of equally-spaced contacts. A collector ring completes the circuit. Each contact is wired to a given point. A set of rotating wipers (brushes), connected directly (or through a gear train) to the motor, makes and breaks continuously over the surface. The entire unit is enclosed in a housing and pin terminals or leads protrude from the unit. (This is basic for all types of switching devices.)

This is the simplest type of switch and can accommodate as many as 500 channels per pole. However, the ones mostly used have about 100 channels and 2 poles.

Failure of these units usually occurs between wipers and contacts in one of two ways. Buildup of metal particles between segments will short them out,

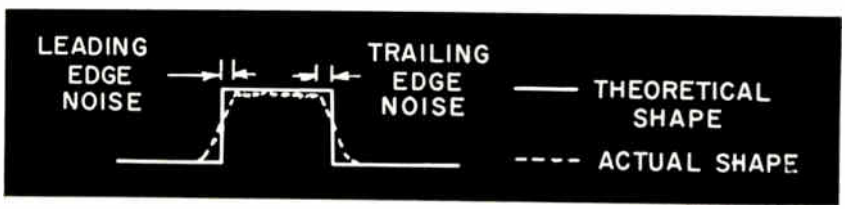


Fig. 3: The difference between the real and the ideal pulse is due to noise.

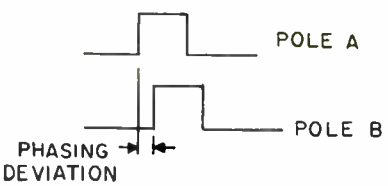
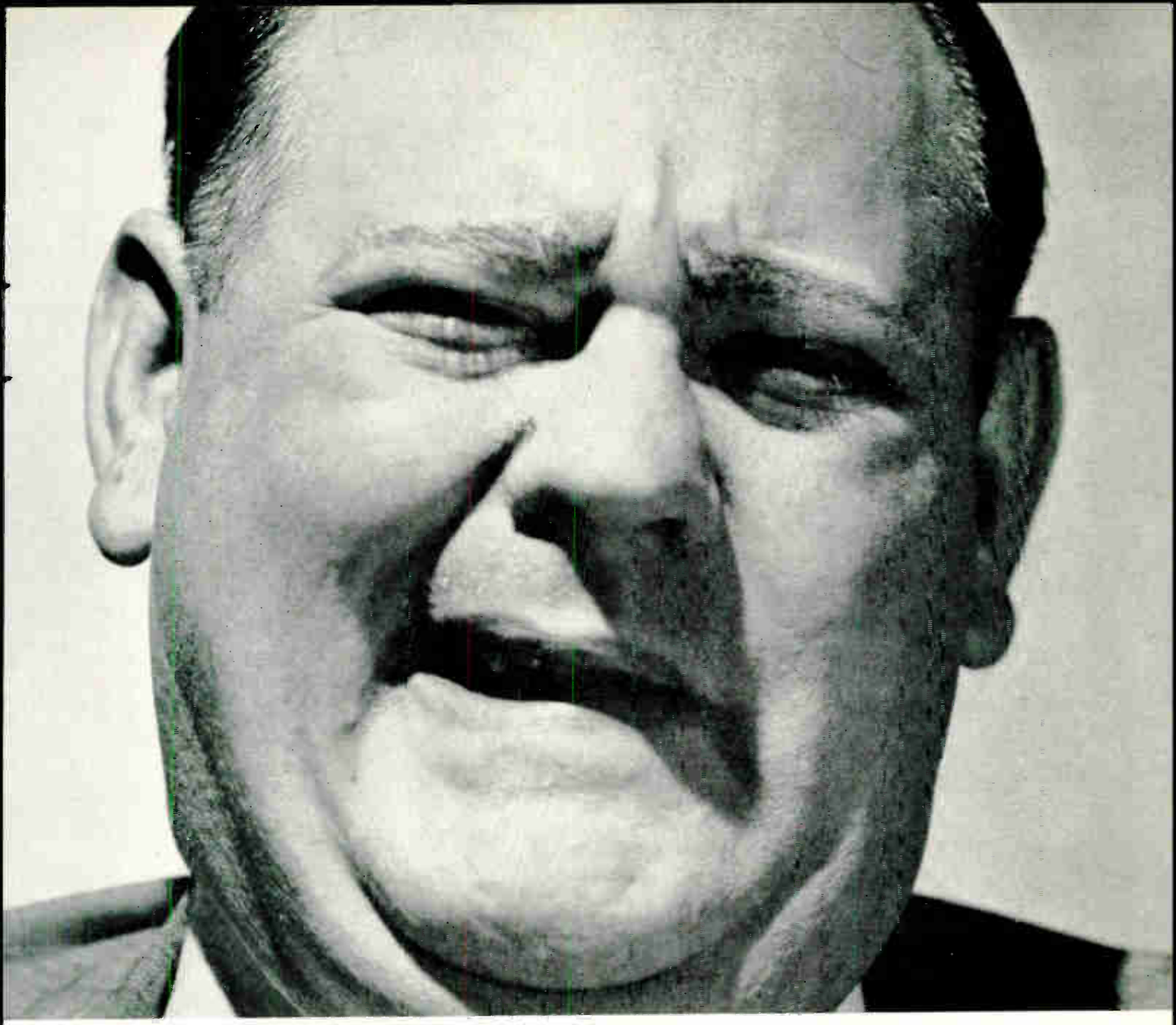


Fig. 4: Phasing in multi-pole units.

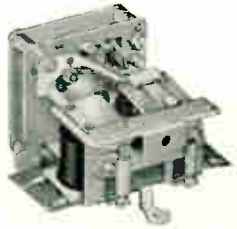


"You tryin' to tell me how to design homing devices?"

No offense, mister, but you know how some things get to be habit-forming. Many experienced designers are so accustomed to using banks of relays and switches for multiple circuitry that they overlook the important advantages of simplified STEPPING. By replacing a bank of complicated devices with a compact Guardian Stepper, you *increase dependability, prolong the life of circuitry,* and reduce costs. The fewer components in your multiple circuitry, the fewer chances for a breakdown. That's why leading designers who place a premium on dependability are now switching to Guardian Steppers.

GUARDIAN STEPPERS CAN DO A JOB FOR YOU! Sequence selecting • Slave and Master • Automatic Resetting • Automatic Homing • Continuous Rotation • Add and Subtract • Circuit Selecting • Remote Homing • Pulse Multiplying • Pulse Dividing • Programming • Latching • Counting • Custom Designs

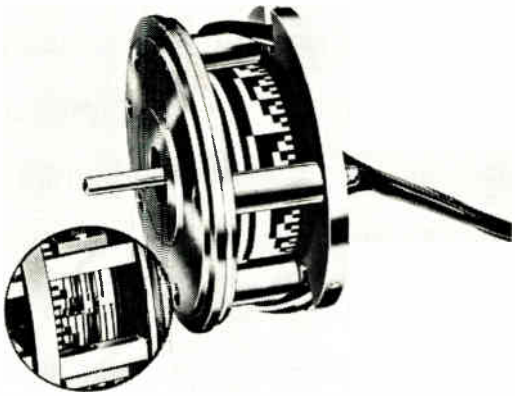
Call your Guardian Distributor or Write for Latest Catalog and Application Information.



GUARDIAN STEPPERS

GUARDIAN ELECTRIC MANUFACTURING COMPANY • 1550 W. CARROLL AVE., DEPT. EI-36 • CHICAGO 7, ILL. • Phone CH 3-1100

Circle 128 on Inquiry Card



Above is a 128-count true binary encoder. Brushes and segments of this A-D encoder are magnified as brought out in the circle.

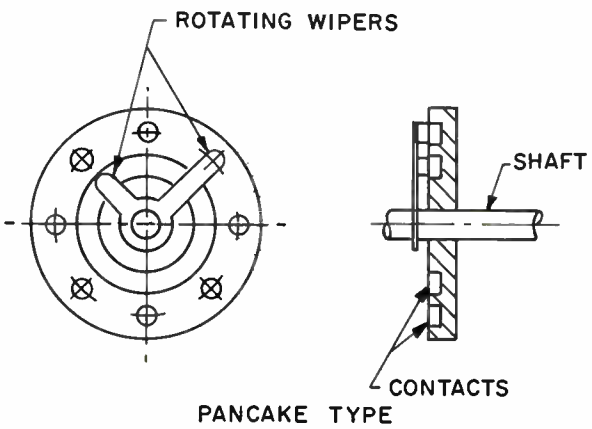
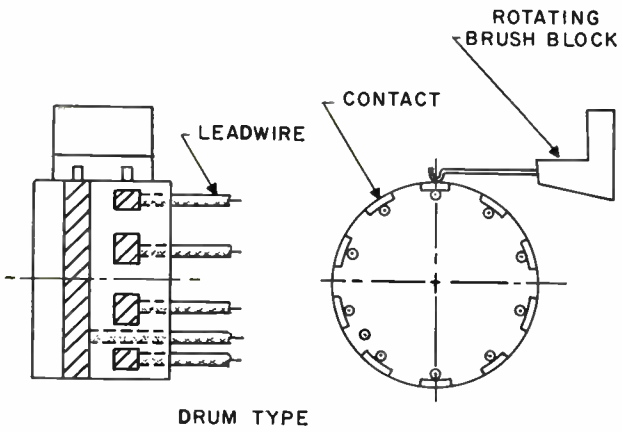


Fig. 5: Views of two basic forms of an electromechanical switch. These switches can have up to 500 channels for each pole. An entire unit is enclosed in a housing with leads coming out.



A REPRINT OF THIS ARTICLE CAN BE OBTAINED
by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

or tracking of insulation will cause opens. The result of a decrease in insulation resistance is a marked change in timing.

Catastrophic failure, such as motor burn out or bearing seizure, is possible. Increased joint effort between motor and switch manufacturers will help decrease the probability of such failures.

Since friction due to sliding motion and its resultant wear is a serious problem, other devices have been engineered. In the electromechanical field these are types worthy of discussion.

1. Mercury Jet: In this particular design a mercury jet impinges on a circle of contact pins located outside the rotor periphery. The mercury is then returned to a pump by gravity. It is lifted through a small centrifugal pump and pushed through a nozzle. While the stream is in contact with a terminal, a low resistance contact is made with the pool which is the common ground. Decks can be stacked to provide multipole construction. Noise is expected to be quite low since there is no contact bounce. Up to 120 samples at 6000 RPM have been obtained successfully. Size may become a problem with this type of switch.

2. Ball Bearing: This device consists of a miniature ball bearing which, by using rolling contact, sequentially dimples teflon-backed foil to provide contact between the segments. A motor drives the arm to which the ball is attached. About 60 channels per pole can be obtained but wafers can be stacked to obtain more poles. Really low contact resistance and life of 1000 hrs. is claimed for this device although motor failure is said to be the major problem rather than wear.

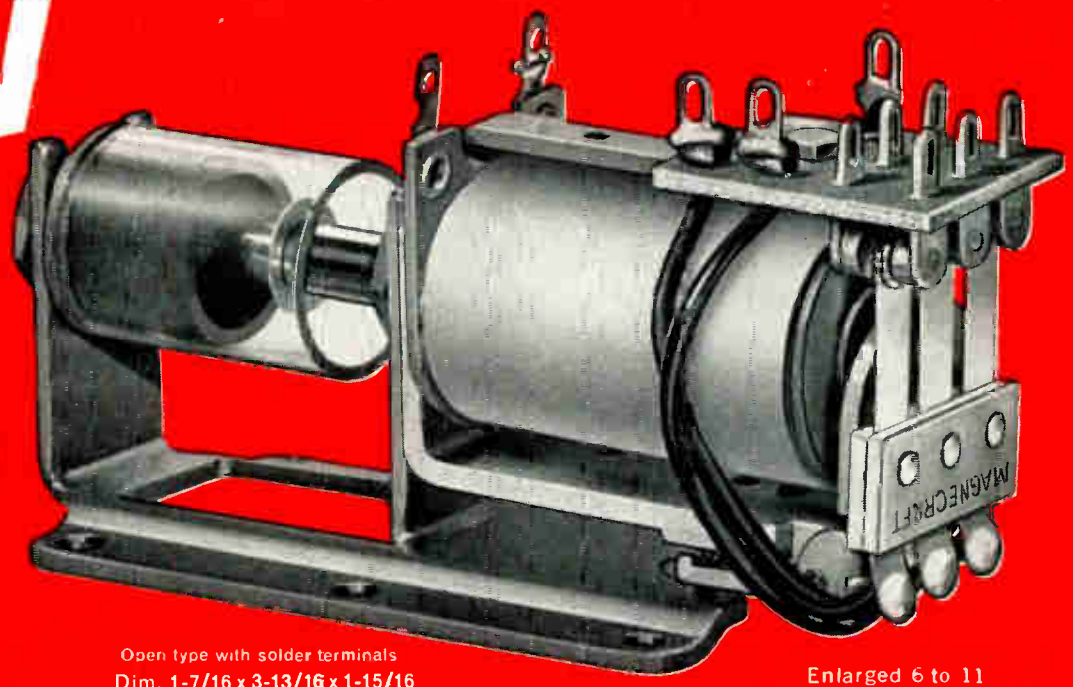
3. Magnetic Reeds: This consists of a number of magnetic reed switches placed around the given circumference of a circle. Closing and opening of the switches is done by a rotating magnet mounted on an arm attached to a motor. Shorting and nonshorting can be effected by proper wiring. The contacts, hermetically sealed in a glass tube, can operate for a long time in corrosive atmospheres. Response time is about 1 msec. For a given size, there are fewer poles in the continuously rotating switch, due to its having the glass tube.

A-D Encoders

Analog-to-digital encoders provide accurate electrical digital readouts, usually in the form of true binary, binary-coded decimal or gray code, which describes the position of a controlling shaft. The electrical readout is fed, through logic circuitry, to a computer or lamp bank display to obtain meaning-

New

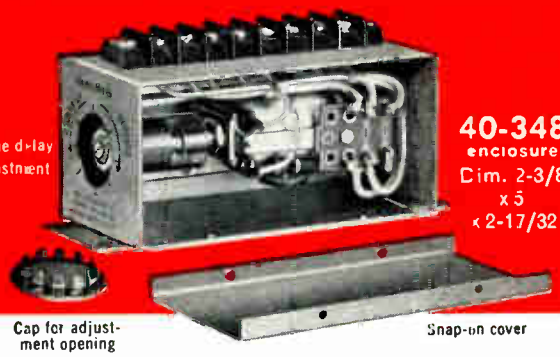
MAGNECRAFT Class 110 Air Dashpot TIME DELAY RELAY AC & DC



Open type with solder terminals
Dim. 1-7/16 x 3-13/16 x 1-15/16

Enlarged 6 to 11

IN STOCK FOR IMMEDIATE SHIPMENT



MAGNECRAFT 110/40-348 Relay and Cover

110 Air Dashpot Time Delay Relay in heavy duty metal enclosure 40-348 with molded phenolic barrier screw type terminal block and snap-on cover. Snap-on cap provides access to timing screw.

Contact Combinations and Ratings

Furnished for AC* and DC operation: open type, in 40-347 plug-in enc. and in 40-348 style enc.

SPDT, DPDT and 3PDT with 10-ampere rating.
DPDT with 15-ampere rating.
SPDT-ND Double Break with 50-ampere rating.

*AC models have built-in diode rectification.

Stocked by Leading Distributors

Call Sales Representative near you for information about MAGNECRAFT 110 Time Delay Relays or names of distributors in your area.

Phone numbers of Sales Representatives.

CALIF	Los Angeles, NO 3-8236	N H	Manchester, 472-4091
COLO	Littleton, 798-0922	N J	Livingston, IN 3-5000 Orange, OR 4-4100
CONN	Farmington, 677-9025 Trumbull, AM 8-9631	N Y	Buffalo, TF 9-0200 Fairport, BR 1-4370 Fayetteville, NE 7-3851
FLA	North Miami, WI 7-5080		
ILL	Chicago, JU 8-3738		
IND	Fort Wayne, 483-6913	ORE	Portland, CA 6-3903
IOWA	Burlington, PL 2-3186	PENN	Philadelphia, PI 2-5476
KANS	Kansas City, JO 2-4108	TEXAS	Dallas, FL 7-5713 Houston, MO 6-2277
MASS	Boston, FA 3-1008		
MICH	Detroit, KE 8-4292	VA	Arlington, JA 5-5898
MINN	Minneapolis, 866-3639	WASH	Seattle, AT 2-7200
MO	St. Louis, WO 2-5627	WISC	Milwaukee, UP 1-2933

In CANADA—Scarborough, Ontario, PL 7-3253

Reliable 0.1- to 45-second timing range— • fast recycling • small space • low cost

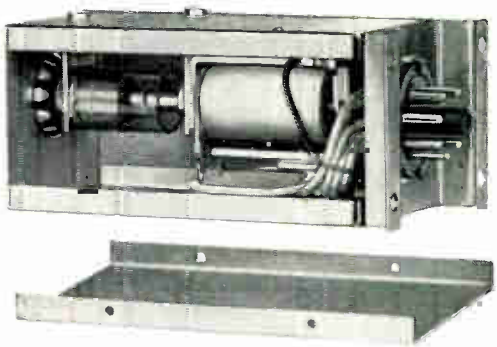
Scientific *merging* of the MAGNECRAFT 88 Relay and a precision-built Air Dashpot Timer *sets a new high in time delay reliability.*

1. *Chatterproof Contacts:* Instant, positive completion of the Relay Magnetic Circuit at expiration of the timing period provides *Full MAGNETIC Power to Snap in the contacts and maintain Full Contact Pressure until the control circuit is broken.*
2. *Instantaneous Recycling:* When the control circuit is broken the relay contacts instantly snap to the normal (de-energized) position and the Dashpot Piston returns to the "start" position within 0.1 second.
3. *0.1 to 45-second Timing Range:* Easily adjustable by turning accessible screw on Airpot Valve.
4. Repeat Accuracy, ± 10%. 5. Temperature Range: −65° to +165°F.
6. *AC and DC operation.* AC models rectified.
7. Simple design and MAGNECRAFT 88 modular construction facilitate manufacture of the New 110 to high reliability standards.

40-347

MAGNECRAFT 110/40-347 Relay & Cover

110 Air Dashpot Time Delay Relay in heavy duty metal enclosure 40-347 with octal phenolic plug-in base, hold down bracket, and snap-on cover. Snap-on cap affords access to timing screw.
Dim. 2-5/8 x 2-5/32 x 4-5/8



Snap-on cover

MAGNECRAFT

The relays you can rely on

MAGNECRAFT ELECTRIC CO., 5577 N. Lynch, Chicago 30, Ill. Area 312—AVenue 2-5500

Circle 129 on Inquiry Card

TELEMETERING DEVICES (Concluded)

ful information. In addition to telemetering, there are many uses for encoders, such as in military servo systems, machine tool control, and process control, all of which are filled by one of the three basic types of encoders on the market today: brush, optical, or magnetic.

Brush Encoders: The brush encoder consists of a rotating disk or drum which is divided into flush conductive and non-conductive segments by precision printed circuit or engraving techniques. Carefully positioned precious metal wipers (brushes) are mounted on a stationary member and the required output is transmitted as the conductive and non-conductive segments pass beneath the brushes.

Optical Encoders: The optical encoder eliminates mechanical contact between circuit elements by use of photocells and a light source. As the shaft turns (in either direction) photocells monitor the light output of a filament bulb through an interrupter (counting disk). The resulting pulses are fed through the required circuitry to remote readout or control devices.

Magnetic Encoders: The basic elements of a magnetic encoder are a code disk which is made from a magnetic material which contains the proper flux pattern for the code readout desired, and a set of readout heads which contain magnetic cores positioned close to the disk in the same quantity and general alignment as in the brush encoder. The signal from the readout windings is monitored as the code disk passes beneath the readout head.

Pros and Cons

Brush Encoder: The main advantages of a brush encoder are its relatively small size and weight which are most suitable for space applications, and its modest price compared to the optical and magnetic type. The chief disadvantages are: (1) short life because of sliding friction between brushes and contacts, and (2) low resolution compared to the other types.

Optical Encoders: These encoders have the advantage of very high resolution and a shaft speed in excess of 10,000 RPM. However, they are limited in applications because of their size.

Magnetic Encoders: The magnetic encoder has the same general performance characteristics as the optical type except that it is more versatile and is being used in many commercial applications.

Many efforts are directed to making smaller switches with more channels and poles; at the same time, to reduce failures, increase life and reliability, and decrease costs. These statements appear to conflict but, with present technological developments, this is not impracticable. This means less wear by removing sliding friction, and improved contact arrangements. In addition, decreasing the number of required elements will improve life and reliability as well as decrease costs since there are fewer parts. At present we have under development a mechanical switch in which there is only one moving member (namely, a motor). All switching is done by solid state devices whose reliability has already been established. While this is not the final answer, we hope that it will successfully bridge the gap between electronic and electromechanical switching devices.

NEW TECH DATA

Airborne Telemeter

Data sheet details specs., characteristics of TCA Type 802 PCM Airborne Telemeter. Unique feature of all-silicon system is self-contained, precision 5v supply for transducer power. Telemetering Corp. of America, 7900 Haskell Ave., Van Nuys, Calif.

Circle 565 on Inquiry Card

Voltage-Controlled Oscillator

Data is available on Model V-510 voltage-controlled oscillator, designed for accurate conversion of analog dc voltage to a linearly proportional sine wave freq. Special consideration has been given to its use in FM-FM telemetering systems and as an analog-to-digital converter. Solid State Electronics Co., 15321 Rayen St., Sepulveda, Calif.

Circle 566 on Inquiry Card

Mast Catalog

Catalog P offers information on pneumatically-operated masts and accessories for transportable communication systems. These modular-design masts are available in a range of sizes between 30 and 100 ft. of extended height. Detailed mechanical specs. are given. Andrew Corp., P.O. Box 807, Chicago 42, Ill.

Circle 567 on Inquiry Card

Antenna Tower Chart

An antenna tower wall chart and condensed catalog, which provides the basic selection data necessary to select a tower to fit antenna-load requirements, are available. Construction and dimensional details are given as well as a complete table of accessories. Tri-Ex Tower Corp., Tulare, Calif.

Circle 568 on Inquiry Card

Antenna Reflectors

Literature on parabolic K-band reflectors, ranging from 12 to 18 ft. in dia., is available from Advanced Structures Div., Telecomputing Corp., 5159 Baltimore Dr., La Mesa, Calif. The reflectors, which feature precise contour, optimum rigidity high resonant freq., low mass moment of inertia, are easily transported and assembled.

Circle 569 on Inquiry Card

Aerospace Ground Equipment

A brochure, "Seven Steps to AGE" (CAP-312) describes the 7 steps to providing reliable Aerospace Ground Equipment. Accent here is on conceptual design and manufacturing procedures rather than the cataloging of existing hardware. It consists of 12 pages defining the facility and capability performance available in this area at Electronic Communications, Inc., Box 12248, St. Petersburg 33, Fla.

Circle 570 on Inquiry Card

MARK OF COMPONENT QUALITY AND RELIABILITY

efc

TIME DELAY RELAYS

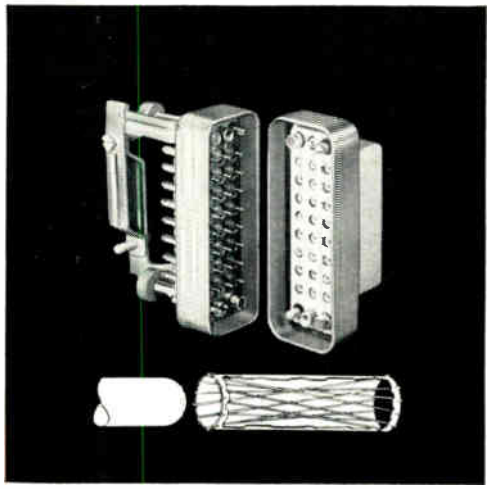
Precision built, to meet a wide variety of military and industrial requirements. Factory preset for delays from 2 to 180 seconds. Contacts reset instantaneously when de-energized. Small size, extreme accuracy, hermetically sealed, voltage and temperature compensated for reliable operation and long life.

- Snap Action
- Instant Reset
- Voltage and Temperature Compensated
- Vibration Resistant
- Contact Arrangement —SPST—SPDT—DPDT

CURTAC® CONNECTORS

Rack and Panel — Coaxial — Combination — Specially Designed

For simple, complex or special connector requirements, CURTAC Connectors provide consistent and reliable electrical and mechanical performance. Elastic wrapping action of each contact wire, under tension, assures smooth mating, dependable contact pressure, low voltage drop and high current rating. Meet or exceed all applicable Mil. Specs. Variety of standard models, or units custom designed to specification.



- Built-in Closed Entry Construction
- Multi-wire, Positive Linear Contacts
- Withstand 50g Shock, 20g Vibration and Temperatures from —65°C. to +125°C.

ULTRASONIC DELAY LINES

Magnetostrictive

Magnetostrictive delay lines are available up to 10,000 microseconds, with excellent stability over wide temperature ranges. Pulse repetition rates up to 2 megacycles NRZ obtainable with negligible phase shift, under all pulse word combinations. Withstand 2000 CPS vibration at 10g, 50g shock. Adjustable over a limited range. Packaged to customer requirements.

- Good Pulse Resolution
- Excellent Signal to Noise Ratio
- Lightweight—Compact
- Good Shock and Vibration Characteristics

WRITE FOR COMPLETE COMPONENTS CATALOG NUMBER 563

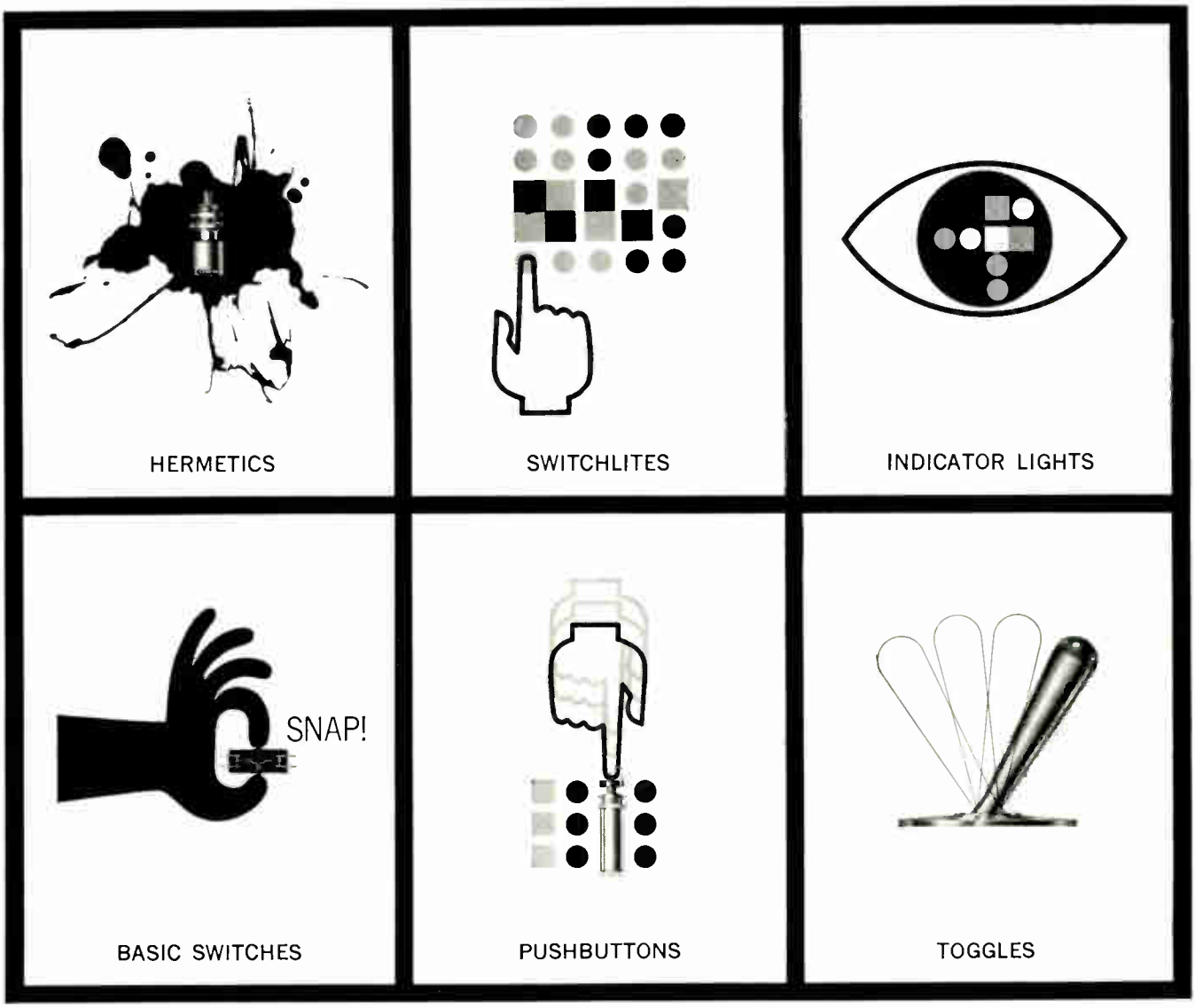
efc

ELECTRONIC FITTINGS CORPORATION

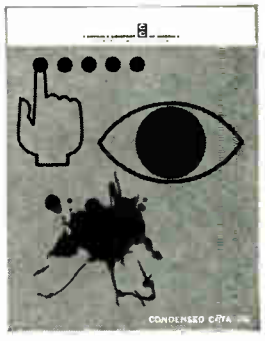
29 Sugar Hollow Road Danbury, Connecticut

Subsidiary of Curtiss-Wright Corporation

CW



A QUICK GUIDE TO 60,000 SWITCHES—Here are specifications, dimension drawings and photos of our most popular switches. This handy reference catalog illustrates the great variety of standard and custom switches available to meet your design requirements. Included are: basic snap-action switches, toggle, pushbutton, interlock, limit, leaf, lever, hermetically-sealed, environment-free and lighted panel switches. Even indicator lights. All items in this catalog are immediately available from stock. If you ever need switches of any kind, you should write for our free *Condensed Switch Catalog #100.*



CONTROLS COMPANY OF AMERICA
CONTROL SWITCH DIVISION
1420 Delmar Drive, Folcroft, Pennsylvania

PROGRESS IN THE RELAY FIELD

Problems of miniaturization, wide current ratings, reliability, environment, and budget are a few of the problems facing relay designers. An eminent authority discusses these problems and offers a procedure to cut manufacturing problems.

By CHARLES F. CAMERON

Professor
School of Electrical Engineering
Oklahoma State University
Stillwater, Okla.

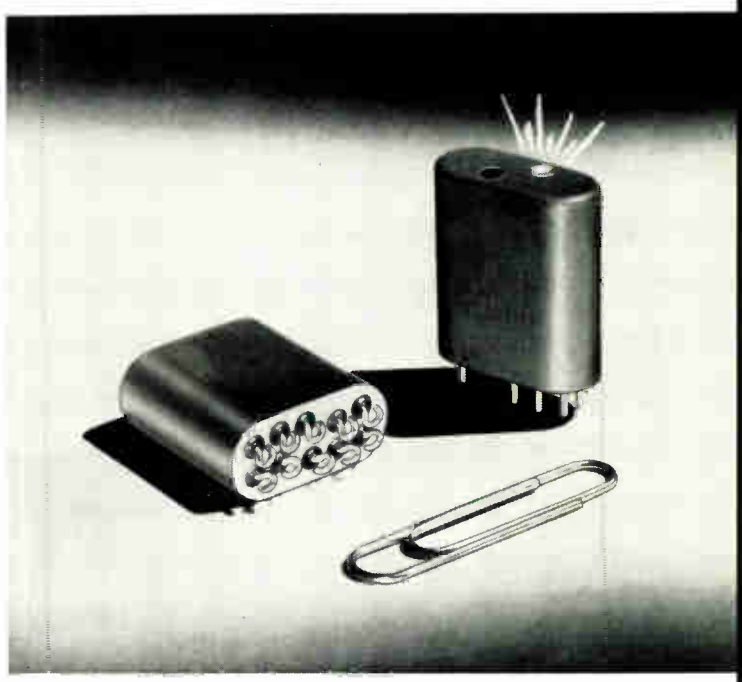
RELAY MANUFACTURERS CONTINUE TO MAKE PROGRESS in the development and design of electromagnetic and thermal relays. Because of the great emphasis placed on reliability, many relay manufacturers have subjected their product to exhaustive life tests, the results of which have been incorporated to make improvements and innovations. If, during these tests, an operating characteristic is found which improves the state-of-the-art, progress has been made.

The areas involved in determining overall relay reliability are far beyond the usual cut and fit schemes. To make an intelligent guess about the probable life of a relay, various tests must yield data from which useful conclusions can be formed. The correlation among the various test methods has been a contributing factor in improving test methods.

Relay contacts may be required to make, break, and transmit current from microamperes to hundreds of amperes. The requirements for a low-level or damp circuit have created many design problems. Therefore, testing dry-circuit and damp-circuit relays was a new division of relay engineering which had to be devised before novel ideas could be incorporated into a final product. These test results provided the reliability information needed for design purposes.

Miniaturization

Component miniaturization, including relays, has brought additional problems in that certain physical limitations are imposed upon a device which makes and breaks a circuit. An obvious constraint would be the transient voltages which the device must withstand. The contact's air gap must have a fixed value for a given set of voltage conditions. Consequently the armature air gap, as well as the mechanical arrangement of the armature and core, seem to have definite lower limits. Although progress has been made in relay miniaturization, it appears that any further reduction in size and weight may not be as important in space-vehicle applications as the question of the power-supply weight.



Miniaturization has produced relays like this one from White Avionics Corp. The Series 700 can switch 250 ma up to 50 volts.

Through study of materials that may be used for relay contacts, many contact characteristics have been determined. In some instances, relay contacts that satisfy one application are unsuitable for another. This becomes obvious when we consider that the

RELAYS (Concluded)

current rating of one relay may be as low as ten microamperes and another may be as high as 300 amperes. These values present a range of 10^8 between the upper and lower limits. When the current is inductive, capacitive, or resistive, it is fantastic that only minor problems occur. In most applications, therefore, the dynamic or transient characteristics determine whether or not the device has performed successfully. The steady-state conditions are usually satisfied if the relay performs satisfactorily during the transient periods. These unusual requirements make the performance specifications a problem which has not been adequately solved. Most performance specifications are involved with static requirements, and do not satisfactorily delineate dynamic performance. However, the studies being performed on dynamic or transient characteristics should lead to useful information concerning the requirements of dynamic conditions.

Testing

A great deal of emphasis has been placed upon an adequate testing program. Relay evaluation consists primarily of two factors: correct relay design and quality control. The performance characteristics decide if a relay is suited to an application. The static and dynamic performance may have to be determined to yield the needed information.

The environmental conditions may be a controlling factor on the dynamic characteristics or the reliability of a relay. For aircraft or space vehicles, the environments may be to the extremes. With temperature, for instance, a relay could cease to function because of either extreme.

Manufacturing

When the requirements of a device are known, the next steps are design and manufacturing. The information contained in Table 1 presents the suggested procedure to be followed when manufacturing a relay.

If, after manufacture, a relay does not meet the outlined performance specifications, the original specifications should be re-examined. Occasionally the specifications are totally inadequate and the performance should be compared to the actual application requirements.

Test procedures vary depending upon the final objective. The test performed by the manufacturer may be considerably different than the acceptance tests. Frequently, acceptance tests are used by an agency to determine if the relay will fulfill their requirements. The evaluation test, however, is the only thorough test that determines performance.

Table 1

PROCEDURE	PURPOSE
Application	End result or function.
Specification	Requirements.
Design	Original design and modification.
Manufacturing	Quality control and adjustments.
Performance	Static, dynamic, and performance application.
Environment	Temperature, humidity, vibration, shock, and altitude.
Evaluation	Performance, design, and quality control.
Performance test procedures	Performance tests, acceptance test, and evaluation tests.
Specification evaluation	Does the specification fit the application.

Considerable progress has been made in testing relays. The numerous techniques have been revised where improvements could be made, and new schemes have been used to find the required test data.

Conclusion

The advancement of the state-of-the-art of components will not be obtained by making the specifications more rigid. If there is a market which will justify the research and development expense, then some progress can be expected. Solid state devices and electromagnetic relays have found the areas for which they are best suited. Most unbiased observers think that there is a place for both, and in many cases, no doubt, these components will be used together to take advantage of their unique characteristics.

DISKS AND ENCODERS (Concluded)

order of magnitude greater, as well as higher-speed data for higher speed control.

Multiturn encoder assemblies are provided as "fine" and "course" arrangements with one or more "course" encoders attached through reduction gears to the fine encoder. The course encoders serve to show the number of turns of the fine encoder which is connected directly to the input shaft being measured.

The problem in multiturn assemblies becomes one of coupling one or more encoders together to accurately read the total accumulated increments. This problem centers mainly around the gear errors and the backlash of the gears between encoders. If all other components in the multiturn encoders were perfect, gearing errors would still cause gross errors at some positions if some means was not used to remove these errors.

To prevent erroneous readings and to provide in addition as wide a gear tolerance as possible Phase-

coders® have been devised using special coded disks having two sets of tracks. These are coded such that one track of a set is displaced in phase from the other by ½ of a quantum sector. Object of this is to permit a readout on the course encoder only while the disk is well removed from a transition region. The Phasecoder offers one additional feature. Since it is possible to avoid transition regions on the disk of this encoder, a straight binary pattern is provided on all Phasecoder disks.

Future Trends

It is predicted that continuing R&D efforts will provide even smaller, lighter-in-weight and higher accuracy photoelectric shaft-position encoders. It is thought that future models will use the recent progress in solid state light methods and thin film circuitry permitting more efficient and more compact units.

As digital methods become even more commonplace it is expected that encoder components will become integrated into many instruments and systems. In the more complex equipments such as antennas for guidance purposes and radio astronomy, use of existing shafts to mount the disk of an integrated encoder will eliminate coupling errors and permit the highest possible accuracy to be attained.

It is predicted that photoelectric encoders will continue to remain decidedly at the top of the list of encoders where simple, low cost, high accuracy and high reliability digital shaft-position encoding is needed.

Acknowledgments

The author wishes to acknowledge the outstanding efforts of Messrs. William H. Mahaney, Project Engineer, and E. M. Jones, Baldwin Research Consultant, who have each, over the past decade, so largely contributed to the advancements of coded disks especially through their many innovations applied to the Baldwin Divided Circle Machine.

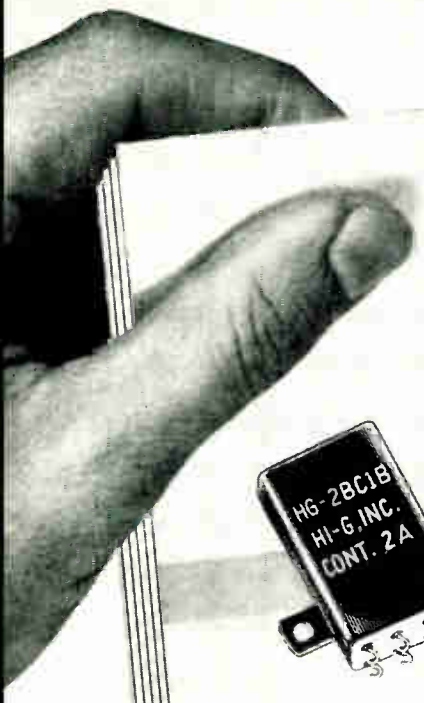
Acknowledgment is also made to the many Baldwin Electronic engineers who have contributed to the encoder advancements referred to in this article; in particular, to Garrard Mountjoy, Manager of Baldwin Electronics Encoder Research, Design and Production.

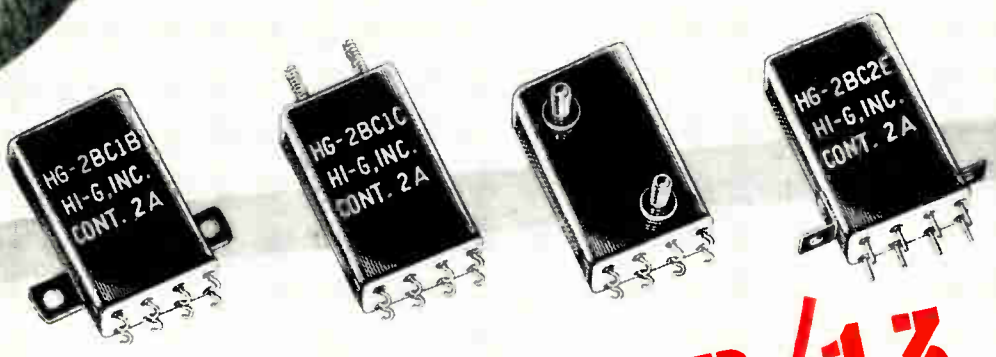
References

1. Robert Nathan and Elizabeth Hanes, *Computer Programming Handbook*, Englewood Cliffs, N. J., Prentice Hall, Inc., 1962, p. 148
2. Paul Siegel, *Understanding Digital Computers*, New York and London, John Wiley & Sons, Inc., 1961
3. Bell Laboratories Record, *A Digital Code Wheel*, J. J. J. Kernahan
4. Ivan Flores, "Reflected Number Systems," *Transactions of the I.R.E.* Professional Group on Electronic Computers, Vol. EC-5, June 1956, No. 2, pp. 79-82
5. C. F. Winder, "Shaft Angle Encoders Afford High Accuracy," *Electronic Industries*, Oct. 1959
6. "Tape Can Run the Machine Better," *Business Week*, March 30, 1963, p. 104
7. Notes on Analog-Digital Conversion Techniques edited by A. K. Susskind. Prepared by J. W. Brean et al. Published jointly by The Technology Press of M.I.T. and J. Wiley and Sons, Inc., N. Y., pp. 6-60, 1957

BC SERIES 1 OR 2 POLE—AC & DC—CURRENT SENSITIVE

BALANCED Hi·G ROTARY





MIL-R-5757D/13 NOT

TYPE	COIL	RATED CONTACT	MAX. CONTACT	MAX. WEIG (oz.)	
BC	DC	2A	6A	1.0	Available in single (1BC, 1BCR) or 2 pole (2BC, 2BCR) units. Add suffix to indicate header style (1, 2, 3, 4) and enclosure (A, B, C, D, E) desired. (See opposite page)
BCR	AC	2A	6A	1.0	

DC CURRENT SENSITIVE RELAYS

COIL DATA: Standard Coil Resistance available to 10K. Standard DC coil tolerance is ± 10%. Closer tolerances and higher coil resistances available.

CONTACT RATING: Standard rating, 2 amperes at 32 V DC. Dry circuit and special contacts also available. Refer to Appendix for contact rating vs. life, but note limits listed above.

LIFE: 100,000 cycles, standard. See Appendix.

SENSITIVITY: Standard DC sensitivity at pull-in at 25° C, 40 mw for DPDT; 25 mw for SPDT

TEMPERATURE:
DC Units —65° C to +125° C standard
AC Units —65° C to +85° C standard

Higher temperature units available, both AC and DC.

VIBRATION: 20G to 2000 cps for standard sensitivity, for best sensitivity 10G to 500 cps. See Appendix for vibration requirements in excess of 20G.

SHOCK: 50G for 11 ms for standard sensitivity, 30G for 11 ms for best sensitivity. These ratings energized or de-energized with no contact opening. See Appendix for further data.

SEALING: 1.3 Hg., standard. Relay filled with dry nitrogen, standard. May be filled with nitrogen and helium, or dry air, if required.

DIELECTRIC STRENGTH: Contacts to Case 1000 VRMS 60 cps Mutually insulated terminals 500 VRMS Std For higher Dielectric Ratings consult factory

Write for catalog

Hi-G INC.

SPRING STREET and ROUTE 75, WINDSOR LOCKS, CONN.

ROTARY SWITCH GLOSSARY

(Continued from page F12)

FRONT END MOUNTING—Most rotary switches for low power are mounted to the panel or mounting bracket by a threaded mounting bushing at the front end of the switch only.

INDEXING — Proper positioning or alignment of the movable contacts with respect to the stationary contacts. (Accurate indexing is primarily dependent upon a good detent system).

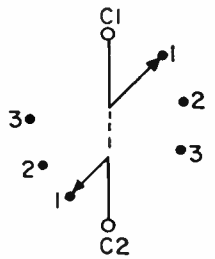
IN-SWITCH CAPACITY — The capacitance between various elements of the switch. (There are various means of making the measurements, which must be tailored to the application parameters.)

NON-SHORTING CONTACTS—A break before make contact. (In switching from position #1 to position #2, e.g., the rotor will break contact with position #1 before it makes contact with position #2.)

NON-TURN DEVICE—The feature which keys the switch to the panel or mounting bracket, so that the orientation of the switch with the mounting surface remains constant. This device is usually a tab protruding forward from the front plate of the switch, which fits into a hole in the panel. It can also consist of a keyway in the mounting bushing which mates with a key in the panel or a separate part which will combine the aspects of the other two means mentioned.

OPEN FRAME SWITCHES—Sometimes called wafer switches, these do not have their contacts enclosed by a housing.

POLE—An individual electrical circuit within a switch. The diagram below is an example of a 2-pole swith.



ROTATIONAL TORQUE — The amount of torque (in pound inches or ounce inches) required to rotate a switch between positions.

ROTOR, OR WIPER—The rotating contact of a switch (which is connected to common, or collector).

SHAFT FLAT ORIENTATION—Relationship of the shaft flat with the position being contacted by the movable contact. (Many shafts are flatted so that the set screw in the knob has a good surface with which to key. Thus it's necessary to carefully orient this flat with the switch keying or mounting means and/or the panel markings. Most shaft flats are oriented so that they are opposite the contacting position of a single pole switch—or something comparable on a multi-pole switch—a practice stemming from the construction of most pointer type knobs which have the set screw opposite the pointer).

(Continued on page F30)

ROTARY SWITCH GLOSSARY

SHAFT PROJECTION—That part of the actuating shaft which projects beyond the end of the threaded mounting bushing, if the switch is so equipped, or a comparable dimension, if the switch uses some other mounting means.

SHELF LIFE—That period of time after manufacture that the switch can be in storage without deteriorating beyond certain pre-determined limits. This deterioration is usually contact contamination and corrosion, loss of solderability of terminals due to corrosion, etc. The rate of deterioration can be controlled and slowed down much by using more noble metals on contacts and terminals or special preservation and packaging.

SHORTING CONTACTS — A make before break contact. (Example: In switching from position #1 to position #2, contact is made with position #2 before it is broken with position #1.)

SPRING RETURN—A mechanism built into rotary switches when the switch is required to do some of the thinking for the operator. The switch is rotated against some type of spring arrangement (normally), in that when the knob is released the switch returns automatically to some neutral position.

STOP—Feature embodied in switch to limit rotation. (See "adjustable stops" and "fixed stops".)

STOP STRENGTH—The maximum rotational torque which can be gradually applied to the shaft against the stops before the stops sustain a mechanical failure.

SWITCH LIFE—The number of cycles of operation during which electrical and mechanical performance will meet pre-determined and stated life-limiting criteria. This term can best be defined only for a particular set of circumstances. Switch life can be limited either electrically or mechanically, and in some instances, both. It is usually dependent upon some previously established life limiting criteria for the application, such as: maximum allowable increase in contact resistance, minimum insulation resistance, minimum value for rotational torque, and others.

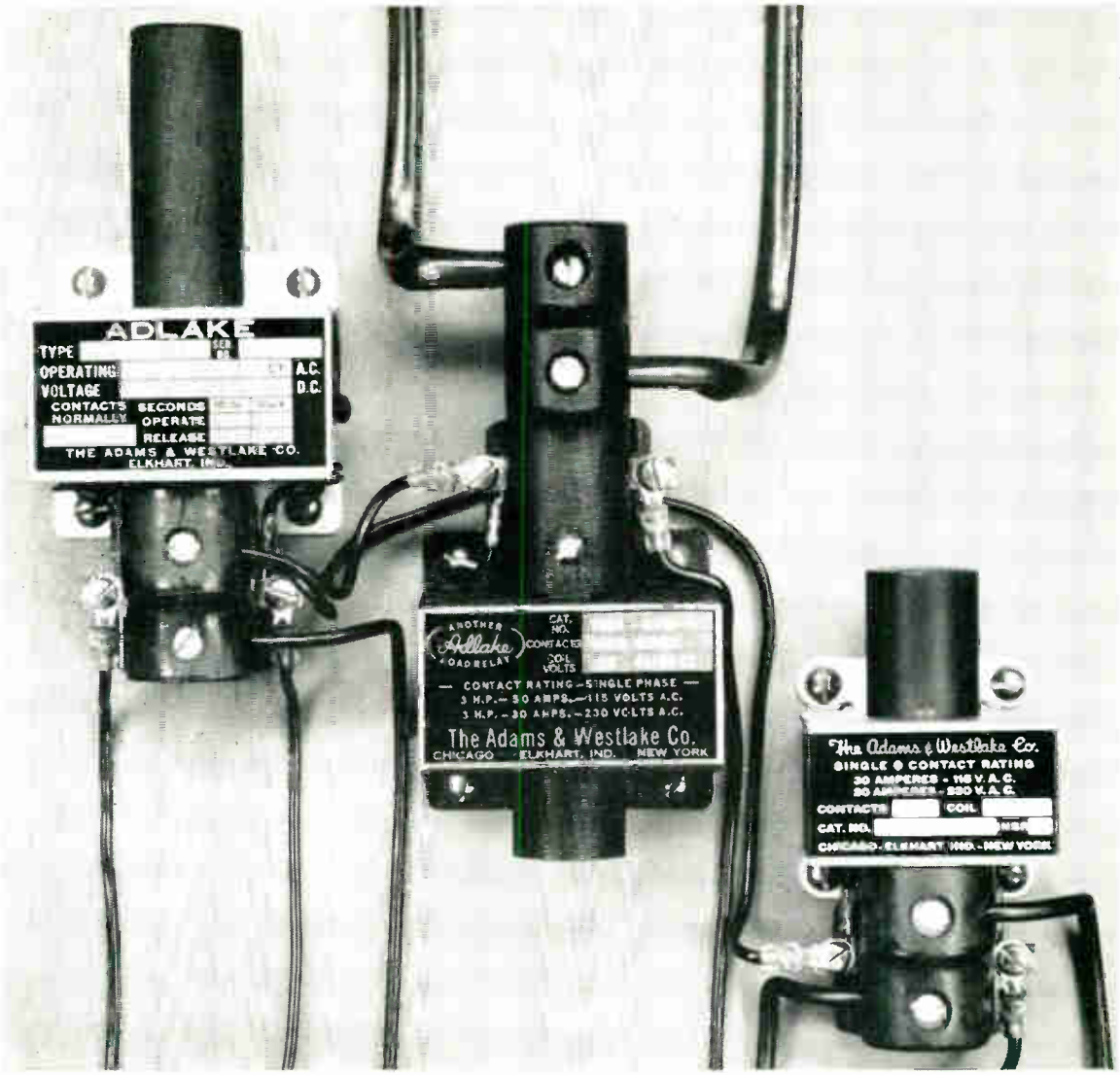
SWITCH RATING—The manufacturer's statement of the switch's load carrying capability.

SWITCH SECTION, OR DECK — The individual switching wafers, or units, within the switch proper.

TERMINAL—A lug extending outward from the switch section, or deck, which is used for soldering or otherwise fastening external connections to the switch.

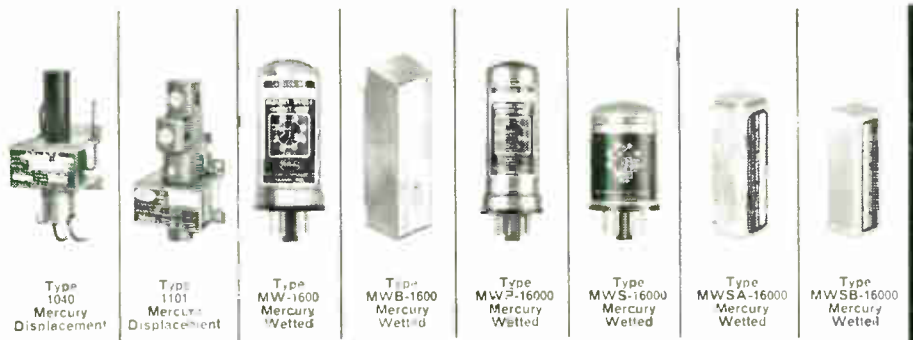
UNIDIRECTIONAL ROTATION — A switch provided without stops so that continuous rotation is provided in a single direction.

DRY CIRCUIT—Circuit where the open-circuit voltage is .03 or less and the current 200 ma. or less. The above is generally agreed to be the most acceptable definition. The voltage is most important because at this level the voltage is not great enough to break through most oxides, sulfides, or other films which can build up on contacting surfaces.



APPLY THESE RELAYS DIRECT

Who needs panels and connectors? Adlake molded (epoxy) head relays fasten directly to the point of application. You save on materials. Because they install faster, production costs are lower. Other advantages include: excellent insulating ability, dimensional stability, proof against flame — and additional Adlake reliability. Available as time delay and quick-acting load relays. Ask for a catalog.

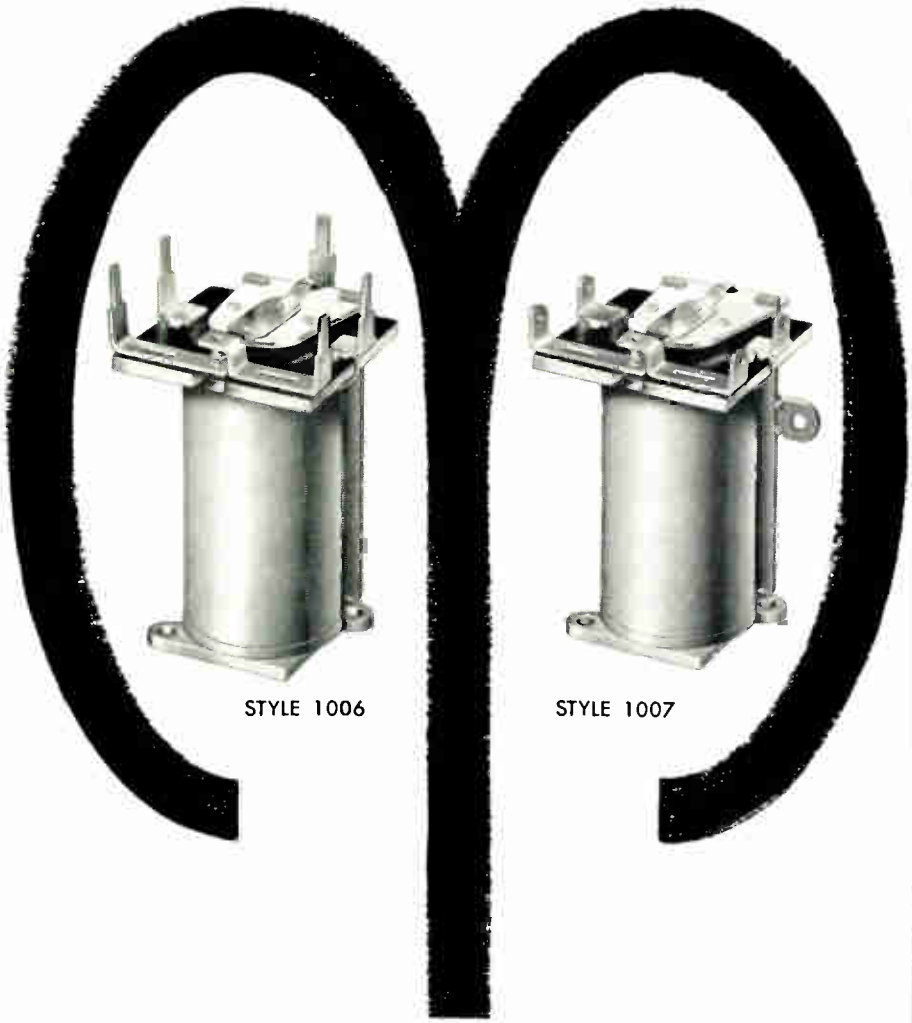


Type 1040 Mercury Displacement | Type 1101 Mercury Displacement | Type MW-1600 Mercury Wetted | Type MWB-1600 Mercury Wetted | Type MWP-16000 Mercury Wetted | Type MWS-16000 Mercury Wetted | Type MWSA-16000 Mercury Wetted | Type MWSB-16000 Mercury Wetted

A+ Adlake® RELAYS

Adlake makes more kinds of mercury relays than anybody.

The Adams & Westlake Company, Dept. 8806
Elkhart, Indiana, phone Area 219, COngress 4-1141



SENSITIVE RELAYS AT SENSIBLE PRICES

Price Electric Series 1000 Relays Now Feature . . .
Sensitive Operation • Solder or Printed Circuit Terminals
Open or Hermetically Sealed Styles • Low Cost

These versatile sensitive relays are designed for applications where available coil power is limited. They retain all the basic features, such as small size, light weight and low cost, that makes the Series 1000 General-Purpose Relays pace setters in their field.

TYPICAL APPLICATIONS

Remote TV tuning, control circuits for commercial appliances (including plate-circuit applications), auto headlight dimming, etc.

GENERAL CHARACTERISTICS

Standard Operating Current:
1 to 7 milliamps DC at 20 milliwatt sensitivity

Maximum Coil Resistance: 16,000 ohms

Sensitivity:
20 milliwatts at standard contact rating; 75 milliwatts at maximum contact rating. Maximum coil power dissipation 1.5 watts.

Contact Combination: SPDT

Contact Ratings:
Standard 1 amp; optional ratings, with special construction, to 3 amps. Ratings apply to resistive loads to 26.5 VDC or 115 VAC.

Mechanical Life Expectancy:
30,000,000 operations minimum.

Dielectric Strength: 500 VRMS minimum.

For additional information, contact:

PRICE ELECTRIC CORPORATION

323 Church St. • Frederick, Md. • Phone: 301/663-5141 • TWX 301/553-0462

NEW TECH DATA

Crystal Case Relay

Bulletin 1077 describes Model 901 2PDT 1/6 size Crystal Case Relay. It meets or exceeds parameters of Mil-R-5757D. Miniature Relay Sales Dept., Union Switch & Signal Div., Westinghouse Air Brake Co., 1789 Braddock Ave., Pittsburgh 18, Pa.

Circle 421 on Inquiry Card

Potentiometer Catalog

This illustrated 19-page industrial catalog describes the precision Series 62JA 10-turn potentiometer and the new Padohm Series 56JA and 56JB trimmer potentiometers, precision single and multiturn potentiometers, industrial controls and resistors. Clarostat Distributor Div., Clarostat Mfg. Co., Dover, N. H.

Circle 422 on Inquiry Card

Capacitor Soldering

Technical report, "Automated Induction Soldering of Tantalum Capacitors," contains a drawing of a device made to do this job. Device solders the assembly and endseal of capacitors using variable-power induction heating generators and automatic turntables. McDowell Electronics, Inc., 105 Forrest St., Metuchen, N. J.

Circle 423 on Inquiry Card

Air Motors

Two article reprints describe general advantages and uses of air bearing motors and other products, including instrument motors, servos, synchros, air movers, solenoids and similar equipment. Catalog listing over 700 types of motors is also available. IMC Magnetic Corp., Westbury, N. Y.

Circle 424 on Inquiry Card

Miniature DC Motors

Brochure 102 describes the Type SS 7/8 in. dia. dc motor, motor and speed governor, planetary gearmotor and spur gearmotor. It has 19 armature variations. Max. RPM, voltage, and torque ratios are given. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

Circle 425 on Inquiry Card

Knob Catalog

Catalog listing "Lerco" line of custom-printed knobs, terminals and other controls is available from Microdot, Inc., 220 Pasadena Ave., S. Pasadena, Calif. Calibration figures, letters, etc., can be printed on the knobs.

Circle 426 on Inquiry Card

Small DC Motors

Brochure 103 describes the Globe Type BD and BL motors, rated at 1/45 and 1/30 hp continuous duty at 10,000 RPM, respectively. Both units are 1½ in. in dia. while the BD is 2 9/16 in. and the BL 2 15/16 in. long. Globe Industries, 1784 Stanley Ave., Dayton 4, Ohio.

Circle 427 on Inquiry Card

NEW TECH DATA

Instrument Switches

A 16-page illustrated instrument switch catalog lists electrical characteristics, information on how to select a switch, standard contact deck and brush arrangements, dimensions, terminal board arrangements, and ordering information. Cinema Plant, Hi-Q Div., Aerovox Corp., 1100 Chestnut St., Burbank, Calif.

Circle 393 on Inquiry Card

Step-Servo Motor Theory

A 10-page booklet covering theory and operation of step-servo motors is available now from IMC Magnetics Corp., 6058 Walker Ave., Maywood, Calif. Discussed are step-servo excitation, performance, efficiency of mmf generation and the dynamic characteristics. Illustrations, power angles, and schematics are included.

Circle 394 on Inquiry Card

Miniature AC Motors

Brochure 106 describes Globe Type SC 1, 2 or 3-phase motors which operate on 60 or 400CPS. Induction or hysteresis rotors available. Planetary gear reducers of 21 different ratios give up to 300 oz./in. max. continuous torque. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

Circle 395 on Inquiry Card

Welder Ignitrons

Data sheet describes 2 high-power resistance welding ignitrons, NL-1081 and 1082. They are metal, water-cooled, mercury-pool ignitrons handling up to 65% more power than the standard size B and C ignitrons, respectively. Max. demand current at 500v. is 2000a. for NL-1081 and 4000a. for 1082. Specs., characteristics, charts and schematics are given. National Electronics, Inc., Geneva, Ill.

Circle 396 on Inquiry Card

Magnetic Amp. Relays

A 6-page bulletin provides design specs. on Series 8200 60CPS polarized magnetic-amplifier relays. Operating on dc input sensitivities ranging from 0.02 to 0.5 mw., they detect and act upon minute variations in current, voltage or resistance to add or subtract signals, or compare a variable signal with a reference. Sigma Div., Sigma Instruments, Inc., Braintree, Mass.

Circle 397 on Inquiry Card

Wafer Bonder

This catalog sheet describes a new machine for bonding wafers, pellets, chips or dice to headers and other substrates. The machine is easily adapted to handle wafers of any practical size. Kulicke and Soffa Mfg. Co., Inc., 135 Commerce Dr., Industrial Park, Ft. Washington, Pa.

Circle 398 on Inquiry Card

Potentiometer Test Report

Report on test results of the Clarostat Series 62 10-turn potentiometer for military and industrial use are available. Report includes conditions and results of tests, run over 1,000 hrs. Tests covered low temp. storage, low temp. operation, temp. cycling, load life, low-frequency vibration, moisture resistance, rotational life, acceleration, shock and high-frequency vibration. Clarostat Mfg. Co., Dover, N. H.

Circle 399 on Inquiry Card

Manual Control System

Catalog 69 describes system of manual control and lighted legend display for modern panels. There are 4 units: 1 indicator for legend display and 3 operator-indicator units for control and display. The 20-page, 4-color catalog contains product photos, circuitry and legend charts, mounting dimensions and other information. Micro Switch, Freeport, Ill.

Circle 400 on Inquiry Card

Chopper Article

Article describes dc feedback amplifiers and their microminiature electro-mechanical choppers. Analyses of chopper noise and offset are provided. Discussion includes descriptions of stabilization of wide-band dc amplifiers for zero and gain, stable transistor wide-band dc amplifiers, and transistor operational amplifiers. Schematics and oscilloscope patterns illustrate functions described in the article. Airpax Electronics, Inc., Cambridge Div., Cambridge, Md.

Circle 401 on Inquiry Card

Cooling Equipment

Blowers for electronic uses are presented in this 42-page catalog. It describes packaged blowers, both commercial and Mil Spec., packaged propeller fans, orifice-mounted fans, dual and single centrifugal blowers and accessories. New line of RFI-shielded packaged blowers is included, as is new McLean Mil Spec. blower line. Engineering drawings, performance curves are given. A 3-page section contains design information on forced air convection for cooling electronic equipment. McLean Engineering Laboratories, P. O. Box 228, Princeton, N. J.

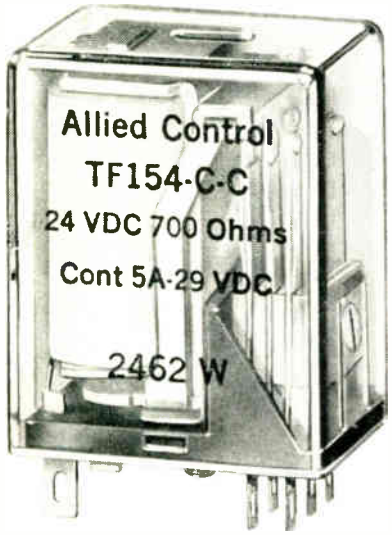
Circle 402 on Inquiry Card

Miniature Potentiometers

Engineering Bulletin 42-1467 describes 3 types of high reliability, miniature composition potentiometers. This 2-color booklet was prepared for engineering use, and contains complete information on uses, electrical, physical and mechanical characteristics as well as environmental specs. A large portion is devoted to detailed engineering drawings. Centralab, The Electronics Div. of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc.

Circle 403 on Inquiry Card

ALLIED CONTROL



relays & switches

- Miniature Relays
- Telephone Type Relays
- Subminiature Relays
- Power Relays
- General Purpose Relays
- Sensitive and Plate Circuit Relays
- Subminiature Switches
- Sockets

LARGEST INVENTORY IN U.S.A.

24 Hour Delivery
COAST-TO-COAST

ARCO
electronics inc.
RELAY DIVISION

EASTERN REGION: ARCO ELECTRONICS INC.
Community Drive, Great Neck, New York
516 HUnter 7-0500 TWX: 516-466-0235

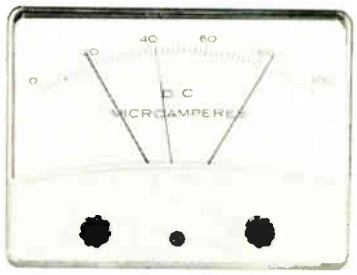
WESTERN REGION: ARCO CAPACITORS INC.
1548 So. Robertson Blvd.; Los Angeles 35, Calif.
213 Crestview 1-1151 TWX: 213-273-4092

ARCO CAPACITORS ■ ELMENCO CAPACITORS
HST TRANSFORMERS ■ DEUTSCH CONNECTORS ■ ALLIED CONTROL RELAYS & SWITCHES

Circle 148 on Inquiry Card

NEW!

THE API OPTICAL METER-RELAY



Continuous indication and control —without contacts

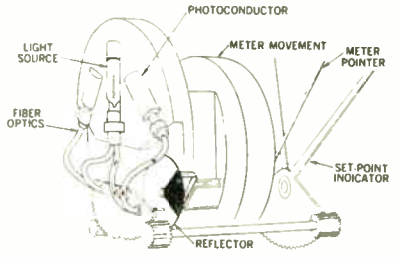
API's new optical meter-relay is a truly remarkable instrument . . . the first to combine fiber optics, the d'Arsonval movement, and solid-state electronics in a sensitive and reliable indicating and control device. Operating without contacts, it requires no amplification and will respond to signal changes as small as 0.0125 ua or mv (or 0.750°F. as a pyrometer).

Set-points are fiber-optic light pipes; there are no other movable parts in the control phase. The measuring element is unrestricted at all times.

The optical meter-relay can monitor and control any variable that is electrically measurable. Control action is produced by the interruption of a beam of light (see below). Through a solid-state output module, the meter-relay can provide on-off, time-proportioning, or modulating (SCR) control. All are fail-safe. Full-scale sensitivity is as low as 5 ua or mv in taut-band models. Seven sizes are available from 3¼" to 6" in API's new Stylist/Panelist line.

For more information on the most talked about control instrument today, request Bulletin 33.

api **ASSEMBLY PRODUCTS, INC.**
Chesterland 92, Ohio



Light passes through fiber-optic light pipes and is reflected by disc on signal coil to complete a normally-closed light circuit. As meter pointer reaches set-point, black segment on reflector interrupts light circuit, changing photocell conductivity and actuating load relays through an isolated solid-state output module. Light source is operated at well below rated power to provide extended service life.

SA 2792

Circle 149 on Inquiry Card

SECTION G

MATERIALS & HARDWARE

Refractory metals go into a variety of products, including solid-state component parts and electrical contacts. These metals have exceptional stability, even in very thin film form. They are being called upon for top performance of thin film circuits, as superconductors, and for critical parts of instruments.

REFRACTORY METALS IN ELECTRONIC COMPONENTS

REFRACTORY METALS ARE WIDELY USED in the electronic industries. These high temperature metals have low coefficients of expansion, good corrosion resistance, and high strength. They are not abundant in the earth's crust and the yearly production of some of these metals is only a few hundred pounds. Molybdenum finds the greatest usage because it can be produced most economically and has a high strength-to-weight ratio. A molybdenum part weighs only half as much as a tungsten part and costs about one-third as much. Yet tungsten, columbium, and tantalum are used extensively where their special properties provide an advantage.

Rhenium, osmium, iridium, and ruthenium have only minor usage.

The major uses of the refractory metals in the electronic industries are in capacitors, vacuum tubes, electrical contacts, thin films, superconductors, and instrumentation. In some cases, only the refractory metals are suitable. The remaining problems, potential solutions, and some of the advantages of using refractory metals will be discussed.

Fig. 1: The tube parts shown on the left are made with refractory metals.

Capacitors

Tantalum, columbium, tungsten, and molybdenum are known as "valve" materials. That is, they form a protective high resistance oxide film on anodic polarization in preference to all other electrode processes. Tantalum is the most nearly perfect example of a "valve" material. A stable, nonporous, structureless, adhering film, grows uniformly thicker with increasing voltage in most all electrolytic solutions.

The protective high resistance oxide film of tantalum had first commercial importance for its rectifying action. (Balkite battery charger made in 1922.) Today, this oxide film is most important as the dielectric of the electrolytic capacitor: a "valve" material is chosen as the anode (positive electrode) and the oxide film (dielectric) is made by polarization of the anode.

For columbium, sister-metal of tantalum, the film is somewhat less stable, indicated by the normally high leakage and lower maximum formation voltage when compared to tantalum. Some columbium capacitors are made commercially. They have weight advantage over tantalum.

Tungsten and molybdenum readily dissolve during anodic polarization in alkaline solutions. Thick films are obtained during polarization in acidic solutions, but these are nonprotective. Passivating films have been produced on tungsten in certain buffered solutions, but the capacitors using these were unstable.

By RALPH F. HOECKELMAN
Project Coordinator
Fansteel Metallurgical Corp.
2200 Sheridan Rd.
North Chicago, Ill.

Three basic types of tantalum anodes are made; the sintered slug, foil and wire. Massive tantalum, with the aid of intermittent vacuum anneals, is cold rolled to a very thin foil of ½ mil or less. The foil is often etched to give more surface area (more capacitance) before formation and assembly into an electrolytic capacitor. The foil type capacitor handles the highest working voltage.

Far more capacitance is achieved in the same volume in a porous slug capacitor. In the conventional method a porous slug of 35 to 45% porosity is prepared by sintering a compact of tantalum powder. The surface area, density and porosity of the compact are dependent on the physical traits of the powder and the sintering temperature. The physical makeup, related to the method of preparation, varies from a structured powder which has a low bulk density to a very fine nonstructured powder with a higher bulk density. Higher voltage of formation is being achieved with powders of higher purity and more specific physical characteristics.

The porous slug capacitor may have either a wet or dry electrolyte. The wet electrolytic capacitor has been characterized by a long life and is more reliable than the dry electrolytic when operated on a low impedance power supply. The wet capacitor has a higher working voltage than presently obtainable for the dry capacitor. The dry electrolyte capacitor has superior capacitance vs. frequency characteristics and eliminates the danger of electrolyte leakage.

The wire type capacitor can have either a wet or dry electrolyte and is well adapted for low capacitance uses.

Future improvements in tantalum capacitors will be higher overall reliability, higher capacitance units and higher voltage units. These will come about from even higher purity and closer tolerance on the physical characteristics of the starting material, as well as improved methods for sintering, anodizing, encapsulating, etc.

Vacuum Tubes

The metallic parts of a vacuum tube must be precision made from low vapor pressure material. The parts must keep their shape at elevated temperatures for long periods of time. The refractory metals are ideal materials for this. Tungsten, the most refractory metal, has a melting point three times as high as copper and twice that of martensitic stainless steel. Hence, tungsten has won acceptance as a heating element, X-ray tube target, heat shield, and as parts in electronic power tubes. Molybdenum is often used for anode and grid structures because of its superior physical properties, workability and low cost compared to tungsten. (Fig. 1.)

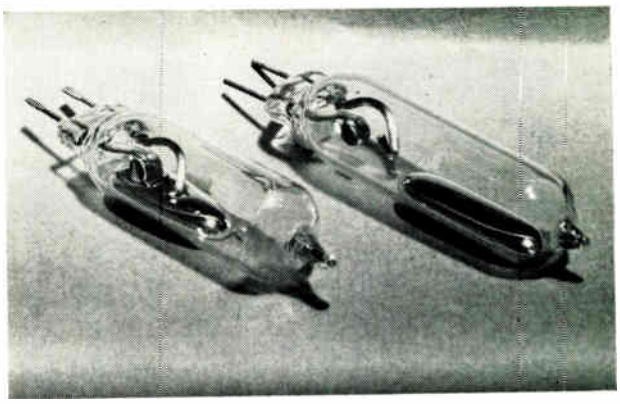


Fig. 2: The precision electrodes of these mercury switches are graphite-coated "moly" wire for wetted contact action.

With continued emphasis on size and cost reduction, vacuum tube parts are being made smaller and with greater precision. Anodes used to be made by the welded cup and cylinder method. But now, using high purity molybdenum sheet, deep drawn moly anodes have become a reality. The uniform wall and end thickness achievable in a one piece structure without grooves or welds has improved both reliability and performance of the tubes. Structures too complicated or too intricate for normal fabrication methods are being "photo formed."

A problem in vacuum tube reliability is the hot cathode. From the earliest days of the light bulb, heated filaments have caused the most concern. In the case of the light bulb, back filling with argon greatly reduced evaporation from the filament. The addition of a small quantity of iodine gas has acted as a scavenger for evaporated metal and returned it to the filament, thus increasing its life. No such easy solution is in sight for the vacuum tube. Hot cathodes have been made from alloys of tungsten with rhenium or hafnium. The development of oxide coatings for low power tubes has provided greater emission at lower temperatures and has greatly improved tube life. Further improvements in the near future will most likely be found in improved materials and processing. Longer range solutions may be possible with cold cathode structures using field or tunnel emission from materials having low work functions.

Electrical Contacts

Tungsten contacts are used primarily in places where very long life is needed, such as distributor parts, radio vibrators, voltage regulators and similar uses. These points not only provide long service under heavy arcing conditions, but are also able to

withstand constant mechanical wear. Molybdenum oxidizes more readily than tungsten and has limited use in low voltage vibrators and relays. The spring properties of molybdenum can sometimes be used to combine spring action and electrical contact. Since molybdenum is wetted but not attacked by mercury, it is often used in mercury switches. (Fig. 2.)

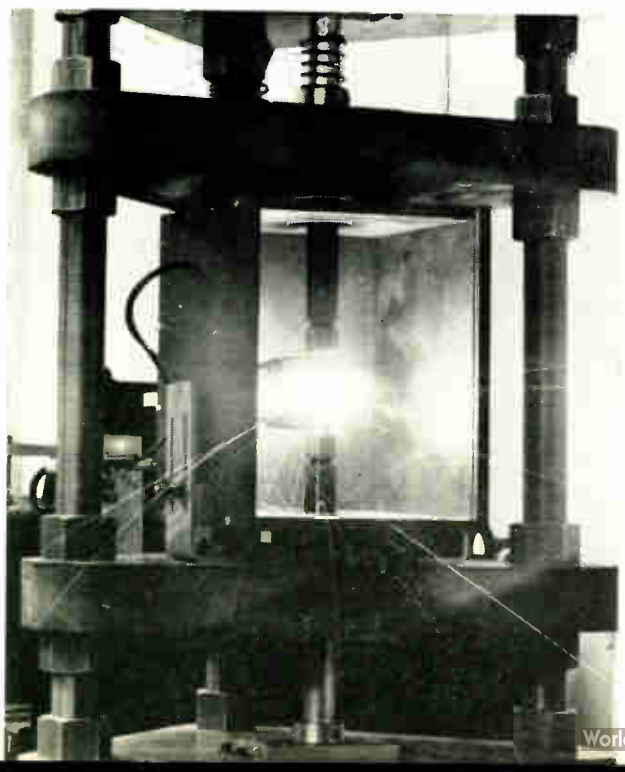
Tungsten and molybdenum are both used in making ohmic contacts to large area silicon rectifiers. The good heat conductivity and low coefficient of expansion, comparable to that of silicon, are the main reasons for its use.

Unalloyed refractory metal contacts have not been able to handle large currents. This problem has been solved by using sintered powder metal mixtures of tungsten or molybdenum, their carbides, and a good conducting metal, such as silver or copper. They have good conductivity, combined with excellent non-sticking properties, and higher resistance to high current arc erosion than any of their pure constituents. Contacts tested at 30,000 amperes shown in Fig. 3 help to determine arc erosion of heavy duty contacts under severe service conditions

Thin Film

Thin films of refractory metals are being used in the expanding microelectronics field. Resistors, capacitors, interconnections, and sometimes inductors are being fabricated in two dimensional arrays, with film thickness measured in terms of hundreds of angstroms. These thin film circuits are not only smaller and lighter, but are being touted as having greatly increased reliability and potentially less costly than normal electronic circuits. The reliability of the thin film circuits rests on the physical and chemical stability of the thin metal films comprising the circuit. The low vapor pressure and the low mobility of the refractory metals is an important factor in film stability. The high recrystallization temperature, the chemical inertness, the relatively high electrical resistivity, and good thermal conductivity are advantageous for preparing resistive films.

Fig. 3: Powder metal contacts are being tested for arc erosion at 30,000 amps to determine best mixture for heavy duty.



Thin film capacitors are conveniently prepared by anodizing a thin film of tantalum and covering the oxide with a vacuum deposited counter electrode of gold. The anodizing process also provides a means of trimming resistive films. Precision resistors with ±0.1% tolerance can be produced. The oxide formed over the surface of the resistor during the trimming step protects it from physical damage and shields the resistive element from atmospheric contamination.

The preparation of thin film resistors, capacitors and interconnections is done by vacuum deposition of the tantalum, followed by photo-etch processing and anodizing. The relatively few number of processing steps make possible the high reliability and ultimate low cost.

Some of the problem areas facing the tantalum thin film circuit designers are high temperature coefficient of resistance, low ohms per square cm. resistance yield and stability of capacitors, and packaging. The solutions to most of these problems are in sight. By control of the atmosphere during sputtering of the tantalum films, compounds of tantalum can be formed. These compounds (tantalum carbide, tantalum nitride, tantalum oxide) increase the resistivity of the film and simultaneously reduce the temperature coefficient of resistance. Newly developed clearing techniques, which dissolve away the tantalum metal films underlying defects in the oxide structure, have greatly increased the yield and stability of capacitors. The packaging problem remains.

Transistor cans, while ideal for transistors and bulk process microelectronics, are not really suitable for the thin film microcircuits and no concerted effort is being made to solve this problem. Single components are available in a variety of form factors; circuit functions are available in a number of encapsulated and canned forms; multiple circuit functions resembling a miniaturized circuit board are available and may contain several hundred individual circuit elements.

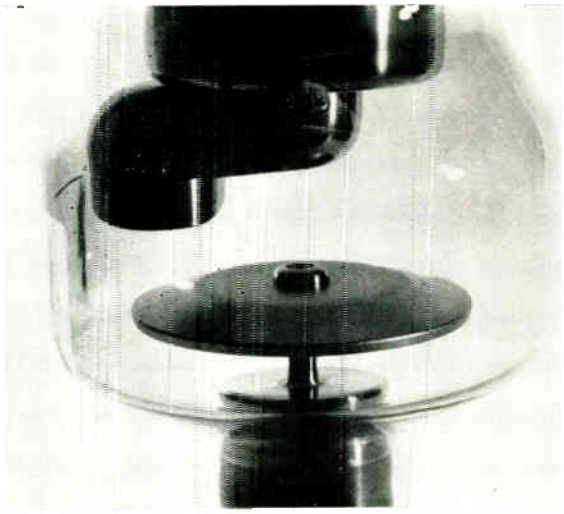


Fig. 4: This x-ray tube's anode is a typical use of tungsten. It may reach a temperature of 1800°F as it spins at 5000 RPM.

Many types of microelectronic circuits are becoming available. They are not mutually exclusive but in many cases are compatible. Circuit functions composed of active elements, with only a few passive parts needed, are most conveniently prepared as integrated circuits in silicon wafers. For the reverse case where passive components dominate the circuit function, the thin film approach is better. Tantalum thin film circuits will play a part on the road to microminiaturization. They are smaller, more reliable and potentially less costly than the micromodule or micro dot forms. They have tighter tolerances and shorter delivery schedules than the integrated circuits based on silicon planar technology. Tantalum thin film circuits have fewer processing steps and less critical vacuum needs than thin film circuits based on vacuum deposited nickel alloys and silicon monoxide.

Superconductivity

All the refractory metals have been extensively investigated for use as superconductors, primarily because they have relatively high super conducting transition temperatures. This work shows that the refractory metals are generally rather poor superconductors in the pure state, because they do not support adequate current densities. However, alloy compounds show greatly improved current carrying capacities (far in excess of materials yet developed) and even higher transition temperatures. Specifically these materials are the columbium compounds; i.e., columbium-tin and columbium-zirconium although molybdenum-rhenium and others have shown promise.

The present potential uses for the refractory superconductors are as very high field solenoid magnets and very fast, economical switches and memory-core elements. The magnets so far constructed have produced up to 100 kilogauss fields for fractions of the costs and current inputs of equivalent copper conductor, water-cooled electromagnets.

Because many variations of alloy compositions seem to offer promise as high strength superconductors it is not possible to single out any one as optimum, however, the principal available alloys at present are those of the Cb-Zr or Cb-Sn systems.

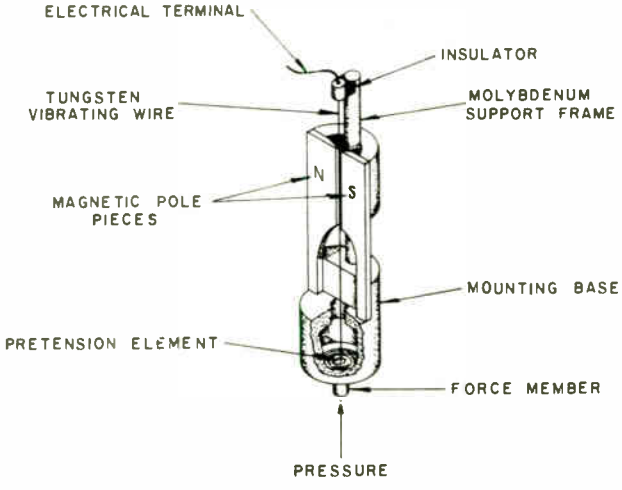
The principal problems are based upon the fact that relatively little is known of a theoretical nature on the reasons for bulk superconducting behavior. The other problems are essentially those of metallurgical preparation, since these alloys are brittle and quite difficult to produce in large, uniform, high quality lots.

Instrumentation

Refractory metals are used in instruments where their special properties are needed to perform a given function. Cathodes in vacuum gauges and mass spectrometers and anodes in X-ray tubes (Fig. 4) commonly use tungsten or tungsten alloys. The highest temperature thermocouples and protection tubes need refractory metal compositions.

The high strength and corrosion resistant properties are often combined in applications needing pointed electrical probes, such as are used in resistivity measurements. Another use needing high strength and corrosion resistance is a miniature electronic transducer (Fig. 5). A tungsten wire held in a molybdenum frame vibrates at a constant frequency. Changes in the variables—acceleration, pressure, displacement, or temperature—change the tension and thus the frequency of the wire. These fluctuations are sensed electrically and produce an electrical output proportional to the variables being measured.

Fig. 5: Basic vibrotron pickup structure shown combines high strength and anti-corrosion in two of its critical gage parts.



New contour-hugging insulations are here in myriad shapes and forms. Radiation chemistry has sired effective thermosetting polyolefin polymers that resist temperature and weather extremes. Older molding-potting methods are losing favor. On the horizon are more versatile heat-shrinkable insulations for practically any electronic requirement.

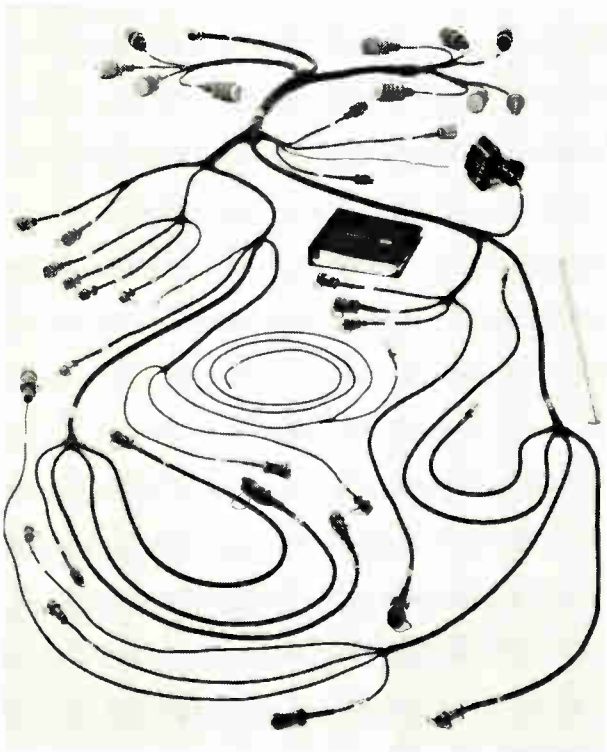
HEAT-SHRINKABLE POLYMERS REDUCE INSULATION PROBLEMS

RADIATION CHEMISTRY OFFERS A "THIRD DIMENSION" to electronic engineers who must select insulating materials.

Less than ten years ago engineers chose sleeving only by determining length and a diameter that would allow the sleeve to slide loosely over a cable connection. Then they hoped it would stay in place during the life of the equipment. To seal harnesses they had to design molds, contend with either messy potting compounds or neoprene rubber stock.

Now, with the advent of irradiation-induced elastic memory in polymers, engineers can select sleevings, cable jackets and pre-molded parts that shrink to conform with cable contours when heated. Thus, a single operation can insulate, seal and provide strain relief. Engineers also have available a wide choice of irradiated plastic and elastomer material. The effect of ionizing radiation on polymers has been known for many years.[1]

Environmental protection of harnesses is now possible using heat-shrinkable tubing and pre-molded parts, without wasted time and the cost of molding with neoprene or with sealants.



In the dawn of the atomic age, researchers found that the physical properties of some materials improve when they are exposed to high-energy radiation from an atomic pile or an electron beam generator. They found, too, that a similar state could be induced through treatment with organic peroxides.

Molecules Become Cross-Linked

When polyolefin compounds, such as polyethylene, are irradiated, their molecules become cross-linked into a three-dimensional gel network with elastic memory. In addition, entirely new materials have been created that behave like common elastomers, such as neoprene and silicone rubbers.

This means that an insulating resin such as low density polyethylene, which generally cannot be used above boiling water temperature, can be changed into a non-melting insulation. That is, it becomes thermosetting instead of thermoplastic. It will then withstand soldering iron heat, or short-term, high temperatures encountered when launching a missile.

When heated above 275°F the irradiated polymer turns to a rubber-like material which can be stretched sometimes as much as 600%. When a tubing or molded part is cooled in its stretched form, it will remain stretched. When heated, the material will shrink to its original shape. Accompanying drawings indicate the phenomena of molecular cross-linking, expansion and heat shrinking.[2]

By DUANE D. RODGER
Product Manager
Raychem Corp.
Redwood City, Calif.

Polyethylene is both crystalline and amorphous. By changing polymerizing techniques, total crystallinity versus amorphous constant can be varied over a broad range. This unique combination of crystallinity-amorphous constant makes this polymer the most versatile.

Acts As Rubber-Like Elastomer

The significant point is that irradiated (cross-linked) polyethylene behaves as a semi-crystalline polymer below its crystalline melting point, and above that point it acts like an elastomer, being quite rubber-like and with significant strength, owing to its three-dimensional get network.

Uncross-linked polyethylene, on the other hand, has no measurable strength above its melting point. It merely melts and flows. It is the rubber-like quality and strength of such materials at elevated temperatures which make it possible to produce insulating materials that are heat deformable, possess elastic memory and serve a multitude of purposes in electronics.

The first products based on radiation chemistry were polyolefin insulated hookup wire, coaxial cable, and tape.[3] Irradiated, modified, polyolefin (IMP) insulated wire is solderable, and its covering weighs one-half that of other high-temperature insulations. It is ideal for wiring missiles. Satellites need radiation resistance among other properties, IMP wire again excels.

Heat-shrinkage molded parts and jacketing developments resulted in harness assemblies which could be completely sealed without laborious, time-consuming molding.

Harnesses required thicker, tougher, jacketing materials. Yet thickening the wall on polyolefin tubing made the tubing too stiff. To answer this problem heat-shrinkable tubings of modified neoprene and silicone rubber were created, and more recently, polyvinylchloride.

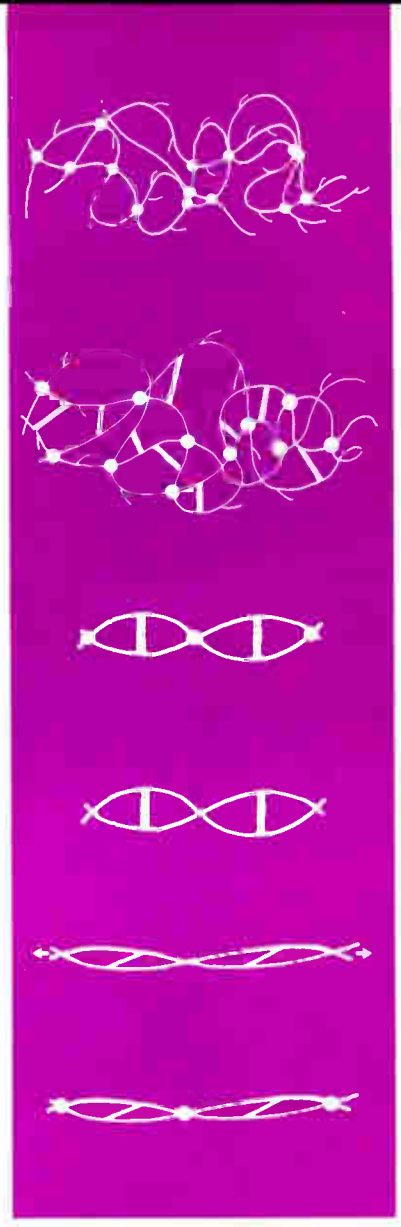
Moisture Exclusion Important

A top insulation need is to exclude moisture. Radiation chemists foresaw a good market for materials that would encapsulate and embed in a single operation. They turned to selective cross-linking that resulted in a tubing with an outer wall fully cross-linked, giving it elastic memory. Being partially cross-linked the inner wall of the tubing becomes soft and viscous when heated, and is thereby forced into the interstices of wires and components. On cooling, the mass becomes a tough, homogeneous molding.

An interesting application for heat-shrinkable insulation is in the harnessing used in aircraft, missiles and ground support systems. Environmental protection of harnesses is now possible without the cost and wasted time of molding with neoprene or with sealants. One major missile builder estimated a savings of $54,000 a year by using heat-shrinkable systems.

Cost savings are always attractive but reliability is more important in space and military applications. Several aerospace contractors have performed environmental tests on harnesses sealed with heat-shrinkable coverings. After impact, vibration at operating temperatures, temperature and humidity cycling according to MIL Standard 202A, and simulated high-altitude flight conditions, harnesses have still performed completely satisfactorily.

For wiring in missiles and aircraft, wire bundles must be compact and lightweight. In one missile it was found that almost fifteen pounds could be saved by changing from other plastic moldings to the heat-shrinkable system.



Polyethylene in long-branch molecule form before high-energy radiation or chemical treatment resulting in cross-linking.

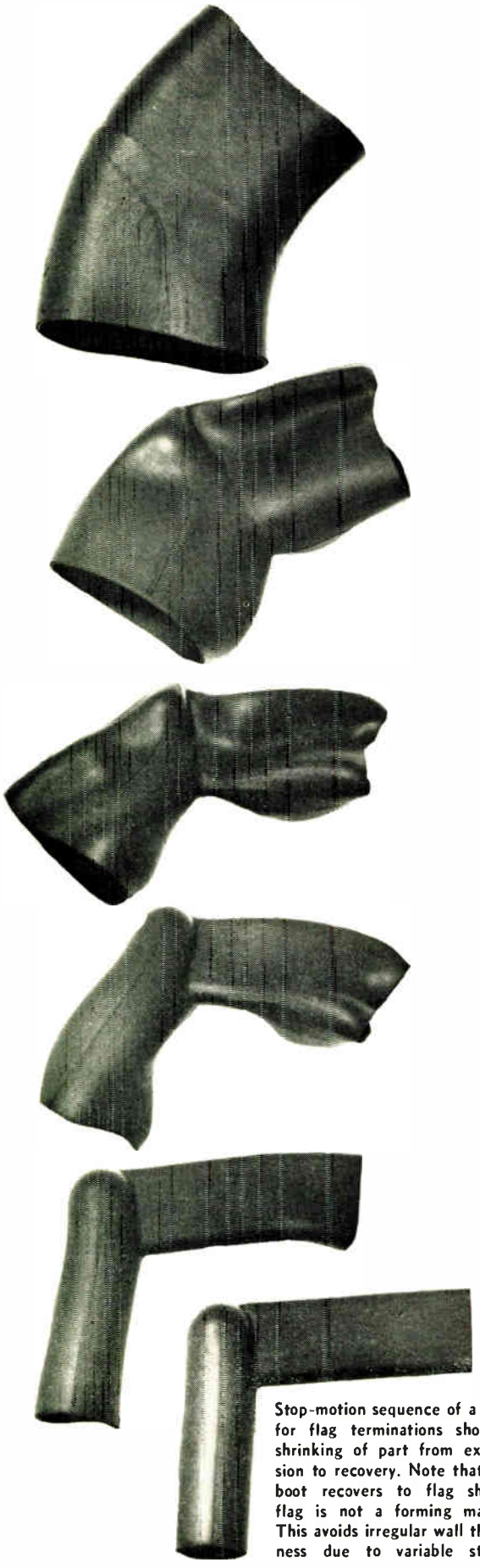
After treatment, polyethylene has three-dimensional gel form with primary valence bonds (heavy lines) called cross-links.

Relatively small part of cross-linked macrostructure (before heat is applied) to help visualize elastic memory phenomenon.

As cross-linked polyethylene is heated above its crystalline melting point, structure is destroyed and it becomes elastic.

In heated, elastic state the material is deformed by a force, and it returns to its original form on removal of the force.

If the cross-linked polymer is cooled in elastic distorted state the material will recrystallize and remain deformed.



Stop-motion sequence of a boot for flag terminations showing shrinking of part from expansion to recovery. Note that the boot recovers to flag shape; flag is not a forming matrix. This avoids irregular wall thickness due to variable stress.

HEAT-SHRINKABLE POLYMERS (Continued)

Must Be Tough, Flexible

Harnesses must be tough and flexible to permit installation in extremely crowded conditions. This is done by combining strong polyolefin molded parts, for strain relief and mechanical protection, with neoprene or silicone rubber parts and jacketing, for flexibility.

Heavy-walled silicone rubber tubing and molded parts can provide thermal insulation for components located near a missile's blast area. Polyolefin tubing and molded parts will resist attack by the storable propellents used in second generation liquid rocket engines such as nitrogen tetroxide and hydrazine.

In ground support applications last minute changes in design can be accommodated from selection of more than 500 different sizes and shapes of molded parts. Since these parts can be expanded to about four times their recovered size, and will conform to any cable diameter between expanded and recovered size, one part can be used many places.

The only tools needed for a heat-shrinkable system are an adhesive package and heat source. Mixing equipment, curing ovens, or jacketing equipment are unnecessary. Work can be moved closer to a missile launching site. Also, using commercially available parts, one or two harnesses can be designed and built for almost the same average cost as a run of 500, making short runs very economical.

New Mold Concept

A new concept for producing molds for epoxies, polysulfides, polyurethanes, and silicone RTV's has been developed using heat-shrinkable molded parts. Standard molds are available to fit most connectors and breakout configurations commonly needed in a harness. Parts come in expanded form, easy to slide over wire bundles. After heat-shrinking, molding compound can be injected with standard air-operated potting guns, mold openings tape sealed, and harnesses set aside to cure.

By using heat-shrinkable molds it is no longer necessary to design, machine, clean and maintain aluminum molds. Ordinarily, there is a wait of as much as three hours between uses for aluminum molds. With heat-shrinkable molds these delays are gone. Harnesses can be finished as fast as wires can be bundled and terminated.

Heat-shrinkable molds may be left in place to give added protection to compounds inside. Less expen-

sive polysulfide sealants can be used satisfactorily with polyolefin molds protecting the outside.

Unusual problems are being solved with heat-shrinkable molded parts. One manufacturer, using coaxial cable as a low-capacitance hookup wire, wanted to terminate the conductor and shield with 24 AWG hookup wire and protect the splice area. The part that solved the problem was a simple transition boot.

Signal Corps engineers for years have been looking for a better method to terminate their spiral four cable. Taping is time consuming and frequently unreliable. The part designed to solve this problem was another type of simple transition boot. (See illustrations for typical examples.)

Anti-Strain Connector Boot

Miniature coaxial cables with extremely small center conductors are susceptible to breakage. Although technicians are aware of this, they occasionally forget and use the cable as a handle to remove the coax connector from its socket. The part designed to cope with this situation is a cable connector boot with an elongated strain shank.

A dramatic example of what can be accomplished with a heat-shrinkable part is demonstrated by a boot designed to cover a flag termination. The end of the boot that seals on the round wire must be expanded 600% to permit the right angle terminal to pass through. (See photo series of shrinking operation.)

Radiation chemistry is a young technology. The materials discussed above are only the beginning in the heat-shrinkable insulation industry. New developments on the horizon include devices which accomplish several functions simultaneously such as terminating a wire, insulating it electrically, sealing out moisture, and supplying mechanical strength.

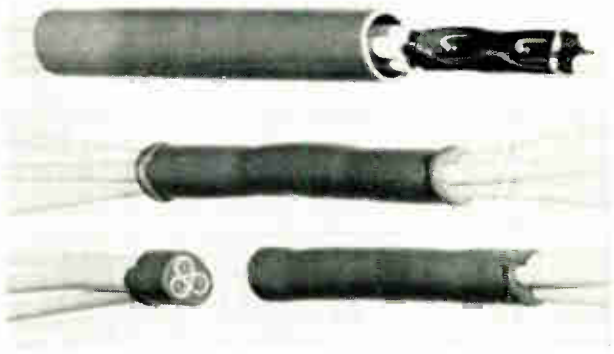
Different materials, some with higher temperature resistance, others with greater strength and flexibility are foreseen. Heat-shrinkable molded parts with extremely high temperature and chemical resistance can also be produced when the market demands such parts.

The electronic industry is making greater demands of its insulating materials than ever before. Radiation chemistry is providing many of the materials to satisfy these demands.

References:

1. Charlesby, Arthur, Proc. Roy. Soc. (London) *A215*, 187 (1952).
2. Cook, Paul M., and Lanza, Vincent L.,—a technical paper on irradiation induced elastic memory of polymers for presentation at the ninth annual symposium on communication wire and cable at Asbury Park, N. J., November 30 and December 1 and 2, 1960.
3. General Electric Technical Report No. 2730 (1956).

A cable connector boot with elongated strain shank, expanded and recovered on the cable, designed specially for technicians who like to use the cable itself as a disconnecting handle.



Self-potting, dual-wall, heat-shrinkable sleeve for splices, terminations and component encasement. Inside wall melts as outside shrinks. Cooled mass is hard, tough and homogenous.

Transition boot insulating a shielded wire or coaxial cable, with shield and conductor spliced and terminated with ordinary hook-up wire, that helped solve many insulation problems.

Heat-shrinkable harness parts showing expanded and recovered boot (right) and transition boot (left), with potting ports, samples of standard molds available for most harness needs.

THE OUTLOOK FOR ADHESIVES IN ELECTRONICS

Structural adhesives offer unusual advantages in solving many design and assembly problems. For example, they bond with uniform spread of load stresses to permit use of lighter gage materials. This article explains various types of these high-strength adhesives and their properties.

IN ELECTRONICS, STRUCTURAL ADHESIVES ARE NOW USED to assemble speakers, gear and shaft assemblies in timing mechanisms, various types of relays and controls, coils of synchrotrons and containers for shipment and storage of complex instruments and systems. Due to the advantages of adhesive bonding, many assembly applications will be developed in the electronic industry in the future.

Advantages of Adhesive Assembly

Reasons for increasing interest in the use of structural adhesives are:

1. Stress Distribution: Adhesives produce continuous bonds and thus distribute stress loads evenly over the entire joined area. This produces joints of greater strength and rigidity, and permits the use of lighter gage materials. The full strength of the thinnest sheets can be utilized.

2. Fatigue Properties: Flexibility even though minute, along with uniform stresses, helps improve resistance to vibrational fatigue.

3. Reduces Corrosion: Adhesives make it possible to join dissimilar metals with a minimum of bi-metallic corrosion, and to minimize corrosion from entrapment of moisture between surfaces. The adhesive acts as a continuous insulating barrier between the two metals.

4. Sealing: Adhesive bonding provides continuous contact between mating metal surfaces, thus sealing as well as bonding in a single operation.

5. Smooth Contours: An adhesive bonded joint eliminates gaps and bulges common with intermediate fastenings and has no external projections as with rivets and bolts. Also, it has no surface mars due to the heat and pressure of spot welding electrodes, thus eliminating the need for post finishing operations.

6. Maintain Soundness of Structure: Adhesives maintain integrity of structural members. Holes for insertion of fasteners, countersinking to give a flush surface, and excessive heat of fusion joining, which can ruin heat treatment or distort parts, are eliminated by the use of adhesives.

Thermosetting Film Adhesives

Film adhesives offer many design and cost saving advantages. They provide uniform thickness throughout the joint, confine adhesive to the bonding area, allow clean bonding, and simplify the use.

Film adhesives do not contain solvents, which eliminates fume disposal and drying problems. They are available in varying thicknesses and widths; and can be die-cut into complicated shapes. This type of adhesive gives the best compromise of shear strength, peel strength, shock and fatigue resistance.

Film adhesives stick to metals and plastics and offer good flexibility, impact strength, vibration absorption, fatigue resistance, and peel strength. Many of them have very good resistance to fuels, lubricants, humidity, and salt spray.

By EUGENE F. HESS
Adhesives, Coatings & Sealers Div.
Minnesota Mining and Mfg. Co.
St. Paul 19, Minn.

They provide shear strengths from 2000 to 6000 psi. Depending on the use and formula, some film adhesives can make high strength bonds at temperatures as low as −80°F. In some cases shear strengths as high as 7300 lbs. have been achieved at −67°F.

Generally, these adhesives can be used in continuous service in the 250°F range. Some bonding film adhesives will withstand moderate stress at temperatures as high as 500° or 600°F for short periods. Typical shear strengths at 300°F are about 2000 psi. At 400°F shear values of over 1000 psi have been reached using MIL-A-50901D specification test methods.

There are 2 basic types of film adhesives: Those which give off a volatile by-product or gas during the heat curing process (Elastomer-phenolic type); and those which release or liberate no volatiles during the heat curing process (Elastomer-resin type). Both types require heat and pressure to effect a cure but these requirements differ in degree.

Elastomer-Phenolic thermosetting film adhesives require pressures of 25 to 150 psi, to bring the parts into contact and to contain the volatile by-products. Exact pressure required depends on the rate of heat input to the bond line and the composition of the specific adhesive film. If sufficient pressure is not maintained during cure, the vapors given off will cause a porous bond.

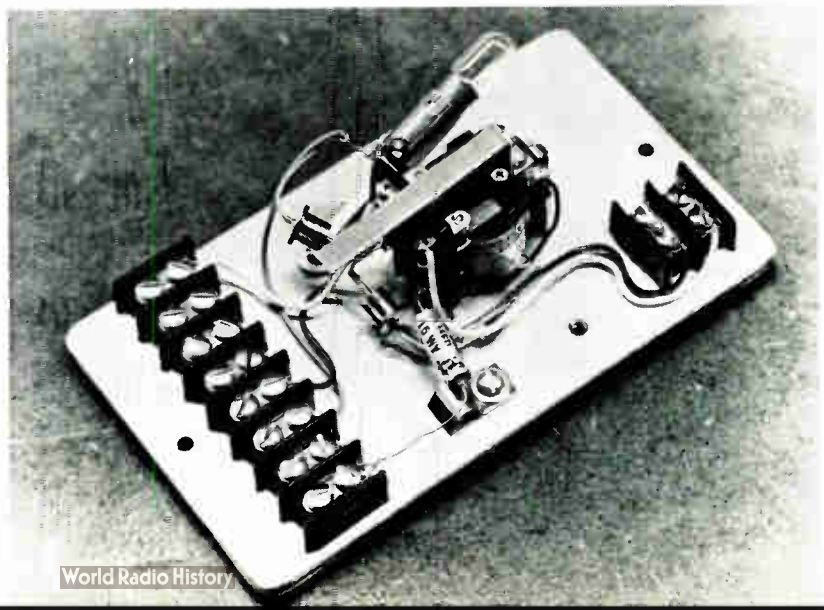
Elastomer-Resin thermosetting film adhesives are of more recent development. The outstanding physical property of these adhesives is their high peel and shear strengths and overall performance up to 250°F. Room temperature peel strength is 80 to 150 lb. per in. width. Room temperature shear strength is 5,000 psi.

Chemically the important difference between this type of film adhesive and the elastomer-phenolic

Above shows tape-bin panel fabrication using sprayable adhesive to bond sheet aluminum to a paper core. The panels can be handled as soon as assembled.

An example of bonding metal to plastic is seen above. Here, a two-part epoxy adhesive helps to position the on-off switch inside the shell of the phone.

Terminal switch is bonded to steel plate of this improved dictating system. The assembly time is reduced since there is no need for drilling and tapping.



type is the lack of volatile by-products given off during cure. Thus, bonding pressure needs are lower with elastomer-resin types and range from contact to 50 psi during cure.

Modified Liquid Epoxy Adhesives

Modified liquid epoxy adhesives are chemical curing and are excellent for metal-to-metal and metal-to-plastic bonding. These adhesives are available in two-part, room temperature curing and one-part heat curing types. Modified epoxy adhesives offer high strength, resistance to creep under constant stress and adhesion to most surfaces. They are self-filleting, which makes them very good for use with honeycomb sandwich construction. Both the one and two-part types are 100% nonvolatile liquids or pastes. Since no gaseous by-products are given off during the curing cycle, they are used for bonding impervious surfaces. The paste type is good for filling voids and is used to join loosely fitting parts. These adhesives require only contact pressure during cure. This eliminates the need for elaborate jigs and fixtures.

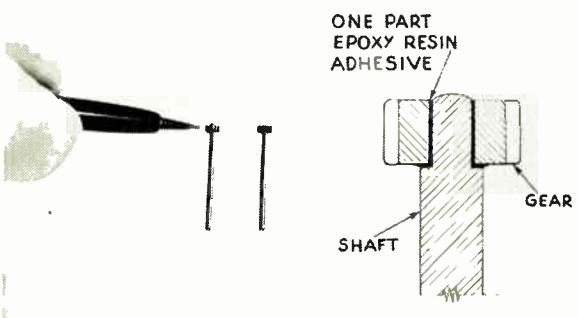
Epoxy resin adhesive will produce from 1000 to over 5000 psi overlap shear strength depending on the particular adhesive used. Heat curing epoxies have higher strengths than the room temperature curing formulas.

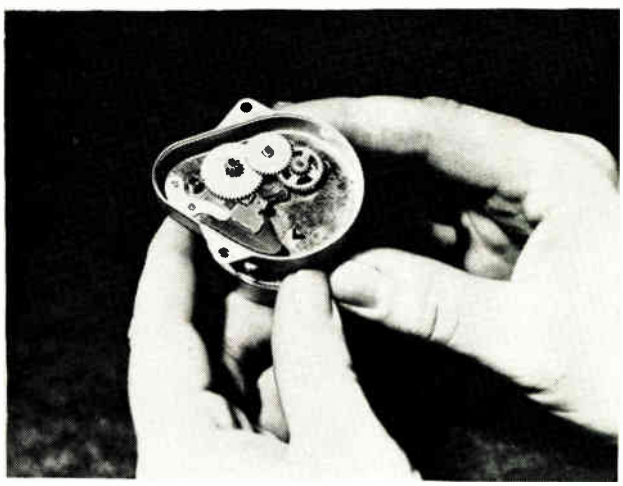
High temperature resistant epoxy adhesives have shear values in excess of 2500 psi at 300°F. Strengths at extremely low temperatures are also good. At −67°F, shear strengths will range from about 500 psi to more than 4000 psi.

Chemical resistance depends on the formulation; but in general, epoxies will resist most solvents, mild acids, and mild alkalies.

One-component modified epoxy heat curing liquid adhesives eliminate the need for accurate weighing and mixing of the hardener and base resin by the user. Besides saving time and minimizing the chance of human error, this system allows an unlimited working life. Heat curing is required in using this type of adhesive. The table below shows the different combinations possible for curing.

Stages in adhesive-bonding process. Upper photos show (left) the parts to be assembled; (right) a rotor shaft is dipped in a container of adhesive. Lower left, a timing gear being pressed on a coated shaft; and right, gear train with bonded pinion.





TYPICAL TIME-TEMPERATURE CURE CYCLE RELATIONSHIP

Temp. (°F) of Bond Line	Time (Min.) At Cure Temp. Adhesive EC-2214	Time (Min.) At Cure Temp. Adhesive EC-2186
250	40-60	—
300	15-20	120-180
350	6-12	40-60
400	1-2	15-20
450	—	6-12
500	—	1-2

Two-component modified epoxy adhesives consist of a base resin and a separate liquid catalyst or accelerator. The 2 materials, base and accelerator, must be mixed in the proper proportion prior to use.

Two-component modified epoxy systems will cure at room temperature, making them useful for many bonding operations where heat or pressure are not feasible in making a high strength bond. A rapid cure can be obtained after the parts are assembled by merely heating the assembly in an oven or under infrared lamps.

Standard adhesives of this type tend to produce rigid bonds. Adhesive EC-2216 produces a flexible, high-peel-strength bond while it maintains its high shear and tensile strength.

Typical Uses

The use of adhesives to assemble components of the new Nyematic Dictating System has reduced assembly time in addition to providing a flexible assembly method at Nye Products Company, Seattle, Washington (see the 3 photos illustrating).

A fast-drying, sprayable adhesive, EC-1828, is used to bond aluminum facings to paper honeycomb cores to make panels for a recording-tape storage bin. A two-part modified epoxy adhesive, EC-1838, bonds metal and plastic components of the dictating system.

In the tape-bin panel manufacture, the fast-drying adhesive permits the immediate assembly of the honeycomb core and aluminum facings. Because of the high immediate strength of the adhesive the panels can be handled as soon as they are assembled.

The two-part epoxy adhesive is used to bond parts of the tape storage bin; an on-off switch inside a plastic phone housing; and an 8-conductor terminal switch to a steel plate.

In the assembly the on-off switch must be properly aligned with the push button controls of the phone. The epoxy adhesive's heavy body helps in positioning the switch.

The terminal switch assembly time is reduced by eliminating drilling and tapping. Adhesive bonding the terminal switch also saves space, since a mounting plate is not needed.

A two-part epoxy adhesive was chosen for bonding these metal and plastic components because the parts did not lend themselves to heat curing operations.

The Haydon Division, General Time Corp., Torrington, Conn., has been assembling timing gears by adhesive-bonding small pinion gears to rotor shafts. These are shown in 4 photographs. These timing gear assemblies are used in synchronous timing motors which require small gear trains of high accuracy. These gears, therefore, are accurately machined and heat treated to provide sufficient hardness for wear resistance.

The previous joining method consisted of brazing the pinion gears to the rotor shaft. This method, in many instances, distorted the gear configuration or effected metal hardness due to the high temperatures involved in brazing.

EC-1386 is a one-part high-strength adhesive with an epoxy resin base selected by Haydon for this use.

This adhesive bonding method has provided savings by: reducing rejects which were distorted by the heat of brazing, eliminating secondary operations required with the previous brazing method, and eliminating the need for 100% inspection for shaft distortion.

NEW TECH DATA

Encapsulating Compound

"Polcast" is a new encapsulating compound with excellent adhesion to polyethylene. Applied hot, it can also be used to laminate polyethylene to itself or polypropylene to itself, bonding instantly. It is applied easily by heating to 300 to 350°F and pouring into the polyethylene or polypropylene shell. Electronics Research Div., Adhesive Products Corp., 1660 Boone Ave., Bronx 60, N. Y.

Circle 639 on Inquiry Card

Silicone Insulators

Tech. data describes a new line of high-reliability room-temp. vulcanizing silicone rubbers. RTV silicone rubbers remain flexible over a wide temp. range and are good insulators. They are used for making flexible molds and phototypes where minute detail must be reproduced. Hysol Corp., Olean, N. Y.

Circle 640 on Inquiry Card

Voltage Breakdown Tester

Data sheet VBT-1A describes voltage breakdown tester Model 1901A. This VBT is non-destructive in that it limits the time factor of the test rather than the amount of current or voltage applied to the test specimen. Uses include testing capacitors, transformers, r-f cavities, and insulation. Microdot Inc., 220 Pasadena Ave., So. Pasadena, Calif.

Circle 641 on Inquiry Card

Encoding Systems

A 12-page brochure describing the Microgon® angle-encoding systems is available from Norden Div., United Aircraft Corp., Norwalk, Conn. The shaft-angle encoders have an accuracy of ±1 count in over 2 million. In addition to a comprehensive explanation of each product, the brochure contains photos, characteristic graphs, and block diagrams.

Circle 642 on Inquiry Card

Some experimental single-crystal silicon carbide components have been recently developed. If they can be produced in uniform quality, greater reliability may be added to micro-circuits. Thermistors, rectifers and even transistors of high heat resistance, fast response time and good stability are the goals. These and other ceramic components and materials are reviewed.

CERAMICS: A NEW DIMENSION IN CIRCUITRY

CERAMICS HAS UNDERGONE A MAJOR CHANGE in the past 20 years. While some of it has been self-generated, most has been induced by the increase of knowledge and material needs in other engineering areas. In thinking about future advances in ceramics, therefore, one must speculate on probable developments in these other areas.

Thinking about ceramics in electronics yields four major trends which will have more and more influence: 1. Increasing miniaturization, both in scope and degree. 2. Much greater strengths, particularly in withstanding thermal and mechanical shock. 3. Higher operating temperatures. 4. Ultra-high purity or precisely controlled composition. These criteria apply to many ceramic materials used in electronics today. Their future depends on the growing needs of users and how the ceramist reacts to meet them.

History of Ceramic Insulators

The history of ceramic insulators shows the changing nature of electronic ceramic materials.

Electrical-grade porcelain was the prime material until 1930. It functioned well at lower frequencies and is still used to transmit power. As frequencies increased, porcelain was found wanting and steatite came into use. This is still quite useful, being inexpensive and easily processed. However, the need for greater strength and better thermal shock resistance has led to widespread use of alumina.

Although the most expensive of the 3, alumina has several advantages: good electrical properties, hardness, toughness and good chemical resistance. More recently, 2 other ceramics, boron nitride and beryllia, have been used as insulators. Both have low-density, which makes them good for aerospace systems.

Ceramics have long been used as insulators and this use is increasing. Ceramic components shown at left include alumina, steatite, graded glass-to-metal and ceramic-to-metal seals.

Because they satisfy the 4 criteria, alumina, berryllia and boron nitride will be the important ceramic dielectrics in the future. The problems in handling toxic beryllia have been largely overcome and it seems certain that the moisture resistance of boron nitride will be upgraded, opening many new uses for both materials.

Silicon Carbides

In recent years, ceramics have also become important in the semiconductor field. Ceramic resistors, particularly those of silicon carbide, have been used for many years, mainly in varistors for lightning arrestors and telephones. Higher temperature environments and greater unit loads have created demand for more and better ceramic semiconductors. Besides silicon carbide, these include many mixed oxides, and in the future will undoubtedly spread to other carbides, borides and possibly nitrides.

Perhaps the fastest growing area for ceramic semiconductors is thermistors. Both positive and negative temperature coefficient devices have a wide range of resistance and beta values. Some ceramic bodies being researched have beta values 3-4 times higher than commercially available thermistors.

Ceramic semiconductor devices available until now have been made from polycrystalline bodies. Quite recently, two labs developed single-crystal silicon car-

By DONALD G. STURGES
Vice President
Research and Development Division
The Carborundum Company
Niagara Falls, New York

bide thermistors. This should extend the uses for this type of device. These thermistors will be of minute size with fast response time, and should have better stability and reproducibility of response than polycrystalline bodies. More important, however, the single-crystal devices will be useful at temperatures far above the upper limits of multi-crystal ones.

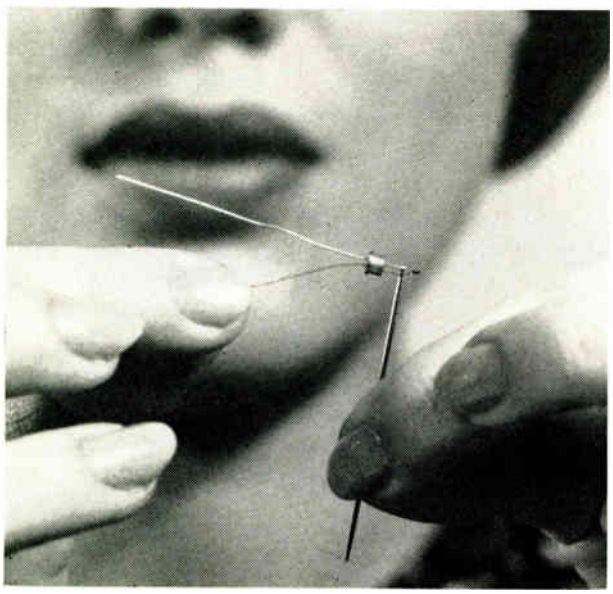
Very High Temperatures

It appears likely that operating temperatures over 1000°C. will be possible for the single-crystal devices. One of the interesting problems here is the need to develop a ceramic encapsulant to protect the electrical junctions where the metal leads join the crystals. This appears feasible.

Many labs have been working with another type of silicon carbide single crystal to make a high-temperature rectifier. Some success has been attained and it appears that these devices will be available commercially in a few years. An effort is also being made to develop silicon carbide transistors. These have been produced experimentally, but prospects appear slim for an early breakthrough in the controlled crystal growing methods needed to mass-produce them.

Microminiaturization is already highly dependent on ceramics. Parts of such circuits are deposited on tiny ceramic wafers, generally of high purity alumina, which are then stacked and interconnected. These wafers are less than 1 mm. thick and free of surface imperfections. Growing of more pure ceramic single crystals should make all components of these materials increasingly useful in microminiature circuits.

One of the major criteria which will influence the future of electronic ceramics is miniaturization. A new single-crystal thermistor is shown being inserted through eye of a needle.



Silicon carbide bodies like those used for refractories find a new use in dummy loads for both microwave and r-f transmitters. Such bodies readily absorb energy at these frequencies and can easily withstand strong local heating as well as high transient heat pulses. The high thermal conductivity of silicon carbide allows the absorbed energy to be quickly conducted to a cooling bath or fins.

Lasers and Masers

The recent development of lasers and masers appears important to the ceramist as well as the electronic engineer. Single-crystal alumina doped with chromium was the first material to show laser action. The effectiveness of this material depends upon crystal perfection and impurity control. Many other ceramics demonstrate this action. Neodymium-doped calcium tungstate, doped glasses, and strontium fluoride with uranium show stimulated emission. Gallium arsenide recently produced coherent radiation by direct electrical stimulation.

Ceramic electromagnetic windows for space uses are becoming more important. Radomes are often formed from alumina, which has the strength, abrasion, heat resistance and dielectric characteristics for the high frequencies involved. The need for better infrared windows in detection and guidance systems has led to the development of better, controlled fabrication methods. Both hot pressed magnesium fluoride and single crystal magnesia are used here.

Other Uses

Other special ceramics for electronics deserve comment. One of these, the ferrites, has been much discussed. Electro-mechanical ceramic devices have good frequency control. Ceramic band-pass filters hold side frequencies to a minimum. Ceramic piezoelectric devices are often used as frequency standards.

Looking to the future, there is a broad field of direct energy conversion, fuel cells, thermionic and thermoelectric converters and MHD, much of whose long range success appears to depend on ceramics. High operating temperatures will characterize many of these operations. The needs of the processes for electrical insulators, temperature sensors and controls and ionic conducting membranes will be satisfied in many cases by ceramic materials. For the ceramist these are exciting challenges.

* * *

THE SEARCH FOR NEW SEMICONDUCTOR MATERIALS

Semiconductors are only as good as
the materials used to make them.
What are these materials?
What qualities do they have
that make them the best for the job?
What do they lack?
What advances have been, and need to be,
made in the materials area?

THE SEMICONDUCTOR INDUSTRY used about 60,000 lbs of silicon (S_i), and a somewhat smaller amount of germanium (G_e) in 1962. As transistors, rectifiers, and controlled rectifiers continue to invade the power market, material needs will increase. Moreover, unless a replacement for solar cells is developed, that area alone could add several thousand pounds a year to the usage of S_i. Thus from a supply standpoint, if any other material is to displace S_i and G_e appreciably in the next few years, it will have to be available in quantities of 50,000 to 100,000 lbs/yr, and at some reasonable cost. Even if better performance could be obtained from a more costly material, it seems unlikely that the general market would bear a higher cost.

Least Expensive

G_e is easy to process but scarce, so its price probably will not decrease much unless new sources are discovered. Even now almost all scrap G_e is reclaimed. S_i, on the other hand, comprises about 25% of the earth's crust, but is more difficult to process than G_e. However, as processes are improved and usage increases, high-purity S_i prices will probably decline. In the case of compound semiconductors each component must be purified before compounding; even if both (or all) components are readily available (which is not the case for gallium), we may expect the processing costs for compound semiconductors to be about twice that of elemental semiconductors. This leads to a price projection for gallium arsenide (G_aA_s) which is twice that of G_e. All of this leads to our first conclusion, that S_i will remain the least expensive material during the next 5 yrs.

Finding the Best

This takes us to the next problem, that of finding the best material. Consider the operating temperature range. For most classes of devices, operation is restricted to temperatures for which n_i is small compared to the impurity doping level. Table I shows some approximate upper temperature ranges for various band gap materials. Desired operating range is creeping up, due both to more severe environmental conditions and to the desire to extract more power from a given device. Even so, G_e, S_i, and G_aA_s are the only contenders far enough advanced to be considered during the next few years. And Table I shows that even G_e is marginal.

Important Factors

As semiconductors invade the higher power areas (which with solar cells will probably account for the majority by weight of material used), mechanical

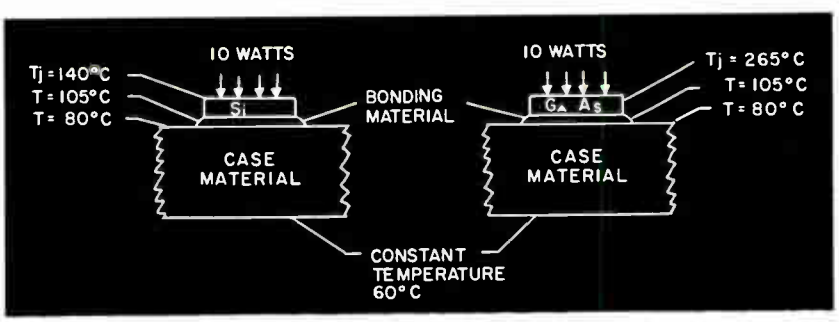


Fig. 1: Some possible temperature drops across the semiconductor, the solder and the case, for silicon and gallium arsenide.

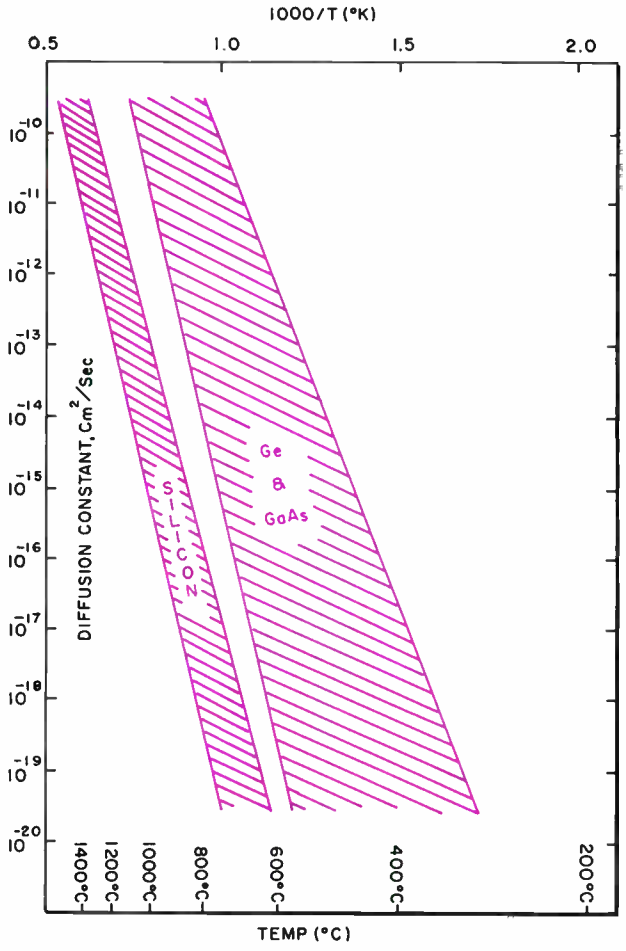
By Dr. W. R. RUNYAN
Texas Instruments Inc.
Dallas, Texas

strength and thermal conductivity will become more and more important factors in the choice of material. Table II shows some "average" values of these properties in the room temperature range.

The thermal conductivity of S_i is highest, followed by G_e and then by G_aA_s, with a value of only about ¼ that of S_i. Fig. 1 shows some possible temperature drops across the semiconductor, solder and case, for S_i and for G_aA_s. It becomes apparent for power uses that the lower thermal conductivity can offset the higher potential operating temperature of G_aA_s.

The breakage rate encountered in handling large-area S_i and G_e wafers is not prohibitive except when their thickness is less than about three mils (0.003). For G_aA_s, however, much difficulty is found even with 10 to 20-mil thick wafers. This behavior is reflected in their relative breaking strengths, Table 2. Also, the weaker the material, the more likely that poor handling methods will cause mechanical damage that will reveal itself only during later operations. For example, most semiconductors, if subjected at room temperature to high localized stress, as from test probes, will dissipate the elastic energy at high temperatures by plastic flow. In wafers, small cracks or even gross failure can occur because of improper matching of the thermal expansion coefficients of the semiconductor and its contacts. Again, the lower the breaking strength, the more likely that such defects will occur.

Fig. 2: Extrapolated diffusion coefficients vs temperature for a range of values for germanium, silicon and gallium arsenide.



Defects

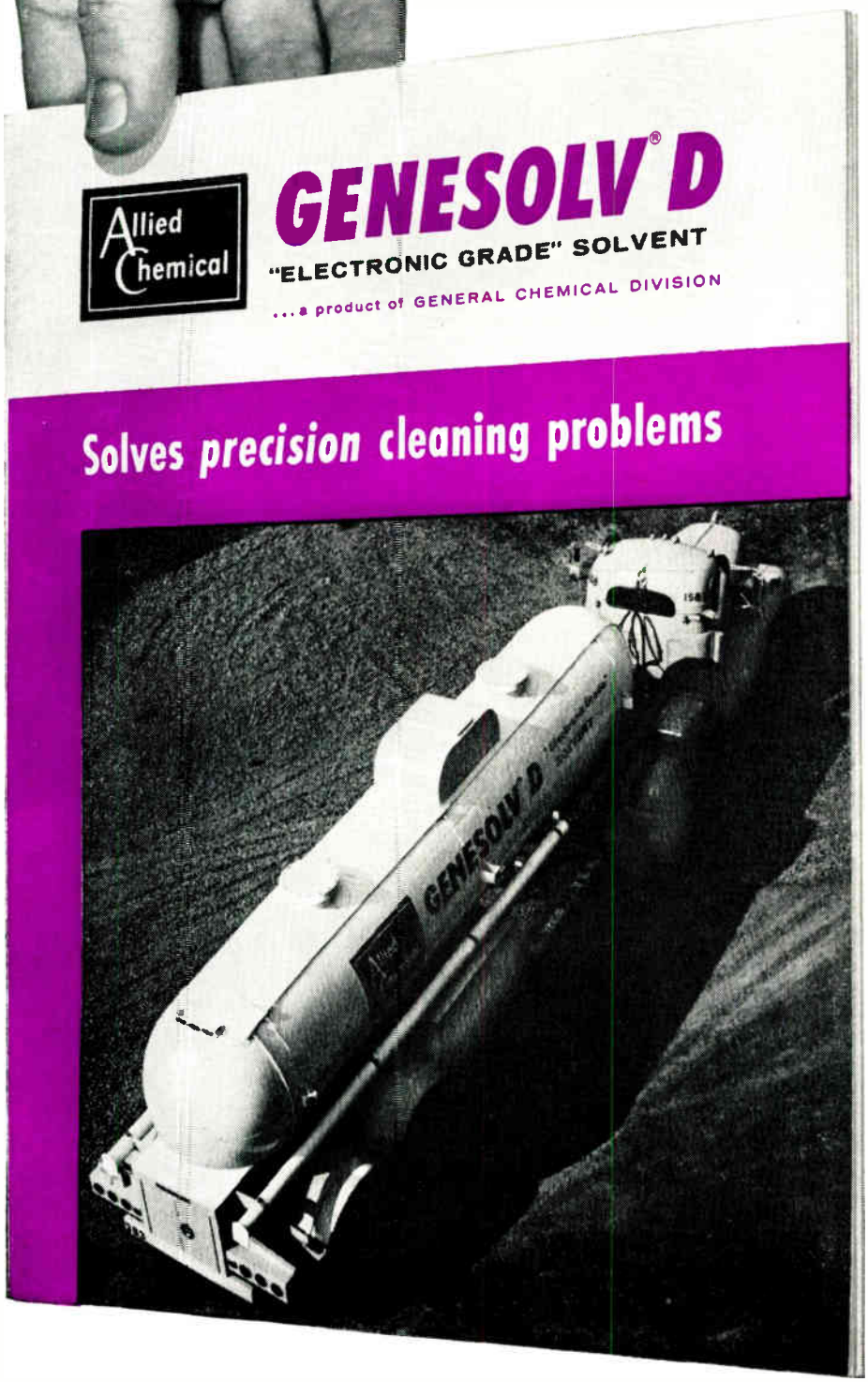
Better methods of studying defects in semiconductors and improved methods for preventing their formation must be developed. As an example of the present status, as late as March 1963, stacking faults covering square cm's of area were first reported in S_i. Also, the old standby of dislocation counting can certainly be misleading. The photo shows a network of dislocations found in "dislocation free" S_i by x-ray topography. These comments do not imply that S_i is particularly bad, but rather that it is the only one studied appreciably at the present. Though impurity-impurity, and impurity-defect interactions have long been studied, only now are their practical effects on device fabrication performance and reliability being considered. The desire for more radiation tolerance in semiconductors is requiring a closer look at the effects of radiation-induced traps on lifetime. It also raises the hope that eventually effects of such traps may be minimized by proper doping prior to irradiation.

In view of increasing demands for reliability, we will consider possible interaction of reliability and materials. Construction of a reliable device requires that its characteristics must remain within tolerable limits during its normal life. The first thing to examine is the possibility of bulk changes which could affect device performance; e.g., a redistribution of impurities caused by precipitation, diffusion, electrolysis, or additional alloying from contacts caused by high localized heating.

It is hard to establish simple criteria for setting limits on the amount of diffusion allowable. So it was assumed that the diffusion should be such that a point on the diffusion front three orders of magnitude lower in concentration than the initial must move less than 0.03 microns (1/10 of the base width of a present day h-f transistor). This requires a Dt (diffusion coefficient-time product) of less than 2.5×10^{-11} cm.² If a device is to be used for 5 years, D must be less than 1.2×10^{-19} cm²/sec. Fig. 2 shows extrapolated diffusion coefficients vs temperature for a range of values appropriate for G_e, S_i and G_aA_s. Observe that in the case of S_i and G_e the temperatures at which any appreciable diffusion occurs are

This is your free copy...

write for it



This is our new 8-page brochure on Genesolv® D "Electronic Grade" Solvent. It's loaded with information. It's free. It's yours if you write.

Five tables give specifics on physical properties of the solvent, Kauri-Butanol values, surface tension, swelling characteristics of various plastics in the solvent, and solubility of organic materials.

There are facts on solvent residue, penetration, safety, solvency, resistivity, dielectric strength, stability and economy of use.

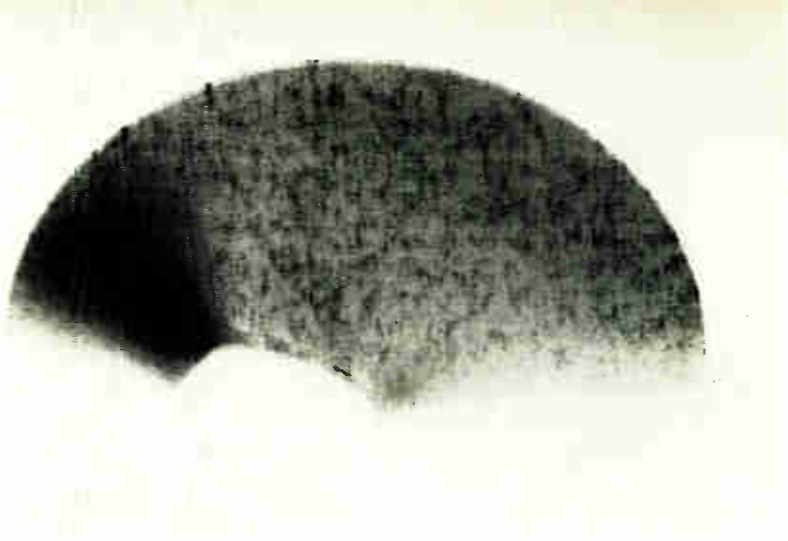
Plus helpful information on handling and using the solvent. Recovery of used solvent (including a schematic drawing of a typical recovery system).

Write on company letterhead for your free copy.

GENERAL CHEMICAL DIVISION
P. O. Box 353, Morristown, N. J.

Allied Chemical

Circle 150 on Inquiry Card



Dislocations found in "dislocation free" Si by x-ray topography.

well above any possible operating temperature. On the other hand, the G_aA_s diffusion coefficients are higher and this may prevent its use at the elevated temperatures that its wider band gap would allow. As a matter of fact, the drift of G_aA_s tunnel diode characteristics has been attributed to a change in the impurity profile near the junction caused by a combination of diffusion and field-induced drift.

There are some elements, e.g. lithium and zinc, in S_i that have high diffusion coefficients at low temperatures, and whose movement can be influenced appreciably by low electric fields. This property is useful in making "adaptive" devices, but care must be taken to keep such elements away from standard device material. Also, there is only a small amount of data on the diffusion rate along grain and twin boundaries, but the rate is greater than in the bulk. Thus, the accidental inclusion of such a defect in a device could lead to eventual failure unpredicted by the previous argument.

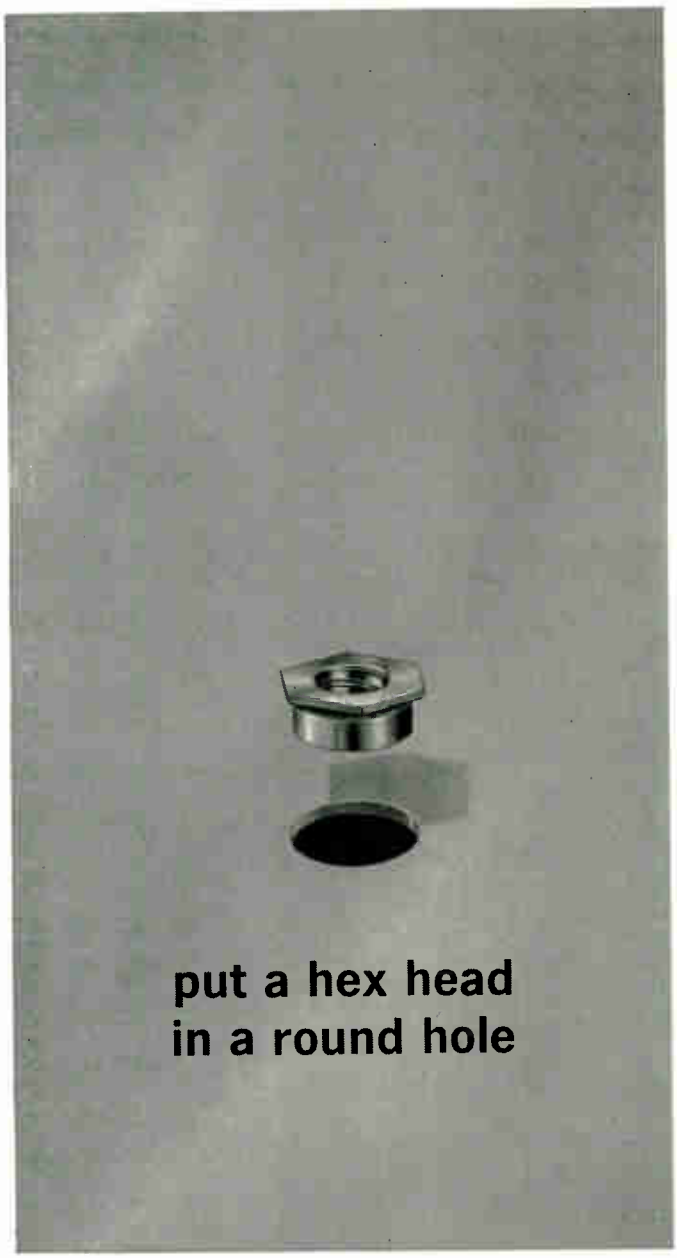
Precipitate formation of another phase has an effect both through removing impurities from solid solution, and through the electrical behavior of the precipitate itself. There is little data available on the rates of precipitation vs temperature and temperature cycling, and mechanical stress cycling. The demand for further reliability will require a more extensive study of these effects in the future.

The more serious problem is not movement in the body of the semiconductor, but rather chemical reactions at the surface, and surface migration. Device performance is very dependent on the semiconductor-surface layer bonds, so any changes with time are usually undesirable, and some are catastrophic. The search for an appropriate stable surface film continues. It has met with little success except in the case of S_i, whose oxide has proven nearly ideal. Use of the material oxide is unique to S_i since it is apparently the only one whose conductivity is low enough not to interfere with device operation. For other semiconductors, either a different compound must be "grown" onto the surface to tie up the broken bonds, or a completely foreign material must be added. Neither of these solutions seems as good as the native grown silicon oxide (with its good mechanical and electrical properties). This is another reason why S_i will probably hold an edge in reliability for years to come.

Our second conclusion, then, is that S_i will be the most widely used material during the next 5 years. This is because of its better physical properties and probable economic advantage. Our third conclusion is that, as the degree of device sophistication and the demands for reliability continue to increase, a much better understanding of material-device interactions will be needed.

Materials for "Specials"

In the case of special low-volume items needing properties peculiar to a particular material, the arguments just advanced are not applicable. It is interesting, however, to do some speculation of a different nature in these areas. Use of G_aA_s for diode light emitters and optically coupled transistors implies a continuing industrial study of G_aA_s fabrication and diffusion methods. The possibility of using G_aA_s in either a good high-temperature or high-frequency transistor is not so clear at the moment, but its future is probably slanted toward high-frequency uses. This end use requires development of more material purification methods and crystal growing methods that will ensure reproducibly high mobilities. G_aA_s's ability to be doped with oxygen to a high resistivity makes it intriguing as a material for functional electronic blocks, since it would offer more latitude in element placement and isolation than is now possible. In order to take full advantage of this property, epitaxial growth of layers is needed. This will necessitate development of much better methods for depositing G_aA_s epitaxially; these will in turn extend the technology and use of epitaxial methods to com-



put a hex head in a round hole

for captive inserts that can't push, pull or torque out!

National's stainless steel threaded inserts for aluminum or brass are truly permanent. They can never be pushed, pulled, or torqued out. There are two reasons: (1) When the distinctive six-sided head is pressed into a round drilled or punched hole the hex shoulder recesses into the softer sheet metal. The diagonals of the hex become widespread anti-torque fingers that positively prevent rotation. (2) Pressing the head into the parent material displaces this softer metal causing it to cold flow into a unique recessed cavity. This locks the nut in place. It becomes impossible to pull or push the insert out unless the force is so great that it destroys the parent material.

A wide variety of National captive nuts and studs are available from distributors in your area. Bulletin CO-2 describes all of the types available. In addition National can make custom variations quickly and inexpensively.

Write for our newest technical Bulletin CO-2 for complete details on National Captive Hardware and the name and address of the distributor nearest you.

NATIONAL RADIO COMPANY, INC.

A Wholly Owned Subsidiary of National Company, Inc.
37 Washington Street, Melrose 76, Mass. Phone NOrmandy 5-4800 TWX 617-665-5032.
Export: Ad Auriema Inc., 85 Broad St., N.Y.C. Canada: Len Finkler Ltd., 2 Tycos Drive, Toronto 19.

pound semiconductors in general. Again, because of the various factors mentioned earlier, it seems unlikely that this usage will supplant large-volume use of S_i for functional electronic blocks within the next 5 years.

Indium antimonide has long been used as an infrared detector (both photovoltaic and photoconductive), but desires to operate detectors at temperatures above that of liquid nitrogen are causing a shift to other materials (notably indium arsenide). On the other hand, the large mobilities in InSb and the possibility of using indium antimonide to achieve a solid state analog of the traveling wave tube will be enough stimulus to maintain a continuing active indium antimonide materials program in many labs.

Recent Advances

Now consider some recent advances in semiconductor material technology, and their probable impact on future developments. Development of methods of growing single crystal semiconductor films on inexpensive polycrystalline substrates by either micro-melting or "rheotaxial" process will probably be more applicable during the next few years to new types of small area active thin film devices than to present day designs. Certainly the realization that epitaxial methods could be used to advantage in building many device configurations marks a major advance. The development of dendrites and webs has not yet made an impact, even though it makes possible direct transformation from a melt to wafers without intermediate cutting and polishing procedures and is a big improvement in crystal growing technology. With the increased emphasis on reliability of finished devices, the development of a dependable surface stabilizer for S_i (thermally grown oxide) represents a milestone.

The combination of epitaxy and web growing, plus an artful use of oxide masking and stabilization, makes feasible the concept of a fully automatic transistor assembly process, which starts with bulk material. Some gaps still exist in the technology—notably in the area of a continuously selective etching process, but some promising avenues are available. Thus, instead of growing crystals, slicing, mechanically or chemically polishing, making an epitaxial deposition, masking, diffusing, etc., one can visualize: (1) a continuously fed dendrite or web machine supplying a ribbon of material directly into an epitaxial deposition furnace (2) next the ribbon receives an oxide coating, which is selectively removed in the following step by an ultraviolet-catalyzed etch (3) the ribbon then progresses to a diffusion or epitaxial furnace as appropriate (4) steps 2 and 3 are repeated as needed depending on the complexity of the device to be built (5) vapor-plated metal contacts are added (6) the ribbon is converted to dice and assembled on headers, given a protective envelope, and tested. There are, of course, many mechanical problems associated with this undertaking but a final conclusion is that such machines will be in operation in about 5 years.

Table 1

COMPOUND AND ELEMENT SEMICONDUCTOR PROPERTIES

Semiconductor	Band Gap (ev)	Electron Mobility cm^2/Vsec	Hole Mobility cm^2/Vsec	Max. Temp. (usable °C)
Ge	0.67	3,900	1,900	85–100
Si	1.11	1,500	500	150
C (diamond)	6.70	1,800	1,200	>1,000
InSb	0.18	65,000	≈1,000	−196
InAs	0.33	20,000	≈200	≈ 30
InP	1.25	>4,000	>100	≈300
GaAs	1.35	>5,000	>400	≈400
GaP	2.25	>100	> 20	≈650
AlSb	1.52	>400	>400	≈450

Table 2

MECHANICAL PROPERTIES OF SOME SEMICONDUCTORS

	Young's Modulus*† dynes/cm^2	Breaking Strength*† dynes/cm^2	Thermal Conductivity Watts/cm deg.
Ge	10.25×10^{11} at 25°C	2.23×10^{10}	0.7 at 300°K
Si	13.56×10^{11} at 25°C	2.65×10^{10}	1.3 at 300°K
GaAs	1.64×10^{11} at 25°C	1.98×10^{9}	0.37 at 300°K
AlSb	6.02×10^{11} at 25°C	1.38×10^{10}	

*[100] direction, 25°C
†1/30 shear modulus
1. McSkimin, *Journal of Applied Physics*, Vol. 24, No. 8, pp. 988, Aug. 1951 (for Ge & Si).
2. *Selected Constants Relative to Semiconductors*, Pergamon Press, 1961 (for GaAs & AlSb).

References

1. Bureau of Mines Annual Report.
2. Dash, W. C., "Dislocations in Silicon and Germanium Crystals," *Properties of Elemental and Compound Semiconductors*, Vol. 5, Metallurgical Society Conferences, Intersciences N. Y. (1960).
3. Schwuttke, G. H., "Large Area Stacking Faults in Czochralski-Grown Silicon Crystals," 1963 March meeting of the American Physical Society.
4. Maserjian, Joseph, "Single Crystal Germanium Film by Micro-Zone-Melting," *Solid State Device Research* Conference, July 1962.
5. Rasmanis, Egons, "Deposition of Device-quality Silicon Films on a Fluid Surface," Spring meeting of the Electrochemical Society, April 1963.
6. Teal, *et al*, "A New Bridge Photo-cell Employing a Photo-Conductive Effect in Silicon," J.A.P., p. 829, 1946.
Theuerer, H. C., *et al*, "Epitaxial Diffused Transistors," *Proc. IRE 48*, 1642, 1961.
7. Billig, E., "Growth of Monocrystals of Germanium From an Undercooled Melt," *Pro. Roy. Soc. A*, Vol. 229, pp. 346-63, 1955.
Bennett, A. I., and R. L. Longini, "Dendritic Growth of Germanium Crystals," *P. R.* Vol. 116, #1, pp. 55-61, 1959.
8. Grinich, V. H., and J. A. Hoerni, "The Planar Transistor Family," International Symposium on Semiconductor Devices, Paris, 1961.

NEW TECH DATA

for Engineers.

Silicon Diodes

Catalog 804 describes silicon diodes for general purpose or low-power rectifier use. It covers over 775 types. Bulletin classifies diodes as to number, kind, and values of characteristics desired. Comparison chart makes clear the differences between germanium and silicon diodes, enabling engineers to make the best choice. Bulletin contains precautionary notes on use and testing of silicon diodes. Ohmite Mfg. Co., 3655 Howard St., Skokie, Ill.

Circle 376 on Inquiry Card

Hall Effect Pocket Booklet

A 23-page, pocket-size booklet, entitled "The Hall Effect and its Applications," discusses the Hall Effect and contains sections on history and theory, practical devices, and instructions for putting the principle to work. For readers who care to conduct actual experiments and apply the Hall Effect to practical problems, "Hall-Pak" kits consisting of a circuit board, magnets, "Hall-Pak" device and the booklet can be supplied. Kits vary in price. Booklet is free. F. W. Bell, Inc., 1356 Norton Ave., Columbus 12, Ohio.

Circle 377 on Inquiry Card

Avalanche Rectifiers

This brochure entitled, "Double Diffused Avalanche Regulated Silicon Power Stud Rectifiers" covers mechanical, performance and environmental features as well as absolute max. ratings, thermal and electrical characteristics. It describes stud rectifiers for 3a., 6a., and 12a. uses, and operate at 1 kv. Atlantic Semiconductor, Inc., 905 Mattison Ave., Asbury Park, N. J.

Circle 378 on Inquiry Card

25-Amp. Transistors

Engineering Data Sheet 2N2636—2N2638 describes a series of three 25-amp. high-speed switching transistors capable of switching clamped inductive loads in μsec at peak powers of 1000, 1500, and 2000w respectively. Information includes schematics, curves, and specs. Bendix Semiconductor Div. of Holmdel, N. J.

Circle 379 on Inquiry Card

Magnetrons

The SYM-4362 is tunable Ku-band magnetron of coaxial design. It can be tuned over a 15.5 to 17.5gc band, with smooth peak output power of 70kw. SYM-4328 is used in the Ku band. It covers the freq. band 15.5 to 17.5gc with a peak output power of 90kw. The SYM-4350 is a beacon magnetron. It operates in the Ka band and has a peak output of 2kw. The SYM-4370 is a fixed freq. Ke band tube with a min. peak output power of 40w. Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y.

Circle 380 on Inquiry Card

Optical Maser Brochure

Full specs. and prices on the complete line of laser optics, dielectric coatings and single crystals available from Perkin-Elmer Corp., are given in a new 12-page brochure, "Optical Maser Services." Brochure also includes coating transmission curves, material transmission characteristics, and typical dimensional tolerances. Electro-Optical Div., Perkin-Elmer Corp., Norwalk, Conn.

Circle 381 on Inquiry Card

Receiving Tube Booklet

A 16-page booklet, "The Box with No Bottom," characterizes the electronic tube carton as a magician's box from which come endless developments and products. Booklet contains details of 22 recent developments in compactrons, receiving tubes, ceramic tubes, photoconductive cells, and reed switches. Receiving Tube Dept., General Electric Co., Owensboro, Ky.

Circle 382 on Inquiry Card

Semiconductor Catalog

Over 3,500 semiconductor devices, including glass zener diodes, silicon controlled rectifiers, silicon and selenium small, medium and high power rectifiers, photocells and zener reference elements are described in 24-page Short Form Catalog No. SFC-1-2. Ratings, characteristics and other descriptive data are included. International Rectifier Corp., 233 Kansas St., El Segundo, Calif.

Circle 383 on Inquiry Card

Tube Catalog

The 68-page illustrated 1963 Quick Reference Catalog describes Eitel-McCullough, its products and facilities. Products described include microwave tubes, power klystron and power grid tubes. Power grid tubes are subdivided into rectifiers, triodes, tetrodes, pentodes and pulse modulators, sockets and other products. Eitel-McCullough, Inc., San Carlos, Calif.

Circle 384 on Inquiry Card

Low-Impedance Silicon Zener

This brochure describes a new line of low-impedance, 1w. miniature silicon zener diodes. Complete specs., a cross sectional drawing, curves and features are included. Diodes, Inc., 9261 Independence Ave., Chatsworth, Calif.

Circle 385 on Inquiry Card

Transistor Amplifier

Data on T-2857 silicon planar-epitaxial transistor amplifier for h-f military and industrial communications circuits is available. Device, which has been functionally tested, exhibits an 18db power gain and a 4.5 typical noise figure at 100mc. It is tested at 100mc in actual amplifier circuit. Essential operating characteristics of the transistor are measured during circuit operation. Noise figure and gain are measured at the same point under the same conditions. Lansdale (Pa.) Div., Philco Corp.

Circle 386 on Inquiry Card

Industrial Tube Guide

Industrial Tube Guide (Form T-23) contains details on the uses, construction, capabilities, number and military uses of industrial tube types, including ballast, computer, electrometer, hydrogen, thyratron, phototube, power triodes, transmitting, voltage amplifier pentodes and voltage regulators. Tung-Sol Electric, Inc., 1 Summer Ave., Newark 4, N. J.

Circle 387 on Inquiry Card

Triode Bulletin

Tech. data is available on the Calvertron A2900 long-life double triode. It is similar to the 12AT7 but has closer tolerances on characteristics, especially balance of current and slope and control of "cut-off" voltage. Also, the A2900 will tolerate long periods of operation under "cut-off" conditions, important in "flip-flop" circuits. Calvert Electronics, Inc., 220 E. 23rd St., New York 10, N. Y.

Circle 388 on Inquiry Card

Tunnel Diodes

Two series of microwave germanium tunnel diodes for h-f uses are described in literature available from Sylvania Electric Products, Inc., 1100 Main St., Buffalo 9, N. J. The devices, D4961 and D4971, have typical resistive cutoff freqs. from 3gc to 32gc and peak currents from 2.0ma to 100ma.

Circle 389 on Inquiry Card

High-Conductance Diodes

Two high-conductance, low-capacitance silicon planar epitaxial diodes with fast recovery times, hpa-1001 and 1002, are described in this data sheet. Attached chart compares combination of high conductance and fast switching with that of other diodes, using the ratio of conductance (I_F) to capacitance (C_o), vs. recovery time (T_{rr}). HP Associates, 2900 Park Blvd., Palo Alto, Calif.

Circle 390 on Inquiry Card

Silicon Transistors

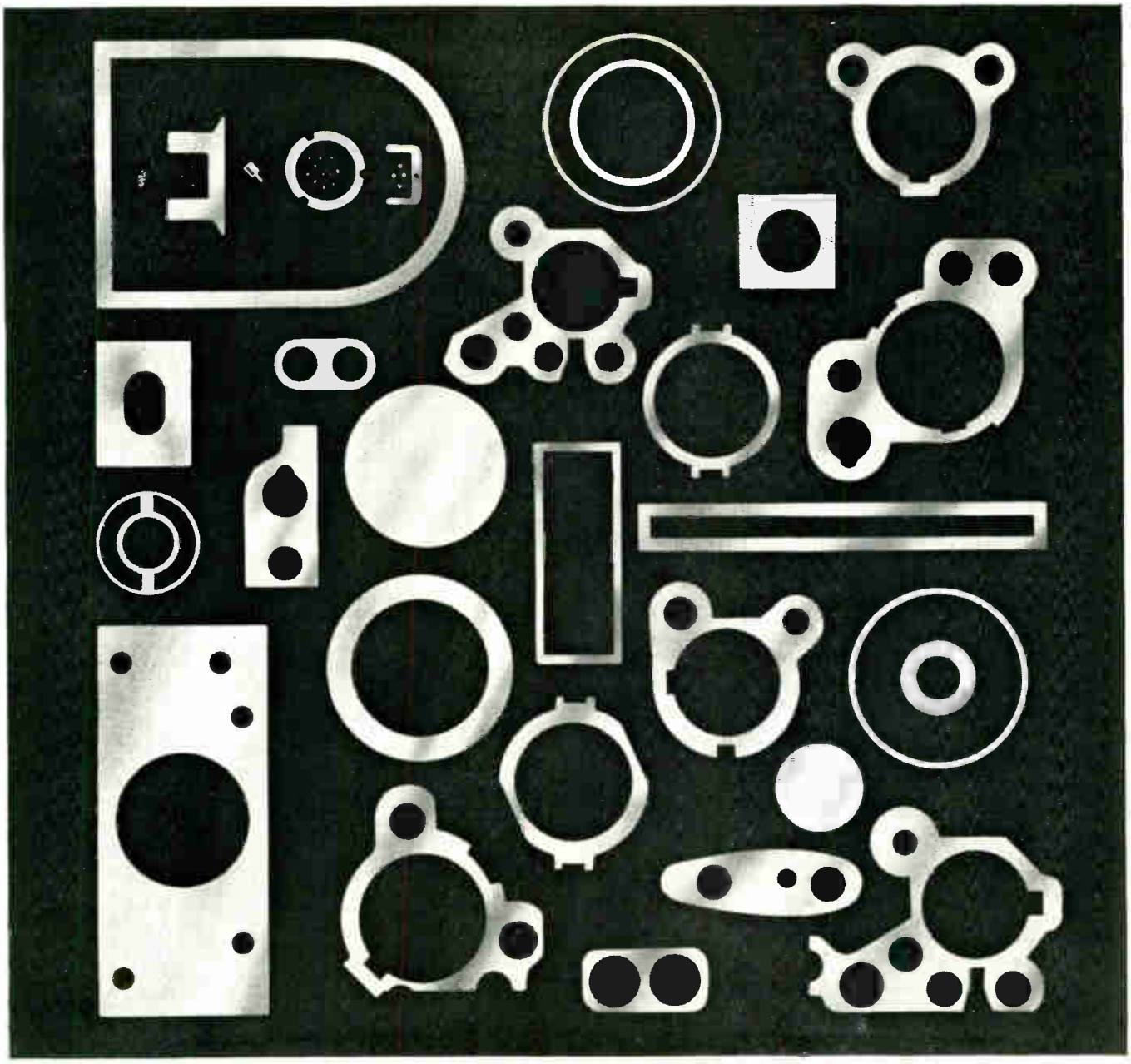
A condensed catalog describes silicon planar/epitaxial transistors. Included are full listings and basic specs. on: high-voltage universal amplifiers, low-level and small-signal amplifiers, universal amplifiers and switches, low-storage saturating switches, UHF and VHF amplifiers and non-saturating switches, industrial types and low-level choppers. Transistors listed are production-run types. Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.

Circle 391 on Inquiry Card

Tunnel Diode Measurements

A brochure, "Technical Report on Tunnel Diode Measurements," includes methods of measuring series and negative resistance, junction capacitance, max. freq. of oscillation, and resistive cutoff freq. Circuits and graphs are included. Microwave tunnel diode line is listed. Sylvania Electric Products, Inc., 1100 Main St., Buffalo 9, N. Y.

Circle 392 on Inquiry Card



Kester "Solderforms" come in any shape or size to save you production time and money

When you order Kester "Solderforms", your specific requirements determine the exact shape, size and alloy of solder. "Solderforms" are made-to-order, prefabricated forms of solder. You automatically get the right amount of solder and flux needed for each application. No more, no less . . . no waste.

"Solderforms" offer unequaled efficiency in production line soldering. You can assemble units with "Solderforms" in position—solder intricate assemblies faster and better.

No question, "Solderforms" save you time and money . . . insure quality soldering!

Perhaps "Solderforms" are just what you need to solve your most difficult soldering problem. Write today briefly stating your application situation. Kester will gladly offer engineering assistance.

KESTER SOLDER

KESTER SOLDER COMPANY

4210 Wrightwood Avenue, Chicago 39, Illinois
Newark 5, New Jersey • Anaheim, California • Brantford, Ontario, Canada
Over 64 years manufacturing quality solders and fluxes

GLOSSARY OF TERMS IN OPTICS AND SPECTROSCOPY

Compiled by Alva H. Bennett,
American Optical Co. (Retired)

ABERRATION—In an optical system any systematic departure from an idealized path of light rays forming an optical image, causing the image to be imperfect.

ACHROMATIC—The property of being free of color. In an optical system, freedom from chromatic aberration.

ACUITY, VISUAL—The degree of keenness of vision.

ACUTANCE—The degree of sharpness and contrast of edges in an image.

ANAMORPHIC—A difference in magnification along two mutually perpendicular axes. Also applied to an optical system producing this effect.

ANASTIGMAT — A lens system corrected especially for freedom from the aberration called astigmatism.

ANGSTROM—A unit of length applied in specifying the length of light waves. It is equal to one ten millionth of a millimeter (10^{-7} mm).

APERTURE—An opening or hole, often circular in outline, through which light or matter passes.

ASTIGMATISM — An aberration of a lens or lens system which causes an off-axis point to be imaged as two separated lines perpendicular to each other.

AXIS, OPTICAL—The line joining the centers of curvature of the surfaces of a lens or lens system.

BLACKBODY—A body which absorbs all the radiation falling on it; the best radiator, and a complete absorber, of radiant energy.

BREWSTER, LAW OF — When light strikes a surface at such an angle that the reflected and refracted rays are at an angle of 90° to each other, maximum polarization of the light occurs in both reflected and refracted rays. The maximum polarization in the reflected ray is perpendicular to the plane containing the ray and the normal to the surface, while the maximum polarization of the refracted ray lies in this plane.

COLLIMATOR—An optical device which converts diverging or converging rays of light into parallel rays.

COLORIMETER—An optical instrument designed to compare the color of a sample with that of a standard sample or a synthesized stimulus. In a three-color colorimeter the synthesized stimulus consists of three colors of constant chromaticity but variable luminance.

CONSTANT, ABBE—A constant of an optical material defining the ratio of its refractivity to its dispersion. Thus a high value of the abbe constant indicates good ability to bend the light rays relative to its dispersing them into their component wavelengths.

DEFINITION—When an object is optically reproduced into an image, the degree of clarity of the image resolution and contrast combine to produce this clarity of an image.

DIFFRACTION — When a light-wave strikes the edge of an obstacle a part of the wave travels straight ahead, without change of direction. By interaction between the light wave and the edge, another portion changes its direction. For this reason the edges of opaque objects do not form absolutely sharp shadows, as some of the light is directed into the edge of the shadow. This phenomenon is caused by diffraction and basically arises from the finite wavelength of light. Diffraction plays a part in all image formation in optics. Diffraction gratings, used in spectroscopy, depend upon diffraction as the basis of their action.

DISPERSION—The process by which light is broken down into its component wavelengths. In this process light beams of different wavelengths are separated from each other by undergoing a different angular deviation. Prisms and gratings are examples of the devices for accomplishing dispersion. The term is also applied to the variation of refractive index of materials with the wavelength of light.

EMISSIVITY—The ratio of the radiant emittance of a source of radiation to the radiant emittance of a blockbody radiator at the same temperature.

FIBER BUNDLE, COHERENT, FLEXIBLE—A flexible bundle of fibers that transmits an image from one end to the other.

FIBERSCOPE — Optical glass fibers, when systematically arranged in a bundle, transmit a full color image that remains undisturbed when the bundle is bent. By mounting an objective lens on one end of the bundle, and an eyepiece at the other, the assembly becomes a flexible fiberscope that can be used to view objects that would be inaccessible for direct viewing.

FIELD FLATTENER, FIBER OPTICS—A plate made of fused optical fibers, with both surfaces ground and polished, having the entrance surface so contoured from a plane perpendicular to the axis of the fibers that it precisely fits the contour of an image formed on that surface, and transmits it to the exit surface that is flat.

FLUORESCENCE — The emission of light on longer wavelengths excited by the absorption of radiation of shorter wavelengths in certain materials.

FOCAL LENGTH—The distance from a lens, or some point therein, or from a mirror, to the image of a small, infinitely distant source of light, known as the focal point.

INFRARED—That part of the electromagnetic spectrum lying beyond the red, having wavelengths from a few millimeters to 7500 angstroms. The infrared region contains heat rays.

INTERFEROMETER—A device employing the interference of light for purposes of measurement of lengths, angular displacements, and optical path differencies, or for isolating different portions of the spectrum.

LASER—A device for transforming incoherent light of various frequencies of vibration into a very narrow, intense beam of coherent light. The name is derived from the initial letters of "Light Amplification by Stimulated Emission of Radiation." In the emission of ordinary light the molecules or atoms of the source emit their radiation independently of each other and consequently there is no definite phase relationship among the vibrations in the resultant beam. The light is incoherent. The laser, by means of an optical resonator, forces the atoms of the material of the resonator to radiate in phase. The emitted radiation is stimulated by the excitation of atoms to a higher energy level by means of energy supplied to the device. In the microwave region the corresponding device is called a maser, and hence the laser is often known as a light maser.

LUMINESCENCE — The emission of light of certain wavelengths or limited regions of the spectrum in excess of that due to incandescence and the emissivity of the surface. This property is not exhibited by all materials.

MODE, TRANSMISSION, OPTICAL FIBER—When the diameter of an optical fiber approaches the wavelength of light an unusual manner of light transmission occurs. The light that can travel along the length of the fiber is limited to certain angles of travel which produce patterns of reinforcement and interference upon emergence. These patterns are characteristic of the transmission modes. Wave guides for waves longer than light, such as microwaves, act in a similar way.

OPTICS, FIBER—A transparent fiber of a homogeneous transparent material such as glass or plastic when enclosed within a material having a lower index of refraction will transmit light by a series of internal reflections, or if its cross-section is suitably small, in the manner of a wave-guide. If many fibers are assembled into a bundle, each individual fiber being encased in a surrounding medium of lower index of refraction, an entire image can be transmitted when it is formed on the entrance end of the fiber bundle. Always each individual fiber transmits but one element of the composite emergent image. The size of this element becomes larger as the cross-section of the fiber is increased. Since the definition in the emergent image depends upon the smallness of each element composing it, it is desirable to keep the cross-section of the fibers small. The image can be transferred in a great number of ways. If the spacing of the fibers increases toward the emergent end of the bundle, the image is magnified. If the fibers are more closely packed together at the emergent end, the image is reduced in size. By crossing the fibers systematically or randomly, the image is accordingly distorted or scrambled. Distortions of the image can be introduced or corrected. Curved image surfaces can be converted into flat ones or of any other form by forming the ends of the bundle into convex, concave, or other shaped surfaces.

PHOTOCONDUCTIVE EFFECT — The change of electrical conductivity produced by the absorption of varying amounts of radiation.

PHOTOEMISSIVE EFFECT—The case in which radiation incident on matter causes electrons to be emitted.

PHOTOMETER — An instrument for measuring the brightness of a source

of light by comparing it with a standard source.

PHOTOVOLTAIC EFFECT—The generation of a difference in electric potential between two electrodes when radiation falls upon one of them.

PLANCK'S CONSTANT—A quantum of energy is equal to the frequency of the radiation multiplied by a constant known as Planck's constant.

QUANTUM—The smallest quantity into which energy can be subdivided.

RADIOMETER—Anv instrument for the detection and measurement of the intensity of radiant energv by means of its heating effect.

REFLECTION, LAW OF—The angle between the reflected ray and the normal drawn to the reflecting surface is equal to the angle between the normal and the incident ray, and more-over both rays and the normal lie in the same plane.

REFRACTION—The bending of light rays as they pass from one medium into another having a different index of refraction, that is, into one in which the velocity of light is different.

RESOLUTION—The ability of an optical system to reproduce fine details in the image of an object.

SNELL'S LAW—The laws of reflection and refraction that state: The incident ray, the normal to the surface at the point of incidence of the ray at the surface, the reflected ray, and the refracted ray all lie in a single plane. The angle between the incident ray and the normal is equal in magnitude to the angle between the reflected ray and the normal. The ratio of the sine of the angle between the normal and the incident ray to the sine of the angle between the normal and the refracted ray is a constant.

SPECTROGRAPH—An instrument for producing a photographic record of the spectrum. The picture of the spectrum is called a spectrogram.

SPECTROMETER — A spectroscope capable of measuring the angular deviation of radiation of different wavelengths. The spectrometer can be used to measure refractive indices of materials and also to determine wavelengths of radiation.

SPECTROSCOPE—In a general sense, any one of a class of instruments used for dispersing radiation, visible or invisible, into its component wavelengths and for observing or measuring the resultant spectrum. In a restricted sense, the instrument is capable of being used only for visual observation of the spectrum.

SPECTROSCOPY—A branch of optics pertaining to radiations which lie in the infrared, visible, ultraviolet, and vacuum ultraviolet regions of the spectrum.

TALBOT—A unit of luminous energy, equal to one lumen-second.

THRESHOLD, LUMINANCE, ABSOLUTE—A term indicating the lowest limit of luminance necessary for vision to take place.

TRANSMITTANCE—The ratio of the flux transmitted by a substance to the incident flux. The term is applied to both radiant and to luminous flux.

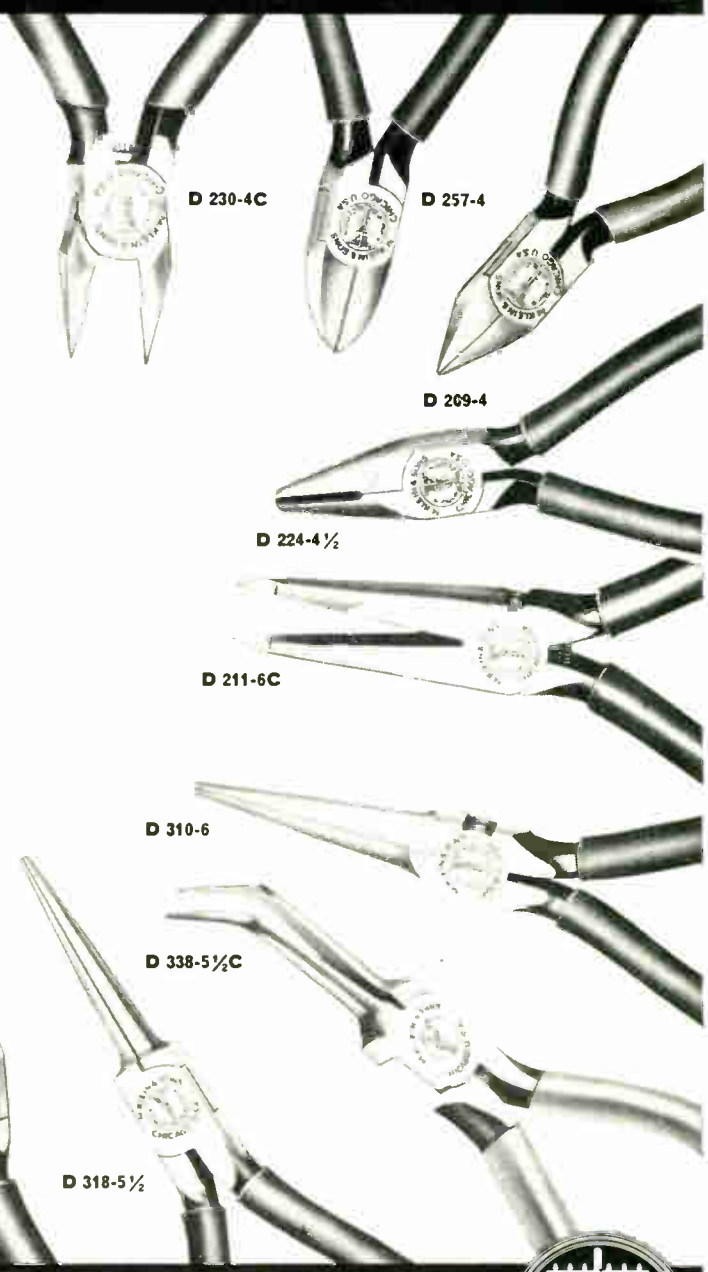
ULTRAVIOLET — That invisible region of the spectrum of radiant energy lying between the wavelengths of approximately 4,000 and 40 angstroms.

MORE THAN 100 KLEIN PLIERS SPECIALLY DESIGNED FOR THE ELECTRONIC FIELD

Special skills are important in the wiring of today's sophisticated assemblies for electronic and telemetry systems. Klein has developed special pliers to assist in solving difficult assembly problems.

- For instance, there is a plier with a blade as hard as a file for cutting nickel ribbon wire (No. D230-4C).
- For instance, there is an oblique cutter, specially designed for printed circuits . . . it cuts and crimps the end to hold wire in place for soldering. (D 052-C).
- For instance, there is a needle nose plier with the tip bent to facilitate reaching into confined spaces. D 338-5½ C.

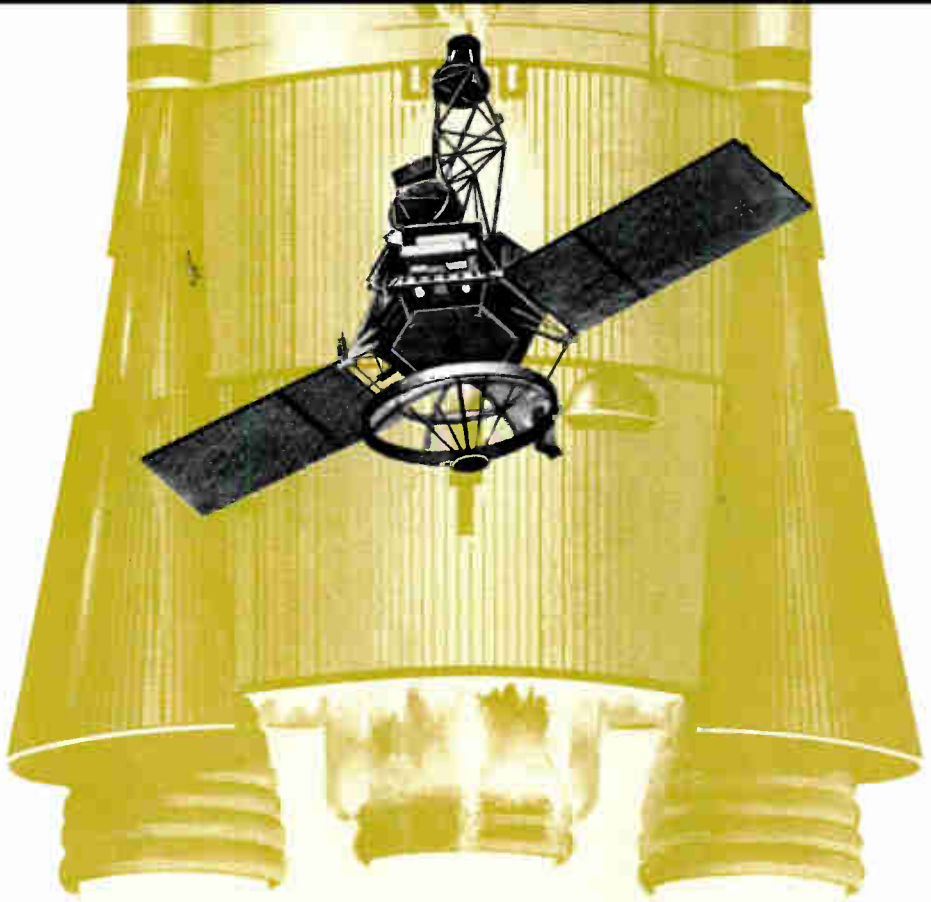
In all, there are over 100 different styles and sizes of pliers available from stock. Klein will be glad to discuss with you the development of a special tool to solve a particular problem you may be facing.



ASK YOUR SUPPLIER

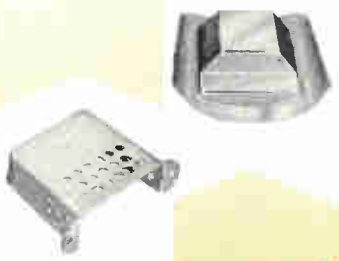
The Klein Plier Catalog illustrating and describing the complete Klein line of pliers is available on request.

Mathias KLEIN & Sons
Established 1857 — Chicago, Ill., U.S.A.
INCORPORATED
7200 McCORMICK ROAD, CHICAGO 45, ILL



—with Aerospace Precision

Kaupp precision metal forming machines, combined with ultra-modern techniques and quality control equipment, assure adherence to close tolerances on instrument cases, weldments, covers and special shapes. Consult Kaupp on military and commercial components, long or short production runs in light, medium or heavy gauges. Highest inspection standards result in metal parts of highest accuracy in a wide range of metals.



metal forming "assist"

KAUPP ...Metal Craftsmen since 1924

Fast Service for Designers and Development Engineers — KAUPP has solved many unusual metal forming problems involving both military and commercial metal components. In many instances design changes, suggested by our engineers, have resulted in important savings in time and money. KAUPP'S wide experience, ranging from parts for electrical appliances to guided missiles, is at your service.

See reverse side for complete data . . .

Kaupp metal forming facilities

for the design and production of
METAL PARTS

HYDROFORMING
KAUPP offers special service to design and development engineers with simpler tooling, faster set-ups and improved quality. Hydroforming combines economical unit cost with fast delivery.

DEEP DRAWING
From carbon steel to "space age" alloys, KAUPP technicians have the knowledge of metals, and the equipment necessary, to hold work to closest tolerances and maintain uniformity throughout production.

SPECIALS
Specify KAUPP for unusual components for rockets, missiles, aircraft and radar. Complete service includes piercing, notching, embossing, annealing, spotwelding and fabricating.

SPINNING
Minimum tooling requirements save time and money on development pieces, sample parts and short production runs. KAUPP offers years of experience in this method of metal forming.

PROTOTYPES
KAUPP "know how" solves unusual design problems. Our engineering department is fully conversant with the problems involved in producing unusual shapes and sizes to exact requirements.

TOOL MAKING
One of the industry's most modern tool and die departments is maintained by KAUPP to assure the efficient production of all dies, punches, jigs and fixtures. There are practically no delays waiting for tools.

WELDING
KAUPP produces weldments and sub-assemblies for military electronics, nucleonics and experimental parts for research and development work throughout general industry.

Precision Metal Forming Equipment for Fast Prototype/Production Service

Selected raw materials and expert metal craftsmanship combine to produce high accuracy metal components at economical cost. KAUPP engineers are thoroughly familiar with the techniques required for forming modern alloys. KAUPP precision metal parts are used in electronics, nucleonics, chemical processing and governmental space and research projects.

MU METAL	TITANIUM
BRASS	CARBON STEEL
INCONEL	MULTIMET*
ALUMINUM	HAYNES* No. 25
COPPER	STAINLESS STEEL
SILVER	HASTELLOY* X
NICKEL	MAGNESIUM
NIMONIC	WASPALLOY

Our engineers will recommend the best method of production for your specific components. Estimates on your metal parts will be supplied on receipt of your blueprints or specifications.

*Union Carbide Corporation Trademarks

HYDROFORMS
1 8" PRESS 1 12" PRESS
2 19" PRESSES

PRESSES
1 BLISS NO. 4A SINGLE CRANK DOUBLE ACTION
1 BLISS NO. S-100—100 TON 10" STROKE PNEUMATIC CUSHION 15 TON
1 BLISS NO. 305 90 TON 10" STROKE PNEUMATIC CUSHION 15 TON
3 NIAGARA NO. H 3 ½A—45 TON
2 NIAGARA NO. H 2 ½—25 TON
1 BLISS NO. 20B—32 TON
3 BLISS NO. 18 HORN
2 BLISS NO. 18 INCLINABLE
3 BLISS NO. 18C INCLINABLE
1 CONSOLIDATED NO. 72 PNEUMATIC CUSHION—5 TON
1 LOSHBOUGH & JORDAN NO. 2 SPECIAL
1 LOSHBOUGH & JORDAN NO. 3 SPECIAL
1 ZEH & HANNEMAN NO. 4
1 ZEH & HANNEMAN NO. 2 INCLINABLE

SPINNING LATHES
1 HAAG GAP LATHE 26 to 48
1 GRABO GAP LATHE 24 to 60
1 PRYBIL LATHE 26
1 GRABO LATHE 26
1 HAAG LATHE 22
3 GRABO LATHES 22
1 GRABO LATHE 16

LATHES
1 MONARCH—12 x 30
1 MONARCH—16 x 54
2 LE BLOND—17 x 54
1 SOUTH BEND—14 x 36
2 SOUTH BEND—10 x 36
2 SOUTH BEND—9 x 36
1 CINCINNATI—26 x 60
1 LE BLOND—22 x 48

MILLING MACHINES
1 MILWAUKEE RAM HD. 5 HP
1 MILWAUKEE VERT. 2 HP
1 MILWAUKEE UNIV. 2 HP
1 HARDINGE PLAIN
2 BRIDGEPORT ½ HP
2 CINCINNATI TOOLMASTERS
3 BRIDGEPORT 1 HP
1 SIMMONS HORIZONTAL PRODUCTION

GRINDERS
1 CINCINNATI UNIVERSAL 14 x 36 INTERNAL EXTERNAL HYDRAULIC
2 BROWN & SHARPE NO. 5 6 x 12 x 18 SURFACE
1 THOMPSON—6 x 12 x 18 SURFACE HYDRAULIC
1 REID—6 x 12 x 18 SURFACE
1 NEVEN BENCH GRINDER COMPLETE WITH DIAMOND WHEEL
1 MONOSET TOOL & CUTTER GRINDER

SAWS
1 GROB BAND FILING FAB NO. 18
2 GROB BAND DIE CUTTING
1 MARVEL POWER 6 x 8
1 MARVEL POWER 10

JIG BORER
1 PRATT & WHITNEY 1 ½B

SHEARS
1 NIAGARA SQUARING SHEAR 6'
1 NIAGARA SQUARING SHEAR 4'
1 FOOT SHEAR 3'
1 NIAGARA POWER CIRCULAR SHEAR & FLANGER
3 NIAGARA POWER RING & CIRCULAR SHEAR
1 HAND CIRCULAR SHEAR

SPOT WELDERS
1 PEER 15 KVA & TIMER
1 EISLER 10 KVA & TIMER
1 TAYLOR WINFIELD 50 KVA

MISCELLANEOUS
1 GOULD & EBERHARDT UNIVERSAL SHAPER 14"
1 MULMAT HIGH SPEED SENSITIVE DRILL PRESS
1 LELAND GIFFORD 26" SINGLE SPINDLE PRESS
1 BUFFALO 16" DRILL PRESS
4 WALKER TURNER 14"
1 DROP HAMMER 200 LB.
2 ATLAS LATHES PROD. WORK TRIM
1 WALKER TURNER 10" TILTING ARBOR TABLE SAW
3 30" x 60" SURFACE PLATE & ANGLE COMPUTER

Call, write or wire for prompt service

C. B. KAUPP & SONS • INC

METAL CRAFTSMEN SINCE 1924

30 NEWARK WAY, MAPLEWOOD, N. J. — Telephone: POplar 1-4000 (Area Code 201)




MAPICO®

IRON OXIDE REAGENTS

Pure Synthetic Iron Oxides for the Magnetics Industries

Columbian has had well over 50 years experience in the business of manufacturing *Pure Synthetic Iron Oxides*. They can be produced by several practical procedures to give a variety of characteristic particle shapes and particle-size ranges. The methods by which MAPICO® Pure Iron Oxides are manufactured were chosen because they enable careful control of preselected characteristics.

MAPICO PURE IRON OXIDES

(a) are strictly uniform from shipment to shipment
(b) are reactive at the high temperatures customarily used in the ceramic industry
(c) are available in three different particle shapes any of which may be had in several ranges of particle size
(d) are of high purity and free from harmful impurities
(e) give controlled shrinkage
(f) give controlled electronic characteristics
(g) are produced in ample supply by a large, modern, technically staffed plant

DATA ▶ / MAPICO PRODUCTS	COMPOSITION	PARTICLE SHAPE	PREDOMINANT PARTICLE SIZE (Microns)	SURFACE AREA m^2/g ***	Apparent Density S.V.†† Gms./CM.³	Apparent Density Tapped Gms./CM.³	% PURITY	% MOISTURE (Loss at 105° C)	LOSS ON IGNITION	TYPICAL CHEMICAL ANALYSIS: % WATER SOLUBLE SALTS	% SiO_2	% TiO_2	% SO_3	% Al_2O_3	% Cu	% Mn
							Min. Max.	Min. Max.	Min. Max.	Min. Max.	Min. Max.	Min. Max.	Min. Max.	Min. Max.	Min. Max.	Min. Max.
Yellow Light Lemon 100	ferric oxide hydrate	acicular	0.4-0.8	22.4	.14	.35	98.8 **99.2**	.30 **.50**	11.5 **12.0**	.04 **.08**	.05 **.15**	.002 **.004**	.20 **.60**	.001 **.002**	.03 **.05**	.015 **.025**
EG-1*	magnesium ferrite	acicular	0.4-1.2	4.7	.18	.40	99.3 **99.6**	.10 **.20**	.05 **.10**	.35 **.45**	.05 **.10**	.002 **.004**	.10 **.30**	.001 **.002**	.02 **.04**	.015 **.025**
EG-2**	zinc ferrite	acicular	0.4-1.2	3.5	.27	.59	99.5 **99.7**	.10 **.20**	.05 **.10**	.05 **.10**	.10 **.20**	.002 **.004**	.02 **.04**	.001 **.002**	.02 **.04**	.010 **.015**
EG-3	gamma ferric oxide	cubical	0.3-1.2	8.7	.39	.71	98.0 **99.0**	.10 **.20**	.80 **1.20**	.10 **.15**	**.03**	.02 **.04**	.15 **.20**	.002 **.005**	.002 **.004**	.10 **.20**
Red 110-2	alpha ferric oxide	cubical	0.3-1.2	5.4	.33	.67	99.1 **99.4**	.05 **.10**	.25 **.35**	.10 **.15**	**.03**	.02 **.04**	.10 **.15**	002 **.005**	.002 **.004**	.08 **.15**
EG-60	alpha ferric oxide	cubical	2.0-4.0	2.8	.45	1.00	99.3 **99.6**	.05 **.10**	.20 **.30**	.10 **.15**	**.03**	.02 **.04**	.10 **.15**	.002 **.005**	.002 **.004**	.06 **.10**
Red H.P.	alpha ferric oxide	cubical	2.0-4.0	2.8	.45	1.00	99.7 **99.8**	.02 **.05**	.07 **.15**	.02 **.04**	**.03**	.005 **.02**	.03 **.06**	.002 **.005**	.002 **.004**	.04 **.06**
EG-80	alpha ferric oxide	cubical	3.8-5.9	1.3	.85	1.74	99.4 **99.7**	.05 **.10**	.10 **.20**	.10 **.15**	**.03**	.02 **.04**	.05 **.10**	.002 **.005**	.002 **.004**	.06 **.10**
Red 297	alpha ferric oxide	spheroidal	0.3-0.8	8.4	.30	.59	99.3 **99.6**	.05 **.20**	.30 **.60**	.08 **.20**	.05 **.15**	.001 **.003**	.05 **.25**	.01 **.02**	.001 **.003**	.01 **.02**
Red 347	alpha ferric oxide	spheroidal	0.3-0.9	7.4	.32	.61	99.4 **99.7**	.05 **.20**	.20 **.50**	.05 **.20**	.05 **.15**	.001 **.003**	.05 **.20**	.01 **.02**	.001 **.003**	.01 **.02**
Red 387	alpha ferric oxide	spheroidal	0.3-1.1	6.5	.33	.69	99.4 **99.7**	.05 **.20**	.20 **.50**	.05 **.20**	.05 **.15**	.001 **.003**	.05 **.15**	.01 **.02**	.001 **.003**	.02 **.03**
Red 477	alpha ferric oxide	spheroidal	0.4-2.0	5.9	.36	.74	99.5 **99.8**	.05 **.15**	.15 **.45**	.04 **.15**	.05 **.15**	.001 **.003**	.05 **.10**	.01 **.03**	.001 **.003**	.02 **.04**
Red 567	alpha ferric oxide	spheroidal	0.4-2.6	4.9	.37	.74	99.5 **99.8**	.05 **.15**	.15 **.45**	.04 **.15**	.05 **.15**	.001 **.003**	.05 **.10**	.01 **.03**	.001 **.003**	.03 **.06**
Red 617	alpha ferric oxide	spheroidal	0.4-3.7	3.9	.39	.74	99.5 **99.8**	.05 **.10**	.15 **.35**	.04 **.10**	.05 **.15**	.001 **.003**	.05 **.10**	.01 **.03**	.001 **.003**	.03 **.10**
Red 516-M	alpha ferric oxide	acicular	0.3-1.0	26.4	.14	.32	97.0 **98.3**	.10 **.30**	1.0 **2.2**	.10 **.30**	.10 **.20**	.002 **.004**	.20 **.40**	.001 **.002**	.03 **.05**	.015 **.025**
Black†	synthetic magnetite	cubical	0.2-0.8	6.7	.34	.71	99.0 **99.2**	.05 **.20**	.70 **.90**	.05 **.10**	.03 **.06**	.02 **.04**	.03 **.06**	.002 **.004**	.002 **.004**	.20 **.25**

*MgO (as $MgO.Fe_2O_3$); 18.7-19.2%—U.S. Patent 2,502,130
**ZnO (as $ZnO.Fe_2O_3$) 32.6-32.8%—U.S. Patent 2,904,395
***As determined by nitrogen adsorption
†FeO (as $FeO \cdot Fe_2O_3$) 21-22%.
††Scott Volumeter

Samples are available on request and our trained technicians who are continually conducting ferrite research concerned with the use of Mapico Iron Oxides are at your service whenever desired.

COLUMBIAN CARBON COMPANY MAPICO IRON OXIDES UNIT

380 Madison Ave., New York 17, N. Y. • Branch Offices, Agents and Warehouses maintained in principal cities to assure quick service

chassis Trak inc.

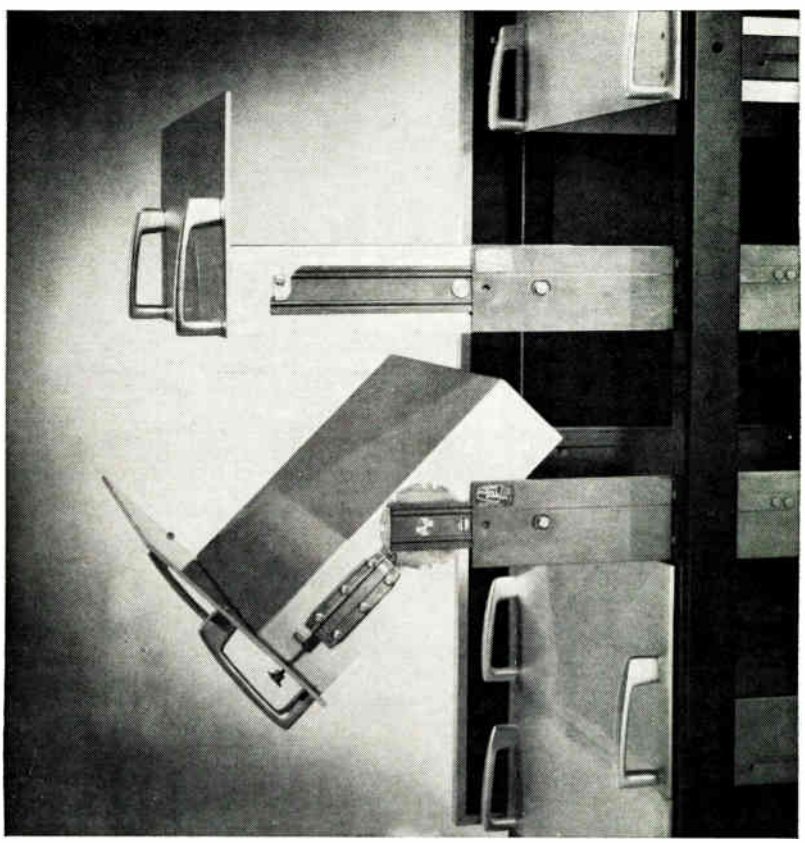
Engineering facts and figures

Construction—Chassis-Trak Slides are made of hard, cold-rolled steel for maximum strength and wearing qualities and are cadmium-plated for extra corrosion resistance. (Special stainless steel slide—Model C-357—also available.) Smooth operation is achieved by means of Poly-Chem's MS-75 dry film lubricant which becomes increasingly slick with use. This permanent formulation is dust-repellent and withstands pressure loading of more than 50,000 psi at 25 ft./min. Finish has passed JAN 100-hour salt spray test and is approved for military use.

Installation—"Pencil thin" Chassis-Trak design permits installation of standard 17" chassis in standard 19" panel racks without modification. Standard slides bolt to front rail and rear of cabinet. On most models, a prefabricated gusset assembly can be furnished for use where load does not exceed 100 lbs. Gusset automatically aligns slides and permits mounting at front rail only. Templates, rear mounting brackets and all hardware furnished together with complete assembly instructions.

Operation—Chassis-Traks are available in non-tilt, tilt, and tilt-detent models. Slides with "B" in the model designation tilt upward only; "D" models tilt and lock in seven different service positions. Choice of solid bearing or roller bearing operation. Roller bearings are recommended for equipment requiring frequent service. Chassis of any length can be fully extended without disconnecting rear cables. Pushbutton spring mechanism releases chassis for convenient slip-out, slip-in servicing.

ROLLER BEARING SLIDES	Model	SLIDE LENGTH								LBS. MAX. LOAD
		10	12	14	16	18	20	22	24	
Basic	CTRB	X	X	X	X	X	X	X	X	175
Detent	CTRD		X	X	X	X	X	X	X	175
Cradle Track	CTEZ			X	X	X	X	X	X	125
Heavy Duty Basic	CTHRB			X	X	X	X	X	X	275
Heavy Duty Detent	CTHRD			X	X	X	X	X	X	275
Lightweight	C-357		X	X	X	X	X	X	X	150
Circulating Ball	CB	16" to 60"								1000
SOLID BEARING SLIDES	**Model**	**SLIDE LENGTH**								**LBS. MAX. LOAD**
		10	12	14	16	18	20	22	24	
Basic	CTB	X	X	X	X	X	X	X	X	175
Detent	CTD		X	X	X	X	X	X	X	175
Lightweight	CTL			X	X	X	X	X	X	100
Heavy Duty Basic	CTHB			X	X	X	X	X	X	250
Heavy Duty Detent	CTHD			X	X	X	X	X	X	250
1¾ Inch	C-300	X	X	X	X	X	X	X	X	50
Light-Duty	C-300	X	X	X	X	X	X	X	X	50
Aluminum	D-600	X	X	X	X	X	X	X	X	125
Utility	C-230		X	X	X	X	X	X	X	100



Chassis-Trak aluminum slides, only ⅜" in width, are ideal for mounting of utility chassis since they fit the smallest panel increment of 3½", and weigh only 4½ lbs.

chassis Trak inc.

For additional engineering information, accessories hardware catalog, and prices, write:

525 South Webster Ave., Indianapolis 19, Ind.

From the use of plastics for lasers to gaseous dielectrics for arc-quenching, chemicals are making significant contributions to the electronic arts. Chemical substances are used to make and process semiconductors, electroplate circuit boards, encapsulate components, clean systems and circuits. Here are the electronic chemicals and their uses.

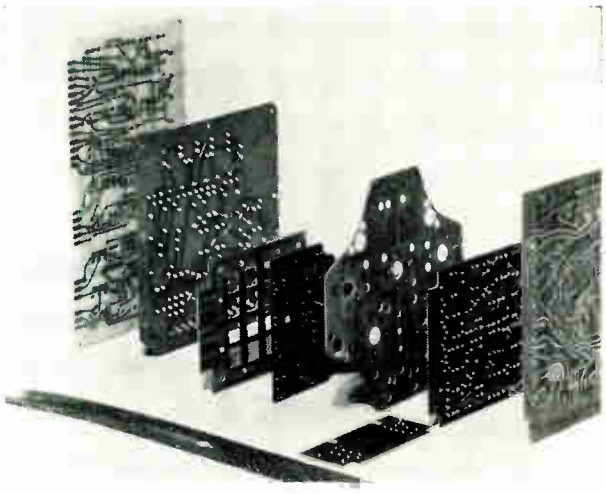
CHEMICALS IN THE ELECTRONIC INDUSTRY

DURING THE LAST DECADE the Chemical Processing Industry (CPI) has become a full-time partner with the Electronic Industry. Chemical products and processes are now used so much in electronics that this industry has become a leading chemical market. Uses of chemicals in electronics range from cyanides, sulfates and fluoroborates for electroplating to fluorinated gases for electrical insulation; from metallic oxides and carbonates for ferrites to alkyds, epoxy resins and silicones for encapsulation; from tungsten filaments and inert gases for indicator light bulbs to synthetic rubies for lasers; and from organic coatings for wire and cable to hyper-pure alloys for superconducting magnets.

In keeping up with rapidly changing technology in electronics, the CPI shares with its customers major R&D costs. Often research projects are undertaken between the CPI and Electronic Industry. Fruits of this R&D are reaped by both, but more by the latter. The following examples are cited:

1. Quality and uniformity of semiconductor metals has increased steadily as their methods of production (basically chemical processes) have been refined. Producers of silicon and germanium, as well as the newer intermetallics, have improved production processes to obtain both higher purity and lower variability.
2. Semiconductor processing chemicals have been improved in quality and uniformity with the net result to semiconductor makers of larger device yields, simpler manufacture, better use of raw materials and lower cost.
3. Potting and encapsulation problems have been eased by the development of specialized alkyd molding compounds, epoxy resins, silicones and additives for these systems to tailor them to specific electronic uses.
4. Gaseous dielectrics of high insulating value, low toxicity and good arc-quenching ability have been developed to allow improvement of circuit breakers, wave guides and radars.

Several chemical processes were used to make these circuit boards. These included molding and lamination of the boards, followed by masking, plating, stripping, etching and finishing.



Fluoride Insulators

In research carried out by Allied Chemical Corp., experience was aquired in "passivating" various metals by exposure to elemental fluorine, thus creating an inert fluoride coating. While this work is still experimental, it has been found possible to coat copper, aluminum and other metals to provide insulation at temperatures near the melting point of the conductor. These coatings offer high dielectric strength, good ductility and small volume. As a wire

By JAMES W. SWAINE
Vice President
General Chemical Division
Allied Chemical Corporation
Morristown, N.J.

CHEMICALS (Continued)

insulation, such fluoride coatings could result in improved electronic devices.

Electroplating Solutions

Development of specialized electroplating solutions is another chemical contribution to electronics. High plating speeds of copper fluoroborate baths and the good solderability of deposits from lead-tin alloy fluoroborate baths have solved problems in the mass-production of circuit boards. Moreover, these baths have been developed to also provide: ease of bath make-up, simplified control, reduced maintenance, good anode corrosion and excellent stability.

Cleaning Solvents

Producers of electronic components, precision instruments and missile systems need an almost residue-free solvent for final-stage cleaning. Existing halocarbons (refrigerant gases) were modified and refined to meet this demand. Genesolv® "D" Electronic Grade and its equivalents can be used. Residues less than 1 ppm, resistivity of 5.0×10^{18} ohm-cm. and low dielectric constants make these ideal solvents for cleaning electrical systems.

Specialized Plastics

Another contribution is in the field of specialized plastics. Electronic firms consume millions of pounds of plastics, chiefly for encapsulating or packaging. Combinations of small, fragile parts are enclosed in plastic, compressed and cured in a mold. The resulting hard block holds the parts in place, protects them from impact damage and moisture, and insulates them from each other and the outside. Also, each encapsulated unit is of uniform size, weight and shape so that automated handling is simplified.

Many plastics, such as alkyd molding compounds, are used for encapsulation. Alkyds have good dielectric strength and high impact resistance. Modular units of nylon are available with molded-in slots and holes.

A REPRINT OF THIS ARTICLE CAN BE OBTAINED
by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

CHEMICALS (Continued)

Epoxy resins for encapsulating or packaging have an important place in electronics. By varying the quantity and type of anhydride hardeners and other additives, a wide range of useful properties can be obtained in the package. Large parts such as toroidal transformers, as well as many small parts, are encapsulated with epoxys.

Plastics are also used in wire covering. Here again there are many types, such as nylon, polyethylene, polypropylene and fluorocarbon polymers. In addition to insulation, plastics provide resistance to corrosion and wear.

Because of high dielectric strength, impermeability to fluids, wide useful temperature range, and chemical inertness the fluorocarbon polymers enjoy widespread use. These polymers include polychlorotrifluorothylene (Halon®, Kel-F), and polytetrafluoroethylene (Teflon, Halon® TFE).

Semiconductor Production

The advent of mass semiconductor production created an increasing demand for high-purity chemicals. Quickly adapting to this demand, the CPI not only produced the needed chemicals but also solved problems in quality control, packaging and logistics. Quality of such critical chemicals as hydrofluoric acid, nitric acid, hydrogen peroxide, acetone, methanol, germanium, silicon, gallium arsenide and phosphorous pentoxide has steadily improved. The higher efficiencies and greater yields enjoyed by device producers today is a result of process sophistication and these improvements in raw material quality.

Dielectric Gases

Many gaseous dielectrics have been developed to replace air, nitrogen and transformer oils, simplifying the design of electronic equipment. Sulfur hexafluoride (SF_6), perfluoropropane (C_3F_8) and octafluorocyclobutane (C_4F_8) are examples of these. Once again the inertness and thermal stability of fluorine find direct use in electronics. Characterized by very high dielectric strength, these fluorine derivatives will be used increasingly in transformers, circuit breakers, wave guides and radar.

Laser Developments

RCA's announcement of a plastic laser is bound to result in a rapid development of this area. As the laser finds more and more uses, needs for pure materials, from Al_2O_3 (derived from various aluminum

Alkyd molding compounds come in 2 shapes: "rope" slugs (1) and "putty." These compounds are used for encapsulation because of their dielectric strength, high resistance to impact, moisture.

CHEMICALS (Concluded)

salts) to special plastics and dopants, will have to be filled.

Service Contributions

As challenging as the technical problems of new product introduction and quality improvement are, the contributions of the CPI are not limited to such tangibles. Intangible services offered to electronic producers fall into two main categories: services directly related to sales and those which are not. The former include location of producing plants, packaging facilities and stocking points near electronic centers (e.g., Boston, San Francisco and Los Angeles).

The other category includes such services as in-plant training programs for electronic workers in proper methods of handling, storing, mixing and applying chemicals and in waste disposal. Many such services are available from chemical suppliers. As an example, General Chemical Div. of Allied Chemical has developed a safety presentation dealing with the problems of semiconductor firms. This presentation has been given 36 times at 27 plants. Chemical waste disposal experts and corrosion engineers are employed by most chemical producers and are available for assistance on specific customer problems.

There is no question but that the Chemical Processing Industry has a major stake in the future of the Electronic Industry. A partnership has developed between the two which has been in large part responsible for the rapid strides made in electronics. Continued progress can be assured by a concerted attack by the two on its mutual problems.

Use the "PLUS VALUES" of Armco Magnetic Materials for lowest cost and maximum performance

For the expanding range of electronic apparatus, Armco produces magnetic materials that enable you to meet specific design and fabrication requirements. They offer "PLUS VALUES" that help you produce units that cost less and perform to the maximum.

Selectivity —a full range of nickel-iron alloys, Armco 48 Ni, 48 Orthonik, and 4-79 plus Armco Thin Gage Silicon Steels in oriented and non-oriented grades, gives you selectivity that enables you to design more precisely. Each material is available in the thicknesses and forms you need.

Consistently Uniform Quality —Special processing controls, plus 60 years' experience in producing magnetic materials, assure uniform high quality magnetic properties.

Design Data —Detailed design manuals—Armco Nickel-Iron Magnetic Alloys and Armco Thin Electrical Steels—provide you with necessary design curves, information on annealing and other pertinent data.

Technical Assistance —The extensive experience of Armco engineers and metallurgists is available to assist you in material selection or with problems in design or production.

Make full use of all these "PLUS VALUES" by using Armco Magnetic Alloys in your products. Just write us for complete information on either Thin Electrical or Nickel-Iron Alloys. **Armco Division, Armco Steel Corporation, Dept. A-1483, P. O. Box 600, Middletown, Ohio.**

ARMCO **Armco Division**

even tough Teflon covered wire... for precise electronic production required to pass high-confidence level inspections*

*TEFLON: REG. TRADE MARK OF DUPONT

IDEAL CUSTOM Stripmaster®

Strip solid or stranded wire easily — with no wire nicks, insulation scratches — no waste or rejects. Unique matched blades, drilled to exact wire size on watchmaker's equipment, plus colleting action, *help you meet high-confidence standards even on toughest insulation.* Three models — for Type E Teflon, Type EE Teflon and general purpose plastic and fibre-glass insulation. Sizes for 10 to 14, 16 to 26, or 26 to 30 wire. Optional transparent wire stop adjusts to strip exact insulation length. Send coupon for full information.

IDEAL INDUSTRIES, Inc.
5127-F Becker Place, Sycamore, Ill.

Please send me my free copy of Production Wire Strippers Catalog
SOLD THRU AMERICA'S LEADING DISTRIBUTORS
In Canada: IDI Electric (Canada) Ltd., Ajax, Ont.

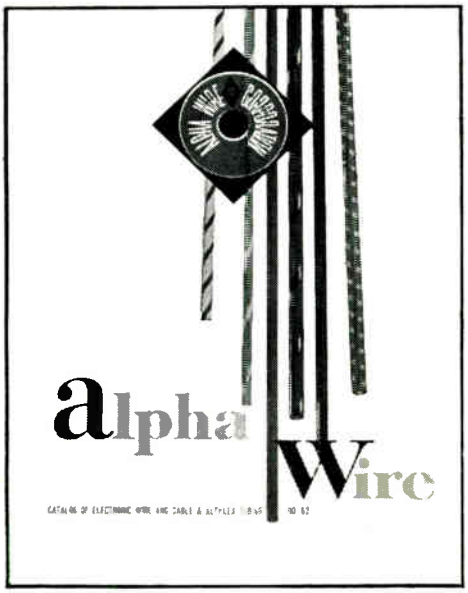
Name_____
Company_____
Address_____
City_____ Zone_____ State_____

Circle 162 on Inquiry Card

Authoritative reference data from the industry's leading wire, cable and tubing manufacturer

ALPHA ENGINEERING CATALOGS TELL YOU

HOW TO SPECIFY ELECTRONIC WIRE, CABLE & INSULATING MATERIALS



COMPREHENSIVE 52-PAGE WIRE AND CABLE CATALOG

Complete with all specifications, this descriptive and illustrative catalog details over 6000 electronic wire, cable and tubing products. A wealth of valuable and helpful data featuring . . .

- a 6-page complete selection of MIL-W-76B Plastic Wire
- a 5-page complete selection of MIL-W-16878C Plastic Wire
- 13 pages on audio and hook-up wire and cable
- Teflon wire, cable and tubing
- Retractile coil cords and extension cord sets
- Shielding and braiding
- a complete section describes Alpha's complete prime manufacturing capabilities plus the special facilities for custom services such as striping, cutting, stripping, tinning, coloring of cable jackets, and short run cables.

ALL-NEW 24-PAGE 1963 TUBING GUIDE

Complete engineering information, featuring the most exciting innovation in tubing insulation today . . . irradiated heat shrinkable tubing — the versatile insulation that shrinks skin-tight to a predetermined size . . . then stops!

- A complete 11-page "how to" section on FIT™ shrinkable tubing, replete with descriptions, engineering data and applications — featuring:
- Shrinkable PVC tubing, ideal for cable jacketing • all-purpose polyolefin tubing in colors and clear • semi-rigid polyolefin tubing in colors and clear • wire termination caps for splices and cables • 4-way markers for wire and cable identification

Also included in this comprehensive book are sections on . . .

- PVC plastic tubing
- Teflon extruded tubing
- Zipper tubing
- Plastic impregnated fiberglass tubing
- Lacing cords and tapes
- RF shielding tape

Whatever your needs in wire, cable and tubing, you can depend on Alpha for . . .

- ☐ the most extensive manufacturing and custom facilities
- ☐ the fullest "in-depth" engineering assistance
- ☐ the latest engineering reference data

So — whether your requirements are for

- ☐ mass production
- ☐ prototypes
- ☐ short runs
- ☐ or anything in the unusual

we suggest you do as hundreds of leading OEM manufacturers do — lean on Alpha for *thorough reliability . . . from original concept to final production.*

All 6,000 Alpha Wire products in these guidebooks are IN STOCK and available from Alpha or your local electronic parts distributor. Write today for your free copy of these 2 guidebooks.

See our complete product listing in
The Radio-Electronic MASTER

ALPHA electronic WIRE
Manufacturers of electronic wire, cable, and tubing.

ALPHA WIRE CORPORATION
Subsidiary of LORAL Electronics Corporation
200 Varick Street, New York 14, N. Y.
Pacific Division: 11844 Mississippi Avenue, Los Angeles 25, California

41 YEARS OF APPLIED ENGINEERING KNOW-HOW AT YOUR SERVICE!

NEW TECH DATA

for Engineers.

Polyethylenes

This brochure outlines recent achievements in insulation technology, including the development of vulcanizable, semiconductive, and cellular polyethylenes. Included are typical property summaries on compounds for primary insulation, cellular uses, TV lead-in wires, vulcanizable wire, ocean cable, cable jackets, line wire covering, spacer cable, and semiconductive uses. Union Carbide Plastics Co., 270 Park Ave., New York 17, N. Y.

Circle 225 on Inquiry Card

Laser Mounts

Tech. data is available on a series of solid-state laser mounts designed to provide a broad range of flash tube and reflector configurations as well as output power. Each of the 6 mounts includes a high-velocity air blower for flash lamp cooling and air or liquid nitrogen-cooled crystal chuck. Crystal sizes accommodated are up to 5/8 in. in dia. by 6 in. long. Electro Powerpacs, Inc., 5 Hadley St., Cambridge 40, Mass.

Circle 226 on Inquiry Card

Spray Compounds

Aerosol spray compounds for precision grinding, buffing, and lapping are available. The spray compounds solve many grinding and buffing problems, such as metal finishing, lapping compound for tool and die work, glass and mirror finishing, optical finishing, plastic lens finishing, lapidary grinding and polishing. Norco Div., The Normand Co., 314 S. W. 8th St., Miami, Fla.

Circle 227 on Inquiry Card

Solder-Flux Preforms

Information is available on 2 new paste solders for use as solder-flux preforms. These materials, designated Paste-Form, consist of a blend of pre-alloyed solder powder and flux. Paste-Form is intended for use where it is desired to pre-place solder and flux in an assembly before heating. It may be applied by brush or applicator and heated by any of the usual methods. Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J.

Circle 228 on Inquiry Card

Aluminum Services

Brochure describes Mideast Aluminum Corp. and its services. Firm specializes in extrusion shapes for the electronic and electrical industries. Facilities for polishing, bending, machining and anodizing are described. Mideast Aluminum Corp., U.S. 130, Dayton, N. J.

Circle 229 on Inquiry Card

R-F Test Equipment

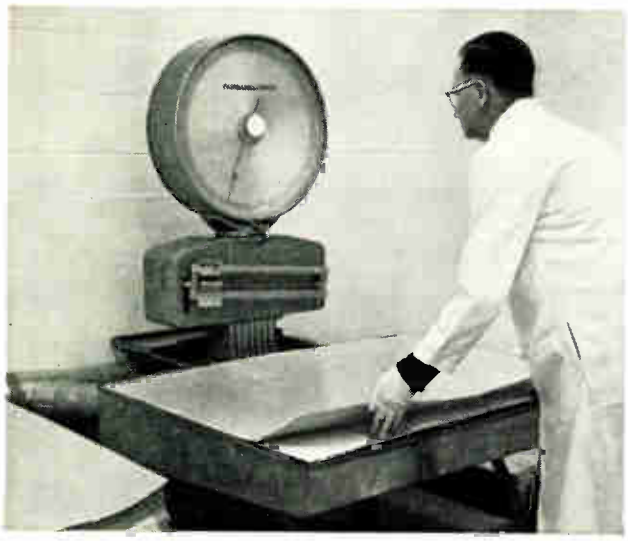
"R-F Test Equipment for Quantitative Measurements," Short Form Catalog HP-C-002, 4 pages, covers wideband, wide-plus-narrow, and ultra-flat sweep signal generators, slow-speed sweep driver, general purpose sweep generators, video sweep generators, r-f precision log amplifier, and marker generators. Also described are a high-speed coax. switch, wide-band comparator, direct-reading tuned r-f voltmeter, variable and fixed attenuators, r-f post amplifiers and r-f bridges. Photos., specs. and prices are included. Industrial Products Div., Jerrold Electronics Corp., 15th & Lehigh Ave., Phila. 32, Pa.

Circle 230 on Inquiry Card

Where does your particular interest lie in high-

. . . in filament wound structures? These weigh only one-quarter as much as steel of the same tensile strength (150,000 psi). Other properties can be engineered into the structure as required.

. . . in high quality copper-clad laminates? These are widely used for printed circuits, but composites can be produced of a number of different metal foils, clad or sandwiched, for many other applications.



NEW TECH DATA

for Engineers.

Wire Test Report

Flex Test Report is available on true concentric vs. unilay stranded wire construction. In this 8-page report, the average number of flexures before complete rupture is in tabulated and graph form. International Wire Products Corp., 300 Greenwood Ave., Midland Park, N. J.

Circle 231 on Inquiry Card

Welding Technique

Digital Sensors, Inc., 6443 Tujunga Ave., No. Hollywood, Calif., has information available on a new ribbon cable harness welding technique which is said to increase reliability through elimination of breakage at point of connections.

Circle 232 on Inquiry Card

Carbon Brushes

A 20-page bulletin on carbon, graphite and metal-graphite industrial brushes, "Carbon Brushes" (Catalog Section B-1100) supplements regular brush catalogs. Available from National Carbon Co., 270 Park Ave., New York 17, N. Y.

Circle 233 on Inquiry Card

Generator Control Device

Bulletin 4200-PRD-279 describes a quick, correct and safe method for synchronizing ac generators. The E-M Synchronator accomplishes synchronizing without jolt or voltage dip. It is a packaged device using static type components to operate a generator switch. Sensing is automatic and foolproof. The package includes a cubicle for wall mounting. Electric Machinery Mfg. Co., Minneapolis 13, Minn.

Circle 234 on Inquiry Card

Duobinary Data Transmission

An 8-page pamphlet describes new 26B data transmission system, which uses a duobinary technique. The duobinary concept extends the theoretical max. rate of binary signaling for a given transmission medium from 2 to 4 bits/sec. for each cycle of bandwidth. The 26B pamphlet includes, in addition to complete performance figures and block diagrams, a description of duobinary coding and a unique error detection scheme. No. 26B-P4. Dept. M90A, Lenkurt Electric, San Carlos, Calif.

Circle 235 on Inquiry Card

Liquid-Level Instruments

A new design spec. bulletin, on liquid-level instruments, No. DS-5200, covers design features, construction materials, level ranges, safe working pressures and temps., and dimensions. Using buoyant floats, a series of 3 standard range level chambers is designed for use with any of 5 interchangeable head assemblies. These include pneumatic or electrical transmitters, indicators, and indicating or non-indicating alarms. Brooks Instrument Co., Inc., Hatfield, Pa.

Circle 236 on Inquiry Card

Digital Signal Simulator

Data Sheet 14 describes Model 510 digital signal simulator. Model 510 is a solid-state unit that handles all major formats, including Saturn, Minuteman, Titan II and OAO. Completely programmable coded output meets all digital signal needs in laboratory and field. The instrument simultaneously generates 3 different word lengths, from 2 to 33 bits. Telemetrics, Inc., 12927 So. Budlong Ave., Gardena, Calif.

Circle 237 on Inquiry Card

NEW TECH DATA

for Engineers.

Chemically Resistant Resins

A 32-page booklet describes General Electric's complete line of Methylon® resins for chemically resistant coatings. Designated CDC-418, this guide includes product descriptions, handling information, test results, and coating formulations. Suggested formulations include those for Methylon resin alone or blended with epoxy, alkyd, vinyl acetal, and amine resins. Chemical Materials Dept., General Electric Co., 1 Plastics Ave., Pittsfield, Mass.

Circle 404 on Inquiry Card

Ceramic Standards

The ACMA Standards Book and 2 new 4-page data supplements, are available. One supplement, E2-63, for electrical and electronic uses, lists for 3 high alumina content grades such properties as apparent specific gravity, flexural strength, impenetrability, dielectric strength, volume resistivity, dielectric constant, heat dissipation factor and loss factor at 25°C. The other supplement, M1-63, lists mechanical properties for each grade. Diamonite Products Mfg. Co., Shreve, Ohio.

Circle 405 on Inquiry Card

Magnesium Coatings

An 8-page brochure, "Custom Application of Anodic Coatings on Magnesium," describes 4 processes, all applied with special equipment. They are: galvanic anodize (Dow 9), Dow 17 anodize, HAE anodize, and fluoride anodize. Reasons for anodizing, properties, characteristics, typical uses, and coating colors are detailed for each process. Illustrations include actual workpieces and a chart on the treatments, their developers, and the applicable U. S. Government specs. Brooks & Perkins, Inc., 1950 W. Fort St., Detroit 16, Mich.

Circle 406 on Inquiry Card

Machine Tools

Use of machine tools in metal forming is covered in this 8-page bulletin. Advantages of using these tools for economical sizing, shaping and forming of cylindrical, rectangular and polysided metal parts are presented. Uses, tooling and design are discussed. The construction and features of the tools are shown in detail. Grotnes Machine Works, Inc., 5454 N. Wolcott Ave., Chicago 40, Ill.

Circle 407 on Inquiry Card

Cable Isolators

This brochure gives performance and dimensional data on cable isolators. Guide allows the selection of the correct isolator system for the cable's size, weight, natural freq., isolation efficiency, and vibration and shock input. Systems are referenced by basic natural freq. and isolated package mass. Mounting dimensions and dynamic deflections are given for each case, making it possible for the engineer to design mounting hardware and space envelope after specifying the isolator system. Aeroflex Laboratories, Inc., S. Service Rd., Plainview, L. I., N. Y.

Circle 408 on Inquiry Card

Micro-Component Coating

Complete specs. on HumiSeal Type 1F19 micro-component protective coating and the HumiSeal protective coating properties chart are available. Type 1F19 protects vapor or cermet-deposited microelectronic components on ceramic or glass substrates. Columbia Technical Corp., 24-30 Brooklyn-Queens Expressway W., Woodside 77, N. Y.

Circle 409 on Inquiry Card

NEW TECH DATA

for Engineers.

Magnet Material

Tech. data 52-168 describes highly oriented ceramic permanent-magnet material, Westro beta, which has a high coercive force, and provides magnet-design flexibility. Characteristics and graphs are given. Westinghouse Materials Mfg. Div., P. O. Box 128, Blairsville, Pa.

Circle 410 on Inquiry Card

Resins

A data file on diallyl phthalate molding compounds contains complete test data on Acme's D-A-P line, including newly developed compounds. General information on electronic and electrical uses is given. Acme Resin Corp., 1401 Circle Ave, Forest Park, Ill

Circle 411 on Inquiry Card

Cable Ties, Clamps

Nylon hand or tool-installed cable straps and clamps are illustrated and described in Bulletin SS-2. Hand and automatic pneumatic powered installation tools are also included. Panduit Corp., 17301 Ridgeland Ave., Tinley Park, Ill.

Circle 412 on Inquiry Card

Laminated Plastic

Properties of new glass-phenolic laminated plastic (Grade 723) which will withstand continuous operating temperatures up to 500°F and has other good properties are given in Technical Data Bulletin No. 3-5-3. Taylor Corp., Valley Forge, Pa.

Circle 413 on Inquiry Card

Compression Terminals

Bulletin TCT-62-102, containing a full-color chart, describes and aids in selection of glass-to-metal tubular single lead compression terminals. Available from Electrical Industries, 691 Central Ave., Murray Hill, N. J.

Circle 414 on Inquiry Card

Single-Unit Seals

A 16-page color catalog, 359C, describes single-unit, high-pressure seals and fasteners for industrial and military uses. APM-Hexseal Corp., 41 Honeck St., Englewood, N. J.

Circle 415 on Inquiry Card

Gold Plating Paper

Latest developments in gold plating are discussed in this 6-page technical paper. It briefly reviews the beginnings of the art and details the effect of additives on gold electrodeposits. The paper lists structure and hardness of different gold deposits, compares gold baths and their additives. Acid gold plating, a relatively new and previously undocumented development, is discussed. Illustrations and graphs are included. Sel-Rex Corp., Nutley 10, N. J.

Circle 416 on Inquiry Card

Foil Service

Information is available on "Foil Service Center" offering fast, round-the-clock national service. Foil will be slit or sheeted to customer specs. with no additional charge for 24 to 36 hr. shipment. Center was set up in cooperation with The Aluminum Co. of America and offers Alcoa foils in gauges from 0.0003 through 0.0059 in widths from ½ through 40 in. in 1/16 in. increments. Available from American Lamotite Corp., 2914 E. 81st St., Cleveland 4, Ohio.

Circle 417 on Inquiry Card

Circle 165 on Inquiry Card

NEW TECH DATA

for Engineers.

Sealing Data

Information on use of stainless steel as the metal in glass or ceramic-to-metal seals to meet the high environmental standards of Mil-C-26500 has been released. The seals can reportedly withstand temps. from −423°F to +1000°F. Networks Electronic Corp., Chatsworth, Calif.

Circle 478 on Inquiry Card

Tubing Catalog

Catalog 63, 20 color pages, lists data on Polyvinylchloride plastic tubing, Teflon® extruded tubing, zipper tubing, and fiberglass tubing, which conform to Milspecs. Included are applications and properties tables. Alpha Wire Corp., 200 Varick St., New York 14, N. Y.

Circle 479 on Inquiry Card

Wire & Cable Catalog

Catalog 863 contains a complete listing of thousands of wires and cables for industrial use. One such product listed is a 60K VDC coaxial high-voltage cable. Included is a wall chart which helps in cable selection. Belden Mfg. Co., 415 S. Kilpatrick, Chicago 44, Ill.

Circle 480 on Inquiry Card

Dust-Free Cabinet

Data sheet describes Sterilshield® dust-free workspace, a functionally designed cabinet for work requiring clean atmosphere. Equipped with new view screen, bigger than that found in older models, and stainless steel air diffuser. Baker Instruments, Inc., P.O. Box 597, Chandler, Ariz.

Circle 481 on Inquiry Card

Electronic Welding Brochure

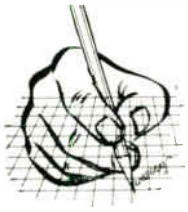
A new 4-page brochure describes accessories for electronic welding systems. Included are descriptions of push button weld heat selectors, fully automatic programmable controls, electrode force gages, tensile testers and complete hookup and installation accessories. Hughes Welders, 2020 Short St., Oceanside, Calif.

Circle 482 on Inquiry Card

Cleaning Solvent

Tech. Bulletin 957-R describes an improved pressurized electrical cleaning solvent for in-place cleaning of electrical and electronic equipment. Improvements result from a change in the pressurizing material from halogenated hydrocarbons to carbon dioxide. Montgomery Chemical Co., Jenkintown, Pa.

Circle 483 on Inquiry Card



Time after time engineers specify Johnson sockets!

Whatever the choice . . . a miniature 7-pin steatite wafer or a low-loss Kel-F socket for high power transmitting tubes . . . time and time again design and development engineers specify Johnson tube sockets! All sockets have been categorized under a socket standardization program, reducing the number of variations in each socket type. Standardization and immediately available stock shortens delivery cycles—permits fast selection of a Johnson socket for almost any application!

Standard: Commercial grade for general requirements. Bases are glazed porcelain or steatite. Etched aluminum shields or bayonet shells.

Industrial: Superior in quality to "Standard" Grade. Glazed steatite bases, DC-200 treated. Phosphor bronze or beryllium copper contacts .0005 silver-plated. Aluminum shells and shields are iridite No. 14 treated. Fungus resistant cushion washers under contacts.

Military: Top quality to meet military requirements. Glazed L-4 steatite bases, DC-200 treated. Phosphor bronze or beryllium copper contacts heavily silver-plated. Hot tin dipped solder terminals. Brass bayonet shells .0003 nickel-plated. Aluminum shells and shields are iridite No. 14 treated. Fungus resistant cushion washers under contacts. Wafer sockets protected for 200 hour salt spray test.

E. F. JOHNSON COMPANY
3021 TENTH AVENUE S.W. • WASECA, MINNESOTA

KEL-F SERIES—Molded of low dielectric loss-factor Kel-F plastic—designed for use with a wide selection of high power transmitting tubes such as: 4X150A; 4X150D; 4X250B; 4CX250B; 4X250F, 7034; 7035. Basic sockets are available in several designs—with or without screen grid by-pass capacitors, mounting saddles, or steatite chimney to direct air flow through tube cooling fins. Control grid contact "guide" is machined for greater alignment accuracy, and tapped for 6-32 machine screw. All contacts are low resistance silver-plated beryllium copper. Tube pin contacts are heat treated to provide positive contact pressure as well as extended life. Annealed soldering tabs may be easily bent or formed.

BAYONET TYPES—Includes Medium and Heavy Duty Medium, Jumbo and Super Jumbo 4-pin types. For use with tubes such as: 866A or 811A, E.I.A. Base No. A4-10; 872A, 211, and others with E.I.A. Base No. A4-29; and tubes such as: 8008, 5C22, FG104, GL146 and others with E.I.A. Base No. A4-18.

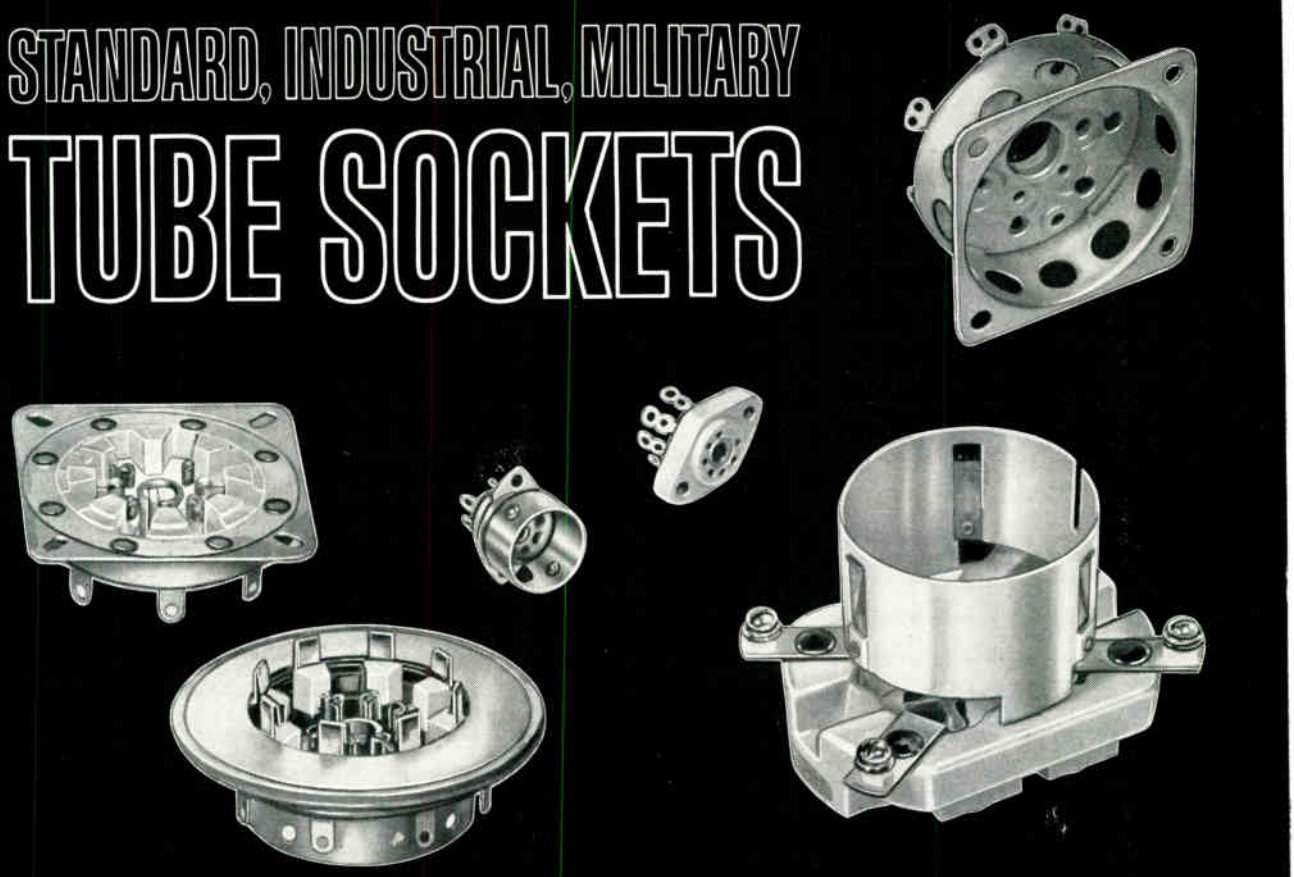
STEATITE WAFER TYPES—Available in 4, 5, 6, 7, and 8-pin standard socket types, as well as Super Jumbo 4-pin for tubes with E.I.A. Base Nos. A4-15, A4-16, and A4-18. Giant 5 and 7-pin models for tubes with E.I.A. Base Nos. A5-19 and A7-17. Septar Sockets for tubes such as the 7094 with E.I.A. Base No. E7-2; and VHF Septar Sockets for tubes such as: 5894, 6524, 6252 with E.I.A. Base No. E7-20; and 826, 832, 4D32 with E.I.A. Base No. E7-2.

MINIATURE TYPES—All steatite, available in Standard Wafer Type or Shield Base Type for 7-pin miniatures such as the: 1RS, 1S5, 6CB6, etc., with E.I.A. Base No. E7-1.

SPECIAL PURPOSE TYPES—Includes sockets for special purpose tubes such as the: 204A and 849; the 833 and 833A; 152TL; 304TL; 750TL; 1500T; 2-2000A; 5D21, 705A and others.

NOTE: Detailed specifications on all Johnson tube sockets have been prepared for engineering department use in Socket Standardization Booklet 536. Should you wish a copy —please make your request on company letterhead.

STANDARD, INDUSTRIAL, MILITARY
TUBE SOCKETS



DETAILED COMPONENTS CATALOG AVAILABLE—Write today on company letterhead

• CAPACITORS • TUBE SOCKETS • CONNECTORS • PILOT LIGHTS • INSULATORS • KNOBS AND DIALS • INDUCTORS • HARDWARE

NEW TECH DATA

Electronic Hardware

Catalog 34, 32 pages, illustrates Microdot's "Lerco" line of electronic hardware. Outline drawings and dimensions of standard terminals, insulated terminals, terminal boards, handles and hardware, eyelets, and control knobs are included. Microdot Inc., 220 Pasadena Ave., So. Pasadena, Calif.

Circle 531 on Inquiry Card

Organic Flux

Alpha #709 soldering flux is recommended for electronic and electrical uses where rosin fluxes are too inactive and inorganic fluxes too corrosive. This water-soluble, spatter-free flux is ideal for printed-circuit boards, hermetically-sealed units and similar uses. Alpha Metals, Inc., 56 Water St., Jersey City, N. J.

Circle 532 on Inquiry Card

Ceramics Chart

Chart No. 631, includes new ceramics in both beryllia and alumina plus comprehensive data on dielectric constant, dissipation factor and loss factor at various temps. and freqs. It is a valuable tool for any engineer using ceramics. American Lava Corp., Manufacturers Rd., Chattanooga 5, Tenn.

Circle 533 on Inquiry Card

Sorting "Exotic" Metals

An interesting 8-page booklet describes the sorting and grading of "exotic" metals such as tantalum, titanium, molybdenum, tungsten and zirconium. Entitled "Specialists in Specialties," it is available from Max Zuckerman & Sons, Music Fair Rd., Owings Mills, Md. Booklet describes firm's manufacturing facilities.

Circle 534 on Inquiry Card

Polycarbonate Resin

Technical report CDC-413 discusses thermoforming of Lexan® polycarbonate resin. The report details techniques; molds, including materials, design, mounting and lubricants; and sheet thermoforming, including drying, temps., gage variations, drape speeds and ring assists. Applications are included. General Electric Co., 1 Plastics Ave., Pittsfield, Mass.

Circle 535 on Inquiry Card

Color Filters

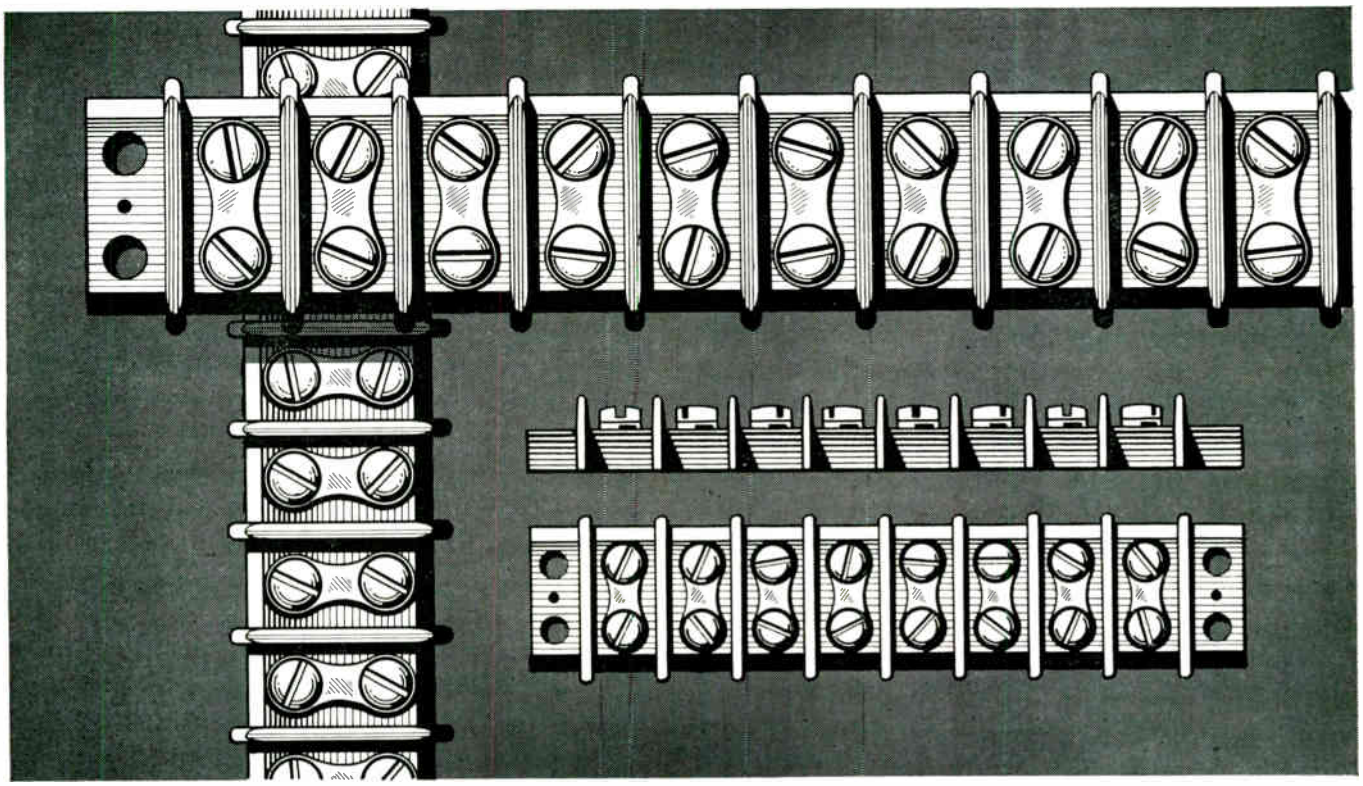
New glass color filters for use in instruments and switches are described in a brochure available from Corning Glass Works, Public Relations Dept., Corning, N. Y. It lists advantages of the filters as precisely controlled color, uniform brightness, dimensional stability, color stability and variety, design flexibility and heat resistance. Applications include electronic switching, pilot lights, indicator lights, split-screen color projection, and 2 to 4 color switching.

Circle 536 on Inquiry Card

NEW GEN-PRO 700 SERIES INDUSTRIAL TERMINAL BOARDS

ALL SIZES AVAILABLE NOW FOR TIMED DELIVERY AS NEEDED

Superior features • Competitively priced • Conveniently packaged



When you need terminal boards for any application, rely on Gen-Pro's great new 700 Series for the quality and interchangeability you want—on Gen-Pro's unique timed delivery for prompt as-needed shipments. Greater length—up to 46 terminals—permits a larger number of connections than ever before possible. Thicker, stronger barriers with rounded corners reduce breakage—creepage path is longer—saddle plates available for more secure mounting. All sizes and variations in number of stations—packaged in lots of 5, 10 and 20. The boards of your choice are delivered from stock in the quantities you require—when you need them. All types of hardware and special molding compounds are available in addition to standard-purpose phenolic. Write today to Dept. SMMD for illustrated literature.

Your assurance of quality.
700 Series terminal boards are subject to the same rigorous quality control procedures as Gen-Pro's famous 400 Series — the finest commercial terminal boards available anywhere today.

700 SERIES TERMINAL BOARDS

Model No.	Voltage, RMS	Terminals
740	1200	1-46
741	1600	1-39
742	2500	1-30
764*	1600	1-46

*32 screws

GEN PRO

GENERAL PRODUCTS CORPORATION
UNION SPRINGS, N.Y.

TWX No. 169
Phone: (area code 315) TT9-7367

NEW TECH DATA

Tools and Instruments

Catalog No. 25, 96 pages, gives a complete listing of precision measuring tools and instruments. A quick index on the inside front cover gives page numbers of the 9 major sections. Alphabetical and numerical indexes at the back of the catalog permit fast reference and location of any item. A separate 34-page consumer price list is also available. Scherr-Tumico, Inc., 301 Armstrong Blvd. N., St. James, Minn.

Circle 537 on Inquiry Card

Instrument Housings

Bulletin 407G, 28 pages, contains engineering design information. It offers many standard solutions to the problems of housing instruments and construction; finishes and environmental specs. are compiled for easy design reference. TA Mfg. Corp., 4607 Alger St., Los Angeles 39, Calif.

Circle 538 on Inquiry Card

Machinery Capabilities

Attractive brochure describes firm's ability to machine-make screws. Brochure contains specs., photos of jobs performed. Work described covers runs from 32 to 285,000. Materials used included inconel, nickel, hastelloy C, molybdenum and A.I.S.I. Type 304 stainless. Allmetal Screw Products Co., Inc, 821 Stewart Ave, Garden City, L. I., N. Y.

Circle 539 on Inquiry Card

Plastic Tie

These plastic ties are inexpensive, easy to use, and require no tools. Wire tie resembles a bead chain with an enlarged section or "key-slot" lock on one end. There are 2 holes in the lock—one big enough for the tie to pull through; the other is smaller to hold the tie at the desired point. Holub Industries, Inc., Sycamore, Ill.

Circle 540 on Inquiry Card

Ceramics and Plastics Saw

Con-O-Saw cuts precious metals and ceramics with little waste, no burrs and no distortion. It uses abrasive wheels for fast, clean, burr-free cutoff of such materials as case-hardened steel, tungsten, wood, plastics and glass. The saw operates on 115v. and weighs 14 lbs. Continental Sensing Inc., 1960 Ruby St., Melrose Park, Ill.

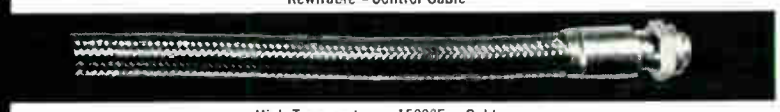
Circle 541 on Inquiry Card

Dowel and Pin Folder

A condensed "in-stock and data" folder concerning stainless steel dowel and taper pins is available. This folder supplies valuable information and latest specs. on commercial, precision and military requirements in easy-to-use format. Allmetal Screw Products Co., Inc., 821 Stewart Ave., Dept. D, Garden City, L. I, N. Y.

Circle 542 on Inquiry Card

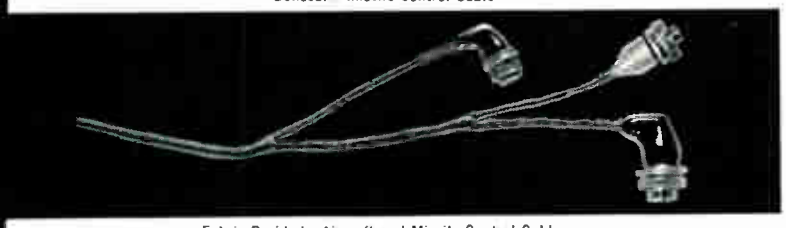
Rewirable—Control Cable



High Temperature—1500°F.—Cable

Heavy Duty—Ground Support Cable

Benseal® Missile Control Cable

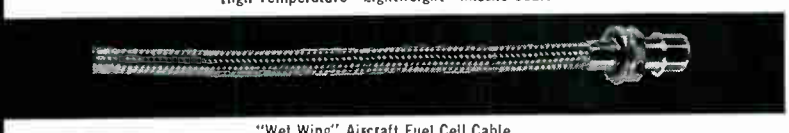


Fabric Braided—Aircraft and Missile Control Cable

Metal Braid—Aircraft and Missile Control Cable

High Temperature—Radiation Resistant Cable

High Temperature—Lightweight—Missile Cable



"Wet Wing" Aircraft Fuel Cell Cable

We're strong in special-purpose cable systems.

You can be too.

Our specialty is producing complex cables for unusual applications to meet our clients' specifications. And we've made some pretty weird looking cables.

A few of the more spectacular types are pictured here. They include metal conduit types available in a variety of metal braids and inner core designs; fabric and metal braid which practically defies limited-space applications; radiation resistant cables; hydrostatic assemblies for critical undersea service; flexible or rigid sealed thermocouple types which operate from −65° to 1500°.

We've found that the best way to sell cable is to have one of our engineers call on a customer and help him solve his particular problem. You know the problem; we know the cable. So why not call us even before you need us. We can be reached at Santa Ana, California, or Sidney, New York. In the meantime, send for our catalog.

Scintilla Division

THE Bendix CORPORATION

Circle 172 on Inquiry Card

NEW TECH DATA

Powder Metal Products

This brochure provides information on the application and use of powder metal components. Featured are stainless steel acoustical filters for communications, sound and sonar equipment. Other powder metal specialty components are also discussed. It provides complete information on the basic design advantages of powder metallurgy. Gilman Engineering & Mfg. Co., 305 W. Delavan Dr., Janesville, Wis.

Circle 543 on Inquiry Card

Lubricant

Hi-T-Lube is a permanent lubricant for easing the action and extending the cycling life of switches, relays and other electrical devices with moving parts. Comprised of several different metals, it uses the lubricating qualities of precious metals and rare metallic oxides. It has a 0.03 coefficient of friction compared to 0.08 for oil lubricants. General Magnaplate Corp., 331 Main St., Belleville, N. J.

Circle 544 on Inquiry Card

Tools Catalog

This catalog describes and illustrates over 800 items including bench tools, epoxy systems, optical production tools, numerous highly-specialized precision tools, comparators, cutters, fabrication tools, microscopes and magnifiers, ultrasonic cleaning equipment, white-room equipment, etc. Request on company letterhead to Micronics Corp. of America, Dept. P-5, 8116 Old York Rd., Elkins Park, Pa.

Circle 545 on Inquiry Card

Tubing Brochure

New 4-page, illustrated brochure on Tungsten-26% Rhenium seamless tubing features physical, thermoelectric and mechanical property data. Tubing is used for cladding for fuel elements, special thermocouple constructions, other parts and components operating in 3000°-5500°F range. Hoskins Mfg. Co., 44455 Lawton Ave., Detroit 8, Mich.

Circle 546 on Inquiry Card

Semiconductor Guide

This guide presents information on the operating characteristics of a complete line of npn and pnp transistors, power diodes, power rectifiers, and high-speed switching transistors. Hundreds of components are listed in easy-to-read tabular form. Bendix Semiconductor Div., Holmdel, N. J.

Circle 547 on Inquiry Card

Semiconductor Polisher

A portable machine for lapping and polishing semiconductors and other materials is described in information available from the Westinghouse Scientific Equipment Dept., P. O. Box 868, Pittsburgh 30, Pa. Called the Mazur, it laps and polishes wafer-thin to bar-sized items.

Circle 548 on Inquiry Card

Circle 173 on Inquiry Card

NEW TECH DATA

Phenolic Laminate

Data is available on a new paper phenolic laminate for flame retardant printed circuitry. FR-200 (NEMA grade FR-2) meets properties of Mil-P-3115C, combines flame retardance with high flexural strength, good insulation and cold punching properties. Solder blister resistance is high. Comes in standard sheet sizes, copper clad and unclad. Formica Corp., 4614 Spring Grove Ave., Cincinnati 32, Ohio.

Circle 554 on Inquiry Card

Silicone Protective Coating

Data sheet describes new silicone surface coating which maintains high surface resistivity in printed circuits even after prolonged high-humidity and temp. cycling from −65°C to +250°C. Also used to protect memory planes of computers and circuitry of precision instruments and in other similar ways. Specs., data on uses, and properties of cured films are supplied. Dow Corning Corp., Midland, Mich.

Circle 555 on Inquiry Card

Laboratory Kiln

Product Information Bulletin describes Bickley 2150 Laboratory Kiln. Bickley 2150 is a general-purpose, semi-muffle kiln for temps. as high as 3200°F in less than 5 hrs. It permits laboratories to explore the high temp. field at min. cost. Any commercial fuel gas can be used, and no bottled oxygen is required. A complete line of accessories, including safety devices and pyrometer equipment is available as an integrated firing system. Bickley Furnaces, Inc., 550 State Rd., Philadelphia 14, Pa.

Circle 556 on Inquiry Card

Environmental Cabinet

A bulletin describes the Tenney-Jr., a new, compact, mechanically refrigerated bench model high-low temp. precision test chamber, is available from Tenney Engineering, Inc., Union, N.J. The unit, with 14 x 10 x 10 in. work space, was designed specifically for small batch, small unit testing of semiconductors and other electronic components to Mil Specs., as well as for testing medical and consumer products.

Circle 557 on Inquiry Card

Colored Filters

SiliKrome™ silicone rubber-colored filters fit over clear miniature incandescent lamps, thus providing a choice of colors. The filter caps slip over lamps of lighting panels, switch indicators, instrument lights and console panels. They conform to Mil-C- 25050 for yellow, red, blue, green and lunar white including instrument lighting red per Mil-L-25467, and instrument lighting white per Mil-L-27160A. SiliKrome Div., APM - Hexseal Corp., 41 Honeck St., Englewood, N. J.

Circle 558 on Inquiry Card

HOW TO CUT KNOB COSTS in Electrical-Electronic Equipment

RB-90120-2801

RB-999-700-SK
Dual-Control

RB-115

Select from Wide Variety of Exclusive Designs From Stock Molds—No Tool Charge—Fast Delivery

Write for BULLETIN CC-6

Molded of thermosetting materials Rogan offers a wide range of stock molded knobs . . . designed by Rogan . . . available *only* from Rogan. Many to MIL specs. Special markings can be branded on knobs at extremely low cost. Get details on the complete Rogan Knob line. Do it NOW!

ROGAN BROTHERS, Inc.

8035 N. MONTICELLO • SKOKIE, ILL.

Specializing In Stock Molded Knobs Since 1939

Circle 180 on Inquiry Cord

LUGS • CLIPS • TERMINALS

hundreds of types!

LOCKWASHER TERMINALS

THE TERMINAL THAT'S A LOCKWASHER . . . for permanent connections that stay permanent 100 types and sizes—all metals Immediate delivery from stock

STANDARD ELECTRICAL PARTS delivered

FAST!

Lugs • Clips • Terminals
Wire Forms from Stock
Send for your copy of the new Zierick catalog No. 23 TODAY!

ZIERICK MANUFACTURING CORP.

106 Beechwood Avenue, New Rochelle, N. Y. • NEw Rochelle 6-8520

Circle 181 on Inquiry Card

MIL-C-3432B
Power & Control Cable, Flexible & Extra Flexible, 300 and 600 volts

MIL-W-7139B
Wire, Polytetrafluoroethylene, 600 volt, 400°F

MIL-W-8777B
Wire, Silicone Rubber, 600 volt, 400°F

MIL-C-3702
Cable, Ignition, High Tension

MIL-C-17C
Radio Frequency Cable, High Temperature Version Only

MIL-C-13486A
Cable, Vehicle, 30 Volt, Heavy Duty, Single & Multiconductor

MIL-W-7500
Antenna Cable, Corona Free

MIL-C-915A
Non-hosing Cables Only

BIW Also designs and manufactures cables to customers' specs, using natural, synthetic, butyl, neoprene and silicone rubber insulating and jacketing materials. Applications requiring radiation, heat, cold, ozone, abrasion, moisture and fungus resistant cables can be met. High voltage, low noise, low capacity and medium-strength cables also available. Write for general brochure.

BIW

"Designers and makers of Specialty Cables since 1905"

Boston Insulated Wire & Cable Co.
81 Bay Street, Boston 25, Mass.

Circle 182 on Inquiry Cord

NEW TECH DATA

Relay Headers

Information is available on a line of standard and custom multiple lead headers for the relay industry. Headers include the standard rectangular and oval shapes as well as 5 and 14-pin sq. headers. In addition, special types can be designed based on customer needs. Terminations include straight, plug in, hook, flat and pierced or lug types. All headers are offered in a number of finishes conforming to applicable military specs. Glass-Tite Mfg. Div., Glass-Tite Industries, Inc., 725 Branch Ave., Providence, R.I.

Circle 559 on Inquiry Card

Molded-Laminated Parts

Data is available on molded-laminated and molded-macerated parts for mechanical, electrical and industrial uses. Molded-laminated parts are almost like similar parts machined from sheet stock in such properties as tensile strength, moisture resistance, specific gravity and dielectric strength. Three advantages claimed for molded laminated over machined are: the molded-laminated angle needs less machining; it has better appearance; it has greater strength. The molded-macerated process is used when parts of intricate shape or of a design that prohibits production by machining from standard forms are required. Synthane Corp., Oaks, Pa.

Circle 560 on Inquiry Card

Pre-Tinned Stainless Strip

Information on a new item which makes automated soldering of stainless steel parts practical is available from American Silver Co., a div. of Sherman Industries, 36-07 Prince St., Flushing 54, N.Y. This new product, known as Stainless Steel ASCO-TIND, is available in most types of stainless steels in the 200, 300 and 400 series. The stainless steel is clad with a metallurgically bonded layer of pure tin, solder or other low melting alloy.

Circle 561 on Inquiry Card

Clean Room Uniform

This clean room uniform catalog, "Packaging People to Protect Products," illustrates an enlarged line of fabrics and garments engineer-designed to prevent physical and chemical contamination of sensitive devices. A new multiplex nylon fabric, Nydura, has superior resistance to abrasion, high absorbency, as well as good opacity and drape. It is featured in a coverall, frock, cap, boots, and wiping cloth. A "Buying Guide for Synthetic Uniform Fabrics" is included in the catalog. Angelica Uniform Co., Box 466, St. Louis 66, Mo.

Circle 562 on Inquiry Card

NEW TECH DATA

Hi-Temp. Furnaces

Bulletin KSK 63 describes 16 standard models of kilns and furnaces using Kanthal-Super heating elements. Uses include ceramic, diffusion, glass melting, atomic research, metallurgical, crystal growing and chemical synthesis. A variety of atmospheres from oxidizing to reducing can be used. W. P. Keith Co., Inc., 8305 Loch Lomond Dr., Pico Rivera, Calif.

Circle 584 on Inquiry Card

Cleanroom Hand Coverings

Bulletin A-4 describes complete line of white-room hand coverings. These encompass latest fabrics and styles used in white-room assembly and production. Bulletin describes nylon gloves, disposable gloves, PVC gloves, finger cots and other accessories inherent to the "tight-tolerance" manufacturing specs. to give complete contamination protection. Techni-Tool, Inc., 1216 Arch St., Phila. 7, Pa.

Circle 585 on Inquiry Card

NEW TECH DATA

Moldings Guide

Brochure No. 1018 describes the design advantages of automatically molded, small-precision thermoplastic parts. A special section describes and illustrates several case histories in which value analysis and value engineering were used to improve product performance while reducing costs. It contains an up-to-date comparison chart giving significant characteristics of important engineering thermoplastics: nylon, acetal, polycarbonate, ABS, fluorocarbon, polypropylene, and polyethylene. Gries Reproducer Corp., New Rochelle, N.Y.

Circle 586 on Inquiry Card

Titanium Manual

This comprehensive manual summarizes the physical and mechanical properties of the 20 titanium metal grades in commercial production. It illustrates the typical strengths of titanium from cryogenic temps. to temps. up to 1000°F. Also included for each grade are annealing times and temps. and tips on fabrication. Titanium Metals Corp. of America, 233 Broadway, New York 7, N. Y.

Circle 587 on Inquiry Card

Resilient Material

Data sheet #3641 introduces Elasticone, a helically wound flat ribbon of resilient material formed into a hollow, truncated cone. It can be used for a wide range of OEM or replacement uses, including heat shields, collapsible antennas, electrical contacts, constant rate lift devices, collapsible covers to protect precision components, etc. Central Safe Equipment Co., Elasticone Div., 6601 Marsden St., Philadelphia 35, Pa.

Circle 588 on Inquiry Card

Permalloys

The Advanced Materials Div. of Materials Research Corp., Orangeburg, N.Y., is now producing pure permalloys by means of electron-beam refining techniques. These alloys are currently used in the communications field where their magnetic properties permit more rapid transmission and detection of small signals. The pure permalloy rods can be fabricated into wire, sheet, ribbon and foil in quantities to meet the needs of research or production.

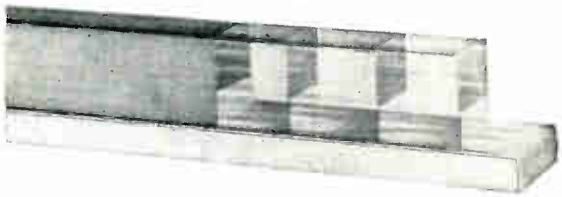
Circle 589 on Inquiry Card

Coaxial Cable

Complete engineering data on Foamflex coaxial cable is detailed in a new 36-page bulletin. Uses, electrical and mechanical characteristics, attenuation and power rating performance curves are included. Foamflex is a semi-flexible, air dielectric coax. cable available in 5 impedances and 7 diameters. Bulletin FF 3. Phelps Dodge Electronic Products Corp., 60 Dodge Ave., North Haven, Conn.

Circle 590 on Inquiry Card

SLIDING SURFACES MOVE MORE FREELY ON FLUOROLIN* TAPE



SLIPPERY ON THE FRONT (it's Teflon®)
STICKY ON THE BACK (it's pressure-sensitive)

Wherever moving parts must slide with the lowest possible friction—product components, production lines, feed chutes, sliding chassis assemblies—there's a Joclin Fluorolin Teflon Tape to make the sliding easier . . . No complex mechanisms or lubrication needed—and it's less expensive.

These rugged pressure-sensitive tapes install in seconds and are available in a wide range of widths and types for any application. Resistant to fuel and chemical action, they stick fast from −100 to +500 F.

Whether the application is mechanical or electrical—commercial or military—Fluorolins by Joclin, the originator of pressure-sensitive Teflon, are the first choice for dependable performance.

THE joclin MANUFACTURING COMPANY
WALLINGFORD, CONNECTICUT

WRITE FOR FREE FACT FILE TODAY

® TM Reg. DuPont * TM Reg.

Circle 189 on Inquiry Card

FABRICATED PLASTIC PARTS

SINCE 1931 A EXTRUDERS FABRICATORS
ACE

ACE is one of America's leading suppliers of precision plastic parts for thousands of different uses. Any shape, form or color. Any type of plastic. Small runs or large runs. Many items in stock. Quick, low-cost service on specials. Ace also supplies a huge variety of plastic extrusions and seamless balls. Write, wire or call for samples, prices and technical bulletins.

ACE PLASTIC CO. 91-22 VAN WYCK EXPWY, JAMAICA 35, N. Y. • JAMAICA 3-5500

Circle 191 on Inquiry Card

Now-Specify VARFIL Sleeving and Tubing...

and get these 5 BIG Advantages

- HIGHER DIELECTRIC RETENTION
- GREATER FLEXIBILITY
- MORE HEAT RESISTANCE
- AVAILABLE IN COILS
- CAN BE AFTER-TREATED

AVAILABLE IN FOLLOWING **NEMA CLASSES**

- CLASS B-A-1 — 7000 VOLTS AVERAGE
- CLASS B-B-1 — 4000 VOLTS AVERAGE
- CLASS B-C-1 — 2500 VOLTS AVERAGE
- CLASS B-C-2 — 1500 VOLTS AVERAGE

Even under the most severe operating conditions, Varfil Sleeving and Tubing retains its average dielectric strength. Twist it, tie it, bend it, wrap it, knot it. Remains just as pliable as when you started. Won't crack, peel or suffer dielectric loss. Heat Varfil 2000 hours at 110° C.—1,000 hours at 125° C.—and even for extensive periods at 150° C. It won't break down. Can be after-treated in baking and varnishing operations. Reacts better than other oleoresinous materials and synthetic coated tubings. Available in handy coils so you can cut the exact lengths you need . . . no waste. Standard colors. Wide range of sizes. Exceeds or meets all A.S.T.M. specifications.

Varflex CORPORATION
Makers of Electrical Insulating Tubing and Sleeving

SEND TODAY FOR FREE SAMPLE FOLDER

VARFLEX Corporation, 506 W. Court St., Rome, N. Y.

Circle 190 on Inquiry Card

STANPAT PRE-PRINTED SYMBOLS SAVE HOURS OF DRAFTING TIME!

Valuable man hours pile up when routine details have to be continually drawn. Now, with amazing STANPAT, engineers and draftsmen save hundreds of man hours each week.

Your own repetitive symbols and drawing details pre-printed for instant use . . . can be applied in seconds, rather than drawn in hours. Three hours can actually be reduced to 15 seconds! That's why STANPAT is used by thousands of companies, in every industry.

Prove it yourself . . . send for STANPAT literature and samples, or enclose your symbols for quote.

STANPAT COMPANY
Whitestone 57, N.Y., Dept. C-6, tel. 212-359-1693

Circle 192 on Inquiry Card

NEW TECH DATA

Flexible Resin

Data is available on Isochemrez 407, a new unusual flexible resin that acts as a diluent and a flexibilizer. Non-shrinking, it brings lower viscosity to most epoxy systems, will not get spongy under heat, can be used in formulations of bisphenol epoxy-peracetic and novalacs to improve the formulations without degradation. Works with all epoxy hardners. Isochem Resins Co., 221 Oak St., Providence 9, R.I.

Circle 634 on Inquiry Card

Plastics Bulletin

New uses of ABS plastics in the field of communications are reviewed in this new product news bulletin. Products reported range from miniature microphones for space uses to magnetic memory devices for busy executives. Other new developments include the latest in portable 2-way radios, 2 slide-projector designs, and an electronic camera that takes the guesswork out of photography. Marbon Chemical Div., P. O. Box 68, Washington, W. Va.

Circle 635 on Inquiry Card

Material Fabrication

A brochure describing facilities for hard material fabrication, sapphire, quartz, spinel, steatite, zircon, alumina, has been published by INSACO Inc., Box 422, Quakertown, Pa. The brochure shows INSACO's capabilities, ranging from the simple modification of prototypes to volume production of precision parts. Uses shown include sapphire windows, lenses, bearings, needle valves and insulators; complex ceramic orifice plates, support discs and helix support rods.

Circle 636 on Inquiry Card

SPE Transistors

A new line of Silicon-Planar Epitaxial Transistors includes military types, high-voltage amplifiers, small signal and low-level amplifiers, general-purpose amplifiers and switches, high-speed saturating switches, UHF and VHF amplifiers, low-level choppers and industrial types. Amperex Electronic Corp., Semiconductor & Receiving Tube Div., 230 Duffy Ave., Hicksville, L. I., N. Y.

Circle 637 on Inquiry Card

Panels and Indicators

This brochure describes edge-lighted panels, indicators, dials and knobs. Panels and indicators meet or exceed Mil Specs. P-7788B, L-25467 and L-25050. Panels shown are typical of the types that can be obtained. Their simplicity makes extensive modification or design changes easy. Panels are for standard airborne equipment. Felsenthal Instruments Co., 7450 Wilson Ave., Chicago 31, Ill.

Circle 638 on Inquiry Card

the aristo TRANS-LUMINATOR

Replaces Carbon Arcs for Finer Reproduction

- **COOL**—film cannot warp or shrink.
- **EVEN**—light is uniform across entire diffusion surface.
- **FAST**—(White) Approximately equal to two 35 Amp arcs. (Blue) Two times faster.
- **QUALITY**—tone reproduced exactly as on original.
- **CLEAN**—No dust, no fumes.
- **ECONOMICAL** — No carbon costs, uses approximately 10% of present power consumption.

and now . . . The Trans-Luminator Feotures Two New Sources from Aristo For Exposing High Resolution Plates & KPR-KMER

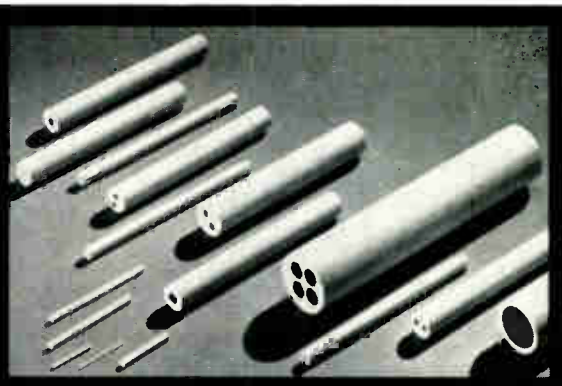
Aristo FYG-54—for exposing high resolution plates is a narrow band source peaking at 548mu. This unit gives greater precision and dimensional stability in producing micro photographs and is superior to either conventional or improved sources in speed, accuracy uniformity coolness, cleanliness & economy

Aristo-B-3642—for exposing KPR-KMER peaks at 365mu and 420mu matching the sensitivity response of this material. This new lamp provides faster, cooler, cleaner reproductions of printed circuits and micro-miniature circuits. It is from 3 to 15 times faster than conventional sources and consumes only a fraction of their power. For further information write:

ARISTO GRID LAMP PRODUCTS INC.
65 Harbor Rd., Port Washington No., L.I., N.Y.

Circle 195 on Inquiry Card

What's the Shape of your High Temp or THERMOCOUPLE TUBING?



STANDARD thermocouple insulators are made from cordierite for use where temperatures do not exceed 2400F. Made in round or oval shape, single hole or multibore, to lengths as specified. Many standard sizes are in stock for immediate shipment.

SWAGEABLE thermocouple tubing, extruded from high-purity alumina or magnesia, withstands temperatures as high as 3500F. Materials crush easily to uniform densities. Available in single hole or multibore shapes with I.D. sizes from .006".

HIGH TEMPERATURE tubing is made from high alumina compositions, single hole or multibore, open or closed ends, in lengths to 60" for temperatures up to 3200F.

Special shapes quoted. Include drawing and quantity, please.

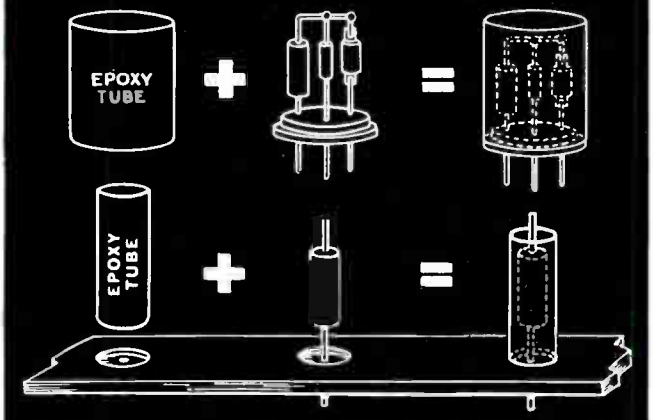
Write on your letterhead for literature and samples.

Saxonburg CERAMICS, INC.
800 3rd AVE., SAXONBURG, PA.
Quality Ceramics for Industry Since 1924

Circle 196 on Inquiry Card

EPOXY TUBING

For ELECTRONIC PACKAGING
SHELLS — COIL FORMS — CONTAINERS



Resistors • Capacitors • Delay Lines • Molded Coils • Plug-in Components • Transformers • Computor Units • Bushings & Spacers

FIFTY SIZES BETWEEN .143" AND 2.000" O.D.
ANY WALL THICKNESS .015" AND HEAVIER
LENGTH 57" OR PRECISION CUT TO SIZE
AVAILABLE IN COLORS AND COMPOUNDS
LARGER O.D. SIZES AVAILABLE

RESDEL CORPORATION
BOX 21 • RIO GRANDE, NEW JERSEY • 609-522-5643

Circle 197 on Inquiry Card

NOW POLYPROPYLENE PLASTIC CLAMPS

7 SIZES 1/8" TO 1/2" DIA.

NEW LOW COST ...much less than other types!

STRONG—toughest plastic clamp made . . . high tensile strength. Tougher 'n 'ell!

MOLDED to uniform size and shape, smooth edges.

DURABLE—for outdoor or indoor use. Excellent dielectric properties. Resist solvent, grease, oil, etc.

FREE SAMPLES

SEND SAMPLES OF PLASTIC CLAMPS

NAME_____
FIRM_____
ADDRESS_____
CITY_____ STATE_____

Hi TRADE MARK REG.

HOLUB INDUSTRIES, Inc.
448 ELM STREET • SYCAMORE ILL

Circle 198 on Inquiry Card

NEW TECH DATA

for Engineers.

Transparent Epoxy

A new, transparent epoxy system with a 7-hr. pot life may be used, unfilled, at temps. of 400°F. The product, Folenco 65, has a dielectric strength of 700v./mil. and a heat distortion point of 300°F. It fills applications for most electronic embedments and as a structural adhesive for steel, aluminum and copper. Supplied as a 2-component, low viscosity system, Folenco 65 cures in 2 hrs. at 175°F. Foltin Engineering Co., Box 6086, Long Island City 6, N. Y.

Circle 643 on Inquiry Card

Insulated Cable

Information is available on new preconduitized insulated cable. Called Precon, it consists of insulated conductors factory-installed in a flexible, high-density black polyethylene pipe. The product is available in 1, 1¼, 1½, and 2-in. standard pipe sizes. A variety of sizes and types of insulated cable can be installed in the pipe. Reynolds Metals Co., Richmond, Va.

Circle 644 on Inquiry Card

Fluorocarbon Products

This brochure describes fluorocarbon products and facilities. It outlines the TFE products for electrical, electronic, chemical and mechanical uses, including stock moldings and extrusions, custom machined and molded parts, O-rings, and chemical processing components. Chicago Gasket Co., 1271 W. North Ave., Chicago 22, Ill.

Circle 645 on Inquiry Card

Defense Capabilities Brochure

A new facilities brochure describes the defense-oriented organization and capability of Philco's Communications and Electronics Div. Brochure covers Government contract work done by Philco and the wide area of defense work in which it is interested. Division has the combined abilities of 2 former operating divisions to provide optimum integration of defense system management. Communications and Electronics Div., Philco Corp., 4700 Wissahickon Ave., Philadelphia 44, Pa.

Circle 646 on Inquiry Card

Flexible Couplings

A new fact file on Lord Elastomeric Flexible Couplings, Bulletin No. 206, has just been released. Lord provides flexible couplings in both standard and custom designs to handle capacity requirements from in.-oz. to ft.-tons. Elastomeric flexible couplings have no moving parts and no metal-to-metal contact. Lord Mfg. Co., Erie, Pa.

Circle 647 on Inquiry Card

Gas-Fired Ovens

New 6-page illustrated brochure, Bulletin GOF, gives data on more than 20 standard sizes of ovens. It gives BTU input, inside and outside dimensions, weight and fan motor horsepower for each size. Also given are standard specs., features including optional items, and information on how to select ovens. Trent, Inc., 201 Leverington Ave., Phila. 27, Pa.

Circle 648 on Inquiry Card

Crystal Oscillators

Two new data sheets on voltage-controlled crystal oscillators are available from Damon Engineering, Inc., 240 Highland Ave., Needham Heights 94, Mass. The first covers a miniaturized VCXO, Model 5114WA, whose freq. can be varied linearly by applying an external dc or ac modulating signal. This data sheet includes a technical description, photo, information on uses, and specs. The second data sheet is a selection guide detailing specs. on a wide variety of VCXOs which can be supplied for individual needs. Standard, multiplier, mixer, and multiplier and mixer types are listed.

Circle 649 on Inquiry Card

Conductive Paint

Information is available on a temporary silver conductive paint which is useful where a temporary common conductive path is needed for the precious metal plating of "fingers" on a printed circuit board. The silver paint is applied with an artist's or draftsman's pen, air dried, and can later be removed, when necessary, by wiping with xylene. Etchomatic, Inc., P. O. Box 444, Waltham, Mass.

Circle 650 on Inquiry Card

Bracket Nut

Bulletin 2606 describes a new miniature right-angle bracket nut. Made of heat-treated carbon steel or corrosion-resistant steel, nut was developed for uses where mounting surfaces are parallel to the screw application and limited mounting areas. Kaylock Div., Kaynar Mfg. Co., Inc., Box 3001, Fullerton, Calif.

Circle 651 on Inquiry Card

Heat-Shrinkable Tubing

This catalog describes a new line of heat-shrinkable tubing products. The tubing is supplied in black, white or transparent irradiated polyolefin, having an expanded dia. to fit easily over the part to be covered. The product is useful for insulating terminals and pigtails, jacketing wires to form cables, for providing identifying markers, shockproofing tool handles, and leakproofing hydraulic fittings and plumbing. Surprenant Mfg. Co., Clinton, Mass.

Circle 652 on Inquiry Card

SECTION H

MILITARY ELECTRONICS & SPACE SYSTEMS

Part One—Military

This is an up-to date listing of key Air Force, Navy and Army procurement and other personnel, indicating the organizational placement of these men, many of whom are concerned with electronic procurement.

1963 MILITARY ELECTRONIC PROCUREMENT DIRECTORY

U. S. DEPARTMENT OF DEFENSE

The Pentagon Wash 25 DC
Phone LIberty 5-6700 or dial OX and the extension

	Extension
SECTY OF DEFENSE Hon R S McNamara	55261
DEP SECTY OF DEFENSE Hon R L Gilpatric	56352
DIR OF DEFENSE RES & ENG Hon H Brown	79111
Dir of Electronics J M Bridges	57245
ASST SECTY INSTALLATION & LOGISTICS Hon T D Morris	55254
DEP ASST SECTY FOR PROCUREMENT G C Bannerman	78177
Dir of Procurement Management R D Lyons	56705
Dir of Small Business Policy R W Webb	76907
Central Mil Procurement Info Office	71481
Dir of Quality Control & Reliability J J Riordan	79263

JOINT CHIEFS OF STAFF

CHAIRMAN JOINT CHIEFS OF STAFF Gen M D Taylor	79121
DIR J-4 LOGISTICS Maj Gen D F Callahan	52732
DIR J-6 COMMUNICATIONS-ELECTRONICS Brig Gen J A McDavid	71998
Electronics Systems Div Col D S Woods	73029

DEFENSE SUPPLY AGENCY

Camden Station Alexandria Va

DIRECTOR Lt Gen A T McNamara	8111
Exec DIRECTORATE Procurement & Production RAdm C A Blick	57951
Small Business Advisor J F Ross	54758
Procurement Div Capt J E Harvey Jr	78516

DEFENSE ELECTRONICS SUPPLY CENTER

1507 Wilmington Pike Dayton 20 Ohio
Responsibility: Procuring, managing, storing & supplying electrical & electronic materiel used by Army, Navy, Air Force & Marine Corps

COMMANDER Brig Gen W W Veal
DEP COMMANDER Capt R H Northwood
DIR OF MATERIEL MANAGEMENT Col R G Kettleson
DIR OF PROCUREMENT & PRODUCTION Col K N Smith
Contract Div C V Evans Chief
Purchase Div R N Bodda Chief

U. S. ARMY

DEPT. OF THE ARMY

The Pentagon Wash 25 D C
Phone LIberty 5-6700 or dial OX and desired extension

	Extension
SECTY OF THE ARMY Hon C R Vance	53211
ASST SECTY for Installation & Logistics Hon P R Ignatius	52254
Dir of Procurement Maj Gen J A Richardson III	52647
ASST SECTY for Res & Dev Hon F J Larsen	56153

ARMY MATERIEL COMMAND HEAD-QUARTERS U S

Tempo T-7 Gravelly Point Va
Wash 25 D C
Phone LIberty 5-6700 or dial OX and the desired extension
COMMANDING GENERAL Lt Gen F S Besson Jr 59154
DEP COMMANDING GENERAL Maj Gen W J Ely 59006
Program & Materiel Mangmt Div Col F H Cantrell 72069
Communications/Elect Branch J N Montgomery 52465
DIR OF PROCUREMENT & PRODUCTION Brig Gen E J Gibson 54471
Missiles & Electronics Div Col P A Nilsson 68382
Electronics Branch C H Butler 68292
Missiles Branch F A Lutz 68385
DIR OF RESEARCH & DEV Maj Gen F H Britton 74728

PROCUREMENT DISTRICTS

BIRMINGHAM ALA 2120 N 7th Ave
Phone FAirfax 3-8011
COMMANDING OFFICER Col R B Sell
Small Business W B Mathews
BOSTON MASS Boston Army Base Boston 10
Phone LIberty 2-6000
COMMANDING OFFICER Col M L Driscoll
Small Business W A Thorpe
CHICAGO ILL 623 S Wabash Ave Chicago 5
Phone WE 9-6000
COMMANDING OFFICER Col T W Davils III
PROCUREMENT & PROD DIV W M Livingston
CINCINNATI OHIO 230 E 9th St Cincinnati 2
Phone DUnbar 1-2200
COMMANDING OFFICER Col J E McKinney
Small Business G Wilson
CLEVELAND O 1367 E 6th St Cleveland 14
Phone TOwer 1-4690
COMMANDING OFFICER Col R M McMahon
Small Business C A Newell
DETROIT MICH 1580 E Grand Blvd Detroit 1
Phone WAlnut 3-0100
COMMANDING OFFICER Col W E Besse
Small Business C M Kaltwasser
LOS ANGELES CALIF Pasadena Calif 55 S Grand Ave
Phone SYcamore 6-0471
COMMANDING OFFICER Col B R Painter
NEW YORK N Y 770 Broadway New York 3
Phone ORegon 7-3030
COMMANDING OFFICER Col J W Graham
CONTRACTOR & INDUSTRIAL RELATIONS OFF S Maisel
Small Business T M Everett
PHILADELPHIA PA 128 N Broad St Phila 2
Phone LOcust 8-0400
COMMANDING OFFICER Col F A Bogart
Small Purchase Branch J J Smith
Res & Dev Branch W P Lehman
Small Business A B Feldman
SAN FRANCISCO CALIF 1515 Clay St Oakland 12 Calif
Phone TEmplebar 4-4121
COMMANDING OFFICER Col J E Johnson
Small Business F M Mayfield
SACRAMENTO ARMY DEPOT Sacramento 1 Calif
Phone GLadstone 6-7841
COMMANDING OFFICER Col L Tamamian
Small Business Mrs B J Bacsik
SIXTH ARMY PURCHASING & CONTRACTING OFFICE Ft Lawton Wash
Phone ATwater 2-0100
CONTRACTING OFFICER A Radinski

NOTE: To obtain the address and telephone number of local Small Business offices throughout the U.S. see "DEPARTMENT OF DEFENSE SMALL BUSINESS SPECIALISTS" Government Printing Office 0-658747. Price 25 cents.

HARRY DIAMOND FUZE LAB

Conn Ave at Van Ness St NW Wash 25 D C
Phone EMerson 2-8000
COMMANDER Lt Col R W McEvoy
PROCUREMENT F T Rainer
Small Business J R Amato

FRANKFORD ARSENAL

Bridge and Tacony Sts
Philadelphia 37 Pa
Phone JEfferson 5-2900

COMM OFF Col George H Pierre Jr	X3100/5200
DEP CO Col R E Le Roy	X6115/6215
CIV ADM T C Kempin	X4201/4205
PROC DIV H J Krusch	X4101
RESEARCH & DEVELOPMENT GRP C C Fawcett	X3101/5140
PROCUREMENT & PRODUCTION GRP Col E A Benser	X3225/21121
SUPPLY & MAINTENANCE GRP Lt Col D H Johnson	X4216
NATL MISSION IND GRP Deputy D W Hood	X22116
SMALL BUSINESS SPECLST W Travis Jr	X7220

FORT MONMOUTH PROCUREMENT OFFICE, USAEMA

Fort Monmouth New Jersey
Phone 532-9000
MISSION: The Fort Monmouth Procurement Office procures Research and Development effort for the U. S. Army in the fields of: Ground, Air and Space Communications for Tactical and Strategic Use: Electronic Systems for Air Defense, Air and Space Navigation Surveillance and Detection; Electronic Computers, Photography, Acoustics, Meteorology, and basic and applied research in all fields of science.

Commanding Officer Col D W Langhan	51115
Executive Officer Maj W H Lytle	52049
Dir Procurement Operations Lt Col W Taliaferro	51602
Asst Director Procurement Operations Mr W E Theysohn	51964
Chief Management Office Captain M B Wier	52954
Procurement Specialist Group Mr F J Corio	52244
Industrial Security Office Mr R T Brower	52754
Legal Office Mr J P Hintelmann	51828
Business Analysis Office Mr K Napier	51549
Small Business & Industrial Relations Office Mr C Hoyt	51729

WASHINGTON PROCUREMENT OFFICE

Main Navy Munitions Building
Room 2604
Washington 25 D C
Phone LIberty 5-6700
MISSION: As a special mission procurement activity, this office serves agencies located at the seat of government. It does not place production contracts or contracts involving items of military specification. It primarily buys standard commercial communications equipment and materials, installations of fixed-plant communications equipment, and leases equipment.

Commanding Officer Major H A Scheibler	67802
Contract Division "A"	
Chief Miss S Thomas	67197
Contract Specialist D Akers	65254
Contract Specialist 1/Lt A Stacy	67197
Contract Specialist 2/Lt T Dungan	65264
Contract Division "B"	
Chief R. Kihm	67634
Contract Specialist Mrs J Hensley	64044
Contract Specialist C Cummings	67634
Contract Specialist F Knight	64044
Technical Services Office	
Attorney E Piggott	67634
Price Analyst E Jensen	67634

U. S. ARMY ELECTRONICS MATERIEL AGENCY (USAEMA)

Headquarters
225 S 18th Street
Philadelphia 3 Pa
Phone KIngsley 6-3200

MISSION: Supply the equipments, maintenance tools and parts required to support the electronics systems of the Army and such federal and foreign establishments as authorized; exercise worldwide and centralized supply control over electronics equipment and maintenance parts; procure materiel and services required for the electronics portion of the Army Supply System: assure that electronics items delivered by contractors meet specified quality standards; plan for maintenance of a production base which will assure an adequate supply of electronics materiel in the event of mobilization.

	Extension
Commanding General	
Brig Gen Allen T Stanwix-Hay	8000
Deputy Commander	
Colonel James E Foster	8001
Chief of Staff	
Colonel J D Nutt	8002
Small Business and Labor Surplus Advisor	
E J O'Neill	749
Dir, Industrial Preparedness	
L A Kapust	300
Oir, Material Readiness	
J G Melvin	200
Chief, Office of Integrated Data Systems	
J Bergman	231
Oir, Quality Assurance	
Col F J Coffey	600
Oir, Procurement	
S. Rabinowitz	500
Asst Dir, Procurement	
A M Schuster	501
Asst Dir, Procurement (Contr)	
N Creager	8372
PROCUREMENT MANAGEMENT DIVISION "A"	
Chief A R Testa	8177

FORT HUACHUCA PROCUREMENT OFFICE, USAEMA

Building 41421
Fort Huachuca Arizona
Phone GLadstone 8-3311
MISSION: Places and administers special equipment contracts and contracts for services and studies as required for performance of the mission assigned to the U. S. Army Electronics Materiel Agency; purchases all equipment, supplies, materials and services and studies as required by the Fort Huachuca Procurement Office units, organizations and activities for which local purchase authority exists; serves in a staff advisory and staff office position in the procurement area as required by the Commanding General, USAERD in providing special procurement services.

Commanding Officer Lt Col A E Barnsbee	3916
Tech Dir V H Hollis	2819
Procurement Specialist Group F Saunders	5938
Legal Office Robert Roubal	2231
Management and Services Office Morris Hill	2723
Industrial Property Office C K Walker	4166
Economics Office F B Laws	5518
Contracts Division Chief Maj C E Crabill	2817
Asst V A Suarez	5117
Purchase Branch "A" R Angell	5838
Purchase Branch "B" Reed Sevy	3131
Purchase Branch "C" Rose Brock	4115
Purchase Branch "D" Matt Werth	4117
Purchase Branch "E" John Kelly	2816
Purchase Branch "F" Maj F W White Jr	4128
Small Business & Labor Surplus Advisor J Horstman	2712
Procurement Engineer W V Record	3237

U S ARMY ELECTRONICS COMMAND

Fort Monmouth New Jersey
Phone: 532-9000

Commanding General Maj Gen Stuart S Hoff	23000
Aide de Camp Capt H E Shelton	22053
Deputy Commanding General Brig Gen Walter E Lotz Jr.	23214
Chief of Staff Col J E Gonseth Jr	23700
Secretary of the Staff Lt Col J G Moses	23800
AVIONICS AND NAVIGATION AIDS	
Commodity Office	
Chief Maj W W Hall	52242
COMMUNICATIONS—ADP	
Commodity Office	
Chief Col G P Lerner	51741
Deputy Chief Maj A B Evans	51990
INTELLIGENCE MATERIEL	
Commodity Office	
Chief Lt Col A D Chiarella	52429
Deputy Chief Maj H Hoffman	52429
RAD—COMBAT SURVEILLANCE	
Commodity Office	
Chief Col J P McGovern	52446
Deputy Chief Lt Col W W Rossman	52446
Technical Director H Goldwag	52446
PROJECT MANAGERS	
AN/USD 2 Col D P Gallagher	51926
Lt Col J F Jenkins	51255
AACOMS Col C P Reeves	52853
Lt Col E D Vaughan	52815
AN/VRC 12 AN/PRC 25 Col J H Schofield Jr	52249
Lt Col E W Daniel Jr	52820
CCIS 70 Lt Col A Q Smith Ft Huachuca 831 1530 Ext 2718	
Maj F W Giggey	52119
RADA SYSTEM Col J B Corbly	51550
Maj J J Hoffman	51971
UNICOM/STARCOM Lt Col H F Foster Jr	51930
Capt R B Craig	52491
ELECTRONIC WARFARE—AIR DEFENSE	
Commodity Office	
Chief Capt R A Kraus	51765
Research Commodity Office	
Chief Col R K Saxe	51561
Deputy Chief Lt Col G D Dean	52064
Technical Director A Cohen	52064
Special Assistants	
Chief Engineer A W Rogers	22901
Chief Scientist Dr H K Ziegler	22748
For Supply John N Montgomery	21248
DIRECTOR OF RESEARCH AND DEVELOPMENT	
Director Col B H Glover	21619
Technical Director R McKinley	21634
Programs Div Chief Maj A Wiegand	22026
Operations Div Chief Maj B L Anderson	21753
Requirements Div Chief Maj W W Chandler	22702
DIRECTOR OF PROCUREMENT AND PRODUCTION	
Director Col C A Cuphaver	22736
Technical Director A J Dalton	21320
Procurement Management Div Chief	
Lt Col L C Welch	22619
Mrs M G Meickle	22605
PRODUCTION MANAGEMENT DIV Chief	
Lt Col J T McKiernan	22436
CONTRACTUAL MANAGEMENT DIV Chief	
I Liberman	23234
QUALITY MANAGEMENT DIV Chief	
H Steiner	22949

PROC BR A-1-2	
Radio, TV and related equipment	
Chief Lt Col G W Hudson	8198
Asst J W Robinson	8197
PROC BR A-3	
Electrical measuring & testing equipment, relays, contacts, solenoids	
Chief Maj F Stone	8179
Asst D Shuman	678
PROCUREMENT MANAGEMENT DIVISION "B"	
Chief J H Schreeter	409
PROC BR B-11	
Electron tubes, transistors, crystals	
Chief L Karafin	470
PROC BR B-12	
Dry, storage & thermal batteries	
Chief R Miller	468
PROC BR B-13-14	
Meteorological & photographic equipment & supplies	
Chief Maj J H Rogers	467
Asst Mrs M Regan	466
SPECIAL PURCHASES BRANCH	
Purchases under $2500, EDPO's	
Chief C J Harris	
TECH ASSISTANCE & SPEC PROD PROC BRANCH	
MWO's Tec Rep program	
Chief C Maurer	457
PROCUREMENT MANAGEMENT DIVISION "C"	
Chief H Oakley	8047
Asst W H White	8049
PROC BR C 21-24	
Telephone & telegraph equipment, wire cable & cord assemblies & reels	
Chief H Walton	758
PROC BR C 22-23-25	
Teletype & facsimile equipment, engine & transmission equipment, mounting hardware, hand & measuring tools	
Chief (acting) L Karafin	480
MISSILE SYSTEMS PROCUREMENT BRANCH	
Chief C Fravel	739
PEM & FAC PROCUREMENT BRANCH	
Chief Miss L Mizdail	8059
Procurement Services Division Chief M Wexler	452
Industry & Procurement Analysis Branch	
Chief E A Jolley	488
Contractual Program Coordination Branch	
Chief H Loose	8340
Processing Branch Chief Mrs I Scott	475
Economics Div Headquarters Chief H E Moore	368
Property & Administrative Div	
Chief F J McAdams	8153

U. S. AIR FORCE

SECTY OF THE AIR FORCE Hon E M Zuckert	77376
UNDER SECTY OF THE AIR FORCE Hon B McMillan	71361
ASST SECTY (MATERIEL) Hon J S Imirie	78147
CHIEF OF STAFF Gen C E LeMay	79225

AIR FORCE SYSTEMS COMMAND HEADQUARTERS

Andrews Air Focre Base Md
Wash 25 D C
Phone 981-9111 or dial 981 and the extension
RESPONSIBILITY: For research, development, production and procurement required to place a complete aerospace system in operation

COMMANDER Gen B A Schriever	6209
VICE COMMANOER Lt Gen H M Estes Jr	3361
OEP CHIEF OF STAFF/PROCUREMENT & MATERIEL Brig Gen G F Keeling	
CONTRACT MANAGEMENT Maj G Arney	3367
Small Business J C Eiden	

AIR FORCE SYSTEMS COMMAND

RESPONSIBLE: For planning, designing, procedure, installation, checkout and placing in operation Air Force command and control systems
COMMANDER Maj Gen C H Terhune Jr
PROCUREMENT & PRODUCTION OFFICE
Col R A Scurlock Chief

AERONAUTICAL SYSTEMS DIVISIONS

Wright-Patterson Air Force Base
Dayton O
Phone 253-7111
MISSION: To procure and manage Air Force aeronautical systems and certain air-to-air and air-to-ground missiles
COMMANDER Maj Gen R G Ruegg
PROCUREMENT & PRODUCTION OFFICE
Col H A Budd
DIRECTORATE OF R & D CONTRACTING
Col C W Pangborn

SPACE SYSTEMS DIV

Air Force Unit Postoffice
Los Angeles 45 Calif
Phone OR 0-1444
RESPONSIBLE: For planning, program, procedure, developing and managing space projects and systems
COMMANDER Maj Gen B I Funk
PROCUREMENT & PRODUCTION OFFICE
Col P S Walker
CONTRACT RELATIONS & SMALL BUSINESS
R Watkins

HANSCOM COMPLEX

Laurence G Hanslom Field
Bedford Mass
Phone CRestview 4-6100

MILITARY PROCUREMENT OFFICES

AIR FORCE LOGISTICS COMMAND

Wright-Patterson Air Force Base
Dayton O
Phone 253-7111
MISSION: To insure that Air Force combat units are equipped for instant action in any emergency
COMMANOER Gen M E Bradley Jr
OIR OF PROCUREMENT & PRODUCTION
Maj Gen L W Fulton

MIDDLETOWN AIR MATERIEL AREA

Olmstead Air Force Base
Olmstead Pa
Phone WHitney 4-5521
COMMANDER Maj Gen F H Miller
DIR OF PROCUREMENT & PRODUCTION
Col N J Beaudrias

MOBILE AIR MATERIEL AREA

Brookley Air Force Base
S Washington Ave
Mobile Ala
Phone HEmlook 8-6011
COMMANDER Maj Gen E B Cassady
DIR OF PROCUREMENT & PRODUCTION
Col W H Harrell

OKLAHOMA CITY AIR MATERIEL AREA

Tinker Air Force Base
Oklahoma City Okla
PErshing 2-7321
COMMANDER Maj Gen L L Mundell
OIR PROCUREMENT & PRODUCTION Col P J Kuhl

ROME AIR MATERIEL AREA

Griffiss Air Force Base N Y
Phone ROme FF6-3200
COMMANDER Maj Gen C B Root
DIR OF PROCUREMENT & PRODUCTION
Col R V Kirkland

SACRAMENTO AIR MATERIEL AREA

McClellan Air Force Base
Sacramento Calif
Phone WA 2-1511
COMMANDER Maj Gen G E Price
DIR OF PROCUREMENT & PRODUCTION
Col F E Oliver
Small Business Office C O Dudley Jr

AIR FORCE CONTRACT MANAGEMENT DISTRICT OFFICE

12 & Market Sts
St Louis 3 Mo
Phone MAin 1-8100
COMMANOER Lt Col L P Money
Small Business & Contract Relations Office
K E Kichline

AIR FORCE CENTRAL CONTRACT MANAGEMENT REGION

CLEVELAND CONTRACT MANAGEMENT DISTRICT

113 St Clair Ave
Cleveland 14 O
Phone 241-7900
COMMANDER Lt Col E H Brass Jr

SAN FRANCISCO CONTRACT MANAGEMENT DISTRICT

1069 E Meadow Circle
Palo Alto Calif
Phone DA 1-6330
COMMANDER Lt Col G M Buckles
Small Business R Quinn

DIRECTORATE OF PROCUREMENT AIR FORCE COMMUNICATIONS SERVICE

Bld. 1602 Scott Air Force Base III
Phone ADams 4-4000
DIR OF PROCUREMENT Lt Col J L Lassandro

STAFF PROCUREMENT OFFICE AIR FORCE AERONAUTICAL CHART & INFO CENTER

6th Floor Schauer Bldg
2nd & Arsenal Sts
St Louis 8 Mo
Phone TOwnsend 5-1210
STAFF PROCUREMENT OFFICER W W Meyers

OGDEN AIR MATERIEL AREA

Hill Air Force Base Utah
TAylor 5-5215
COMMANDER Maj Gen D Coupland
DIR OF PROCUREMENT & PRODUCTION Col R J Iverson

SAN ANTONIO AIR MATERIEL AREA

Kelly Air Force Base
San Antonio Texas
Phone WAlnut 3-5411
COMMANDER Maj Gen W THudnell
DIR OF PROCUREMENT & PRODUCTION
Col R H Terzian

WARNER ROBINS AIR MATERIEL AREA

Robins Air Force Base
Warner Robins Ga
Phone 926-1110
COMMANDER Maj Gen W T Hefley
DIR OF PROCUREMENT & PRODUCTION Col R E Lee

AIR FORCE MISSILE TEST CENTER

Patrick Air Force Base
Patrick Fla
Phone Coca Beach UL 7-7545
DIR FOR PROCUREMENT Col A W James
BASE PROCUREMENT DIV T V Buchanan
RANGE PROCUREMENT Maj R W Morrow

PAN AMERICAN AIRWAYS GUIDED MISSILES RANGE DIV SUPPLY DEPT PROCUREMENT DIV

Patrick Air Force Base Fla
Phone UL 7-2653
SUPT W L Overstreet
SPECIAL PROJECTS PROCUREMENT AGENT A P Crews

AIR FORCE FLIGHT TEST CENTER

Edwards Air Force Base
Edwards Calif
Phone CLifford 8-2111
COMMANDER Brig Gen I L Branch
DIR OF PROCUREMENT Lt Col R L Beeler Jr
Small Business & Contractor Relations Office
J A Beucherie

DEPARTMENT OF THE NAVY

The Pentagon Wash 25 D C
Phone LIberty 5-6700 or dial OX- and the extension
SECTY OF THE NAVY Hon F Korth 53131

ASST SECTY OF THE NAVY (INSTALLATIONS & LOGISTICS) OFFICE OF NAVAL MATERIAL

Hon K E BeLieu 63213
Main Navy Bldg 18th & Constitution Ave
Wash 25 D C
Phone LIberty 5-6700 or dial OX- and the extension
CHIEF VAdm G F Beardsley 63168
PROCUREMENT DIV Capt J B Cline 65811
Procurement Branch Capt R Cobb 64086

OFFICE OF NAVAL RESEARCH

Bldg T-3 Wash 25 D C
CHIEF RAdm L D Coates 64911
Small Business L O Lincoln 66650
Procurement Services Cdr H D Moore 65321

U S MARINE CORPS

Arlington Annex
Wash 25 D C
COMMANDANT Gen D M Shoup 42500
MATERIEL DIV Col K E Martin 42906
Procurement Branch J W McLain 42583
Small Business Capt H F Olsen 41083

OFFICE OF THE CHIEF OF NAVAL OPERATIONS

The Pentagon
CHIEF Adm G W Anderson 56007
ANTI-SUBMARINE WARFARE DIV
Capt J N Shaffer 74783
COMMAND CONTROL & ELECTRONICS DIV
Capt M B Freeman 57642
DEP CHIEF OF NAVAL OPERATIONS (LOGISTICS)
VAdm J Sylvester 52154

BUREAU OF NAVAL WEAPONS

Main Navy Bldg Wash 25 D C
CHIEF RAdm P D Stroop 62465
ANTI-SUBMARINE WARFARE OFFICE
Capt F E McEntire 65298
ASST CHIEF FOR CONTRACTS
RAdm J W Bottoms 62436
Small Business J F Lenahan 64972
Purchase Officer Capt K L Jeffery Jr 62905

BUREAU OF SHIPS

Main Navy Bldg Wash 25 D C
CHIEF RAdm R K James 62058
Small Business M Chemsak 63695
CONTRACT DIV Capt G C Wells 62112
Electronics Purchase Branch E H Koch 61803
ASST CHIEF OF BUREAU FOR TECH LOGISTICS
RAdm R B Fulton 61714
ELECTRONICS DIV Capt R R Bradley Jr 64586

BUREAU OF SUPPLIES & ACCOUNTS

Arlington Annex Wash 25 D C
CHIEF RAdm J W Crumpacker 63411
ASST CHIEF FOR PURCHASING
Capt T H Bell 62136

U S NAVY PURCHASING OFFICE—WASHINGTON

Bldg Temp-D
OFFICER IN CHARGE Capt C A Appleby 65141
Small Business P E Ferrante 66900
Procurement Information 67477
Contract Adm Div LCdr E H Clark 66960
Purchase Div LCdr M S Anderson 66479

3rd NAVAL DISTRICT

90 Church St New York City
Phone REctor 2-9100
COMMANDANT RADm G Wales

NAVAL PURCHASING OFFICE

29th & Third Ave Brooklyn 32 N Y
Phone STerling 8-5000
COMMANDANT Capt G Waters

10th NAVAL DISTRICT

San Juan Puerto Rico
Phone 722-0080
INDUSTRIAL MANAGER Capt J W Henry

NAVAL SUPPLY CENTER PURCHASING OFFICE

Bldg 311 Oakland 14 Calif
Phone TWin Oaks 3-4224
COMMANDING OFFICER RAdm H C Haynsworth Jr
DIRECTOR PURCHASING SERVICE Cdr M Schuller

U S NAVY PURCHASING OFFICE

929 South Broadway Los Angeles 55 Calif
Phone RIchmond 9-4711
OFFICER IN CHARGE Capt R W Cope
Small Business O A Grundwald Jr
Purchase Div Officer Cdr R A Schauffler

U S NAVY ELECTRONICS SUPPLY OFFICE

Bldg 3400 Great Lakes III
Phone DE 6-3500
BUYING BRANCH Lt J B Whittaker
Small Business G O Gifford

U S NAVAL SUPPLY DEPOT

Mechanicsburg Pa
Phone POpular 6-8511
COMMANDER W G Bacon

U S NAVY AVIATION SUPPLY OFFICE

700 Robbins Ave Phila 11 Pa
Phone Randolph 8-1212
COMMANDING OFFICER RAdm H F Kuehl
Buying Branch Head Cdr W A Wilson
Electronic Section Head P Bieg

U S NAVAL ORDNANCE TEST STATION

3202 East Foothill Blvd Pasadena Calif
Phone FRontier 7-7411
ASSOC DIRECTOR OF SUPPLY Cdr C A Cassin
CONTRACTING OFFICER J E Fletcher
Purchase Div K M Thompson
Small Business C V Weaver

13th NAVAL DISTRICT NAVAL AIR STATION U S NAVY SUPPLY DEPOT

Pier 91 Seattle Wash
Phone ATwater 3-5200
PURCHASING OFFICER LCdr L J Crook

NAVAL TORPEDO STATION

Keyport Wash
Phone ES 3-5011
CONTRACT ASST W M Bennet
NOTE: For list of the names and addresses of Navy SMALL BUSINESS SPECIALISTS located in various cities and for INDUSTRY CORPORATION REPRESENTATIVES write to OFFICE OF NAVAL MATERIAL 18th & Constitution Ave N W Wash 25 D C

SELECTED GOVERNMENTAL AGENCIES

(Note: For information regarding bids for equipment or services purchased by the Govt. services, subscribe to COMMERCE BUSINESS DAILY. Yearly subscription $20 (reg. mail). Write U S Dept of Commerce, Room 1300, 433 W. Van Buren St., Chicago 7, Ill.)

FEDERAL AVIATION AGENCY

1711 New York Ave N W Wash 25 D C
Phone STerling 3-2100
ADMINISTRATOR N E Halaby

INSTALLATION & MATERIEL SERVICE

Procurement Div Procurement Service Branch
Room 2601 Bldg T-5
L G Ozier Chief
Phone WO 7-4736

INSTALLATION & MATERIAL DEPOT

P O Box 1082
Oklahoma City I Okla
Phone MUtual 1-2311
PROCUREMENT BRANCH D J Odvody Chief

U S DEPT OF COMMERCE U S WEATHER BUREAU

Procurement & Supply Section
B F Loveless Chief
1115 18th St N W Wash 25 D C
Phone 965-2400

U S COAST & GEODETIC SURVEY

Procurement Branch
E T Peterson Chief
1741 Rhode Island Ave N W
Wash 25 D C
Phone DU 2-3791

NAT BUREAU OF STANDARDS

Conn Ave & Van Ness St N W
Wash 25 D C
Phone EMerson 2-4040
DIRECTOR Dr A V Astin
SUPPLY DEPT G B Kefover
Procurement Sect C B Kipps

ATOMIC ENERGY COMMISSION

Germantown Md
Mail: Wash 25 D C
Phone HAzelwood 7-7831
CHAIRMAN Dr G T Seabord
GEN MANAGER A R Lueddecke
DIV OF HEADQUARTERS SERVICES (Purchasing)
E H Glade
DIC OF CONTRACTS J H Wells
(Large amount of contracting is done by numerous field offices. For addresses of these offices write to **CONTRACT DIV** (above) for booklet "SELLING TO THE AEC")

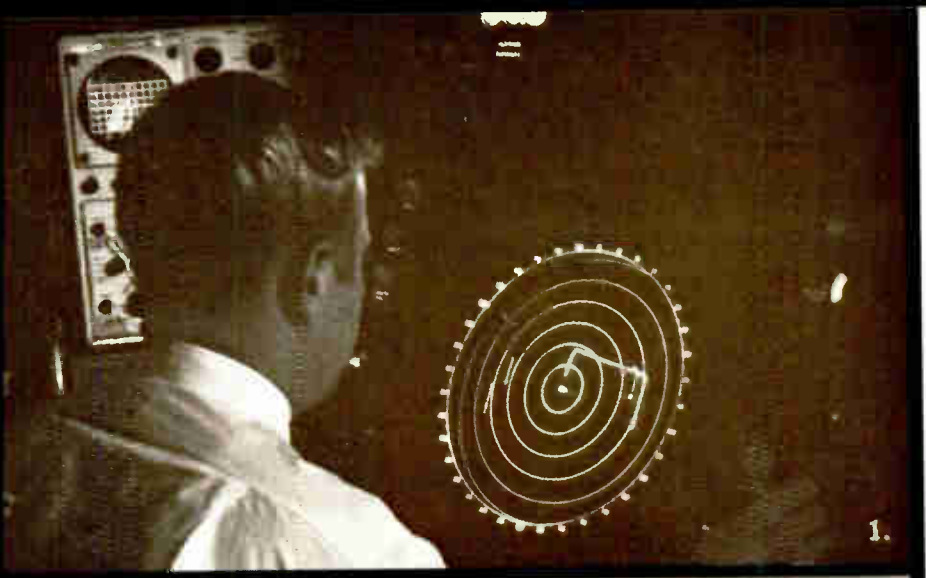
HEADQUARTERS Federal Office Bldg No 6
Maryland Ave & 4th St SW
Washington 25 D C
Phone EX 3-3260
ADMINISTRATOR J E Webb WO 2-1271
DEP ADMINISTRATOR Dr H L Dryden WO 2-4504

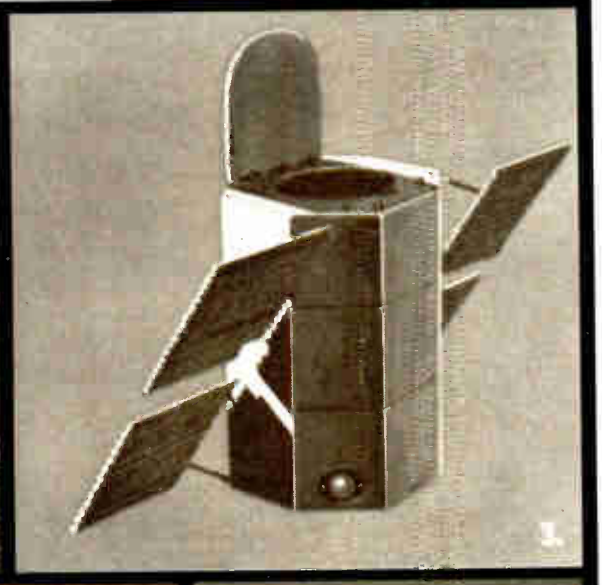
NASA PROCUREMENT CENTERS:

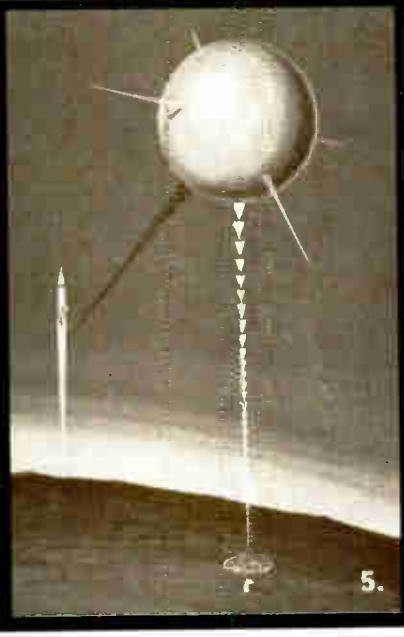
NASA HEADQUARTERS
Washington 25 D C
DIRECTOR E W Bracket WO 3-7969
Small Business J M Roey
HEADQUARTERS PROC BR
Washington 25 D C
PROC CHIEF A A Clagett WO 2-4017
Small Business E W Quintrell
AMES RESEARCH CNTR
Moffett Field Calif
PROC CHIEF A S Hertzog YO 8-9411
Small Business D E Davis
LANGLEY RESEARCH CNTR
Langley Field Va
PROC CHIEF S L Butler 722-7961
Small Business J F Braig
GODDARD SPACE FLIGHT CNTR
Greenbelt Md
PROC CHIEF G H Tyler GR 4-9000
Small Business H T O'Toole
JET PROPULSION LAB
Pasadena Calif
PROC CHIEF T Candee SY 0-6811
Small Business G I Lawrence
WESTERN OPERATIONS
Santa Monica Calif
PROC CHIEF E Sample EX 3-9641
Small Business A Mirosav
FLIGHT RESEARCH CNTR
Edwards Calif
PROC CHIEF M E Bowling CL 8-2111
Small Business S C Kucharik
WALLOPS RESEARCH STA
Wallops Island Va
PROC CHIEF L T Birch VA 4-3411
Small Business H Hammond
MARSHALL SPACE FLIGHT CNTR
Huntsville Ala
PROC CHIEF W S Davis 536-8516
Small Business E J Havrilla
LEWIS RESEARCH CNTR
Cleveland Ohio
PROC CHIEF E S Hicks Jr 252-7700
Small Business N C Prahst
LAUNCH OPER CNTR
Cocoa Beach Fla
PROC CHIEF G A Michaud SU 3-8244
Small Business T M Davis
MANNED SPACE CNTR
Houston Tex
PROC CHIEF D W Lang Jr WA 8-2811
Small Business H Christman

Key Missile & Space Vehicle Contractors

COMPANY	ENGINEERING EXECUTIVE	PERSONNEL DIRECTOR
Aerojet-General Corp. 332 Irwindale Ave., Azusa, Calif.	C. C. Ross, V. P. Engineering	L. L. Thompson
Aeronutronic, Div. of Ford Motor Co. Ford Rd., Newport Beach, Calif.	Dr. R. S. Carlson Dir. of Engineering	R. F. Fallon
Avco Corp. 201 Lowell St., Wilmington, Del.	Dr. C. J. Burton V. P. & Dir. Product Dev.	E. W. Stupack
Beech Aircraft Corp. Wichita, Kan.	J. N. Lew, V. P. Eng.	J. E. Isaacs
Bendix Corp. South Bend 20, Ind.	J. F. Clayton, Dir. Eng. Programs	D. L. Kirkpatrick
Boeing Corp. Seattle 14, Wash.	L. A. Woods V. P. & Gen. Mgr. Aerospace Div.	F. Huleen
Douglas Aircraft Co. Santa Monica, Calif.	R. L. Johnson V. P. & Dir. Product Div.	L. W. Tixier
Fairchild Stratos Corp. Hagerstown 10, Md.	L. L. Farnham, V. P.	R. A. Newton
General Dynamics/Astronautics San Diego 12, Calif.	M. Rosenbaum Exec. V. P.	R. M. Smith
General Electric Co. Valley Forge Space Technology Center P.O. Box 8555 Phila. 1, Pa.	H. W. Paige Gen. Mgr. Missile & Space Div.	R. J. Haughton
General Precision, Inc. Little Falls, N. J.	R. N. Brown, Exec. V. P. Kearfott Div.	P. Kull
Goodyear Aircraft Corp. Akron, Ohio	E. A. Brittenham, Jr. Chief Eng.	C. Taylor
Gyrodyne Co. of Am., Inc. St. James, L. I., N. Y.	A. H. Yates, V. P.	W. J. Aylward
Grumman Aircraft Eng. Corp. Bethpage, L. I., N. Y.	R. M. Crabtree LEM Sub-systems Proj. Eng.	J. G. Galvin, Jr.
Hughes Aircraft Corp. Culver City, Calif.	N. I. Hall, V. P.	S. L. Gillespie
Lear-Siegler, Inc. Instrument Div. Grand Rapids, Mich.	J. M. Walsh, Pres.	G. Branston
Ling-Temco-Vought Dallas 22, Texas	J. R. Clark, V. P. & Gen. Mgr. Astronautics Div.	M. L. Taylor
Lockheed Missiles & Space Co. Sunnyvale, Calif.	R. R. Kearton, V. P. & Gen. Mgr. Space Systems Div.	R. C. Birdsall
Martin Co. Martin Marietta Corp. Friendship International Airport 40, Md.	G. F. Metcalf, V. P. Res. & Eng.	D. V. Dorman
McDonnell Aircraft Corp. St. Louis, Mo.	B. G. Bromberg, V. P. Missile Eng. Div.	W. R. Orthwein, Jr.
Minneapolis Honeywell Reg. Co. Minneapolis, Minn.	C. L. Davis, V. P. Military Prods. Group	J. S. Gibson A. F. Urbiha
North American Aviation, Inc. El Segundo, Calif.	B. D. Haber Asst. to the President	North Am. Aviation, Inc. Downey, Calif.
Northrop Corp. Space Labs. Hawthorne, Calif.	R. E. Horner Sr. V. P. & Gen. Mgr.	J. Richardson
RCA Moorestown, N. J.	J. H. Sidebottom V. P. & Gen. Mgr.	N. J. Cappello
Republic Aviation Corp. Farmingdale, L. I., N. Y.	A. R. Crawford, V. P.	C. Ketson
Raytheon Co. Space & Info. Systems Div. Missile Systems Div. Bedford, Mass.	D. L. Yates, V. P. & Gen. Mgr. Dr. M. Schilling, Gen. Mgr.	R. C. Story J. C. Enos
Ryan Aeronautical Co. San Diego, Calif.	F. W. Fink, V. P. Eng. Prods.	W. Wagner
Sperry Gyroscope Co. Great Neck, L. I., N. Y.	H. Harris, Div. of Eng.	R. Hamlett
Thiokol Chemical Corp. Ogden, Utah	Dr. H. W. Richey, V. P.	J. Lorenz
Thompson Ramo Wooldridge, Inc. Space Technology Labs. Redondo Beach, Calif.	Dr. A. K. Thiel, V. P.	R. C. Potter
United Aircraft Corp. Farmington, Conn.	C. M. Kearns, Pres. & Gen. Mgr.	N. B. Morse
Vickers, Inc. Detroit 32, Mich.	B. W. Badenoch V. P. & Gen. Mgr.	D. M. Norton
Westinghouse Electric Corp. Astronuclear Labs. Pittsburgh 36, Pa.	Dr. A. L. Bethel Dept. Mgr.	D. C. Lee Baltimore 3, Md.







Advances from Avco/Electronics: in space, on earth— and more to come!

Tiny radios that tell space vehicles what to do. Radar that pinpoints distant planes. Communications gear to keep operations on the move. These are a few products from Avco's Electronics Division, prime contractor to each of the armed services and NASA.

1. Air traffic control. A "predicted paths" system, developed by Avco, assures greater safety. Makes it easier for busy air traffic controllers to see on radarscopes a projected flight path for every aircraft in the area.

2. Front-line communications. A new radio receiver-transmitter, developed by Avco for the U.S. Army, makes it possible to direct by voice: tanks, artillery, aircraft, and troops in a combat area.

3. The Orbiting Astronomical Observatory, to study the stars, planets, and the universe, will use satellite receivers and a video detector built by Avco. Instructions from NASA's Goddard Flight Center to OAO and transmissions from the satellite to Earth will be triggered by special radio receivers which Avco has developed under subcontract to Grumman. Avco supplies a variety of space communications equipment to a wide range of NASA and defense contractors.

4. Three-dimensional display. A unique Avco/Electronics display makes possible "3-D" tracking of space vehicles, missiles, aircraft, ships, submarines without the use of special optics or viewing lenses.

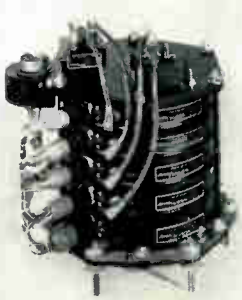
5. Infrared research. The uses of infrared are many, and Avco is a leading developer of significant new applications for the future.

Other projects that are now underway at Avco/Electronics include: data processing and handling, production recording, and advanced radio communications.

UNUSUAL CAREER OPPORTUNITIES FOR QUALIFIED SCIENTISTS AND ENGINEERS... REGARDLESS OF RACE, CREED, COLOR, OR NATIONAL ORIGIN... WRITE AVCO/ELECTRONICS TODAY.

Avco / Electronics
DIVISION

Mock-up of Avco's satellite receivers and video detector for the Orbiting Astronomical Observatory series of satellites.



Circle 200 on Inquiry Card

The following list classifies and gives the value of electronic equipment selected from contracts awarded in 1962. Classified contracts or awards of less than $25,000 are not listed.

GOVERNMENT CONTRACT AWARDS

Accelerators	$169,644
Accelerometers	3,897,936
Actuators	425,661
Altimeters	48,396
Amplifiers	18,720,749
Analog-Digital conversion sys.	370,875
Analyzing systems	69,191
Analyzers	1,776,742
Antenna & systems	16,626,847
Astro tracker	1,400,750
Attenuators	261,430
Batteries	5,385,728
Cable	1,371,710
Cable assemblies	1,774,784
Cable, coaxial	333,826
Cable, instrumentation	148,425
Cable R-F	355,287
Cable, shielded	74,900
Cable, special purpose	64,053
Cable, telephone	9,319,224
Calibration equipment	839,482
Calibrators	555,371
Capacitors	478,181
Cavity assembly	31,520
Cavity, tuned	48,969
Chaff, countermeasures	3,656,862
Chopper, electronic	91,644
Circuit boards	158,017
Coder-Decoder group	3,239,672
Coil	136,177
Communication satellite mobile ground stations	5,000,000
Communications equipment	29,600,192
Comparators	1,761,033
Computers	36,918,849
Computer displays	1,315,448
Connectors	4,258,260
Control equipment	509,942
Control subsystem	1,800,000
Control systems	2,146,560
Controls	3,439,732
Converters, freq.	597,605
Converters	7,645,914
Coordinate data set	390,000
Countermeasures set	8,529,104
Counter-Timers	69,391
Counters	645,699
Couplers	915,229
Coupling units	1,465,098
Data conversion systems	2,920,324
Data equipment	52,580
Data monitoring set	974,253
Data plotter	93,645
Data processing equipment	879,350
Data transmission equipment	124,603
Delay lines	43,606
Demodulation equipment	83,984
Demodulator	54,000
Detecting set	1,192,723
Detection instruments, radiation	1,576,480
Detectors	1,110,724
Dial & wavemeter assy.	26,350
Digital data acquisition system	305,955
Digital data communication control	1,738,954
Digital data terminal	151,848
Digital data transmission system	174,400
Digital speech system	49,225
Digital system	355,901
Digital trainer	134,498
Digital X-Ray plotter	40,871
Direction finders	44,230
Discriminator	759,376
Discriminator systems	72,446
Display system, remote	355,600
Distance measuring equipment	47,000
Dosimeters, radiological	6,483,279
Drone system	5,500,000
Dummy load, electrical	57,798
Duplexer	64,343
Dynamic demonstrators	99,022
Dynamometers	38,200
Echo sounders, portable	166,669
ECM equipment	3,075,000
Electron guns	46,000
Electron microscope	32,937
Electronic control systems	213,260
Electronic digital voltmeter system	194,556
Encoder system	99,443
Environmental chamber	27,860
Equalizer system	58,530
Exciter system, vibration	81,144
Facsimile equipment	933,509
File conversion equipment	750,937
Film Analyzer-Recorders	51,900
Filters	1,886,707
Fire control system	6,750,139
Flight trainer	800,000
Frequency controller	50,280
Fuel cells	89,225
Gages, thermocouple	35,338
Generators	71,862
Generators/Detectors	98,298
Generators, time code	147,327
Global tracking network	2,715,028
Guidance system	7,500,000
Gyroscopes	8,021,442
Gyroscope equipment	10,347,416
Handsets	1,162,206
Headsets	3,121,557
Hydrophones	93,255
Indicators	7,842,119
Indicators, transducer	164,621
Infrared radiometer	284,626
Intercommunication equipment	272,309
Intercommunications system	233,469
Interrogation sets	1,177,498
Intrusion detection equipment	73,301
Jamming systems	56,507
Lab equipment	410,000
Laser	224,914
Light indicators	25,740
Loran C	1,278,331
Loudspeakers	1,856,525
Magnetic core storage	117,254
Magnetic detecting set	785,517
Magnetic memory disc files	318,600
Magnetic tape dataplotter sys.	52,500
Magnetic tape memory	95,352
Magnetron assy.	181,000
Magnetron assy., stabilized	27,423
Mapping & survey sets	4,116,942
Measuring systems	9,909,683
Memory systems	435,000
Meteorological systems, airborne	1,072,088
Meters	11,755,481
Microfilm reader-printer	158,750
Microphone assemblies	47,971
Microphones	2,200,995
Microscope, electron	30,685
Microwave, digital, geodetic, subsystem	750,000
Microwave equipment	330,315
Modules digital	38,551
Modulator	329,645
Monitors, R-F	76,804
Monitoring system, radiation	46,615
Multicouplers	678,554
Multiplex equipment	200,934
Noise measuring set	77,622
Navigation equipment	21,946,829
Oscillators	2,872,774
Oscillographs	449,017
Oscilloscopes	2,948,897
PCM conversion system	55,519
Photoelectric cell	140,804
Plotting System, digital	54,960
Power supplies	1,880,076
Power system, fuel cell	120,204
Preamps	48,500
Print stations, high speed	315,580
Printers	253,553
Programmer tape units	75,760
Public address system	57,558
Pulse ranging equipment	30,652
Radar	81,335,303
Radar monitors	56,000
Radiacmeters	369,550
Radiac set	1,213,474
Radiac computer, indicator	76,608
Radiac equipment	923,909
Radiation monitoring equipment	138,748
Radio director finder	1,312,000
Radio equipment	3,827,470
Radio sets	61,092,536
Radiotelephone sets	64,775
Radio terminal sets	6,320,210
Radio transmitters	41,855
Radiosonde sets	986,846
Radomes	2,914,622
Range finders	1,293,858
Ranging & recording system	34,550
Ratiometer	31,610
Receivers	20,776,004
Receiving system	1,299,818
Reconnaissance sets	539,861
Record reproduce mechanism	346,155
Recorders	6,312,808
Recorder/Reproducer	8,244,801
Recording oscillograph system	37,169
Recording systems	4,648,914
Regenerators, time code	99,950
Relay armatures	953,906
Relays & assemblies	2,539,849
Relay systems	1,518,262
Reproducers	443,636
Resistors	2,313,817
RFI equipment	39,197
Selector Unit, transmitter	342,569
Semiconductors	8,624,493

Sensing elements	58,474
Sequencer	43,750
Servo equipment	887,299
Shelters, electric equipment	1,974,409
Shielded enclosures	58,383
Signal generators	6,318,064
Simulators	6,063,830
Solar cells	132,768
Solenoids, electrical	77,799
Sonar	13,100,497
Sonobuoys	37,588,966
Spectrometer system	87,307
Spectrophotometer	90,737
Spectrum surveillance sys.	352,581
SSB equipment	5,078,778
Standards	994,676
Switchboard	4,030,145
Switches	3,505,694
Switching equipment	1,307,490
Switching system	977,048
Synchronizers	1,012,391
Synchronizing circuit	27,444
Synchro equipment	1,426,915
Synthesizers	77,885
Tape, magnetic	342,249
Tape readers	150,000
Tape, recording	2,221,071
Tape, sound recording	290,371
Tape transports	51,000
Target detecting device	430,090
Target location system	133,091
Telephone & Telegraph equipment	8,598,404
Telemetry equipment	8,790,286
Teletypewriter equipment	12,745,264
Terminal digital equipment	349,303
Terminal, telegraph	27,617
Test consoles	273,570
Test equipment	25,023,651
Test sets	6,015,986
Thermocouples & accessories	735,554
Timers	116,515
Time signal generators sys.	515,393
Timing sets	76,039
Tracking equipment	106,709
Tracking system beacon	53,008
Trainers	2,899,169
Transceivers	18,439,957
Transducers	2,845,605
Transformers	461,334
Transmission systems	7,879,900
Transmitters	9,410,576
Transponders	2,276,876
Tuning units	818,197
Tubes, CRT	94,269
Tubes, electron	35,050,089
Tubes, klystron	2,031,485
Tube, maanetron	6,817,420
Tubes, TWT	2,337,094
Tuning units	36,876
Tuners	188,996
TV equipment	964,075
Ultrasonic cleaners	61,665
Ultrasonic equipment	29,930
Vacuum equipment	147,561
Vibrators	36,123
Video, integrating groups	1,400,000
Video transmission equipment	267,530
Viewing set, infrared	375,166
Vocoders	322,125
Voltage dividers	28,500
Waveguide	125,901
Wire & cable	1,535,246
X-Ray equipment	1,576,395
X-Y plotter	118,254

Publications Helpful in Selling to the U. S.

"Selling To Navy Prime Contractors" (July 1961) p. 89. Helpful suggestions, followed by listing of hundreds of prime contractors. Obtainable from Supt. of Documents, U. S. Govt. Printing Office, Wash. 25, D. C., price 50 cents.

"General Procurement Information" (July 1961) p. 32. Lists hundreds of items from many guided missiles together with the names of their prime contract suppliers. U. S. Govt. Printing Office, price 15 cents or free from Off. Secty. Defense, Information Office, Wash. 25, D. C.

"Selling To The Military" p. 27. General Information. Items Purchased, Location of Military Purchasing Offices, etc. U. S. Govt. Printing Office, price 25 cents.

"Air Force Small Business Specialists" p. 10. A listing of names, addresses and phone numbers. From Secty. of Defense, Information Office, Air Force Desk, free.

"Armed Services Procurement Regulations." Information Office, Sec. of Defense, Wash. 25, D. C., free.

"The Army Procurement Procedure." Information Office, Sec. of Defense, Wash. 25, D. C., free.

"The Air Force Procurement Procedure." Information Office, Sec. of Defense, Wash. 25, D. C., free.

"Navy Procurement Directives." From U. S. Govt. Printing Office at $7 per year, subscription.

"Doing Business With The Federal Government" (Jan. 1961) p. 58. Contents: Govt. procurement methods; Military procurement General Services administration; Other civil agencies with supply activities responsibility of the govt. contractor. Believed available from General Services Administration, Wash. 25, D. C., free.

(Continued on page 1-10)

NUMBER ONE IN ELECTRICAL CONNECTORS... 1

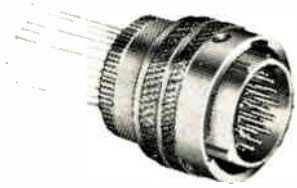
2 OUTSTANDING CANNON® PLUG SERIES MEETING REQUIREMENTS OF MIL-C-26482C

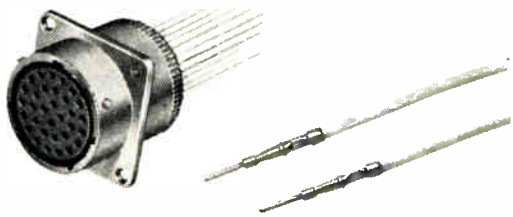
KPT SOLDER POT

- SMOOTHER ENGAGEMENT AND SEPARATION FORCES, INHERENTLY PERFORMING IN A NARROWER RANGE, PROVIDED BY A REVOLUTIONARY BOWSPRING* SOCKET CONTACT DESIGN.
- HIGHLY CONDUCTIVE LEADED-COPPER, PROBE-PROOF, CLOSED-ENTRY SOCKET CONTACT HAS LOWER MILLIVOLT DROP.
- LOWER COUPLING FORCES REQUIRED ON THE CANNON QUICK CONNECT-DISCONNECT BAYONET LOCK.
- SUPERIOR INSULATORS COMPLETELY MANUFACTURED AND QUALITY-CONTROLLED BY CANNON.
- AVAILABLE IN 7 SERVICE TYPES—7 SHELL STYLES.
- SIZES 8 THRU 24; 2 TO 61 CONTACTS.
- ACCOMMODATES AWG SIZE 26 THRU 16 WIRE.
- 5-KEY POLARIZATION PREVENTS CROSS PLUGGING.
- HIGH STRENGTH IMPACT EXTRUDED HOUSINGS.
- AVAILABLE FOR QUICK DELIVERY THRU CANNON AUTHORIZED DISTRIBUTORS.

KPTM CRIMP TYPE

- IMPROVED RELIABILITY BECAUSE OF SIMPLE ONE-PIECE MOLDED INSULATOR/GROMMET CONSTRUCTION —DUAL SHORE* OF SPECIALLY COMPOUNDED POLYCHLOROPRENE RUBBER.
- HIGHLY CONDUCTIVE LEADED-COPPER, PROBE-PROOF, CLOSED-ENTRY CONTACT HAS LOWER MILLIVOLT DROP PLUS MEETS REQUIREMENTS OF MIL-C-23216.
- INTEGRALLY-MOLDED POSITIVE STOP PREVENTS CONTACT OVER-INSERTION.
- DUAL SHORE INTEGRALLY-MOLDED INSULATOR/GROMMET FOR DEPENDABLE SEALING OF CONTACTS.
- RAISED BARRIERS AROUND EACH PIN, MATING WITH LEAD-IN CHAMFER AROUND SOCKET, PROVIDE INDIVIDUAL INTERFACIAL CONTACT SEALING.
- REAR HARDWARE FOR KPT/KPTM COMPLETELY INTERCHANGEABLE.
- SEALED IN TRANSPARENT, ENVIRONMENTAL PROOF BAG, WITH COMPLETE ASSEMBLY INSTRUCTION; CONTACTS, WITH SPARES, AND SEALING PLUGS PROTECTED IN SEPARATE VIAL.





WHETHER YOUR REQUIREMENTS ARE FOR MIL-C-26482C (NAVY) SOLDER POT OR CRIMP TYPE, SPECIFY CANNON, THE WORLD'S LARGEST AND MOST EXPERIENCED MANUFACTURER OF ELECTRICAL CONNECTORS. FOR COMPLETE INFORMATION, WRITE TO:

CANNON ELECTRIC COMPANY

3208 Humboldt Street, Los Angeles 31, California

ADDITIONAL PLANTS IN: SANTA ANA & ANAHEIM, CALIF. • PHOENIX, ARIZ. • SALEM, MASS. • TORONTO • LONDON • PARIS • BORNEM, BELGIUM • TOKYO • MELBOURNE

Sales offices and representatives in principal cities of the world

CANNON® PLUGS

CANNON ELECTRIC ®

SECTION I

MILITARY ELECTRONICS & SPACE SYSTEMS

Part Two—Space

work in which this recognition permeates the organization is essential.

Manufacturing a Vital Factor

An additional factor of extreme importance in reliability which perhaps has not received universal recognition is the importance of manufacturing processes. The role of manufacturing engineering is normally considered to be of prime importance in large quantity production, when every cent counts, and of minor importance when small quantities were produced. Within the space program quantities are inherently small.

There has been a prevalent attitude that good conceptual engineering plus "tender loving care" was the recipe for success. It is my firm opinion that a radically different approach is essential. Production quantities are small. But each item—whether for test or for flight—must be fabricated under controlled conditions. Only in this way will the results of reliability testing be meaningful. This can be achieved only if manufacturing processes are controlled with extreme rigidity. This requirement for high reliability on the first item—not only on the thousandth—presents a major problem of space electronics and one to which Aeronutronic along with other contractors is devoting top priority.

Like all fundamental problems there is a trade-off in requirements. The system must be flexible enough to accommodate engineering change—for first models have a high probability of change—yet the system must be so rigid that all items are either identical or differ only in known ways. This can be achieved only with close and early integration of development and manufacturing engineering. Furthermore, the cost must be reasonable. Steps toward a solution to this problem are of the greatest importance as a partial solution to the reliability problem.

Ranger 5 Reliability Example

As an example of electronic design for reliability in space, I would like to describe a program of which we at Aeronutronic are very proud—the transmitter for the Ranger lunar landing capsule.

This 960 mc transmitter was developed by Aeronutronic for the National Aeronautics and Space Administration, and its Jet Propulsion Laboratory, as part of the payload for the Ranger spacecraft program—designed to land a 25 inch capsule on the surface of the moon to gain seismic information.

The requirements on this capsule can be summarized briefly as follows:

(1) Weight—1.5 pounds
(2) Power Input—1 watt
(3) Power Output—50 milliwatts
(4) Volume—40 cubic inches (with subcarrier electronics)
(5) Environment—Standard Atlas-Agena booster environment at launch; outer space environment during the trip to the moon; 3,000 g acceleration upon hard landing on the lunar surface; lunar day and night with temperature variations of nearly 500°F—minus 250 degrees at night, and as high as 220 degrees during the lunar day—for at least one month.

These requirements were met with the solid state transmitter shown in an accompanying photo. In the development of this transmitter it was necessary to consider all the factors for reliability. The intended use of the transmitter required a minimum of 5% efficiency to provide one month to 45 days lunar operation with the available battery pack, and a mechanical design capable of withstanding the 3,000 g 3 millisecond landing impact.

Components Held to Minimum

The design used a minimum number of circuit components in order to enhance the reliability and minimize the power consumption.

Aeronutronic carried out an extensive component qualification program to select components with a high probability of withstanding the 3,000 g impact.

This transmitter was flown on Ranger flight 3, 4, and 5. Its function was to transmit data from the lunar surface. It was also to operate during the approximately 66-hour flight to the moon. Due to malfunctions of the booster or spacecraft, it was not possible to attempt a lunar landing on any of the three Ranger flights.

However, on all Ranger missions, this small transmitter performed as required, and in fact provided the last signal from the spacecraft on all three of the shots.

This demonstration of reliability was, of course, encouraging to us—and is but one small example of the importance of this factor in our U. S. space programs.

As space and electronic systems become even more complex in the ensuing years, there must be intelligent and strong management support of engineering projects if we are to meet the demands of continued reliability in our manned and unmanned program to explore the universe.

Success in space systems depends on many things... individual, yet all somehow related. Weight, power, stress, parameter distribution, all plague the design engineer in his efforts to generate a trustworthy package balanced somewhere between simplicity and redundancy. Will circuit and component innovations be the panacea for reliability troubles? Microminiaturization seems to point the way.

CONTROLLING STRESS INCREASES RELIABILITY

PROBABLY THE MOST IMPORTANT REQUIREMENT for electronic systems in space is reliability. In recent years engineers have developed techniques to increase electronic system reliability, based on the premise that an object fails when certain stresses exceed the strength of the object.

Space reliability factors for electronic gear are not very different from those in earthbound equipment. Exceptions are: (1) constraints applied to equipment by space environment factors; (2) limitations imposed by minimal weight and power requirements; and (3) limitations on maintenance.

Emphasis was once on electronic equipment designed to operate on earth when and where needed. This emphasis now is quite different from space requirements which call on equipment to operate continuously for a specified time span.

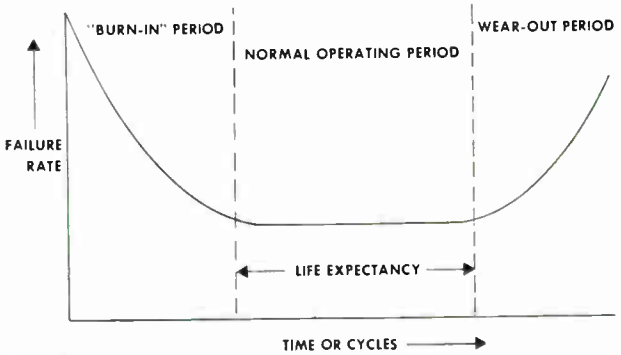
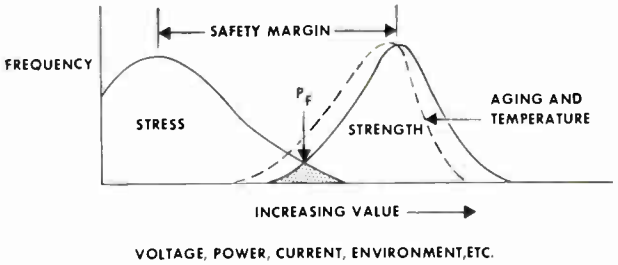


Fig. 1. Classic failure rate curve.

Fig. 2. Relationship of stress and strength distributions determine the probability of failure by the area of overlap.



Environment Considerations

Stresses taken by a space vehicle will depend on its mission, orbit, and life. Some environment aspects are summarized in Table I.

Other space environments such as magnetic, gravitational and radiation fields have little effect, or, known design factors minimize their importance.

A conclusion to draw from environment factors is that environment has only a small effect on stresses associated with reliability. High-vacuum effects produce some new failure mechanisms such as galling and seizure, electrical breakdown—caused by evaporation or whisker growth—and malfunctions caused by meteor puncture.

However, there is no significant increase in stress values. The hostile environment of space does not materially degrade the reliability of the system.

Weight and Power Consumption

Severe limits imposed on a system's weight and power consumption has, in many cases, caused components to be operated in overstressed conditions.

To obtain lowest possible failure rate and the highest reliability, materials and electronic parts are selected with great care. In an attempt to meet weight and power goals, however, materials and parts are often overstressed.

Power tubes for transmitting are operated at near maximum output to increase efficiency. Amplifiers are operated near maximum gain. Rectifiers are pushed to near peak currents. All of these strains increase stress and decrease reliability.

By ROBERT E. HOVDA
and Dr. WILLIAM J. WEST
Armament Control Advanced Engineering Dept.
Autonetics Division
North American Aviation, Inc.

CONTROLLING STRESS (Continued)

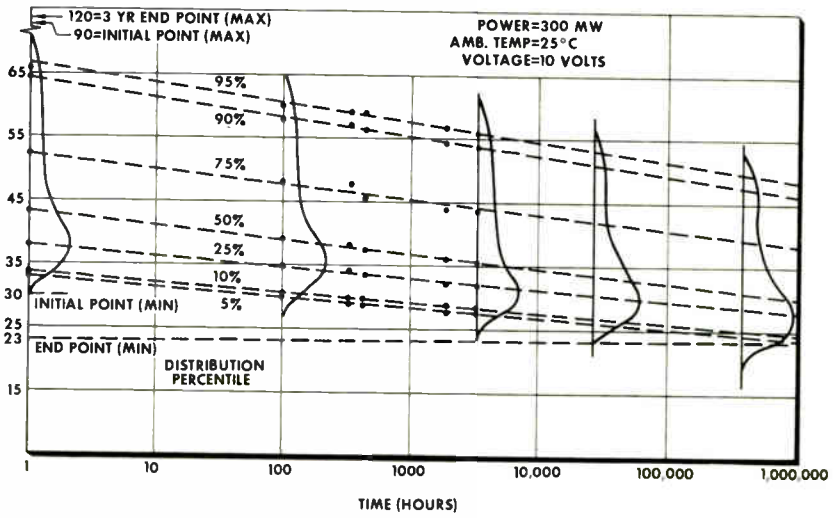


Fig. 3. Measured distribution of transistor life - test parameter ($1 + h_{fe}$) for various points in time.

Table 1

SUMMARY OF SPACE ENVIRONMENT

ENVIRONMENT	EFFECT AND CONTROL
Temperature	EFFECT: Thermal energy within vehicle produced primarily by solar radiation and internal heating. CONTROL Radiation and conduction heat sinks provide stabilization between 0° and 60°C.
Vibration Acceleration Shock	EFFECT: Not important in space. CONTROL: Equipment designed to withstand transportation, launch handling, and boost will survive in space.
High vacuum	EFFECT: Sublimation, evaporation of materials; seizure and vacuum welding of materials; corrosion, plating, or chemical reactions. CONTROL: Selection of materials and lubricants.
Meteorites and micrometeorites	EFFECT: Collision damage. CONTROL: Statistical risk involved.
X-rays and Gamma rays Trapped electrons	EFFECT: Ionization of material; collection of charges. CONTROL: Protection for externally mounted equipment; provide discharge paths to decrease charge effects.

Table 2

RENDEZVOUS RADAR ELECTRONICS

	Radar and Beacon		Computer	
	Solid State	Micromin	Solid State	Micromin
Total circuits	—	73	—	123
Total components	1,241	200	2,758	123
Resistors	740	—	1,106	—
Capacitors	354	—	312	—
Transistor	146	146	221	—
Diodes	20	20	1,119	—
Connections (welded or soldered)	5,332	870	11,474	1,476
Number of manufacturing processes	43,578	1,985	65,840	1,722

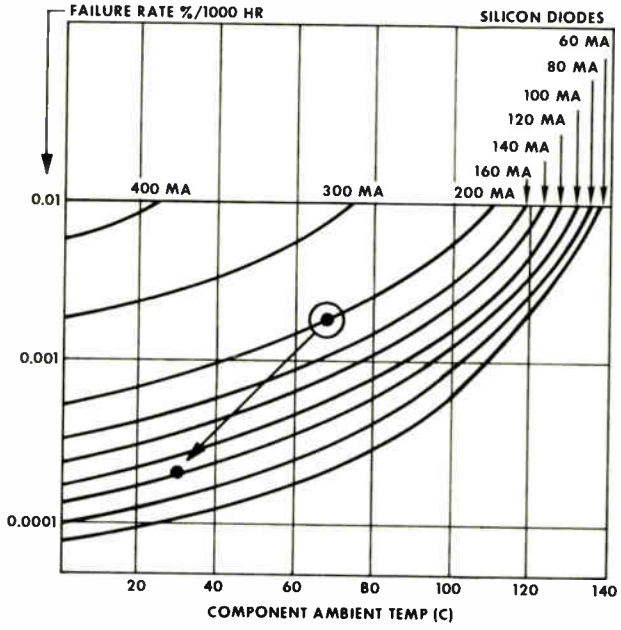
Maintenance in Space Operations

The maintenance concept in space operations is related to desired operating life. The classic failure rate curve (Fig. 1) illustrates that for a given failure rate, the "burn-in" period must be exceeded, and the wearout period must not be reached.

A 50,000-hour MTBF (Mean Time Between Failures) can be achieved by a component with a statistically predictable failure rate of 2%/1000 hours with a component life expectancy of either 5000 hours or 50,000 hours. The difference is that the 5000-hour life expectancy component must be replaced every 5000 hours, or 10 times more often than the 50,000-hour device.

In earthbound operations, the cost of the 5000-hour component may be low enough to allow for the programmed replacement. Space mission requirements may be such that the 5000-hour life component

Fig. 4. Design engineer may achieve reliability through derating by adjusting power loads and environmental stresses.



with a 50,000-hour MTBF will ensure mission success. However, if the life of the mission is extremely long, the 50,000-hour life component will be needed because maintenance is not available.

Simplicity vs Redundancy

There are two types of redundancy to consider—that of the multiple path circuit, typical of the "majority type circuit" or "quad type circuit," and that of the multiple subsystem. Component redundancy is not generally accepted, even though it can reach basic circuit reliability to two or three orders of magnitude.

Component redundancy increases requirements on circuit parameters, decreases circuit drive, is slower in propagation time, and uses more voltage and thus more power. These factors make component redundancy undesirable in space environment.

Redundant subsystems, such as identical transmitters, will be used in space applications wherever straight forward control of stresses will not give the reliability required. Absolute control of processes and stresses is the preferred reliability method.

Work accomplished at Autonetics on the Minuteman system has proven that absolute process and stress control offers reliability with simplicity, plus minimum cost and weight. Redundancy is required only where the performance of a given mode is extremely critical, and where confidence limits are low enough to justify power drain and weight penalty.

Components Must Be Limited

To maintain absolute process control, component part types incorporated into the system must be limited. Because there is only a selected number of parts, the parameter distribution for each component part can be determined as a function of stress. That is, parameter distribution can be determined as a function of voltage, current, power, tem-

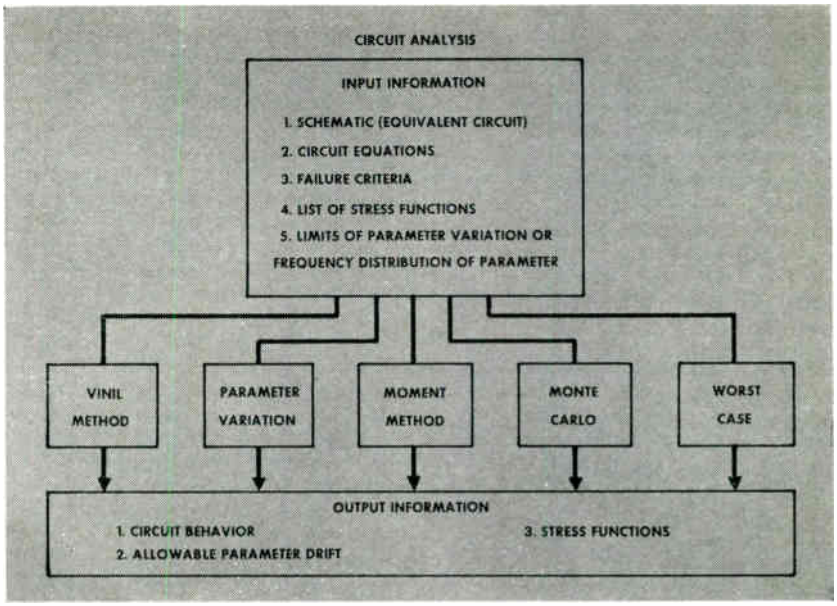


Fig. 5. Information needed, methods available, and some information gained from computer methods of circuit analysis.

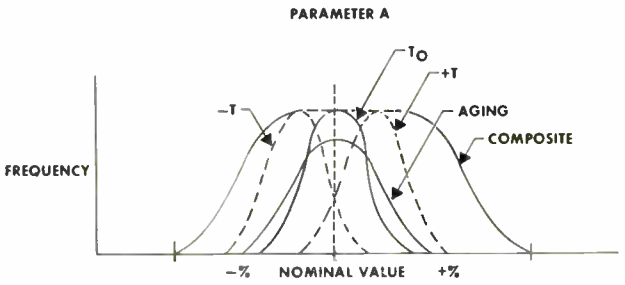
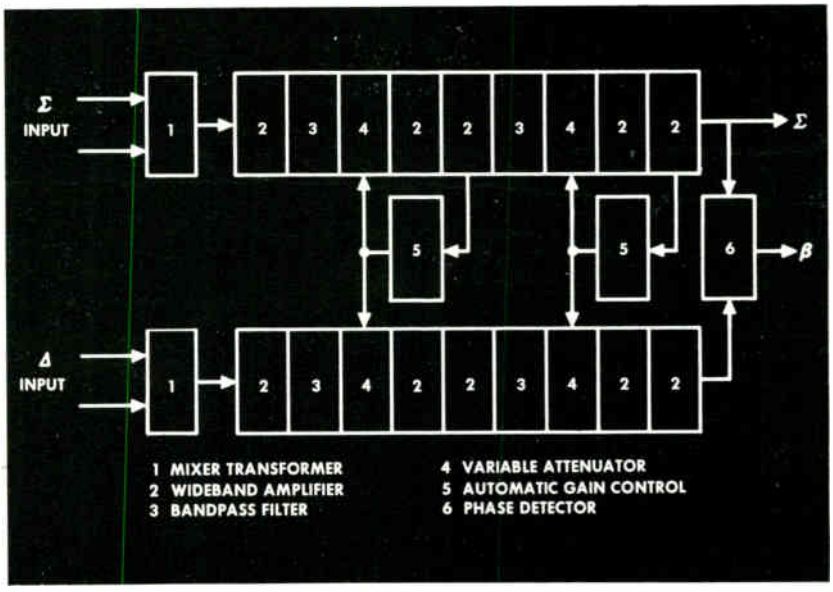


Fig. 6. Tolerance circuit analyses require circuit function over total range of composite temperature and life tolerance.

A REPRINT OF THIS ARTICLE CAN BE OBTAINED
by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

Fig. 7. An example of how standardized thin-film microelectronics are used in 60-mc monopulse i-f receiver amplifier.



perature, and other stresses as a function of component life.

In designing equipment, distribution of applied loads (stress) and capacity to withstand each load (strength) must be considered. See Fig. 2. The relationship of these two distributions determines the probability of failure by the area of the overlap between the two distributions. Safety margins based on nominal values are inadequate. The shaded areas show how the probability of failure can vary according to stress and strength distribution even though the nominal value safety margin is quite large. It is important to remember that the strength of an object may not be constant. Strength usually decreases with time.

Fig. 3 illustrates the type of information developed at Autonetics on part characteristics. The figure represents measured distribution of the transistor parameters ($1 + h_{fe}$) for various points in time. By projecting the percentile line from known points in time, it is possible to predict distribution. The cross-hatched area represents parts that failed because of excessive drift.

Derating is the direct reduction of stress. The design engineer must analyze the circuits and determine the stresses to which parts will be subjected. By using derating curves, the engineering can perform a trade-off study involving gain in failure rate realized by pitting higher-rated parts against their additional weight and volume.

May Vary Failure Rate

The engineer may vary the failure rate of each part by adjusting power loads and other environmental stresses the part must withstand. An example of reliability through derating information is shown in Fig. 4.

The initial phase is identical for all methods of circuit analyses, except preparation of part-parameter data (Fig. 3). An equivalent circuit is written as a linear representation of the physical system. The equivalent circuit should include circuit inputs and outputs, considering load impedance, input signal, and input generator impedances.

After the equivalent circuit is developed, the circuit equations are derived, reduced to matrix form and analyzed by a high speed digital computer. Fig. 5 shows information needed, methods available, and some information gained by using these analysis methods.

Included in these analyses is information on the distribution of each parameter including environmental and aging effects. The tolerance circuit analysis requires that the circuit will function over the total range of composite tolerance as indicated in Fig. 6.

sile and space applications; the greatest emphasis is on low weight.

The total reliability of any system is determined by the individual reliability of its parts. To have the highest possible equipment reliability, we must use components that have the greatest individual reliability.

For a number of reasons it is safe to predict that microelectronics will have increased reliability over discrete components. Microelectronic circuits require fewer materials and production processes than do present discrete component circuits. The number of mechanical interconnections (soldered and welded joints) will be reduced sharply as entire surfaces are bonded to each other.

Further, the use of microcircuitry will shrink the overall parts count as well as steps in assembly and testing. Redundancy can be fully exploited because of the small size of the equipment.

Microminiaturization Methods

There are at least three dozen microminiaturization methods available or in development. All of them fall into three general categories:

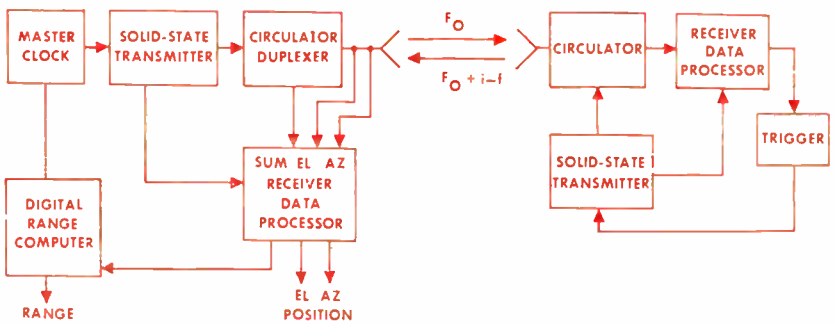


Fig. 8. Space rendezvous radar system is a good example of the use of microelectronic circuits in space applications.

Microminiature Electronics

Microelectronic design is being used first in spacecraft, missiles, and advanced military aircraft. Prime requirements for these applications are high reliability and lower power dissipation. Small size and low weight is extremely valuable in mis-

(1) high-density packages, (2) thin film, and (3) solid-state circuits. The three categories do not represent alternative solutions.

In most applications the equipment will be hybrid combinations of two or three microminiaturization methods and conventional miniature

circuit design as well. The Armament Control Division of Autonetics has developed approximately 20 standardized circuits which include linear and digital functions for radar applications. The linear circuits are thin-film and the digital are semiconductor integrated circuits.

An example of how standardized linear thin-film microelectronics are utilized in 60 mc monopulse i-f amplifier is shown in Fig. 7. There is some evidence that thin-film microcircuits have increased radiation resistance over other forms of microcircuits.

Rendezvous Radar Good Example

A rendezvous radar system is illustrated in Fig. 8. This system is a good example of the use of microelectronic circuits in a space application. The radar and beacon primarily use linear circuits while the range tracking computer uses digital circuits. The characteristics of the radar are listed below:

1. Peak power—0.75 watts.
2. PRF—180 pps.
3. Frequency—X-band
4. Weight—24 pounds.
5. Input power—36 watts.
6. MTBF—10,000 hours (solid state).

Table 2 is a comparison of processes and connections in solid-state and microelectronic versions. The comparison includes only those components common to the electronics of the system and do not include common elements such as antennas and integrated cooling structure.

The solid-state components are Minuteman high-reliability quality. The numbers are relative and they illustrate the large reduction of process steps and mechanical interconnection achieved through the use of microelectronics.

A REPRINT OF THIS ARTICLE CAN BE OBTAINED BY WRITING
on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

NEW TECH DATA

for Engineers.

High-Power Loads

Data describes 2 high-power loads (air-cooled and water-cooled) which feature high temp., high heat conductivity, good thermal shock and virtually no cycling effects. These important characteristics are possible because of techniques developed in the use of high temp. refractory silicon carbide. This basic absorbent material remains stable to 2000° in air. Typical vswr is a max. of 1.08 at f/f_c of 1.9. The air-cooled series is available in models having average power ratings over a range of 10 to 5,000 w. (max. peak power 0.005 to 3.0 megawatts). The water cooled series is available in models having average power ratings over a range of 5000 to 8000w. (max. peak power 0.15 to 3.0 megawatts). DeMornay-Bonardi Corp., 780 South Arroyo Pkwy., Pasadena, Calif.

Circle 238 on Inquiry Card

Strain Sensors

Information is available on semiconductor strain gage and sensor elements. Both single and multi-element strain sensors are offered. Some of the sensor elements detect normal stress independent of shear stress, while the other sensor elements are designed to detect shear stress independent of normal stress. Prices and sales data are given on the 17 models. General Electric Co., Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

Circle 239 on Inquiry Card

Pressure-Vacuum Pumps

A spec. sheet aids in designing and specifying pressure-vacuum pumps for airborne, environmental simulation and ground support systems. It introduces plan under which engineers can specify operating parameters of their system. From this data, pumps are application-fitted. Aero Devices Co., a div. of Guide Manufacturing Co., 8218 Lankershim Blvd., No. Hollywood, Calif.

Circle 240 on Inquiry Card

Deep Test Facilities

Brochure describing outdoor underwater deep test facility and bulletin on indoor test facility are available from General Dynamics/Electronics, 1400 N. Goodman St., Rochester 1, N. Y. Both of these facilities are available to government and industry for test programs. Rates are on a time and material basis. Test programs have been conducted at both facilities for BuShips, BuWeps, (and their laboratories), and for several private contractors. In some instances facility personnel made the measurements, and in others they assisted other organizations' measurement personnel.

Circle 241 on Inquiry Card

Resistance Thermometers

Application Bulletin 1, "Resistance Temperature Transducers," 13 pages, discusses the properties of resistance materials, mechanical considerations affecting resistance temp. transducers, and design features. It compares resistance thermometers with thermocouples, includes tables, graphs, drawings, and a brief historical note. Nova-Netics Corp., 232 Glasgow Ave., Inglewood 1, Calif.

Circle 242 on Inquiry Card

Hall-Effect Multipliers

Models ML-21B, 25B, and 27B are Hall-effect magnetic circuits which feature increased stability when operating in varying amb. temps. Coil inputs range from 15ma to 14a; the max. output is 600mv. The circuits can be linearized to better than 1%. Ohio Semiconductors, 1205 Chesapeake Ave., Columbus 12, Ohio.

Circle 243 on Inquiry Card

SCR Commutating Capacitors

"Capacitors for SCR Commutation Applications," GEC-155, describes low equivalent series-resistance designs for silicon controlled rectifier commutation and other similar sq. wave voltage uses. The 8-page brochure is intended to help circuit designers select the proper capacitor for use with "breadboard" development work for SCR commutation. Covered in the application data are topic headings on commutation period, power loss, size, weight, life, capacitance tolerance, and capacitance vs. temp. Photos, typical capacitor curves, voltage and current graphs, and outline drawings are included. Marketing Section, Capacitor Dept., General Electric Co., Hudson Falls, N. Y.

Circle 244 on Inquiry Card

Direct-Writing Recorders

"Direct Writing Recorders," a new short form catalog, describes recorders which have an exclusive direct-carbon transfer writing technique which offers good freq. response at full pen deflection. These recorders are used for test instrumentation, research, aerospace vehicle check-out and tracking, analog computer read-out and telemetry recording, industrial process and control analysis. American Optical Co., Instrument Div., Buffalo 15, N. Y.

Circle 245 on Inquiry Card

Zener Regulators

This bulletin describes 10w. silicon zener regulators. Nominal voltage ratings range from 6.8 to 200v; test current ranges from 12ma. to 370ma. Diodes, Inc., 7303 Canoga Ave., Canoga Park, Calif.

Circle 246 on Inquiry Card

NEW TECH DATA

for Engineers.

Telemetry Transmitter

Catalog No. 290PC, a 2-color brochure on airborne VHF/FM 2w. telemetry transmitters is now available from Advanced Electronics Corp., Hicksville, L. I., N. Y. The literature describes and illustrates 2 new transmitters for the 215 to 260MC range. Complete physical and electrical specs., as well as performance characteristics are detailed.

Circle 247 on Inquiry Card

Ferrite Circulators

Data is available on 2 wideband ferrite circulators that eliminate the need for magnetic protection. Equipped with full magnetic shielding, the units are designed for uses requiring small rugged units capable of operating over wide freq. ranges. One unit, a 3-port coax. circulator, provides 20db minimum isolation and 0.4db max. insertion loss from 2GC to 4GC. VSWR is less than 1.3 to 1.0 over this frequency range. Second unit, a 3-port circulator with coax. connectors in a tee shape, provides 20db min. isolation and max. insertion loss of 0.4db from 3GC to 4GC. Sylvania Electric Products Inc., 1100 Main St., Buffalo, N. Y.

Circle 248 on Inquiry Card

PIN Diodes

A new series of high-voltage silicon PIN diodes for microwave switching are described in catalog MS-6000. Features incorporated include low insertion loss and high isolation characteristics, high reliability and miniaturization. A complete spec. chart for both the microwave pill and coaxial pin package is shown, along with electrical characteristics and actual size schematics. Micro State Electronics Corp., 152 Floral Ave., Murray Hill, N. J.

Circle 249 on Inquiry Card

Groupable Potentiometers

New tech. data sheet on Daystrom 319 Series groupable potentiometers provides complete specs. Twenty-four individual cups can be grouped in a space of 6 in., then individually phased without interference to adjacent cups. Ideal for multichannel uses where space and weight are critical, the 319 Series offers good resistance to shock, vibration, and other severe environmental influences. Weston Instruments & Electronics Div., 614 Frelinghuysen Ave., Newark 14, N. J.

Circle 250 on Inquiry Card

Telecommunications Equipment

Catalog describes solid-state telecommunications equipment. This book includes tech. data on teleprinter relay, repeaters, polarized high-speed telegraph relays and transistorized high-speed telegraph relays. Trepac Corp. of America, 30 W. Hamilton Ave., Englewood, N. J.

Circle 251 on Inquiry Card

Space Activities

A 3-color, 28-page booklet describes space activities and capability of the Westinghouse Air Arm Div. Well-illustrated publication outlines the division's work on the Gemini rendezvous radar, the UK-2/S-52 international scientific satellite, and related space projects. Westinghouse Air Arm Div., Box 746, Mail Stop 210, Baltimore 3, Md.

Circle 252 on Inquiry Card

Radar System Capabilities

Canoga Electronics has published a 20-page brochure on its systems capability in radar, telemetry trackers, digital data handling, antennas and pedestals, beacons and feeds. Canoga Electronics Corp., 15330 Oxnard St., Van Nuys, Calif.

Circle 253 on Inquiry Card

Tunable Notch Filter

A new 2-color bulletin, NF-1000-321, describes new tunable notch filter, Model NF-1000. This device can be used as a cw interference rejection filter; a means of removing cross modulation products; a versatile carrier on sideband elimination filter; or for investigating spectral distributions in vibration analysis. Correlated Data Systems Corp., 1007 Air Way, Glendale, Calif.

Circle 254 on Inquiry Card

Two-Axis Gyro

Gyro G-12 has no gimbal rings, flexes, and pivots. G-12 design eliminates all mechanical and electrical connections from the gyro housing to the float. It has an operating life of 20,000 hrs.; weight 1.5 lbs.; measures 3 in. in dia.; requires no power during storage and shipment; features extremely rapid start up. American Bosch Arma Corp., Garden City, N. Y.

Circle 255 on Inquiry Card

Instrumentation Printer

Bulletin ITR-7 describes new instrumentation printer, which electrostatically records up to 5 columns of numeric characters across 1 in. paper tape at a speed of 300 lines/sec. synchronously or 30 lines/sec. asynchronously. Omnitronics, Inc., 511 N. Broad St., Philadelphia 23, Pa.

Circle 256 on Inquiry Card

Microwave Switch

The SRL Series SMA X405 microwave switch features a 0.5 in. bandwidth, an insertion loss of 1.25db, and a peak power of 1kw. The weight is less than 2.5 oz. Somerset Radiation Laboratory, Inc., 192 Central Ave., Stirling, N. J.

Circle 257 on Inquiry Card

Publications

(Continued from page H-9)

"Commerce Business Doily." A daily list of govt. procurement invitations, subcontracting leads, contract awords, etc. Published by Dept. of Commerce. Subscription $20 per year. U. S. Dept. of Commerce, Raom 1300, 433 West Van Buren St., Chicago 7, Ill.

"Federol Purchosing Directory," a 6-page folder and chart, showing principal agencies and materials bought. Obtainable from General Services Administration, Regional Office Bldg. Wash. 25, D. C., free.

"Procurement Hondbook" (1959). By General Services Adm. A very general book but helpful to those selling to GSA. From U. S. Govt. Printing Office, price $1.50.

"Selling to NASA." Available free from J. M. Roey, NASA, 1520 H St., N.W., Wash. 25, D. C.

"Selling to AEC." Available free from J. H. Wells, Div. of Contracts, Atomic Energy Commission, Wasn. 25, D. C.

"Novy Procurement Directives." (Apr. 1, 1959). Catalog No. D 201.6/10:959. Includes revisions issued irregularly for an indefinite period. In looseleaf form punched for 3-ring binder. Consists basically of a compilation of procurement directives which set forth procurement policies and procedures to be followed by all purchasing activities of the Department of the Navy. Subscription price $9, $2.25 additional for foreign mailing.

"Procurement Hondbook." Catalog No. GS 2.6/3:P 94. $1.50.

"Provisions Governing Qualificotion (quolified products list) (Mar. 1961). Catalog No. D 7.6:Q 2/961. 15 cents.

"Smoll Business Speciolists and Advisors, by Organizotion and States." (Contains the addresses of the field offices which conduct purchasing for the Army.) Catalog No. D 101.22:-715 3. 15 cents.

"Selling to AEC" (organization and purchasing program, directory of purchasing offices, lists of products purchased, information on atoms for peace). (Includes enclosure entitled Principal Construction Contractors, and Subcontractors on AEC Projects, 1958.) Catalog No. Y 3.At 7:2 Se 4/2/961. 25 cents.

"Selling to Navy Prime Contractors." Catalog No. D 201.2Se 4/2/961. 50 cents.

"U. S. Government Purchasing, Specifications and Sales Directory. Catalog No. SBA 1.13/3:962. 60 cents.

"Index to Navy Procurement Information." Catalog No. D 201.6 11:962. 50 cents.

"Air Force Procurement Instruction." (Dec. 1960) Catalog No. D 301.6/4:960. Includes supplementary material for an indefinite period. In looseleaf form, punched for 3-ring binder. Implements the Armed Services Procurement Regulation and establishes for the Department of the Air Force uniform policies, procedures, and instructions relating to the procurement of supplies and services. This instruction applies to all purchases and contracts for the procurement of supplies and services which obligate appropriated funds (including available contract authorizations). Subscription price $28, $8 addition for foreign mailing.

"Armed Service Procurement Regulotion." (Being revised.) Catalog No. D 1.13:963. Includes supplementary material for an indefinite period. Revised pages not sold separately. In looseleaf form, punched for 3-ring binder. This regulation establishes for the Department of Defense uniform policies and procedures relating to the procurement of supplies and services under the authority of chapter 137, title 10, United States Code, or under other statutory authorization. The regulation applies to all purchases and contracts made by the Department of Defense, within or without the continental United States, for the procurement of supplies or services which obligate appropriated funds. Subscription price $15, $4 additional for foreign mailing.

"Deportment of Defense Small Business Specialists Designed to Assist the Businessman." (Small Business specialists of the Department of Defense procurement offices are available to assist businessmen in obtaining information and guidance on defense procurement procedures how to be placed on the bidder's mailing list and identification of both prime and subcontract opportunities. Catalog No. D 1.2:Sm 1/2 25 cents.

SECTION J

MICROWAVE

MICROWAVE TUBES: AFTER THREE DECADES

Conceived more than thirty years ago, microwave tubes are still undergoing a rapid evolution. Reductions in size and weight and increases in power and efficiency have produced the new generation of tubes discussed in this report.

MINIATURIZATION IS THE CRY OF MODERN ELECTRONICS and microwave tubes are no exception. The needs of industry for smaller, efficient components have produced microwave tubes that would amaze earlier designers. Here are a few of them.

Low-Noise TWTs

The traveling-wave tube, unique for its extreme wideband capabilities, has been available as a low-noise amplifier for about ten years. During this time the attainable noise figure has steadily decreased and, at present, noise figures of 3 to 5 db are available in L- and S-bands.

Recent developments have resulted in a tremendous improvement in reliability, convenience, and adaptability to a wide variety of systems applications. Chief among these advances are permanent-magnet focusing, the integration of the power supply into the amplifier package, extension of low-noise techniques to higher frequency bands, and the maintenance of tight tolerances on performance characteristics. Heretofore, solenoid focusing was required to obtain the best noise performance from a traveling-wave tube. The total weight for an amplifier system could be 100 pounds or more. Permanent-magnet focusing has rendered the solenoid and its power supply unnecessary, thus reducing the weight of an amplifier package to between ten and fifteen pounds. Fig. 1 shows the permanent-magnet package used to focus an S-band low-noise tube. Both the outer housing and the cylinder surrounding the magnet are steel, thus confining the external flux. Consequently, identical units can be operated side by side without mutual magnetic interference.

As a further step toward operational simplicity, the power supply needed for tube operation has been built into the amplifier package. Amplifiers of this type operate over the 1 to 2 gc band with less than 5 db noise figure, and from 2 to 4 gc with under 5.5 db. Small-signal gain in each case is 25 db minimum. Fig. 2 shows an L-band low-noise amplifier with integral power supply.

Work is being carried on to extend these results to higher frequency bands. Experimental tubes have yielded noise figures between 5 and 6 db in X-band, and between 8 and 9 db K_u-band. Permanent-magnet focusing will also be applicable in these bands. K_a-band and millimeter-wave tubes are also under development, with an expected noise figure of 10 db or under.

Certain applications, such as phased-array radars, require that tubes be matched one to another to a high degree of accuracy. This is accomplished by maintaining close control over mechanical tolerances and by practically eliminating reflections due to mismatches at input and output terminals and at the mid-section attenuator. For example, permanent-magnet focused tubes operating over a 15% bandwidth in L-band with noise figure between 3.5 and 4 db have been matched in gain to ± 0.3 db and in phase to ± 2 degrees.

TWTs for Space

The use of traveling-wave tubes in satellites or other space vehicles has produced a new generation of these devices. Although only modest power (typically 1 to 20 watts) is required, other factors such as efficiency, reliability and life, minimum size and weight, and the rigors of the space environment place special restrictions on the tube design.

Tubes have been developed for space programs

By Dr. DEAN A. WATKINS
President,
[illegible]
Palo Alto, Calif.

such as Telstar, Syncom, Relay, Advent, and others. These tubes were developed by Bell Telephone Laboratories, Hughes Microwave Tube Division, RCA Tube Division, and Watkins-Johnson Company respectively. Typical performance characteristics are:

Power output—2 to 35 w
Center frequency—1.7 to 8.5 gc
Bandwidth—20 to 100%
Gain—30 to 35 db
Efficiency—25 to 35% (depending on mode of operation)
Weight—1 to 3 lbs.
Volume—Less than 40 cubic in.
Vibration—10 to 50 g, 20 to 3000 cps
Shock—50 to 100 g, 11 millisec duration
Temperature—50°C to +85°C
Cooling—Conduction
Life—Greater than 20,000 hrs.
Focusing—PPM or single reversal PM

This specification is not intended to be all inclusive but merely to give a general impression of this new breed of traveling-wave tube.

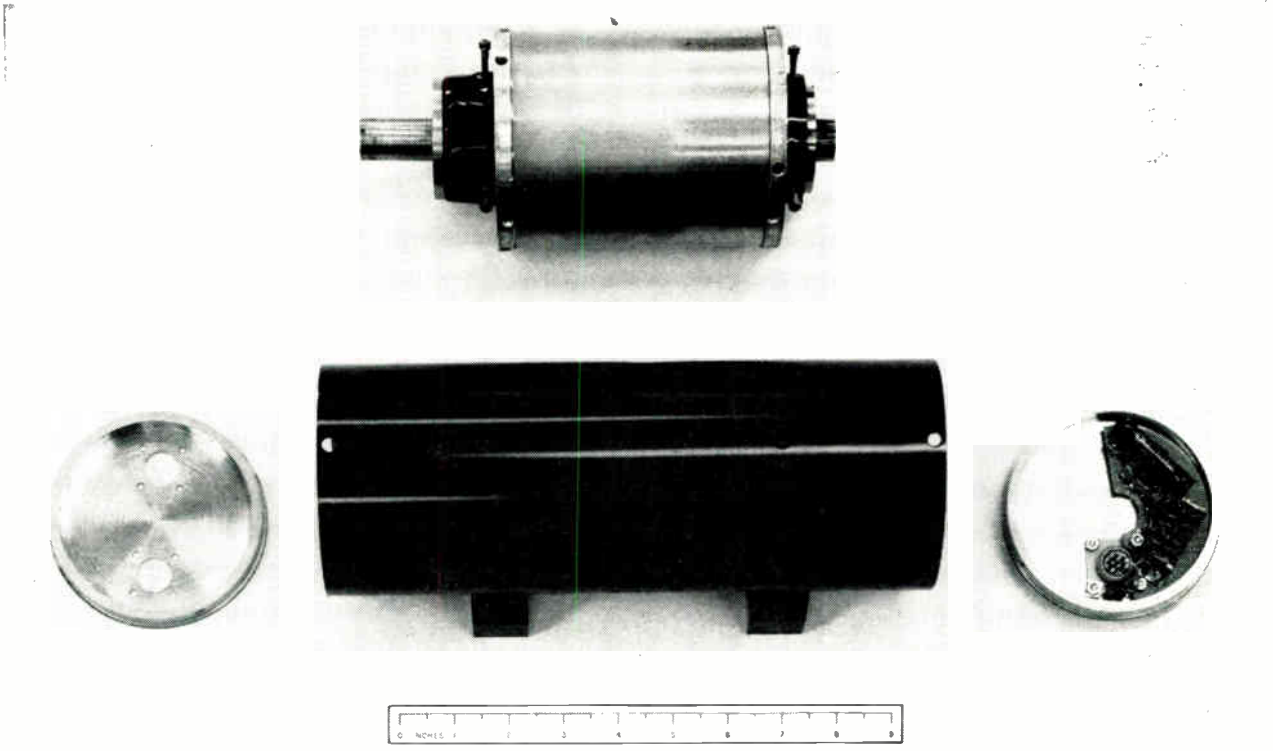
Fig. 3 shows the WJ-227 which is a 10 to 20 watt, 2 to 3 gc tube developed for space applications. It is 13.5 inches long and weighs 35 ounces. The efficiency including heater power is 27%; without heater power the efficiency exceeds 30%. Special versions of this tube have exhibited efficiencies without heater power of 39%.

Future Tubes

Currently the major development effort is being devoted to efficiency improvement and weight reductions. Over-all tube efficiency can be improved by increasing the electronic (or interaction) efficiency, by improving the depressed collector design (reduction of power input), and by reducing the heater power. The basic interaction efficiency is a function of the tube design parameters such as circuit diameter and impedance, beam diameter and impedance, and space charge. Once these are optimized, the power lost in heat is reduced by operating the collector at a lower potential than the slow-wave interaction circuit.

The tubes mentioned previously have uniform helix circuits and single-stage depressed collectors. Improvements in laboratory tubes have been obtained by reducing the circuit phase velocity near the output of the tube, thus keeping the electrons more nearly in synchronism with the beam as its kinetic energy is extracted. Multi-stage depressed collectors have also reduced input power. The present 40% and higher efficiencies now measured on laboratory models should be available in flight models perhaps within one year, and with continued research even higher values may be possible. Life tests on the BTL 1789 tube have already demonstrated over 50,000 hours/tube on a 12 tube sample, and major difficulties have

Fig. 1: The permanent-magnet package eliminates the need for the solenoid focusing system and its power supply.



been overcome in meeting the present launch and flight environments.

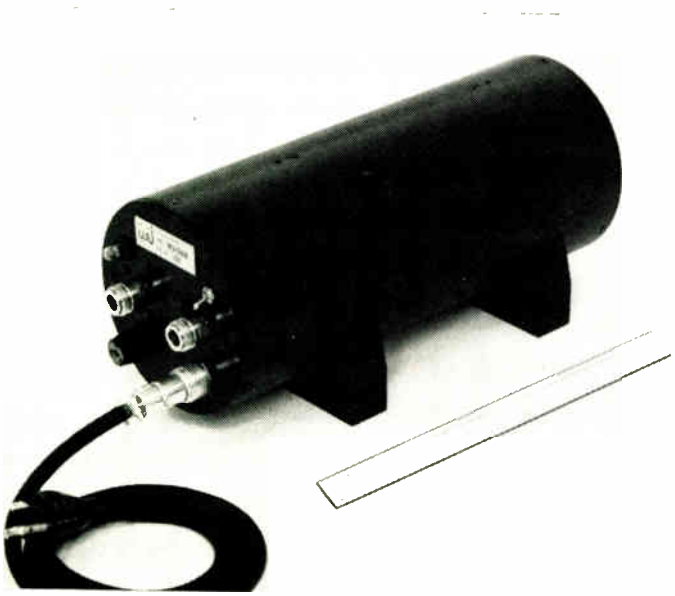
Additional weight and size reductions can be expected as higher perveance electron beams are used. Higher perveance (perveance = $\frac{I_o}{V_o}$ 3/2) means higher gain per unit length and therefore shorter tubes. Higher perveance electron beams are more difficult to focus, however, so that improvements in beam focusing must precede the use of these beams.

Another area of current interest is the distortion and additional frequency components produced by multi-signal operation. These effects, known as cross-modulation and intermodulation, can have significant bearing on the design of communication equipment. Small signal theory and results are presently available, but more information and study is needed under large signal conditions where tube efficiency is high.

PHASED-ARRAY TUBES

The increasing requirements on radar scanning, acquisition, and tracking have intensified interest in phased-array systems. Although this system can be achieved by splitting the power of a few tubes into many transmission lines and using a phase shifter to adjust each of the individual lines, there are good reasons for using a separate tube in each output line. Using many tubes places severe restrictions on the phase characteristics of the tubes and requires them to be as identical as possible in performance. In addition, efficiency, size and weight, reliability and life, and cost are all very important when a system requiring 1000 or more tubes is contemplated.

Fig. 2: Operating simplicity is increased by building the tube's power supply into the amplifier package.



Both traveling-wave tubes and crossed-field amplifiers have been considered for these systems. Crossed-field tubes have higher efficiencies, and due to lower-voltage, higher-current operation they may be less phase sensitive to voltage changes. Traveling-wave tubes have higher gain, are easier to modulate, and have better form factor for phase-array stacks. In order to compare these two types of devices, some specific examples of each tube type will be given. More tubes have been developed for phased-array systems, but these are believed to be typical.

Crossed-Field Tubes consisting of a two-tube chain of tubes at L-band is being developed at S-F-D Laboratories for phased-array application. The following data shows the present status of development.

Characteristic	Driver Tube (SFD-209)	Power Tube (SFD-208)
Center frequency	1.250 Gc	1.250 Gc
Gain	15.2 db	8.4 db
Peak output power	>100 kw	700 kw
Bandwidth	8%	5%
Operating voltage	8 kv	35 kv
Efficiency	35–50%	65%
Tube diameter (without magnet)	3⅝ inches	3⅝ inches
Magnet cross-section	6 x 6 inches	Not determined
Control electrode mu*	3	None
Phase change for 1% variation in voltage	>3°	Not measured

*Turn-on time is 30 to 50 μsec; turn-off time is 0.15 μsec.

Three Traveling-Wave Tubes have been developed at Watkins-Johnson Company which are suitable for phased-array systems. Some of their characteristics are:

Characteristic	Transmitting (WJ-228)	Transmitting (WJ-234)	Receiving (WJ-252)
Gain	43 db	13 db	22 db (small signal)
Peak power output	13–18 kw	100 kw	−3 dbm (cw)
Center frequency	5.66 Gc	1.29 Gc	1.3 Gc
Bandwidth	8.8%	15.5%	15.4%
Operating voltage	23 kv	21 kv	90 v
Efficiency	22–30%	30%	Not applicable
Tube and magnet cross-section	2⅝ in. dia.	4 in. dia.	4.5 in. dia.
Control grid mu	46	60	None
Phase change for 1% voltage variation	25°	3°	30°
Maximum phase variation tube to tube	± 7.5°	Not measured	3°
Noise figure (typical)	50 db	Not measured	3.6 db

The WJ-228 is shown in Fig. 4. Although the phase sensitivity in the WJ-228 is larger than the refer-

enced crossed-field tubes, the gain and consequently the number of wavelengths is correspondingly much greater. If the beam perveance (I_o/V_o 3/2) is increased and the gain reduced as in the WJ-234, a more comparable figure results.

The choice between these two competing devices will depend upon the particular system characteristics as both types have unique capabilities. The technical problems, although not completely solved in all cases, appear to be well on the way to solution. However, the most significant problem still remaining is cost. For these systems to be practical, significant reductions in tube cost must result. Many pessimistic predictions about the future of these systems have been made on the basis of tube cost. Due to the small quantity demand and ever changing product designs, microwave tube production is presently a job-shop type of activity where little automation has been introduced. Once the capability and clear demand for these tubes in really large quantities is actually present, there is little doubt that microwave tube production techniques can be re-oriented to mass-production methods.

CROSSED-FIELD AMPLIFIERS

Crossed-field amplifiers are classified into two general types: reentrant-beam tubes, in which the current circulates continuously around a cylindrical cathode, and nonreentrant-beam tubes. The reentrant-beam tubes can use either a backward-wave or a forward-wave circuit structure. The backward-wave tubes built by Raytheon are called Amplitrons. In the Amplitron tubes, the drift space between the input and output is short so that the electronic feedback is very strong. Forward-wave tubes have been built with short drift spaces and with drift spaces long enough to result in demodulation of the electron stream.

Nonreentrant beam tubes are of two types: tubes in which the beam is injected into the circuit region from a gun, much as in a klystron or traveling-wave tube, and tubes in which the sole plate opposite the circuit is a continuous cathode.

Characteristics

The reentrant-beam tubes have efficiencies from 55 to 60%, and in some cases reported for low-gain Amplitrons it exceeds 80%. The bandwidth of reentrant-beam tubes with short drift spaces is generally less than about 8% with gains in the order of 10 db, although gains in excess of 20 db have been reported. These tubes behave as locked oscillators. The gain and bandwidth restrictions are imposed be-

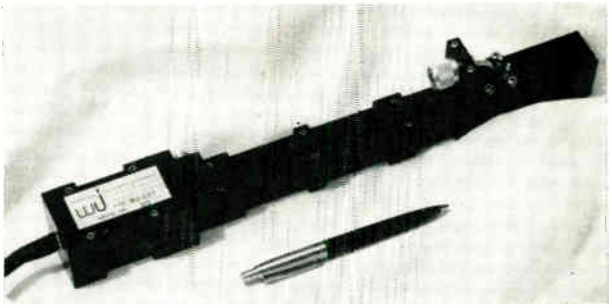


Fig. 3: Developed for space applications, the WJ-227 produces 20 watts and weighs 35 ounces.

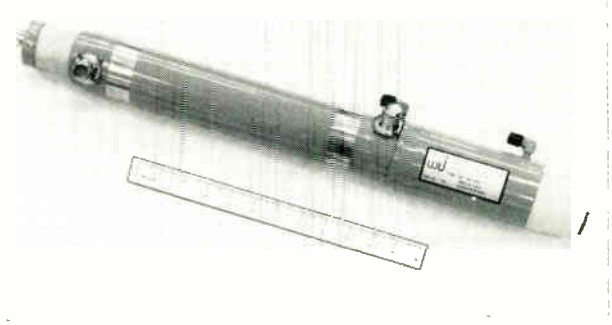


Fig. 4: The WJ-228 is used in phased-array applications. It weighs less than 14 lb., produces 18 KW, and is 34% efficient.

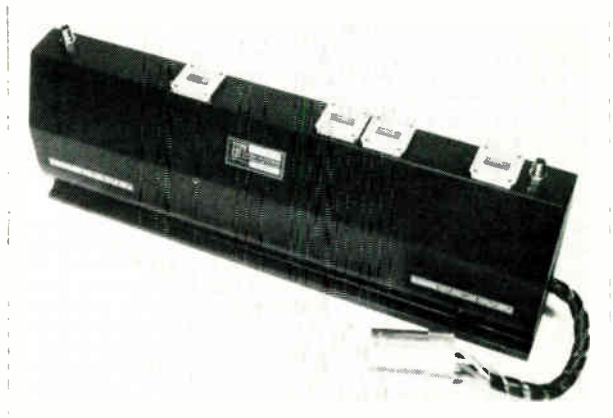
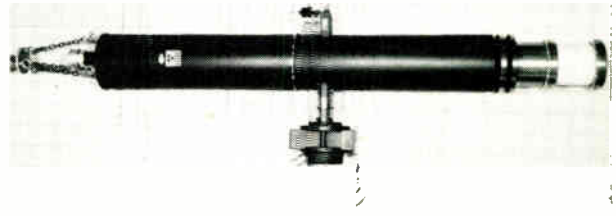


Fig. 5: The L-3652 is an injected-beam crossed-field amplifier which produces 1 KW cw in the freq. range 8.5 to 11 GC.

Fig. 6: This L-band klystron produces 30 megwatts peak power, has 33 db gain, and a 100 MC bandwidth.



cause the tube length must allow positive electronic feedback. Reentrant beam tubes with long drift spaces do not have the same restrictions, but thus far gains have not been greater than 20 db at 10% bandwidth. Tubes with long drift spaces have efficiencies in the order of 40%.

Nonreentrant-beam tubes have made real progress in achieving wide bandwidth and high gain in a crossed-field device. Fig. 5 shows an injected-beam amplifier, L-3652, developed by Litton that produces 1 kw cw from 8.5 to 11 GC, has a 26 db saturation gain, and has an efficiency of 30 to 35%. This tube has a single circuit sever and behaves as a linear amplifier. Litton is also working on a nonreentrant tube with a distributed emission cathode for higher peak-power levels where the emission densities that would be required from an injection gun become excessive.

Fig. 7: The SE203 covers a freq. range of 5.3 to 6.0 GC and has a minimum power output of 100 milliwatts.

Most of the really high peak and average powers have been achieved with Amplitrons. Raytheon has reported 30 megwatts peak at S-band and 3 megwatts peak and over 40 KW average also at S-band. The major emphasis in the development of other crossed-field tubes has been on gain, bandwidth, and novel pulsing techniques, although peak powers of a megwatt or more have been achieved.

Considerable effort for reentrant-beam amplifiers has gone into "self-pulsing" techniques. Ideally, a self-pulsed tube has a cold secondary-emission cathode that allows a dc voltage to be applied to the tube without drawing current. The introduction of an r-f drive signal causes sufficient electrons to bombard the cathode, thus producing secondary emission and amplification. Removing the r-f drive signal causes amplification to cease. In practice, turn on is accomplished in a time which corresponds to several electron transits around the circuit. However, oscillation continues in a space-charge mode or circuit cutoff mode after the drive pulse has been removed. Turn off is accomplished by placing a positively pulsed electrode in the drift space between input and output to draw the electrons out of the interaction space. The mu of this electrode is about 3.

All reentrant-beam type devices can operate without heaters. Continuous emission nonreentrant-beam tubes can operate with only the first part of the cathode heated. Litton is using an injection gun to trigger secondary emission from a continuous cathode. Conduction is, therefore, controlled by the grid.

High-Power Klystrons

At present 25 to 30 megwatts peak power is the state-of-the-art at S-band and lower frequencies. At C-band, the peak power level is about 5 megwatts, and at X-band, where little work has been done on high peak-power tubes, the power level is about 1 megwatt. There are virtually no high peak-power klystrons above X-band. The projected peak power level at the lower frequencies is 50 to 75 megwatts. The major problem at this time is the r-f window. A single-surface multipactor effect in which electrons leave the window surface and return with additional energy results in heating and eventual cracking of the window due to thermal stresses.

The Litton L-3702 (Fig. 6), which produces 30 megwatts peak power and 150 KW average power, best represents the state-of-the-art at L-band. Other tubes are available with 300 KW average power. At S-band state-of-the-art is represented by the tube used in the Stanford Linear Accelerator, which produces 24 megwatts peak power and 24 KW average power. Tubes, however, have been operated at the S-band to about 100 KW average power, and no limitation was found.

The outstanding achievement in CWTs is the Varian single-beam klystron, which has produced 100 kw cw at X-band. General Electric's multiple-beam klystrons have produced 50 kw cw also at X-band. As yet there has not been a corresponding effort to try for maximum cw powers at lower frequencies.

Efficiency of 45% is good in narrow-band tubes that have been tuned for high efficiency. An efficiency of 40% is easily obtained. In wideband tubes efficiencies are typically lower—35% efficiency in a 5% bandwidth tube is good. Where solid-beam gun perveances are as high as 3×10^{-6}, a bandwidth of 5% and a gain of 50 db can be achieved with 7 cavities at the lower frequencies.

Hollow Beam Tubes

Hollow beam tubes offer the possibility of obtain-

Fig. 8: Power and tuning curves for Steward OD 1-2.6.

ing greater bandwidths without sacrificing efficiency. At L-band, 5% bandwidth at 40% efficiency has been achieved, and a 15% bandwidth does not appear to be difficult. The problem presently being encountered with hollow beam klystrons is the noise associated with the magnetron injection electron gun. This noise is suppressed by a strong r-f drive signal; thus the signal-to-noise ratio during the r-f drive is generally greater than 30 db. However, the noise level during the rise and fall of the voltage pulse before the r-f drive is applied is significantly greater than the level during the drive pulse. This problem is not well understood.

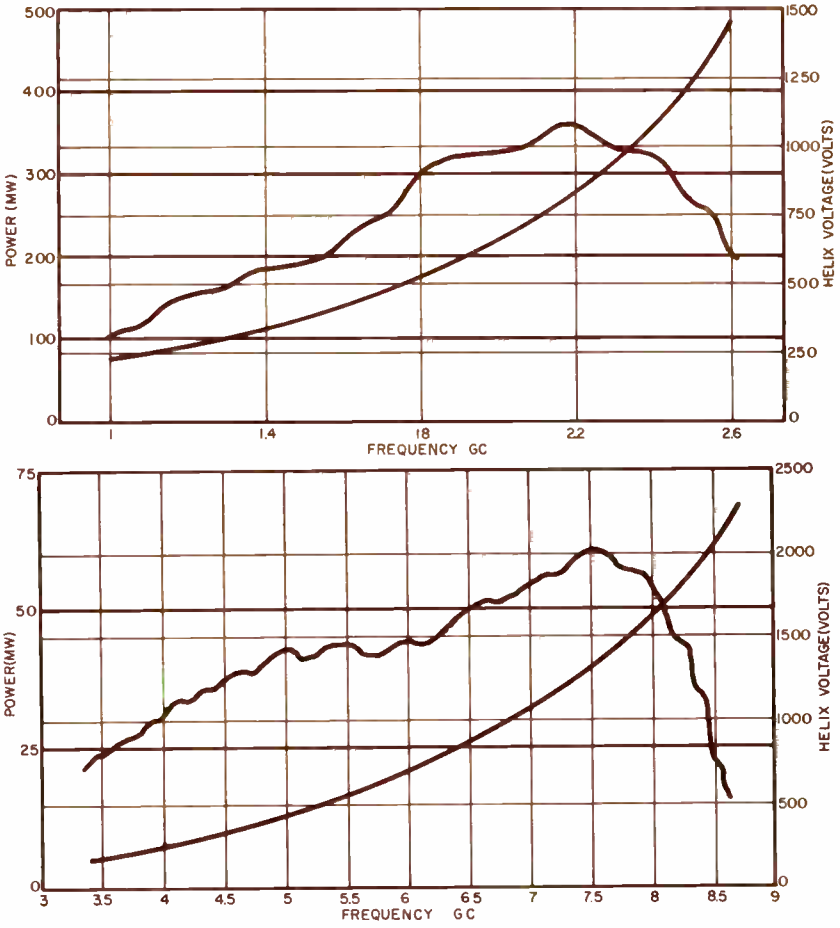


Fig. 9: Power and tuning curves for Steward OD 3.4-8.7.

Backward-Wave Oscillators

The "O"-type backward-wave oscillator is the highest frequency microwave tube yet produced. Power output of several milliwatts has been obtained by CSF at 500 gc, using a vane-line slow-wave structure and a highly convergent solenoid-focused electron beam. CSF has also built similar tubes operating at 425 gc, 300 gc and 150 gc, and work is being performed on a 750 gc model. Typical tube bandwidths are 10%. Beam-current densities up to 2000 amps/cm² have been achieved with cathode density of 1 amp/cm². Usual beam voltages are 4 to 6 kv; beam currents are 10 ma; and focusing fields of 5 to 7000 gauss are required.

In the 40 to 120 gc range, CSF is joined by Bendix and Sperry. The slow-wave structures used are of the Karp type or the vane-line. Power outputs of 10 to 50 milliwatts are available and focusing is either solenoid or permanent magnet. The slow-wave structures used by Sperry are fabricated by photoetching techniques, thus allowing higher production precision and more uniformity of tube performance. Typical beam voltages are 2 to 4 kv; beam currents are 15 to 20 ma; and focusing fields of 2 to 3000 gauss are required.

Below 40 gc there are many companies which produce both solenoid and permanent-magnet focused tubes. These tubes cover all waveguide bands and some octave bandwidths at the lower microwave frequencies. The slow-wave structures are either helix in monofilar or bifilar form or they are interdigital. These tubes are used in commercial applications where wideband tuning is desired. Stewart Engineering's SE 203 (Fig. 7) covers a frequency range of 5.3 to 6.0 gc with a minimum power output of 100 milliwatts. Bifilar helix structures and balun con-

(*Continued on page* J18)

Fig. 10: The 1300 MC degenerate electron-beam parametric amplifier tube. The electron gun is at the left, followed by the input coupler, quadrupole pump, and output coupler.

NEW DEVELOPMENTS IN ANTENNAS

Antennas are probably the single most costly component of a transmitting/receiving system. They are also a limiting factor in the art of microwave. The work being done toward improving antennas is largely in four general areas: phased arrays, Luneberg lens antennas, traveling wave antennas and radio frequency interference.

FOUR AREAS IN ANTENNA RESEARCH are very active at present and are discussed here. These areas are: radio frequency interference (RFI), phased arrays, Luneberg lens antennas, and traveling wave antennas.

The importance of antenna sidelobes and backlobes has increased because of radio frequency interference (RFI) problems. The geometrical theory of diffraction allows calculation of the complete radiation pattern, including backlobes, of reflector and horn antennas.

In phased array studies the advantages of an adaptively phased array of independently steered elements are being investigated. Phase lock circuitry is used so that the signals from each element can be summed coherently, regardless of phase disturbances.

In research on lens antennas, new types of Luneberg lens antennas have been derived and are being studied. These lenses can scan 360° as well as provide multiple beam formation and appear to be useful for many tasks. Finally, a brief summary of traveling-wave antennas is given. Traveling-wave antennas exist in many forms, mainly in the form of radiating transmission lines.

Antenna Considerations in RFI

Increasing demands of communications and radar systems mean that many radiating systems will be operated close together. These demands, coupled with higher powers, greater receiver sensitivities and lower noise capabilities lead to increased RFI problems. This means that portions of the antenna radiation pattern previously ignored are now important. Consider, for example, the parabolic antenna which has 3 distinct types of radiation. These are[1]:

1. aperture radiation, or energy radiated by the feed and reflected by the parabolic surface to form the main beam and its side lobes;

2. direct feed radiation, or energy radiated by the feed which is not reflected by the parabolic surface;

3. edge-diffracted radiation, or energy radiated by the feed which is incident on the edge of the parabola and is then diffracted to the rear of the parabola.

The portion of the pattern due to the aperture radiation should be controlled to yield low side lobe levels. Methods for obtaining such low side lobes have been known since World War II[2] and consist of keeping an appropriate aperture distribution. Jacobs[3] notes that for large antennas and short wavelengths, a low side lobe level can be obtained only by meeting certain mechanical tolerances on the parabolic surface.

The unwanted direct radiation may be controlled through the design of the feed antenna. This usually means a larger feed antenna. This yields increased aperture blocking and hence, higher side lobes for the aperture radiation pattern for intermediate-sized antennas. Thus the need to reduce direct feed radiation and reduce aperture radiation side lobes conflict, and in many cases requires a compromise. This type of radiation is not significant for extremely high gain antennas, as the magnitude of the direct feed radiation is independent of reflector size.

By Dr. L. PETERS, Jr.
Dr. R. C. RUDDUCK
and Dr. C. H. WALTER
Antenna Laboratory
Dept. of Electrical Engineering
The Ohio State Univ.
Columbus 10, Ohio

Greater interference problems of modern systems increase the need to examine the edge-diffracted radiation. In many cases, spurious transmitter emissions or spurious receiver responses interfere with fundamental frequency operation of a closely located system. Also, personnel, explosives, etc., at the rear of an antenna may be affected if this radiation is not controlled. This radiation may be reduced by either reducing radiation incident on the edge or by modifying the edge so that the energy incident on it is not diffracted behind the antenna.

The geometrical theory of diffraction[4] has recently been used to compute the diffracted radiation level for a parabola[5] and a horn antenna.[1] By this method calculation of the rear 180° of the radiation patterns

The antenna temperature is a property of large directional antennas that is closely related to side lobe structure. Energy received by an antenna from noise sources is transmitted by the antenna to the receiver where it appears as noise.[6] More precisely, the antenna temperature is defined as the temperature of a matched load which generates the same receiver noise when the matched load replaces the antenna. The antenna temperature is a function of the noise sources and the radiation pattern of the antenna. Among the most important noise sources are the sun, galaxy, radio stars, thermal radiation from the ground and man-made noise. To reduce the antenna temperature at a given site the radiation pattern should be reduced as far as possible everywhere except near the main beam. The lowest temperature antenna now available is the horn reflector antenna developed by Bell Labs. It was used in the Telstar satellite experiment. It has the disadvantage that it is a huge, unwieldy structure.

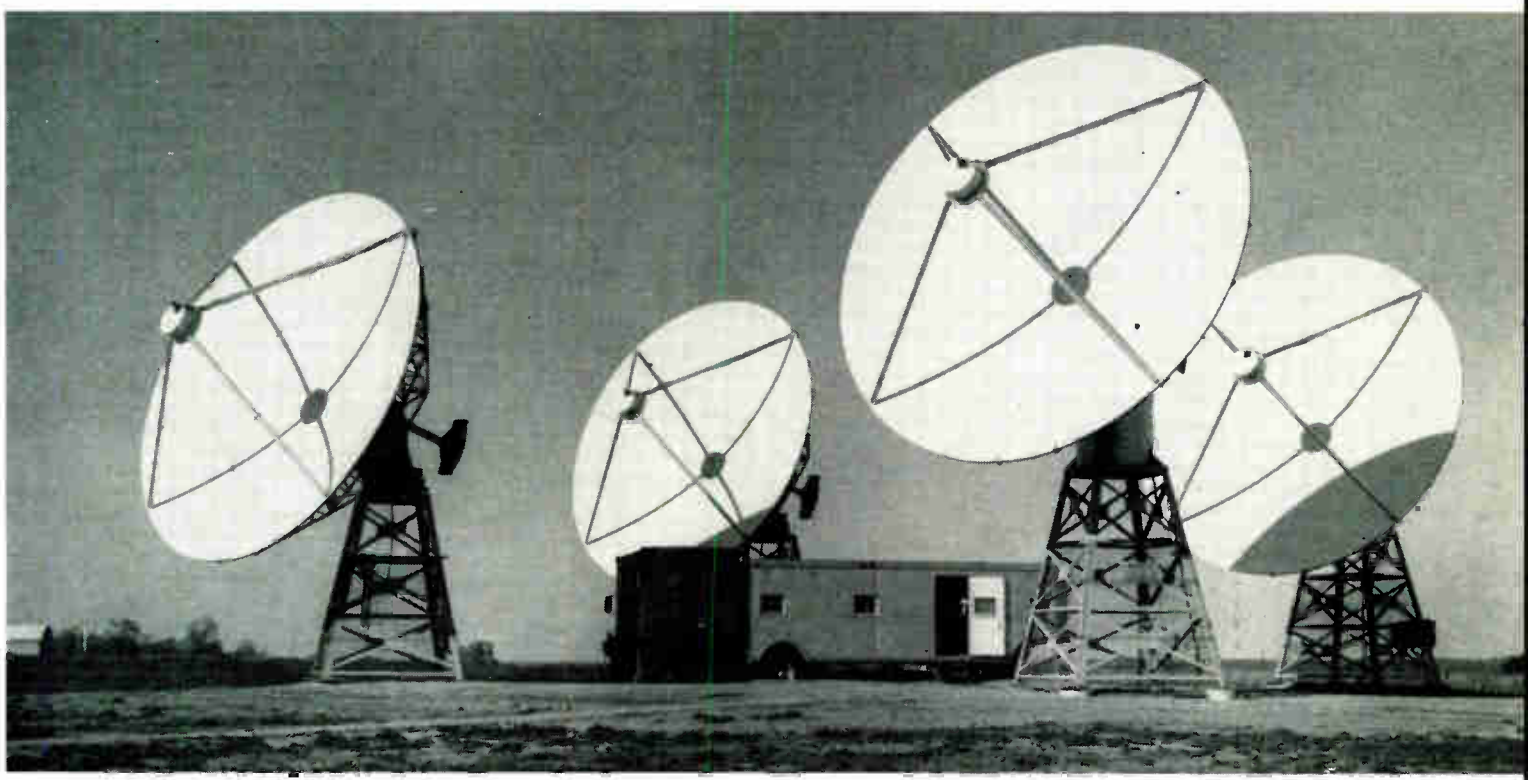


Fig. 1: This array of 30 ft. diameter reflector antennas has been installed at Ohio State Univ. to prove some theories about steered arrays.

of reflector and horn antennas is now practical. Further use of this method should reveal ways for reducing far sidelobes and backlobes.

Greater spurious emissions and responses, which accompany higher transmitter powers and better receiver sensitivities, create RFI at frequencies other than the frequency of a given radar. Consequently, antenna properties at these other frequencies are now important. The spurious frequency radiation patterns may differ from the fundamental frequency pattern, depending on the feed antenna and discontinuities in the transmission line that may excite higher-order modes.

Parabolic antennas[7] have been designed with realistic temperatures which may be used in lieu of the reflector horn antenna in many cases without adding much noise. The major exception occurs when the receiver makes use of low noise masers.

Adaptively Phased Array

An array of four 30 ft. diameter paraboloidal re-

flector antennas has been installed at Ohio State University.[8] The main purpose of this array is to show the feasibility of self-phasing techniques in an array of independently steered elements. This approach presents several obvious advantages over a single large aperture in achieving high antenna gain at high frequencies.[8,9] This is a new approach and there are several unanswered questions that need to be studied. It is for this purpose that the antenna array was built. In addition to the design as a research tool, careful thought was given to the system so that it would function as an operational site in a communication system using passive reflectors. Right now the array is instrumented for the Echo II sphere. In these experiments, the array will act as a receiver with transmitters being located at Rome, N. Y., and Trinidad, Federated West Indies. A 60 ft.

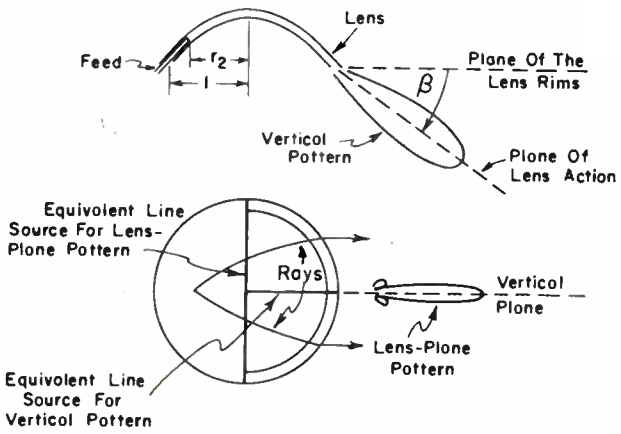
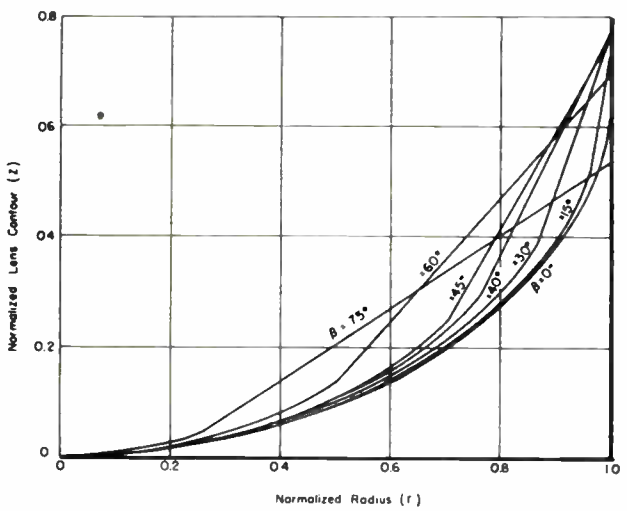


Fig. 2: Antenna lens patterns are shown. Lens action is achieved by proper combination of index of refraction and contour.

Fig. 3: Unit-index contours which have an outer annulus of constant slope and for which the focal radius is $r_1=\cos\beta$.



parabola at Rome, N. Y., which is the aperture equivalent to the antenna array, will function as a receiver also and hence, will afford a good check on the performance of the array.

The array consists of four 30 ft. parabolic reflectors arranged on the corners of a square 60 ft. on a side, with the diagonals located in a north-south and east-west direction. It is shown in Fig. 1. The reflectors can operate up to frequencies greater than 15 gc and are steered by elevation over azimuth mounts. While the mounts have individual servo systems, they can operate in a closed loop where one of them functions as a master and the others are slaves. Input information to the master can be in the form of a remote system source, auto track information or manual position, while input information to the slaves is remote synchro source or manual position.

The antennas are each focal point fed with the capability of a Cassegrain geometry. Each waveguide feed has a parametric amplifier with a 180°K to 300°K noise temperature, mixer-i-f preamp, test couplers and polarization switches. The master also has equipment for the auto track function. The signals from the mixers at 30 mc are distributed by coax cables to a common summing point in a van at the center of the array. Local oscillator signals, as well as the various power and control signals, are fed through cables to each antenna.

There are two tracking functions needed in an array of this type. One is that of mechanically tracking the antennas so that the element patterns will be centered on the signal source for maximum signal. The second function needed is that of electrically tracking the interferometer lobes within the element patterns. This insures that one of the lobes is centered on the signal source for full gain of the antenna system. To accomplish the electrical tracking function, the 30 mc signals are each fed to a phase locked receiver in which the reference signals for the phase detectors are obtained from a common source. In this way each signal is locked in phase to a common source and hence are in phase with each other. Thus, they may be added to obtain an increase in signal to noise ratio.

The auto track function is done by an amplitude monopulse system located in one of the antennas. Tracking is done on the data signal with the master antenna, and the slave antennas are kept collimated with the master by a common servo system.

Acquisition in the array is done by decollimating the antennas into a fan beam which is controlled in azimuth, elevation and beam tilt angle. In the acquisition mode, the fan beam is positioned so that its wide

A REPRINT OF THIS ARTICLE
CAN BE OBTAINED BY WRITING
on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

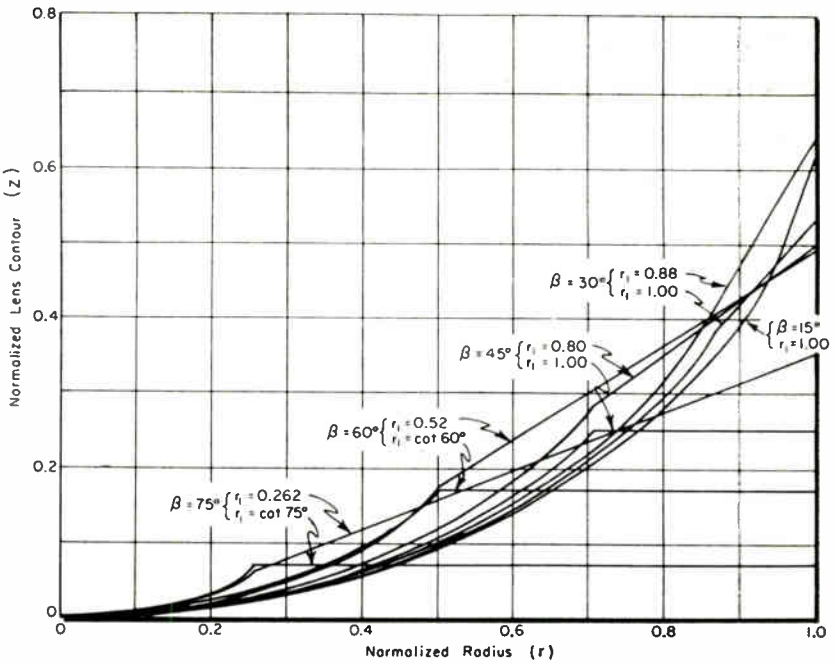


Fig. 4: Unit-index lens contours are shown when the focal radius is $r_1 > \cos\beta$.

dimension is perpendicular to the expected trajectory of the signal source. When one of the antennas picks up a signal in its threshold detection circuit, the remaining 3 antennas collimate with it and the tracking is started by means of logic circuitry.

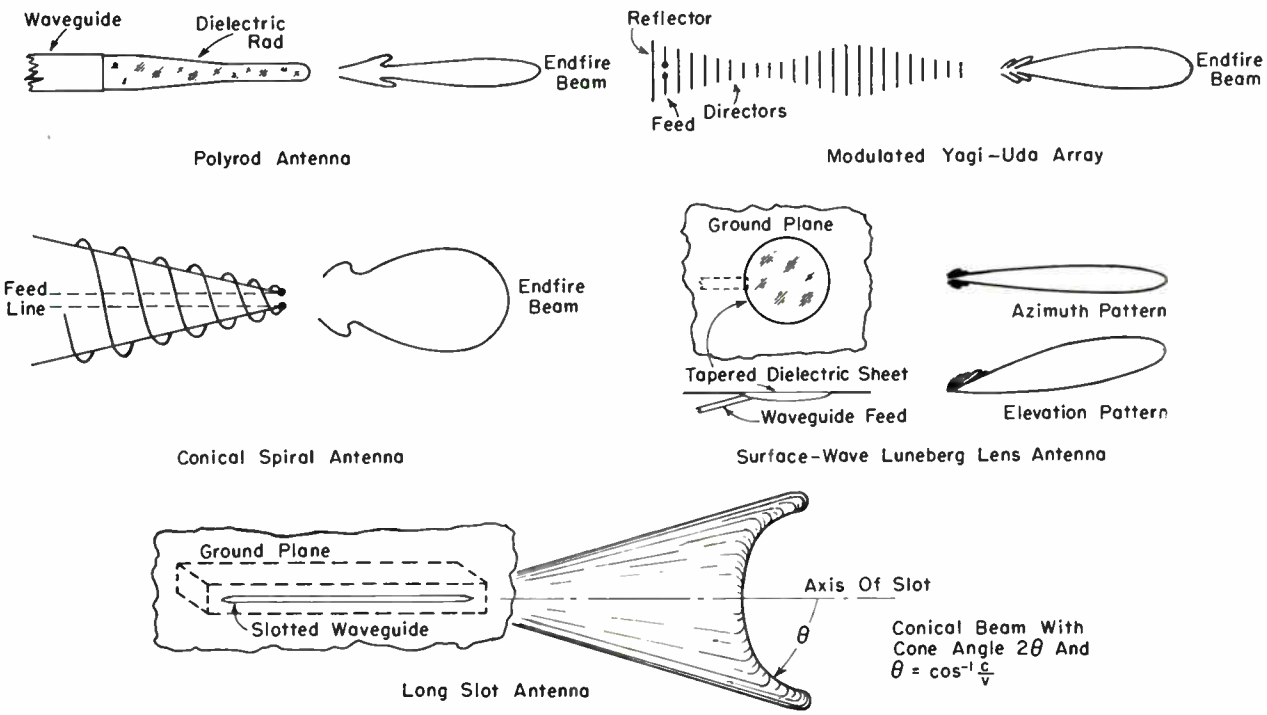
Lens Antennas

Two classes of multiple beam antennas appear quite promising for use in aerospace vehicles, ground-based installations and satellites. These are the most recent in the general area of circularly symmetric or Luneberg lens antennas. The main feature of these lenses is circular symmetry which provides multiple beam capability as well as scan by feed movement alone. In many cases, this is a major advantage over mechanically-steered antennas, e.g., reflector antennas. The recent lens types have better radiation patterns than previous lenses. They can be flush-mounted to a wide variety of surfaces such as flat surfaces on aerospace vehicles, or conical surfaces in the nose sections of planes and missiles.

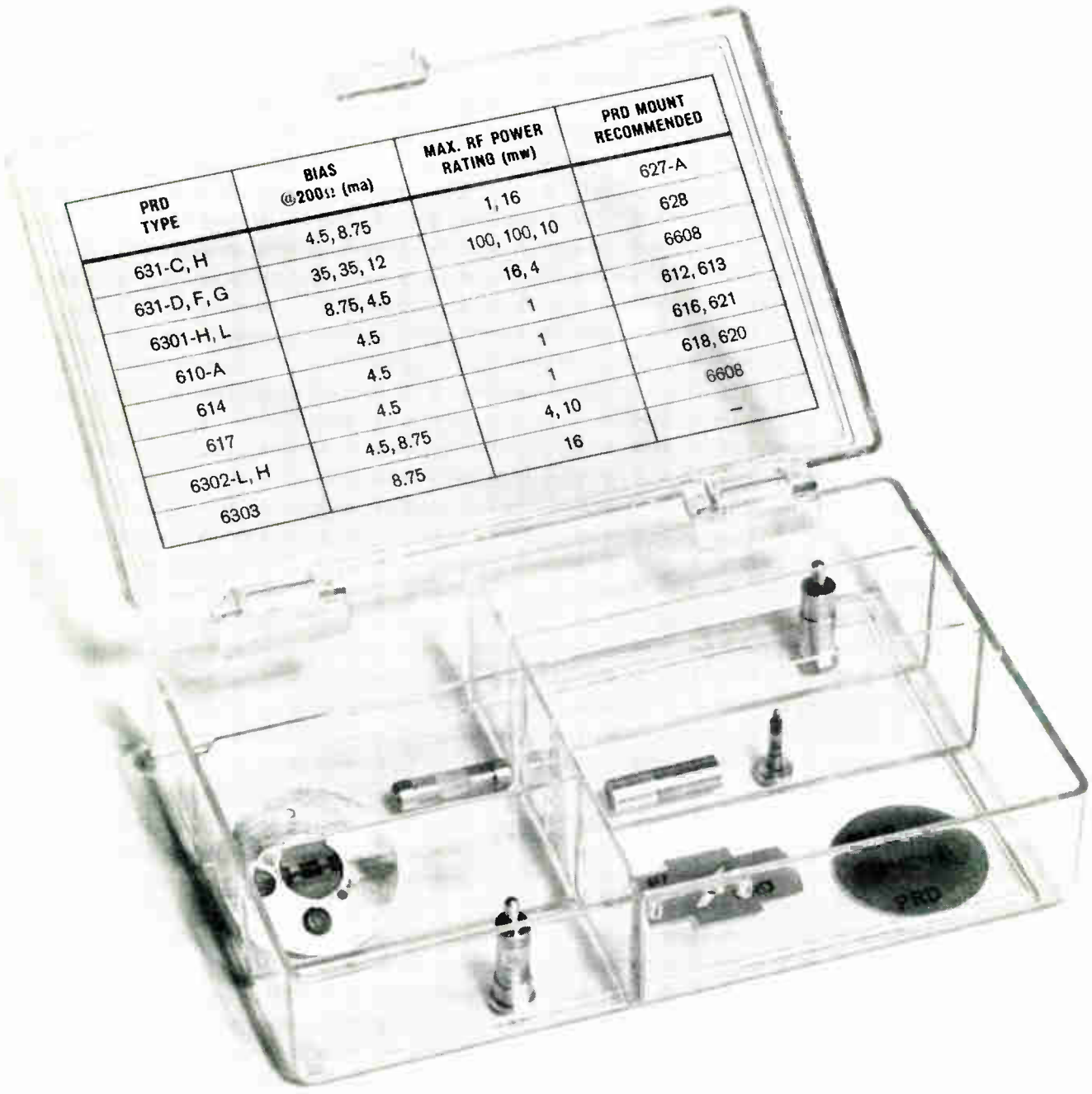
Basically, the recent lenses are two-dimensional waveguide structures in which energy is refracted to give the focussing or lens action. The lens structure is a surface of revolution so that circular symmetry is preserved. The energy propagates between the feed

(Continued on page J16)

Fig. 5: Various traveling-wave antennas and their general radiation patterns are sketched here for comparison.



PRD TYPE	BIAS @200Ω (ma)	MAX. RF POWER RATING (mw)	PRD MOUNT RECOMMENDED
631-C, H	4.5, 8.75	1, 16	627-A
631-D, F, G	35, 35, 12	100, 100, 10	628
6301-H, L	8.75, 4.5	16, 4	6608
610-A	4.5	1	612, 613
614	4.5	1	616, 621
617	4.5	1	618, 620
6302-L, H	4.5, 8.75	4, 10	6608
6303	8.75	16	–



THE MANY BOLOMETERS FROM PRD

PRD bolometers and thermistors are designed for use in attenuation or power measurements at microwave frequencies. ▪ All types are in stock and available for immediate delivery. ▪ Write for new low prices on FIVE-PACKS or a BAKER'S DOZEN (13).

PRD ELECTRONICS, INC.,
202 Tillary St., Brooklyn 1, N. Y., ULster 2-6800 • *A Subsidiary of Harris-Intertype Corporation*

HARRIS INTERTYPE CORPORATION

PRD Electronics, Inc.

OFFICES: Los Angeles and Redwood City, Calif. • Cherry Hill, N.J. • Westbury, L.I., N.Y.

Circle 203 on Inquiry Card

FREE! *use these cards for:*

- Catalogs, Bulletins, Literature
- Design features of advertised products
- Information about new products
- New Tech Data for engineers

YOUR NAME ..... TITLE .....

FIRM .....

FIRM ADDRESS .....

CITY OR TOWN..... ZONE..... STATE .....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112
113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168
169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196
197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224
225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252
253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308
309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336
337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364
365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392
393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420
421	322	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448
449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476
477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504
505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532
533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560
561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588
589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616
617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644
645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672
673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700

Please send me further information on the items I have circled above.

EI-09 JUNE, 1963

FIRST CLASS
PERMIT NO. 2333
CAMDEN, N. J.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

The Computer Center

P. O. Box 1970

Camden 1, New Jersey

FREE! use these cards for:

- Catalogs, Bulletins, Literature
- Design features of advertised products
- Information about new products
- New Tech Data for engineers

FIRST CLASS
PERMIT NO. 2333
CAMDEN, N. J.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

The Computer Center

P. O. Box 1970

Camden 1, New Jersey

YOUR NAME .....TITLE .....

FIRM .....

FIRM ADDRESS .....

CITY OR TOWN.....ZONE.....STATE .....

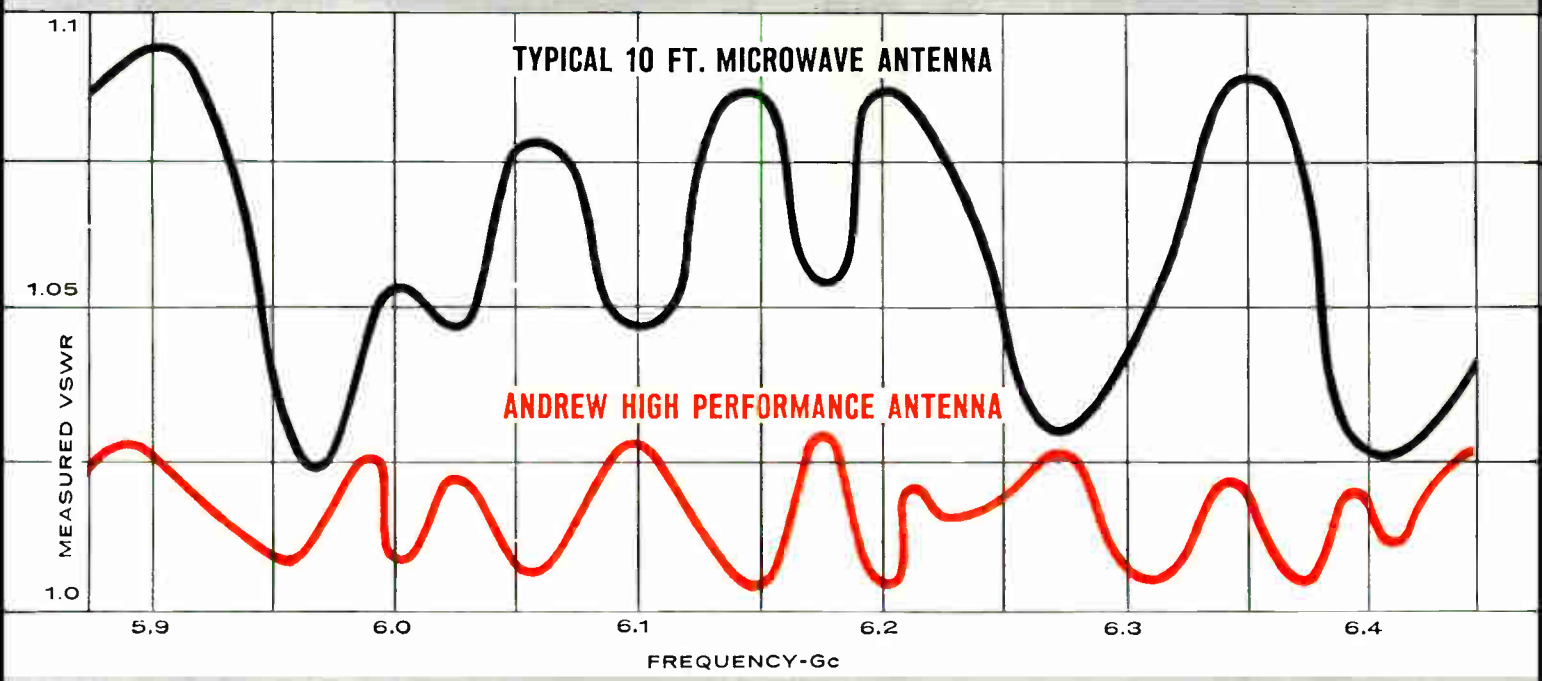
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112
113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168
169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196
197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224
225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252
253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308
309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336
337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364
365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392
393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420
421	322	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448
449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476
477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504
505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532
533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560
561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588
589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616
617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644
645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672
673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700

Please send me further information on the items I have circled above.

EI-09 JUNE, 1963

ANTENNA PERFORMANCE

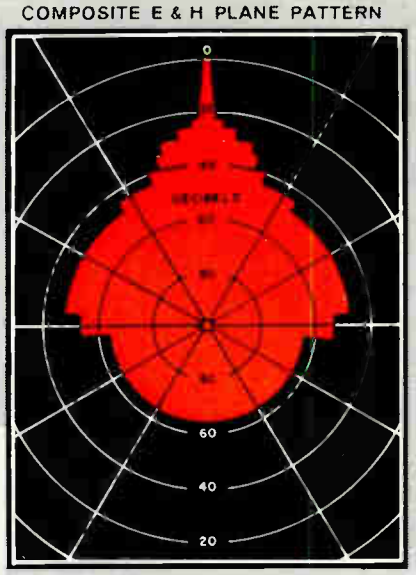
IN A CLASS BY ITSELF



NEW high performance Microwave Antenna

5925-8250 Mc

COMPOSITE E & H PLANE PATTERN



The certification of each individual antenna in this line is your assurance of high performance with low VSWR. Specially designed for signal congested areas, the Andrew High Performance Microwave Antenna is shielded to reduce the wide angle lobes and to increase the front to back ratio. A reinforced back frame provides an extremely stable system and keeps the antenna pointed on the path after installation. New radomes, engineered specifically for high performance characteristics, maintain gain efficiency of basic antenna. Write or call your Andrew sales engineer for complete information.

Andrew

P.O. BOX 807, CHICAGO 42, ILLINOIS

BOSTON
NEW YORK
WASHINGTON, D. C.
LOS ANGELES
TORONTO

Circle 100 on Inquiry Card

on the focal radius and the aperture at the lens rim as shown in Fig. 2. The lens action is achieved by the proper combination of index of refraction and contour, both of which are functions only of radius. This lens can be designed for a radiated beam maximum at any specific angle β with respect to the plane of the lens rim. The beam maximum is also diametrically opposite the feed. Thus, beams can be obtained anywhere around the symmetry axis of the lens at the design beam angle from the plane of the lens rim.

For a horizontal lens, a plane containing the symmetry axis is a vertical plane and, for convenience, will be so designated. Since the radiating aperture is semi-circular as shown in Fig. 2, the beam is fan-shaped with its broad cross-section in the vertical plane. Thus, some coverage is obtained transverse to the dimension in which the beam position can be controlled. Some of these lenses have shown the capability of beam positioning in the vertical plane. The vertical beam position is controlled by the radial feed position.[10]

In a lens structure the index variation is achieved with proper control of the phase velocity. For example, in the TE_{01} waveguide mode, the index can be controlled by variation in plate spacing. In this mode the electric field is parallel to the lens plates, giving horizontal polarization for a horizontal lens. In the TEM mode the index must be obtained by variation of the dielectric constant of the medium between the lens plates. Since the electric field is perpendicular to the lens plates, this mode gives vertical polarization. The index is frequency-independent for the TEM mode, whereas it varies with frequency for the TE_{01} mode. Thus, wide frequency bandwidth is possible with the TEM mode. The lens structure may also be a surface-wave structure[11] (see Fig. 5) in which the fundamental modes are the TM_0 and the TE_1 modes which radiate vertical and horizontal polarizations, respectively.

The whole class of lens antennas, in which the lenses have variable index of refraction possessing circular symmetry, is often denoted Luneberg lenses.[12] The best known Luneberg lens has the geometrical optics property that rays from a point on the lens rim are refracted into a collimated beam. In this case, lens action is by an index variation as expressed by

$$n(r) = \sqrt{2 - r^2},\ 0 \le r \le 1. \qquad (1)$$

A common use of this design is a three-dimensional spherical lens constructed from concentric dielectric shells of polystyrene foam or similar material, giving the appearance of a foam ball.

In one of the new classes of lenses, the nonplanar lens is of arbitrary contour along the radius. The index of refraction needed to give proper lens action can be represented by a complex equation which is a function of radius inside the lens and depends on the lens contour, the design focal radius, and the design vertical beam angle.[13] A simple example of index variation is that for a planar lens with design focus at the rim. The index of refraction for a lens of this type, which has a vertical beam angle β is given by

$$n(r) = (\cos\beta)\sqrt{2 - r^2},\ 0 \le r \le 1. \qquad (2)$$

This index is a constant multiple of that for the lens of Eq. 1, which has a design angle of $\beta = 0$. In fact, any lens design for $\beta = 0$ can be converted to a design for angle β by multiplication of the index by $\cos\beta$, as in the above equation.

Another, and perhaps more important class, is the geodesic lenses.[14] In these lenses the index of refraction is arbitrarily chosen and the contour needed to give the desired lens action is obtained. The name "geodesic" comes from the fact that the ray paths in a constant-index lens follow the geodesics on the mean surface between the lens plates. The original geodesic Luneberg lens, which was derived by Rinehart,[15] is the unit-index equivalent of the lens of Eq. 1. The unit-index contours which have an outer annulus of constant slope and for which the focal radius $r_1 = \cos\beta$ are shown in Fig. 3. The Rinehart lens contour is labelled $\beta = 0$ in Fig. 3. Some of the lens contours having the same properties, except that $r_1 > \cos\beta$, are shown in Fig. 4.

Low power handling capability is a limitation in some lenses using dielectric materials. Unit-index geodesic lenses, which need no dielectric material, potentially have very high power handling capabilities. For some receiving antenna or low-power transmitting antenna uses, a nonplanar lens with dielectric material might be desirable because the lens contour is more versatile.

Traveling Wave Antennas

Traveling wave antennas are antennas for which the fields and currents that produce the pattern can be pictured as waves traveling over the antenna structure. In general, the amplitude and phase of a wave will vary with position on the antenna. The velocity with which a point of constant phase moves is known as the phase velocity v. The phase velocity, too, may vary with position.

When the phase velocity v is less than or equal to the velocity of light c in free space, the antenna is said to be a slow wave antenna. This usually means that the energy is bound to the surface of the antenna and such antennas are called surface wave antennas.

On the other hand, a structure which has a phase velocity greater than light in free space permits energy to leak away from the structure. These are usually known as leaky wave antennas. A useful relation for finding the angle θ that the antenna beam makes with axis of the source along which the wave is propagating is $\cos \theta = c/v$. The angle θ can be varied (i. e., the beam can be scanned) by simply varying the phase velocity.

If the structure supporting a traveling wave is properly terminated, the reflected wave will be quite small and essentially a traveling wave distribution will exist. Examples of early traveling wave antennas are the long wire and rhombic antennas.[16] A standing wave antenna, however, can be considered as a traveling wave antenna with waves going in opposite directions. The pattern of a half-wave dipole can be obtained in this manner.[17] Even the aperture distribution of a horn or dish antenna can be treated as a traveling wave. In this case the wave travels over the aperature with infinite phase velocity.

To many engineers, a traveling wave antenna is synonymous with radiation from a continuous source. Actually, many arrays of discrete elements can be satisfactorily approximated by a traveling wave current or field distribution.

Antenna needs from WWII to now have led to extensive studies of traveling wave antennas. These include polyrod antennas,[18] long, continuous slots in waveguides,[19, 20, 21] Yagi-Uda antennas,[22, 23] helical antennas,[24, 25] spiral antennas,[26] closely spaced slots and holes in waveguides,[21, 27, 28] reactive grid antennas,[29] and various surface-wave antennas.[11, 30, 31] Some of these antennas are shown in Fig. 5. A good summary of surface- and leaky-wave antennas with further references is given by Zucker in Chapter 16 of Ref. 16.

The interest in traveling wave antennas is due to several basic properties of this type of radiator. These are:

1. Good bandwidth characteristics. The traveling wave antenna is generally a non-resonant structure and has good pattern and impedance bandwidths. Frequency independent antennas, such as the spiral antenna[26] are traveling wave antennas.

2. Low frontal area. Endfire traveling wave antennas, such as the polyrod and the Yagi-Uda array give good gain from length alone. Using the usual definition of antenna gain as the ratio of the power density in the direction of maximum radiation to the average power radiated, the gain of an endfire antenna of length L/λ (where λ is wavelength) ranges from about $4L/\lambda$ ($7L/\lambda$ for modulated structures)[31] for lengths greater than 10λ to about 10 L/λ for lengths approaching a wavelength. For comparison the gain of an aperture antenna such as a horn or dish is about $2\ \pi A/\lambda^2$ where A is the area of the aperture.

3. Flush mounting capability. Traveling wave antennas in the form of slotted waveguides and surface wave structures can be mounted on a surface so that one side is perfectly flush and the other side nearly so (see Fig. 5). This is important in antennas for missiles and high performance aircraft.

REFERENCES

1. Peters, L. and Rudduck, R. C., "RFI Reduction by Control of Antenna Sidelobes," Contractors Conference, Electromagnetic Vulnerability Laboratory, Rome Air Dev. Ctr., Griffiss Air Force Base, Rome, N. Y., 22-24 Jan. 1963.

2. Silver, S. and Van Atta, L. C., "Contributions to the Antenna Field During World War II," *Proc. IRE*, Vol. 50, No. 5, May 1962, pp. 692-697.

3. Jacobs, E., "Predicting the Antenna's Role in RFI," *Electronic Industries*, Vol. 19, No. 5, May 1960, p. 98.

4. Keller, J. B., "Diffraction by an Aperture," *Jour. Appl. Phys.*, Vol. 28, No. 4, Apr. 1957, pp. 426-444.

5. Lysher, L. J., "A Study of the Near-Field Behind a Parabolic Antenna," Master's Thesis, The Ohio State Univ., 1961.

6. Caldecott, R. and Peake, W., "Designing Low Noise Antennas," *Electronics*, Vol. 34, No. 3, Jan. 20, 1961.

7. Caldecott, R., and Brown, D. M., "The Design of Low Noise Antennas for Tropospheric Scatter Reception," 15 Jan. 1960 (AD 236 181) Report 904-1, Antenna Lab., The Ohio State Univ. Research Found.; prepared under Contract DA-18-119-sc-533, U.S. Army Signal Procurement Office, 9800 Savage Road, Fort Meade, Md.

8. Eberle, J. W., "High Gain Antenna Realization and Tracking Study," (Final Report, Vol. I) 22 Jan. 1961, Report 1072-1, Antenna Lab., The Ohio State Univ. Research Found.; prepared under Contract AF 30(602)-2166, Rome A. F. Dev. Ctr., Air Force Systems Command, U.S. Air Force, Griffiss Air Force Base, N. Y.

9. Eberle, J. W., "The Design of Antenna Arrays for Maximum Signal to Noise Ratio," 15 Mar. 1961, Report 1072-2, Antenna Lab., The Ohio State Univ. Research Found.; prepared under Contract AF 30(602)-2166, Rome Air Dev. Ctr., Air Force Systems Command, U.S. Air Force, Griffiss Air Force Base, N. Y.

10. Rudduck, R. C., Walter, C. H., and Ryan, C. E., "Geodesic Lenses for Flush Mounted Applications," Twelfth Annual Symp. on USAF Antenna R. & D. Program, Univ. of Illinois, 16-19 Oct. 1962.

11. Walter, C. H., "Surface-Wave Luneberg Lens Antennas," *IRE Trans. on Antennas and Propagation*, Vol. AP-8, No. 5, Sept. 1960.

12. Luneberg, R. K., "Mathematical Theory of Optics," Brown University Press, Providence, R. I., pp. 189-213; 1944.

13. Adachi, S., Rudduck, R. C., and Walter, C. H., "A General Analysis of Non-Planar, Two Dimensional Luneberg Lenses," *IRE Trans. on Antennas and Propagation*, Vol. AP-9, No. 4, July 1961.

14. Rudduck, R. C. and Walter, C. H., "A General Analysis of Geodesic Luneberg Lenses," *IRE Trans. on Antennas and Propagation*, Vol. AP-10, No. 4, July 1962.

15. Rinehart, R. F., "A Solution of the Problem of Rapid Scanning for Radar Antennae," *J. Appl. Phys., 19*, 860-862, 1948.

16. Jasik, H., *Antenna Engineering Handbook*, McGraw-Hill, 1961, Chap. 4.

17. Kraus, J. D., *Antennas*, McGraw-Hill, 1950, Chap. 5.

18. Mueller, G. and Tyrrell, W. A., "Polyrod Antennas," *Bell System Technical Journal*, Vol. 26, 1947, pp. 827-851.

19. Cullen, A. L., "On the Channel Section Waveguide Radiator," *Phil. Mag. 40*, pp. 417-428, April 1949.

20. Hines, J. N., Rumsey, V. H. and Walter, C. H., "Traveling Wave Slot Antennas," *Proc. IRE*, Vol. 41, pp. 1624-1631, Nov. 1953.

21. Goldstone, L. O. and Oliner, A. A., "Leaky Wave Antennas," *IRE Trans. on Antennas and Propagation*, Part I, Vol. AP-7, Oct. 1959; Pt. II, Vol. AP-9, May 1961.

22. Yagi, H., "Beam Transmission of Ultra Short Waves," *Proc. IRE*, Vol. 16, pp. 715-741, June 1928.

23. Sengupta, D. L., "On Uniform and Linearly Tapered Long Yagi Antennas," *IRE Trans. on Antennas and Propagation*, Vol. AP-8, No. 1, pp. 11-17, Jan. 1960.

24. Kraus, J. D., *Antennas*, McGraw-Hill, 1950, Chap. 7.

25. Jasik, H., *Antenna Engineering Handbook*, McGraw-Hill, 1961, Chap. 7.

26. Jasik, H., *Antenna Engineering Handbook*, McGraw-Hill, 1961, Chap. 19.

27. Elliott, R. S., "Serrated Waveguide—Part I: Theory," *IRE Trans. on Antennas and Propagation*, AP-5, p. 270, 1957.

28. Hyneman, R. F., "Closely Spaced Transverse Slots in Waveguide," *IRE Trans. on Antennas and Propagation*, AP-7, p. 335, 1959.

29. Honey, R. C., "A Flush-Mounted Leaky-Wave Antenna with Predictable Patterns," *IRE Trans. on Antennas and Propagation*, AP-7, p. 320, 1958.

30. Jones, E. M. T., "An Annular Corrugated-Surface Antenna," *Proc. IRE*, Vol. 40, p. 721, 1952.

31. Simon, J. C. and Baggi, V., "A New Type of Antenna and its Application to Long Distance Television Transmission" (in French) *L'Onde Electrique*, Vol. 34, p. 883, 1954.

nectors have produced BWOs with extremely wide bandwidths. Examples are the Stewart OD 1 to 2.6 GC and OD 3.4 to 8.7 GC; the power output and tuning curves are shown by Figs. 8 and 9 respectively.

Using permanent-magnet focusing in the range below 40 GC has produced packaged tubes which weigh less than 6 pounds. The Ophitron electrostatic focused BWO, developed by G.E.C. England, covers the full X-band region and weighs 8 ounces. Microwave Associates has developed a 5-ounce narrow band tube which covers the lower X-band range. Difficulties in structural requirements have hampered severely the development of tubes using electrostatic focusing at high microwave frequencies.

Parametric Amplifiers

The electron-beam parametric amplifier is a relatively recent addition to the microwave tube art, with the first commercial units appearing over four years ago. In concept, this device is quite simple. Energy is coupled onto the electron beam and amplified in a quadrupole pump structure. The amplified energy is then removed from the beam by a second coupler.

The first electron-beam parametric amplifiers were of the degenerate type, with the pump frequency nearly twice the signal frequency. This resulted in an idler very near the signal frequency. The presence of an idler at or near the signal frequency is frequently a disadvantage in the degenerate amplifier. Recent work has resulted in the successful operation of nondegenerate amplifiers near 400 MC with a 2100 MC pump. Single-channel noise figure of less than 2 db was obtained. Development of similar nondegenerate tubes for L-band, pumped at C-band, is now in process. How nondegenerate amplifiers will perform at higher frequencies is not known. If a broadband noise source is used with a degenerate amplifier, the double-channel noise figure is yield. Degenerate amplifiers are available as packaged units which contain the amplifier tube, solenoid, power supply, and pump generator. Two different models cover the center frequencies of 350 to 850 MC and 850

to 1800 MC. Fig. 10 is a photograph of a 1300 MC degenerate tube. Instantaneous bandwidths of up to 100 MC, broadband noise figure as low as 0.9 db, and gain adjustable from 20 to 45 db have been measured.

Degenerate amplifiers are available that operate in both S- and C-bands. A 5 GC fixed-tuned unit with 50 MC bandwidth and 1.5 to 2 db noise figure has been reported. The X-band seems to be a practical upper limit because 3500 gauss is required at X-band, and the magnetic field increases with frequency.

Beam-Plasma Amplifiers

A great deal of work is being done to provide a harder vacuum within the tube since gas is generally associated with short life, ion-modulation noise, cathode poisoning, and arcing. The beam-plasma amplifier attempts to use an ionized gas, such as mercury or hydrogen, to provide the gain otherwise provided by the slow-wave structure of the TWT. The microwave signal is fed onto an electron beam by a slow-wave structure such as a helix. The beam passes through an ionized gas (with no helix) where the signal is rapidly amplified through interaction with the free electrons of the plasma. The beam then passes through another slow-wave structure which picks up the amplified beam modulation and transfers it to the output of the tube.

Ion noise, high electron temperature, and efficiency limit the use of beam-plasma amplifiers. There is, however, a possibility that a use may be found for them in the future.

Acknowledgements

The author gratefully acknowledges the contributions of Drs. Boyd P. Israelsen, O. Thomas Purl, and James W. Sedin of Watkins-Johnson; Dr. C. B. Crumly of Zenith Radio; A. T. Isaacs of Stewart Engineering, and D. W. Reid of Litton Industries.

NEW TECH DATA

for Engineers.

Microwave Tubes, Components

This fully illustrated 84-page catalog covers complete range of microwave tubes and components. Included are reflex klystrons, medium-power klystron oscillators and amplifiers, high-power klystron CW amplifiers and pulse amplifiers, BWO's, TWT's, magnetrons, freq. standard tubes, and solid-state products, including varactor diodes and ferrite components. Other components covered include gas switching tubes, surge protectors, ignitor power supplies, microwave plumbing, noise sources and pressurizing windows. A product index and general sales data are included. Tube Div., Varian Associates, Palo Alto, Calif.

Circle 571 on Inquiry Card

Microwave Diodes

A 29-page brochure on microwave semiconductor products features device characteristics and uses. It includes diode speed index and complete data on mixers, detectors, tunnel diodes, varactors and microwave switches. Package outlines, photos, mechanical and environmental test methods are included. Sylvania Electric Products, Inc., 1100 Main St., Buffalo 9, N. Y.

Circle 572 on Inquiry Card

Microwave Analyzer

This 20-page brochure includes comprehensive data on 3 panoramic spectrum analyzers for r-f and microwave bands (10 to 44GC), including specs. and design descriptions. Special considerations in the use of the instruments for CW and pulsed-signal analysis are covered. Singer Metrics Div., The Singer Mfg. Co., 915 Pembroke St., Bridgeport, Conn.

Circle 573 on inquiry Card

Coaxial Iso-Filter

A microwave device called an Iso-Filter which converts low-priced signal sources into precision systems is described on this data sheet. It functions as an isolator within its freq. range and also filters out harmonics of pass-band freqs. Useful in laboratory test set-ups, microwave systems and missile system test equipment. E & M Laboratories, 15145 Califa St., Van Nuys, Calif.

Circle 574 on Inquiry Card

Microwave Device Folder

Informative file folder and other enclosed technical bulletins on solid-state r-f and i-f amplifiers, oscillators, mixers, and receivers are available. Bulletin G-101. International Microwave Corp., 105 River Rd., Cos Cob, Conn.

Circle 575 on Inquiry Card

Microwave Catalog

Catalog 634, 68 pages, 2 colors, covers the complete line of electronic instruments and microwave components available from Empire Devices, Inc., Amsterdam, N. Y. In addition to noise and field intensity meters, crystal mixers, attenuators and power supplies, it presents several new instruments for r-f interference measurements and a new group of versatile microwave signal generators. Each item is illustrated, described, and data includes complete specs., operating characteristics, and accessories.

Circle 576 on Inquiry Card

Microwave Switches

Three new solid-state microwave switches for use with low-power r-f are available from Westinghouse Electronic Tube Div., Elmira, N. Y. The WX-5329 features a switching speed of 1 nsec, operates in the C-band, and has an isolation rating of 40db. The WX-5385 operates between 1.7GC and 5.5GC, has a switching speed of 10 nsec. and a min. isolation of 23db. The WX-5080 has an isolation of 80 db (min.), a freq. range of 5.4GC to 5.9GC, and switches at 40 nsec. No dc bias is required for any tube.

Circle 577 on Inquiry Card

Microwave Components

This 24-page catalog, 12-H, includes descriptions, specs. and illustrations of standardized microwave components in the following product categories: waveguide preselectors, waveguides, waveguide filters, freq. selective diplexers, variable power dividers, diode switches, cavity oscillators, crystal mixers, and high pass filters. Microlab, 570 W. Mt. Pleasant Ave., Livingston, N. J.

Circle 578 on Inquiry Card

Time Code Generator

Model TIM-01 features solid-state components and is used as a timing reference for data telemetered via an air-to-ground link and a source of on-board timing for navigation, communications or flight planning. A precise timing reference for use in conjunction with electronic countermeasures, electronic intelligence, or reconnaissance systems. Correlated Data Systems Corp., 1007 Air Way, Glendale 1, Calif.

Circle 579 on Inquiry Card

Full Ku-Band Attenuator

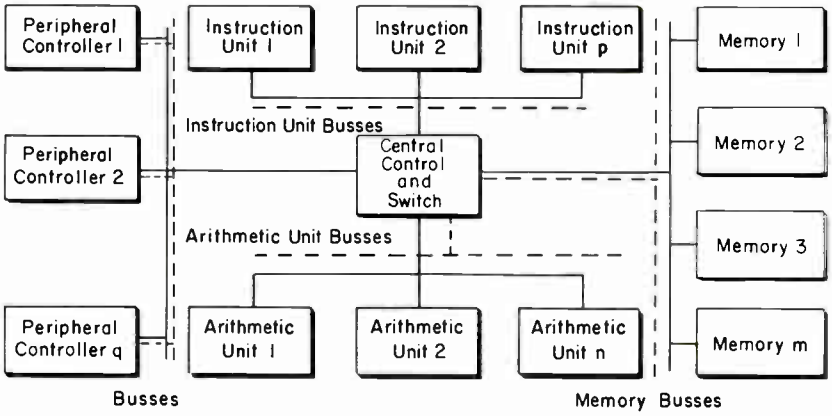
Data on a full Ku-band variable attenuator contains specs. and typical curves of attenuation vs. coil current. Two models are described. E & M Laboratories, 15145 Califa St., Van Nuys, Calif.

Circle 580 on Inquiry Card

SECTION K

DATA PROCESSING & AUTOMATION

DATA PROCESSING (Continued)



With multi-processing systems such as this, an automatic supervisor is needed to keep track of everything and to schedule work.

another in the case of either machine or program errors?

Multi-processing: An extension of multi-programming is the addition of several computers to the system complex. This makes available several arithmetic and control units to interlace among themselves and among the several tapes, printers, disc memories, and punch card peripherals. With some systems an automatic supervisor is needed to keep track of everything and schedule work to the various equipments. Design of these routines is itself a new technology, and extension of this idea to automatic test and diagnostic programs is becoming a reality. Computers are tending to be used to run themselves and diagnose their own malfunctions as well as to do useful work.

Data Communications: Data communications is one of the pressures moving system organization toward multi-programming and multi-processing. With the large, on line, data input/output capacity that can be achieved using communications methods, it is possible to overwhelm even the 20 MC computers being designed today. System complexes are being contemplated to use data communications in a sophisticated multi-processing mode.

Satellite & Remote Processing: Ramifications of these system concepts are the ideas of satellite and remote processing. These approaches may or may not use long distance communications, but the idea is to use a remote large computer, with something smaller at the customer site. Satellite processing is the term applied to the use of a customer's small computer tied into a remote large computer.

The small computer would do editing and minor local problems. It would automatically draw on the large capacity and memory of the remote large computer for file inquiry or overflow problem handling.

With remote processing only the problem input/output means would be located at the customer's site; the remote computer would solve the computational problems and provide all memory and file storage functions.

Another industry controversy concerns centralized vs. decentralized computers. The problem is the competition between the small self-standing computer and the large central computer with many small remotes tied into the central machine with data communications.

Which approach gives the best performance, and the best cost/performance to the small user? The high cost of data communications and questionable reliability are obstacles to effective decentralized small user complexes built around a large central. Which way it turns out in the future will be determined by the resourcefulness of the proponents of each systems approach. However, if small machines can be built at low enough cost, they have the real advantage, in that, everyone prefers his own machine.

There has been a feeling in the industry for a long time that the larger and faster a computer, the lower the cost per computation. This is not necessarily the case if one makes this comparison using all of the technologies available at any given time. And it certainly will not be the case in the future if low cost, high speed methods evolve which are suited for making small but not large computers. An example of such a method might be the 500 MC. circuits.

While there are not large memories that could be used at such speeds, there are small ones; and because of the limited logical gain of this kind of circuit, and signal propagation limitations, it is conceivable that a small computer could be built that had a lower cost/computation than a large computer. The reasons this has not been done are also simple—of the kinds of problems needing computer solution, they are either larger problems than most small machines can handle, or the problems are data processing uses where the cost of the computer is only a small portion of the cost of the peripherals necessary to print, handle cards and paper tape, and store data

on discs or random access memories. Centralized vs. decentralized machine will continue to be a controversy between computer system developers.

Compatible Computer Families: The real trend to a family of small, medium, and large size computers, that are program-compatible upward, has arrived. All major computer companies have recognized both the need and their capability to provide these families. The problem originally associated with this concept was the price one had to pay to provide this upward compatibility in the larger machine. This price was both in the higher shop cost of the larger machine and/or in the reduced performance of the larger machine in its own right. This problem has now been solved, with computer organization structures and instruction formats which allow for this growth as the smaller machine is designed. This is really the answer to both the manufacturer's and the user's problem of conversion when the user's load builds up and he is otherwise faced with the task of converting to a new and different larger-scale computer.

Two of the major system concepts which have enabled this growth compatibility are the ideas of memory buses and common peripheral interfaces. With a memory bus, the builder can introduce bigger and faster memories in his basic structure. With a standard interface going out to his peripherals, he can have a variety of computers, each working with the same peripheral instructions and the same peripherals.

Thus far, we have discussed problems and trends the engineers are involved with in the design of the computers themselves.

Input/Output Trends

An equally important problem is the development of input/output machines which will ease the difficulties and cost of getting the business's information into and out of the computer. Operators of large computer centers often state they would not mind having a new, larger, faster computer—but what can they do to eliminate the keypunchers? The crude methods used to collect information, and the equally crude methods used to distribute results to its users severely limit computer uses.

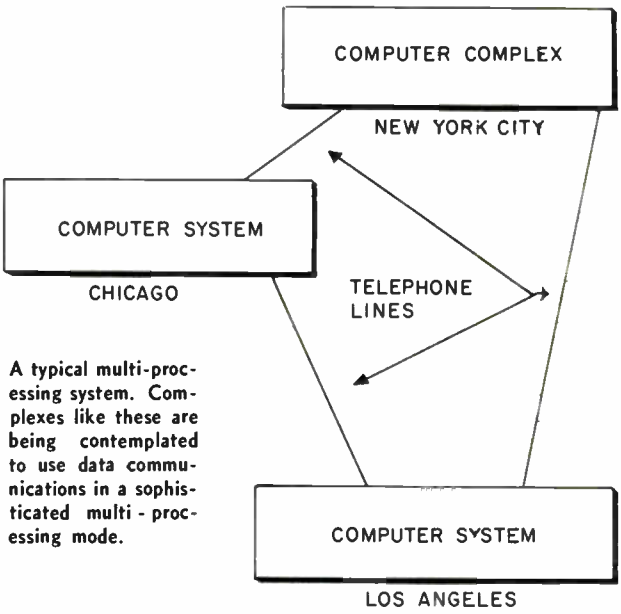
Character Reading: Lately, machines for reading printed characters have been introduced as a partial solution to the input limitation. Depending upon the kind of use, and in particular on the kinds of mutilation and over-printing, these machines read characters printed with magnetic ink for magnetic scanning or with regular ink for optical scanning. Main advantage of magnetic ink is the ability to read it despite severe over-printing.

The steady gaze of this Otus asio owl is an important factor in studies being conducted on the nervous system by the Massachusetts Institute of Technology. The owl's pupillary system is under careful scrutiny by a computer in an effort to develop a clearer understanding of human nerve and brain disorders.

The advantage of optical scanning is the potential ability to read printing from any source. The limitation on all present character readers is that they should only read printing put out from certain specified sources. This constraint is usually placed on the type font; a given reader reads fonts made by certain printers or typewriters much more reliably than other fonts.

The trend for source document input is certainly for character reading. And, except for uses needing the highest reading reliability on documents subject to mutilation, optical scanning has developed to the point of greatest potential for general computer input.

The current challenging problem in optical character recognition is the design of a standard font.



A typical multi-processing system. Complexes like these are being contemplated to use data communications in a sophisticated multi-processing mode.

DATA PROCESSING (Continued)

This font should have the maximum reading reliability. It should be readable by the lowest cost reader consistent with the fact that generally many printing or encoding devices are involved, but only a few character readers. The font must be easily printed by cheap imprints and read with few rejects or errors. A measure of the adequacy of any given font design is the separation between various characters in that font. The greater the distance between the characters, the greater their potential to be reliably recognized. A difficulty with this concept is that the concept of distance must be coupled with the concept of resolution. Optical noise or distortion in the font image picked up by the transducer, or electrical noise picked up before decoding this font image, can significantly modify the apparent distance between characters within a given font. Effect of non-linear noise and distortion cannot be calculated in general, particularly with respect to its effect on the non-linear decision-making recognition electronics. The only significant answer to this problem is simulation and field test of the font and its reader under realistic conditions.

Document Handlers: Computer installations are getting to be paper handling factories in many instances. With the crush of source documents and mass-punched cards, paper and document handlers are becoming a major product. The trend for input card readers or bank check readers has been to go from one stacking pocket to two. In the future, it will probably continue to five or ten pockets, even for the input devices.

A 12-pocket MICR document handler. It can read and sort bank checks and other documents at the rate of 1,200 per minute.

The reason for this is that engineers are recognizing that it saves time and effort to physically separate the input documents by varying criteria, such as, whether or not they were read successfully. Shutting a large computer down just because the input device mis-read a card or a character is an expensive waste of computer time.

Another future trend in document handlers is toward completely self-contained units which will, for example, sort a given batch of bank checks into complete sequence without having an operator pick up the stacks under each pocket during each pass. Cartridges or magazines which are appearing on some document handlers to speed the manual handling of the large volumes of input and source documents evidence this trend.

Re-entry Printers: Final partner in the immediate input/output family of character reader/document handler is the computer connected printer capable of printing fonts on documents that can be distributed to customers. These include bills, invoices, and tickets for automatic re-entry into the computer when the customer sends in his payment or uses his ticket.

Management Display Devices: Military systems are leading with the use of direct computer-connected display methods for command management purposes. Little work has been devoted to the extension of displays for managements using business data processors, but a need is there and management displays will evolve.

A question related to displays is the ability of data processing systems to work directly with managers. An ideal approach is to have a small management display and inquiry console located in the manager's office. With this console, the manager can issue a rapid series of questions and look at the answers derived from all the files available to the computer. He can then ask questions as he sees partial answers and obtain a paper copy of the data he wants to keep.

Advantages of such a hypothetical system are obviously many. Time is saved; the manager can see as much as he desires of the data and the analytical process; programming and keypunch operations are eliminated; and waste of reams of relatively useless print-outs is bypassed.

(Continued on page K13)

The operational system gathers data from many facets of a business on a current basis, processes them according to a stored program and makes the results available immediately to management. The goal is to react faster and more efficiently to a given situation.

OPERATIONAL SYSTEMS... A CURRENT COMPUTER TREND

WHEN COMPUTERS FIRST APPEARED, many of them were used for record keeping and manipulation of historical data. This was to be expected. Their ability to store vast amounts of data in one place, and then retrieve any or all of it rapidly, marked an end to many problems. This was particularly true in such industries as insurance, utilities and banking.

Simulation

As industry became more familiar with the tool, there was a change in emphasis—and important new concepts emerged. Among these was a better method of planning. This covered the scientific computing and operations research areas. Here both physical phenomena and economic situations are reduced to mathematical terms. They are then stored in computers as simulated models. Management presents a series of hypothetical "what happens if . . ." questions to this model. It gets back a survey of possible results, or the best possible choice among many alternatives.

A numerically controlled jig borer automatically machines a part. Jig borer is directed by a punched paper tape produced by a computer. AUTOSPOT language was used to write the program.

Simulation is particularly successful in the aerospace and electronic industries. At the George C. Marshall Space Flight Center in Redstone, Ala., computer simulated models of Saturn rockets are "built, flown and torn down" many times before an actual prototype is constructed. Without the expense of building actual vehicles, engineers get a good idea of how various configurations will perform under different sets of conditions. Result: savings in both time and dollars.

Another important area for simulation methods is in design. Computers can be used to design new random access memories, process control systems, and system components.

The method of building a mathematical model and then simulating the philosophy of engineering has proved to be an important adjunct to the build-and-try approach. In development of a part such as a cam, for instance, time can be cut from 120 hr. by manual methods to just 50 min. on a computer. Also, accuracy of the computer-produced cam is 0.0002 in. as compared with 0.0003 in. for a hand produced one.

Aerospace Uses

Aerospace engineering is a fruitful area for advanced data processing methods. It has been estimated that from 70 to 90% of engineers' time in this industry is spent on non-creative chores. Other problems are increasing product complexity, rigid reliability needs, and an advancing technology. Changes and modifications must be made at every stage of a product's life. These changes create mountains of paperwork and data.

By ROBERT E. CLEMENT
Manager, Industry Marketing
Data Processing Div., IBM Corp.
White Plains, N.Y.

Customer engineer hooks up power cables inside the main frame while installing a computer system.

OPERATIONAL SYSTEMS (Continued)

Future data processing needs for this industry are in six major areas: information dissemination and control, structural design, electronic design, reliability assurance, engineering data control, and configuration management.

A mechanized approach to the first of these problems — information retrieval — is inevitable. Over 8,000 journals publish almost a quarter of a million papers a year. Most of this information is valuable for only a short period of time. Also, specific nature of the data requires a more selective method of indexing than has been used in the past.

To overcome these difficulties, information centers using both broadcast and selective dissemination methods need to be developed. Both approaches make use of the computer, which can maintain bibliographical files of current literature, indexed according to key title words. A periodic computer printout lists the latest articles according to key words. This allows an engineer to select rapidly those of value to him.

The selective dissemination method compares the bibliography index with an interest profile established for key engineering personnel and selects and prints out titles of interest to them. The interest profile may also be used to help locate the persons most knowledgeable on a certain subject. These methods can be applied to many industries and professional disciplines.

Operational Systems

Simulation and information retrieval are examples of computer methods developed to solve specific problems. But perhaps more important is the trend toward operational systems. These systems, in effect, gather data from many facets of a business on a current basis, mathematically "massage" it according to stored programs, and make results available immediately. In some cases this means a real-time closed-loop system whereby an event is sensed, translated into digital terms, fed into a computer, projected and corrected within seconds and without manual intervention. This is a "total" system. In other cases it involves updating of many files from a single input so that the total company picture is accurate at all times. In all cases it means putting current information and alternative solutions at the elbow of management so they can react faster and more efficiently to a given situation.

Such operational systems are of value in almost all areas of computer use. In manufacturing industries, for example, there are many systems planned or underway where the objective is control of production.

At Inland Steel in Chicago a computer has been tied directly to a blast furnace for the first time in the history of the steel industry. An IBM 1710 is

linked to analog measuring instruments at the furnace. These devices are scanned at the rate of 20 measurements a second, translated into digital terms and compared with predetermined parameters stored within the computer. Any abnormal situation is displayed to engineers as an exception item. Reaction is fast, positive and effective.

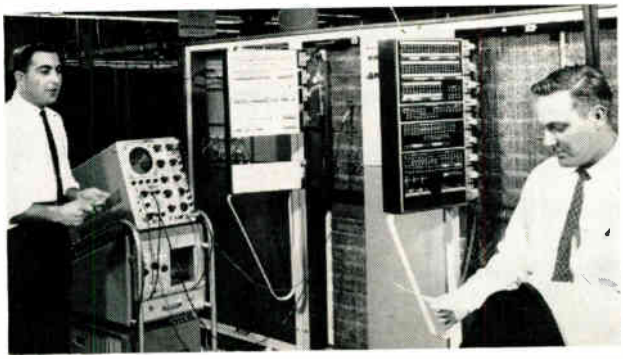
In the petroleum industry there are examples of catalytic cracking units being adjusted on-line as the result of computer calculations. Measurements are fed directly from the unit into a computer. Once within the system they are projected and compared with previously stored parameters. If the computer —through its stored program—determines that flow, temperature, percentage or any other factors are out of line, then an analog signal is generated to adjust the cracking unit. Thus, direct control of a production device is effected on a totally "hands off" basis.

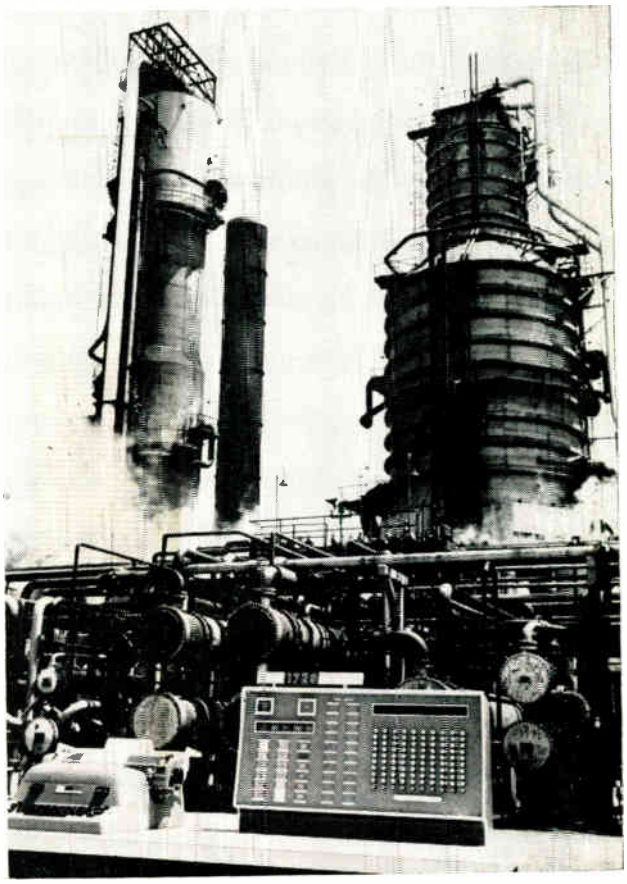
Paper making is another process benefiting from operational systems. Instrument readings from hundreds of points along a paper production line are translated from analog into digital terms by a data converter. Once in digital form, the information is fed into the computer, which compares these samples against standards already stored in the machine. Needed adjustments are printed out for monitoring of the paper run, or are fed directly on-line to the various production units for real-time corrections. In either case, the results are greater product uniformity, reduction of off-grade runs and higher efficiency.

Operational systems are not restricted to the real-time control or rapid adjustment of production machines. They are just as valuable in distribution and service industries.

One California distributor uses a Management Operating System (MOS) to: (1) provide a daily shipping schedule for supplying thousands of stores with over 100 fast moving items; (2) update inventory levels at 50 warehouses; and (3) produce daily production schedules for 21 plants distributing over $100 million worth of products annually.

Engineers test the 7750 programmed transmission control. Unit enables users to design IBM Tele-processing system in which communications nets are linked to a single computing center.





This American Oil Co. 140,000-barrel-a-day crude-oil still will be under continuous computer control. Operator's console for fully automatic, or closed-loop system is in the foreground.

MOS, in essence, is an total systems concept designed to provide continuous coordination among the sales, inventory, shipping and production facilities of a company.

Another computer approach to inventory management is a program known as Inventory Management Program and Control Techniques (IMPACT).

Through a series of mathematical and statistical methods—all written into the program—it answers those two critical management questions "when to buy and how much" with more precision than was ever possible before.

IMPACT is made up of three basic functions stored within the computer: ordering, forecasting and reviewing. The ordering function determines how much to order. Forecasting has to do with the order point, or when to order.

Finally, the reviewing function parallels the action of a buyer in analyzing stock status figures. The order point set by the forecasting function is compared with available stock to find out if inventory is low enough to order. If it is, the reviewing function

(*Continued on page* K23)

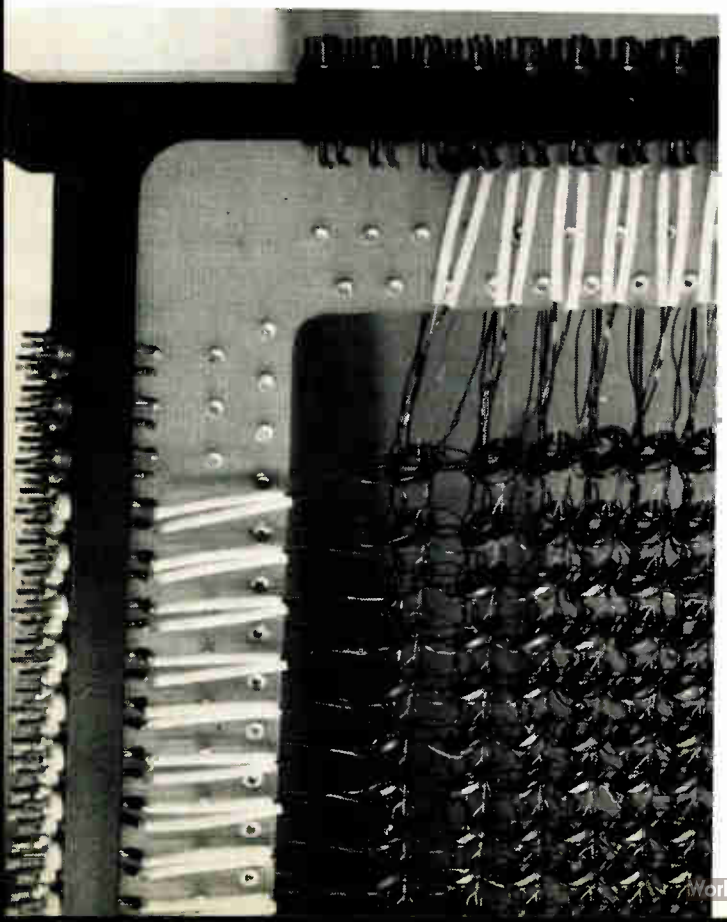
PROCESS CONTROL (Continued)

Software

Development of process control software is as much a part of the state-of-art as the hardware changes. While its progress has not been as rapid as that of hardware, its importance cannot be overlooked. Availability of process control compilers enhances the prospects for long-term control computer success as much as any other single item.

Programming has always been both time-consuming and costly. To ease these difficulties, computer manufacturers have developed a number of compilers (FORTRAN, ALGOL, and COBOL) which are problem-oriented, mainly toward scientific or business data processing problems. With industrial process control, a further software development was needed. This development has been made more difficult, however, by the variety of computational tasks inherent to a typical industrial process. In addition to the areas similar to scientific and engineering calculations of the general purpose computer, process control programming is confronted with unique routines: Logging, scanning and limit determinations. The compiler must also be comprehensive enough to effect complete on-line control of physical, real-time processes.

Typical core memory matrix is shown. Hand-wiring of the matrix accounts for a large percentage of the core memory cost.



Previously, no available software system has been adequate for all these needs of process programming. For this reason, PROCOMP, an integrated process control software system was developed by TRW. This system allows for programming in user-oriented language. It was designed with a number of basic building blocks so that computer addressing is available on several levels. It contains computational statements for linearization and scaling, and FORTRAN statements for algebraic equation interpretation.

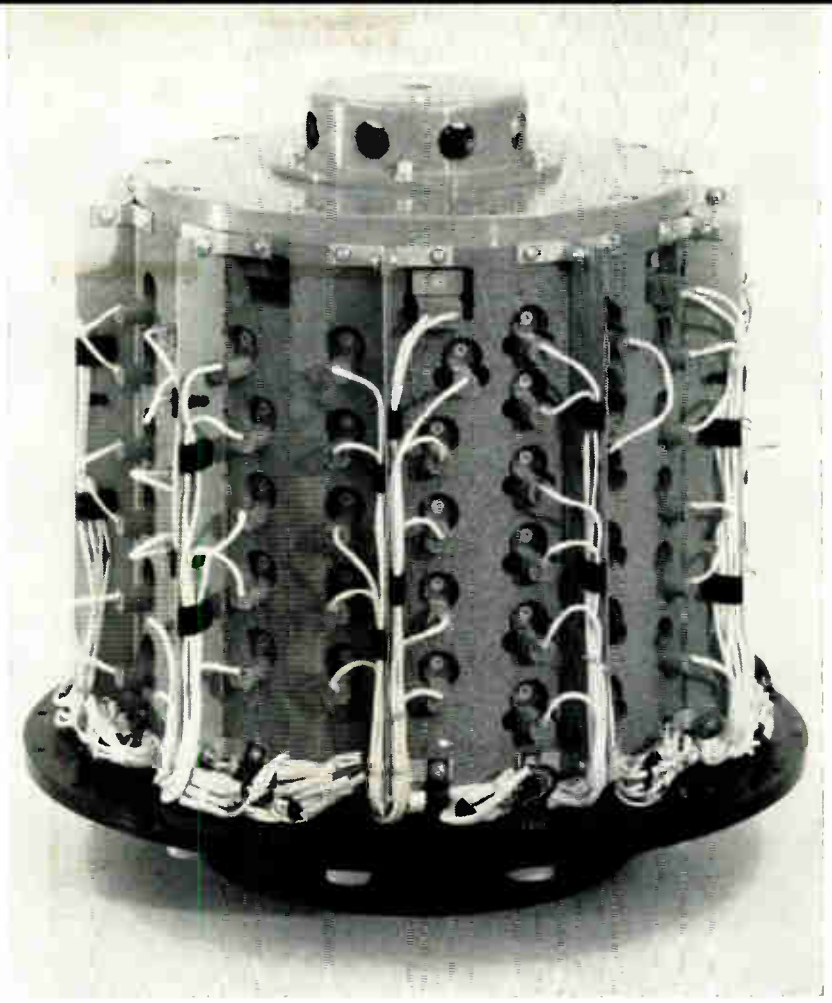
Future Trends

Several users and manufacturers are investigating the use of direct digital computer control systems as a substitute for normal single-loop controllers. By eliminating a cost of $500 to $1000 per set-point controller, a digital computer controlling several hundred loops simultaneously could offer savings in plant investment. In many cases, it would also provide better control than the normal analog controller, plus a gain in accuracy, flexibility, and display convenience. This is the direction in which the process industries are heading; a few of the approaches to this as yet unresolved area are offered.

Machine-time availability of supervisory and optimizing control computers is quoted at 99.5%—or all but about 40 hr/yr. However, for direct digital control, a big improvement is needed. Four approaches are listed, from the most expensive way of achieving higher availability to the cheapest method. The first three solutions are too costly; the fourth already has been used successfully in some installations.

1. Use two small computers back-to-back to perform the controller function; when one system is down, the other automatically takes over.
2. Use one small computer with a redundancy of circuits that would be active. (It is debatable how much less expensive this would be than #1.)
3. Use a supervisory computer as back-up for a small satellite computer; if the satellite computer is down, the supervisory computer can interrupt its optimizing operation and temporarily take over.
4. Use a supervisory computer for direct control and omit the critical set-point controllers from the computer program (provide normal control with the most critical areas where any computer failure is not tolerable).

At this point it is impossible to predict which, if any, of these solutions will be the accepted means of achieving direct digital control. Perhaps this control will only be economically feasible using the fourth



Exterior of a magnetic, bulk-memory drum. As the drum revolves within this frame, the read-write heads extract or deposit information bits according to programmed instruction. Drum speed is 3600 RPM.

approach, with continually improved optimizing computers gradually taking control over more and more loops.

It should be restated that computer manufacturers are actively striving for faster and cheaper memory systems; but there are doubts that they will have them in the near future. Fast, homogenous memory is, of course, wanted in any system; but by the time the core memory price is reduced, a breakthrough in still faster memory systems is likely to occur. If this happens, non-homogenous memories probably will be used indefinitely.

DATA PROCESSING (Concluded)

The trouble is that we do not yet know how to do all of these things as cheaply as we can by using filing cabinets, secretaries, financial analysts, and conventional computers, printers and output plotters.

Automatic Filing Systems: A needed part of future computer systems is the electronic filing system. Such files will contain both analog information (statistics, costs, etc.) and identity codes. This file is desirably accessible via program control, displayable and changeable via remote console control, and centrally locatable.

Thermoplastic tapes or disc memories are suited to such use because of their erasability characteristic and because of their high storage capacity for analog, digital, and color information. Systems of this nature have been made using microfilm or Kalvar as the basic storage medium. These systems have generally limited themselves to semi-permanent storage where the partial contents of each file are not changed. File updating is done by replacing large chunks of the file with, for example, a new micro-film strip.

Likely uses for these systems are for large personnel files, finger print and criminal records, title and other public record files, and for patent, legal, or even medical records, pictures and charts.

Conclusions

New methods in computer system structures, computer designs and devices and in their input/output media are coming. They will have a dramatic effect on people's lives, businesses, and activities.

Computers are accepted and used by growing segments of our society. They are no longer oddities. They are a basic tool, reasonably available and commonly used in most businesses, academic, civic, governmental, and military activities.

The engineering problems at this stage of development are to make computers easier to use; more accessible in cost; more reliable and effective; and more generally applicable to a broader spectrum of applications and customers.

NEW TECH DATA

for Engineers.

Integrated Circuits

A 16-page booklet discusses design problems in integrated circuitry, details the PEC® concept, and describes the manufacturing process. Illustrated, colorful booklet describes integrated circuits, gives case histories, involving such uses as in computers, undersea detection equipment, stereo equipment, electronic organs and cameras. Centralab, The Electronics Div. of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wisc.

Circle 360 on Inquiry Card

Digital Systems

A colorful 36-page brochure details activity in the design and development of specialized digital systems. Systems are described in each of 6 broad application areas: space, defense, industry, business, education, and science research. Computer Control Co., Inc., Old Connecticut Path, Framingham, Mass.

Circle 361 on Inquiry Card

Computer Tape Preparation

Systems applications showing computer-tape preparation from analog and digital data by use of EECO 751 Computer Format Control Buffer are part of a 16-page brochure available from Electronic Engineering Co. of California, Box 58, Santa Ana, Calif.

Circle 362 on Inquiry Card

Magnetic Tape Systems

Data Sheet No. 1-204, describes the MT-36 magnetic tape transport, and magnetic tape systems. Designed for moderate data transfer rates, the equipment is well suited for use with small and medium-scale computers in mass storage and sequential access operations. Potter Instrument Co., Inc., 151 Sunnyside Blvd., Plainview, L. I., N. Y.

Circle 363 on Inquiry Card

Logic Modules

Information on transistorized digital modules for control, drive and translation in crossbar switching applications is available from James Cunningham, Son & Co., Honeoye Falls, N. Y. Modules have 0, —6v inputs. Zener diodes suppress inductive circuits to protect transistors.

Circle 364 on Inquiry Card

Magnetic Tapes

Spec. sheets describe a new line of professional tapes which includes a log-print master tape, a high-output master tape and a new duplicating tape. Data sheets list the tapes' electromagnetic and physical properties. Reeves Soundcraft Corp., Great Pasture Rd., Danbury, Conn.

Circle 365 on Inquiry Card

Computer Circuit Analysis

A 6-page brochure entitled SPARC explains simulation of electronic circuits and sub-systems on RECOMP computer to achieve greater reliability, improved efficiency and reduced costs. SPARC system provides ac, dc and transient analysis on a computer operated independently by engineer. Autonetics Industrial Products, 3400 E. 70th St., Long Beach 5, Calif.

Circle 366 on Inquiry Card

Plug-in Logic

Data sheet describes transistorized plug-in digital logic elements that make it possible to readily convert from logic diagram to operative system. Input and output connections are made on a color coded front panel imprinted with appropriate logic symbols. Logic symbol concept also makes the line ideal for breadboarding systems and teaching digital logic. Tech Serv, Inc., 5451 Holland Dr., Beltsville, Md.

Circle 367 on Inquiry Card

Synchro/Servo Catalog

A 44-page catalog gives electrical and mechanical characteristics on synchros, servo motors, precision computing resolvers, linear transformers, motor rate tachometers and other rotating components. Synchro information is included for sizes 8, 10, 11, 15 and a wide variety of gyro pick-off (pancake) synchros. Also included is detailed information on the company's servo motors, including 24 detailed performance graphs. Catalog contains considerable general information on rotating components and the servo field. Clifton Precision Products Co., Inc., 5050 State Rd., Drexel Hill, Pa.

Circle 368 on Inquiry Card

Perforated Tape System

Data Sheet No. 2-110, describes the PTR/PTS perforated tape system. The standard 2-speed PTR-500 reads tape dependably at 25 or 50IPS. The bi-directional reader uses photoelectric sensing with silicon solar cells to read 5, 7, or 8-level perforated tape. PTS-500 perforated tape spooler provides tape supply and takeup. It operates compatibly with PTR-500 at speeds up to 50IPS. Potter Instrument Co., Inc., Sunnyside Blvd., Plainview, L. I., N. Y.

Circle 369 on Inquiry Card

NOR Logic Modules

Data sheets describe in detail silicon-transistor U-series universal NOR logic-welded modules available from Engineered Electronics Co., 1441 E. Chestnut Ave., Santa Ana, Calif. Products covered include dual NOR circuits, dual dc drivers, ac power drivers, converters, multivibrators, one-shots, flip-flops and circuit-board assemblies. Price list is also included.

Circle 370 on Inquiry Card

Printed-Circuit Connector

Catalog PC-1, 20 pages, includes photos, dimension specs. and performance data. Among the connectors covered are Micro-Edge® printed-wiring receptacles and Micro-Min® connectors with 0.050 in. centers plus special printed-circuit connectors. Literature entitled, "How to Select the Best Connector for Your Printed Circuit Requirements" is available from Amphenol Connector Div., Amphenol-Borg Electronics Corp., 1830 S. 54th Ave., Chicago 50, Ill.

Circle 371 on Inquiry Card

Low-Power Thin Films

Univac® has developed low-power thin films that are compatible with molecular integrated circuits. The films operate reliably at drive currents of 20 to 30ma; have a flux of 0.2ma; and an output of a few tenths of a mv. The reduction in drive-current was accomplished by 2 radical approaches to thin-film fabrication. Univac, Div. of Sperry Rand Corp., 315 Park Ave. So., New York 10, N. Y.

Circle 372 on Inquiry Card

Memory Brochure

This brochure features uses of delay-line serial memories to 3C digital systems. Applications include signal processing, detection and analysis equipment, digital computers and other related special-purpose instruments. Detailed are systems descriptions and specs. Computer Control Co., Inc., Old Connecticut Path, Framingham, Mass.

Circle 373 on Inquiry Card

Pin-Board Programming

A 20-page booklet describing many uses and applications for Sealectoboard pin-board programming devices is available. Entitled, "Sealectoboard Design Ideas for Engineers," the booklet offers detailed information on the operation and function of the cordless program boards. It also provides complete case histories of the boards in actual applications such as data loggers, process analyzers, automatic inspection equipment, machine tools and control selectors. Sealectro Corp., 139 Hoyt St., Mamaroneck, N. Y.

Circle 374 on Inquiry Card

High-Speed Printer

Brochure describes Series 1000 Digital Electronic Alpha-Numeric (DEAN) Printer. It prints over 8,100 lines/min.; over 6,000 characters/sec. Firm also has brochures on an FM telemetry calibrator (Model 850), digital Decalock oscillators (Series 820), and a direct writing oscillograph (Model 444P). Century Electronics & Instruments, P. O. Box C—Admiral Sta., Tulsa 15, Okla.

Circle 375 on Inquiry Card

The tape with the built-in duster!

1000 times greater conductivity than ordinary tapes! That's how "SCOTCH" BRAND Heavy Duty Tapes drain off static charges before they can attract dust. That's the built-in duster that flicks away the growing danger of dust-caused dropout errors . . . a danger greater than ever as higher and higher recorder speeds and tape tensions generate more and more static.

Electrical resistance of the oxide coating of "SCOTCH" Heavy Duty tapes is 50 megohms per square or less. The resulting conductivity, unusual in magnetic tape, not only avoids dust contamination, it minimizes such other static problems as tape drag and skew, noise induced by arcing.

Heavy duty formulation of binder and high potency oxides withstands temperatures from −40 to as high as +250°F to conquer high head heat, assures tapes that outlast standard tapes by at least 15 times. Exclusive Silicone lubrication reduces recorder head and tape wear. And "SCOTCH" Heavy Duty Tapes are offered for all high-speed applications, even for extreme high frequency and short wavelength requirements. 16 different constructions include a variety of backing and coating thicknesses.

TECHNICAL TALK Bulletin No. 4 provides detailed discussion of the effects of static electricity on instrumentation recording, offers helpful information in solving static-caused problems. It's free. Write 3M Magnetic Products Division, Dept. MBR-63, St. Paul 19, Minn.

NEW TECH DATA

UHF Signal Generator

Information on a new UHF standard signal generator, Type SDAF, with a freq. range of 170 to 940MC in 9 sub-ranges, is available. The unit has been designed for use in conjunction with AM, FM and video equipment. Its output, continuously variable from 1.0μv to 0.5v., may be either AM or FM, or both simultaneously. Rohde & Schwarz, 111 Lexington Ave., Passaic, N. J.

Circle 624 on Inquiry Card

Tapes

Information on Memorex Types 22, 33, 42, and 62 is available. Type 22 is for use on standard digital computer transports; type 33 is a magnetic instrumentation tape; type 42 in a high-resolution tape; and type 62 is a broadband tape. Memorex Corp., 1180 Shulman Ave., Santa Clara, Calif.

Circle 625 on Inquiry Card

Crystal Oscillator

Tech. data is available on the Model 140000 crystal oscillator, a unit for printed-circuit board mounting and other tight locations. It is available in the 3KC to 150MC range, with fixed freq. output if desired. Greenray Industries, Inc., 5281 E. Simpson Rd., Mechanicsburg, Pa.

Circle 626 on Inquiry Card

Power Transistors

Information on 4 pnp germanium-alloy junction-power transistors is available from General Precision Aerospace, 1150 McBride Ave., Little Falls, N. J. These hermetically sealed, dynamically-tested units have an internal heat sink which allows a dissipation of 0.4w in free air or, with heat-sink well, 8w. Characteristic curves are included.

Circle 627 on Inquiry Card

Instrument Catalog

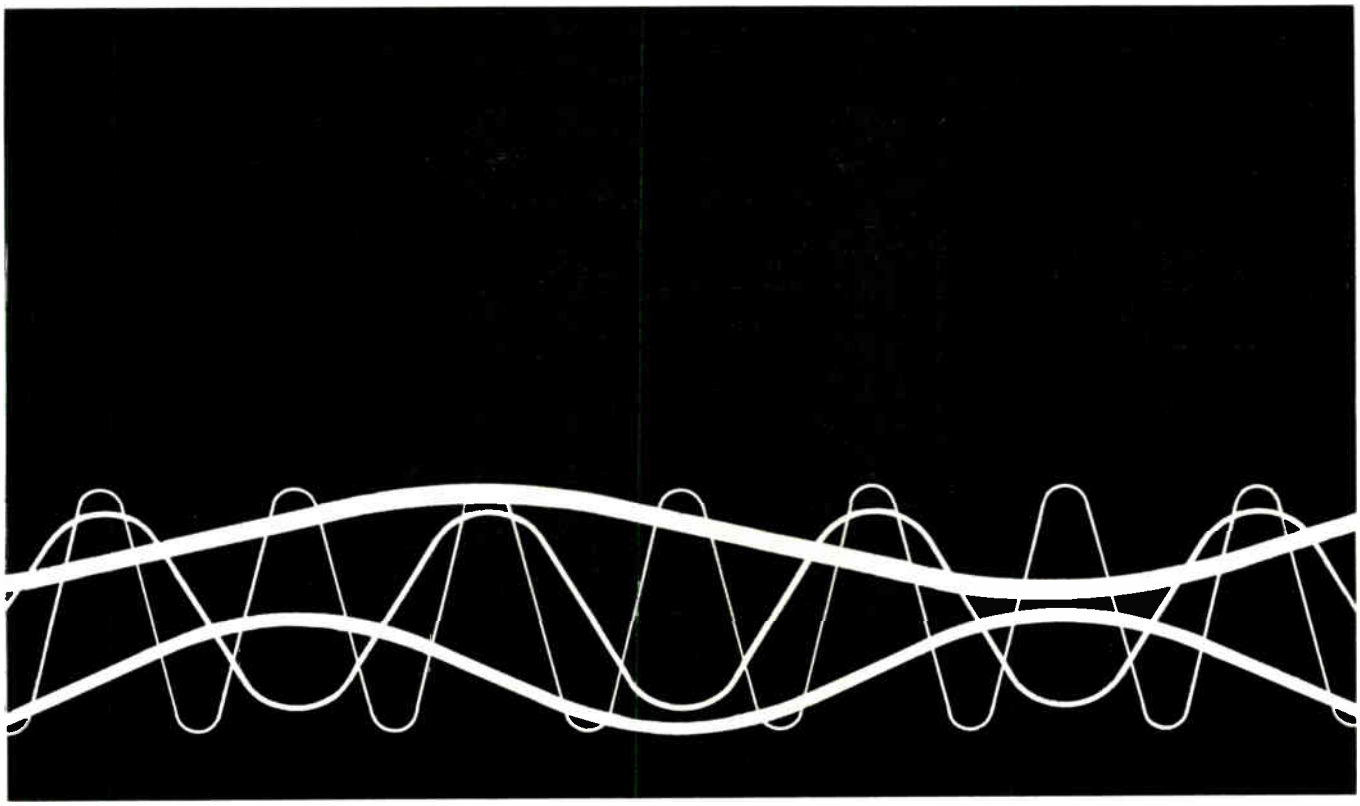
A 44-page catalog describing a full line of sensitive electronic instruments is available from Keithley Instruments, Inc., 12415 Euclid Ave., Cleveland 6, Ohio. It contains sections covering measurements, dc high-voltage supplies, nuclear instrumentation, and space science instrumentation. Many sections are preceded by introductory pages discussing problems, applications, and instrument selection applicable to the measurements involved. Selection charts are also provided.

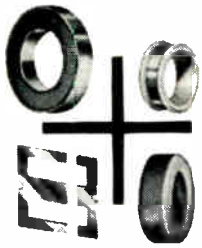
Circle 628 on Inquiry Card

Multi-Purpose Readout

Data is available on the Digivisor, a one-plane, in-line digital readout device that will accept analog, decimal, or binary input directly from low signal voltage. Industrial Electronic Engineers, Inc., 5528 Vineland Ave., N. Hollywood, Calif.

Circle 629 on Inquiry Card





Optimizing circuit components to frequency? Get more from magnetics

THE CORE: What's the best core for operating at low frequencies? What powder core or flake core is best for a higher frequency? That depends on what you're looking for. Frequency alone does not determine where one type of core should be used in favor of another. There's an overlap of usefulness and many core possibilities within a frequency range. Core choice for optimum performance at a given frequency must be related to core cost, and operating temperature, to name a few. Optimizing comes from a careful analysis of the many variables. The *man from Magnetics Inc.* will re-acquaint you with them and will assist you with your selection.

THE MORE: The 550 mu Permalloy cores permit greater circuit miniaturization, bridging the design selection gap between laminations and powder cores. Or, choosing a laminated core where you may have thought to use a powder core might be just the thing to effect lower costs, size reduction, operating stability, and high efficiency. Because we produce and stock a wide range of sizes and types of high permeability components, we can assist you a little more than most. Just how much more? Ask the *man from Magnetics Inc.* next time he calls . . . or write us on your letterhead giving the details of your problem. Magnetics Inc., Dept. EI-6 Butler, Pa.

TOTAL ASSISTANCE, SERVICE, SELECTION/GET THE MORE FROM MAGNETICS

MAGNETICS inc. ®

NEW TECH DATA

Logic Card Connector

The MOD-U-CON female receptacle contains three-fingered 30 contacts. Each basket-weave contact has double readout taper pin receptacle, providing 60 different readout positions. The mating male plugs are right angled, 15-pin strip connectors for solder dipping to a printed circuit board. Modular Electronics, Inc., 21-4th St., S.W., Osseo, Minn.

Circle 630 on Inquiry Card

Electrometer

Bulletin 781 describes the Model CS-57 electrometer, which eliminates inaccurate readings caused by damage or component changes within the instrument. Each range may be checked in seconds. It is capable of current increments from 10^{-3} to 10^{-13} amps. Information includes specs. and a block diagram. Gyra Electronics Corp., P.O. Box 184, La Grange, Ill.

Circle 631 on Inquiry Card

Integrated Circuit Headers

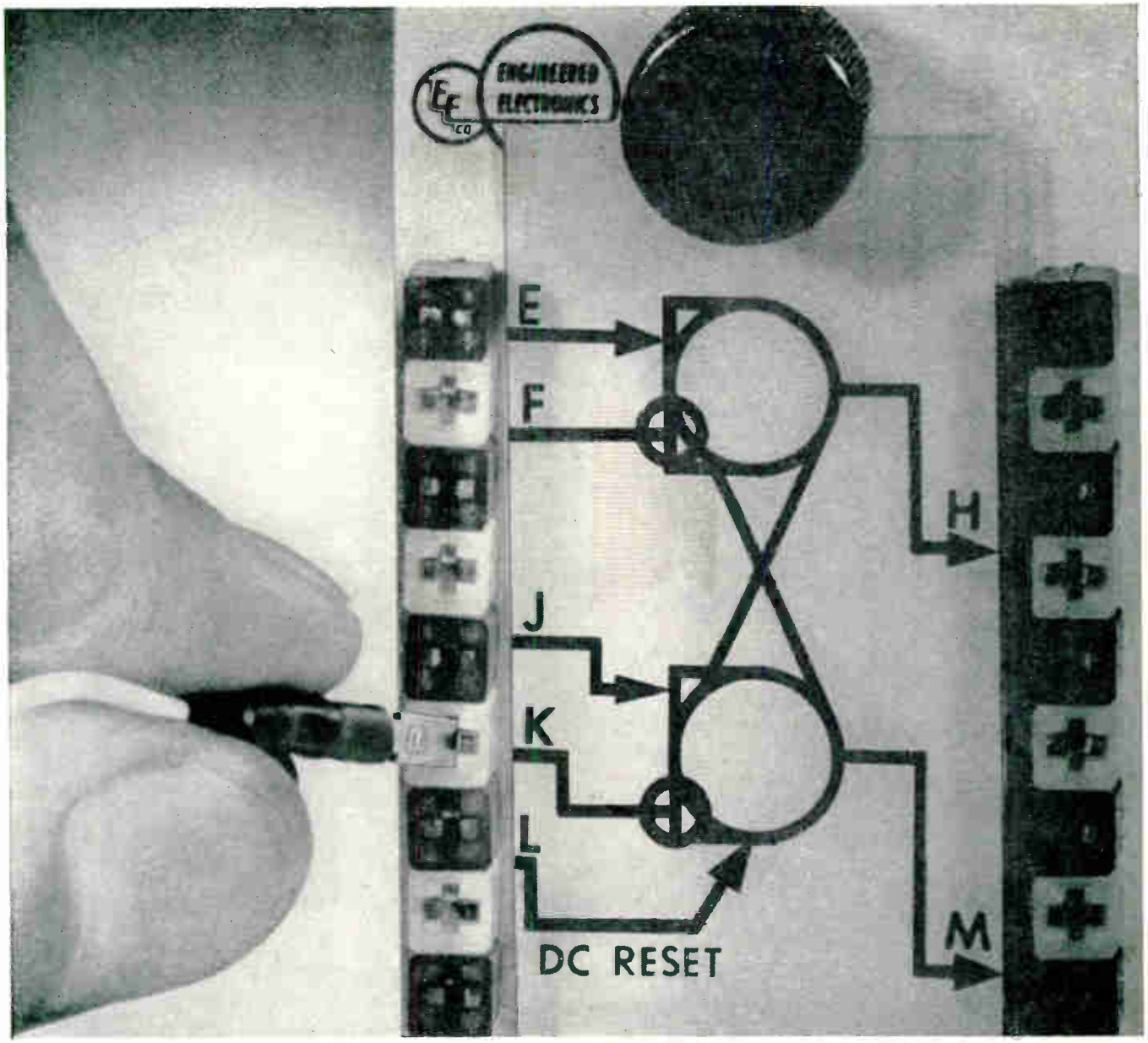
Information is available on multiple-lead, integrated circuit packages. These packages are available in the basic TO-5, TO-18 and TO-46 configurations. Lead combinations vary from 1 to 12 per package. Grounded and ungrounded leads are optional. Dept BN, Glass-Tite Mfg. Div., Glass-Tite Industries, Inc., 725 Branch Ave., Providence, R. I.

Circle 632 on Inquiry Card

Oscillating Tables

Illustrated, 2-color catalog product data sheet on oscillating rate tables and flight simulation test equipment is available from Micro Gee Products, Inc., a sub. of Menasco Mfg. Co., 805 So. San Fernando Blvd., Burbank, Calif. The data sheet contains descriptive information on the new Model 64A Oscillating Rate Table. Major sections include operating description, specs., including dimensional information, data on uses, price and delivery. Of interest to test and environmental check-out engineers, designers and users of gyroscopes, accelerometers and flight package. Request Model 64A oscillating rate table data sheet.

Circle 633 on Inquiry Card



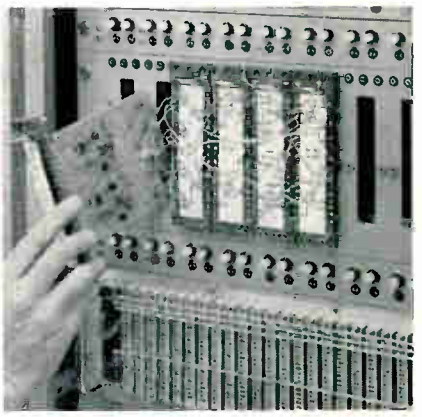
HOW TO BREADBOARD A 10 MC DIGITAL SYSTEM—FAST

Your fastest, surest means is EECo's new high-speed system breadboard. This transistor unit lets you: (1) patch up trial circuit combinations with the same catalog modules that go into the final system, (2) perform tests at operating frequencies by pushbutton and (3) get a "stop-action" look at the over-all logic flow.

Using patchcords, you can hook up, take down or change circuitry at will to study the effects of wiring, propagation delay, clock duty cycle and alternative design approaches. And, because you use field-proven modules in the breadboard, you know that the final system will work.

EECo equipment has no equal for practicality or versatility. It is completely self-contained, but has provision for external test equipment. The built-in clock source lets you apply pulses singly or in pairs. You may operate the system slowly to watch individual operations or at high speeds to simulate end-system performance. To help you patch your circuits together, EECo provides handy symbol cards — cards that indicate module circuitry, part numbers and input-output pin connections to give you a road map of the system as you assemble it.

The more you value your time and ability, the more you can benefit by using EECo breadboard equipment. Write today for the full story.



Breadboard (first stage shown) uses standard EECo catalog modules, permits pushbutton tests at operating frequencies.

ENGINEERED ELECTRONICS Company
1441 East Chestnut Avenue, Santa Ana, California
Telephone 547-5651 • Cable Address: Engelex

PHOTOCONDUCTIVE DEVICES

(*Continued from page* D17)

All types of CdS and CdSe photocells are limited to a maximum operating temperature of 70° to 80°C. Thus, when handling power they must be provided with adequate heat sinks. Further, the sensitivity of CdSe decreases sharply with increasing temperature so that CdSe is not used for high power. Since moisture greatly affects every type, plastic encapsulations are not widely used.

Applications

Photoconductive devices of interest are really resistors whose value of resistance depends upon the incident light intensity. Thus, we shall refer to these devices (CdS and CdSe) as light dependent resistors (LDR).

Vacuum and gas-filled photoelectric devices can usually be replaced by LDRs where sensitivity is important but not speed. Here photoconductive devices do not need amplifiers. The lower power units need an intervening relay, but even this can be left out by using the high power device now on the market.

Of course, the applications of interest are those in which the LDR cannot be replaced by photoelectric devices. These are many so only a few will be discussed; viz., those in which the cell must dissipate some power (at least a few hundred mw).

One example of a group of uses is in safety monitoring in an oil or gas furnace where the LDR actuates a relay to cut off the fuel supply. The device can also be used in the safety line for smoke detection.

An obvious application is the dimming of automotive headlamps, or switching them on or off under set conditions. Also, LDRs can be used

for street light control, resulting in a more simple circuit.

In consumer products, LDRs can be used for automatic changing of contrast and brightness of a TV image with the level of lighting in a room, and possibly by remote control.

TV may have a need of LDRs in a more refined use of a noise-free potentiometer. With a small lamp whose intensity can be varied and a fixed resistor whose value is about 20% of the dark resistance of the LDR, it is possible for the voltage tapped by the potentiometer to vary almost linearly by a factor of nearly 10,000. So, there are many uses for this device; one is remote volume control of hi-fi sound systems.

Power Capability

So far we have cited uses for cells of relatively low power. There is now, a cell (Delco type LDR-25) which is able to dissipate 25 w. and switch or control up to 100 w. This cell can be used for prior unfulfilled needs. Also, it can eliminate intervening relays now in use. In general, here is a device which may be plugged into the power line to handle enough power for operating small motors or large relays. Thus, plants can use them in servo systems for counting, detecting, or operation cycling. As shown in Fig. 5, the LDR is used to detect whether or not the feeding mechanism of the furnace is properly loaded; it also runs a motor to feed the next boat into position.

Perhaps the most promising use of the LDR is to control the speed of small motors. Fig. 6 shows 3 methods of motor speed control. Compare a typical SCR circuit in A to a more simple LDR circuit (B or C). The LDR alone costs less than an SCR. Where only one SCR is used for cost reasons, this circuit. due to the rectifier nature of the SCR, will permit the motor to come up to only half-speed unless it is abruptly switched to direct line voltage. This is not the case of either of the LDR circuits. However, the simplest LDR circuit does not allow the motor to supply as much torque at low speeds as the SCR circuit, because the latter provides feedback. With a series resistance across which a voltage is developed to control a second lamp shining on the LDR, (as in C of Fig. 6) one can provide feedback to improve the torque appreciably. Since the LDR is in effect a resistor, power is consumed by it. However, in most small motor uses this is not a serious setback. Delco Radio has, with success, operated household mixers and sewing machines in addition to small motors in servo systems. In general, the speed control is quite accurate and reproducible.

Thus, it would appear that in power photoconductors, we have reliable, low cost solid state devices for switching inductive loads and for controlling speeds of small motors.

Now available!

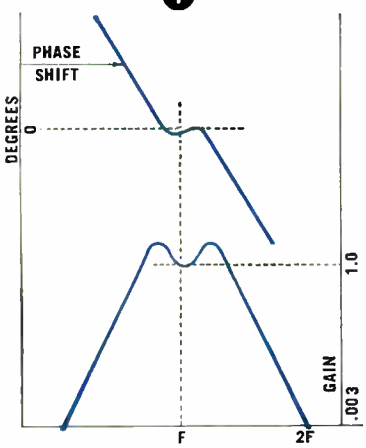
THREE NEW FILTER FAMILIES

designed to improve future systems!

If you are concerned with new systems development, and would like to take advantage of advanced technology and the kind of sophistication that will improve transient response and eliminate obsolete circuitry . . . then here are three new filter families, that have advanced the state of the art, which you can immediately incorporate in your network designs — exclusive from Burnell. Call or write today for literature and technical assistance.

Burnell offers the most complete line of communications network components available to the electronics industry, with a versatility of experience unmatched in the production of filters, delay lines and toroids for interpretation of *complex signals*. Burnell will custom design filter networks to your specifications which may include special delay, attenuation, and transient response, involving precisely specified rise time, overshoot and ringing.

❶



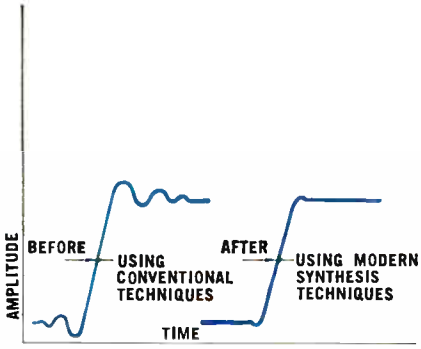
ZERO PHASE FILTERS

Impedance 1000 ohms/Grid 400 cps Center			
ATTENUATION & PHASE CHARACTERISTICS			
OP SERIES	OP400 L	OP400 M	OP400 H
Pass Band (3 DB)	±20 cps	±20 cps	±20 cps
Harmonic attenuation 2nd harmonic and all higher frequencies			50 DB
Harmonic attenuation (2nd)	>15 DB	>25 DB	
Harmonic attenuation (3rd)	>40 DB	>60 DB	
Max. phase ±20 cps	±1°	±1°	±1°
Max. phase ±30 cps			±5°
Phase shift at Center Frequency	0°±½°	0°±½°	0°±½°
Gain =	UNITY	UNITY	UNITY

60 cps equivalent filters are also available having a pass band of ±5% with phase of ±1°.

For the **Servo** Engineer . . .
By specifying Burnell's new line of **Zero Phase Shift** networks, it is possible to recover, without phase shift, the fundamental frequency from any periodic wave form without using complex squaring circuitry. This advancement in the state of the art is accomplished by combining zero phase shift in the vicinity of the center frequency — with high attenuation in the stop bands.

❷

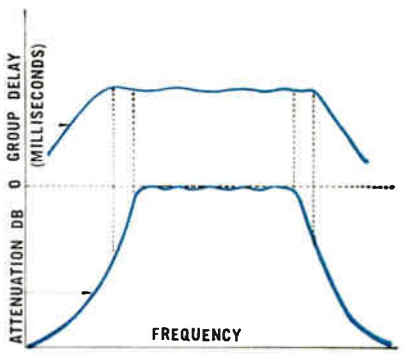


LOW PASS FILTERS WITHOUT DISTORTION

This family of filters is designed with modern synthesis techniques to have specified transient characteristics such as fast rise time, low overshoot and ringing.

60/3 DB Shape Factor	Ringing (over/undershoot)
2:1	<5%
3:1	<2%
4:1	<1%

❸



CONSTANT DELAY BAND PASS FILTERS

This is part of a family of constant delay band pass filters of unusual characteristics, for example:

1—Group delay is constant well into the stop band!
2—Matched delay—as an example of delay matched band pass filters, we have produced a set of four filters having the same band widths of 500 cycles at 1½ DB with center frequencies ranging from 680 cycles to 2720 cycles; having a 20 DB band width of 710 cycles with group delay constancy of ±3½% over the pass band and between channels.
3—Constant delay band pass filter.

Frequency	Attenuation
5210 cps to 8336 cps	< .5 DB
1,000 cycles & below	>20 DB
10,000 cycles & higher	>20 DB
Delay: Group delay constant ±1% from 3,500 cps to 9,900 cps.	

Burnell & Co., Inc.

PIONEERS IN microminiaturization OF TOROIDS, FILTERS AND RELATED NETWORKS

EXECUTIVE OFFICE AND PLANT
DEPT. EI-36
PELHAM, NEW YORK
PELHAM 8-5000
TELETYPE PELHAM 3633

MFD. IN CANADA
BY EDO (CANADA) LTD.
CORNWALL, ONT.
WELLINGTON 2-6774
ALSO MFD. AT
PACIFIC DIV.

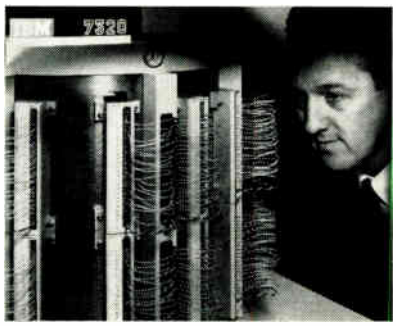
SUBSIDIARIES: G-K Electronics, Inc., Pelham, N.Y. • GLP Electronics, Inc., Bristol, Conn.

OPERATIONAL SYSTEMS (Concluded)

looks up the order quantity computed by the ordering function. This figure is then sent to the buyer for his approval.

In industries with much paperwork, operating systems are used to centralize records so that vital facts are available to management on short notice. As an example, Connecticut Blue Cross is installing a computer system which will be linked to member hospitals through data communication channels. With policyholder data maintained on the computer random access disks, member hospitals can get answers to vital questions almost immediately. When a patient is admitted, the admissions clerk simply "asks the computer" for a status report and, within seconds, the information is being typed out on a receiving machine.

In other branches of the insurance industry there are many instances of firms tying their field offices to the home office computer via common carrier lines for the transmission of typed, punched tape or punched card data. These systems eliminate a lag of days or weeks while remote branches wait for needed information.



Engineer checks wiring of a random access magnetic drum. The IBM unit was designed to speed storage and retrieval of computer programs.

Major Need

These examples show that most of the hardware needed for effective operating systems is now in existence. The need now is for better ways to get information into and out of the centralized system. Solutions to this problem will be found through such devices as optical scanners and magnetic ink character readers, voice recognition systems, Tele-processing units capable of accepting machine codes, and production reporting devices located on the manufacturing line.

Meaning

What does this all mean? It means that the present trend toward operational systems will provide management in all facets of business with a lot more information about how things happen and what they can do to correct or maintain quality and quantity levels. With current information available faster and in more detail than ever before, EDP is becoming a tool almost any business can use to do a better job.

Investment Opportunity

The hand holding the hammer will someday make products for you.

Long years of training will have to go into making those chubby fingers productive. Much care, much love, much planning and money.

But no matter how lean and hard and skillful they become, it will signify little if the fruits of their skill are produced in anything but a free society.

You have an investment in those hands. To protect your investment, you can join with other leading American businessmen to promote the Treasury's Payroll Savings Plan for United States Savings Bonds. The Treasury Department's Plan works for soundness in our economy, strength in our defenses, and thriftiness and self-reliance in our thinking.

When you bring the Payroll Savings Plan into your plant—*when you encourage your employees to enroll*—you are investing in the hands of tomorrow's tool makers and tool users. You are investing in America's next generation of machine operators, mechanics, metal workers—in all of America's skilled labor force. You are investing in America's future. In freedom itself.

Don't pass this investment opportunity by. Call your State Savings Bonds Director. Or write today to the Treasury Department, U.S. Savings Bonds Division, Washington 25, D.C.

in your plant...promote the PAYROLL SAVINGS PLAN for U.S. SAVINGS BONDS

The U. S. Government does not pay for this advertisement. The Treasury Department thanks, for their patriotism, The Advertising Council and this magazine.

SECTION L

MANUFACTURERS & PRODUCTS

INDUSTRIAL ELECTRON TUBES

OA2	80	3C22	17 50	5R4WGA	3 50	T55	3 50	417A	6 50	927	2 50	5763	1 75	6167	25 00
OA2WA	1 50	3C23	5 00	5R4WGB	5 00	FG-57	10 00	418A	10 00	929	1 50	5768	30 00	6173	8 00
OA3	85	3C24	6 00	5R4WGY	2 00	RK-60	1 50	420A	4 00	931A	5 00	5777	150 00	6177	60 00
OA4G	1 00	3C45	6 00	5RP1A	35 00	HY-65	3 00	421A	7 50	1000T	100 00	5778	150 00	6186	1 50
OA5	5 00	3CX100A5	16 50	5RP7A	75 00	FG-67	20 00	422A	7 50	CK-1006	2 50	5783	2 25	6189	1 50
OB2	70	3D21A	5 00	5RP11A	50 00	HY-69	3 00	423A	4 00	NL-1052AP	75 00	5783WB	3 00	6197	1 75
OB2WA	1 50	3D22	10 00	5SP7	10 00	BL-75	3 50	427A	4 00	R1130B	10 00	5784	2 00	6199	35 00
OB3	75	3DP1A	5 00	5UP1	12 50	HY-75	3 50	428A	6 50	1229	3 50	5784WA	3 35	6201	1 50
OC3	50	3E22	10 00	5UP7	15 00	RK-75	75	429A	6 50	1237	3 50	5787	2 50	6202	1 50
OD3	50	3E29	10 00	5XP1	50 00	75TL	15 00	432B	5 00	VC-1257	600 00	5796	10 00	6203	2 50
O1A	8 50	3GP1	2 50	5XP11A	50 00	TG-77	10 00	GL-434A	10 00	VC-1258	15 00	5800	7 50	6211	75
1AD4	1 75	3GP1A	12 50	5Y3WGT	1 25	FG-81A	7 50	QK-436A	100 00	K-1303	35 00	5801	3 50	6213	2 50
1AE4	1 25	C3J	8 50	5Y3WGTB	2 25	FG-95	20 00	437A	5 00	1500T	200 00	5803	5 00	6216	3 00
C1B	2 50	C3J/A	10 00	5YP2	35 00	KU-99	13 85	450TH	50 00	1603	3 50	5814A	1 35	6233	100 00
1B24A	17 50	3J21	50 00	6AC7W	1 00	HF-100	10 00	450TL	40 00	1612	2 50	5814WA	1 75	6236	125 00
1B35A	3 50	3J31	100 00	6AC7WA	2 50	100TH	12 00	8S-501	17 50	1613	1 25	5819	40 00	6247	5 00
1B38A	35 00	3JP1	5 00	6AG5WA	1 50	100TL	12 00	CK-503AX	1 00	1614	2 50	5822A	75 00	6248	350 00
1B59	10 00	3K21	125 00	6AG7Y	1 00	FG-104	30 00	CK-510AX	1 00	1616	2 50	5823	1 25	6252	20 00
1B60	7 50	3K22	125 00	6AJ5	1 25	FG-105	25 00	CK-512AX	1 00	1619	1 00	5824	2 00	6263	9 00
1B63A	10 00	3K23	200 00	6AK5W	1 25	121A	1 50	QK-531	35 00	1620	4 00	5828	8 00	6265	2 50
1B65	5 00	3K27	125 00	6AL5W	60	122A	2 50	QK-532	35 00	1622	3 00	5829	1 00	6279	22 50
EL-1C	4 00	3K30	100 00	6AM5	3 75	F-123A	7 50	QK-549	45 00	1624	1 00	5829WA	1 25	6280	30 00
1C21	2 50	3KP1	9 75	6AM6	1 85	FG-172A	25 00	CK-570AX	2 50	1625	75	5836	50 00	6282	50 00
1D21/SN4	6 00	3RP1	7 50	6AN4	2 00	HF-200	15 00	575A	15 00	1629	50	5837	40 00	6291	35 00
C1K	8 50	3WP1	12 50	6AN5	1 75	CE-203	10 00	576	15 00	1633	1 00	5839	3 50	6292	50 00
1P21	30 00	3X2500A3	150 00	6AN5WA	3 50	203A	5 00	57S	5 00	1635	1 75	5840	1 50	6293	4 50
1P22	8 00	4-65A	12 00	6AQ5W	1 25	205F	3 50	610	15 00	1641	1 50	5841	2 50	6299	40 00
1P25	10 00	4-125A	20 00	6AR6	60	211	1 50	NL-615	7 50	1645A	4 00	5842	6 50	6303	65 00
1P28	15 00	4-250A	35 00	6AS6W	1 00	212E	50 00	NL-623	10 00	1846	50 00	5845	6 00	6310	125 00
1P37	2 50	4-400A	37 50	6AS7G	2 50	231D	1 50	627	15 00	1855	250 00	5847	6 50	6316	100 00
1Z2	2 50	4-1000A	95 00	6AU6WA	1 10	CE-235	5 00	631-P1	6 00	2000T	285 00	5852	2 50	6328	7 50
2-01C	12 50	4AP10	10 00	6AU6WB	2 00	FG-235	60 00	632A	20 00	2050	1 50	5854	1 00	6336	8 75
2AP1A	8 50	4B24	4 00	6B4G	3 35	242C	15 00	651	60 00	ZB-3200	150 00	5864	10 00	6336A	12 75
2B23	20 00	4B25	5 00	6BA6W	75	244A	3 50	652	50 00	5514	7 50	5876	9 00	6344	375 00
2BP1	10 00	4B31	15 00	6BE6W	2 50	245A	3 50	655	125 00	5516	7 50	5879	1 00	6350	1 25
2C36	25 00	4B32	8 50	6BF7W	2 00	249B	10 00	672A	37 50	5528	5 00	5881	2 50	6360	4 00
2C39	5 50	4C22	10 00	6BH6W	2 50	249C	6 50	673	15 00	5531	425 00	5886	3 50	6363	90 00
2C39A	11 00	4C27	7 50	6BL6	30 00	250R	12 50	676	25 00	5545	25 00	5893	10 00	6364	130 00
2C39B	16 50	4C28	12 50	6BM6	30 00	250TH	25 00	677	50 00	5550	35 00	5894	18 50	6385	5 00
2C39WA	15 00	4C33	100 00	6BM6A	35 00	250TL	22 00	681/686	35 00	5551	50 00	5896	1 00	6390	125 00
2C40	8 50	4C35	15 00	6C4W	2 50	251A	75 00	BL-696	30 00	5552	60 00	5899	2 00	6394	12 75
2C42	3 00	4CX125C	35 00	6C4WA	1 00	252A	6 00	701A	7 50	5553	125 00	5902	2 50	6438	6 00
2C43	10 00	4CX250B	30 00	6C21	35 00	254A	3 50	703A	1 50	5556	20 00	5906	5 00	6442	25 00
2C46	3 50	4CX300A	40 00	6C24	35 00	257A	5 00	707B	1 50	5557	5 00	5915	85	6463	1 00
2C50	4 00	4CX1000A	135 00	6CN6	3 60	FG-258A	125 00	NL-710	10 00	5558	10 00	5922	20 00	6468	175 00
2C51	1 25	4CX5000A	475 00	6D4	1 00	259A	5 00	NL-714	8 85	5559	10 00	5930	2 50	6476	10 00
2C52	2 00	4D32	15 00	6DJ8	1 35	V-262	125 00	NL-715	5 00	5560	20 00	5931	2 00	6478	5 00
2C53	7 50	4E27	10 00	6EH7	1 75	262R	4 00	715B	5 00	5561	30 00	5932	1 50	6484	4 00
2D21	65	4E27A	30 00	6F4	2 50	264C	3 00	715C	15 00	5586	100 00	5933	3 50	6485	1 75
2D21W	1 25	4J31	100 00	6GW8	1 50	FP-265	15 00	719A	10 00	5590	1 50	5948	150 00	6517	500 00
2E22	3 00	4J32	100 00	C6J	10 00	267B	7 50	721B	5 00	5591	3 00	5949	100 00	6524	10 00
2E24	3 50	4J34	100 00	C6J/A	12 50	FG-271	50 00	723A/B	3 50	5603	3 50	5956	25 00	6528	12 75
2E25A	3 00	4J45	100 00	C6J/K	15 00	271A	12 50	725A	15 00	5608A	5 00	5963	95	6533	7 50
2E26	3 00	4J46	100 00	6J4	1 75	272A	6 00	726A	5 00	5610	75	5964	85	6542	6 00
2E41	2 00	4J47	100 00	6J4WA	2 50	274A	3 50	726B	5 00	5632	8 50	5965	75	6550	3 50
2J42	88 85	4J50	100 00	6J6W	75	275A	4 00	726C	10 00	5636	2 25	5975	2 50	6626	1 50
2J51	50 00	4J52	35 00	6J6WA	1 00	276A	7 50	NL-740	17 50	5639	2 50	5976	50 00	6627	1 50
2J51A	100 00	4J52A	100 00	6K4	1 50	279A	200 00	750TL	112 50	5641	2 00	5977	1 50	6655	40 00
2J55	100 00	4J61	225 00	C6L	5 00	283A	3 50	759	25 00	5642	2 25	5981	50 00	6688	5 00
2J66	200 00	4J62	150 00	6L4	3 00	285A	5 00	NL-760	23 00	5643	2 50	5987	6 00	6700	37 50
2K22	25 00	4J63	150 00	6L6GAY	1 00	287A	3 50	BL-800	50 00	5644	2 00	5992	5 00	6754	12 50
2K25	10 00	4J64	150 00	6L6WGA	1 50	QK-288	200 00	802	7 50	5646	1 50	5993	5 00	6802	7 50
2K26	35 00	4PR60A	50 00	6L6WGB	2 00	HP-300	35 00	803	5 00	5647	3 50	5998	2 50	6807	23 00
2K28	20 00	4PR60B	75 00	6Q5G	2 50	300B	5 00	801	15 00	5651	1 00	6004	1 50	6818	40 00
2K28A	30 00	4X150A	12 50	6SJ7WGT	1 25	304TH	35 00	805	7 50	5651WA	2 00	6005	1 25	6829	5 00
2K29	25 00	4X150D	12 50	6SK7W	1 00	304TL	40 00	807	1 50	5654	1 50	6012	5 00	6832	10 00
2K30	50 00	4X150F	20 00	6SK7WA	1 00	307A	75	807W	2 50	5656	5 00	6014	8 50	6877	12 50
2K33A	200 00	4X150G	25 00	6SL7WGT	1 25	310A	3 50	808	1 00	5660	4 00	6021	2 00	6883	3 00
2K34	75 00	4X250B	25 00	6SN7W	75	311A	3 50	809	4 75	5663	1 00	6028	2 75	6888	3 00
2K35	200 00	4X250F	25 00	6SN7WGT	1 25	RL-312	80 00	810	18 85	5665	45 00	6032	50 00	6896	250 00
2K39	135 00	4X500A	100 00	6SN7WGTA	2 50	313C	1 50	811	3 00	5667	150 00	6037	100 00	6897	20 00
2K41	35 00	4X500F	200 00	6SU7GTY	1 25	323A	6 00	811A	4 75	5670	1 00	6045	1 25	6901	7 50
2K42	150 00	5ABP1	25 00	6V6GTY	1 00	328A	4 50	812A	4 75	5670WA	1 50	6050	1 00	6907	20 00
2K43	150 00	5ABP7	30 00	6X4W	75	329A	4 50	813	15 00	5672	1 35	6072	1 25	6922	2 75
2K44	150 00	5ADP1	25 00	6X4WA	1 50	336A	2 50	814	5 00	5675	9 50	6073	1 00	6939	7 50
2K45	20 00	5ADP7	25 00	6X5WGT	85	337A	3 50	815	3 00	5676	1 50	6074	1 50	7034	12 50
2K47	125 00	5ADP11	25 00	7AK7	2 50	338A	5 00	816	2 00	5678	1 50	6080	3 00	7044	1 50
2K48	50 00	5AHP1A	30 00	7BP7A	12 50	339A	7 50	826	10 00	5683	8 50	6080WA	4 00	7203	30 00
2K50	100 00	5AHP7A	25 00	7MP7	22 50	347A	2 50	828	17 50	5684	10 00	6080WB	15 00	7204	25 00
2K54	15 00	5AQP1	25 00	10KP7	15 00	348A	4 50	829B	10 00	5685	12 50	6081	25 00	7236	7 00
2K55	15 00	5BDP7	60 00	10KP7A	30 00	349A	3 50	832A	7 50	5686	2 25	6082	3 35	7289	16 50
2K56	50 00	5BP1	6 00	12AT7WA	1 25	350A	3 50	833A	37 50	5687	1 50	6087	2 25	7377	20 00
2P21	35 00	5BP1A	12 00	12AU7WA	1 50	350B	2 50	836	2 50	5687WA	2 50	6094	5 00	7391	47 50
2V3G	1 00	5BP4	6 00	12AX7W	1 35	352A	10 00	837	1 50	5691	5 00	6095	1 50	7403	12 00
2X2	35	5C21	10 00	12AY7	1 00	354A	12 50	838	2 50	5692	3 50	6096	1 25	7521	100 00
2X2A	1 35	5C22	17 50	12GP7	25 00	355A	12 50	842	7 50	5693	3 50	6097	60	7580	30 00
3A4	65	5CP1	6 00	X-13	225 00	P-375A	10 00	845	12 50	5696	1 00	6098	4 00	8000	18 85
3A5	1 00	5CP1A	12 00	16P	15 00	393A	5 00	849	75 00	5702WA	2 00	6100	1 00	8002R	35 00
3ABP1	25 00	5CP7A	12 00	C16J	30 00	394A	3 00	850	15 00	5703	1 50	6101	1 00	8005	12 50
3AP1	2 50	5CP11A	15 00	FG-17	5 00	395A	2 00	851	75 00	5703WA	2 50	6106	6 00	8008	6 00
3AP1A	12 50	5D22	35 00	RK-23	5 00	396A	1 50	866A	2 00	5718	1 00	6111A	2 50	8013A	5 00
3AP11A	12 50	5HP1A	13 00	HK-24	5 00	397A	50 00	868	2 25	5719	1 50	6112	2 50	8014A	17 50
3B4	2 50	5J26	75 00	24G	6 00	398A	3 50	869B	75 00	5720	17 50	6115A	65 00	8020	6 00
3B22	4 00	5JP1	15 00	BL-25	15 00	401A	1 50	872A	5 00	5721	90 00	6130	6 50	8025A	7 50
3B23	2 50	5JP1A	30 00	25T	7 50	403A	1 35	874	75	5725	1 25	6135	1 50	8161	150 00
3B24 (WE)	1 00	5JP5A	30 00	26C6	1 00	403B	3 00	884	1 25	5726	75	6136	1 10	8165	12 00
3B24W	3 85	5JP7A	30 00	26D6	1 50	404A	6 50	885	1 00	5727	1 25	6137	1 50	8166	95 00
3B24WA	5 00	5JP11A	30 00	26Z5W	1 50	407A	3 75	889RA	150 00	5728	20 00	6146	3 25	8167	40 00
3B25	3 00	5LP1	7 50	FG-27A	25 00	408A	2 75	891R	300 00	5734	15 00	6147	2 50	8168	135 00
3B26	3 50	5LP1A	20 00	28D7W	3 50	409A	1 00	892R	300 00	5744	1 00	6152	5 00	8252	75 00
3B28	3 00	5LP2A	20 00	FG-32	10 00	410R	50 00	913	12 50	5749	1 00	6155	20 00	8438	37 50
3B29	5 00	5LP5	10 00	FG-33	17 50	412A	2 50	914A	50 00	5750	2 50	6159	4 00	9001	75
3BP1	2 50	5LP7A	20 00	35T	7 50	GL-414	80 00	917	3 00	5751	1 25	6161	50 00	9002	75
3BP1A	6 25	5LP11A	20 00	35TG	3 75	415A	3 00	920	2 50	5751WA	1 50	6163	15 00	9003	2 00
EL-3C	4 00	5R1GY	1 25	FP-54	150 00	416B	25 00	926	3 00	5755	5 00	6164	15 00	9C05	3 50

ALL TUBES ARE NEW, INDIVIDUALLY CARTONED, FULLY GUARANTEED

For 24 hour TELEX or TWX service dial: 916-681-3061
Telephone: 916-685-9582

western engineers

ELK GROVE, CALIFORNIA

SUPPLIERS OF ELECTRON TUBES SINCE 1932

Orders for less than $10. cannot be processed

Prices are FOB shipping point

ELECTRONIC INDUSTRIES

1963 DIRECTORY

ALPHABETICAL LISTING OF MANUFACTURERS

A listing of the names and addresses of manufacturers in the electronic and allied industries. All the information in this listing and in the product listing section has been supplied by the manufacturers.

A A METAL PRODUCTS
154 ELLIOT ST BRATTLEBORO VT
AAA WIRE WORKS INC
45 FOX ST NEW HAVEN CONN
ABALON PRECISION MFG CORP
540 CASANOVA ST NEW YORK 59 N Y
ABACUS INC
1718 TWENTY FIRST SANTA MONICA CALIF
ABAR CORP
2424 WYANDOTTE RD WILLOW GROVE PA
ABBEON INCORPORATED
179-15 JAMAICA AVE JAMAICA 32 N Y
ABBEY ELECTRONICS CORP
143 OLD COUNTRY RD CARLE PL N Y
ABBOTT PRODUCTS INC
123 ST COLLEGE PT 56 N Y
ABBOTT SCREW & MFG CO
6525 N CLARK ST CHICAGO 26 ILL
ABBOTT TRANSISTOR LABS INC
3055 BUCKINGHAM RD LOS ANGELES CALIF
ABC FAIRCO INC
543 MONTEREY PASS RD MONTEREY PK CALIF
ABESTE CORP
49 ACKERMAN ST BLOOMFIELD N J
ABRAMS INSTRUMENT CORP
606 E SHIAWASSEE ST LANSING 1 MICH
ABTRONICS INC
64 S P ST LIVERMORE CALIF
ACCESSORY CONTROLS EQUIPMENT
805 BLOOMFIELD AVE WINDSOR CONN
ACCURACY INC
223 CRESCENT ST WALTHAM MASS
ACCURATE ELECTRONICS CO
2005 BLUE ISLAND AVE CHICAGO 8 ILL
ACCURATE ELECTRONICS INC
13215 LEADWELL ST N HOLLYWOOD CAL
ACCURATE ELECTRONICS CORP
169 S ABBE RD SE ELYRIA OHIO
ACCURATE INSTRUMENT CO
2418 ALABAMA AVE HOUSTON 6 TEXAS
ACCURATE MFG CO
44 HEPWORTH PL GARFIELD N J
ACCURATE PAPER TUBE CO
903 W CULLERTON CHICAGO 8 ILL
ACCURATE SPECIALTIES CO INC
345 LODI ST HACKENSACK N J
ACCURATE SPRING MFG CO
3811 W LAKE ST CHICAGO 24 ILL
ACCUTRONICS INC
12 SO ISLAND BATAVIA ILL
ACDC ELECTRONICS INC
2979 N ONTARIO ST BURBANK CALIF
ACE COIL & ELECTRONICS CO
914 LINCOLN HWY METUCHEN N J
ACE DRILL BUSHING CO INC
3407 FOUNTAIN AVE LOS ANG CALIF
ACE ELECTRIC MFG CO
1458 SHAKESPEARE AVE NEW YORK 52 N Y
ACE ELECTRONICS ASSOC
99 DOVER ST SOMERVILLE MASS
AC ELECTRONICS INC
11725 MISSISSIPPI AVE LOS ANG CALIF
ACE ENGG & MACHINE CO INC
TOMILSON RD HUNTINGDON VALLEY PENNA
ACE PLASTIC CO
91-30 VAN WYCK EXPWY JAMAICA 35 N Y
ACE SPRING MFG CO
146 32ND ST BROOKLYN N Y
ACE SYCAMORE INC
SYCAMORE ILL
ACCESSORY PROD CO DIV OF TEXTRON INC
616 WHITTIER BLVD WHITTIER CALIF
ACETO CHEMICAL CO INC
40 40 LAWRENCE ST FLUSHING N Y
ACF ELECTRONICS DIV
RIVERDALE MD
ACF ELECTRONICS DIV ACF INDUSTRIES INC
11 PARK PL PARAMUS N J
ACHESON COLLOIDS CO
1951 WASHINGTON AVE PORT HURON MICH
ACKERMAN ENGRAVERS
43-22 36TH ST LONG ISLAND CITY N Y
ACKERMAN-GOULD CO INC
10 NEIL COURT PO BOX 188 OCEANSIDE LI N Y
ACME BATTERY CORP
200 HENRY ST STAMFORD CONN
ACME BRASS FOUNDRY CO OF S A INC
716 WYOMING ST SAN ANTONIO 3 TEXAS
ACME ELECTRIC CORP
WATER ST CUBA N Y
ACME ELECTRIC HEATING CORP
99 READING ST BOSTON MASS
ACME INDUSTRIAL CO
200-222 N LAFLIN ST CHICAGO 7 ILL
ACME MFG & GASKET CO
738 N 41 ST PHILA PA
ACME MODEL ENGG CO
6224 15TH AVE BROOKLYN 19 NY
ACME NEWPORT STEEL CO
NEWPORT KY
ACME WIRE CO
1255 DIXWELL AVE NEW HAVEN 14 CONN
ACOPIAN TECHNICAL CO
927 SPRUCE ST EASTON PA
ACOUSTICA ASSOCIATES INC
5331 W 104TH ST LOS ANGELES 45 CALIF
ACOUSTICA ASSOCIATES
10400 AVIATION BLVD LOS ANGELES 45 CALIF
ACOUSTIC RESEARCH INC
24 THORNDIKE ST CAMBRIDGE MASS
AC RAY ELECTRONICS INC
910 N 20 AVE HOLLYWOOD FLA
ACR ELECTRONICS CORP
551 W 22 ST NEW YORK 11 N Y
ACRD DIV ROBERT SHAW FULTON CONTROL CO
2040 E MAIN ST COLUMBUS OHIO
ACRO ELECTRONIC PRODUCTS CO
119 ST MIHIEL DR RIVERSIDE N J
ACROMAG INC
15360 TELEGRAPH RD DETROIT MICH
ACROMARK CO
309 MORRELL ST ELIZABETH NJ
ACRO PRODUCTS CO
369 SHURS LANE PHILADELPHIA 28 PA
ACRO TOOL & DIE WORKS
4554 BROADWAY CHICAGO ILL
ACRO WELDER MFG CO
1719 W ST PAUL AVE MILWAUKEE WISC
AC SPARK PLUG ELECT DIV GMC
P O BOX 1002 FLINT 1 MICH
AC SPARK PLUG ELECT DIV GMC
1925 KENILWORTH PL MILWAUKEE WISC
ACTAN ELECTRONICS INC ENGRG MFG & DEV CORP
130 COUNTY COURTHOUSE RD NEW HYDE PARK NY
ACTIONCRAFT PRODUCTS
2 YENNICOCK AVE PORT WASHINGTON N Y
ACTON LAB
1180 RAYMOND BLVD NEWARK N J
A C TRANSFORMER CORP
89 MADISON ST NEWARK 5 N J
ADAGE INC
292 MAIN ST CAMBRIDGE MASS
ADAM METAL SUPPLY INC
463 48TH AVE LONG ISLAND CITY N Y
ADAMS & WESTLAKE CO
1025 N MICHIGAN ELKHART IND
ADAMS ELECTRONICS INC
16 CHARLES ST BANGOR MICH
ADAMS RITE MFG CO
540 W CHEVY CHASE DR GLENDALE 4 CALIF
ADAMS RUSSELL CO INC
200 SIXTH ST CAMBRIDGE MASS
ADC PRODUCTS DV OF MAGNETIC CONTROLS
6405 CAMBRIDGE ST MINN MINN
ADCOM CORP
9732 COTYCROFT AVE CHATSWORTH CALIF
ADCON DIV WAYNE-GEORGE CORP
322NEEDHAM STREET NEWTON 64 MASS
ADCRAFTERS CO
325 W HURON ST CHICAGO ILL
ADDRESSOGRAPH MULTIGRAPH CORP
1200 BABBITT RD CLEVELAND OHIO
ADEC INC
86 FRELINGHUYSEN AVE NEWARK N J
ADEL PRECISION PROD DV GENERAL METALS CORP
1444 WASHINGTON AVE HUNTINGTON W VA
ADEPT INDUSTRIES INC
1636 W HUNTING PARK AVE PHILA 4 PA
ADLER ELECTRONICS INC
1 LEFEVRE LANE NEW ROCHELLE N Y
ADMIRAL CORP
3800 W CORTLAND ST CHICAGO ILL
ADTROL ELECTRONICS INC
116 N 7TH ST PHILA 6 PA
ADVANCE CARBON & ELECTRIC MFG CO
2505 MARIPOSA ST SAN FRANCISCO 10 CALIF
ADVANCE GEAR & MACHINE CORP
5851 HOLMES AVE LOS ANG CALIF
ADVANCE GLOVE MFG CO
901 W LAFAYETTE BLVD DETROIT 26 MICH
ADVANCE INSTRUMENT CORP
1709 F ST BELMAR N J
ADVANCE ROSS ELECT CORP
2538 PETERSON AVE CHICAGO 45 ILL
ADVANCE RDSS ELECT CORP
860 WASHINGTON ST BURLINGTON IOWA
ADVANCE RDSS ELECT CORP
1010 W MADISON WASHINGTON IOWA
ADVANCE TECHOLOGY LABS DIV AMER STANDARD
369 WHISMAN RD MT VIEW CALIF
ADVANCED ELECTRONICS INC
94 SILAS DEANE HWY ROCKY HILL CONN
ADVANCED ELECT CORP
2 COMMERCIAL ST HICKSVILLE LI N Y
ADVANCED INSTRUMENTS
45 KENNETH ST NEWTON HIGHLANDS 61 MASS
ADVANCED KINETICS INC
1231 VICTORIA ST COSTA MESA CALIF
ADVANCED MEASUREMENT INST INC
109 DOVER ST SOMMERVILLE MASS
ADVANCED SCIENTIFIC INSTRUMENTS
5249 HANSEN CT MINNEAPOLIS 29 MINN
ADVANCED STRUCTURES
5159 BALTIMORE DR LAMESA CALIF
ADVANCED TECHNOLOGY INC
SANTA BARBARA CALIF
ADVANCED VACUUM PRODUCTS INC
430 FAIRFIELD AVE STAMFORD CONN
AD-YU ELECTRONICS LAB INC
249 TERHUNE AVE PASSAIC N J
AERCOIL INC
2207 SUMMIT AVE UNION CITY N J
AERMOTER CO
2500 W ROOSEVELT RD CHICAGO ILL
AERODEX INC
PO BOX 123 MIAMI 48 FLA
AERO ELECTRONICS CORP
1729 W 134 ST GARDENA CALIF
AEROFLEX CORP DIV AERDFLEX LAB
48 25 36TH ST LONG ISLAND CITY N Y
AEROFLEX LABORATORIES INC
SOUTH SERVICE ROAD PLAINVIEW L I N Y
AERO GEO ASTRO CORP
EDSALL & LINCOLNIA RD ALEXANDRIA VA
AEROJET GENERAL CORP ASTRONICS DIV
6352 N IRWINDALE AVE AZUSA CALIF
AEROJET-GENERAL NUCLEONICS
P O BOX 77 SAN RAMON CALIF

ELECTRONIC MANUFACTURERS—A TO Z

AEROLITE ELECTRONICS CORP
2207SUMMIT AVE UNION CITY NJ
AERDLUX LIGHT CORP
653 11 AVE NEW YORK 36 N Y
AERO MECHANISMS INC
7750 BURNET AVE VAN NUYS CALIF
AERONAUTICAL COMM EQUIP CO
3090 S W 37 AVE MIAMI FLA
AERONAUTICAL ELECT CO
5656 NORTHWEST HWY CHICAGO 46 ILL
AERONAUTICAL ELECTRONICS INC
P O BOX 6527 RALEIGH N C
AERONAUTICAL & INST DV RDBERTSHAW FULTON CD
SANTA ANA FREEWAY-EUCLID AVE ANAHEIM CALIF
AERONCA MFG CORP
MIDDLETOWN OHIO
AERONCA MFG CORP AEROSPACE DIV
BOX 536 BALTIMORE MD
AERONUTRDNIC SYSTEMS INC
FORD RDAD NEWPORT BEACH CALIF
AEROQUIP CORP
300 S EAST AVE JACKSON MICH
AERD RESEARCH INSTRUMENT CO
315 N ABERDEEN ST CHICAGO 7 ILL
AERO SERVICE CORP
210 E CORTLAND ST PHILA PENNA
AEROSONIC MARINE INC
PO BOX 569 CLEARWATER FLA
AEROSPACE ELECTRONICS INC
PO BOX 48-495 MIAMI FLA
AEROSPACE RESEARCH INC
130 LINCOLN ST BRIGHTON 35 MASS
AEROTEST LABORATORIES INC
COMAC RD DEER PARK L I N Y
AEROTRONIC ASSOCIATES INC
BOX 367 CONTOOCOOK N H
AEROVOX CORP
740 BELLEVILLE AVE N BEDFORD MASS
AEROVOX CANADA LTD
1551 BARTON ST HAMILTON ONTARIO CANADA
AEROVOX CORP HIQ OIVISION
MYRTLE BEACH SC
AEROVOX PACIFIC
1100 CHESTNUT ST BURBANK CALIF
AETNA ELECTRONICS CORP
READINGTON RO N BRANCH N J
AETNA FELT CO
204 CENTRE ST NEW YORK 13 NY
AFFILIATED MANUFACTURERS INC
P D BOX 248 WHITEHOUSE N J
AFFILIATED PHOTOGRAPHIC CO
21 W 45 ST NEW YORK 36 N Y
AFFILIATED SCREW PROD CO
3800 WESLEY TERR SCHILLER PK ILL
AGA CORP OF AMERICA
P O BOX 147 SOUTH PLAINFIELD N J
A G A DIV ELASTIC STOP NUT CORP
1027 NEWARK AVE ELIZABETH 3 N J
AGARD ELECTRONICS CORP
25 DENTON AVE NEW HYOE PARK N Y
AGASTAT TIMING INSTRUMENTS
1027 NEWARK AVE ELIZABETH N J
A H B ELECTRONIC PARTS INC
129 05 LIBERTY AVENUE RICHMOND HILL 19 N Y
AIDIN AUTOMATION INC
1613 E NEW YORK AVE BRODKLYN 12 N Y
AINSLIE CORP
531 POND ST BRAINTREE MASS
AIRBORNE ACCESSORIES CORP
1414 CHESTNUT AVE HILLSIDE 5 N J
AIR BORNE CONTROLS INC
12173 BRANFORD ST SUN VALLEY CALIF
AIRBORNE ELECT CO
6813 TROOST AVE N HOLLYWOOD CALIF
AIRBORNE INSTRS LAB OIV CUTLER HAMMER INC
COMAC ROAD DEER PARK LI N Y
AIRCOM INC
48 CUMMINGTON ST BOSTON 15 MASS
AIRCONDUCTORS
367 E ALONDRA GARDENA CALIF
AIRCRAFT & ELECT SPEC
22 GREEN ST BROWNSBURG IND
AIRCRAFT ARMAMENTS INC
INDUSTRY LANE COCKEYSVILLE MD
AIRCRAFT FITTING CO
701 FEDERAL HWY DANIA FLA
AIRCRAFT INSTRUMENTS CO
304 KING OF PRUSSIA RD RADNOR PENNA
AIRCRAFT RADIO CORP
BOONTON N J
AIRDESIGN CORP
BOX 987 NORRISTOWN PA
AIR ELECTRONICS CO
7250 HINDS AVE N HOLLYWOOD CALIF
AIRESEARCH MFG CO DIV GARRETT CORP
9851 SEPULVEDA BLVD LOS ANGELES 45 CAL
AIREX CORP
TIBBETTS RD BOx 1517 ROCHESTER N H
AIR FILTER CORP
4554 W WOOLWORTH AVE MILWAUKEE WISC
AIRFLYTE ELECTRONICS CO
535 AVENUE A BAYONNE N J
AIRGUIDE INSTRUMENT CO
2210 WABANSIA AVE CHICAGO ILL
AIR MARINE MOTORS INC
2221 BARRY AVE LOS ANG CALIF
AIR MARINE MOTORS
369 BAYVIEW AVE AMITYVILLE L I N Y
AIRMATIC VALVE INC
7314 ASSDCIATE AVE CLEVELANO 9 OHIO
AIRMATICS SYSTEMS CORP
441 MARKET ST SADDLE BROOK NJ
AIR MAZE DIV ROCKWELL STANDARD CORP
25000 MILES RD CLEVELAND OHIO
AIR O TRONICS ENG CO
MORRISVILLE N Y
AIRPAX ELECT INC SEMINOLE DIV
FORT LAUDERDALE FLA
AIRPAX ELECTRDNICS INC
CAMBRIDGE MD
AIRPAX ELECTRDNICS PACIFIC DIV
NORTHRIDGE CALIF
AIRPAX ELECTRDNICS INC
2550 E FODTHILL BLVD PASADENA CALIF
AIRPAX PRODUCTS CD
JACKTOWN RD CAMBRIDGE MD
AIR REDUCTION SALES CO REDUCTION CD
150 E 42 ST NEW YORK N Y
AIR-SHIELDS INC
HATBORO PENNA
AIRTEC INC
139 E 1ST AVE ROSELLE N J
AIR TRANSPORT MFG CD
1114 N SYCAMORE AVE LOS ANGELES CALIF
AIRTRON A DIV DF LITTON INDUST
200 E HANOVER AVE MORRIS PLAINS N J
AIRTRONICS INC
5221 RIVER RD BETHESDA MD
AIRTRONICS INTL CORP
6900WEST RD BOX 8576 FT LAUDERDALE FLA
AIRTRONIX DEVELOPMENT CORP
628 E 83RD ST BRODKLYN 36 N Y
A & J MFG CO
4214 ARTESIA FULLERTON CALIF
AJAX CONDENSER CO
932 WRIGHTWDOD AVE CHICAGO ILL
AJAX ELECTROTHERMIC CORP
AJAX PARK TRENTON N J
A K MFG CO INC
410 S HAGER AVE BARRINGTON ILL
AKRON METALLIC GASKET CO
150 N UNION ST AKRON OHIO
ALAC INC
365 W ARDEN ST GLENDALE 3 CALIF
ALADDIN ELECTRDNICS DIV ALADDIN INDUSTRIES
703 MURFREESBORO RD NASHVILLE 1 TENN
A L A INDUSTRIES INC
151 CRDTONA AVE HARRISON N Y
ALAN ELECTRONICS
1167 HILDA ST ANAHEIM CALIF
ALAN WOOD STEEL CO
CONSHOHOCKEN PA
ALBEROX CORP
INOUST PARK NEW BEOFORD MASS
ALCAR INSTRUMENTS INC
411 ROBBINS AVE TRENTON N J
ALCO ELECTRONIC PRODUCTS INC
3 WOLCOTT AVE LAWRENCE MASS
ALCON METAL PRDUCTS INC
1750 N KIMBALL AVE CHICAGO ILL
ALCONOX INC
853 BROADWAY NEW YORK N Y
ALDEN ELECTRONIC & IMPULSE
P O BOX 125 WESTBORO MASS
ALDEN PRODUCTS CO
12359 N MAIN ST BROCKTON 64 MASS
ALDEN SYSTEMS CD
117 N MAIN ST BROCKTON MASS
ALDSHIR MANUFACTURING CO INC
111 LAKE AVE TUCKAHOE N Y
ALECTRIC MFG CO
7842 39TH AVE KENOSHA WISC
ALERT PRODUCTS INC
728 MARKET ST CAMDEN N J
ALERT SUPPLY CO
7343 PARAMOUNT BLVD PICO RIVERA CALIF
ALEXANDRIA DIV AMF
1025 ROYAL ST ALEXANDRIA VA
ALFAX PAPER & ENG CO INC
BOX 125 WESTBORO MASS
ALFORD MFG CO
299 ATLANTIC AVE BOSTON 10 MASS
ALFRED ELECTRONICS
PALO ALTO CALIF
ALITE DIV U S STONEWARE CO
BOX 119 ORRVILLE OHIO
ALKALINE BATTERY DIV
212 DURHAM AVE METUCHEN N J
ALLACO PRODUCTS
238 MAIN ST CAMBRIDGE 42 MASS
ALL AMERICAN ENGG CO
BOX 1247 WILMINGTON DEL
ALL AMERICAN TOOL & MFG CO
8027 LAWNDALE AVE SKOKIE 1LL
ALLARD INSTRUMENT CORP
146 E 2ST MINEOLA N Y
ALLARD INSTRUMENT CORP
770 MAIN ST WESTBURY N Y
ALL CHANNEL PRODUCTS CORP
JERSEY SHORE PENNA
ALLEGANY INSTRUMENT CO
1091 WILLS MOUNTAIN CUMBERLAND MD
ALLEGHENY ELECTRONICS CHEMICALS CO
20 LEAR ST BRADFORD PA
ALLEGHENY ELECTRONIC CHEMICALS CO
LEWIS RUN PENNA
ALLEGHENY PLASTICS INC
ROUTE 51 THORN RN RD CORAPOLIS PENNA
ALLEGRI TECH INC
41 43 RIVER RD NO ARLINGTON N J
ALLEN AVIONICS INC
255 E 2ND ST MINEOLA N Y
ALLEN-BRADLEY CO
136 W GREENFIELD AVE MILWAUKEE 4 WISC
ALLEN BUSINESS MACHINE INC
333 COMMERCE S W GRAND RAPIDS MICH
ALLEN ELECTRIC & EQUIPMENT CO
2101-2117 N PITCHER ST KALAMAZOO MICH
ALLEN ELECTRONIC CORP
937 INDUSTRIAL AVE PALO ALTO CALIF
ALLEN ELECTRONICS CORP
92 BRANCH ST PONTIAC MICH
ALLEN MFG CO
BLOOMFIELD CONN
ALLEN TOOL CORP
308 MALTBIE ST SYRACUSE NY
ALLIED ALLEGRI MACHINE CO INC
141 RIVER RD NUTLEY 10 N J
ALLIED CHEMICAL CORP GENERAL CHEM DIV
40 RECTOR ST NEW YDRK 6 NY
ALLIED CONTROL CD
2 EAST END AVE NEW YORK 21 N Y
ALLIED CONTROL CD INC
PLANTSVILLE CONN
ALLIED CONTROL CO INC
WAUREGAN CONN
ALLIED DECALS INC
20700 MILES AVE CLEVELAND DHIO
ALLIED RESEARCH & ENG CO
6916 SANTA MONICA BLVD HOLLYWOOD CALIF
ALLIED WITAN CO
BOX 8725 12500 BELLAIRE RD CLEVE DHID
ALLIES PRODUCTS CORP
P O BOX 188 KENDALL BRANCH MIAMI FLA
ALLIS CHALMERS
COLUMBUS & PREBLE AVES PITTSBURGH PA
ALLIS CHALMERS
1126 S 70TH ST WEST ALLIS WISC
ALLIS CO LOUIS
427 E STEWART ST MILWAUKEE 1 WISC
ALLISON LABS INC
11301 E OCEAN AVE LA HABRA CALIF
ALLMETAL SCREW PRODUCTS CO
821 STEWART AVE GARDEN CITY NY
ALLOY BELLOWS INC
18125 ROSELAND RD CLEVELAND 12 OHIO
ALLOY METAL WIRE WORKS
PROSPECT PARK PENNA
ALLOY METALSMITHS INC
88 COMMERCE RD CEDAR GROVE NJ
ALLOYD ELECTRONICS CORP
35 CAMBRIDGE PKWAY CAMBRIDGE MASS
ALLOYS UNLIMITED INC
21 01 43RD AVE LONG ISLAND CITY N Y
ALLOYS UNLIMITED INC
26 32 SKILLMAN AVE L IS CITY N Y
ALL PRODUCTS CO COMMUNICATION PROD OIV
BOX 520 MINERAL WELLS TEX
ALL STAINLESS INC
40 RUGG RD ALLSTON MASS
ALL STAR PRODUCTS INC
SQUIRE AVE DEFIANCE OHIO
ALLSTATE ELECTRONICS INC
32 ORAWAUPUM ST WHITE PLAINS N Y
ALL-STATE WELDING ALLOYS CO
249 FERRIS AVE WHITE PLAINS N Y
ALL TRONICS INC
45 BOND ST WESTBURY L I N Y
ALL WEATHER ANTENNA MFG CO INC
350 S EGG HARBOR HAMMONTON NJ
ALLYN INC WELCH
SKANEATELES FALLS NY
ALMA ENGINEERING
8135 ENGINEER RD SAN DIEGO CALIF
ALMOR DEVELOPMENT CO INC
2021 W 17TH ST LONG BEACH CALIF
ALNOR INST CO DV DF ILL TESTING LABS INC
420 N LASALLE ST CHICAGO ILL
ALONGE PRODUCTS INC
163 W 23RO ST NEW YORK N Y
ALPAR MFG CORP
220 DEMETER ST PALO ALTO CALIF
ALPHA CORP
820 ARAPAHO RD RICHARDSON TEXAS
ALPHA METALS INC
56 WATER ST JERSEY CITY 4 N J
ALPHA MOLYKOTE CORP
65 HARVARD AVE STAMFORD CONN
ALPHA SCIENTIFIC LABS INC
P O BDX 333 BERKELEY 1 CALIF
ALPHA WIRE CORP
200 VARICK ST NEW YORK N Y
ALPHADUCT WIRE & CABLE CO
25 VAN DYKE AVE NEW BRUNSWICK N J
ALPINE ELECTRIC COMPONENTS INC
WATERBURY CONN
ALPINE ELECTRONIC COMPONENTS INC WOLCOTT
NUTMEG ROAD WOLCOTT CONN
ALPITEC INC
49 GLEASON AVE STAMFORD CDNN
ALSOP ENGRG CORP
MILLDALE CONN
ALTAIR RESEARCH & MFG CO
BOX 106 BALDWIN PARK CALIF
ALTEC LANSING CORP
1515 S MANCHESTER AVE ANAHEIM CALIF
ALTHOR PRODUCTS
2301 BENSON AVE BROOKLYN N Y
ALTO FONIC TAPE SERVICE INC
211 LAMBERT ST PALO ALTO CALIF
ALTO SCIENTIFIC CO
4083 TRANSPORT ST PALO ALTO CALIF
ALTRON ELECTRONICS CO
1309 JEFFERSON AVE WOODLYN PA
ALUMINUM ALLOYS CORP
6650 W WALTEN DETROIT MICH
ALUMINUM CO DF AMERICA
1501 ALCOA BLDG PITTSBURGH 19 PA
ALUMINUM CO OF AMER REA MAGNET WIRE CO
CDNCORD RD LAFAYETTE IND
ALVA ALLEN INDUSTRIES
35 & 13 JCT CLINTON MO
ALWAC COMPUTER DIV EL-TRONICS INC
13040 S CERISE HAWTHORNE CALIF
AMATON ELECTRONIC HARDWARE CO INC
88 DRAKE AVE NEW ROCHELLE N Y
AMBROID CO
BOX 30 WEYMOUTH 88 MASS

AMCHEM PRODUCTS INC
AMBLER PENNA
AMCO ENG CO
7333 W AINSLIE ST CHICAGO ILL
AMECO DIV ANTENNAVISION INC
2949 W OSBORN RD PHOENIX ARIZ
AMELCO INC
12964 PANAMA ST LOS ANGELES CALIF
AMELCO INC ELECT DEVICES DIV
341 MOFFET BLVD MT VIEW CALIF
AMERAC INC
DUNHAM RD BEVERLY MASS
AMERICAN AEROSPACE CONTROLS INC
123 MILBAR BLVD FARMINGDALE N Y
AMERICAN AIR FILTER CO
215 CENTRAL AVE LOUISVILLE KY
AMERICAN AIRFRAME CORP
721 W 25TH ST HIALEAH FLA
AMERICAN ALUMINUM CO
230 SHEFFIELD ST MOUNTAINSIDE N J
AMERICAN ASTRO-SYSTEMS
2112 CHICO AVE EL MONTE CALIF
AMERICAN AVIONICS INC
2028-2032 STONER AVE LOS ANGELES 25 CALIF
AMERICAN BOSCH CORP
ROOSEVELT FIELD GARDEN CITY N Y
AMERICAN BOSCH ARMA CORP
5000 PARKSIDE PHILA PA
AMERICAN BRASS CO
414 MEADOW ST WATERBURY CONN
AMERICAN BRAKE SHOE CO RAYMOND ATCHLEY DIV
2339 COTNER AVE LOS ANG CALIF
AMERICAN CAPACITOR CO INC
32 HIGH ST AMESBURY MASS
AMER CHAIN & CABLE BRISTOL CO
127 BRISTOL ST WATERBURY CONN
AMERICAN CHAIN & CABLE DATA MASTERS CORP
85 HAZEL ST GLEN COVE NY
AMER CHAIN & CABLE WILSON MECH INST DIV
929 CONNECTICUT AVE BRIDGEPORT CONN
AMERICAN COMPONENTS INC
8TH AT HARRY CONSHOHOCKEN PA
AMERICAN CONCERTONE
9449 W JEFFERSON BLVD CULVER CITY CALIF
AMERICAN CYANAMID CO FORMICA DIVISION
CINCINNATI OHIO
AMERICAN CYSTOSCOPE MAKERS INC
8 PELHAM PKY PELHAM MANOR N Y
AMERICAN DATA MACHINES
7 COMMERCIAL ST HICKSVILLE N Y
AMERICAN DECALCOMANIA CO
310 LAKESIDE CLEVELAND OHIO
AMERICAN DISTRICT TELEGRAPH CO
20 BRIDEWELL PLACE CLIFTON N J
AMERICAN ELECTRIC CABLE CO
181 APPLETON ST HOLYOKE MASS
AMERICAN ELECTRONICS CO
178 HERRICKS RD MINEOLA L I N Y
AMERICAN ELECT INC INSTRUMENT
9503 JEFFERSON BLVD CULVER CITY CALIF
AMERICAN ELECT INC TALLER & COOPER DIV
75 FRONT ST BROOKLYN N Y
AMERICAN ELECT LABS INC
RICHARDSON RD COLMAR PENNA
AMERICAN ELECTRONICS CO
2801 37TH AVE NE MINN MINN
AMERICAN ELECTRICAL HEATER CO
6110 CASS AVE DETROIT MICH
AMERICAN ELECT LABS MICROWAVE & PHASING
P O BOX 552 LANSDALE PA
AMERICAN ELECTRONICS INC
1596 E ROSS AVE FULLERTON CALIF
AMERICAN ELECTRIC SWITCH DIV
CLARK CONTROLLER CO MINERVA OHIO
AMERICAN EMBLEM CO
4 GENESEE ST NEW HARTFORD NY
AMERICAN FELDMUEHLE CORP
11 W 42ND ST NEW YORK 36 N Y
AMERICAN GELOSO ELECT INC
251 FOURTH AVE NEW YORK N Y
AMERICAN GYRO DIV TAMAR ELECT INC
9320 LINCOLN BLVD LOS ANG CALIF
AMER HYDROMATH CORP
24 20 JACKSON AVE L I CITY N Y
AMERICAN INSTRUMENT CO
8050 GEORGIA AVE SILVER SPRING MD
AMERICAN INSULATOR CORP
NEW FREEDOM PA
AMER LATEX FIBRE CORP
500 N BROADWAY LAWRENCE MASS
AMERICAN LAVA CORP SUBS MINN MINING MFG
CHEROKEE BLVD & MFRS RD CHATTANOOGA 5 TENN
AMERICAN LIGHT ALLOYS INC
1265 MCBRIDE AVE LITTLE FALLS NJ
AMERICAN MACH & FOUNDRY CO
261 MADISON AVE NEW YORK N Y
AMER MACH & FOUNDRY
BOX 187 STA F BUFFALO N Y
AMF INSTR DIV AMER MACH & FDRY
4304 WHEELER AVE ALEXANDRIA VA
AMER MACH & FOUNDRY POTTER & BRUMFIELD DIV
MARION KY
AMERICAN MAGNETICS CORP
P O BOX 98 CARTERVILLE ILL
AMERICAN MEASUREMENT & CONTROL BURLINGTON
SUB COMPUDYNE CORP BURLINGTON MASS
AMERICAN MEASUREMENT & CONTROL INC
240 CALVARY ST WALTHAM 54 MASS
AMERICAN METAL CLIMAX INC
1270 AVE OF AMERICAS NEW YORK 2 N Y
AMERICAN MICA INSULATION CO
235 PARKER AVE MANASQUAN N J
AMERICAN MICRO DEVICES
10888 N 19TH AVE PHOENIX ARIZ
AMERICAN MICROPHONE CO DIV G C ELECT CO
400 S WYMAN AVE ROCKFORD ILL
AMERICAN MICROWAVE & TV CORP
1369 INDUSTRIAL RD SAN CARLOS CALIF
AMERICAN MISSILE PROD CO INC
15233 GREVILLEA AVE LAWNDALE CALIF
AMERICAN MOLDED PRODS CO
2727 W CHICAGO AVE CHICAGO ILL
AMERICAN OPTICAL CO INSTRUMENT DIV
BOX A BUFFALO 15 N Y
AMERICAN OPTICAL
1 MARLBORO ST KEENE NH
AMERICAN PERFIT CRYSTAL CORP
653 11 AVE NEW YORK 36 N Y
AMERICAN PHOTOCOPY EQUIP CO
2100 W DEMPSTER ST EVANSTON ILL
AMERICAN PRINTED CIRCUITS CO
104 FORREST ST METUCHEN N J
AMERICAN PRODUCT DEVELOPMENT CO
DIV AMERICAN DOOR & WINDOW CO INC
4585 S ALAMEDA ST LOS ANGELES 58 CAL
AMERICAN PRODUCTS MFG CO
8127 33 OLEANDER ST NEW ORLENAS LA
AMERICAN RADAR COMPONENTS INC
415 E MAIN ST DENVILLE N J
AMERICAN RECTIFIERS CORP
MFRS RICHARDSON ALLEN POWER SUPPLIES
116 15 15TH AVE COLLEGE POINT 56 N Y
AMERICAN RESEARCH CORP
ROUTE 6 FARMINGTON CONN
AMERICAN RESEARCH & MFG CORP
920 HALPINE AVE ROCKVILLE MD
AMERICAN SEALANTS CO
705 N MOUNTAIN RD HARTFORD CONN
AMERICAN SEMICONDUCTOR CORP
3940 N KILPATRICK AVE CHICAGO 41 ILLINOIS
AMERICAN SILVER CO
3607 PRINCE ST FLUSHING 54 N Y
AMERICAN SOLDER & FLUX CO
19 & WILLARD STS PHILADELPHIA 4 PA
AMERICAN SOUND PROD INC
4753 4TH AVE S MINNEAPOLIS MINN
AMERICAN SPACE EXPLORATION INC
3910 S KALAMATH ST ENGLEWOOD COLORADO
AMER SPEEDLIGHT CORP
6301 METROPOLITAN AVE MIDDLE VILLAGE NY
AMERICAN STANDARD AD TECH LAB
369 WHISMAN RD MOUNTAIN VIEW CALIF
AMERICAN STANDARD CONTROL DIV
5900 TRUMBULL AVE DETROIT MICH
AMERICAN STANDARD CONTROL DV
100 ROCKWOOD ST ROCHESTER N Y
AMERICAN STANDARD CORP NORWOOD PRODS
5900 TRUMBULL AVE DETROIT 8 MICH
AMERICAN STERILIZER SCIENTIFIC & IND DEPT
ERIE PENNA
AMERICAN SUPER TEMPERATURES WIRES INC
DIV OF HAVEG INDUST
32 W CANAL ST WINOOSKI VT
AMERICAN TELEVISION & RADIO CO
ST PAUL MINN
AMERICAN THERMO ELECTRIC CO
1023 N FULLER AVE LOS ANGELES 46 CALIF
AMERICAN TIME PROD INC
61-20 WOODSIDE AVE WOODSIDE 77 LI NY
AMERICAN TOWER CO
BOX 29 SHELBY OHIO
AMERICAN TRANSFORMER DIV RADIO ENG LABS
29 01 BORDEN AVE L I CITY N Y
AMERICAN TUBE BENDING CO
5 LAWRENCE ST NEW HAVEN CONN
AMERLINE CORP
2727 W CHICAGO AVE CHICAGO ILL
AMERSIL QUARTZ DIV ENGELHARD INDUST INC
685 RAMSEY AVE HILLSIDE NJ
B C AMES CO
131 LEXINGTON ST WALTHAM MASS
AMETEK INC LAMB ELECTRIC DIV
KENT OHIO
AMETEK INC HUNTER SPRING DIV
1 SPRING AVE HATFIELD PENNA
AMEY CORP
246 E 2ND ST PLAINFIELD N J
AMFLEX PRODUCTS INC
689 HOPE ST SPRINGDALE CONN
AMGLO CORP
4333 RAVENSWOOD AVE CHICAGO 13 ILL
AMI INC
1500 UNION AVE GRAND RAPIDS 2 MICH
AMMON INSTRUMENTS INC
345 KELLEY ST MANCHESTER N H
AMP INC CAPITRON DIV
155 PARK AVE ELIZABETHTOWN PA
AMP INCORPORATED
EISENHOWER BLVD HARRISBURG PENNA
AMPEREX ELECTRONICS CORP
SLATERVILLE R I
AMPEREX ELECTRONIC CORP
230 DUFFY AVE HICKSVILLE N Y
AMPERITE CO
561 BROADWAY NEW YORK 12 N Y
AMPEX AUDIO/SUB AMPEX CORP
1020 KIFER RD SUNNYVALE CALIF
AMPEX CORP
934 CHARTER ST REDWOOD CITY CALIF
AMPEX MAGNETIC DIV
BOX 190 OPELIKA ALA
AMPEX MAGNETIC TAPE PRODUCTS
OPELIKA ALA
AMPEX PROFESSIONAL PROD CO
BOX 5000 REDWOOD CITY CALIF
AMPHENOL CANADA LTD
349 CARLAW AVE TORONTO ONT CANADA
AMPHENOL CONNECTOR
1830 S 54TH AVE CHICAGO 50 ILL
AMPHENOL WESTERN DIV
9201 INDEPENDENCE AVE CHATSWORTH CALIF
AMPLIFIER CORP OF AMER
398 BROADWAY NEW YORK N Y
AMPLIVOX LTD
BERESFORD AVE WEMBLEY MIDDLESEX ENGLAND
AMPOWER PROD INC
10207 RIDGELAND CHICAGO RIDGE ILL
AMSTRO CORPORATION
9 CENTER AVE LITTLE FALLS N J
AMTEL AMERICAN MICROWAVE & TELEVISION
1369 INDUSTRIAL RD SAN CARLOS CALIF
AMTHOR TESTING INST CO
45 53 VAN SINDEREN AVE BROOKLYN N Y
AMTRON INC MIDLOTHIAN
14631 S WAVERLY AVE MIDLOTHIAN ILL
AMTRON CORP
17 FELTON ST WALTHAM 54 MASS
AMULEX ELECTRONICS INC
467 CONNECTICUT AVE S NORWALK CONN
AMY ACEVES & KING
11 W 42 ST NEW YORK N Y
ANACONDA ALUMINUM CO
BOX 1654 LOUISVILLE KY
ANACONDA ALUMINUM CO
20-21 WAGARAW RD FAIRLAWN NJ
ANACONDA WIRE & CABLE CO
25 BROADWAY NEW YORK 4 N Y
ANACONDA WIRE & CABLE
RIVER ST HASTINGS ON HUDSON N Y
ANADEX INSTRUMENT S INC
14734 ARMINTA ST BOX 472 VAN NUYS CALIF
ANALAB INSTRUMENT CORP
30 CANFIELD RD CEDAR GROVE N J
ANALOGUE CONTROLS INC
200 FRANK RD HICKSVILLE N Y
ANALYTIC SYSTEMS CO
370 N FAIR OAKS AVE PASADENA CALIF
ANALYTICAL MEASUREMENTS INC
585 MAIN ST CHATHAM N J
ANATRAN DIV OF ENDEVCO CORP
45 W UNION ST PASADENA CALIF
ANCHOR ALLOYS INC
966 MEEKER AVE BROOKLYN N Y
ELECTRONIC SPECIALTY CO ANCHOR METALS DIV
HURST TEXAS
ANCHOR PLASTICS CO
3636 36ST LONG ISLAND CITY N Y
ANCHOR SPEC MFG CO
300 HOLLISTER RD TETERBORO N J
ANCO INSTR DIV AMER NAME PLANE & MFG CO
4254 W ARTHINGTON ST CHICAGO ILL
ANDERS ELECTRONICS INC
30 BROOK RD NEEDHAM HGTS MASS
ANDERSEN LAB INC
501 NEW PARK AVE W HARTFORD CONN
ANDERSON & SONS INC
NORTH ELM ST WESTFIELD MASS
ANDERSON AIRCRAFT CO
SPRING ST NORTH DIGHTON MASS
ANDERSON CONTROLS INC
9959 PACIFIC AVE FRANKLIN PARK ILL
ANDERSON CONTROLS INC
3906 ELM ST MCHENRY ILL
ANDERSON ELECTRONICS INC
1012 CHESTNUT AVE ALTOONA PA
ANDERTON ELECTRONIC LAB
129 E 1800 ST BOUNTIFUL UTAH
ANDOVER CORP
318 N EARL AVE LAFAYETTE IND
ANDREA RADIO CORP
27 01 BRIDGE PLAZA N LONG ISLAND CITY N Y
ANDREW ANTENNA CORP
606 BEECH ST WHITBY ONTARIO CAN
ANDREW CALIF CORP
941 MARYLAND AVE CLAREMONT CALIF
ANDREW CORP
BOX 807 CHICAGO ILL
ANDREWS TOWER INC
1420 LAYTON AVE FORT WORTH TEXAS
ANDOROFORM INDUSTRIES INC
SPRING ST NORTH DIGHTON MASS
ANDROMEDA INC
11151 VIERS MILL RD WHEATON MD
ANELEX CORP
150 CAUSEWAY ST BOSTON MASS
ANGLER INDUSTRIES
107 TRUMBULL ST ELIZABETH N J
ANGSTROHN PRECISION INC
7341 GREENBUSH AVE NORTH HOLLYWOOD CAL
ANKO MFG CO
5025 N 124TH ST MILWAUKEE 18 WIS
ANNIS CO R B
1101 N DELWARE ST INDIANAPOLIS IND
ANDOYNE INC
1270 N W 165 ST MIAMI BEACH FLA
ANSLEY MFG CO ARTHUR
NEW HOPE PA
ANSONIA WIRE & CABLE CO
111 MARTIN ST ASHTON R I
ANTARA CHEMICALS DIV GEN FILM CORP
435 HUDSON AVE NEW YORK N Y
ANTENNA & RADOME RESEARCH ASSOC
27 BOND ST WESTBURY N Y
ANTENNA CORP
21341 ROSCOE BLVD CANOGA PARK CALIF
ANTENNACRAFT CO
1215 AGENCY ST BURLINGTON IOWA
ANTENNA DESIGNS INC
802 WASHINGTON ST BURLINGTON IOWA
ANTENNA PRODUCTS CO DIV OF ALL PROD CO
BOX 110 MINERAL WELLS TEXAS
ANTENNA SPECIALISTS CO
12435 EUCLID AVE CLEVELAND OHIO
ANTENNA SYSTEMS INC
GRENIER FIELD MANCHESTER N HAMP
ANTHONY & CO J L
115 BAKER ST PROVIDENCE R I
ANTI CORROSIVE METAL PRODUCTS CO
CASTLETON-ON-HUDSON N Y

ELECTRONIC MANUFACTURERS—A TO Z

ANTLAB INC
6330 PROPRIETORS RD WORTHINGTON OHIO
ANTON ELECTRONICS LABS
1226 FLUSHING AVE BROOKLYN 37 NY
ANTON MACHINE WORKS
1226 FLUSHING AVE BROOKLYN 37 N Y
ANTREX CORP
2001 W WILLOW ST CHICAGO 47 ILL
AOTO SWAGE PRODS INC
255 CANAL ST SHELTON CONN
APAHOUSER CORP OF N E
1312 BOYLSTON ST BOSTON 15 MASS
APCO ACCESSORY PRODUCTS CO
616 W WHITTIER BLVD WHITTIER CALIF
APCO MOSSBERG CO
205 LAMB ST ATTLEBORO MASS
APEL CO SUB RAYTHEON CO
213 E GRAND AVE S SAN FRAN CALIF
APEX COIL TRANSFORMER CORP
1919 S FAIRFIELD AVE CHICAGO 8 ILL
APEX MACHINE CO
14 13 118TH ST COLLEGE POINT 56 N Y
APEX WIRE CABLE CORP
237 37ST BROOKLYN N Y
A P M CORP
41 HONECK ST ENGLEWOOD N J
APPALACHIAN ELECTRONIC INSTRUMENTS INC
810 MONROE AVE RONEEVERTE W VA
APPARATUS DEVELOPMENT CO
115 MAIN ST WETHERSFIELD 9 CONN
APPLE FREQUENCY MEASURING SERVICE
409 UNION AVE BURLINGTON N C
APPLETON CO INC HARRY
136 SAN FERNANDO RD LOS ANG CALIF
APPLIED CONTROL CORP
1000 MAIN ST HACKENSACK N J
APPLIED DEVELOPMENT CORP
12838 WEBER WAY HAWTHORNE CALIF
APPLIED DEVELOPMENT CORP
1131 MONTEREY PASS RD MONTEREY PARK CALIF
APPLIED ELECTRONICS CO
213 E GRAND AVE SAN FRANCISCO CALIF
APPLIED ELECTRONICS CORP OF N J
METUCHEN N J
APPLIED MAGNETICS CORP
GOLETA CALIFORNIA
APPLIED MICROWAVE LAB INC
106 ALBION ST WAKEFIELD MASS
APPLETON ELECTRIC CO
1701 W WELLINGTON AVE CHICAGO ILL
APPLIED RADIATION CORP
2404 N MAIN ST WALNUT CREEK CALIF
APPLIED RESEARCH INC
76 S BAYLES AVE PORT WASHINGTON N Y
APPLIED RESEARCH LABS
3717 PARK PL GLENDALE CALIF
APPLIED SYSTEMS CORP
925 E MEADOW DR PALO ALTO CALIF
APPLIED TECHNOLOGY CORP
73 03 GRAND AVE MASPETH N Y
APPLIED TECHNOLOGY INC
930 INDUSTRIAL AVE PALO ALTO CALIF
APPLIED DYNAMICS INC
ANN ARBOR MICH
APPROVED PLASTICS CO
1189 VALLEY ROAD STIRLING N J
APW CO
72 MAIN ST ROCKAWAY N J
ARCAN EASTERN LTD
P O BOX 158 STA C HAMILTON ONT CANADA
ARCEL DAVIS MFG CO
3687 S STATE SALT LAKE CITY UTAH
ARCH GEAR INC
4336 E 10TH CT HIALEAH FLA
ARCH GEAR WORKS INC
97 HOLMES ST QUINCY MASS
ARCH INSTRUMENT CO
101 HOLMES ST N QUINCY MASS
ARCO ELECT INC
COMMUNITY DRIVE GREAT NECK N Y
ARCON ELECTRONICS DIV OF ARCON INDUST
BOX 31 3052 BURNEY PL LOS ALAMITOS CALIF
AR & DA ENGG CO
135 MAIN ST BELLEVILLE NJ
ARDE ASSOC ENGRG DIV
11 HILL ST NEWARK N J
ARDE PORTLAND INC
80 SECOND ST SOUTH PORTLAND MAINE
ARDENTE ACOUSTIC LABS LTD
MINERVA RD LONDON N W 10 ENGLAND
ARENBERG ULTRASONIC LABORATORY INC
94 GREEN ST JAMAICA PLAIN 30 MASS
A R F PRODUCTS INC
7627 LAKE ST RIVER FOREST ILL
ARF PRODUCTS INC
GARDNER RD RATON N M
ARGONNE ELECT MFG CORP
111 JERICHO TPKE SYOSSET L I N Y
ARGOS PRODUCTS CO
301 MAINS T GENOA ILL
ARISTO CRAFT DISTINCTIVE MINIATURES
314 FIFTH AVE NEW YORK 1 N Y
ARIZONA GEAR MFG CO
3544 E FORT LOWELL TUCSON ARIZ
ARKAY INTERNATIONAL INC
2372LINDEN BLVD BROOKLYN 8 N Y
ARK ELECT CORP
624 DAVISVILLE RD WILLOW GROVE PA
ARK LES SWITCH CORP
51 WATER ST WATERTOWN MASS
ARLIN MFG CO
12 PERKINS ST P O BOX 296 LOWELL MASS
ARMCO STEEL CORP
703 CURTIS ST MIDDLETOWN OHIO
ARMEL ELECTRONICS INC
1601 75TH ST N BERGEN N J
ARMSTRONG CORK CO
LANCASTER PENNA
ARMSTRONG RESINS INC
P O BOX 657 WARSAW IND
ARMSTRONG WHITWORTH EQUIP
HUCCLECOTE GLOUCESTER ENG
ARNOLD ENG G CO
P O BOX G MARENGO ILL
ARNOLD ENGG CO REPATH PACIFIC DIV
1551 EAST ORANGETHORPE FULLERTON CALIF
ARNOLD MAGNETICS CORP
6050W JEFFERSON BLVD LOS ANGELES CALIF
ARNOUX CORP
11924 W WASHINGTON BLVD LOS ANGELES CALIF
ARRA RESEARCH ASSOCIATES
27 BOND ST WESTBURY N Y
ARROW HART & HEGEMAN ELEC CO
103 HAWTHORN ST HARTFORD 6 CONN
ARROW MACHINIST & FABRICATORS
154 E 3RD ST MT VERNON N Y
ARROW RADIO CO
1829 DAVENPORT RD TORONTO ONTARIO CANADA
ARROWHEAD PRODUCTS
DIV FEDERAL-MOGUL-BEARINGS INC
4411 KATELLA AVE LOS ALAMITOS CALIF
AR&T ELECTRONICS INC
1101 MCALMONT LITTLE ROCK ARK
ART WIRE & STAMPING CO
227 HIGH ST NEWARK 2 N J
ARTISAN ELECTRONICS CORP
171 RIDGEDALE AVE MORRISTOWN N J
ARTISAN METAL WORKS CO
11400 MADISON AVE CLEVELAND 2 OHIO
ARTOS ENGG CO
2757 S 28TH ST MILWAUKEE WISC
ARTRONIC INSTRUMENT CO
11232 TRIANGLE LA SILVER SPRING MD
ARTTED CO INC
367 WORTHINGTON ST SPRINGFIELD 3 MASS
ARVEY CORP
300 COMMUNIPAW AVE JERSEY CITY 4 N J
ARVIN INDUSTRIES INC
COLUMBUS IND
ASCOP DIV ELECTRO MECHANICAL RESCH INC
44 WALLACE RD PRINCETON N J
ASHEVILLE-SCHOONMAKER MICA CO
900 JEFFERSON AVE NEWPORT NEWS VA
ASHLAND ELECTRIC PRODUCTS INC
3202 QUEENS BLVD LONG ISLAND CITY 1 N Y
ASKANIA REGULATOR CO
240 E ONTARIO ST CHICAGO 11 ILL
ASQUITH CO S A
427 W CHEVY CHASE DR GLENDALE CALIF
ASSEMBLY PRODUCTS INC
75 WILSON MILLS RD CHESTERLAND OHIO
ASSOC AMER WINDING MACHINERY INC
750 ST ANNS AVE NEW YORK N Y
ASSOCIATED COMMODITY CORP
620 FIFTH AVE NEW YORK 20 N Y
ASSOCIATED ELECTRICAL INDUSTRIES LTD
155 CHARING CROSS RD LONDON W C 2 ENGLAND
ASSOCIATED ELEC IND LTD ELEC APPARATUS DIV
CARHOLME RD LINCOLN ENGLAND
ASSOCIATED ELECTRICAL INDUSTRIES LTD
ELCT CNTRL SLS DPT NEW PKS LEICSTR ENGLAND
ASSOCIATED ELECTRICAL INDUSTRIES LTD
COMPUTER SLS DPT TRFFRD PK MNCHSTR ENGLAND
ASSOCIATED ELECTRICAL INDUSTRIES LTD
MILITARY RDR SLS DPT BLCKBD RD LEICSTR ENG
ASSOCIATED ENG & MFG CORP
210 STONEHOUSE RD GLEN RIDGE N J
ASSOCIATED ENG CORP
65 KENT ST BROOKLINE MASS
ASSOCIATED ENGINEERING CO
MATTHEWS NO CAR
ASSOCIATED MFG CO
4755 N ROCKWELL ST CHICAGO ILL
ASSOCIATED PRODUCTION CO
162 N CLINTON ST CHICAGO 6 ILL
ASSOCIATED RESEARCH INC
3787 W BELMONT AVE CHICAGO ILL
ASSOCIATED SPECIALTIES CO
1751 MAIN ST OREFIELD PA
ASSOCIATED TESTING LABS
109 ROUTE 46 WAYNE N J
ASSOC TESTING LABS INC SOUTHEASTERN DIV
1112 SOLANA AVE WINTER PARK FLA
ASTATIC CORP
250 HARBOR ST CONNEAUT OHIO
ASTRA TECHNICAL INSTRUMENT CORP
9905 W JEFFERSON BLVD CULVER CITY CALIF
ASTRODATA INC
240 E PALAIS RD ANAHEIM CALIF
ASTRO DYNAMICS INC
2ND AVE N W IND PK BURLINGTON MASS
ASTROLAB INC
35 COMMERCE ST SPRINGFIELD N J
ASTROMARINE PRODUCT CORP
1733 N 33RD AVE MELROSE PARK 1 ILL
ASTROMATIC DIV CONTROL CO OF AMER
140 WASHINGTON ST EL SEGUNDO CALIF
ASTROMETRICS INC
1108 SANTA BARBARA ST SANTA BARBARA CALIF
ASTRON CORP
255 GRANT AVE E NEWARK N J
ASTRONICS DIV LEAR SIEGLER INC
SANTA MONICA CALIF
ASTRO SYSTEMS INC
220 E 23RD ST NEW YORK N Y
ASTROSONICS INC
190 MICHAEL DR SYOSSET N Y
ASTROSYSTEMS INTL INC
1275 BLOOMFIELD AVE CALDWELL N J
ASTROTHERM CORP
1625 BELLEFONTAINE ST INDIANAPOLIS IND
A T ELECTRONICS INC
BOX 1841 NEW HAVEN CONN
ATELIERS DE MONTAGES ELECT
77 RUE ST CHARLES PARIS 15 EME FRANCE
ATKINS & MERRILL INC
POST RD SOUTH SUDBURY MASS
ATKINSON LAB INC
7070 SANTA MONICA BLVD LOS ANGELES CALIF
ATKOMATIC VALVE CO INC
545 W ABBOTT ST INDIANAPOLIS 25 IND
ATLANTIC INSTRUMENTS & ELECTRONICS INC
103 N BEACON ST BOSTON 34 MASS
ATLANTIC OPTICAL MOULDING CO
ELLIS ST DUDLEY MASS
ATLANTIC & PACIFIC WIRE & CABLE CO
137 GRAND ST NEW YORK NY
ATLANTIC RESEARCH CORP
SHIRLEY HWY AT EDSALL RD ALEXANDRIA VA
ATLANTIC SEMICONDUCTOR INC
905 MATTISON AVE ASBURY PARK N J
ATLANTIC TRANSFORMER CORP
30 HYNES AVE GROTON CONN
ATLANTIS ELECTRONICS CORP
1807 STRATFORD DR GARLAND TEXAS
ATLANTIS ELECTRONIC CORP
3326 BROADWAY GARLAND TEXAS
ATLAS COIL CORP
63 MAIN ST ANSONIA CONN
ATLAS CONNECTORS CORP
RIVER RD N ARLINGTON N J
ATLAS CONTROLS INC
9 ERIE DRIVE NATICK MASS
ATLAS ENG CO
10 CHENEY ST ROXBURY MASS
ATLAS MINERAL PRODUCTS CO
151 WALNUT ST MERTZTOWN PA
ATLAS OVERHEAD DOOR CO
MILL ST AT READING RR QUAKERTOWN PA
ATLAS POWDER CO
TAMAQUA PA
ATLAS SOUND CORP
1449 39 ST BROOKLYN 18 N Y
ATLAS TRANSFORMER CO
5975 FAIRMOUNT EXT SAN DIEGO CALIF
ATLEE CORP
2 LOWELL AVE WINCHESTER MASS
ATMO SEAL CO
3475 CARDIFF AVE CINCINNATI OHIO
ATOCON CORP
527 N UNION ST GALION OHIO
ATOHM ELECTRONICS
7648 SAN FERNANDO RD SUN VALLEY CALIF
ATOMIC ACESSORIES INC
811 W MERRICK RD VALLEY STREAM N Y
ATOMIC LABS INC
3086 CLAREMONT AVE BERLELEY CALIF
ATOMIUM CORP
575 MIDDLESEX TPKE BILLERICA MASS
ATTLEBORO REFINING CO
36 UNION ST ATTLEBORO MASS
AUBURN INDUSTRIAL PARK
AUBURN MASS
AUBURN MFG CO
PEASE AVE & STACK ST MIDDLETOWN CONN
AUDAX INC
109 01 37TH AVE CORONA N Y
AUDEX CO
3968 XENWOOD AVE MPLS MINN
AUDIO ACCESSORIES
279 BROADWAY AMITYVILLE N Y
AUDIO CRAFTERS
1601 BLUFF ROAD MONTEBELLO CALIF
AUDIO DEVICES INC RECTIFIER DIV
620 E DYER RD SANTA ANA CALIF
AUDIO ELECTRONICS
15858 35TH N E SEATTLE 55 WASH
AUDIO EQUIPMENT CO
75 HARBOR ROAD PORT WASHINGTON N Y
AUDIO EQUIPMENT
15749 WYOMING AVE DETROIT MICH
AUDIO INSTRUMENT CO
135 W 14 ST NEW YORK 11 N Y
AUDIO MFG CORP
100 RESEARCH DRIVE STAMFORD CONN
AUDIOMATION LABS
7230 CLINTON RD UPPER DARBY 14 PA
AUDIO PRECISION AIDS INC
SCARBOROUGH PK OSSINING N Y
AUDIOSEARS CORP
SHEPARD HILL RD ROXBURY NY
AUDIOTAPE CORP
25 PARKER AVE GLENBROOK CONN
AUDIOTEX MFG CO/DIV G C TEXTRON INC
400 S WYMAN ROCKFORD ILL
AUDIOTRONICS CORP
P O BOX 151 N HOLLYWOOD CALIF
AUDIVOX INC
123 WORCHESTER ST BOSTON MASS
AUERBACH CORP
1634 ARCH ST PHILA PA
AUGAT BROS
33 PERRY AVE ATTLEBORO MASS
AULT MAGNETICS CO
3501 48 AVE N MINNEAPOLIS 22 MINN
AUREX CORP
315 W ADAMS ST CHICAGO 10 ILL
AUSTIN ELECTRONICS DIV AUSTIN CO
76 9TH AVE NEW YORK 11 NY
AUTH ELECTRIC CO
34 20 45 ST LONG ISLAND CITY N Y
AUTHORIZED MFRS SERVICE CO
919 WYCKOFF AVE BROOKLYN 27 N Y
AUTOCRAT ELECTRONICS CO
5024 ELM ST SKOKIE ILL
AUTO DATA
BOX 9146 SAN DIEGO CALIF
AUTOMATED CONTROLS
1815 MAGNOLIA ALDERWOOD MANOR WASH

AUTOMATIC COIL CO INC
76 E 2ND ST MINEOLA N Y
AUTOMATIC CONTROL CO
995 UNIVERSITY AVE ST PAUL 4 MINN
AUTOMATIC CONTROLS DIV MAYS MFG CO
859 WEST 12TH STREET ERIE PA
AUTOMATIC ELECTRIC CO
NORTHLAKE ILL
AUTOMATIC ELECTRIC LAB
NORTHLAKE ILL
AUTOMATIC METAL PROD CORP
323 BERRY ST BROOKLYN N Y
AUTOMATIC SWITCH CO
HANOVER RD FLORHAM PARK N J
AUTOMATIC TAPE CONTROL INC
209 E WASHINGTON BLOOMINGTON ILL
AUTOMATIC TIMING & CONTROLS INC
KING OF PRUSSIA PENNA
AUTOMATION COMPONENTS INC
875 HICKORY ST PECKVILLE PA
AUTOMATION DEVICES INC
3125 BRANDES ST ERIE PENNA
AUTOMATION DYNAMICS CORP
255 COUNTY RD TENAFLY N J
AUTOMATION INC
212 WORCESTER ST WELLESLEY HILLS 82 MASS
AUTOMATION IND INC MAGNETICS DIV
INDUSTRIAL PARK BOULDER COLORADO
AUTOMATION MANAGEMENT INC
25 BRIGHAM ST WESTBORO MASS
AUTOMATION PRODUCTS INC
3030 MAX ROY ST HOUSTON TEX
AUTONETICS DIV NORTH AMERICAN AVIATION INC
LA PALMA ANAHEIM CALIF
AUTO PRODUCTS MFG
2735 OLIVE ST ST LOUIS MO
AUTO-SWAGE PRODUCTS INC
SHELTON CONN
AUTO TEST INC
600 S MICHIGAN AVE CHICAGO 5 ILL
AUTO TEST INC
411 W 8TH ST NEILLSVILLE WISC
AUTO TROL CORP
14500 W 82 AVE ARVADA COLO
AUTOTRON INC
3629 N VERMILION ST DANVILLE ILL
AUTOTRONICS INC
P O BOX 208 FLORISSANT MO
AUTRON ENG INC
1301 WILSHIRE BLVD LOS ANGELES 17 CALIF
AUTRONICS CORP
180 N VINEDO AVE PASADENA CALIF
AVCO CROSLEY DIV
BOX 116 EVENDALE OHIO
AVCO CORP ELECTRONICS & ORDNANCE DIV
2630 GLENDALE CINCINNATI 41 OHIO
AVCO LYCOMING DIV
550 S MIAN ST STRATFORD CONN
AVCO CORP ORDNANCE DIV
RICHMOND IND
AVEY DIV MOTCH & MERRYWEATHER
25 E 3RD ST COVINGTON KY
AVIATION INSTRUMENT & GEAR
2051 W 9TH AVE HIALEAH FLA
AVIATION INSTRUMENT MFG CORP
9033 MONROE RD HOUSTON 17 TEX
AVIEL ELECTRONICS INC
1755 BERKELEY ST SANTA MONICA CALIF
AVION FOUNDRY CORP
PO BOX 397 TARPON SPRINGS FLA
AVIONICS LTD
PO BX 200 NIAGARA-ON-THE-LK ONT CANADA
AVIONICS INC
425 S CHAPIN ST SOUTH BEND IND
AVNET CORP
5877 RODEO RD LOS ANG CALIF
AVNET ELECTRONICS CORP OF N CALIF
1262 N LAWRENCE STATION RD SUNNYVALE CAL
AVNET ELECTRONICS CORP
70 STATE ST WESTBURY N Y
AVO LTD
80 SHORE RD PORT WASH N Y
AVTRON MFG INC
10409 MEECH AVE CLEVELAND 5 OHIO
AXEL ELECTRONICS INC
134 20 JAMAICA JAMAICA N Y

B

BABBITT CHEMICAL CO
BOX 457 MATTAPOISETT MASS
BABCOCK & WILCOX CO
TUBULAR PRODUCTS DIV BEAVER FALLS PA
BABCOCK & WILCOX BAILEY METER CO
2980 EUCLID AVE WILCLIFFE OHIO
BABCOCK & WILCOX DIAMOND POWER SPEC CORP
BOX 415 LANCASTER OHIO
BABCOCK ELECT CORP
1640 MONROVIA AVE COSTA MESA CALIF
BABCOCK RELAYS
1640 MONROVIA AVE COSTA MESA CALIF
BABCO PRODUCTS INC
28 WATER ST DANVERS MASS
BACH AURICON INC
6900 ROMAINE AVE HOLLYWOOD CALIF
BACH-SIMPSON LTD
1255 BRYDGES ST LONDON ONT CANADA
BACHE & CO SEMON
636 GREENWICH ST NEW YORK 14 N Y
BACON INDUSTRIES
192 PLEASANT ST WATERTOWN 72 MASS
BAER CO N S
1-11 MONTGOMERY ST HILLSIDE 5 N J
BAILEY METER COMPANY
1050 IVANHOE RD CLEVELAND 10 OHIO
BAILEY METER CO
29801 EUCLID AVE WICKLIFF OHIO
BAIRD ATOMIC INC
WALTHAM MASS
BAKER CHEMICAL CO J T
PHILLIPSBURG N J
BAKER CO
106 GRANITE ST BIODEFORD ME
BAL CORP WILLIAM
947 NEWARK AVE ELIZABETH N J
BALCO RESEARCH LABS CAPACITOR DIV
49-53 EDISON PL NEWARK 2 N J
BALCRANK INC MACHINE TOOL DIV
DISNEY ST CINCINNATI 9 OHIO
ELECTRONICS DIV BALDWIN HAMILTON CORP
WALTHAM MASS
BALDWIN MFG CO INC
140 HOMER ST WATERBURY CONN
BALDWIN PIANO CO
1801 GILBERT AVE CINCINNATI 2 OHIO
BALLANTINE LABS INC
BOONTON N J
BALLARD CO IRVING
407 SANSOME ST SAN FRAN CALIF
BALLASTRAN CORP
1701 N CALHOUN ST FT WAYNE IND
BALTEAU ELECTRIC CORP
NEW & MEADOW STS STAMFORD N Y
H S BANCROFT & CO
209 COOPER ST WESTMONT COLLINGSWOOD N J
BAR WORK MFG CO INC
1198 HIGHLAND AVE WATERBURY CONN
BARBER & HOWARD CO
EAST AVE WESTERLY R I
BARBCO INC
BOX 1222 MILWAUKEE WIS
BARBER COLMAN CO AIRCRAFT & MISSILE PROD DIV
ROCKFORD ILL
BARBER COLMAN CO MOTORS & COMPONENTS DIV
ROCKFORD ILL
BARBER COLMAN CO ELECT COMPONENTS DIV
ROCKFORD ILL
BARBER LABS ALFRED W
32 44 FRANCIS LEWIS BLVD FLUSHING N Y
BARBER-COLMAN CO
1300 ROCK ST ROCKFORD ILL
BARBOUR STOCKWELL CO
205 BROADWAY CAMBRIDGE MASS
BARCO CHEMICAL PRODUCTS CO
701 S LASALLE ST CHICAGO ILL
BARDEN CORP
200 PARK AVE DANBURY CONN
BARFIELD INSTRUMENT CORP
4101 N W 29TH ST MIAMI FLA
BARIUM & CHEMICALS INC
WILLOUGHBY OHIO
BARIUM CHEMICALS INC
STEUBENVILLE OHIO
BARKER & WILLIAMSON INC
CANAL & BEAVER STS BRISTOL PENNA
BARKER PRODUCTS CO
WEST BRIDGEWATER MASS
BARKSDALE VALVES
5125 ALCOA AVE LOS ANGELES 58 CALIF
BARNES DEVELOPMENT CO
213 W BALTIMORE AVE LANSDOWNE PA
BARNES ENGINEERING CO
30 COMMERCE RD STAMFORD CONN
BARNES METAL PRODUCTS CO
4425 W 16ST CHICAGO ILL
BARNETT INST CO
430 COMMERCE ST CLARKSVILLE TENN
BARNETT INSTRUMENT CO
KRAFT ST CLARKSVILLE TENN
BARNEY CHENEY CO
EIGHTH AVE NORTH CASSADY COLUMBUS OHIO
BARNSTEAD STILL & DEMINERALIZER CO
331 LANESVILLE TERR BOSTON 31 MASS
BAR RAY PRODUCTS INC
211 25TH ST BROOKLYN N Y
BARRETT CO LEON J
P O BOX 378 WORCESTER 1 MASS
BARRETT ELECTRONICS CORP
630 DUNDEE RD NORTHBROOK ILL
BARRETT ELECT CORP WESTERN DIV
897 COMMERCIAL ST PALO ALTO CALIF
BARRETT VARNISH CO
1532 S 50TH COURT CICERO ILL
BARRY CONTROLS DV OF BARRY WRIGHT CORP
700 PLEASANT ST WATERTOWN MASS
BARRY ELECTRONICS CORP
512 BROADWAY NEW YORK N Y
BARTA GRIFFIN CO
PO BOX 808 72 COMMERCIAL ST WORCT MASS
BARTH ENGRG & MFG CO INC
48 ELM ST MERIDEN CONN
BARTON INSTRUMENT CORP
580 MONTERY PASS RD MONTEREY PK CALIF
BARWOOD ELECTRONICS INC
120 S MARYLAND AVE GLENDALE 5 CALIF
BARWOOD MFG INC L J
18 WILLIAMS ST EVERETT MASS
BASCH CO GEORGE
19 HANSE AVE FREEPORT L I N Y
PENN CONTROLS INC BASCO DIV
1007 S 12TH ST WATERTOWN WISC
BASIC & EXPERIMENTAL PHYSICS
BOX 689 FALMOUTH MASS
BASLER ELECTRIC CO
BOX 269 RT 143 HIGHLAND ILL
BASO DIV PENN CONTROLS INC
4000 W BURNHAM ST MILWAUKEE WISC
BASSETT INC REX
1314 N E 17 CT FT LAUDERDALE FLA
BAUSCH & LOMB INCORP
1762 BAUSCH ST ROCHESTER N Y
BAYLEY INSTRUMENT CO
PO BOX 538 DANVILLE CALIF
BAY PRODS DIV AMER METAL WKS INC
1835 W CAMBRIA ST PHILA 32 PA
BAY ROY ELECTRONICS INC
16608 MADISON AVE CLEVELAND OHIO
BAY STATE ABRASIVE PRODUCTS CO
12 UNION ST WESTBORO MASS
BAYSIDE TIMERS
45-25 162 ST FLUSHING 58 N Y
B & B ELECTRONICS CORP
17360 S GRAMERCY PL GARDENA CALIF
B & C INSULATION PRODUCTS INC
LINCOLN HWY ISELIN N J
BEACH-RUSS CO
622 GRAYBAR BLDG NEW YORK 17 N Y
BEAD CHAIN MFG CO
110 MOUNTAIN GROVE ST BRIDGEPORT 5 CONN
BEAN & CO MORRIS
HYDE RD YELLOW SPRINGS OHIO
BEARING INSPECTION INC
3311 E GAGE AVE HUNTINGTON PK CAL
BEATTIE-COLEMAN INC
1000 N OLIVE ST ANAHEIM CALIF
W A BEAUCHAINE & SONS INC
P O BOX 127 LAKEPORT N H
BEAU ELECTRONICS INC
1066 WOLCOTT ROAD WATERBURY CONN
BEAVER GEAR WORKS INC
1025 PARMELEE ST ROCKFORD ILL
BEAZART ELECTRONICS CO
7459 DEERING CANOGA PARK CALIF
BECK CO HAROLD
3640 N 2 ST PHILA 40 PENNA
BECKER BROS CARBON CO
3450 S LARIME AVE CICERO ILL
BECKER DURHAM
EAST DURHAM N Y
BECKER ELECT MFG CORP
1091 ROCKAWAY AVE VALLEY STREAM N Y
BECKER ELECTRONICS MFG CORP
RTE 145 E DURHAM N Y
BECKLEY MFG CO
BECKLEY W VA
BECKMAN & WHITLEY
993 E SAN CARLOS AVE SAN CARLOS CALIF
BECKMAN INST INC
2500 HARBOR BLVD FULLERTON CALIF
BECKMAN INST SPINCO DIV
PALO ALTO CALIF
BECKMAN INST INC BERKELEY DIV
2200 WRIGHT AVE RICHMOND CALIF
BECKS INC
298 E 5 ST ST PAUL MINN
BEE CHEMICAL CO
2700 E 170TH ST LANSING ILL
BEEMER ENG CO
INDUSTRIAL PARK FT WASHINGTON PA
BEGEN CO M
1683 JERROLD ST SAN FRANCISCO 24 CALIF
BEHLMAN INVAR ELECTRONICS CORP
1723 CLOVERFIELD BLVD SANTA MONICA CALIF
BELDEN MFG CO
415 S KILPATRICK CHICAGO 44 ILL
BELDING CORTICELLI INDUST INC
1407 BROADWAY NEW YORK N Y
BELFAB CORP
MUNICIPAL AIRPORT DAYTONA BEACH FLA
BELFAB CORP
BOX 1881 DAYTONA BEACH FLA
BELFAB CORP
PO BOX 1446 DAYTONA BEACH FLA
BELFUSE INC
198 VAN VORST JERSEY CITY N J
BELL & HOWELL PHOTO PRODUCTS DIVISION
7100 MCCORMICK RD CHICAGO 45 ILL
BELL AIRCRAFT CORP
P O BOX 1 NIAGRA FALLS BLVD BUFFALO 5 N Y
BELL HELICOPTER CO ELECTRONIC DEPT
DIV BELL AEROSPACE
P O BOX 482 FT WORTH TEXAS
BELL INC F W
1356 NORTON AVE COLUMBUS 12 OHIO
BELL SOUND DIV THOMPSON RAMO WOOLDRIDGE INC
555 MARION RD COLUMBUS 7 OHIO
BELLAIRE ELECTRONICS INC
62 WHITE ST RED BANK N J
BELLEVILLE MEXEM CORP
638 UNIVERSITY AVE LOS GATOS CALIF
BELLOWS VALVIAR
PO BOX 631 AKRON 9 OHIO
BELMONT SMELTING & REFINING WORKS
330 BELMONT AVE BROOKLYN 7 N Y
BELOCK INSTRUMENT CORP
111 01 14 AVE COLLEGE POINT N Y
BELTRONICS CORP
344 INTERSTATE RD ADDISON ILL
BELZ INDUSTRIES DIV EL TRONICS INC
89 UNION ST MINEOLA N Y
BENCO TELEVISION ASSOC LTD
27 TABER RD REXDALE ONT CANADA
BENDIX CORP BENDIX PACIFIC DIV
11600 SHERMAN WAY N HOLLYWOOD CALIF
BENDIX CORP BENDIX SYSTEMS DIV
ANN ARBOR MICH
BENDIX CORP IND CONTROLS DIV
8880 HUBBELL AVE DETROIT 28 MICH
BENDIX CORP RED BANK DIV
RT 35 EATONTOWN N J

ELECTRONIC MANUFACTURERS—A TO Z

BENDIX CORP/SCINTILLA DIV
OELAWARE AVE SIDNEY N Y
THE BENDIX CORP CINCINNATI DIV
3130 WASSON RD CINCINNATI OHIO
BENDIX COMPUTER DIV THE BENDIX CORP
5630 ARBOR VITAE LOS ANG CALIF
BENDIX CORP BENDIX RADIO DIV
BALTIMORE MD
BENDIX CORP SEMICONDUCTORS DIV
HOLMDEL N J

BENDIX CORP MISHAWAKA DIV
400 S BEIGER ST MISHAWAKA IND
BENDIX CORP THE PIONEER CENTRAL DIV
2734 HICKORY GROVE RD DAVENPORT IOWA
BENDIX CORP THE FRIEZ INST DIV
BALTIMORE 4 MD
BENDIX CORP THE SHEFFIELD CORP SUB
BOX 893 MIU SPRINGFIELD ST OAYTON OHIO
BENNETT LAB INC
1475 POWELL ST EMERYVILLE CALIF
BENRUS WATCH CO INC
30 CHERRY AVE WATERBURY CONN
BENSON LEHNER CORP
11930 W OLYMPIC BLVO LOS ANG CALIF
BENSON LEHNER CORP
14761 CALIFA STREET VAN NUYS CALIFORNIA
BENSON LEHNER G B LTO
WEST QUAY RO SOUTHHAMPTON ENG
BENTLEY HARRIS MFG CO
CONSHOHOCKEN PA
BERG MFG CORP
NEW CUMBERLANO PA
BERGEN LABS INC
60 SPRUCE ST PATERSON 1 N J
BERGEN WIRE ROPE CO
456 GREGG ST LODI N J
BERGER BROS CO SPECIAL PRODS OIV
135 DERBY AVE NEW HAVEN CONN
BERKELEY DYNAMICS
BOX 1098 BURLINGAME CALIF
BERKELEY INSTRUMENTS
1475 POWELL ST EMERYVILLE 8 CAL
BERKELEY INSTRUMENT CO
BOX 146 BERKELEY HGTS N J
BERKSHIRE LABS
11-35 KINGSFORD RD HANOVER NEW HAMPSHIRE
BERKSHIRE TRANSFORMER CORP
ROUTE 341 KENT CONN
BERMAN LABS
112 03 ROCKAWAY BLVO OZONE PK N Y
BERMITE POWDER
22216 W SOLEDAD CANYON RO SAUGUS CAL
BERNARO FRANKLIN CO INC
FRANKFORD & TORRESDALE AVE PHILA PA
BERNCO ENGINEERING CORP
2320 S TIBBS AVE INDIANAPOLIS 41 IND
BERYLLIUM CORP
P O BOX 1462 READING PENNA
BEST MFG CO
1333 WALNUT ST BOX 2126 KANSAS CITY 42 MO
BESTCRAFT PRODUCTS CO
626 BROADWAY NEW YORK 12 N Y
BETHLEHEM STEEL CO
BETHLEHEM PA
BETTER COIL & TRANSFORMER CORP
GOODLANO INO
BETTS & BETTS CORPORATION
POMPERAUG ROAD WOODBURY CONN

BEVA LABORATORY
185 FOURTH STREET TRENTON 9 NJ
BEVIN WILCOX LINE CO
95 SKINNER ST E HAMPTON CONN
B & F INSTRUMENTS INC
3644 N LAWRENCE ST PHILA PA
B G CORP THE
321 BROAO AVE RIOGEFIELO NJ
B & H INSTRUMENT CO INC
3479 W VICKERY BLDG FT WORTH TEXAS
BIODLE CO JAMES G
1316 ARCH ST PHILAOELPHIA 7 PA
B I F INDUSTRIES
345 HARRIS AVE PROVIDENCE R I
BIGGS CO CARL H
1547 FOURTEENTH ST SANTA MONICA CALIF
BILL JACK INDUSTRIES
143 S CEOROS ST SOLANA BEACH CALIF
BINARY ELECTRONICS INC
30 48 LINDEN PL FLUSHING N Y
BIO-RAD LABS
32ND AND GRIFFIN AVE RICHMOND CALIF
BIOPHYSICAL INSTRUMENTS INC
20 HERMAN ST PHILA PA
BIOPHYSICAL ELECT OIV COMM INO
221 ROCK HILL RO BALA CYNWYO PA
BIOS LABS INC
17 W 60 ST NEW YORK N Y
BIRD & CO RICHARO H
1 SPRUCE ST WALTHAM 54 MASS
BIRO & SONS LTO SYDNEY S
FLEETS LANE POOLE OORSET ENG
BIRD ELECTRONIC CORP
30303 AURORA RO CLEVELAND 39 OHIO
BIROAIR STRUCTURES INC
1800 BROADWAY BUFFALO 12 N Y
BIRDSELL PROOS AFFL SUSQUEHANNA SCIENCES
350 N HALSTEAD ST PASAOENA CALIF
BIRMA MFG CO INC
254 RANO ST BUFFALO 7 N Y
BIRMINGHAM SOUNO REPRODUCERS LTO
MONARCH WKS POWER LANE STAFFOROSHIRE ENG
BIRNBACH RADIO CO
145 HUDSON ST NEW YORK 13 N Y
THE BIRTCHER CORP INDUSTRIAL DIV
745 S MONTEREY PASS RO MONTEREY PK CALIF
BISCHOF OIE ENGRAVING
1405 16TH ST RACINE WISC

BISHOP ENGINEERING CO INC
804 S MAIN ST MOUNT AIRY MO
BISHOP & CO PLATINUM WORKS J
MALVERN PENNA
BISHOP MFG CORP
10 CANFIELO RO CEOAR GROVE NJ
BITTERMANN ELECTRIC CO
BARLOW ST CANAAN CONN
BIWAX CORP
3445 HOWARO ST SKOKIE ILL

B & K INSTRUMENTS INC OF BRUEL & KJAER
3044 W 106 ST CLEVELANO 11 OHIO
B & K MFG CO
1801 W BELLE PLAINE AVE CHICAGO 13 ILL
BLACK & OECKER MFG CO
E PENNA AVE TOWSON 4 MO
BLACK & WEBSTER INC
570 PLEASANT ST WATERTOWN MASS
BLACK LIGHT EASTERN CORP
24 KINKEL ST WESTBURY N Y
BLACK LIGHT PRODUCTS INC
4868 N SHERIDAN RO CHICAGO ILL
BLACKBURN ELECTRONIC CORP
55 W 7 ST WYOMING PA
BLACKHAWK ENGINEERING CO
P O BOX 146 JANESVILLE WISC
BLACKSTONE CORP
1111 ALLEN ST JAMESTOWN N Y
BLACO MFG CO
6541 EUCLID AVE CLEVELANO OHIO
BLAINE ELECTRONICS INC
14757 KESWICK ST VAN NUYS CALIF
BLASS ANTENNA ELECTRONICS CORP
11-1134TH AVE LONG ISLAND CTY 6 N Y
BLAW-KNOX CO/BLAW-KNOX EQUIP OIV
PITTSBURGH 38 PENNA
BLEHART CO L O
10 FISKE PL MT VERNON N Y
BLICKMAN INC
201 GREGORY AVE WEEHAWKEN N J
BLILEY ELECTRIC CO
UNION STATION BLOG ERIE PA
BLINN CO OELBERT
P O BOX 757 POMONA CALIF
BLISS ELECTRONIC CORP
BOX 366 SUSSEX NJ
BLOCK ASSOC
395 PUTNAM AVE CAMBRIDGE MASS
BLOCKSOM & CO
5TH CANAL ST MICHIGAN CITY INO
BLOOMINGOALE RUBBER CO
P O BOX 191 ABERDEEN MO
BLOWERS INC
12655 WESTERN AVE BLUE ISLAND ILL
BLUE M ELECTRIC CO
138 E CHATHAM ST BLUE ISLANO ILL
BOOINE ELECTRIC CO
2500 BRADLEY PLACE CHICAGO ILL
BOEHME INC H O
915 BROAOWAY NEW YORK 10 N Y
BOEHM CO R A
1218 OIAMONO AVE BETHEL CONN
BOEING AIRPLANE CO
OEPT 8200 WICHITA 1 KANSAS
BOESCH MFG CO
45 RIVER ST OANBURY CONN
BOETSCH BROS
115 CEOAR ST N ROCHELL N Y

BOGART MFG CORP
315 SIEGEL ST BROOKLYN N Y
BOGUE ELECTRIC MFG CO
52 IOWA AVE PATERSON 3 NJ
BOLTA PROOUCTS OIV GENERAL TIRE & RUBBER CO
70 GAROEN ST LAWRENCE MASS
BOMAC LABS INC
SALEM RO BEVERLY MASS
BOMYTE CO
GREEN ST SILVERDALE PA
BON OE ELECTRONIC LABS INC
361 363 RANTOUL ST BEVERLY MASS
BONE ENGG CORP
701 BROADWAY GLENDALE CALIF
BONNY MFG CORP
146 MAIN ST MAYNARO MASS
BOOKER & WALLSTAD OIV THERMOTECH INO
3330 GORHAM AVE MINN MINN
BOONSHAFT & FUCHS INC
HATBORO INDL PARK HATBORO PA
BOONTON ELECTRONICS CORP
738 SPEEOWELL AVE MORRIS PLAINS N J
BOONTON MOLDING CO INC
300 MYRTLE AVE BOONTON N J
BOONTON RADIO CORP
INTERVALE RO BOONTON N J
BOOTH CO ARTHUR E
265 S ALEXANDRIA AVE LOS ANGELES 4 CALIF
BOOTS AIRCRAFT NUT CO
NEWTON TURNPIKE NORWALK CONN
THE BORDEN CO CHEMICAL OIV
1 CLARK ST NO ANDOVER MASS
BORDEN CHEMICAL CO DIV BORDEN CO
P O BOX 4428 COMPTON CALIF
BORDEN CHEMICAL CO
5000 LANGDON ST BOX 9522 PHILA PA
BORG EQUIP DIV AMPHENOL BORG ELECT CORP
120 MAIN ST JANESVILLE WISC
BORG-WARNER CONTROLS
3300 NEWPORT BLVO BOX 1679 SANTA ANA CALIF
BORO PRECISION PROOUCTS CORP
76 14 WOODSIOE AVE ELMHURST N Y
BOSCO ELECT INC
56 ROUTE 10 HANOVER N J
BOSTON AUTO GAGE CO
70 WEST ST PITTSFIELO MASS
BOSTON GEAR WORKS
QUINCY 71 MASS

BOSTON INSULATED WIRE & CABLE CO
65 BAY ST BOSTON MASS
BOULEVARD ELECTRONICS INC
1229 WASHINGTON BLVO CHICAGO ILL
BOULVARO RECORDING STUDIOS INC
632 N OEARBORN ST CHICAGO ILL
BOURNS INC
6135 MAGNOLIA AVE RIVERSIDE CALIF
BOURNS INC TRIMPOT OIV
1200COLUMBIA AVE RIVERSIDE CAL

BOURNS LABS INC
118 HAYWARO AVE AMES IOWA
BOW SOLDER PRODUCTS CO
251 FREEMAN ST BROOKLYN N Y
BOWMAR INSTRUMENT CORP
8000 BLUFFTON RO FT WAYNE IND

BOWMAR INSTRUMENT TIC OIV
531 MAIN ST ACTON MASS

BOZAK MFG CO R T
587 CONNECTICUT AVE S NORWALK CONN
BOY-MAR ELECTRICAL SERVICE CO
1271 MISSION ST SAN FRANCISCO 3 CALIF
B & R TOOL & OIE CO
947 INDUSTRIAL AVE PALO ALTO CALIF
BRABENDER INST INC C W
50 E WESLEY ST S HACKENSACK N J
BRACH MFG CORP OIV GEN BRONZE CORP
20O CENTRAL AVE NEWARK 3 N J
BRAO THOMPSON INOUST INC
83 81O TAMARISK ST INDIO CALIF
BRADFORO COMPONENTS INC
65 SOUTH AVE SALAMANCA N Y
BRADLEY ELECTRONICS CO INC
68 FIRST ST NEW ROCHELLE N Y
BRADLEY SEMICONDUCTORS CORP
275 WELTON ST HAMDEN CONN
BRADY CO W H
727 W GLENDALE AVE MILWAUKEE 9 WISC
BRAILSFORO & CO
670 MILTON RO RYE N Y
BRAININ CORP C S
320 WASHINGTON ST MT VERNON N Y
BRAMCO INC SUB LEDEX INC
COLLEGE & SOUTH PIQUA OHIO
BRAM METALLURGICAL-CHEMICAL CO
820 65 AVE PHILADELPHIA 26 PA
BRAND REX OIV AMER ENKA CORP
18120 S BROADWAY GARDENA CALIF
BRANO REX DIV AMER ENKA CORP
ROUTE 6 N WINOHAM CONN
BRANO REX DIV AMER ENKA CORP
HAYWARO RO W ACTON MASS
BRANSON CORP
41 S JEFFERSON RO WHIPPANY N J
BRANSON INSTRUMENTS INC
37 BROWN HOUSE RO STAMFORO CONN
BRAUN KNECHT HEIMANN CO
601 ONEIL AVE BELMONT CALIF
BRAUN TOOL & INSTRUMENT CO INC
140 FIFTH AVE HAWTHORNE N J
BREEZE CORPS
700 LIBERTY AVE UNION NJ
BREON LABS
1520 EVERGREEN RO WILLIAMSPORT PA
BREVEL PROOUCTS CORP
601 W 26TH ST NEW YORK N Y
BREW & CO RICHARO O
90 AIRPORT RO CONCORO N H

BRIOGE ELECTRONICS CO INC
408 WARREN ST BEVERLY N J
BRIDGEPORT BRASS CO
30 GRAND ST BRIOGEPORT 2 CONN
BRIGHT RAOIO LABS INC
222 E 2NO ST MINEOLA LI N Y
BRIGHT STAR BATTERY
CLIFTON N J
BRILMAYER LAB E W
330 FIFTH AVE PELHAM N Y
BRINKMANN INSTRUMENTS INC
115 CUTTER MILL RO GREAT NECK N Y
BRISTOL BRASS CORP
58O BROAO ST BRISTOL CONN
BRISTOL CO
PO BOX 1790 WATERBURY CONN
BRISTOL CO
2040 N HAWTHORNE MELROSE PARK ILL
BRISTOL CO
6800 E ACCO ST LOS ANGELES CALIF
BRISTOL MOTORS OIV VOCALINE CO AMERICA INC
OLO SAYBROOK CONN
BRITISH RADIO ELECTRONICS LTO
1833 JEFFERSON PL NW WASHINGTON OC
BRITTON ELECTRONICS CORP
35 10 36TH AVE LONG ISLAND CITY N Y
BROADWAY COIL CO
5638 BROADWAY CHICAGO 4O ILL
BRON-SHOE CO
269 E BROAO ST COLUMBUS 15 OHIO
BROOKS INSTRUMENT CO INC
HATFIELO PENNA
BROOKS & PERKINS INC
1950 W FORT ST DETROIT MICH
BROOKS RAOIO & TV CORP
84 VESEY ST NEW YORK 7 N Y
BROOKS RESEARCH
499 WEST COMMERCIAL ST EAST ROCHESTER NY
BROOKS ROTAMETER CO
P O BOX 432 LANSDALE PA
BROWN & SHARPE MFG CO
235 PROMENADE ST PROVIDENCE R I
BROWN BROCKMEYER CO
1000 S SMITHVILLE RO DAYTON OHIO
BROWN ENG CO INC
1100 MERIDIAN ST HUNTSVILLE ALA
BROWN INC DAYTON T
1305 STRONG RO COPIAGUE N Y

BROWNING LABS INC
100 UNION AVE LACONIA N H
BRUBAKER ELECTRONICS INC
11800 OLYMPIC BLVD LOS ANG CALIF
BRUMBERGER CO
34 34TH ST BROOKLYN N Y
BRUNING CO INC CHARLES
1800 W CENTRAL RD MT PROSPECT ILL
BRUNO NEW YORK INDUST CORP
460 W 34 ST NEW YORK 1 NY
BRUNSWICK INSTRUMENTS
P O BOX 813 NEW BRUNSWICK N J
BRUSH BERYLLIUM CO READING DIV
SHOEMAKERSVILLE PENNA
BRUSH BERYLLIUM CO
5209 EUCLID AVE CLEVELAND OHIO
BRUSH INSTRUMENTS
37TH & PERKINS CLEVELAND OHIO
BRYANT COMPUTER PRODUCTS DIV EX-CELLO CORP
850 LADD ROAD WALLED LAKE MICH
BRYS INSTRUMENT CO
7026 6TH AVE BROOKLYN N Y
BTU ENGG CORP
179 BEAR HILL RD WALTHAM 54 MASS
BUCHANAN ELECTRICAL PROD CORP
HILLSIDE N J
BUCK EPGG FO
37 MARCY ST FREEHOLD N J
BUCKBEE MEARS CO
245 E 6TH ST ST PAUL MINN
BUCKBEE MEARS CO TONI BUILDING
4TH & ROSABEL ST ST PAUL MINN
BUCKEYE IRON & BRASS WORKS
324 E 3RD ST DAYTON OHIO
BUD RADIO INC
2118 E 55TH ST CLEVELAND 3 OHIO
BUDD CO POLYCHEM DIV
NEWARK DELAWARE
BUDD ELECTRONICS A DIV OF THE BUDD CO
43 22 QUEENS ST LONG ISLAND CITY N Y
BUDD STANLEY CO
175 EILEEN WAY SYOSSET N Y
BUDELMAN ELECTRONICS CORP
375 FAIRFIELD AVE STAMFORD CONN
BUFFALO INSTRUMENT CORP
1780 ELMWOOD AVE BUFFALO NY
H H BUGGIE DIV BURNDY CORP
P O BOX 817 TOLEDO OHIO
BUHL OPTICAL CO
1009 BEECH AVE PITTSBURGH 33 PA
BUILDING BLOCKS ELECTRONIC CO
2506 GERRITSEN AVE BROOKLYN 29 N Y
BULLARD
286 CANFIELD AVE BRIDGEPORT 9 CONN
BULOVA WATCH CO ELECT DIV
40 01 61 ST WOODSIDE N Y
BUNDY ELECTRONICS CORP
171 FABYAN PL NEWARK 12 N J
BUNNELL & CO J H
81 PROSPECT ST BROOKLYN 1 N Y
BURDICK CORP
635 PLUMB ST MILTON WISC
BUREAU OF ENGRAVING INC INDUST DIV
500 S 4TH ST MINN MINN
BUREAU OF ENGRAVING INC
219 NORTH 2ND ST MINNEAPOLIS 15 MINN
BURGESS BATTERY CO
FOOT OF EXCHANGE ST FREEPORT ILL
BURGESS BATTERY CO DIV SERVEL CANADA LTD
415 BUTTREY ST NIAGARA FALLS ONT CANADA
BURGESS CELLULOSE CO GRADE O MAT DIV
FREEPORT ILL
BURGMASTER CORP
15001 S FIGUEROA GARDENA CALIF
BURKE & JAMES INC
321 S WABASH AVE CHICAGO 4 ILL
BURKLYN CO
3429 GLENDALE BLVD LOS ANG CALIF
BURLING INSTRUMENT CO
16 RIVER RD CHATHAM N J
BURMAC ELECTRONICS CO
142 LONG BEACH RD ROCKVILLE CENTRE N Y
BURMAC ELECTRONICS CO INC
24 CENTRAL DR FARMINGDALE N Y
BURNDY CORP
MILFORD CONN
BURNDY-ESCON INC
NORWALK CONN
BURNDY ESCON INC
725 BRANCH AVE PROVIDENCE 4 R I
BURNDY CORP OMATON DIV
NORWALK CONN
BURNELL & CO INC
10 PELHAM PKWY PELHAM MANOR NY
BURNETT RADIO LAB W W L
4814 IDAHO ST SAN DIEGO 16 CALIF
BURNLEY BATTERY & MFG CO
103 CLAY ST NORTH EAST PA
BURR BROWN RESEARCH CORP
BOX 6444 TUCSON ARIZ
BURROUGHS CORPORATION ELECTRO DATA DIVISION
460 SIERRA MADRE VILLA PASADENA CALIFORNIA
BURROUGHS CORP MILITARY ELCTRNC CMPTR DIV
14300 TIREMAN AVENUE DETROIT 28 MICHIGAN
BURROUGHS CORPORATION PLYMTH MFG ENG DIV
41100 PLYMOUTH ROAD PLYMOUTH MICHIGAN
BURROUGHS CORP ELEC COMP DIV
BOX 1226 PLAINFIELD N J
BURROUGHS CORP CONTROL INSTR DIV
67 35TH STREET BROOKLYN 32 NY
BURROUGHS CORP ELECTRONIC INSTRS DIV
1209 VINE STREET PHILADELPHIA 7 PA
BURTON MFG CO TRANS ELECTRONIC DIV
8910 WINNETKA AVE NORTHRIDGE CALIF

BURTON INSTRUMENT DIV BURTON MFG CO
8910 WINNETKA AVE NORTHRIDGE CALIF
BUSH TRANSFORMER CORP
707 N ST ENDICOTT N Y
BUSHNELL ELECTRIC
345 HESS ST BUSHNELL ILL
BUSSMANN MFG CO DIV MCGRAW EDISON
UNIVERSITY AT JEFFERSON ST LOUIS MO
BUTCHER CO L H
3628 E OLYMPIC BLVD LOS ANG CALIF
BV GENERAL ARMATURE & MFG CO
P O BOX 370 LOCK HAVEN PA
B/W CONTROLLER CORP
2200 E MAPLE BIRMINGHAM MICH
B W MFG INC PHILLIPS RADIO DIV KOKOMO IND
321 S UNION ST KOKOMO IND
B-W MFGRS INC PHILLIPS RADIO DIV
721 N WEBSTER ST KOKOMO IND
BY-BUK CO
4314 W PICO BLVD LOS ANGELES 19 CALIF
BYREX CORP
50 HUNT ST NEWTON MASS
BYTREX CORP
50 HUNT ST NEWTON 58 MASS

C

CABLE & WIRE PRODUCTS CO
CHICAGO RD SWANTON OHIO
CABLE DESIGNS INC
66 RUSHMORE ST WESTBURY LI N Y
CABLE SPEC OF CONN
95 KITTS LANE NEWINGTON CONN
CABRAL MOTORS INC
51 VICTORY LANE LOS GATOS CALIF
CADDELL-BURNS MFG CO
40 E 2 ST MINEOLA N Y
CADILLAC GAGE CO
25760 GROESBECK HWY WARREN MICH
CADRE INDUSTRIES CORP
ENDICOTT N Y
CAIG LABS INC
46 STANWOOD RD NEW HYDE PARK N Y
CALATROL ELECTRONIC INC
3492 PICKETT ST SAN DIEGO 10 CALIF
CALBEST ELECTRONICS CO
4801 EXPOSITION BLVD LOS ANGELES 16 CALIF
CALCON MFG CO
100 OAKLAND AVE WASHINGTON PA
CALCOR SPACE FACILITY INC
1010 W PHILADELPHIA WHITTIER CAL
CALCULAGRAPH CORP INC
272 RIDGEDALE AVE BOX 72 HANOVER NJ
CALEDONIA ELECTRONICS & TRANSFORMER CORP
MAPLE ST CALEDONIA N Y
CALFAX INC
115 MAIN ST EL SEGUNDO CALIF
CALIDYNE CO INC SUB LING-ALTEC ELECTRONICS
120 CROSS ST WINCHESTER MASS
CALIF MAGNETIC CONTROL CORP
11922 VALERIO ST HOLLYWOOD CALIF
CALIF TECHNICAL INDUST DIV TEXTRON INC
1421 OLD COUNTY RD BELMONT CALIF
CALIFONE CORP
5922 BOWCROFT ST LOS ANGELES 16 CALIF
CALIFORNIA COMPUTER PRODS INC
305 MULLER AVE ANAHEIM CALIF
CALIFORNIA COMPUTER PROD INC
8714 CLETA ST DOWNEY CALIF
CALIF ELECTRO SCIENTIFIC CORP
1214 PARK LANE SANTA ANA CALIF
CALIFORNIA INSTRUMENTS CORP
3511 MIDWAY DR SAN DIEGO CALIF

CALIFORNIA RESISTOR CORP
1631 COLORADO AVE SANTA MONICA CALIF
CALIFORNIA CHASSIS CO
5445 E CENTURY BLVD LYNWOOD CALIF
CALLINS INDUSTRIES INC
P O BOX 356 GREENFIELD TENN
CALMAG DIV CALIF MAGNETIC CONT CORP
11922 VALERIO ST N HOLLYWOOD CALIF
CALTRON PRODUCTS CO
3518 PICO BLVD LOS ANG CALIF
CALVERT ELECTRONICS INC
536 BROADWAY NEW YORK N Y
CALVIDEO ELECTRONICS INC
18601 S SANTA FE AVE COMPTON CALIF
CAMBLOCK CORP SUB WALTHAM PREC INST
221 CRESCENT ST WALTHAM MASS
CAMBRIDGE FILTER CORP
738 E ERIE BLVD SYRACUSE N Y
CAMBRIDGE INSTRUMENT CO INC
OSSINING NEW YORK
CAMBRIDGE PANELYTE MOLDED PLASTICS CO
WEST PIKE RD CAMBRIDGE OHIO
CAMBRIDGE PATTEN WORKS
55 FIRST ST CAMBRIDGE MASS
CAMBRIDGE SCIENTIFIC INDUST INC
18 POPLAR ST CAMBRIDGE MD
CAMBRIDGE SYSTEMS INC
50 HUNT ST NEWTON MASS
CAMBRIDGE THERMIONIC CORP
445 CONCORD AVE CAMBRIDGE MASS
CAMCAR SCREW & MFG CO DIV TEXTRON INC
600 18 AVE ROCKFORD ILL
CAMDALE PRECISION INC
28300 GROESBECK HWY ROSEVILLE MICH
CAMERA MART INC
1845 BROADWAY NEW YORK 23 N Y
CAMLOC FASTENER CORP
22 SPRING VALLEY RD PARAMUS N J
CAMPBELL INDUSTRIES INC
DOVER N H
CAMPBELL INDUSTRIES INC
NORTH AURORA ILL
CAMPBELL X RAY CORP
108 CUMMINGTON ST BOSTON MASS
CAMPRO CO
3131 ALLIANCE RD N E CANTON 1 OHIO
CANADAIR LTD
PO BOX 6087 MONTREAL P Q CANADA
CANADIAN APPLIED RESCH DV A V ROE CANADA LTD
BOX 4004 TERM A TORONTO ONT CANADA
CANADIAN ASTATIC LTD
2273 DANFARTH AVE TORONTO ONT CANADA
CANADIAN AVIA ELECTS
6214 COTE DE LIESSE RD ST LRNT QUE CANADA
CANADIAN MARCONI CO
2442 TRENTON AVE MONTREAL 16 CAN
CANADIAN RADIUM URANIUM DV CANRAD PRES IND
43 W SIXTEENTH ST NEW YORK N Y

CANADIAN RESEARCH INSTITUE
85 CURLEW DRIVE DON MILLS ONT
CANNON CO C F
SPRINGWATER N Y
CANNON ELECT CANADA LTD
160 BARTLEY DR TORONTO ONT CANADA
CANNON ELECTRIC CO EASTERN DIV
PINGREE & LEAVITT STS SALEM MASS
CANNON ELECTRIC CO
2801 AIRLINE PHOENIX ARIZ
CANNON MFG CO INC L J
653 S MELROSE ST PLACENTIA CALIF
CANOGA ELECT CORP
15330 OXNARD ST VAN NUYS CALIF
CAPCON INC
61 STANTON ST NEW YORK 2 N Y
CAPEHART CORP DYNAMIC ELECTRONICS DIV
87046 123TH ST RICHMOND HILL 18 LI NY
CAPITOL CITY MFG CO
857 KING AVE COLUMBUS OHIO
CAPITOL MACHINE CO
36 BALMFORTH AVE DANBURY CONN
CAPPS & CO
20 ADDISON PL VALLEY STREAM L I N Y
CAPTIVE SEAL CORP
121 CLINTON RD CALDWELL N J
CAPTRAN CORP
1910 N ELSTON AVE CHICAGO ILL
CAPTRONICS INC
9 CRICKET TERRACE ARDMORE PA
CARAD CORP
3381 JUNIPERO SERRA BLVD PALO ALTO CALIF
CARBOLINE CO
32 HANLEY IND CT ST LOUIS MO
CARBONE CORP
MYRTLE AVE BOONTON N J
CARBONNEAU INDUSTRIES INC
100 LEXINGTON AVE S W GRAND RAPIDS 4 MICH
ELECTRONICS DIV CARBORUNDUM CO
LATROBE PA
CARBORUNDUM CO THE REFRACTORIES DIV
LATROBE PA
CARBORUNDUM CO GLOBAR PLANT
P O BOX 339 NIAGARA FALLS N Y
CARDINAL CONTROL CO INC
KENSINGTON RD KENSINGTON CONN
CARDION ELECTRONICS INC
65 RUSHMORE ST WESTBURY NEW YORK
CARDOX DIV CHEMETRON CORP
MONEE ILL
CARDWELL CONDENSER CORP
30 E MONTAUK HYW LINDENHURST N Y
CAREY ELECTRONIC ENG
1887 CLIFTON AVE SPRINGFIELD OHIO
CARLETON AVIATION CO INC
EAST AURORA N Y
CARLING ELECTRIC INC
505 NEW PARK AVE W HARTFORD 10 CONN

CAROLINA COMPONENTS INC
721 ROSEWOOD DR COLUMBIA S C
CAROLINA MEDICAL ELECTRONICS INC
3712 REYNOLDA RD WINSTON SALEM NO CAR
CARLSTEDT RESEARCH INC
2501 E 68TH ST LONG BEACH CALIF
CARMA MANUFACTURING CO
1879 MULLIN AVE TORRANCE CALIF
CARMER INDUSTRIES
22 N 26TH ST KENILWORTH NJ
CARMODY CORP
2360 WEHRLE DR BUFFALO 21 N Y
CAROL CABLE DV CRESCENT CO INC
20 CENTRAL AVE PAWTUCKET R I
CAROL ELECT DIV WEECO INC
315 W STEPHEN ST MARTINSBURG W VA
CAROLINA INDUST PLASTICS DIV ESSEX WIRE CORP
MT AIRY S C
CAROLINA WELDS PLANT
900 N GEORGE ST GOLDSBORO N C
CARPENTER MFG CO INC
P O BOX 217 DEWITT N Y
CARPENTER STEEL CO
FRONT & BERN STS READING PA
CARPENTER STEEL CO ALLOY TUBE DIV
SPRINGFIELD RD UNION NJ
CARROLL PRESSED METAL INC
133 DEWEY ST WORCESTER MASS
CARRUTHERS & FERNANDEZ MFG CO
1501 COLORADO AV BX 1470 SANTA MONICA CAL
CARSON MFG CO INC
INDIANAPOLIS IND
CARSTEDT RESEARCH
2501 E 68TH ST LONG BEACH CALIF
CARTER MFG CORP
23 WASHINGTON ST HUDSON MASS

ELECTRONIC MANUFACTURERS—A TO Z

CARTER MOTOR CO
2760 W GEORGE ST CHICAGO ILL
CARTER CO J C
671 W 17TH ST COSTA MESA CALIF
CARTER PARTS CO
3401 W MADISON ST SKOKIE ILL
CARTER PRINCETON ELECTR DIV
178 ALEXANDER ST PRINCETON N J
CARTRISEAL CORP
3515 W TOUHY AVE LINCOLNWOOD ILL
CARVIL TECHNICAL CERAMICS INC
801 23RD ST UNION CITY N J
CASCADE RESEARCH DIV
5245 SAN FERNANDO RD W LOS ANGELES CALIF
CASTLE ENGINEERING CO
SENECA CASTLE NEW YORK
CASWELL ELECTRONICS CORP
414 QUEENS LANE SAN JOSE CALIF
CATALIN CORP OF AMERICA
1 PARK AVE NEW YORK 16 N Y
CATALYST RESEARCH CORP
6101 FALLS RD BALTIMORE MD
CATHODEON
CHURCH ST CAMBRIDGE ENGLAND
CATON INDUSTRIES
646 W FIRST AVE ROSELLE N J
CAVITRON ELECTRON OSCILLATOR CO
2755 BRISTOL ST COSTA MESA CALIF
C B C ELECTRONICS CO
2601 N HOWARD ST PHILA PA
C & D BATTERIES DIV ELECTRIC AUTOLITE CO
ATTICA IND
C & D BATTERIES DIV ELECT AUTOLITE CO
PENNSBURG PENNA
CEDAR ENG DIV CONTROL DATA CORP
5806 W 36TH ST ST LOUIS PK MINN
CEETRONICS
PO BOX 32 ALGER MICH
CELCO CONSTANTINE ENG LABS CO
P O BOX 555 MAHWAH N J
CELCO CONSTANTINE ENG LAB CO PACIFIC DIV
1150 E 8TH ST UPLAND CALIF
C E M CO INC
24 SCHOOL ST DANIELSON CONN
CENTIMEG ELECTRONICS
312 IMPERIAL HWY EL SEGUNDO CALIF
CENTRALAB DIV GLOBE UNION
3450 HOPKINS MILWAUKEE WISC
CENTRALAB DIV GLOBE UNION INC
FORT DODGE IOWA
CENTRALAB DIV GLOBE-UNION INC
900 E KEEFE AVE MILWAUKEE 1 WISC
CENTRALAB DIV GLOBE UNION
5150 N 32ND ST MILWAUKEE WISC
CENTRALAB DIV GLOBE UNION
3238 N BREMEN MILWAUKEE WISC
CENTRAL COIL CORP
857 N QUEENS AVE LINDENHURST N Y
CENTRAL DYNAMICS LTD
147 HYMUS BLVD PTE CLAIRE QUE CANADA
CENTRAL ELECTRONIC MFRS
2 RICHWOOD PL DENVILLE N J
CENTRAL ELECTRONICS INC
1247 W BELMONT AVE CHICAGO 13 ILL
CENTRAL PORCELAIN CO
511 RAILROAD ST COLUMBIANA OHIO
CENTRAL RESEARCH LABS
RED WING MINN
CENTRAL SCIENTIFIC CO OF CANADA LTD
146 KENDAL AVE TORONTO 4 ONT CANADA
CENTRAL SCIENTIFIC CO
1700 IRVING PARK RD CHICAGO ILL
CENTRAL TRANSFORMER CO
900 W JACKSON BLVD CHICAGO 7 ILL
CENTRAL TRANSFORMER CORP
ARCADIA FLA
CENTROL ENG CO
119 E LEXINGTON INDEPENDENCE MO
CENTURY COIL CORP
1522 N CLYBOURN AVE CHICAGO 10 ILL
CENTURY ELECT INST INC
1333N UTICA TULSA OKLA
CENTURY ELECT CO
1806 PINE ST ST LOUIS MO
CENTURY ELECT CO
111 ROOSEVELT AVE MINEOLA N Y
CENTURY ELECTRONICS IN INSTS INC
SUB CENTURY GEOPHYSICAL CORP
6540 E APACHE ST BOX C TULSA OKLA
CENTURY LIGHTING INC
521 W 43 ST NEW YORK N Y
CENTURY LIGHTING INC
1477 N E 129TH ST N MIAMI FLA
CENTURY PROJECTOR CORP
3202 QUEENS BLVD LONG ISLAND CITY N Y
CERAMASEAL INC
P O BOX 25 NEW LEBANON CENTER N Y
CERAMATRONICS INC
364 HIGHLAND AVE PASSAIC N J
CERAMCO INC CHEMISTS
175 RIDGE ST NEWARK N J
CERAMICS INTERNATIONAL CORP
39 SIDING PLACE MAHWAH N J
CERBERUS AG WERK ELEKTRONENTECHNIK
MANNEDORF SWITZERLAND
RONSON METALS CORP CERIUM METAL ALLOYS DIV
45 MFRS PL NEWARK N J
CERRO SALES CORP
300 PARK AVE NEW YORK N Y
CERTIFIED RADIO LABS
5507 13 AVE BROOKLYN N Y
C E S ELECTRONIC PRODUCTS INC
5026 NEWPORT AVE SAN DIEGO CALIF
CETRON ELECTRONIC CORP
715 HAMILTON ST GENEVA ILL
CFI CORP
1 COTTAGE PLACE MINEOLA N Y
C&H SUPPLY
415 E BEACH INGLEWOOD CALIF
CHACE CO W M
1600 BEARD AVE DETROIT 9 MICH
CHADWICK-HELMUTH CO
472 E DUARTE RD MONROVIA CALIF
CHALCO ENGINEERING CORP
15126 S BROADWAY GARDENA CALIF
CHAMPION DEARMENT TOOL CO
S MAIN ST MEADVILLE PENNA
CHANNEL INDUSTRIES INC
427 OLIVE ST P O BOX 1408 SANTA BARB CALIF
CHANNEL MASTER CORP
ELLENVILLE N Y
CHARLESTON RUBBER CO
STARK INDUSTRIAL PARK CHARLESTON S C
CHART-PAK INC
321 RIVER RD LEEDS MASS
CHASE BRASS & COPPER CO MILL DIV
236 GRAND ST WATERBURY CONN
CHASE MTLS SERV DIV CHASE BRASS & COPPER CO
236 GRAND ST WATERBURY 20 CONN
CHASSIS-TRAK CORP
7302 S LA CIENEGA BLVD INGLEWOOD CALIF
CHATHAM CONTROLS CORP
33 RIVER ST CHATHAM N J
CHATHAM ELECTRONICS DIV-TUNG-SOL ELECTRIC IN
630 W MT PLEASANT AVE LIVINGSTON N J
CHATILLON SONS JOHN
85 CLIFF ST NEW YORK N Y
CHEMALLOY ELECTRONICS CORP
GILLESPIE AIRPORT SANTEE CALIF
CHEMCUT DIV CENTRE CIRCUITS INC
BOX 799 STATE COLLEGE PA
CHEM ELECTRO RESEARCH INC
14706 ARMINTA ST VAN NUYS CALIF
CHEMICAL COMMERCE
123 SUSSEX AVE NEWARK N J
CHEMICAL DEVELOPMENT CORP
ENDICOTT ST DANVERS MASS
CHEMICAL ELECTRONIC ENG
PO BOX 203 MATAWAN NJ
CHEMICAL PLATING CO
120 BRUCE AVE STRATFORD CONN
CHEMPLAST INC
3 CENTRAL AVE EAST NEWARK NJ
CHEMTRONIC CORP
2950 FOSTER CREIGHTON DR NASHVILLE TENN
CHERRY ELECT PROD CORP
1650 DEERFIELD RD HIGHLAND PARK ILL
CHESAPEAKE INSTRUMENT CORP
SHADYSIDE MD
CHESTER CABLE CORP
CHESTER N Y
CHET ENGINEERING CO
8140 ORION VAN NUYS CALIF
CHICAGO AERIAL INDUSTRIES
BARRINGTON ILL
CHICAGO CONDENSER CORP
3255 W ARMITAGE AVE CHICAGO ILL
CHICAGO DYNAMIC INDUSTRIES INC
1725 DIVERSEY BLVD CHICAGO 14 ILL
CHICAGO ELECTRONIC ENGG CO
3223 W ARMITAGE AVE CHICAGO 47 ILL
CHICAGO GASKET CO
1271 W NORTH AVE CHICAGO 22 ILL
CHICAGO MINIATURE LAMP WORKS
4435 RAVENSWOOD AVE CHICAGO ILL
CHICAGO RIVET & MACHINE CO
950 S 25 AVE BELLWOOD ILL
CHICAGO SCREW CO DIV STANDARD SCREW CO
2701 WASHINGTON BLVD BELLWOOD ILL
CHICAGO TELEPHONE OF CALIF
1010 SYCAMORE AVE S PASADENA CALIF
CHICAGO TELEPHONE O FCALIF INC
105 PASADENA AVE BOX 269 S PASADENA CALIF
CHICAGO THRIFT ETCHING
1555 N SHEFFIELD AVE CHICAGO ILL
CHICOPEE MILLS
47 WORTH ST NEW YORK N Y
CHISHOLM INDUST LTD
ELECT AVE PORT MOODY B C CANADA
CHOMERICS INC
341 VASSAR ST CAMBRIDGE MASS
CHRISTIAN PRECISION MFG
12TH & FEDERAL STS CAMDEN N J
CHRISTIE ELECTRIC CORP
3410 W 67 ST LOS ANGELES 43 CALIF
CHROMALLOY CORP
WEST NYACK NY
CHRONO LOG CORP
2583 WEST CHESTER PIKE BROOMALL PENNA
CHRYSLER CORP MISSILE DIV
P O BOX 2628 DETROIT MICHIGAN
CHU ASSOCIATES
BOX 387 WHITCOMB AVE LITTLETON MASS
CICOIL CORP
13833 SATICOY ST VAN NUYS CAL
CIMCO WIRE & CABLE CO
303 CRESCENT AVE ALLENDALE N J
CIMRON CORP
1152 MORENA BLVD SAN DIEGO CALIF
CINAUDAGRAPH INC
7334 N CLARK ST CHICAGO 26 ILL
CINCH MFG CO CINCH JONES DIV
1026 S HOMAN AVE CHICAGO ILL
CINCINNATI CLEANING & FINISHING MACHINERY CO
SHARONVILLE OHIO
CINCINNATI CLEANING & FINISHING MACHINERY
1100 HAGEMAN ST CINCINNATI OHIO
CINN MILLING MACH CO CIMASTRA DIV
4752 MARBORGH CINCINNATI OHIO
CINCINNATI MILLING MACHINE CO
MARSBURG AVE CINNATI OHIO
CINCINNATI SHAPER CO
BOX 111 CINN OHIO
CINCINNATI SUB-ZERO PRODUCTS
3932 READING RD CINCINNATI 29 OHIO
CINCINNATI TIME RECORDER CO
1733 CENTRAL AVE CINCINNATI 14 OHIO
CINEMA ENGINEERING DIV AEROVOX CORP
1100 CHESTNUT ST BURBANK CALIF
CINEMATIC DEVELOPMENTS CO
P O BOX 151 MENA ARKANSAS
CIRCON COMPONENTS CORP
SANTA BARBARA MUNICIPAL AIRPORT GOLETA CAL
CIRCUIT INSTRUMENT DIV INTL RESISTANCE CO
2801 72ND ST N ST PETERSBURG FLA
CIRCUITDYNE CORP
480 MERMAID ST LAGUNA BCH CALIF
CIRCUITS INC
1445 TOLLAND TPK MANCHESTER CONN
CIRCUIT STRUCTURES LAB
2414 S BROADWAY SANTA ANA CALIF
CITY CHEMICAL CORP
132 W 22 ST NEW YORK N Y
CITY MARKING DEVICES CORP
69 MURRAY ST NEW YORK N Y
C-THRU RULER CO
827 WINDSOR ST HARTFORD CONN
CK COMPONENTS INC
101-103 MORSE ST NEWTON 58 MASS
CLAIREX CORP
8 W 30ST NEW YORK N Y
CLARAGE FAN CO
KALAMAZOO MICH
C P CLARE & CO
3101 W PRATT BLVD CHICAGO 45 ILL
CLARE & CO P J
FAIRVIEW N C
CLARE CERAMICS INC
E MAIN ST CARY ILL
CLARK CONTROLLER CO
1146 E 152 ST CLEVELAND OHIO
CLARK CONTROLLER CO
4755 E 49TH ST LOS ANGELES CALIF
CLARK CRYSTAL CO
2 FARM RD MARLBORO MASS
CLARK ELECTRONIC LABS
BOX 165 PALM SPRINGS CALIF
CLARKE H JOY CO
27003 KNICKERBOCKER RD BAY VILLAGE OHIO
CLARK SEMICONDUCTOR CORP
WALNUT AVE CLARK N J
CLARKSON LABORATORIES INC
1450 FERRY ST CAMDEN N J
CLAROSTAT MFG CO
WASHINGTON ST DOVER N H
CLARY CORP
408 JUNIPERO ST SAN GABRIEL CALIF
CLAUSS CUTLERY CO
223 PROSPECT ST FREMONT OHIO
CLEAR BEAM ANTENNA CORP
21341 ROSCOE BLVD CANOGA PARK CALIF
CLEARTONE REPRODUCTION CORP
23-14 122ND ST COLLEGE POINT N Y
CLEGG LABS DIV CLEGG INC
RT 53 MT TABOR N J
CLEVELAND CONTAINER CO
6201 BARBERTON AVE CLEVELAND 2 OHIO
CLEVELAND ELECTRONICS INC
1974 E 61ST ST CLEVELAND 3 OHIO
CLEVELAND FABRICATING CO
7424 BESSEMER AVE CLEVELAND OHIO
CLEVELAND GRAPHITE BRONZE DIV CLEVITE CORP
CALDWELL OHIO
CLEVELAND INSTRUMENT CO
6220 E SCHAAF RD CLEVELAND 31 OHIO
CLEVELAND METAL SPEC CO
1789 E 21 ST CLEVELAND OHIO
CLEVELAND METAL SPECIALTIES CO
15516 INDUSTRIAL PKWY CLEVELAND OHIO
CLEVELAND WELDS PLANT
1133 E 152 ST CLEVELAND OHIO
CLEVITE ELECT COMPONENTS DIV CLEVITE
232 FORBES RD BEDFORD OHIO
CLEVITE HARRIS PRODS INC
LOCKWOOD RD MILAN OHIO
CLEVITE ORDNANCE DIV CLEVITE CORP
540 E 105TH ST CLEVELAND 8 OHIO
CLEVITE ORDNANCE DIV CLEVITE CORP
232 FORBES RD BEDFORD OHIO
CLEVITE TRANSISTOR PALO ALTO PLT
1801 PAGE MILL RD PALO ALTO CALIF
CLEVITE TRANSISTOR
200 SMITH ST WALTHAM MASS
CLIFTON PRECISION PRODUCTS CO INC
BROADWAY AT MARPLE CLIFTON HGTS PA
CLIFTON PRECISION
COLORADO SPRINGS COLO
CLIMET INSTRUMENTTS INC
570 SAN XAVIER AVE SUNNYVALE CALIF
CLIPPARD INSTRUMENT LAB
7390 COLERAIN AVE CINN OHIO
CLIPPARD INSTRUMENT INC
513 E WASH ST PARIS TENN
CLOUGH BRENGLE CO
6014 BROADWAY CHICAGO ILL
CLOVER INDUSTRIES INC
578-588 YOUNG ST TONAWANDA N Y
CLOWES CERAMICS CORP
3711 CALHOUN AVE CHATTANOOGA TENN
CLUM MFG CO
611 NATIONAL MILWAUKEE WISC
CLY DEL MFG CO INC
P O BOX 1367 WATERBURY 20 CONN
C M MFG & MACHINERY CO
103 DEWEY ST BLOOMFIELD NJ
CO ENGINEERING CO
P O BOX 194 BOONTON N J
COAST COIL CO
5333 W WASHINGTON BLVD LOS ANGELES CALIF

CDAST PRO-SEAL & MFG CO
2235 BEVERLY BLVD LOS ANGELES 57 CALIF
COAX DEVICES
BOX 5 CHELSEA 50 MASS
COAXIAL COMPONENTS CORP
391 LUOLOW ST STAMFORD CONN
COEHN INC
PASSAIC AVE CALDWELL N J
COGNITRONICS CORP
549 PLEASANTVILLE RD BRIARCLIFF MANOR N Y
COHAN EPNER CO
142 W 14 ST NEW YORK 11 N Y
COHU ELECTRONICS INC KIN TEL DIV
5725KEARNY VILLA RO SAN DIEGO CALIF
COHU ELECTRONICS INC MASSA DIV
280 LINCOLN ST HINGHAM MASS
COIL COMPANY OF AMERICA
212 WASHINGTON ST NORTHVALE N J
COIL ENG & MFG
MARKLE IND
COIL ENG & MFG CO
ROANOKE INO
COIL WINDING EQUIP CO
RAILRDAO PLAZA OYSTER BAY N Y
COILCRAFT INC
CARY ILL
COILS ELECTRONICS CO
2939-49 N 2ND ST PHILA PA
COLBER CORP
26 BUFFINGTON ST IRVINGTON 11 N J
COLE RADIO WORKS
86 WESTVILLE AVE CALDWELL N J
COLEMAN CABLE & WIRE CO
1900 N RIVER RO RIVER GROVE ILL
COLEMAN ELECTRONIC SYSTEMS
3210 CENTRAL AVE SANTA ANA CAL
COLEMAN ELECTRONICS INC
133. EAST 162ND ST GARDENA CALIF
COLEMAN INSTRUMENTS INC
42 MADISON ST MAYWOOO ILL
COLIN CAMPBELL CO INC
MIRY BROOK RD DANBURY CONN
COLLECTRON CORP
304 E 45TH ST NEW YORK 17 N Y
COLLINS CORP G L
2820 E HULLETT ST LONG BEACH CALIF
COLLINS ELECTRONICS INC
STEVENSVILLE MO
COLLINS MICROFLAT CO INC
3249 W EL SEGUNOO BLVO HAWTHORNE CALIF
COLLINS RAOIO CO
1930 HILINE DR DALLAS 7 TEXAS
COLLINS RADIO CO OF CANADA LTD
11 BERMONDSEY RD TORONTO ONT CAN
COLLINS RADIO CO
19700 SAN JOAQUIN RD NEW PORT BEACH CALIF
COLLINS RADIO TEXAS DIV
1200 ALMA RD RICHARDSON TEXAS
COLLINS RADIO CO
315 2ND AVE S E CEDAR RAPIDS IOWA
COLLYER INSULATEO WIRE CO
249 ROOSEVELT AVE PAWTUCKET R I
COLMAN ELECTRONIC PROOUCTS INC
1017 N E 3RD AVE AMARILLO TEX
COLONIAL ALLOYS CO
RIDGE AVE & CRAWFORD STS PHILA PA
COLORADO INSTRUMENT INC
GARDEN OFFICE CTR BROOMFIELD COLO
COLORADO RESEARCH CORP
BROOMFIELD COLO
COLUMBIA ELECT MFG CO
4519 HAMILTON AVE CLEVELAND OHIO
COLUMBIA METAL BOX CO
260 E 143 ST NEW YORK 51 N Y
COLUMBIA PRODUCTS CO
6625 SHAKESPEARE RD COLUMBIA S C
COLUMBIA PROD CD
R F O 3 COLUMBIA S C
COLUMBIA TECHNICAL CORP
24 30 BKLYN QUEENS WOODSIDE N Y
COLUMBIA RECORDS
799 7 AVE NEW YORK N Y
COLUMBIA RESEARCH LABS
MACOADE BLVD & BULLENS LA WOODLYN PA
COLUMBIA WIRE & SUPPLY CO
2850 IRVING PARK RD CHICAGO ILL
COLUMBIAN CARBON CO MAPICO IRON OXIDE
MONMOUTH JUNCTION N J
COLUMBIAN ROPE CO
AUBURN NY
COLUMBUS ELECT MFG CO
621 N HAMILTON RD
COLUMBUS ELECTRONICS CORP
1000 SAW MILL RIVER RD YONKERS N Y
COLUMBUS PROCESS CO
2851 SOUTHEASTERN AVE COLUMBUS IND
COLUMN MACHINE CO
MOULTON ST GEORGETOWN MASS
COLVIN LABS INC
364 GLENWOOD AVE E ORANGE N J
COMAR ELECTRIC CO
3349 ADDISON ST CHICAGO 18 ILL
COMBINED ELECT INC
4616 W 26TH ST CHICAGO ILL
COMCO PLASTICS INC
9834 JAMAICA AVE RICHMOND HILL N Y
COMERFORD MFG CO
880 S ROSE PL ANAHEIM CALIF
COMET LTD
WALDEGGSTRASSE 72
LIEBEFELD BERNE SWITZERLAND
COMMER PLASTICS & SUPPLY CO
630 BROADWAY NEW YORK N Y
COMMERCIAL PLASTICS CO
945 GEORGE ST CHICAGO ILL
COMMERCIAL RADIO SOUND CORP
652 1 AVE NEW YORK N Y
COMMERCIAL RESINS DIV INTERPLASTICS CORP
102 W FAIRFIELD AVE ST PAUL 7 MINN
COMMONWEALTH METAL CRAFTS
NORTH AVE & AMORY STS WAKEFIELD MASS
COMMUNICATIONS CO
300 GRECO AVE CORAL GABLES FLA
COMMUNICATION ACCESSORIES CO
U S 50 HWY LEES SUMMIT MO
COMMUNICATION ASSOCIATES INC
NEW HYDE PARK L I N Y
COMMUNICATION ELECTRONIC INC
4908 HAMPDEN LN BETHESDA 14 MD
COMMUNICATION EQUIPMENT & ENGRG CO
5646 W RACE AVE CHICAGO 44 ILL
COMMUNICATION MEASUREMENTS LABS
350 LELAND AVE PLAINFIELD N J
COMMUNICATIONS ELECTRONICS CO
2803 EIGHTH AVE W SEATTLE 99 WASH
COMMUNICATIONS PROOUCTS CO
MARLBORO N J
COMMUNITY ENGG CORP
BOX 824 STATE COLLEGE PA
COMPONENTS INC
SMITH ST BIODEFORD MAINE
COMPONENTS FOR RESEARCH INC
979 COMMERCIAL ST PALO ALTO CALIF
COMPACT CONTROLS CO INC
1633 N HALSTED ST CHICAGO 14 ILL
COMPONENTS CORP
106 MAIN ST DENVILLE N J
COMPTON CORP
778 PLEASANT ST BELMONT 79 MASS
COMPONENT RESEARCH CO INC
3019 S ORANGE DR LOS ANGELES 16 CALIF
COMPUOYNE CORP
HATBORO PENNA
COMPUTER CONTROL CO INC WESTERN DIV
2251 BARRY AVE LOS ANGELES CALIF
CAMPAGNIE GENERALE DE METROLOGIE
ANNECY HAUTE SAVOIE FRANCE
COMPUTER COMPONENTS INC
88-06 VAN WYCK EXP JAMAICA 18 N Y
COMPUTER CONTROL CO INC EASTERN DIV
983 CONCORD ST FRAMINGHAM MASS
COMPUTER DIODE CORP
250 GARIBALDI AVE LOOI NJ
COMPUTER ENGG ASSOC AFF SUSQUEHANNA INC
1610 MAGNOLIA MONROVIA CALIF
COMPUTER EQUIPMENT CORP
11612 OLYMPIC BLVD LOS ANGELES CALIF
COMPUTER INSTRUMENTS CORP
92 MADISON AVE HEMPSTEAD N Y
COMPUTER LOGIC CORP
11800W OLYMPIC BLVD LOS ANGELES 64 CALIF
COMPUTER MEASUREMENTS CO
12970 BRADLEY AVE SYLMAR CALIF
COMPUTER PRODUCTS INC
1717 F STREET S BELMAR N J
COMPUTER SYSTEMS INC
CULVER RD MONMOUTH JUNCTION N J
COMPUTER TEST CORP
RTE 38 & LONGWOOO AVE CHERRY HILL N J
COMPUTING DEVICES OF CANADA LTD
P O BOX 508 OTTAWA ONTARIO CANADA
COM TRONICS INC
3409 VENICE BLVD LOS ANG CALIF
CON-ELCO
1711 S MOUNTAIN AVE MONROVIA CALIF
CONANT LABS
BOX 3997 BETHANY STA LINCOLN 5 NEBR
CONAP INC
184 6 E UNION ST ALLEGANY N Y
CONAX CORP
2300 WALDEN AVE BUFFALO N Y
CONCO
300 GRECO CORAL GABLES FLA
CONDENSER PROD DIV NEW HAVEN CLOCK & WATCH
BOX 1046 BROOKSVILLE FLA
CONDOR ELECTRONICS INC
620 ORVIS ST SAN JOSE CALIF
CONDUCTORLAB INC
GROTON MASS
CONFORMING MATRIX CORP
830 NEW YORK AVE TOLEDO 11 OHIO
CONLEY ELECTRONICS CORP
8225 CHRISTIANA AVE SKOKIE ILL
CONN LTD C G
555 E JACKSON BLVD ELKHART IND
CONN MARINE INSTRUMENT CO
ESSEX CONN
CONN VALLEY ENTERPRISES
P O BOX 188 ESSEX CONN
CONN-CRAFT CO
301 FAIRLAWN AVE WATERBURY 5 CONN
CONNECTICUT ELECTRONIC PROO
18 LAKE ST MERIDEN CONN
CONN HARD RUBBER CO
P O BOX 1911 NEW HAVEN 9 CONN
CONNECTICUT HARD RUBBER CO
407 EAST ST NEW HAVEN CONN
CONNECTICUT INSTRUMENT CORP
80 DANBURY RD WILTON CONN
CONNECTICUT VALLEY CHEMICALS INC
49 W 57TH ST NEW YORK 19 N Y
CONNECTOR CORPORATION OF AMERICA
12959 SHERMAN WAY N HOLLYWOOD CALIF
CONNECTOR CORP
6027 N KEYSTONE AVE CHICAGO 30 ILL
CONNOLLY & CO WALLACE E
PO BOX 295 MENLO PARK CALIF
CONNOR SPRING MFG CO
1901 S BROAOWAY PL LOS ANGELES 37 CALIF
CONOFLOW CORP
2100 ARCH ST PHILA PENNA
CONRAC INC
19217 E FOOTHILL BLVO GLENDORA CALIF
CONRAD CARSON ELECTRONICS INC
1347 BROADWAY EL CAJON CAL
CONRAD & MOSER
2 BORDEN AVE LONG ISLAND CITY 1 N Y
CONRAD INC
141 JEFFERSON ST HOLLAND MICH
CONSOLIDATED AIRBORNE SYSTEMS INC
900 3RD AVE NEW HYDE PARK N Y
CONSOLIDATED AVIONICS CORP
80D SHAMES DR WESTBURY N Y
CONSOLIDATED CERAMICS & METALIZING CORP
FLEMINGTON N J
CONSOLIDATEO CONTROLS CORP
4 DURANT AVE BETHEL CONN
CONSOLIDATED DIESEL ELECTRIC CORP
880 CANAL ST STAMFORD CONN
CONSOLIDATED ELECT CORP
360 SIERRA MADRE VILLA PASADENA CALIF
CONSOLIDATED ELECTDYNAMICS CORP
1775 MT READ BLVO ROCHESTER N Y
CONSOLIDATED MINING SMELTING OF CANADA LTD
TRAIL BC CANADA
CONSOLIDATED MOLDED PROOUCTS CORP
309 CHERRY ST SCRANTON 2 PENNA
CONSOLIDATEO REACTIVE METLS INC
115 HOYT ST MAMARONECK N Y
CONSOLIDATEO RESISTANCE CO OF AMERICA
44 PROSPECT ST YONKERS 1 N Y
CONSOLIDATED SYSTEMS CORP
1500 S SHAMROCK AVE MONROVIA CALIF
CONSOLIDATED VACUUM CORP
1775 MT READ BLVO ROCHESTER N Y
CONSOLIDATED WIRE & ASSOCIATED COS
1635 S CLINTON ST CHICAGO 16 ILL
CONSTANTA CO OF CANADA LTO
280 REGINA AVE MONTREAL CANAOA
CONSTANTIN CO L L
ROUTE 46 LOOI NJ
CONTACT INC
BOX 6 HUDSON N HAMPSHIRE
CONTACTS INC
1100 SILAS DEANE HWY WETHERSFIELD 9 CONN
CONTINENTAL CONNECTOR CORP
34-63 56 ST WOODSIDE 77 NY
CONTINENTAL OEVICE CORP
12515 CHAORON AVE HAWTHORNE CALIF
CONTINENTAL-DIAMONO FIBRE CORP
NEWARK DELA
CONTINENTAL ELECTRIC CO
325 FERRY ST NEWARK 5 N J
CONTINENTAL ELECTRONICS CORP
2724 LEONIS BLVD LOS ANGELES 58 CALIF
CONTINENTAL ELECTRONICS CORP
302 OAKLANO ST BROOKLYN 22 N Y
CONTINENTAL ELECTRONIC MFG CO
85 LING TEMCO-VOUGHT INC
4212 S BUCKNER BLVO DALLAS TEXAS
CONTINENTAL ELECT CORP OF CALIF
LOS ANGELES CALIF
CONTINENTAL PRECISION PROD
1026 E 179TH ST NEW YORK N Y
CONTINENTAL SCREW CO
459 MT PLEASANT ST NEW BEDFORD MASS
CONTINENTAL SENSING INC
1960 N RUBY ST MELROSE PARK ILL
CONTINENTAL TECHNICAL SERVICE INC
19 W FOURTH ST OAYTON OHIO
CONTINENTAL WIRE CORP
322 N CHERRY ST WALLINGFORD CONN
CONTINENTAL X RAY CORP
1536 N CLYBOURN AVE CHICAGO ILL
CONTINENTAL-WIRT ELECTRONICS CORP
5221 GREENE ST PHILA 44 PA
CONTROL CIRCUITS INC
66 MARLBOROUGH ST PORTLANO CONN
CONTROL CORP
718 CENTRAL AVE NE MINNEAPOLIS 14 MINN
CONTROL DATA CORP
501 PARK AVE MINN MINN
CONTROL DEVICES
925 S ETON BIRMINGHAM MICH
CONTROL OYNAMICS
7420 FULTON AVE N HOLLYWOOD CALIF
CONTROL ELECT CO INC
10 STEPAR PLACE HUNTINGTON STA N Y
CONTROL EQUIPMENT CORP
19 KEARNEY RD NEEDHAM HEIGHTS 94 MASS
CONTROL LOGIC INC
11 MERCER RD NATICK MASS
CONTROLLEO ATMOSPHERE ENCLOSURES MFG CO
P O BOX 615 ORANGE CALIF
CONTROLLED ATMOSPHERE ENCLOSURES MFG CO
1061 E 8 ST JACKSONVILLE FLA
JERVIS B WEBB CO CONTROL ENG CO DIV
8900 ROSELAWN DETROIT MICH
CONTROL INDICATING CORP
BRADLEY FIELD WINDSOR LOCKS CONN
CONTROL MFG CO
ST PAUL MINN
CONTROLOMAG LABS
2459 SUSQUEHANNA RD ROSLYN PA
CONTROL PRODUCTS INC
280 RIDGEDALE AVE E HANOVER N J
CONTROL SCIENCE CORP
5150 DUKE STREET ALEXANDRIA VIRGINIA
CONTROL SWITCH DIV CONTROLS CO OF AMERICA
4218 W LAKE ST CHICAGO 24 ILL
CONTROL SWITCH DIV CONTROLS CO OF AMERICA
DELMAR DR FOLCROFT PA
CONTROL TECHNOLOGY CO
41 16 29ST L I C NEW YORK
CONTROLIER CORP
DAVENPORT FLA

CONTROLS CO OF AMER ELECTRON DV
811 W BROADWAY BOX 937 TEMPE ARIZ
CONTROLS CO OF AMER
2450 N 32 ST MILWAUKEE WISC
CONTROLS FOR RADIATION INC
130 ALEWIFE BROOK PKWY CAMBRIDGE 40 MASS
CONTRONICS IN
43 LEON ST BOSTON MASS
CONVAIR ASTRONAUTICS
BOX 1128 SAN DIEGO 17 CALIF
COOK BATTERIES
3850 OLIVE ST DENVER COLO
COOK CO FRANK R
3850 OLIVE ST DENVER 7 COLO
COOK CO KEN
9929 W SILVER SPRING RD MILWAUKEE 18 WISC

COOK ELECTRIC CO DATA STOR DIV
8100 N MONTICELLO AVE SKOKIE ILL
COOK ELECTRIC CO NUCLEDYNE DIV
3412 RIVER RD FRANKLIN PARK ILL
COOK ELECT CO WIRECOM DIV
2700 N SOUTHPORT AVE CHICAGO ILL
COOK RESEARCH LABS
P O BOX 696 MENLO PARK CALIF
COOK TECHNOLOGICAL CENTER DIV
6401 OAKTON ST MORTON GROVE ILL
COOL FIN ELECTRONICS CORP
1717 N POTRERO AVE S EL MONTE CALIF
COOPER CO D C
1467 S MICHIGAN AVE CHICAGO 5 ILL
CO-OPERATIVE INDUSTRIES INC
100 OAKDALE RD CHESTER NJ
COOPERTRONIX
939 INDUSTRIAL PALO ALTO CALIF
COORS PORCELAIN CO
600 9TH ST GOLDEN COLO
COOPER & SONS INC JOSEPH B
180 VARICK ST NEW YORK N Y
COPPERWELD STEEL CO FLEXO WIRE DIV
70 W FIRST ST OSWEGO N Y
COPPUS ENGRG CORP
344 PARK AVE WORCHESTER MASS
COPYMATION INC
5650 N WESTERN AVE CHICAGO 45 ILL
CORBETT SCIENCE LABS F W
3115 VENICE BLVD LOS ANG CALIF
CORBIN CORP
76 PRIMROSE LA LEVITTOWN NJ
CORDIN CO THE
226 W HAVEN AVE SALT LAKE CITY 15 UTAH
CORDO CHEMICAL CORP
34 SMITH ST NORWALK CONN
CORE TRONICS INC
241 N DAY ST ORANGE N J
CORNELL-DUBILIER ELECTRIC CORP
4144 GLENCOE AVE VENICE CALIF
CORNELL-DUBILIER ELECT DIV
921 PROVIDENCE HWY NORWOOD MASS
CORNELL-DUBILIER ELECTRIC CORP
1605 RODNEY FR BLVD NEW BEDFORD MASS
CORNELL DUBILIER ELECTRONICS DIV
118 E JONES ST FUQUAY SPRINGS NC
CORNELL-DUBILIER ELECTRONICS DIV SANFORD PLT
2652 DALRYMPLE BOX 2070 SANFORD NO CAR
CORNELL DUBILIER ELECTR DIV
289 W RIVER ST PROVIDENCE 4 R I
CORNING GLASS WORKS
CORNING N Y
CORNING GLASS WORKS ELECTRICAL PRODUCTS DIV
HOUGHTON PARK CORNING NY
CORNING GLASS WORKS
RALEIGH N C
CORNISH WIRE CO DIV GENERAL CABLE CORP
730 3RD AVE NEW YORK 17 N Y

CORONA ENGG SERVICE
94 52 CORONA AVE ELMHURST N Y
CORRIGAN COMMUNICATIONS INC
3015 S KILSON DR SANTA ANA CALIF
CORRUGATED PAPER PRODUCTS
2233 UTICA AVE BROOKLYN 34 N Y
CORSON ELECTRIC MFG CORP
WATROUS ST E HAMPTON CONN
CORSON ELECTRIC MFG CORP
540 39 ST UNION CITY N J
COSMIC INC
3206 GRACE ST WASHINGTON D C
COSMIC RADIATION LABS
1645 MONTAUK HWY BELLPORT N Y
COSMIC RADIO CORP
853 WHITTIER ST NEW YORK 59 N Y
COSMO PLASTICS CO
3239 W 14 ST CLEVELAND OHIO
COTO COIL CO
65 PAVILION AVE PROVIDENCE R I
COTTRELL PAPER CO INC
888 PURCHASE ST FALL RIVER MASS
COUCH ORDNANCE INC
3 ARLINGTON ST N QUINCY MASS
COURTER PROD DIV MODEL ENGG & MFG INC
N LAKE ST BOYNE CITY MICH
COUSINO ELECT CORP
1941 FRANKLIN AVE TOLEDO OHIO
COVEL MFG CO
P OBOX 116 BENTON HARBOR MICH
COX & CO
115 E 23 ST NEW YORK 10 N Y
COX INSTRUMENTS DIV GEORGE C NANKERVIS CO
15300 FULLERTON AVE DETROIT MICH
CP ELECTRONICS INC
2851 SOUTHEASTERN AVE COLUMBUS IND
CRAFT LABS
209 AYLIFFE AVE WESTFIELD N J
CRAIG SYSTEMS INC
360 MERRIMACK ST LAWRENCE MASS
CRAMER DIV GIANNINI CONTROLS CORP
CENTERBROOK CONN

CRANE ELECTRONICS CO
1401 FIRESTONE SANTA BARB A P GOLETA CAL
CRANE PACKING CO
6400 OAKTON ST MORTON GROVE ILL
CRANE SYST & CONTROLS GROUP
HOOKSETT INDUST PARK MANCHESTER N H
CRATEX MFG INC
1600 ROLLINS RD BURLINGAME CALIF
CRESCENT CO
20 CENTRAL AVE PAWTUCKET R I
CRESCENT COMMUNICATIONS CORP
43 HEMPSTEAD ST N LONDON CONN
CRESCENT ENGG & RESEARCH CO
5440 N PECK RD EL MONTE CALIF
CRESCENT EAST ENGR & RES CO
363 W GLENSIDE AVE GLENSIDE PA

CREST ULTRASONICS CORP
MERCER CTY AIRPORT TRENTON 8 N J
CRITTENDEN TRANSFORMER WORKS
13011 S SPRING ST LOS ANG CALIF
CRITTENDEN TRANSFORMER WORKS
1220 N ADEAU ST LOS ANG CALIF
CRONAME INC
6283 HOWARD ST CHICAGO ILL
CROSS CO H
3229 BERGENLINE AVE UNION CITY N J
CROUSE HINDS CO
BOX 131 SYRACUSE NY
CROVEN LTD
500 BEECH ST WHITBY ONT CANADA
CROWN CONTROLS CORP
40 44 S WASHINGTON NEW BREMEN OHIO
CROWN ENG DIV DATA TECH INC
3821 COMMERCIAL N E ALBUWERQUE NEW MEXICO
CROWN INTL DIV INTL RADIO & ELECT CORP
1718 MISHAWAKA RD ELKHART IND
CROWN TOOL & INST INC
810 N CASS ST WABASH IND
CROYOGENICS INC
STAFFORD VA
CRUCIBLE STEEL CO OF AMERICA
P O BOX 2518 PITTSBURGH 30 PENNA
CRYONETICS CORP
NORTHWEST IND PK BURLINGTON MASS
CRYO THERM INC
FOGELSVILLE PA
CRYSTAL RESEARCH PRODUCTS
W MADSON & PROSPECT AVE DUMONT NJ
CRYSTALONICS INC
249 5TH ST CAMBRIDGE MASS
CRYSTALONICS INC SEMICONDUCTOR PRODS
147 SHERMAN ST CAMBRIDGE 40 MASS
CRYSTAL-X CORP
SECOND & PINE STS DARBY PA
CRYS TECH INC
1534 E CHESTNUT ST SANTA ANA CALIF
CTS CORP
ELKHART INO
CTS INC
P O BOX 152 BERNE IND
CTS OF ASHEVILLE INC
MILLS GAP ROAD SKYLAND NORTH CAROLINA
CTS OF CANADA LTD
80 THOMAS ST STREETSVILLE ONT CAN
CUBEX CO
3322 TONIA AVE ALTADENA CALIF
CUBIC CORP
5575 KEARNY VILLA RD SANDIEGO CALIF
CULBERTSON PRODUCTS INC
25 SAMSON AVE MADISON N J
CUMMINS CHICAGO CORP
4740 RAVENSWOOD CHICAGO ILL
CUMMINS PORTABLE TOOLS DIV JOHN OSTER MFG CO
5055 N LYDELL AVE MILWAUKEE 17 WISC

CUNNINGHAM INDUST INC
56 HUBBARD AVE STAMFORD CONN
CUNNINGHAM SON & CO INC JAMES
HONEOYE FALLS N Y
CUNNINGHAM SONS & CO JAMES
33 LITCHFIELD ST ROCHESTER N Y
CURRY ARTS
522 GREEN RIDGE ST SCRANTON PENNA
CURTIS DEVELOPMENT & MFG CO
3218 N 33 ST MILWAUKEE 16 WISC
CURTIS DEVELOPMENT & MFG CO
3276 N 33RD ST MILWAUKEE 16 WISC
CURTIS INSTRUMENTS INC
351 LEXINGTON AVE MT KISCO N Y
ELECTRONICS DIV CURTISS WRIGHT
E PATERSON N J
CURTISS WRIGHT CORP
9733 COORS RD NW BX 10044 ALBUQUEREUE N M
CURTISS-WRIGHT CORP ELECTRONICS DIV
35 MARKET ST EAST PATERSON NJ
CURTISS-WRIGHT CORP WRIGHT AERONAUTICAL DIV
WOOD RIDGE NJ
CUSH CRAFT
621 HAYWARD ST MANCHESTER N H
CUSTOM COMPONENTS INC
P O BOX 248 CALDWELL N J
CUSTOM ELECT MFG CORP
5009 E ADMIRAL PLACE TULSA OKLA
CUSTOM GEAR CO
648 COLLEGE SOUTH BEND IND
CUSTOM PRODUCTS CORP
606 LINDLEY ST BRIDGEPORT CONN
CUSTOM SCIENTIFIC INSTRUMENTS INC
541 DEVON ST KEARNEY NJ
CUTLER HAMMER INC
436 W 12 ST MILWAUKEE WISC
CUTLER METAL PRODUCTS CO
1025 LINE ST CAMDEN N J
CYBETRONICS INC
132 CALBARY ST WALTHAM MASS
CYCLE EQUIPMENT CO
17480 SHELBURNE WAY LOS GATOS CALIF

CYCLE TRANSFORMER CORP
356 GLENWOOD AVE ORANGE N J

D

DACO INSTRUMENT CO
TILLARY & PRINCE STS BROOKLYN 1 N Y
DAGE ELECTRIC CO
HURRICANE RD FRANKLIN INDIANA
THOMPSON RAMO WOOLDRIDGE INC DAGE DIV
W 10 ST MICHIGAN CITY IND
DAHLSTROM METALLIC DOOR CO
BUFFALO 2 STS JAMESTOWN N Y
DAISLEY CO INC RAY
585 W HOFFMAN AVE LINDENHURST N Y
DALE ELECTRONICS INC DIV OF LIONEL CORP
BOX 488 COLUMBUS NEBR
DALE ELECTRONICS INC SIOUX DV
DIV OF LIONEL CORP YANKTON S D
DALES CO FRANKLIN
185 E MILL ST AKRON OHIO
DALES MFG CO
WABASSO FLA
DA-LITE SCREEN CO
WARSAW IND
DALLONS LABS
120 KANSAS ST EL SEGUNDO CALIF
DALLONS SEMICONDUCTORS DIV DALLONS LABS INC
5066 SANTA MONICA BLVD LOS ANGELES 29 CAL
DALMO VICTOR CO DIV TEXTRON INC
1515 INDUSTRIAL WAY BELMONT CAL
DALTRONICS INC
100 MANTON AVE PROVIDENCE R I
DALWELD CO INC
15 BERTEL AVE MT VERNON N Y
DAMON ENGINEERING INC
240 HIGHLAND AVE NEEDHAM HEIGHTS 94 MASS
DAMON RECORDING STUDIOS
117 W 14 ST KANSAS CITY 5 MO
DAMPP CHASER INC
BOX 1641 1404 SPARTANBURG HWY
HENDERSONVILLE N CAROLINA
DANA LAB INC
630 YOUNG ST SANTA ANA CALIF
DANIELS INC C R
DANIELS MO
DANLY MACHINE SPECIALITIES INC
2100 S LARAMIE AVE CHICAGO 50 ILL
DANLY MACHINE SPEC INC
2100 S 54TH AVE CICERO ILL
DANO ELEC CO
93 MAIN ST WINSTED CONN
DANTE ELECTRIC MFG CO
BANTAM CONN
DARCO IND INC
2151 ROSECRANS AVE EL SEGUNDO CALIF
DARE INC
BOX 312 TROY OHIO
DATA CONTROL SYSTEMS INC
E LIBERTY ST DANBURY CONN
DATA DISPLAY INC
1820 COMO AVE ST PAUL MINN
DATA INSTRUMENTS
12838 SATICOY N HOLLYWOOD CALIF
DATALOG DIVISION AIR LOGISTICS CORP
2415 AMSLER ST TORRANCE CALIF
DATAMEC CORP
345 MIDDLEFIELD RD MOUNTAIN VIEW CALIF
DATA SENSORS INC
13112 CRENSHAW BLVD GARDENA CALIF
DATA SYSTEMS NORDEN OV UNITED AIRCRAFT
3501 HARBOR BLVD COSTA MESA CALIF
DATA SYSTEMS INC
20535 MACK AVE GROSSE POINTE WOODS MICH
DATA TECH
238 MAIN ST CAMBRIDGE MASS
DATA TECHNOLOGY CORP
BOX 10935 PALO ALTO CALIF
DATA TECHNOLOGY INC
3821 COMMERCIAL NE ALBUQUERQUE N MEX
DATAMETRICS INC
87 BEAVER ST WALTHAM MASS
DATAPULSE INC
509 HINDRY AVE INGLEWOOD CALIF
DATASCAN INC
P O BOX 785 CLIFTON N J
DATASTROBE CORP
1275 BLOOMFIELD AVE W CALDWELL N J
DATA TRONIX CORP
415 GREEN ST NORRISTOWN PA
DATEX CORP
1307 MYRTLE AVE MONROVIA CALIF
DATRAN DIV AUTO INDUST INC
3501 LOMITA BLVD TORRANCE CALIF
DATRAX DIV W W HENRY CO
4443 E SLAUSON AVE MAYWOOD CALIF
DAVEN CO
ROUTE 10 LIVINGSTON NJ
DAVIDOFF CHARLES
198 BROADWAY NEW YORK 38 NY
DAVIDSON OPTRONICS INC
2223 ROMONA BLVD W COVINA CALIF
DAVIES MOLDING CO HARRY
1428 WELLS ST CHICAGO ILL
DAVIES SUPPLY & MFG CO
4160 MERAMEC ST ST LOUIS 16 MO
DAVIS & CO J W
9212 DENTON DR DALLAS TEXAS

DAVIS ELECTRIC CO
230 SPRING AVE CAPE GIRARDEAU MO
OAVISON CHEMICAL CO
BOX 488 POMPTON PLAINS N J
DAWE INSTRUMENTS LTD
WESTERN AVE LONDON ENG
DAWELD CO INC
13 BERTEL AVE MOUNT VERNON N Y
DAYMARC CORP
180 BEAR HILL RD WALTHAM 54 MASS
DAY-RAY PRODUCTS INC
1133 MISSION ST S PASADENA CALIF
DAYSTROM INC MILITARY ELECTRONICS DIV
ARCHBALD PENNA
DAYSTROM INC TRANSICOIL DIV
WORCESTER PA
DAYSTROM INC POTENTIOMETER DIV
ARCHBALD PENNA
DAYSTROM INC CONTROL SYSTEMS DIV
4455 MIRAMAR RD LAJOLLA CALIF
DAYSTROM INCORPORATED WESTON INSTRUMENTS DIV
614 FRELINGHUYSEN AVE NEWARK 12 N J
DAYSTROM TRANSISTOR CORP
WORCESTER PENNA
DAYSTROM WESTON INDUST DIV DAYSTROM INC
MANCHESTER RD POUGHKEEPSIE N Y

DAYTON AIRCRAFT PRODUCTS INC
812 NW 1ST AVE FORT LAUDERDALE FLA
DAYTON AVIATION RADIO & EQUIP CO
BOX 312 BUSINESS RT 25 TROY OHIO
DAYTON ELECT PROD CO INC
117 EAST HELENA STREET DAYTON 4 OHIO
DAYTRONIC CORP
223 227 JEFFERSON ST DAYTON OHIO
DBM RESEARCH CORP
P O BOX 521 COCOA BEACH FLA
DEARBORN ELECTRONIC LABS INC
P O BOX 3431 ORLANDO FLA
DEBELL & RICHARDSON INC
WATER ST HAZARDVILLE CONN
DECCO INC
2025 FARRINGTON DALLAS TEX
DECHERT DYNAMICS CORP
PALMYRA PENNA
DECIBEL PRODUCTS INC
3184 QUEBEC DALLAS TEXAS
DECIMETER PRODUCTS CO
STAR ROUTE BOX 67 LITTLETON COLO
DECITRON ELECTRONICS CORP
850 SHEPHERD AVE BROOKLYN 8 N Y
DECKER CORP
45 MONUMENT RD BALA CYNWYD PENNA
DECO ELECTRONICS INC
1000 CONNECTICUT AVE N W WASHINGTON D C
DECOURSEY ENGG LAB
11828 W JEFFERSON BLVD CULVER CITY CALIF
DEE ELECTRIC CO
1708 BELMONT AVE CHICAGO ILL
DEFIANCE PRINTED CIRCUIT CORP
144 COMMERCIAL ST MALDEN MASS
DEITZ CO S J
9 E WESLEY ST S HACKENSACK NJ
DEJUR-AMSCO CORP ELECTRONICS DIV
45-01 NORTHERN BLVD LONG ISLAND CITY 1 N Y
DE LANDRI PRECISION ELEMENTS CO INC
39 SCHOOL ST YONKERS N Y
DEL ELECTRONICS CORP
521 HOMESTEAD AVE MT VERNON N Y
DELCO APPLIANCE DIV GMC
P O BOX 230 ROCHESTER 1 N Y
DELCO RADIO DIV GMC
700 FIRMIN ST KOKOMO IND
DELCO REMY DIV GENERAL MOTORS CORP
2401 COLUMBUS AVE ANDERSON IND
DELCON CORP
943 INDUSTRIAL AVE PALO ALTO CALIF
DELMAR ENG LAB
6901 IMPERIAL HWY LOS ANG CALIF
DELMHORST INSTRUMENT CO
601 CEDAR ST BOONTON N J
DELS TUMBLING SERVICE
232 N ROSEMARY DEARBORN 6 MICH
DELSEN CORP
719 W BROADWAY GLENDALE 4 CALIF

DELTA COILS INC
1128 MADISON AVE PATERSON N J
DELTA DESIGN INC C O NON LINEAR SYSTEMS INC
DEL MAR AIRPORT DEL MAR CAL
DELTA ELECT CO
MARION IND
DELTA ELECTRONICS INC
4206 WHEELER AVE ALEXANDRIA VA
DELTA F INC
113 E STATE ST GENEVA ILL
DELTA SEMICONDUCTORS
835 PRODUCTION PL NEWPORT BCH CALIF
DELTA SONICS INC
12918 CERISE AVE HAWTHORNE CALIF
DELTA T SEMICONDUCTOR CO
139 FOUNDRY ST WAKEFIELD MASS
DELTIME INC
608 FAYETTE AVE MAMORONECK N Y
DELTRON CO INC
14736 ARMINTA ST VAN NUYS CALIF
DELTRON INC
4TH & CAMBRIA STS PHILA PA
DELTRON INC
2905 N LEITHGOW ST PHILADELPHIA 33 PA
DELUXE COILS INC
HUNTINGTON IND
DELVATEX CORP
34 PARKER AVE TRENTON 9 N J
DEMENT LABS
1717 E 19TH AVE PORTLAND OREGON
DEMORNAY BONARDI CORP
780 S ARROYO PKWY PASADENA CALIF

DENNISON MFG CO
300 HOWARD ST FRAMINGHAM MASS
DENRAD MFG CO INC
309 W WOODARD ST DENISON TEXAS
DENSON ELECTRONICS CORP
P / BOX 122 ROCKVILLE CONN
DEPENDABLE PRINTED CIRCUIT CORP
827 BLACK OAK RIDGE WAYNE NJ
DERBY LUMINESCENTS LTD OF LONDON ENG
C/O UNITED MINERAL & CHEMICAL CORP
16 HUDSON ST NEW YORK 13 NY
DERINGER METALLURGICAL CORP
8131 MONTICELLO AVE SKOKIE ILL
DERO ELECTRONICS
10 WOODS AVE ROOSEVELT NY
A L DERY & SONS TOOL & DIE CI
MAIN ST PINE MEADOWS CONN
DESIGN TOOL CO
1055 STEWART AVE GARDEN CITY N Y
DESMOND STEPHAN MFG CO
BOX NO 30 URBANA OHIO
DESPATCH OVEN CO
619 S E 8 ST MINNEAPOLIS MINN
DESTRON CO
25914 CHALMETTE ROLLING HILLS EST CALIF

DE-TEC-TRONIC CORP
2512 N HALSTED ST CHICAGO 14 ILL
DETROIT DESIGNING & ENG CO
1429 MAGNOLIA LONG BEACH 13 CALIF
DETROIT HOIST & MACHINE CO
8201 MORROW ST DETROIT 11 MICH
DETROIT POWER SCREWDRIVER CO
2813 W FORT ST DETROIT MICH
DEUTSCH CO ELECTRONIC COMPONENTS DIV
MUNICIPAL AIRPORT BANNING CALIF
DEUTSCH CO THE
BLDG 74 KINSTON MUNICIPAL A/P KINSTON N C
DEVCO DIV R E PHELONCO INC
70 MAPLE ST E LONGMEADOW MASS
DEVCO ENGG INC
PIER LANE WEST CALDWELL N J
DEVELCO INC
440 PEPPER ST PALO ALTO CALIF
DEVELOPMENT ASSOCIATES
2600 DE LA VINA SANTA BARBARA CALIF
DEVELOPMENT ENGG CO
9 CROSS ST NORWALK CONN
DEVELOPMENTAL ELECT CORP
3340 W EL SEGUNDO BLVD HAWTHORNE CALIF
DEVICE DEVELOPMENT CORP
428 BOSTON POST RD WESTON MASS
DEVICE SEALS INC
11684 TUXFORD ST SUN VALLEY CALIF
DEV TEK INC
5720 PRECISION RD ORLANDO FLA
DEWALD RADIO MFG CORP
DIV OF UNITED SCIENTIFIC LABS
35 15 37 TH AVE LONG ISLAND N Y
DEWEY & ALMY CHEMICAL CO
6050 W 51 ST CHICAGO ILL
DEWITT DEVELOPMENT CO
3008 W 127 ST BLUE ISLAND ILL
DI-ACRO CORPORATION
300 8TH AVE LAKE CITY MINN
DIAL PRODUCTS CO
19 COTTAGE ST BAYONNE N J
DIALIGHT CORP
60 STEWART AVE BROOKLYN 37 N Y
DIAMOND ANTENNA & MICROWAVE CORP
35 RIVER ST WINCHESTER MASS
DIAMOND CHAIN CO INC
402 KENTUCKY AVE IND IND
DIAMOND COILS INC
540 39 ST UNION CITY N J
DIAMOND POWER SPECIALTY CORP ELECTRONIC DIV
BOX 415 LANCASTER OHIO
DIAMOND TOOL ENGG CO
108 MASSACHUSETTS AVE BOSTON 15 MASS
DIAMOND TOOL & HORSESHOE CO
4602 4706 GRAND AVE W DULUTH MINN
DIAMONITE PRODUCTS MFG CO
DIV U S CERAMIC TILE CO SHREVE OHIO

DI-AN CONTROLS INC
944 DORCHESTER AVENUE DORCHESTER MASS
DIAPHLEX DIV
2700 N SOUTHPORT CHICAGO 14 ILL
DIATRON INC
BOX 3426 BELLAIRE TEXAS
DICE CO J W
16 HIGHWOOD AVE ENGLEWOOD N J
DICKSON ELECTRONICS CORP
248 WELLS FARGO AVE SCOTTSDALE ARIZ
DICON CORP
P O BOX 177 PORT WASHINGTON N Y
DICTAPHONE CORP
375 HOWARD AVE BRIDGEPORT CONN
DIE-FORM CIRCUITS INC
6045 W OGDEN AVE CHICAGO 50 ILL
DIEBEL DIE & MFG CO
6505 OAKTON ST MORTON GROVE ILL
DIEHL MFG CO
FINDERNE AVE SOMERCILLE N J
DIELECT INC
CORAL ST BOX 44 FORDS N J
DIELECTRIC MATERIALS CO
1811 W BRYN MAWR AVE CHICAGO ILL
DIELECTRIC PRODUCTS ENGG CO
RAYMOND ME
DIELECTRIC PRODUCTS ENGG CO
BRIDGETON ME
DIE TECH CORP
29 MARBLE AVE PLEASANTVILLE N Y
DIETZ CO HENRY G INC
12-16 ASTORIA BLVD LONG ISLAND CITY 2 N Y
DIETZ CO S J
9 E WESLEY ST HACKENSACK N J

DIETZ DESIGN INC
GRANDVIEW MO
DIGITAL DESIGN CORP
BOX 21 CLAY N Y
DIGITAL DEVELOPMENT CORP
7541 EADS AVE LA JOLLA CALIF
DIGITAL ELECTRONICS INC
2200 SHAMES DR WESTBURY L I N Y
DIGITAL EQUIPMENT CORP
146 MAIN ST MAYNARD MASS
DIGITAL SYSTEMS INC
1008 E EDNA PLACE COVINA CALIF
DIGITECH INC
382 DANBURY RD WILTON CONN
DIGITECH INC
130 WATER ST S NORWALK CONN
DIGITOOL CORP
5300 BROADWAY RD HOUSTON TEXAS
DIGITRAN CO DIV ENDEVCO
855 S ARROYO PARKWAY PASADENA CALIF
DIGITROL SYSTEMS INC
TYRELL RD MILLBROOK N Y
DIGITRONICS CORP
ALBERTSON AVE ALBERTSON L I N Y

DILECTRIX CORP
ALLEN BLVD & GRAND AVE FARMINGDALE LI N Y
DILECTRON DIV BESTRAN CORP
2669 S MYRTLE AVE MONROVIA CALIF
DILL PRODUCTS INC
371 E MAIN ST NORRISTOWN PA
DILLON & CO INC W C
14620 KESWICK ST VAN NUYS CALIF
DIMCO-GRAY CO
207 E 6 ST DAYTON 2 OHIO
DIMENSIONS INC
7314 20TH AVE BROOKLYN 4 N Y
DINION COIL CO
CALEDONIA N Y
DIOTRON INC
3650 RICHMOND ST PHILA PENNA
DIRIGO COMPASS & INSTRUMENT CO
BOEING FIELD BOX 37 SEATTLE WASH
DISC INSTRUMENTS INC
3014 B SO HALLADAY ST SANTA ANA CALIF
DIT-MCO INC ELECTRONICS DIV
911 BROADWAY KANSAS CITY MO
DI-TRAN CORPORATION
11307 MINDRY AVE LOS ANGELES 45 CALIF
DITTMORE FREIMUTH CORP
2517 E NORWICH ST MILWAUKEE WISC
DIXON CORP
BURNSIDE BRISTOL R I
DIXON CRUCIBLE CO JOSEPH
167 WAYNE ST JERSEY CITY 3 N J
DJORDJEVIC ENG CO
1933 N DAMEN CHICAGO ILL
DKE ELECTRIC BASES CORP
27 WRIGHT ST NEWARK NJ
DMETER MFG CO
22 24 LARKIN PLAZA YONKERS N Y
THE DOALL CO
254 N LAUREL AVE DES PLAINES ILL
DOCKENDORFF & CO INC
606 LINDLEY ST BRIDGEPORT CONN
DODGE FIBERS CORP
JOHN ST HOOSICK FALLS N Y
DOLIN METAL PRODUCTS INC
315 LEX95706N AVE BROOKLYN N Y
DOLINKO & WILKENS INC
1907 SUMMIT AVE UNION CITY N J
DON BOSCO ELECT SUB OF HOWELL ELECT MOTORSCO
LITTELL RD HANOVER N J
DONGAN ELECTRIC MFG CO
2987 FRANKLIN ST DETROIT MICH
DON LAN ELECTRONICS CORP SUB QUANTATRON INC
2520 COLORADO AVE SANTA MONICA CAL
DONMAR PRODUCTS INC
P O BOX 8396 DENVER 10 COLO
DONNELLY MFG CO
580 WINTER ST WALTHAM MASS
DORE CO JOHN L
PO BOX 7772 HOUSTON 7 TEX

DORMEYER CORP
700 N KINGSBURY AVE CHICAGO ILL
DORMEYER INDUSTRIES
3418 MILWAUKEE AVE CHICAGO 41 ILL
DORMEYER INDUSTRIES
KENTLAND INDIANA
DORNE & MARGOLIN
29 N Y AVE WESTBURY N Y
DORSETT ELECTRONICS
119 W BOYD NORMAN OKLA
DOSS ELECTRONIC RES INC
820 BALTIMORE AVE KANSAS CITY MO
DOSSERT MFG CORP
249 HURON ST BROOKLYN 22 N Y
DOTCO INC
HICKSVILLE OHIO
DOTY ACOUSTICAL ELECTRONIC LABS
TOBYHANNA PENNA
DOUBLE E PRODUCTS CO
208 STANDARO ST EL SEGUNDO CALIF
DOUGLAS ELECTRONICS
1429 OREGON ST BERKELEY 2 CALIF
DOUGLAS MICROWAVE CO
252 E 3 ST MT VERNON N Y
DOUGLAS ROESCH COMMUNICATIONS
2727 SAN FERNANDO ROAD LOS ANGELES 65 CAL
DOW CORNING CORP
BOX 592 MIDLAND MICH
DOW KEY CO
P O BOX 711 THIEF RIVER FALLS MINN
DOW KEY CO INC
RT 3 59 THIEF RIVER FALLS MINN
D & R PILOT PLANTS INC
WATER ST HAZARDVILLE CONN

DRAKE CO R L
540 RICHARD ST MIAMISBURG OHIO
DRAKE MFG CO
4626 N OLCOTT AVE CHICAGO ILL
DRESSEN BARNES CORP
250 N VINEDO AVE PASADENA CALIF
DRESSER ELECT SIE DIV
10201 WESTHEIMER RD HOUSTON TEXAS
DRESSER ELECTRIC CO
2705 WIGHT ST DETROIT 7 MICH
DRESSER ELECT HST DIV
555 N 5ST GARLAND TEXAS
DRESSER-IDECO CO
8909 S VERMONT AVE LOS ANGELES 44 CALIF
DREXEL DYNAMICS CORP
MAPLE AVE HORSHAM PA
DRICO INDUSTRIAL CORP
100 8TH ST PASSAIC N J
DRIVER CO WILBUR B
1875 MCCARTER HWY NEWARK 4 N J
DRIVER HARRIS CO
HARRISON N J
DRY SCREEN PROCESS INC
1016 MADISON AVE PITTSBURGH 12 PA

DRYOMATIC CORP
BOX 591 715 FAYETTE ST ALEXANDRIA VA
DUBROW ELECTRONIC INDUSTRIES INC
235 PENN ST BURLINGTON N J
DU-CO CERAMICS CO
BOX 278 SAXONBURG PA
DUDEK & CO R C
407 MAPLE DR BEVERLY HILLS CALIF
DUKANE CORP
ST CHARLES ILL
DUMONT AIRPLANE & MARINE INSTRUMENT INC
PO BOX 92 CLEARFIELD PENNA
DUMONT LABS INC ALLEN B
750 BLOOMFIELD AVE CLIFTON NJ
DUMORE CO
1300 17TH ST RACINE WISC
DUNCAN ELECT INC
3865 FAIRVIEW RD COSTA MESA CALIF
DUNHAM-BUSH INC
W HARTFORD CONN
DUNLEE CORP
1023 S PUSCHECK RD BELLWOOD ILL
DUNN ENG CORP
38 HENRY ST CAMBRIDGE MASS
DUNTON CO MW
7 GOFF ST PROVIDENCE R I
DUOTONE CO
LOCUST ST KEYPORT N J
DU PONT DE NEMOURS & CO E I
WILMINGTON 98 DEL
DURA BUSINESS MACHINES INC
322000 STEPHENSON HWY MADISON HGTS MICH
DURAKOOL INC
1010 N MAIN ST ELKHART IND
DURALITH CORP
1025 RACE ST PHILADELPHIA 7 PA
DURAMARK INC
P O BOX 231 PORT WASHINGTON N Y
DURAMIC PRODUCTS INC
426 COMMERCIAL AVE PALISADES PARK N J
DURANT MFG CO
15 THURBERS AVE PROVIDENCE 5 RI
DURANT MFG CO
1912 N BUFFUM ST MILWAUKEE 1 WIS
DURANT MFG CO
12TH & CLARK STS WATERTOWN WISC
DURA PLASTICS OF N Y INC
49 RICHMONDVILLE AVE WESTPORT CONN
DURATRON CORP
154 W 14TH ST NEW YORK 11 NY
DUREZ PLASTIC DIV-HOOKER CHEMICAL CORP
1926 WALCK RD NORTH TONAWANDA N Y
DURO MATIC PRODUCTS CO
8509 HIGUERA ST CULVER CITY CAL
DURO SPECIALTY CO
811 BOSTON ST LYNN MASS
DWYER ELECTRONICS CO
AIRPORT RD BOX 452 NASHUA N HAMPSHIRE

DWYER MFG CO F W
P O BOX 373 MICHIGAN CITY IND
DX RADIO PRODUCTS CO
2300 W ARMITAGE AVE CHICAGO 47 ILL
DYMEC DIV OF HEWLETT PACKARD CO
395 PAGE MILL RD PALO ALTO CALIF
DYMO CORP
1476 66TH ST EMERYVILLE CALIF
DYNACO INC
3912 POWELTON AVE PHILA 4 PA
DYNACOR INC
1D431 METROPOLITAN AVE KENSINGTON MD
DYNA-EMPIRE INC
1075 STEWART AVE GARDEN CITY L I N Y
DYNAIR ELECTRONICS INC
7564 BROADWAY LEMON GROVE CALIF
DYNALECTRON CORP MATTERN DIV
7444 WILSON AVE CHICAGO 7 ILL
DYNAMETRICS CORP
NORTHWEST INDUST PARK BURLINGTON MASS
DYNAMIC AIR ENGG INC
7412 MAIE AVE LOS ANGELES 1 CALIF
DYNAMIC CONTROLS CO
2225 MASSACHUSETTS AVE CAMBRIDGE MASS
DYNAMIC GEAR CO INC
175 DIXON AVE AMITYVILLE N Y
DYNAMIC INSTRUMENT CORP
E BETHPAGE RD PLAINVIEW N Y
DYNAMIC MEASUREMENTS CO
DAVISVILLE & TERWOOD RD WILLOW GROVE PA
DYNAMICS INST CO
583 MONTEREY PASS RD MONTEREY PK CALIF
DYNAMU MAGNETRONICS CORP DIV MAICO ELECT INC
21 N 3 ST MINNEAPOLIS MINN

DYNAPAR CORP
437 E STEWART MILWAUKEE WISC
DYNAPLEX CORP
P O BOX 341 PRINCETON N J
DYNAPOWER SYSTEMS CORP
2222 S CENTINELA AVE LOS ANGELES 64 CALIF
DYNASCIENCES CORP
FORT WASHINGTON PA
DYNASONICS CORPORATION
200 MICHAEL DRIVE SYOSSET NY
DYNATRON LAB
553 E DAWSON DR CAMARILLO CALIF
DYNATRONIC INST CORP ELECTR DIV
LAB LINE INSTRUMENTS INC
3070 W GRAND AVE CHICAGO 22 ILL
DYNATRONICS CABLE ENGG CORP
136 SAN FERNANDO RD LOS ANG CALIF
DYNATRONICS INC
P O BOX 2566 ORLANDO FLA
DYNAVOX CORP
40-50 21ST ST LONG ISLAND CITY 1 N Y
DYNEL INC
12923 S SPRING ST LOS ANG CALIF
DYNISCO DIV AMERICAN BRAKE SHOE CO
42 CARLETON ST CAMBRIDGE MASS
DYTRONICS CO
BOX 3676 COLUMBUS OHIO
DYTRONICS INC DIV OF TAYLOR CORP
ROCHESTER 53 MICHIGAN
DZUS FASTENER CO
125 UNION ST WEST ISLIP N Y

E

EAGLE ELECTRIC MFG CO
2310 BRIDGE PLAZA SO LONG ISLAND CITY 1 NY
EAGLE ELECTRIC MFG CO INC
2814-18 W FULLERTON AVE CHICAGO 47 ILL
EAGLE SIGNAL CO DIV GAMEWELL CO
202 20 ST MOLINE ILL
EAGLE-PICHER CO AMERICAN BLDG
AMERICAN BLDG CINCINNATI 1 OHIO
EALING CORP
33 UNIVERSITY RD CAMBRIDGE MASS
EASTERN AIR DEVICES
391 CENTRAL AVE DOVER N H
EASTERN CHEMICAL CORP
34 SPRING ST NEWARK N J
EASTERN ETCHING & MFG CO
GRAPE ST CHICOPEE MASS
EASTERN INDUSTRIES DIV OF L F E INC
100 SKIFF ST HAMDEN CONN
EASTERN SMELTING & REFINING CORP
109 W BROOKLINE ST BOSTON 18 MASS
EASTERN SPECIALTY CO
3617 N 8 ST PHILA 40 PA
EASTERN TECHNICAL ASSOC INC
MAIN ST NORTH ACTION MASS
EATON MFG CO DYNAMIC DIV
3122 14TH AVE KENOSHA WISC
EATON MFG CO RELIANCE DIV
23 CHARLES AVE SE MASSILLON OHIO
EBAUCHES A DEP SEMICONDUCTEURS
FAUBOURG HOPITAL NEUCHATEL SWITZERLAND
EBERLINE INSTRUMENT CORP
805 EARLY ST SANTA FE NEW MEXICO
EBERT ELECTRONICS CORP
212-26 JAMAICA AVE QUEENS VILLAGE 28 N Y
EBY CO H H
4700 GERMANTOWN AVE PHILADELPHIA 44 PA
EBY SALES CO
148-05 ARCHER AVE JAMAICA 35 NY
ECKEL CORP
155 FAWCETT ST CAMBRIDGE 38 MASS
ECKEL VALVE CO
1425 FIRST ST SAN FERNANDO CALIF
ECLIPSE ENG CO
226 S GLASGOW AVE INGLEWOOD CALIF
ECLIPSE-PIONEER DIV BENDIX CORP
TETERBORO N J
ECM CORP
8160 ORION AVE VAN NUYS CALIF
EDAL INDUSTRIES INC
64 FRANKLIN ST NEW HAVEN 11 CONN

EDAL INDUSTRIES INC
4 SHORT BCH RD EAST HAVEN 12 CONN
EDCLIFF INSTRUMENTS
1711 S MOUNTAIN AVE MONROVIA CALIF
EDCO ENG & OEV CORP
2225 E FRANKLIN MINN MINN
EDER INSTRUMENT CO INC
2293 N CLYBOURN AVE CHICAGO ILL
EDERER ENGG CORP
2931 1ST AVE S SEATTLE WASH
EDGERTON GERMESHAUSEN & GRIER INC
BLDG 226 SANTA BARBARA AIRPORT GOLETA CAL
EDGERTON GERMESHAUSEN & GRIER
160 BROOKLINE AVE BOSTON MASS
EDISON INDUST THOMAS A INST DIV
45 LAKESIDE AVE W ORANGE N J
EDKO ELECTRONICS ENGG CO
397 BEDFORD AVE BROOKLYN 11 NY
E D L CO
BOX 2508 5929 DUNES HWY GARY INO
EDO CANADA LTD
BOX 97 CORNWALL ONT CANADA
EDO CORP
13 10 111 ST COLLEGE POINT L I N Y

EDP CORPORATION
3501 SO ORANGE BLOSSOM TRAIL ORLANDO FLA
EDROY PRODUCTS CO
480 LEXINGTON AVE NEW YORK N Y
EDUCATIONAL ELECTRONICS CO
1227 LOYOLA AVE CHICAGO 26 ILL
EFCON INCORP SUB GENERAL INST
GARDEN CITY L I N Y
EGAN LABORATORY
107-56 113TH ST RICHMOND HILL 19 N Y
E H RESEARCH LAB INC
163 ADELINE ST OAKLAND CALIF
EIDSON ELECTRONIC CO
1902 N 3 ST TEMPLE TEXAS
EISLER ENGG CO
750 S 13 ST NEWARK 3 N J
EISLER TRANSFORMER CO INC
24 N SALEM ST DOVER N J
EISLER TRANSFORMER CO INC
16 N SALEM ST DOVER N J
EITEL-MC CULLOUGH INC
301 INDUSTRIAL WAY SAN CARLOS CALIF
EITEL-MCCULLOUGH INC
798 SAN MATEO AVE SAN BRUNO CALIF
ELASCO INC
5 PRESCOTT ST ROXBURY 19 MASS
ELASTIC STOP NUT CORP OF AMERICA
2330 VAUXHALL RD UNION N J
ELASTIC STOP NUT CORP OF AMER
ELIZABETH DIVISION
1027 NEWARK AVE ELIZABETH 3 N J
ELCO CORP
M ST BELOW ERIE AVE PHILA 24 PA
ELCO ELECTRONICS
MICHIGAN CITY IND
ELCO TOOL & SCREW CORP
1111 SAMUELSON RD ROCKFORD ILL
ELCOR INC
1225 W BROAD ST FALLS CHURCH VA
ELDEMA CORP
1805 BELCROFT AVE EL MONTE CALIF
ELDORADO ELECT CO
2821 10 ST BERKELEY CALIF
ELDRE COMPONENTS INC
187 N WATER ST ROCHESTER 4 N Y
ELECT MECHANICAL RES INC
SARASOTA FLA
ELECT STORAGE BATTERY MISSILE BATTERY DIV
2510 LOUISBURG RD RALEIGH N C
ELECT STORAGE BATTERY CO DIV EXIDE IND
2 PENN CENTER PLAZA PHILA PA
ELECTRA MFG CO
800 N 21ST ST INDEPENDENCE KANSAS
ELECTRA MFG CO
4051 BROADWAY KANSAS CITY MO
ELECTRA SCIENTIFIC CORP
ELECTRA WAY FULLERTON CALIF
ELECTRAC INC
1001 ARLEE PL ANAHEIM CALIF
ELECTRADA CORP
11244 PLAYA ST CULVER CITY CAL
ELECTRALAB PRINTED ELECT
1105 SECOND ST ENCINITAS CALIF
ELECTRALAB PRINTED ELECT CORP
NEEDHAM HTS MASS
ELECTRAMATIC INC
3324 HIAWATHA AVE MINN MINN
ELECTRAN MFG CO
1901 CLYBOURN AVE CHICAGO ILL
ELECTREND PRODUCTS CORP
BOX 110 ST JOSEPH MICH
ELECTRI WIRE ASSEMBLIES
700 W VIRGINIA MILWAUKEE WISC
ELECTRIC AUTO-LITE CO
WIRE & CABLE DIV PORT HURON MICH
ELECTRIC AUTO-LITE CO
HAZELTON PENNA
ELECTRIC AUTOLITE CO THE
901 N SELBY ST EL SEGUNDO CALIF
THE ELECTRIC AUTOLITE CO
P O BOX 366 HAZELTON PENNA
ELECTRIC AUTOLITE DIE CASTING CO
1ST & CLAY STS WOODSTOCK ILL
ELECTRIC AUTOLITE CO
PENNSBURG PA
ELECTRIC AUTOLITE CO
VINCENNES IND
ELECTRIC CORDS & SUPPLY CORP
413 E THIRD ST LOS ANG CALIF
ELECTRIC DESIGN & MFG CO
722 JEFFERSON ST BURLINGTON IOWA

ELECTRIC EYE EQUIPMENT CO
1948 E FAIRCHILD ST DANVILLE ILL
ELECTRIC INDICATOR CO INC
CAMP AVE SPRINGDALE CONN
ELECTRIC MACHINERY MFG CO
800 CENTRAL AVE MINNEAPOLIS 13 MINN
ELECTRIC MOTORS & SPECIALTIES
KING & HAMPSHER ST GARRETT IND
ELECTRIC POWER DOOR CO INC
MINNEAPOLIS MINN
ELECTRIC REGULATOR CORP
PEARL ST NORWALK CONN
ELECTRIC SOLDERING IRON CO
W ELM ST DEEP RIVER CONN
ELECTRIC SPECIALTY CO
207 SOUTH ST STAMFORD CONN
ELECTRIC STORAGE BATTERY CO EXIDE IND DIV
RISING SUN & ADAMS AVES PHILA PA
ELECTRIC STORAGE BATTERY CO
5335 WESTERN BLVD S CHICAGO 9 ILL
ELECTRIC STORAGE BATTERY CO
251D LOUISBURG RD RALEIGH N C
ELECTRIC TACHOMETER CORP
68TH & UPLAND STS PHILA PENNA
ELECTRIC TERMINAL CORP
PO BOX 2217 PROVIDENCE 5 RI

ELECTRICAL INSULATION CO INC
1245 MARCONI BL COPIAGUE N Y
ELECTRICAL INSTRUMENT CORP
200 HARVARD AVE STAMFORD CONN
ELECTRICAL INDUSTRIES
691 CENTRAL AVE MURRAY HILL NJ
ELECTRICAL PRODUCTS RES & DEV CO INC
1206 CHERRY ST TOLEDO 4 OHIO
ELECTRICAL REFRACTORIES CO
E CLARK ST E PALESTINE OHIO
ELECTRICAL SERVICE CO
1271 MISSION ST SAN FRANCISCO CALIF
ELECTRICAL SPECIALTY CO
2820 E 12ST LOS ANG CALIF
ELECTRICAL SPECIALTY CO
158 ELEVENTH ST SAN FRAN CALIF
ELECTRICAL UTILITIES CO
2427 ST VINCENTS AVE LA SALLE ILL
ELECTRICAL WINDINGS INC
2015 N KOLMAR AVE CHICAGO ILL
ELECTRO-AIR CLEANER CO INC
OLIVIA & SPROUL ST MCKEES ROCKS PA
ELECTRO ASSEMBLIES INC
4444 N KEDZIE AVE CHICAGO 25 ILL
ELECTRO CAPACITORS CO
10132 EDES AVE OAKLAND 3 CAL
ELECTRO-CERAMICS INC
120 STATE ST NEW HAVEN CONN
ELECTRO CERAMICS INC
2645 S 2ND W SALT LAKE CITY UTAH
ELECTRO CHEMICAL ENGRAVING CO INC
1100 BROOK AVE BRONX N Y
ELECTRO CHEMICAL ENGG & MFG CO
750 BROAD ST EMMAUS PA
ELECTRO CHEMICAL DIV REPUBLIC FOIL INC
SALISBURY NC
ELECTRDCHEMICAL INDUSTRIES INC
35 ARMORY ST WORCESTER 3 MASS
ELECTRO CIRCUITS INC
176 WALKER STREET LOWELL MASS
ELECTRODATA DIV BURROUGHS CORP
460 SIERRA MADRE VILLA PASADENA CALIF
ELECTRO-DEVELOPMENT CO
14701 KESWICK ST VAN NUYS CALIF
ELECTRO DEVELOPMENT CORP
4530 UNION BAY PL NE SEATTLE 5 WASH
ELECTRO DEVICES INC
75 ADAMS ST NEWTON MASS
ELECTRO DEVICES INC
4 GODWIN AVE PATERSON N J
ELECTRODYNAMIC INSTRUMENT CORP
1841 OLD SPANISH TR HOUSTON 25 TEX
ELECTRO ENGG WORKS
401 PREDA ST SAN LEANDRO CALIF
ELECTRO-ETCH CIRCUITS INC
7112 SO VICTORIA AVE LOS ANGELES 43 CALIF
ELECTRO FLEX HEAT INC
83 WOODBINE ST HARTFORD CONN
ELECTROFLOR INC
7356 SANTA MONICA BL LOS ANGELES CALIF
ELECTROID CORP
107 PROGRESS ST UNION N J
ELECTRO IMPULSE LAB INC
208 RIVER ST RED BANK N J
ELECTRO INSTRUMENT INC
8611 BALBOA AVE SAN DIEGO 11 CALIFORNIA
ELECTRO INTERNATIONAL INC
GREENWOOD ACRES SECOND ST ANNAPOLIS MD
ELECTRO KINETICS CORP
909 BORDER AVE TORRANCE CALIF
ELECTRO LOGIC CORP
110 W 131 ST LOS ANGELES 61 CALIF
ELECTROL SPECIALTIES CO
441 CLARK ST S BELOIT ILL
ELECTROMAGNETIC PROBE CO
3800 CASH DRIVE WINSTON SALEM NO CAR
ELECTROMAGNETIC TECHCORP
1375 CALIF AVE PALO ALTO CALIF
ELECTROMATH CORP
115 PLEASANT AVE ROOSEVELT N Y
ELECTROMATIC EQUIP CO
562 ALBERMARLE RD CEDARHURST N Y
ELECTRDMATION CO
4254 GLENCOE AVE VENICE CALIF
ELECTRO MECHANICAL CORP
375 FAIRFIELD AVENUE STAMFORD CONNECTICUT
ELECTRO-MECHANICAL INSTRUMENT CO
8 & CHESTNUT ST PERKASIE PA
ELECTRO MECHANICAL RESEARCH INC
BOX 3041 A SARASOTA FLA
ELECTRO MECHANICAL RESEARCH
BOX 44 PRINCETON NJ
ELECTRO MECHANICAL SPEC
528 LAMBERT RD WHITTIER CALIF
ELECTRO MECHANICS CORP
P O BOX 5061 HIGH POINT N C
ELECTRO MEC INSTRUMENT CORP
47 51 33RD ST LONG ISLAND CITY 1 N Y
ELECTRO MED INC
4748 FRANCE AVE N MINNEAPOLIS MINN
ELECTRO-MEDICAL LAB INC
S WOODSTOCK 10 VT
ELECTRO MEDICAL ENG CO
703 MAIN ST BURBANK CALIF
ELECTRO-MINIATURES CORP
604 HUYLER ST SOUTH HACKENSACK NJ
ELECTRDMODE
P O BOX 1052 ROCHESTER 3 N Y
ELECTRO MOTIVE MFG CO INC
WILLIMANTIC CONN
ELECTRO METIC STEEL INC
9535 RIVER ST SCHILLER PARK ILL
ELECTRO NEUTRONICS INC
940 DWIGHT WAY BERKELEY 2 CALIF
ELECTRONEX INDUSTRIAL LABORATORIES
2459 SUSQUEHANNA RD ROSLYN PA
THE ELECTRO NUCLEAR SYS CORP
9449 SCIENCE CENTER DR MINN MINN
ELECTRO PHYSICS CO
297 BROADWAY NEW YORK 7 N Y
ELECTRO PHYSICS LABS
1900 WALKER AVE MONROVIA CALIF
ELECTRO PRODUCTS LABS INC
4501 N RAVENSWOOD AVE CHICAGO 4 ILL
ELECTRO PROD LABS INC
6125 W HOWARD ST CHICAGO 48 ILL
ELECTRO PRODUCTS INC
15050 SCHAFER HWY DETROIT MICH
ELECTRO RACK INC
1341 S CLAUDINA ST ANAHEIM CALIF
ELECTRO RADIATION INC
11916 W PICO BLVD LOS ANGELES 64 CAL
ELECTRO SCIENTIFIC IND INC
7524 S W MACADAM AVE PORTLAND ORE
ELECTRO SEAL CORP
946 NORTH AVE DES PLAINES ILL
ELECTRO-SECURITY CORP
275 MAIN ST WEBSTER MASS
ELECTRO SOLID CONTROLS INC
8001 BLOOMINGTON FREEWAY MINN MINN
ELECTRO-SONIC LABS
35-54 36 ST LONG ISLAND CITY 6 N Y
ELECTROSPACE CORP
12 G MORRIS AVE GLEN COVE N Y
ELECTRO SPACE FAB INC
CENTRE AVE TOPTON PA
ELECTRO SWITCH CORP
KING AVE WEYMOUTH 88 MASS
ELECTRO-TEC CORP
1 HENDERSON DRIVE WEST CALDWELL NJ
ELECTRO TEC CORP VIRGINIA DIV
BOX 219 BLACKSBURG VA
ELECTRO TECHNICAL PRODUCTS
DIV SUN CHEMICAL CORP
113 E CENTRE ST NUTLEY N J
ELECTRO TECHNIQUES
11301 E OCEAN AVE LA HABRA CALIF
ELECTRO-THERMO CERAMICS INC
7510 5TH AVE SO SEATTLE 8 WASH
ELECTRO VISION LAB
41-08 45TH ST LONG ISLAND CITY 1 N Y
ELECTRO VOICE INC
CARROLL CECIL STS BUCHANAN MICH
ELECTRO WELD CO
55 GOFFLE ROAD HAWTHORNE N J
ELECTRO WINDERS CO INC
854 W FRONT ST COVINA CAL
ELECTRON CORP
747 S CENTRAL EXPWY RICHARDSON TEXAS
ELECTRONANTICS CORPORATION
BLDG 111 MAYNARD IND CTR MAYNARD MASS
ELECTRON ARC DIV IONICS INC
244 BROAD ST LYNN MASS
ELECTRON BEAM DEVICES CORP
105 E MAIN ST PLAINVILLE CONN
ELECTRON ENTERPRISES
6917 W STANLEY AVE BERWYN ILL
ELECTRON HEATING CORP
80 HICKS AVE MEDFORD 55 MASS
ELECTRON OHIO INC
1111 POWER AVE CLEVELAND 14 OHIO
ELECTRONIC APPLICATIONS INC
194 RICHMOND HILL AVE STAMFORD CONN
ELECTRONIC APPLICATIONS INC
80 DANBURY RD RTE 7 WILTON CONN
ELECTRONIC ASSEMBLY CO INC
5 PRESCOTT ST ROXBURY 19 MASS
ELECTRONIC ASSISTANCE CORP
20 BRIDGE AVE RED BANK N J
ELECTRONIC ASSOCIATES INC
LONG BRANCH & NABERAL AVES LONG BRANCH NJ
ELECTRONIC BATTERIES INC
28 34 35 ST BROOKLYN 32 N Y
ELECTRONIC BRAZING CO
140 GLENRIDGE AVE MONTCLAIR N J
ELECTRONIC CHEMICAL CORP
813 COMMUNIPAW AVE JERSEY CITY 4 N J
ELECTRONIC CIRCUITS
641 N LA PEER DR LOS ANGELES 69 CAL
ELECTRONIC COILS INC
P O BOX 1665 SPRINGFIELD MASS
ELECTRONIC COMPONENTS DIV TELECOMPUTING CORP
838 SATICOY ST NO HOLLYWOOD CALIF
ELECTRONIC COMMUNICATION EQPT CO
1249 W LOYOLA AVE CHICAGO 26 ILL
ELECTRONIC COMMUNICATIONS
1501 72ND ST N ST PETERSBURG FLA
ELECTRONIC COMM & COMP DES & DEV CORP
503 MCCARTER HWY NEWARK N J
ELECTRONIC COMPONENTS CORP
311 W MULBERRY ST WATSEKA ILL
ELECTRONIC COMPONENTS
520 INTERSTATE RD ADDISON ILL
ELECTRONIC COMPUTER CORP
BOX 177 PIPER CITY ILL
ELECTRONIC COMPUTER CO
618 MAPLE ST CONSHOHOCKEN PA
ELECTRONIC CONNECTORS INC
84 45 ABINGTON RD KEW GARDENS 15 N Y
ELECTRONIC CONTRACTORS INC
2101 SE 6 AVE PORTLAND 14 ORE
ELECTRONIC CONTROL CORP
15341 DALE DETROIT MICH
ELECTRONIC CONTROLS INC
62 SOUTHFIELD AVE STAMFORD CONN
ELECTRONIC CONTROLS SYSTEMS INC
P O BOX 47 FAIRMONT W VA
ELECTRONIC COUNTERS INC
164 EILEEN WAY SYOSSET LI N Y
ELECTRDNIC CRAFTSMEN INC
3305 RUTGERS ST W HYATTSVILLE MD
ELECTRONIC CREATIONS CORP
1668 WEBSTER AVE NEW YORK 57 N Y
ELECTRONIC CRYSTALS CORP
31 N COBURN ST ORLAND FLA
ELECTRONIC DESIGN & DEVELOP CO
60 PENNINTON ST NEWARK N J
ELECTRONIC DEVELOPMENT CORP
423 W BROADWAY BOSTON 27 MASS
ELECTRONIC DEVELOPMENT LABS
71 NASSAU ST N Y N Y
ELECTRONIC DEVICES CORP
4212 PONCE DE LEON CORAL GABLES 46 FLA
ELECTRONIC DEVICES INC
50 WEBSTER AVE N ROCHELLE N Y
ELECTRONIC ENGG CO
362 W BOWERY ST AKRON OHIO
ELECTRONIC ENTERPRISES INC
65 7 AVE NEWARK N J
ELECTRONIC ENGG CO OF CALIF
1601 CHESTNUT SANTA ANA CALIF
ELECTRONIC EQUIPMENT SUPPLY CO
249 N 48TH ST LINCOLN NEB
ELECTRONIC FITTINGS CORP
RT 7 AT DANBURY AIRPORT DANBURY CONN
ELECTRONIC INSTRUMENT CO INC
3300 NORTHERN BLVD LONG ISLAND CITY N Y
ELECTRONIC INDUST INC
18 MARSHALL ST NORWALK CONN
ELECTRONIC INTL CO
145 MAGNOLIA BLVD BURBANK CALIF
ELECTRONIC MACHINE PARTS INC
128 11 18TH AVE COLLEGE POINT N Y
ELECTRONIC MEASUREMENTS CO INC
EATONTOWN N J
ELECTRONIC MEASUREMENTS CORP
625 BROADWAY NEW YORK 12 N Y
ELECTRONIC MECHANICAL PROD CO
929 ATLANTIC AVE ATLANTIC CITY NJ
ELECTRONIC MEMORIES INC
9430 BELLANCA AVE LOS ANGELES 45 CALIF
ELECTRONIC MODULES CORP
1949 GREENSPRING DR TIMONIUM MD
ELECTRONIC MOLDING CORP
42 CHURCH ST PAWTUCKET R I
ELECTRONIC PARTS MFG CO
508 25 ST UNION CITY NJ
ELECTRONIC PLASTICS CORP
16 SALEM ST WAKEFIELD MASS
ELECTRONIC PRODUCTS DIV POST MACHINERY
140 ELLIOT ST BEVERLY MASS
ELECTRONIC PROCESS CORP
990 VARIAN ST SAN CARLOS CAL
ELECTRONIC PROCESSES CORP OF CALIF
436 BRYANT ST SAN FRAN CALIF
ELECTRONIC PRODUCTION & DEVELOPMENT
501 N PRAIRIE AVE HAWTHORNE CALIF
ELECTRONIC PRODUCTS CO
DIV OF VICTOREEN INST CO
111 E 3RD ST MOUNT VERNON N Y
ELECTRONIC PRODUCTS CORP
2315 CECIL AVE BALTIMORE 18 MARYLAND
ELECTRONIC RECTIFIERS INC
2102 SPANN AVE IND IND
ELECTRONIC RESEARCH CO
KANSAS CITY MO
ELECTRONIC RESEARCH ASSOCIATES INC
67 FACTORY PL CEDAR GROVE NJ
ELECTRONIC SECRETARY INDUSTRIES INC
1101 S PRAIRIE AVE WAUKESHA WISC
ELECTRONIC SPECIALTY CO ELECTIC SPEC DIV
207 SOUTH ST STAMFORD CONN
ELECTRONIC SPECIALTY CO
TECHNICRAFT DIVISION
THOMASTON CONNECTICUT
ELECTRONIC SPECIALTIES MFG CORP
100 LAMARTINE ST WORCESTER MASS
ELECTRONIC SYSTEMS
7309 VARNA AVE N HOLLYWOOD CALIF
ELECTRONIC SYSTEMS ENGG CO
2838 WILSHIRE BLVD OKLAHOMA CITY OKLA
ELECTRONIC TECHNOLOGY RESEARCH INC
2153 MOORE SAN DIEGO 10 CALIF
ELECTRONIC TIMERS CO
PANA ILL
ELECTRONIC TRAINING AIDS CO
P O BOX 53 CAMBRIDGE 41 MASS
ELECTRONIC TRANSFORMERS CORP
29 PARK PL PASSAIC N J
ELECTRONIC TRANSISTORS CORP
153-13 NORTHERN BLVD FLUSHING 54 N Y
ELECTRONIC TUBE COIL CO
557 EAGLE ROCK AVE ROSELAND NJ
ELECTRONIC TUBE & INST DIV
GENERAL ATRONICS CORP
1200 E MERMAID LANE PHILA PA
ELECTRDNICS & ORDNANCE DIV AVCO CORP
CINCINNATI OHIO
ELECTRONICS BATTERIES INC
28 34 35 ST BROOKLYN N Y
ELECTRDNICS CORP OF AMERICA
1 MEMORIAL DR CAMBRIDGE 42 MASS
ELECTRONICS CORP OF AMER
104 ADVANCE RD TORONTO ONTARIO CANADA
ELECTRONICS DEVELOPMENT CO
3743 CAHUENGA BLVD N HOLLYWOOD CALIF
ELECTRONICS DEVELOPMENT INC
521 MARYLYN AVE BOX 813 STATE COLLEGE PA
ELECTRONICS INTL CO INC
20 N LEE ST OKLAHOMA CITY 2 OKLA
ELECTRONICS INC OF PA
2440 MARYLAND AVE WILLOW GRDVE PA
ELECTRDNICS INC
127 SUSSEX AVE NEWARK N J
ELECTRONICS OF CLEARFIELD INC
PO BOX 792 CLEARFIELD PA
ELECTRONICS MISSILES & COMMUNICATIONS INC
262 E THIRD ST MT VERNON N Y

ELECTRONICS RESEARCH INC
P O BOX 327 EVANSVILLE IND
ELECTRONICS SYSTEMS INC
105 CHAUNCY ST BOSTON 11 MASS
ELECTRON PRODS DIV MARSHALL IND
1960 WALKER AVE MONROVIA CALIF
ELECTRON RESEARCH INC
530 W 12TH ST ERIE PENNA
ELECTRONS INC
127 SUSSEX AVE NEWARK 3 N J
ELECTRON TECHNOLOGY INC
626 SCHUYLER AVE KEARNY N J
ELECTROPAC INC
PETERBOROUGH N H
ELECTROPOT INC
3155 W SEGUNDO BLVD HAWTHORNE CALIF
ELECTROSONIC ENGINEERING CO
2120 PONTIUS AVE LOS ANGELES 25 CALIF
ELECTROSONICS INTERNATIONAL INC
150 BURNSIDE ST PHILADELPHIA 27 PA
ELECTROVART INC
240 MADISON AVE NEW YORK 16 N Y
ELEKTRON STANDARD INC
RTE 5 SOUTH WINDSOR CONN
ELEMATIC EQUIPMENT CORP
6731 S CHICAGO AVE CHICAGO 37 ILL
ELGENCO INC
1231 COLORADO AVE SANTA MONICA CALIF
ELGIN MICRONICS DIV ELGIN NAT WATCH CO
366 BLUFF CITY BLVD ELGIN ILL
ELGIN NATIONAL WATCH CO
366 BLUFF CITY BLVD ELGIN ILL
ELECTRONICS DIV ELGIN NATL WATCH CO
2435 N NAOMI ST BURBANK CALIF
ELGIN LABS INC
WATERFORD PA
ELIN DIV INTL ELECT RESCH CORP
145 W MAGNOLIA BLVD BURBANK CALIF
ELION INSTRUMENTS INC
ROUTE 130 NORTH BURLINGTON N J
ELITE ELECTRONICS ENGRG CO
5100 S ASHLAND AVE CHICAGO 9 ILL
ELJAY CORP
2908 HERBERT ST BALTIMORE MD
ELK ELECTRONICS LABS INC
333 W 52 ST NEW YORK 19 N Y
ELLIOTT BROS LONDON LTD RADAR DIV
ELSTREE WAY BOREHAMWOOD HERTS ENGLAND
ELLIOTT BROS LTD
BOREHAMWOOD HERTS ENGLAND
ELLIS & WATTS PRODUCTS INC
P O BOX 33 CINCINNATI 36 OHIO
ELLIS ASSOCIATES
67 LINCOLN AVE PELHAM N Y
ELLISON DRAFT GAGE CO
548 W MONROE ST CHICAGO 6 ILL
ELM INSTRUMENT
30 CHASNER ST HAMPSTEAD LI NY
ELM MFG CO INC
PO BOX 14 HASTINGS ON HUDSON NY
ELMWOOD SENSORS INC
1655 ELMWOOD AVE CRANSTON R I
ELPAC INC
4270 ARTESIA ST FULLERTON CALIF
EL PRODUCTS CORP
P O B 41 NEW YORK 63 N Y
EL-RAD MFG CO
4300 N CALIFORNIA AVE CHICAGO 18 ILL
ELSCO SYSTEMS INC
4516 STONE WAY N SEATTLE 3 WASH
ELZEE METAL PRODUCTS CO
775 39 ST BROOKLYN 32 N Y
EMARCO CORP
1950 NEVA DRIVE DAYTON 14 OHIO
EMCEE ELECTRONICS INC
1202 ARNOLD AVE NEW CASTLE DEL
EMERSON & CUMING INC
869 WASHINGTON ST CANTON 1 MASS
EMERSON & CUMING INC WESTERN DIV
604 W 182ND ST GARDENA CALIF
EMERSON ELECTRIC
8100 W FORISSANT AVE ST LOUIS 21 MO
EMERSON ELECTRIC MFG CO ELECT & AVIONICS DIV
8100 FLORISSANT AVE ST LOUIS 36 MO
EMERSON PLASTICS CORP
SEABURY AVE & BUTLER PL BRONX 61 N Y
EMERSON-RITTENHOUSE CO INC
68 EAST ST HONEOYE FALLS N Y
EMI COSSOR ELECTRONICS
WOODSIDE DARTMOUTH NOVA SCOTIA
EMI US
1750 VINE ST LOS ANG CALIF
EMI US LTD GENERAL COMM DIV
FORT ATKINSON WISC
EMI/US
13259 SHERMAN WAY NO HOLLYWOOD CALIF
E M J MFG CO
760 REED SANTA CLARA CALIF
EMMCO PLASTIC FAB DIV
M MC CARTHY MACHINE CO
68 VINE ST EVERETT MASS
EMMCO PLASTICS CORP
MILL STREAM IND PARK ANDOVER MASS
EMMERT MFG CO
1051 E MAIN ST WAYNESBORO PA
EMPIRE DEVICES PRODUCTS CORP
37 PROSPECT ST AMSTERDAM NY
EMPIRE ELECTRONICS CO INC
60 SPRUCE ST PATERSON 1 NJ
ENDECO ENGG DEVELOPMENT CO OF LOS ANGELES
8021 LONG BEACH VIKING WY LONG BEACH 8 CAL
ENDERES DIV MUTER CO
GUTTENBERG IOWA
ENDEVCO CORP
161 E CALIFORNIA BLVD PASADENA CALIF
ENDEVCO CORP
801 S ARROYO PKWY PASADENA CALIF
ENDICOTT COIL CO INC
24 CHARLOTTE ST BINGHAMTON NY
ENERGY CONVERSION INC
336 MAIN ST CAMBRIDGE 42 MASS
ENERTRAN INC
2710 NUTTAM AVE FORT WAYNE IND
ENFAB INC
312 E BROKAW RD SAN JOSE CALIF
ENFLO CORP
FELLOWSHIP RD ROUTE 73 MAPLE SHADE N J
ENG NORTHWEST
2309 SNELLING MINN MINN
ENG SPECIALITIES INC
LAKEVILLE MINN
ENGELHARD INDUSTRIES
INDUST EQUIPT DIV
850 PASSAIC AVE E NEWARK NJ
ENGELHARD INDUSTRIES INC
113 ASTOR ST NEWARK N J
ENGELMANN MICROWAVE CO
MOUNTAIN LAKES N J
ENGINEERED ELECTRONICS CO
1441 E CHESTNUT AVE SANTA ANA CALIF
ENGINEERED MAGNETICS
13041 CERISE AVE HAWTHORNE CALIF
ENGINEERED PLASTICS INC
GIBSONVILLE NO CAR
ENGINEERED YARNS
100 PULASKI ST WARWICK R I
ENGINEERING ASSOCIATES
434 PATTERSON RD DAYTON 19 OHIO
ENGG & MFG CORP OF TEXAS
PO BOX 14216 DALLAS 34 TEXAS
ENGIS EQUIP CO
431 E DEARBORN ST CHICAGO ILL
ENGLEHARD HANOVIA INC
100 CHESTNUT ST NEWARK N J
ENGLER INSTRUMENT CO
250 CULVER JERSEY CITY 5 N J
ENGLISH ELECTRIC VALVE CO LTD
CHELMSFORD ESSEX ENGLAND
ENSCO INC
3100 ELDREDGE ST SALT LAKE CITY UTAH
ENSIGN COIL CO
2520 S PULASKI CHICAGO 23 ILL
ENTHONE INC
442 ELM ST NEW HAVEN 8 CONN
ENTRON INC
4902 LAWRENCE ST BLADENSBURG MD
ENVIRON LAB INC
9725 GIRARD AVE S MINN 31 MINN
ENVIRONMENTAL EQUIPMENT CO
369 LINDEN ST BROOKLYN 27 N Y
E O ELECTRONICS INC
14 MORRIS AVE MOUNTAIN LAKES NJ
EON CORP
175 PEARL ST BROOKLYN 1 N Y
EONETICS
3800 COHASSET BURBANK CALIF
EPCO PRODUCTS INC
2500 ATLANTIC AVE BROOKLYN 7 NY
EPCO PRODUCTS INC
BOX 298 WALLKILL NY
EPIC INC
150 NASSAU ST NEW YORK 38 N Y
EPOXYCAST ELECTRONIC CASE CO
46 PROSPECT ST YONKERS N Y
EPOXYLITE CORP THE
P O BOX 3397 SO EL MONTE CALIF
EPOXY PRODUCTS DIV JOS WALDMAN & SONS
133 COIT ST IRVINGTON NJ
EPPLEY LAB INC
12 SHEFFIELD AVE NEWPORT RI
EPRAD INC
1206 CHERRY ST TOLEDO 4 OHIO
EPSCO INC
275 MASSACHUSETTS AVE CAMBRIDGE 39 MASS
EQUIPMENT AND SERVICE CO
7118 ENVOY CT DALLAS 7 TEXAS
EQUIPTO DIV AURORA EQUIPMENT CO
AURORA ILL
EQUIPTO ELECTRONICS CORP
319 N WEBSTER ST NAPERVILLE 6 ILL
ERA DYNAMICS
CEDAR GROVE NJ
ERA RESEARCH INC
1009MONTANA AVE SANTA MONICA CALIF
ERASER CO
1068 S CLINTON ST SYRACUSE 4 NY
ERCA TOOL DIE & STAMPING CO
19 ASH ST BROOKLYN 22 N Y
ERCO RADIO LABS INC
637 STEWART AVE GAROEN CITY NY
ERCONA CORP
16 W 46TH ST NEW YORK 36 N Y
ERDCO ENGG CORP
136 OFFICIAL RD ADDISON ILL
ERIC ELECTRONICS INC
1823 COLORADO SANTA MONICA CAL
ERICSON MFG CO
1660 HAYOEN AVE CLEVELAND OHIO
ERIE ELECTRONICS DIV
ERIE PA
ERIE PACIFIC
12932 S WEBER WAY HAWTHORNE CALIF
ERIE RESISTOR OF CANADA LTD
7 FRASER AVE TRENTON ONT CANADA
ELECTRONICS DIV ERIE RESISTOR CORP
644 W 12TH ST ERIE PA
ERIE RESISTOR CORP
644 W 12 ST ERIE 6 PA
ERIE TECHNICAL CERAMICS INC
BOX 677 STATE COLLEGE PANNA
ERIKSON SPECIALIZED TOOL CO
P O BOX 424 PICO CALIF
ERWOOD INC
1770 W BERTEAU AVE CHICAGO 13 ILL
ESC ELECTRONICS CORP
534 BERGEN BLVD PALISADES PARK NJ
ESCO GROUP DIV ELECTRONIC SPECIALTY CO
5121 SAN FERNANDO RD LOS ANGELES 39 CALIF
ESPEY MFG & ELECTRONICS CORP
CONGRESS BALLSTON AVES SARATOGA SPRINGS NY
ESSEX ELECTRONICS DIV NYTRONICS INC
550 SPRINGFIELD AVE BERKELEY HEIGHTS N J
ESSEX ELECTRONICS OF CANADA LTD
99 WRAGGE ST TRENTON ONT CANADA
ESSEX MFG CO
8213 GRAVOIS AVE ST LOUIS 23 MO
ESSEX WIRE CORP
1601 WALL ST FT WAYNE 6 IND
ESS GEE INC
15 HAVENS ST ELMSFORD NY
ESTERLINE ANGUS INSTRUMENT COMPANY INC
PO BOX 596 INDIANAPOLIS 6 IND
E-T-A PRODUCTS CO OF AMERICA
6284 N CICERO AVE CHICAGO 46 ILL
E T C INCORPORATED
990 E 67ST CLEVELAND OHIO
ETCHING CORP OF CALIF
DIV ALLEGRI TECH INC
865 HINCKLEY ROAD BURLINGAME CALIF
EUBANKS ENG CO
260 N ALLEN AVE PASADENA CALIF
EUGENE ENGINEERING CO INC
1217 HYDE PARK AVE HYDE PARK 36 MASS
EUREKA X-RAY TUBE CORP
3250 N KILPATRIC AVE CHICAGO 41 ILL
EUTECTIC WELDING ALLOYS NEW ENG DIV INC
167 BRIGHTON AVE BOSTON MASS
EUTECTIC WELDING ALLOYS CORP
538 20TH ST OAKLAND CALIF
EUTECTIC WELDING ALLOYS CORP
40 40 172 ST FLUSHING N Y
EWALD INSTRUMENTS
ROUTE 7D KENT CONN
EWEN KNIGHT CORP
EAST NATICK MASS
EXACT ELECTRONICS INC
PO BOX 234 HILLSBORO OREGON
EXACT ENGG MFG INC
PO BOX 447 OCEANSIDE CALIF
EXACT WEIGHT SCALE CO
538 E TOWN ST COLUMBUS 15 OHIO
EXACTEL INSTRUMENT CO
89 ALICE AVE MOUNTAIN VIEW CALIF
EX-CELL-O CORP
1200 OAKMAN BLVD DETROIT MICH
EXCELLEX ELECTRONICS INC
88 06 VAN WYCK EXPWY JAMAICA 18 N Y
EXECUTONE INC
47 37 AUSTELL PL LONG ISLAND CITY 1 N Y
EYELEMATIC INC
STRAITS TURNPIKE OAKVILLE CONN
EYELET TOOL CO
76 ROGERS ST CAMBRIDGE MASS
E-Z-HOOK TEST PRODUCTS
1536 WOODBURN AVE COVINGTON KY
E-Z-WAY TEMPLATES
PO BOX 535 RESEDA CALIF
E-Z WAY TOWERS INC
5901 E BROADWAY BX 5767 TAMPA 5 FLA

F

FABRA PRINT INC
1531 E FRANKLIN MINNEAPOLIS 4 MINN
FABRI-TEK INC
PO BOX 645 AMERY WIS
FABRI TEK CIRCUITS INC
1111 E EXCELSIOR BLVD HOPKINS MINN
FACTORY SERVICE CO
4615 N 21ST ST MILWAUKEE 9 WISC
FAE INSTRUMENT CORP
16 NORDEN LANE HUNTINGTON STA L I N Y
FAFNIR BEARING CO
9000 DIRECTORS ROW DALLAS TEXAS
FAFNIR BEARING CO
NEW BRITAIN CONN
FAIR RITE PRODUCTS CORP
COMMERCIAL ROW WALLKILL N Y
FAIRBANKS CO
393 LAFAYETTE ST NEW YORK 3 N Y
FAIRBANKS WIRE CO
WALNUT ST NEWBURGH N Y
FAIRCHILD CONTROLS CORP COMPONENTS DIV
225 PARK AVE HICKSVILLE L I N Y
FAIRCHILD CONTROLS CORP
6111 E WASHINGTON BLVD LOS ANGELES CALIF
FAIRCHILD SPACE & DEFENSE PRODS
DIV FAIRCHILD CAMERA & INST CORP
300 ROBBINS LA SYOSSET N Y
FAIRCHILD RECORDING EQUIPMENT CO
10-40 45 AVE LONG ISLAND CITY 1 N Y
FAIRCHILD SEMICONDUCTOR CORP
545 WHISMAN RD MOUNTAIN VIEW CALIF
FAIRCHILD SEMICONDUCTOR CORP
4300 REDWOOD HGWY SAN RAFAEL CALIF
FAIRMOUNT CHEMICAL CO INC
136 LIBERTY ST NEW YORK N Y
FALCON DIV GEN THERMODYNAMICS
150 BALLARDVASE ST NO WILMINGTON MASS
FALSTROM CO
12 FALSTROM COURT PASSAIC N J
FANSTEEL METALLURGICAL CORP
2200 SHERIDAN RD N CHICAGO ILL

FARADAY INC
ADRAIN MICH
FARADYNE ELECT CORP
471 CORTLANDT ST BELLEVILLE NEW JERSEY
FARINON ELECTRIC
935 WASHINGTON ST SAN CARLOS CALIF
FARMER ELECTRIC PRODUCTS CO
TECH CIRCLE NATICK MASS
FARMER ELECTRIC PRODUCTS CO
2300 WASHINGTON ST NEWTON LOWER FALLS MASS
FARRALL INSTRUMENT CO
BOX 658 GRAND ISLAND NEB
FARRAND OPTICAL CO INC
BRONX BLVD & E 238TH ST NEW YORK
FARRELLOY CO
1243 N 26TH ST PHILA PA
FARRINGTON ELECT INC
7019 EDSALL RD ALEXANDRIA VA
FARWELL METAL FABRICATING
83 W FAIRFIELD AVE ST PAUL 7 MINN
FASCO INDUSTRIES INC
255 N UNION ST ROCHESTER N Y
JOHN E FAST CO DIV VICTOREEN INST CO
3580 N ELSTON AVE CHICAGO 18 ILL
FAULTLESS CASTER CORP
1427 N GARVIN ST EVANSVILLE 7 IND
FEAY CO NEAL
133 LA PATERA AVE COLETA CALIF
FECKER INC J W
6592 HAMILTON AVE PITTSBURGH PA
FEDERAL ANTI CAPACITY SWITCH CORP
BOX 25 LANCASTER N Y
FEDERAL ENG & MFG CORP
1004 6TH ST N W WASHINGTON D C
FEDERAL EQUIPMENT CO
38 BRADY ST SAN FRANCISCO 3 CALIF
FEDERAL LAB INC
SALTSBURG PA
FEDERAL MACHINE CO
835 GARFIELD AVE JERSEY CITY 5 N J
FEDERAL MFG & ENGG CORP
1055 STEWART AVE GARDEN CITY LI N Y
FEDERAL MFG & ENG CORP TV SPECIALTY DIV
1055 STEWART AVE GARDEN CITY N Y
FEDERAL SCIENTIFIC CORP
615 W 131ST ST NEW YORK 27 NY
FEDERAL SCREW PRODUCTS INC
3917 N KEDZIE AVE CHICAGO 18 ILL
FEDERAL STAMPING CO
7347 ATOLL AVE N HOLLYWOOD CALIF
FEDERAL TOOL ENGINEERING CO
1384 POMPTON AVE CEDAR GROVE NJ
FEDERAL TOOL & MFG CO
3600 ALABAMA AVE MINNEAPOLIS 16 MINN
AMERICAN SMELTING REFINING CO
FEDERATED METALS DIV
150 ST CHARLES ST NEWARK 5 NJ
FEEDBACK CONTROLS INC
8 ERIE DRIVE NATICK MASS
FEILER ENGG & MFG CO
8026 N MONTICELLO AVE SKOKIE ILL
FEINER & SONS P
522 W 45 ST NEW YORK N Y
FELT PRODUCTS MFG CO
7450 MCCORMICK BLVD SKOKIE ILL
FEN-TONE CORP
106 5TH AVE NEW YORK 11 N Y
FENWAL ELECTRONIC INC
63 FOUNTAIN ST FRAMINGHAM MASS
FENWAL INC
PLEASANT ST ASHLAND MASS
FERRANTI ELECT INC
INDUSTRIAL PK PLAINVIEW L I N Y
FERRIS INDUSTRUMENT CORP
110 CORNELIA ST BOONTON N J
FERRO DYNAMICS CORP
GREGG ST & RTE 17 LODI N J
FERROTHERM CO
1861 E 65TH ST CLEVELAND OHIO
FERROTRAN ELECTRONICS CO INC
693 BROADWAY NEW YORK 12 N Y
FERROXCUBE CORP OF AMERICA
35 E BRIDGE ST SAUGERTIES N Y
F & F ENTERPRISES INC CHICAGO SWITCH DIV
1733 MILWAUKEE AVE CHICAGO 47 ILL
FF&M ELECTRONICS
12820 PANAMA ST LOS ANG CALIF
FIBRE GLASS EVERCOAT CO
BLUE ASH KIGLER MILLS RDS CINN OHIO
FIDELITONE MICROWAVE INC
6415 RAVENSWOOD AVE CHICAGO ILL
FIDELITY AMPLIFIER CO
1633 HALSTEAD ST CHICAGO ILL
FIDELITY CHEMICAL PRODUCTS CORP
470 FRELINGHUYSEN AVE NEWARK 12 N J
FIDELITY ELECTRIC CO
332 N ARCH ST LANCASTER PA
FIDELITY INSTRUMENT CORP
100 E BOUNORY AVE YORK PA
FIELD EMISSION CORP
611 3RD ST MCMINNVILLE ORE
FIFTH DIMENSION INC
P O BOX 483 PRINCETON N J
FILM CAPACITORS INC
3400 PARK AVE NEW YORK 56 NY
FILMOHM CORP
48 W 25 ST NEW YORK 10 N Y
FILTORS INC
30 SAGMORE HILL PORT WASH N Y
FILTRON CO
131-15 FOWLER AVE FLUSHING 55 N Y
FILTRON CO INC WESTERN DIV
10023 JEFFERSON BLVD CULVER CITY CALIF
FINNELL SYSTEM INC
ELKHART IND
FINNEY CO
34 INTERSTATE ST BEDFORD OHIO
FIRE CONTROL CO INC
703 THORNTON ST WILMINGTON 1 DEL
FIRST ELECTRONICS CORP
13 ST ANNE ST JAMAICA PLAIN MASS
FISCHER & CO R A
517 COMMERCIAL ST GLENDALE 3 CALIF
FISCHER & PORTER CO
WARMINSTER PA
FISCHER ELECTRONICS INC
2238 BAILEY AVE BUFFALO 11 N Y
FISH-SCHURMAN CORP
70 PORTMAN RD NEW ROCHELLE N Y
FISHER AKIN CO
1005 SEPULVEDA BLVD MANHATTAN BEACH CALIF
FISHER & CROME
109 N CAMAC ST PHILA 7 PA
FISHER BERKELEY CORP
1475 POWELL ST EMERYVILLE CALIF
FISHER CO INC OSCAR
P O BOX 426 NEWBURGH N Y
FISHER ENGG INC
P O BOX 327 HUNTINGTON IND
FISHER GOVERNOR CO
BOX 307 MARSHALLTOWN IOWA
FISHER PIERCE CO
170 PEARLS ST BRAINTREE MASS
FISHER RADIO CORP
2121 44 DR LONG ISLAND CITY N Y
FISHER RESEARCH LAB
1975 UNIVER AVE PALO ALTO CALIF
FISHER SCIENTIFIC CO
1 REAGENT LANE FAIR LAWN NJ
FISHER SCIENTIFIC CO INSTRUMENT DIV
INDIANA PENNA
FISHER SPECIAL MFG CO
446 MORGAN ST CINN OHIO
FITCHBURG ENGINEERING CORP
CLEGHORN ST FITCHBURG MASS
FLAME RESEARCH INC
BOX 10502 PITTSBURGH 35 PA
FLEXONICS DIV OF CALUMET & HECLA
300 E DEVAN AVE BARTLETT ILL
FLEETWOOD LABS INC
35 ROCKWOOD PL N ROCHELLE N Y
FLEXAUST CO
100 PARK AVE NEW YORK 7 N Y
FLEXO INTERNATIONAL CORP
3720 MILWAUKEE AVE CHICAGO ILL
FLEXO WIRE DIV COPPERWELD STEEL CO
OSWEGO N Y
FLEXROCK CO
3609 FILBERT ST PHILA PENNA
FLOQUIL PRODUCTS INC
COBLESKILL N Y
FLORIDA GEARS & SYSTEMS INC
16550 N W 10TH AVE MIAMI FLA
FLORIDA TRANSFORMER DIV YORK RES CORP
DE LEON SPRINGS FLA
FLO-TRONICS INC ELECT CONTROLS IDV
1330 QUINCY ST NE MINNEAPOLIS 13 MINN
FLOW CORP
11 CARLETON ST CAMBRIDGE MASS
FLUIDYNE ENG CORP
5740 WAYZATA BLVD MINN MINN
FLUKE MFG CO INC JOHN
BOX 7161 SEATTLE WASH
THE FLUOROCARBON CO
1754 S CLEMENTINE ANAHEIM CALIF
FLUORULON LABS INC
BOX 305 CALDWELL N J
FLUSH WALL RADIO CO
1012 CLEVELAND ST CLEARWATER FLA
F & M SCIENTIFIC CORP
RT 41 & STARR RD AVONDALE PA
FONDA GAGE CO INC
STAMFORD CONN
FORBER & WAGNER INC
SILVER CREEK N Y
FORBES & WAGNER INC
345 CENTRAL AVE SILVER CREEK N Y
WM A FORCE & CO INC
216 NICHOLS AVE BROOKLYN 8 NY
FORD ELECTRONICS CORP
11747 VOSE ST N HOLLYWOOD CALIF
FORD INSTRUMENT CO DIV SPERRY RAND CORP
31-10 THOMSON AVE LONG ISLAND CITY 1 N Y
FORO RADIO MICA CORP
536 63 ST BROOKLYN N Y
FORDHAM MFG CO
2220 PEARSALL AVE NEW YORK 69 N Y
FOREDOM ELECTRIC CO INC
BETHEL CONN
THE FOREST ELECT CO
1001 N 25TH AVE MELROSE PARK ILL
FORK STANDARDS INC
WEST CHICAGO ILL
FORM-IT PRODUCTS INC
16-19 W WALNUT ST CHICAGO 12 ILL
FORMCRAFT TOOL CO
2465 ARCHER AVE CHICAGO ILL
FORMEO PLASTICS INC
207 STONEHINGE LANE CARLE PL N Y
FORMICA CORP
4614 SPRING GROVE AVE CINCINNATI 11 OHIO
FORMICA METAL PROD CO
CORPORATION WAY MEDFORD MASS
FORMSPRAG INC
23601 HOOVER RD WARREN MICH
FORSBERG MFG CO
125 SEAVIEW AVE BRIDGEPORT CONN
FORT WAYNE METALS INC
3211 MACARTHUR DR FT WAYNE IND
FORWAY INDUSTRIES INC
122 GREEN AVE WOODBYRY N J
FOSTER TRANSFORMER CO
3820 COLERAIN AVE CINNATI OHIO
FOSTORIA CORP DEPT D2
TITUS AVE WARRINGTON IND PK WARRINGTON PA
FOSTORIA CORP
1200 MAIN ST FOSTORIA OHIO
FOTO VIDEO LABS
36 COMMERCE RD CEDAR GROVE N J
FOURDEE INC
5440 E COLONIAL DR ORLANDO FLA
FOURJAY INDUSTRIES
2801 ONTARIO AVE DAYTON OHIO
FOX CO THOMAS T
304 MT PLEASANT AVE NEWARK 4 N J
FOX PRODUCTS CO
4720 N 18 ST PHILA PA
FOXBORO CO
NEPONSET AVE FOXBORO MASS
F & R ENTERPRISES
910 VALENCIA ST SAN FRAN CALIF
FRANCE MFG CO
10325 BEREA RD CLEVELAND 2 OHIO
FRANKE GEAR WORKS INC
4401 RAVENSWOOD AVE CHICAGO ILL
FRANKLIN ELECTRONICS INC
E 4TH ST BRIDGEPORT PA
FRANKLIN MFG CO
65 NE 22ND AVE MINN MINN
FRANKLIN SYSTEMS INC
WEST PALM BEACH FLORIDA
FREBANK CO
711 W BROADWAY GLENDALE CALIF
FREDERICK ELECT CORP
414 PINE AVE FREDERICK MD
FREDERICKS CO
PHILMONT ANNE ST BETHAYRES PENNA
FREED TRANSFORMER CO
1718-36 WEIRFIELD ST BROOKLYN 27 N Y
FREELAND PRODUCTS CO
706 OKEEFE ST NEW ORLEANS LA
FREEMAN CO
8TH & WALNUT YANKTON S D
FREEWAY WASHER & STAMPING CO
4911 GRANT AVE CLEVELAND OHIO
FRENCHTOWN PORCELAIN CO
FRENCHTOWN N J
FRENCHY RADIO MFG CO
164 W PARKER ST SCRANTON PA
FREQUENCY ENGG LABS
BOX 504 ASBURY PARK NJ
FRICK GALLAGHER MFG CO
200 S MICHIGAN WELLSTON OHIO
FRIDEN CALCULATING MACHINE CO
2350 WASHINGTON AVE SAN LEANDRO CALIF
FRIDEN COMMERCIAL CONTROLS CORP
1 LEIGHTON AVE ROCHESTER N Y
FRONTIER ELECT CO
4608 MEMPHIS AVE CLEVE OHIO
FRYLING ELECT PROD INC
HOLLY SPRINGS MISS
FRYLING MFG CO
531 W 11TH ST ERIE 6 PA
FUEL WATCHMAN INC
77 29 138 ST FLUSHING N Y
FUGLE MILLER LABS INC
301 CENTRAL AVE CLARK N J
FULLER CO H B
1201 FULLER RD LINDEN N J
FULLER CO H B
904 W BLACKHAWK ST CHICAGO ILL
FURANE PLASTICS INC
4516 BRAZIL ST LOS ANGELES 39 CALIF
FURANE PLASTICS INC
42 CHASNER ST HEMPSTEAD L I N Y
FURNAS ELECTRIC CO
1000 MCKEE ST BATAVIA ILL
FURZEHILL LABS LTD
THEOBALD ST BOREHAMWOOD HERTS ENG
FUSITE CORP
6000 FERNVIEW AVE CINCINNATI 12 OHIO
F X R INC
26-12 BOROUGH PLACE WOODSIDE 77 N Y
FYR-FYTER ELECTRONIC & ALARM CORP
EDISON N J

G

GABRIEL ELECTRONICS DIV GABRIEL CO
MILLIS MASS
GAI-TRONICS CORP
525 LANCASTER AVE READING PENNA
GALLAND-HENNING NOPAK DIV
2753 S 31ST ST MILWAUKEE WISC
GAMMA SCIENTIFIC INC
4455 TWAIN SAN DIEGO 20 CALIF
GAP INSTRUMENT CORP
116 E MERRICK RD FREEPORT N Y
GAP INSTRUMENT CORP
17 BROOKLYN AVE WESTBURY L I N Y
GAR PRECISION PARTS
190 HENRY ST STAMFORD CONN
GAROE MFG CO
53 JOHN ST CUMBERLAND R I
GARDINER ELECTRONIC CO
2545 E INDIAN SCHOOL RD PHOENIX ARIZ
GARONER LAB INC
P O BOX 5728 BETHESDA MD
GARDNER-DENVER CO
FRONT ST QUINCY ILL
GARLOCK ELECTRONIC PRODUCTS
402 MAIN ST PALMYRA N Y
GARLOCK ELECTRONIC PRODUCTS
600 N 10TH ST CAMDEN 1 NJ

ELECTRONIC MANUFACTURERS—A TO Z

GARNER T H CO
177 S INDIAN HILL BLVD CLAREMONT CALIF
GARRARD SALES CORP
80 SHORE RD PORT WASHINGTON N Y
GARY WELLS CO
361 ROCKAWAY AVE VALLEY STREAM N Y
GASSER METAL PRODUCTS
69-15 50TH AVE WOODSIDE N Y
GATES & CO GEO W
HEMPSTEAD TPKE & LUCILLE AVE FRANK SQ N Y
GATES ELECTRONIC CO
2243 WHITE PLAINS RO BRONX N Y
GATES RADIO CO
123 HAMPSHIRE ST QUINCY ILL
GAVIN INSTRUMENTS INC
DEPOT SQUARE SOMERVILLE N J
GAVITT WIRE & CABLE CO DIV OF AMERACE CORP
455 N QUINCE ST ESCONOIDO CALIF
GAVITT WIRE & CABLE CO PLANT & GEN OFFICE
DIV AMERACE CORP
BROOKFIELD MASS
GAYLOR PRODUCTS CO
1110 CUMPSTON ST N HOLLYWOOD CALIF
GAYLORD RIVES CO
181 N HILL ST PASADENA CALIF
GB COMPONENTS INC
14621 ARMINTA ST VAN NUYS CAL
G C ELECTRONICS COMPANY CHEMICAL TOOL DIV
400 SO WYMAN ST ROCKFORD ILL
G-C ELECTRONICS CO KNOB & RESISTOR DIV
400 S WYMAN ST ROCKFORD ILL
GC ELECTRONICS CO DIV TEXTRON ELECTRONICS
400 S WYMAN ST ROCKFORD ILL
GEARTRONICS CORPORATION
114 CHELMSFORD RD BILLERICA MASS
GEBE ELECTRONIC SERVICE
4112 W JEFFERSON BLVD LOS ANG CAL
GEE LAR MFG CO
400 WYMAN ST ROCKFORD ILL

GEER MACHINE WORKS INC
200 NEVADA ST EL SEGUNDO CALIF
GEFCO MFG CORP
101 PINE ST BOX 436 GRAYSLAKE ILL
GELMAN INSTRUMENT CO
CHELSEA MICH
GEMCO ELECTRIC CO
25685 W EIGHT MILE RD DETROIT MICH
GEMS CO
SHEPPARD LANE BOX 255 FARMINGTON CONN
GENALEX DIV BRITISH INDUSTRIES CORP
80 SHORE RD PORT WASHINGTON N Y
GENERAL APPLIED SCIENCE LAB
MERRICK & STEWART AVE WESTBURY N Y
GENERAL ATOMATICS INC
331 ALMA ST PALO ALTO CALIF
GENERAL ATRONICS CORP ATRONIC PROD DIV
1200 E MERMAID LANE PHILA PA
GENERAL ATRONICS CORP
UNION HILL W CONSHOHOCKEN PENNA
GENERAL ATRONICS CORP
ELECTRONIC TUBE AND INSTRUMENT DIVISION
1200 EAST MERMAID LANE PHILA 18 PA
GENERAL AUTOMATIC CORP
111 33RD ST UNION CITY N J
GENERAL AUTOMATICS INC
331 ALMA ST PALO ALTO CALIF
GENERAL BOX CO
1825 MINER ST DES PLAINES ILL
GENERAL CABLE CORP
QUINCY MICH
GENERAL CABLE CORP
730 3RD AVE NEW YORK N Y
GENERAL CABLE CORP
25 WASHINGTON ST PERTH AMBOY N J
GENERAL CABLE CORP
1278 ORGILL AVE MEMPHIS TENN
GENERAL CABLE CORP
600 RAILROAD ST ROME N Y
GENERAL CAPACITOR CO
755 LOMA VERDE AVE PALO ALTO CALIF
GENERAL CERAMICS DIV IND GENERAL CORP
CROWS MILL RD KEASBEY N J
GENERAL COIL PRODUCTS CORP
147 12 LIBERTY AVE JAMAICA N Y
GENERAL COMMUNICATION CO
677 BEACON ST BOSTON 15 MASS
GENERAL COMPUTERS INC
9000 W PICO BLVD LOS ANG CALIF
GENERAL CONTROL CO
1200 SOLDIERS FIELD RD BOSTON 34 MASS
GENERAL CONTROLS CO
801 ALLEN AVE GLENDALE 1 CALIF
GENERAL CONTROLS CO AIRCRAFT/ELEC CONTROLS
1320 S FLOWER ST BURBANK CALIF
GENERAL CONTROLS CO IRON MOUNTAIN DIV
IRON MOUNTAIN MICH

GENERAL CONTROLS CO OF CANADA LTD
171 SURREY ST GUELPH ONT CANADA
GENERAL CONTROLS CO
8080 MCCORMICK BLVD SKOKIE ILL
GENERAL CRYSTAL CO INC
P O BOX 9 BURLINGTON WISC
GENERAL DEVICES INC
P O BOX 253 PRINCETON N J
GENERAL DYNAMICS TELECOMMUNICATION
100 CARLSON RD ROCHESTER N Y
GENERAL DYNAMICS ELECT
3302 PACIFIC HWY SAN DIEGO CALIF
GENERAL DYNAMICS POMONA
P O BOX 1011 POMONA CALIF
GENERAL DYNAMICS/ASTRONAUTICS
DIV OF GENERAL DYNAMICS CORP
PO BOX 1128 SAN DIEGO 12 CALIF
GENERAL DYNAMICS/ELECTRONICS
INFORMATION TECHNOLOGY DIV
1895 HANCOCK ST SAN DIEGO 12 CALIF

GENERAL DYNAMICS ELECTRONICS
1400 GOODMAN ST ROCHESTER N Y
GENERAL ELECTRIC CO COMPUTER DEPT
13430 N BLACK CANYON HWY PHOENIX ARIZ
GENERAL ELECTRIC CO
1034 66TH AVE OAKLAND 21 CALIF
GENERAL ELECTRIC CO POWER TUBE DEPT
PALO ALTO CALIF
GENERAL ELECTRIC CO ATOM POWER EQUIP
NUCLEAR ELECTRONIC PROGS SECT
175 CURTNER AVE SAN JOSE CALIF
GENERAL ELECTRIC CO
1285 BOSTON AVE BRIDGEPORT 2 CONN
GENERAL ELECTRIC CIRCUIT PROTECTIVE
41 WOODFORD AVE PLAINVILLE CONN

GENERAL ELECTRIC CO AUDIO PRODUCTS DEPT
2200 N 22 ST DECATUR ILL
GENERAL ELECTRIC HOTPOINT DIV
E PLEASANT ST DEKALB ILL
GENERAL ELECTRIC CO SPECIALTY MOTOR DEPT
1635 BROADWAY FORT WAYNE 2 IND
GENERAL ELECTRIC CO
SHELBYVILLE IND
GENERAL ELECTRIC CO RECEIVING TUBE DEPT
316 E 9TH OWENSBORO KY
GENERAL ELECTRIC CO INSULATOR DEPT
S CHARLES & CROMWELL ST BALTIMORE 30 MD
GENERAL ELECTRIC DIST TRANSFORMER DEPT
60 JACKSON ST HOLYOKE MASS
GENERAL ELECTRIC COMPANY CHEM MATERIAL DEPT
ONE PLASTICS AVENUE PITTSFIELD MASS
GENERAL ELECTRIC CO ORDNANCE DEPT
100 PLASTICS AVE PITTSFIELD MASS
GENERAL ELECTRIC CO MAGNETIC MATERIALS SEC
EDMORE MICH
GENERAL ELECTRIC RECEIVING TUBE DEPT
BOX 47 SPRINGFIELD N J
GENERAL ELECTRIC RECTIFIER COMPONENTS DEPT
COLUMBIA ST CLYDE N Y

GENERAL ELECTRIC CO
10 MANSION ST PO BOX 278 COXSACKIE N Y
GENERAL ELECTRIC CO CAPACITOR DEPT
JOHN ST HUDSON FALLS N Y
GENERAL ELECTRIC CO
APPARATUS SALES DIV SCHENECTADY N Y
1 RIVER RD SCHENECTADY 5 N Y
GENERAL ELECTRIC CO POWER TUBE DEPT
BLDG 267 SCHENECTADY 5 N Y
GENERAL ELECTRIC CO
SYRACUSE N Y
GENERAL ELECTRIC CO CATHODE RAY TUBE DEPT
ELECTRONICS PARK SYRACUSE N Y
GENERAL ELECTRIC HEAVY MILITAR ELECT DEPT
COURT ST SYRACUSE N Y
GENERAL ELECTRIC CO SEMICONDUCTOR DEPT
SYRACUSE N Y
GENERAL ELECT CO SPECIALTY DEVICES OPER
1811 LEMOYNE AVE SYRACUSE N Y
GENERAL ELECTRIC CO
TECHNICAL PRODS DEPT
ELECTRONIC PARK SYRACUSE N Y
GENERAL ELECTRIC CO TELEVISION RECEIVER DEPT
ELECTRONICS PARK SYRACUSE N Y
GENERAL ELECTRIC CO
FRENCH RD UTICA N Y
GENERAL ELECTRIC CO
SILICONE PRODUCTS DEPT A WATERFORD N Y
GENERAL ELECTRIC CO
CAROLINA WELDS PLANT GOLDSBORO N C
GENERAL ELECTRIC CO
21800 TUNGSTEN RD CLEVELAND 17 OHIO
GENERAL ELECTRIC CO MINIATURE LAMP DEPT
NELA PARK CLEVELAND 12 OHIO
GENERAL ELECTRIC LAMINATED PRODUCTS DEPT
COSHOCTON OHIO
GENERAL ELECTRIC CO DOVER WIRE PLT
100 W BROADWAY DOVER OHIO
GENERAL ELECT CO LOW VOLT SWITCHGEAR DIV
6901 ELMWOOD AVE PHILA PA
GENERAL ELEC CO MISSILE & SPACE VEH DEPT
VALLEY FORGE SPACE TECH CTR
P O BOX 8555 PHILA 1 PA
GENERAL ELECT CO WIRING DEVICE DEPT
95 HATHAWAY ST PROVIDENCE 7 R I
GENERAL ELECTRIC CAPACITOR DEPT
IRMO S C
GENERAL ELECTRIC CO MISSILE AND ARMAMENT DEP
LAKESIDE AVE BURLINGTON VT
GENERAL ELECTRIC COMMUNICATION PROD DEPT
MOUNTAIN VIEW RD LYNCHBURG VA
GENERAL ELECTRIC CO INDUSTRY CONTRDL DEPT
1501 ROANOKE BLVD SALEM VA
GENERAL ELECTRIC CO SPECIALTY CONTROL DEPT
P O BOX 812 WAYNESBORO VA
GENERAL ELECT CONTROL INC
8001 BLOOMINGTON FREEWAY MINN MINN

GENERAL ELECTRODYNAMICS CORP
4430 FOREST LANE GARLAND TEXAS
GENERAL ELECTRONICS INC
101 HAZEL ST PATERSON N J
GENERAL ELECTRONIC LABS INC
8440 SECOND AVE SILVER SPRING MD
GENERAL ELECTRONIC LAB INC
SIMON ST NASHUA NH
GENERAL ELECTRO MECHANICAL CORP
785 HERTEL AVE BUFFALO N Y
GENERAL FINDINGS INC
LEACH & GARNER BLDG ATTLEBORO MASS
GENERAL FORMULATIONS INC
320 S UNION SPARTA MICH
GENERAL INDUSTRIES CO
OLIVE & TAYLOR STS ELYRIA OHIO
GENERAL INDUSTRIES CO
RTE 97 BELLEVILLE OHIO
GENERAL INST CORP MAGNE HD & SYSTMTCS DIV
3216 EL SEGUNDO BLVD HAWTHORNE CALIF

GENERAL INSTR CORP HARRIS A S W DIV
WOODBURY CONN
GENERAL INSTRUMENT CO
DARLINGTON SC
GENERAL INSTRUMENT CORP CAPACITOR DIV
ORANGE ST DARLINGTON SC
GENERAL INSTRUMENT CORP
65 GOUVEURNER ST NEWARK N J
GENERAL INSTRUMENT CORP RADIO RECEPTOR DIV
DEF & ENGG PRODS GRP
ANDREWS RD HICKSVILLE L I N Y
GENERAL INSTRUMENT CORP SEMICONDUCTOR DIV
600 W JOHN ST HICKSVILLE N Y
GENERAL INSTRUMENT CORP F W SICKLES DIV
165 FRONT ST CHICOPEE MASS
GENERAL INSTRUMENT CORP CAPACITOR DIV
TAZEWELL VA
GENERAL INSULATED WIRE WORKS INC
69 GOROON AVE PROVIDENCE 5 RI
GENERAL KINETICS INC
2611 SHIRLINGTON RD ARLINGTON VA
GENERAL MAGNETICS INC
135 BLOOMFIELD AVE BLOOMFIELD N J
GENERAL MAGNETIC CORP
10001 ERWIN AVE DETROIT MICH
GENERAL MAGNETICS INC
2641 LOUISANA AVE MINN MINN
GENERAL METAL PROD CO
DIV OF PLANETRONICS INC
CENTRE & GLENDALE STS EASTON PA
GENERAL METAL PROD CO
1010 CENTRE ST EASTON PA
GENERAL METERS INC
P O BOX 1701 GRAND JUNCTION COLO
GENERAL MICROWAVE CORP
155 MARINE ST FARMINGDALE N Y

GENERAL MILLS INC
1620 CENTRAL AVE MINNEAPOLIS 13 MINN
GENERAL MILLS INC CHEMICAL DIV
S KENSINGTON RO KANKAKEE ILL
GENERAL MOTORS CORP NEW DEPARTURE DIV
HAYES AVE SANDUSKY OHIO
GENERAL PLASTICS CORP
55 LA FRANCE AVE BLOOMFIELD N J
GENERAL PRECISION INC
LIBRASCOPE DIV SAN MARCOS BRANCH
1370 ENCINITAS RD SAN MARCOS CALIF
GENERAL PRECISION EQUIP LIBRASCOPE DIV
670 ARQUES AVE SUNNYVALE CALIF
GENERAL PRODUCTS CORP
SALEM ST UNION SPRINGS N Y
GENERAL RADIO CO
WEST CONCORD MASS
GENERAL RAILWAY SIGNAL CO
P O BOX 600 ROCHESTER N Y
GENERAL RELAY CORP
39 LEONARD ST DOVER N J
GENERAL RESISTANCE INC
430 SOUTHERN BLVD NEW YORK 55 N Y
GENERAL RF FITTINGS INC
702 BEACON ST BOSTON MASS
GENERAL SCIENTIFIC EQUIP CO
7516 LIMEKLIN PIKE PHILA PA
GENERAL SCIENTIFIC CORP
1509 FIRST ST SAN FERNANDO CALIF
GENERAL STENCILS INC
827 E 92ND ST BROOKLYN 36 N Y
GENERAL TECHNOLOGY CORP
3510 TORRANCE BLVD TORRANCE CALIF
GENERAL TEL & ELECT LEICH ELECT CO
333 E FIRST ST GENOA ILL
GENERAL TEL & ELECT ANNARBOR PLANT
405 FOURTH ST ANN ARBOR MICH
GENERAL TEL & ELECT WALTHAM PLANT
63 SECOND AVE WALTHAM MASS
GENERAL TEL & ELECT HILLSBORO PLANT
HILLSBORO N H
GENERAL THERMODYNAMICS INC
7649 SAN FERNANDO RD BURBANK CALIF
GENERAL TIME CORP ELECTR SYS DIV
201 SUMMER ST STAMFORD CONN
GENERAL TRANSISTOR CORP
600 W JOHN ST HICKSVILLE N Y
GENERAL VACUUM CORP
81 HICKS AVE MEDFORD MASS
GENISCO INC
2233 FEDERAL AVE LOS ANGELES CALIF
GENISTROM INC
6320 W ARIZONA CIRCLE LOS ANG CALIF
GENISTRON INC
111 GATEWAY RD BENSENVILLE ILL
GENTAPE CORP
51 LA FRANCE AVE BLOOMFIELD N J

GEOPHYSICAL INST CO INC
315 TUDOR RD MANASSAS VA
GEOPHYSICAL SPECIALTIES CO
3110 SHORES BLVD WAYZATA MINN
GEOPHYSICAL SPEC CO
BOX 301 ROUTE 3 HOPKINS MINN
GEOPHYSICS CORP OF AMER
BURLINGTON RD BEDFORD MASS
GEORATOR CORP
TUDOR LANE MANASSAS VA
GEORGE GORTON MACHINE CO
1321RACINE ST RACINE WISC
GEOSCIENCE INSTRUMENTS CORP
110 BEEKMAN ST NEW YORK N Y
GEOTECHNICAL CORP
3401 SHILOH RD GARLAND TEXAS
GEOTRONIC LABS INC
1314 CEDAR HILL AVE DALLAS 8 TEXAS
GERBER SCIENTIFIC INST CO
1505 RTE 5 S WINDSOR CONN
GERST & CO PAUL E
4868 N CLARK ST CHICAGO 40 ILL
GERTSCH PRODUCTS INC
3211 LA CIENEGA BLVD LOS ANGELES 16 CALIF

GIANNINI CONTROLS CORP SERVD COMP DIV
1133 FLOWER GLENDALE CALIF
GIANNINI CONTROLS CORP GYRO DIV
1600 S MOUNTAIN AVE DUARTE CALIF
GIANNINI CONTROLS CORP SYSTEMS DIV
1600 S MOUNTAIN AVE DUARTE CALIF
GIANNINI CONTROLS CORP CONRAC DIV
GLENDORA CALIF
GIANNINI CONTROLS CORP TRANSDUCER DIV
55 N VERNON AVE PASADENA CALIF
GIANNINI CONTROLS CORP CRAMER DIV
OLD SAYBROOK CONN
GIANNINI CONTROLS CORP NJ DIV
SHERWOOD LANE CALDWELL TWP NJ
GIBBS MFG RESEARCH CORP
490 N MAIN ST JANESVILLE WISC
GIBSON ELECTRIC CO
OLD WM PENN HWY DELMONT PA
GILBERT & BAKER MFG CO
WEST SPRINGFIELD MASS
GILFORD INSTRUMENT LABS INC
OBERLIN OHIO
GILLIES CO INC DUNCAN M
66 CENTRAL ST WEST BOYLSTON MASS
GILMORE INDUSTRIES INC
3335 RICHMOND RD CLEVELAND OHIO
GIRARD-HOPKINS
1000 40 AVE OAKLAND 1 CALIF
GIRDLER PROCESS EQUIP DIV
2820 BROADWAY BOX 43 LOUISVILLE KY
GISHOLT MACHINE CO
1245 WASHINGTON MADISON WISC
GITS BROS MFG CO
1846 S KILBOURN AVE CHICAGO ILL

GLADDING MCBEAM & CO
2901 LOS FELIZ BLVD LOS ANGELES CALIF
GLADDING MCBEAM & CO
1551 PRIMROSE ST MONROVIA CALIF
GLASER STEERS CORP
155 ORATON ST NEWARK N J
GLASPLY CORP
S SIXTH ST VERPLANCK N Y
GLASSCO INSTRUMENTS CO
777 SO ARROYO PKWY PASADENA CALIF
GLASS-SOLDER ENGG
4232 TEMPLE CITY BLVD ROSEMEADE CALIF
GLASS-TITE INDUSTRIES INC
725 BRANCH AVE PROVIDENCE 4 R I
GLASSEAL PRODUCTS CO INC
725 COMMERCE RD LINDEN N J
GLEASON AVERY INC
AUBURN N Y
G L ELECTRONICS CO INC
300 HARVARD AVE WESTVILLE N J
GLP ELECTRONICS INC
350 RIVERSIDE AVE BRISTOL CONN
GLENN PACIFIC CORP
703 37TH AVE OAKLAND 1 CALIF
GLENTRONICS INC
748 E ALOSTA BLVD GLENDORA CALIF
THE GLIDDEN CO
5662 BRIDGE ST JOHNSTOWN PENNA
GLOBE ELECTRICAL MFG CO
1729 W 134 ST GARDENA CALIF
GLOBE ELECTRONICS CO
400 S WYMAN ST ROCKFORD ILL
GLOBE INDUSTRIES INC
1784 STANLEY AVE DAYTON 4 OHIO
GLYCO CHEMICALS DIV C L HUISKING CO INC
417 5TH AVE NEW YORK 16 N Y
G-M LABORATORIES INC
4300 N KNOX AVE CHICAGO 41 ILL
G M MFG CO
12 E 12ST NEW YORK N Y
GODFREY MFG CO
1633 HALSTED ST CHICAGO ILL
GOE ENGG CO
P O BOX 22004 LOS ANGELES CALIF
GOLDEN CO
1054 38 ST BROOKLYN 19 N Y
GOLDING MFG CO
90 PORETE AVE N ARLINGTON N J
GOLDSMAN CO
1328 34 N 6TH ST PHILA PA
GOMBOS INC CO JOHN
WEBRO ROAD CLIFTON N J
GOOD ALL ELECTRIC MFG CO
112 W FIRST ST OGALLALA NEBR
GOOD ELECTRONICS CORP
P O BOX 2406 W PALM BEACH FLA
GOOD-ALL ELECTRIC MFG CO
ALLIANCE NEB

GOODRICH AVIATION PRODUCTS DIV B F GOODRICH
500 S MAIN ST AKRON 18 OHIO
GORDON CO CLAUD S
RICHMOND ILL
GORDON ENTERPRISES
5362 N CAHUENGA BLVD N HOLLYWOOD CALIF
GORDOS CORP
250 GLENWOOD AVE BLOOMFIELD N J
GORE & ASSOC INC W L
555 PAPER MILL RD NEWARK DEL
GORHAM ELECT DIV GORHAM MFG CO
PROVIDENCE R I
GORMAN MACHINE CORP
480 S MAIN ST RANDOLPH MASS
GORN ELECTRIC CO GORN ELECT DIV
845 MAIN ST STAMFORD CONN
GOTHAM AUDIO DEVELOPMENT CORP
2 W 46 ST NEW YORK 36 N Y
GOW MAC INSTRUMENT CO
100 KINGS RD MADISON N J
G P E CONTROLS INC
240 E ONTARIO ST CHICAGO 11 ILL
GPL DIV GENERAL PRECISION INC
63 BEDFORD RD PLEASANTVILLE N Y

GPS INSTRUMENT CO
180 NEEDHAM ST NEWTON 64 MASS
W R GRACE & CO DAVISON CHEMICAL DIV
ERWIN TENN
GRAFLEX INC
3750 MONROE AVE ROCHESTER N Y
GRAFO COLLOIDS CORP
310 WILKES PL SHARON PA
GRAHAM MFG CO
147 BRIDGE ST EAST GREENWICH 1 RI
GRAHAM RESEARCH INC
666 22ND AVE N E MINNEAPOLIS 18 MINN
GRAHAM TRANSMISSION INC
MENONONEE FALLS WIS
GRANCO PRODUCTS INC
83 30 KEW GARDENS RD KEW GARDENS N Y
GRAND COIL WINDERS
14306 LAKESHORE AVE GRAND HAVEN MICH
GRAND TRANSFORMERS INC
BEECHTREE & MARION STS GRAND HAVEN MICH
GRAND TRANSFORMERS INC
PAW PAW AVE BENTON HARBOR MICH
GRANER T H CO
177 S INDIAN HILL BLVD CLAREMONT CALIF
GRANGER ASSOC
974 COMMERCIAL ST PALO ALTO CALIF
GRANITE STATE MACH CO INC
124 JOLIETTE ST MANCHESTER N H
GRANT GEAR WORKS
154 W 2 ST S BOSTON MASS
GRANT PULLEY & HARDWARE CORP INDUSTRIAL DIV
HIGH ST W NYACK N Y
GRANT PULLEY & HDWE CORP
944 LONG BEACH AVE LOS ANGELES CALIF

GRAPHIC SYSTEMS
925 DANVILLE ROAD YANCEYVILLE NC
GRAPHICS INC
590 BELLEVILLE TURNPIKE KEARNY N J
GRAPHICS INC
PO BOX 72 STATE 59 POTEAU OKLA
GRAPHIK CIRCUITS DIV CINCH MFG CORP
200 TURNBULL CANYON RD CITY OF INDUST CAL
GRAPHITE METALLIZING CORP
1050 NEPPERHAN AVE YONKERS NY
GRASON-STRADLER CO INC
WEST CONCORD MASS
GRAY GAINER ELECTRONICS
BOX 3736 AKRON 14 OHIO
GRAY & KUHN
10 PELHAM PKWAY PELHAM N Y
GRAY INSTRUMENT CO
448 MILL RD ANDALUSIA PA
GRAY MFG CO
16 ARBOR ST HARTFORD CONN
GRAY RADIO CO
501 FOREST HILL BLVD W PALM BEACH FLA
GRAYHILL INC
561 HILLGROVE AVE LA GRANGE ILL
GRAYHILL MOLDTRONICS INC
229 BURLINGTON AVE CLARENDON HILLS ILL
GREAT EASTERN MFG CO
163-165 REMSEN AVE BROOKLYN 12 N Y
GREAT FALLS PRODUCTS CO INC
GREAT FALLS AVE ROCHESTER N H
GREAT LAKES ELECTRIC MFG CO
17 S DESPLAINES ST CHICAGO 6 ILL
GREEN INSTRUMENTS INC H J
2500 SHAMES DR WESTBURY N Y
GREEN INSTRUMENT CO
295 VASSAR ST CAMBRIDGE MASS
GREEN RECTIFIER CO
1-10 30 ST FAIRLAWN N J
GREENBRIER INSTRUMENTS INC
RONCEVERTE WEST VA
GREENE CO L CHARLTON
MILLSTREAM CHELMSFORD MASS
GREENE CORP G G
WARREN PA
GREENE TWEED & CO
NORTH WALES PA

GREENLEAF DIV OF SYSTRON DONNER CORP
7814 MAPLEWOOD INDUST ST LOUIS MO
GREENTREE ELECTRONICS CORP
2020 PLACENTIA AVE COSTA MESA CALIF
GREGORY MAGNETIC INDUST INC
2133 N E 19TH AVE FT LAUDERDALE FLA
GREIBACH INSTRUMENT SCORP
315 NORTH AVE NEW ROCHELLE N Y
GREINER CO EMIL
22 N MOORE ST NEW YORK 13 N Y
GREM ENGG CO
923 LONGVIEW RD KING OF PRUSSIA PA

GREMAR MFG CO
7 NORTH AVE WAKEFIELD MASS
GRIES REPRODUCER CORP
5 2ND ST NEW ROCHELLE N Y
GRINNELL ELECTRONICS INC
742 E ALOSTA BLVD GLENDORA CALIF
GROOV-PIN CORP
1125 HENDRICKS CAUSEWAY RIDGEFIELD N J
GROVER PHOTO PROD
341 ARDEN GLENDALE CALIF
GRUENBERG ELECTRIC CO INC
9 COMMERCIAL AVE GARDEN CITY N Y
GUARDIAN ELECTRIC MFG CO
1550 W CARROLL ST CHICAGO 12 ILL
GUARDIAN ELECTRIC MFG CO
333 W CARROLL CHICAGO ILL
GUARDIAN ELECTRIC MFG CO OF CALIF INC
5755 CAMILLE AVE CULVER CITY CALIF
THE GUDEMAN CO
W HURON ST CHICAGO 10 ILL
GUDEMAN CO OF CALIF
7473 AVE 304 VISALIA CALIF
GUIDANCE CONTROLS CORP
SUB WARNER ELEC BRAKE & CLUTCH CO

GUIDANCE TECHNOLOGY INC
2500 BROADWAY SANTA MONICA CALIF
GUIOE LAMP DIV
2915 PENDLETON AVE ANDERSON IND
GUIDE MFG CO
8218 LANKERSHIM BLVD N HOLLYWOOD CALIF
GUILD ELECTRONICS INC
388 BROADWAY NEW YORK N Y
GUILLEMIN NETWORKS INC
381 ELIOT ST NEWTON 64 MASS
GULTON INDUSTRIES INC
212 DURHAM AVE METUCHEN N J
GULTON INDUSTRIES INC ENG MAGNETICS DIV
13031 CERISE AVE HAWTHORNE CALIF
GULTON INDUSTRIES INC WEST INSTRUMENT CORP
4363 MONTROSE AVE CHICAGO ILL
GULTON INDUSTRIES INC ORTHOLOG DIV
4054 QUAKER BRIDGE RD TRENTON N J
GULTON INDUSTRIES INC
CG ELECTRONICS DIV
15000 CENTRAL EAST ALBUQUERQUE N M
GUNNAR LABS
3333 26TH ST BOX 546 RT 1 BRADENTON FLA
GURLEY W & L E
514 FULTON ST TROY N Y
G-V CONTROLS INC
OKNER PARKWAY LIVINGSTON N J
GWILLIAM CO
342 FURMAN ST BROOKLYN 1 N Y
GYRA ELECTRONICS CORP
WASHINGTON & ELM STS LA GRANGE ILL
GYREX CORP
3003 PENNA AVE SANTA MONICA CALIF

H

HACKENSACK CABLE CORP
110 ORCHARD ST HACKENSACK N J
HACKER INSTRUMENTS INC
SHERWOOD LANE PASSAIC AVE CALDWELL TW N J
HAGAN CHEMICALS & CONTROLS INC
BOX 1346 PITTSBURGH PA
HAIRSPRING VIBRATING CO
406 32ND ST UNION CITY N J
HAL HEN CO
36 14 11 ST LONG ISLAND CITY N Y
HALEDY ELECT CO
1949 51 MCDONALD AVE BROOKLYN N Y
HALEX INC
P O BOX 546 EL SEGUNDO CAL
HALEX CORP
27302 W 7 MILE RD DETROIT MICH
HALL MFG CO
3901 WESLEY TERRACE SCHILLER PK ILL
HALLAMORE ELECTRONICS CO
714 N BROOKHURST ST ANAHEIM CALIF
HALLETT MFG CO
5910 BOWCRAFT ST LOS ANGELES CALIF
HALLIBURTON ENTERPRISES INC MFG DIV
4724 S BOYLE AVE LOS ANGELES 58 CAL
HALLICRAFTERS PACIFIC DIV
300 W WARNER AVE SANTA ANA CALIF
HALLICRAFTERS CO
4401 W 5TH AVE CHICAGO 26 ILL
HALLIKAINEN INSTRUMENTS
1341 7 ST BERKELEY CALIF
HALLMARK INST CORP
2215 COMMERCE ST DALLAS TEXAS
HALMAR ELECTRONICS INC
1544 WEST MOUND ST COLUMBUS 23 OHIO
HALOGEN INSULATOR & SEAL CORP
9960 PACIFIC AVE FRANKLIN PARK ILL
HAMILTON ELECTRONICS CORP
2726 W PRATT AVE CHICAGO ILL
HAMILTON HALL INC
227 N WATER MILWAUKEE WISC
HAMILTON KENT MFG CO
427 GRANT ST KENT OHIO
HAMILTON MFG CO
TWO RIVERS WISC
HAMILTON STANDARD ELECTRONICS DEPT
MAIN ST BROAD BROOK CONN
HAMILTON STANDARD DIV OF UNITED AIRCRAFT
WINDSOR LOCKS CONN
HAMILTON WATCH CO INDUSTRIAL PRODS DIV
COLUMBIA AVE LANCASTER PA
HAMLIN INC
LAKE & GROVE STS LAKE MILLS WISC
HAMMARLUND MFG CO INC
MARS HILL N CAROLINA
HAMNER ELECTRONICS CO INC
P O BOX 531 PRINCETON N J
HANCOCK TELECONTROL CORP
143 SOUND BEACH AVE OLD GREENWICH CONN
HANDEE HOUSEHOLD PRODUCTS
408 12 ST BROOKLYN NY
HANDY & HARMAN
850 THIRD AVE NEW YORK N Y
HANDY & HARMAN
BRIDGEPORT CONN
HANDY & HARMAN
330 N GIBSON RD EL MONTE CALIF
HANOVIA LAMP DIV/ENGLEHARD INDUSTRIES INC
100 CHESTNUT ST NEWARK 5 N J
HANSEN MFG CO
R R 1 PRINCETON IND
HARDER CO DONALD C
2580 K ST SAN DIEGO 2 CALIF

ELECTRONIC MANUFACTURERS—A TO Z

HARDMAN CO H V
583 CORTLANDT ST BELLEVILLE 9 N J
HARKINS RADIO INC
4444 E WASHINGTON ST PHOENIX ARIZ
HARMAN KARDON INC
AMES CT PLAINVIEW L I N Y
HARMON LICHTENSTEIN & CO
26 BROADWAY NEW YORK 4 N Y
HAROWE SERVO CONTROLS INC
W CHESTER PK AT WESTTOWN RD W CHESTER PA
HARPER LEADER INC
1046 S MAIN ST WATERNURY CONN
HARREL INC
16 FITCH ST E NORWALK CONN
HARRIS MFG CO INC
8031 35 LITZSINGER RD ST LOUIS 17 MO
HARRISON LABS
45 INDUSTRIAL RD BERKELEY HGTS N J
HARRISON PAINT & VARNISH CO
1329 HARRISON AVE S W CANTON 1 OHIO
HARRITON SHARPE CORP
8060 SALT LAKE AVE HUNTINGTON PK CALIF
HARRIS REFRIGERATION CO
308 RIVER ST CAMBRIDGE 39 MASS
HARRISTAHL LABORATORIES
474 E 2ND ST BROOKLYN 26 N Y
HARSHAW CHEMICAL CO
1945 E 97 ST CLEVELAND 6 OHIO
HART MFG CO
128 BARTHOLOMEW AVE HARTFORD CONN
HART MFG CO
ANN ARBOR MICH
HARTLEY PROD RESCH LAB
397 W 21 ST HOLLAND MICH
HARTLEY PRODUCTS CO
517 519 E 162 ST NEW YORK N Y
HARTMAN ELECTRICAL MFG CO
175 N DIAMOND ST MANSFIELD OHIO
HARTWELL CORP
9035 VENICE BLVD LOS ANGELES 34 CALIF
HARVEY ALUMINUM
19200 S WESTERN AVE TORRANCE CALIF

HARVEY HUBBELL INC
STATE ST & BOSTWICK AVE BRIDGEPORT 2 CONN
HARVEY WELLS ELECTRONICS INC
14 HURON ORIVE NATICK MASS
HARVICK MFG CORP
SOUTH GATE CALIF
HARWALD CO INC
1245 CHICAGO AVE EVANSTON ILL
HARDWIC HINDLE INC
40 HERMON ST NEWARK N J
HARWORTH MFG CO
409 EL CAMINO REAL MENLO PARK CALIF
HASSALL INC JOHN
CANTIAGUE RD WESTBURY LI N Y
HASTINGS-RAYOIST INC
NEWCOMB AVE HAMPTON VA
HATHAWAY INSTRUMENTS DIV LIONEL
5800 E JEWELL AVE OENVER 22 COLO
HAVEG INDUSTRIES INC
900 GREENBANK RD WILMINGTON 8 DELA
HAVIR MFG CO
436 CLEVELAND AVE ST PAUL MINN
HAWLEY PRODUCTS CO
333 N 6TH ST ST CHARLES ILL
HAYOON CO A W
232 N ELM ST WATERBURY 20 CONN
THE A W HAYDON CO
4060 INCE BLVD CULVER CITY CALIF
HAYOON OIV GENERAL TIME CORP
245 E ELM ST TORRINGTON CONN
HAYOON INSTRUMENT CO
17 BROWN ST WATERBURY CONN
HAYDON SWITCH INC
536 S LEONARD ST WATERBURY CONN
HAYES INC C I
875 WELLINGTON AVE CRANSTON R I
HAYNES LABS INC C W
61 CHANDLER ST SPRINGFIELD 9 MASS
HAYNES STELLITE CO
1020 PARK AVE KOKOMO IND
HAYS CORP
742 E 8TH ST MICHIGAN CITY IND
HAZELTINE ELECTRONICS DIV/HAZELTINE CORP
59-25 LITTLE NECK PKWY LITTLE NECK 62 N Y
H B INSTRUMENT CO
AMERICAN BRISTOL STS PHILA PA
HEALY-RUFF CO
2255 UNIVERSITY AVE ST PAUL 14 MINN
HEAREVER CO INC
2644 CASTRO VALLEY BLVD CASTRO VALLEY CAL
HEATH CO SUB OF DAYSTROM INC
BENTON HARBOR MICH
HEATH CO DIV OF DAYSTROM INC
HILLTOP RO ST JOSEPH MICH
HEATRON CO
333 EBERTS ST YORK PA
HEHN LESTER C
30 MANORHAVEN BLVD PRT WASH N Y

HEINEMANN ELECTRIC CO
BRUNSWICK PIKE TRENTON N J
HEINRICH CO CARL
711 CONCORD AVE CAMBRIDGE 38 MASS
HEINZ MUELLER ENGG CO
4725 IOWA ST CHICAGO 51 ILL
HEINZE ELECT CO DIV CONSOLIDATED ELEC LAMP
685 LAWRENCE S T LOWELL MASS
HELCO PRODUCTS CORP
7832 BALBOA BLVD VAN NUYS CALIF
HELDOR MFG CORP
238 LEWIS ST PATERSON N J
HELICAL PROD CO INC
622 THIRD ST HERMOSA BCH CALIF
HELI-COIL CORP
SHELTER ROCK LANE DANBURY CONN
HELIOTEK DIVISION OF TEXTRON ELECTRONICS INC
12500 GLADSTONE AVE SYLMAR CALIF
HELIPOT DIV BECKMAN INSTRUMENTS INC
2500 FULLERTON RD FULLERTON CALIF
HELLER CO GERALD K
2673 S WESTERN ST LAS VEGAS NEV
HELLIGE INC
877 STEWART AVE GARDEN CITY NY
HELWIG CO
2550 N 30TH ST MILWAUKEE 10 WISC
HENES MFG CO
4301 E MADISON ST PHOENIX ARIZ
HENNEKE ENG CO
STONE RIDGE N Y
HENRY ENGINEERING CO
3625 W PACIFIC AVE BURBANK CALIF
HENRY & MILLER INDUSTRIES INC
675 GARFIELD AVE JERSEY CITY 5 N J
HENSCHEL CORP
14 CEDAR ST AMESBURY MASS
HEPPNER MFG CO
BOX 608 ROUND LAKE ILL
HERCULES CHEMICAL CO INC
416 BROADWAY NEW YORK 13 N Y
HERMASEAL CO
1010 N MAIN ST ELKHART IND
HERMES PLASTICS INC
154 W 14TH ST NEW YORK 11 N Y
HERMES-SONIC CORP
13-19 UNIVERSITY PL NEW YORK N Y
HERMETIC PACIFIC CORP
4232 TEMPLE CITY ROSEMEAD CALIF
HERMETIC SEAL CORP
4232 TEMPLE CITY BLVD PASADENA CALIF
HERMETIC SEAL CORP
NORTH ARLINGTON N J
HERMETITE CORP
100 LADGE DRIVE AVON MASS
HERZOG MINIATURE LAMP WORKS
50 17 5 ST LONG ISLNAD CITY N Y
HETCO INC
110-114 TREMONT ST EVERETT MASS

HEVI-DUTY ELECTRIC CO DIV BASIC PROD CORP
3002 W BURLEIGH ST POBX 563 MILWAUKEE WIS
HEWLETT PACKARO CO
1501 PAGE MILL RD PALO ALTO CALIF
HEXACON ELECTRIC CO
161 W CLAY AVE ROSELLE PARK N J
HEXCEL PRODUCTS INC EASTERN DIV
HAVRE DE GRACE MO
HEYER INDUSTRIES INCORPORATED
LAB OF MARQUETTE CORP
500 CORTLANOT ST BELLEVILLE N J
HEYMAN MFG CO
147 MICHIGAN AVE KENILWORTH N J
H & H MACHINE CO INC
NOBLE & JACKSON STS NORRISTOWN PA
H & H PRODUCTS CO
766 RAMSEY AVE HILLSIDE N J
HICKOK ELECTRICAL INSTRUMENT CO
10514 DU PONT AVE CLEVELAND 8 OHIO
HICO CORP
76 COOLIOGE HILL RO WATERTOWN MASS
HIDYNE INSTRUMENT & ENGRG CO
309 ANDERSON ST TULLAHOMA TENN
HIEATT ENGG CO
2228 N HOLLYWOOO WAY BURBANK CALIF
HI G INC
BRAOLEY FIELO WINDSOR LOCKS CONN
HIGH RELIABILITY CIRCUIT SYSTEMS
1853 N RAYMOND AVE ANAHEIM CALIF
HIGH SPEED HAMMER CO
313 NORTON ST ROCHESTER N Y
HIGH VACUUM EQUIPMENT CORP KINETICS DIV
2 CHURCHILL RD HINGHAM MASS
HIGH VACUUM EQUIP CORP
HINGHAM MASS
HIGH VACUUM FURNACE & ELECT DV
90 AIRPORT RD CONCORD N H
HIGH VOLTAGE ENG CORP
BURLINGTON MASS
HIGHLAND OESIGN INC
90 MAGNOLIA AVE WESTBURY N Y
HIGHSIDE CHEMICALS INC
11 COLFAX AVE CLIFTON N J
HILDEBRAND JOHN CO
45 BRIGHTON ST BELMONT MASS
HILL & CO E VERNON
PO BOX 189 LAKE GENEVA WISC
HILL ELECTRONICS INC
300 N CHESTNUT ST MECHANICSBURG PA
HILLBURN ELECTRONIC PRODUCTS CO
55 GREENPOINT AVE BROOKLYN 22 N Y
HI LO MFG CORP
1122 NEWPORT AVE CHICAGO ILL
HINCHMAN MFG CO INC
259 E FIRST AVE ROSELLE N J
HINDLE TRANSFORMER CO
WOODS CHURCH RD RD 3 FLEMINGTON NJ
HI-PAR PRODUCTS CO
347 LUNENBURG ST FITCHBURG MASS
HI PURITY METALS INC
340 HUOSON ST HACKENSACK N J
HIQ DIV
AEROVOX CORP OLEAN N Y
HI-Q DIV AEROVOX CORP
BOX 68 MYRTLE BEACH S C
HI-SHEAR RIVET TOOL CO
2600 W 247TH ST TORRANCE CALIF
HISONIC INC
P O BOX 534 SHAWNEE KANS
HI SPEC ELECTRONICS CORP
7328 ETHEL AVE HOLLYWOOD CALIF
HI SPEC ELECTRONICS CORP
14713 KESWICK ST VAN NUYS CALIF
HI-SPEED EQUIPMENT CO
73 POND ST WALTHAM 54 MASS
HITCHINER MFG CO INC
PO BOX 330 MILFORD NH
HITEMP INC
1532 CALIFORNIA AVE MONROVIA CALIF
HITEMP WIRES INC
1200 SHAMES DRIVE WESTBURY NY
HI TEST CHEMICAL CORP
722 64TH ST BROOKLYN 20 N Y
HOBBS CORP JOHN W DIV STEWART-WARNER CORP
SPRINGFIELD ILL
HOBBS MFG CO
24 SALISBURY ST WORCHESTER MASS
HOBSON BROS
4940 LAWRENCE AVE CHICAGO ILL
HOFFMAN CO P R
321 CHERRY ST CARLISLE PA
HOFFMAN ELECT CORP SEMICONDUCTORS DIV
1001 N ARDEN DR EL MONTE CALIF
HOFFMAN ELECTRONICS CORP INDUSTRIAL PROD DIV
3761 S HILL ST LOS ANGELES 7 CALIF
HOFFMAN ELECTRONICS CORP
2205 LEE ST EVANSTON ILL
HOFFMAN ELECTRONICS CORP INDUSTRIAL PROD DIV
2621 S HILL ST LOS ANGELES 7 CALIF
HOFFMAN ELECTRONICS CORP MLTRY PROD DIV
3740 GRAND AVE LOS ANG CALIF
HOFFMAN ENG CORP
9TH & TYLER ANOKA MINN
HOGAN FAXIMILE CORP
635 GREENWICH ST NEW YORK N Y
HOKE INC
1 TENAKILL PARK CRESKILL N J
HOLBROOK MERRILL CO
1150 KIFER RD SUNNYVALE CALIF
HOLEX INC
P O BOX 148 HOLLISTER CALIF
HOLLAND ELECTRONICS
772 E 53 ST BROOKLYN N Y
HOLLINGSWORTH CO
FORT LAUDERDALE FLA

HOLLIS ENGINEERING INC
PINE ST EXT NASHUA N H
HOLO-KROME SCREW CORP
HARTFORD 10 CONN
HOLT INSTRUMENT LABS
DIV HOLT HARDWOOO CO INC OCONTO WISC
HOLTZER CABOT DIV NATL PNEUMATIC CO
125 AMORY ST BOSTON 19 MASS
HOLUB INDUSTRIES INC
413 OE KALB AVE SYCAMORE ILL
HOMALITE CORP
11-13 BROOKSIOE OR WILMINGTON OEL
HOME ELECT MFG CO
2825 E SPRING ST LONG BEACH 6 CALIF
HOMMEL CO
HOPE & MAPLE STS CARNEIGIE PENNA
HONEYWELL CONTROLS LTO
VANDERHOOF AVE TORONTO ONTARIO CANADA
HOOKER CHEMICAL CORPORATION
28 IROQUOIS ST NIAGARA FALLS N Y
HOOVER ELECTRIC CO
2100 STONER AVE LOS ANGELES CALIF
HOOVER ELECTRONICS CO
110 W TIMONIUM RO TINONIUM MO
HOPAX ELECTRIC INC
680 OAVISVILLE RD WILLOW GROVE PA
HORLICK CO INC WM I
266 SUMMER ST BOSTON 10 MASS
HOSKINS MFG CO
4445 LAWTON AVE OETROIT MICH
HOTPACK CORP
5074A COTTMAN AVE PHILA PA
HOTWATT INC
OANVERS MASS
HOUDAILLE IND INC BUFFALO HYORAULICS OIV
539 E DELAVAN AVE BUFFALO 11 N Y
HOULIHAN CO T J
2510 W LAWRENCE CHICAGO 25 ILL
HOUSTON FEARLESS CORP WESTWOOD DIV
11801 W OLYMPIC BLVD LOS ANGELES 64 CAL
HOUSTON INSTRUMENT CORP
4950 TERMINAL AVE BELLAIRE 101 TEXAS
HOUSTON INSTRUMENT CORP
BOX 22234 HOUSTON TEXAS
HOWARD CRYSTAL HOLDERS INC
2600 GRAND AVE KANSAS CITY 8 MO
HOWARD FOUNORY CO
1700 N KOSTNER AVE CHICAGO 39 ILL
HOWARD INDUSTRIES INC LOYD SCRUGGS DIV
P O DRAWER 232 FESTUS MO
HOWARD INOUSTRIES INC
1760 STATE ST RACINE WISC
HOWARD INSTRUMENT CO
RED BANK N J
HOWELL INSTRUMENTS INC
3479 VICKERY BLVD FT WORTH TEXAS
HOYT ELECTRICAL INSTRUMENT WORKS
42 CARLETON ST CAMBRIDGE 42 MASS

HP ASSOCIATES AFF HEWLETT PACKARD
2900 PARK AVE PALO ALTO CALIF
HRB SINGER INC
SCIENCE PARK STATE COLLEGE PA
HUBBARD - SPOOL DIV
GARRETT IND
HUBER INDUSTRIES INC
4974 HILLSIDE AVE CINN OHIO
HUDSON LAMP CO
528 ELM ST KEARNY N J
HUDSON TOOL & DIE CO
18 MALVERN ST NEWARK 5 N J
HUDSON WIRE CO WINSTED DIV
981 MAIN ST WINSTED CONN
HUDSON WIRE CO
OSSINING NEW YORK
HUFCO INDUSTRIES
2815 OLIVE AVE BURBANK CALIF

HUGGINS LABS INC
999 E ARQUES SUNNYVALE CALIF
HUGHES AIRCRAFT CO-GROUND SYSTEMS DIV
PO BOX 2097 FULLERTON CALIF
HUGHES AIRCRAFT CO IND SYSTEMS DIV
5261 W IMPERIAL LOS ANG CALIF
HUGHES AIRCRAFT CO ELECT PROD DIV
P O BOX 278 NEWPORT BEACH CALIF
HUGHES AIRCRAFT CO
BOX 45426 AIRPORT STA LOS ANG CALIF
HUGHES AIRCRAFT CO VACUUM TUBE PROD DIV
2020 SHORT ST OCEANSIDE CALIF
HUGHES AIRCRAFT CO MICROWAVE TUBE DIV
11105 S LA CIENEGA BLVD LOS ANGELES 9 CAL
HUGHES PRODUCTS GROUP HUGHES AIRCRAFT CO
BOX 90427 LOS ANGELES 45 CALIF
HUGHES SEMICONOUCTORS DIV
500 SUPERIOR AVE NEWPORT BEACH CALIF
HUGHES TREITLER MFG CORP
1045 39TH ST BROOKLYN N Y
HUGHEY & PHILLIPS
3200 SAN FERNANDO BLVD BURBANK CALIF
HUGHSON CHEM CO DIV LORD MFG CO
GREEN GARDEN 12TH ERIE PA
HULL CORP
DAVISVILLE RD AT PA TWPK HATBORO PA
HUMPHREY INC
2805 CANON ST SAN DIEGO CALIF
HUNT CO PHILIP A
5150 GRANT AVE CLEVELAND OHIO
HUNT CORP
453 LINCOLN ST CARLISLE PA
HUNT ELECTRONICS
2617 ANTON DR DALLAS TEXAS
HUNTER SPRING CO
1 SPRING AVE LANSDALE PA
HUNTER TOOLS
9851 ALBURTIS AVE SANTA FE SPRINGS CALIF
HUPPERT CO K H
6830 COTTAGE GROVE AVE CHICAGO 37 ILL

HURLETRON INC EMS DIV
528 WEST LAMBERT ROAD WHITTIER CALIFORNIA
HURLETRON INCORPORATED ELECTRIC EYE EQP DIV
1938 E FAIRCHILD ST DANVILLE ILL
HURLETRON INC WHEATON ENG DIV
920 MANCHESTER RD WHEATON ILL
HURON INDUSTRIES
PO BOX 557 PORT HURON MICH
HURST TOOL & MFG CO
RD 46 PRINCETON IND
HUSE-LIBERTY MICA CO
PEABODY INDUSTRIAL CENTER PEABODY MASS
HUYCK SYSTEMS CO DV OF HUYCK CORP
360 WOLF HILL RD HUNTINGTON STA L I N Y
H W ELECTRONICS INC
NATICK MASS
HY GAIN ANTENNA PRODUCTS CO
1135 N 22 ST LINCOLN NEBR
HYCON MFG CO
700, ROYAL OAKS OR MONROVIA CALIF
HYORA POWER CO
10 PINE COURT NEW ROCHELLE N Y
HYDRAULIC RES ELECT DIV
1675 SHELDON AVE SUNVALLEY CALIF
HYDRO MOLDING CO
100 SHARRON AVE PLATTSBURGH N Y
HYDROMATICS INC
5 LAWRENCE ST BLOOMFIELD N J
HYDROPOISE INC SUB BROOKS INST CO
SCOTTSDALE ARIZ
HYGRODYNAMICS INC
949 SELIM RD SILVER SPRING MD
HYLETRONICS CORP
165 CAMBRIDGE ST BURLINGTON MASS
HYPERION INC
127 COOLIDGE HILL RD WATERTOWN MASS
HYSER ELECT MFG CO
556 SEVENTH AVE MINN MINN
HYSOL CANADA LTD
P O BOX 53 POSTAL STA R TORONTO ONT CANADA
HYSOL CORP
OLEAN N Y
HYSOL OF CALIF DIV
1706 POTRERO S EL MONTE CALIF
HYSON MFG CO
P O BOX N PASADENA CALIF
HYTECH DIV OF BISSETT BERMAN CORP
G STREET PIER SAN DIEGO 1 CALIF

I

ICONIX INC
945 INDUSTRIAL PALO ALTO CALIF
IDAHO MARYLAND MINES CORP MAGNETICS DIV
4310 SAN FERNANDE RD GLENDALE 4 CALIF
IDEAL AEROSMITH INC DIV ROYAL INDUSTRIES
3913 EVANS AVE CHEYENNE WYO
IDEAL ELECTRIC & MFG CO
300 E 1 ST MANSFIELD OHIO
IDEAL INDUSTRIES INC
5127 PARK AVE SYCAMORE ILL
IDEAL INDUSTRIES INC
PETERSBURG ILL
IDEAL INDUSTRIES
5127 BECKER PLACE SYCAMORE ILL
IDEAL PRECISION METER CO
214 FRANKLIN ST BROOKLYN 22 NY

IDEAS INC
214 IVINSON AVE LARAMIE WYD
IDENTIFICATION SERVICE CORP
144 W 46 ST NEW YORK 36 N Y
IE MFG
3039 CARROLL AVE CHICAGO 12 ILL
IERC DIV INTERNTL ELECT RESCH CORP
135 W MAGNOLIA BLVD BURBANK CALIF
I H MFG CO
121 GREENE ST NEW YORK N Y
ILEX OPTICAL COMPANY
ILG ELECTRIC VENTILATING CO
2850 PULASKI RD CHICAGO ILL
ILG ELECTRIC VENTILATING CO
1709 W 8TH ST LOS ANG CALIF
ILIKON CORP
NATICK IND CENTRE NATICK MASS
ILLINOIS CONDENSER CO
1616 N THROOP ST CHICAGO 22 ILL
ILLUMINATED CONTROLS INC
RIVERTON N J
ILLUMITRONIC ENGG CO
680 E TAYLOR AVE SUNNYVALE CALIF
IMAGE INSTRUMENTS INC
2300 WASHINGTON ST NEWTON 62 MASS
IMC MAGNETICS CORP
570 MAIN ST WESTBURY LI NY
IMC MAGNETICS CORP WESTERN DIV
6058 WALKER AVE MAYWOOD CALIF
IMC MAGNETICS CORP
917 W MADISON ST PHOENIX ARIZ
IMPACT-O-GRAPH CORP
1508 BF KEITH BLDG CLEVELAND 15 OHIO
IMPERIAL ELECT INC
8530 ROLAND ST BUENA PARK CALIF
IMPROVED SEAMLESS WIRE CO
775 EDDY ST PROVIDENCE R I
INCELOID CO INC
8127 33 OLEANDER ST NEW ORLEANS LA
IND ELEC RUBBER CO
31945 AURORA RD SOLON OHID
IND HARDWARE MFG CO INC
109 PRINCE ST NEW YORK NY
INDAMER ELECTRONICS
1038 W EVELYN SUNNYVALE CALIF
INDAR CORP SUB PR MALLORY CO
3448 SHELBY ST INDIANAPOLIS IND
INDIANA GENERAL CORP
EICOR DIV OGLESBY ILL
INDIANA GENERAL CORP MAGNET DIV
VALPARAISO IND
INDIANA GENERAL CORPORATION
KEASBEY N J
INDIANA STEEL & WIRE CO
2200 E JACKSON ST MUNCIE IND
INDIANA STEEL PRODUCTS DIV IND GEN CORP
405 ELM ST VALPARISO INO
INOIKON CO
76 COOLIDGE HILL RD WATERTOWN MASS
INDIUM CORP OF AMERICA
1676 LINCOLN AVE UTICA 4 N Y
INDUCTION HEATING CORP
181 WYTHE AVE BROOKLYN 11 N Y
INDUCTOR ENGG INC
117 SCHLEY AVE LEWES DELA
INDUSTRIAL ACOUSTICS CO
341 JACKSON AVE N Y N Y
INDUSTRIAL CONDENSER CORP
3243 N CALIFORNIA AVE CHICAGO 18 ILL
INDUSTRIAL CONTROL CO
CENTRAL AVE AT PINELAWN FARMINGDALE LI NY
INDUSTRIAL DEVICES INC
EDGEWATER N J
INDUSTRIAL DEVELOPMENT LABS INC
982 RIVER RD EDGEWATER NJ
INDUSTRIAL ELECTRONIC ENGINEERS INC
5528 VINELAND AVE N HOLLYWOOD CALIF
INDUSTRIAL ELECTRONIC HARDWARE CORP
109 PRINCE ST NEW YORK NEW YORK
INDUSTRIAL ELECTRONICS INC
8060 WHEELER ST DETROIT 10 MICH
INDUSTRIAL ELECTRONICS OF OMAHA INC
6614 BLONDO ST OMAHA NEBR
INDUSTRIAL ELECTRICAL WORKS
1509 CHICAGO ST OMAHA 2 NEBR
INDUSTRIAL ENGRAVERS INC
130 25 180 ST SPRINGFIELD GARDENS N Y
INDUSTRIAL INSTRUMENTS INC
89 COMMERCE RD CEDAR GROVE N J
INDUSTRIAL MATERIALS CO
383 BRANNAN ST SAN FRANCISCO CALIF
INDUSTRIAL METALS ALLOY CO INC
20 E ACADIA AVE WINSTON-SALEM NO CAR
INDUSTRIAL NUCLEONICS CORP
650 ACKERMAN RD COLUMBUS 21 OHIO
INDUSTRIAL RADIO CORP
462 N PARKSIDE AVE CHICAGO 44 ILL
INDUSTRIAL RETAINING RING CO
57 CORDIER ST IRVINGTON 11 NJ
INDUSTRIAL TEST EQUIPMENT CO
55 E 11TH ST NEW YORK 3 NY
INDUSTRIAL TECTONICS INC
3686 JACKSON AVE ANN ARBOR MICH
INDUSTRIAL TIMER CORP
1407 MCCARTER HWY NEWARK 4 N J
INDUSTRIAL TRANSFORMER CORP
GOULDSBORO PA
INDUSTRIAL WINDING MACHINERY CORP
BX 744 CHURCH ST STA NEW YORK 8 NY

INDUSTRIAL WIRE & CABLE CO INC
110-114 TREMONT ST EVERETT MASS
INDUSTRO TRANSISTOR CORP
35-10 36TH AVE LONG ISLAND CITY 6 NY
INDUSTRIONICS CONTROLS INC
20 VANDAM ST NEW YORK N Y
INERTIA SWITCH INC
311 W 43 ST NEW YORK 36 NY

INFINETICS INC
1601 JESSUP ST WILMINGTON 2 DEL
INFORMATION PRODUCTS CORP
1566TH ST CAMBRIDGE MASS
INFORMATION SYSTEMS INC
10131 NATIONAL BLVD LOS ANG CALIF
INFOTRONICS CORPORATION
1401 S POST OAK ROAD HOUSTON TEXAS
INFRARED INDUSTRIES INC
62 4TH AVE WALTHAM 54 MASS
INFRARED INDUSTRIES INC WESTERN DIV
PO BOX 989 SANTA BARBARA CALIF
INGERSOLL-RAND CO
PHILLIPSBURG N J
INGERSOLL PRODUCTS DIV BORG-WARNER CORP
1000 W 120TH ST CHICAGO 43 ILL
INJECTORALL CO
6 BAY ST BROOKLYN 14 N Y
INLAND MOTOR CORP
RAOFORD VA
INMANCO INCORPORATED
712 SOUTH FEDERAL STREET CHICAGO 5 ILL
INSACO INC
BOX 422 QUAKERTOWN PA
INSCO COMPANY
MAIN STREET GROTON MASS
INSL X PRODUCTS CORP
115 117 WOODWORTH AVE YONKERS N Y
INSO ELECT PROD INC
103 PARK AVE NUTLEY NJ
INSTRON ENGG CORP
2500 WASHINGTON ST CANTON MASS
INSTRU LAB INC
1207 LAMAR ST DAYTON OHIO
INSTRU-LEC CORP
520 HOMESTEAD AVE MOUNT VERNON NY
INSTRUMENT CASE DIV TA MFG CORP
4607 ALGER ST LOS ANGELES 39 CALIF
INSTRUMENT CORP OF FLA
PO BOX 1226 MELBOURNE FLA
INSTRUMENT CORP OF AMER
516 GLENWOOD AVE BALTIMORE MD
INSTRUMENT DEVELOPMENT LABS INC
67 MECHANIC ST ATTLEBORO MASS
INSTRUMENT ELECTRONICS CORP
PO BOX 830 PORT WASHINGTON NY
INSTRUMENT LABS CORPORATION
315 W WALTON PL CHICAGO 10 ILL
INSTRUMENT MASTERS INC
11 HAMBURG TURNPIKE RIVERDALE N J

INSTRUMENT RESISTORS CO
1036 COMMERCE AVE UNION N J
INSTRUMENTATION ASSOCIATES
17 W 60 ST NEW YORK 23 NY
INSTRUMENTS FOR INDUSTRY INC
101 NEW SOUTH RD HICKSVILLE LI NY
INSTRUMENTS INC
3102 CHARLES PAGE BLVD BX 556 TULSA OKLA
INSTRUMENTS OF N E
108 GREENWOOD LANE WALTHAM MASS
INSULATING FABRICATORS OF NE INC
69 GROVE ST WATERTOWN 72 MASS
INSULATING FABRICATORS INC
150 UNION AVE E RUTHERFORD NJ
INSULEX CO
1504 10TH ST NORTH BERGEN N J
INSUL VICON CORP
1369 INDUSTRIAL RD SAN CARLOS CALIF
INT EASTERN CO
801 6TH AVE NEW YORK NY
INTEGRATED MICA CORP
202 FRANKLIN PLACE WOODMERE NY
INTELLUX INC
30 S SALSIPUEDES ST SANTA BARBARA CALIF
INTERCONTINENTAL ELECTRONICS CORP
300 SHAMES DRIVE WESTBURY NEW YORK
INTERCONTINENTAL INSTRUMENTS INC
123 GAZZA BLVD FARMINGDALE L I N Y
INTERELECTRONICS CORP
2432 GRD CONCOURSE NEW YORK 58 NY
INTERFERENCE MEASUREMENT LAB INC
850 SHEPHERD AVE BROOKLYN 8 N Y
INTERLAKE STAMPING CORP
12415 EUCLID AVE CLEVELAND 6 OHIO
INTERLECTRIC DIV EL TRONICS
1401 LEXINGTON AVE WARREN PA
INTERNATION AUDIO STYLUS CORP
107 LAKE AVE TUCKAHOE N Y
INTERNATIONAL BUSINESS MACH
NEW CIRCLE RD LEXINGTON KY
INTL BUSINESS MACH FEDERAL SYS DIV
NEIGHBORHOOD RD KINGSTON N Y
INTL BUSINESS MACHINES DATA SYSTEMS DIV
P O BOX 390 POUGHKEEPSIE N Y
INTL CRYSTAL MFG CO INC
18 N LEE OKLAHOMA CITY OKLA
INTERNATIONAL DATA SYSTEMS INC
2925 MERRELL RD DALLAS 29 TEXAS
INTERNATIONAL DIODE CORP
88 90 FORREST ST JERSEY CITY N J
INTERNATIONAL ELECTRIC INDUSTRIES INC
468 GRAND AVE BROOKLYN 38 NY
INTL ELECTRIC INDUSTRIES INC
14 SUFFOLK ST FREEPORT LI NY
INTERNATIONAL ELECT INDUST
P O BOX 9036 NASHVILLE TENN
INTL ELECTRONIC INDUSTRIES
9036 MELROSE NASHVILLE TENN

INTERNATIONAL ELECT MAGNETICS INC
1901 MARQUETTE ST N CHICAGO ILL
INTL ELECTRONIC RESEARCH CORP
135 W MAGNOLIA BLVD BURBANK CALIF
INTL ELECT RESCH CORP
177 W MAGNOLIA BLVD BURBANK CALIF
INTERNATIONAL ELECTRONICS CORP
81 SPRING ST NEW YORK 12 N Y

INTL ELECTRONICS MFG CO
2ND ST EXT GREENWOOD ACRES ANNAPOLIS MD
INTERNATIONAL ENGG INC
PO BX 536 FAR HILLS BRANCH DAYTON 19 OHIO
INTERNATIONAL INSTRUMENTS INC
BOX 2954 NEW HAVEN 15 CONN
INTL INSTRUMENT INC
88 MARSH HILL RD ORANGE CONN
INTERNATIONAL NICKEL CO
67 WALL ST NEW YORK 5 N Y
INTL POWDER METALLURGY CO
439 W MAIN ST RIDGEWAY PENNA
INTL PUMP & MACHINE WORKS
81 DORSIA AVE LIVINGSTON N J
INTERNATIONAL RADIANT CORP
577 EAST 156TH ST NEW YORK 55 N Y
INTERNATIONAL RADIO ELECTRONICS CORP
R 4 BOX 261 ELKHART IND
INTL RADIO & ELECTRON
17TH & MISHAWAKA ELKHART IND
INTERNATIONAL RECTIFIER CORP
233 KANSAS ST EL SEGUNDO CALIF
INTERNATIONAL RESEARCH & DEVELOPMENT CORP
PO BOX 55 WORTHINGTON OHIO
INTERNATIONAL RESISTANCE CO ST PETERSBG DIV
2801 72ND STREET N ST PETERSBURG FLA
INTERNATIONAL RESISTANCE CO
BURLINGTON IOWA
INTERNATIONAL RESISTANCE CO
401 N BROAD ST PHILADELPHIA 8 PA
INTL RESISTANCE CO
BOONE NC
INTERSTATE ELECTRONICS CORP
707 E VERMONT AVE ANAHEIM CALIF
INTERTECH INC
333 STATE ST NORTH HAVEN CONN
INVAC CORP
26 FOX RD WALTHAM 54 MASS
INVENGINEERING INC
PO BOX 360 BELMAR N J
INVESTMENT CASTING CO
60 BROWN AVE SPRINGFIELD N J
INVEX INC
DIV OF CONTINENTAL OIVERSFIELD INDUST INC
1100 N E 125 ST N MIAMI FLA
IONIC ELECTROSTATIC CORP
111 MONROE ST GARFIELD N J
IONIC MIOWEST CORP
450 N SOMERSET AVE INDIANAPOLIS 22 IND
IONICS INC ELECTRON ARC OIV
244 BROAD ST LYNN MASS
IPPOLITO & CO INC JAMES
1624 STILLWELL AVE BRONX N Y
IRCO CORP
16 HUDSON ST NEW YORK 13 NY
IRCON INFRARED CONTROLS INC
4431 W DIVISION ST CHICAGO 51 ILL
IRON FIREMAN MFG CO ELECTRONICS DIV
2838 S E 9 AVE PORTLAND 2 ORE
IRVAN FERROMAGNETICS CORP
13856 SATICOY ST VAN NUYS CALIF
IRWIN LABS INC
1238 S GERHART AVE LOS ANGELES 22 CALIF
ISOCHEM RESINS CO
221 OAK ST PROVIDENCE 9 R I
ISOCYANATE PRODUCTS INC
900 WILMINGTON RD NEW CASTLE DELA
ISOLANTITE MFG CORP
337 WARREN AVE STIRLING N J
ISOMET CORP
430 COMMERCIAL AVE PALISADES PARK NJ
ISOTOPE ACCESSORIES CO INC
5312 WESTMINSTER AVE PHILA 31 PA
ISOTOPES INC
123 WOODLAND AVE WESTWOOD NJ
ISTOPES SPEC CO
P O BOX 688 BURBANK CALIF
ITA ELECTRONICS CORP
LANSDOWNE PENNA
ITEK ELECTRO - PRODUCTS
75 CAMBRIDGE PKWY CAMBRIDGE 42 MASS
ITEL INC
P O BOX 641 ROCKVILLE MD
ITE-T-E CIRCUIT BREAKER CO
601 E ERIE AVE PHILA 34 PENNA
ITT I BEARING DIVN
18301 SANTE FE AVE COMPTON CALIF
ITTI ELECTRONICS INC
369 LEXINGTON AVE CLIFTON N J
ITT COMPONENTS DIV
100 KINGSLAND RD CLIFTON N J
ITT COMPONENTS DIV
P O BOX 7065 ROANOKE VA
ITT FEDERAL LABS DIV INT TEL & TEL CORP
3301 WAYNE TRACE FORT WAYNE IND
ITT FEDERAL LABORATORIES DIV INTL TEL & TEL
500 WASHINGTON AVE NUTLEY NJ
IT & T INDUSTRIAL PRODUCTS DIV
15191 BLEDSOE ST SAN FERNANDO CAL
ITT KELLOGG
6650 S CICERO AVE CHICAGO 38 ILL
ITT KELLOGG COMM SYSTEMS DEPT
500 N PULASKI RD CHICAGO 24 ILL
ITT KELLOGG
951 COMMERCIAL ST PALO ALTO CALIF
ITT SURPRENANT MFG CO
172 STERLING ST CLINTON MASS

FOR INFORMATION ON PRODUCTS

SEE THE

"PRODUCT AND MANUFACTURERS" SECTION

J

JACK & HEINTZ DIV SIEGLER CORP
BOX 6719 CLEVELAND 1 OHIO
JACK INDUSTRIES BILL
143 S CEDROS AVE SOLANA BEACH CALIF
JACKES-EVANS MFG CO
4427 GERALDINE ST LOUIS 15 MO
JACKSON BROS LONDON LTD
KINGSWAY WADDON SURREY ENGLAND
JACKSON ELECTRICAL INSTRUMENT CO
124 MCDONOUGH ST DAYTON 2 OHIO
JACOBS INSTRUMENT CO
BETHESDA 14 MO
JACOBSON NUT MFG CORP
MARK RD KENILWORTH N J
JADARO MACHINE PRODUCTS
325 S SHILOH RD GARLAND TEXAS
JAIDINGER MFG CO
1921 W HUBBARD ST CHICAGO 22 ILL
JAMESBURY CORP
45 NEW ST WORCESTER MASS
JAMES ELECTRONIC INC
4050 ROCKWELL ST CHICAGO ILL
JAMES PLATING WORKS INC
1609 N ELSTON AVE CHICAGO 22 ILL
JAMISON PLASTIC CORP
1225 NEW BRIDGE RO N BELLMORE LI NY
JAMPRO ANTENNA CO
7500 14TH AVE SACRAMENTO CALIF
JAN ENG
2018 PICO BLVD SANTA MONICA CALIF
JAN HARDWARE MFG CO
38-01 QUEENS BLVD LONG ISLAND CITY 1 N Y
JANCO CORP
3111 WINONA AVE BURBANK CALIF
JANDOR INC
948 IRVING AVE DAYTON OHIO
JANSA WOODWORKING CORP
350 MESEROLE ST BROOKLYN 6 N Y
JANSEN ELECT MFG CO INC
2285 UNIVERSITY AVE ST PAUL MINN
JARRELL ASH CO
26 FARWELL ST NEWTONVILLE MASS
JARVIS ELECTRONICS CORP
1140 CHERRY ST WINNETKA ILL
JAVEX ELECTRONICS
PO BOX 646 REDLANDS CALIF
JAY-EL PRODUCTS INC
1859 W 169TH ST P O BOX 25 GARDENA CAL
J B L INSTRUMENT CO
SYCAMORE MILL RD CLIFTON HGTS PA
JEFFERS ELECTRONICS DIV SPEER CARBON CO
HOOVER AVE DUBOIS PA
JEFFERSON ELECTRONIC PRODUCTS CORP
322 STATE ST SANTA BARBARA CALIF
JEFFERSON WIRE & CABLE CORP
181 GREENWOOD ST WORCESTER MASS
JEFFREY MFG CO
803 N 4 ST COLUMBUS 16 OHIO
JELLIFF MFG CORP C O
PEQUOT RD SOUTHPORT CONN
JENNINGS RADIO MFG CORP
970 MCLAUGHLIN AVE SAN JOSE 8 CALIF
JENSEN INDUSTRIES INC
7333 HARRISON ST FOREST PARK ILL
JENSEN MFG DIV MUTER CORP
6601 S LARAMIE AVE CHICAGO 38 ILL
JERROLO ELECTRONICS CORP
15TH & LEHIGH AVE PHILA PENNA
JERSEY SPECIALTY CO INC
PO BOX 235 WAYNE N J
JETA INC
957 SAW MILL RIVER RD YONKERS 2 NY
JET-O-MATIC ENGINEERING INC
2126 RIVERSIDE AVE MINNEAPOLIS 4 MINN
JETRONIC INDUSTRIES
MAIN & COTTON ST PHILA 27 PA
JETTRON PRODUCTS
56 ROUTE 10 HANOVER N J
JFD ELECTRONIC CORP
6101 16 AVE BROOKLYN 4 N Y
JFD ELECTRONICS SOUTHERN INC
INDUSTRY DRIVE OXFORD DRIVE OXFORD NO CAR
J & G MACHINE CO INC
42 LA GRANGE ST WORCESTER MASS
JO-BELL PRODUCTS INC
5456 W 111 ST OAK LAWN ILL
JOCLIN MFG CO
LUFBERY AVE WALLINGFORD CONN
JODEE PLASTIC INC
9903 FOSTER AVE BROOKLYN N Y
JOHANSON MFG CO
PO BOX 329 BOONTON NJ
JOHNS-MANVILLE
200 N MAIN ST MANVILLE N J
JOHNS-MANVILLE
TILTON N H
JOHNSON & CO INC K W
1825 WEBSTER ST DAYTON 4 OHIO
JOHNSON & HOFFMAN MFG CORP
31 E 2ND ST MINEOLA L I N Y
JOHNSON AIRCRAFT ENGG CO M J
BOX 10 MORRISTOWN AIRPORT MORRISTOWN N J
JOHNSON CO E F
299 10 AVE S W WASECA MINN
JOHNSON CO E F
2210 SECOND AVE S W WASECA MINN
JOHNSON ELECTRONICS INC
P O BOX 1675 HWY 17-92 CASSELBERRY FLA
JOHNSON MFG CO INC
MOUNT VERNON IOWA
JOHNSON SERVICE CO
507 E MICHIGAN ST MILWAUKEE 2 WISC
JOHNSON WILLIAMS INC
2300 LEGHORN ST MT VIEW CALIF
JOHNSTON FOIL MFG CO
6106 S BROADWAY ST LOUIS 11 MO
JOHNSTON HEARING AID MFG CO
708 WEST 40 TH ST MINNEAPOLIS 9 MINN
JO-LINE TOOLS INC
8442 OTIS ST SOUTH GATE CALIF
JONATHAN MFG CO
720 E WALNUT FULLERTON CALIF
JONES ELECTRONICS HIRAM
2313 W OLIVE AVE BURBANK CALIF
JONES ELECTRONIC CO INC M C
185 N MAIN ST BRISTOL CONN
JONES & LAMSON MACH CO
160 CLINTON ST SPRINGFIELD VT
JONES & LAUGHLIN STEEL CORP
WIRE ROPE DIV MUNCY PA
JONES OPTICAL WORKS A D
2400 MASSACHUSETTS AVE CAMBRIDGE 4 MASS
JONTZ MFG CO INC
1101 E MCKINLEY AVE MISHAWAKA IND
JORDAN CONTROLS INC
3235 W HAMPTON AVE MILWAUKEE 9 WISC
JORDAN ELECTRONICS DIV VICTOREEN
3025 W MISSION RD ALHAMBRA CALIF
JOR MAC CO
704 10TH AVE GRAFTON WISC
JOSLYN MFG & SUPPLY CENTRAL MFG DIV
3700 S MORGAN ST CHICAGO ILL
JOVAL PRODUCTS
250 MCWHORTER ST NEWARK N J
JOY MFG CO
338 S BROADWAY NEW PHILA OHIO
JSC ENGINEERING & DEVELOPMENT CORP
P O BOX 295 HIALEAH FLA
JUALL GEAR CO INC
1108 GOFFLE RD HAWTHORNE NJ
JUDD WIRE MFG CORP
TURNPIKE RD TURNERS FALLS MASS
JULIE RESEARCH LABS
603 W 130 ST NEW YORK 27 NY
J-V-M DIVISION FIDELITONE MICROWAVE INC
9300 W 47TH BROOKFIELD ILL

K

KAAR ENGG CORP
2995 MIDDLEFIELD RD PALO ALTO CALIF
GEORGE E KAERCHER CO
4911 36TH AVE S MINNEAPOLIS 17 MINNESOTA
KAHLE ENGG CO
3300 HUDSON AVE UNION CITY N J
KAHLENBERG BROS CO
TWO RIVERS WISC
KAHN & CO
885 WELLS ROAD WETHERSFIELD HARTFORD CONN
KAHN RESEARCH LABS
81 S BERGEN PL FREEPORT N Y
KAISER AIRCRAFT & ELECTRONICS
2222 W PEORIA AVE PHOENIX ARIZ
KAISER ELECTRONICS INC
13 MONROE ST UNION N J
KALPA SCIENTIFIC LABORATORIES INC
P O BOX 172 FLEMINGTON N J
KAMAN AIRCRAFT CORP
OLD WINDSOR RD BLOOMFIELD CONN
KANE ENGINEERING LABORATORIES
845 COMMERCIAL ST PALO ALTO CALIF
KANE MFG CORP
P O BOX 641 N FRALEY ST KANE PA
KANO LABS
1000 S THOMPSON LANE NASHVILLE TENN
KANTHAL CORP
AMELIA PLACE STAMFORD CONN
KAPITOL MAGNATIC CORP
2241 N KNOX AVE CHICAGO 39 ILL
KARG LAB INC
30 MEADOW ST SOUTH NORWALK CONN
KARG LABS INC
162 ELY AVENUE SO NORWALK CONN
KARLSON ASSOCIATES INC
433 HEMPSTEAD AVE W HEMPSTEAD N Y
KARTRON
P O BOX 472 BEACH CALIF
KAUKE & CO INC
1632 EUCLID ST SANTA MONICA CALIF
KAUPP & SON C B INC
610 NEWARK WAY MAPLEWOOD N J
KAWECKI CHEMICAL CO
P O BOX 60 BOYERTOWN PENNA
KAY ELECTRIC CO
MAPLE AVE PINE BROOK N J
KAY ELECTRIC CO PINLITE DIV
OLD BLOOMFIELD AVE PINE BROOK NJ
KAYE & CO INC JOSEPH
737 CONCORD AVE CAMBRIDGE 38 MASS
KAY-ESS CO
8 NORTH ST DANBURY CONN
KAYNAR CO
7875 TELEGRAPH RD PICO RIVERO CALIF
KAYNAR MFG CO INC
BOX 2001 TERMINAL ANNEX LOS ANGELES CALIF

KAY-TOWNES ANTENNA CO
BOX 593 ROME GA
KEARFOTT DIV GENERAL PRECISION INC
LITTLE FALLS NJ
KEARFOTT CO INC
253 N VINEDO AVE PASADENA CALIF
KEARFOTT SEMICONDUCTOR CORP
437 CHERRY ST WEST NEWTON 65 MASS
KEARFOTT DIV GPI INC
12690 ELMWOOD AVE CLEVELAND 11 OHIO
KEASBEY & MATTISON CO
BURLER AVE AMBLER PA
KEIL ENGG PRODUCTS CORP
6833 MANCHESTER AVE ST LOUIS 10 MO
KEISER IND INC
LAUMAN ST P O BOX MT HOLLY SPRINGS PA
KEITHLEY INSTRUMENTS INC
12415 EUCLID AVE CLEVELAND 6 OHIO
KELEKET X RAY DV LABS FO ELECT
1601 TRAPELO RD WALTHAM MASS
KELL STROM TOOL CO INC ELECT DIV
214 CHURCH ST WETHERSFIELD CONN
KELTRON CORP
223 CRESCENT ST WALTHAM MASS
KELVIN ELECTRIC CO
5919 NOBLE AVE VAN NUYS CALIF
KEMET CO DIV UNION CARBIDE CORP
PO BOX 6087 CLEVELAND 1 OHIO
KEMET CO DIV OF UNION CARBIDE CORP
11901 MADISON AVE CLEVELAND 1 OHIO
KEMLITE LABS INC
1819 W GRAND AVE CHICAGO 22 ILL
KEMODE MFG CO
161 W 18 ST NEW YORK 11 N Y
KEMTRON ELECTRON PRODUCTS INC
14 PRINCE PL NEWBURYPORT MASS
KEN-DEL PRODUCTIONS INC
515 SHIPLEY ST WILMINGTON 1 DEL
KENHOS CORP DV
BOX 2 NORTON HGTS STA DARIEN CONN
KENNAMETAL INC
LLOYD AVE LATROBE PA
KENNEDY INDUSTRIES
1581 E CHARLES ST BANNING CALIF
KENRU CO
PO BOX 121 PARSIPPANY N J
KENSICO TUBE CO DIV
MT KISCO N Y
KENT CORP F C
135 MANCHESTER PLACE NEWARK 4 N J
KENT LIGHTING CORP
500 JOHNSON AVE BROOKLYN 37 N Y
KENT MFG CORP
206 CENTER PRINCETON N J
KENTRON HAWAII LTD
1140 WAIMANU ST HONOLULU 14 HAWAII
KEN TRON CORP
395 LYNNWAY LYNN MASS
KENTUCKY ELECTRONICS INC
2208 W SECOND ST OWENSBORO KY
KENWOOD ENGG CO
265 COLFAX AVE KENILWORTH N J
KENYON TRANSFORMER CO
1057 SUMMIT AVE JERSEY CITY 7 N J
KEPCO INC
131 38 SANFORD AVE FLUSHING 55 N Y
KERN INSTRUMENTS INC
120 GRAND ST WHITE PLAINS NY
KERRCO PRODUCTS
PO BOX 4178 LINCOLN 7 NEBR
KERSSILK PRODUCTS INC
73 MURRAY ST NEW YORK N Y
KESSLER CHEMICAL CO INC
STATE RD & COTTMAN AVE PHILA 35 PA
KESTER SOLDER CO
4201 WRIGHTWOOD AVE CHICAGO 39 ILL
KESTER SOLDER CO
88 FERGUSON ST NEWARK N J
KEUFFEL & ESSER CO
DEPT EI 6 HOBOKEN N J
KEWAUNEE SCIENTIFIC EQUIP
4012 LOGAN ST ADRAIN MICH
KEY RESISTOR CORP
321 W REDONDO BEACH BLVD GARDENA CALIF
KEYSTONE BOLT & NUT CORP OF TENN
422 FIFTH AVE S NASHVILLE TENN
KEYSTONE CARBON CO
1935 STATE ST ST MARYS PA
KEYSTONE ELECTRONICS CO
65 7 AVE NEWARK 4 N J
KEYSTONE ELECTRONICS CORP
49 BLEECKER ST NEW YORK 12 N Y
KEYSTONE PRODUCTS CO
904-6 23RD ST UNION CITY N J
K-F DEVELOPMENT CO
2606 SPRING ST REDWOOD CITY CALIF
KFR CORP
6006 W WASHINGTON BLVD CULVER CITY CALIF
KIBBY INSTRUMENT CO
P O BOX 50 PERKINS CALIF
KIEKHAEFER MFG CO
901 S 2ND ST MILWAUKEE 4 WISC
KIDCO INC
PO BOX 178 RT 70 MEDFORD NJ
KIDDE & CO WALTER
1156 MAIN ST BELLEVILLE 9 NJ
KIDDE ULTRASONIC & DETECTION ALARMS INC
1156 BRIGHTON RD CLIFTON N J
KILO ENG CO
2011 3RD ST LAVERNE CALIF
KIMBALL ELECTRONICS CO INC
3620 N W 48 TERRACE MIAMI FLA
KINELOGIC CORP
29 S PASADENA AVE PASADENA CALIF
KINETICS CORP
410 S CEDROS AVE SOLANA BEACH CALIF
KING LABS INC
127 SOLAR ST SYRACUSE 3 N Y
KING RADIO CORP
139 S BROCKWAY BOX 106 OLATHE KANS
KINGS ELECTRONICS CO INC
40 MARBLEDALE RD TUCKAHOE NY
KINGSLEY MACHINE CO
850 CAHUENGA BLVD HOLLYWOOD 38 CAL
KINNELECTRONICS CORP
4125 HAYWARD AVE BALTIMORE 15 MD
KINNEY VACUUM DIV THE NEW YORK AIR BRAKE CO
3529 WASHINGTON ST BOSTON 30 MASS
KINSMAN MFG CO INC
54 MILL ST LACONIA N H
KIP ELECTRONICS CORP
29 HOLLY PL BOX 562 STAMFORD CONN
KIRKLAND CO H R
10 KING ST MORRISTOWN N J
KIRSCH MUSIC CORP
15 58 127 ST FLUSHING N Y
KISTLER INSTRUMENT CORP
15 WEBSTER ST N TONAWANDA NY
KLANN ORGAN SUPPLY CO
PARK STATION WAYNESBORO VA
KLEER-TRONICS INC
1933 OCEAN AVE SAN FRANCISCO CALIF
KLEER VUE MFG CO INC
P O BOX 10326 PITTSBURGH 34 PA
KLEIN ELECT CO LEO
8526 WASHINGTON BLVD CULVER CITY CALIF
KLEINSCHMIDT DIV SMITH-CORONA MARCHANT INC
COUNTY LINE RD DEERFIELD ILL
KLEIN & SONS MATHIAS
7200 MCCORMICK RD CHICAGO 45 ILL
KLIEGL BROS UNIV ELEC STAGE LIGHTING CO I
321 W 50TH ST NEW YORK 19 NY
KLINCHER LOCKNUT CORP
2153 HILLSIDE AVE INDIANAPOLIS 18 INO
KLINE IRON & STEEL CO
P O BOX 1013 1225 35 HUGER ST COLUMBIA S C
KLING METAL SPINNING & STAMPING CO
245 CENTRE ST NEW YORK 13 N Y
KLIPSCH & ASSOCIATES
P O DRAWER 96 HOPE ARK
KNIGHT ELECTRONICS CORP
2200 W MAYWOOD DRIVE MAYWOOD ILLINOIS
KNIGHTS CO JAMES
CHURCH & WELLS STS SANDWICH ILL
KNOPP INC
1307 66TH ST OAKLAND 8 CALIF
KNOWLES ELECTRONICS INC
10545 ANDERSON PLACE FRANKLIN PARK ILL
KOBZY TOOL CO
1535 N DAYTON CHICAGO ILL
KOILED KORDS DIV WHITNEY BLAKE CO
106 PERSHING ST NEW HAVEN 14 CONN
KOLLMORGEN CORP
347 KING ST NORTHAMPTON MASS
KOLLSMAN INST CORP STD KOLLSMAN IND INC
80-08 45TH AVE ELMHURST 73 NY
KOLLSMAN INSTRUMENT CORP
SUB STANDARD KOLLSMAN IND
SYOSSET L I N Y
KOLLSMAN MOTOR CORP
OUBLIN PA
KOLLSTAN SEMICDT ELMNT DIV KOLLSMN INST CORP
111 NEW YORK AVE WESTBURY LI NY
KOLTON ELECTRIC MFG CO
123 N J RAILROAD AVE NEWARK 5 N J
KOMAK INC
2632 CUMBERLAND ST PHILA PA
KONIGSLOW STAMPING & TOOL CO E
450 N 9TH ST ELWOOD IND
KOOLTRONIC FAN CO
PO BOX 504 PRINCETON NJ
KOONTZ WAGNER ELECT CO INC
516 N MICHIGAN ST SOUTH BEND IND
KOPP GLASS INC
SWISSVALE PITTSBURGH 18 PENNA
KOPPERS CO INC
KOPPERS BLDG PITTSBURGH 19 PA
KORFUND CO INC
CANTIAGUE RO WESTBURY L I N Y
KORFUND DYNAMICS CORP
CANTIAGUE RD WESTBURY L I N Y
KORRY MANUF CO
223 8TH AVE SEATTLE WASH
KPT MFG CO
ROSELAND N J
KRAEUTER & CO
585 18TH AVE NEWARK N J
KRAUS ELECTRONICS INC
543 CENTER DR PALO ALTO CALIF
KRAUTTER ELECTRIC MACHINE CO
360 GROVE ST NEWARK 3 N J
KRAUTTER-WEBER TOOL CO
69 12TH AVE NEWARK 2 NJ
KRECKMAN CO HERB
CRESCO PA
KRENGEL MFG CO
227 FULTON ST NEW YORK CITY N Y
KRESKY MFG CO INC
2ND & H STS PETALUMA CALIF
KRESSILK PROD INC
73 MURRAY ST NEW YORK 7 NY
KRISS ELECTRONICS INC
191-195 ORATON ST NEWARK 4 NJ
KROKER ENGG & DEVEL CO
9947 FRANKLIN AVE FRANKLIN PARK ILL
KROHN-HITE CORP
580 MASSACHUSETTS AVE CAMBRIDGE 39 MASS
KRYLON INC
FORD & WASHINGTON STS NORRISTOWN PA
KRYSTINEL CORP
BOX 6 FOX ISLAND RD PORT CHESTER N Y
KTV TOWER COMMUNICATION EQUIP CO
BOX 294-82D S HAMILTON ST SULLIVAN ILL
KUBAR INC
21 ERIE ST CAMBRIOGE MASS
KUHN ELECTRONICS INC
1801 MILLS AVE NORWOOD 12 OHIO
KULICKE & SOFFA MFG CO
401 N BROAD ST PHILA 8 PA
KULITE BYTREX CORP
50 HUNT ST NEWTON MASS
KULITE SEMICONDUCTOR PROD INC
1030 HOYT AVE RIDGEFIELD N J
KULITE TUNGSTEN CO
1040 HOYT AVE RIDGEFIELD NJ
KULKA ELEC CORP
633 S FULTON ST MT VERNON NY
KUPFRIAN MFG DIV ROBINSON TECH PROOS INC
1 HENRY ST BINGHAMTON NY
KURMAN ELECTRIC CO SUB CRESCENT PETROLEUM
191 NEWEL ST BROOKLYN 22 N Y
KURTSTON ELECTRONICS
702 BAY ST STATEN ISLAND 4 NY
KURZ-KASCH INC
1421 S BROADWAY DAYTON 1 OHIO
KUTHE LABS
730 S 13 ST NEWARK 3 N J
K V TRANSFORMER CORP
81 WATER ST OSSINING N Y
K W ENGINEERING WORKS
PIN OAK COURT MENOMONEE FALLS WISC
KWIKHEAT MFG CO
3732 SAN FERNANDO RD GLENDALE CALIF
KYLE PRDOUCTS
9 & MARION S MILWAUKEE WISC

L

LAB CORP
E ONONDAGA SKANEATELES N Y
LABELLE INDUSTRIES INC
510 S WORTHINGTON ST OCONOMOWOC WISC
LABLINE INC
3070 W GRAND AVE CHICAGO 22 ILL
LABORATORY EQUIPMENT CORP
LAKEVIEW HILLTOP RD ST JOSEPH MICH
LABORATORY FOR ELECTRONICS INC
1079 COMMONWEALTH AVE BOSTON 15 MASS
LAB-TRONICS INC
3656 N LINCOLN AVE CHICAGO 13 ILL
LACESA ENGG CORP
5614 W GRAND AVE CHICAGO 39 ILL
LACONIA MALLEABLE IRON CO INC
71 WATER ST LACONIA N H
LAFAYETTE INSTRUMENT CO
P O BOX 57 LAFAYETTE INO
LAI I & E DIV
2133 ADAMS AVE SAN LEANDRO CALIF
THE LAKE CHEMICAL CO
3052 W CARROLL AVE CHICAGO ILL
LAKE CITY INC SUB OF CONTROLS CO OF AMERICA
110 WOODSTOCK ST CRYSTAL LAKE ILL
LAKE MFG CO
2323 CHESTNUT ST OAKLAND 7 CALIF
LAKE SHORE ELECTRIC CORP
205 WILLIS ST BEDFORD OHIO
LAMACO OF FLORIDA
BOX 1386 HAINES CITY FLORIDA
LAMARCHE MFG CO
3955 25TH AVE SCHILLER PARK ILL
LAMBDA ELECTRONICS CORP
515 BROAD HOLLOW RD HUNTINGTON L I N Y
LAMINAIR INC
18530 S BROADWAY GARDENA CALIF
LAMINATED SHEET PRODUCTS CORP
449 NEPONSET ST NORWOOD MASS
LAMINATED SHIM CO
UNION STREET GLENBROOK CONN
LA MOREE C D
2433 BIRKDALE ST LOS ANGELES 31 CALIF
LAMOTTE CHEMICAL PRODUCTS CO
CHESTERTOWN MD
LAMPKIN LAB INC FDC DIV
BRADENTON FLA
LAMPKIN LABS INC
TECHNICAL DIVISION BRADENTON FLA
LAMSON & SESSIONS CO
5025 W 73 ST CHICAGO ILL
LANCASTER GLASS CORP
LANCASTER OHIO
LANCE ANTENNA MFG CORP
1730-1802 1ST ST SAN FERNANOO CALIF
LAND AIR INC CHEYENNE DIV
PO BOX 2327 CHEYENNE WYO
LAND AIR INSTRUMENT & ELECT DIV
440 HESTER SAN LEANDRO CALIF
LANDAU METAL PROD CORP
2 62 51ST AVE LONG ISLAND CITY N Y
LANDSVERK ELECTROMETER CO
641 SONORA AVE GLENDALE CALIF
LANES INDS CORP DIV CORNELL DEEP DRAWING CO
612 COLORADO AVENUE SANTA MONICA CALIF
LANG ELECTRIC MFG CO
EDINBORO PA
LANGEVIN OIV OF SONOTEC INCORP
503 S GRAND AVE SANTA ANA CALIF
LANGLEY CORP
310 EUCLID AVE SAN DIEGO CALIF
LANSING SOUND INC JAMES B
3249 CASITAS LOS ANGELES 39 CALIF
LAPHAM HICKEY STEEL CORP
3333 W 47TH ST PL CHICAGO ILL

ELECTRONIC MANUFACTURERS—A TO Z

LAPMASTER DIV CRANE PACKING CO
6400 OAKTON ST MORTON GROVE ILL
LAPP INSULATOR CO RADIO SPECIALTIES DIV
318 GILBERT ST LE ROY NY
LA POINTE INDUSTRIES INC
155 W MAIN ST ROCKVILLE CONN
LA ROSE & ASSOC INC W T
BOX F LANS STA TROY NY
LARSON INSTRUMENT CO
GREENBUSH RO ORANGEBURG N Y
LASER SYSTEMS CENTER OF LEAR SEIGLER INC
2320 WASHTENAW AVE ANN ARBOR MICH
LAS LAB INC
1113 N ROLLING RO BALTIMORE MO
LAURENK RADIO MFG CO
3927 WAYNE RD WAYNE MICH
LAVELLE AIRCRAFT CORP
STERLING ST NEWTOWN PA
LA VEZZI MACHINE WORKS
4635 W LAKE ST CHICAGO 44 ILL
LAVOIE LABS INC
MATAWAN-FREEHOLD RD MORGANVILLE NJ
LEACH CORP INET DIV
18435 SUSANA RD COMPTON CALIF
LEACH CORP LEACH RELAY DIV
5915 AVALON BLVD LOS ANGELES 3 CALIF
LEACH CORP SPECIAL PRODUCTS DIV
717 NORTH CONEY AZUSA CALIF
LEACH & GARNER CO INDUSTRIAL DIVISION
LEACH & GARNER BLDG ATTLEBORO MASS
LEAR INC ASTRONICS DIV
3171 S BUNOY DR SANTA MONICA CALIF
LEAR INC ELECTRO-MECHANICAL DIV
110 IONIA AVE NW GRAND RAPIDS MICH
LEAR INCORPORATED INSTRUMENT DIVISION
110 IONIA AVENUE N W GRAND RAPIDS MICH
LEAR ROMEC DIV LEAR INC
ELYRIA OHIO
714 N BROOKHURST ST ANAHEIM CALIF
LEAR SIEGLER INC ELECT INST DIV
LEAR SIEGLER INC POWER EQUIP DIV
P O BOX 6719 CLEVELAND 1 OHIO
LEBOW ASSOCIATES
21820 WYOMING OAK PARK 37 MICH
LECLANCHE S A
48 AVE DEGRANDSON YVERDON SWITZERLAND
LECTROHM INC
5560 NORTHWEST HWY CHICAGO ILL
LEDEX INC
123 WEBSTER ST DAYTON 2 OHIO
LEE ELECTRIC INC
566 52ND ST WEST N Y N JERSEY
LEECRAFT MFG CO INC
2116 44TH RD LONG ISLAND CITY N Y
LEEDAL INC
2929 S HALSTED CHICAGO ILL
LEED INSULATOR CORP
781 E PICO BLVD LOS ANGELES 21 CALIF
LEEDS & NORTHRUP CO
4901 STENTON AVE PHILA PA
L E E INC
625 N Y AVE N W WASHINGTON 1 D C
LEESONA CORPORATION
WARWICK RHODE ISLAND
LEETRONICS INC
30 MAIN ST BROOKLYN 1 N Y
LEFFINGWELL CHEMICAL CO
P O BOX 1187 PERRY ANNEX WHITTIER CALIF
LEHIGH VALLEY ELECT ENGG & MFG CO
RD 1 BREININGSVILLE PA
LEICHNER MFG CO
1510 N NEIL ST CHAMPAIGN ILL
LEIGHTON LABS H W
YORK RD & SUNSET LANE HATBORO PA
LEIMAN BROS
146 CHRISTIE ST NEWARK 5 NJ
LEITCH HUARD CORP
STARK & COMMERCIAL ST MANCHESTER N H
LEKTRA LABS INC
154 11 AVE NEW YORK 11 N Y
LELAND AIRBORNE PRODUCTS
740 E NATIONAL RD VANDALIA OHIO
LEL INC
75 AKRON ST COPIAGUE NY
LEMERT ENGG CO
1313 WESTERN AVENUE PLYMOUTH IND
LENK MFG CO
FRANKLIN KY
LENKURT ELECTRIC CO
1105 COUNTY RD SAN CARLOS CALIF
LENZ ELECTRIC MFG CO
1751 N WESTERN AVE CHICAGO 47 ILL
LEPEL HIGH FREQUENCY LABS
54-18 37 AVE WOODSIDE 77 NY
LERCO ELECTRONICS INC
501 S VARNEY ST BURBANK CALIF
LESA COSTRUZIONI ELETTROMECCANICHE SPA
VIA BERGAMO 21 MILANO ITALY
LESLIE CO
LYNDHURST NJ
LESLIE CREATIONS
LAFAYETTE HILL PENNA
LESSELLS & ASSOCIATES INC
916 COMMONWEALTH AVE BOSTON 15 MASS
LE SUEUR MFG CO INC
PATTONS CHAPEL BIRMINGHAM ALA
LEVEY LABS HAROLD A
8127-33 OLEANDER ST NEW ORLEANS 18 LA
LEVIN & SON LOUIS
3610 S BROADWAY LOS ANGELES 7 CALIF
LEVOLOR LORENTZEN INC H K LORENTZEN DIV
391 W BROADWAY NEW YORK 12 N Y
LEWIS CO E B
11 BRASS ST E HARTFORD 8 CONN
THE LEWIS ENGINEERING CO
339 CHURCH ST NAUGATUCK CONN
LEWIS & KAUFMAN ELECTRONICS TUBE DIV
17320 EL RANCHO AVE LOS GATOS CALIF
LEYGHTON-PAIGE CORP
76 INDIANA AVE W ST PAUL 7 MINN
LEYMAN MAGNETICS DIV
5178 CROOKSHANK RD CINCINNATI OHIO
LEYSE ALUMINUM CO
KEWAUNEE WISC
LIBBEY OWENS FORD GLASS CO LIBERTY MIRROR DV
BRACKENRIDGE PA
LIBRASCOPE DIV GENERAL PRECISION INC
808 WESTERN AVE GLENDALE 1 CALIF
LIBRASCOPE DIV GENERAL PRECISION INC
100 E TUJUNGA AVE BURBANK CALIF
LICON DIV ILLINOIS TOOL WORKS
6615 W IRVING PARK RD CHICAGO 34 ILL
LICON SWITCH & CONTROL
2501 N KEELER AVE CHICAGO 30 ILL
LIEBEL-FLARSHEIM CO
111 E AMITY RD CINCINNATI 15 OHIO
LIECO INC
130 EILEEN WAY SYOSSET L I NY
LIFE INSTRUMENT CO
BROOK ST FRANKLIN MASS
LIGHT ELECTRIC CORP
214 LACKAWANNA AVE NEWARK 3 N J
LIGHT METALS INC
1100 E 24TH ST INDIANAPOLIS 5 IND
LIGNACRAFT
66 TRAVIS AVE BINGHAMTON N Y
LIGNACRAFT DESIGN & DRAFTING SERVICE
66 TRAVIS AVE BINGHAMTON N Y
LIND INSTRUMENTS INC
2294 MORA DRIVE MOUNTAIN VIEW CALIF
LINDBERG ENGG CO
2450 W HUBBARD ST CHICAGO 12 ILL
LINDGREN & ASSOC ERIK A
4515 N RAVENSWOOD CHICAGO 40 ILL
LINDLY & CO
248 HERRICKS RD MINEOLA NY
LINDSAY STRUCTURE INC DIV INTL STEEL CO
EVANSVILLE IND
LINEAR INC
DALLAS PENNA
LINE ELECTRIC CO DIV IND TIME CORP
229 RIVER STREET ORANGE NJ
LINELL ENGG CORP CHAS S
3974 N AVONDALE AVE CHICAGO 41 ILL
LINEMASTER SWITCH CORP
WOODSTOCK CONN
LINE MATERIAL INDUSTRIES
CENTRAL PLANT S MILWAUKEE WISC
LINEN THREAD CO
BLUE MOUNTAIN ALABAMA
LING-ELECTRONICS DIV LING-TEMCO VOUGHT
1515 S MANCHESTER ANAHEIM CALIF
LINGO & SON INC JOHN E
2814 BUREN AVE CANDEN N J
LING-TEMCO VOUGHT INC ELECT DIV
BOX 6191 DALLAS TEXAS
LINK AVIATION INC SUB GEN PREC EQUIP CORP
HILLCREST BINGHAMTON NY
LINK-BELT CO
200 LYNDALE AVE MINNEAPOLIS MINN
LINK-BELT COMPANY
3405 SIXTH AVE SEATTLE 4 WASH
LINK-BELT COMPANY
300 W PERSHING RD CHICAGO ILL
LINK-BELT COMPANY BEARING PLANT
7601 ROCKVILLE ROAD INDIANAPOLIS 41 IND
LINK-BELT COMPANY
3203 S WAYSIDE HOUSTON 1 TEXAS
LINK-BELT COMPANY
2045 W HUNTING PARK AVE PHILADELPHIA 40 PA
LINK-BELT COMPANY
COLMAR PA
LINK-BELT COMPANY EWART PLANT
220 S BELMONT AVE INDIANAPOLIS 6 INO
LINK-BELT COMPANY
400 PAUL AVE SAN FRANCISCO 19 CALIF
LINK-BELT COMPANY
1200 SYCAMORE ST MNTBLO LOS ANGELES 22 CAL
LINK DIV GENERAL PRECISION INC
BINGHANTON N Y
LIN RESEARCH CORP
2412 REEDIE DR WHEATON MD
LIONEL - WADSWORTH ULTRASONICS INC
1440 BROADWAY NEW YORK 18 NY
LIONEL CORP
HOFFMAN PLACE HILLSIDE N J
LIONEL CORP LIONEL ELECTRONIC LABS DIV
1226 FLUSHING AVE BROOKLYN 37 NY
LION FASTENER CO INC
HONEOYE FALLS N Y
LION FASTENER CO INC
LESTER PA
LIPPS CO EDWIN A
1511 COLORADO AVE SANTA MONICA CALIF
LIQUIDOMETER CORP
41-03 36 ST LONG ISLAND CITY 1 N Y
LIQUIDOMETER CORP
ROCKINGHAM RD BELLOWS FALLS VERMONT
LISK CO G W
CLIFTON SPRINGS N Y
LITTELFUSE INC
1865 MINER ST DES PLAINES ILL
LITTLE FALLS ALLOYS INC
189 CALDWELL AVE PATERSON 1 NJ
LITTLEFORD BROS INC
451 E PEARL ST CINCINNATI 2 OHIO
LITTON ENGG LABS
PO BOX 949 GRASS VALLEY CALIF
LITTON INDUSTRIES ELECTRON TUBE DIVISION
960 INDUSTRIAL RD SAN CARLOS CAL
LITTON INDUSTRIES MARYLAND DIV
4900 CALVERT COLLEGE PARK MD
LITTON SYSTEMS INC APPLIED SCIENCE DIVISION
8535 WARNER DRIVE CULVER CITY CALIFORNIA
LITTON SYS INC GUIDANCE & CONTROL DIV
550D CANOGA AVE WOODLAND HILLS CALIF
LITTON SYST INC GUIDANCE & CONTROL DIV
2211 WEST NORTH TEMPLE SALT LAKE CITY UTAH
LITTON SYSTEMS CANADA LIMITED
123 REXDALE BLVD REXDALE TORONTO ONT CAN
LIVINGSTON AUDIO PRODUCTS CORP
BOX 202 CALDWELL N J
LIVINGSTON ELECT CORP
320 RUNNYMEDE RD ESSEX FALLS N J
L & L MFG CO
804 MULBERRY ST UPLAND CHESTER PA
LMB
2528 W 9TH ST LOS ANGELES CALIF
LOCKHEED AIRCRAFT LOCKHEED AIRCRAFT SER
ONTARIO AIRPORT ONTARIO CALIF
LOCKHEED ELECT CO INFORMATION TECHNOLOGY DIV
US HIGHWAY 1 METUCHEN NJ
LOCKREY CO
P O BOX J SOUTHAMPTON N Y
LOENCO INC
2092 N LINCOLN AVE ALTADENA CALIF
LOGE ELECTRONICS INC
2171 W WASHINGTON BLVD LOS ANGELES 18 CAL
LOGEMAN CO C W
633 BERGEN ST BROOKLYN 38 NY
LOGETRONICS INC
500 E MONROE AVE ALEXANDRIA VA
LONDON CHEMICAL CO INC
1535 N 31ST AVE MELROSE PARK ILL
LONG INC THOMAS J
215 STONEHINGE LA CARLE PL LI NY
LORAIN COUNTY RADIO CORP
203 9TH ST LORAIN OHIO
LORAL ELECTRONICS CORP
825 BRONX RIVER AVE NEW YORK 72 N Y
LORD MFG CO
1635 W 12TH ST ERIE 6 PA
LOUD MACHINE WORKS INC
969 E 2ND ST POMONA CALIF
LOUTHAN MFG CO DIV FERRO CORP
2000 HARVY AVE E LIVERPOOL OHIO
LOUTHAN PLANT REFRACTORIES DIV FERRO CORP
BOX 781 E LIVERPOOL OHIO
LOWELL MFG CO
3030 LACLEDE STATION RD ST LOUIS 17 MO
L & R MFG CO
577 ELM ST ARLINGTON NJ
LUCAS MILHAUPT ENGG CO
5051 S LAKE DR CUDAHY WISC
LUCCI AIRCRAFT INC
SARASOTA BRADENTON AIRPORT SARASOTA FLA
LUCKENBACH & CO PAUL
312 W 231ST ST NEW YORK 63 N Y
LUDLOW-SAYLOR WIRE CLOTH CO
634 S NEWSTEAD AVE ST LOUIS MO
LUDWIG HONOLD MFG CO
CHESTER PIKE & FOLCROFT AVE FOLCROFT PA
LUFKIN RULE CO
1730 HESS ST SAGINAW MICH
LUHRS & CO C H
297 HUDSON ST HACKENSACK N J
LUMA ELECTRIC EQUIPMENT CO
P O BOX 132 TOLEDO 1 OHIO
LUMATRON ELECTRONICS INC
116 COUNTY COURTHOUSE RO NEW HYDE PK LI NY
LUMEN INC
BOX 905 JOLIET ILLINOIS
LUMINATOR INC
630 TERMINAL WAY COSTA MESA CALIF
LUMINOUS PROCESSES INC
161 E 42 ST NEW YORK 17 NY
LUMINOUS PROCESSES INC
444 GREEN BAY RD KENILWORTH ILL
LUNDEY ASSOCIATES INC
694 MAIN ST WALTHAM 54 MASS
LUNDY ELECTRONICS & SYSTEMS INC
GLEN HEAD L I N Y
LUPER & SUNBERG
AVON ILL
LUXO LAMP CANADA LTD
370 STE CROIX BLVD MONTREAL 9 P Q CANADA
LUXO LAMP CORP
DOCK STREET PORT CHESTER N Y
LUXO LAMP CORP
1683 JERROLD AVE SAN FRAN CALIF
LYMAN ELECTRONIC CORP
P O BOX 1649 SPRINGFIELD 1 MASS
LYN TRON INC
5350 RIVERTON AVE N HOLLYWOOD CALIF
LYNCH COMMUNICATION SYSTEMS INC
695 BRYANT ST SAN FRANCISCO CALIF
LYNCH CORPORATION
2304 CRYSTAL ST ANDERSON IND
LYNCH MFG CO R H
7831 ARROYO DR SAN GABRIEL CALIF
LYNCOACH & TRUCK CO INC
ONEONTA N Y
LYON AIRCRAFT SERVICE
2701 N ONTARIO ST BURBANK CALIF
LYON METAL PRODUCTS INC
P O BOX 671 AURORA ILL

FOR INFORMATION

ON PRODUCTS

SEE THE

"PRODUCTS AND MANUFACTURERS"

SECTION

M

MAAS & WALDSTEIN CO
2121 MCCARTER HWY NEWARK N J
MACALLEN CO INC
BAY RD NEWMARKET N H
MACDERMID INCORPORATED
WATERBURY 20 CONN
MACDONALD AND COMPANY
714 E CALIFORNIA AVE GLENDALE 6 CALIF
MACHINE O MATIC
717 CHICAGO AVE EVANSTON ILL
MACHINERY ELECTRIFICATION INC
35 HUDSON ST NORTHBORO MASS
MACHLETT LABS INC
1063 HOPE ST SPRINGDALE CONN
MACK ELECTRIC DEVICES INC
48 GLENSIDE AVE WYNCOTE PENNA
MACK ENGINEERING
2626 31ST AVE SO MINNEAPOLIS 6 MINN
MACKAY INC A D
198 BROADWAY NEW YORK 38 N Y
MACKAY RADIO & TELEGRAPH CO MARINE DIV
133 TERMINAL AVE CLARK N J
MACKAY RESEARCH LABS
P O BOX 148A BENSON ARIZ
MACKENZIE ELECTRONICS INC
1025 N MCCADDEN PL HOLLYWOOD 38 CALIF
MACLEAN-FOGG LOCK NUT CO
5535 N WOLCOTT AVE CHICAGO 40 ILL
MACLEOD & HANOPOL
10 ROLAND ST CHARLESTOWN 29 MASS
MAC PANEL CO
BRENTWOOD ST HIGH POINT NO CAR
MADIGAN CORP
2119 W CENTRAL AVE ORLANDO FLA
MADIGAN ELECTRONIC CORP
200 STONEHINGE LANE CARLE PLACE NY
MAGNADYNE CORP
PORT CHESTER NY
MAGNAFLUX CORP
7328 W LAWRENCE AVE CHICAGO 31 ILL
MAGNASYNC MFG CO
5546 SATSUMA AVE N HOLLYWOOD CALIF
MAGNATRAN INC
PO BOX 211 KEARNY NJ
MAGNAVOX
US HWY 11 E JEFFERSON CITY TENN
MAGNAVOX
1505 E MAIN ST URBANA ILL
MAGNAVOX CO
2255 S CARMELINA AVE LOS ANGELES CALIF
MAGNAVOX COMPANY THE
2131 BUETER RD FT WAYNE 4 IND
MAGNE HEAD DIV GENERAL INST CORP
2660 S LACIENEGA BLVD LOS ANG CALIF
MAGNE-TRONICS INC
49 W 45 ST NEW YORK N Y
MAGNECESSORIES
BOX 6960 WASHINGTON 20 DC
MAGNECORD DIV MIDWESTERN INSTRUMENTS INC
P O BOX 7186 TULSA OKLA
MAGNECRAFT ELECTRIC CO
5575 N LYNCH AVE CHICAGO 30 ILL
MAGNETIC ANALYSIS CORP
42-44 12TH ST LONG ISLAND CITY NEW YORK
MAGNETIC CIRCUIT ELEMENTS INC
3722 PARK PL MONTROSE CALIF
MAGNETIC CONTROLS CO
6405 CAMBRIDGE ST MINN MINN
MAGNETIC CORE CORP
JOHN & LAWRENCE STS BOX 368 NEWBURGH N Y
MAGNETIC CORP
7232 ETON AVE CANOGA PARK CALIF
MAGNETIC DEVICES INC
712 EAST ST FREDERICK MD
MAGNETIC INDUSTRIES INC SUB PREC INSTR CO
3941 E BAYSHORE BLVD PALO ALTO CALIF
MAGNETIC INSTRUMENT CO INC
546 COMMERCE ST THORNWOOD NY
MAGNETIC METALS CO
HAYES AVE & 21 ST CAMDEN 1 N J
MAGNETIC RESEARCH CORP
3160 W EL SEGUNDO BLVD HAWTHORNE CALIF
MAGNETIC SHIELD DIV PERFECTION MICA CO
1322 N ELSTON AVE CHICAGO 22 ILL
MAGNETICO INC
6 RICHTER CT E NORTHPORT LI NY
MAGNETICS INC
BUTLER PA
MAGNETICS RESEARCH CO
179 WESTMORELAND AVE WHITE PLAINS N Y
MAGNETIC SYSTEMS CORP
1897 US 19 S CLEARWATER FLA
MAGTON INC SUB MORTON SALT CO
110 N WACKER DR CHICAGO 6 ILL
MAGNION INC
195 ALBANY ST CAMBRIDGE 39 MASS
MAGTROL INC
240 SENECA ST BUFFALO 4 NY
MAHLER RESEARCH FOUNDATION
PO BOX 1159 NEW YORK 1 NY
MAHONEY TELETRONIC LABS INC
209 16 AVE NEWARK 3 N J
MAICO ELECTRONICS INC
21 N 3RD ST MINNEAPOLIS 1 MINN
MAICO ELECTRONICS INC DYNAMU MAGNETRONICS DV
21 N 3 ST MINNEAPOLIS 1 MINN
MAICO ELECTRONICS INC ENG DIV
123 NORTH 3RD ST MINN MINN
MAIDA DEVELOPMENT CO
214 ACADEMY ST HAMPTON VA
MAILINK STEEL SAFE CO GIANT VIEW NETWORK
1672 OAKWOOD AVE TOLEDO 6 OHIO
MAJESTIC EXTRUDERS INC
32-37 DOWNING ST FLUSHING 52 N Y
MAJOR ELECTRONICS CORP
762 WYTHE AVE BROOKLYN 11 N Y
MAKEPEACE DIV D E ENGLEHARD INDUSTRIES INC
PINE & DENHAM STS ATTLEBORO MASS
MALCO MFG CO
4025 W LAKE ST CHICAGO 24 ILL
MALKIN-ILLION CO
400 COIT ST IRVINGTON 11 N J
MALLINCKRODT CHEMICAL WORKS
2 & MALLINCKRODT STS ST LOUIS 7 MO
MALLINCKRODT CHEMICAL WORKS
223-243 W SIDE AVE JERSEY CITY N J
MALLINCKRODT CHEMICAL WORKS
3600 N 2ND ST ST LOUIS MO
P R MALLORY & CO INC
3029 E WASHINGTON ST INDIANAPOLIS 6 IND
MALLORY & CO INC P R
42 S GRAY ST INDIANAPOLIS 6 INO
MALLORY CAPACITOR CO DIV P R MALLORY CO INC
CRAWFORDSVILLE IND
MALLORY CAPACITOR CO DIV P R MALLORY CO INC
HUNTSVILLE ALA
MALLORY CAPACITOR CO DIV PR MALLORY CO INC
42 S GRAY ST INDIANAPOLIS IND
MALLORY CAPACITOR CO
GREENCASTLE IND
MALLORY ELCTMGNTC CO DIV PR MALLORY & CO INC
DUQUOIN ILL
MALLORY ELECTRONICS CO PR MALLORY CO INC
3302 ENGLISH AVE INDIANAPOLIS 6 IND
MALLORY ELECT CO
3625 INDUSTRY AVE LAKEWOOD CALIF
MALLORY METALLURGICAL CO
3029 E WASHINGTON ST IND IND
MAMCO CORP
532-542 4TH ST RACINE WISC
MANDEX MFG CO INC
2614 W 48TH ST CHICAGO 32 ILL
MANDREL INDUSTRIES INC MEG PRODUCTS DIVISION
BOX 3115 SEATTLE 14 WASHINGTON
MANNING PAPER CO JOHN A
P O BOX DRAWER 328 TROY N Y
MANOSTAT CORP
20-26 N MOORE ST NEW YORK 13 NY
MANSOL CERAMICS CO
140 LITTLE ST BELLEVILLE NJ
MANSON LABORATORIES INC
375 FAIRFIELD AVE STAMFORD CONN
MANUFACTURERS ENGG & EQUIP CORP
YORK RD & SUNSET LANE HATBORO PA
MANUFACTURERS CHEMICAL CO INC
1450 FERRY ST CAMDEN N J
MARANTZ CO
25-14 BDWY LONG ISLAND CITY N Y
MARATHON BATTERY CO
840 HENRIETTA ST WAUSAU WISC
MARATHON ELECTRIC MFG CO
EARLVILLE ILL
MARBLETTE CORP
37-31 30 ST LONG ISLAND CITY 1 N Y
MARBON CHEMICAL DIV BORG-WARNER CORP
P O BOX 68 WASHINGTON W VA
MARCH DYNAMICS INC
920 SOUTH OYSTER BAY ROAD HICKSVILLE NY
MARCHANT MACHINING CORP
4704 RHODE ISLAND AVE HYATTSVILLE MD
MARCO INDUSTRIES CO
207 SOUTH HELENA ST ANAHEIM CALIF
MARCON ELECTRONICS CORP
KEARNY NJ
MARCONI INSTRUMENTS
111 CEDAR DRIVE ENGLEWOOD N J
ROBERT J MARCY ASSOCIATES
80 8TH AVE NEW YORK 11 NY
MAROUTH PROD
1387 LEDGE RD HINCKLEY OHIO
MARINE ELECTRIC CORP
600 4TH AVE BROOKLYN 15 N Y
MARION INSTRUMENT DIV
GRENIER FIELD MANCHESTER NH
MARK PRODUCTS CO
5439 FARGO AVE SKOKIE ILL
MARKAL COMPANY
3052 W CARROLL AVE CHICAGO ILL
MARKEL & SONS LFRANK
SCHOOL LANE NORRISTOWN PA
MARKEM MACHINE CO
150 CONGRESS ST KEENE N H
MARKITE CORP
155 WAVERLY PL NEW YORK N Y
MARLIN-ROCKWELL CORP
402 CHANDLER ST JAMESTOWN NY
MARLIN-ROCKWELL CORP
FALCONER N Y
MARMA ELECTRONICS CO
1633 N HALSTED ST CHICAGO 14 ILL
MARQUARDT CORP
2771 N GAREY AVE POMONA CAL
MARQUETTE DIV CURTISS-WRIGHT CORP
1145 GALEWOOD DR CLEVELAND 10 OHIO
MARS INDUSTRIES INC
5209 W BROADWAY MINNEAPOLIS 22 MINN
MARSHALL ASSOCIATES INC JOHN
BOX 2463 BRIDGEPORT 8 CONN
MARSHALLTOWN MFG CO
810 E NEVADA ST MARSHALLTOWN IOWA
MARSLAND ENGG LTD
350 WEBER ST N WATERLOO ONT CANADA
MARSTAN ELECTRONICS CORP
204 BABYLON TURNPIKE ROOSEVELT LI NY
MARTIN MARIETTA CORP ORLANDO DIV
BOX 5837 ORLANDO FLA
MARTIN MARIETTA CORP
DENVER 1 COLO
MARTIN COMPANY ELECT SYS & PROD DIV
BALTIMORE 1 MARYLAND
MARTIN PROD INC
139 E CENTRAL BLVD PALISADES PARK N J
MARTRONICS INC
82 SANFORD ST HAMDEN 14 CONN
MARYLAND CERAMIC & STEATITE CO INC
BOX 127 BELAIR MD
MARYLAND TELECOMMUNICATIONS INC
10 B WINTERS LANE BALTIMORE 28 MD
MASER OPTICS INC
89 BRIGHTON AVE BOSTON 34 MASS
MASK O MATIC INC
55 BELMONT AVE PATERSON 2 N J
MASON ELECTRIC CORP
3839 VERDUGO RD LOS ANGELES 65 CALIF
MASON-NEILAND DIV WORTHINGTON CORP
55 NAHATAN ST NORWOOD MASS
MASONITE CORP
LAUREL MISSISSIPPI
MASONITE FABRICATORS
1577 RIO VISTA AVE LOS ANGELES CALIF
MASONITE FABRICATORS
10360 EVENDALE DR CINN OHIO
MAST DEVELOPMENT CO INC
2212 E 12TH ST DAVENPORT IOWA
MASTER APPLIANCE INC
1600 FACTORY AVE MARION IND
MASTER ENGRAVING STUDIOS
135 LIBERTY ST NEW YORK 6 NY
MASTER MOBILE MOUNTS INC
4125 W JEFFERSON BLVD LOS ANG CALIF
MASTER SPECIALTIES CO
956 E 108TH ST LOS ANGELES 59 CALIF
MASTER TAPE PRINTERS INC
3400 N HALSTED ST CHICAGO ILL
MASTERCRAFT INSTRUMENT CO
DUBUQUE IOWA
MASTERITE INDUSTRIES INC
835 W OLIVE ST INGLEWOOD CALIF
MASTRA CO
2104 SUPERIOR AVE CLEVELAND 18 OHIO
MATERIALS FOR ELECTRONICS CO
BLDG 17 INTL AIRPORT JAMAICA N Y
MATHIS CO G E
6100 S OAK PARK AVE CHICAGO 38 ILL
MATRIX CORP
839 NEW YORK AVE TOLEDO OHIO
MATRIX ELECTRONICS CORP
6360 FEDERAL BLVD SAN DIEGO 14 CALIF
MATRIX RES & DEV CORP
11 MULBERRY ST NASHUA N H
MATTERN CORPORATION
7444 W WILSON AVENUE CHICAGO 31 ILL
MATTHEWS & CO JAS
3823 FORBES ST PITTSBURGH 13 PA
MATTHEWS RESEARCH INC
4306 WHEELER AVE ALEXANDRIA VA
MAURER INC J A
3701 31 ST LONG ISLAND CITY 1 NY
MAUREY INSTRUMENT CORP
4555 W 60TH ST CHICAGO 29 ILL
MAXSON ELECTRONICS CORP
475 10TH AVE NEW YORK 18 N Y
MAXSON ELECTRONICS CORP
MAXSON DR OLD FORGE PENNA
MAXSON INSTRUMENTS
DIV MAXSON ELECTRONICS CORP
460 W 34 ST NEW YORK 1 NY
MAXSON ELECTRONICS CORP ELECTRONIC OES DIV
2311 FARRINGTON DALLAS 7 TEX
MAY RESEARCH INC
1405 11 AVE SO BOX 1167 MPLS 40 MINN
MAYBERRY ELECTRONICS CO
111 S OAK ST INGLEWOOD 1 CALIF
MAYFLOWER ELECTRONIC DEVICES INC
20 INDUSTRIAL AVE LITTLE FERRY NJ
MAYSTEEL PRODUCT INC
MAYVILLE WISC
MAYTAG ELECTRONICS INC
730 S TEJON STREET COLORADO SPRINGS COLO
MB ELECT VIBRATION ENGG PLANT
781 WHALLEY AVE NEW HAVEN CONN
MB ELECTRONICS DIV TEXTRON ELECT INC
781 WHALLEY AVE NEW HAVEN CONN
MC CLURE PROJECTORS
BX 1338 1012 CHURCH ST EVANSTON ILL
MCALISTER INC J G
1117 N MCCADDEN PL HOLLYWOOD 38 CALIF
MCCARRON ELECTRIC CO
721 MONTEREY PASS RD MONTEREY PK CALIF
MCCORMICK SELPH ASSOC
HOLLISTER AIRPORT HOLLISTER CALIF
MCCOY ELECTRONICS CO
CHESTNUT & WATTS STS MT HOLLY SPRINGS PA
MCCULLOUGH TOOL CO
5820 S ALAMEDA ST LOS ANG CALIF
MCDONNELL & MILLER INC
3500 N SPAULDING AVE CHICAGO 18 ILL
MCDONNELL AIRCRAFT CORP
LAMBERT-ST LOU ARPT BX 516 ST LOUIS 66 MO
MCGILL MFG CO ELECTRICAL DIV
1002 N CAMPBELL ST VALPARAISO IND
MCGOHAN INC DON
3700 W ROOSEVELT RD CHICAGO 24 ILL
MCGRAW EDISON PRIMARY BATTERY DIV
BLOOMFIELD N J
MCGREGOR ELECTRONIC INDUSTRIES INC
132 FIRST ST MCGREGOR IOWA
MCINTOSH LABS INC
2 CHAMBERS ST BINGHAMTON N Y
MCKENNA LABORATORIES
2503 MAIN ST SANTA MONICA CALIF
MCLEAN ENGG LABS
P O BOX 228 70 WASHINGTON RD PRINCETON N J

MCLEAN SYNTORQUE CORP
WEST HURLEY N Y
MCMARTIN INDUSTRIES INC
OMAHA NEBRASKA
MCMILLAN COMPANIES
BROWNVILLE AVE IPSWICH MASS
MEAGHER ELECTRONICS CO
177 WEBSTER STREET MONTEREY CALIF
MEASUREMENT ENGG LTD
232 JOHN ST ARNPRIOR ONTARIO CAN
MEASUREMENTS DIV MC GRAW-EDISON CO
BOX 180 BOONTON NJ
MEASUREMENT SYSTEMS INC
140 WATER ST S NORWALK CONN
M E C INC
796 BERRY RD P O BOX 577 NASHVILLE TENN
MECA ELECTRONICS
107 E 8TH ST GIBSON CITY ILL
MECA ELECTRONICS INC
P O BOX 645 DOVER N J
MECH-TRONIC EQUIPMENT CO
P O BOX 510 SILVER SPRING MD
MECHANICAL ENGRAVING CO INC
10 VAN CORTLANDT AVE E NEW YORK 68 N Y
MECHANICAL INDUSTRIES PRODS CO
217 ASH ST AKRON 8 OHIO
MECHANICAL INDUST SOUTHERN CORP
1500 S W 40TH ST FORT LAUDERDAL EFLA
MECHANICAL PRODUCTS INC
1824 RIVER ST JACKSON MICH
MECHANICS FOR ELECTRONICS INC
249 FIFTH ST CAMBRIDGE 42 MASS
MECHATROL DIV SERVOMECHANISIMS INC
1200 PROSPECT AVE WESTBURY NY
MECTRON CO
166 RIDGE AVE NORTH PLAINFIELD NJ
MECTRON CO
501 E 1ST AVE ROSELLE N J
MEDCRAFT ELECTRONIC CORP
426 GREAT EAST NECK RD BABYLON NY
MEDISTOR INST CO
1443 NORTHLAKE WAY SEATTLE 3 WASH
MEDTRONIC INC
3055 HIWAY NO 8 MINNEAPOLIS 18 MINN
MEKTRON DIV CALIF GENERAL INC
798 F BOX 937 CHULA VISTA CALIF
MELABS
3300 HILLVIEW AVE PALO ALTO CALIF
MELCO PRODUCTS INC
301 5 AVE S MINNEAPOLIS 15 MINN
MELCOR ELECT CORP
48 TOLEDO ST S FARMINGDALE N Y
MELETRON CORP
950 N HIGHLAND AVE LOS ANGELES 38 CALIF
MELETRON CORP
940 N ORANGE DR LOS ANG CALIF
MELODY MASTER MFG CO
2149 W ROSCOE ST CHICAGO 18 ILL
MELPAR INC
3000 ARLINGTON BLVD FALLS CHURCH VA
MEL-RAIN CORP
2100 E FLETCHER AVE INDIANAPOLIS 3 IND
MELROY ELECTRONIC MFG CO
1012 CLEVELAND ST CLEARWATER FLA
MEL SCHWARTZ CO
48 PINE ST EAST PATERSON NJ
MEMOREX CORP
1180 SHULMAN AVE SANTA CLARA CALIF
MENLO PARK ENGG
711 HAMILTON AVE MENLO PARK CALIF
MEPCO INC
35-37ABBETT AVE MORRISTOWN NJ
MERCAST MFG CORP
2620 1 ST LA VERNE CALIF
MERCK & CO INC ELECTRONIC CHEM DIV
LINCOLN AVE RAHWAY NJ
MERCOID CORP
4201 BELMONT AVE CHICAGO 41 ILL
MERCURY AIR PARTS CO INC
BX 135 9310 W JEFFERSON CULVER CITY CALIF
MERCURY CONTACTS INC
1950 NEVA DRIVE DAYTON 14 OHIO
MERCURY ENGG CORP
339 E COTTAGE PL YORK PA
MERCURY TRANSFORMER CORP
12964 PANAMA ST LOS ANGELES 66 CALIF
MERIAM INSTRUMENT CO ELECTRONIC DIV
10120 MADISON CLEVELAND 35 OHIO
MERIDIAN METALCRAFT INC
8739 S MILLERGROVE DR WHITTIER CALIF
MERIT SHORT WAVE DIATHERMY CO
2758 WHITTIER BLVD LOS ANGELES 23 CALIF
MERIX CHEMICAL CO
2234 E 75TH ST CHICAGO 49 ILL
MERRIMAC RESEARCH & DEVELOPMENT INC
517 LYONS AVE IRVINGTON N J
MESA PLASTICS CO
12270 NEBRASKA AVE LOS ANGELES 25 CALIF
MESUR MATIC ELECTRONICS CORP
BRADFORD NH
METACHEM RESINS CORP MERECO PRODS DIV
530 WELLINGTON AVE CRANSTON 10 R I
ELECTRONICS DIV METAL TEXTILE CORP
647 E 1ST AVE ROSELLE N J
METAL CRAFT INC
BURGESS PL WAYNE N J
METAL EDGE INDUSTRIES
GLOUSTER PIKE BARRINGTON NJ
METAL FABRICATORS CORP
73 POND ST WALTHAM 54 MASS
METAL HYDRIDES INCORP
12 24 CONGRESS ST BEVERLY MASS
METAL SPECIALTY PRODUCTS CORP
27-01 BROOKLYN QUEENS EXP W WOODSIDE 77 NY
METAL & THERMIT CORP
CARTERET N J
METALECTRO LAB
11423 VANOWEN ST HOLLYWOOD CALIF
METALLIZING CO OF LOS ANG INC
1233 S BOYLE AVE LOS ANG CALIF
METALLO GASKET CO
16 BETHANY ST NEW BRUNSWICK N J
METALPHOTO CORP
18531 S MILES RD CLEVELAND OHIO
METALPHOTO OF CINCINNATI
7 E 75TH ST CINCINNATI OHIO
METALS & CONTROLS INC COMMERCIAL CONTRLS DPT
300 N MAIN VERSAILLES KY
METAVAC INC
45-68 162 ST FLUSHING 58 N Y
METCOM INC
76 LAFAYETTE ST SALEM MASS
METEOR PRODUCTION ENGRG INC
1465 S VANDEVENTER AVE ST LOUIS MO
METER MAKERS INC
1101 W ARMITAGE CHICAGO ILL
METERS INC
5353 N KEYSTONE AVE INDIANAPOLIS 20 IND
METETELIC CORP
83 ERNA AVE MILFORD CONN
METEX ELECTRONICS
WALNUT AVE CLARK N J
METHODE MFG CORP
7447 W WILSON AVE CHICAGO 31 ILL
METHODE MFG CO
1700 HICKS RD ROLLING MEADOWS ILL
METHODS RESEARCH CORP
105 W WILLOW AVENUE STATEN ISLAND 5 NY
MET-L-CHEK CO THE
11919 S WESTERN AVE LOS ANGELES 47 CALIF
METOX
68 RUE VILLIERES DE 1 PARIS 20EME FRANCE
METPRO INC R I
230 TORONTO AVE PROVIDENCE 5 R I
METRIC SYSTEMS CORP
736 N BEALE ST FT WALTON BEACH FLA
METRON INSTRUMENT CO
432 LINCOLN ST DENVER 3 COLO
METRON INSTRUMENT CO
5302 S DELAWARE ST LITTLETON COLO
METRONIX INC
75 WILSON MILLS RD CHESTERLAND OHIO
METROPOLITAN TELECOMMUNICATIONS CORP
COIL WINDERS DIV
AMES CT PLAINVIEW NY
METROTEK ELECTRONICS INC
205 W CABARRUS ST RALEIGH NO CAR
METZ REFINING CO
369 MULBERRY ST NEWARK 2 NJ
MEYER MANUFACTURING
410 NW 2ND ST PIPESTONE MINN
M F ELECTEONICS CORP
118 E 25 ST NEW YORK NY
M-G METAL PRODS CO
1217 WEBSTER AVE CHICAGO 14 ILL
M H STANDARD CORP
400 HEATON ST HAMILTON OHIO
M-H STANDARD CORP
510 COMMUNIPAW AVE JERSEY CITY 4 NJ
MICA CORP
4031 ELENDA ST CULVER CITY CALIF
MICA INSULATOR DIV MINNESOTA MINING MFG CO
797 BROADWAY SCHENECTADY 1 NY
MICACRAFT PRODUCTS INC
49 LIBERTY STREET NEWARK NJ
MICA FAB CO
53 CENTRAL AVE ROCHELLE PARK N J
MICAMOLD ELECTRONICS MFG CORP
65 GOUVERNEUR ST NEWARK 4 NJ
MIAC PRODUCTS CO
8506 ILL RD HWY 14 FORT WAYNE IND
MICARTA FABRICATORS INC
5324 N RAVENSWOOD AVE CHICAGO 4 ILL
MICHIGAN MAGNETICS INC
VERMONTVILLE MICH
MICHIGAN MAGNETICS INC
656 GRAND ALLEGAN MICH
MICHIGAN PANELYTE MOLDED PLASTICS DIV
ST REGIS PAPER CO
DEXTER MICH
MICHIGAN WIRE CLOTH CO
2100 HOWARD ST DETROIT MICH
MICO INSTRUMENT CO
80 TROWBRIDGE ST CAMBRIDGE 38 MASS
MICON ELECTRONICS INC SUB METALCRAFT INC
ROOSEVELT FIELD GARDEN CITY L I N Y
MICRO BALANCING INC
191 HERRICKS RD GARDEN CITY N Y
MICRO-CIRCUITS CO
NEW BUFFALO MICH
MICRODOT INC
220 PASADENA AVE S PASADENA CALIF
MICRODOT INC MAGNETICS DIV
5960 BOWCROFT ST LOS ANG CALIF
MICRO GEE PROD INC
6319 SLAUS AVE CULVER CITY CALIF
MICROFLECT CO
3450 S 25 ST SALEM DRE
MICRO INSTRUMENT CO
2245 S FEDERAL AVE LOS ANGELES 64 CAL
MICROLAB
570 W MT PLEASANT AVE LIVINGSTON N J
MICRO LECTRIC INC
19 DEBEVOISE AVE ROOSEVELT N Y
MICROLECTRON INC
1547 18TH ST SANTA MONICA CALIF
MICROMAG INSTRUMENT CO
115 HALLECK ST ROXBURY 20 MASS
MICRO MAGNA ELECTRONICS CORP
1101 POWER AVE CLEVELAND 14 OHIO
MICROMAT CO
548 PIERMONT AVE HILLSIDE N J
MICRDMATIC MACHINE CORP
45 MORGAN AVE BROOKLYN 37 N Y
MICRO MEASUREMENTS CORP
2412 NORWOOD MELROSE PARK ILL
MICROMECH MFG CO
695 RAHWAY AVE UNION N J
MICROMEGA CORPORATION
4134 DEL REY AVE VENICE CALIF
MICROMETALS
72 E MONTECITO AVE SIERRA MADRE CALIF
MICROMETRICAL MFG CO
3621 S STATE ANN ARBOR MICH
MICRO METRICS INC
165 PENNSYLVANIA AVE PATERSON 3 N J
MICROMODULAR COMPONENTS DIV
BOX S 1 ANAHEIM CALIF
MICROMOLD PRODUCTS CORP
1 SCHOOL ST YONKERS N Y
MICRONETICS INC
5221 UNIVERSITY AVE SAN DIEGO 5 CALIF
MICRON GEAR MFG CO
73 RUSHMORE ST WESTBURY L I NY
MICRONICS CORP OF AMERICA
8116 OLD YORK RD PHILA 17 PA
MICRO-NOW INSTRUMENT CO INC
6340 N TRIPP AVE CHICAGO 46 ILL
MICROPHASE CORP
BOX 1166 GREENWICH CONN
MICRO PUMP CORP
BOX 392 DANVILLE CALIF
MICRO-RADIONICS INC
14844 OXNARD ST VAN NUYS CALIF
MICROSECOND ELECT INC
3213 E WASHINGTON PHOENIX ARIZONA
MICROSEMICONDUCTOR CORP
11250 PLAYA CT CULVER CITY CALIF
MICRO SONIC INDUSTRIES INC
5305 CHICAGO AVE MINNEAPOLIS MINN
MICROSONICS INC
349 LINCOLN ST HINGHAM MASS
MICROSONICS INC
60 WINTER ST WEYMOUTH 88 MASS
MICROSPACE INC
170 S VAN BRUNT ST ENGLEWOOD N J
MICRO STATE ELECTRONICS CORP
152 FLORAL AVE MURRAY HILL N J
MICRO SYSTEMS INC
319 AGUSTINO RD SAN GABRIEL CALIF
MICROTECH INC
MILLDALE RD CHESHIRE CONN
MICROTRAN CO
145 E MINEOLA AVE VALLEY STREAM NY
MICROWAVE ASSOCIATES INC
BURLINGTON MASS
MICROWAVE DEVELOPMENT LABS
15 STRATHMORE ROAD NATICK MASS
MICROWAVE ELECTRONIC TUBE CO INC
76 LAFAYETTE ST SALEM MASS
MICROWAVE ELECT CORP
4061 TRANSPORT ST PALO ALTO CALIF
MICROWAVE ENG LABS
943 INDUSTRIAL AVE PALO ALTO CALIF
MICROWAVE PHYSICS CORP
420 KIRBY ST GARLAND TEX
MICROWAVE PRODUCTS INC
14821 AETNA ST VAN NUYS CAL
MICROWAVE SERVICES INTL INC
ROUTE 46 CISCO RD DENVILLE NJ
MID-CONTINENT ENGINEERING
1712 NORTHEAST NARSHALL MINN MINN
MIDDLESEX PAPER TUBE CO
345 CHELMSFORD ST LOWELL MASS
MID-EASTERN ELECTRONICS INC
32 COMMERCE ST SPRINGFIELD NJ
MIDGET LOUVER CO
6-8 WALL ST NORWALK CONN
MIDLAND INDUSTRIAL FINISHES CO
E WATER ST WAUKEGAN ILL
MIDLAND MFG CO
3155 FIBERGLAS RD KANSAS CITY 15 KANSAS
MIDWEST COIL & TRANSF CO
1640 N HALSTED ST CHICAGO ILL
MIDWEST ELECTRIC PRODUCTS INC
1515 N FRONT ST MANKATO MINN
MIDWEST METAL PRODUCTS INC
450 E DONOVAN ROAD KANSAS CITY 15 KANS
MIDWEST MOLDING & MFG CO
GURNEE ILL
MID-WEST SPRING CO
ETNA ST MENTON IND
MIDWESTERN INSTRUMENTS
PO BOX 7509 TULSA OKLA
MIKROS INC
7620 S W MACADAM AVE PORTLAND ORE
MILAM ELECTRIC MFG CO
1100 ELMWOOD AVE PROVIDENCE 7 RI
MILBURN CO
3246 E WOODBRIDGE DETROIT 7 MICH
MILES REPRODUCER CO
812 BROADWAY NEW YORK 3 N Y
MILFORD RIVET & MACHINE CO
MILFORD CONN
MILFORD RIVET & MACH CO
801 ILL AVE AURORA ILL
MILFORD RIVET & MCH CO
FLYRIA OHIO
MILGO ELECT CORP
7620 N W 36TH AVE MIAMI FLA
MILLEN MFG CO JAMES
150 EXCHANGE ST MALDEN 48 MASS
MILLER ASSOCIATES
P O BOX 369 LAKEVILLE CONN
MILLER CO J W
5917 S MAIN ST LOS ANGELES 3 CALIF
MILLER CO M C
288 SADDLE RIVER RD UPPER SADDLE RV N J

MILLER CORP HARRY
4TH & BRISTOL STS PHILA PA
MILLER DIAL & NAMEPLATE CO
4400 N TEMPLE CITY BLVD EL MONTE CALIF
MILLER ELECTRO RESEARCH LABS
5529 S 5TH ST MILWAUKEE 7 WISC
MILLER FRANKLIN P & SON INC
36 MEADOW ST EAST ORANGE N J
MILLER-HARRIS INSTRUMENT CO
1134 S FIRST ST MILWAUKEE 4 WISC
MILLER-TROJAN CO INC
TROY OHIO
MILLETRON INC
IRWIN PA
MILLI SWITCH CORP
FRANKFORT INO
MILLI-SWITCH CORP
PO BOX 67 MILL CREEK RD GLADWYNE PA
MILLIPORE FILTER CORP
P O BOX 427 BEDFORD MASS
MILLITEST CORP
88 MADISON AVE HEMPSTEAD N Y
MILLIVAC INSTRUMENTS INC
BOX 997 SCHENECTADY N Y
MILRO CONTROLS CO INC
280 MIDLAND AVE SADDLE BROOK N J
MILTON-ROY CO
6301 49TH BOX 12169 ST PETERSBURG FLA
MILWAUKEE ELECTRONICS CORP
5219 N HOPKINS ST MILWAUKEE 9 WIS
MILWAUKEE RELAYS INC
606 E PIONEER RD CEDARBURG WIS
MILWAUKEE RESISTOR CO
700 W VIRGINIA ST MILWAUKEE 4 WISC
MILWAUKEE STAMPING CO
800 S 72 ST MILWAUKEE 14 WISC
MINARIK ELECTRIC CO
224 E 3RD ST LOS ANG CALIF
MINATRON CORP
BELLE MEAD 9 N J
MINATURE INSTRUMENTS INC
PTONE ELECTRONICS DIVISION
9440 SCIENCE CENTER DRIVE MINN 27 MINN
MINCO PRODUCTS INC
740 WASHINGTON AVE MINNEAPOLIS 1 MINN
MINCOM DIV MINN MINING & MFG CO
2049 S BARRINGTON AVE LOS ANGELES 25 CAL
MINE SAFETY APPLIANCES CO
201 N BRADDOCK AVE PITTSBURGH 8 PA
MINELCO
21 PLYMOUTH ST HOLBROOK MASS
MINERALS & INSULATION CO
ROCHELLE PARK NJ
MINIATURE ELECTRONIC COMPONENTS CORP
HOLBROOK MASS
MINI-MOLD INC
14759 BESSEMER ST VAN NUYS CALIF
MINI-TOOL TECHNICAL INDUST INC
344 GRAND AVE ENGLEWOOD N J
MINICORD CORP OF AMERICA
1915 ATLANTIC AVE ATLANTIC CITY N J
MINISINK RUBBER CO INC
ORANGE COUNTY UNIONVILLE N Y
MINITEC
5423 DELAWARE AVE LOS ANGELES 4 CALIF
MINNEAPOLIS ELECT
2233 UNIVERSITY AVE ST PAUL MINN
MINNEAPOLIS-HONEYWELL HEILAND DIV
5200 E EVANS AVE DENVER COLO
MINNEAPOLIS-HONEYWELL MICRO SWITCH DIV
CHICAGO & SPRING STS FREEPORT ILL
MINNEAPOLIS-HONEYWELL BOSTON DIV
1400 SOLDIERS FIELD RD BOSTON MASS
MINNEAPOLIS-HONEYWELL FALL RIVER DIV
PENN & BAY STS FALL RIVER MASS
MINNEAPOLIS-HONEYWELL ELECT PROC DIV
60 WALNUT ST WELLESLEY HILLS MASS
MINNEAPOLIS HONEYWELL APPARATUS CONTROLS DIV
2753 4TH AVE MINNEAPOLIS MINN
MINNEAPOLIS-HONEYWELL CERAMIC LAB
1885 DOUGLAS DR N MINNEAPOLIS MINN
MINNEAPOLIS-HONEYWELL ORDNANCE DIV
600 2ND ST N HOPKINS MINN
MINNEAPOLIS-HONEYWELL AERO DIV
2600 RIDGWAY RD MINNEAPOLIS MINN
MINNEAPOLIS-HONEYWELL SEMICOND PROD DIV
1015 S 6 ST MINNEAPOLIS MINN
MINNEAPOLIS-HONEYWELL PRECISION METER DIV
GRENIER FIELD MANCHESTER N H
MINNEAPOLIS-HONEYWELL BROWN INST DIV
WAYNE & WINDRIM AVES PHILA PA
MINNEAPOLIS-HONEYWELL RUBICON DIV
RIDGE AVE 35 ST PHILA PA
MINNEAPOLIS-HONEYWELL SPECIAL SYS DIV
QUEEN & S BAILEY POTTSTOWN PA
MINN MINING & MFG CO ELECT PRODS DIV
900 BUSH ST ST PAUL 6 MINN
MINN MINING & MFG CO IRVINGTON DIV
BOX 108 FREEHOLD N J
MINN MINING MFG CO CHEMICAL DIV
900 BUSH ST ST PAUL 6 MINN
MINNESOTA MINING & MFG CO
900 BUSH AVE ST PAUL 6 MINN
MINNESOTA MINING & MFG CO
HUTCHINSON MINN
MINNESOTA RUBBER CO
3630 WOODALE AVE MINN MINN
MINOR RUBBER CO
ACKERMAN ST BLOOMFIELD N J
MINSHALL ORGAN INC
28 BIRGE ST BRATTLEBORO VT
MINSTER MACHINE CO
1500 S 5TH ST MINSTER OHIO
MIRATEL INC
1 ST SE & RICHARDSON NEW BRIGHTON MINN
MIRATEL INC
1080 DIONNE ST ST PAUL 13 MINN
MISCO
3806 GRAND AVE MINNEAPOLIS MINN
MISKELLA INFRA-RED CO
E 73 & GRAND AVE CLEVELAND 4 OHIO
MISSILE SYSTEMS CORP CALIFORNIA DIVISION
11949 VOSE ST N HOLLYWOOD CALIF
MISSILE TRONICS CORP
245 4TH ST PASSAIC N J
MISSIMERS INC
3737 SAN FERNANDO RD GLENDALE CALIF
MISSOURI RESEARCH LABORATORIES INC
2109 LOCUST ST ST LOUIS 3 MO
MITCHELL CAMERA CORP ASTRONICS DIV
666 W HARVARD ST GLENDALE CALIF
MITCHELL INDUSTRIES INC
MUNICIPAL A P PO BOX 17 MINERAL WELLS TEX
MITE CORP
580 WINTERS AVE PARAMUS N J
MITRONICS INC
132 FLORAL AVE MURRAY HILL NJ
MKS INSTRUMENTS INC
45 MIDDLESEX TPKE BURLINGTON MASS
M & O PLASTICS PRODUCTS
BOX 402 BANNARD ST FREEHOLD NJ
MNEMOTRON CORP
441 WASHINGTON AVE NO HAVEN CONN
MOBIL ELECTRONICS MFG CO
1111 STATE RO 67 E ANDERSON INO
MODEL ENGG & MFG INC
50 FREDERICK ST HUNTINGTON INO
MODEL RECTIFIER CORP
1675 UTICA AVENUE BROOKLYN 34 N Y
MODELECTRIC PRODUCTS CORP
ASBURY PARK N J
MODERN DESIGN OIV H C SCHLOER INC
VESTAL PARKWAY EAST VESTAL N Y
MODERN INDUSTRIES INC
5755 CAMILLE AVE CULVER CITY CALIF

FOR INFORMATION

ON PRODUCTS

SEE THE

"PRODUCTS AND MANUFACTURERS"

SECTION

MODERN LABORATORY EQUIP CO
1811 1 AVE NEW YORK 28 N Y
MODULAR INST CORP DIV ASTROSONICS INC
190 MICHAEL DR SYOSSET N Y
MOHAWK COMMUNICATIONS INC
CHAOWICKS 1 NY
MODULAR ELECTRONICS INC
521 CENTRAL AVE OSSEA MINN
MOHAWK ELECTRONICS CORPORATION
944 HALSEY ST BROOKLYN 33 NY
MOHAWK MFG CO
P O BOX 1110 MIDDLETOWN CONN
MOHAWK WIRE & CABLE CORP
45 SUMMER ST LEOMINSTER MASS
MOISTURE REGISTER CO
1510 W CHESTNUT ST ALHAMBRA CALIF
MOLDED FIBRE GLASS BODY CO
4601 BENEFIT AVE ASHTABULA OHIO
MOLDED FIBER GLASS CO
4401 BENEFIT AVE ASHTABULA OHIO
MOLDED INSULATION CO
335 E PRICE ST PHILADELPHIA 44 PA
MOLDED INSULATION CO
123 E 8TH AVE CONSHOHOCKEN PENNA
MOLDING ENGINEERS INC
102 INTERSTATE RD ADDISON ILL
MOLDOMATIC CORP
17301 RIDGELAND AVE TINLEY PARK ILL
MOLE-RICHARDSON CO
937 N SYCAMORE AVE HOLLYWOOD 38 CALIF
MOLECULAR DIELECTRICS INC
101 CLIFTON BLVD CLIFTON NJ
MOLECU-WIRE CORP
SCOBEYVILLE N J
MOLEX PRODUCTS CO
9515 SOUTHVIEW AVE BROOKFIELD ILL
MOLLY CORP
230 N 5 ST READING PA
MOLON MOTOR & COIL CORP
3737 INDUSTRIAL AVE ROLLING MEADOWS ILL
MOLONEY ELECTRIC CO
5390 BIRCHER BLVD ST LOUIS 20 MO
MONA INDUSTRIES INC
PO BOX 1786 PATERSON 17 NJ
MONADNOCK MILLS
1977 FIRST AVE SAN LEANDRO CALIF
MONAGHAM CO J J
500 ALCOTT ST DENVER 4 COLO
MONITOR CONTROLLER
99 GROVE ST ROCKLAND MASS
MONITOR PRODUCTS CO INC
815 FREMONT AVE S PASADENA CALIF
MONITOR SYSTEMS INC
FORT WASHINGTON PA
MONODE INC
3751 PROSPECT AVE CLEVE OHIO
MONOSILICON INC
139 E 157ST GARDENA CALIF
MONROE CALCULATING MACHINE COMPANY
555 MITCHELL ST ORANGE N J
MONROE CALCULATING MACHINE CO
VALLEY DRIVE BRISTOL VA
MONROE ELECTRONICS INC
MIDDLEPORT N Y
MONROE INDUSTRIES INC
934 36TH ST SE GRAND RAPIDS 8 MICH
MONTEK ASSOCIATES INC
4675 S STATE ST SALT LAKE CITY 7 UTAH
MONTEREY ENGINEERING
PO BOX 3083 GRANADA HILLS CALIF
MONTGOMERY MFG CO
206 S MAIN ST OWENSVILLE IND
MONTRONICS INC
1212 W MAIN ST BOX 135 BOZEMAN MONT
MONTROSE PRODUCTS CO INC
AUBURN INDUSTRIAL PARK AUBURN MASS
MOODY MACHINE PRODUCTS CO INC
40 DUDLEY ST PROVIDENCE 5 RI
MOORE ASSOCIATES INC
893 AMERICAN ST SAN CARLOS CALIF
MOORE CO HOWARD J
105 E 16ST NEW YORK N Y
MOORE CORP JOHN B
BOX O DEPT EI PEERLESS BLDG NUTLEY 1 N J
MOORE & CO SAMUEL
MANTUA OHIO
T R MORAN CO INC
P O BOX 185 EL SEGUNDO CAL
MORAN INSTRUMENT CORP
170 E ORANGE GROVE BLVD PASADENA CALIF
MORAN PRODUCTS CO
7199 WENTWORTH AVE CLEVELAND 2 OHIO
MOREY CORP
2014 N MAJOR AVE CHICAGO 39 ILL
MORGAN ADHESIVES CO
4650 DARROW RD STOW OHIO
MORNINGSTAR PAISLEY FACTORIES
1111 CHESTNUT ST REDWOOD CITY CALIF
MORRIS CO J I
390 ELM ST SOUTHBRIDGE MASS
MORSE CO FRANK W
354 CONGRESS ST BOSTON 10 MASS
MORSE INSTRUMENT CO
20 CLINTON ST HUDSON OHIO
MOSAIC FABRICATION INC
205 CHAPIN ST SOUTHBRIDGE MASS
MOSELEY CO F L
409 FAIR OAKS AVE PASADENA CALIF
MOSER JEWEL CO
544 FAYETTE ST PERTH AMBOY NJ
MOSINEE PAPER MILLS CO
MOSINEE WISC
MOSLER RESEARCH PROD INC
9 SOUTH ST DANBURY CONN
MOSLEY ELECTRONICS INC
4610 N LINDBERGH BRIDGETON MO
MOSSMAN INC DONALD P
PO BOX 265 BREWSTER NY
MOSSMAN-ELLIOTT CORP
204 SO LARKIN AVE JOLIET ILL
MOTIOGRAPH INC
4441 W LAKE ST CHICAGO 24 ILL
MOTORDYNE INC
2221 BARRY AVE LOS ANG CALIF
MOTOROLA AVIATION ELECTRONICS INC
10916 W WASHINGTON BLVD CULVER CITY CALIF
MOTOROLA COMMUNICATIONS & ELECT INC
4501 W AUGUSTA BLVD CHICAGO ILL
MOTOROLA DAHLBERG CO
BOX 549 MINNEAPOLIS MINN
MOTOROLA INC
1400 W 30TH ST QUINCY ILL
MOTOROLA INC SEMICONDUCTOR PRODUCTS DIV
5005E MCDOWELL RD PHOENIX ARIZ
MOTOROLA INC SOLID STATE SYSTEMS OIV
3102 N 56TH ST BOX 5409 PHOENIX 10 ARIZ
MOTOROLA INC
9401 GRAND AVE FRANKLIN PARK ILL
MOTORESEARCH CO
1600 JUNCTION AVE RACINE WISC
MOTOR GENERATOR CORP HOBART BRO AFF
W WATER ST TROY OHIO
MOTSON CO J FRANK
1717 BETHLEHEM PIKE FLOURTOWN PA
MOULIC SPECIALITES CO
1007 W WASHINGTON ST BLOOMINGTON ILL
MOVIOLA MFG CO
1451 N GORDON ST HOLLYWOOD 28 CALIF
MOXNESS PRODUCTS INC
1914 INDIANA ST RACINE WISC
MOYEN CO C P
8157 MONTICELLO AVE SKOKIE ILL
MP ENGINEERING CO
FAIRFIELD 1 CONN
MRC MFG CO SUB MATERIALS RES CORP
RT 303 ORANGEBURG NY
M & T MOULDING CO
BLACK MOUNTAIN AVE BLACK MOUNTAIN NO CAR
MUCKLE MFG CO
U S HWY 14 OWATONNA MINN
MUCON CORP
9 ST FRANCIS ST NEWARK 5 N J
MUELLER BRASS CO
1925 LAPEER AVE PORT HURON MICH
MUELLER ELECTRIC CO
1583 E 31 ST CLEVELAND 14 OHIO
MUIRHEAD & CO LTD
BECKENHAM KENT ENGLAND
MUIRHEAD INSTRUMENTS LTD
STRATFORD ONTARIO CANADA
MUIRHEAD INSTRUMENTS INC
441 LEXINGTON AVE NEW YORK 17 NY
MULLARD EQUIPMENT LTD
MANOR ROYAL CRAWLEY SUSSEX ENG
MULTI AMP ELECT CORP
61F MYRTLE ST CRANFORD N J
MULTICORE SOLDERS LTD
MAYLANDS AVE HEMEL HEMP HERTFORDSHIRE ENG
MULTI FLEX SEALS INC
1811 FIRST AVE NEW YORK 28 N Y

MULTI-PRODUCTS CO
21470 CODLIDGE HWY OAK PARK 37 MICH
MULTRONICS INC
BX 227 1747 E MONTGOMERY AV ROCKVILLE MD
MUNDT & SONS CHARLES
53 FAIRMOUNT AVE JERSEY CITY 4 N J
MUNSTON ELECTRONIC MFG CORP
#1 BEECH ST ISLIP N Y
MUNTZ INDUSTRIES INC
1000 GREY AVE EVANSTON ILL
MURRAY MFG CORP
1250 ATLANTIC AVE BROOKLYN 16 NY
MURA CORP THE
777 NORTHERN BLVD GREAT NECK NY
MUTER CO
1255 S MICHIGAN AVE CHICAGO 5 ILL
MUTRON INC
MORRIS MINNESOTA
M-W LABS INC
1824 N MILWAUKEE AVE CHICAGO ILL
MY-T-GRIP CO INC
623 GLIDE ST ROCHESTER N Y
MY-T-GRIP MFG CO INC
176 BROADWAY NEW YORK 38 N Y
MYCALEX CORP OF AMERICA
125 CLIFTON BLVD CLIFTON NJ
MYERS & SONS INC E A
375 VALLEY BROOK RD CANONSBURG PA
MYKROY INC
645 WHEELING ROAD WHEELING ILL
MYTRON MFG CO
4522 BRAZIL ST LOS ANGELES 39 CALIF
MYTRON PRODUCTS INC
656 ATKINS AVE BROOKLYN 8 NY

N

NAGEL-CHASE MFG CO
2811 N ASHLAND AVE CHICAGO 13 ILL
NAMEPLATES INC
421 E 101 ST BROOKLYN N Y
NANILOA CORP
P O BOX 2791 STATION TOLEDO OHIO
NAPOLEON PRODUCTS CO
410 FILMORE ST NAPOLEON OHIO
NARDA MICROWAVE CORP
COMMERCIAL ST PLAINVIEW NY
NARROW FABRIC CO
P O BOX 742 READING PA
NASCO SERVICE CORP
6405 N W 36TH ST MIAMI FLA
NASH-HAMMOND CO
10141 E RUSH ST EL MONTE CALIF
NASHVILLE ELECTRONICS INC
2950 FOSTER CRIEGHTON DR NASHVILLE TENN
NATIONAL AERONAUTICAL CORP
COMMERCE DR FT WASHINGTON PENNA
NATIONAL BERYLLIA CORP
1ST & HASKELL AVE HASKELL N J
NATIONAL CARBON CO DIV UNIDN CARBIDE CORP
270 PARK AVENUE NEW YORK 17 N Y
NATL CASH REGISTER CO ELECTR DIV
1401 E EL SEGUNDO BLVD HAWTHORNE CALIF
NATIONAL CASH REGISTER CO
MAIN & K STS DAYTON 9 OHIO
NATIONAL CERAMIC CO
500 SOUTHARD ST TRENTON N J
NATIONAL CINE EQUIPMENT INC
209 W 48 ST NEW YORK 36 N Y
NATIONAL COIL CO
P O BOX 1237 SHERIDAN WYP
NATIONAL COMPANY INC
61 SHERMAN ST MALDEN 48 MASS
NATIONAL CONNECTOR CORP
SCIENCE INDUSTRY CENTER MINN 27 MINN
NATIONAL ELECTRONICS LABS INC
1713 KALARAMA RD N W WASHINGTON 9 D C
NATIONAL ELECT COIL DIV MCGRAW EDISON CO
800 KING AVE COLUMBUS OHIO
NATIONAL ELECTRONICS INC
628 NORTH ST GENEVA ILL
NATIONAL ELECTRONICS LAB
304 BURNT MILLE AVE SILVER SPRING MD
NATIONAL ENGG PRODUCTS INC
435 WASHINGTON BLDG WASHINGTON D C
NATIONAL GASKET & WASHER MFG CO
124 E 25 ST NEW YORK 10 N Y
NATIONAL INSTRUMENT LABS INC
828 EVARTS ST N E WASHINGTON D C
NATIONAL METALLIZING CORP
825 NEW YORK AVE TRENTON 8 N J
NATIONAL MOLDITE CO
250 SOUTH AVE NEWARK N J
NATL RADIAC INC
475 WASHINGTON ST NEWARK N J
NATL RADIO CO INC
37 WASHINGTON ST MELROSE MASS
NATIONAL RESISTRONICS INC
58 WALTER ST PEARL RIVER N Y
NATIONAL SCIENTIFIC LABS INC
2010 MASSACHUSETTS AVE WASHINGTON D C
NATIONAL SCREW & MANUFACTURING CO
2440 E 75 ST CLEVELAND 4 OHIO
NATL SEMICONDUCTORS LTD
230 AUTHIER SR MONTREAL QUE CANADA
NATL SEMICONDUCTOR CORP
DANBURY CONN
NATIONAL SPECTROGRAPHIC LABS INC
6300 EUCLID AVE CLEVELAND 3 OHIO
NATIONAL STANDARD CO
8TH & HOWARD STS NILES MICH
NATL TELEVISION TUBE INC
ROUTE 46 SADDLE BROOK N J
NATIONAL TELEVISION TUBE INC
PO BOX 133 ROCHELLE PARK NJ
NATIONAL TEL TRONICS CORP
52 ST CASIMIR AVE YONKERS N Y
NATL TRANSISTOR DIV INT TEL & TEL CORP
500 BROADWAY LAWRENCE MASS
NATL ULTRASONIC CORP
95 PARK AVE NUTLEY N J
NATIONAL ULTRASONIC CORP
JAMES ST SOMERVILLE N J
NATIONAL UNION ELECT CORP ELECT DIV
1201 BELL ST BLOOMINGTON ILL
NATL UTILITIES CORP
826 S ARROYO PARKWAY PASADENA CALIF
NATIONAL VACUUM PLATERS INC
2633 E HAGERT ST PHILA PA
NATIONAL VIDEO CORP
4300 W 47TH ST CHICAGO 32 ILL
NATIONAL VULCANIZED FIBRE CO
BOX 311 WILMINGTON DELA
NATIONAL VULCANIZED FIBRE CO
YORKLYN DEL
NATL VULCANIZED FIBRE CO
MULBERRY LAFAYETTE KENNETT SQ PA
NATL WATER LIFT CO DIV PNEUMO DYNAMICS CORP
2220 PALMER AVE KALAMAZOO MICH
NATURAL LIGHTING CORP
630 S FLOWER BURBANK CAL
NATVAR CORP
211 RANDOLPH AVE WOODRIDGE N J
NAUGLER ENGG INC
19 MADISON AVE BEVERLY MASS
NAVCOR
960 RITTENHOUSE RD VALLEY FORGE IND PK
NORRISTOWN PENNA
NAVIGATION COMPUTER CORP
VALLEY FORGE INDUSTRIAL PARK NORRISTOWN PA
NAYBOR LAB INC E V
26 MANORHAVEN BLVD PORT WASH N Y
NAZ-DAR CO
461 MILWAUKEE AVE CHICAGO 10 ILL
NEDMAC INC
708-42ND AVE NO MINNEAPOLIS 12 MINN
NEFF INSTRUMENT CORP
1088 HAMILTON RD DUARTE CALIF
NEICO MICROWAVE CO
19 JONES RD WALTHAM 54 MASS
NELSON VACUUM PUMP CO GEO F
2133 4 ST BERKELEY 10 CALIF
NEMS-CLARKE CO DIV VITRO CORP OF AMERICA
919 JESUP-BLAIR DR SILVER SPRING MD
NEPTUNE ELECTRONICS CO
30 W 15TH ST NEW YORK 11 NY
NESHAMINY ELECT CORP
EASTON RD NESHAMINY PA
NESOR ALLOY PRODUCTS CO
666 PASSAIC AVE W CALDWELL N J
NETWORK INDUSTRIES INC
P D BOX 397 BAYONNE N J
NETWORKS ELECT CORP
9750 DESOTS CHATSWORTH CALIF
NEUSES INC P K
511 DWYER ST ARLINGTON HGTS ILL
NEUTRONIC ASSOCIATES INC
32 TENNESSEE AVE HEMPSTEAD N Y
NEVADA AIR PRODUCTS CO
O BOX 1090 N VALLEY RD RENO NEV
NEVEDA ANTENNA CO
P O BOX 530 COLUSA CALIF
NEWARK CONTROLS CO
15 WARD ST BLOOMFIELD N J
NEWARK SPINNING & STAMPING
472 BLOY ST HILLSIDE N J
NEWARK WIRE CLOTH CO
351 VERONA AVE NEWARK N J
NEWCASTLE FABRICS CORP
75 N 11TH ST BROOKLYN 11 N Y
NEWCOMB AUDIO PROD CO
6824 LEXINGTON AVE HOLLYWOOD CALIF
NEWCOMB SPRING CORP
77 E HAWTHORNE AVE VALLEY STREAM N Y
NEWCOMB SPRING OF ATLANTA INC
1200 SPRING ST NW ATLANTA GA
NEWCOMB SPRING OF CONN
510 QUEEN ST SOUTHINGTON CONN
NEW DEPARTURE DIV GMC
269 N MAIN ST BRISTOL CONN
NEW DEPARTURE DIV GMC
HAYES AVE SANDUSKY OHIO
NEW ENG ELECT WORKS INC
365 MAIN ST LISBON N H
NEW ENGLAND INSTRUMENT CO
39 GREEN ST WALTHAM MASS
NEW ENGLAND LAMINATES CO
481 CANAL ST STAMFORD CONN
NEW ENGLAND NUCLEAR CORP
575 ALBANY ST BOSTON MASS
NEW ENGLAND TAPE CO
30 TOWER ST HUDSON MASS
NEW ENGLAND TRANSFORMER CO
47 MCGRATH HWY SOMERVILLE 43 MASS
NEW HAMPSHIRE BALL BEARINGS INC
ROUTE 202 PETERBOROUGH N H
NEW HERMES ENGRAVING MACHINE CORP
154 W 14TH ST NEW YORK 11 NY
NEW JERSEY WOOD FINISHING CO
AMBOY AVE WOODBRIDGE N J
NEW LONDON INST CO INC
82 UNION ST NEW LONDON CONN
NEWMAN CORP M M
79 CLIFTON AVE MARBLEHEAD MASS
NEW PRODUCTS INC
CAMERON VILLAGE STA RALEIGH N C
NEWTON CO
55 ELM ST MANCHESTER CONN
NEWTON INSERT CO
6500 AVALON BLVD LOS ANG CALIF
NEWTON INSTRUMENT CO INC
2410 GUESS RD DURHAM NO CAR
NEW-TRONICS CORP
3455 VEGA AVE CLEVELAND 13 OHIO
N Y MFG & GENERAL SUPPLY CO
144 46 70TH AVE FLUSHING N Y
NEW YORK COIL CO
40 2 AVE PHOENIXVILLE PA
NEW YORK SOLDER CO
684 E 133 ST NEW YORK 54 N Y
NEW YORK TRANSFORMER CO
3 AVE ALPHA N J
NEW YORK TWIST DRILL CO INC
30 N CLIFTON ST CHICAGO ILL
N Y TWIST DRILL MFG CORP
99 MAGNOLIA AVE WESTBURY N Y
NEY CO J M
P O BOX 990 HARTFORD 1 CONN
NIAGARA ELECTRON LABS
BOX 128 MAIN ST ANDOVER N Y
NIAGARA ELECTRON LABS
MAIN & GREENWOOD ST ANDOVER N Y
NIAGARA MACH & TOOL WKS
683 NORTHLAND AVE BUFFALO N Y
NICAD DIV GOULD NATIONAL BATTERIES INC
EASTHAMPTON MASS
NICAD DIV GOULD NATL BATTERIES INC
931 N VANDALIA ST ST PAUL MINN
NICHOLS & CLARK INC
321 NEWBURY PORT TURNPIKE HATHORNE MASS
NICHOLS ELECTRONICS
85 SO 13TH ST MINNEAPOLIS 3 MINN
NICHOLS PRODUCTS CO
325 W MAIN ST MOORESTOWN NJ
NIELSEN HARDWARE CORP
770 WETHERSFIELD AVE HARTFORD CONN
NILSEN MFG CO
PO BOX 127 HAINES CITY FLA
NILSSON ELECTRICAL LABORATORY INC
103 LAFAYETTE ST NEW YORK 13 N Y
NIPPERT ELECTRIC PRODUCTS CO
1759 W MOUND ST COLUMBUS 23 OHIO
NITINE INC
45 S JEFFERSON RD WHIPPANY N J
NJE CORP
20 BORIGHT AVE KENILWORTH NJ
NOBLE & WESTBROOK MFG CO
EAST HARTFORD 8 CONN
NOEL MFG CO
3 W 18 ST NEW YORK 11 N Y
NON LINEAR SYSTEMS INC
DEL MAR AIRPORT DEL MAR CALIF
NON-METALLICS INC
58 FELTON ST WALTHAM MASS
NONOTUCK MFG CO
CANAL ST S HADLEY FALLS MASS
NOPCO CHEMICAL CO
60 PARK PLACE NEWARK N J
NOPCO CHEMICAL CANADA LTD
PO BOX 68 LONDON ONT CANADA
NOPCO CHEMICAL CO PLASTICS DIV
175 SCHUYLER AVE NORTH ARLINGTON NJ
NORBATROL ELECTRONICS CORP
356 COLLINS AVE PITTSBURGH PA
NORDEN DIV UNITED AIRCRAFT CORP
HELEN ST NORWALK CONN
NORDEN DIV UNITED AIRCRAFT CORP DATA SYS DPT
3501 HARBOR BLVD COSTA MESA CALIF
NORMAN JONES INC
SO MERRIMACK N H
NORPLEX FABRICATORS INC
BLACK RIVER FALLS WISC
NORRICH PLASTICS CORP
107 W 18TH ST NEW YORK N Y
NORRMAN LABORATORIES ERNST
WILLIAMS BAY WISC
NORTH AMERICAN AVIATION AUTONETICS DIV
9150 E IMPERIAL HWY DOWNEY CALIF
NORTH AMERICA ELECTRONICS
723 3RD AVE W BIRMINGHAM ALA
NORTH AMERICAN ELECT INC
71 LINDEN ST WEST LYNN MASSACHUSETTS
NORTH ATLANTIC INDUSTRIES INC
TERMINAL DR PLAINVIEW NY
NORTH ATLANTIC INDUST INC
603 MAIN ST WESTBURY N Y
NORTHEAST ELECT CORP
AIRPORT RD CONCORD N H
NORTHEASTERN ENG INC
25 S BEDFORD RD ST MANCHESTER N H
NORTHEAST SCIENTIFIC CORP
30 WETHERBEE ST ACTON MASS
NORTH ELECTRIC CO
GALION OHIO
NORTHERN ELECT INC
8440 PILLSBURY AVE S MINN MINN
NORTHERN ENGG LABS
845 BELOIT ST BURLINGTON WISC
NORTHERN ORDNANCE INC
48TH & MARSHALL ST NE ST PAUL 21 MINN
NORTHERN PLASTICS CORP
2ND MARKET ST LACROSSE WISC
NORTHERN PRECISION LABORATORIES
541 COMMERCE ST FRANKLIN LAKES N J
NORTHERN RADIO CO
143 W 22 ST NEW YORK 11 N Y
NORTHERN RADIO MFG CO LTD
1950 BANK ST OTTAWA ONT CANADA
NORTH HILLS ELECTRONICS INC
ALEXANDER PL GLEN COVE L I N Y

NORTHMOOR RECORDING
BDX 691 ST LOUIS 88 MO
NORTHROP CORP
9744 WILSHIRE BLVD BEVERLY HILLS CAL
NORTH SHORE NAMEPLATE DIV ANODYNE INC
214-27 NORTHERN BLVD BAYSIDE 61 N Y
NORTON ASSOC INC
240 OLD COUNTRY RD HICKSVILLE NY
NORTON CO NEW PRODS DEPT
WORCESTER MASS
NORTRONICS CO INC
8101 W 10TH AVE N MINNEAPOLIS MINN
NORTRONICS DIV NORTHROP CORP
222 N PRAIRIE AVE HAWTHORNE CALIF
NORWALK CUTTER SHARPENING CO
69 CONN AVE BOX 588 S NORWALK CONN
NORWOOD CONTROLS UNIT DETROIT CONTROLS DIV
5900 TRUMBULL AVE DETROIT MICH
NOTHELFER WINDING LABS INC
P O BOX 455 TRENTON 3 N J
NP KFR CORP
6006 WASHINGTON BLVD CULVER CITY CALIF
NRC EQUIPMENT CORP
160 CHARLEMONT ST NEWTON 61 MASS
NRK MICROWAVE DIV COOK ELECT CO
4601 W ADDISON ST CHICAGO 41 ILL
NUCLEAR-CHICAGO CORP
333 E HOWARD AVE DES PLAINES ILL
NUCLEAR CORP OF AMER
2 RICHWOOD PL DENVILLE NJ
NUCLEAR CORP OF AMER
3540W OSBORN RD PHOENIX ARIZ
NUCLEAR DEVELOPMENT LAB INC
P O BOX 7034 KANSAS CITY 13 MO
NUCLEAR-ELECTRONICS CORP
2925 N BROAD ST PHILADELPHIA 32 PA
NUCLEAR ENTERPRISES G B LTD
BANKHEAD MEDWY SIGHTHL EDINBURGH 11 SCTLND
NUCLEAR MEASUREMENTS CORP
2460 N ARLINGTON AVE INDIANAPOLIS 18 IND
NUCLEAR PROD INC
10173 RUSH ST EL MONTE CALIF
NUCLEONIC CORP OF AMERICA
196 DEGRAW ST BROOKLYN 31 N Y
NUCLEONIC PROD CO
3133 E 12TH ST LOS ANGELES 23 CALIF
NUCLIDE ANALYSIS ASSOC
P O BOX 752 STATE COLLEGE PA
NUGENT ELECT CO INC
802 E 8TH ST NEW ALBANY IND
NU-LINE INDUSTRIES
1015 SO SIXTH ST MINNEAPOLIS 4 MINN
NU STEEL CO
1714 S ASHLAND AVE CHICAGO 8 ILL
NUTMEG SCREW MACH PROD CO
P O BOX 147 WATERBURY CONN
NUTONE INC
MADISON & RED BANK RDS CINCINNATI OHIO
NUTRON DIV WESTMORE INC
137 SOUTH AVE FANWOOD NJ
NYGLASS INC
7314 E MADISON PARAMOUNT CALIF
NYLOGRIP PROD
570 PLEASANT ST WATERTOWN MASS
NYLOK CORP
8046 CENTRAL PARK AVE SKOKIE ILL
NYTRONICS INC
550 SPRINGFIELD AVE BERKELEY HEIGHTS N J
NYTRONICS INC
480 FAIRMAN RD PO BOX 259 LEXINGTON KENTY

O

OAK MFG CO
CRYSTAL LAKE ILLINOIS
O DELL BROS
2950 GRANT RD MOUNTAIN VIEW CALIF
OGDEN COIL TRANSFORMER CO
3323 W CERMAK RD CHICAGO 23 ILL
OHIO BRASS CO
380 N MAIN ST MANSFIELD OHIO
OHIO CARBON CO
12508 BEREA RD CLEVELAND 11 OHIO
OHIO CHEMICAL & SURGICAL EQUIPMENT CO
1177 MARQUETTE ST CLEVELAND 14 OHIO
OHIO CHEMICAL & SURGICAL EQUIPMENT CO
1130 GRAND ST HOBOKEN NJ
OHIO CRANKSHAFT CO TOCCO DIV
3800 HARVARD AVE CLEVELAND 5 OHIO
OHIO SEAMLESS TUBE DIV COPPERWELD STEEL CO
SHELBY OHIO
OHIO SEMICONDUCTORS
OIV TECUMSEN PRODS CO
1205 CHESAPEAKE AVE COLUMBUS OHIO
OHMART CORP
4241 ALLENDORF DR CINN OHIO
OHMITE MFG CO
3601 HOWARD ST SKOKIE ILL
OHMWEVE CO INC
43 DARCY ST WEST HARTFORD CONN
OIL RITE CORP
2318 WALOO BLVD MANITOWOC WISC
OK ELECTRONICS CORP
7 HUNT PL NUTLEY 1 NJ
OLSEN TINIUS TESTING MACH CO
EASTON ROAD WILLOW GROVE PA
OLYMPIC INSTRUMENTS INC
VASHON WASH
OLYMPIC PLASTICS CO INC
3471 S LACIENEGA BLVD LOS ANGELES 16 CALIF
OLYMPIC PRODUCTS CO INC
3 AVE ALPHA NJ
OLYMPIC RADIO & TV DIV SIEGLER CORP
34-01 38 AVE LONG ISLAND CITY 1 NY
OMCO
BOX 1110 US 93 & LAS PALMS ST KINGMAN ARIZ
OMEGA LABS INC
HAVERHILL ST ROWLEY MASS
OMNI SPECTRA INC
8844 PURITAN AVE DETROIT 38 MICH
OMNITRONICS INC SUB BORG WARNER CORP
511 N BROAD ST PHILA PA
OMTRONICS MFG INC
PO BOX 1419 PEDNY PARK ST OMAHA NEBR
ONAN DV OF STUDEBAKER PACKARD CORP
2515 UNIVERSITY AVE S E MINN MINN
ONEIDA ELECTRONICS INC
YORKVILLE NY
ONIC DEVICES INC
P O BOX 144 10 E BROAD ST PALMYRA N J
ON MARK COUPLINGS INC
4440 YORK BLVD LOS ANGELES 41 CALIF
ONONDAGA ELECTRONICS DIV SPEER CARBON CO
1810 W FAYETTE ST SYRACUSE 1 N Y
ONSRUD MACHINE WORKS INC
7720 N LEHIGH AVE MILES 48 ILL
OPAD ELECTRIC CO
43 WALKER ST NEW YORK 13 N Y
OPTECH INC
102 GRAND ST WESTBURY N Y
OPTICAL COATING LAB INC
977 SEBASTOPOL RD SANTA ROSA CALIF
OPTICAL GAGING PRODUCTS INC
26 FORBES ST ROCHESTER 11 N Y
OPTIC ELECTRONIC CORP
2605 MANNA DR DALLAS 20 TEX
OPTICS FOR INDUSTRY
3727 N PALMER ST MILWAUKEE 12 WIS
OPTIMIZED DEVICES INC
864 FRANKLIN AVE THORNWOOD NY
OPTO ELECTRONIC DEVICES INC
660 NATIONAL AVE MOUNTAIN VIEW CALIF
OPTOMECHANISMS INC
216 E 2ND ST MINEOLA N Y
OPTRON CORP
335 S SALINAS ST SANTA BARBARA CALIF
ORANGE ROLLER BEARINGS CO INC
557 MAIN ST ORANGE NJ
ORBITT ELECTRONICS IND
306 N ALBANY AVE N MASSAPEQUA LI N Y
ORBIT INDUSTRIES
BOX 666 RESEDA CALIF
ORBITRAN CO INC
11487 WOODSIDE AVE LAKESIDE CALIF
ORBITRONICS INC
3660 E 40TH AVE DENVER 5 COLO
ORDANCE OPERATION ELECT DIV AVCO CORP
RICHMOND IND
OREGON ELECTRONICS MFG CO
2105 SE 6 AVE PORTLAND 14 ORE
ORGAN CO ROBERT R
297 PASSAIC AVE CALDWELL TWP N J
ORIGINAL ENDERES CO
GUTTENBERG IOWA
ORION ELECTRONICS CORP
108 COLUMBUS AVE TUCKAHOE N Y
ORTHO FILTER CORP
7 PATERSON ST PATERSON 1 N J
ORTHOLOG DIV
P O BOX 37 PRINCETON JUNCTION N J
ORTHOLOG DIV GULTON INDUST
4054 QUAKER BRIDGE RD TRENTON NJ
ORTHO MAGNETICS INC
BOX 240 KUTZTOWN PENNA
ORTHO PRECISION RESISTORS INC
7 PATTERSON ST PATERSON N J
ORTMAN-MILLER MACHINE CO INC
19 143RD ST HAMMOND IND
ORTRONIX INC
FORSYTH RD DR 8217 ORLANDO FLA
OSBORNE ELECTRONIC CORP
712 SE HAWTHORNE BLVD PORTLAND 14 ORE
OSBORNE TRANSFORMER CORP
3834 MITCHELL AVE DETROIT 7 MICH
OSCAR A SCHOTT CO
500-11TH AVE SO MINNEAPOLIS 4 MINN
O & S RESEARCH INC
1811 BANNARD ST RIVERTON N J
OSTER MFG CO JOHN AVIONIC DIV
1 MAIN ST RACINE WISC
OTARION LISTENER CORP
SCARBOROUGH PK OSSINING N Y
OTIS ELEVATOR CO DEFENSE & INDUSTRIAL DIV
35 RYERSON ST BROOKLYN 5 N Y
OTTO CONTROLS
8611 LINCOLN AVE MORTON GROVE ILL
OVENAIRE INC
706 FOREST ST CHARLOTTESVILLE VA
OVERHEAD DOOR CORP
PO BOX 188 HARTFORD CITY IND
OVERLOAD CONTROL CO
151 PENNA AVE N LONG BEACH ISLAND PARK N Y
OWEN LABS INC
55 BEACON PL PASADENA CALIF
OXFORD COMPONENTS DIV OXFORD ELECT CORP
3911 S MICHIGAN CHICAGO 15 ILL
OXFORD ELECTRIC CORP
3911 S MICHIGAN AVE CHICAGO 53 ILL
OXYGEN EQUIPMENT & SERVICE CO
8335 S HALSTED ST CHICAGO 20 ILL
OZONE METAL PRODUCTS CORP
101-32 101ST OZONE PARK L I N Y
OZONE RESEARCH & EQUIP CORP
3840 N 40TH AVE PHOENIX ARIZ

P

PACE ELECTRICAL INSTRUMENTS CO
70-31 84 ST GLENDALE 27 L I N Y
PACE ENGINEERING CO
13035 SATICOY ST N HOLLYWOOD CALIF
PACIFIC AUTOMATION PRODUCTS
1200 AIR WAY GLENDALE 1 CALIF
PACIFIC COMMUNICATIONS & ELECTRONICS CO
3102 ROLISON RD REDWOOD CITY CALIF
PACIFIC ELECTRODEVICES
9820 EVEREST ST DOWNEY CALIF
PACIFIC ELECTRO MAGNETICS CO INC
942 COMMERCIAL ST PALO ALTO CALIF
PACIFIC MERCURY ELECT INC
8345 HAYVENHURST AVE SEPULVEDA CALIF
PACIFIC MERCURY TV MFG CORP
8345 HAYVENHURST AVE SEPULVEDA CALIF
PACIFIC OPTICAL CORP DIV CHICAGO AERIAL IND
120 GLASGOW AVE INGLEWOOD 1 CALIF
PACIFIC PHOTOMETRIC INSTRUMENTS
BOX 996 BERKELEY 4 CALIF
PACIFIC RELAYS INC
13915 SATICOY ST VAN NUYS CALIF
PACIFIC SCIENTIFIC CO
P O BOX 22019 LOS ANGELES 22 CALIF
PACIFIC SEMICONDUCTORS INC
12955 CHADRON AVE HAWTHORNE CALIF
PACIFIC SEMICONDUCTORS INC
14520 S AVIATION BLVD LAWNDALE CALIF
PACIFIC TRANSDUCER CORP
11836 W PICO BLVD LOS ANGELES CAL
PACIFIC UNIVERSAL PROD CORP
168 VISTA AVE PASADENA 8 CALIF
PACKARD BELL COMPUTER CORP
1905 ARMACOST AVE LOS ANGELES 25 CALIF
PACKARD BELL ELECTRONICS CORP
12333 W OLYMPIC BLVD LOS ANGELES 64 CALIF
PACKARD BELL ELECTRONICS
2341 MICHIGAN AVE SANTA MONICA CALIF
PACKARD INSTRUMENT CO
P O BOX 428 LAGRANGE ILL
PACO ELECTRONICS CO INC
70-31 84TH ST GLENDALE 27 LI NY
PACO PRECISION
70-31 84TH ST GLENDALE 27 LI N Y
PAECO DIV HEWLETT PACKARD CO
620 PAGE MILL RD PALO ALTO CALIF
PAGE FOGWELL CORP
3014 N COOLIDGE AVE LOS ANGELES CALIF
PAKTRON DIV ILL TOOL WORKS
1321 LESLIE AV ALEXANDRIA VA
PALCO ENG CO
355 COLUMBIA ST P O BOX 291 FRANKFORT IND
PALNUT CO
25 GLEN RD MOUNTAINSIDE NY
PALO ALTO ENGG CO
620 PAGE MILL RD PALO ALTO CALIF
PALOMAR EQUIP CO
4254 NIAGARA AVE SAN DIEGO 7 CALIF
PAMPA ELECT CORP
221 ROCK HILL RD BALA-CYNWYD PA
PANDUIT CORP
17301 RIDGELAND AVE TINLEY PARK ILL
PAN-ELECTRONICS CORP
PO BOX 404 GRIFFIN GA
PANEL ENG CORP
222 W HURON ST CHICAGO ILL
PANELLIT INC OIV INFORMATION SYS INC
7401 HAMLIN AVE SKOKIE ILL
PANELYTE DIV ST REGIS PAPER CO
ENTERPRISE AVE TRENTON 4 NEW JERSEY
PANELLIT LTD
MEMBER OF ELLIOTT AUTOMATION GROUP
ELSTREE WAY BOREHAMWOOD HERTS ENGLAND
PAN FAX INC
401 OLD COAST HWY SANTA BARBARA CALIF
PANOB CORP
49 BEECH PORT CHESTER N Y
PANTHER ELECTRONICS INC
901 S MAIN ST BURBANK CALIF
PAPER PRODUCTS MINNESOTA MINING & MFGING CO
HARTFORD CITY INDIANA
PAPESCH & KOLSTAD INC
BOX 3726 10703 CAPITAL AV OAK PARK 37 MICH
PARABAM INC
12822 YUKON HAWTHORNE CALIF
PARADYNAMICS INC
10 STEPAR PLACE HUNTINGTON STA L I N Y
PARAGON ELECTRIC CO
1600 12 ST TWO RIVERS WISC
PARAGON REVOLUTE OIV CHARLES BRUNING CO INC
77 SOUTH AVE ROCHESTER 4 N Y
PARAMOUNT PAPER TUBE CORP
614 S LAFAYETTE ST FORT WAYNE 2 IND
PARAPLEGICS MFG CO INC PMCO CABLES DIV
BENSENVILLE ILL
PARK ELECTROCHEMICAL CORP
34-10 LINDEN PLACE FLUSHING N Y
PARK NAMEPLATE CO
34 10 LINDEN PL FLUSHING 54 N Y
PARKER ELECTRICAL INSTRUMENT CORP
200 HARVARD AVE STAMFORD CONN
PARKER KALON GENERAL AMER TRAN CO
1 PEEKAY DR CLIFTON N J
PARKER METAL GOODS CO
85 PRESCOTT ST WORCESTER MASS

ELECTRONIC MANUFACTURERS—A TO Z

PARKER SEAL CO DIV PARKER-HANNIFIN CORP
10567 JEFFERSON BLVD CULVER CITY CALIF
PARKS LAB HENRY FRANCIS
P O BOX 1665 LAKE CITY STA SEATTLE 55 WASH
PARMENTER & BULLOCH MFG CO LTD
GANANOQUE ONTARIO CANADA
PAR-METAL PRODUCTS CORP
32-62 49 ST LONG ISLAND CITY 3 NY
PAR PRODUCTS CORP
602 COLORADO AVE SANTA MONICA CALIF
PARR MFG CORP
44 AUSTIN ST NEWARK 14 N J
PARSONS CO RALPH M ELECTRONICS DIV
151 S DE LACEY AVE PASADENA CALIF
PARTLOW CORP
211 CAMPION RD NEW HARTFORD N Y
PARTRICK & WILKINS CO
51 N 7 ST PHILA PA
PARTRIDGE TRANSFORMERS LTD
ROEBUCK RD TOLWORTH SURREY ENGLAND
PASTORIZA ELECT INC
285 COLUMBUS AVE BOSTON MASS
PATTERSON MOOS RESEARCH DIV LEESONA CORP
90 28 VAN WYCK EXPRESSWAY JAMAICA N Y
PATWIN DIV PATENT BUTTON
WATERBURY CONN
PAUL F M & STEIN BROS INC
235 5 AVE NEW YORK N Y
THE PAVELLE CORP
32 DEPOT PLAZA WHITE PLAINS N Y
PCA ELECTRONICS INC
16799 SCHOENBORN ST SEPULVEDA CALIF
PEARCE SIMPSON INC MARINE & COMM DIVISION
2295 NW 14TH ST MIAMI 35 FLA
PEARCE SIMPSON CO
8040 S W 69TH AVE S MIAMI FLA
PEARSON ELECTRONICS INC
707 URBAN LA PALO ALTO CALIF
PECK SPRING CO
89 WHITING ST PLAINVILLE CONN
PECK STOW WILCOX CO
217 274 CENTER ST SOUTHINGTON CONN
PEE WEE MOLDING CO
1720 ATLANTIC AVE BROOKLYN N Y
PEEBLES & CO LTD BRUCE
EAST PILTON EDINBURGH 5 SCOTLAND
PEER INC
1200 MILTON ST BENTON HARBOR MICH
PEER INC PROFESSIONAL ELECT ENG
2624 SHELBY ST DALLAS TEXAS
PEERLESS ELECT PRODS DIV ALTEC LANSING CORP
1515 S MANCHESTER AVENUE ANAHEIM CALIF
PEERLESS PRODUCTS INDUSTRIES
812 N PULASKI RD CHICAGO 51 ILL
PEGASUS LABS INC
3500 W ELEVEN MILE RD BERKLEY MICH
PEK LABS INC
4024 TRANSPORT ST PALO ALTO CALIF
PELLEY CO
37 HURLEY ST CAMBRIDGE MASS
PELTON DIV BALDWIN LIMA HAMILTON CORP
2929 19TH ST SAN FRAN CALIF
PELTON & CRANE CO THE
200 CLANTON RD CHARLOTTE NO CAR
PENCO DIV ALAN WOOD STEEL CO
OAKS PENNA
PENDAR INC
14744 ARMINTA ST VAN NUYS CALIF
PENETONE CO
TENAFLY N J
PENN ENGG & MFG CORP
DOYLESTOWN PA
PENN FIBRE SPECIALTY CO
2020 WESTMORELAND ST PHILA PA
PENN KEYSTONE CORP
P O BOX 350 DERBY CONN
PENN METER CO
4110 HAVERFORD AVE PHILA PA
PENN TRANSFORMER CORP
E BISHOP ST BELLEFONTE PA
PENNWOOD NUMECHRON CO
7249 FRANKSTOWN AVE PITTSBURG 8 PA
PENSINULAR MFG CO INC
1600 W SMITH ST ORLANDO FLA
PENTA LAB INC
312 NOPAL ST SANTA BARBARA CALIF
PENTRON ELECT CORP
777 S TRIPP AVE CHICAGO ILL
PERENY EQUIP CO INC
BOX 5064 TRIVILLAGE STA COLUMBUS OHIO
PERFECT COMPONENTS INC
43 MILBAR BLVD FARMINGDALE N Y
PERFECTION MICA CO MAGNETIC SHIELD DIV
1322 ELSTON AVE CHICAGO ILL
PERFORMANCE MEASUREMENTS CO
15120 THIRD AVE DETROIT 5 MICH
PERKIN ELMER CORP
MAIN AVE NORWALK CONN
PERKIN ELMER CORP VERNISTAT DIV
EMERALD ST NORWALK CONN
PERKIN-ELMER CORP SD WILTON PL
WILTON CONN
PERKIN ELECTRONICS CORP
345 KANSAS ST EL SEGUNDO CALIF
PERMACOR DIV RADIO CORES INC
9540 TULLEY AVE OAK LAWN ILL
PERMAG CORP
88 06 VAN WYCK EXPRESSWAY JAMAICA N Y
PERMALI INC
P O BOX 718 MT PLEASANT PA
PERMA-POWER CO
3102 N ELSTON AVE CHICAGO 18 ILL
PERMOFLUX CORP
4101 SAN FERNANDO RD GLENDALE CALIF
PERMOFLUX DIV
2300 W ARMITAGE AVE CHICAGO 47 ILL
PERMONITE MFG CO
910 JACKSON BLVD CHICAGO ILL
PESCHEL ELECTRONICS INC
TOWNERS RT 216 PATTERSON NEW YORK
PESCO PRODUCTS DIV WESTERN BRANCH
3310 VANOWEN ST BURBANK CALIF
PESCO PRODUCTS DIV BORG WARNER CORP
24700 N MILES RD BEDFORD OHIO
PETTINOS GRAPHITE CORP
1 E 42ND ST NEW YORK 17 N Y
PFANSTIEHL CHEMICAL CORP
104 LAKE VIEW AVE WAUKEGAN ILL
PFI PRODUCTS FOR INDUSTRY INC
PENNDEL PA
PHALO PLASTICS CORP
530 BOSTON TWPK SHREWSBURY MASS
PHAOSTRON INSTRUMENT & ELECTRONIC CO
151 PASADENA AVE S PASADENA CALIF
P & H ELECTRONICS
424 COLUMBIA LAFAYETTE IND
P & H SALES CORP
5650 N WESTERN AVE CHICAGO 45 ILL
PHELPS DODGE COPPER PRODS CORP INCA MFG DIV
FORT WAYNE IND
PHELPS DODGE COPPER PRODUCTS CORP
300 PARK AVE NEW YORK 22 N Y
PHELPS DODGE ELECTRONIC PRDDS CORP
60 DODGE AVE NO. HAVEN CONN
PHEOLL MFG CO
5700 W ROOSEVELT RD CHICAGO 50 ILL
PHILA INSULATED WIRE CO
333 NEW ALBANY RD MOORESTOWN N J
PHILA SCIENTIFIC GLASS CO
RIDGE AVE PERKASIE PENNA
PHILBRICK RESEARCHES INC GEORGE A
127 CLARENDON ST BOSTON MASS
PHILCO CORP
TIOGA & C STS PHILADELPHIA 24 PA
PHILCO CORP
SANDUSKY OHIO
PHILCO CORP
WILLOW GROVE PA
PHILCO CORP
SPRING CITY PENNA
PHILCO CORP
4700 WISSAHICKON AVE PHILA PENN
PHILCO CORP SPACE DIV
3875 FABIAN WAY PALO ALTO CALIF
PHILCO CORP COMMUNICATIONS & WEAPONS DIV
4700 WISSAHICKON AVE PHILA PENNA
PHILCO CORP G & I DIV
4700 WISSAHICKON AVE PHILA 44 PENNA
PHILCO CORP GOVT & INDUSTRIAL GROUP
4700 WISSAHICKON AVE PHILADELPHIA 44 PA
PHILCO CORP LANSDALE DIV
CHURCH RD LANSDALE PA
PHILCO CORP SIERRA ELECTRONIC DIV
3885 BOHANNAN DR MENLO PARK CALIF
PHILIPS ELECTRONIC INSTRUMENTS
750 S FULTON AVE MT VERNON N Y
PHILIPS ELMET CORP
LISBON RD LEWISTON ME
PHILLIPS CONTROL CORP
JOLIET ILL
PHILLIPS PROCESS CO
192 MILL ST ROCHESTER 14 N Y
PHILAMON LABS INC
90 HOPPER ST WESTBURY N Y
PHILMORE MFG CO INC
130-01 JAMAICA AVENUE RICHMOND HILL 18 N Y
PHOENIX ENGINEERING & MFG CO
1320 N 52ND ST PHOENIX ARIZ
PHOENIX PRECISION INSTRUMENT CO
3805 N 5 ST PHILADELPHIA 40 PA
PHOTOMATION INC
280 POLARIS AVENUE MOUNTAIN VIEW CALIF
PHOTOBELL CO
12 EAST 22ND ST NEW YORK N Y
PHOTOCIRCUITS CORP
31 SEA CLIFF AVE GLEN COVE N Y
PHOTOCON RESEARCH PRODUCTS
421 N ALTADENA DR PASADENA CALIF
PHOTO - CRYSTALS
605 PRAIRIE ST ST CHARLES ILL
PHOTO-RESEARCH CORP
837 N CAHUENGA BLVD HOLLYWOOD 38 CALIF
PHOTO-TRONIC PRODUCTS CORP
517 OAK ST FORT ATKINSON WIS
PHOTOVOLT CORP
95 MADISON AVE NEW YORK 16 N Y
PHOTRON INSTRUMENT CO
6516 DETROIT AVE CLEVELAND 2 OHIO
PHYS CHEMICAL RES CORP
40 E 12TH ST NEW YORK N Y
PHYSICAL SCIENCES CORP
389 N FAIR AVE LOS ANG CALIF
PHYSIONICS INC
P O BOX 6420 FT WORTH 15 TEXAS
PIASECKI AIRCRAFT CORP MAYFIELD ELECT DIV
MAYFIELD PENNA
PIASECKI AIRCRAFT CORP
ISLAND RD INTL A P PHILA 42 PA
PIC AUTOMATION CONTROLS
8080 MCCORMICK BLVD SKOKIE ILL
PIC DESIGN CORP SUB OF BENRUS WATCH CO INC
477 ATLANTIC AVE E ROCKAWAY LI NY
PICKARD & BURNS INC SUB GORHAM CORP
103 FOURTH AVE WALTHAM 54 MASS
PICKER X-RAY CORP WAITE MFG DIV INC
17325 EUCLID AVE CLEVELAND OHIO
PIERPONT INDUSTRIES INC
77 15 25TH AVE EAST ELMHURST 69 N Y
PIEZO CRYSTAL CO
265 POMFRET ST CARLISLE PA
PIEZO PRODUCTS CO
WHITNEY ST SHERBORN MASS
PIFER INDUSTRIES INC
2210 PETTIGREW ST DURHAM NO CAR
PILGRIM SCREW CORP
P O BOX 1452 PROVIDENCE R I
PILOT CHEMICALS INC
36 PLEASANT ST WATERTOWN MASS
PILOT RADIO CORP
37-06 36 ST LONG ISLAND CITY 1 N Y
PIONEER ELECTRIC & RES CO
743 CIRCLE AVE FOREST PARK ILL
PIONEER INDUSTRIES INC
2700 HAWKEYE DR SIOUX CITY IOWA
PIONEER MAGNETICS INC
850 PICO BLVD SANTA MONICA CALIF
PIONEER PATENTS & PRODUCTS CO
3720 N NEW ENGLAND AVE CHICAGO 34 ILL
PIQUA MACHINE & MFG CO
PIQUA OHIO
PITOMETER LOG CORP
237 LAFAYETTE ST NEW YORK 12 N Y
PIONEER GEN-E-MOTOR CORP
5841 W OICKENS AVE CHICAGO 39 ILL
PHOTOVOLT CORP
1115 BROADWAY NEW YORK N Y

FOR INFORMATION

ON PRODUCTS

SEE THE

"PRODUCTS AND MANUFACTURERS"

SECTION

MCGRAW EDISON CO PITTSBURGH LECTRODRYER DIV
FOOT 32 ST PITTSBURGH PA
PIX MFG CO
75 HUDSON ST NEWARK NJ
PLANAUTICS CORP
485 FIRST BOX 665 ENCINITAS CALIF
PLANET MFG CORP
225 BELLEVILLE AVE BLOOMFIELD N J
PLANET PLATING CO INC
1333 FLUSHING AVE BKLYN N Y
PLANETRONICS INC
CENTER AT GLENDALE STS EASTON PA
PLASTIC ASSOCIATES
773 BROADWAY LAGUNA BEACH CALIF
PLASTIC CAPACITORS INC
2620 N CLYBOURN AVE CHICAGO 14 ILL
PLASTIC FAB INC
N MAIN ST FRANKLIN N H
PLASTIC FACTORS INC
926 BROADWAY REDWOOD CITY CALIF
PLASTIC MOLD & ENGG CO
WAMPANOAG TRAIL E PROVIDENCE 14 RI
PLASTIC PROCESS DIV MONADNOCK MILLS
11200 HINDRY AVE LOS ANG CALIF
PLASTIC WIRE & CABLE CORP
BOX 486 JEWETT CITY CONN
PLASTICRAFT PRODUCTS CO
1 STATION PLAZA WEST NYACK N Y
PLASTICRAFTS INC
2800 N SPEER BLVD DENVER COLO
PLASTICS & RESINS DIV SHELL CHEMICAL CO
110 W 51ST ST NEW YORK 20 N Y
PLASTICS STAMPING CO
932 PRINCE ST POMONA CALIF
PLASTIGAGE CORP
915 E SOUTH ST JACKSON MICH
PLASTOFILM INC
916 W UNION AVE WHEATON ILL
PLASTOID CORP
45 GINGERBREAD RD HAMBURG N J
PLASTOID CORP
42 61 24TH ST LONG ISLAND CITY N Y
PLAS TRON CORP
815 S W VIEWMONT DR PORTLAND OREGON
PLATRONICS INC
500 COMMERCE RD LINDEN N J
PLECTRON CORP
OVERTON NEBR
PLISCO WILLIAM B
62 SCHENECTADY AVE BROOKLYN NY
PLUG IN INSTRUMENTS INC
1416 LEBANON RD NASHVILLE TENN
PLYMOUTH RUBBER CO
REVERE ST CANTON MASS
P M DIV CRANE CO
1960 BRIDGE ST JOHNSTOWN PA
PM ELECTRONICS INC
5221 UNIVERSITY AVE SAN DIEGO CALIF
PNEU-HYDRO VALVE CORP
52 HORSE HILL RD CEDAR KNOLLS N J
PNEUMAFIL CORP
2516 WILKINSON BLVD CHARLOTTE 8 N C
PNEUMO DYNAMICS CORP INST & CONTROL DIV
305 W FULTON ST GRAND RAPIDS MICH
POBOG INDUSTRIES INC
WHITTIER CALIF
POLACOAT INC
9750 CONKLIN RD BLUE ASH OHIO
POLARAD ELECTRONICS CORP
4320 34 ST LONG ISLAND CITY N Y
POLLAK CORP JOSEPH
81 FREEPORT ST BOSTON 22 MASS
POLYCO INC
145 ROSWELL RD SMYRNA GA
POLY KOTE INC
82 CHESTNUT NORTH ATTLEBORO MASS
POLYMER CORP
2120 FAIRMONT AVE READING PA
POLYMICA & INSULATION CO INC
WILLIMANTIC CONN
POLYPHASE INSTRUMENT CO
E 4 ST BRIDGEPORT PA
POLY-SCIENTIFIC CORP
COLLEGE AVE BLACKSBURG VA
POLYTRONIC RESEARCH INC
7326 WESTMORE RD ROCKVILLE MD
POLYTRONICS CO
582 BATHURST ST TORONTO ONT CANADA
POMONA ELECTRONICS CO INC
1500 E NINTH ST POMONA CALIF
POOLE INSTRUMENTS INC
150 EXPRESS ST DALLAS 21 TEXAS

PORCELAIN PRODUCTS CO
224 N PATTERSON ST CAREY OHIO
PORTER CO INC H K RIVERSIDE-ALLOY METAL DIV
RIVERSIDE N J
H K PORTER CO INC DELTA STAR ELECTRIC DIV
WASHINGTON ST LISBON OHIO
PORTER INC H K
74 FOLEY ST SOMERVILLE 43 MASS
PORT O VOX CORP
521 W 43RD ST NEW YORK 36 N Y
POSITIVE LOCK WASHER CO
181 VANDERPOOL ST NEWARK 5 NJ
POSSIS MACHINE CORP
825 RHODE ISLAND AVE S MINNEAPOLIS MINN
POST ELECTRONICS PROD
12 LOTHROP ST BEVERLY MASS
THE POTTER CO
950 CONGRESS ST BROOKHAVEN MISS
POTTER AERONAUTICAL CORP
U S ROUTE 22 UNION N J
POTTER & BRUMFIELD
1200 E BROADWAY PRINCETON IND

POTTER & BRUMFIELD
DIV OF AMER & FOUNDRY CO
FRANKLIN KY
POTTER CO THE
WESSON MISS
POTTER ENG CO
1410 SANTA ANNA DR DUNEDIN FLA
POTTER INSTRUMENT CO
SUNNYSIOE BLVD PLAINVIEW N Y
POTTER PACIFIC CORP
POTTER AERONAUTICAL CORP
23917 CRAFTSMAN RO CALABASAS CALIF
POWELL ELECTRONICS INC
PO BOX 8765 PHILA 1 PA
POWER COMPONENTS INC
P O BOX 421 SCOTTDALE PA
POWER DESIGN INC
1700 SHAMES DR WESTBURY LI NY
POWER OESIGNS INC
89 25 130 ST RICHMOND HILL N Y
POWER OEVICES INC
8710 DARBY AVE NORTHRIOGE CALIF
POWERDYNE DIVISION
28 RANICK DRIVE AMITYVILLE L I NY
POWER INSTRUMENTS INC
7352 N LAWNOALE AVE SKOKIE ILL
POWER SOURCES INC
SOUTH AVE BURLINGTON MASS
POWER SOURCES OIV TELECOMPUTING CORPORATION
3850 OLIVE ST DENVER 7 COLO
POWERTON ULTRASONICS CORP
PATTERSON PL ROOSVELT FIELO N Y
POWERTRAN CORP
10230 CAPITAL AVE OAK PARK MICH
POWER TRONIC SYSTEMS INC
10 PINE COURT NEW ROCHELLE N Y
PRATT ALBERT
114 W LAKE VIEW AVE MILWAUKEE WISC
PRD ELECTRONICS INC
202 TILLARY ST BROOKLYN N Y
PRL ELECTRONICS INC
232 WESTCOTT OR RAHWAY NJ
PRECISE OIE & STAMPING CO
5931 N RAVENSWOOD CHICAGO ILL
PRECISE ELECTRONICS & DEVELOPMENT CORP
76 E 2NO ST MINEOLA NY
PRECISE INST PARTS CO
4520 SAN FERNANDO RD GLENDALE CALIF
PRECISION APPARATUS CO
70-31 84 ST GLENDALE 27 L I N Y
PRECISION CAPACITORS INC
150 W CYPRESS ST BURBANK CALIF
PRECISION CIRCUITS INC
85 WEYMAN ST NEW ROCHELLE N Y
PRECISION CONNECTORS INC
134-20 JAMAICA AVE JAMAICA L I N Y
PRECISION CORPORATION
236 W 23RD ST HIALEAH FLA

PRECISION CRYSTAL LAB
2223 WARWICK AVE SANTA MONICA CALIF
PRECISION ELECTRONICS INC
9101 KING ST FRANKLIN PK ILL
PRECISION ELECTROPLATING CO
6045 NORTH KEYSTONE AVE CHICAGO ILL
PRECISION INSTRUMENT CO
1011 COMMERCIAL ST SAN CARLOS CALIF
PRECISION LAMINATES CORP
7 E FRANKLIN ST DANBURY CONN
PRECISION LINE INC
63 MAIN ST MAYNARD MASS
PRECISION MADE PRODUCTS INC
7 HARRIS CT WORCHESTER MASS
PRECISION METALCRAFT INC
4748 FRANCE AVE N MINNEAPOLIS MINN
PRECISION METAL PRODUCTS CO
41 ELM ST STONEHAM MASS
PRECISION METALSMITHS INC
1081 E 200 ST CLEVELAND OHIO
PREC METHODS & MCH DV TEXTRON INC
CUMBERLAND DR WATERBURY CONN
PRECISION PAPER TUBE CO
2035 W CHARLESTON ST CHICAGO ILL
PRECISION PAPER TUBE CO
1 FLOWER ST HARTFORO CONN
PRECISION RADIATION INSTRUMENTS INC
5810 S NORMANDIE AVE LOS ANGELES CALIF
PRECISION RESISTOR CO
109 U S HWY 22 HILLSIDE N J
PRECISION SCIENTIFIC CO
3737 W CORTLANO ST CHICAGO 47 ILL
PRECISION SENSORS INC
789 ELLSWORTH ST BRIDGEPORT CONN
PRECISION SENSORS INC
1133 MAIN ST PATERSON N J

PRECISION SPECIALTIES INC
PO BOX 118 PITMAN NJ
PRECISION THEROMETER & INST CO
1434 BRANDYWINE ST PHILA PA
PRECISION TRANSFORMER CORP
2483 GREENLEAF AVE ELK GROVE VILLAGE ILL
PRECISION TUBE CO
CHURCH RD & WISSACHICKON AVE N WALES PA
PREIS ENGRAVING MACHINE CO H P
651 U S HWY 22 HILLSIDE N J
PREMAX PRODUCTS DIV CHISHOLM RYDER CO
COLLEGE HIGHLAND AVES NIAGARA FALLS N Y
PREMIER METAL PRODUCTS CO
337 MANIDA ST NEW YORK 59 N Y
PREMIER RESEARCH LABS INC
79 7 AVE NEW YORK 11 N Y
PREMMCO INC
5470 VALLEY BLVD LOS ANG CALIF
PREMMCO INC OF NORTHERN CALIF
P O BOX 412 ALAMEDA CALIF
PRENCO INCORP
246 PARK AVENUE GARDEN CITY NY

PRENTISS WIRE MILLS
HOLYOKE MASS
PRESCOTT TV CO
920 CITRUS AVE LOS ANG CALIF
PRESCRIPTION HEARING AID CO INC
2233 UNIVERSITY AVE ST PAUL MINN
PRESSED STEEL TANK CO
1445 S 66TH ST MILWAUKEE WISC
PRESIN CO INC
2014 BROADWAY SANTA MONICA CALIF
PRESSTEEL CO
9705 GARVEY AVE EL MONTE CALIF
PRESSTITE DIV AMER MARIETTA
39TH & CHOUTEAU ST ST LOUIS MO
PRESTOLE CORP
1345 MIAMI ST TOLEOO OHIO
PRESTO ELECTRONIC METAL PROO CO INC
1021 GRANO ST HOBOKEN NJ
PRICE ELECTRIC CORP
E CHURCH & 2 ST FREDERICK MO
PRICE & RUTZEBECK
P O BOX 30 HAYWARD CALIF
PRINCETON APPLIED RESEARCH CORP
P O BOX 565 PRINCETON N J
PRINCETON DIV ELECTRO MECHANICAL RESCH INC
44 WALI ACE RD PRINCETON N J
PRINCETON ELECT CORP
PRINCETON N J
PRINTEO CIRCUITS INC
7800 COMPUTER AVE MINNEAPOLIS 6 MINN
PRINTED ELECT CORP
INOUSTRIAL CENTER NEEDHAM HGTS MASS
PRINTLOIO CORP DEPT E
10-08 44TH AVE LONG ISLANO CITY 1 N Y
PROBESCOPE CO INC
8 SAGAMORE HILL DR PORT WASHINGTON N Y
PROBESCOPE CO INC
211 ROBBINS LANE SYOSSET N Y
PROCESS & INSTRUMENTS
15 STONE AVE BROOKLYN 33 N Y
PROCESS GEAR CO INC
3313 W NEWPORT CHICAGO ILL
PRODELIN INC
HIGHTSTOWN N J
PROOUCERS SALES CORP & PHOTO-SONICS INC
820 SOUTH MARIPOSA ST BURBANK CALIF
PRODUCTION ELECTRONICS INC
525 LEHIGH AVE UNION NJ
PRODUCTS & INDUSTRIAL ENGRG CORP
3806 S FOUR MILE RUN DR ARLINGTON VA
PROFEXRAY INC
1401 N 1 AVE MAYWOOD ILL
PROFILE ELECTRONICS INC
CONCORD N H
PROJECTS UNLIMITED INC
1926 E SIEBENTHLER AVE DAYTON OHIO
PROSPECT MACHINE PROD INC
REX LANE PROSPECT CONN

PROTECTION EQUIPMENT CO INC
1025 HILL STREET HOPKINS MINN
PROTECTION EQUIPMENT CO INC
2924 EMERSON AVE S MINNEAPOLIS MINN
PROTECTIVE COATINGS CORP
596 RIVER RD CLIFTON NJ
PRO-TEX REEL BAND CO
200 FILM BLDG CLEVELAND 14 OHIO
PROVO TOOL CO LOS ANGELES CALIF
BOX 351 TERMINAL ANNEX LOS ANGELES CALIF
PROVIDENCE BASE PLANT
586 ALWELLS AVE PROVIDENCE RI
PRY WELDING & MFG INC
MODENA PA
PULSE ENG INC
560 ROBERT AVE SANTA CLARA CALIF
PULSE TECHNIQUES INC
1411 PALISADE AVE W ENGLEWOOD N J
PUROLATOR PRODUCTS INC
970 NEW BRUNSWICK AVE RAHAWAY N J
PYE CANADA LTD
82 NORTHLINE RD TORONTO ONTARIO CANADA
PYE CORP OF AMERICA
1149 RARITAN AVE HIGHLAND PARK N J
PYE TELECOMMUNICATIONS LTO
NEWMARKET RO CAMBRIDGE ENGLANO
PYLE-NATIONAL CO
1334 N KOSTNER AVE CHICAGO 51 ILL
PYLON CO INC
ATTLEBORO MASS
PYRAMID SCREEN CORP
181 HARVARD ST BROOKLINE BOSTON MASS
PYRAMID SCREEN CORP
NICHOLS & CLARK BLDG OANVERS MASS
PYROCIRCUITS DIV MICROTRON INC
6 MANHASSET AVE PRT WASHINGTON N Y

PYRODYNE INC
11876 WILSHIRE BLVD LOS ANGELES 25 CALIF
PYRO-ELECTRIC INC
BOX 65 MUSKIN RD WALKERTON IND
PYRDFERRIC CO INC
621 E 216ST NEW YORK 67 N Y
PYROFILM RESISTOR CO
U S HIGHWAY 46 PARSIPPANY N J
PYROMETER INSTRUMENT CO
92 PORTLAND AVE BERGENFIELD N J
PYROTEL CORP
MAMARONECK N Y

Q

Q L C CORP
409 MAIN ST GREENPORT N Y
Q-MAX CORP
MARLBORO NEW JERSEY
QOS CORP
621 E 216 ST BRONX N Y
QUALITONE CO
4318 UPTON AVE S MINNEAPOLIS 10 MINN
QUALITY COMPONENTS INC
ST MARYS PA
QUALITY CONTROL CORP
10 OEPOT PLAZA WHITE PLAINS N Y
QUALITY STAMPING CO
6311 CEDAR AVE MINNEAPOLIS 23 MINN
QUAM NICHOLS CO
234 E MARQUETTE RO CHICAGO 37 ILL
QUANTAMETRIC DEVICES INC
BOX 1107 BINGHAMPTON N Y
QUANTAMETRIC OEVICES INC
109 WASHINGTON BINGHAMTON NY
QUANTATRON INC
2520 COLORAOO AVE SANTA MONICA CALIF
QUAN TECH LAB INC
60 PARSIPPANY BLVO BOX 187 BOONTON N J
QUELCOR INC
670 W WASHINGTON ST NORRISTOWN PA
QUICK CHARGE OIV LINE SCALE CO INC
3737 NW 37TH ST OKLAHOMA CITY OKLA
QUIETROLE CO
395 ST JOHN ST SPARTANBURG S C
QUIK CHEK CORP
5212 PULASKI AVE PHILA PA
QUINCY COMPRESSOR CO
QUINCY ILL
QUINCY SPEAKER MFG CORP
221 OAK ST QUINCY ILL
QUINDAR ELECTRONICS INC
5 LAWRENCE ST BLOOMFIELD N J
QUTRONIC TRANSFORMER CORP
525 BROADWAY NEW YORK 12 N Y
Q V S INC
20 N 15 ST ORANGE N J

R

RACAL ELECTRONICS LTD
WESTERN RD BRACKNELL BERKS ENG
RACINE HYDRAULICS & MACH INC
2000 ALBERT RACINE WISC
RACON ELECTRIC CO
67 HANFORD ST MIDDLETOWN N Y
RACON LOUDSPEAKER INC
1261 BROADWAY NEW YORK 1 N Y
RADA PROOUCTS CO
2911 CARROLL AVE CHICAGO ILL
RADAR DESIGN CORP
PICKARD DR SYRACUSE N Y
RADAR ENGINEERS
4719 BROOKLYN SEATTLE 5 WASH
RADAR MEASUREMENTS CORP
190 DUFFY AVE HICKSVILLE LI N Y
RADAR RELAY INC
1631 TENTH ST SANTA MONICA CALIF
RADATRON INC
232 ZIMMERMAN ST N TONAWANDA NY
RADEX CORP
2076 ELSTON AVE CHICAGO ILL
RADIANT LAMP CORP
300 JELLIFF AVE NEWARK 8 NJ
RADIAPHONE CO
600 E EVERGREEN AVE MONROVIA CALIF
RADIATION AT STANFORO
3180 HANOVER ST PALO ALTO CALIF
RAOIATION COUNTER LABS INC
5121 W GROVE ST SKOKIE ILL
RAOIATION ELECT CO DIV COMPOMETER CORP
5600 JARVIS AVE CHICAGO ILL
RADIATION ENGG LABS
MAIN ST MAYNARD MASS
RADIATION INC
MELBOURNE FLA
RADIATION INC PRODUCTION OIV
501 COMMONWEALTH AVE ORLANOO FLA
RADIATION INSTRUMENT CO
PO BOX 733 SILVER SPRING MD

RADIATION INSTRUMENT DEVELOPMENT LAB INC
4501 W N AVE MELROSE PARK ILL
RADIATION MATERIALS INC
36-40 37TH ST LI CITY 1 NY
RADIATION RESEARCH CORP
314 FLORIDA AVE W PALM BEACH FLA
RADIATION RESEARCH CORP
1150 SHAMES DR WESTBURY N Y
RADIATRONICS INC
14801 CALIF ST VAN NUYS CALIF
RADIO ACTIVITIES INC
119 DAWSON AVE BOONTON N J
RADIO CITY PROD CO
CENTRE & GLENDALE ST EASTON PA
RADIO COND CO SUB THOMPSON RAMO WOOLDRIDGE
DAVIS & COPEWOOD STS CAMDEN 3 NJ
RADIO CONDENSER CO LTD
6 BERMONDSEY RD TORONTO CANADA
RADIO CONDENSER CO WESTERN CONDENSER DV
WATSEKA ILL
RADIO CONDENSER CO WESTERN CONDENSER DIV
HOOPESTON ILL
RADIO CORES INC
9540 S TULLEY AVE OAK LAWN ILL
RADIO CORP OF AMERICA DEFENSE ELECT PRODUCTS
11819 W OLYMPIC BLVD LOS ANGELES 64 CALIF
RADIO CORP OF AMERICA DEFENSE ELECT PRODUCTS
8500 BALBOA BLVD VAN NUYS CALIF
RADIO CORP OF AMERICA ELECT DATA PRDC DIV
3900 MONET ROAD WEST PALM BEACH FLA
RADIO CORP OF AMERICA HOME INSTRS DIV
1300 SOUTH ROGERS STREET BLOOMINGTON IND
RADIO CORP OF AMERICA ELECTRN TUBE DIV
501 N LASALLE ST INDIANAPOLIS IND
RADIO CORP OF AMERICA HOME INSTRS DIV
501 N LASALLE ST INDIANAPOLIS IND
RADIO CORP OF AMERICA ELECTRN TUBE DIV
3300 S ADAMS ST MARION INDIANA
RADIO CORP OF AMERICA DEFENSE ELECT PRODUCTS
BURLINGTON MASS
RADIO CORP OF AM SEMI-CNDCTRS & MTRLS DIV
64 A STREET NEEDHAM HEIGHTS MASS
RADIO CORP OF AMER
13541 AUBURN DETROIT MICH

RADIO CORP OF AMERICA
SEMICONDUCTOR & MATERIAL DIV SOMERVILLE NJ
RADIO CORP OF AMERICA BRDCST & COMM PROD DIV
FRONT & COOPER STS CAMDEN NJ
RADIO CORP OF AMER DEFENSE ELECT PORD
FRONT & COOPER STS CAMDEN 2 NJ
RADIO CORP OF AMER ELECT TUBE DIV
415 S 5TH ST HARRISON N J
RADIO CORP OF AMERICA ASTRO ELCTS DIV
EDINBURG ROAD LOCUST CORNERS NJ
RADIO CORP OF AMERICA DEFENSE ELECTRONICS
MARNE HWY & BORTON LANDING MOORESTOWN NJ
RADIO CORP OF AMERICA ELECTRN TUBE DIV
1550 ST GEORGE AVE WOODBRIDGE NJ
RADIO CORP OF AMERICA DEFNS ELECT PRODS
CAMBRIDGE OHIO
RADIO CORP OF AMERICA ELECT TUBE DIV
5040 LESTER ROAD CINCINNATI OHIO
RADIO CORP OF AMERICA SEMI CNDCTR MTRS DIV
FINDLAY OHIO
RADIO CORP OF AMERICA DFNS ELECT PRODS
COVENTRY & LAKESIDE AVES CROYDON PA
RADIO CORP OF AMERICA ELECTRN TUBE DIV
NEW HOLLAND PIKE LANCASTER PA
RADIO CORP OF AM BRDADCAST & COM PROD DIV
BROADCAST & COMM PROD DIV MEADOW LANDS PA
RADIO CORP OF AMERICA SEMI CNDCTRS & MTRS DV
CRESTWOOD ROAD MOUNTAINTOP PA
RADIO ENGG CO
8 STATE ST NEW YORK 4 N Y
RADIO ENG LABS INC
2901 BORDEN AVE LONG IS CITY N Y
RADIO ENGG PRODUCTS
ATHOLVILLE NEW BRUNSWICK CANADA
RADIO ENGG PRODUCTS
325 DECELLES STREET GRANBY QUEBEC CANADA
RADIO FREQUENCY CO
44 PARK ST MEDFIELD MASS
RADIO FREQUENCY LABS INC
BOONTON N J
RADIO INDUSTRIES TRW ELECTRONICS
666 GARLAND PL DES PLAINES ILL
RADIO MFG ENGG INC
501 WALNUT ST WASHINGTON ILL
RADIO MATERIALS CO DIV PR MALLORY CO INC
4242 W BRYNMAWR AVE CHICAGO 46 ILL
RADIO MATIC OF AMERICAN INC
1550 SPRINGFIELD AVEMAPLEWOOD N J
RADIO RECEPTOR CO INC SELENIUM DIV
240 WYTHE AVE BROOKLYN 11 N Y
RADIO RECEPTOR CO GEN INST CORP SEMICN DIV
120 WYTHE AVE BROOKLYN NY
RADIO SPECIALTY MFG CO
2023 S E 6 AVE PORTLAND ORE
RADIO SWITCH CORP
MARLBORO NEW JERSEY
RADION CORP
345 TERRA COTTA AVE CRYSTAL LAKE ILL

RADIO T V PRODUCTS CORP
308 N LAKE ST GRASS LAKE MICH
RADIUM CHEMICAL CO
6 27TH AVE WOODSIDE 77 N Y
RADIX WIRE CO
26260 LAKELAND BLVD CLEVELAND 32 OHIO
RAECO
1351 DELOSS INDIANAPOLIS 3 IND
RAE MOTOR CORP
BOX 518 MCHENRY ILL
RAILWAY COMMUNICATIONS INC
9351 E 59 ST RAYTOWN MO
RAM CHEMICALS INC
210 E OLIVE ST GARDENA CALIF

RAM METER INC
1100 HILTON RD FERNDALE MICH
RAMSEY ENG CO
1853 COUNTY RD ST PAUL MINN
RAMYR MFG CO
1779 N MAIN LOS ANGELES 31 CALIF
RANDALL INC DOUGLAS
6 PAWCATUCK AVE WESTERLY R I
RANDOLPH PRODUCTS CO
CARLSTADT N J
RANGERTONE INC
73 WINTHROP ST NEWARK N J
RANK CINTEL LTD
WORSLEY BR RD LWR SYDENHAM ENGLAND
RANSOM RESEARCH
BOX 269 SAN PEDRO CALIF
RAPID ELECTRIC CO
2881 MIDDLETOWN RD BRONX 61 N Y
RAPID ELECTRIC CO
BROOKFIELD CONN
RAPID ELECTROPLATING PROCESS INC
1414 S WABASH AVE CHICAGO 5 ILL
RAPID SPECIALTIES CO
327 W HURON ST CHICAGO 10 ILL
RAPIDS STANDARD CO INC
RAPISTAN BLDG GRAND RAPIDS MICH
RATEL INC
1 EL CAMINO RATEL GOLETA CALIF
RA TONE ELECTRONIC SALES CO
1848 W CAMPBELL AVE PHOENIX ARIZ
RAU FASTENER CO
102 WESTFIELD ST PROVIDENCE R I
RAU FASTENER CO
50 ALEPPO ST PROVIDENCE RI
RAULAND CORP
4245 N KNOX AVE CHICAGO ILL
RAVEN INDUSTRIES INC
205 E 6TH ST SIOUX FALLS S D
RAWAY BEARING CO INC
141 CHRYSTIE ST NEW YORK N Y
RAWDON SMITH ASSOC INC
1735 20 ST N W WASHINGTON D C
RAWSON ELECTRICAL INSTRUMENT CO
116 POTTER ST CAMBRIDGE 42 MASS

RAYBESTOS-MANHATTAN INC
P O BOX 1021 BRIDGEPORT 2 CONN
RAYBESTOS-MANHATTAN INC
61 WILLETT ST PASSAIC N J
RAYBESTOS-MANHATTAN INC PLASTIC PRODUCTS DIV
MANHEIM PA
RAYCHEM CORP
OAKSIDE NORTHSIDE REDWOOD CITY CALIF
RAYCHEM CORP
2821 FAIR OAKS AVE REDWOOD CITY CAL
RAYCLAD TUBES INC
OAKSIDE AT NORTHSIDE REDWOOD CITY CALIF
RAYCO ELECTRONIC MFG INC
7229 ATOLL AVE N HOLLYWOOD CALIF
RAYMOND ENGINEERING LABORATORY INC
SMITH ST MIDDLETOWN CONN
RAY O VAC INC
WILLIAMSPORT PA
RAY-O-VAC CO
212 E WASHINGTON AVE MADISON WISC
RAYPAR INC
7800 W ADDISON ST CHICAGO 34 ILL
RAY PROOF CORP
843 CANAL ST STAMFORD CONN
RAYTHEON COMPANY INDUSTRIAL OPERATION
KEELER AVE S NORWALK CONN
RAYTHEON CO SEMICOND DIV
350 ELLIS ST MOUNTAIN VIEW CALIF
RAYTHEON CO MICROWAVE & POWER TUBE DIVISION
SPENCER LABORATORY BURLINGTON MASS
RAYTHEON CO
CORPORATE GOVT MKTG LEXINGTON MASS
RAYTHEON CO INDUSTRIAL COMPONENTS DIV
55 CHAPEL ST NEWTON MASS
RAYTHEON COMM & DATA PROC OPER
1415 BOSTON & PROVIDENCE TPK NORWOOD MASS
RAYTHEON CO DIST PROD DIV
PROVIDENCE TURNPIKE WESTWOOD MASS
RAYTHEON CO COMM APPARATUS & SYSTEMS
HOOKSETT PLANT MANCHESTER N H
RAYTHERM CORP
OAKSIDE AT NORTHSIDE REDWOOD CITY CALIF
RAZDOW LABORATORIES INC
377 5TH ST NEWARK 7 N J
R B M CONTROLS DIV ESSEX WIRE CORP
131 GODFREY ST LOGANSPORT IND
RBM DEVELOPMENT CORP
174 MAIN ST METUCHEN N J
R B M DIV ESSEX WIRE CORP
131 GODFREY ST LOGANSPORT IND
R C L ELECTRONICS INC
NEW JERSEY AVE RIVERSIDE N J
RDF CORP
HUDSON N H
REA MAGNET WIRE CO
3610 E PONTIAC ST FT WAYNE IND
REACH CORP
LEXINGTON NEBRASKA

READY POWER CO
11231 FREUD AVE DETROIT 14 MICH
READY POWER CO
3826 GRAND RIVER AVE DETROIT MICH
RECORA CO
POWIS RD BOX 68 ST CHARLES ILL
RECORDED PUBLICATIONS LABS
1558PIERCE AVE CAMDEN N J
RECORDIO CORP
600 SEMINARY ST CHARLOTTE MICH
RECOTON CORP
5235 BARNETT AVE LONG ISLAND CITY N Y
RECTICO INC
20 FACTORY ST CEDAR GROVE N J

RECTIFIER DIV AUDIO DEVELOPMENT
620 E DYER RD SANTA ANA CALIF
REDCOR CORP
7760 DEERING AVE CANOGA PARK CALIF
RED DEVIL MFG CO
1412 N DGDEN AVE CHICAGO 10 ILL
REDFORD CORP INSTRUMENT DIV
33 CRANE ST STATION SCHENECTADY 3 NY
REDMAN ELECTRONICS CORP
92 PROSPECT ST THOMPSONVILLE CONN
REDMOND CO
MONROE ST OWOSSO MICH
REDMOND CO INC
ITHACA MICH
RED POINT CORP
105 W SPAZIER AVE BURBANK CALIF
RED SEAL ELECTRIC CO
10307 DETROIT AVE CLEVELAND 2 OHIO
REEDER & CO CHARLES M
173 VICTOR AVE DETROIT MICH
REED RESEARCH INC
1048 POTOMAC ST WASHINGTON D C
REED & REESE INC
717 LAKE AVE PASADENA CALIF
REEVE ELECTRONICS INC
609 W LAKE ST CHICAGO 6 ILL
REEVES HOFFMAN DIV
CHERRY & NORTH STS CARLISLE PA
REEVES INSTRUMENT CORP
ROOSEVELT FIELD GARDEN CITY NY
REEVES PULLEY CO DIV RELIANCE ELEC & ENG CO
1225 7TH ST COLUMBUS IND
REEVES SOUNDCRAFT CORP
15 GREAT PASTURE ROAD DANBURY CONN
REFLECTONE ELECT
POST RD STAMFORD CONN
REF MFG CORP
393 JERICHO TURNPIKE MINEOLA N Y
REGCO INC
3025 W MISSION RD ALHAMBRA CALIF
REGENCY ELECTRONICS INC
7900 PENDLETON PIKE INDIANAPOLIS IND
REGENT CONTROLS INC
HARVARD AVE STAMFORD CONN

REGO INSULATED WIRE CO
830 MONROE ST HOBOKEN N J
REICHHOLD CHEMICALS INC
525 N BROADWAY WHITE PLAINS N Y
REID ENTERPRISES
2610 E 67 ST LONG BEACH 5 CALIF
REIGNER RECORDING LIBRARY
3401BROOK RD RICHMOND 27 VA
REILLY TAR & CHEMICAL CORP
1615 MERCHANT BANK BLDG INDIANAPOLIS 4 IND
REITER CO F
3340 BONNIE HILL DR HOLLYWOOD 28 CALIF
REK O KUT COMPANY INC
38 19 108TH ST CORONA 68 L I N Y
RELCOIL PRODUCTS
75 & SPRING ST WINDSOR LOCKS CONN
RELIANCE TIME CONTROLS INC
1927 MEAD ST RACINE WISC
RELIANCE ELECTRIC & ENGG CO
24701 EUCLID AVE CLEVELAND 17 OHIO
RELIANCE ELECTRIC & ENG CO IVANHOE DIV
561A CLEVELAND OHIO
RELIANCE MICA CO INC
341 39TH ST BROOKLYN 32 N Y
REMANCO INC
1805 COLORADO SANTA MONICA CALIF
REMINGTON CORP
WILLEY ST AUBURN N Y
REMINGTON RAND UNIVAC DIV SPERRY RAND
UNIVAC PARK ST PAUL 16 MINN
REMINGTON RAND UNIVAC DIV OF SPERRY RAND CRP
1900 W ALLEGHENY AVENUE PHILADELPHIA 32 PA
REMLER CO
2101 BRYANT ST SAN FRAN CALIF
RENBRANDT INC
6 PARMELEE ST BOSTON 18 MASS
RENFREW ELECTRIC CO LIMITED
349 CARLAW AVE TORONTO ONT CANADA
RENWELL ELECTRONICS CORPORATION
755 NEW LUDLOW RD SOUTH HADLEY FALLS MASS
REON RESISTOR CORP
155 SAWMILL RIVER RD YONKERS N Y
REPUBLIC AVIATION CORP
FARMINGDALE LI NY
REPUBLIC ELECT INDUST CORP
575 BROAD HOLLOW RD HUNTINGTON N Y
REPUBLIC FLOW METERS CO
2240 DIVERSEY PKWY CHICAGO ILL
REPUBLIC FOIL & METAL MILLS INC
55 TRIANGLE ST DANBURY CONN
REPUBLIC LENS CO
31 E 169TH ST NEW YORK 52 N Y
REPUBLIC RUBBER DIV LEE RUBBER & TIRE CORP
1410 ALBERT ST YOUNGSTOWN OHIO
RESDEL CORP
P O BOX 217 RIO GRANDE N J
RESDEL ENGG CORP
330 S FAIR OAKS AVE PASADENA CALIF

RESEARCH CHEMICALS
170 W PRODICENCIA BURBANK CALIF
RESEARCH-COTTRELL INC
BOX 740 BOUND BROOK NJ
RESEARCH DEVELOPMENT MFG INC
429 E COLLOM ST PHILADELPHIA 44 PA
RESEARCH INC
STATE HWY 169 @ CO RD 18 MINNEAPOLIS MINN
RESEARCH INC
PO BOX 6164 EDINA STA MINNEAPOLIS 24 MINN
RESEARCH INDUSTRIAL LAB OF ELECTRONICS
ROSLYN PA
RESEARCH INST CO INC
558 MAIN ST WESTBURY L I N Y

RESEARCH MFG CORP
4152 VOLTAIRE SAN DIEGO 7 CALIF
RESEARCH SPECIALTIES CO
200 S GARRARD BLVD RICHMOND CALIF
RESE ENGG INC
A AND COURTLAND STS PHILA PA
RESISTANCE PRODUCTS CO
914 S 13 ST HARRISBURG PA
RESISTOFLEX CORP
WOODLAND RD ROSELAND N J
RESISTOFLEX CORP SOUTHWESTERN DIV
135 GLASS ST DALLAS 7 TEX
RESISTOR NETWORKS INC
556 W 168TH ST NEW YORK N Y
RESISTORS INC
5226 W 26 ST CHICAGO ILL
RESITRON LABS INC
3 860 CENTINELLA AVE LOS ANGELES 66 CALIF
RESITRON LABS INC
2908 NEBRASKA AVE SANTA MONICA CALIF

FOR INFORMATION ON PRODUCTS

SEE THE

"PRODUCT AND MANUFACTURERS" SECTION

REUTER INC
3965 MEADOWBROOK RD MINN MINN
REUTER STOKES ELECT COMPONENTS
2149 HAMILTON AVE CLEVELAND OHIO
REVCOR INC
251 EDWARDS ST CARPENTERSVILLE ILL
REVERE CORP OF AMERICA
N COLONY RD WALLINGFORD CONN
REVERE SCREW & RIVET CORP
1728 W WALNUT ST CHICAGO ILL
REVOLVATOR CO
86TH ST US RT 169 N BERGEN N J
REX RHEOSTAT CO
149 BABYLON TURNPIKE ROOSEVELT N Y
REYNOLDS DIV NATIONAL STANDARD CO
DIXON ILL
REYNOLDS ELECTRIC CO
3000 RIVER RD RIVER GROVE ILL
REYNOLDS INDUSTRIES INC
2105 COLORADO AVE SANTA MONICA CALIF
REYNOLDS METALS CO
PO BOX 2346 RICHMOND VA
REYNOLDS ROCKET SYSTEMS INC
2301 ALEXDALE LA LA PUENTE CALIF
REYNOLDS WIRE DIV NATIONAL STANDARD CO
809 E 2ND ST DIXON ILL
RF COMMUNICATIONS ASSOCIATES INC
13 CANAL ST ROCHESTER 8 N Y
RF INTERONICS INC
15 NEIL COURT OCEANSIDE L I N Y
R F PRODUCTS INC DIV AMPHENOL BORG
33 E FRANKLIN DANBURY CONN
RFS ENGINEERING CO
2ND & WESTMORELAND STS PHILA 40 PA
R G CIRCUITS CO
15216 MANSEL AVE LAWNDALE CALIF
RHEEM CALIFONE CORP
5922 BOWCROFT ST LOS ANG CALIF
RHEEM ELECTRONICS CORP
5200 W 104TH ST LOS ANGELES 45 CALIF
RHEEM SEMICONDUCTOR CORP
350 ELLIS ST MOUNTAIN VIEW CALIF
R H ELECTRONICS CO
PO BOX 35121 DALLAS 35 TEXAS
RHG ELECTRONICS LAB INC
94 MILBAR BLVD FARMINGDALE N Y
RHODES INC M H
30 BARTHOLOMEW AVE HARTFORD CONN
RHO ENG CO
2242 SEPULVEDA BLVD LOS ANGELES CALIF
RICHARDSON ALLEN CORP
SUB STANDARD KOLLSMAN IND
116 15 15 AVE COLLEGE POINT N Y
RICHARDSON CO
2790 LAKE ST MELROSE PARK ILL
RICHARDSON CO
409 CODWISE AVE NEW BRUNSWICK N J
RICHARDSON LABS KENNETH
254 VINCENT AVE LYNBROOK N Y
RICHARDSON SCALE CO
668 VAN HOUTEN AVE CLIFTON NJ
RICH ELECTRONICS INC
212 NW 8TH AVE MIAMI 36 FLA
RICHFIELD COINED PRODUCTS CO
722 BROAD ST CLIFTON N J
RICHMOND ENGINEERING CO INC
19 CONCORD ST S NORWALK CONN
RICHO PLASTIC CO
3722 W NORTH AVE CHICHAGO 47 ILL
RIEDON DIV ON MARK ENGINEERING CO
11728 VOSE ST NO HOLLYWOOD CAL
RIEGEL PAPER CORP
1143 E FOURTH ST CHARLOTTE N C
RIESTER & THESMACHER CO
1526 W 25 ST CLEVELAND OHIO
RIGGS NUCLEONICS CORP
177 W MAGNOLIA BLVD BURBANK CALIF
RIKER INDUSTRIES INC
875 E JERICHO TNPKE HUNTINGTON STA N Y
RIL ELECTRONICS CORP
STREET RD & 2ND ST PKE SOUTHAMPTON PA
RIMAK ELECT INC
10929 VANOWEN ST N HOLLYWOOD CALIF
RIPLEY CO
1 FACTORY ST MIDDLETOWN CONN
RISCO
1086 FOLSOM ST SAN FRAN CALIF
RI TONE PRODS INC
157 LIVINGSTON ST BROOKLYN N Y
RIVERBANK LABS ENGG DEPT
P O BOX 65 GENEVA ILL
RIVERSIDE ALLOY METAL DIV
1 PAVILION AVE RIVERSIDE N J
RIVETT LATHE & GRINDER INC
P O BOX 7 BOSTON 35 MASS
RIXON ELECTRONICS INC
2121 INDUSTRIAL PKWY SILVER SP MD
R M E DIV ELECTRO VOICE INC
BUCHANAN MICH
R M S ASSOCIATES INC
805 MAMARONECK AVE MAMARONECK NY
RMS ENG INC
95 BENNETT ST N W ATLANTA GA
ROANWELL CORP
180 VARICK ST NEW YORK 14 N Y
ROBBINS & MYERS INC
1345 LAGONDA AVE SPRINGFIELD OHIO
ROBERTS ELECTRONICS INC
1028 LABREA AVE HOLLYWOOD CALIF
ROBERTSHAW-FULTON CONTROLS CO
SANTA ANA FRWY EUCLID AVE ANAHEIM CALIF
ROBERTSHAW CONTROLS CO ACRO DIV
COLUMBUS 16 OHIO
ROBERTSHAW-FULTON CO FULTON SYLPHON DIV
P O BOX 400 KNOXVILLE 1 TENN
ROBERTSON ELEC CO INC
124 S ELMWOOD AVE BUFFALO N Y
ROBERTSON INSTRUMENT CO
240 MOTOR AVE BOX 834 AZUSA CALIF
ROBERTS R O
8338 S ALLPORT SANTA FE SPRINGS CALIF
ROBERTS TOLEDO RUBBER CO
4143 MONROE ST TOLEDO 6 OHIO
ROBINAIR MANUF CORP
1224 S E AVE MONTPELIER OHIO
ROBINS INDUSTRIES CORP
15 58 127 ST FLUSHING N Y
ROBINSON MACHINE CO INC
286 PREAKNESS AVE PATERSON N J
ROBINSON MACHINE WORKS INC
802 E EIGHTH ST NEW ALBANY IND
ROBINSON RECORDING LABS
35 S 9 ST PHILA PA
ROBINSON TECHNICAL PRODUCTS INC
TETERBORO N J
ROBINSON VIBRASHOCK DIV ROBINSON TECH PROD
ROBINSON TECHNICAL PRODUCTS INC
TETERBORO AIR TERM TETERBORO N J
ROBOT INDUSTRIES INC
7041 ORCHARD AVE DEARBORN MICH
ROBOTOMICS ENTERPRISES INC
4504 N 16TH ST PHOENIX 16 ARIZ
ROBOTOMICS ENTERPRISES INC
2422 INOIAN SCHOOL PHOENIX ARIZ
ROBOTRON CORP
21300 W 8 MILE RD DETROIT 19 MICH
ROCHESTER INSTRUMENT SYS INC
275 N UNION ST ROCHESTER 3 N Y
ROCKBESTOS WIRE & CABLE CO DIV OF CERRO CORP
NICOLL & CANNER STS NEW HAVEN CONN
ROCKER SOLENOID CO
140 MARINE ST WILMINGTON CALIF
ROCKWELL ENGINEERING
2133 E 45 ST INDIANAPOLIS 5 IND
ROCKWELL MFG
510 LANSING AVE TULSA OKLA
ROCKWELL PRODUCTS CORP
146 CENTRAL AVE NEWARK N J
RODALE ELECTRONICS INC
562 GRAND BLVD WESTBURY N Y
RODALE MFG CO
6 & MINOR STS EMMAUS PA
RODE INC
5 GREEN ST WOBURN MASS
RODNEY METALS INC
1357 RODNEY FRENCH BLVD NEW BEDFORD MASS
ROEBLINGS SONS JOHN A DIV
640 S BROAD ST TRENTON N J
ROESCH COMMUNICATIONS DOUGLAS
2727 SAN FERNANDO RD LOS ANG CALIF
ROGAN BROS INC
8031 MONTICELLO SKOKIE ILL
ROGERS CORP
ROGERS CONN
ROGERS ELECTRONIC CORP
49 BLEECKER ST NEW YORK 12 N Y
ROHDE & SCHWARZ
111 LEXINGTON AVE PASSAIC NEW JERSEY
ROHDEN MFG CO INC
4739 W MONTROSE AVE CHICAGO 41 ILL
ROHN MFG CO
BOX 2000 PEORIA ILL
ROHR AIRCRAFT CORP
FOOT OF H ST VISTA CALIF
ROLA CO
ROUTE 28 HAWTHORNE PA
ROLA CO
2530 SUPERIOR AVE CLEVELAND OHIO
ROLLAN ELECTRIC CO
8233 S PRINCETON AVE CHICAGO 20 ILL
ROLOCK INC
1350 KINGS HWY FAIRFIELD CONN
ROMAC PRODUCTS CO
48-01 25 AVE LONG ISLAND CITY 3 N Y
ROME CABLE DIV ALCOA
RIDGE ST ROME N Y
ROME TURNEY RADIATOR CO
BOX 32 ROME N Y
RONAN & KUNZL INC
502 S KALAMAZOO AVE MARSHALL MICH
RONDO OF AMERICA INC
100 SANFORD ST HAMDEN CONN
RON ELECTRONICS CORP
150 PINE ST MONTCLAIR NJ
ROSEMOUNT ENG CO
4900 W 78TH ST MINN MINN
ROSENTHAL ISOLATOREN GMBH OF UNITED
MINERAL & CHEM CO 16 HUDSON ST NY 13
ROSS METALS CO MILTON
237 JACKSONVILLE RD HATBORO PA
ROSS CO MILTON
511 SECOND ST PIKE SOUTHAMPTON PA
ROSTAN CORP
101 VARICK AVE BROOKLYN N Y
ROSTONE CORP
STATE RD 52 S LAFAYETTE IND
ROTARY LIFT CORP DIV DOVER CORP
1054 KANSAS ST MEMPHIS TENN
ROTATING COMPONENTS INC
1560 FIFTH AVE BAY SHORE L I N Y
ROTATING ELECTR SYSTEMS CO
14755 BESSEMER ST VAN NUYS CALIF
ROTEK INSTRUMENT CORP
11 GALEN ST WATERTOWN 72 MASS
ROTOTEST LABS INC
2800 LOS FLORES BLVD LYNWOOD CALIF
ROTRON MFG CO
HASBROUCK LANE WOODSTOCK N Y
ROUGE ELECTRONICS CO
4921 N LINCOLN OKLAHOMA CITY 5 OKLA
ROWAN CONTROLLER CO
30 BRIDGE AVE RED BANK N J
ROWAN CONTROLLER CO
2315 HOMEWOOD AVE BALTIMORE 18 MD
ROWE ENGRAVERS INC
68 UNION AVE CLIFTON N J
ROWE INDUSTRIES
1702 WAYNE ST TOLEOO OHIO
ROY CO MILTON
1300 E MERMAID LANE PHILA 18 PA
ROYAL COMMUNICATION SYSTEMS
4501 PROSPECT AVE CLEVELANO 3 OHIO
ROYAL ELECTRIC CORP
95 GRAND AVE PAWTUCKET RI
ROYAL MCBEE INST DEVELOP LAB
67 MECHANIC ST ATTLEBORO MASS
ROYCO INSTRUMENTS INC
440 OLIVE ST PALO ALTO CALIF
ROYSON ENGRG CO
HATBORO PA
R S ELECTRONICS CORP
BOX 11368 STA PALO ALTO CALIF
RUBBER & ASBESTOS CORP
225 BELLEVILLE AVE BLOOMFIELD N J
RUBBERCRAFT CORP OF CALIFORNIA
1800 W 220TH ST TORRANCE CALIF
RUBBER TECK INC
19115 S HAMILTON ST GARDENA CALIF
RUBY CHEMICAL CO
68-70 MCDOWELL ST COLUMBUS 16 OHIO
RUCKELSHAUS LABORATORIES INC JOHN G
110 POMEROY RD MADISON NJ
RUCKER CO
EMERYVILLE CALIF
RUE PRODUCTS
10539 CLARKSON RD LOS ANG CALIF
RUNZEL CORD & WIRE CO
4727 MONTROSE ST CHICAGO ILL
RUSSELL BURDSALL & WARD BOLT & NUT CO
P O BOX 110 PORT CHESTER N Y
RUSSELL GASKET CO
7424 BESSEMER AVE CLEVELANO 27 OHIO
RUSSELL REINFORCED PLASTICS CORP
521 HOFFMAN AVE LINDENHURST N Y
RUST-LICK INC
755 BOYLESTON ST BOSTON 16 MASS
RUTHERFORD ELECTRONICS CO
8944 LINDBLADE ST CULVER CITY CALIF
RUTHERFORD RESEARCH PRODS CO
P O BOX 162 RUTHERFORD N J
RYE CONTROLS INC
710 S 33RO ST RICHMOND CALIF
RYTRON CO INC
7303 LANKERSHIM BLVD HOLLYWOOD CALIF

S

S & A ELECTRONICS
102 NEVADA ST TOLEDO 3 OHIO
SAFE-T-MIKE CORP
2904 CHAPMAN ST OAKLAND CALIF
SAGE CRAFT INC
NORWICH N Y
SAGE ELECTRONICS CORP
O BOX 126 ROCHESTER 10 NY
SAGE LABORATORIES INC
3 HURON DR E NATICK MASS
SAG HARBOR INDUSTRIES
BOX N SAG HARBOR NY
SAINE EQUIPMENT LAB HARRY T
RT 2 BOX 407 E MAIN AVE MORGAN HILL CALIF
SAMPSON CHEMICAL & PIGMENT CORP
2830 W LAKE ST CHICAGO 12 ILL
SANBORN CO
175 WYMAN ST WALTHAM 54 MASS
SANDERS ASSOCIATES
95 CANAL ST NASHUA N H

SAN FERNANDO ELECTRIC MFG CO
1509 1 ST SAN FERNANDO CALIF
SANFORD MILLER CO
89 THROOP AVE BROOKLYN 6 N Y
SANGAMO ELECTRIC CO
1207 N 11TH ST SPRINGFIELD ILL
SANGAMO MICROSONICS INC
60 WINTER ST WEYMOUTH 88 MASS
SANTA ANITA ENGG CO OF CALIF
3270 E FOOTHILL BLVD PASADENA CALIF
SARASOTA ENG CO INC
2010 PINE TERRACE SARASOTA FLA
SARATOGA INDUSTRIES
CONGRESS & BALLSTON AVES SARATOGA SPGS N Y
SARATOGA PLASTICS INC
N WALPOLE NH
SARGEANT & WILBUR HEAT TREATING CORP
170 YORK AVE PAWTUCKET R I
SARGENT ELECTRIC CORP
23-16 40 AVE LONG ISLAND CITY NY
SARKES TARZIAN INC
EAST HILLSIDE DR BLOOMINGTON IND
SARKES TARZIAN INC
415 N COLLEGE AVE BLOOMINGTON IND
SARTRON INC
114 MAIN ST NEWBERG ORG
SATELLITE CORP OF AMERICA
CHEWONKI RD WISCASSET MAINE
SATURN ELECTRONICS CORP
10665 HARRY HINES BLVD
BOX 13305 DALLAS TEXAS
SAUEREISEN CEMENTS CO
SAUEREISON BLVD PITTSBURGH PENNA
SAVAGE-ROWE PLATING CO INC
2152 PORTAGE ST KALAMAZOO MICH
SAVOY ELECTRONICS INC
P O BOX 584 GRIFFIN GA
SAVOY ELECTRONICS INC
1314 NE 17 CT BOX 7127 FT LAUDERDALE FLA
SAXONBURG CERAMICS INC
BOX 157 SAXONBURG PA
SAXTON PRODUCTS INC
4320 PARK AVE NEW YORK 57 N Y
SAYRE ELECTRONICS
BLOOMFIELD N J
SBD SYSTEMS
90 ROME ST FARMINGDALE N Y
SCAICO CONTROLS INC
210 TAYLOR ST RIVERSIDE NJ
SCALA RADIO CO
2814 19 ST SAN FRANCISCO 10 CALIF
SCANTLIN ELECTRONICS INC
2215 COLBY AVE LOS ANGELES 64 CALIF
SCHAEVITZ ENGG
US RTE 130 & SCHAEVITZ BLVD CAMDEN NJ
SCHAFER CUSTOM ENGG
235 S 3 ST BURBANK CALIF
SCHAFFER AIR INDUSTRIES
290 N HENRY ST BROOKLYN 22 N Y
SCHAUER MFG CORP
4501 ALPINE AVE CINCINNATI OHIO
SCHENECTADY CHEMICALS INC
SCHENECTADY 1 NEW YORK
SCHENECTADY VARNISH CANADA LTD
409 COMSTOCK RD SCARSBOROUGH ONT CANADA
SCHENECTADY VARNISH CO
ROTTERDAM JCT N Y
SCHERMA MFG CO F A
424 BROOME ST NEW YORK 13 N Y
SCHINDLERS
195 GREENFIELD AVE LOS ANGELES 49 CALIF
SCHIRMER-NATIONAL ALARM CORP
20 WESTSIDE AVE BERGENFIELD N J
SCHJELDAHL CO G T
BOX 170 NORTHFIELD MINN
SCHLIEBUS ELECTRONIC INSTRUMENT OC
14 ABBOTT LANE CHELMSFORD MASS
SCHMELING ELECTRONICS DIV RARITAN INDS CORP
20 1ST ST KEYPORT NJ
SCHMITT MFG CO
1821 UNIVERSITY AVE ST PAUL MINN
SCHOENE ELECTRONICS LABORATORY
915 WASHINGTON AVE EVANSVILLE 13 IND
SCHONSTEDT ENG CO
9170 BROOKVILLE RD SILVER SPRING MD
SCHOTT CO OSCAR A
500 11TH AVE S MINNEAPOLIS 4 MINN
SCHRACK ELECTRICAL SALES CORP
1100 MADISON AVE NEW YORK 28 NY
SCHULMERICH ELECTRONICS INC
CARILLON HILL SELLERSVILLE PA
SCHLUMBERGER RIDGEFIELD INSTRUMENTS
RIDGEFIELD CONN
SCHUTTE & KOERTING CO
CORNWELL HTS BUCKS CO PA
SCHWARZER CORP
46 SALMI RD FRAMINGHAM MASS
SCHWEITZER DIV P J KIMBERLY CLARK CORP
MT HOLLY SPRINGS PA
SCHWEITZER INC PETER J DIVN
LEE MASS
SCIAKY BROS
4915 W 67 ST CHICAGO 38 ILL
SCIENTIFIC ATLANTA INC
2162 PIEDMONT RD NE ATLANTA 9 GA
SCIENTIFIC ELECTRIC INC
105 119 MONROE ST GARFIELD N J
SCIENTIFIC ELECTRONIC LABS INC
24 WOODSIDE AVE LITTLE FALLS NJ
SCIENTIFIC RADIO PRODS INC
2303 W 8TH ST LOVELAND COLORADO
SCIENTIFIC RADIO SERVICE
4301 SHERIDAN ST UNIV PK HYATTSVILLE MD
SCINTILLA DIV BENDIX CORP
DELAWARE AVE SIDNEY NY
SCINTILLONICS INC
P O BOX 701 FT COLLINS COLO
SCIOTO SIGN CO
370 VINE ST KENTON OHIO
SCOPES CO INC
PO BOX 56 MONSEY NY
SCOTT INC H H
111 POWDER MILL RD MAYNARD MASS
SEABOARD ELECTRONIC CORP
417-421 CANAL STREET NEW YORK 13 NY
SEABORD PACIFIC DIV ASSOC SPRING
15001 S BROADWAY PO BX 231 GARDENA CALIF
SEAGER STANDARD CARBON CO
291 CHURCH ST NEW YORK 13 N Y
SEAL-A-METIC CO DIV OF FILTORS INC
1 JOHN ST MALEDON N J
SEALECTRIC SWITCH & RELAY CORP
6025 N KEYSTONE AVE CHICAGO 3 ILLINOIS
SEALECTRO CORP
610 FAYETTE AVE MAMARONECK NY
SEALECTRO CORP
139 HOYT ST MAMORONECK N Y
SEALOL INC
WARWICK INDUSTRIAL PARK PROVIDENCE 5 RI
SEAL PEEL INC
775 STEPHENSON HWY ROYAL OAK MICH
SEALTRON CORP
READING RD AT AMITY CINCINNATI 15 OHIO
SECOA ELECTRONICS CORP
86 KYLVESTER ST WESTBURY LI NY
SECODE CORP
555 MINNESOTA ST SAN FRANCISCO 7 CALIF
SECO ELECTRONICS INC
5015 PENN AVE S MINN MINN
SECO ELECTRONICS INC
1201 S CLOVER DR MPLS MINN
SECON METALS CORP
7 INTERVALE ST WHITE PLAINS NY
SECTRON INC
ONE PINGREE ST SALEM MASS
SECURITY CONTROLS INC
503 FRANKLIN ST BUFFALO 2 N Y
SECURITY DEVICES INC
818 S CHOCTAW AVE EL RENO OKLAHOMA
SECURITY DEVICES LAB
24 SENECA AVE ROCHESTER 21 NY
SEEBURG CORP
1500 N DAYTON ST CHICAGO 22 ILL
SEELY INSTRUMENT CO INC
377 4TH ST PO BOX 387 NIAGARA FALLS NY
SEGAL EDWARD INC
132 LAFAYETTE ST NEW YORK 13 NY
SEG ELECTRONICS CO INC
12 MINSOALE ST BROOKLYN 7 NY
SEISCOR MFG CO DIV SEISMOGRAPH SERVICE CORP
P O BOX 1590 TULSA OKLAHOMA
SEKONIC INC
130 WEST 42ND ST NEW YORK 36 NY
SELAS CORP OF AMERICA
DRESHER PENNA
SELECTRONS LTD
520 FIFTH AVE NEW YORK 36 NY
SEL REX CORP
75 RIVER RD NUTLEY 10 N J
SEMCOM
262 E 16 ST PATERSON 4 NJ

SEMCOR
3536 W OSBORN RD PHOENIX ARIZ
SEMI-ALLOYS INC
550 S FULTON AVE MOUNT VERNON N Y
SEMICON ASSOCIATES INC
PO BOX 832 LEXINGTON KY
SEMICON INC
SWEETWATER RD PO BOX 328 BEOFORD MASS
SEMICON OF CALIF INC
70 MARIPOSA AVE WATSONVILLE CALIF
SEMI ELEMENTS INC
SAXONBURG BLVD SAXONBURG PENNA
SEMIMETALS INC
172 SPRUCE ST WESTBURY LI
SEMITRONICS INC
63 SCRANTON ST WINCHESTER MASS
SEMITRONICS CORP
265 CANAL ST NEW YORK 13 N Y
SEMTRAN INSTRUMENTS INC
RTE 73 INDUSTRIAL CTR MAPLE SHADE N J
SENECA FALLS MACHINE CO
314 FALL ST SENECA FALLS NY

SENSORY INC
7 MAPLE AVE MORRISTOWN N J
SEQUENTIAL ELECTR SYSTEM INC
66 SAW MILL RD ELMSFORD NY
SEQUOIA WIRE
2201 BAY RD REDWOOD CITY CALIF
SERCO ELECT RESEARCH CORP
15735 AMBAUM BLVD SEATTLE WASH
SERDEX INC
12 BOWDOIN SQ BOSTON MASS
SERVICE ASSOCIATED INC
9236 S VINCENNES ST CHICAGO 20 ILL
SERVICE INSTRUMENTS CORP
426 S WESTGATE DR ADDISON ILL
SERVICE INSTRUMENT CORP
171 OFFICIAL RD ADDISON ILL
SERVICE PARTS SYSTEMS
13380 E 9 MILE RD E DETROIT MICH
SERVO CONSULTANTS LTD
70 STATE ST WESTBURY NY
SERVO CONTROL DIV OILGEAR CO
160 BEAR HILL RD WALTHAM 54 MASS
SERVO CORP OF AMERICA
111 NEW SOUTH RD HICKSVILLE NY
SERVO DYNAMICS CORP
MAIN ST SOMERSWORTH NH
SERVOMECHANISMS INC
200 N AVIATION BLVD EL SEGUNDO CALIF
SERVO SYSTEMS CO
14 CARMER AVE BELLEVILLE N J
SERVOMECHANISMS INC
625 MAIN ST WESTBURY NY
SERVOMECHANISNS INC
200 AVIATION BLVD EL SEGUNDO CALIF

SERVONIC INSTRUMENTS INC
1644 WHITTIER AVE COSTA MESA CALIF
SERVOSPEED DIV ELECTRO DEVICES INC
4 GODWIN AVE PATERSON NJ
SERVO TEK PRODUCTS CO
1086 GOFFLE RD HAWTHORNE NJ
SERVWELL PRODUCTS CO
6541 EUCLID AVE CLEVELAND OHIO
SESSIONS CLOCK CO INDUSTRIAL TIMING DIV
61 E MAIN ST FORESTVILLE CONN
SETCHELL-CARLSON INC
NEW BRIGHTON ST PAUL 12 MINN
SETHCO MFG CORP
2284 BABYLON TPKE MERRICK N Y
SETTER BROS INC
CATTARAUGUS N Y
SHALLCROSS MFG CO
PRESTON ST SELMA NC
SHAMBAN & CO W S
11617 W JEFFERSON BLVD CULVER CITY CALIF
SHAMBAN & CO W S
2531 BREMER DRIVE FT WAYNE 8 IND
SHAND & JURS CO
2600 8TH ST BERKELEY 10 CALIF
SHAW INSULATOR CO
201 1ST ST STROUDSBURG PENNA
SHAW INSULATOR CO
276 SNYDER AVE BERKELEY HEIGHTS N J
SHEFFCO MFG CORP
FAIRVIEW N J
SHEFFIELD CORP SUB THE BENDIX CORP
BOX 893 SPRINGFIELD ST DAYTON OHIO
SHELL ELECTRONIC MFG CORP
112 STATE ST WESTBURY N Y
SHELTERED WORKSHOPS INC
2619 MAIN ST SANTA MONICA CALIF
SHEPARD LABS INC
480 MORRIS AVE SUMMIT NJ
SHEPHERD INDUSTRIES INC
103 PARK AVE NUTLEY 10 NJ
SHERIDAN GRAY INC
21000 S NORMANDIE TORRANCE CALIF
SHERIDAN-GRAY INC
24701 CRENSHAW BLVD TORRANCE CALIF
SHERMAN MFG CO H B
22 BARNEY ST BATTLE CREEK MICH
SHEROLD CRYSTALS INC
1510-12 MCGEE TRAFFICWAY KANSAS CITY 8 MO
SHERWOOD ELECTRONIC LABS INC
4300 N CALIFORNIA AVE CHICAGO 18 ILL
SHIELDALLOY CORP
NEWFIELD N J
SHIELDING INC
N READ AVE RIVERTON N J
SHIPLEY CO INC
WALNUT ST WELLESLEY 81 MASS
SHORT BROS & HARLAND LTD
CASTLEREAGH BELFAST NORTHERN IRELAND

F W SHROOER CO
11623 S BROADWAY LOS ANG CALIF
SHURCLOSE SEAL CO
17411 E WARREN AVE DETROIT 24 MICH
SHURE BROS
222 HARTREY AVE EVANSTON ILL
SHURITE METERS
130 WALLACE ST NEW HAVEN 8 CONN
SHUR-LOK CORP
879 S EAST ST PO BOX 563 ANAHEIM CALIF
SIBLEY CO
BRIDGE ST HADDAM CONN
SICKLES F W DIV GIC
165 FRONT ST CHICOPEE MASS
SIEMON MFG CO
BOX 275 WAYNE ILL
SIERRA ELECTRONIC DIV PHILCO CORP
3885 BOHANNON DR MENLO PARK CALIF
SIERRA ENGG CO
123 E MONTECITO AVE SIERRA MADRE CALIF
SIFCO METACHEMICAL INC
935 E 63RD ST CLEVELAND 22 OHIO
SIGHTMASTER CORP
50 ALEPPO ST PROVIDENCE R I
SIGMA INSTRUMENTS INC
170 PEARL ST S BRAINTREE MASS
SIGMUND COHN CORP
121 S COLUMBUS AVE MT VERNON N Y
SIGNALITE INC
1933 HECK AVENUE NEPTUNE NJ
SIGNAL TRANSFORMER CO
1661 MCDONALD AVE BROOKLYN N Y
SIGNETICS CORP
680 W MAUDE AVE SUNNYVALE CALIF
SILICON TRANSISTER CORP
150 GLEN COVE RD CARLE PLACE NY
SILICONE INSULATION INC
1383 SEABURY AVE BRONX 61 NY
SILICONE SEALS INC
3694 MILWAUKEE AVE CHICAGO 41 ILL
SILICONIX INC
1140 W EVELYN AVE SUNNYVALE CALIF
SILIKROME DIV APV-HEXSEAL CORP
41 HONECK ST ENGLEWOOD N J
SILLCOCKS MILLER CO
MAPLEWOOD N J
SIMMONDS AEROCESSORIES INC
VERGENNES VT
SIMMONDS PRECISION PRODUCTS INC
105 WHITE PLAINS RD TARRYTOWN NY
SIMMONDS PRECISION PRODUCTS INC
1515 S GARDENA AVE GLENDALE CALIF
SIMMONS FASTENER CORP
N BROADWAY ALBANY 1 NY

SIMONDS SAW & STEEL CO
INTERVALE RD FITCHBURG MASS
SIMPLATROL PRODUCTS CORP
24 SALISBURY ST WORCESTER MASS
SIMPLEX TIME RECORDER CO
24 S LINCOLN ST GARDNER MASS
SIMPSON ELECTRIC CO DIV AMER GAGE MACH CO
5200 W INZIE ST CHICAGO 44 ILL
SIMPSON ELECTRIC CO DIV AMER GAGE MACH CO
BOX 249 LAC DU FLAMBEAU WISC
SIMPSON ELECTRIC CO
MERCER WISC
SIMS CASTING CORP
2174 E ERIE BLVD SYRACUSE
SINCLAIR MFG CO
S WORCESTER ST CHARTLEY MASS
SINGER MFG
FINDERNE NJ
SINGER METRICS DIV SINGER MFG CO
915 PEMBROKE ST BRIDGEPORT 8 CONN
SINGER METRICS PANORAMIC DIV
915 PEMBROKE ST BRIDGEPORT 8 CONN
SINGER METRICS SENSITIVE RES DIV
915 PEMBROKE ST BRIDGEPORT 8 CONN
SINGLETON CO
11770 BEREA RD CLEVE OHIO
SITTLER CORP
18 N ADA ST CHICAGO 7 ILL
SIVERS LAB
BOX 42018 STOCKHOLM SWEDEN
C SJOBERG & SON
115 STATION ST BRANSTON 10 R I
SKF INDUSTRIES
TULIP & KENNEDY ST PHILA PA
SKIATRON ELECTRONICS TV CORP
18D VARICK ST NEW YORK 14 NY
SKIDMORE-WILHELM MFG CO
442 GREEN RD CLEVELAND 21 OHIO
SKIL CORP
5033 ELSTON AVE CHICAGO 30 ILL
SKINNER PREC INDUST INC POLYNOID DIV
NEW BRITAIN CONN
SKOTTIE ELECTRONICS INC
204 BRIDGE ST PECKVILLE PA
SKYDYNE INC
RIVER RD PORT JERVIS NY
SKYRON CORPORATION
106 20 ATLANTIC AVE OZONE PARK 16 N Y
SKYSWEEPER INC
PO BOX 92 MCHENRY ILL
SKYTRON ELECTRONICS
2032 SCOTT ST HOLLYWOOD FLA
SLATER ELECTRIC INC
45 SEA CLIFF AVE GLEN COVE NY
SLAUGHTER CO
YOUNG AND COLLEGE STS PIQUA 9 OHIO
SLIP RING CO OF AMERICA
3622 W JEFFERSON BLVD LOS ANGELES 16 CAL
SLOAN CO THE
7704 SAN FERNANDO RD SUN VALLEY CAL
SLOCOMB CO J T
68 MATSON HILL RD S GLASTONBURY CONN
SMALL MOTORS INC
2076 ELSTON AVE CHICAGO 14 ILL
SMALLWOOD LTD S G
391-397 KING ST E KITCHENER ONTARIO CANADA
SMITH CORP A O
531 N 4 ST TIPP CITY OHIO
A D SMITH CO
ELKHORN WIS
SMITH ELECTRONIC INC
8200 SNOWVILLE RD BRECKSVILLE OHIO
SMITH-FLORENCE INC
OVERLAKE IND PARK BOX 717 REDMOND WASH
SMITH INC HERMAN H
2326 NOSTRAND AVE BROOKLYN 10 NY
SMITH-MEEKER ENGG CO
157 CHAMBERS ST NEW YORK 7 N Y
SMITH THERMOTRONICS INC
FORREST HECTOR STS CONSHOHOCKEN PA
SNAP TITE INC
201 TITUSVILLE RD UNION CITY PENNA
SNC MFG CO
PO BOX 277 OSHKOSH WISC
SNYDER ELECTRONICS CORP
212 E NORTH ST WAUKESHA WIS
SNYDER MFG CO
22 & ONTARIO STS PHILADELPHIA 4 PA
SODERBERG MFG CO
628 S PALM AVE ALHAMBRA CALIF
SOHOT DIV OF THERMOLAB CORP
69400 FARMDALE AVE N HOLLYWOOD CALIF
SOLA ELECT CO SOLA TRANSFORMER DV
BUSSE RD AT LUNT AVE ELK GROVE ILL
SOLAR MFG CORP
4553 SEVILLE AVE LOS ANGELES 58 CALIF
THE SOLARTRON ELECTRONIC GROUP LTD
VICTORIA ROAD FARNBOROUGH HANTS ENGLAND
SOLAR VOLT CO INC
118 E SAMPLE SOUTH BEND IND
SOLID STATE CONTROLS INC
P O BOX 63 FLUSHING 52 N Y
SOLID STATE ELECTRONICS CO
15321 RAYEN ST SEPULVEDA CALIF
SOLID STATE PRODUCTS INC
1 PINGREE ST SALEM MASS
SOLITRON DEVICES INC
500 LIVINGSTON ST NORWOOD N J
SOLVERE INC
1902 W CHESTNUT ST SANTA ANA CALIF
SOMERS BRASS CO
94 BALDWIN AVE WATERBURY CONN
SONAR RADIO CORP
3050 W 21 ST BROOKLYN 24 NY
SONEX INC
20 E HERMAN ST PHILA 44 PA
SONIC MEMORY CORP
494 OAK ST COPIAGUE NY
SONOBOND CORP SUB OF AEROPROJECTS INC
202 W MARKET WEST CHESTER PA
SONOTONE CORP
PO BOX 200-SAW MILL RIVER RD ELMSFORD NY
SONOTONE CORP
COLO SPRING NY
SONY CORP
514 BROADWAY NEW YORK N Y
SORENSEN INDUSTRIAL ELECTRONIC CO
ROUTE 10 DOVER NJ
SORENSEN-UNIT OF RAYTHEON CO
RICHARDS AVENUE SOUTH NORWALK CONN
SOROBAN ENGG INC
PO BOX 1717 MELBOURNE FLA
SOSTMAN & CO HE
PO BOX 60 CRANFORD NJ
SOUNDSCRIBER CORP
6 MIDDLETOWN AVE NEW HAVEN CONN
SOUTH BEND LATHE WORKS
425 E MADISON ST SOUTH BEND 22 IND
SOUTHCO DIV SOUTH CHESTER CORP
LESTER PA
SOUTHERN ELECTRONICS CORP
150 W CYPRESS AVE BURBANK CALIF
SOUTHERN ELECTRONICS CO INC
MOSHEIM TENN
SOUTHERN INSTRUMENTS COMPUTER DIV
FRIMLEY RD CAMBERLEY SURREY ENGLAND
SOUTHERN PLASTICS CO
408 PENDLETON ST COLUMBIA SC
SOUTHERN SCREW CO
PO BOX 1360 E I D STATESVILLE NC
SOUTHERN TOOL & MACH CO
NEW BIRMINGHAM HWY ANNISTON ALA
SOUTHWESTERN INDUSTRIAL ELECT CO
1D201 W HEIMER RD HOUSTON TEXAS
SOUTHWIRE CO
FERTILLA ST CARROLLTON GA
SOUTHWORTH MACH CO
30 WARREN AVE PORTLAND MAINE
SPACE CONTROL CORP
1416 W 166TH ST GARDENA CALIF
SPACE INSTRUMENTATION CORP
907 PICO BLVD SANTA MONICA CALIF
SPACEONICS & PORTABLE ELECTRIC TOOLS INC
1200 E STATE ST GENEVA ILL
SPACE SYSTEMS INC
P O BOX 122 HICKSVILLE L I N Y
SPARTA MFG CO
DOVER OHIO
SPARTON ELECTRONICS
JACKSON MICH
SPASORS INC SUB SILICON TRANSISTOR
1090 MORENA BLVD SAN DIEGO 10 CALIF
SPATCO MFG CO
40-24 22ND ST L I N Y
SPAULDING FIBRE CO INC
1325 SAN JULIAN ST LOS ANGELES 15 CALIF
SPAULDING FIBRE CO
310 WHEELER ST TONAWANDA N Y
SPAULDING FIBRE CO
N ROCHESTER NH
SPAULDING FIBRE CO INC
MILTON N H
SPAULDING PRODUCTS CO
550 W BARNER ST FRANKFORT IND
SPEC-HEATING INC
13942 SATICOY ST VAN NUYS CALIF
SPEC-PLATING INC
13871 SATICOY ST VAN NUYS CALIF
SPEC-SWITCH INC
13901 SATICOY ST VAN NUYS CALIF
SPEC-TRONICS
13901 SATICOY ST VAN NUYS CALIF
SPECIAL CHEMICALS CORP
100 S WATER ST OSSINING N Y
SPECIAL INSTRUMENTS LABORATORY INC
312 W VINE AVE KNOXVILLE 2 TENN
SPECIALTIES INC
CHARLLOTTESVILLE VA
SPECIALTY AUTOMATIC MACHINE CORP
80 CAMBRIDGE ST BURLINGTON MASS
SPECIALTY ELECTRONICS DEVELOPMENT CORP
131-03 39TH AVE FLUSHING NY
SPECIFIC PLATING CORP
3002 DOWNEY RD LOSANGLES CALIF
SPECIFIC PROD
P D BOX 425 WOODLAND HILLS CALIF
SPEC TOOL CO
9626 E BEVERLY RD PICO RIVERA CALIF
SPECTRA ELECT CORP
250 E THIRD ST MT VERNON N Y
SPECTRA-STRIP WIRE & CABLE CORP
10052 LARSON AVE GARDEN GROVE CALIF
SPECTRAL DYNAMICS CORP OF SAN DIEGO
1162 MORENA BLVD SAN DIEGO 10 CALIF
SPECTRAN ELECTRONICS CORP
146 MAIN ST MAYNARD MASS
SPECTRO MAGNETIC INDUST
PO BOX 3306 HAYWARD CALIF
SPECTROLAB DIV TEXTRON ELECTRONICS INC
SYLMAR CALIF
SPECTROL ELECTRONICS CORP
AMES CT PLAINVIEW NY
SPECTROL ELECTRONICS CORP
1704 S DEL MAR AVE SAN GABRIEL CALIF
SPECTRUM INSTRUMENTS INC
BOX 61 STEINWAY STA L I CITY 3 N Y
SPFER CARBON CO DIV AIR REDUCTION CO
THERESIA ST ST MARYS PA
SPEER RESISTOR DIV SPEER CARBON CO
BRADFORD PA
SPEIDEL CORP PRESSURE CONT GRP
WARWICK RHODE ISLAND
SPELLMAN HIGH VOLTAGE CO INC
1930 ADEE AVE NEW YORK 69 NY
SPENCE CORP ADAM
964 FRELINGHUYSEN AVE NEWARK NJ
SPENCER-KENNEDY LABS INC
1320 SOLDIERS FIELD RD BOSTON 35 MASS
SPERRY ELECTRONIC TUBE DIV SPERRY RAND CORP
GAINESVILLE FLA
SPERRY FARRAGUT CO DIV SPERRY RAND CORP
FARRAGUT RD BRISTOL TENN
SPERRY GYROSCOPE CO DIV SPERRY RAND CORP
GREAT NECK NY
SPERRY ELECTRONIC TUBE DIV
SPERRY RAND CORP
GREAT NECK L I N Y
SPERRY MICROWAVE ELECT INC
BOX 1828 CLEAWATER FLA
SPERRY PHOENIX CO DV
19TH & DEER VALLEY RD PHOENIX ARIZ
SPERRY PIEDMONT CO DIV SPERRY RAND CORP
CHARLOTTESVILLE VA
SPERRY PRODUCTS CO DIV HOWE SOUND CO
SHELTER ROCK RD DANBURY CONN
SPERRY RAND REMINGTON RAND DIV
311 TURNER ST UTICA N Y
SPERRY RNAD REMINGTON RAND DIV
7 SPRUCE ST ILION N Y
SPERRY RAND CORP WRIGHT DIV
PO BOX 2211 DURHAM NO CAR
SPERRY SEMICONDUCTOR DIV SPERRY RAND CORP
NORWALK CONN
SPERRY UTAH CO DV SPERRY RAND CORP
322 N 21ST WEST SALT LAKE CITY UTAH
SPERTI FARADAY INC
1322 E CHURCH ST ADRIAN MICHIGAN
THE SPHERE CO INC
25 AMITY ST LITTLE FALLS N J
SPICO ELECTRONICS INC
HENRIETTA & DUFFY HICKSVILLE N Y
SPINCRAFT INC
4122 W STATE ST MILWAUKEE 8 WISC
SPIRLING PRODUCTS CO
HENRIETTA ST & DUFFY AVE HICKSVILLE LI NY
SPIROTECH CORP
160 MARINE ST FARMINGDALE LI NY
SPIVEY INC JAMES S
4908 HAMPDEN LANE WASHINGTON 14 DC
SPLIT BALLBEARING DIV INC
LEBANON NEW HAMPSHIRE
SPRAGUE ELECTRIC CO
NORTH ADAMS MASS
SPRINGER AIRCRAFT RADIO CORP
IND IND
SPRUCE PINE MICA CO
PO BOX 456 SPRUCE PINE N CAROLINA
SPS WESTERN
5625 CENTURY BLVD LOS ANG CALIF
SQUARE D CO COMM CONTROL DIV
BIGHAM RD ASHEVILLE NO CAR
SQUARE D EC & M DIV
4500 LEE RD CLEVELAND OHIO
S RIVER METAL PRODUCTS CO
377 TURNPIKE S RIVER N J
ST CROIX PLASTICS CORP
PRODUCTION DIV UNITED FAB & ELECT
DRESSER WIS
ST JOE MACHINES INC
ST JOSEPH MICH
ST JOHN X-RAY LABORATORY
CALIFON NJ
ST MARYS CARBON CO
STATE ST ST MARYS PA
STACKPOLE CARBON CO
ST MARYS PA
STACKPOLE CARBON CO
KANE PENNA
STACO INC STANDARD ELEC PRODS DIV
2240 E 3RD ST DAYTON 3 OHIO
STAHLIN BROS INC
500 MAPLE ST BELDING MICH
STAINLESS INC
3 ST NORTH WALES PA
STA LIT LIGHTER CO ELECTRO LAB DIV
647 NORTH ST DAYTON BEACH FLA
STAMFORD METAL SPECIALTY CO
427 W BROADWAY NEW YORK N Y
STANAT MFG CO
523 SHAMES DR WESTBURY NY
STANCIL-HOFFMAN CORP
845 N HIGHLAND AVE HOLLYWOOD 38 CALIF
STANCOR ELECTRONICS INC
3501 W ADDISON ST CHICAGO 18 ILL
STANDARD AUTO CORP
333 CEDAR ST WYANDOTTE MICH
STANDARD COIL PRODUCTS CO
2085 N HAWTHORNE AVE MELROSE PARK ILL
STANDARD COMPONENTS CORP
780 S 3RD AVE MOUNT VERNON N Y
STANDARD CONTROLS INC
1130 POPLAR PLACE SEATTLE WASHINGTON
STANDARD ELECTRIC MFG CO
HADDON AVE W BERLIN NJ
STANDARD ELECTRIC PRODUCTS
2240 E THIRD ST DAYTON OHIO
STANDARD ELECTRIC TIME CO
89 LOGAN ST SPRINGFIELD 2 MASS
STANDARD ELECTRONICS
FARMINGDALE NJ
STANDARD GLOVE CO OF N J
101 FRELINGHUYSEN AVE NEWARK NJ
STANDARD INSTRUMENT CORP
657 BROADWAY NEW YORK 12 NY
STANDARD KOLLSMAN
BOX 618 OSHKOSH WISC
STANDARD KOLLSMAN INDUSTRIES INC TUNER DIV
920 RATHBONE AURORA ILL

STANDARD KOLLSMAN INDUSTRIES INC TUNER DIV
MELROSE PARK ILL
STANDARD LOCKNUT & LOCKWASHER INC
2250 VALLEY AVE INDIANAPOLIS 18 IND
STANDARD METALS CORP
262 BROAD ST N ATTLEBORO MASS
STANDARD PLASTICS CO INC
62 WATER ST ATTLEBORO MASS
STANDARD PRESSED STEEL CO
BOX 899 JENKINTOWN PA
THE STANDARD PRODUCTS CO
FORT LAUDERDALE FLA
STANDARD PRODUCT INC SUB ELECTR COMM INC
WICHITA KANS
STANDARD RECORD MFG CO
70 N SAN GABRIEL BLVD PASADENA 8 CALIF
STANDARD REGISTER CO
626 ALBANY ST DAYTON 1 OHIO
STANDARD TELEVISION & TUBE CORP
3233 CONTI ST NEW ORLEANS 19 LA
STANDARD T V TUBE CORP
700 DRYADES ST NEW ORLEANS 12 LA
STANDARD WINDING CO DIV OF OVITRON CORP
44-62 JOHNES ST NEWBURGH NY
STANLEY TRANSFORMER CO
31-23 VERNON BLVD LONG ISLAND CITY N Y
STANPAT CO
150 42 12TH RD WHITESTONE N Y
STANWYCK WINDING CO
137-151 WALSH AVE NEWBURGH N Y
STAPLEX CO
775 5 AVE BROOKLYN 32 NY
STAR-A ELECTRIC MFG CO INC
41 VARICK AVE BROOKLYN 37 NY
STAR ENGRAVING & NAME PLATE CO
3222 E OLYMPIC BLVD LOS ANG CALIF
STARK TOOL CO
BOX 288 ANN HARBOR MICH
STAR PORCELAIN CO
21 MUIRHEAD AVE TRENTON 9 NJ
STAR-TRONICS INC
MOULTON ST GEORGETOWN MASS
STATES CO
19 NEW PARK AVE HARTFORD 6 CONN
STATES ELECTRONICS CORP BLUDWORTH MARINE DIV
96 GOLD ST NEW YORK 38 NEW YORK
STATHAM INSTRUMENTS INC OF PUERTO RICE
HATO REY IND SUBDIV
HATO REY PUERTO RICO
STATHAM INSTRUMENTS INC
12401 W OLYMPIC BLVD LOS ANGELES 64 CALIF
STATIKIL INC
1220 W 6TH ST CLEVELAND OHIO
STAVER CO
41-51 N SAXON AVE BAY SHORE L I N Y
STA WARM ELECTRIC CO
222 CHESTNUT ST RAVENNA OHIO
STEARNS MAGNETIC PRODUCTS
635 S 28 ST MILWAUKEE 46 WISC
STEINEN MFG CO WM
43 BRUEN ST NEWARK 5 N J
STELMA INC
200 HENRY ST STAMFORD CONN
STEPHENS ADAMSON MFG CO SEAL MASTER BEARING
RIDGEWAY AVE AURORA ILL
STEPHENS TRU-SONIC INC
8538 WARNER DR CULVER CITY CALIF
STEPPER MOTOR DIV LAND AIR INC
16226 BROADWAY GARDENA CALIF
STERLING ELECT MOTORS INC
4610 SMITH RD NORWOOD CINN OHIO
STERLING ELECTRIC MOTORS INC
5401 TELEGRAPH RD LOS ANGELES 22 CALIF
STERLING MFG CO
2880 DETROIT AVE CLEVELAND 13 OHIO
STERLING INSTRUMENT DIV DESIGNATRONICS INC
76 E 2ND ST MINEOLA N Y
STERLING TRANSFORMER CORP
510 DRIGGS AVE BROOKLYN NY
STEVENS-EVANS INC
3801 HICOCK ST SAN DIEGO 10 CALIF
STEVENS MFG CO GEO
6001 N KEYSTONE CHICAGO 46 ILL
STEVENS MFG CO
PO BOX 1007 ANNEX MANSFIELD OHIO
STEVENS PAPER MILLS INC
PO BOX 347 WINDSOR CONN
STEVENS PAPER MILLS INC
77 MILL ST WESTFIELD MASS
STEVENS PRODUCTS INC
86 MAIN ST E ORANGE N J
STEWARD MFG CO D M
CHATTANOOGA TENN
STEWART ENGG CO
467 BEAN CREEK RD SANTA CRUZ CALIF
STEWART & STEVENSON SERVICES INC
4516 HARRISBURG BLVD HOUSTON 1 TEXAS
STEWART TRANS LUX CORP
1111 W SEPULVEDA BLVD TORRANCE CALIF
STEWART WARNER ALEMITE & INST DIV
1826 DIVERSEY PKWY CHICAGO ILL
STEWART WARNER ELECT DIV STEWART-WARNER CORP
1300 KOSTNER AVE CHICAGO ILL
STODDART AIRCRAFT RADIO CO
6644 SANTA MONICA BLVD HOLLYWOOD 38 CALIF
STOELTING CO C H
424 N HOMAN AVE CHICAGO 24 ILL
STOKES CORP F J
5500 TABOR RD PHILADELPHIA 20 PA
STONE CITY PRODUCTS CO
1206 7 ST BEDFORD IND
STONE PAPER TUBE CO DIV OF STONE STRAW CORP
900 FRANKLIN ST NE WASHINGTON 17 OC
STONE & SMITH INC
5965 ALCOA AVE LOS ANGELES CALIF
STONHARD CO INC
401 N BROAD ST PHILADELPHIA 8 PA
STONITE COIL CORP
RT 130 YARDVILLE N J
STRANDBERG ENGG LABS INC
1001 S ELM ST GREENSBORO N CAROLINA
STRAND LABS INC
294 CENTRE ST NEWTON 58 MASS
STRATOCON CORP
BOX 10 MORRISTOWN NJ
STRAT-O-SEAL MFG CO
3039 W FULLERTON AVE CHICAGO 47 ILL
STREETER AMET
GRAYS LAKE ILL
STROBLITE CO INC
75 W 45 ST NEW YORK 36 NY
STROMBERG DIV GENERAL TIME CORP
135 S MAIN ST THOMASTON CONN

FOR INFORMATION
ON PRODUCTS
SEE THE
"PRODUCTS AND MANUFACTURERS"
SECTION

STRONG ELECTRIC CORP
87 CITY PARK AVE TOLEDO 1 OHIO
STRUTHERS-DUNN INC
LAMBS RD PITMAN NJ
STUCKER & YALE INC
GREEN ST MARBLEHEAD MASS
STUDEBAKER HYDRAULIC PRODUCTS CO
2511 ST CHARLES ROAD BELLWOOD ILLINOIS
STUDIO TV PRODUCTS SALES
356 W 40TH ST NEW 18 NY
STUECK INC W WHITNEY
BOX 335EI OLD SAYBROOK CONN
STURRUP INC
50 SILVER ST MIDDLETOWN CONN
STURTEVANT CO P A
ADDISON ILL
STYROFORMICS
17 HAWKINS ST SOMERVILLE MASS
SUBMINIATURE INST CORP
3236 KANSAS AVE RIVERSIDE CALIF
SUCKLE ELECTRONICS CO
22 & HAYES AVE CAMDEN 5 N J
SULLIVAN INDUSTRIES INC
1050 W EVELYN ST SUNNYVALE CALIF
SULLIVAN LTO H W
70 STATE ST WESTBURY NY
SULZER LABORATORIES INC
621 LOFSTRAND LANE ROCKVILLE MD
SUMMERS & MILLS INC
1511 LEVEE ST DALLAS TEX
SUMMIT COIL CO
4 CLAREMONT RD BERNARDSVILLE NJ
SUMMIT INDUSTRIES INC
2104 W ROSECRANS AVE GARDENA CALIF
SUNAIR OYNAMICS CORP
4415 E TENTH LANE HIALEAH FLA
SUNAIR ELECT INC
3101 S W 3RD AVE FT LAUDERDALE FLA
SUNBANK ELECTRONICS INC
2516 N ONTARIO ST BURBANK CALIF
SUN CHEMICAL CORP ELECTRO TECH PROD DIV
113 E CENTRE ST NUTLEY 10 N J
SUNCOAST INSTRUMENTS DIV MILTON ROY CO
6301 49TH ST ST PETERSBURG FLA
SUNOSTRAND CORP
2531 11 ST ROCKFORD ILL
SUNDSTRAND DENVER
2480 W 70TH AVE DENVER COLO
SUN ELECTRIC CORP
HARLEM & AVONDALE AVE CHICAGO ILL
SUN ENG INC OF ST PETERSBURG
Z399 26 AVE ST PETERSBURG FLA
SNYVL DEV CTR SPRY PHOENIX CO SPRY RAND CORP
294 COMMERCIAL ST SUNNYVALE CALIF
SUNSHINE SCIENTIFIC INSTRUMENT
1810 GRANT AVE PHILADELPHIA 15 PENNA
SUPA INSULATIONS INC
RTE 301 A NORTH ROCKY MOUNT NC
SUPEREX ELECTRONICS CORP
4-6-RADFORD PL YONKERS NY
SUPERIOR CABLE CORP
P O BOX 489 HICKORY NO CAR
SUPERIOR ELECTRIC CO
383 MIDDLE ST BRISTOL CONN
SUPERIOR ELECTRONICS CORP
208 PIAGET AVE CLIFTON N J
SUPERIOR ELECT CO
1011 S FIFTH ST MINN MINN
SUPERIOR FLUX & MFG CO
1536 ST CLAIR AVE CLEVELAND OHIO
SUPERIOR INSULATED WIRE CO
WASHBURNS LANE STONY POINT N Y
SUPERIOR RESISTOR & ELECTRONICS CORP
333 W SUPERIOR PL BOX 274 FRANKFORT IND
SUPERIOR SPINNING & STAMPING CO
4057 63 FITCH RD TOLEDO 13 OHIO
SUPERIOR STEATITE & CERAMIC CORP
83 91 W FOREST ST ENGLEWOOD NJ
SUPERIOR TUBE CO
BOX 191 NORRISTOWN PA
SUPERIOR TUBE CO
WAPAKONETA OHIO
SUPREME ELECTRO-MAGNETIC CO DIV OXFORD ELEC
2331 N WASHTENAW AVE CHICAGO 47 ILL
SUPREME ELECTRONICS CORP
1714 CARROLLTON AVE GREENWOOD MISS
SUPREME TRANFORMER CORP
PO BOX 237 HERRIN ILL
OXFORD ELECTRIC CORP DIV SUPREME TRANSFORMER
4308 W ARMITAGE CHICAGO ILL
SURFACE COMBUSTION CORP
2375 DORR ST TOLEDO OHIO
SURFACE CONDUCTION INC
PARAMOUNT BLDG 1501 BROADWAY NEW YORK N
SURPRENANT MFG CO
172 STERLING ST CLINTON MASS
SWAN ENGINEERING CO
417 VIA DEL MONTE OCEANSIDE CALIF
SWEDLOW PLASTICS CO
394 N MERIDIAN RD YOUNGSTOWN OHIO
SWEENEY MFG CO B K
6300 E 44TH AVE DENVER 16 COLO
SWEET MFG CO
84 DUNHAM ST ATTLEBORO MASS
SWIFT LUBRICATOR CO INC
780 LAKE ST ELMIRA NY
SWIFT TEXTILE METALLIZING & LAMINATING CORP
10 LOVE LANE HARTFORD 1 CONN
SWING O LITE INC
15 MOONACHIE RD HACKENSACK N J
SWITCHCRAFT INC
5555 N ELSTON AVENUE CHICAGO ILL
FULLERTON CALIF
SYLVANIA ELECT PRODS MICROWAVE DEVICE DIV
BOX 997 MOUNTAIN VIEW CALIF
SYLVANIA ELECTRIC PRODUCTS INC
MICROWAVE DEVICE DIVISION
EAST 3RD ST WILLIAMSPORT PENNSYLVANIA
SYLVANIA ELECTRONIC SYSTEMS
PO BOX 941 SANTA CRUZ CALIF
SYLVANIA ELECTRIC PRODUCTS
ESTES ST IPSWICH MASS
SYLVANIA ELECTRIC PRODS INC
DATA SYSTEMS OPERATIONS
189 B ST NEEDHAM MASS
SYLVANIA ELECTRIC PRODUCTS
60 BOSTON ST SALEM MASS
SYLVANIA ELECTRIC PRODS INC WALTHAM LABS
100 FIRST AVE WALTHAM MASS
SYLVANIA ELECTRIC PRODS SEMICOND DIV
WOBURN MASS
SYLVANIA ELECTRIC PRODS INC
BUFFALO OPER ELECTR SYSTEMS
175 GREAT ARROW BUFFALO NY
SYLVANIA ELECTRIC PRODUCTS INC
SENECA FALLS N Y
SYLVANIA ELECTRIC PRODUCTS INC
EMPORIUM PENNA
SYLVANIA ELECTRIC PRODS INC
COMPUTER PROD PLANT
PO BOX 360 MUNCY PA
SYLVANIA ELECTRIC PRODUCTS INC
CHEM & METALLURGICL DIV
TOWANDA PA
SYLVANIA ELECTRIC PROD INC PARTS DIV
12 2ND AVE WARREN PA
SYNCOR PRODUCTS CO
30 EASTERN AVE BOX 51 MALDEN 48 MASS
SYNCRO CORP ELECT DIV
MEUSSE ARGONNE AVE HICKSVILLE OHIO
SYNTHANE CORP
MONTGOMERY AVE OAKS PA
SYNTRON CO
263 LEXINGTON AVE HOMER CITY PA
SYNTRONIC INSTRUMENTS INC
100 INDUSTRIAL RD ADDISON ILL
SYSTEMATICS OF MO INC
2222 OLIVE ST ST LOUIS MO
SYSTEMS DEVELOPMENT INC
307 WATER ST BINGHAMTON NY
SYSTEMS ENGRG LABORATORIES INC
PO BOX 9148 FT LAUDERDALE FLA
SYSTEMS INC
2400 DIVERSIFIED WAY ORLANDO FLA
SYSTEMS MATRIX INC
2219 NOTTINGHAM WAY BOX 3020 TRENTON N J
SYSTRON DONNER CORP
CONCORD CALIF

T

TABER INSTRUMENT CORP
107 GOUNDRY ST NORTH TONAWANDA N Y
TABET MFG CO
1336 BALLENTINE BLVD NORFOLK 12 VA
TAFFET ELECTRONICS INC
27-05 BROOKLYN-QUEENS EXP W WOODSIDE 77 NY
TAFT PEIRCE MFG CO
32 MECHANIC AVE WOONSOCKET RI
TABER INSTRUMENT CORP
AEROSPACE ELECTRONICS DIV
107 GOUNDRY ST NO TONAWANDA N Y
TAKK CORP
P O BOX 346 NEWARK OHIO
TALK-A-PHONE CO
5013 NORTH KEDZIE CHICAGO ILL
TALKING DEVICES CO
4447 IRVING PARK RD CHICAGO 41 ILL
TALKMASTER INC
534 LAUREL ST SAN CARLOS CALIF
TALLER & COOPER INC
75 FRONT ST BROOKLYN 1 N Y
TALLEY CORP THE
NEWBURY PARK CALIF

TALLY REGISTER CORP
1310 MERCER SEATTLE 9 WASH
TA MFG CORP
4607 ALGER ST LOS ANGELES 39 CALIF
TAMAR ELECTRONICS INC
2045 ROSECRANS AVE GARDENA AVE
TANDBERG OF AMERICA INC
8 THIRD AVE PELHAM N Y
TANN CONTROLS CO DIV TANN CORP
DETROIT 34 MICH
TANSITOR ELECTRONICS INC
WEST RD BENNINGTON VT
TAP A LINE MFG CO
71 S W 5TH ST POMPAND BEACH FLA
TAPCO GROUP THOMPSON RAMO WOOLDRIDGE INC
23555 EUCLID AVE CLEVELAND 17 OHIO
TAPE ATHON
523 S HINDRY INGLEWOOD CALIF
TAPE CABLE CORP
790 LINDEN AVE ROCHESTER 10 N Y
TAPECODE
142 N HAWTHORNE AVE LANGHORNE PENNA
TARC ELECTRONICS INC
48 URBAN AVE WESTBURY L I N Y
TAURUS CORP
ACADEMY HILL LAMBERTVILLE NJ
TAYLOR EMMETT CONTROLS INC
449 E TURKEY FOOT LAKE RD AKRON OHIO
TAYLOR FIBRE CO
BOX 471 NORRISTOWN PA
TAYLOR INSTRUMENT CO INC
557 E TALLMADGE AVE AKRON 10 OHIO
TAYLOR INSTRUMENTS COMPANIES
95 AMES ST ROCHESTER 1 N Y
TAYLOR WINFIELD CORP
1052 MAHONING AVE N W WARREN OHIO
TEALE MACHINE CO INC
1425 UNIVERSITY AVE ROCHESTER 7 NY
TE CO THE
415 E MONTECITO ST SANTA BARBARA CALIF
TECH ART PLASTICS CO
111 RIDGEDALE AVE MORRISTOWN NJ
TECH-MASTER CORP
75 FRONT ST BROOKLYN 1 N Y
TECHNIBILT CORP
905 AIRWAY GLENDALE CALIF
TECHNICAL APPARATUS BUILDERS
109 LIBERTY ST NEW YORK 6 N Y
TECHNICAL APPLIANCE CORP
SHERBURNE NY
TECHNICAL ASSOCIATES
140 W PROVIDENCIA AVE BURBANK CALIF
TECHNICAL ASSOCIATES OF NEW ORLEANS INC
511 S CARROLLTON AVE NEW ORLEANS LA
TECHNICAL CERAMICS & LAVA CORP
85 5TH AVE PATERSON NJ
TECHNICAL DEVELOPMENT CO
305 S CHESTER PK GLENOLDEN PA
TECHNICAL DEVICES CO
11242 PLAYA COURT CULVER CITY CALIF
TECHNICAL DYNAMICS DIV JAMIESON IND INC
P O BOX 4098 SANTA BARBARA CALIF
TECHNICAL LABS
BERGEN & EDSALL BLVD PALISADES PK N J
TECHNICAL MEASUREMENT CORP
411 WASHINGTON AVE NORTH HAVEN CONN
TECHNICAL OIL TOOL CORP
1057 N LA BREA LOS ANGELES 38 CALIF
TECHNICAL PRODUCTS CO INSTRUMENT DIV
6670 LEXINGTON AVE LOS ANGELES 38 CALIF
TECHNICAL SERVICE CORP
917-19 S THIRD LOUISVILLE 3 KY
TECHNICAL WIRE PRODUCTS INC
129 DERMODY ST CRANFORD NJ
TECHNI CAST CORP
11455 CHECK AVE LYNWOOD CALIF
TECHNIC INC
88 SPECTACLE ST CRANSTON R I
TECHNICRAFT CO
1156 COMMONWEALTH AVE BOSTON 34 MASS
TECHNICRAFTDIV
THOMASTON CONN
TECHNIQUE ASSOCIATES
1413 N CORNELL AVE INDIANAPOLIS 2 IND
TECHNIQUES INC
40 JAY STREET ENGLEWOOD N J
TECHNI RITE ELECTRONICS INC
65 CENTERVILLE RD WARWICK R I
TECHNIT SALES CO
48 BROWN AVE SPRINGFIELD N J
TECHNITROL ENG CO
1952 E ALLEGHENY AVE PHILADELPHIA 34 PA
TECHNO COMPONENTS CORP
18232 PARTHENIA ST NORTHRIDGE CALIF
TECHNOGRAPH PRINTED ELECTRONICS INC
920 NORTHWEST BLVD WINSTON-SALEM N C
TECHNOLOGY INC
3090 RICHFIELD CTR DAYTON 30 OHIO
TECHNOLOGY INSTRUMENT CORP
ACTON MASS
TECH-OHM ELECTRONICS INC
36-11 33 ST LONG ISLAND CITY 6 N Y
TECH PANEL CO INC
PO BOX 293 37 MILFORD STREET BINGHAMTON NY
TECHRON CORP
20 SIMMONS ST BOSTON 20 MASS
TECH SERV INC
5451 HOLLAND DR BELTSVILLE MD
TECT INC
LIVINGSTON & PEGASUS ST NORTHVALE N J
TECHTROMATIC
N WALPOLE NEW HAMPSHIRE
TED MFG CORP
11415 JOHNSON DR SHAWNEE KANSAS
TEKTRONIX INC
PO BOX 500 BEAVERTON OREGON
TELAUTOGRAPH CORP
8700 BELLANCA AVE LOS ANGELES 45 CALIF
TELCO ELECTRONICS MFG COMPANY
400 S WYMAN ST ROCKFORD ILL
TELCON METALS TELCON WORKS
MANOR ROYAL CRAWLEY SUSSEX ENGLAND
TELE-COIL CO INC
2733 SAUNDERS ST CAMDEN 5 NJ
TELE COMMUNICATIONS CORP
50 DRUMM ST SAN FRAN CALIF
TELECHROME MFG CORP
28 RANICK DR AMITYVILLE LI NY
TELECOMPUTING CORP ELECTR SYS & DATA INST DV
12838 SATICOY ST N HOLLYWOOD CALIF
TELECOMPUTING CORP POWER SOURCES DIV
3850 OLIVE STREET DENVER 7 COLO
TELECOMPUTING SERVICES INC
8949 RESEDA BLVD NORTHRIDGE CALIF
TELECONTROL CORPORATION
20 DILLER AVE NEWTON N J
TELECTRO INDUSTRIES CORP
35-18 37 ST LONG ISLAND CITY 1 N Y
TELECTRON CO
4050 SW 14TH AVE FT LAUDERDALE FLA
TELECTROSONIC CORP
3516 37TH ST LONG ISLAND CITY N Y
TELE-DYNAMICS DIV AMER BOSCH ARMA CORP
5D00 PARKSIDE AVE PHILA 31 PA
TELEDYNE PRECISION INC
3155 WEST EL SEGUNDO HAWTHORNE CALIF
TELEGRAPH CONDENSER CO
N ACTON LONDON W 3 ENGLAND
TELEGRAPH CONSTRUCTION & MAINTENANCE CO LTD
MERCURY HOUSE THEOBALDS RD LONDON WC 1 ENG
TELE MEASUREMENTS INC
72 N MITCHELL AVE LIVINGSTON N J
TELEMET CO
185 DIXON AVE AMITYVILLE N Y
TELEMETER MAGNETICS INC
9937 JEFFERSON BLVD CULVER CITY CALIF
TELEMETRICS INC
12927 S BUDLONG AVE GARDENA CALIF
TELEPHONICS CORP
770 PARK AVE HUNTINGTON L I N Y
TELEPROMPTER CO
300 W 43RD ST NEW YORK N Y
TELERAD DIV OF THE LIONEL CORP
1440 BROADWAY NEW YORK 18 NY
TELERAD MFG CORP
FLEMINGTON N J
TELE-SIGNAL CORP
198 MILLER PLACE HICKSVILLE LI N Y
TELETEST INSTRUMENT CORP
136-10 31 RD FLUSHING 54 N Y
TELE-TONE CO OF AMERICA
1668 WEBSTER AVE NEW YORK 57 NY
TELETRAY ELECT SYSTEMS INC
5462 3RD ST N E WASH D C
TELETRONICS CORP
12786 WESTERN AVE GARDEN GROVE CALIF
TELETRONIX ENG CO
4688 EAGLE ROCK BLVD LOS ANGELES CALIF
TELETYPE CORP
5555 W TOUHY AVE SKOKIE ILL
TELETYPE CORP
4400 W 65TH ST LITTLE ROCK ARK
TELEVISIONLABS INC
333 MILL STREET WAUCONDA ILL
TELEVISION SPECIALTY CO DIV F M E
1055 STEWART AVE GARDEN CITY LI NY
TELEVISION UTILITIES CORP DIV NORD
300 DENTON AVE NEW HYDE PARK L I N Y
TELEWAVE LABS INC DIV POLARAD ELECT
43 20 34TH ST LONG ISLAND CITY N Y
TELEX/BALLASTRAN
1701 N CALHOUN ST FT WAYNE 7 IND
TELEX/AEMCO DIV OF TELEX INC
10 STATE ST MANKATO MINN
TELEX INC
1633 EUSTIS ST ST PAUL MINN
TELEX INC COMM ACC DIV
1633 EUSTIS AVE ST PAUL MINN
TEL-INSTRUMENT ELECTRONICS CORP
728 GARDEN ST CARLSTADT N J
TELKOR INC
BOX 186 ELYRIA OHIO
TEL-LABS INC
1050 2 ST MANCHESTER N H
TELONIC ENGINEERING CORP
773 BROADWAY LAGUNA BEACH CALIF
TELONIC INDUSTRIES INC
60 N FIRST AVE BEECH GROVE INO
TELOSTAT CORP
1003 FIRST ST HOPKINS MINN
TEMESCAL METALLURGICAL CORP
2850 7TH ST BERKELEY CALIF
TEMPCO TV PROD CO
21341 ROSCOE BLVD CANOGA PK CALIF
TEMPEL STEEL CO
1939 BRYN MAWR AVE CHICAGO 26 ILL
TEMPERATURE ENGG CORP
1600 UNION LANDING ROAD RIVERTON N J
TEMPIL CORP
132 W 22 ST NEW YORK 11 N Y
TEMPLET INDUSTRIES INC
701 ATKINS AVE BROOKLYN N Y
TEMPO INSTRUMENT INC
BETHPAGE RD PLAINVIEW NY
TEMPRESS RESEARCH INC
566 SAN XAVIER AVE SUNNYVALE CALIF
TENATRONICS LTD
1011 POWER AVE CLEVELAND 14 OHIO
TEN BOSCH INC M
PLEASANTVILLE NY
TENNALAB
417 S 10 ST QUINCY ILL
TENNA MFG CO
7580 GARFIELD BLVD CLEVELAND 25 OHIO
TENNEY ENGG INC
1090 SPRINGFIELD RD UNION N J
TENSITRON INC
PIN HILL HARVARD MASS
TENSOLITE INSULATED WIRE CO INC
198 W MAIN ST TARRYTOWN N Y
TENSOR ELECT DEVELOP CO
1873 EASTERN PKWY BROOKLYN 33 NY
TEPRO ELECTRIC CORP
5 ST PAUL ST ROCHESTER 4 NY
TEPRD OF FLORIDA INC
375 PATRICIA AVENUE DUNEDIN FLORIDA
TERADO CO
1068 RAYMOND AVE ST PAUL MINN
TERADYNE INC
87 SUMMER ST BOSTON 10 MASS
TERRY CO GEORGE A
356 S ELMWOOD AVE BUFFALO 1 NY
TEST EQUIPMENT CORP
3009 S POST OAK RD HOUSTON 27 TEXAS
TESTING MACHINES INC
73 JERICHO TNPKE MINEOLA L I N Y
TEVCO INSULATED WIRE
108 E PROSPECT AVE BURBANK CALIF
TEXAS CAPACITOR CO DIV K-C-K CORP
4310 LANGLEY RD HOUSTON 16 TEXAS
TEXAS CRYSTALS
1000 CRYSTAL DR FORT MYERS FLA
TEXAS ENST INC SEMICONDUCTOR COM DIV
DALLAS TEXAS
TEXAS INSTRUMENTS INC APPARATUS DIV
BOX 6015 6000 LEMMON AVE DALLAS 22 TEX
TEXAS INSTRUMENT SEMICON-COMPONENTS DIV
135000 CENTRAL EXPRESSWAY DALLAS TEX
TEXAS INSTRUMENTS INC APPARATUS DIV
P O BOX 66027 HOUSTON 6 TEXAS
TEXSTAR PLASTICS DIV TEXSTAR CORP
1400 HENDERSON ST BOX 1440 FT WORTH 2 TEX
TEXTRAN CORP
PO BOX 9207 AUSTIN 17 TEXAS
TEXTRON ELECTG GENERAL CEMENT CO
400 S WYMAN ST ROCKFORD ILL
TEXTRONIX ENG CO
4688 EAGLE ROCK BLVD LOS ANG CALIF
THERMADOR ELECTRICAL MFG CO
715 S RAYMOND AVE ALAHMBRA CALIF
THERMAL AMERICAN FUSED QUARTZ CO
202 & CHANGE BRIDGE RD MONTVILLE NJ
THERMAL DYNAMICS CORP
LEBANON NH
THERMALLOY CO
414 EXPOSITION DALLAS 5 TEXAS
THERMAL WIRE OF AMERICA
KEELERS BAY SOUTH HERO VT
THERMATICS INC
ELM CITY NO CAR
THERMATRON DIV WILCOX & GIBBS
214 W 39TH ST NEW YORK N Y
THERMAX WIRE CORP
304 E 45TH ST NEW YORK 17 N Y
THERMOCAL DIV OF JAMIESON LABORATORIES
7900 HASKELL AVE VAN NUYS CALIFORNIA
THERM-O-DISC INC
MAIN ST RD MANSFIELD OHIO
THERMO ELECTRIC CO
109 5 ST SADDLE BROOK N J
THERMOLYNE CORP
2555 KERPER BLVD DUBUQUE IOWA
THERMONETICS INC
7246 ETON AVENUE CANOGA PARK CALIF
THERMOSEN INC
375 FAIRFIELD AVE STAMFORD CONN
THETA INSTRUMENT CORP
520 VICTOR STREET SADDLE BROOK NJ
THIOKOL CHEMICAL CORP NATL ELECTRONICS DIV
1713 KALARAMA RD NW WASHINGTON 9 DC
THOMAS & BETTS CO INC
36 BUTLER ST ELIZABETH 1 N J
THOMAS ELECTRONICS INC
118 9TH ST PASSAIC N J
THOMAS INDUSTRIES INC
700 OAK ST FORT ATKINSON WIS
THOMAS INSTRUMENT CO
BOX 41 OSWEGO RD PHOENIX N Y
THOMAS MOLD & DIE CO
249 W HENRY ST WOOSTER OHIO
THOMAS & SKINNER INC
1120 E 23 ST INDIANAPOLIS 7 IND
THOMPSON LIGHTNING PROTECTION INC
616 41ST AVE MINN 12 MINN
THOMPSON MACHINE & TOOL CORP
PO BOX 12289 ST PETERSBURG FLA
THOR CERAMICS INC
225 BELLEVILLE AVE BLOOMFIELD N J
THORSEN CORP L S
BOX 60 ELLSWORTH MAINE
THWING ALBERT INSTRUMENT CO
5351 PULASKI AVE PHILA 44 PA
TIBBETTS INDUSTRIES INC
COLCORD AVE CAMDEN ME
TICKLE ENGG WORKS ARTHUR
21 DELAVAN ST BROOKLYN 31 N Y
TIMBER-TOP INC
38 BROOKLYN AVE FREEPORT 6 NY
TIME & FREQUENCY
127 S BATAVIA AVE BATAVIA ILL
TIMES WIRE & CABLE DIV THE INTL SILVER CO
358 HALL AVE WALLINGFORD CONN
TINNERMAN PRODUCTS INC
DEPT 16 P O BOX 6688 CLEVELAND 1 OHIO
TIPPTRONIC INC
P O BOX 306 CHARGIN FALLS OHIO
TI TAL INC
2001 MAIN ST SANTA MONICA CALIF

TITAN METAL MFG CO DIV CERRO DE PASCO CORP
BELLEFONTE PA
TITANIUM ALLOY MFG DV NATL LEAD CO
HYDE PARK BLVD NIAGARA FALLS N Y
TITCHENER CO E H
67 CLINTON ST BINGHAMTON NY
TITEFLEX INC
HENDEE ST SPRINGFIELD MASS
TKM ELECTRIC CORP
820 LINDEN AVE ROCHESTER 25 N Y
TODD ELECTRIC CO INC
20 HARRISON AVE YONKERS NY
TOLEDO COMMUTATOR CO
1101 S CHESTNUT ST OWASSO MICH
TOLEDO SCALE DIV TOLEDO SCALE CORP
1027 TELEGRAPH RD TOLEDO 12 OHIO
TOMORROW INC
7 W JACKSON HAYWARD CALIF
TOPATRON INC
11601 ANABEL AVE GARDEN GROVE CALIF
TOPAZ TRANSFORMER PRODUCTS INC
3802 HOUSTON SAN DIEGO 10 CALIF
TOPPER MFG CO INC
1100 SHAMES DRIVE WESTBURY LI NY

TOPPING ELECTRONICS LTD F V
94 LAIRD AVE TORONTO 17 ONTARIO CANADA
TORK TIME CONTROLS INC
1 GROVE ST MT VERNON NY
TOR MANUFACTURING CO
1533 E WALNUT ST PASADENA CAL
TORNGREN CO C W
236 PEARL ST SOMERVILLE 45 MASS
TOROIDS UNLIMITED
3830 TERRACE ST PHILA PA
TOROTEL INC
5512 E 110 ST KANSAS CITY 34 MO
TOROTRON CORP
256 E 3RD ST MOUNT VERNON N Y
TORQ ENGINEERED PRODUCTS INC
32 W MONROE BEDFORD OHIO
TORQUE CONTROLS INC
825 E BROADWAY SAN GABRIEL CALIF
TORRES ENGG CO INC
5 CAROLINE ST S HACKENSACK NJ
TORRINGTON CO THE SPECIALTIES DIV
59 FIELD ST TORRINGTON CONN
TORRINGTON MFG CO SPECIALTY BLOWER DIV
100 FRANKLIN DR TORRINGTON CONN
TORSION BALANCE CO
35 MONHEGAN ST CLIFTON N J
TORWICO ELECTRONICS INC
ROUTE 70 LAKEWOOD NJ
TOUCH-PLATE MFG CORP
PO BOX 1970 LONG BEACH 1 CALIF
TOWACO ELECTRONICS
PINE BROOK RD TOWACO NJ
TOWER COMMUNICATIONS CO
2700 HAWKEYE DRIVE SIOUX CITY IOWA
TOWER CONSTRUCTION CO
2700 HAWKEYE DR SIOUX CITY 2 IOWA
TOWNSEND CO
PO BOX 71 ELLWOOD CITY PA
TOWNSEND CO CHERRY RIVET DIV
1224 E DELHI RD SANTA ANA CALIF
TRACERLAB INC
2030 WRIGHT AVE RICHMOND CALIF
TRACERLAB INC
1601 TRAPELO RD WALTHAM 54 MASS
TRA-CON RESIN SYSTEMS DIV
25 SHIP AVE MEDFORD 55 MASS
TRADE WINDS MFG CO
5718 N 25 AVE OMAHA NEBR
TRAK ELECTRONICS COMPANY INC
59 DANBURY ROAD ROUTE 7 WILTON CONN
TRAK MICROWAVE CORP
5006 N COOLIOGE AVE TAMPA FLA
TRANCOA CHEMICAL CORP
312-326 ASH ST READING MASS
TRANE CO
CAMERON & 2 ST LA CROSSE WISC
TRANSCON MFG CO
8410 CRAIGHILL DALLAS 9 TEX

TRANSCO PRODUCTS INC
12210 NEBRASKA AVE LOS ANGELES 25 CALIF
TRANSCRIBER CO
98 COUNTY ST ATTLEBORO MASS
TRANSDATA INC
1000 N JOHNSON AVE EL CAJON CALIF
TRANSELECTRIC MFG CO
PO BOX 97 OXFORD PA
TRANS ELECTRONICS DIV BURTON MFG CO
8910 WINNETKA AVE NORTHRIDGE CALIF
TRANSFORMER & ELECTRONIC SPECIALTIES
3824 28 TERRACE ST PHILA 28 PA
TRANSFORMER DESIGN INC OF MILWAUKEE
7377 N 76TH ST MILWAUKEE 18 WISC
TRANSFORMER ELECTRONICS CO
BOULDER IND PARK BOULDER COLO
TRANSFORMER ENGINEERS
1039 E VALLEY BLVD SAN GABRIEL CALIF
TRANSFORMER TECHNICIANS INC
2608NN CICERO AVE CHICAGO 39 ILL
TRANSFORMERS MFG INC
NORRIDGE ILL
TRANSFORMERS INC
200 STAGE RD VESTAL NY
TRANSICOIL CORP
CHURCH RD WORCESTER PA
TRANSISTOR AUTOMATION CORP
101 ERIE ST CAMBRIDGE MASS
TRANSISTOR DEVICES INC
40 FACTORY ST CEDAR GROVE NJ
TRANSISTOR ELECTRONICS CO
3357 REPUBLIC AVE MINNEAPOLIS 26 MINN
TRANSITEL INTERNATIONAL CORP
615 WINTERS AVE PARAMUS N J

TRANSITRON ELECTRONIC CORP
WAKEFIELD MASS
TRANSLINE ELECT COMMUNICATIONS CO
503 MCCARTER HWY NEWARK N J
TRANS-LUX CORP
W SEPULVEDA BLVD TORRANCE CAL
TRANSMAGNETICS INC
40 66 LAWRENCE ST FLUSHING 54 N Y
TRANSMASK
1541 W OLYMPIC BLVD LOS ANGELES 15 CALIF
TRANS METRICS INC
P O BOX 2014 NEWPORT BCH CALIF
TRANS-SIL CORP
55 HONECK ST ENGLEWOOD NJ
TRANSONIC INC
808 16 ST BAKERSFIELD CALIF
TRANSONIC INC
700 16TH ST BAKERSFIELD CALIF
TRAN SONICS
MIDDLESEX TURNIPIKE BURLINGTON MASS
TRANS-TECH INC
PO BOX 457 GAITHERSBURG MD
TRANSVISION INC
460 NORTH AVE NEW ROCHELLE NY

TRELCON ENGINEERING CO
P O BOX 6209 BALTIMORE 6 MD
TRENT INC
211 LEVERINGTON AVE PHILA PA
TRENTON TRANSFORMER CORP
P O BOX 568 822 E STATE ST TRENTON N J
TREPAC CORP OF AMERICA
30 W HAMILTON AVE ENGLEWOOD N J
TRESCO INC
3824 TERRACE ST PHILADELPHIA 28 PA
TRG INC
2 AERIAL WAY SYOSSETT LI N Y
TRG INCORPORATED
400 BORDER ST EAST BOSTON 28 MASS
TRIAD TRANSFORMER CORP
4055 REDWOOD AVE VENICE CALIF
TRI ACRE ELECTRONICS
EAST PINE ST PLAISTOW N H
TRIANGLE MACHIEN
7700 MARBLE AVE CLEVELAND OHIO
TRICON MFG CO
8008 WALLACE ST CHICAGO 20 ILL
TRICONIX INC
BEAR HILL WALTHAM MASS
TRICRAFT PRODUCTS CORP
1124 W NEWPORT AVE CHICAGO 22 ILL
TRI-DEX ELECTRONICS
P O BOX 1207 LINDSAY CALIF
TRI-EX TOWER CORP
127 E INYO ST TULARE CALIF
TRI-KRIS CO
WALNUT & HATFIELD STS LANSDALE PA
TRILSCH INC JOHN D
P O BOX 14201 HOUSTON 21 TEXAS
TRIMETAL WORKS INC
1600 BANNARD ST RIVERTON NJ
TRIMOUNT INSTRUMENT DIV GENERAL CONTROLS CO
8080 MCCORMICK BLVD SKOKIE ILLINOIS
TRIMM INC
400 W LAKE ST LIBERTYVILLE ILL
TRIMOUNT PLASTIC CO
INDUSTRIAL PARK NEW BEDFORD MASS
TRINDL PRODUCTS LTD
1807-11 S CLARK ST CHICAGO 16 ILL
TRINITY EQUIPMENT CORP
CORTLAND NY
TRIO LABS INC
PLAINVIEW LI NY
TRIO MFG CO
GRIGGSVILLE ILL
TRION INC
1000 ISLAND AVE MCKEES ROCKS PA
TRIONICS CORP
4600 W BELTLINE HWY MADISON WIS
TRIPLETT ELECTRICAL INSTRUMENT CORP
202 VIA DEL MONTE OCEANSIDE CALIF
TRIPLETT ELECTRICAL INSTRUMENT CO
HARMON RD BLUFFTON OHIO

TRIPLEX RUBBER & SUPPLY CO
5819 ARMOUR HOUSTON TEXAS
TRI-POINT INDUSTRIES INC
175 1 U WILLETS RO ALBERTSON L 1 N Y
TRI-R INSTRUMENTS
144-13 JAMAICA AVE JAMAICA 35 N Y
TRITON MFG CO
4000 TOWNE ST E HADDAM CONN
TRI-TRONICS CO
2607 ST CHARLES RO BELLWOOD 13 ILL
TRI-TRONICS LAB INC
EULESS TEXAS
TRI-VI-TRON INC
8139 ENGINEER RD SAN OIEGO 11 CALIF
TROMPETER ELECTRONICS
7238 ETON CANOGA PARK CALIF
TRONEX INC
G STREET MILLVILLE NJ
TRONIC COIL WINDING CO INC
58 WESLEY ST WATERBURY CONN
TROPICAL SCREW PRODUCTS
3275 N W 28TH ST MIAMI FLA
TROTT ELECTRONICS INC
412 SMITH ST ROCHESTER 6 N Y
TROXLER ELECTRONICS LAB INC
3048 MEDLIN DR RALEIGH NO CAR
TRU BEAM PROD
4141 BROADWAY OAKLAND CALIF
TRU-CONNECTOR CORP
416 UNION ST LYNN MASS
TRU CONNECTOR CORP
245 LYNNFIELD ST PEABODY MASS
TRU-OHM PRODUCTS DIV MODEL ENG & MFG CO
3426 W DIVERSEY CHICAGO 47 ILL

TRUTONE ELECTRONICS INC
14660 RAYMER ST VAN NUYS CALIF
TRW COMPUTERS CO
8433 FALLBROOK AVE CANOGA PARK CALIF
T T ELECTRONICS INC
P O BOX 180 CULVER CITY CALIF
TRYGON ELECTRONICS INC
111 PLEASANT AVE ROOSEVELT LI NY
TUBULAR RIVET & STUD CO
WESTON AVE WOLLASTON 70 MASS
TUCK MFG CO
19 ELLIS AVE W BRIDGEWATER MASS
TUCOR INC
59 DANBURY RD WILTON CONN
TUNG-SOL ELECTRIC INC
200 BLOOMFIELD AVE BLOOMFIELD N J
TUNG SOL ELECTRIC INC
ONE SUMMER AVE NEWARK 4 NJ
TUNG SOL ELECT
545 ARLINGTON AVE ORANGE N J
TURBO JET PRODUCTS INC
424 S SAN GABRIEL BLVD SAN GABRIEL CALIF
TURBO MACHINE CO
LANSDALE PA
TURCO PRODUCTS INC
24600 MAIN ST WILMINGTON CAL
TURNER CO
909 17 ST N E CEDAR RAPIDS IOWA
TUTTLE ELECTRIC PRODUCTS INC
KIRKLAND ILL
TV DEVELOPMENT CORP
469 JERICHO TURNPIKE MINEOLA NY
TV UTILITIES CORP DIV NORD PHOTOCOPY CO
300 DENTON AVE NEW HYDE PARK NY
TWEEZER WELD CORP
4820 PARK BLVD PINELLAS PARK FLA
TWINCO INC
9 ERIE DR NATICK MASS
TYCO INCORP
585 BOYLSTON ST BOSTON MASS

U

U B S CHEMICAL CORP
491 MAIN ST CAMBRIDGE 42 MASS
U S CAPACITOR CORPORATION
8917 MELROSE AVE LOS ANGELES 69 CALIF
U S COMPONENTS
1320 ZEREGA AVE NY 62 NY
U S CONTROLS INC
161 GRAND ST NEW YORK N Y
US CONTROLS INC
410 4TH AVE BROOKLYN 15 N Y
U S DIELECTRIC INC
181 GREENWOOD ST WORCESTER 6 MASS
U S DYNAMICS CORP
1250 COLUMBUS AVE BOSTON MASS
US ELECTRICAL MOTORS INC
200 E SLAUSON AVE LOS ANGELES 54 CALIF
U S ELECTRICAL MOTORS INC
MILFORD CONN
THE U S ELECTRIC MOTOR CO
CADIZ OHIO
U S ELECTRONICS CORP
278 WARREN ST LYNDHURST N J
U S ELECTRONICS CORP
800 SLATERS LANE ALEXANDRIA VA
U S ENG CO
5873 RODEO RD LOS ANG CALIF
U S GEAR CORP
81 BAY STATE RD WAKEFIELD MASS
U S GRAPHITE CO DIV WICKLES CORP
1621 HOLLAND AVE SAGINAW MICH
U S INDUSTRIES INC AUTOMATION DIV
12345 NEW COLUMBIA PIKE SILVER SPRING MD
U S INSTRUMENT CORP
PO BOX 1288 CHARLOTTESVILLE VA
U S PLASTIC MOLDING CORP
150 CARLTON ST WALLINGFORD CONN
U S PLYWOOD CORP
55 W 44 ST NEW YORK 36 N Y
U S RADIUM CORP
5420 VINELAND AVE N HOLLYWOOD CALIF
U S RADIUM CORP
BLOOMSBURG PENNA
U S RECORDING CO
1347 S CAPITOL ST WASHINGTON 5 D C
U S RUBBER CO
1230 AVE OF THE AMERICAS NEW YORK 20 N Y
U S SCIENCE CORP
5221 W 102ND ST LOS ANGELES 45 CALIF
US SEMCOR
3540 W OSBORN RD PHOENIX 19 ARIZ
US SEMICONDUCTOR PRODUCTS
3540 W OSBORN RD PO BOX 11098 PHOENIX ARIZ
U S STEEL AMER STEEL & WIRE DIV
767 MILLBURY ST WORCESTER MASS
U S TAXIMETER CORP
516 W 54 ST NEW YORK 19 N Y
US TIME CORP
WATERBURY 20 CONN
US TRANSISTOR CORP
149 EILEEN WAY SYOSSET NY
UCINITE CO DIV UNITED CARR FASTENER CORP
459 WATERTOWN ST NEWTONVILLE 60 MASS
ULANET CO GEORGE
413 MARKET ST NEWARK 5 NJ
ULMER CO THE DIV MICROTRON INDUSTRIES INC
3018 SAN LUIS REY RD OCEANSIDE CALIF

ULTEK CORP
920 COMMERCIAL ST PALO ALTO CALIF
ULTRA CARBON CORP
1310 N MADISON ST BAY CITY MICH
ULTRA ELECTROFORMING MFG CO
110 CEDAR AVE PITMAN 15 NJ
ULTRASONIC ENGG CO
618 LAKE ST MAYWOOD ILL
ULTRASONIC DEVICES INC
695 RAHWAY AVE UNION NJ
ULTRASONIC INDUSTRIES INC
AMES COURT PLAINVIEW L I N Y
ULTRASONIC LABS INC
1695 ELIZABETH AVE RAHWAY N J
ULTRASONIC MACHINING CO
1015 ASBURY AVE ASBURY PARK NJ
ULTRAUDIO DIV OBERLINE INC
PO BOX 921 BEVERLY HILLS CALIF
ULTRAUDIO PRODUCTS
6573 ST MONICA BLVD LOS ANGELES CALIF
ULTRA-VIOLET PRODUCTS INC
5114 WALNUT GROVE AVE SAN GABRIEL CALIF
ULTRONICS INC
12 FRANKLIN AVE CLINTON N Y
ULTRONIX INC
GRAND JUNCTION COLO
ULTRONIX INC
111 E 20TH AVE SAN MATEO CALIF
UNBRAKO SOCKET SCREW CO LTD
BURNABY RD COVENTRY ENGLAND
UNDERWOOD CORP CANOGA DIV
736 BEAL ST WALTON BEACH FLA
UNDERWOOD ELECTRIC & MFG CO INC
148 SO 8TH AVE MAYWOOD ILL

UNGAR ELECT TOOLS INC
1475 E EL SEGUNDO BLVD HAWTHORNE CALIF
UNHERSOLL PRODUCTS
1000 W 120TH ST CHICAGO 43 ILL
UNHOLTZ DICKIE CORP
2994 WHITNEY AVE HAMDEN CONN
UNI SEAL INC
NORTH AVE & MAPLE ST GARWOOD N J
UNIFORM TUBES INC
LEVEL RD COLLEGEVILLE 2 PA
UNIFORM TUBES INC MICRO DELAY DIV
COLLEGEVILLE PA
UNIMAX SWITCH MAXSON ELECT CORP
IVES RD WALLINGFORD CONN
UNION CARBIDE CONSUMER PRODUCTS CO
270 PARK AVE NEW YORK 17 N Y
UNION CARBIDE CORP SILICONES DIV
P O BOX 180 SISTERVILLE W VA
UNION CARBIDE UNION CARBIDE CONSUMER PROD CO
501 GAGE ST BENNINGTON VT
UNION CARBIDE CONSUMER PROD CO
BOX 749 CHARLOTTE N C
UNION CARBIDE PLASTICS CO
270 PARK AVE NEW YORK NY
UNION CITY FILAMENT CORP
540 39TH ST UNION CITY N J
UNION SWITCH & SIGNAL DIV
1789 1807 BRADDOCK AVE
SWISSVALE P O PITTSBURGH PENNA
UNION ULTRA-SONICS CORP
576 LAWRENCE ST LOWELL MASS
UNIQUE WIRE WEAVING CO INC
762 RAMSEY AVE HILLSIDE N J
UNISON ELECTRONICS
1634 MARION ST GRAND HAVEN MICH
UNISTRUT PRODS CO
933 W WASHINGTON BLVD CHICAGO 7 ILL
UNIT PROCESS ASSEMBLIES INC
53-15 37TH AVE WOODSIDE 77 NY
UNITED AERO PRODUCTS CORP
DIV AERO CHATILLON CORP
COLUMBUS RD BURLINGTON N J
UNITED AIRCRAFT PRODUCTS INC
50 E 42ND ST NEW YORK 17 N Y
UNITED AIRCRAFT PRODUCTS INC
137 W 157TH ST GARDENA CALIF
UNITED AIRCRAFT PROD INC
FOREST OHIO
UNITED CONDENSER CORP
3400 PARK AVE NEW YORK N Y
UNITED CONTROL CORP OVERLAKE INDUSTRIAL PK
PO BOX 3104 SEATTLE 14 WASH
UNITED DATA CONTROL INC
380 N HALSTEAD ST PASADENA CALIF
UNITED ELECTRIC CONTROLS CO
85 SCHOOL ST WATERTOWN 72 MASS
UNITED ELECTRODYNAMICS
200 ALLENDALE RD PASADENA CALIF

UNITED ELECTRONIC MFG CORP
542 39 ST UNION CITY NJ
UNITED ELECTRONICS
42 SPRING ST NEWARK N J
UNITED ENGRS ELECTRO NUCLEAR INSTRS DIV
2139 S SHERIDAN TULSA OKLA
UNITED MFG CO DIV UMC ELECTRONICS
41 HAIG ST HAMDEN 14 CONN
UNITED MINERAL & CHEMICAL CORP
16 HUDSON ST NEW YORK 13 N Y
UNITED PROCESS MACHINERY CO
1649 12TH ST SANTA MONICA CALIF
UNITED SENSOR & CONTROL CORP
89 91 CHURCH ST E HARTFORD 8 CONN
UNITED SHOE MACHINERY CORP
SHELTON CONN
UNITED STATES GASKET CO
P O BOX 93 CAMDEN N J
UNITED TESTING LABS
573 MONTEREY PASS RD MONTEREY PARK CALIF
UNITED TRANSFORMER CORP
150 VARICK ST NEW YORK 13 N Y
UNITED TRANSFORMER CORP PACIFIC DIV
4008 JEFFERSON BLVD LOS ANG CALIF
UNITED WIRE & SUPPLY CORP
1497 ELMWOOD AVE PROVIDENCE 7 R I
UNITRODE TRANSISTOR PRODUCTS
214 CALVARY ST WALTHAM MASS
UNITRON INC
1624 N FIRST BOX 1331 GARLAND TEX
UNIVERSAL CIRCUIT CONTROLS
3610 OAKTON ST SKOKIE ILL
UNIVERSAL CONDENSER CO
3435 N KIMBALL AVE CHICAGO ILL
UNIVERSAL DRAFTING MACHINE CORP
7960 LORAIN AVE CLEVELAND 2 OHIO
UNIVERSAL ELECTRIC CO
300 E MAIN ST OWOSSO MICH
UNIVERSAL ELECTRONICS CO
1720 22 ST SANTA MONICA CALIF
UNIVERSAL INDUSTRIAL EQUIPMENT CORP
1625 PATERSON PLANK RD SECAUCUS N J
UNIVERSAL INSTRUMENTS CORP
139 E FREDERICK ST BINGHAMTON NY
UNIVERSAL MATCH CO UNDYNAMICS DIV
472 PAUL AVE ST LOUIS 35 MO
UNIV MATCH CORP ARMA DIV AVNC & ELECT DEPT
4407 COOK AVE ST LOUIS 13 MISSOURI
UNIVERSAL MFG CO INC
1168 GROVE ST IRVINGTON 11 N J
UNIVERSAL MOTOR CO
1552 HARRISON ST OSHKOSH WISC
UNIVERSAL PRODUCTS ENGG CO
4100 TAYLOR AVE RACINE WISC
UNIVERSAL RELAY CORP
42 WHITE ST NEW YORK 13 NY
UNIVERSAL SCIENTIFIC CO INC
1102 SHELBY ST VINCENNES IND
UNIVERSAL SHELLAC & SUPPLY CO
540 IRVING AVE BROOKLYN NY
UNIVERSAL SYNAMICS CORP
130 LOS AGUAJES AVE SANTA BARBARA CALIF
UNIVERSAL TOROID COIL WINDING INC
171 COIT STREET IRVINGTON 11 NJ
UNIVERSAL TRANSISTOR PROD CORP
380 OAK ST COPIAGUE N Y
UNIVERSITY LOUDSPEAKERS INC
80 S KENSICO AVE WHITE PLAINS NY
UNIVOX CORP
4301 W JEFFERSON BLVD LOS ANGELES CALIF
UNIVOX CORP
102 WARREN ST NEW YORK 7 N Y
UNIWAVE INC
109 MARINE ST FARMINGDALE N Y
UNMANCO INCORP
712 S FEDERAL SR CHICAGO ILL
UPPCO INC
900 S DESPLAINES ST CHICAGO 7 ILL
UTAH RADIO CORP
1124 E FRANKLIN ST HUNTINGTON IND
UTILITIES SERVICE CO
PO BOX 627 ALLENTOWN PA
UTILITY METAL PRODUCTS CO INC
117 ELLIOTT ST BEVERLY MASS
UTRAD CORP DIV LITTON IND
305 N BRIANT ST HUNTINGTON IND

V

VACAP CORP
1905 SUMMIT AVE UNION CITY N J
VACO PRODUCTS CO
317 E ONTARIO ST CHICAGO 11 ILL
VACTITE
1890 EMBARCADERO RD PALO ALTO CAL
VACTRONIC LAB EQUIPMENT INC
21 MONMOUTH CT E NORTHPORT N Y
VACUDENT MFG CO
975 E 5 ST SALT LAKE CITY UTAH
VACUUM APPARATUS CO
906 INDUSTRIAL AVE PALO ALTO CALIF
VACUUM ELECTRONICS CORP
TERMINAL DR LONG ISLAND N Y
VACUUM SPEC INC
34 LINDEN ST SOMERVILLE MASS
VALCO AMPLIFIERS INC
4701 GRAND AVE CHICAGO ILL
VALCOR ENG CORP
365 CARNEGIE AVE KENILWORTH N J
VALOR ELECTRONICS CO
13214 CRENSHAW BLVD GARDENIA CALIF
VALOR INSTRUMENTS INC
13214 CRENSHAW BLVD GARDENA CALIF
VALPEY CRYSTAL CORP
1244 HIGHLAND ST HOLLISTON MASS
VALUE ENG PROD INC
890 MONTEREY PASS RD MONTEREY PARK CALIF
VALVERDE LABS
252 LAFAYETTE ST NEW YORK 12 N Y
VANGUARD ELECTRONICS CO
3384 MOTRO AVE LOS ANGELES 34 CALIF
VANGUARD ELECTRONIC LABS
190 48 99TH AVE HOLLIS N Y
VANISTOR MFG DIV WESTON ELEC INST CORP
UNION N J
VANITY FAIR ELECTRONICS
50 S 4ST BROOKLYN N Y
VANTON PUMP & EQUIPMENT CORP
201 SWEETLAND AVE HILLSIDE 5 N J
VAP AIR DIV VAPOR CORP
6444 HOWARD ST CHICAGO ILL
VARD INC
2981 E COLORADO PASADENA 8 CALIF
VARE INDUSTRIES
128 W FIRST AVE ROSELLE N J
VARFLEX CORP
512 W COURT ST RDME N Y
VARI CORP
2825 CEDAR AVE MINN MINN
VARI L CO
207 GREENWICH AVE STAMFORD CONN
VARIAN ASSOC
611 HANSEN WAY PALO ALTO CALIF
VAR-LAC-OID CHEMICAL CO
116 BROAD ST NEW YORK 4 N Y
VARO INC
402 E GUTIGRREZ ST SANTA BARBARA CALIF
VARO MFG CO
2201 WALNUT ST GARLAND TEXAS
VECTOR ELECTRONIC CO
1100 FLOWER ST GLENDALE 1 CALIF
VECTOR MFG CO
KEYSTONE RD SOUTH HAMPTON PA
VECTOR MANUFACTURING CO
5616 LAWNDALE HOUSTON 23 TEXAS
VEEDER ROOT INC ELECT CONTROLS DIV
5 MAPLE ST DANVERS MASS
VEET INDUSTRIES
25753 GROSBECK HWY E DETROIT MICH
VELONEX DIV PULSE ENGR
560 ROBERT AVE SANTA CLARA CALIF
VEMALINE PRODUCTS CO
PO BOX 1 FRANKLIN LAKES N J
VENNER ELECTRONICS LTD
KINGSTON BY-PASS NEW MALDEN SURREY ENGLAND
VERCO INC
1430 130TH N E BELLEVUE WASH
VERITRON WEST INC
5353 STROHM AVE N HOLLYWOOD CALIF
VERMONT RESEARCH CORP
SPRINGFIELD VERMONT
VERNITRON CORP
50 GAZZA BLVD FARMINGDALE LI N Y
VERNITRON CORP
1742 S CRENSHAW BLVD TORRANCE CALIF
VERSA-TRONICS
RT 1 BOX 264 MARENGO ILL

VIBRAC CORP
ALPHA IND PK RTE 129 CHELMSFORD MASS
VIBRA SEAL CORP
2832 E GRAND BLVD DETROIT 11 MICH
VIBRATION ENGINEERING PLANT
781 WHALLEY AVE NEW HAVEN CONN
VIBRO MFG CO INC
6117 ROOSEVELT AVE WOODSIDE 77 NY
VICKERS INC ELECTRIC PRODUCTS DIV
1887 LOCUST ST ST LOUIS 3 MO
VICTOR ADDING MACHINE CO
3900 N ROCKWELL ST CHICAGO 18 ILL
VICTOR ELECTRIC WIRE CABLE CORP
618 MAIN ST WARWICK R I
VICTOR METAL PRODUCTS CORP
813 N MAIN ST HARRISONBURG VA
VICTOR RF MICROWAVE CO
36 W WATER ST WAKEFIELD MASS
VICTOREEN INSTRUMENT CO TULLAMORE DIV
5857 WEST 95 TH ST OAKLAWN ILL
VICTOREEN INSTRUMENT CO
5806 HOUGH AVE CLEVELAND OHIO
VICTORY ENGG CO
124-28 SPRINGFIELD AVE SPRINGFIELD NJ
VICTORY MICA MFG CO INC
1313 39TH ST BROOKLYN N Y
VIDAIRE ELECTRONICS MFG CORP
365 BABYLON TURNPIKE ROOSEVELT N Y
VIDEO INDUSTRIES CO
242 MADISON AVE PORT CHESTER N Y
VIDEO DIV OF DEVENCO
161 EAST CALIFORNIA BLVD PASADENA CALIF
VIDEON CORP
3456 E 10TH LANE HIALEAH FLA
VIEWLEX INC
HOLBROOK N Y
VIKING INDUSTRIES INC
21343 ROSCOE BLVD CANOGA PARK CALIF
VIKING TOOL & DIE CO
9600 ARDICH AVE SOUTH MINNEAPOLIS MINN
VINCO ELECTRONICS CORP
65 WALLACE ST NEW HAVEN CONN
VINSON ENGG & SALES CORP
8044 WOODLEY AVE VAN NUYS CALIF
VINSON MFG INC
8044 WOODLEY AVE NUYS CALIF
VIRGINIA ELECTRONICS CO
RIVER RD WASHINGTON D C
VIRGINIA PLAK COMPANY
270 MADISON AVE NEW YORK 16 N Y
VISHAY INSTR INC PHOTOTRONICS DIV
63 LINCOLN HWY MALVERN PA
VISHAY INSTR INC PREC RESISTOR DIV
63 LINCOLN HWY MALVERN PA
VITRAMON INC
111 MAIN ST STEPNEY CONN
VITRO CHEMICAL CO
261 MADISON AVE NEW YOKR N Y
VITRO ELECTRONICS DIV OF VITRO CORP OF AM
919 JESUP-BLAIR DR SILVER SPRING MARYLAND
VITRO LABORATORIES
200 PLEASANT VALLEY WAY W ORANGE NJ
VITROSEAL CORP
RACE & VINE STRS RIDGWAY PA
VLCHEK PLASTICS CO
MIDDLEFIELD OHIO
VOAK ENG CO
129 EAST A ST UPLAND CALIF

VOCALINE CO OF AMERICA
COULTER ST OLD SAYBROOK CONN
VOGUE INSTRUMENT CORP
2350 LINDEN BLVD BROOKLYN 8 NY
VOLK RADIOCHEMICAL CO
8260 ELMWOOD SKOKIE ILL
VOLKERT STAMPINGS INC
222-34 96 AVE QUEENS VILLAGE 29 N Y
VOLTARC TUBES INC
44 CROSS ST NORWALK CONN
VOLTRON PRODUCTS
1020 S ARROYO PARKWAY PASADENA CALIF
VORAC CO
147 MEADOW RD RUTHERFORD N J
VORON ELECTRONICS CORP
1230 E MERMAID LANE PHILA 18 PA
VUE TRONICS INC DV OF PRESCOTT CO
920 CITRUS AVE LOS ANGELES 38 CALIF
VULCAN ELECTRIC CO
88 HOLTEN ST DANVERS MASS
VULCAN-TV MAST & TOWER CO INC
PO BOX 6537 BIRMINGHAM 7 ALA

W

WAAGE ELECTRIC INC
720 COLFAX AVE KENILWORTH N J
WABASH MAGNETICS INC
FIRST & WEBSTER STS WABASH IND
WABASH METAL PRODUCTS CO
1569 MORRIS ST WABASH IND
WABASSO PRODUCTS INC
WABASSO FLA
WABER ELECTRONICS INC
HANCOCK & SOMERSET STS PHILA 33 PA
WACLINE INC
35 S ST CLAIR ST DAYTON OHIO
WADDELL DYNAMICS INC
5015 WEEKS AVE SAN DIEGO CALIF
WADE ELECTRIC PRODUCTS CO
BOX 271 STURGIS MICH
WAHLGREN MAGNETICS
1900 WALKER AVE MONROVIA CALIF
WAIMET ALLOYS CO
5320 OAKMAN BLVD DEARBORN 2 MICH
WAKEFIELD ENGINEERING INC
WAKEFIELD MASS
WALCO ELECT CO INC
60 FRANKLIN ST E ORANGE N J
WALDES KOHINOOR INC
47 16 AUSTEL PL LONG ISLAND CITY N Y
WALDOM ELECTRONICS INC
4625 W 53 ST CHICAGO 32 ILL
WALES STRIPPIT INC UNIT OF HOUDAILLE IND INC
66 WILOBOLY ST BROOKLYN N Y
WALES STRIPPIT INC
AKRON NEW YORK
WALKER CO GEORGE
118 AMSTERDAM AVE PASSAIC NJ
WALKIRT CO
10321 S LA CIENAGA BLVD LOS ANGELES 45 CAL
WALLINGFORD STEEL CO
VALLEY ST WALLINGFORD CONN
WALLIN OPTICAL SYSTEMS INC
18670 VENTURA BLVD TARZANA CALIF
WALL MFG CO P
ERIE ST GROVE CITY PA
WALLSON ASSOC INC
35 E RUNYON ST NEWARK N J
WALSCO ELECTRONICS MFG CO
100 W GREEN ST ROCKFORD ILL
WALTHAM ELECTRONICS CORP
751 MAIN ST WALTHAM MASS
ELECTRO MEC DIV OF WALTHAM PRE INSTR CO
47 51 33 ST LONG ISLAND CITY 1 N Y
WALTHAM SCREW CO
77 RUMFORD AVE WALTHAM 54 MASS
WANG LABS INC
12 HURON DRIVE NATICK MASS
WARD LEONARD ELECTRIC CO
MT VERNON N Y
WARD PRODUCTS CORP
EDSON ST AMSTERDAM N Y
WARE MARINE PRODUCTS INC
6763 S W 81ST ST MIAMI FLA
WARMINSTER FIBERGLASS CO
WARMINSTER PA
WARNECKE ELECTRON TUBES INC
175 W OAKTON ST DES PLAINES ILL
WARNER ELECTRIC BRAKE & CLUTCH CO
INDUSTRIAL DIV BELOIT WISC
WARNER & SWASEY CO
32 16 DOWNING ST FLUSHING N Y
WARREN COMPONENTS DIV EL-TRONICS INC
S IRVINE ST WARREN PA
WARREN MFG CO
NEWTOWN RD LITTLETON MASS
WARREN WIRE CO
POWNAL VT
WARRICK CO CHARLES F
1964 W 11 MILE RD BERKLEY MICH
WARSAW COIL CO
RD 25 WEST WARSAW IND
WARWICK MANUFACTURING CORP
27TH & DEBORAH STS ZION ILL
WARWICK MFG CORP
5900 W TOUHY ST NILES ILL
WARWICK MFG CORP
7300 N LEIGH AVE CHICAGO ILL
WASHINGTON PORCELAIN CO
WASHINGTON N J
WASHINGTON SCIENTIFIC INDUST
13111 WAYZATA BLVD MINN MINN
WASHINGTON TECHNOLOGICAL ASSOC INC
979 ROLLINS AVE ROCKVILLE MD
WATERBURY COS INC
835 S MAIN ST P O BOX 1032 WATERBURY CONN
WATERBURY PRESSED METAL CO
300 CHASE AVE WATERBURY 14 CONN
WATERMAN PRODUCTS CO
2445 EMERALD ST PHILADELPHIA 25 PA
WATERS CONLEY CO INC
ROCHESTER MINN
THE WATERS CORP
18 S W 14TH ST ROCHESTER MINN
WATERS MFG INC
BOSTON POST RD WAYLAND MASS
WATKINS-JOHNSON CO APPL ENGRG
3333 HILLVIEW AVE PALO ALTO CALIF
WATLOW ELECTRIC MFG CO
12001 LARKLAND RD ST LOUIS MO
WATSCO INC
1800 W 4TH AVE HIALEAH FLA
WATSON MFG CO
63 TAYLOR ST JAMESTOWN NY
WAVEFORMS INC
333 6 AVE NEW YORK N Y
WAVEGUIDE INC
851 W 18 ST COSTA MESA CALIF
WAVELABS INC
4343 TWAIN ST SAN DIEGO 20 CALIF
WAVELINE INC
P O BOX 718 CALDWELL N J
WAYNE GEORGE CORP
322 NEEDHAM ST NEWTON MASS
WEATHERS INDUSTRIES DIV ADVANCE INDS
66 E GLOUCESTER PIKE BARRINGTON NJ
WEBBER ENGINEERING CORP
P O BOX 217 INDIANAPOLIS IND
WEBBER MANUFACTURING CO INC
PO BOX 217 INDIANAPOLIS 6 IND
WEBCOR ELECTRONICS
2431 WOLCOTT CHICAGO ILL
WEBCOR INC LAMINATION DIV
3912 W MCLEAN AVE CHICAGO 47 ILL
WEBCOR ELECTRONICS
3912 W MCLEAN AVE CHICAGO 47 ILL
WEBCOR ELECTRONICS
1516 WABASH CHICAGO ILL
WEBCOR INC
5610 BLOOMINGDALE AVE CHICAGO ILL
WEBCOR INC-ELECTRONICS DIV
816 N KEDZIE CHICAGO 51 ILL
WEBER AIRCRAFT CORP
2820 ONTARIO ST BURBANK CALIF
WEBER ELECT DIV
3050 CALIF ST BURBANK CALIF
WEBSTER MFG
317 ROEBLING RD S SAN FRANCISCO CALIF
WECKESSER
5701 NORTHWEST HWY CHICAGO ILL
WEDGELOCK CORP OF CALIF
11323 HARTLAND ST N HOLLYWOOD CALIF
WEIDNHOFF CORP
ALGONA IOWA
WEIGHING & CONTROL DIAGONAL TRANS WIGH
KING OF PRUSSIA PA
WEINSCHEL ENGG
10503 METROPOLITAN AVE KENSINGTON MD
WEITERMANN ELECTRONICS
4549 N 38TH ST MILWAUKEE 9 WIS
WEKSLER INSTRUMENTS CORP
195 E MERRICK RD FREEPORT L I N Y
WELCH SCIENTIFIC CO W M
1515 SEDGWICK ST CHICAGO ILL
WELDEX DIVISION
23361 TELEGRAPH SOUTHFIELD MICH
WELDMATIC DIV UNITEK CORP
950 ROYAL OAKS DRIVE MONROVIA CALIF
WELEX ELECTRONICS CORP
1000 16TH ST N W WASHINGTON 6 D C
WELLCOR INC
1218 N WELLS ST CHICAGO ILL
WELLER ELECTRIC CORP
601 STONES CROSSING RD EASTON PENNA
WELLMAN BRONZE & ALUMINUM CO
801 ANDRE ST BAY CITY MICH
WELLS GARDNER ELECT CORP
2701 KILDARE AVE CHICAGO ILL
WELLS INDUSTRIES CORP
6880 TROOST AVE N HOLLYWOOD CALIF
WELSH CO INC WM H
224 INDIANA AVE CHICAGO ILL
WELTRONIC CO
19500 W 8 MILE RD DETROIT 19 MICH
WELWYN CANADA LTD
125 BRYDGES ST LONDON CANADA
WELWYN ELECTRIC LIMITED
BEDLINGTON NORTHUMBERLAND ENGLAND
WEMS INC
4807 W 118TH PL HAWTHORNE CALIF
WEN PRODUCTS INC
5810 NORTHWEST HIGHWAY CHICAGO 31 ILL
WERNER CO INC R D
GREENVILLE PA
WESCHE ELECTRIC CO B A
9027 SHELL RD CINCINNATI 36 OHID
WESCO ELECTRIC & MFG CO
27 OLIVE ST GREENFIELD MASS
WEST COAST ELECTRICAL MFG CORP
233 W 116 LOS ANGELES CALIF
WEST COAST RESEARCH CORP
2102 S SEPULVEDA BLVD LOS ANG CALIF
WEST INSTRUMENT CORP
4363 MONTROSE AVE CHICAGO ILL

FOR INFORMATION ON PRODUCTS

SEE THE

"PRODUCT AND MANUFACTURERS" SECTION

WESTBERG MFG CO
144 S COOMBS ST PO BOX 239 NAPA CALIF
WESTERN APPARATUS
2001 GREENLEAF EVANSTON ILL
WESTERN ARC WELDING INC
749 KOHLER ST LOS ANG CALIF
WESTERN COATING CO
BOX 598 OAKRIDGE STA ROYAL OAK MICH
WESTERN COIL & ELECTRICAL CO
215 STATE ST RACINE WISC
WESTERN DESIGN & ELECT
6312 HOLLISTER AVE SANTA BARBARA CALIF
WESTERN DEVELOPMENT LABS PHILCO CORP
918 INDUSTRIAL PALO ALTO CALIF
WESTERN DEVICES INC
600 W FLORENCE AVE INGLEWOOD 1 CALIF
WESTERN DEVICES INC
555 FRONT ST BURBANK CALIF
WESTERN DIV PENN CONTROLS INC
BOX 553 COSTA MESA CALIF
WESTERN ELECTRO ACOUSTIC LAB INC
2222 SO BARRINGTON LOS ANGELES 49 CALIF
WESTERN ELECTRONIC PRODUCTS CO
2420 NORTH LAKE AVE ALTADENA CALIF
WESTERN ELECTRONICS CO
717 DEXTER AVE SEATTLE WASH
WESTERN ELECT KANSAS CITY PLANT
777 N 50 HIGHWAY LEES SUMMIT MO
WESTERN ELECTRIC CO
6655 WEST RENO OKLAHOMA CITY OKLA
WESTERN ELECTRIC
3300 LEXINGTON RD WINSTON-SALEM NC
WESTERN ELECTRODYNAMICS
PO BOX 98 COLORADO SPRINGS COLO
WESTERN FELT WORKS
402 OGDEN AVE CHICAGO ILL
WESTERN GEAR CORP
P O BOX 126 BELMONT CALIF
WESTERN GEAR CORP ELECTRO PRODUCTS DIV
132 W COLORADO BLVD PASADENA CALIF
WESTERN GOLD & PLATINUM CO
525 HARBOR BLVD BELMONT CALIF
WESTERN INSTRUMENT CO
826 VICTORY BLVD BURBANK CALIF
WESTERN INSULATED WIRE CO
E 30TH ST AT SANTE FE LOS ANGELES CALIF
WESTERN INTAGLIO INC
4801 W JEFFERSON LOS ANGELES CALIF
WESTERN INTL CO
45 VESEY ST NEW YORK 7 N Y
WESTERN RADIATION LAB
1107 W 24 ST LOS ANGELES 7 CALIF
WESTERN RUBBER CO
GOSHEN 6 INDIANA
WESTERN SEMICONDUCTORS INC
605 ALTON ST SANTA ANA CALIF
WESTERN SKY INDUSTRIES
21300 CLOUD WAY HAYWARD CALIF
WESTERN TRANSISTOR CORP
13021 BUDLONG AVE GARDENA CALIF
WESTFIELD METAL PRODUCTS CO
1035 LOWER UNION ST WESTFIELD MASS
WESTGATE LAB INC
P O BOX 63 YELLOW SPRING OHIO
WESTINGHOUSE ELEC CORP ASTROELECTRONICS DEPT
BOX 245 NEWBURY PARK CAL
WESTINGHOUSE ELECT CORP APPARATUS DIV
BLOOMINGTON IND
WESTINGHOUSE ELECTRIC CO DIV AIR ARM DIV
PO BOX 746 FRIENDSHIP INTL AP BALTIMORE MD
WESTINGHOUSE ELEC CORP TV RADIO DIVISION
METUCHEN N J
WESTINGHOUSE ELEC CORP ELEC TUBE DIV
ELMIRA NY
WESTINGHOUSE ELECTRIC CORP STANDARD CONTROL
BEAVER PENNA
WESTINGHOUSE ELECTRIC CORP
MATERIALS MFG DEPT BLAIRSVILLE PENNA
WESTINGHOUSE ELECTRIC CORP BENOLITE MICARTA
MANOR PENNA
WESTINGHOUSE MOLECULAR ELECTRONICS DIV
CHURCHILL BORO PITTSBURGH 35 PA
WESTINGHOUSE ELECTRIC CORP TRANSFORMER DIV
SHARON PA
WESTINGHOUSE ELECTRIC CORP MICARTA DIV
HAMPTON SC
WESTINGHOUSE ELECTRIC CORP
SEMICONDUCTOR DEPT YOUNGWOOD PA
WESTLAB INC
590 TUCKAHOE RD YONKERS N Y
WESTLAKE PLASTICS CO
133 LENNI RD LENNI MILLS PA
WESTLINE PRODUCTS DIV WESTERN LITHOGRAPH CO
600 E 2 ST LOS ANGELES 54 CALIF
WESTMORE INC
137 SOUTH AVE FANWOOD NJ
WESTREX CO DIV OF LITTON SYS INC
540 W 58 ST NEW YORK N Y
WESTREX CO RECORDING EQUIP DIV LITTON SYS IN
335 N MAPLE DR BEVERLY HILLS CALIF
WESTRONICS INC
3605 MCCART FT WORTH TEXAS

WESTWOOD CABLE CORP
3440 OVERLAND AVE LOS ANGELES CALIF
WESTWOOD CABLE CORP
3416 S ORANGE DR LDS ANG CALIF
WHEELABRATOR CORP
1471 BYRKITTST MISHAWAKA IND
WHEELER ELECTRONIC CORP SUB SPERRY RAND CORP
150 AUROR A ST WESTERBURY CONN
WHEELOCK SIGNALS INC
LONG BRANCH N J
WHITAKER CABLE CORP
1301 BURLINGTON ST KANSAS CITY MO
WHITE AVIONICS CORP
TERMINAL ROAD PLAINVIEW LI NY
WHITE DENTAL MFG CO SS INDUSTRIAL DIV
10 E 40 ST NEW YORK 16 N Y
WHITEFORD LAB
258 BROAD ST LYNN 9 MASS
WHITEHALL ELECTRONICS CORP
1645 HENNEPIN AVE MINN MINN
WHITEHEAD METALS INC
303 W 10TH ST NEW YORK 14 NY
WHITE INSTRUMENT LABS
BOX 9006 AUSTIN 17 TEXAS
WHITE MFG CO
2326 UNIVERSITY AVE ST PAUL MINN
WHITE & SON JAMES L
374 VERONA AVE NEWARK 4 N J
WHITEWATER ELECTRONICS INC
136 MAIN ST WHITEWATER WISC
WHITING & DAVIS CO
23 E BACON ST PLAINVILLE MASS
WHITNEY METAL TOOL CO
110 FORBES ST ROCKFORD ILL
WHITSO INC
9330 BYRON ST SCHILLER PARK ILL
WHITTAKER CONTROLS & GUIDANCE
16217 LINDBERGH ST VAN NUYS CALIF
WIANCKO ENG CO
255 N HALSTEAD ST PASADENA CALIF
WICKES ENGG & CONSTRUCTION CO
12TH ST & FERRY AVE CAMDEN 4 N J
WIEGAND MFG CO
882 BALFOUR ST VALLEY STREAM L I N Y
WILBRECHT ELECTRONICS
GRIGGS MIDWAY BDG
1821 UNIVER AVE ST PAUL MINN
WILCO CORP
4030 TENTH ST IND IND
WILCOLATOR CO
1001 NEWARK AVE ELIZABETH N J
WILCOX ELECTRIC CO INC
1400 CHESTNUT ST KANSAS CITY 27 MO
WILCOX PRODUCTS CO
3455 DAKOTA AVE MINNEAPOLIS 16 MINN
WILDER MFG CO
MECHANIC ST & ERIE R R PORT JERVIS N Y
WILEY ELECTRONIC PROD CO
2045 W CHERYL DR PHOENIX ARIZONA
WILKENS INC ALWIN FR
PAWLING NY
WILKINSON CO
1660 9TH ST SANTA MONICA CALIF
WILK INSTRUMENTS DIV QUALITY ELEC CO
3700 SO BROADWAY LOS ANGELES 7 CALIF
WILKS PRECISION INST CO INC
4821 BETHESDA AVE BETHESDA MD
WILLIAMS & CO J H DIV UNITED GREENFIELD CORP
400 VULCAN ST BUFFALO 7 N Y
WILLIAMS & CO C K
2001 LYNCH AVE E ST LOUIS ILL
WILLIAMS & CO C K
640 N 13 ST EASTON PA
WILLIAMS SHIP RADIO CO
4366 MENTONE ST SAN DIEGO 7 CALIF
WILLSON CAMERA CO INC
1395 LAWRENCE RD HAVERTOWN PENNA
WILMINGTON FIBRE SPECIALTY CO
NEW CASTLE DELA
WILRITE PRODUCTS INC SUB GLOBE UNION INC
3835 W 150TH ST CLEVELAND OHIO
WILSON & CO G C
1915 8 AVE HUNTINGTON W VA
WILSONS OF CLEVELAND
6502 N W 16TH ST FORT LAUDERDALE FLA
WILTON TOOL MFG CO
9525 IRVING PK SCHILLER PK ILL
WILTRON CO
717 LOMA VERDE AVE PALO ALTO CALIF
WINATIC CORP
50 STAGE RD VESTAL NY

WINCHARGER CORP SUB ZENITH RADIO CORP
P O BOX 1168 SIOUX CITY IOWA
WINCHESTER ELECTRONICS INC
19 WILLARD RD NORWALK CONN

WINCHESTER ELECT INC
NEW MILFORD CONN
WIND TURBINE CO
E MARKET ST & P RR WEST CHESTER PA
WINDSOR ELECTRONICS INC
999 N MAIN ST GLEN ELLYN ILL
WINEGARD CO
3000 KIRKWOOD BURLINGTON IOWA
J H WINN INC
620 WASHINGTON ST WINCHESTER MASS
WINPOWER MFG CO
1207 FIRST AVE E NEWTON IOWA
WINSCO INSTRUMENTS & CONTROLS CO
1533 26TH ST SANTA MONICA CALIF
WINSLOW PRODUCT ENGG CORP
47 ST JOSEPH ST ARCADIA CALIF
WINSTROM
353 FLORENCE RD FLORENCE MASS
WINTERBURN MFG CO
11 WHITTEMORE ST PUTNAM CONN
WINTRONICS INC
213 HAWTHORNE BLVD HAWTHORNE CALIF

WINZELER MFG & TOOL CO
7355 W WILSON AVE CHICAGO ILL
WINZEN RESEARCH INC
8401 LYNDALE AVE SO MINNEAPOLIS MINN
WIRE CO DF AMER SUB WARREN WIRE CO
POWNAL VERMONT

WIRE CO OF AMER SUB WARREN WIRE CO
400 DAVID LOVE PLACE GOLETA CALIF
WIRECRAFT PRODUCTS INC
RT 9 W BROOKFIELD MASS
WISCONSIN PORCELAIN CO
121 LINCOLN ST SUN PRAIRIE WISC

WITTEK MFG CO
4305 W 24TH PL CHICAGO ILL
WOLLAM AIRCRAFT & MARINE PRODUCTS CO
222 S MILL ST CELINA OHIO
N WOOD COUNTER LAB INC
1525 E 53 ST CHICAGO 15 ILL
WOOD ELEC CORP
244 BROAD ST LYNN MASS
WOODBURY GLASS CO
34 BURNSIDE AVE E HARTFORD 8 CONN
WOODLAND ELECTRONICS CO INC
503 MC CARTER HWY NEWARK 2 NJ
WOODWELDING INC
355 N NEWPORT BLVD NEWPORT BEACH CALIF
WOODWORTH METAL FAB DIV SHELBURNE INDUSTRIES
182 BROAD AVE BINGHAMTON N Y
WORKMAN ELECT PROD INC
BOX 5397 PACKINGHOUSE RD SARASOTA FLA
WORLD WIDE WIRE INC
119 FLORIDA ST FARMINGDALE LI N Y
WORNER ELECTRONIC DEVICES
RANKIN ILL
WRIGHT & SONS CO WM E
WEST WARREN MASS
WRIGHT ELECTRONICS INC
2537 GRAND AVE KANSAS CITY MO
WRIGHT EQUIPMENT CORP
LUKACK COURT MILLTOWN N J
WRIGHT MACHINERY CO DIV SPERRY RAND CORP
BOX 2211 DURHAM N C
WRIGHT METALCOATERS INC
255 WEST ST S HACKENSACK N J
WRIGHT ZIMMERMAN INC
NEW BRIGHTON ST PAUL 12 MINN
WUERTH PRODUCTS CORP
1949 MOFFETT ST HOLLYWOOD FLA
WURLITZER CO
NORTH TONAWANDA N Y
WYCO METAL PRODUCTS
6918 BECK AVE HOLLYWOOD CALIF
WYE INDUSTRIES
6 GEN DEVINE WAY BOSTON MASS
WYETH ENG INC
9911 WALDEN PKWY CHICAGO ILL
WYLE MANUFACTURING DIV OF WYLE LABS
133 CENTER ST EL SEGUNDO CALIF
WYRCO PROJECTS INC
FORSYTHE AVE OWEGO NY
WYZENBEEK & STAFF INC
223 N CALIFORNIA AVE CHICAGO 12 ILL

X

X-ACTO INC
48-41 VAN DAM ST LI CITY 1 N Y
XCELITE INC
THORN-BANK STS ORCHARD PARK NY
X PANDO CORP
43 15 36TH ST LONG ISLAND CITY N Y
X RAY MFG CORP OF AMERICA
LAKE SUCESS PARK GREAT NECK N Y
X TRON ELECT INC
890 71ST AVE OAKLAND CALIF

Y

YARDNEY ELECTRIC CORP
40 LEONARD ST NEW YORK N Y
YARNALL WARING CO
102 E MERMAID LANE PHILA PA
YELLOW SPRINGS INSTRUMENT CO
P O BOX 106 YELLOW SPRINGS OHIO
YDKOGAWA ELECTRIC WKS INC
40 WORTH ST NEW NEW YORK N Y
YOLATRON INC
DALLAS TEXAS
YORK CO INC OTTO H
6 CENTRAL AVE ORANGE N J
YORK RESEARCH CORP KIP ELECTRONICS DIV
1 RESEARCH DRIVE STAMFORD CONN
YOUNG BROTHERS CO
1831 COLUMBUS RD CLEVELAND 13 OHIO
YOUNG SPRING & WIRE CORP GONSET DIV
801 S MAIN ST BURBANK CALIF

Z

ZACHARIAS CO ROBERT
6045 N KEYSTONE AVE CHICAGO 46 ILL
ZACHARIAS ELECTRONICS CORP
P O BOX 172 LIVINGSTON N J
ZAGORA GEAR PRODUCTS INC
1327 S MINT ST CHARLOTTE 3 N C
ZELL PRODUCTS CORP
280 MAIN ST NORWALK CONN
ZENITH ELECTRIC CO
152 W WALTON ST CHICAGO 10 ILL
ZENITH OPTICAL LAB
75 MAIN ST DOBBS FERRY N Y
ZENITH RADIO RES CORP
4040 CAMPBELL AVE MENLD PARK CALIF
ZERNICKOW CO O
15 PARK ROW N Y N Y
ZERD MFG CO
1127 CHESTNUT ST BURBANK CALIF
ZEUS ENG G CO INC
625 S KINGSLEY DRIVE LA 5 CALIF
ZIERICK MFG CORP
BEECHWOOD & ROCKDALE AVE N ROCHELLE N Y
ZIMNEY CORP
160 TAYLOR ST MONROVIA CALIF
ZINN INSTRUMENTS
P O BOX 733 LOMITA CALIF
ZIPPERTUBING CO
13000 S BROADWAY LOS ANG CALIF
ZIRCONIUM CORP OF AMER
31501 SOLON RD SOLON OHIO
ZOOMAR INC
ZOPHAR MILLS INC
112 26 ST BROOKLYN N Y
Z & W MFG CORP
30240 LAKELAND BLVD WICKLIFFE OHIO

1963 DIRECTORY

PRODUCT FINDING INDEX

Here's How To Use This Index:

Find the product in the alphabetical list below.

Products are listed by their basic description (i.e. a wheatstone bridge will be found listed as "bridge, wheatstone"). Cross-referencing is also provided where a product may be known by a number of different names—for instance, volume control; resistor, variable; and potentiometer will be found listed separately in alphabetical order but all indicating page L98 where their manufacturers are listed.

ELECTRONIC INDUSTRIES

1963 DIRECTORY OF PRODUCTS & MANUFACTURERS

This is a comprehensive listing of equipment, test and measuring instruments, and components manufactured by the electronic industries. Also listed are supplementary items such as cabinets, chemicals, hardware, raw materials and services related to the electronic field. Names and addresses of manufacturers are given for over 1,500 product categories. Companies making these products or offering services in the field are arranged alphabetically. Addresses of the companies are contained in the alphabetical listing of manufacturers at the beginning of the directory. Numbers printed at the right of each column indicate the products each firm manufactures.

AMPLIFIERS, AUDIO 100

ABBEY ELECTRONICS CORP 7
ACF ELECTRONICS DIV ACF INDUSTRIES INC 4-9-13
ADCRAFTERS CO 3
ADEC INC 6
ADVANCED MEASUREMENT INST INC 18
AO-YU ELECTRONICS LAB INC 3-6-7-12-14-18-19
AEROSPACE ELECTRONICS INC 3-6-8-9-16
AIRCRAFT RADIO CORP 4-6-7
AIR ELECTRONICS CO 4
AIRPAX ELECTRONICS INC PASADENA 5
AIRTRONIX DEVELOPMENT CORP 3
ALERT PRODUCTS INC 5-12-18
ALLISON LABS INC 3-6
ALMA ENGINEERING 0
ALPHA CORP 3
ALTEC LANSING CORP 2-3-7-8-9-10-13-14-15-16-17-19-20
ALTO FONIC TAPE SERVICE INC 15-19-20
ALTRON ELECTRONICS CO 3-14
AMERICAN AIRFRAME CORP 2-3-14
AMERICAN BOSCH ARMA CORP 18
AMERICAN CONCERTONE 15
AMERICAN MEASUREMENT & CONTROL INC 3
AMERICAN MISSILE PROD CO INC 14
AMPLIFIER CORP OF AMER 3-7-8-9-11-15-19-20
AMPLIVOX LTD 7
AMTRON INC MIDLOTHIAN 15-18
ANDERSEN LAB INC 18
ANDREA RADIO CORP 6-7-10-16-17
ANTLAB INC 12-15
APPLIED CONTROL CORP 2-3-16
APPLIED TECHNOLOGY CORP 14-15
AR & DA ENGG CO 3-14
ARKAY INTERNATIONAL INC 3-17-20
ASTROMETRICS INC 10-11
ATLANTIC INSTRUMENTS & ELECTRONICS INC 14
AUDEX CO 10-15-17-18
AUDIO EQUIPMENT CO PORT WASHINGTON 3-7
AUDIOMATION LABS 6-19
AUDIVOX INC 7
AUTOCRAT ELECTRONICS CO 11-17
AVCO CORP ELECTRONICS & ORDNANCE DIV 14
BACH AURICON INC 7-8-9-10-15
BALDWIN PIANO CO 11
BALLANTINE LABS INC 1
BARKER & WILLIAMSON INC 3
BELL SOUND DIV THOMPSON RAMO WOOLORIDGE INC 3-17
BENDIX CORP BENDIX RADIO DIV 4
BENNETT LAB INC 6-7-16
BERGEN LABS INC 14-17-18-20
B & K INSTRUMENTS INC OF BRUEL & KJAER 1
BLACKBURN ELECTRONIC CORP 14
BORG-WARNER CONTROLS 15
BOULEVARD ELECTRONICS INC 3-4-7-15-17-19-20
BRAMCO INC SUB LEDEX INC 12
BRUSH INSTRUMENTS 4-14-15
BUDELMAN ELECTRONICS CORP 6
BUILDING BLOCKS ELECTRONIC CO 3
BURR BROWN RESEARCH CORP 1-4-14-18
CALBEST ELECTRONICS CO 13-17-20
CALIFORNIA INSTRUMENTS CORP 3
CANADIAN MARCONI CO 16
CAROL ELECT DIV WEECO 3
CENTRALAB DIV GLOBE-UNION INC 7-9-14
CENTRALAB DIV GLOBE UNION 7-9-14
CENTRAL DYNAMICS LTD 1-2-3-4-5-6-7-8-9-10-14-15-16-17-18-19-20
CENTRAL ELECTRONICS INC 5
CENTURY ELECTRONICS & INSTS INC SUB CENTURY GEOPHYSICAL CORP 3
CENTURY PROJECTOR CORP 3-14
C E S ELECTRONIC PRODUCTS INC 1-3-12
CHALCO ENGINEERING CORP 2-4-6-7-18
CHESAPEAKE INSTRUMENT CORP 17-20
CINEMATIC DEVELOPMENTS CO 15
CLEVITE ORDANCE DIV CLEVITE CORP 7-14-15-16-18
COHU ELECTRONICS INC KIN TEL DIV 3-12-14-18
COLUMBIA RECORDS 6-7-8-15
COLUMBUS PROCESS CO 11
COMMERCIAL RADIO SOUND CORP 5
COMMUNICATION ELECTRONIC INC 2
COMMUNICATION MEASUREMENTS LABS 3-12-18
COMMUNICATIONS ELECTRONICS CO 3-7
COMPUTER SYSTEMS INC 4
CONCO 16
CONTINENTAL ELECTRONICS CORP BROOKLYN 6-7
CONTROL SCIENCE CORP 12
CONTROL TECHNOLOGY CO 1-3-4-5-6-13-16-18
CONTRONICS IN 3
COOK ELECTRIC CO DATA STOR DIV 15
COOPERTRONIX 2-5
CP ELECTRONICS INC 3-11-17-19
CROWN ENG DIV DATA TECH INC 5
CUBIC CORP 3-12-18
ELECTRONICS DIV CURTISS WRIGHT 3-14
CUSTOM ELECT MFG CORP 4
DALLONS LABS 1
DATA SENSORS INC 2-4-6-7-8-10-14-18
DATA TECHNOLOGY CORP PALO ALTO 5
DATA TRONIX CORP 3-4-8-9-12-14-18
DAYSTROM INC MILITARY ELECTRONICS DIV 3-8-9-14-15
DAYTON ELECT PROD CO INC 3-14-17-18-19-20
DENRAD MFG CO INC 6-7
DENSON ELECTRONICS CORP 3-7
DEVELCO INC 2-3-4-6-12-14
DEWALD RADIO MFG CORP DIV OF UNITED SCIENTIFIC LABS 17
DICTAPHONE CORP BRIDGEPORT 15
DON BOSCO ELECT SUB OF HOWELL ELECT MOTORSC6 14
DOTY ACOUSTICAL ELECTRONIC LABS 3-14
DYNACO INC 3-17-18-19-20
DYNATRON LAB 6
DYNAVOX CORP 7-11-17
EDO CANADA LTD 3-6
EDP CORPORATION 3
EGAN LABORATORY 3
ELCOR INC 4-8-18
ELECTRAMATIC INC 17
ELECTRO MECHANICAL CORP 3-7-10-12
ELECTRO MEDICAL ENG CO 15
ELECTRO-SONIC LABS 3-15
ELECTRO VOICE INC 7
ELECTRON ENTERPRISES 17
ELECTRONIC APPLICATIONS INC 3-6-7-8-17-19-20
ELECTRONIC COMMUNICATION EQPT CO 3-5-6-7-10
ELECTRONIC CONTROLS SYSTEMS INC 4
ELECTRONIC DESIGN & DEVELOP CO 9-15
ELECTRONIC ENGG CO 6-7
ELECTRONIC INSTRUMENT CO INC 17-19-20
ELECTRONIC INTL CO 3
ELECTRONIC MEASUREMENTS CORP N Y 17
ELECTRONIC SYSTEMS ENGG CO 5-6-7-10-13-15
ELECTRONICS INC OF PA 17-20
ELGIN MICRONICS DIV ELGIN NAT WATCH CO 3-4-7-8-9-10-12-14-15-18-19
ELGIN NATIONAL WATCH CO 1-2-3-4-5-6-12-14-15
ELIN DIV INTL ELECT RESCH CORP 1-12
ELION INSTRUMENTS INC 3
EL-RAD MFG CO 17
EMI US LOS ANG 2-3-4-6-7-14-15-17-19-20
EMI US LTD GENERAL COMM DIV 2-3-4-6-7-14
EMI/US NO HOLLYWOOD 2-6
ENOECO ENGG DEVELOPMENT CO OF LOS ANGELES 3
ENDEVCO CORP 7

AMPLIFIERS, RF-IF 200

AMPLIFIERS, TELEVISION 300

AMPLIFIERS, SPECIAL FUNCTION 400

ARBEY ELECTRONICS CORP 4-7-18-31
ARRAMS INSTRUMENT CORP 7
ACDC ELECTRONICS INC 16
AC ELECTRONICS INC 16
ACF ELECTRONICS DIV RIVERDALE 7-10-22
ACF ELECTRONICS DIV ACF INDUSTRIES INC 10-24-29
ACOUSTICA ASSOCIATES INC 32
ACOUSTICA ASSOCIATES 32
ACROMAG INC 7-9-12-16-20-23-24-26-29
AC SPARK PLUG ELECT DIV GMC 21-24-28
ADAGE INC 4-7-9
ADVANCE INSTRUMENT CORP 24
ADVANCED ELECTRONICS INC 33
ADVANCED MEASUREMENT INST INC 29
AERONCA MFG CORP 28
AEROSPACE RESEARCH INC 7-10-14-15-24-29
AIRBORNE ACCESSORIES CORP 5-7-9-10-12-16-20-23-24
AIRBORNE INSTRS LAB DIV CUTLER HAMMER INC 17-31
AIRCOM INC 25-34
AIRPAX ELECT INC SEMINOLE DIV 16-29
AIRPAX ELECTRONICS PACIFIC DIV 7-29-31
AIRPAX ELECTRONICS INC PASADENA 16-21-29
AIRTRONICS INTL CORP 31
ALFRED ELECTRONICS 7
ALLEGANY INSTRUMENT CO 4-7-9-18-26-31
ALMA ENGINEERING 2-3-7-14-18-21-29-31
ALPHA CORP 21
AMELCO INC ELECT DEVICES DIV 9-31
AMERICAN AIRFRAME CORP 2-5-7-13-19-21-24-30-31
AMERICAN AVIONICS INC 3-31
AMERICAN BOSCH CORP 21-29
AMERICAN BOSCH ARMA CORP 21
AMERICAN BRAKE SHOE CO RAYMOND ATCHLEY DIV 4-5-7-18-24-31
AMERICAN ELECT LABS INC 15
AMERICAN ELECTRONICS CO MINN 16-24-31
AMERICAN ELECT LABS MICROWAVE & PHASING 7-29
AMERICAN ELECTRONICS INC FULLERTON 5-24
AMERICAN ELECTRIC SWITCH DIV 16
AMERICAN MEASUREMENT & CONTROL BURLINGTON 24
AMERICAN MEASUREMENT & CONTROL INC 5-7-24-28
AMERICAN MICROWAVE & TV CORP 13
AMERICAN MISSILE PROD CO INC 6-26
AMERICAN OPTICAL CO INSTRUMENT DIV 7-9-26
AMERICAN RECTIFIERS CORP MFRS RICHARDSON ALLEN POWER SUPPLIES 16
AMERICAN RESEARCH & MFG CORP 16
AMPLIFIER CORP OF AMER 21
AMPLIVOX LTD 10-31
AMTRON INC MIDLOTHIAN 10-21-24-31
AMULEX ELECTRONICS INC 2-5-7-14-19-21-22-27
ANALYTIC SYSTEMS CO 6-7-9
ANDERSEN LAB INC 5-24-32
ANTLAB INC 1-5-18-30
APPALACHIAN ELECTRONIC INSTRUMENTS INC 20-30-31
APPLIED CONTROL CORP 7-24
APPLIED DEVELOPMENT CORP MONTEREY PK 4-6-22-23-31
APPLIED ELECTRONICS CORP OF N J 7-9-29-31
APPLIED MICROWAVE LAB INC 34
APPLIED TECHNOLOGY CORP 4-5-7-9-20-21-23-31
AR & DA ENGG CO 4-6-7-16-18-20-22-23-24-26-31
ARDENTE ACOUSTIC LABS LTD 31
ARENBERG ULTRASONIC LABORATORY INC 32
ARKAY INTERNATIONAL INC 31
ARMSTRONG WHITWORTH EQUIP 26
ASSEMBLY PRODUCTS INC 23
ASSOCIATED ELECTRICAL INDUSTRIES LTD 7-16-24-31
ASSOCIATED ELECTRICAL INDUSTRIES LTD 25
ASSOCIATED ENGINEERING CO MATTHEWS 16
ASTRODATA INC 7-9
ASTROMETRICS INC 3-7-29-31
ATELIERS DE MONTAGES ELECT 5-7-14-15-21-22-24
ATLANTIC INSTRUMENTS & ELECTRONICS INC 6-10-22
ATLANTIC RESEARCH CORP 2
ATLAS ENG CO 16
AUDEX CO 21
AUDIO INSTRUMENT CO 2-15
AUSTIN ELECTRONICS DIV AUSTIN CO 2-4-5-6-7-9-18-20-21-22-24-28-31
AUTO DATA 7
AUTOMATED CONTROLS 3-5-22-32
AUTOMATIC CONTROL CO 7-18-29
AUTOMATION DYNAMICS CORP 5-23-24-29-31
AVIATION INSTRUMENT MFG CORP 24
AVIONICS INC 16
BABCOCK & WILCOX BAILEY METER CO 16
BACH AURICON INC 6-20-31
ELECTRONICS DIV BALDWIN HAMILTON CORP 7-9-26
BARBER & HOWARD CO 7
BARKER & WILLIAMSON INC 7-10-14-21
BARNES ENGINEERING CO 1-15
BASLER ELECTRIC CO 16
BECKMAN INST INC BERKELEY DIV 7-12-14-15
BELDOCK INSTRUMENT CORP 2-4-5-7-9-10-18-27-28-31
BENCO TELEVISION ASSOC LTD 31
BENDIX CORP BENDIX RADIO DIV 15-31
BENDIX CORP THE POINEER CENTRAL DIV 32
BERGEN LABS INC 31
BERKELEY INSTRUMENT CO 16
BEVA LABORATORY 22
BIOPHYSICAL INSTRUMENTS INC 20
B & K INSTRUMENTS INC OF BRUEL & KJAER 26-33
BLACKBURN ELECTRONIC CORP 16
BLACKSTONE CORP 32
BOONSHAFT & FUCHS INC 7
BORG-WARNER CONTROLS 10
BOY-MAR ELECTRICAL SERVICE CO 20
BRAMCO INC SUB LEDEX INC 5-29
BROWN ENG CO INC 0-24
BROWNING LABS INC 25
BRUNO NEW YORK INDUST CORP 10-31
BRUSH INSTRUMENTS 6-7-9-14-21-24-26-31
BUDELMAN ELECTRONICS CORP 14-21
BUFFALO INSTRUMENT CORP 1-6-8-19-26
BULOVA WATCH CO ELECT DIV 16-24
BURMAC ELECTRONICS CO INC 22
BURR BROWN RESEARCH CORP 4-5-6-7-8-9-12-14-21-31
BUSH TRANSFORMER CORP 16
BYTREX CORP 26
CALIF MAGNETIC CONTROL CORP 16
CALIF TECHNICAL INDUST DIV TEXTRON INC 15
CALIFORNIA COMPUTER PROD INC 5-22
CALIFORNIA INSTRUMENTS CORP 5-6-7-8-9-12-21-24-26-31-33
CALMAG DIV CALIF MAGNETIC CONT CORP 7-16
CANADIAN AVIA ELECTS 4-5-6-7-12-14-15-16-18-24-31
CAROL ELECT DIV WEECO 10-21
CEDAR ENG DIV CONTROL DATA CORP 24
CELCO CONSTANTINE ENG LAB CO PACIFIC DIV 27
CENTRALAB DIV GLOBE UNION 10-31
CENTRALAB DIV GLDBE UNION 7-31
CENTRAL DYNAMICS LTD 31
CENTRAL ELECTRONICS INC 3-31
CENTRAL TRANSFORMER CO 16
CENTURY ELECT INST INC TULSA 6-31
CENTURY PROJECTOR CORP 20-21-31
C E S ELECTRONIC PRODUCTS INC 5-6-7-8-9-15-26
CHADWICK-HELMUTH CO 19
CHALCO ENGINEERING CORP 3
CHESAPEAKE INSTRUMENT CORP 31
CHICAGO ELECTRONIC ENGG CO 16
CIMRON CORP 6-7-9-18-26
CIRCUITDYNE CORP 9-16-21-31
CLEVITE ORDANCE DIV CLEVITE CORP 6-7-32
COAST COIL CO 16
COILCRAFT INC 16
COLUMBIA RECORDS 3
COLUMBIA RESEARCH LABS 2-10-21-33
COLUMBUS PROCESS CO 31
COMMERCIAL RADIO SOUND CORP 31
COMMUNICATION ACCESSORIES CO 16
COMMUNICATION ELECTRONIC INC 22-29
COMMUNICATION MEASUREMENTS LABS 14-21-22-30-31-32
COMMUNITY ENGG CORP 22-29
COMPTON CORP 4-6-31
COMPUDYNE CORP 5-24-29
COMPUTER CONTROL CO INC EASTERN DIV 4
COMPUTER ENGG ASSOC AFF SUSQUEHANNA INC 6
COMPUTER LOGIC CORP 22
COMPUTER PRODUCTS INC 4-7-12-23-24-31
COMPUTER SYSTEMS INC 4-24
COMPUTER TEST CORP 4-22
COMPUTING DEVICES OF CANADA LTD 15
CONSOLIDATED AIRBORNE SYSTEMS INC 5-6-7-24-28-29
CONSOLIDATED ELECT CORP 6-7-12-14-22
CONTINENTAL ELECTRONIC MFG CO LABS LING TEMCO-VOUGHT INC 13-14-21-22
CONTINENTAL MFG INC 31
CONTROL LOGIC INC 4-10
CONTROLOMAG LABS 5-7-9-16
CONTROL TECHNOLOGY CO 2-3-4-5-6-7-8-9-10-12-14-15-16-18-20-21-23-24-26-28-29-30-31-33
CONTRONICS IN 31
COOK ELECTRIC CO DATA STOR DIV 6-20
COSMIC RADIATION LABS 22
COURTER PROD DIV MODEL ENGG & MFG INC 24
CP ELECTRONICS INC 31
CRANE ELECTRONICS CO 31
CROWN ENG DIV DATA TECH INC 26
CUBIC CORP 2-4-7-9-10-21-24-28-31
ELECTRONICS DIV CURTISS WRIGHT 21
CURTISS-WRIGHT CORP ELECTRONICS DIV 4-7
DALLONS LABS 19
DALMO VICTOR CO DIV TEXTRON INC 2-5-6-7-10-12-17-21-24
DALTRONICS INC 16
DAMON ENGINEERING INC 15
DANA LAB INC 1-4-5-6-7-9-29-33
DATA CONTROL SYSTEMS INC 6-29
DATA MASTER CORP THE 24-30
DATA TECHNOLOGY CORP PALO ALTO 9-31
DATASCAN INC 18-20
DATA TRONIX CORP 7-9-14-24-29-31
DATEX CORP 31
DAYSTROM INC MILITARY ELECTRONICS DIV 4
DAYSTROM INC TRANSICOIL DIV 24
DAYSTROM INCORPORATED WESTON INSTRUMENTS DIV 20
DAYSTROM TRANSISTOR CORP 24
DAYTON ELECT PROD CO INC 2-7-19-27
DAYTRONIC CORP 6-19-26-33
DBM RESEARCH CORP 6-22-29-31
DECITRON ELECTRONICS CORP 16-21-22-24
DECKER CORP 2-29
DEITZ CO S J 5-20-23-30
DELCON CORP 32
DELTRON CO INC VAN NUYS 16
DE-TEC-TRONIC CORP 5-7-20-23-30-31
DETROIT DESIGNING & ENG CO 4-5-7-10-14-21-22-23-24-28-29-31
DEVELCO INC 2-10-31
DI-AN CONTROLS INC 24-28
DIATRON INC 7
DIEHL MFG CO 24-31
DIETZ CO S J 5-20-23-30
DIGITROL SYSTEMS INC 5-20
DIOTRON INC 16
DON BOSCO ELECT SUB OF HOWELL ELECT MOTORSC6 33
DORSETT ELECTRONICS 7-29
DOTY ACOUSTICAL ELECTRONIC LABS 7-21-31
DRESSER ELECT SIE DIV 7-21
DRESSER ELECT HST DIV 16
DREXEL DYNAMICS CORP 4
DUKANE CORP 4
DYNACO INC 21
DYNAIR ELECTRONICS INC 14-21-31
DYNAMETRICS CORP 18-24-26
DYNAMICS INST CO 2-4-6-7-9-12-14-15-26-31
DYNAPLEX CORP 2-4-6-7-9-10-14-22-26-29-31-33
DYNASCIENCES CORP 24-29-31
DYNATRON LAB 7-9-22-29
DYNATRONIC INST CORP ELECTR DIV LAB LINE INSTRUMENTS INC 16
EASTERN INDUSTRIES DIV OF L F E INC 24
EATON MFG CO DYNAMIC DIV 10-21-26-31
EDO CANADA LTD 22-24-28-31
EDO CORP COLLEGE PT 31-32
EDP CORPORATION 29
ELCOR INC 2-4-7-9-12-14-18-19-20-27
ELECT MECHANICAL RES INC 29-31
ELECTRA SCIENTIFIC CORP 2-33
ELECTRAN MFG CO 16
ELECTRIC EYE EQUIPMENT CO 5-20-24-31
ELECTRO DEVELOPMENT CORP SEATTLE 6-7-16-26-29-33
ELECTRODYNAMIC INSTRUMENT CORP 6-21-24
ELECTRO INSTRUMENT INC 6-7-9-26-31
ELECTRO KINETICS CORP 10-16-21-24
ELECTROL SPECIALTIES CO 24
ELECTROMATION CO 24
ELECTRO MECHANICAL CORP 1-2-5-18-21-24-31
ELECTRO MECHANICAL RESEARCH INC 7-29
ELECTRO MEDICAL ENG CO 2-6-12-19-26
ELECTRONEX INDUSTRIAL LABORATORIES 5-7-9-16
ELECTRO SCIENTIFIC IND INC 18
ELECTRO VISION LAB 5-23-30
ELECTRO WINDERS CO INC 16
ELECTRON OHIO INC 6-16-31
ELECTRONIC APPLICATIONS INC 37
ELECTRONIC COMMUNICATION EQPT CO 21
ELECTRONIC COMMUNICATIONS 24
ELECTRONIC COMM & COMP DES & DEV CORP 2-6-11-20
ELECTRONIC COMPUTER CO 4-7-9
ELECTRONIC CONTROL CORP 20-30
ELECTRONIC CONTROLS INC 4-9-18-20-23-30-31
ELECTRONIC CONTROLS SYSTEMS INC 4-5-7-9-10-16-18-23-24
ELECTRONIC COUNTERS INC 4
ELECTRONIC CRAFTSMEN INC 2-5-6-7-8-9
ELECTRONIC DESIGN & DEVELOP CO 6-7-20
ELECTRONIC DEVELOPMENT CORP 7-31
ELECTRONIC ENGG CO 21
ELECTRONIC INTL CO 21
ELECTRONIC PROCESS CORP SAN CARLOS 9-18-24
ELECTRONIC RESEARCH ASSOCIATES INC 7-16-31
ELECTRONIC SYSTEMS ENGG CO 5
ELECTRONIC TRANSISTORS CORP 31
ELECTRONICS SYSTEMS INC 15
ELGIN MICRONICS DIV ELGIN NAT WATCH CO 2-3-4-6-7-9-10-12-14-15-16-21-22-23-31-33
ELIN DIV INTL ELECT RESCH CORP 21
ELION INSTRUMENTS INC 10-19-27
ELLIOTT BROS LONDON LTD RADAR DIV 4-5-6-7-12-31
EMCEE ELECTRONICS INC 5-6-7-8-24-26-31
EMERSON ELECTRIC MFG CO ELECT & AVIONICS DIV 4-5-24
ENDEVCO CORP 2-6-7-9-10-14-21-26-29-31-33
ENG NORTHWEST 4-5-22
ENGINEERED ELECTRONICS CO 31
ENGINEERED MAGNETICS 26
ENSCO INC 4-7-26-31
ENTRON INC 14-21-31
E O ELECTRONICS INC 8-33
EPSCO INC CAMBRIDGE 4-11-14-15-29-31
ERWOOD INC 2-7-33
ESPEY MFG & ELECTRONICS CORP 4-7-9-10-16-21-22-26-31
ESS GEE INC 2-4-6-7-8-9-12-23-24-26-28-29-31
EXACTEL INSTRUMENT CO 24

FARINON ELECTRIC 21
FARRAND OPTICAL CO INC 7
FEDERAL MFG & ENG CORP TV SPECIALTY DIV 31
FEEDBACK CONTROLS INC 4-16-24
FIDELITY AMPLIFIER CO 20-21-23-30-31
FIDELITY INSTRUMENT CORP 16
FIFTH DIMENSION INC 7-9-29
FISHER RADIO CORP 21
FISHER RESEARCH LAB 33
FORWAY INDUSTRIES INC 20-31-34
FOXBORO CO 5-6-7-16-24-29-31
FRANKLIN ELECTRONICS INC 7-14
FRANKLIN SYSTEMS INC 23
FREED TRANSFORMER CO 16-18
F X R INC WOODSIDE 1
FYR-FYTER ELECTRONIC & ALARM CORP 21-31
GAI-TRONICS CORP 31
GATES RADIO CO 31
GB COMPONENTS INC 9
GEMCO ELECTRIC CO 5-21
GENERAL COMPUTERS INC 4-5-6-7-8-9-12
GENERAL DYNAMICS ELECTRONICS ROCHESTER 4-6-21-22-29-31
GENERAL ELECTRIC CO POWER TUBE DEPT 13
GENERAL ELECTRIC CO ATOM POWER EQUIP NUCLEAR ELECTRONIC PRODS SECT 22
GENERAL ELECTRIC CO UTICA 4-5-21-22-23-24
GENERAL INSTRUMENT CORP RADIO RECEPTOR DIV DEF & ENGG PRODS GRP 29
GENERAL MAGNETICS INC BLOOMFIELD 16
GENERAL MAGNETICS INC MINN 16
GENERAL MICROWAVE CORP 1-13-25-34
GENERAL MILLS INC MINN 4-7
GENERAL RADIO CO 7-18-21-22-31-33
GEORGE GORTON MACHINE CO 5
GEOTECHNICAL CORP 6-7-18-26-33
GEOTRONIC LABS INC 4-16-24-31
GERST & CO PAUL E 16
GERTSCH PRODUCTS INC 18
GIBBS MFG RESEARCH CORP 18-24-31
GISHOLT MACHINE CO 24
GOOD ELECTRONICS CORP 7-9-26
GPL DIV GENERAL PRECISION INC 24
GRAFLEX INC 31
GRANGER ASSOC 13
GREGORY MAGNETIC INDUST INC 22-31
GULTON INDUSTRIES INC METUCHEN 2-3-4-5-6-7-8-10-15-16-24-26-29-31
GULTON INDUSTRIES INC ENG MAGNETICS DIV 16
GULTON INDUSTRIES INC ORTHOLOG DIV 3
HAGAN CHEMICALS & CONTROLS INC 7-9-12-14-16-18-21-22-31
HALEX INC 6-7-29
HALL MFG CO 16
HALLAMORE ELECTRONICS CO 7-29
HALLICRAFTERS PACIFIC DIV 6-9-10-15-29
HALLICRAFTERS CO CHICAGO 3-15-29
HAMILTON ELECTRONICS CORP 21-31
HAMNER ELECTRONICS CO INC 14-22
HARREL INC 5-7-9-16-18-24-26-31
HAYS CORP 24
HEATH CO SUB OF DAYSTROM INC B HARBOR 4
HEATH CO DIV OF DAYSTROM INC ST JOS 4-14-24-31
HELIPOT DIV BECKMAN INSTS FULLERTON 24
HENRY & MILLER INDUSTRIES INC 24
HENSCHEL CORP 24-28-31
HEWLETT PACKARD CO 31-34
HEYER INDUSTRIES INCORPORATED LAB OF MARQUETTE CORP 16-19
HOFFMAN ELECTRONICS CORP INDUSTRIAL PROD DIV 5-23
HOGAN FAXIMILE CORP 6-11
HONEYWELL CONTROLS LTD 23-24
HOOVER ELECTRIC CO 24
HOOVER ELECTRONICS CO 29
HOUSTON INSTRUMENT CORP 7
HOWARD INSTRUMENT CO 22-31
HRB SINGER INC 15-32
HUGHEY & PHILLIPS 30
HUNT ELECTRONICS 3
HURLETRON INCORPORATED ELECTRIC EYE EQP DIV 5-20-24-31
HUYCK SYSTEMS CO DV OF HUYCK CORP 9-24
H W ELECTRONICS INC 4-31
HYCON MFG CO 24
HYDROPOISE INC SUB BROOKS INST CO 22
HYSON MFG CO PASADENA 5-24
IMPERIAL ELECT INC 4-7-9-12
INDUCTOP ENGG INC 16
INDUSTRIAL CONTROL CO 5-7-18-24-28
INDUSTRIAL ELECTRONICS INC 6-20-26-31
INDUSTRIAL TEST EQUIPMENT CO 18-21
INFRARED INDUSTRIES INC WESTERN DIV 1-2-5-10-12-20-31
INSTRON ENGG CORP 12-26
INSTRUMENT LABS CORPORATION 31
INSTRUMENTS FOR INDUSTRY INC 2-14-15-21-22-29-31
INTERELECTRONICS CORP 2-3-4-5-7-10-15-16-18-21-31-32-33
INTERNATIONAL DATA SYSTEMS INC 2-5-6-7-14-22-24-26-29-31-33
INTERNATIONAL RESEARCH & DEVELOPMENT CORP 5-6-33
INTERSTATE ELECTRONICS CORP 7
ITA ELECTRONICS CORP 13
I TEL INC 15
ITT FEDERAL LABS NUTLEY 17
ITT KELLOGG COMM SYSTEMS DEPT 4-5-13
JACK & HEINTZ DIV SIEGLER CORP 21
JAMES ELECTRONIC INC 7
JANSEN ELECT MFG CO INC 31
JARVIS ELECTRONICS CORP 2-3-5-7-8-14-15-19-20-21-24-26-28
JERROLD ELECTRONICS CORP 15-19-27-31
JOHNSON CO E F 14
JOHNSON ELECTRONICS INC 16
JORDAN CONTROLS INC 24
J-V-M DIVISION FIDELITONE MICROWAVE INC 1-
KAMAN AIRCRAFT CORP 21-34
KANE ENGINEERING LABORATORIES 5-24-31
KEARFOTT DIV GPI LITTLE FALLS 3-7-14-15-19-20-22-26-29-31-33
KEITHLEY INSTRUMENTS INC 31
KELTRON CORP 2-7-8-9-15
KENYON TRANSFORMER CO 4-5-7-12-16-21-22-24-27-31
KEPCO INC 16
KEYSTONE PRODUCTS CO 16
KINELOGIC CORP 16-24
KINNELECTRONICS CORP 6
KISTLER INSTRUMENT CORP 4
KLEER-TRONICS INC 2-33
KOLLMORGEN CORP 31
KOLLSMAN INSTRUMENT CORP SUB STANDARD KOLLSMAN IND 31
KROHN-HITE CORP 4-5-10-16-17-18-20-21-24-28
LABLINE INC 7-21
LAFAYETTE INSTRUMENT CO 20-23
LANDSVERK ELECTROMETER CO 6-7-9-20
LANGEVIN DIV OF SONOTEC INCORP 14-15-22
LASER SYSTEMS CENTER OF LEAR SEIGLER INC 3
LEACH CORP SPECIAL PRODUCTS DIV 17-35
LEAR INC ASTRONICS DIV 6-7-31
LEAR SIEGLER INC ELECT INST DIV 0
LEAR SIEGLER INC POWER EQUIP DIV 7
LEEDS & NORTHRUP CO 16-24
LEHIGH VALLEY ELECT ENGG & MFG CO 5-7-14-15-18-24
LEL INC 33
LESSELLS & ASSOCIATES INC 15-29-31
LEWIS & KAUFMAN ELECTRONICS TUBE DIV 26
LIBRASCOPE DIV GENERAL PRECISION INC 13
LING-TEMCO VOUGHT INC FLECT DIV 4-5-9-12-21-22-24
LINK DIV GENERAL PRECISION INC 29
LIQUIDOMETER CORP 2-4-5-7-9-12-14-15-21-22-24-28-31
LITTON SYSTEMS INC APPLIED SCIENCE DIVISION 18-24
LOENCO INC 29
LUMATRON ELECTRONICS INC 7
LUMEN INC 19-31
LYNCH COMMUNICATION SYSTEMS INC 16-31
MACHINERY ELECTRIFICATION INC 2-3-4-6-9-12-14-15-18-21-22-23-24-27-29-31
MADIGAN ELECTRONIC CORP 20
MAGNADYNE CORP 24-31
MAGNASYNC MFG CO 2-4-5-7-10-16-21-24-26-31
MAGNETIC CIRCUIT ELEMENTS INC 31
MAGNETIC CONTROLS CO 7-10-14-16-21-24-26-29
MAGNETIC INSTRUMENT CO INC 5-7-16-24
MAGNETIC RESEARCH CORP 7-9-24
MAGNETICO INC 7-16-24
MAGNETICS INC 5-16-24-31
MAGNETIC SYSTEMS CORP 5-7-14-16-21-22-26
MALLORY ELECT CO 16
MANSON LABORATORIES INC 5-7-8-9-10-18-26-31
MARCH DYNAMICS INC 2-13-14-21-31
MARCON ELECTRONICS CORP 34
MARINE ELECTRIC CORP 29
MARSLAND ENGG LTD 21-31
MASER OPTICS INC 12-24
MAXSON ELECTRONICS CORP N Y 22
MAXSON INSTRUMENTS DIV MAXSON ELECTRONICS CORP 15
MAXSON ELECTRONICS CORP ELECTRONIC DES DIV 15
MAYBERRY ELECTRONICS CO 3-7-8-14-15-22
MCGOHAN INC DON 7-24-31
MCKENNA LABORATORIES 21
MCMARTIN INDUSTRIES INC 32
MEASUREMENT ENGG LTD 31
MEASUREMENT SYSTEMS INC 3-7-20-31
MEDCRAFT ELECTRONIC CORP 1-24
MEDISTOR INST CO 5-9-26
MEDTRONIC INC 7-18-19-25-31
MELABS 29
MELCOR ELECT CORP 13-17-21-22-23-29-34
MELROY ELECTRONIC MFG CO 2-3-4-7-9-10-24-31
MICRODOT INC MAGNETICS DIV 21
MICRO GEE PROD INC 7
MICROMAG INSTRUMENT CO 7
MICROMETRICAL MFG CO 16
MICRO METRICS INC 18-20-23-33
MICROSONICS INC 4-5-24-28
MIDWESTERN INSTRUMENTS 4-9-12-14-15-16-22-27-28-32
MILGO ELECT CORP 6-7-24-26-29
MILLEN MFG CO JAMES 7-24
MILLIVAC INSTRUMENTS INC 19-27
MILRO CONTROLS CO INC 7-31
MILWAUKEE ELECTRONICS CORP 16
MINNEAPOLIS-HONEYWELL HEILAND DIV 10-16-24
MINNEAPOLIS-HONEYWELL BOSTON DIV 6-9-12-14-21-26-31-33
MINNEAPOLIS-HONEYWELL FALL RIVER DIV 31
MINNEAPOLIS HONEYWELL APPARATUS CONTROLS DIV 4-5
MINNEAPOLIS-HONEYWELL ORDANCE DIV 5-23-24-31
MINNEAPOLIS-HONEYWELL AERO DIV 22-32
MINNEAPOLIS-HONEYWELL BROWN INST DIV 1-4-5-6-7-9-10-11-12-14-15-16-17-18-20-21-22-23-24-26-28-29-31-33
MIRATEL INC NEW BRIGHTON 7-16-
MODEL ENGG & MFG INC 24
MONROE ELECTRONICS INC 0
MONTEK ASSOCIATES INC 2-5-6-7-9-10-12-14-15-18-19-21-22-23-24-28-31-34
MOSLER RESEARCH PROD INC 4-7-8-9-12-14-18-20-21-26-29-31
MUIRHEAD & CO LTD 5-7-14-24-31
MUIRHEAD INSTRUMENTS INC 33
MUTRON INC 24
NANILOA CORP 11-24-33
NATIONAL ELECTRONICS LAB 4-7-9-10-12-14-21-26-31-32
NATIONAL SCIENTIFIC LABS INC 20-24
NATIONAL ULTRASONIC CORP 7
NAVIGATION COMPUTER CORP 22
NEFF INSTRUMENT CORP 32
NEPTUNE ELECTRONICS CO 4-6-31
NEWCOMB AUDIO PROD CO 7-9
NICHOLS & CLARK INC 5-7-21
NORBATROL ELECTRONICS CORP 22
NORTH ATLANTIC INDUST INC 31
NORTH ELECTRIC CO 9-16-18
NORTHERN RADIO CO 24
NORTHERN RADIO MFG CO LTD 31
NORTH HILLS ELECTRONICS INC 29
NORTRONICS DIV NORTHROP CORP HAWTHORNE 3-31
NUCLEAR ENTERPRISES G B LTD 7
NUCLEONIC CORP OF AMERICA 4-
NUCLIDE ANALYSIS ASSOC 7-12-20-24
ONEIDA ELECTRONICS INC 22
ORION ELECTRONICS CORP 22
ORTHO FILTER CORP 2-7-9-15-19-22
ORTHOLOG DIV 0
ORTHOLOG DIV GULTON INDUST 2-7-14-15-27-31
ORTRONIX INC 16
OSTER MFG CO JOHN AVIONIC DIV 3
OTIS ELEVATOR CO DEFENSE & INDUSTRIAL DIV 15
PACIFIC COMMUNICATIONS & ELECTRONICS CO 4-5-6-7-9-10-12-14-29-31
PACIFIC ELECTRODEVICES 2-4-5-14-21-22-24-28
PACIFIC ELECTRO MAGNETICS CO INC 7
PACKARD BELL ELECTRONICS CORP LOS ANG 6-7-29-31
PANELLIT LTD MEMBER OF ELLIOTT AUTOMATION GROUP 6-29
PAN FAX INC 4-5-6-7-12-31
PARADYNAMICS INC 6-7-11-20-21-22-27-34
PASTORIZA ELECT INC 2-4-5-6-7-9-10-12-31
PEEBLES & CO LTD BRUCE 2-4-7-12-14-16-20-21-24-27-31
PEGASUS LABS INC 5-7-9-14-24-26-31
PENN KEYSTONE CORP 31
P & H ELECTRONICS 3
PHILBRICK RESEARCHES INC GEORGE A 2-4-7-9-12-24-31
PHILCO CORP PHILA 3-4-5-7-8-13-28-31
PHILCO CORP COMMUNICATIONS & WEAPONS DIV 3-4-5-7-8-13-28-31
PHILCO CORP SIERRA ELECTRONIC DIV 13
PHILIPS ELECTRONIC INSTRUMENTS 14-15-22-26-33
PHILAMON ABS INC 11
PHOENIX PRECISION INSTRUMENT CO 1-7-9-15-18-20-24
PHOTOMATION INC 5-20
PHOTOCON RESEARCH PRODUCTS 7
PHOTRON INSTRUMENT CO 2-4-6-7-9-14-26-31
PHYSIONICS INC 2-21-29-31
PIEZO PRODUCTS CO 16
PIONEER MAGNETICS INC 7-9-16-21-31
PLANAUTICS CORP 16
PLANETRONICS INC 19
PLECTRON CORP 21
PLUG IN INSTRUMENTS INC 5-7-9-12-24-26-31-33
PM ELECTRONICS INC 7-9-10-12-14-26-29-31-33
POLYPHASE INSTRUMENT CO 16-26
POTTER INSTRUMENT CO 6
POWER DEVICES INC 16
POWER TRONIC SYSTEMS INC 2-4-5-7-8-9-12-14-20-21-24-31
PRD ELECTRONICS INC 25
PRECISION ELECTRONICS INC 2-5-20
PRECISION SPECIALTIES INC 5-20-24
PRINCETON APPLIED RESEARCH CORP 31
PRODUCTION ELECTRONICS INC 5
PROJECTS UNLIMITED INC 2-10-31
PROTECTION EQUIPMENT CO INC MPLS 5-21
QUANTAMETRIC DEVICES INC 4-5-6-14-15-18-20-31
QUANTATRON INC 17
QUINDAR ELECTRONICS INC 3
QUTRONIC TRANSFORMER CORP 16
RACAL ELECTRONICS LTD 3
RACON ELECTRIC CO 14-21
RADIAPHONE CO 1-2-3-4-5-6-7-8-9-12-14-15-18-19-20-21-22-23-24-25-26-27-28-29-30-31-33
RADIATION AT STANFORD 13-21-22
RADIATION COUNTER LABS INC 7-14-22
RADIATION INC PRODUCTION DIV 19
RADIATION INSTRUMENT CO 26
RADIATION INSTRUMENT DEVELOPMENT LAB INC 2-9-14-22
RCA DEFENSE ELECT PRODS CAMDEN 4-5-7-31
RADIO ENG LABS INC 13-21
RAYCO ELECTRONIC MFG INC 16
RAYTHEON CO MICROWAVE & POWER TUBE DIVISION 16-17
REDCOR CORP 7-9-14-18
REEVES INSTRUMENT CORP 4-7-10-24
REGCO INC 16
REGENCY ELECTRONICS INC 6-16-31
REMANCO INC 7-9-21-24
REPUBLIC ELECT INDUST CORP 31
REPUBLIC FLOW METERS CO 24
RESEARCH INDUSTRIAL LAB OF ELECTRONICS 7-9-16
RESEARCH MFG CORP 32

ANTENNAS 500

ANTENNA ACCESSORIES 600

BATTERIES, CHARGERS & ACCESSORIES 700

CAPACITORS, FIXED 800

CAPACITORS, VARIABLE 900

CHASSIS, ACCESSORIES, FUSES 1000

CHEMICALS, COATINGS & RELATED PRODUCTS 1100

COMMUNICATIONS SYSTEMS 1200

ACCURATE ELECTRONICS CORP ELYRIA 5
ACF ELECTRONICS DIV RIVERDALE 8-19-21-23-24
ACR ELECTRONICS CORP 16-37
AC SPARK PLUG ELECT DIV GMC 25
ADCRAFTERS CO 17
AOEC INC 10-12-14-17
ADLER ELECTRONICS INC 19-22-24-26-31-32-37
ADMIRAL CORP 19-38
ADVANCED ELECT CORP 29
AEROFLEX LABORATORIES INC 7
AERO GEO ASTRO CORP 1-19
AERONAUTICAL COMM EQUIP CO 1-2-23-36
AERONAUTICAL ELECTRONICS INC 2-6-8-26-35-37
AERONAUTICAL & INST DV ROBERTSHAW FULTON CO
AEROSPACE ELECTRONICS INC 17-23-24-33-34
AEROSPACE RESEARCH INC 23
AGA CORP OF AMERICA 5-6-10-18
AIRBORNE ELECT CO 5-18-23
AIRCRAFT RADIO CORP 1-17-34-35
AIR ELECTRONICS CO 1
AIRGUIDE INSTRUMENT CO 17
ALCAR INSTRUMENTS INC 27
ALERT PRODUCTS INC 28
ALPHA CORP 2-4-6-7-8-9-17-18-19-20-21-22-23-24-26-28-29-32
ALTEC LANSING CORP 6-8-21-30
ALTO FONIC TAPE SERVICE INC 8
AMERICAN AIRFRAME CORP 10-17-18-34-35
AMERICAN AVIONICS INC 17
AMERICAN ELECTRONICS CO MINEOLA 0
AMERICAN ELECT LABS MICROWAVE & PHASING 19
AMERICAN GELOSO ELECT INC 3-17
AMERICAN MICROWAVE & TV CORP 2-7-19-38
AMERICAN TRANSFORMER DIV RADIO ENG LABS 1-18-34-35
AMPLIVOX LTD 12-13-14-15-17-20-22-31
AMTEL AMERICAN MICROWAVE & TELEVISION 19-38
ANALYTIC SYSTEMS CO 29
ANDREA RADIO CORP 1-17-20-22-24
ANTREX CORP 1-2-6-17-20-22-25-30-31
APPARATUS DEVELOPMENT CO 8
APPLIED CONTROL CORP 25
APPLIED ELECTRONICS CO SUB 5-18
APPLIED TECHNOLOGY INC 19
ARKAY INTERNATIONAL INC 5-17
ARNOUX CORP 29
ASSOCIATED ELECTRICAL INDUSTRIES LTD 4-15-17
ASSOCIATED ELECTRICAL INDUSTRIES LTD 19-29
ASTROMARINE PRODUCT CORP 18-20-23-24
ATELIERS DE MONTAGES ELECT 2-4-7-9-17-18-22-23-24
AUDIO ELECTRONICS 30
AUDIO EQUIPMENT CO PORT WASHINGTON 6-17-22
AUDIO EQUIPMENT DETROIT 13-17
AUDIOSEARS CORP 10-12-14
AUTH ELECTRIC CO 30
AUTOMATIC ELECTRIC CO 2-10-17-30
AUTOMATIC ELECTRIC LAB 0
AUTOMATION DYNAMICS CORP 19
AUTRON ENG INC 17
AVCO CORP ELECTRONICS & ORDNANCE DIV 16-20-22-24-26
BAIRO ATOMIC INC 16
BARBER LABS ALFRED W 23-26-36
BARKER & WILLIAMSON INC 3-9-20-26-34-35-36-37
BASSETT INC REX 18
BELL AIRCRAFT CORP 19
BELZ INDUSTRIES DIV EL TRONICS INC 19
BENCO TELEVISION ASSOC LTD 5-19-38
BENDIX CORP BENDIX RADIO DIV 1-8-9-17-19-20-21-22-23-24-28-34-35-36-37-39
BENRUS WATCH CO INC 21
BERKELEY INSTRUMENTS 29
B & K MFG CO 38
BLOCK ASSOC 16
BOEHME INC H O 9-32
BOEING AIRPLANE CO 1
BRAMCO INC SUB LEDEX INC 29
BRIDGE ELECTRONICS CO INC 1-26-29-32
BRIGHT RADIO LABS INC 10-14-17
BRISTOL MOTORS DIV VOCALINE CO AMERICA INC 5
BROWN ENG CO INC 29
BROWNING LABS INC 5-6-8-21-23-24-35-36-37
BRUMBERGER CO 17-30-31-39
BRUNING CO INC CHARLES 7
BRUNO NEW YORK INDUST CORP 17
BUDD ELECTRONICS A DIV OF THE BUDD CO 1-19-20-21-23-24-26-36-37
BUDELMAN ELECTRONICS CORP 4-19-21-22-23-24-25-26-30-34-35-36-37
BUNNELL & CO J H 9-35-36
B W MFG INC PHILLIPS RADIO DIV KOKOMO IND 17-23
B-W MFGRS INC PHILLIPS RADIO DIV 17
CADRE INDUSTRIES CORP 5-6-17-39
CALBEST ELECTRONICS CO 17-21
CANADIAN AVIA ELECTS 34
CANADIAN MARCONI CO 1-8-18-19-20-24-26
CANNON CO C F 14
CAROLON ELECTRONICS INC 9-26
CAROL ELECT DIV WEECO INC 17
CENTRAL COIL CORP 1-17-18-30-32-36-37-39
CENTRAL DYNAMICS LTD 5-35-36-37
CENTRAL ELECTRONICS INC 26
CHALCO ENGINEERING CORP 1-4-17-18-22-30
CHISHOLM INDUST LTD 22-23
CLEGG LABS DIV CLEGG INC 17
CLEVITE ELECT COMPONENTS DIV CLEVITE 11
CLEVITE ORDANCE DIV CLEVITE CORP 27
COLLINS RADIO CO DALLAS 1-19-21-22-28
COLLINS RADIO CO OF CANADA LTD 20-23-34-36
COLLINS RADIO CO NEWPORT BCH 7-9-21-32
COLLINS RADIO CO CEDAR RAPIDS 1-3-20-26-34-35
COLORADO INSTRUMENT INC 2
COLORADO RESEARCH CORP 38
COMMERCIAL RADIO SOUND CORP 17-30
COMMUNICATIONS CO 1-2-8-26
COMMUNICATION ASSOCIATES INC 2-9-20-22-23-24-26-34-35-36
COMMUNICATION ELECTRONIC INC 23-24
COMMUNICATION EQUIPMENT & ENGRG CO 30
COMMUNICATION MEASUREMENTS LABS 36-37
COMMUNICATIONS ELECTRONICS CO 17-20-23-24-29-34-35-36-37
COMMUNITY ENGG CORP 38
CONCO 1-2-8-20-22-23-24-26-34-35-36-37
CONSOLIDATED AIRBORNE SYSTEMS INC 29
CONTINENTAL ELECTRONIC MFG CO LABS LTNG TEMCO-VOUGHT INC 26-36-37
CONTINENTAL MFG INC 8-21-23
CONTINENTAL TECHNICAL SERVICE INC 25-29
CONTROL SCIENCE CORP 8-28-29
COOK ELECT CO WIRECOM DIV 17-25
COOK TECHNOLOGICAL CENTER DIV 33-34
CORBIN CORP 2-3-7-9-26-30
CP ELECTRONICS INC 5
CRAIG SYSTEMS INC 20-22-24
CROWN ENG DIV DATA TECH INC 25
CRYSTAL RESEARCH PRODUCTS 21
CUSTOM ELECT MFG CORP 1-35
THOMPSON RAMO WOOLDRIDGE INC DAGE DIV 38
DALMO VICTOR CO DIV TEXTRON INC 15-17-27
DARE INC 1-8-20-23-24-31-35-36-37
DATA CONTROL SYSTEMS INC 21
DATALOG DIVISION AIR LOGISTICS CORP 29
DATA SENSORS INC 38
DATA TRONIX CORP 29
DATEX CORP 29
DAYSTROM INC MILITARY ELECTRONICS DIV 21-23-24-26-27-29-36-37
DAYTON AVIATION RADIO & EQUIP CO 1-23-24-35-37
DAYTON ELECT PROD CO INC 5-39
DBM RESEARCH CORP 19-29
DECITRON ELECTRONICS CORP 19-21-23-34-35-36
DELCO RADIO DIV GMC 24
DELCON CORP 3-6-22-26-28-34-35-36-37-39
DENSON ELECTRONICS CORP 38
DIGITECH INC WILTON 32
DIGITRONICS CORP 19-23-30
DON BOSCO ELECT SUB OF HOWELL ELECT MOTORSC6 15
DON LAN ELECTRONICS CORP SUB QUANTATRON INC 16
DORSETT ELECTRONICS 8
DOUGLAS ROESCH COMMUNICATIONS 17
DRAKE CO R L 23
DRESSER ELECT SIE DIV 29
DUBROW ELECTRONIC INDUSTRIES INC 17-23-26
DUKANE CORP 6-17-22-25-30
DUMONT LABS INC ALLEN B 1-5-20-22-24-28-29-37-38
DYNA-EMPIRE INC 27
DYNAIR ELECTRONICS INC 38
DYNAPLEX CORP 29
DYNATRONICS INC 28
DYNEL INC 29
EDO CANADA LTD 27
EDO CORP COLLEGE PT 27
ELECT MECHANICAL RES INC 28
ELECTRICAL PRODUCTS RESEARCH & DEV CO INC 13-17
ELECTRO MECHANICAL CORP 17-25
ELECTRO MECHANICAL RESEARCH 29
ELECTRO RADIATION INC 16
ELECTRO-SONIC LABS 13-14
ELECTROSPACE CORP 10-17-30-31
ELECTRON CORP 3-8-38
ELECTRONANTICS CORPORATION 19
ELECTRONIC APPLICATIONS INC 12-14
ELECTRONIC COMMUNICATIONS 1-7-8-19-34
ELECTRONIC COMM & COMP DES & DEV CORP 7-17-23-36
ELECTRONIC DESIGN & DEVELOP CO 23
ELECTRONIC DEVICES CORP CORAL GABLES 1-18
ELECTRONIC ENGG CO 17
ELECTRONIC INSTRUMENT CO INC 3-5-39
ELECTRONIC RESEARCH ASSOCIATES INC 5-8-17-18-19-36
ELECTRONIC SPECIALTIES MFG CORP 0
ELECTRONICS & ORDANCE DIV AVCO CORP 2-16-23-24
ELECTRONICS INTL CO INC OKLA 5
ELECTRONICS MISSILES & COMMUNICATIONS INC 34-35
ELECTROSONICS INTERNATIONAL INC 5-6-8-22-23-25-39
ELGIN NATIONAL WATCH CO 4-9-17-21-32
ELION INSTRUMENTS INC 27
ELLIOTT BROS LTD 1
EMERSON ELECTRIC ST LOUIS 6-17
EMERSON ELECTRIC MFG CO ELECT & AVIONICS DIV 19
EMI US LOS ANG 17-19-20-21-29-38
ENDECO ENGG DEVELOPMENT CO OF LOS ANGELES 17-18-30
ENTRON INC 17-38
EPSCO INC CAMBRIDGE 8-9-21-22-29
ERCO RADIO LABS INC 2-9-12-20-21-22-23-24-25-34-35-36-37
ERWOOD INC 29
EWEN KNIGHT CORP 19
EXECUTONE INC 17-25
FAIRCHILD SPACE & DEFENSE PRODS DIV FAIRCHILD CAMERA & INST CORP 7-19-38
FARINON ELECTRIC 4-8-19-21-23-30-36
FARRAND OPTICAL CO INC 1-16-38
FEDERAL MFG & ENGG CORP 1-5-17-22-39
FEDERAL MFG & ENG CORP TV SPECIALTY DIV 3-5-6-8-17-20-22-23-24
FEILER ENGG & MFG CO 17
FERRANTI ELECT INC 27
FISHER RADIO CORP 8-23
FISHER RESEARCH LAB 5-18-27
FLUSH WALL RADIO CO 17-25
FORWAY INDUSTRIES INC 23
FOURDEE INC
FOX CO THOMAS T 7-17
FRANKLIN SYSTEMS INC 17
FREDERICK ELECT CORP 32
FREQUENCY ENGG LABS 21
F X R INC WOODSIDE 19
GATES RADIO CO 26
GC ELECTRONICS CO DIV TEXTRON ELECTRONICS 3-5-6-10-12-18-20-22-23-24-25-33-34-35-36-37-39
GENERAL ATOMATICS INC 18
GENERAL ATRONICS CORP CONSHOHOCKEN 21-27-28
GENERAL CABLE CORP N Y 1-17-18-30-31
GENERAL DYNAMICS TELECOMMUNICATION 4-17-21-30-31
GENERAL DYNAMICS ELECTRONICS ROCHESTER 1-17-19-20-21-22-23-24-25-26-27-30-33-34-35-36-37
GENERAL ELECTRIC COMMUNICATION PROD DEPT 4-6-8-9-18-19-20-21-22-23-24-25-26-34-35-36-37-39
GENERAL ELECTRODYNAMICS CORP 38
GENERAL ELECTRONIC LABS INC 8-23-24-29-36
GENERAL INSTR CORP HARRIS A S W DIV 27
GENERAL INSTRUMENT CORP RADIO RECEPTOR DIV DEF & ENGG PRODS GRF 1-2-8-9-19-23-24-26-34-35-36-37
GENERAL RAILWAY SIGNAL CO 2-4-9-16-17-29
GEOTECHNICAL CORP 29
GLOBE ELECTRONICS CO 3-5-18-20-36-37-39
GOMBOS INC CO JOHN 19
GORHAM ELECT DIV GORHAM MFG CO 19
GPL DIV GENERAL PRECISION INC 19-21-22-38
GRANGER ASSOC 1-33-34-35-36
GRAY GAINER ELECTRONICS 3-4-5
GRAY RADIO CO 18
HALLAMORE ELECTRONICS CO 23-24-29-38
HALLETT MFG CO 23-24
HALLICRAFTERS PACIFIC DIV 29
HALLICRAFTERS CO CHICAGO 0
HALLMARK INST CORP 5-6-21-28-37
HAMILTON ELECTRONICS CORP 17
HAMILTON MFG CO 17
HAMMARLUND MFG CO INC MARS HILL 3-5-20-23-26-29-36
HARVINS RADIO INC 21
HARRISTAHL LABORATORIES 5-18-20-26
HAZELTINE ELECTRONICS DIV/HAZELTINE CORP 1-38
HEATH CO SUB OF DAYSTROM INC 3-5-17-20-22-B HARBOR 26-37
HEATH CO DIV OF DAYSTROM INC 3-5-17-23-24-ST JOS 26-30-35-36-37-39
HENRY & MILLER INDUSTRIES INC 19

COMPUTERS & ACCESSORIES 1300

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

CONNECTORS & TERMINALS 1400

CONTROL EQUIPMENT 1500

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

GULTON INDUSTRIES INC WEST INSTRUMENT CORP 13-32
G-V CONTRDLS INC 47-55
HAGAN CHEMICALS & CONTROLS INC 1-3-4-16-24-28-32
HAIRSPRING VIBRATING CO 35-49-52
HALLETT MFG CO 42
HALLICRAFTERS PACIFIC DIV 31
HALLIKAINEN INSTRUMENTS 29-32
HALLMARK INST CORP 10-11-17-32
HAMILTON STANDARD ELECTRONICS DEPT 26
HAMILTON STANDARD DIV OF UNITED AIRCRAFT 32
HAMMARLUND MFG CO INC MARS HILL 31
HAMNER ELECTRONICS CO INC 48-49-52
HANOVIA LAMP DIV/ENGLEHART INDUSTRIES INC 15
HARREL INC 32
HARRIS MFG CO INC 16-26
HART MFG CO 32
HARTMAN ELECTRICAL MFG CO 49-52
HARWALD CO INC 3-10-11-34
HASTINGS-RAYDIST INC 12-26-38
HAYDON CO A W WATERBURY 35-48-49-50-51-52-54
HAYDON DIV GENERAL TIME CORP 18-35-48-49-50-52-54
HAYDON INSTRUMENT CO 35-48
HAYS CORP 11-16-20-26
H B INSTRUMENT CO 47
HEALY-RUFF CO 16-26-31
HENES MFG CO 40
HEYER INDUSTRIES INCORPORATED
LAB OF MARQUETTE CORP 38-47
HIGH VACUUM EQUIP CORP 38
HILL & CO E VERNON 32
HOFFMAN ELECTRONICS CORP INDUSTRIAL PROD DIV 1-22-31-36
HOKE INC 46
HONEYWELL CONTROLS LTD 4-11-12-13-14-16-21-26-28-29-30-31-36-38-46-47
HORLICK CO INC WM I 18
HOWARD CRYSTAL HOLDERS INC 22
HOWELL INSTRUMENTS INC 1
HUGHES AIRCRAFT CO IND SYSTEMS DIV 18-24
HUGHES AIRCRAFT CO LOS ANG 5
HUGHES AIRCRAFT CO VACUUM TUBE PROD DIV 38-40
HUGHEY & PHILLIPS 22
HUNT ELECTRONICS 4-15-18-23-25
HUPPERT CO K H 13-32
HURLETRON INCORPORATED ELECTRIC EYE EQP DIV 17-22-23-25-27-33-34
HURLETRON INC WHEATON ENG DIV 19-35-48-49-50-52-54
HUYCK SYSTEMS CO DV OF HUYCK CORP 28-36
H W ELECTRONICS INC 5-48
HYDRA POWER CO 11-26-46
HYDRAULIC RES ELECT DIV 18
HYDROMATICS INC 11-12-20-38-46
HYDROPOISE INC SUB BROOKS INST CO 5-11
HYGRODYNAMICS INC 1-14-32
HYSON MFG CO PASADENA 1-22-23-24-28
ICONIX INC 5-54
ILIKON CORP 38
IMC MAGNETICS CORP PHOENIX 46
IMPERIAL ELECT INC 32
INDUSTRIAL CONTROL CO 14-17-23-28
INDUSTRIAL ELECTRONIC ENGINEERS INC 1-36
INDUSTRIAL ELECTRONICS INC 22
INDUSTRIAL ELECTRONICS OF OMAHA INC 26-31-35
INDUSTRIAL INSTRUMENTS INC 14
INDUSTRIAL TIMER CORP 35-45-48-49-5D-52-54-55
INDUSTRIONICS CONTROLS INC 5-18-26-34
INERTIA SWITCH INC 18-19-35-51
INFORMATION SYSTEMS INC 0
INFRARED INDUSTRIES INC WESTERN DIV 1-5-7-22-32-36
INSCO COMPANY 24-35
INSTRUMENT CORP OF FLA 23-48
INSTRUMENT DEVELOPMENT LABS INC 32
INSTRUMENTS INC 6-16
INSTRUMENTS OF N E 34-49-52-54
INTERNATIONAL DATA SYSTEMS INC 49-50-52-54
INTERNATIONAL INSTRUMENTS INC 1-24
INTL INSTRUMENT INC 1
INTERNATIONAL RECTIFIER CORP 45
INVAC CORP 53
IONICS INC ELECTRON ARC DIV 4-40
IRCON INFRARED CONTROLS INC 32
ITI ELECTRONICS INC 7
ITT KELLOGG COMM SYSTEMS DEPT 1-7-48
JACK & HEINTZ DIV SIEGLER CORP 40-45
JACKES-EVANS MFG CO 46
JACOBS INSTRUMENT CO 48
JAMESBURY CORP 11-12
JARVIS ELECTRONICS CORP 17-18-22-27-33-36-48
JFD ELECTRONICS SOUTHERN INC 39
JO-BELL PRODUCTS INC 1-16
JOHNSON SERVICE CO 14-32-47
JORDAN CONTROLS INC 24
KAHLENBERG BROS CO 46
KAHN & CO 14-32
KEARFOTT DIV GPI INC CLEVELAND 39
KEN-DEL PRODUCTIONS INC 32-33-34-35-50-52-54
KEUFFEL & ESSER CO 22
KIDDE & CO WALTER 1-28
KINETICS CORP 48-54
KINNELECTRONICS CORP 14
KINNEY VACUUM DIV THE NEW YORK AIR BRAKE CO 38
KIRKLAND CO H R 1-15
KLEER-TRONICS INC 1
KLIEGL BROS UNIV ELEC STAGE LIGHTING CO I 15
KOLLSMAN INST CORP STD KOLLSMAN IND INC 22-28
KOLLSMAN INSTRUMENT CORP
SUB STANDARD KOLLSMAN IND 22-28
KOONTZ WAGNER ELECT CO INC 46
KPT MFG CO 24-28
KYLE PRODUCTS 24
LABLINE INC 14-15-16-22-32-35-47-49-52
LABORATORY FOR ELECTRONICS INC 36-43
LAKE CITY INC SUB OF CONTROLS CO OF AMERICA 49-52-54
LAKE SHORE ELECTRIC CORP 32-39-45
LAMOTTE CHEMICAL PRODUCTS CO 3-21
LARSON INSTRUMENT CO 19-32
LEACH CORP INET DIV 39-44-45
LEACH CORP SPECIAL PRODUCTS DIV 35-39-48-52
LEAR INC ASTRONICS DIV 0
LEAR INC ELECTRO-MECHANICAL DIV 3-8-11-18-24-28
LEAR ROMEC DIV LEAR INC 11-26-28
LEAR SIEGLER INC POWER EQUIP DIV 28-39-45
LEBOW ASSOCIATES 26
LEEDS & NORTHRUP CO 1-3-4-10-11-12-13-14-16-20-21-26-28-30-32-34
LEHIGH VALLEY ELECT ENGG & MFG CO 22-27-52
LEKTRA LABS INC 22-23-49-52-53-54
LELAND AIRBORNE PRODUCTS 39-44-45
LESLIE CO 11-16-26-32-38-47
LE SUEUR MFG CO INC 0
LIBRASCOPE DIV GENERAL PRECISION INC 5-23-24-28-42
LINDBERG ENGG CO 13-45
LINDLY & CO 22
LINK AVIATION INC SUB GEN PREC EQUIP CORP 36
LINK DIV GENERAL PRECISION INC 11-12-18-24-26-28-39-44-45
LIQUIDOMETER CORP 16-32
LOCKHEED ELECT CO INFORMATION TECHNOLOGY DIV 1-31
LOENCO INC 3-32
LOGEMAN CO C W 52
LOGETRONICS INC 14-22-23
LOUD MACHINE WORKS INC 0
LUMEN INC 1-5-28-32-35-36-39-44-45
LYNCH COMMUNICATION SYSTEMS INC 1-31
MACHINE O MATIC 22
MACHINERY ELECTRIFICATION INC 1-16-19-22-35-53
MACK ELECTRIC DEVICES INC 1-36
MADIGAN CORP 28
MAGNADYNE CORP 1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-16-17-18-19-20-21-22-23-24-25-26-27-28-29-30-31-32-33-34-35-36-37-38-39-40-41-42-43-44-45-46-47-48-49-50-51-52-53-54-55
MAGNETIC CONTROLS CO 32
MAGNETIC INSTRUMENT CO INC 16-28
MAGNETICO INC 28
MAGNETICS INC 1-5-13-15-18-19-24-25-28-30-32-33-34-35-39-40-44-45
MAICO ELECTRONICS INC 24
MAICO ELECTRONICS INC DYNAMU MAGNETRONICS DV 24-36
MAICO ELECTRONICS INC ENG DIV 24-36
MALLORY ELECT CO 1-17-19-25-35-44-45-48-49-52-54
MANSON LABORATORIES INC 2
MARANTZ CO 0
MARINE ELECTRIC CORP 1-3-4-10-14-16-32-35-49-52
MARQUETTE DIV CURTISS-WRIGHT CORP 11-24-26-28
MARS INDUSTRIES INC 40
MARYLAND TELECOMMUNICATIONS INC 5
MATTERN CORPORATION 35-41-50-53
MAXSON ELECTRONICS CORP ELECTRONIC DES DIV 35-48-52
MCDONNELL & MILLER INC 1-11-16
MEASUREMENT ENGG LTD 16-19-22-32-37-49
MEASUREMENT SYSTEMS INC 22-23-28-37
MECHANICS FOR ELECTRONICS INC 24
MELABS 1-2
MERCOID CORP 16-26-32-38
METALS & CONTROLS INC COMMERCIAL CONTRLS DPT 32-47-55
METROTEK ELECTRONICS INC 21
MICRO BALANCING INC 22
MICRO GEE PROD INC 26-28
MICRO INSTRUMENT CO 18-32
MICRO MEASUREMENTS CORP 22
MICRO METRICS INC 1-5-18-24-28
MID-EASTERN ELECTRONICS INC 39-44-45
MIDWESTERN INSTRUMENTS 28-46
MILLER FRANKLIN P & SON INC 3-18
MILLER-HARRIS INSTRUMENT CO 35-52
MILLER-TROJAN CO INC 15
MILLETRON INC 32
MILTON-ROY CO 0
MINE SAFETY APPLIANCES CO 1-20
MINNEAPOLIS-HONEYWELL FALL RIVER DIV 1-3-11-13-16-17-26-28-31-32-38
MINNEAPOLIS HONEYWELL APPARATUS CONTROLS DIV 1-11-12-13-14-16-18-24-26-28-32-33-38-46-47-49
MINNEAPOLIS-HONEYWELL ORDANCE DIV 4-6-14-18-22-26-52
MINNEAPOLIS-HONEYWELL AERO DIV 5-6-16-17-24-26-28-32-38-39-44-45-46-47-52
MINNEAPOLIS-HONEYWELL BROWN INST DIV 3-4-6-10-11-13-14-16-21-24-25-26-28-30-31-32-38-45
MINNEAPOLIS-HONEYWELL SPECIAL SYS DIV 25
MINSTER MACHINE CO 17-18-19
MIRATEL INC NEW BRIGHTON 0
MIRATEL INC ST PAUL 1
MITE CORP 27-31
MKS INSTRUMENTS INC 11-16-26-38
MODEL ENGG & MFG INC 1-5-11-12-24-26-28-32-39-43-45-46
MODELECTRIC PRODUCTS CORP 1-18-43
MODERN LABORATORY EQUIP CO 32-47
MONITOR CONTROLLER 18-26-27
MONITOR SYSTEMS INC 1-31
MONTEK ASSOCIATES INC 1-24-28-39-45
MONTGOMERY MFG CO 35-49-54
MOORE ASSOCIATES INC 1-31
MORSE INSTRUMENT CO 23-24-52
MOSLER RESEARCH PROD INC 1
MOTOROLA INC SOLID STATE SYSTEMS DIV 3-27-31
MUIRHEAD & CO LTD 28
MUIRHEAD INSTRUMENTS INC 28-32-34
MULTI-PRODUCTS CO 0
NANILOA CORP 5-18-24-28-31-48-54
NATIONAL COMPANY INC 28
NATIONAL INSTRUMENT LABS INC 11-12
NATL WATER LIFT CO DIV PNEUMO DYNAMICS CORP 28
NATURAL LIGHTING CORP 39
NAVIGATION COMPUTER CORP 5-48-52-54
NEPTUNE ELECTRONICS CO 2
NEWARK CONTROLS CO 6-12-16-26-38
NEWTON INSTRUMENT CO INC 9
NIAGARA ELECTRON LABS 3-11-16-24-26-32
NORBATROL ELECTRONICS CORP 1-17-18-24-28-32-39-44-45
NORDEN DIV UNITED AIRCRAFT CORP 18-28
NORTH ATLANTIC INDUST INC 17-28-30-31-32-34-39-44-45
NORTHERN PRECISION LABORATORIES 24-31
NORTHERN RADIO CO 31
NORTHROP CORP 1
NUCLIDE ANALYSIS ASSOC 1-38-44-45-49
OAK MFG CO 49-54
OHIO SEMICONDUCTORS
DIV TECUMSEN PRODS CO 25
OHMART CORP 1-6-16-29-34
OIL RITE CORP 1-11-16-35-46-49
OMTRONICS MFG INC 32
ONIC DEVICES INC 42
OPAD ELECTRIC CO 9-19-39-45
OPTO ELECTRONIC DEVICES INC 22
ORBITRAN CO INC 30-31
ORTRONIX INC 31
OSTER MFG CO JOHN AVIONIC DIV 28
OTIS ELEVATOR CO DEFENSE & INDUSTRIAL DIV 28-35-39-44-45
OVERHEAD DOOR CORP 7
OVERLOAD CONTROL CO 19
OXYGEN EQUIPMENT & SERVICE CO 20
PACE ENGINEERING CO 28-31
PACIFIC SCIENTIFIC CO 13-33
PACO ELECTRONICS CO INC 44-45
PANELLIT INC DIV INFORMATION SYS INC 1-32
PANELLIT LTD
MEMBER OF ELLIOTT AUTOMATION GROUP 1
PARABAM INC 35-48-50-52-54
PARAGON ELECTRIC CO 35
PARKS LAB HENRY FRANCIS 14-49-50-52-54
PAR PRODUCTS CORP 23
PARSONS CO RALPH M ELECTRONICS DIV 48-52-54
PARTLOW CORP 1-12-14-32-35-47-52
PARTRICK & WILKINS CO 1
PASTOR12A ELECT INC 1-3-17
THE PAVELLE CORP 15-23-53
PEER INC 40-45-54
PEGASUS LABS INC 2-11-18-24-28-30-33-34-40-46
PENN KEYSTONE CORP 1
PENN METER CO 12-16
PENNWOOD NUMECHRON CO 48-5D-52
PERFECT COMPONENTS INC 28
PERFORMANCE MEASUREMENTS CO 11-12
PERMA-POWER CO 0-7
PESCO PRODUCTS DIV WESTERN BRANCH 18-32
PHILA SCIENTIFIC GLASS CO 1-14-32-38-44-47
PHILCO CORP LANSDALE DIV 14-32-38
PHILIPS ELECTRONIC INSTRUMENTS 41
PHOENIX PRECISION INSTRUMENT CO 1-3-6-22-23-37
PHOTOMATION INC 1-6-16-22-35-37
PHOTOBELL CO 1-5-7-15-16-17-18-22-34-36-48-52-53
PHOTO - CRYSTALS 1-5-12-14-15-22-53-56
PHYS CHEMICAL RES CORP 14
PICKARD & BURNS INC SUB GORHAM CORP 32
PIEZO PRODUCTS CO 32
PIONEER MAGNETICS INC 19
PLANAUTICS CORP 1-25-44-45-49-50-54-55
PLUG IN INSTRUMENTS INC 1-3-12-24-26-28-30-32-35
PNEUMO DYNAMICS CORP INST & CONTROL DIV 28
POLYTRONICS CO 22-32-39-45
POOLE INSTRUMENTS INC 29
POTTER AERONAUTICAL CORP 11
POTTER PACIFIC CORP
POTTER AERONAUTICAL CORP 5-6-11-16-17-29-48
POWERTON ULTRASONICS CORP 11-16-20
POWER TRONIC SYSTEMS INC 17-18-22-24-25-26-28-32-44-45
PRECISION SCIENTIFIC CO 3-13
PRECISION SENSORS INC 1-6-11-12-16-26-32-38
PRECISION SPECIALTIES INC 8-24-28-33-34-42
PRECISION THEROMETER & INST CO 6-16-29-32-47
PRESIN CO INC 5-50
PRINCETON APPLIED RESEARCH CORP 32
PRINCETON DIV ELECTRO MECHANICAL RESCH INC 1-31
PROCESS & INSTRUMENTS 21-32-38
PRODUCERS SALES CORP & PHOTO-SONICS INC 23-53
PROJECTS UNLIMITED INC 18-32
PROTECTION EQUIPMENT CO INC HOPKINS 1
PROTECTION EQUIPMENT CO INC MPLS 1
PYROMETER INSTRUMENT CO 32
PYROTEL CORP 32
QUANTAMETRIC DEVICES INC 6-15-34

CRYSTALS, CRYSTAL PRODUCTS & ACCESSORIES 1600

AMERICAN ELECT LABS MICROWAVE & PHASING 7-26
ANDERSON ELECTRONICS INC 18
ARRA RESEARCH ASSOCIATES 7
ASSOCIATED ELEC IND LTD ELEC APPARATUS DIV 13-17
ATLANTIC RESEARCH CORP 27
ATOMIC ACESSORIES INC 22
AUGAT BROS 7-9-26
BAKER CHEMICAL CO J T 19
BARIUM CHEMICALS INC 11
BARNES DEVELOPMENT CO 9
BASSETT INC REX 3-12-14-18
BELZ INDUSTRIES DIV EL TRONICS INC 7-17-26
BIRMINGHAM SOUND REPRODUCDERS LTD 4
THE BIRTCHER CORP INDUSTRIAL DIV 26
BLILEY ELECTRIC CO 6-12-14-18-25-26
BOMAC LABS INC 13
BORDEN CHEMICAL CO PHILA 22
BRAUN TOOL & INSTRUMENT CO INC 26
BREON LABS 3-14-18-19-26
BULOVA WATCH CO ELECT DIV 3-6-8-9-12-14
BURNETT RADIO LAB W W L 6-7-8-12-14-24
CANADIAN ASTATIC LTD 4
CARLSTEDT RESEARCH INC 23
CATHODEON 1
CFI CORP 6
CHANNEL INDUSTRIES INC 11
CINCH MFG CO CINCH JONES DIV 9
CLARK CRYSTAL CO 3-8-14-18
CLEVITE ELECT COMPONENTS DIV CLEVITE 3-4-10-11-20-25
COLUMBIA RESEARCH LABS 25
CONSTANTIN CO L L 5-7-26
COX & CO 8
CROVEN LTD 8-12
CRYS TECH INC 3-13-19
DALLONS LABS 3-25
DAYTON ELECT PROD CO INC 7
DELTA F INC 8
DIAMOND ANTENNA & MICROWAVE CORP 7-26-27
DIOTRON INC 13-17-23
DOUGLAS MICROWAVE CO 7
DOW CORNING CORP 23
DX RADIO PRODUCTS CO 14-18
EASTERN CHEMICAL CORP 22
EBY SALES CO 9
EDO CANADA LTD 10-11-14-18-25
EDO CORP COLLEGE PT 10-11-25
EIDSON ELECTRONIC CO 3-14
ELECTRA SCIENTIFIC CORP 25
ELECTRO CERAMICS INC SALT LAKE 10-11-25
ELECTRO FLEX HEAT INC 6-8
ELECTRONIC CRYSTALS CORP 12-14-18
ELECTRONIC RESEARCH CO 8-14-18
ELECTRONIC TECHNOLOGY RESEARCH INC 7-26
ELION INSTRUMENTS INC 10-25
ELM MFG CO INC 6-8-26
EMI US LOS ANG 22
EMPIRE DEVICES PRODUCTS CORP 17
ENDEVCO CORP 25
ENERGY CONVERSION INC 8
ENGELHARD INDUSTRIES INC 13
ERWOOD INC 8
FEN-TONE CORP 4
FRONTIER ELECT CO 12-14-18
F X R INC WOODSIDE 17
GARLOCK ELECTRONIC PRODUCTS PRODS PALMYRA 9
G C ELECTRONICS COMPANY CHEMICAL & TOOL DIV 27
GENERAL CRYSTAL CO INC 3-14
GENERAL INSTRUMENT CORP NEWARK 11-26
GENERAL RADIO CO 14
GLASS-TITE INDUSTRIES INC 26
GRAYHILL MOLDTRONICS INC 1
GREAT FALLS PRODUCTS CO INC 7-26
GREMAR MFG CO 7
GUIDE MFG CO 7-17-26-27
GULTON INDUSTRIES INC METUCHEN 11
HARSHAW CHEMICAL CO 22
HERMETIC SEAL CORP PASADENA 26
HEWLETT PACKARD CO 27
HOFFMAN CO P R 3-18-19-25
HOWARD CRYSTAL HOLDERS INC 1-5-7-9-26
HUGHES AIRCRAFT CO ELECT PROD DIV 9
HUGHES SEMICONDUCTORS DIV 13-14-16-17-23
HUNT CORP 3-6-8-14-18-25
INSACO INC 21
INTL CRYSTAL MFG CO INC 12
IRVAN FERROMAGNETICS CORP 18-19-21
ISOMET CORP 3-10-22-25
ISOTOPES INC 3-10-22
ITT FEDERAL LABS NUTLEY 11-13
JAVEX ELECTRONICS 9
JOHNSON CO E F 26
JONES ELECTRONIC CO INC M C 7-26
JONES OPTICAL WORKS A D 16-18-21-23
KAHLE ENGG CO 8
KEMET CO DIV UNION CARBIDE CORP 23
KEMTRON ELECTRON PRODUCTS INC 16-23
KEYSTONE ELECTRONICS CO NEWARK 8-12-14-18
KISTLER INSTRUMENT CORP 25
KNIGHTS CO JAMES 8-14-18
KOLLSTAN SEMICDT ELMNT DIV KOLLSMN INST COR 7 16-23
LAVOIE LABS INC 8
LEHIGH VALLEY ELECT ENGG & MFG CO 6-8-10
LESA COSTRUZIONI ELETTROMECCANICHE SPA 4-20
LEWIS CO E B 12-14-18-25
MALLINCKRODT CHEMICAL WORKS ST LOUIS 23
MALLINCKRODT CHEMICAL WORKS 3-23
MANSON LABORATORIES INC 2-8
MASTER MOBILE MOUNTS INC 12-14-18
MCCOY ELECTRONICS CO 3-8-12-14-18
MCKENNA LABORATORIES 26-27
MERCK & CO INC ELECTRONIC CHEM DIV 23
MERIDIAN METALCRAFT INC 7-17-26
MICRO LECTRIC INC 26
MICROMATIC MACHINE CORP 26
MICRO STATE ELECTRONICS CORP 13
MICROWAVE ASSOCIATES INC 13-17-23-26
MICROWAVE DEVELOPMENT LABS 26
MICROWAVE ELECTRONIC TUBE CO INC 17
MIDLAND MFG CO 12-18
MILLEN MFG CO JAMES 9-10
MINNEAPOLIS-HONEYWELL CERAMIC LAB 11-25
MINNEAPOLIS-HONEYWELL ORDANCE DIV 11-16-18-20-24
MONITOR PRODUCTS CO INC 3-8-14-18
MONTRONICS INC 2
MOTOROLA INC SOLID STATE SYSTEMS DIV 14
MUNSTON ELECTRONIC MFG CORP 9-12
NATL RADIO CO INC 8-9
NIPPERT ELECTRIC PRODUCTS CO 7
NORRICH PLASTICS CORP 3
NORTHEASTERN ENG INC 8
NORTHERN ENGG LABS 1-8-12-14-18
NUCLEAR ENTERPRISES G B LTD 22
NUGENT ELECT CO INC 9
OLYMPIC PRODUCTS CO INC 1
OPTECH INC 21
OVENAIRE INC 6-8
PAN-ELECTRONICS CORP 14
PEARCE SIMPSON INC MARINE & COMM DIVISION 12
PHILMORE MFG CO INC 13-15
PIEZO CRYSTAL CO 3-6-8-12-14-18-25
PILOT CHEMICALS INC 22
PRD ELECTRONICS INC 7-27
PRECISION CRYSTAL LAB 3-8-14-25
PREMIER METAL PRODUCTS CO 3-6-8-14-18-24-25
PREMIER RESEARCH LABS INC 3-6-8-14-18-24-25
PROBESCOPE CO INC 17
QUANTATRON INC 7-26
RADAR MEASUREMENTS CORP 7-26
RADIATION COUNTER LABS INC 26-27
RADIATION INSTRUMENT DEVELOPMENT LAB INC 22
RAU FASTENER CO 26
RAYTHEON CO SEMICOND DIV 13-17
REEVES HOFFMAN DIV 3-8-12-14-18-25
REPUBLIC LENS CO 3-16-18
ROSENTHAL ISOLATOREN GMBH OF SELB W GERMA 11-16-22-23-24
SAGE LABORATORIES INC 17-26
SANDERS ASSOCIATES 26
SAVOY ELECTRONICS INC GRIFFIN 3-12-14-25
SAVOY ELECTRONICS INC FT LAUDERDALE 3-12-14-18
SCIENTIFIC ATLANTA INC 7
SCIENTIFIC ELECTRONIC LABS INC 1
SCIENTIFIC RADIO PRODS INC 12-14-18
SCIENTIFIC RADIO SERVICE 11-14
SEAL-A-METIC CO DIV OF FILTORS INC 7-26
SEALECTRO CORP 26
SECO ELECTRONICS INC 27
SEMI-ALLOYS INC 3-19
SEMI ELEMENTS INC 1-3-5-7-10-11-12-13-14-15-16-18-19-20-21-22-23-24-25
SEMIMETALS INC 16-23
SHEROLD CRYSTALS INC 3-6-7-8-12-14-18
SKYRON CORPORATION 7-8
SMITH INC HERMAN H 9-12
SPERRY MICROWAVE ELECT INC 7
STAVER CO 1-7
SULLIVAN INDUSTRIES INC 3-18-26
SYLVANIA ELECT PRODS CHEM & METALLURG DIV 16-23
SYNCOR PRODUCTS CO 18-21
SYSTEMS INC 12-14-18
TECHNICAL DYNAMICS DIV JAMIESON IND INC 25
TELEDYNE PRECISION INC 8-12
TEXAS CRYSTALS 3-9-12-14-18-26
THERMAL AMERICAN FUSED QUARTZ CO 18
TRANCOA CHEMICAL CORP 23
TRAN SONICS 25
TRU CONNECTOR CORP 26
UNI SEAL INC 26
UNIVERSAL SYNAMICS CORP 11-25
VACUUM ELECTRONICS CORP 14
VALPEY CRYSTAL CORP 3-8-14-25
VERITRON WEST INC 1-7-26
VICTOREEN INSTRUMENT CO CLEVELAND 22
WALDOM ELECTRONICS INC 9
WALTHAM ELECTRONICS CORP 8
WARREN COMPONENTS DIV EL-TRONICS INC 7-13-26
WAVELINE INC 7-17-25-26-27
WEINSCHEL ENGG 7
WESTERN SEMICONDUCTORS INC 13-17-19-23
WRIGHT ELECTRONICS INC 8-14-18
X TRON ELECT INC 3-12-14-25

DETECTORS 1700

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

ACCESSORY CONTROLS EQUIPMENT 8
ACCUTRONICS INC 14-21
ACF ELECTRONICS DIV ACF INDUSTRIES INC 6
ACOUSTICA ASSOCIATES 19
ACR ELECTRONICS CORP 6
ACROMAG INC 4
AC SPARK PLUG ELECT DIV GMC 4
AC SPARK PLUG ELECT DIV GMC 14
ADVANCED ELECTRONICS INC 20
ADVANCED KINETICS INC 6
AD-YU ELECTRONICS LAB INC 14
AEROJET-GENERAL NUCLEONICS 15-16
AEROSPACE ELECTRONICS INC 4-15-16
ALCAR INSTRUMENTS INC 3-19
ALFORD MFG CO 18-21
AMERICAN AEROSPACE CONTROLS INC 6-11
AMERICAN DISTRICT TELEGRAPH CO 2-7-17-19-20
AMERICAN ELECT LABS INC 4-15-16
AMERICAN ELECTRONICS CO MINN 14-21
AMERICAN INSTRUMENT CO 5-6
AMERICAN RESEARCH & MFG CORP 11-20
AMERICAN SPACE EXPLORATION INC 11
AMPEREX ELECTRONIC CORP HICKSVILLE 15
ANADEX INSTRUMENT S INC 4-21
ANALYTIC SYSTEMS CO 5
ANCO INSTR DIV AMER NAME PLANE & MFG CO 20
ANTENNA SYSTEMS INC 18-21
ANTON ELECTRONICS LABS 15-21
APPLIED PHYSICS CORP 15-21
ARRA RESEARCH ASSOCIATES 4
ASSEMBLY PRODUCTS INC 3-11-21
ASSOCIATED ELECTRICAL INDUSTRIES LTD 7-8-17-18
ASSOCIATED ELECTRICAL INDUSTRIES LTD 18
ASSOCIATED RESEARCH INC 9
ASTRO SYSTEMS INC 14
ATELIERS DE MONTAGES ELECT 15-16
ATLANTIC RESEARCH CORP 19
ATOMIC ACESSORIES INC 15-16
ATOMIC LABS INC 15
ATOMIUM CORP 16
AUTHORIZED MFRS SERVICE CO 21
AUTOMATION DEVICES INC 12
AUTOMATION PRODUCTS INC 5
AUTRONICS CORP 10
AVIONICS INC 12
BAIRD ATOMIC INC 6-16
BARBER-COLMAN CO 15
BARKER & WILLIAMSON INC 18
BARNES ENGINEERING CO 6
BEARING INSPECTION INC 3-20
BECKMAN INST SPINCO DIV 6
BERKELEY DYNAMICS 5-8-14
BERMAN LABS 12
BINARY ELECTRONICS INC 21
BIOPHYSICAL INSTRUMENTS INC 10
BLACK LIGHT EASTERN CORP 3-8-13
BLOCK ASSOC 6-10
BORDEN CHEMICAL CO PHILA 16
BRAMCO INC SUB LEDEX INC 4
BRANSON INSTRUMENTS INC 3
BRILMAYER LAB E W 12
BRUNO NEW YORK INDUST CORP 21
BUDD ELECTRONICS A DIV OF THE BUDD CO 7
BUDELMAN ELECTRONICS CORP 4
CALIF TECHNICAL INDUST DIV TEXTRON INC 5-14
CAMBRIDGE INSTRUMENT CO INC 15
CANADIAN RESEARCH INSTITUE 1-9-10-21
CANOGA ELECT CORP 6
CARDOX DIV CHEMETRON CORP 17
CARLETON AVIATION CO INC 4
CASTLE ENGINEERING CO 2
CENTROL ENG CO 1-6-21
CERAMCO INC CHEMISTS 2-17
CERBERUS AG WERK ELEKTRONENTECHNIK 2-7-17
CHESAPEAKE INSTRUMENT CORP 19-20
CHICAGO AERIAL INDUSTRIES 6-10
CLEVELAND METAL SPECIALTIES CO 21
CLEVITE ELECT COMPONENTS DIV CLEVITE 20
CLEVITE ORDANCE DIV CLEVITE CORP 19
COLORADO RESEARCH CORP 2
COMPACT CONTROLS CO INC 2
CONSOLIDATED CONTROLS CORP 11
CONSOLIDATED ELECT CORP 8
CONSOLIDATED VACUUM CORP 8
CONTINENTAL SENSING INC 2
CONTROL PRODUCTS INC 2
CONTROL TECHNOLOGY CO 21
CONTROLS FOR RADIATION INC 15
CRESCENT EAST ENGR & RES CO 11-12
DATA CONTROL SYSTEMS INC 4
DAYSTROM INC CONTROL SYSTEMS DIV 1-21
DAYTON ELECT PROD CO INC 18
DECKER CORP 20
DEITZ CO S J 10
DEL ELECTRONICS CORP 5
DELCON CORP 19
DEMORNAY BONARDI CORP 18
DE-TEC-TRONIC CORP 17
DEVCO ENGG INC 5-8
DEVELCO INC 4-14
DEVICE SEALS INC 21
DICE CO J W 3-12
DIETZ CO S J 10

DIALS & FRONT PANEL ACCESSORIES 1800

DIALS AND FRONT PANEL ACCESSORIES--1800

(SEE PRODUCT CODE LIST ON PRECEDING PAGE)

ACKERMAN ENGRAVERS 5-6-12
ACROMARK CO 5-10-21
ADCOM CORP 11
ADEPT INDUSTRIES INC 4-21
AEROLITE ELECTRONICS CORP 14-15-16-17
AERONAUTICAL ELECT CO 14-15-16-17
AIRCRAFT & ELECT SPEC 21
ALDEN PRODUCTS CO 13-14-15-16-17-21
ALDEN SYSTEMS CO 15
ALLIED DECALS INC 4-21
AMATON ELECTRONIC HARDWARE CO INC 2-12-13-18-19
AMERAC INC 2
AMERICAN CYSTOSCOPE MAKERS INC 16
AMERICAN DECALCOMANIA CO 21
AMERICAN EMBLEM CO 21
ANCO INSTR DIV AMER NAME PLANE & MFG CO 2-5-9-10-21
ANDERSON & SONS INC 2-5-6-8-9-10-11-21-22
ANDOYNE INC 9-10-11-21
APAHOUSER CORP OF N E 5-6-21
APPROVED PLASTICS CO 13
ARCH GEAR WORKS INC 5-6-21-22
ARCON ELECTRONICS DIV OF ARCON INDUST 8-18
ARISTO CRAFT DISTINCTIVE MINIATURES 14-15-16-17
ASQUITH CO S A 6
ASSOCIATED PRODUCTION CO 12
ASTROMATIC DIV CONTROL CO OF AMER 5-6-14-15-17
AUBURN MFG CO 23
AUDIOTEX MFG CO/DIV G C TEXTRON INC 13
AUTOMATIC ELECTRIC CO 7
AVIONICS LTD 4-5-21
BACH-SIMPSON LTD 5
BARBER & HOWARD CO 2-5-6-20-21
BEAU ELECTRONICS INC 12-18
BEST MFG CO KANSAS CITY 10-21
BEVIN WILCOX LINE CO 3
BIRMA MFG CO INC 2
BIRMINGHAM SOUND REPRODUCDERS LTD 9-13
BOLTA PRODUCTS DIV GENERAL TIRE & RUBBER CO 13
BORG EQUIP DIV AMPHENOL BORG ELECT CORP 5-6-8
BRADY CO W H 4-21
BRITISH RADIO ELECTRONICS LTD 6
BRUNSWICK INSTRUMENTS 15
BUCKBEE MEARS CO 21
BUD RADIO INC 18
CANADIAN RADIUM URANIUM DV CANRAD PRES IND 5-6-10-20-21-22
CARMA MANUFACTURING CO 17
CARROLL PRESSED METAL INC 2-5
C&H SUPPLY 9-10-21
CHICAGO MINIATURE LAMP WORKS 14-15-16-17
CHICAGO THRIFT ETCHING 5-6-9-21
CHICOPEE MILLS *
CIRCON COMPONENTS CORP 14-15-16
CK COMPONENTS INC 15
CLEVELAND METAL SPEC CO 21
CLEVELAND METAL SPECIALTIES CO 21
COLMAN ELECTRONIC PRODUCTS INC 3-13
CONN-CRAFT CO 21
CONSOLIDATED MOLDED PRODUCTS CORP 6-7-9-10-13-14-21
CONTROL DEVICES 9-21
CONTROL SWITCH DIV CONTROLS AMER CHICAGO 14-15-16-17
CRONAME INC 2-5-6-8-9-10-11-21
CRYSTAL-X CORP 21
DAISLEY CO INC RAY 10
DALE ELECTRONICS INC COLUMBUS 12-13
DAVIES MOLDING CO HARRY 5-13
DECIMETER PRODUCTS CO 4
DELTA ELECT CO 2-13-15
DEMENT LABS 20
DEVCO ENGG INC 5-10-14-15-16-17-20-21
DIALIGHT CORP 14-15-16-17
DIETZ CO HENRY G INC 21
DIMCO-GRAY CO 13
DRAKE MFG CO 2-9-14-15-16-17
DUNCAN ELECT INC COSTA MESA 8
DURAMIC PRODUCTS INC 21
EAGLE ELECTRIC MFG CO 14-17
EAGLE ELECTRIC MFG CO INC 14
ELDEMA CORP 14-15-16-17
ELECTRICAL INSULATION CO INC 21
ELECTRO CHEMICAL ENGRAVING CO INC 2-5-10
ELECTRODYNAMIC INSTRUMENT CORP 12
ELECTRO SPACE FAB INC 2-10
ELJAY CORP 5-6-9-10-12-21
ELZEE METAL PRODUCTS CO 2
EMMCO PLASTICS CORP ANDOVER 2-5-6-10-13-21-22
ENGINEERED ELECTRONICS CO 15
ERWOOD INC 12
ETCHING CORP OF CALIF DIV ALLEGRI TECH INC 5-21
EUGENE ENGINEERING CO INC 5
FABRA PRINT INC 4-5-6-10-21
FEAY CO NEAL 5-6-9-10-12-21
FEDERAL SCREW PRODUCTS INC 14-15
FIDELITY AMPLIFIER CO 15
FILTRON CO INC WESTERN DIV 20
FISHER & CROME 5-6-21
FLORIDA GEARS & SYSTEMS INC 5-6
G C ELECTRONICS COMPANY CHEMICAL & TOOL DIV 1-3-4-14-22
G-C ELECTRONICS CO KNOB & RESISTOR DIV 12-13
GC ELECTRONICS CO DIV TEXTRON ELECTRONICS 1-3-4-12-13-18-22-23
GENERAL FORMULATIONS INC 4-9-10-11-21
GENERAL MILLS INC MINN 5-10
GENERAL PLASTICS CORP 1
GENERAL RADID CO 5-6-13
GENERAL RAILWAY SIGNAL CO 15-17
GENERAL STENCILS INC 5-6-9-21
GENTAPE CORP 1-5-6-8-10-21-22
GEORGE GORTON MACHINE CO 21
GODFREY MFG CO 15
GOE ENGG CO 12
GRAPHICS INC KEARNY 5-6-10-20-21
GRAYHILL MOLDTRONICS INC 2
HACKENSACK CABLE CORP 3
HELDOR MFG CORP 5
HELIPOT DIV BECKMAN INSTS FULLERTON 8
HINCHMAN MFG CO INC 13
HURLETRON INC WHEATON ENG DIV 15-17
IDENTIFICATION SERVICE CORP 21
ILLUMINATED CONTROLS INC 6
INDUSTRIAL DEVICES INC 13-14-15-16-17
INDUSTRIAL ELECTRONIC ENGINEERS INC 15
INDUSTRIAL ENGRAVERS INC 5-6-10-21-22
INGERSOLL PRDDUCTS DIV BORG-WARNER CORP 17
INSTRUMENT MASTERS INC 5
INSULEX CO 21-22
INTERNATIONAL RESISTANCE CO ST PETERSBG DIV 6-8
INTERNATIONAL RESISTANCE CO PHILA 6
JACKSON BROS LONDON LTD 5-19-22
JAN HARDWARE MFG CO 2-5-9-10-12-13-18-19
JAY-EL PRODUCTS INC 15-16
JFD ELECTRONIC CORP 1-3
JFD ELECTRONICS SOUTHERN INC 1-3
JOHNSON CO E F 5-6-12-13-16-17
JOHNSON CO E F 8-13-17
KAY ELECTRIC CO PINLITE DIV 14-15-16-17
KERRCO PRODUCTS 5-6-13-21
KEYSTONE ELECTRONICS CORP N Y 18-19
KILO ENG CO 5-6-8-12-18-19
KLANN ORGAN SUPPLY CO 21
KORRY MANUF CO 14-15-16-17
KURZ-KASCH INC 13
LABELLE INDUSTRIES INC 2-10
LAMINATED SHEET PRODUCTS CORP 21
LEED INSULATOR CORP 13
LEITCH HUARD CORP 2-10
LERCO ELECTRONICS INC 13-22
LEYSE ALUMINUM CO 2-5-10-11-22
LIBBEY OWENS FORD GLASS CO LIBERTY MIRROR DV 5-10
LIBRASCOPE DIV GENERAL PRECISION INC 2
LINK DIV GENERAL PRECISION INC 5-6-21-22
LUDWIG HONOLD MFG CO 2
LUMINOUS PROCESSES INC 5-20-22
MAHLER RESEARCH FOUNDATION 4-9-10-21
MARTIN PROD INC 5-6-9-21
MASTER ENGRAVING STUDIOS 5-21
MATTERN CORPORATION 2
MECHANICAL ENGRAVING CO INC 2-5-6-8-9-10-12-13-20-21-22
METAL SPECIALTY PRODUCTS CORP 12
METALPHOTO OF CINCINNATI 5-6-10-21
METER MAKERS INC 5
MICARTA FABRICATORS INC 14
MICROSPACE INC 6
MILLEN MFG CO JAMES 2-5-6-8-12-13-18-19-22
MILLER DIAL & NAMEPLATE CO 4-5-9-10-11-20-21
MINOR RUBBER CO 23
MOLDED INSULATION CO PHILA 13
MOLDING ENGINEERS INC 13
MONROE INDUSTRIES INC 6-22
MUIRHEAD & CO LTD 6-13
MUIRHEAD INSTRUMENTS INC 5-6-13
MURA CORP THE 14-16
NAMEPLATES INC 0-21
NATL RADIO CO INC 6-12-13-18-19-22
NATIONAL TEL TRONICS CORP 10
NEW ENGLAND NUCLEAR CORP 20
NICHOLS PRODUCTS CO 6
NORMAN JONES INC 13
NORRICH PLASTICS CORP 3-12
NORTH ATLANTIC INDUST INC 13
NORTH ELECTRIC CO 7
NORTH SHORE NAMEPLATE DIV ANODYNE INC 1-2-3-4-5-6-7-9-10-11-21-22
OPTICAL GAGING PRODUCTS INC 5-6-21
O & S RESEARCH INC 15
OXFORD ELECTRIC CORP 14-15-16-17
PACIFIC TRANSDUCER CORP 12
PANEL ENG CORP 5-7-10-13-21
PANELLIT INC DIV INFORMATION SYS INC 2-15-16-17-21
PANOB CORP 5-6-12-13-21
PARK ELECTROCHEMICAL CORP 2-4-5-7-9-10-11-21
PARK NAMEPLATE CO 2-9-12-21
PFLLEY CO 21
PFNDAR INC 2-15-17
PERFECT COMPONENTS INC 5-6-12-13-18-19-21
PERMONITE MFG CO 14
PFI PRODUCTS FOR INDUSTRY INC 2-9-10-12-21
PIFER INDUSTRIES INC 10
PHOTOVOLT CORP 10-11
PRECISION METAL PRODUCTS CO 19-21
PRINTLOID CORP DEPT E 6-9-10-21-22
RAYTHEON CO INDUSTRIAL COMPONENTS DIV 13-19
RAYTHEON CO DIST PROD DIV 14-17
REEVES INSTRUMENT CORP 6
REPUBLIC LENS CO 6
RESEARCH DEVELOPMENT MFG INC 22
REUTER INC 2-12
RIMAK ELECT INC 10-21
ROGAN BROS INC 5-9-13
ROSS METALS CO MILTON 2-9-13-21-22
SCIENTIFIC ELECTRONIC LABS INC 15
SCIDTO SIGN CO 4-5-9-10-11-20-21
SECODE CORP 7
SILICONE INSULATION INC 13
SILIKROME DIV APM-HEXSEAL CORP 15
SILLCOCKS MILLER CO 5-6-7-9-10-11-12-13-21-22
SIMMONDS PRECISION PRODS TARRYTOWN 15
SIMPSON ELECTRIC CO DIV AMER GAGE & MACH CO 5
SLOAN CO THE 14-15-16-17
SMITH INC HERMAN H 4-5-13-17-18-19
SPECTROL ELECTRONICS CORP SAN GABR 5-6-8
SPERTI FARADAY INC 5-9-10-15
ST CROIX PLASTICS CORP 13
STANDARD PRODUCT INC SUB ELECTR COMM INC 5
STAR ENGRAVING & NAME PLATE CO 21
STEWART TRANS LUX CORP 6
SYLVANIA ELECTRIC PRODUCTS SALEM 5-7-14-15-17-20-22
TAFFET ELECTRONICS INC 3-12
TECHNICRAFT CO 5
TELEX INC 15
TEXSTAR PLASTICS DIV TEXSTAR CORP 5-6-12-13-16-17-20-21-22
THETA INSTRUMENT CORP 5-6
TORWICO ELECTRONICS INC 8
TRANSISTOR ELECTRONICS CO 14-15-16-17
TUNG SOL ELECTRIC INC NEWARK 14-15-16-17
TV DEVELOPMENT CORP 13
U S RADIUM CORP HOLLYWOOD 3-5-6-10-12-13-14-16-17-20-21-22
U S RADIUM CORP BLOOMSBURG 5-12-13-14-20-21-22
UCINITE CO DIV UNITED CARR FASTENER CORP 14-15-16-17
ULTRAUDIO PRODUCTS 13
UNHERSOLL PRODUCTS 17
VEMALINE PRODUCTS CO 5-12-13-14-15-16-17-22
WALDOM ELECTRONICS INC 5-6-10-13-18-19-21-22
WALSCO ELECTRONICS MFG CO 1-3-4-22-23
WESTLAKE PLASTICS CO 13
WILKENS INC ALWIN FR 5-6-10
WILLSON CAMERA CO INC 9-20
J H WINN INC 22
ZERO MFG CO 5-6

FILTERS 1900

ACDC ELECTRONICS INC 18
AC ELECTRONICS INC 2-3-4-5-7-8-10-11-12-16-17-18-21-23
ACCESSORY PROD CO DIV OF TEXTRON INC 1
ACF ELECTRONICS DIV ACF INDUSTRIES INC 14
AC SPARK PLUG ELECT DIV GMC 13
ADAMS RUSSELL CO INC 2-4-5-8-9-12-14-18-22-25
ADC PRODUCTS DV OF MAGNETIC CONTROLS 3-4-5-7-8-10-11-12-15-16-19-24
ADVANCED ELECT CORP 11-16-18
AD-YU ELECTRONICS LAB INC 3-4-5-12-23
AEROSPACE ELECTRONICS INC 2-3-4
AEROSPACE RESEARCH INC 10
AEROVOX CORP 11-16-17-18-20
AIRCRAFT ARMAMENTS INC 14
AIR FILTER CORP 1
AIRMATIC VALVE INC 1
AIR MAZE DIV ROCKWELL STANDARD CORP 1-18
AIRPAX ELECT INC SEMINOLE DIV 4-5-12
AIRPAX ELECTRONICS PACIFIC DIV 4-5-6-8-9-12-22
AIRPAX ELECTRONICS INC PASADENA 3-4-5-7-8-12

PIASECKI AIRCRAFT CORP MAYFIELD ELECT DIV 3
PIEZO CRYSTAL CO 6
POLARAD ELECTRONICS CORP 14
POLYPHASE INSTRUMENT CO 4-5-8-11-12
THE POTTER CO 11-12-18
POTTER CO THE 16
PRD ELECTRONICS INC 14
PROBESCOPE CO INC 6
PULSE TECHNIQUES INC 3-7-23
PUROLATOR PRODUCTS INC 1-13
QUINDAR ELECTRONICS INC 3-4-5-12
RACON ELECTRIC CO 3
RADAR DESIGN CORP 14
RADAR MEASUREMENTS CORP 14
RADEX CORP 1
RADIAPHONE CO 2-3-4-5-7-8-10-12-16-21
RADIATRONICS INC 2-25
RADIO COND CO SUB THOMPSON RAMO WOOLDRIDGE 4-8-12
RAOIO ENG LABS INC 4-18
RADIO ENGG PRODUCTS 4-5-7-8-12
RAILWAY COMMUNICATIONS INC 4-7-8-12
RAYTHEON CO INDUSTRIAL COMPONENTS DIV 3-4-13
REDCOR CORP 4-12
REED & REESE INC 3-4-5-11-12
REEVES HOFFMAN DIV 4-5-6-8-10-12-18-19
REGENCY ELECTRONICS INC 3-6-22
RELCOIL PRODUCTS 4-8-10-12-16-18
REMANCO INC 14
RF INTERONICS INC 4-5-8-9-11-12-16-17-18-20
RHG ELECTRONICS LAB INC 4-5-10-18-22-23
RISCO 3-4-5-17
RIVERBANK LABS ENGG DEPT 3-4-13
RIXON ELECTRONICS INC 3-4-5-7-8-10-12-19-24
ROHDE & SCHWARZ 4
RYTRON CO INC 4-5-6-7-8-12-18
SAGE LABORATORIES INC 4-5-8-9-12-14-25
SANDERS ASSOCIATES 14
SANGAMO ELECTRIC CO 4-5-8-11-12-16-17-18
SANGAMO MICROSONICS INC 4-5-6-8-12-19
SARTRON INC 4-5-8-12-16-17
SATURN ELECTRONICS CORP 3-4-5-8-11-12-16-18-19
SAVOY ELECTRONICS INC FT LAUDERDALE 16
SCOTT INC H H 3-4-16-23
SECODE CORP 3-4
SECO ELECTRONICS INC 16
SECURITY DEVICES LAB 13
SEG ELECTRONICS CO INC 2-3-4-5-6-7-8-10-11-12-16-17-18-19-20
SEMI ELEMENTS INC 6
SERCO ELECT RESEARCH CORP 0
SERVO CORP OF AMERICA 3-4-22-23
SERVOMECHANISNS INC EL SEGUNOO 1
SHEROLO CRYSTALS INC 6
SICKLES F W DIV GIC 4-8-12-18
SIERRA ELECTRONIC DIV PHILCO CORP 4-9-12-25
SIVERS LAB 14-25
SPARTON ELECTRONICS 3-4-5-8-10-12-18
SPASORS INC SUB SILICON TRANSISTOR 2-14-25
SPECTRAL OYNAMICS CORP OF SAN DIEGO 23
SPECTRAN ELECTRONICS CORP 3-4-5-13-18-24
SPECTRUM INSTRUMENTS INC 3-4-5-8-23
SPENCER-KENNEDY LABS INC 2-23
SPERRY MICROWAVE ELECT INC 14
SPRAGUE ELECTRIC CO N AOAMS 3-4-5-7-8-10-11-12-16-17-18-20
ST MARYS CARBON CO 1
STANCOR ELECTRONICS INC 3-4-7-8-12
STANOARO WINDING CO DIV OF OVITRON CORP 4-5-8-10-11-12-16-17-18-19-22-23
STEPHENS TRU-SONIC INC 3
STEWART WARNER ELECT DIV STEWART-WARNER COR7 3-4-8-10-12
STODOART AIRCRAFT RADIO CO 12
SWIFT TEXTILE METALLIZING & LAMINATING CORP 20
SYLVANIA ELECTRIC PRODUCTS IPSWICH 4
SYLVANIA ELECTRIC PROOS INC WALTHAM LABS 14-25
SYSTEMS INC 4-5-6-19-22-24
TAFFET ELECTRONICS INC 4-11
TAPCO GROUP THOMPSON RAMO WOOLDRIDGE INC 14-25
TECHNICAL PRODUCTS CO INSTRUMENT OIV 6
TELECHROME MFG CORP 24
TELEMETRICS INC 12-23
TELERAO MFG CORP 4-5-8-9-14-25
TELEX/BALLASTRAN 3-4-5-8-10-11-12
TELONIC ENGINEERING CORP 2-3-4-5-8-9-10-12-18-22-23
TOROTEL INC 4-5-11-12
TOROTRON CORP 3-4-5-8-12
TORWICO ELECTRONICS INC 4-12
TRANSFORMER & ELECTRONIC SPECIALTIES 3-4-5-8-12
TRANSFORMER OESIGN INC OF MILWAUKEE 3-4-5-8-12
TRANSFORMER ENGINEERS 3-4-8-12
TRANSFORMER TECHNICIANS INC 3-4-5-8-12
TRANSFORMERS INC 4-8-11-12-13-17
TRANSICOIL CORP 13
TRANSONIC INC 3-4-5-7-11-12
TRELCON ENGINEERING CO 4-8-12
TRESCO INC 3-4-5-8-12
TRG INCORPORATEO BOSTON 14
TRIAD TRANSFORMER CORP 3-4-5-8-12
TRINITY EQUIPMENT CORP 1
TRION INC 1
T T ELECTRONICS INC 3-4-5-7-8-11-12-15-16-19-21
UNIQUE WIRE WEAVING CO INC 13
UNITED TRANSFORMER CORP 2-3-4-5-7-8-11-12-14-18-20-23-24
UNITED TRANSFORMER CORP PACIFIC DIV 3-4-5-8-11-12-16
UTAH RADIO CORP 3
VACUDENT MFG CO 1
VALOR ELECTRONICS CO 4-10-12-18
VALOR INSTRUMENTS INC 4-9-10-12
VARO MFG CO 4-5-8
VIDAIRE ELECTRONICS MFG CORP 8-11
VITRO LABORATORIES 22
WABASH MAGNETICS INC 3-4-5-8-12
WABER ELECTRONICS INC 3-4-5-8
WAHLGREN MAGNETICS 3-4-5-8-11-12
WASHINGTON TECHNOLOGICAL ASSOC INC 3
WATKINS-JOHNSON CO APPL ENGRG 4-5-14-18
WAVELABS INC 23
WAVELINE INC 4-5-8-12-14-25
WELEX ELECTRONICS CORP 2-4-5-8-12-16-17-18
WELLS INDUSTRIES CORP 1
WESCO ELECTRIC & MFG CO 11-12-16-17
WESTERN ELECTRO ACOUSTIC LAB INC 3-4-7-12
WESTERN FELT WORKS 16
WESTREX CO DIV OF LITTON SYS INC 3
WHEELABRATOR CORA 1
WHITE INSTRUMENT LABS 3-4-5-8-12
WHITEWATER ELECTRONICS INC 4-5-10-13-18
WILCOX ELECTRIC CO INC 12
WINEGARD CO 2
WINTRONICS INC 4
WYETH ENG INC 12-16-17-18-20
YORK CO INC OTTO H 13

GAGES & INDICATORS 2000

ABBEON INCORPORATED 26
ABBEY ELECTRONICS CORP 33-35
ACF ELECTRONICS OIV ACF INDUSTRIES INC 18-46
ACOUSTICA ASSOCIATES INC 28-50-51
AC SPARK PLUG ELECT DIV GMC 7-10-13-18-22-37
ADVANCE INSTRUMENT CORP 18-26-41-48
AD-YU ELECTRONICS LAB INC 35
AERO MECHANISMS INC 37
AEROSPACE ELECTRONICS INC 33-34-39-40
AEROSPACE RESEARCH INC 23
AFFILIATED MANUFACTURERS INC 12
AIRBORNE INSTRS LAB DIV CUTLER HAMMER INC 40
AIRCRAFT INSTRUMENTS CO 15-18-28-37
AIRCRAFT RADIO CORP 19
AIRGUIDE INSTRUMENT CO 2-10-26-44
ALEXANDRIA OIV AMF 18-23
ALLARD INSTRUMENT CORP 18
ALLARD INSTRUMENT CORP 18
ALLIS CO LOUIS 18-44
ALMA ENGINEERING 31
ALNOR INST CO DV OF ILL TESTING LABS INC 10-20-47-52
AMERAC INC 23-40
AMERICAN AEROSPACE CONTROLS INC 30
AMERICAN BOSCH CORP 46
AMERICAN BRAKE SHOE CO RAYMOND ATCHLEY DIV 7-15-33
AMER CHAIN & CABLE BRISTOL CO 22-23-26-28-32-33-34-35-36-37-45-46-47-51
AMERICAN GYRO DIV TAMAR ELECT INC 18-41-47
AMERICAN INSTRUMENT CO 12
AMERICAN RESEARCH & MFG CORP 30-50
AMERICAN STANDARD CONTROL DIV DETROIT 7-8-10-37-46-47
AMERICAN STANDARD CONTROL DV ROCHESTER 7-10-13-22-37-47
AMERICAN STANDARD CORP NORWOOD PRODS 7-8-37-44-47
AMERICAN TIME PROD INC 23
B C AMES CO 12-29
AMETEK INC HUNTER SPRING DIV 11
AMMON INSTRUMENTS INC 18-33-43-47
AMSTRO CORPORATION 44-47-48-52
ANADEX INSTRUMENT S INC 23
ANALYTICAL MEASUREMENTS INC 32
ANTLAB INC 15
APPLIED TECHNOLOGY CORP 31
ARMSTRONG WHITWORTH EQUIP 8
ASSEMBLY PRODUCTS INC 4-10-36-44-47
ASSOCIATEO ELECTRICAL INDUSTRIES LTO 26-30-33
ASSOCIATEO RESEARCH INC 24-35
ASTRA TECHNICAL INSTRUMENT CORP 47
ASTROMATIC DIV CONTROL CO OF AMER 18
ASTRO SYSTEMS INC 35-41
AUDIOTEX MFG CO/DIV G C TEXTRON INC 9
AUSTIN ELECTRONICS OIV AUSTIN CO 33
AUTHORIZED MFRS SERVICE CO 19-33
AUTO OATA 33
AUTOMATIC TIMING & CONTROLS INC 4-7-8-11-12-14-22-28-29-37-38
AUTOMATION PRODUCTS INC 28
AVIATION INSTRUMENT MFG CORP 13
BABCOCK & WILCOX BAILEY METER CO 0
BACH-SIMPSON LTD 33
BAILEY METER COMPANY CLEVELAND 7-10-29-37-47-52
BAILEY METER CO WICKLIFF 7-10-13-22-28-34-37-46-47-52
ELECTRONICS DIV BALDWIN HAMILTON CORP 8-10-41-45-49
BALLANTINE LABS INC 33
BARBER-COLMAN CO 10-33-37-47
BARNES DEVELOPMENT CO 17-19-33
BARTON INSTRUMENT CORP 7-22-26-37-47-51
BAUSCH & LOMB INCORP 12-25
BEARING INSPECTION INC 50
BECKMAN INST INC 32
BECKMAN INST INC BERKELEY DIV 18-19-23
BELL HELICOPTER CO ELECTRONIC OEPT DIV BELL AEROSPACE 18
BENOIX CORP THE POINEER CENTRAL DIV 34-41
BENDIX CORP THE FRIEZ INST OIV 2-26-44-47-49
BENDIX CORP THE SHEFFIELO CORP SUB 12-25-29
BERGEN LABS INC 47
B & F INSTRUMENTS INC 45-47-49
BIDOLE CO JAMES G 23-24-35-44
B I F INDUSTRIES 22
B & K INSTRUMENTS INC OF BRUEL & KJAER 43-50
BLOCK ASSOC 52
BLUE M ELECTRIC CO 26-47-52
BON DE ELECTRONIC LABS INC 5-13
BOONTON ELECTRONICS CORP 33-36
BOSTON AUTO GAGE CO 28
BRAILSFORD & CO 48
BRAMCO INC SUB LEDEX INC 23
BRANSON INSTRUMENTS INC 12
BRISTOL CO LOS ANG 7-10-13-22-26-37-46-47-52
BROOKS INSTRUMENT CO INC 22-28
BROOKS ROTAMETER CO 22-28
BROWN & SHARPE MFG CO 14-29
BRUNO NEW YORK INOUST CORP 33
BRUNSWICK INSTRUMENTS 35
BUDELMAN ELECTRONICS CORP 19-23-40
BURGMASTER CORP 44
BYTREX CORP 8-45-49
CADDILLAC GAGE CO 14
CAMBRIDGE INSTRUMENT CO INC 26-32
CAMBRIDGE SYSTEMS INC 20
CAMPBELL X RAY CORP 12
CANADIAN RESEARCH INSTITUE 17-21-24-32-44
CAROLINA MEDICAL ELECTRONICS INC 22
CARTER CO J C 30
CATHODEON 5-6
CEDAR ENG DIV CONTROL DATA CORP 41
CENTRAL COIL CORP 47
CENTRAL ELECTRONIC MFRS 5-13

HARDWARE 2100

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

INDUCTORS & ACCESSORIES 2200

INDUSTRIAL ELECTRONIC EQUIPMENT 2301

INSULATION MATERIALS & COMPOUNDS 2400

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

27-29-30-33-35-38-39-40
ELECTRO CERAMICS INC SALT LAKE 3-12-28
ELECTRO TECHNICAL PRODUCTS DIV SUN CHEMICAL CORP 11-20-39-40
ELECTRO-THERMO CERAMICS INC 3-12-28-34-38
ELECTRONANTICS CORPORATION 4-6-7-8-11-12-17-32-33-35-41
ELECTRONIC PRODUCTION & DEVELOPMENT 32
ELJAY CORP 33
EMERSON & CUMING INC 4-6-7-11-12-15-17-32-35-37-41
EMERSON & CUMING INC WESTERN DIV 3-4-6-7-11-12-17-18-32-35-36-37
EMMCO PLASTICS CORP ANDOVER 32-33
ENFAB INC 24
ENFLO CORP 17-32-40
ENGINEERED PLASTICS INC 4-17-21-22-24-30-32-33
ENGINEERED YARNS 21-24
EPOXYLITE CORP THE 4-6-7-35-41
EPOXY PRODUCTS DIV JOS WALDMAN & SONS 6-7-17-30-32-35-41
ERIE ELECTRONICS DIV 3-11-12-38
ERIE TECHNICAL CERAMICS INC 3
EXCELLEX ELECTRONICS INC 21
FABRA PRINT INC 33
FISCHER & PORTER CO 23
FISHER & CROME 33
FORD RADIO MICA CORP 26
FORM-IT PRODUCTS INC 17-21-29-32
FORMICA CORP 33
FULLER CO H B LINDEN 4-5-6-18-35
FURANE PLASTICS INC LOS ANG 0-32
FURANE PLASTICS INC HEMPSTEAD 4-6-7-11-17-32-33
GARLOCK ELECTRONIC PRODUCTS PRODS PALMYRA 1-11-17-32-33-40
GARNER T H CO 23
G C ELECTRONICS COMPANY CHEMICAL & TOOL DIV 4-5-6-7-17-18-19-20-21-22-29-30-32-33-40
GC ELECTRONICS CO DIV TEXTRON ELECTRONICS 4-5-6-7-15-17-18-19-22-29-30-32-33-35-36-40
GENERAL BOX CO 32-33
GENERAL ELECTRIC CO RECEIVING TUBE DEPT 3
GENERAL ELECTRIC COMPANY CHEM MATERIAL DEPT 9-32-41
GENERAL ELECTRIC CO WATERFORD 4-6-7-11-15-17-32-41
GENERAL ELECTRIC LAMINATED PRODUCTS DEPT 33
GENERAL PLASTICS CORP 4-20-33-40
GLADDING MCBEAM & CO LOS ANG 3-28
GLADDING MCBEAM & CO MONROVIA 12
GLASPLY CORP 32-33

GRANER T H CO 23
GREEN RECTIFIER CO 4-6-35
GULTON INDUSTRIES INC METUCHEN 3-12
HALEX CORP DETROIT 11-17
HALOGEN INSULATOR & SEAL CORP 17-32
HARDMAN CO H V 6-7-36
HARWALO CO INC 5
HAVEG INDUSTRIES INC 40
HAYNES LABS INC C W 4-6-7-18
HILDEBRAND JOHN CO 32
HINCHMAN MFG CO INC 32
HI TEST CHEMICAL CORP 2-4-6-7-31
HUGHES AIRCRAFT CO ELECT PROD DIV 37
HURON INDUSTRIES 5
HUSE-LIBERTY MICA CO 26
HYSOL CANADA LTD 4-6-7-17
HYSOL CORP DLEAN 4-6-7-17-32-35-41
HYSOL OF CALIF DIV 6-16-32-37-41
INCELOID CO INC 32
IND ELEC RUBBER CO 32-36-37
INDIANA GENERAL CORPORATION KEASBEY 3-38
INSL X PRODUCTS CORP 4-7-11-18-35-36-37
INSULATING FABRICATORS OF NE INC 17-22-33
INSULATING FABRICATORS INC RUTHERFORO 30-32-33
INTEGRATED MICA CORP 11-16-26-27
IRVAN FERROMAGNETICS CORP 3-11-12-38
ISOCHEM RESINS CO 4-6-7-32-35-36-41
ISOLANTITE MFG CORP 3-12-38
ITT FEDERAL LABS NUTLEY 3-11-12-28
JANSA WOODWORKING CORP 21
JFD ELECTRONIC CORP 14-23
JOCLIN MFG CO 9-11-17-30-32-35-39-40-41
JOHNS-MANVILLE 0
KEASBEY & MATTISON CO 1
KOPPERS CO INC 31-32-35
KRESSILK PROD INC 19
LAMINATED SHEET PRODUCTS CORP 17-21-22-25-30-32-33
LA MOREE C D 4-6-8-11-16-17-25-26-27-33-37-39-40
LAPMASTER DIV CRANE PACKING CO 28-40
LAPP INSULATOR CO RADIO SPECIALTIES DIV 3-34-38
LEED INSULATOR CORP 17-22-26-30-32-33
LONG INC THOMAS J 22-24-29-30-32-33
LOUTHAN MFG CO DIV FERRO CORP 3
MAAS & WALDSTEIN CO 18
MACALLEN CO INC 26
MAGNETIC SHIELD DIV PERFECTION MICA CO 10-21-26-27
MAJESTIC EXTRUDERS INC 32
MALLINCKRODT CHEMICAL WORKS ST LOUIS 37
MANNING PAPER CO JOHN A 29
MANSOL CERAMICS CO 3

MARBLETTE CORP 4-6-7-11-17-24-30-32-35
MARBON CHEMICAL DIV BORG-WARNER CORP 32-35
MARYLAND CERAMIC & STEATITE CO INC 3-32-38
MATERIALS FOR ELECTRONICS CO 3-28
MCMILLAN COMPANIES 16-25
MESA PLASTICS CO 6-32-41
METACHEM RESINS CORP MERECO PRODS DIV 4-6-7-32-35
MICA INSULATOR DIV MINNESOTA MINING MFG CO 4-16-17-20-25-26-27-32-33-40
MICACRAFT PRODUCTS INC 26
MICARTA FABRICATORS INC 33
MICHIGAN PANELYTE MOLDED PLASTICS DIV ST REGIS PAPER CO 0
MICRO-CIRCUITS CO 5
MID-CONTINENT ENGINEERING 36-37
MIDLAND INDUSTRIAL FINISHES CO 4-6-18
MILLEN MFG CO JAMES 34-38
MINERALS & INSULATION CO 16-17-25-26-27-30-32-33
MINISINK RUBBER CO INC 4-36
MINNEAPOLIS-HONEYWELL CERAMIC LAB 3
MINN MINING & MFG CO ELECT PRODS DIV 4-6-9-16-40
MINN MINING & MFG CO IRVINGTON DIV 0-32
MINN MINING MFG CO CHEMICAL DIV 4-7-11-13-15-17-32-35-36
MINNESOTA MINING & MFG CO ST PAUL 3-4-6-7-8-12-16-18-20-25-26-27-29-32-33-35-38-39-40-41
MINOR RUBBER CO 36
M & Q PLASTICS PRODUCTS 0
MOLDED FIBRE GLASS BODY CO 0
MOLDED FIBER GLASS CO 24
MOLDING ENGINEERS INC 17-32-41
MOLECULAR DIELECTRICS INC 27
MOREY CORP 16-26
MOSINEE PAPER MILLS CO 29
MOTOROLA INC SOLID STATE SYSTEMS DIV 17-23
MOXNESS PRODUCTS INC 17-32-36-39-40
MULTI FLEX SEALS INC 36
MYCALEX CORP OF AMERICA 26-27
MYKROY INC 14-16-17-23-24-25-34
NARROW FABRIC CO 24-40
NATIONAL BERYLLIA CORP 3-12-28
NATIONAL CERAMIC CO 3-34
NATIONAL ELECT COIL DIV MCGRAW EDISON CO 25-26
NATIONAL ENGG PRODUCTS INC 4-6-32
NATIONAL VACUUM PLATERS INC 7-32
NATIONAL VULCANIZED FIBRE CO YORKLYN 21-22-29
NATL VULCANIZED FIBRE CO KENNET SQ 17-22-25-33
NEW ENGLAND LAMINATES CO 24
NEW ENGLAND TAPE CO 4-6-17-32
NEW HERMES ENGRAVING MACHINE CORP N Y 33
NOPCO CHEMICAL CO PLASTICS DIV 4
NORPLEX FABRICATIRS INC 33
NORRICH PLASTICS CORP 4-17-22-30-32-41
NORTHERN PLASTICS CORP 20-33
NYGLASS INC 6
OPTICAL COATING LAB INC 11
OPTICS FOR INDUSTRY 23
PACIFIC UNIVERSAL PROD CORP 23
PANEL ENG CORP 32-33
PANELYTE DIV ST REGIS PAPER CO 9-17-20-25-32-33-41
PAPER PRODUCTS MINNESOTA MINING & MFGING CO 29
PARABAM INC 25
PARK ELECTROCHEMICAL CORP 20-25-33
PENN FIBRE SPECIALTY CO 21-22-29-30-32-33
PERFECTION MICA CO MAGNETIC SHIELD DIV 21-25-26-32
PERMONITE MFG CO 32
PHOENIX PRECISION INSTRUMENT CO 23
PHYSICAL SCIENCES CORP 6-12
PLASTIC FACTORS INC 29
PLASTICS & RESINS DIV SHELL CHEMICAL CO 17-32-35
PLASTICS STAMPING CO 22-25-32-33
PLYMOUTH RUBBER CO 40
POLYMICA & INSULATION CO INC 16-26
PORCELAIN PRODUCTS CO 34
H K PORTER CO INC DELTA STAR ELECTRIC DIV 34
PRECISION METAL PRODUCTS CO 33
PRECISION PAPER TUBE CO CHICAGO 29-30-32-33
PRESSTITE DIV AMER MARIETTA 1-2-6-10-11
PRINTED ELECT CORP 28
PYLE-NATIONAL CO 4-7-9-11-32-36-37-41
QUELCOR INC 4-6-17-32-41
RADIATION RESEARCH CORP WESTBURY 17
RAYBESTOS-MANHATTAN INC BRIDEPORT 1-4-6-7-9-35-41
RAYBESTOS-MANHATTAN INC PASSAIC 1-32-33-36-37-40
RAYBESTOS-MANHATTAN INC PLASTIC PRODUCTS DIV 17-32
RAYCHEM CORP 17-32-41
RAYCLAD TUBES INC 6-32
RAYTHEON CO MICROWAVE & POWER TUBE DIVISION 3
REICHHOLD CHEMICALS INC 30-32-33-35
REID ENTERPRISES 32
RELIANCE MICA CO INC 26
RESDEL CORP 32
RICHARDSON CO MELROSE PK 33
RICHARDSON CO N BRUNSWICK 11-17-21-30-32-33
RIEGEL PAPER CORP 11-17-33
ROBERTSON ELEC CO INC 6
ROBERTS TOLEDO RUBBER CO 36
ROGERS CORP 29-33
ROSENTHAL ISOLATOREN GMBH OF SELB W GERMA 11-16-17-21-22-23-24-25-26-27-33
ROSS METALS CO MILTON 6
ROSTONE CORP 1-17-24-32
RUBBER TECK INC 36
RUSSELL REINFORCED PLASTICS CORP 32-33
SATELLITE CORP OF AMERICA 33
SAUEREISEN CEMENTS CO 2-6-7
SAYRE ELECTRONICS 3-6-28-30-32-34-38-41
SCHENECTADY VARNISH CANADA LTD 4-7-18-35
SCHENECTADY VARNISH CO 4-6-7-35
SCHRACK ELECTRICAL SALES CORP 3
SCHWEITZER DIV P J KIMBERLY CLARK CORP 29
SCHWEITZER INC PETER J DIVN 29
SCIENTIFIC ELEGTRONIC LABS INC 23-41
SEMICON ASSOCIATES INC 3
SEMICON OF CALIF INC 3-4-6
SEMI ELEMENTS INC 17-28-32-37
SHAMBAN & CO W S CULVER CITY 17-32-33
SILICONE INSULATION INC 32-33
SILLCOCKS MILLER CO 17-21-22-32-33
SOLAR VOLT CO INC 17-21
SOUTHERN PLASTICS CO 17-32
SPARTA MFG CO 17-20-32-33
SPATCO MFG CO 4
SPAULDING FIBRE CO INC LOS ANG 22-29-33
SPAULDING FIBRE CO N ROCHESTER 21-29-33-41
SPECTRA-STRIP WIRE & CABLE CORP 4-5
SPRUCE PINE MICA CO 11-16-17-26-27-32-33
STAR PORCELAIN CO 3-12-34-38
STEVENS PAPER MILLS INC 29
STEVENS PRODUCTS INC 25-33
STEWARD MFG CO D M 3-38
SUN CHEMICAL CORP ELECTRO TECH PROD DIV 20-39
SYLVANIA ELECTRIC PRODUCTS IPSWICH 4
SYNCOR PRODUCTS CO 3
SYNTHANE CORP 30-32-33
TAYLOR FIBRE CO NORRISTOWN 22-33
TECHNICAL CERAMICS & LAVA CORP 3-5
TECHNICAL DYNAMICS DIV JAMIESON IND INC 3
TECHNICRAFT CO 6-7-32-35
THOR CERAMICS INC 3-6-32-33-34-35-38-41
TITANIUM ALLOY MFG NIAGARA FALLS 12
TRA-CON RESIN SYSTEMS DIV 4-6-7-11-17-32-35-41
TRANS-TECH INC 11
TRIMOUNT PLASTIC CO 32
U S DIELECTRIC INC 11-17-32-33
U S RUBBER CO 1-33-35-36
UNION CARBIDE CORP SILICONES DIV 4-6-17-20-41
UNION CARBIDE PLASTICS CO 6-7-30-32-35-41
UNITED CONDENSER CORP 28-30-31-33
VARFLEX CORP 24
VIRGINIA PLAK COMPANY 32-33
WABER ELECTRONICS INC 24
WALSCO ELECTRONICS MFG CO 4-18-20-33
WARREN WIRE CO 20
WASHINGTON PORCELAIN CO 34
WATERBURY COS INC 32
WESTERN FELT WORKS 21-36
WESTERN GOLD & PLATINUM CO 28
WESTINGHOUSE ELECTRIC CORP BENOLITE MICARTA 6-7-15-18-19-20-35-40
WESTINGHOUSE ELECTRIC CORP MICARTA DIV 17-20-33
WESTLAKE PLASTICS CO 32-33
WILMINGTON FIBRE SPECIALTY CO 22-33
WISCONSIN PORCELAIN CO 3-34
WRIGHT & SONS CO WM E 39-40
X PANDO CORP 6
ZOPHAR MILLS INC 4-6-7-31

INSULATORS 2500

ACCURATE ELECTRONICS CORP ELYRIA 6-10
AC SPARK PLUG ELECT DIV GMC 4
ADEC INC 19
ADVANCED VACUUM PRODUCTS INC 4-7-19
AEROLITE ELECTRONICS CORP 6-7-10-13-19
A H B ELECTRONIC PARTS INC 7-12-13-19
AIRCONDUCTORS 13-16-17
ALITE DIV U S STONEWARE CO 4-7
ALLEGHENY PLASTICS INC 13
AMATON ELECTRONIC HARDWARE CO INC 1-3-4-5-6-7-13-19
AMERICAN CYANAMID CO FORMICA DIVISION 10

KITS 2600

CENTRAL COIL CORP 6-10
CENTRAL ELECTRONICS INC 3-11-13-14
CERTIFIED RADIO LABS 6-11
CIRCUIT STRUCTURES LAB 2
CLEAR BEAM ANTENNA CORP 1
COLMAN ELECTRONIC PRODUCTS INC 9
COMPONENTS CORP 4
COMPTON CORP 4
COMPUTER LOGIC CORP 2-4
CONNECTICUT ELECTRONIC PROD 2-6
CONSOLIDATED ELECT CORP 6
CONSOLIDATED WIRE & ASSOCIATED COS 1
CONTROL LOGIC INC 4
COOK ELECT CO WIRECOM DIV 9
DAYTON AIRCRAFT PRODUCTS INC 1
DI-AN CONTROLS INC 2-4
DIGITAL ELECTRONICS INC 4
DYNACO INC 8
DYNALECTRON CORP MATTERN DIV 5-6
EALING CORP 2-6
EASTERN SPECIALTY CO 13
EDUCATIONAL ELECTRONICS CO 2-5-6-11
ELECTRAMATIC INC 1-3-14
ELECTRO MECHANICAL CORP 9
ELECTRONIC INSTRUMENT CO INC 6-8-12-13-14
ELECTRONIC MEASUREMENTS CORP N Y 8-13
ELECTRONIC TRAINING AIDS CO 2
ENGINEERED ELECTRONICS CO 2
EPSCO INC CAMBRIDGE 4
FAE INSTRUMENT CORP 2-5-9
FEDERAL MFG & ENGG CORP 7
FISHER RADIO CORP 8-11-12-13
FOURJAY INDUSTRIES 12

FRONTIER ELECT CO 3-4-9
GAP INSTRUMENT CORP WESTBURY 5
G C ELECTRONICS COMPANY CHEMICAL & TOOL DIV 1-6
GC ELECTRONICS CO DIV TEXTRON ELECTRONICS 1-3-14
GENERAL ELECTRONIC LAB INC 2
GOOD ELECTRONICS CORP 6-9
GRAY GAINER ELECTRONICS 10-11-13-14
GRAY MFG CO 8
GREGORY MAGNETIC INDUST INC 9
HALLETT MFG CO 9
HALLICRAFTERS CO CHICAGO 3-6-9-11-13-14
HAYDON CO A W WATERBURY 5
HEATH CO SUB OF DAYSTROM INC 2-3-4-5-6-7-8-
B HARBOR 9-11-12-13-14
HEATH CO DIV OF DAYSTROM INC 1-8-11-12-13-
ST JOS 14
HELDOR MFG CORP 5
HI LO MFG CORP 1
HOFFMAN ELECTRONICS CORP INDUSTRIAL PROD DIV 3-6-9-13-14
HY GAIN ANTENNA PRODUCTS CO 1
IE MFG 1
INDUSTRIAL ELECTRONICS OF OMAHA INC 7
INTERNATIONAL ELECTRIC INDUSTRIES INC 2-3-
4-5-6-9
INTL ELECTRIC INDUSTRIES INC N Y 9
JAMES ELECTRONIC INC 2
JERROLD ELECTRONICS CORP 1
JFD ELECTRONIC CORP 1
JOHNSON CO E F 14
KARG LABS INC 8-11-13
KARLSON ASSOCIATES INC 12
KEIL ENGG PRODUCTS CORP 6
KNIGHT ELECTRONICS CORP 1-2-3-5-6-8-9-11-
13-14
LANCE ANTENNA MFG CORP 1
LEHIGH VALLEY ELECT ENGG & MFG CO 13
LINK DIV GENERAL PRECISION INC 9-13
MAGNAFLUX CORP 13
MANSON LABORATORIES INC 9
MATTERN CORPORATION 5-6-9
METROTEK ELECTRONICS INC 3-6-10-11-14
MICRO-CIRCUITS CO 6
MICRO LECTRIC INC 5
MODEL ENGG & MFG INC 9
MOSLEY ELECTRONICS INC 1
NATIONAL ELECTRONICS LAB 2
NESHAMINY ELECT CORP 8
NUCLEAR CORP OF AMER DENVILLE 2-7
ONEIDA ELECTRONICS INC 9
OXFORD ELECTRIC CORP 6-8
PACO ELECTRONICS CO INC 2-3-5-6-8-11-12-13-
14

PARIRIOGE TRANSFORMERS LTD 8
PERFECT COMPONENTS INC 5
P & H ELECTRONICS 3-14
PHILMORE MFG CO INC 1-3-6-14
PIC DESIGN CORP SUB OF BENRUS WATCH CO INC 2-4-6
POWER TRONIC SYSTEMS INC 4-6-9-13
PRECISION METAL PRODUCTS CO 2
PREMMCO INC OF NORTHERN CALIF 2
RCA ELECTRN TUBE DIV INDIANAPLS 13
RCA ELECTRN TUBE DIV MARION 13
RCA ELECTRN TUBE DIV HARRISON 13
RCA ELECTRN TUBE DIV WOODBRIDGE 13
RCA ELECT TUBE DIV CINN 13
RCA ELECTRN TUBE DIV LANCASTER 13
REEVES INSTRUMENT CORP 2-5
RENFREW ELECTRIC CO LIMITED 6-10
R H ELECTRONICS CO 3-11-14
RIMAK ELECT INC 6
ROBINAIR MANUF CORP 13
SCOTT INC H H 8
SERVO CORP OF AMERICA 2-5
SERVO SYSTEMS CO 5
SORENSEN INDUSTRIAL ELECTRONIC CO 3-6-13-14
STRATOCON CORP 9
SUPEREX ELECTRONICS CORP 2-6-11
TALLEY CORP THE 5
TECH-MASTER CORP 8-11
TECHNICAL OIL TOOL CORP 5
TECHNIQUES INC 2
TRANSDATA INC 3-5-6

TRANSVISION INC 6
TRI ACRE ELECTRONICS 2
TRICRAFT PRODUCTS CORP 1
UCINITE CO DIV UNITED CARR FASTENER CORP 2-5-6-13
UNIVERSAL SCIENTIFIC CO INC 2-3-6
UNIVERSITY LOUDSPEAKERS INC 12
VANGUARD ELECTRONIC LABS 3
VIDEO INDUSTRIES CO 1
WABER ELECTRONICS INC 6-8-12
WALSCO ELECTRONICS MFG CO 1-2
WANG LABS INC 2-4
WARD PRODUCTS CORP 1
WELEX ELECTRONICS CORP 9
WINTRONICS INC 6-8
WORNER ELECTRONIC DEVICES 6

LIGHTING EQUIPMENT & ACCESSORIES 2700

Accessories & supplies 1
Cold cathode 2
Consoles control 3
Dimmers 4
Gobos 5
Lamps, infrared 6
Lamps, inspection 7
Lamps, ultraviolet 8
Lighting, emergency 9
Lighting, preset panels 10
Lighting, tower 11
Lighting, TV 12
Lights, arc 13
Lights, dial 14
Lights, flood 15
Lights, glow 16
Lights, neon test 17
Lights, signal 18
Lights, spot 19
Meters, light 20
Panelboard, lighting 21
Power supplies, lighting 22
Scoops 23
Strobe lighting 24
Studio lightrigging 25

ABTRONICS INC 24
AEROLITE ELECTRONICS CORP 14-18
AERONAUTICAL ELECT CO 14-16-21
AEROSONIC MARINE INC 21
ALDEN SYSTEMS CO 7
AMERICAN CYSTOSCOPE MAKERS INC 7
AMERICAN ELECTRIC CABLE CO 22
AMERICAN ELECTRONICS INC FULLERTON 22
AMER SPEEDLIGHT CORP 14
AMERICAN TOWER CO 12
AMEY CORP 11
AMGLO CORP 2-8-16-18-24
ANCHOR SPEC MFG CO 3-21
APPLIED PHYSICS CORP 15-19-21
ARCEL DAVIS MFG CO 3-4-21-22
ASTROMATIC DIV CONTROL CO OF AMER 3-9-14-21-22
ATOCON CORP 1
AUDIOTEX MFG CO/DIV G C TEXTRON INC 24
AUTOMATIC SWITCH CO 1-9-11
AUTO TEST INC CHICAGO 24
BEATTIE-COLEMAN INC 24
BEGEN CO M 1-7
BELLOWS VALVIAR 21
BERGEN LABS INC 4-22
BETTS & BETTS CORPORATION 1
BLACK LIGHT EASTERN CORP 1-7
BLACK LIGHT PRODUCTS INC CHICAGO 7-8
BLOWERS INC 7-15
BRIGHT STAR BATTERY 19
BUD RADIO INC 3
BUNOY ELECTRONICS CORP 9
BURTON MFG CO TRANS ELECTRONIC DIV 7-8
CARLING ELECTRIC INC 14
CARMA MANUFACTURING CO 18-21
CATON INDUSTRIES 7
CENTRAL COIL CORP 10-18-21
CENTROL ENG CO 3-21-22
CENTURY LIGHTING INC N Y 1-3-4-5-10-12-13-15-19-21-23-25
CENTURY LIGHTING INC MIAMI 4-19
CERBERUS AG WERK ELEKTRONENTECHNIK 18
CHADWICK-HELMUTH CO 24
CHICAGO MINIATURE LAMP WORKS 2-6-9-10-14-16-18-21-24
CHRISTIE ELECTRIC CORP 22
CIRCON COMPONENTS CORP 14-21
CONTROL SWITCH DIV CONTROLS AMER FOLCROFT 21
CUTLER METAL PRODUCTS CO 3
DAISLEY CO INC RAY 3
DALE ELECTRONICS INC COLUMBUS 4
DALLONS LABS 8
DAY-RAY PRODUCTS INC 4-7
DAYSTROM INC WESTON INSTRUMENTS DIV 20

DELTA ELECT CO 9
DEMENT LABS 8
DIALIGHT CORP 14-16-17-18-21
DRAKE MFG CO 4-12-14-16-18-20-21-22
DRY SCREEN PROCESS INC 13
DRYOMATIC CORP 18
DYNALECTRON CORP MATTERN DIV 21
EAGLE ELECTRIC MFG CO 7-14-19
EAGLE ELECTRIC MFG CO INC 1-6-7-14
EDER INSTRUMENT CO INC 1
ELECTRAMATIC INC 14
ELECTROL SPECIALTIES CO 22
ELECTRO PHYSICS CO 20
ELECTRON ARC DIV IONICS INC 3-13-21-22-24
ELECTRONIC BRAZING CO 24
ELECTROSONIC ENGINEERING CO 1-21
EMARCO CORP 1
ERICSON MFG CO 1-7
ESPEY MFG & ELECTRONICS CORP 4-22
E-Z WAY TOWERS INC 11
FLEXO INTERNATIONAL CORP 0
FOSTORIA CORP DEPT D2 3
FOSTORIA CORP OHIO 6-7
GAMMA SCIENTIFIC INC 20
GASSER METAL PRODUCTS 3
GATES & CO GEO W 1-8-22
GC ELECTRONICS CO DIV TEXTRON ELECTRONICS 14
GENERAL ELECTRIC CO MINIATURE LAMP DEPT 7-8-9-14-15-16-18-19-21
GENERAL ELECT CO LOW VOLT SWITCHGEAR DIV 9
GENERAL ELECT CO WIRING DEVICE DEPT 4
GENERAL ELECT CONTROL INC 1
GENERAL RAILWAY SIGNAL CO 18
GORDON ENTERPRISES 12-22-24-25
GRAPHICS INC POTEAU 18-21
GRAY GAINER ELECTRONICS 1
GREEN RECTIFIER CO 4-22
GROVER PHOTO PROD 5-15
GUIDE LAMP DIV 3-19
HACKER INSTRUMENTS INC 22
HANOVIA LAMP DIV/ENGLEHART INDUSTRIES INC 6-7-8-13-19-22
HARRIS MFG CO INC 4
HERZOG MINIATURE LAMP WORKS 7-14
HICO CORP 24
HIGH VACUUM FURNACE & ELECT DV 3
HOFFMAN ENG CORP 3
HUDSON LAMP CO 9-14-16-20-21
HUGHEY & PHILLIPS 11
HUNT ELECTRONICS 4-25
IDEAL INDUSTRIES INC SYCAMORE 1
ILLUMINATED CONTROLS INC 3-21
INDUSTRIAL DEVICES INC 14-16-17
INTERLECTRIC DIV EL TRONICS 0
INTL ELECTRIC INDUSTRIES INC N Y 7
IONICS INC ELECTRON ARC DIV 3-13-21-22-24
ITI ELECTRONICS INC 9
JETA INC 22
JOHNSON CO E F 14
KAY ELECTRIC CO PINLITE DIV 6-8-14-19-20
KEMLITE LABS INC 2-8-9-11-18-24
KIRKLAND CO H R 14-18-21
KLIEGL BROS UNIV ELEC STAGE LIGHTING CO I 1-3-4-5-9-10-12-15-19-21-23
KOLTON ELECTRIC MFG CO 21
KOPP GLASS INC 1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-16-17-18-19-20-21-22-23-24-25
KORRY MANUF CO 14-18
KULKA ELEC CORP 1
LABLINE INC 4
LAFAYETTE INSTRUMENT CO 24
LAVELLE AIRCRAFT CORP 3
LEECRAFT MFG CO INC 18-21
LUMINATOR INC 21
LUXO LAMP CANADA LTD 7-21
LUXO LAMP CORP PORT CHESTER 7-12-19
LUXO LAMP CORP SAN FRAN 1-7
MAGNAFLUX CORP 7-8
MAGNETICS INC 4
MARCO INDUSTRIES CO 14-21
MCALISTER INC J G 1-12
MILLER-TROJAN CO INC 20
MINI-TOOL TECHNICAL INDUST INC 1
MISKELLA INFRA-RED CO 0-6
MOLE-RICHARDSON CO 4-5-12-13-15-19-23-25
MONROE INDUSTRIES INC 10-21
MORSE INSTRUMENT CO 15
MOULIC SPECIALITES CO 2
MURRAY MFG CORP 21-22
NATIONAL CINE EQUIPMENT INC 12-19-23
NATURAL LIGHTING CORP 4-12-15-19-23-25
N Y MFG & GENERAL SUPPLY CO 7-10-14
NICAD DIV GOULD NATIONAL BATTERIES INC 9
NORTH HILLS ELECTRONICS INC 1-4-22
O & S RESEARCH INC 3
OXFORD ELECTRIC CORP 14-16
PANEL ENG CORP 21
PANELLIT INC DIV INFORMATION SYS INC 10-18
PANOB CORP 21
PEK LABS INC 6-8-22-24
PELTON & CRANE CO THE 2-7
PHOTO-RESEARCH CORP 20
PLASTIC PROCESS DIV MONADNOCK MILLS 1
PREMIER METAL PRODUCTS CO 3
PROVIDENCE BASE PLANT 1
PYLE-NATIONAL CO 9-15
RADIANT LAMP CORP 5-15-19
REGCO INC 22
RESEARCH INC 6
RETICO INC 9
RICHARDSON ALLEN CORP SUB STANDARD KOLLSMAN IND 22
RIESTER & THESMACHER CO 3
ROCKWELL PRODUCTS CORP 1
ROOALE MFG CO 15-19
ROHN MFG CO 11
ROSTAN CORP 11

PLASTOFILM INC 13
PLATRONICS INC 2-10-14
PLUG IN INSTRUMENTS INC 3-8-13
POLYCO INC 8
POLY KOTE INC 14
POLYTRONICS CO 6-17
PRECISE DIE & STAMPING CO 7
PRECISE INST PARTS CO 7
PRECISION ELECTROPLATING CO 14
PREC METHODS & MCH DV TEXTRON INC 7-8-9
PRECISION SENSORS INC 1-18
PRECISION TRANSFORMER CORP 1-8-18
PRECISION TUBE CO 7
PREMIER METAL PRODUCTS CO 7
PRESSED STEEL TANK CO 7
PRESTOLE CORP 7
PRESTO ELECTRONIC METAL PROD CO INC 1-2-7-16-21
PRINTED ELECT CORP 12
PRINTLOID CORP DEPT E 5-8
PROFILE ELECTRONICS INC 4
PROJECTS UNLIMITED INC 1-4-16
PROTECTION EQUIPMENT CO INC MPLS 1-7
PRY WELDING & MFG INC 7
QOS CORP 1-7-8
RADIAPHONE CO 1-5-7-8-16
RADIO CORP OF AMER DETROIT 11
RADIO SPECIALTY MFG CO 1-7
RAM METER INC 1-8-15-17
RAMYR MFG CO 8
RAVEN INDUSTRIES INC 1-4-11-16
RAYTHEON CO 15-17-18
RECTICO INC 13
RED DEVIL MFG CO 7
REF MFG CORP 9
REGENCY ELECTRONICS INC 1-13
REMINGTON RAND UNIVAC ST PAUL 3
RENWELL ELECTRONICS CORPORATION 1
REPUBLIC AVIATION CORP 1-6-7-8-10
RESEARCH DEVELOPMENT MFG INC 7
RESEARCH INST CO INC 7-8
REUTER INC 1-7-8-11
RHEEM SEMICONDUCTOR CORP 1-4-13
RHO ENG CO 4
RICHARDSON CO MELROSE PK 8
RICHFIELD COINED PRODUCTS CO 7
RIESTER & THESMACHER CO 7
RIVERBANK LABS ENGG DEPT 15
RIXON ELECTRONICS INC 1-4-7
ROBERTSON ELEC CO INC 1-4-7-14-16
ROBERTSON INSTRUMENT CO 17
ROBINAIR MANUF CORP 1-2-7-12-15-16-21
ROBINSON TECHNICAL PRODUCTS INC 18
ROCKWELL ENGINEERING 18
RODE INC 7
ROHDEN MFG CO INC 7-8
ROHN MFG CO 7
ROLOCK INC 21
RONAN & KUNZL INC 1-7-21
RONDO OF AMERICA INC 13
ROSENTHAL ISOLATOREN GMBH OF SELB W GERMA 13
ROSS METALS CO MILTON 4-14
ROTOTEST LABS INC 18
ROWE INDUSTRIES 1-5
ROYSON ENGRG CO 7
RUE PRODUCTS 4
SARATOGA PLASTICS INC 0
SARGEANT & WILBUR HEAT TREATING CORP 2-9-16
SATELLITE CORP OF AMERICA 8
SAVAGE-ROWE PLATING CO INC 0-14
SCHAFFER AIR INDUSTRIES 1-7
SCIENTIFIC ELECTRONIC LABS INC 2-9-10-14-21
SCIOTO SIGN CO 12
SEABORD PACIFIC DIV ASSOC SPRING 7
SEAL-A-METIC CO DIV OF FILTORS INC 2-10
SELECTRONS LTD 14
SEL REX CORP 12
SEMI-ALLOYS INC 2-7-8-12-14-16
SEMICON OF CALIF INC 7-21
SERVICE ASSOCIATED INC 15
SERVOMECHANISMS INC EL SEGUNDO 15
SERVWELL PRODUCTS CO 7-16
SHAMBAN & CO W S FT WAYNE 7-8
SHAW INSULATOR CO 5-13
SHELTERED WORKSHOPS INC 1-7-8-13-16
SHIPLEY CO INC 12
SIFCO METACHEMICAL INC 12-14
SILLCOCKS MILLER CO 4-5-6-8
SIMMONDS PRECISION PRODS TARRYTOWN 2-3-7-9-12-14-20
SIMS CASTING CORP 7
SINCLAIR MFG CO 2-7-9-10-12-16
SINGER METRICS DOV SINGER MFG CO 15-17-18
SITTLER CORP 1-2-16
SKYRON CORPORATION 1-7-21
SLOCOMB CO J T 2-7-21
SOLAR VOLT CO INC 4
SOLITRON DEVICES INC 4-10
SOMERS BRASS CO 7
SOUTHWORTH MACH CO 7
SPARTA MFG CO 8
SPATCO MFG CO 1-4-12
SPAULDING FIBRE CO INC MILTON 8
SPEC-PLATING INC 0-14
SPECIALTY AUTOMATIC MACHINE CORP 7
SPECIFIC PLATING CORP 14
SPINCRAFT INC 7-21
ST CROIX PLASTICS CORP 1
ST JOE MACHINES INC 1-7
STANDARD AUTO CORP 7-9
STANDARD METALS CORP 22
THE STANDARD PRODUCTS CO 1-2-7-9-12-16-21
STANDARD WINDING CO DIV OF OVITRON CORP 1-8
STAR-A ELECTRIC MFG CO INC 1
STAVER CO 7-8
STEVENS PRODUCTS INC 8
STONE CITY PRODUCTS CO 7
STRATOCON CORP 1-7-16
STYROFORMICS 13
SULLIVAN INDUSTRIES INC 8-12
SUNAIR ELECT INC 1-4
SUNDSTRAND DENVER 3
SUNSHINE SCIENTIFIC INSTRUMENT 1-15-17-18
SYLVANIA ELECTRIC PROD INC PARTS DIV 21
SYNTHANE CORP 8
SYSTEMATICS OF MO INC 3
TAFFET ELECTRONICS INC 2-7
TE CO THE 3
TECHNICAL DIL TOOL CORP 1-5-6-7-8-9-11
TECHNICRAFT CO 7-8
TECHRON CORP 5-8
TECHTROMATIC
TEKTRONIX INC BEAVERTON 15-17
TELETRAY ELECT SYSTEMS INC 1
TELKOR INC 1-5-6-7
TICKLE ENGG WORKS ARTHUR 7-21
TOPPER MFG CO INC 4
TORNGREN CO C W 7
TORRINGTON CO THE SPECIALTIES DIV 7
TORWICO ELECTRONICS INC 4
TRA-CON RESIN SYSTEMS DIV 4
TRANSISTOR ELECTRONICS CO 1
TRI ACRE ELECTRONICS 1
TRICON MFG CO 1-2-21
TRICRAFT PRODUCTS CORP 1-2-7-8-13-16-20
TRINITY EQUIPMENT CORP 1-2-10-11-12-13-15-16-18-19-20-21
TRIONICS CORP 18
TRI-TRONICS LAB INC 14
TROTT ELECTRONICS INC 7-13-15-17-18
TROXLER ELECTRONICS LAB INC 1-4-8
TRUTONE ELECTRONICS INC 1
U S ENG CO 7-8
U S INDUSTRIES INC AUTOMATION DIV 1-7-8
UCINITE CO DIV UNITED CARR FASTENER CORP 1-4-16-18
ULMER CO THE DIV MICROTRON INDUSTRIES INC 4-12
ULTRA CARBON CORP 8
ULTRA ELECTROFORMING MFG CO 14
UNIFORM TUBES INC 7-8
UNITED AERO PRODUCTS CORP
DIV AERO CHATILLON CORP 7
UNITED DATA CONTROL INC 15-17
UNITED MFG CO DIV UMC ELECTRONICS 7
UNITED STATES GASKET CO 7-8
UNITED TESTING LABS 11-15-17-18
UNITED WIRE & SUPPLY CORP 2-16
UNIVERSAL INSTRUMENTS CORP 1-7-9-13-18
UNIVERSAL MATCH CO UNDYNAMICS DIV 1-4-7
UNIV MATCH CORP ARMA DIV AVNC & ELECT DEPT 1-4-7
UNIVOX CORP N Y 1-16
UTILITIES SERVICE CO 7
VACUUM APPARATUS CO 18
VALPEY CRYSTAL CORP 8
VALUE ENG PROD INC 1-13
VANGUARD ELECTRONIC LABS 7
VERITRON WEST INC 2-12-16
VIBRATION ENGINEERING PLANT 7
VIDEON CORP 1-16-17
VIRGINIA PLAK COMPANY 8
WAHLGREN MAGNETICS 4-10
WALKIRT CO 1-4-16-21
WALLIN OPTICAL SYSTEMS INC 3
WARREN COMPONENTS DIV EL-TRONICS INC 4-10
THE WATERS CORP 1
WELDEX DIVISION 7-21
WELEX ELECTRONICS CORP 1-7-10-15-17-18-20
WELLS INDUSTRIES CORP 1-2-4-7-8-13-16-21
WELTRONIC CO 1-7-21
WERNER CO INC R O 7-12-21
WESTERN ARC WELDING INC 7
WESTERN COIL & ELECTRICAL CO 1-5-6-13
WHITING & DAVIS CO 7-8
WILCOX ELECTRIC CO INC 1-7
WILCOX PRODUCTS CO 0
WILKINSON CO 22
WILKS PRECISION INST CO INC 1-2-5-6-7-8-9-11-16-21
WILTRON CO 18
WIND TURBINE CO 7
WINDSOR ELECTRONICS INC 1-7-8-18
WINTRONICS INC 1
WINZEN RESEARCH INC 1
WOODWORTH METAL FAB DIV SHELBURNE INDUSTRIES 7
WRIGHT METALCOATERS INC 12-14-16
WYETH ENG INC 18
YORK RESEARCH CORP KIP ELECTRONICS DIV 1-4-15-18
ZACHARIAS CO ROBERT 14
ZEUS ENG CO INC 18
ZIMNEY CORP 5-7-8-21

SHIELDING 3200

Cathode ray shielding 1
Coil shielding 2
Electrostatic shielding 3
Ferrite shielding 4
Glass R-F shielding 5
Heat shielding 6
Ignition shielding 7
Lead shielding 8
Magnetic shielding 9
Radiation shielding 10
Rubber shielding 11
Screen shielding 12
Screen rooms 13
Sheer on screen shielding 14
Solid shielding 15
Transformer shielding 16
Tube shielding 17
Wire shielding 18

ACE ENGG & MACHINE CO INC 3-12-13-15
AEROJET-GENERAL NUCLEONICS 10
AERONCA MFG CORP 3-10
AINSLIE CORP 9-16-17
AIRCONDUCTORS 7-11
AIRCRAFT & ELECT SPEC 7-18
A K MFG CO INC 18
AMERICAN ELECTRIC CABLE CO 18
ARNOLD ENG G CO 9-16-17
ASTROMATIC DIV CONTROL CO OF AMER 5
ATLEE CORP 17
ATOMIC ACESSORIES INC 10
ATOMIUM CORP 10
AUBURN MFG CO 3-11
BARBER COLMAN CO AIRCRAFT & MISSILE PROD DIV 9
BARNES METAL PRODUCTS CO 2-16-17
BAR RAY PRODUCTS INC 8-10
BELMONT SMELTING & REFINING WORKS 1-8-10
THE BIRTCHER CORP INDUSTRIAL DIV 17
BRAUN TOOL & INSTRUMENT CO INC 17
BREEZE CORPS 7-8-17-18
BREW & CO RICHARD D 6-10
BROOKS & PERKINS INC 6-10
CANADIAN RADIUM URANIUM DV CANRAD PRES IND 8
CHESTER CABLE CORP 18
COLUMBIA WIRE & SUPPLY CO 18
CONN HARD RUBBER CO 10-11
CONNECTICUT HARD RUBBER CO 11
CONSOLIDATED WIRE & ASSOCIATED COS 18
CONTROL SCIENCE CORP 12
CONTROLS FOR RADIATION INC 10
COOK ELECTRIC CO NUCLEDYNE DIV 8
COOL FIN ELECTRONICS CORP 6-17
CO-OPERATIVE INDUSTRIES INC 7-18
CORDO CHEMICAL CORP 8
DALMO VICTOR CO DIV TEXTRON INC 9
DANIELS INC C R 6
DAVIDOFF CHARLES 10
DBM RESEARCH CORP 8-10-12-13-15
DIELECTRIC MATERIALS CO 17-18
EISLER TRANSFORMER CO INC 16
ELORE COMPONENTS INC 1-3-9
ELECTRONIC TECHNOLOGY RESEARCH INC 17
ELGIN MICRONICS DIV ELGIN NAT WATCH CO 8
EMERSON & CUMING INC 10-12-15
EMERSON & CUMING INC WESTERN DIV 3-10-11-13-15
EONETICS 16-17
ESPEY MFG & ELECTRONICS CORP 2-9-13-16
AMERICAN SMELTING REFINING CO 8
FILMOHM CORP 5-8
FILTRON CO INC WESTERN DIV 13-15
GENERAL ATRONICS CORP ELECT TUBE & INST 1
HALLETT MFG CO 2-3-7-8-9-12-15-18
HEXCEL PRODUCTS INC EASTERN DIV 12
IERC DIV INTERNTL ELECT RESCH CORP 3-9-17
INSO ELECT PROD INC 18
INTL ELECTRONIC RESEARCH CORP 3-6-9-17
INTL ELECT RESCH CORP 17
IRVAN FERROMAGNETICS CORP 4
ISTOPES SPEC CO 8-10
JAN HARDWARE MFG CO 1-2-9-16-17
JOHNSTON FOIL MFG CO 8-10
KELEKET X RAY DV LABS FO ELECT 10
KEWAUNEE SCIENTIFIC EQUIP 8-10
KULITE TUNGSTEN CO 10
KUPFRAIN MFG DIV ROBINSON TECH PRODS INC 2
LANOSVERK ELECTROMETER CO 10
LIBBEY OWENS FORD GLASS CO LIBERTY MIRROR DV 5-6
LINDGREN & ASSOC ERIK A 12-13
LIVINGSTON ELECT CORP 17
MAGNETIC METALS CO 1-9-16-17
MAGNETIC SHIELD DIV PERFECTION MICA CO 1-2-9-11
MALLORY METALLURGICAL CO 10
MARBLETTE CORP 10
MCMILLAN COMPANIES 10-13
MELABS 4
ELECTRONICS DIV METAL TEXTILE CORP 3-6-7-16-17-18
METEX ELECTRONICS 3-11-17-18
METHODE MFG CO 17
MICRO-CIRCUITS CO 1-3-5
MID-CONTINENT ENGINEERING 11
MILLEN MFG CO JAMES 1-2-9-17
MOORE & CO SAMUEL 18
MUTER CO
NATIONAL MOLDITE CO 2-4
NEW ENG ELECT WORKS INC 18
NUCLEAR-CHICAGO CORP 8
NUCLEONIC CORP OF AMERICA 8-10
OLYMPIC PRODUCTS CO INC 16
PERFECTION MICA CO MAGNETIC SHIELD DIV 1-2-4-9-15-16-17-18
PRECISION TUBE CO 18
PYRAMID SCREEN CORP 12
RADIATION INSTRUMENT DEVELOPMENT LAB INC 10

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

RADIATION MATERIALS INC 18
RAYCHEM CORP 18
REYNOLDS DIV NATIONAL STANDARD CO 12
RIEGEL PAPER CORP 18
RIMAK ELECT INC 1-2-7-8-9-12-14-15-16-17
SETTER BROS INC 8-10-15
SHIELDING INC 2-12-13-14-15
SOHOT DIV OF THERMOLAB CORP 6
SPECTRA-STRIP WIRE & CABLE CORP 3
STAVER CO 2-8-10-16-17
SWIFT TEXTILE METALLIZING & LAMINATING CORP 13
TECHNICAL WIRE PRODUCTS INC 3-7
TECHNIT SALES CO 3-7-12-14
TELCON METALS TELCON WORKS 1-9-12-16-17
TOPATRON INC 3-13-14-15
TOPPER MFG CO INC 11
TROXLER ELECTRONICS LAB INC 8-10
UNIFORM TUBES INC MICRO DELAY DIV 18
VECTOR MANUFACTURING CO HOUSTON 18
WATERMAN PRODUCTS CO 1
WEBCOR INC LAMINATION DIV 2-16
YORK CO INC OTTO H 12
ZIPPERTUBING CO 3-5-6-9-18

SOUND RECORDING EQUIPMENT 5900

Brushes, record 1
Clothes, record cleaning 2
Compensators 3
Editing blocks 4
Equalizers, record 5
Filters, needle scratch 6
Heads, magnetic film stripe 7
Heads, magnetic tape playback 8
Heads, magnetic wire playback 9
Needles 10
Players, magnetic tape 11
Players, magnetic wire 12
Pickups, binaural 13
Pickups, capacity 14
Pickups, ceramic 15
Pickups, crystal 16
Pickups, dynamic 17
Pickups, magnetic 18
Pickups, photoelectric 19
Pickups, reluctance 20
Pickups, resistance 21
Record changers 22
Record pads 23
Record players, home 24
Record players, transcription 25
Record racks 26
Record presses 27
Records, blank 28
Records, sound effects 29
Records, test 30
Tape indexes 31
Tape, magnetic 32
Tape, prerecorded 33
Tapes, test 34
Turntables 35
Wire, magnetic recording 36

ACOUSTIC RESEARCH INC 35
ADC PRODUCTS DV OF MAGNETIC CONTROLS 6
ALDSHIR MANUFACTURING CO INC 1-2-10-15-16-17-18-20
ALMA ENGINEERING 5
AMERICAN CONCERTONE 8-11
AMERICAN GELOSO ELECT INC 32
AMPEX CORP REDWOOD CITY 8-11
AMPEX MAGNETIC TAPE PRODUCTS 31-32-34
ANTREX CORP 32-33
APPLIED MAGNETICS CORP 7-8-9
APW CO 18
ARNOLD ENG G CO 32
ARVIN INDUSTRIES INC 24
ATLANTIC RESEARCH CORP 15
AUDIOTEX MFG CO/DIV G C TEXTRON INC 1-2-30-31-34
AUDIOTRONICS CORP 24-25
AUTOCRAT ELECTRONICS CO 24
AUTOMATIC TAPE CONTROL INC 0
BACH AURICON INC 7-8-19
BEAU ELECTRONICS INC 11
BELL SOUND DIV THOMPSON RAMO WOOLDRIDGE INC 33
BENDIX COMPUTER DIV THE BENDIX CORP 5
BERNCO ENGINEERING CORP 33
BIRMINGHAM SOUND REPRODUCERS LTD 16-22-24-35
BURGESS BATTERY CO 32
BYREX CORP 21
CALIFONE CORP 24-25-35
CAMERA MART INC 8-18
CANADIAN ASTATIC LTD 10-15-16-32
C B C ELECTRONICS CO 23
CENTRALAB DIV GLOBE UNION 15
CLEARTONE REPRODUCTION CORP 10
CO ENGINEERING CO 11
COLUMBIA RECORDS 5-29-30
COMPONENTS CORP 27-30-35
CONLEY ELECTRONICS CORP 33
CONSOLIDATED ELECT CORP 32
CONTROL INDICATING CORP 21
COUSINO ELECT CORP 11-32
OBM RESEARCH CORP 32
DIAMOND TOOL ENGG CO 10
DOCKENDORFF & CO INC 35
DUOTONE CO 1-2-10-16
DURAMIC PRODUCTS INC 15
DYNACO INC 18-20
EDUCATIONAL ELECTRONICS CO 24
ELECTRAMATIC INC 1-2-15-16-23-30-31-34-36
THE ELECTRO NUCLEAR SYS CORP 8
ELECTRO PRODUCTS LABS INC 17-18
ELECTRO-SONIC LABS 1-15-17-24
ELECTRO VISION LAB 11
ELECTRO VOICE INC 10-13-15
ELECTRON ENTERPRISES 24
ELECTRONIC APPLICATIONS INC 11-17-25-35
ELECTRONIC INSTRUMENT CO INC 22
ELGIN MICRONICS DIV ELGIN NAT WATCH CO 8-11
FAIRCHILD RECORDING EQUIPMENT CO 5-13-17-18-23-24-25-30-34
FEN-TONE CORP 16-17-18
FERRO DYNAMICS CORP 32
FIDELITONE MICROWAVE INC 1-2-8-10-32-36
FORT WAYNE METALS INC 36
G C ELECTRONICS COMPANY CHEMICAL & TOOL DIV 36
GC ELECTRONICS CO DIV TEXTRON ELECTRONICS 1-2-15-16-23-30-31-34-36
GIANNINI CONTROLS CORP TRANSDUCER DIV 21
GIANNINI CONTROLS CORP NJ DIV 21
GLASER STEERS CORP 24
GRAY MFG CO 5-25
GREENE CO L CHARLTON 24-25
GREENTREE ELECTRONICS CORP 32-33
GREGORY MAGNETIC INDUST INC 7-8
GULTON INDUSTRIES INC METUCHEN 15
HAMILTON ELECTRONICS CORP 24-25
HARWALD CO INC 11
HEATH CO SUB OF DAYSTROM INC 11
IDAHO MARYLAND MINES CORP MAGNETICS DIV 7-8
IDEAL AEROSMITH INC DIV ROYAL INDUSTRIES 35
INTERNATION AUDIO STYLUS CORP 10
IRVAN FERROMAGNETICS CORP 7-8-18
ITA ELECTRONICS CORP 35
JAMES ELECTRONIC INC 18
JENSEN INDUSTRIES INC 10-16
KEN-DEL PRODUCTIONS INC 33
KINELOGIC CORP 11
KIRSCH MUSIC CORP 23-26
LABELLE INDUSTRIES INC 11
LANGEVIN DIV OF SONOTEC INCORP 5
L E E INC 11
LESA COSTRUZIONI ELETTROMECCANICHE SPA 16-22-24-35
LITTON SYSTEMS INC APPLIED SCIENCE DIVISION 33
LIVINGSTON AUDIO PRODUCTS CORP 32
MAGNASYNC MFG CO 4-5-7-8
MAGNE HEAD DIV GENERAL INST CORP 7-8
MAGNE-TRONICS INC 33
MAICO ELECTRONICS INC DYNAMU MAGNETRONICS DV 7-8
MAICO ELECTRONICS INC ENG DIV 7-8
METROPOLITAN TELECOMMUNICATIONS CORP COIL WINDERS DIV 18-20
MICHIGAN MAGNETICS INC 7-8
MICRO SYSTEMS INC 21
MIDWESTERN INSTRUMENTS 8-11
MINNEAPOLIS-HONEYWELL HEILAND DIV 8
MINNESOTA MINING & MFG CO ST PAUL 32-34
MINNESOTA MINING & MFG CO HUTCHINSON 32
MOTOROLA INC QUINCY 24
MOVIOLA MFG CO 4
MURA CORP THE 8-15
NESOR ALLOY PRODUCTS CO 36
NORTHMOOR RECORDING 33
NORTON ASSOC INC 7-8-9
NORTRONICS CO INC MPLS 7-8-34
NUCLEAR PROD INC 1
PACIFIC ELECTRODEVICES 11
PACIFIC MERCURY ELECT INC 24
PACIFIC TRANSDUCER CORP 30
PAMPA ELECT CORP 7-8
PFANSTIEHL CHEMICAL CORP 1-2-10
PHOTO-TRONIC PRODUCTS CORP 11
PICKERING CO INC 7-8-13-18-20-35
PRODUCTS & INDUSTRIAL ENGRG CORP 24
PROTECTION EQUIPMENT CO INC MPLS 11
RCA ELECTRN TUBE DIV INDIANAPLS 32-33
RCA ELECTRN TUBE DIV MARION 32-33
RCA BRDCST & COMM PRODS DIV CAMDEN 32-35
RCA ELECTRN TUBE DIV HARRISON 32-33
RCA ELECTRN TUBE DIV WOODBRIDGE 31-32-33
RCA ELECT TUBE DIV CINN 32-33
RCA ELECTRN TUBE DIV LANCASTER 32-33
RCA BRDCST & COMM PROOS DIV MEADOW LANOS 32-35
RADIO MFG ENGG INC 15-16
RANGERTONE INC 8-34
RECOROED PUBLICATIONS LABS 33
RECORDIO CORP 11-24
RECOTON CORP 1-2-10
REEVES SOUNDCRAFT CORP 31-32-33
REIGNER RECORDING LIBRARY 33
REK O KUT COMPANY INC 3-5-11-18-24-25-35
RHEEM CALIFONE CORP 24
ROBINS INDUSTRIES CORP 2-8
ROBINSON RECORDING LABS 25-35
SANGAMO ELECTRIC CO 7-8-11-18
SHURE BROS 5-8-17-18
SOLAR VOLT CO INC 8
SONOTONE CORP ELMSFORD 8-15-16
SONY CORP 7-8-11-32
STANCIL-HOFFMAN CORP 7-8-11
TANDBERG OF AMERICA INC 7-8-11-27-32
TAPE ATHON 11
TRANSCRIBER CO 10
U S RECORDING CO 25
ULTRAUDIO DIV OBERLINE INC 5
UNITED DATA CONTROL INC 11-33
UNITED TRANSFORMER CORP 5
VANITY FAIR ELECTRONICS 24
WABER ELECTRONICS INC 23
WEBCOR INC 22-24
WESTREX CO RECORDING EQUIP DIV LITTON SYS I5 8

SOUND SYSTEMS 6000

Alarms 1
Amplifiers, power 2
Carillons, electronic 3
Carrier current systems 4
Dictating machines 5
Hearing aids 6
Home sound systems 7
Intercommunications 8
Megaphones, electronic 9
Musical equipment electronic 10
Musical instruments, electronic 11
Paging systems 12
Preamplifiers, P.A. 13
Public address systems 14
Public address systems, mobile 15
Speaker systems, marine 16
Telephone systems 17
Telephones, sound powered 18
Theater sound systems 19

AC SPARK PLUG ELECT DIV GMC 2-12
ADEC INC 8
AEROSPACE ELECTRONICS INC 2-8-12-13-14
AIRCRAFT & ELECT SPEC 3
AIRTRONIX DEVELOPMENT CORP 2-7-14
ALMA ENGINEERING 7-19
ALTEC LANSING CORP 1-2-7-12-13-14-16-17-19
AMERICAN AIRFRAME CORP 2-8-9
AMERICAN CONCERTONE 5
AMERICAN DISTRICT TELEGRAPH CO 1
AMERICAN ELECTRIC CABLE CO 1
AMERICAN GELOSO ELECT INC 5-8
AMERICAN SOUND PROD INC 6
AMPEX CORP REDWOOD CITY 19
AMPLIFIER CORP OF AMER 12
AMPLIVOX LTD 6-17
ANOREA RADIO CORP 8
ANTREX CORP 1-7-8-9-12-14-15-17
APEL CO SUB RAYTHEON CO 17
APPLIED CONTROL CORP 2-8-13-14-15
ASSOCIATED ELECTRICAL INDUSTRIES LTD 4
ASTROMETRICS INC 7
AUDAX INC 16
AUDIO EQUIPMENT CO PORT WASHINGTON 2-6-8-9-10-13-14-15-16
AUDIVOX INC 6
AUREX CORP 6
AUTH ELECTRIC CO 1-7-8-17
BALDWIN PIANO CO 10-11
BELL SOUND DIV THOMPSON RAMO WOOLDRIDGE INC 14-15
BERNCO ENGINEERING CORP 5
BLISS ELECTRONIC CORP 8-17
BOULEVARO ELECTRONICS INC 2-8-13-14-15
BOY-MAR ELECTRICAL SERVICE CO 1
BRIGHT RADIO LABS INC 18
BUDELMAN ELECTRONICS CORP 12-15-17
CALBEST ELECTRONICS CO 7-8
C B C ELECTRONICS CO 8
CENTRAL ELECTRONICS INC 6
CENTROL ENG CO 1
CENTURY PROJECTOR CORP 2-19
CERBERUS AG WERK ELEKTRONENTECHNIK 1
CHALCO ENGINEERING CORP 2-8-12-13-14-15
COGNITRONICS CORP 12
COMMERCIAL RADIO SOUND CORP 1-12-13-14-15-16-17
COMMUNICATIONS ELECTRONICS CO 2-7-8-12-13-14-15
CONTINENTAL ELECTRONICS CORP BROOKLYN 8-18
COOK ELECT CO WIRECOM DIV 8
CP ELECTRONICS INC 2-10
DATA SENSORS INC 8
DELCON CORP 1
DICON CORP 1
DICTAPHONE CORP BRIDGEPORT 5

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

SPEAKERS & ACCESSORIES 6100

STUDIO BROADCAST EQUIPMENT 6200

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

SWITCHES 6300

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

TEST EQUIPMENT
BRIDGES & DECADE BOXES 3300

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

COUNTING DEVICES 3400

GENERATORS 3500

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

ABACUS INC 8
ABBEY ELECTRONICS CORP 1-13
ACCUTRONICS INC 13-17
ADLER ELECTRONICS INC 3
ADVANCED MEASUREMENT INST INC 1-3-8-10-12-13-14-19-20
AERDSPACE RESEARCH INC 22
AETNA ELECTRONICS CORP 21
AIRBORNE INSTRS LAB DIV CUTLER HAMMER INC 6-19-21
AIRCOM INC 22
AIRCRAFT RADIO CORP 10-19-20
AJAX ELECTROTHERMIC CORP 22
ALFRED ELECTRONICS 5-7-8-13
ALLEN ELECTRONIC CORP 14
ALLISON LABS INC 6
ALTO SCIENTIFIC CO 8
AMERAC INC 22
AMERICAN AIRFRAME CORP 1-3-13-14
AMERICAN ASTRO-SYSTEMS 1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-16-17-18-19-20-21-22
AMERICAN ELECT LABS INC 4-9
AMERICAN MISSILE PROD CO INC 17-21
AMULEX ELECTRONICS INC 8-13-21
ANDERTON ELECTRONIC LAB 23
ANDREA RADIO CORP 2-3-14-18-19-20
APPLIED DEVELOPMENT CORP MONTEREY PK 8-17
APPLIED MICROWAVE LAB INC 4-5-19-22
APPLIED RESEARCH INC 22
APPLIED SYSTEMS CORP 8
ARF PRODUCTS INC RATON 7
ARKAY INTERNATIONAL INC 10
ASSOCIATED ELECTRICAL INDUSTRIES LTD 23
ASTRODATA INC 17
ATELIERS DE MONTAGES ELECT 10
BABCOCK ELECT CORP 3-10-19
BECKMAN INST INC BERKELEY DIV 4-8-17
BEHLMAN INVAR ELECTRONICS CORP 23
BENRUS WATCH CO INC 13
B & K INSTRUMENTS INC OF BRUEL & KJAER 1
B & K MFG CO 2-15-18
BOONTON RADIO CORP 3-10-14-18-20
BORG-WARNER CONTROLS 3-5-10-11-19-20
BOSCO ELECT INC 23
BROWN ENG CO INC 10
BRUNO NEW YORK INDUST CORP 5-10-19
BUDD ELECTRONICS A DIV OF THE BUDD CO 19-20
BURMAC ELECTRONICS CO INC 8
BURR BROWN RESEARCH CORP 1-13
CALBEST ELECTRONICS CO 3
CALIF TECHNICAL INDUST DIV TEXTRON INC 10
CAROL ELECT DIV WEECO 1-8-10

CHALCO ENGINEERING CORP 1
CLOUGH BRENGL E CO 1-10-14
COMMUNICATION MEASUREMENTS LABS 1-13-21
CAMPAGNIE GENERALE DE METROLOGIE 1-3-8-14-18-20
COMPUTER LOGIC CORP 8-17-21
COMPUTER TEST CORP 8
COOPERTRONIX 8-14
CORDIN CO THE 0
CRANE ELECTRONICS CO 8
CYBETRONICS INC 8
DATA CONTROL SYSTEMS INC 3
DATA TECHNOLOGY CORP PALO ALTO 17
DATAPULSE INC 8
DAVEN CO 1
DAWE INSTRUMENTS LTD 1-6-8
DECITRON ELECTRONICS CORP 5-6-9-10-12
DELTA F INC 10
DIGITAL ELECTRONICS INC 8-13
DIGITAL SYSTEMS INC 8
DIGITECH INC WILTON 8
DON BOSCO ELECT SUB OF HOWELL ELECT MOTORSC6 6-8
DUKANE CORP 23
DUMONT LABS INC ALLEN B 8-18
DYMEC DIV OF HEWLETT PACKARD CO 5-10
DYTRONICS CO 1-13
E H RESEARCH LAB INC 8-13
ELECT MECHANICAL RES INC 15
ELECTRAMATIC INC 1-4-6
ELECTRIC SPECIALTY CO 0
ELECTRONIC COUNTERS INC 8-17
ELECTRONIC INSTRUMENT CO INC 1-2-3-10-13-14-18
ELECTRONIC INTL CO 1
ELECTRONIC MEASUREMENTS CORP N Y 1-10
ELECTRONICS INTL CO INC OKLA 10
ELECTRONICS OF CLEARFIELD INC 1-8-14
ELGENCO INC 6
ELGIN MICRONICS DIV ELGIN NAT WATCH CO 8-21
ELIN DIV INTL ELECT RESCH CORP 1-13

EMI COSSOR ELECTRONICS 23
EMPIRE DEVICES PRODUCTS CORP 5
ENGINEERING ASSOCIATES 1-3-5-6-8-10-11-13-19-20-22
ERA DYNAMICS 23
ESPEY MFG & ELECTRONICS CORP 9
EXACT ELECTRONICS INC 8-13-21
FERRIS INDUSTRUMENT CORP 0-3-10-12-19-20
FISCHER ELECTRONICS INC 1-23
FISHER AKIN CO 8-13
FOTO VIDEO LABS 2-9-15-18
FRANKLIN ELECTRONICS INC 8
FREDERICK ELECT CORP 8-21
FREQUENCY ENGG LABS 5-7-9-10-19-20-22
FRONTIER ELECT CO 8-17
FURZEHILL LABS LTD 1-13
GC ELECTRONICS CO DIV TEXTRON ELECTRONICS 1-4-6
GENERAL APPLIED SCIENCE LAB 8-13
GENERAL COMMUNICATION CO 5-9
GENERAL DEVICES INC 23
GENERAL DYNAMICS ELECTRONICS ROCHESTER 8
GENERAL MICROWAVE CORP 5-6-9-10-22
GENERAL RADIO CO 1-6-8-10-13-14-19-20-22
GENERAL TECHNOLOGY CORP 22
GERTSCH PRODUCTS INC 22
GURLEY W & L E 8
GYREX CORP 1
HALLICRAFTERS CO CHICAGO 10
THE A W HAYDON CO CULVER CITY 8
HEATH CO SUB OF DAYSTROM INC 1-2-4-10-13-14-18-20-23
HEATH CO DIV OF DAYSTROM INC 1-2-3-10-13
HERMES-SONIC CORP 23
HEWLETT PACKARD CO 1-4-5-6-8-10-11-13-14-19-20-21
HICKOK ELECTRICAL INSTRUMENT CO 1-2-3-4-7-8-10-13-14-17-18-19-20-21
HOFFMAN ELECTRONICS CORP INDUSTRIAL PROD DIV 8-12
HOLT INSTRUMENT LABS 1
HOUSTON INSTRUMENT CORP 14
HURLETRON INC WHEATON ENG DIV 8-17
H W ELECTRONICS INC 8
HYPERION INC 17
ICONIX INC 8-21
INDUSTRIAL CONTROL CO 14
INSTRUMENT CORP OF AMER 8-13
INTERCONTINENTAL INSTRUMENTS INC 8-13
INTERELECTRONICS CORP 1-4-6-13-21-22
INTERNATIONAL DATA SYSTEMS INC 12
ITEK ELECTRO - PRODUCTS 17-22
I TEL INC 4-14-22
JACKSON ELECTRICAL INSTRUMENT CO 1-3-13-14-18-20
JACOBS INSTRUMENT CO 8
JERROLD ELECTRONICS CORP 10-14-21
JETRONIC INDUSTRIES 1-2-3-5-8-10-13-19
KARG LABS INC 9
KAY ELECTRIC CO 1-3-6-7-8-9-10-14-18-19-20
KFLL STROM TOOL CO INC ELECT DIV 8
KROHN-HITE CORP 1-13
KURTSTON ELECTRONICS 1-10-13-22
LABORATORY FOR ELECTRONICS INC 5-8-9-10-11-14-19-20-22
LAMPKIN LABS INC 10
LA ROSE & ASSOC INC W T 20
LAVOIE LABS INC 8-13
LEAR SIEGLER INC ELECT INST DIV 15
LINK DIV GENERAL PRECISION INC 8
LIVINGSTON ELECT CORP 1
LUMATRON ELECTRONICS INC 8
MADIGAN CORP 3-10-12
MANSON LABORATORIES INC 5-7-8-10-12-13-17-19-20
MANUFACTURERS ENGG & EQUIP CORP 14
MARCONI INSTRUMENTS 1-3-4-6-8-10-13-14
MARYLAND TELECOMMUNICATIONS INC 15
MAXSON INSTRUMENTS DIV MAXSON ELECTRONICS CORP 5
MAXSON ELECTRONICS CORP ELECTRONIC DES DIV 1-5-7-8-9-10-11-13-17-19-20-21-22
MEASUREMENT ENGG LTD 1-6-9-13
MEASUREMENTS DIV MC GRAW-EDISON CO 1-2-3-8-10-12-13-18-19-20
MELABS 3-5-10-14-22
MENLO PARK ENGG 14-19-20
METAL SPECIALTY PRODUCTS CORP 1-10-17-21
M F ELECTEONICS CORP 1
MICRONETICS INC 5-9
MICRO NOW INSTRUMENT CO INC 4-22
MICRO STATE ELECTRONICS CORP 4
MIRATEL INC NEW BRIGHTON 0
MISSOURI RESEARCH LABORATORIES INC 8
MODEL ENGG & MFG INC 1-3-5-7-8-9-10-12-19-20-21-22
MONTRONICS INC 4-22
MOTOROLA COMMUNICATIONS & ELECT INC 10
MUIRHEAD & CO LTD 1-10
MUIRHEAD INSTRUMENTS INC 1
MUTRON INC 1-10
NAVIGATION COMPUTER CORP 8
NEICO MICROWAVE CO 5
NEW LONDON INST CO INC 3-6-10-20
NORRMAN LABORATORIES ERNST 1-10-17-22
NORTHEAST ELECT CORP 1
NORTHEASTERN ENG INC 3-10-14-19-20
NORTHERN RADIO CO 3-10-13-22
NUCLEAR-ELECTRONICS CORP 3-5-10-19-20
ONEIDA ELECTRONICS INC 11
ORBITRAN CO INC 8-9-17
PACIFIC TRANSDUCER CORP 14
PACO ELECTRONICS CO INC 2-3-4-10-13-14-18
PACO PRECISION 23
PARABAM INC 1-8-13-21
PARADYNAMICS INC 8-13-14

PASTORIZA ELECT INC 8-13-14
PERKIN ELMER CORP VERNISTAT DIV 0
PHILCO CORP SIERRA ELECTRONIC DIV 3-10
PHILAMON ABS INC 8-22
PHOTO-TRONIC PRODUCTS CORP 18
PLANETRONICS INC 5
PLECTRON CORP 1-3
POLARAD ELECTRONICS CORP 3-4-5-6-8-14
PRD ELECTRONICS INC 5
PRECISE ELECTRONICS & DEVELOPMENT CORP 1-10
PRECISION APPARATUS CO 23
PRESCOTT TV CO 15
PROBESCOPE CO INC 14
PROBESCOPE CO INC SYOSSET 14
PULSE ENG INC 8
RADAR ENGINEERS 8-19
RADAR MEASUREMENTS CORP 5
RADIAPHONE CO 1
RADIATION AT STANFORD 8
RADIATION INC PRODUCTION DIV 5-8-10
RADIATION INSTRUMENT CO 8
RADIO CITY PROD CO 23
RCA ELECTRN TUBE DIV INDIANAPLS 1-2-3-10-13-14-18-19-20
RCA ELECTRN TUBE DIV MARION 1-2-3-10-13-14-18-19-20
RCA DEFENSE ELECT PRODS CAMDEN 10-15
RCA ELECTRN TUBE DIV HARRISON 1-2-3-10-13-14-18-19-20
RCA ELECTRN TUBE DIV WOODBRIDGE 1-2-3-10-13-14-18-19-20
RCA ELECT TUBE DIV CINN 1-2-3-10-13-14-18-19-20
RCA ELECTRN TUBE DIV LANCASTER 1-2-3-10-13-14-18-19-20
RANK CINTEL LTD 23
REACH CORP 1
REEVES INSTRUMENT CORP 6
REMANCO INC 5-6-8-9-10-21
REPUBLIC ELECT INDUST CORP 1
RESEARCH INDUSTRIAL LAB OF ELECTRONICS 8
RESE ENGG INC 8
RFS ENGINEERING CO 8
RIKER INDUSTRIES INC 2-8-13-14-15-18
RIVERBANK LABS ENGG DEPT 1
R M S ASSOCIATES INC 9
RMS ENG INC 22
ROBERTSON INSTRUMENT CO 2
ROHDE & SCHWARZ 1-3-6-10-11-14-18-19-20
RON ELECTRONICS CORP 12
R S ELECTRONICS CORP 3
RUTHERFORD ELECTRONICS CO 8
SCOTT INC H H 3-6
SERVICE INSTRUMENTS CORP 4
SERVICE INSTRUMENT CORP 6
SERVO CORP OF AMERICA 7-8-13
SIERRA ELECTRONIC DIV PHILCO CORP 3
SIMPSON ELECTRIC CO DIV AMER GAGE & MACH CO 2-8-14
SIMPSON ELECTRIC CO MERCER 1-4-18-21
SINGER METRICS DOV SINGER MFG CO 1-10-12-14
THE SOLARTRON ELECTRONIC GROUP LTD 1-3-8-21
SOLID STATE ELECTRONICS CO 1-3-4-8-10-15-21
SORENSEN INDUSTRIAL ELECTRONIC CO 10
SOUTHWESTERN INDUSTRIAL ELECT CO 23
SPECIALTY ELECTRONICS DEVELOPMENT CORP 23
SPECTRAN ELECTRONICS CORP 1
SPENCER-KENNEDY LABS INC 8
SPERRY MICROWAVE ELECT INC 5-6
SPIVEY INC JAMES S 23
STODDART AIRCRAFT RADIO CO 8
STRAND LABS INC 5-9
SULLIVAN LTD H W 23
SUMMERS & MILLS INC 10
SYSTEMS INC 1-3-12-17-21
SYSTRON DONNER CORP 1
TAFFET ELECTRONICS INC 1-10-17-21
TEKTRONIX INC BEAVERTON 8-13-17-21
TELECHROME MFG CORP 2-5-6-8-12-13-15-18-21
TELECTRO INDUSTRIES CORP 10
TELEMET CO 2-15-17-18-21
TELEMETRICS INC 8
TELEVISION UTILITIES CORP DIV NORD 18
TEL-INSTRUMENT ELECTRONICS CORP 3-14
TELONIC ENGINEERING CORP 3-4-5-8-9-10-14-20-22-18-19
TELONIC INDUSTRIES INC 3-8-10-14-18-19-20
TEXAS INSTRUMENTS INC APPARATUS DIV 8
TOPPING ELECTRONICS LTD F V 4-10-22
TRAK ELECTRONICS COMPANY INC 14
TRIPLETT ELECTRICAL INST BLUFFTON 2-3-10-18-19
U S SCIENCE CORP 12
VALOR ELECTRONICS CO 8
VELONEX DIV PULSE ENGR 8-21
VERCO INC 1-8
VICTOREEN INSTRUMENT CO CLEVELAND 8
VITRO ELECTRONICS DIV OF VITRO CORP OF AM 15
VITRO LABORATORIES 8-17-22
VUE TRONICS INC DV OF PRESCOTT CO 15
WALTHAM ELECTRONICS CORP 1-3-4-5-6-7-10-13-14-19-20
WAVEFORMS INC 1-12-13
WAVELINE INC 6
WEINSCHEL ENGG 5-13
WESTERN INSTRUMENT CO 21
WILTRON CO 7-8-13
WINTRONICS INC 7

METERS 2900

ABBEY ELECTRONICS CORP 10-20
AD-YU ELECTRONICS LAB INC 11
AIRCRAFT RADIO CORP 6
AIRPAX ELECTRONICS PACIFIC DIV 20
ALCO ELECTRONIC PRDDUCTS INC 4-8-17-20
ALEXANDRIA DIV AMF 6-17
ALWAC COMPUTER DIV EL-TRONICS INC 6
AMERAC INC 6
AMERICAN AIRFRAME CORP 6-10-20
AMERICAN ASTRO-SYSTEMS 1-2-3-4-14-5-6-7-8-9-10-11-12-13-15-16-17-18-19-20-21-22
AMERICAN MACH & FOUNDRY CD NEW YORK 17
AMF INSTR DIV AMER MACH & FDRY 6-17-18
AMERICAN SPACE EXPLORATION INC 21
AMERICAN STANDARD CONTROL DV ROCHESTER 4-10-17
AMMON INSTRUMENTS INC 4-8-17
AMSTRO CORPORATION 10
ANADEX INSTRUMENT S INC 6
APPLIED PHYSICS CORP 1
ARISTO CRAFT DISTINCTIVE MINIATURES 4-20
ARKAY INTERNATIDNAL INC 12-16-20
ASSEMBLY PRODUCTS INC 12-16-17-18-20
ASSOCIATED RESEARCH INC 10-20
ASTRO SYSTEMS INC 11
AUDIOTEX MFG CO/DIV G C TEXTRON INC 17
AUTO DATA 21
AUTO TEST INC CHICAGO 14-17
AVIONICS INC 8-17
AVNET CORP LOS ANG 17
AVTRON MFG INC 6
BACH-SIMPSON LTD 4-6-8-9-10-16-17-20
BALLANTINE LABS INC 2-9-16-21
BARBER-COLMAN CO 17
BARBER & WILLIAMSON INC 6
BARNES DEVELOPMENT CO 2
BARNETT INST CO 10-16-17-20
BARNETT INSTRUMENT CO 16
BARRY ELECTRONICS CORP NEW YORK 8
BASSETT INC REX 6
BECKMAN INST INC BERKELEY DIV 4-6-10-11-16-21
BELL INC F W 21
BELLEVILLE HEXEM CORP 4-8-10-16-17
BERGEN LABS INC 10-16
BIDDLE CO JAMES G 6-10-11
BIRD ELECTRONIC CDRP 12-18
B & K INSTRUMENTS INC DF BRUEL & KJAER 1
B & K MFG CO 7-10-16-17-20
BOONTON ELECTRONICS CORP 16
BORG-WARNER CONTROLS 10-12-16
BRIDGE ELECTRONICS CO INC 6-16
BRUNO NEW YORK INDUST CORP 10-14-16-17
BUCK ENGG CO 4-17
BUDELMAN ELECTRONICS CORP 6
BURR BROWN RESEARCH CORP 17
CAMBRIDGE INSTRUMENT CO INC 5
CANADIAN RESEARCH INSTITUE 4-6-10-12-17-18-22
CAROL ELECT DIV WEECO 20
CARTER CO J C 5
CENTURY ELECT INST INC TULSA 21
CHATILLON SONS JOHN 15
CIMRON CORP 4-8-21
CLOUGH BRENGL E CO 16
COMU ELECTRONICS INC KIN TEL DIV 8-17-21
COILS ELECTRONICS CO 0
COLUMBIA ELECT MFG CO 4-14-17
COMMUNICATION MEASUREMENTS LABS 10
CAMPAGNIE GENERALE DE METROLOGIE 4-8-16-17-20
CONSOLIDATED CONTROLS CORP 6
CONSOLIDATED ELECT CORP 17
CUBIC CORP 10-21
CURTIS INSTRUMENTS INC 4-18-19
CURTISS-WRIGHT CORP ELECTRONICS DIV 17
CUSTOM SCIENTIFIC INSTRUMENTS INC 22
DANA LAB INC 21
DATA INSTRUMENTS 17-2
DAVEN CO 6-15
DAWE INSTRUMENTS LTD 6-16
DAYSTROM INCORPORATED WESTON INSTRUMENTS DIV 2-3-4-5-6-8-9-10-11-13-14-17-18-20
DIAMOND ANTENNA & MICRDWAVE CORP 11
DIGITAL ELECTRONICS INC 21
DITTMORE FREIMUTH CDRP 4-17
DYMEC DIV OF HEWLETT PACKARD CO 21
DYNAMICS INST CO 1-16-20
DYTRONICS CO 6-11
EALING CORP 8
EASTERN SPECIALTY CO 11
E H RESEARCH LAB INC 1-8
ELCOR INC 4
ELECTRIC DESIGN & MFG CO 4-8-17
ELECTRICAL INSTRUMENT CORP 4-6-8-9-17
ELECTRO IMPULSE LAB INC 6-12
ELECTRO INSTRUMENT INC 2-7-10-17-20-21
ELECTRO-MECHANICAL INSTRUMENT CO 4-8-17
ELECTRO SCIENTIFIC IND INC 2
ELECTRONIC APPLICATIONS INC 22
ELECTRONIC COUNTERS INC 6
ELECTRONIC DEVELOPMENT LABS 4-17
ELECTRONIC INSTRUMENT CO INC 16-20
ELECTRONIC MEASUREMENTS CORP N Y 16-20
ELECTRONICS OF CLEARFIELD INC 16
ELECTRONICS SYSTEMS INC 11
ELGIN MICRONICS DIV ELGIN NAT WATCH CO 6
ENGELHARD INDUSTRIES INDUST EQUIPT DIV 17
ENGINEERING ASSOCIATES 6-16
EPIC INC 2-4-5-12-16-17-18
EPSCO INC CAMBRIDGE 10-21
ERDCO ENGG CORP 2
ERIE PACIFIC 6
ESPEY MFG & ELECTRONICS CORP 6
ESTERLINE ANGUS INSTRUMENT COMPANY INC 6-13-17-18
FERRANTI ELECT INC 19-22
FLOW CORP 16
FLUKE MFG CO INC JOHN 16-17-18
FRANKLIN ELECTRONICS INC 20-21
FREQUENCY ENGG LABS 6
FURZEHILL LABS LTD 16
F X R INC WOODSIDE 6
GENERAL COMMUNICATION CO 6-12
GENERAL METERS INC 10-17-18-19
GENERAL MICROWAVE CORP 6-7-12
GENERAL RADIO CO 7-16
GERTSCH PRODUCTS INC 6-11-16
G M MFG CO 4
GOMBOS INC CO JOHN 6
GREIBACH INSTRUMENT SCORP 4-8-10-17-20
GYRA ELECTRONICS CORP 1
HALEX INC 1-22
HALLICRAFTERS CO CHICAGO 10-16
HALMAR ELECTRONICS INC 9
HEATH CO SUB OF DAYSTROM INC 2-4-10-16-17-B HARBOR 18
HEATH CO DIV OF DAYSTROM INC ST JOS 16-30
HELIPOT DIV BECKMAN INSTS FULLERTON 6-8-17
HEWLETT PACKARD CO 4-6-8-9-10-16-17-21
HEYER INDUSTRIES INCORPORATED LAB OF MARQUETTE CORP 8-10-17
HICKDK ELECTRICAL INSTRUMENT CO 2-3-7-8-10-11-12-13-14-16-17-18-20-22
HOUSTON INSTRUMENT CORP BELLAIRE 17
HOUSTON INSTRUMENT CORP 16
HOWELL INSTRUMENTS INC 21
HOYT ELECTRICAL INSTRUMENT WDRKS 8-17
HYCON MFG CO 21
HYDROPOISE INC SUB BROOKS INST CO 6
IDEAL PRECISION METER CO 4-8-17
INDUSTRIAL CONTROL CO 8
INDUSTRIAL DEVICES INC 17
INDUSTRIAL INSTRUMENTS INC 10
INDUSTRIAL TEST EQUIPMENT CO 11-13
INDUSTRIAL WINDING MACHINERY CORP 15
INSTRUMENT ELECTRDNICS CORP 16
INSTRUMENT MASTERS INC 4-8-9-10-17-20
INSTRUMENTS INC 2
INTERCONTINENTAL INSTRUMENTS INC 21
INTERNATIONAL INSTRUMENTS INC 4-8-17-20
INTL INSTRUMENT INC 4-8-17-20
IRWIN LABS INC 5
ITI ELECTRONICS INC 20
JACKSDN ELECTRICAL INSTRUMENT CO 16
JETRONIC INDUSTRIES 6-10-16-20-21
JONES ELECTRONIC CO INC M C 18
KAY ELECTRIC CD 16
KEITHLEY INSTRUMENTS INC 10-16-17-22
KELL STROM TOOL CO INC ELECT DIV 6
LAMPKIN LAB INC FDC DIV 0-6
LAMPKIN LABS INC 6
LANDSVERK ELECTROMETER CO 1-17
LAVOIE LABS INC 6
LEEDS & NDRTHRUP CO 5-8-10-17
LEYGHTON-PAIGE CORP 4-12-17
LINK DIV GENERAL PRECISION INC 21
MACLEOD & HANOPOL 2-10
MARCONI INSTRUMENTS 6-16
MARINE ELECTRIC CDRP 3
MARION INSTRUMENT DIV 4-8-17
MASTERCRAFT INSTRUMENT CO 4-8-17
MAXSON ELECTRONICS CORP N Y 11
MAXSON INSTRUMENTS DIV MAXSON ELECTRONICS CORP 11
MAXSON ELECTRONICS CORP ELECTRONIC DES DIV 6-11-21
MCMARTIN INDUSTRIES INC 6
MEASUREMENT ENGG LTD 12-18
MEASUREMENTS DIV MC GRAW-EDISDN CO 6-10-16-17
MEDISTOR INST CO 1-16
MELABS 6
MERIDIAN METALCRAFT INC 6
MESUR MATIC ELECTRONICS CORP 16-17
METAL SPECIALTY PRODUCTS CORP 6
METER MAKERS INC 20
METERS INC 4-8-10-17-20
METETELIC CORP 1-4-8-17
METRONIX INC 16
MICRO INSTRUMENT CD 2-17
MICRDWAVE ASSOCIATES INC 6
MID-EASTERN ELECTRONICS INC 1
MILLEN MFG CD JAMES 6
MILLER CO M C 0-4-8-17-20-22
MILLIVAC INSTRUMENTS INC 8-10-16-17-20
MINI-TOOL TECHNICAL INDUST INC 10-17
MINNEAPOLIS-HONEYWELL PRECISION METER DIV 8-17
MINNEAPOLIS-HONEYWELL BROWN INST DIV 1
MODEL ENGG & MFG INC 7-10-12-17-18-20
MONROE ELECTRONICS INC 1
MOSELEY CD F L 17
MOTOROLA COMMUNICATIONS & ELECT INC 6-17
MUIRHEAD INSTRUMENTS INC 11-16
MURA CORP THE 4-10-17-20
MUTRON INC 17
NEW LONDON INST CO INC 6
NON LINEAR SYSTEMS INC 20-21
NORTH ATLANTIC INDUSTRIES INC 11
NORTH ATLANTIC INDUST INC 11-16-18-21
NORTHEAST ELECT CORP 16
NORTHERN RADIO MFG CO LTD 6
NUCLEAR-CHICAGO CORP 1
NUCLEAR-ELECTRONICS CORP 16
NUCLIDE ANALYSIS ASSOC 1-4-16-17
NUTRON DIV WESTMORE INC 20
OHIO SEMICONDUCTORS DIV TECUMSEN PRODS CO 5
ONIC DEVICES INC 6-9
ORION ELECTRONICS CORP 11-17
PACE ELECTRICAL INSTRUMENTS CO 4-8-9-17
PACO ELECTRONICS CO INC 1-2-4-8-10-16-17-20
PARADYNAMICS INC 12
PARKER ELECTRICAL INSTRUMENT CORP 4-6-8-9-17
PHAOSTRON INSTRUMENT & ELECTRONIC CO 4-6-8-10-16-17
PHILCO CORP SIERRA ELECTRONIC DIV 16
PLANETRONICS INC 16-20
POLYTRONICS CD 10
POTTER AERONAUTICAL CORP 6
PRD ELECTRONICS INC 6
PRECISE ELECTRDNICS & DEVELOPMENT CORP 16
PRECISION SPECIALTIES INC 15
PRINCETON APPLIED RESEARCH CORP 21
QUAN TECH LAB INC 8
Q V S INC 8-17
RADAR MEASUREMENTS CORP 6-7-18
RADIAPHONE CO 16
RCA ELECTRN TUBE DIV INDIANAPLS 10-16-17-20
RCA ELECTRN TUBE DIV MARION 10-16-17-20
RCA ELECTRN TUBE DIV HARRISON 10-16-17-20
RCA ELECTRN TUBE DIV WOODBRIDGE 10-16-17-20
RCA ELECT TUBE DIV CINN 10-16-17-20
RCA ELECTRN TUBE DIV LANCASTER 10-16-17-20
RADIO FREQUENCY LABS INC 5
RANGERTONE INC 6
RAWSON ELECTRICAL INSTRUMENT CO 4-5-8-12-17-18-20-22
REDCOR CORP 18
RESEARCH INDUSTRIAL LAB OF ELECTRDNICS 10-16
RIL ELECTRONICS CORP 1-10-16
ROBERTSON INSTRUMENT CO 10-16-17-20-21
ROBINAIR MANUF CORP 20
ROHDE & SCHWARZ 2-6-7-10-20
ROWAN CONTROLLER CO RED BANK 4-6-8-10-14-16-17-20
SANGAMO ELECTRIC CO 4-13-17-18-19
SAVOY ELECTRONICS INC FT LAUDERDALE 6
SCOPES CO INC 16-20
SFCO ELECTRONICS INC 16
SFKONIC INC 4-17
SEMITRONICS CORP 4-8-17
SERVICE INSTRUMENTS CORP 16
SERVICE INSTRUMENT CORP 10-16
SHURITE METERS 4-17
SIERRA ELECTRONIC DIV PHILCO CDRP 12-16-18
SIMMONDS PRECISION PRODS GLENDALE 2
SIMPSON ELECTRIC CO DIV AMER GAGE & MACH CO 2-3-4-5-6-7-8-9-10-11-12-16-17-18-19-20
SIMPSON ELECTRIC CO FLAMBEAU 4-6-8-9-10-11-12-14-16-17-18-20
SIMPSON ELECTRIC CO MERCER 2-4-6-10-16-17-20
SINGER METRICS DIV SINGER MFG CO 4-5-6-8-9-12-13-17-18-22
SINGER METRICS SENSITIVE RES DIV 4-5-6-8-9-12-13-17-18-22
SIVERS LAB 6
SMITH-FLDRENCE INC 8-10-16-17-20-21
THE SOLARTRON ELECTRONIC GRDUP LTD 14-21
SOLID STATE ELECTRONICS CD 6
SPECTRO MAGNETIC INDUST 5
STERLING MFG CO 4-8-17
STEVENS-EVANS INC 10-17-21
SUMMERS & MILLS INC 1-2-3
SUN ELECTRIC CORP 2-3-4-6-8-10-17
SUNSHINE SCIENTIFIC INSTRUMENT 8-10-14-16-17-18-20
SWEENEY MFG CO B K 15-17-22
SYSTRON DONNER CORP 21
TAFFET ELECTRONICS INC 6
TEKTRDNIX INC BEAVERTON 2
TELECHROME MFG CORP 6
TELOSTAT CORP 10

TESTING MACHINES INC 15
THERMOLYNE CORP 4-8-17
THETA INSTRUMENT CORP 11-17
TORQUE CONTRDLS INC 15
TRICONIX INC 12
TRIO LABS INC 16
TRIPLETT ELECTRICAL INSTRUMENT CORP 4-8-17
TRIPLETT ELECTRICAL INST BLUFFTON 4-8-9-10-14-16-17-18-20
VACUUM ELECTRONICS CORP 1
VARO MFG CO 6
VENNER ELECTRONICS LTD 21
VERCO INC 4-6-10-17
VOLTRON PRODUCTS 4-6-11-12-16-17-18
WACLINE INC 4-6-8-17
WASHINGTON TECHNOLOGICAL ASSOC INC 1
WAVEFORMS INC 16
WAVELINE INC 6
WEIDNHOFF CORP 4-17
WELCH SCIENTIFIC CO W M 4-10-11-17-18
WESTERN APPARATUS 17
WESTERN ELECTRODYNAMICS 0
WESTMORE INC 10-17-20
WILK INSTRUMENTS DIV QUALITY ELEC CO 17
WILTRON CO 11
WINTRONICS INC 11
YOKOGAWA ELECTRIC WKS INC 11-13-17-18
ZACHARIAS ELECTRONICS CORP 10
ZINN INSTRUMENTS 21

METERS–RF 3000

- Ammeters, RF 1
- Meters, attenuation 2
- Meters, distortion 3
- Meters, field strength 4
- Meters, FM Deviation 5
- Meters, grid dip 6
- Meters, output 7
- Meters, phase 8
- Meters, RF frequency 9
- Meters, R–F power 10
- Meters, standing wave ratio 11
- Meters, volt 12
- Meters, wave 13

ADVANCED MEASUREMENT INST INC 5-6
AD-YU ELECTRONICS LAB INC 8
AEROSPACE RESEARCH INC 11
AIRBORNE INSTRS LAB DIV CUTLER HAMMER INC 10
ALCO ELECTRONIC PRODUCTS INC 6
AMERAC INC 13
AMERICAN ASTRO-SYSTEMS 1-2-3-4-5-6-7-8-9-10-11-12-13
AMERICAN MACH & FOUNDRY CO NEW YORK 9
ARF PRODUCTS INC RATON 5
ASSEMBLY PRODUCTS INC 1-7-10-12
BACH-SIMPSON LTD 1-12
BARKER & WILLIAMSON INC 3-6-9-11-13
BECKMAN INST INC BERKELEY DIV 9
BENCO TELEVISION ASSOC LTD 4-10-12
BIRO ELECTRONIC CORP 10
BOONTON ELECTRONICS CORP 3-6-10
BORG-WARNER CONTROLS 10-11-12
BRUNO NEW YORK INDUST CORP 10
BUDELMAN ELECTRONICS CORP 5-9
CAORE INDUSTRIES CORP 4-10
CHEMALLOY ELECTRONICS CORP 10
DAVEN CO 2-7
DAYSTROM INCORPORATED WESTON INSTRUMENTS DIV 1-7-9-12
DECITRON ELECTRONICS CORP 10
DIAMOND ANTENNA & MICROWAVE CORP 8-9-13
DOUGLAS MICROWAVE CO 11
DYTRONICS CO 8
ELECTRO IMPULSE LAB INC 9-10
ELECTRONIC DEVELOPMENT LABS 1
ELECTRONIC INSTRUMENT CO INC 12
ELECTRONICS OF CLEARFIELD INC 9-10
ELECTRONICS SYSTEMS INC 8
EMPIRE DEVICES PRODUCTS CORP 4
ENGELHARD INDUSTRIES INDUST EQUIPT DIV 12
ENGELHARD INDUSTRIES INC 1
ENGINEERING ASSOCIATES 4-6-9-11
FERRIS INDUSTRUMENT CORP 4
FREQUENCY ENGG LABS 9-13
F X R INC WOODSIDE 13
GENERAL COMMUNICATION CO 9-10
GENERAL METERS INC 1-12
GENERAL MICROWAVE CORP 2-4-9-10-11-13
GENERAL RADIO CO 5-13
GERTSCH PRODUCTS INC 5
GREIBACH INSTRUMENT SCORP 1-12
HAMMARLUND MFG CO MARS HILL 9
HEATH CO SUB OF DAYSTROM INC 4-6-7-10-11-12
HEATH CO DIV OF DAYSTROM INC ST JOS 6
HEWLETT PACKARD CO 10-11-12-13
HEYER INDUSTRIES INCORPORATED LAB OF MARQUETTE CORP 12
HICKOK ELECTRICAL INSTRUMENT CO 1-12
IDEAL PRECISION METER CO 1-12
INSTRUMENT MASTERS INC 1-12
INTERNATIONAL INSTRUMENTS INC 12
JENNINGS RADIO MFG CORP SAN JOSE 12
JONES ELECTRONIC CO INC M C 10-11
KAY ELECTRIC CO 12
LAMPKIN LABS INC 5-9
LAVOIE LABS INC 5
MARCONI INSTRUMENTS 5-9-10
MAXSON ELECTRONICS CORP ELECTRONIC DES DIV 5-8
MCMARTIN INDUSTRIES INC 5-9
MEASUREMENTS DIV MC GRAW-EDISON CO 4-5-6-9-12
MELABS 9
METAL SPECIALTY PRODUCTS CORP 6-9
MICRO INSTRUMENT CO 12
MILLEN MFG CO JAMES 6-9-11
MILLIVAC INSTRUMENTS INC 12
MOBIL ELECTRONICS MFG CO 4-10
MODEL ENGG & MFG INC 7-10-12
MOTOROLA COMMUNICATIONS & ELECT INC 12
NEW LONDON INST CO INC 5
NORTHEAST ELECT CORP 10
ORION ELECTRONICS CORP 7-12
PACO ELECTRONICS CO INC 6-12
PHILCO CORP SIERRA ELECTRONIC DIV 10
PHILMORE MFG CO INC 4
PLAS TRON CORP 4-10
PRD ELECTRONICS INC 11
PROBESCOPE CO INC SYOSSET 3-4-5-9-13
PROJECTS UNLIMITED INC 11
RADAR MEASUREMENTS CORP 10-11-13
RADATRON INC 4-10-11
RAILWAY COMMUNICATIONS INC 13
RAWSON ELECTRICAL INSTRUMENT CO 12
REMANCO INC 9-10
SECO ELECTRONICS INC 10-11
SERCO ELECT RESEARCH CORP 11
SERVICE INSTRUMENT CORP 12
SIERRA ELECTRONIC DIV PHILCO CORP 10
SIMPSON ELECTRIC CO DIV AMER GAGE & MACH CO 1-9-12
SIMPSON ELECTRIC CO FLAMBEAU 12
SINGER METRICS DIV SINGER MFG CO 1-12
SINGER METRICS SENSITIVE RES DIV 1-12
SMITH ELECTRONIC INC 4
SPERRY MICROWAVE ELECT INC 2-4-9-10-11-13
STODDART AIRCRAFT RADIO CO 4
SUN ELECTRIC CORP 1-4-7-9
SUNSHINE SCIENTIFIC INSTRUMENT 1-12
SYSTRON DONNER CORP 13
TAFFET ELECTRONICS INC 6-9
TELEMET CO 8
TRICONIX INC 4
TRIPLETT ELECTRICAL INSTRUMENT CORP 1
TRIPLETT ELECTRICAL INST BLUFFTON 1
VITRO ELECTRONICS DIV OF VITRO CORP OF AM 4-8
WACLINE INC 1-12
WAVELINE INC 2-9-11-13
WEINSCHEL ENGG 2-4-10-13
WILK INSTRUMENTS DIV QUALITY ELEC CO 12
WILTRON CO 8-11
YOKOGAWA ELECTRIC WKS INC 1-12

METERS, AUDIO 3100

- Meters, A–F 1
- Meters, dicibel 2
- Meters, distortion 3
- Meters, intermodulation 4
- Meters, recording 5
- Meters, wow & flutter 6

AIRPAX ELECTRONICS PACIFIC DIV 6
AMERICAN ASTRO-SYSTEMS 1-2-3-4-5-6
AMMON INSTRUMENTS INC 2
AMPLIFIER CORP OF AMER 6
ASSEMBLY PRODUCTS INC 2-5
AUDIO INSTRUMENT CO 4
AUDIO PRECISION AIDS INC 1
BALLANTINE LABS INC 2
BARKER & WILLIAMSON INC 3
BORG-WARNER CONTROLS 1-2
CLOUGH BRENGL E CO 2
DAVEN CO 2-3
DAYSTROM INCORPORATED WESTON INSTRUMENTS DIV 1-2
DYNAMU MAGNETRONICS CORP DIV MAICO ELECT IND 2
ELECTRO-MECHANICAL INSTRUMENT CO 1
ELECTRONIC INSTRUMENT CO INC 3
GENERAL RADIO CO 3-4
HEATH CO SUB OF DAYSTROM INC 3
HEWLETT PACKARD CO 1
HICKOK ELECTRICAL INSTRUMENT CO 1
HOYT ELECTRICAL INSTRUMENT WORKS 2-5
IDEAL PRECISION METER CO 1-2
INDUSTRIAL ACOUSTICE CO 2
INTERNATIONAL INSTRUMENTS INC 2
INTL INSTRUMENT INC 1
ITI ELECTRONICS INC 6
KAY ELECTRIC CO 1-2-5
LANGEVIN DIV OF SONDTEC INCORP 2
MARION INSTRUMENT DIV 3
MAXSON ELECTRONICS CORP ELECTRONIC DES DIV 2
METERS INC

MILLIVAC INSTRUMENTS INC 1
MURA CORP THE 1
NORTH ATLANTIC INDUST INC 3-4
NORTHEAST ELECT CORP 1
NORTHERN RADIO MFG CO LTD 2
ORION ELECTRONICS CORP 1
PACE ELECTRICAL INSTRUMENTS CO 2
PROBESCOPE CO INC SYOSSET 1-2-3-4-6
QUALITONE CO 1
QUAN TECH LAB INC 3-6
RCA ELECTRN TUBE DIV INDIANAPLS 1
RCA ELECTRN TUBE DIV MARION 1
RCA ELECTRN TUBE DIV HARRISON 1
RCA ELECTRN TUBE DIV WOODBRIDGE 1
RCA ELECT TUBE DIV CINN 1
RCA ELECTRN TUBE DIV LANCASTER 1
ROBINS INDUSTRIES CORP 2
SCOTT INC H H 2
SIMPSON ELECTRIC CO DIV AMER GAGE & MACH CO 1-2
SIMPSON ELECTRIC CO FLAMBEAU 2
SUN ELECTRIC CORP 1
THETA INSTRUMENT CORP 2
TRIPLETT ELECTRICAL INSTRUMENT CORP 2
TRIPLETT ELECTRICAL INST BLUFFTON 1-2
WACLINE INC 1
WAVEFORMS INC

METERS, SPECIAL PURPOSE 4000

- Boxes, echo 1
- Calorimeters 2
- Gaussmeters 3
- Magnetometers 4
- Meters, acceleration 5
- Meters, cable testing 6
- Meters, counting rate 7
- Meters, deflection 8
- Meters, deviation 9
- Meters, elapsed time 10
- Meters, electronic micrometer 11
- Meters, events-per-unit time 12
- Meters, flutter 13
- Meters, goniometer 14
- Meters, humidity 15
- Meters, infrared 16
- Meters, photoelectric 17
- Meters, pyrometer 18
- Meters, rate 19
- Meters, ratio 20
- Meters, tachometer 21
- Meters, thermocouple 22
- Meters, time 23
- Meters, ultra-violet 24
- Meters, vibrating read 25
- Meters, vibration 26
- Meters, X-ray intensity 27
- Meter shunts 28
- Micromanometers 29
- Multipliers, meter 30
- Tensiometers, wire 31

ABBEY ELECTRONICS CORP 22
ADVANCED INSTRUMENTS 0
AD-YU ELECTRONICS LAB INC 6
AIRPAX ELECT INC SEMINOLE DIV 21
AIRPAX ELECTRONICS PACIFIC DIV 21
ALNOR INST CO DV OF ILL TESTING LABS INC 15-18-22
ALPHA SCIENTIFIC LABS INC 3
ALWAC COMPUTER DIV EL-TRONICS INC 6
AMERAC INC 1
AMERICAN GYRO DIV TAMAR ELECT INC 22
AMF INSTR DIV AMER MACH & FDRY 21
AMSTRO CORPORATION 10-18-21-23
ANNIS CO R B 4-10-20-23
APPLIED CONTROL CORP 3
ASSOCIATED ELECTRICAL INDUSTRIES LTD 18-26
ASSOCIATED RESEARCH INC 6
ATELIERS DE MONTAGES ELECT 7
ATOMIC ACESSORIES INC 7-10-19
AUTOMATION DYNAMICS CORP 1-6
AUTO TEST INC CHICAGO 21-28
AVTRON MFG INC 12
BACH-SIMPSON LTD 10-21-28-30
BALLANTINE LABS INC 30
BARBER-COLMAN CO 18-22
BARNES DEVELOPMENT CO 9
BARNETT INST CO 28
BEARING INSPECTION INC 26
BECKMAN INST INC BERKELEY DIV 10-12-20
BELL INC F W 3
BERGEN LABS INC 10
BIDDLE CO JAMES G 6-10-21-25
BRISTOL MOTORS DIV VOCALINE CO AMERICA INC 23
BYREX CORP 8

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

PRODUCTS & MANUFACTURERS

CALIFORNIA COMPUTER PROD INC 12
CAMBRIDGE INSTRUMENT CO INC 15
CANADIAN RESEARCH INSTITUE 6-17-18-21-22-28-29-30
CHEMALLOY ELECTRONICS CORP 2
CHRONO LOG CORP 10-23
CIMRON CORP 20
COLEMAN INSTRUMENTS INC 17
CONRAD CARSON ELECTRONICS INC 15
CONSOLIDATED ELECT CORP 26
CORDIN CO THE 0
CRAFT LABS 6-18
CRAMER DIV GIANNINI CONTROLS CORP 10-23
CURIC CORP 2-7-20
CURTIS INSTRUMENTS INC 10-17-23
CUSTOM SCIENTIFIC INSTRUMENTS INC 31
DALMO VICTOR CO DIV TEXTRON INC 4
DAYSTROM INC TRANSICOIL DIV 21
DAYSTROM INCORPORATED WESTON INSTRUMENTS DIV 10-21-22-28-29-30
DEJUR-AMSCO CORP ELECTRONICS DIV 10-12-17
DEMENT LABS 16-24
DIAMOND ANTENNA & MICROWAVE CORP 1
DICE CO J W 11
DILLON & CO INC W C 31
ELECTRIC TACHOMETER CORP 7-12-21
ELECTRO IMPULSE LAB INC 2
ELECTRO INSTRUMENT INC 9-10-23
ELECTROMATIC EQUIP CO 31
ELECTRO MEC INSTRUMENT CORP 14
ELECTRO PHYSICS CO 16-17-24
ELECTRO PRODUCTS LABS INC 21
ELECTRONIC APPLICATIONS INC 13
ELECTRONIC COUNTERS INC 7
ELECTRONIC DEVELOPMENT LABS 18-22-28
ELGIN MICRONICS DIV ELGIN NAT WATCH CO 10-23
ENDEVCO CORP 5-26
ENGINEERING ASSOCIATES 1
ENGLER INSTRUMENT CO 7-10-23
E O ELECTRONICS INC 26
EPIC INC 6-10-18-21-26
EPSCO INC CAMBRIDGE 12
ERWOOD INC 26
ESTERLINE ANGUS INSTRUMENT COMPANY INC 12-21
FARRAND OPTICAL CO INC 16-17-24
FLOW CORP 22-29
FORK STANDARDS INC 21
GAMMA SCIENTIFIC INC 17
GARDNER LAB INC 16-17
GB COMPONENTS INC 28
GEARTRONICS CORPORATION 21
GENERAL COMMUNICATION CO 1
GENERAL KINETICS INC 31
GENERAL METERS INC 21-29
GENERAL MICROWAVE CORP 1-2
GENERAL RADIO CO 5-9
GEOTECHNICAL CORP 5-26
GERTSCH PRODUCTS INC 20
GIANNINI CONTROLS CORP CRAMER DIV 10-23
G M MFG CO 2-15-17-31
GRAY INSTRUMENT CO 28
GREINER CO EMIL 2
HACKER INSTRUMENTS INC 14-17
HALEX INC 3-4
HAYDON CO A W WATERBURY 7-10-12-23
HEATH CO OIV OF DAYSTROM INC 21
HEWLETT PACKARD CO 2-12-20-21-28-30
HEYER INDUSTRIES INCORPORATED LAB OF MARQUETTE CORP 21-28
HICKOK ELECTRICAL INSTRUMENT CO 3-11
HICO CORP 17-26
HILL & CO E VERNON 15-29
HOBBS CORP JOHN W DIV STEWART-WARNER CORP 10-23
HOWELL INSTRUMENTS INC 18-21-22
HOYT ELECTRICAL INSTRUMENT WORKS 28
HUMPHREY INC 5-20
HUPPERT CO K H 18
HURLETRON INC WHEATON ENG DIV 23
HYOROPOISE INC SUB BROOKS INST CO 19
HYGRODYNAMICS INC 15
IDEAL PRECISION METER CO 22-28
ILLUMITRONIC ENGG CO 31
IMPACT-O-GRAPH CORP 5-12-26
INDUSTRIAL TEST EQUIPMENT CO 20
INDUSTRIAL WINDING MACHINERY CORP 31
INSTRUMENT LABS CORPORATION 6
INTERNATIONAL INSTRUMENTS INC 22
INTERNATIONAL RESEARCH & DEVELOPMENT CORP 26
ISOTOPES INC 7
JARVIS ELECTRONICS CORP 14-20-21-30
KENTRON HAWAII LTD 17
KEUFFEL & ESSER CO 5-17
KNOPP INC 9
KORFUND CO INC 26
LABLINE INC 15-21
LAMPKIN LABS INC 9
LEEDS & NORTHRUP CO 18-22
LEHIGH VALLEY ELECT ENGG & MFG CO 9-26
LEKTRA LABS INC 2
LELAND AIRBORNE PRODUCTS 10
THE LEWIS ENGINEERING CO 22
LINK DIV GENERAL PRECISION INC 11-20
MAGNAFLUX CORP 3-4
MAGNETIC INSTRUMENT CO INC 19-20
MARION INSTRUMENT DIV 10
MASTERCRAFT INSTRUMENT CO 18
MAXSON ELECTRONICS CORP ELECTRONIC DES DIV 9-12
MEASUREMENT ENGG LTD 7
MEASUREMENTS DIV MC GRAW-EDISON CO 9
MEASUREMENT SYSTEMS INC 16-17-18-24
MEDISTOR INST CO 11
MELABS 2
METERS INC 18-21-22-28
METRON INSTRUMENT CO DENVER 21
METRON INSTRUMENT CO 21
MILLER ELECTRO RESEARCH LABS 20
MINI-TOOL TECHNICAL INDUST INC 2
MINNEAPOLIS-HONEYWELL PRECISION METER DIV 10
MONROE ELECTRONICS INC 29
MONTRONICS INC 15
MUIRHEAD INSTRUMENTS INC 6-11-22-31
NEWTON INSTRUMENT CO INC 10
NON LINEAR SYSTEMS INC 9-20
NORTH ATLANTIC INDUST INC 20
NUCLEAR-CHICAGO CORP 7-19-25
NUCLEAR MEASUREMENTS CORP 19
NUCLEONIC CORP OF AMERICA 7-10-19
OHIO SEMICONDUCTORS DIV TECUMSEN PRODS CO 4
PACE ELECTRICAL INSTRUMENTS CO 28-30
PACIFIC PHOTOMETRIC INSTRUMENTS 17
PARABAM INC 10
PARKS LAB HENRY FRANCIS 15
PASTORIZA ELECT INC 3
PENNWOOD NUMECHRON CO 23
PERKIN-ELMER CORP SO WILTON PL 2
PHILCO CORP SIERRA ELECTRONIC DIV 2
PHILIPS ELECTRONIC INSTRUMENTS 27
PHOENIX PRECISION INSTRUMENT CO 2
PHYS CHEMICAL RES CORP 15
PICKER X-RAY CORP WAITE MFG DIV INC 27
POWER INSTRUMENTS INC 21
PRD ELECTRONICS INC 1
PRECISION RESISTOR CO 28
PRECISION SPECIALTIES INC 11
PROCESS & INSTRUMENTS 17-24
PYROMETER INSTRUMENT CO 22
QUAN TECH LAB INC 29
Q V S INC 18
RADAR MEASUREMENTS CORP 27
RCA ELECTRN TUBE DIV INDIANAPLS 11
RCA ELECTRN TUBE DIV MARION 11
RCA ELECTRN TUBE DIV HARRISON 11
RCA ELECTRN TUBE DIV WOODBRIDGE 11
RCA ELECT TUBE DIV CINN 11
RCA ELECTRN TUBE DIV LANCASTER 11
RADIO FREQUENCY LABS INC 3
RADIO SPECIALTY MFG CO 9
RAWSON ELECTRICAL INSTRUMENT CO 3-22
RAZDOW LABORATORIES INC 8
ROBERTSON INSTRUMENT CO 20
ROHDE & SCHWARZ 6
ROWAN CONTROLLER CO RED BANK 6-10-28-30
SANGAMO ELECTRIC CO 21-28
SCHOENE ELECTRONICS LABORATORY 11
SCHONSTEDT ENG CO 4
SCOTT INC H H 26
SEABOARD ELECTRONIC CORP 7-19-20
SERVICE ASSOCIATED INC 18-22
SIERRA ELECTRONIC DIV PHILCO CORP 2-6
SIMPSON ELECTRIC CO DIV AMER GAGE & MACH CO 10-23-28-30
SINGER METRICS DIV SINGER MFG CO 3-6-8-20-
SINGER METRICS SENSITIVE RES DIV 6-20-22-28-30 22-28-30
SMITH-FLORENCE INC 6
SOHOT DIV OF THERMOLAB CORP 22
SOLID STATE CONTROLS INC 3
SPACE INSTRUMENTATION CORP 8-21
SPECTRAL DYNAMICS CORP OF SAN DIEGO 26
SPERRY MICROWAVE ELECT INC 1
STANDARD INSTRUMENT CORP 10
STEVENS-EVANS INC 20
STRANOBERG ENGG LABS INC 21
SUN ELECTRIC CORP 10-21-22
SUNSHINE SCIENTIFIC INSTRUMENT 3-6-10-21-23-25-28-29
SYSTRON DONNER CORP 5-8-12-26
TE CO THE 16-24
TECHNICAL PRODUCTS CO INSTRUMENT DIV 26
TELOSTAT CORP 15
TESTING MACHINES INC 8-26
THERMO ELECTRIC CO 18-22
THERMOLYNE CORP 18
THETA INSTRUMENT CORP 9-14
TRACERLAB INC WALTHAM 7-27
TRELCON ENGINEERING CO 0
TRIPLETT ELECTRICAL INST BLUFFTON 28
TROXLER ELECTRONICS LAB INC 7-9
U S TAXIMETER CORP 21
UNHOLTZ DICKIE CORP 26
UNITED AERO PRODUCTS CORP DIV AERO CHATILLON CORP 5-11-26
UNIWAVE INC 21
VERCO INC 9
VIBRATION ENGINEERING PLANT 26
VICTOREEN INSTRUMENT CO, CLEVELAND 7
VOLTRON PRODUCTS 9-21-22
WACLINE INC 10-21-22-28-31
WAVELABS INC 26
WELCH SCIENTIFIC CO W M 17
WEST INSTRUMENT CORP 23
WESTERN APPARATUS 16
WESTMORE INC 21
WILK INSTRUMENTS DIV QUALITY ELEC CO 22-28
WINSTROM 31
YOKOGAWA ELECTRIC WKS INC 21-28-29-30
ZERNICKOW CO O 21
ZINN INSTRUMENTS 20
ZOOMAR INC 17

OSCILLOSCOPES 3600

ALLEGANY INSTRUMENT CO 1-2-10
AMERICAN AIRFRAME CORP 2
AMERICAN ASTRO-SYSTEMS 1-2-3-4-5-6-7-8-9-10-11-12-13-14-15
AMERICAN OPTICAL CO INSTRUMENT DIV 4
ANALAB INSTRUMENT CORP 1-2-7-8-9-10-12-13-14
BACH-SIMPSON LTD 8
BARRY ELECTRONICS CORP NEW YORK 1
BEATTIE-COLEMAN INC 1
BECKMAN INST INC BERKELEY DIV 6
BENRUS WATCH CO INC 2
BUILDING BLOCKS ELECTRONIC CO 8
CALIFORNIA INSTRUMENTS CORP 8
CANADIAN APPLIED RESCH DV A V ROE CANADA LT4 1
CAROL ELECT DIV WEECO 8
CAROL ELECT OIV WEECO INC 8
CENTRAL ELECTRONICS INC 2
CENTRAL RESEARCH LABS 2
CENTRAL SCIENTIFIC CO CHICAGO 8
CENTURY ELECT INST INC TULSA 3-4-6-7
CENTURY ELECTRONICS & INSTS INC SUB CENTURY GEOPHYSICAL CORP 3-4-6
CHADWICK-HELMUTH CO 1
CHICAGO AERIAL INDUSTRIES 1
CAMPAGNIE GENERALE DE METROLOGIE 8
DALLONS LABS 3-4-8
DAYSTROM INCORPORATED WESTON INSTRUMENTS DIV 14
DAYTON ELECT PROD CO INC 8-9-10-12-14
DUMONT LABS INC ALLEN B 1-2-8-13
DYTRONICS CO 2
EDGERTON GERMESHAUSEN & GRIER BOSTON 2-7-13
ELECTRODYNAMIC INSTRUMENT CORP 4-6
ELECTRO INSTRUMENT INC 8-10
ELECTRO-MEDICAL LAB INC 1-3
ELECTRONIC INSTRUMENT CO INC 8
ELECTRONIC MEASUREMENTS CORP N Y 2
ELECTRONIC TUBE & INST DIV GENERAL ATRONICS CORP 1-2-8-9-10-12-13
ELECTRONICS OF CLEARFIELD INC 8
ENSCO INC 2-10
EPIC INC 2-4
FURZEHILL LABS LTD 8
GENERAL ATRONICS CORP ELECT TUBE & INST 1-2-9-10-12-13
GEOTECHNICAL CORP 1-2-3-4-5-6-7
GORDON ENTERPRISES 1
HAMILTON WATCH CO INDUSTRIAL PRODS DIV 2-3-4-5-6-7
HATHAWAY INSTRUMENTS DIV LIONEL 1-6
HEATH CO SUB OF DAYSTROM INC B HARBOR 8
HEATH CO DIV OF DAYSTROM INC ST JOS 8
HEWLETT PACKARD CO 1-2-8-10-13-14
HEYER INDUSTRIES INCORPORATED LAB OF MARQUETTE CORP 8
HICKOK ELECTRICAL INSTRUMENT CO 10
HUGHES AIRCRAFT CO VACUUM TUBE PROD DIV 8-12-13
IT & T INDUSTRIAL PRODUCTS DIV 2-3-4-5-6-7-8-9-10-11-12-13
JACKSON ELECTRICAL INSTRUMENT CO 8
JETRONIC INDUSTRIES 8
LAS LAB INC 1
LAVOIE LABS INC 8-14
LUMATRON ELECTRONICS INC 8
METAL SPECIALTY PRODUCTS CORP 2-8
MICROMETRICAL MFG CO 2
MIDWESTERN INSTRUMENTS 3-4-6
MILLEN MFG CO JAMES 14
MINNEAPOLIS-HONEYWELL HEILAND DIV 3-4-6
MODEL ENGG & MFG INC 8-10-14
NATIONAL UNION ELECT CORP ELECT DIV 8
PACKARD BELL ELECTRONICS CORP LOS ANG 1D
PACO ELECTRONICS CO INC 2-8
PHILBRICK RESEARCHES INC GEORGE A 1-8-10
PIASECKI AIRCRAFT CORP MAYFIELD ELECT DIV 8
PLANETRONICS INC 8
POLYTRONIC RESEARCH INC 8
PRECISE ELECTRONICS & DEVELOPMENT CORP 8
PROBESCOPE CO INC 2-8
PROBESCOPE CO INC SYOSSET 1D
PRODUCERS SALES CORP & PHOTO-SONICS INC 1
RADIAPHONE CO 8
RCA ELECTRN TUBE DIV INDIANAPLS 8
RCA ELECTRN TUBE DIV MARION 8
RCA ELECTRN TUBE DIV HARRISON 8

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

SPECIAL PURPOSE TEST EQUIPMENT 3700

PRODUCTS & MANUFACTURERS

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

STANDARDS 3800

TESTERS 3900

PRODUCTS & MANUFACTURERS

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

TRACERLAB INC WALTHAM 32
TRANE CO 28
TRANS ELECTRONICS DIV BURTON MFG CO 8
TRANSICOIL CORP 17
TRANSISTOR AUTOMATION CORP 8
TRANSISTOR ELECTRONICS CO 8-19
TRIPLETT ELECTRICAL INST BLUFFTON 3-19-20
TURBO MACHINE CO 13
TV UTILITIES CORP DIV NORO PHOTOCOPY CO 0
U S DYNAMICS CORP 25-26-28-29
U S ELECTRONICS CORP ALEXANDRIA 12
U S PLYWOOD CORP 25-26
ULTRAUDIO DIV OBERLINE INC 4
UNHOLTZ DICKIE CORP 23
UNITED AIRCRAFT PRODUCTS INC N Y 30
UNITED CONTROL CORP OVERLAKE INDUSTRIAL PK 25
UNITED PROCESS MACHINERY CO 0
UNIVERSAL INSTRUMENTS CORP 2-8-19
VALOR ELECTRONICS CO 19
VARO INC 4-23
VIBRATION ENGINEERING PLANT 23
VICTOREEN INSTRUMENT CO TULLAMORE DIV 32
VIRGINIA ELECTRONICS CO 1
VOLTRON PRODUCTS 6
VORON ELECTRONICS CORP 0
WABASH MAGNETICS INC 5
WALLSON ASSOC INC 2-8-19-20
WALTHAM ELECTRONICS CORP 20

WATSCO INC 2-8
WAVELABS INC 23
WAVELINE INC 13
WELTRONIC CO 4-20
WESTERN ELECTRODYNAMICS 0
WESTINGHOUSE ELEC CORP ELEC TUBE DIV 12-13-20
WESTMORE INC 19-20
WHITEHALL ELECTRONICS CORP 0-32
WILEY ELECTRONIC PROD CO 1-11
WILTRON CO 19
WINDSOR ELECTRONICS INC 3
WINSLOW PRODUCT ENGG CORP 0
WRIGHT EQUIPMENT CORP 3-8-12-14-19-21
WYLE MANUFACTURING DIV OF WYLE LABS 23-25-26-30
ZACHARIAS ELECTRONICS CORP 1

TOOLS, HAND 6400

Alignment tools 1
Cutters, hole 2
Cutters, metal 3
Cutters, wire 4
Drills, electric 5
Drills, hand 6
Drills, twist 7
Etchers, electric 8
Files 9
Hammers 10
Holders, chassis 11
Knob pullers 12
Lenses, inspection 13
Marking stamps 14
Micrometers 15
Mirrors, inspection 16
Pliers 17
Punches 18
Ratchet wrenches 19
Rivet tools 20
Saws 21
Scales & tapes 22
Scissors 23
Screwdrivers 24
Shears, squaring 25
Snips 26
Solder pots 27
Soldering guns 28
Soldering iron stands 29
Soldering irons 30
Splicing tools 31
Staplers 32
Terminal lug swagiers 33
Tube pin straighteners 34
Tube pullers 35
Tweezers 36
Vises 37
Wire strippers, mechanical 38
Wrenches 39

ACROMARK CO 14
ACRO TOOL & DIE WORKS 11-14
AIR O TRONICS ENG CO 29
ALDEN PRODUCTS CO 33
ALDEN SYSTEMS CO 27
ALVA ALLEN INDUSTRIES 37
AMATON ELECTRONIC HARDWARE CO INC 1-33-37
AMERICAN CYSTOSCOPE MAKERS INC 13
AMERICAN ELECTRIC CABLE CO 4
AMERICAN ELECTRICAL HEATER CO 29-30
AMERICAN FELOMUEHLE CORP 3
AMERICAN OPTICAL 13
AMP INCORPORATED HARRISBURG 33
ANNIS CO R B 8
APCO MOSSBERG CO 39
AUDIOTEX MFG CO/DIV G C TEXTRON INC 24-30-36-38
BALCRANK INC MACHINE TOOL DIV 12
BAUSCH & LOMB INCORP 13
BLACK & DECKER MFG CO 2-5-6-7-10-21-24-25
BLACK & WEBSTER INC 4-10-18-33
BLOWERS INC 16
BOW SOLDER PRODUCTS CO 28-30
BROWN & SHARPE MFG CO 3-15-18
BUCHANAN ELECTRICAL PROD CORP 31-33
BUHL OPTICAL CO 13-16
BY-BUK CO 1
CAIG LABS INC 27-30
CARPENTER MFG CO INC 38
CHAMPION DEARMENT TOOL CO 4-10-17
CHASE MTLS SERV DIV CHASE BRASS & COPPER CO 30
CIRCON COMPONENTS CORP 20-22
CITY MARKING DEVICES CORP 14
CLAUSS CUTLERY CO 4-36
COLUMBIAN ROPE CO 22
CUMMINS PORTABLE TOOLS DIV JOHN OSTER MFG C6 5-28
DEE ELECTRIC CO 27
DESMOND STEPHAN MFG CO 37
DIAMOND TOOL & HORSESHOE CO 17-26-39
DIEHL MFG CO 5-6
DITTMORE FREIMUTH CORP 27-31
THE DOALL CO 3-7-9-15-21
DORMEYER CORP 5-21
DURAMIC PRODUCTS INC 1-14
DYMO CORP 14
EDROY PRODUCTS CO 13
ELECTRAMATIC INC 1-2-3-4-11-12-13-16-17-18-19
ELECTRIC SOLDERING IRON CO 27-28-29-30
ELECTRO PRODUCTS LABS INC 15
EMMERT MFG CO 37
ERASER CO 38
ERIKSON SPECIALIZED TOOL CO 1-4-6-17-19-21-30-38
ERWOOD INC 21
E T C INCORPORATED 33
EYELET TOOL CO 20
FOREDOM ELECTRIC CO INC 5-24
FORSBERG MFG CO 5-6-21-24
GARDNER-DENVER CO 6-19-24
G C ELECTRONICS COMPANY CHEMICAL & TOOL DIV 1-2-4-11-12-13-16-17-18-19-24-34-36-38-39
GC ELECTRONICS CO DIV TEXTRON ELECTRONICS 1-2-3-4-11-12-13-16-17-18-19
GENERAL ELECTRIC CO SHELBYVILLE 27-30
GENERAL SCIENTIFIC EQUIP CO 16-36
GEORGE GORTON MACHINE CO 2-3-8
GREM ENGG CO 23
HARRITON SHARPE CORP 0
HAVIR MFG CO 3-25
HEATH CO DIV OF DAYSTROM INC 30
HEXACON ELECTRIC CO 27-28-29-30
HOBBS CORP JOHN W DIV STEWART-WARNER CORP 13
HOLUB INDUSTRIES INC 38
HUGHES AIRCRAFT CO ELECT PROD DIV 33
HUNTER TOOLS 1-10-17-24-35-36-37-38-39
IDEAL INDUSTRIES INC SYCAMORE 4-8-17-38
IDEAL INDUSTRIES 28-30-38
INDUSTRIAL WINDING MACHINERY CORP 7
INSTRUMENT CASE DIV TA MFG CORP 17
INT EASTERN CO 14
JFD ELECTRONIC CORP 1
JO-LINE TOOLS INC 24-39
GEORGE E KAERCHER CO 20
KEMODE MFG CO 30
KERN INSTRUMENTS INC 1
KESTER SOLDER CO CHICAGO 27-28-29-30
KEYSTONE ELECTRONICS CORP N Y 1-33
KINGSLEY MACHINE CO 14
KLEIN & SONS MATHIAS 1-17-23-24-26-31-39
KRAEUTER & CO 6-17-18-26
KRENGEL MFG CO 10-14-32
KWIKHEAT MFG CO 20-29
LENK MFG CO 28-30
LERCO ELECTRONICS INC 33
LUFKIN RULE CO 15-18-22
LUXO LAMP CORP PORT CHESTER 13-16
LUXO LAMP CORP SAN FRAN 13-16
LYN TRON INC 33
MACDONALD AND COMPANY 4-29
MARQUETTE DIV CURTISS-WRIGHT CORP 19
MASK O MATIC INC 2-18
MATTHEWS & CO JAS 14
MICROLECTRON INC 30
MICRONICS CORP OF AMERICA 1-4-11-17
MILLITEST CORP 1
MINI-TOOL TECHNICAL INDUST INC 4-5-6-7-9-11-13-15-16-17-21-22-23-24-25-26-27-28-29-30-31-36-37-38-39
MONODF INC 8-14
MOODY MACHINE PRODUCTS CO INC 24-39
MORRIS CO J I 3-4-7
MULTICORE SOLDERS LTD 4-31
NEDMAC INC 30
NEUSES INC P K 14-16
NEWMAN CORP M M 30
NEW YORK TWIST DRILL CO INC CHICAGO 7
N Y TWIST DRILL MFG CORP WESTBURY 7
NIAGARA MACH & TOOL WKS 2-3-10-18-25-26
NOBLE & WESTBROOK MFG CO 14
NORWALK CUTTER SHARPENING CO 3-21
OPTIC ELECTRONIC CORP 13-16
ORBIT INDUSTRIES 36
OVERLOAD CONTROL CO 24
PACIFIC UNIVERSAL PROD CORP 16
PORTER INC H K 3-4-24
PRECISION METAL PRODUCTS CO 20
PRICE & RUTZEBECK 2-3-21
PROVO TOOL CO LOS ANGELES CALIF 10-17-18-19-24-39
ROBINAIR MANUF CORP 1
ROSS METALS CO MILTON 34
SIMONDS SAW & STEEL CO 2-21
SKIL CORP 2-3-5-9-24
SLOCOMB CO J T 15
SMITH INC HERMAN H 34-38
SPACEONICS & PORTABLE ELECTRIC TOOLS INC 5-28
SPEC TOOL CO 1-18-39
STANDARD GLOVE CO OF N J 0
STURTEVANT CO P A 39
TECHNICAL DEVICES CO 11
TECHNICRAFT CO 2-30
TEMPRESS RESEARCH INC 30
TERRY CO GEORGE A 5-6
TOPAZ TRANSFORMER PRODUCTS INC 20
TORQUE CONTROLS INC 24-39
TRENT INC 27
TRINOL PRODUCTS LTD 8
TRITON MFG CO 28-30-38
TUBULAR RIVET & STUD CO 20
TUCK MFG CO 24
UNBRAKO SOCKET SCREW CO LTD 24
UNGAR ELECT TOOLS INC 30
VACO PRODUCTS CO 1-10-17-24-33
VIRGINIA ELECTRONICS CO 28
VULCAN ELECTRIC CO 27-29-30
WALDES KOHINOOR INC 17
WALDOM ELECTRONICS INC 33
WALES STRIPPIT INC AKRON 38
WALL MFG CO P 28-30
WALSCO ELECTRONICS MFG CO 1-2-4-11-12-24-35-36-38-39
WATSCO INC 39
WEDGELOCK CORP OF CALIF 1-17
WELLER ELECTRIC CORP 28-30
WEN PRODUCTS INC 5-21-28
WESTERN ELECTRONIC PRODUCTS CO 37-38
WHITNEY METAL TOOL CO 2-3-18-20-25
WILDER MFG CO 29
WILKENS INC ALWIN FR 14
WILMINGTON FIBRE SPECIALTY CO 1-24
WYZENBEEK & STAFF INC 2
X-ACTO INC 37-4-6-7-9-17-18-21-24-36
XCELITE INC 24-39

TRANSFORMERS 7000

Brighteners, TV tube 1
Transformers, antenna matching 2
Transformers, audio 3
Transformers, autotransformer 4
Transformers, bias 5
Transformers, current 6
Transformers, filament 7
Transformers, flyback 8
Transformers, 400 cycle 9
Transformers, HV 10
Transformers, instrument 11
Transformers, isolation 12
Transformers, microwave 13
Transformers, modulation 14
Transformers, plate 15
Transformers, power 16
Transformers, precision matched 17
Transformers, voltage dividing 18
Transformers, pulse 19
Transformers, RF–IF 20
Transformers, toroidal 21
Transformers, transistor 22
Transformers, ultrasonic 23
Transformers, variable 24
Transformers, vibrator 25
Transformers, voltage regulating 26
Transformer, velocity 27

ABBOTT TRANSISTOR LABS INC 9-10-16-20
ABTRONICS INC 11
ACDC ELECTRONICS INC 2-3-4-5-6-7-9-10-11-12-14-15-16-17-19-20-21-22-25
AC ELECTRONICS INC 3-4-5-6-7-9-11-12-14-15-16-17-18-19-20-21-22-26
ACF ELECTRONICS DIV ACF INDUSTRIES INC 13-14-16-19-21-26

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

TRANSMITTERS & ACCESSORIES 7100

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

PRODUCTS & MANUFACTURERS

TUBES 7200

GENERAL PURPOSE

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

ABTRONICS INC 5-19-27
AC RAY ELECTRONICS INC 35
ALLEN ELECTRONICS CORP 35
ALLSTATE ELECTRONICS INC 5-35
AMGLO CORP 11-13-27-28-36
AMPEREX ELECTRONIC CORP HICKSVILLE 5-6-8-9-10-11-12-13-14-15-16-17-19-21-23-24-25-27-29-30-32-33-34-37-38
AMPERITE CO 4
ANTON ELECTRONICS LABS 8-12-37
ANTON MACHINE WORKS 0
ASSOCIATED ELEC IND LTD ELEC APPARATUS DIV 2-11-14-16-17-18-19-24-26-30-31
ATOMIC ACESSORIES INC 12-25
AVNET CORP LOS ANG 33
AVO LTD 43
BARRY ELECTRONICS CORP NEW YORK 1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-16-17-18-19-20-21-22-23-24-25-26-27-28-29-30-31-32-33-34-35-36-37-38
BENDIX CORP RED BANK DIV 3-11-13-16-21-23-24-26-27-30-31-33-37
BOMAC LABS INC 2-11-16-17-18-27-31
BON DE ELECTRONIC LABS INC 13
B & R TOOL & DIE CO 16-27-33
H H BUGGIE DIV BURNDY CORP 42
BURROUGHS CORP ELEC COMP DIV 8-18-27-29
CALVERT ELECTRONICS INC 1-38
CALVIDEO ELECTRONICS INC 5-27-35
CANADIAN MARCONI CO 2-17-23-31-33-34-35
CATHODEON 34
CENTRAL ELECTRONIC MFRS 6-11-12-13-18-21-24-27-29-32-37
CERAMICS INTERNATIONAL CORP 6
CERBERUS AG WERK ELEKTRONENTECHNIK 6-8-11-29-30-37
CETRON ELECTRONIC CORP GENEVA 11-13-15-19-20-21-22-24
CHATHAM ELECTRONICS OIV-TUNG-SOL ELECTRIC 15 4-6-11-13-18-19-21-23-24-27-29-30-32-37
COMET LTD 38
CONDOR ELECTRONICS INC 6-21-23-24-27-32
CONNOLLY & CO WALLACE E 37
CONSOLIDATED VACUUM CORP 20
CONTINENTAL ELECTRONICS CORP LOS ANG 5-22-27-35
CONTINENTAL ELECT CORP OF CALIF 5-22-27-35
DALLONS LABS 5
DEMENT LABS 15-36
DIMENSIONS INC 13-27
DORE CO JOHN L 42
DU-CO CERAMICS CO 6
DUMONT LABS INC ALLEN B 5-9-19-27-35
DUNLEE CORP 38
EDGERTON GERMESHAUSEN & GRIER BOSTON 5-6-11-19-26-28-29-30
EITEL-MC CULLOUGH INC SAN CARLOS 6-11-13-14-16-17-20-21-24-27-29-30-32-33-37
EITEL-MCCULLOUGH INC SAN BRUNO 16
ELECTRICAL REFRACTORIES CO 6
ELECTRO CERAMICS INC SALT LAKE 6
ELECTRONIC ENTERPRISES INC 21-24-27-30-32
ELECTRONIC INDUST INC 8-11-13-18-26-27-29-30-37
ELECTRONIC PRODUCTS CO DIV VICTOREEN 11-12-13-27-37
ELECTRONIC SPECIALTIES MFG CORP 35
ELECTRONIC TUBE & INST DIV GENERAL ATRONICS CORP 5
ELFCTRONICS INC NEWARK 24-30
ELECTRONS INC 24-30
ELECTRON TECHNOLOGY INC 5-11-19-20-27
EMI/US NO HOLLYWOOD 16-17-33
ENGLISH ELECTRIC VALVE CO LTD 3-5-6-11-13-14-16-17-21-22-24-26-30-32-33-34-37
EON CORP 10-12-13-36-37
EUREKA X-RAY TUBE CORP 38
FIELD EMISSION CORP 27-38
FRANKLIN MFG CO 17
FREELAND PRODUCTS CO 32
GEE LAR MFG CO 0
GENERAL ATRONICS CORP ELECT TUBE & INST 5-22
GENERAL DYNAMICS ELECT INFORM TECH DIV 5
GENERAL ELECTRIC CO POWER TUBE DEPT 16-21-32-33
GENERAL ELECTRIC CO RECEIVING TUBE DEPT 6-19-23-27-30
GENERAL ELECTRIC CO POWER TUBE DEPT 6-13-14-16-17-21-24-30-32-37
GENERAL ELECTRIC CO CATHODE RAY TUBE DEPT 5-22-27-34-35
GENERAL ELECTRIC CO TELEVISION RECEIVER DEPT 5-35
GENERAL ELECTRIC CO CLEVELAND 0
GENERAL ELECTRODYNAMICS CORP 15-27-34-36
GENERAL ELECTRONICS INC 4-5-11-21-24-27-28-32-37
GENERAL VACUUM CORP 5
GLADDING MCBEAM & CO LOS ANG 6
GLADDING MCBEAM & CO MONROVIA 6
GORDOS CORP 11-13-24-36
GREENE CORP G G 42
HEATH CO SUB OF DAYSTROM INC 43
HUGGINS LABS INC 3-33
HUGHES AIRCRAFT CO VACUUM TUBE PROD DIV 5-27
HUGHES AIRCRAFT CO MICROWAVE TUBE DIV 3-33
I H MFG CO 23-32
IND HARDWARE MFG CO INC 42
INSTRUMENTS INC 10-12
INTERNATIONAL ELECTRONICS CORP 23-27
ISOLANTITE MFG CORP 6
ITT COMPONENTS DIV CLIFTON 3-5-6-11-15-19-21-24-27-30-32-33-42
ITT COMPONENTS DIV ROANOKE 3-27-33
ITT FEDERAL LABS NUTLEY 3-5-6-9-15-16-19-27-33-34-36
KEMLITE LABS INC 11-13-15-27-28-36
KENTUCKY ELECTRONICS INC 39-40
KFR CORP 7
KING LABS INC
KIP ELECTRONICS CORP 44
KRISS ELECTRONICS INC 5-7-27-35
KUTHE LABS 6-11-24-26-27-29-30
LANCASTER GLASS CORP 0
LEWIS & KAUFMAN ELECTRONICS TUBE DIV 3-16-33
LIONEL CORP LIONEL ELECTRONIC LABS DIV 0-27
LITTON ENGG LABS 6-21-24-27
LITTON INDUSTRIES ELECTRON TUBE DIVISION 3-5-6-7-16-17-18-27-29-33-35
LOUTHAN MFG CO DIV FERRO CORP 6
MACHLETT LABS INC 0
MACKAY RESEARCH LABS 5-9-15-17-27
METOX 42
MICROWAVE ELECTRONIC TUBE CO INC 2-3-16-17-18-26-27-31-33
MICROWAVE ELECT CORP 3-6-16-27-33
MURA CORP THE 23-28
NATIONAL BERYLLIA CORP 6-16
NATIONAL ELECTRONICS INC 14-24-27-30
NATL RADIAC INC 25
NATL TELEVISION TUBE INC 5-35
NATIONAL TELEVISION TUBE INC 5-35
NATIONAL UNION ELECT CORP ELECT DIV 5-8-27-37
NATIONAL VIDEO CORP 5
NP KFR CORP 5-27-35
NUCLEAR CORP OF AMER DENVILLE 6-11-12-13-18-21-24-27-29-32-37
NUCLEAR DEVELOPMENT LAB INC 10-12
PACO PRECISION 43
PEK LABS INC 13-24-28-36-38
PENTA LAB INC 21-30-32
PHILCO CORP LANSDALE DIV 5-7-35
PHILIPS ELECTRONIC INSTRUMENTS 12-25-38
PHOENIX PRECISION INSTRUMENT CO 19
PHOTO - CRYSTALS 19
PRECISION APPARATUS CO 43
PRINCETON DIV ELECTRO MECHANICAL RESCH INC 25-27
RADIATION COUNTER LABS INC 12-25
RADIATION INSTRUMENT DEVELOPMENT LAB INC 25
RCA ELECTRN TUBE DIV INDIANAPLS 5-6-7-11-13-14-15-16-17-19-20-21-22-23-24-25-27-30-31-33-34-35-36-37
RCA ELECTRN TUBE DIV MARION 5-6-7-11-13-14-15-16-19-20-21-22-23-24-25-27-30-32-33-34-35-36-37
RCA ELECTRN TUBE DIV HARRISON 5-6-7-11-13-14-15-16-17-19-20-21-22-23-24-25-27-30-32-33-34-35-36-37
RCA ELECTRN TUBE DIV WOODBRIDGE 5-6-7-11-13-14-15-16-17-19-20-21-22-23-24-25-30-32-33-34-35-36-37
RCA ELECT TUBE DIV CINN 5-6-7-11-13-14-15-16-17-19-20-21-22-23-24-25-27-30
RCA ELECTRN TUBE DIV LANCASTER 5-6-7-11-13-14-15-16-17-19-20-21-22-23-24-25-27-30-31-33-34-35-36-37
RAULAND CORP 5-27-35
RAYTHEON CO MICROWAVE & POWER TUBE DIVISION 1-3-15-16-17-33
RAYTHEON CO INDUSTRIAL COMPONENTS DIV 5-6-8-11-12-13-21-23-24-26-27-30-32-37
RESITRON LABS LOS ANG 5-20-27-31-32-34-35-38
RESITRON LABS INC SANTA MONICA 5-6-11-15-26-27-29-32-34-36-38
SAXONBURG CERAMICS INC 6-27
SCIENTIFIC ELECTRONIC LABS INC 11-13-26
SKIATRON ELECTRONICS TV CORP 5
SKYTRON ELECTRONICS 35
SONOTONE CORP ELMSFORD 23-27
SPERRY ELECTRONIC TUBE DIV SPERRY RAND CORP 3-16-21
SPERRY GYROSCOPE CO OIV SPERRY RAND CORP 16-33
SPERRY ELECTRONIC TUBE DIV SPERRY RAND CORP 3-9-16-18-21-23-38
STANDARD TELEVISION & TUBE CORP 35
STANDARD T V TUBE CORP 35
STEWART ENGG CO 3
STROBLITE CO INC 36
SUPERIOR ELECTRONICS CORP 0
SYLVANIA ELECTRIC PROD INC FULLERTON 5
SYLVANIA ELECT PRODS MICROWAVE DEVICE DIV 16-33
SYLVANIA ELECTRIC PRODS WILLIAMSPORT 3-16-33
SYLVANIS ELECTRIC PRODS SENECA FALLS 5-7-35
SYLVANIA ELECTRIC PRODS S EMPORIUM 8-11-18-23-32
TECHNICAL APPARATUS BUILDERS 0-27
TEXTRON ELECTG GENERAL CEMENT CO 0
THERMAL AMERICAN FUSED QUARTZ CO 0
THERMOSEN INC 24-27-37
THOMAS ELECTRONICS INC 5-27
TRG INCORPORATED BOSTON 3
TUCOR INC 2-3-6-11-16-17-18-20-29-31-33
TUNG-SOL ELECTRIC INC BLOOMFIELD 23
TUNG SOL ELECTRIC INC NEWARK 4-5-9-11-14-18-19-21-23-24-27-29-30
TUNG SOL ELECT ORANGE 5
ULMER CO THE DIV MICROTRON INDUSTRIES INC 20-27
ULTRA-VIOLET PRODUCTS INC 36
UNITED ELECTRONICS 21-27-32
VACUUM ELECTRONICS CORP 20
VARIAN ASSOC PALO ALTO 3-16-33
VICTOREEN INSTRUMENT CO CLEVELAND 8-10-12-13-27-37
VOLTARC TUBES INC 0
WARNECKE ELECTRON TUBES INC 1-3-5-8-9-11-12-13-15-16-17-18-19-21-27-29-30-32-33-37
WATERMAN PRODUCTS CO 5
WATKINS-JOHNSON CO APPL ENGRG 3-21-32-33
WAVELINE INC 18
WESTERN ELECT KANSAS CITY PLANT 0-27
WESTINGHOUSE ELEC CORP ELEC TUBE DIV 2-5-9-11-14-15-16-17-19-20-21-23-24-26-27-29-30-31-32-33-34-35-36
WINDSOR ELECTRONICS INC 5-7-13-15-28-35
N WOOD COUNTER LAB INC 5-8-10-12-25
ZENITH RADIO RES CORP 38

ULTRASONICS 7300

ACOUSTICA ASSOCIATES INC 2-3-6-8
ACOUSTICA ASSOCIATES 2-6-7-8-9-10
ALCAR INSTRUMENTS INC 1-2-3-6-8-10
ALLOYD ELECTRONICS CORP 9
AMERICAN BOSCH CORP 8
AMERICAN TIME PROD INC 2
ANDREA RADIO CORP 6-10
ARENBERG ULTRASONIC LABORATORY INC 6
ASTROSONICS INC 6-8
ATOMIC ACESSORIES INC 2
ATOMIC LABS INC 6
AUTOMATED CONTROLS 6
BEARING INSPECTION INC 2
BENDIX CORP THE POINEER CENTRAL DIV 2-6-8
BENDIX CORP THE SHEFFIELD CORP SUB 7
BLACKSTONE CORP 1-2-6-8
BRANSON INSTRUMENTS INC 2-5
BREW & CO RICHARD D 3-8
CANADIAN RESEARCH INSTITUE 2
CHANNEL INDUSTRIES INC 8
CHESAPEAKE INSTRUMENT CORP 3-6-8
COMMUNICATION MEASUREMENTS LABS 6
CONNECTICUT VALLEY CHEMICALS INC 1-2
COOPER CO D C 2
CREST ULTRASONICS CORP 2-6-8
DALLONS LABS 2
DELCON CORP 3
DELTA SONICS INC 1-2-6-9
DICE CO J W 5
DIGITOOL CORP 8
DIGITROL SYSTEMS INC 3
DYNASONICS CORPORATION 2-6-8-10
ELECTRO CERAMICS INC SALT LAKE 8
ELECTRONIC ASSISTANCE CORP 2-6-8
ELECTRONIC ENTERPRISES INC 2-6
ELION INSTRUMENTS INC 3-6-8
ERIE RESISTOR CORP 8
FERROXCUBE CORP OF MAER 8

PRODUCTS & MANUFACTURERS

WIRE, CABLE & ACCESSORIES 7400

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

For Company Addresses, See Alphabetical Listing of Electronic Mfrs.

REPRINTS ARE AVAILABLE...

A limited number of copies of the following articles from back issues of ELECTRONIC INDUSTRIES are available, free of charge. For copies write, Reader Service Dept., Electronic Industries, 56th & Chestnut Sts., Phila. 39, Pa.

JANUARY 1963
A Transistor Amplifier With AGC
Coaxial Magnetrons A New Class of Tubes
High Speed Digital Communication Networks
For X-Y Plotting Saturable Reactor Sweep Supply
Transient Response Of Ceramic Filters
Designer's Guide To Lamps, Indicator Lights, Illuminated Switches

FEBRUARY 1963
Calibration Laboratory On Wheels
Constructing Broadband R-F Switches
Improving Semiconductor Reliability
Gallium Arsenide: What is Its Status?
Self-Verification—Needs and Methods

MARCH 1963
An Engineer's Guide To Job Hunting
A Simple Electronic Analog Multiplier

APRIL 1963
Connectors & Terminations
Circuit Reliability Criteria
Integrated Circuit Design Techniques
Silicone Dielectrics Improve Connectors
A Look At Modern Diplexers
Function Generation With Active Nonlinear

JANUARY 1962
Inexpensive Remote Pickup Receivers
Shielding An Enclosure
Silicon Logarithmic

FEBRUARY 1962
A Spectrum Analyzer from General Lab Instruments
Measuring Infrared Radiation
Company Educational Programs
Tunnel Diode Switching Times

MARCH 1962
Designing Beam Switching Circuitry
Severe Environmental Potentiometer Applications
A New Suspension for Meter Movements
Designing A CW FM Altimeter
Simplified Resolution Measurements

APRIL 1962
Analyzing Power Transfer In Microwave Systems
Automation for Future Space System Launchings
Tunnel Diode Amplifier Gain
Adjusting Micro-Element Resistors
Design and Packaging for Nuclear Exposure

MAY 1962
Developments In Klystron Oscillators
Proving Long Term Reliability
Effects of Mounting on Accelerometer Response
Measuring Step Function Response
Chemicals for the Electronic Industries

JULY 1962
Generating Microwave Superpower
High Power Transmitter Design

AUGUST 1962
Drawing Ladder Networks Flowgraphs
X-Band Aircraft Antennas
Directed Energy Weapons

SEPTEMBER 1962
Understanding Microwave System Loading
Ceramic Reduces Grid Emission
Analyzing Data By Least Squares

OCTOBER 1962
Nuclear Blast Effects On Components & Equipment
Designing Diffused Integrated Circuit Resistors

NOVEMBER 1962
Passive Detection With Radiometers
Light Modulation With Piezoelectric Crystals
Microwave Tubes State of the Art
Traveling Wave Tubes and Reliability

DECEMBER 1962
Improving AGC Amplifier Control
Phase Shifting With Nonlinear Dielectrics
Microelectronics Today
Portable Tester For Thyratron Tubes

FEBRUARY 1961
Designing 2-Millimeter Wave Components

APRIL 1961
The Problem of Splinter Companies
Satellite Flashing Light System

MAY 1961
Solid Networks
Recording Flow Meter Readings

JUNE 1961
Potentiometers—Terms & Data
FCC Adopts FM Stereo Standards
Selected Printed Circuit Boards
Standard Frequency Stations

JULY 1961
Putting Diode Modulators To Work
Electronic Ignition Systems Designs
Missile Computer Has Self-Checking Capability
Connector Design Considerations
Distributing Industrial Electronic Parts
Switching Drawings Show Logic
Noise Properties of Beam Switching Tubes

SEPTEMBER 1961
Countermeasures Card File System
What Price Reliability?

OCTOBER 1961
Analyzing Non-Linear Circuits
Simplify Your Turntable Operation
The Representative's Role In Electronics

NOVEMBER 1961
High Power TWT's With Wide Bandwidths
Microwaves, Past, Present and Future

DECEMBER 1961
Handling Light With Fiber Optics
Insulating Against Nuclear Effects
Connectors and Galvanic Corrosion
Cataloging Technical Articles
Nuclear Blasts and Unreliability
Ultramicroanalysis
Electronic Materials Now and In The Future

REPRINTS ARE AVAILABLE...

A limited number of copies of the following articles from back issues of ELECTRONIC INDUSTRIES are available, free of charge. For copies write, Reader Service Dept., Electronic Industries, 56th & Chestnut Sts., Phila. 39, Pa.

JANUARY 1960
The Case For DC Restoration
The Importance of International Standards
Applying Transistor "Y" Parameters

FEBRUARY 1960
"TPR" Recording
The R&D Personnel Administrator
100 KW Transmitter Has New Design Ideas

MARCH 1960
Build A Suitcase Studio
Molecular Electronics
Accurate Tracking For Radiotheodolites
Controlling Alternator Frequency
The AC Potentiometer—A New Circuit Component
A One Megabit Storage

APRIL 1960
Bio Medical Measuring In Space
RC Filter Networks In Missile Control
Applying Microwaves To Space Problems
Engineering For Space Opportunity and Challenge
How Coriolis Works
The Challenge of Space

MAY 1960
Ultrasonic Welder Design Considerations
Current Stabilizer Has Wide Dynamic Range
Radar Tester Needs Wide Band AFC
Heat Sinks For Power Transistors
Encapsulating With Alkyd
Double Coil Relay With One Working Gap
Rectification of Narrow Band Noise

JULY 1960
Searching for New Electronic Markets

AUGUST 1960
The Search For New Electronic Markets
Conversion Chart—Decimal To Binary To Gray Code

SEPTEMBER 1960
Bandwidth-Risetime Nomographs
How To—Duplicate Technical Papers

DECEMBER 1960
Using Transient-Testing Techniques
Compact Traveling Wave Tube Design

DECEMBER 1959 & JANUARY 1960
Printed Diode and Resistor Matrices (2 parts)

FEBRUARY 1959
Some Survival Aspects Of Space Travel

MARCH 1959
Interference from the Ionosphere

MAY 1959
Thermal Stresses in Klystron Windows

AUGUST 1959
A Novel Method for Frequency Multiplication
Asymptotes Solve Design Problems

OCTOBER 1959
Shaft Angle Encoders Afford High Accuracy
Sensing RMS Values For Servo Systems

NOVEMBER 1959
Better Resolution Through PPI Shading

DECEMBER 1958
Dividing Wide Frequency Bands
Hermaphroditic Connectors
Maintaining an Analog Computing System

JANUARY 1957
Closed-Circuit Color TV Trains Army Medicos

JUNE 1957
Pepperpot Tube Checks Yoke Linearity

AUGUST 1957
New "Lighthouse" Tube for High Altitudes
A Magnetometer for the Satellite
The Four-Layer Diode

OCTOBER 1957
Semiconductor Rectifiers
Duplexer For Sweep-Frequency Pulse Transmitters

ALSO AVAILABLE
Electron Tube Interchangeability Chart
1963 Microwave Power Tube Directory
1962 Summary of Vacuum Tube Voltmeters
The 1962 Electronic Spectrum Chart is also available. Write on Company letterhead.

Abracadabra and a crystal ball won't put your product on top in today's competitive market. You need two indispensable tools to sell the $11 billion electronic industry:

1. ELECTRONIC INDUSTRIES' exclusive Marketing Assistance Program. M-A-P gives you fundamental facts fast. It helps you determine sales potentials, product applications, specifying influences . . . gives you competitive standings, data on product and company recognition.

2. ELECTRONIC INDUSTRIES magazine. EI presents your advertising story within a framework of editorial vigor to all the important buying influences in over 6100 plants. These constitute 96% of the electronic market.

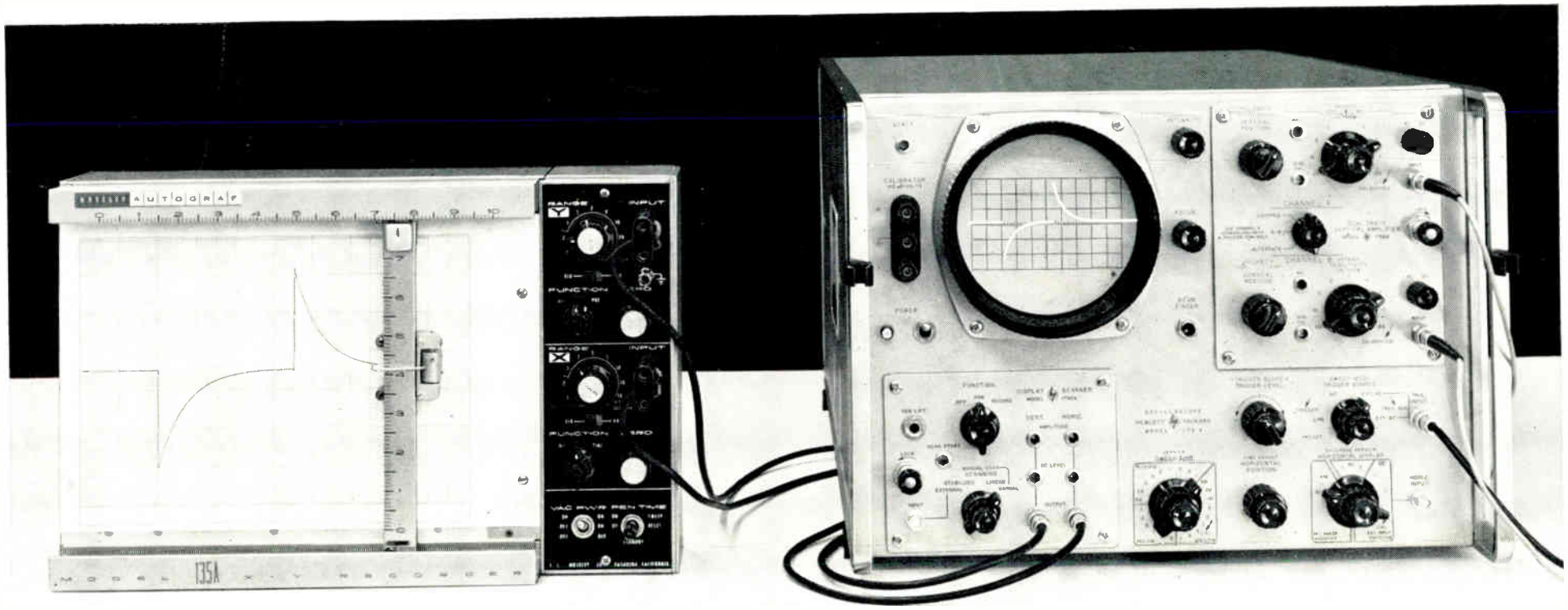
Call your local EI representative for a fact-filled presentation. Marketing-wise, it could be the most important time you spend this year.

ELECTRONIC INDUSTRIES

The Source of Useful Theory and Applied Engineering

A Chilton Publication

Chestnut and 56th Streets • Philadelphia 39, Pa.



High resolution, permanent recordings of waveforms displayed on the hp 175A 50 MC Oscilloscope are now possible with the new hp 1782A Display Scanner Plug-in.

Used with an x-y recorder, such as the Moseley 135 or 2D, the plug-in transforms high speed phenomena to the bandwidth of the recorder and permits large, permanent recordings to be made. The x-y plots provide greater resolution than photographs, are easy to study and keep as permanent records.

This new plug-in offers new versatility for your hp 175A —a 50 mc universal oscilloscope which combines these

PLOT SCOPE TRACES

with your hp 175A 50 MC Oscilloscope

unparalleled advantages:

Full 6 x 10 cm no-parallax display

Rise times of less than 7 nsec at all sensitivities

Sweep speeds to 10 nsec/cm

Vertical and time axis plug-in versatility

Easy to calibrate, easy to maintain

Get complete details on the 175A, its dual trace, fast rise and high gain plug-in amplifiers, and its horizontal plug-ins for sweep delay and time marker. A call to your hp representative will bring a 175A to you for comparison against any high-frequency scope. hp 175A, $1325 without plug-ins; hp 1782A Display Scanner, $425.

Data subject to change without notice. Prices f.o.b. factory. 8433

HEWLETT PACKARD COMPANY

1501 Page Mill Rd., Palo Alto, Calif., (415) 326-7000.
Sales and service representatives in principal areas.
Europe, Hewlett-Packard S.A., 54 Route des Acacias, Geneva, Switzerland; Canada, Hewlett-Packard (Canada) Ltd., 8270 Mayrand St., Montreal, Quebec.

Circle 7 on Inquiry Card

The Revolutionary New RCA 2N2476 & 2N2477

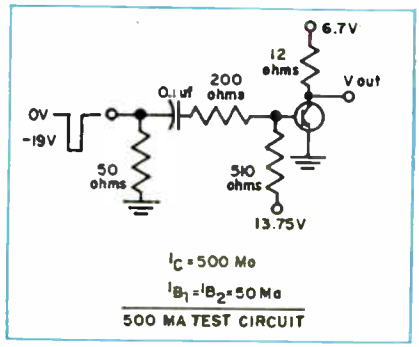
Switch 500 Milliamperes in 50 Nanoseconds

Unique "SHARKSTOOTH" geometry of RCA's new Silicon NPN 2N2476 and 2N2477 provides new levels of performance as core or line drivers in high-speed memory circuits, and in other high-frequency, high-current applications.

The unique internal geometry of RCA's new 2N2476 and 2N2477 achieves a much larger emitter periphery AND a substantially reduced emitter area, providing high beta over a wide range of collector currents AND excellent switching speeds at high currents. For example, these new types have more than adequate speed and current capabilities for driving RCA's new Micro-ferrite Memory Stacks. Check these outstanding performance features:

- **Excellent high-current beta**...20 typ. at $I_C = 1$ amp. for the 2N2476; 40 typ. for the 2N2477 (pulsed condition).
- **Low V_{CE} (Sat) at High Currents**... V_{CE} (Sat) = 0.75V max. for the 2N2476, 0.65V max. for the 2N2477 at I_C = 500 ma, I_B = 50 ma.
- **Low Collector Capacitance** . . . 10pf max.
- **Short Turn-On Time**...25nsec. max., I_C = 150ma, $I_{B_1} = I_{B_2}$ = 15ma.
- **Short Turn-Off Time**...45nsec. max., I_C = 150ma, $I_{B_1} = I_{B_2}$ = 15ma.
- **Dissipation**...0.6 watt max. free-air temp. up to 25°C (in TO-5 case).
- **Gain-Bandwidth Product**.. 250 Mc min.

Call your RCA Representative today for complete information or write RCA Semiconductor and Materials Division, Commercial Engineering, Section CJ6, Somerville, N. J.



AVAILABLE THROUGH YOUR RCA DISTRIBUTOR

RCA **THE MOST TRUSTED NAME IN ELECTRONICS**

RCA SEMICONDUCTOR AND MATERIALS DIVISION FIELD OFFICES—EAST: 32 Green St., Newark 2, N. J., 485-3900 • 731 James St., Room 402, Syracuse 3, N. Y., GR 4-5591 • 605 Marlton Pike, Erlton, N. J., HA 3-4802 • Greater Baltimore Area, 1725 "K" St., N.W., Washington 6, D.C., FE 7-8500 • NORTHEAST: 64 "A" St., Needham Heights 94, Mass., HI 4-7200 • SOUTHEAST: 200 East Marks St., Orlando, Fla., 425-5563 • CENTRAL: Suite 1154, Merchandise Mart Plaza, Chicago 54, Ill., 527-2900 • 2132 East 52nd St., Indianapolis 5, Ind., CL 1-1405 • 5805 Excelsior Blvd., Minneapolis 15, Minn., WE 9-0676 • 714 New Center Bldg., Detroit 2, Mich., TR 5-5600 • 7905 Carpenter Freeway, Dallas 7, Tex., ME 1-9720 • Continental Terrace Bldg., 2785 North Speer Blvd., Room 346, Denver 11, Colo., 477-1688 • WEST: 6801 E. Washington Blvd., Los Angeles 22, Calif., RA 3-8361 • 1838 El Camino Real, Burlingame, Calif., OX 7-1620 • 2250 First Avenue, S., Seattle 4, Wash., MA 2-38'c • GOVERNMENT: 224 N. Wilkinson St., Dayton 2, Ohio, BA 6-2366 • 1725 "K" St., N.W., Washington 6, D.C., FE 7-8500 • RCA INTERNATIONAL DIVISION, 30 Rockefeller Plaza, New York 20, New York, Cable Address: RADIOINTER, N. Y.

Circle 8 on Inquiry Card