March 31, 1961

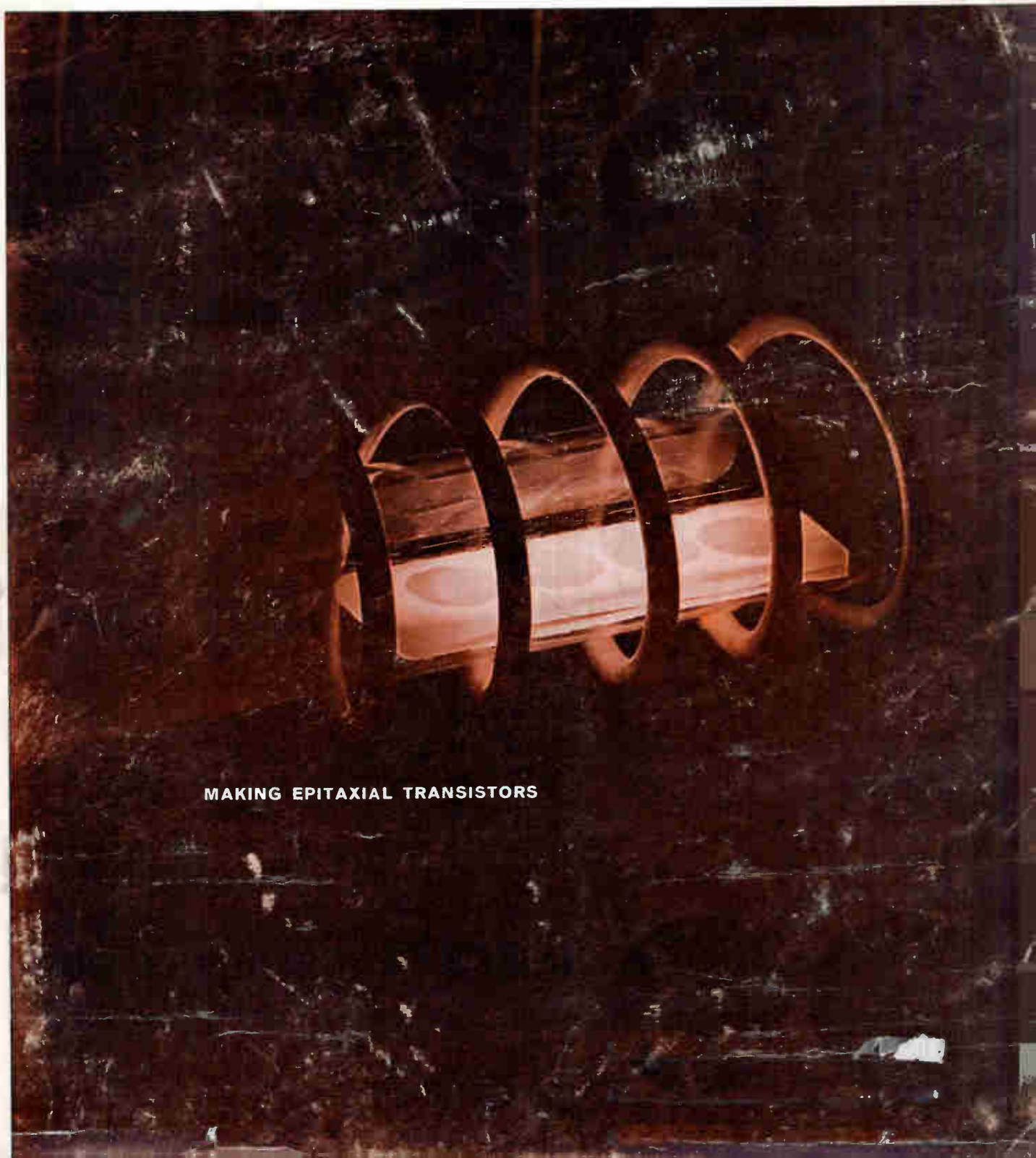
electronics

Circuit design with epitaxial transistors shown below, p 52

Using H-guide feed in flush-mounted microwave antennas, p 54

Cooling transistors with separate thermoelectric elements, p 43

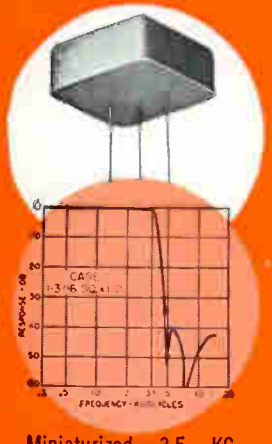
A McGraw-Hill Publication 75 cents



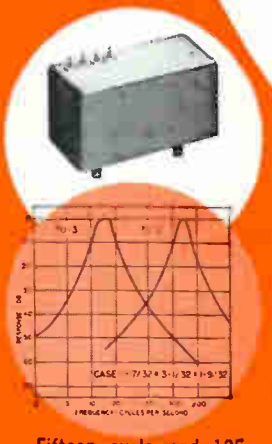
MAKING EPITAXIAL TRANSISTORS

SPECIAL FILTERS

TO YOUR REQUIREMENTS

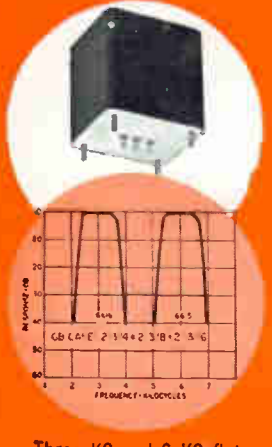


Miniaturized 3.5 KC low pass filter. 10K ohms to 10K ohms. Within 1 db up to 3500 cycles. Greater than 40 db beyond 4800 cycles.

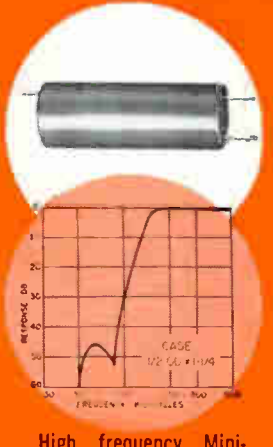


Fifteen cycle and 135 cycle filters for Tacan. 600 ohms to high impedance. Extreme stability —55°C. to + 100°C.

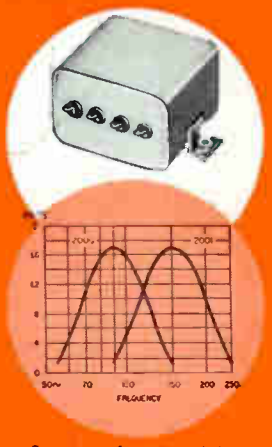
Almost thirty years of experience in the design and production of special filters have resulted in UTC being a first source for difficult units. Present designs incorporate a wide variety of core structures, winding methods, and capacitors to provide maximum performance, stability, and reliability. The units illustrated show a few of the thousands of specials produced by UTC, to customers' requirements, and only slightly indicate the possibilities in present special filter design. Range of frequencies on special units is from .1 cycles to 400 MC.



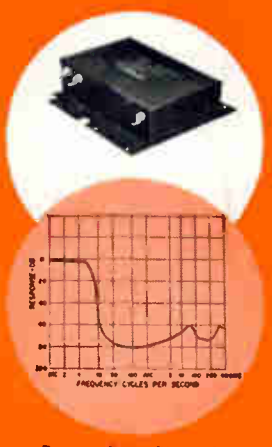
Three KC and 6 KC flat top band pass filters. 400 ohms to 20K ohms. MIL T-27A; each filter 1.7 lbs.



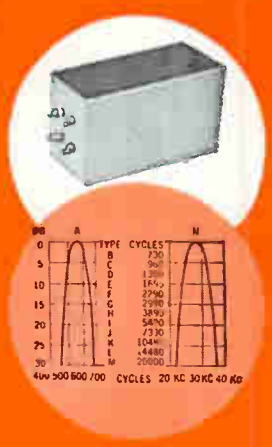
High frequency Mini-filters, .33 oz. MIL-T-27A Grade 5. 150 KC High Pass 3 db to 150 KC, down 45 db below 85 KC. 7500 ohms.



Curves of our miniaturized 90 and 150 cycle filters for glide path systems. 1¼" x 1¾" x 1⅝".



Power line filter from sources of 50 to 400 cycles . . . attentuation from 14 KC to 400 MC . . . 29 cubic inches.



Multi-channel telemetering band pass filters for 400 cycle to 40 KC. Miniaturized units for many applications.

Plus over 1,000 STOCK ITEMS with UTC High Reliability from your local distributor

write for catalog

UNITED TRANSFORMER CORP.

150 VARICK STREET, NEW YORK 13, N. Y.

PACIFIC MFG. DIVISION: 4008 W. JEFFERSON BLVD., LOS ANGELES 16, CALIF.
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "ARLAB"

March 31, 1961

electronics

A McGraw-Hill Publication 75 Cents

W. W. MacDONALD, Editor

J. M. CARROLL, Managing Editor
SENIOR ASSOCIATE EDITORS: Samuel Weber, Roland J. Charest. ASSOCIATE EDITORS: Frank Leary, Michael F. Tomaino, Sylvester P. Carter, William P. O'Brien, John F. Mason, William E. Bushor, Thomas Emma, Sy Vogel, Leslie Solomon, M. M. Perugini, George J. Flynn. ASSISTANT EDITORS: Michael F. Wolff, Nilo Lindgren, Stanley Froud, Stephen B. Gray, Roy J. Bruun, George V. Novotny, Leon H. Dulberger.
REGIONAL EDITORS: Harold C. Hood (Pacific Coast, Los Angeles), Thomas Maguire (New England, Boston), Cletus M. Wiley (Midwest, Chicago). BUYERS' GUIDE EDITOR: George Sideris. ART DIRECTOR: Harry Phillips; Howard R. Berry. PRODUCTION EDITOR: John C. Wright, Jr. EDITORIAL ASSISTANTS: Gloria J. Filippone, Arlene Rudd, Bernice Duffy, Lorraine Rossi, Virginia T. Bastian, Lynn Emery, Avis Pomeranz, Florence Hajaistron.

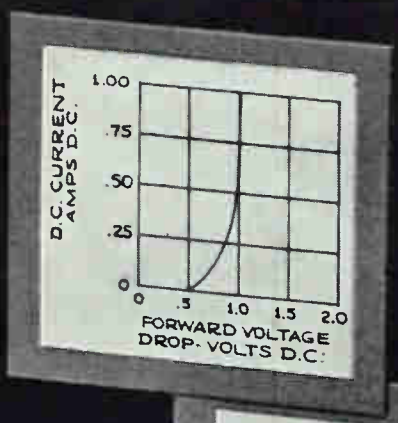
JAMES GIRDWOOD, Publisher

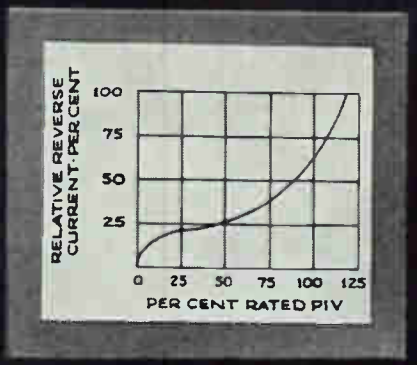
BUSINESS

ENGINEERING

DEPARTMENTS

SARKES TARZIAN
SERIES F
SILICON RECTIFIERS





Tarzian Type	Amps. DC	PIV	Max. RMS Volts	Max. Amps.	
				Recurrent Peak	Surge (4 MS)
2F4	.20	400	260	2.0	20
F-2	.75	200	140	7.5	75
F-4	.75	400	280	7.5	75
F-6	.75	600	420	7.5	75

THERE'S EVEN MORE TO THIS...

This small "F" unit contains the oversize junction that is characteristic of all Tarzian silicon rectifiers. The result is big performance; specifically, lower temperature rise, longer life, increased reliability, and the capacity to handle inrush currents well above normal circuit requirements.

Furthermore, present production of Series F units is at the rate of tens of thousands per day. Production of these units to date is in the millions. Performance testing and life testing go on continuously, of course. The experience of users is not only favorable, but extremely large. And prices are realistic, to say the least.

In short, we don't know of anybody who makes more of these, or who makes them better, or who makes them at less cost. Do they meet your requirements? Write for the facts you need for decision. Application engineering service is also available without cost or obligation.

Where highest quality is in volume production

SARKES TARZIAN, INC.

World's Leading Manufacturers of TV and FM Tuners • Closed Circuit TV Systems • Broadcast Equipment • Air Trimmers • FM Radios • Magnetic Recording Tape • Semiconductor Devices

SEMICONDUCTOR DIVISION • BLOOMINGTON, INDIANA

In Canada: 700 Weston Rd., Toronto 9 • Export: Ad Auriema, Inc., New York

Know ye that we, the corporation of Burnell & Co., upon the recommendation of our customers in the electronics industry do hereby inaugurate the esteemed order of Shrinker Cum Laude.

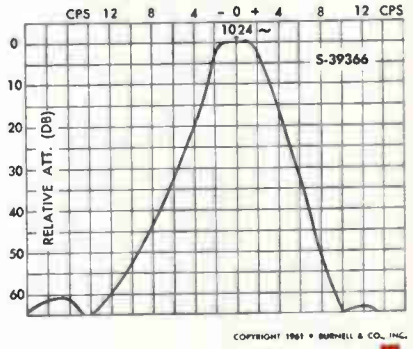
Be it further known that, (without undue modesty), the Shrinker Cum Laude award has been made to Burnell for displaying the highest degree of shrinkmanship in the design and utilization of microminiature, subminiature and miniature toroids, filters and related networks.

The Shrinker Cum Laude award has also been tendered for signal achievement in reducing developmental costs while increasing performance range–a feat accomplished by the designers of the new Burnell high selectivity, high attenuation, 1 kc crystal filter which possesses the following unique characteristics:

Attenuation — 3 db bandwidth — 3.8 cps
Shape Factor 60/6 — 4½:1
Input — 500 ohms
Output Impedance—500,000 ohms
Meets MIL-C 3908 B vibration standards

Other Burnell crystal filters available in frequencies up to 30 mcs with considerable latitude in impedance range. Write for Bulletin XT 455.

Send for membership in Space Shrinkers Club.



Burnell & Co., Inc.
PIONEERS IN microminiaturization OF TOROIDS, FILTERS AND RELATED NETWORKS

EXECUTIVE OFFICE AND PLANT
DEPT. E-33,
PELHAM, NEW YORK
PELHAM 8-5000
TELETYPE PELHAM 3633

PACIFIC DIVISION
SOUTH PASADENA, CAL.
MFD. IN CANADA
BY EDO (CANADA) LTD.
CORNWALL, ONT.
WELLINGTON 2-6774

electronics
Mar. 31, 1961 Volume 34 Number 13

Published weekly, with Electronics Buyers' Guide and Reference issue, as part of the subscription, by McGraw-Hill Publishing Company, Inc. Founder: James H. McGraw (1860-1948).

Title registered U.S. Patent Office; Copyrighted 1961, McGraw-Hill Publishing Company, Inc. All rights reserved, including the right to reproduce the contents of this publication, in whole or in part.

Executive, editorial, circulation and advertising offices McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y. Telephone Longacre 4-3000. Teletype TWX N.Y. 1-1636. Cable McGrawhill, N.Y. Printed in Albany, N. Y.; second class postage paid.

OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, President; Shelton Fisher, Wallace F. Traendly, Senior Vice Presidents; John R. Callaham, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator.

OFFICERS OF THE CORPORATION: Donald C. McGraw, President; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, Executive Vice Presidents; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary.

Subscriptions are solicited only from those actively engaged in the field of the publication. Position and company connection must be indicated on orders. Subscription rates: United States and Possessions, $6.00 one year; $9.00 two years; $12.00 three years. Canada, $10.00 one year. All other countries $20.00 one year. Single Copies, United States and Possessions and Canada 75¢; Buyers' Guide $3.00; Single Copies all other countries $1.50; Buyers' Guide $10.00.

The Publisher, upon written request from any subscriber to our New York Office, agrees to refund that part of the subscription price applying to copies not yet mailed.

Subscribers: Please address all correspondence, change of address notices, subscription orders or complaints to Fulfillment Manager, Electronics, at above address. Change of address notices should provide old as well as new address, including postal zone number if any. If possible, attach address label from recent issue. Allow one month for change to become effective.

Postmaster: Please send Form 3579 to Fulfillment Manager, Electronics, 330 West 42nd Street, New York 36, New York.

Audited Paid Circulation

CROSSTALK

THE IRE SHOW, A RETAKE. Each year as more than 850 of the 4,000-odd manufacturers that make up the electronics industry assemble under one roof for four days hand standing, the keen observer can make some pretty valid deductions about the health and direction of the business.

Undeniably our industry has felt some of the pinch of the recent general business recession. For instance, there were more two-dimensional, stand-up booths at the show, more hardware-store shelf displays of instruments and components, fewer displays of actual systems or large-scale antennas.

However, the show clearly indicated the road upwards to even greater heights of prosperity, a road made possible by the inherent ingenuity of electronics engineers and scientists.

Literally dozens of new components and materials that not long ago were subjects largely for academic discourse today are on the shelf, packaged and ready for sale. And showgoers were looking, too—order books in hand.

At least a half dozen firms had packaged parametric amplifiers ready to go. Traveling-wave and backward-wave tubes were relatively common items. Thin-film memories were offered for sale. One manufacturer has already designed tunnel diodes into a line of pulse generators. Another showed a packaged tunnel-diode amplifier.

All this shows that new materials and devices constantly emerging from research laboratories do not long remain mere curiosities. Furthermore, the time from initial developmental design through preproduction prototype to finished product is constantly decreasing. It used to be some 18 to 24 months. Today a development cycle of six months or even less is not uncommon.

This year's IRE Show demonstrates unmistakably that the electronics industry is moving ahead like never before with the trail being blazed by our research and development engineers who continually think smarter, work faster.

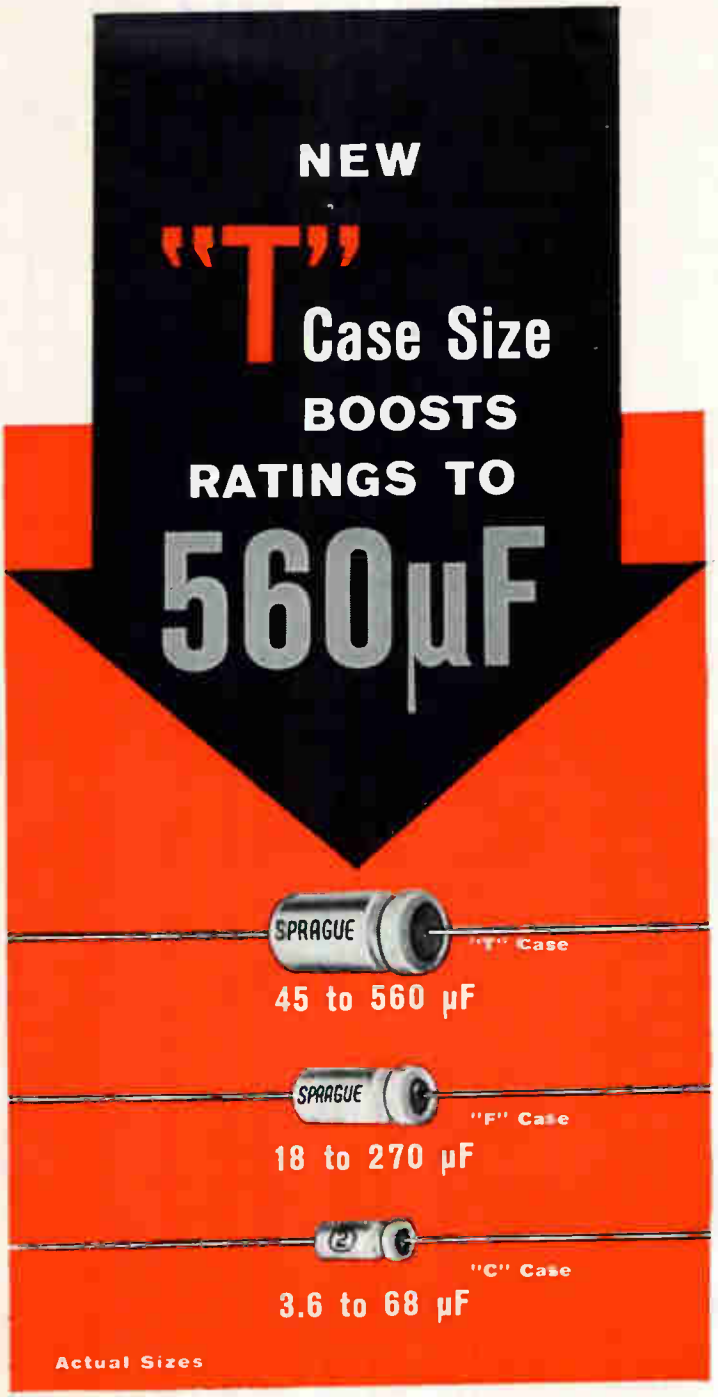
Coming In Our April 7 Issue

AVALANCHE SWITCHING. High power and voltage ratings of silicon mesa transistors have increased the capabilities of avalanche-mode switching circuits. These circuits are now useful for high-speed, high-power pulse generation applications such as in nuclear instrumentation.

In our next issue R. P. Rufer of the Radiation Laboratory at the University of California in Livermore describes the design of avalanche switching circuits. His comprehensive article reviews the avalanche phenomena, presents circuit design principles and discusses the design procedure for pulse generation and switching applications. A criterion for selecting avalanche transistors is developed.

IN ADDITION. A variety of feature material to appear next week includes: determining electron density and distribution in plasmas by H. L. Bunn of the University of California; using *pin* diodes to control a shorted stub by R. H. Mattson of Iowa State University; designing thin-film resistors by I. L. Brandt of CBS Electronics; improving power rectifier circuits by G. F. Montgomery of National Bureau of Standards; and vlf antenna efficiency charts by G. J. Monser of American Electronic Laboratories.

Tubular Sintered-Anode TANTALEX® Capacitors



Pack High Capacitance In Small Volume

Now designers can get the reliability and performance of Sprague's Type 109D and 130D Tubular Sintered-Anode Tantalex Capacitors *in ratings up to 560 μF.* A new "T" case size permits more ratings in every working voltage. Type 109D capacitors can be operated up to 85 C without voltage derating and up to 105 C with a voltage derating of only 15%; Type 130D to 125 C without derating.

Designed to MIL-C-3965B

These Tantalex Capacitors are designed to meet vibration (2000 cycle), shock, and all other environment requirements of MIL-C-3965B. Outstanding mechanical features include a specially-treated cathode; a double-spun, missile-proven fluorocarbon elastomer high temperature seal; and a special porous sintered tantalum anode developed to give unusually high capacitance per unit volume.

No Shoulders; No Chassis Slots Required

The clean, shoulder-less shape of these capacitors was pioneered by Sprague to simplify printed wiring layout and assembly. It eliminates the need to punch mounting slots of the type required for older shouldered cup designs. Wiring boards can also be stacked more compactly.

For more information on Type 109D and 130D Tubular Sintered-Anode Tantalex Capacitors, write for Engineering Bulletin 3700D and Bulletin 3701 to Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

SPRAGUE COMPONENTS

CAPACITORS	INTERFERENCE FILTERS	HIGH TEMPERATURE MAGNET WIRE
MAGNETIC COMPONENTS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
RESISTORS	PIEZOELECTRIC CERAMICS	PACKAGED COMPONENT ASSEMBLIES
TRANSISTORS	PULSE-FORMING NETWORKS	FUNCTIONAL DIGITAL CIRCUITS

HPB 4S-253R

SPRAGUE®
THE MARK OF RELIABILITY

'Sprague' and '℗' are registered trademarks of the Sprague Electric Co.

March 31, 1961

CIRCLE 5 ON READER SERVICE CARD 5

TURN TIME INTO OPPORTUNITY with RCA TECHNICAL SUPPORT SERVICES

It is good business to utilize established sources for technical support services that enable you to realize savings in time. This savings means opportunity and money to you! RCA Service Company —the military and industrial service arm of the Radio Corporation of America—is equipped to provide skilled, specialized technical support services to help you utilize precious hours more effectively . . . yielding the results you need in the face of tight deadlines and peak workloads.

Regardless of project scope, look to RCA Service Company for assistance in any, or all, of these services;

- **Field Engineering**
- **Systems Engineering Services**
- **Equipment Installation, Check-out, and Maintenance**
- **Equipment Repair and Calibration**

For almost two decades, RCA Service Company has been providing technical support services on complex equipment and systems to branches of the U. S. Armed Forces, governmental agencies, and prime contractors. This experience and skill assure you of ingenuity and excellence in support services demanded in this era of technical achievements.

RCA Service Company enables you to utilize your project time to its fullest. Time is opportunity. We'll help you make the most of it!

For complete information, contact J. R. Corcoran, Location 206-2, RCA Service Company, Camden 8, N.J.

The Most Trusted Name in Electronics

RADIO CORPORATION OF AMERICA

COMMENT

Medical Electronics

It was a pleasure to read your article from Holloman Air Force Base about Gulton's physiological data-acquisition system ("Medical Data Telemetry System Unveiled," p 32, Feb. 17).

This note is just to tell you my reaction, and to commend your magazine for its work in publishing technical articles of this nature. I have also enjoyed your series on medical electronics (p 49, Jan. 20; p 46, Feb. 3; p 54, Feb. 24), which seems to be presenting a competent survey of the field.

MAX TRAITE
GULTON INDUSTRIES
METUCHEN, N. J.

(Referring to your excellent articles on medical electronics . . .)

We manufacture a biological computer of average responses. This is a small desk-top-size transistorized digital computer which allows the evoked responses in the brain to be precisely measured. These evoked responses are on the order of two or three microvolts and happen within milliseconds after the stimulus. They are quite invisible in the electroencephalogram because of the much greater ongoing activity which tends to swamp them. However, when averaged over many responses, the ongoing activity averages out and the evoked response appears clearly.

This instrument is valuable for measuring evoked responses in the brain through pickup electrodes on the scalp of a human. We have used it extensively in research to determine differences between normal and mentally ill people. Also we are using it for measurement of communications channels from one part of the brain to another in animals by means of implanted electrodes. We call it CAT (computer of average transients) Mark II . . .

MANFRED CLYNES
MNEMOTRON CORP.
SPRING VALLEY, N. Y.

This general area was discussed in Part II of the Medical Electronics series.

Superconductive Power Grid?

Reference is made to your report (Newsletter, p 9, Feb. 10) on the superconductivity of the niobium-tin alloy.

It appears that if one-centimeter area wires can carry 100 kilamps in an 88,000-gauss field, then this may be the breakthrough required for a nationwide power grid. The transmission lines would consist of relatively thin zero-resistance wires, enclosed in tubes of liquid helium. As heat leaked in (as it would despite the best insulation), some of the helium would evaporate to absorb this. Periodically spaced valves would be required to let the gaseous helium out and this would have to be liquefied and pumped back into the tube.

This sounds like quite an undertaking, as indeed it is; but perhaps some of the benefits should be considered:

A line carrying 100 kilamps at a power-line voltage of 330 Kv is transmitting 33,000 Mw. This is roughly a fifth the total U. S. capacity. Furthermore, the 100-kilamp figure was determined in a magnetic field many times stronger than would be produced by a straight transmission line. It does not appear impossible that a single superconducting transmission line could carry the entire U. S. capacity.

This would certainly permit power to be generated near the coal mines, avoiding the fuel-shipping expense as well as helping keep the cities cleaner.

Since peak electrical loads vary throughout the day, a nationwide grid would permit a more even load distribution. This would eliminate much of the generating equipment which must normally be kept idle at each power station waiting for the peak loads.

If we think in hemispheric terms, our underemployed coal mines (which make up a good deal of the distressed areas) could supply power to the fuel-short sections of Central and South America. The vast hydroelectric potential of northern Canada might also be finally harnessed in a joint pan-American effort to correct the maldistribution of resources.

A. HEMEL
ILLINOIS INSTITUTE OF TECHNOLOGY
CHICAGO

General Instrument Semiconductor... Exclusive!

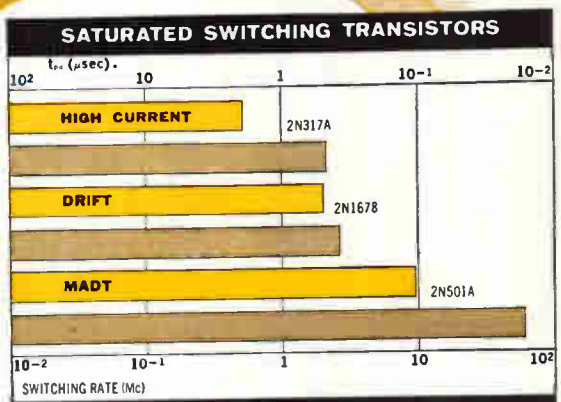
NOW... MADT® COMPLETES GI SPECTRUM OF SWITCHING SPEEDS...DC to 50 Mc

MADT 50 Mc

DRIFT 5 Mc

ALLOYED-JUNCTION 2 Mc

Only General Instrument offers the *MADT*, *Drift*, and *Alloyed-Junction Transistors* for all your switching needs! The new GI MADT completes the entire switching spectrum from dc to 50 Mc, as illustrated above. GI computer semiconductors are immediately available, realistically priced, and produced by advanced manufacturing techniques to assure highest quality and long life.

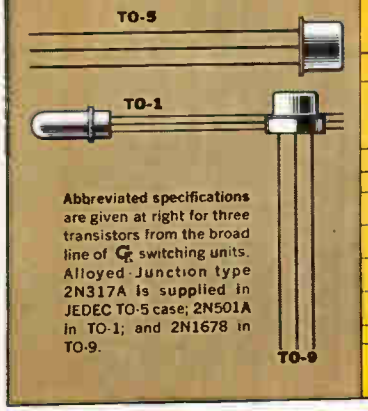


Saturated Switching Speeds for three GI PNP transistor families. Shaded bar represents speeds obtainable with speed-up capacitor.

YOU CAN DEPEND ON GI FOR ALL YOUR COMPUTER NEEDS

Devices • Full Specifications • Engineering Assistance

General Instrument is your single source of supply for a full range of germanium computer transistors, companion diodes, logic encapsulations and rectifiers. In addition GI provides *complete* engineering and reliability design data. The abbreviated specifications below, for example, illustrate the range of data available from GI on its entire line of computer semiconductors. Write today for device information, engineering data and applications assistance on your special computer problems. Contact General Instrument for the name of your local stocking distributor.



Abbreviated specifications are given at right for three transistors from the broad line of GI switching units. Alloyed-Junction type 2N317A is supplied in JEDEC TO-5 case; 2N501A in TO-1; and 2N1678 in TO-9.

RATINGS and CHARACTERISTICS	ALLOYED-JUNCTION		DRIFT		MADT	
	Conditions	2N317A	Conditions	2N1678	Conditions	2N501A
RATINGS						
BV_{CBO}		20 v		60 v		15 v
BV_{EBO}		20 v		4 v		2 v
P_C		150 mw		120 mw		60 mw
$T_{j\,max}$		100°C		85°C		100°C
CHARACTERISTICS						
I_{CBO}	V_{CB} = 5 v	2 μa max	V_{CB} = 10 v	5 μa max	V_{CB} = 5 v	5 μa max
h_{FE}	I_C = 400 ma, V_{CE} = 0.25 v	20 min, 60 max	I_C = 20 ma, V_{CE} = 0.25 v	25 min	I_C = 10 ma, V_{CE} = 0.5 v	20 min
f_{hfb}	V_{CB} = 5 v, I_C = 1 ma	20 Mc typ	V_{CB} = 5 v, I_C = 1 ma	25 Mc min, 50 Mc typ	V_{CB} = 0.5 v, I_E = 2 ma	130 Mc typ*
V_{BE}	I_C = 400 ma, V_{CE} = 0.25 v	0.95 v max	I_C = 20 ma, V_{CE} = 0.25 v	0.6 v max	I_C = 10 ma, I_B = 1 ma	0.45 v max
$V_{CE\,(SAT)}$	I_C = 400 ma, I_B = 40 ma	0.2 v max	I_C = 20 ma, I_B = 0.8 ma	0.25 v max	I_C = 10 ma, I_B = 1 ma	0.20 v max
t_{ON} (t_d+t_r)	I_C = 400 ma, $I_{B\,(ON)}$ = 20 ma, $I_{B\,(OFF)}$ = 10 ma, V_{CC} = 9 v	600 nS max	I_C = 20 ma, $I_{B\,(ON)}$ = 1 ma, $I_{B\,(OFF)}$ = 1 ma, V_{CC} = 20 v	400 nS typ	I_C = 20 ma, $I_{B\,(ON)}$ = 2.2 ma, $V_{B\,(OFF)}$ = + 0.5 v	13 nS typ
t_{OFF} (t_i+t_f)		1200 nS max		400 nS typ		14 nS typ

*Gain-bandwidth Product, f_T

®T. M. Philco-GI Micro Alloy Diffused-base Transistors Are Fully Licensed Under Philco Patents

GENERAL INSTRUMENT
GENERAL TRANSISTOR
TRANSISTORS, DIODES, RECTIFIERS

SEMICONDUCTOR
DIVISION OF GENERAL INSTRUMENT CORPORATION
65 Gouverneur Street, Newark 4, New Jersey

IN CANADA: General Instrument Ltd., Semiconductor Division, P.O. Box 9, 151 Weber Street South, Waterloo, Ont., Canada.

What will ISOPLYS® lead to next?

Isoplys (isolated power supplies) were first introduced by Elcor, Inc., now a Welex Subsidiary, back in 1957. Since that time many of our customers have introduced imaginative applications for Isoplys that are new to even its inventors.

The Isoply is more than just new equipment. It represents a totally new concept, for Isoplys are used ungrounded. Unique construction provides extremely low shunt capacitance and low noise. It offers new flexible designs for direct-coupled amplifier circuits that are relatively insensitive to power line fluctuations. They give excellent frequency response.

Bridge, cathode follower, and other type circuits can be improved significantly. Less design and assembly time is needed. Interaction between circuits is substantially reduced which helps not only in design problems but also in simplifying maintenance. Learn how ISOPLYS can help reduce costs and improve performance in circuits you design.

Elcor

Write for full information: **ELCOR Incorporated**

Subsidiary of Welex Electronics Corporation
Sales / R & D Laboratory / Manufacturing
1225 W. Broad Street / Falls Church, Virginia
JEfferson 2-8850

ELECTRONICS NEWSLETTER

Tests Approaching For Space Fuel Cells

EXPERIMENTAL FUEL CELLS designed to produce auxiliary power of 50 watts for orbiting satellites are being developed for the Air Research and Development Command's Wright Air Development Division. Flight testing of these cells will be done in the near future according to Air Force spokesmen.

The cells being developed under the USAF project are ion exchange membrane fuel units, are reported to operate without noise on noxious odor.

Missile and space vehicle department of General Electric is now working on three hydrogen-oxygen ion exchange membrane fuel cells under a $90,738 contract with WADD. Each cell is composed of a membrane with an electrode on each side. On one side of the membrane is hydrogen gas, on the other oxygen gas. The two gasses enter the chambers on opposite sides of the membrane, penetrate the porous electrodes to contact the surface of the ion-permeable membrane. On the hydrogen side, the electrons are given up, collected in the electrode and conducted to the load. The hydrogen ions travel through the solid electrolyte to the other surface of the membrane where they combine with returning electrons in the presence of oxygen.

Electrolysis of the water back into hydrogen and oxygen makes the process regenerative.

International Tv Talks Slated in Switzerland

INTERNATIONAL TELECOMMUNICATIONS UNION announced its readiness to participate in the International Festival of Television Arts & Sciences to be held this May in Montreux, Switzerland.

The event will be held in three parts from May 15 to May 27. The technical symposium will be held from May 17 to 21. Object of the technical meetings will be to bring together an international representation of television engineers and scientists to exchange views and information and discuss the regulatory responsibilities of ITU.

Expectations are that considerable time will be devoted to educational television as a tool for raising living standards in backward nations, and the possibilities for growth of commercial television. This second area is considered of increasing importance since most nations rely primarily on government-operated tv service.

ITU spokesmen told ELECTRONICS they intend to work in collaboration with the European Broadcasting Union, the International Broadcasting & Television Organization and other large professional societies. UN participation will be through UNESCO.

Chemical Firms Poised To Supply Epitaxial Items

ELECTRONIC COMPONENT manufacturers may shortly find they are able to purchase more than just the raw semiconductor materials they are now getting from chemical supply companies, according to information received this week by ELECTRONICS.

Several manufacturers now supplying silicon and germanium to semiconductor manufacturers are reportedly considering expanding their processing to aid epitaxial component makers. Instead of supplying silicon billets, for example, the chemical firms may be offering doped single-crystal silicon rods. In addition, they will offer the rods sliced into wafers with the high-resistivity layer epitaxially deposited as required. Purchasers will merely have to put the wafers through diffusion and fabrication processes.

At present, Merck is one of the suppliers known to be contemplating this service. Other chemical firms are also reported thinking along the same lines.

Ion-Beam Technology Emerges As New Field

ION BEAM technology is emerging as a new field, according to observers at a symposium held a few days ago in Boston. One firm described research it is conducting on an ion-beam deposition system for microcircuit applications.

Positive ions are used for tandem accelerators, for injector devices in thermonuclear work, and for ion-propulsion rocket development efforts.

In the exploratory stage are studies on the advantages of ion emitters over electron guns. These studies aim to probe applications for microminiature cutting and machining operations. X-ray danger is not a problem with ion beams, a strong advantage over high-voltage electron beams.

Brought out at the Boston symposium was information indicating increased applications being found for electron-beam welding, especially in such exotic metals as beryllium and titanium which need closed-system welding to sidestep toxicity effects. Researchers are also exploring electron-beam processes for such varied fields as welding waveguides and joining thermoelectric materials.

Australia to Buy More Computers

FEDERAL AUSTRALIAN government will shortly be asking for bids and proposals covering some $10-million worth of large computers, according to Melbourne sources. Besides the computers, bidders will also be asked for input, output and processing hardware. The computers are intended for Austrlian armed forces use.

Local observers say other federal departments are now formulating requirements for computers and hardware in amounts that will require expenditures in the tens of million of dollars.

FCC to Fine Station For Passing Power Limit

FIRST ACTUAL punitive movement against a radio station for using higher power than authorized was announced last week by Federal Communications Commission. The Commission intends to fine station KDWB St. Paul, Minn., $10,000 for exceeding authorized power in night-time operations.

The announcement said that if

the station wished to contest the matter it will have an opportunity to do so; otherwise station owners, Crowell-Collier Broadcasting, must pay the fine.

This action is the first of its kind since Congress amended the Communications Act last September to provide penalties other than license revocation for violations of Commission rules.

KDWB, operating at 630 Kc, has authorized daytime operating power of 5 Kw, nighttime power of 500 watts.

Commission reports say the station admitted using full daytime power between midnight and 4:00 p.m. since late 1959.

H-P Radar Transmitter Being Made for NASA

FIVE MILLION-WATT radar transmitter for long-range tracking of space probes and orbiting vehicles is now under development for the National Aeronautics & Space Administration.

The transmitter will be a major part of a radar system using a 60-ft diameter dish antenna to be used by NASA's Wallops Island, Va., personnel. The system will be used to measure the radar cross-section of vehicles in space to determine their suitability for communication or navigation.

Work on the transmitter is being done by Raytheon's surface radar and navigation operation at Wayland, Mass.

Japan Electronics Firm Plans Factory Expansion

JAPAN'S LARGE manufacturing entity, Hitachi is getting still bigger. Company officials in Tokyo estimate capital plant expenditures in fiscal 1961 (starting April 1) will reach to nearly $100 million.

Hitachi will put its biggest effort into heavy electrical equipment with new manufacturing facilities accounting for almost one-third of the year's total outlay. In heavy electrical goods, Hitachi is neck and neck with Tokyo Shibaura (Toshiba).

Hitachi's electronics expansion will account for some $19 million in the year ahead. About $13 million will go into appliances and almost $10-million will go into research facilities.

All told, Hitachi officials say capital plant outlay in the coming fiscal year will be 15 percent higher than in the year before.

Lawyers Study Computer Usage

THREE-DAY computer forum on the legal problems that have arisen or might arise in the future was sponsored last week in Washington, D. C.

Sponsored by the joint committee on continuing legal education of the American Law Institute and the American Bar Association, the forum aimed at outlining but not answering some potential legal tangles that may result from the growing use of computers. Among the hypothetical questions: If an electronically processed check is bounced in error, whose fault is it? Is information on magnetic tape, punch cards or other computer input form admissible as courtroom evidence?

R. N. Freed, chairman of the meeting and an associate of Ballard, Spahr, Andrews and Ingersoll, a Philadelphia law firm, told the group that such questions are only now beginning to filter into law courts. The idea behind the forum, Freed said, is to get lawyers thinking about legal problems of electronics and how to solve them before the lawyers become hopelessly entangled.

Besides the legal discussions, the lawyers also got a primer course in electronic data-processing. W. D. Bartlett of General Electric, E. Glazer of the National Bureau of Standards and A. I. Dumey of Data Sciences briefed the legal men on terminology and operations.

Survey Cites Rise In Engineer Pay

SALARY LEVELS for engineers rose approximately five percent per year between 1958 and 1960 according to a study released this month by Engineering Manpower Commission.

Overall median salary now stands at $9,600 annually. Seven years ago, the first EMC survey taken on median salaries found the median engineer salary to be $6,500.

The report also points out that engineers are a young group with median age at 32 based on a graduation average age of 22. Their salaries grow at a greater rate during the early years of an engineer's career and slow down at about 20 years of experience. The present survey indicated that the slow-down tendency has been less pronounced in the recent past.

Air Force Awards Contract For Cryogenic Delay Line

MATERIAL INVESTIGATION for properties and techniques required to build a superconducting 20-microsecond delay line operating at microwave frequencies between 4 and 12 Gc is being explored through Air Research & Development Command.

A $90,000 contract to explore this field has been awarded to Martin Company by Rome Air Development Center, Griffiss Air Force Base, N. Y. Martin says they plan to produce the line within 18 months. USAF requirements call for 15,000-ft transmission without energy loss. The line will be encapsulated in a 3-in. cubic chamber and maintained at 4.2 K.

Tests Being Readied For New Space Project

FIRST TEST of project West Ford is expected within a month by MIT's Lincoln Laboratory and Air Force.

The West Ford package of reflective needle-sized tuned dipoles will ride piggyback on one of the military rockets scheduled for launching within the next month. Nearing completion in Westford, Mass., and Camp Parks, Calif., are 60-ft dishes for bouncing signals off dipoles tuned to 8,000 Mc. The 120-ft Haystack Hill antenna is slated for completion in Tyngsboro, Mass., late in 1962. The big antenna will form part of the West Ford operation.

The belt of tuned dipoles is expected to remain in orbit for several years.

ACTUAL SIZE

TRUE FM, 2 WATT TELEMETRY TRANSMITTER

THIS SOLID STATE, CRYSTAL STABILIZED TRANSMITTER HAS AN OPERATING TEMPERATURE RANGE OF −20° TO +90° C

True FM response within 3db from 50 CPS to 100 KCPS / Deviation ±125 KCPS / Frequency range 215 MC to 260 MC / Frequency stability ±0.01% Silicon semiconductors are used throughout / WRITE DEPT. 27.

VECTOR Manufacturing Company, Inc., Southampton, Pennsylvania
TELEMETRY SYSTEMS AND COMPONENTS

FROM Monsanto FLUIDESIGN SERVICE:

NEW DIELECTRIC-PINPOINTS TEMPERATURE VITAL ELECTRONIC

COOLANOL® 35 STAYS IN LIQUID PHASE

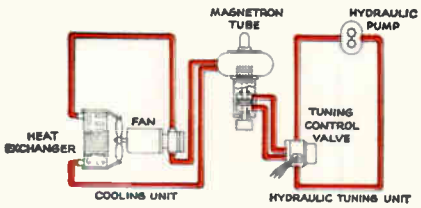
500° F. OPERATING

Temp., °F.	Viscosity, cs. COOLANOL 35	COOLANOL 45
420	0.84	1.25
410	0.87	1.30
400	0.90	1.35
0	60	125
-10	80	170
-20	110	260
-30	160	380
-40	240	650
-50	400	1030
-60	700	1800
-65	934	2600
-80	2700	—

Mission: national survival.

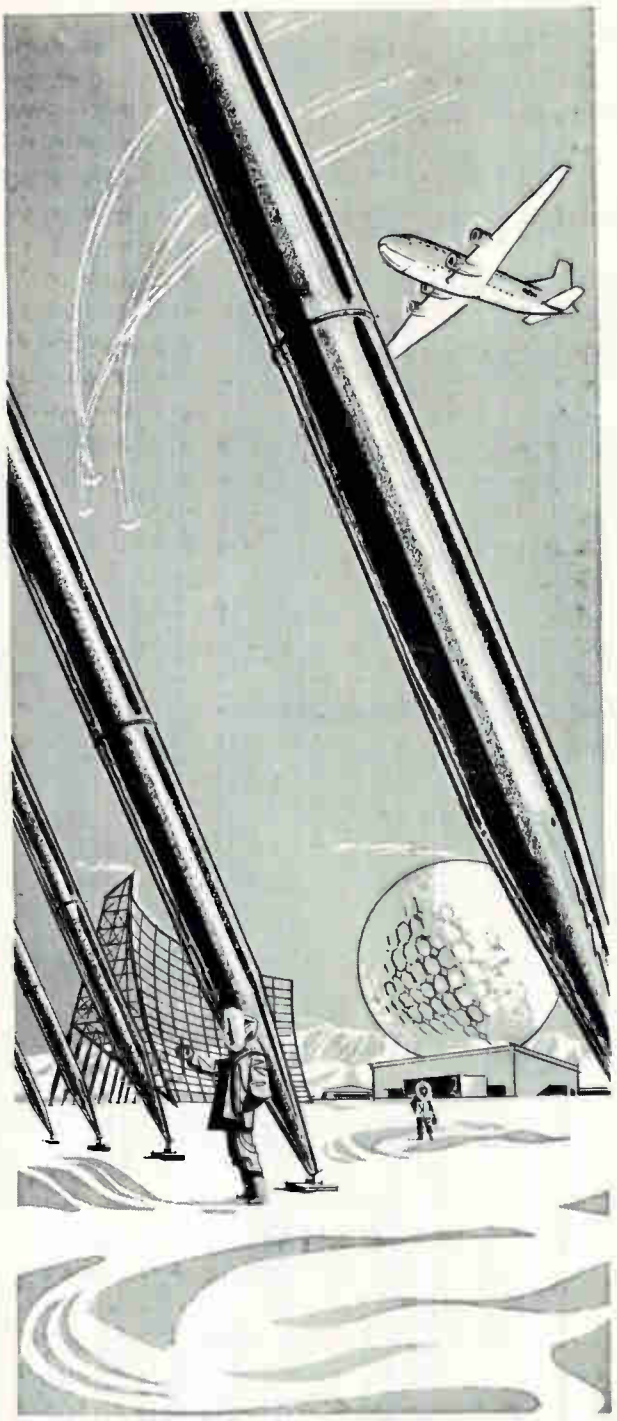
Assignment: synthesize a liquid dielectric-coolant to meet stringent new military requirements—for critical heat control of compact electronic components that must *function flawlessly*—in supersonic aircraft, tactical missiles, tropical ground support complexes, and radar installations along the Arctic shores.

Achievement: COOLANOL 35—a "chemically tailored" fluid combining excellent low-temperature viscosity—thermal stability—high dielectric strength—and good heat transference in environments ranging from *a sizzling 420°F. to an icy -80°F.* (so cold lead pencils won't write and ordinary rubber tires crack like eggshells)!



Here's how COOLANOL cools, lubricates, and hydraulically actuates a magnetron and tuner.

COOLANT CONTROL OF EQUIPMENT!



THROUGH A RANGE!

GET THE COMPLETE FACTS ON NEW COOLANOL 35. MAIL THE HANDY COUPON TODAY.

SOME TYPICAL PROPERTIES OF COOLANOL 35

Pour Point (ASTM D97)	<-120°F.
Specific Gravity, 25/25°C.	0.889
Dielectric Strength, 25°C. (ASTM D877)	47KV
Thermal Conductivity, 25°C. (cal./sec. cm^2 °C. cm)	29.1×10^{-5}

MONSANTO CHEMICAL COMPANY
FluiDesign Service, Dept. 4436 D
St. Louis 66, Missouri

Please send my copy of Technical Bulletin AV-6 on new COOLANOL 35

Name _____ Title _____

Company _____

Street _____

City _____ Zone _____ State _____

JERROLD

R. F. Test Equipment

Quantitative Measurements Using Sweep Frequency Techniques

Model 900A—THE MOST VERSATILE SWEEP GENERATOR $1,260.00

CENTER FREQUENCY—VHF 0.5 to 400 MC UHF 275 to 1000 MCS—SWEEP WIDTH—up to 400 MCS—FLATNESS—±0.5 db over widest sweep!

Model 707—ULTRA FLAT SWEEP GENERATOR $795.00

Featuring ±5/100 db flatness—Plug-in osc. heads*; variable sweep rates from 1/min. to 60/sec.; all electronic sweep fundamental frequencies; sweep width min. of 1% to 120% of C.F.

*Heads available within the spectrum 2 to 265 MCS

Models 601/602—PORTABLE GENERAL PURPOSE $295.00

COVERAGE—Model 601—12 to 220 MCS. Model 602—4 to 112 MCS—FLATNESS — ±0.5 db OUTPUT—up to 2.5 V RMS WIDTH-1% to 120% of C.F.

Model FD-30 $165.00

High speed DPDT coaxial switch permitting oscilloscope measurements without calibration—all measurements referenced continuously against standard attenuators.

Model AV-50 Variable Precision Attenuator $150.00

Long life rotary switches; dual wiping silver contacts on "Kel-F" dielectric. 0-62.5 db in ½ db steps; DC to 500 MCS.

Write for catalog and technical Newsletter series on measurements using sweep frequency techniques. Prices and data subject to change without notice.

JERROLD **ELECTRONICS CORPORATION**
Industrial Products Division Dept. ITE-95
The Jerrold Building, Philadelphia 32, Pa.
Jerrold Electronics (Canada) Ltd., Toronto
Export Representative: Rocke International, N.Y. 16, N.Y.

WASHINGTON OUTLOOK

A MAJOR REORGANIZATION of Air Force contracting agencies is now under way. Purpose is to simplify and centralize the management of electronics, missile, aircraft and space systems. Responsibilities for R&D and production will be merged in a new Air Force Systems Command. The Air Research & Development Command and Air Materiel Command will be abolished as separate entities.

The new Systems Command will be headed by Lt. Gen. Bernard A. Schriever, ARDC's chief, with headquarters at Andrews AFB, near here. An Air Force Logistics Command will replace AMC, and will be based at Wright-Patterson AFB, Dayton, Ohio, under Gen. Samuel E. Anderson. Function of the Logistics Command will be (1) procurement of common-use items not tied to specific weapon systems (components such as electron tubes) and spare parts and (2) general supply management tasks—distribution and warehousing and the like.

The reorganization stems from dissatisfaction over the division of responsibilities between ARDC and AMC—a situation that critics say has resulted in confused lines of authority, delays in pushing new projects into operation and other administrative bottlenecks. The new organization means that contractors will now deal with one agency regardless of the status of their projects.

The new Systems Command will consist of an Electronic Systems Div. at Hanscom Field near Boston, incorporating ARDC's Command and Control Development Div. and AMC's Electronics Systems Center; an Aeronautical Systems Div.; a Space Systems Div.; and a Ballistic Systems Div. Each division will handle contracting and project management from the design study stage through production.

In a move to upgrade research projects not specifically connected with weapons systems, the Air Force reorganization sets up a new office of aerospace research organized under the USAF Chief of Staff. The agency will award and administer basic and applied research projects and will incorporate functions and projects now under ARDC's.

THE PROPOSED COMMUNICATIONS SATELLITE SYSTEM was cited by a union official in recent congressional testimony as a threat to employment in the communications industries. Joseph A. Beirne, president of the AFL-CIO Communications Workers Union, said the space system could affect jobs of hundreds of thousands of workers. He appeared before a House subcommittee on unemployment which is studying the impact of automation on joblessness. Said Beirne: "There won't be one inch of wire from the earth to that satellite."

Beirne said he did not oppose technological advances resulting from automation. His point was this: that Washington has the responsibility for special aid to workers laid off by automation. He recommended creation of a Federal Automation Commission, representing labor and management to plan for handling economic problems that accompany automation. He also called for a greatly strengthened public employment service geared to finding jobs for technologically displaced workers and unemployment insurance for as long as the worker who wants to work is unemployed due to technological change.

THE PENTAGON has liberalized rules dealing with payments on cost-plus-fixed-fee procurement contracts. The new policy provides for full payment to contractors as costs are incurred. Since 1957, the policy has been to withhold 20 percent of the costs until final delivery of the end-item.

THE WHITE HOUSE has ordered the Defense Dept. to step up the volume of prime defense contracting to small business. The goal is an increase of at least 10 percent in contracts during fiscal 1962, which starts July 1, 1961, over the fiscal 1960 rate. Latest Pentagon figures show small firms with 16.1 percent of total prime contracts, amounting to $3.4 billion annually.

Introducing

ALSiBASE®

improved ceramics result from a new method of fabrication.

Favorable characteristics include:

1. Fabrication of thin sections especially suited for substrates. Marked improvement has been made in flatness or camber control.

2. Flatness and dimensional accuracy within normally accepted ranges without grinding expense, contaminants or scratches. However where especially strict requirements must be met, AlSiBase can be furnished both ground and polished at commensurate cost.

3. Ability to fabricate holes, slots, serrations to tighter than usual tolerances without machining after firing.

4. A superior and uniform surface especially adapted to economical coating or metalizing. Surface finish in 10-25 microinch range is available without grinding or polishing.

5. AlSiBase has exceptional dielectric strength in thin sections. Measurements made to date on AlSiBase in the new thin sections indicate better dielectric strengths than those of similar ceramic formulations processed by conventional methods and tested on ¼" thick discs in accordance with A.S.T.M. D 667-44. A typical AlSiBase design in alumina had a dielectric strength up to 2000 ACV/mil at 10 mil thickness.

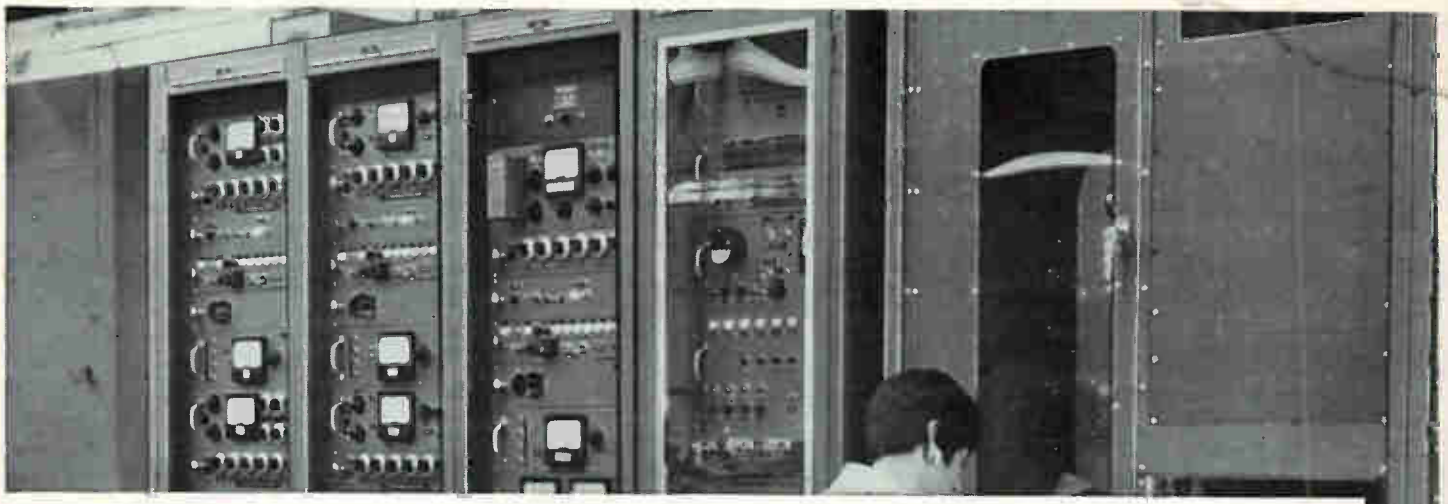
May we see your prints on parts where this might apply?

A subsidiary of Minnesota Mining and Manufacturing Company

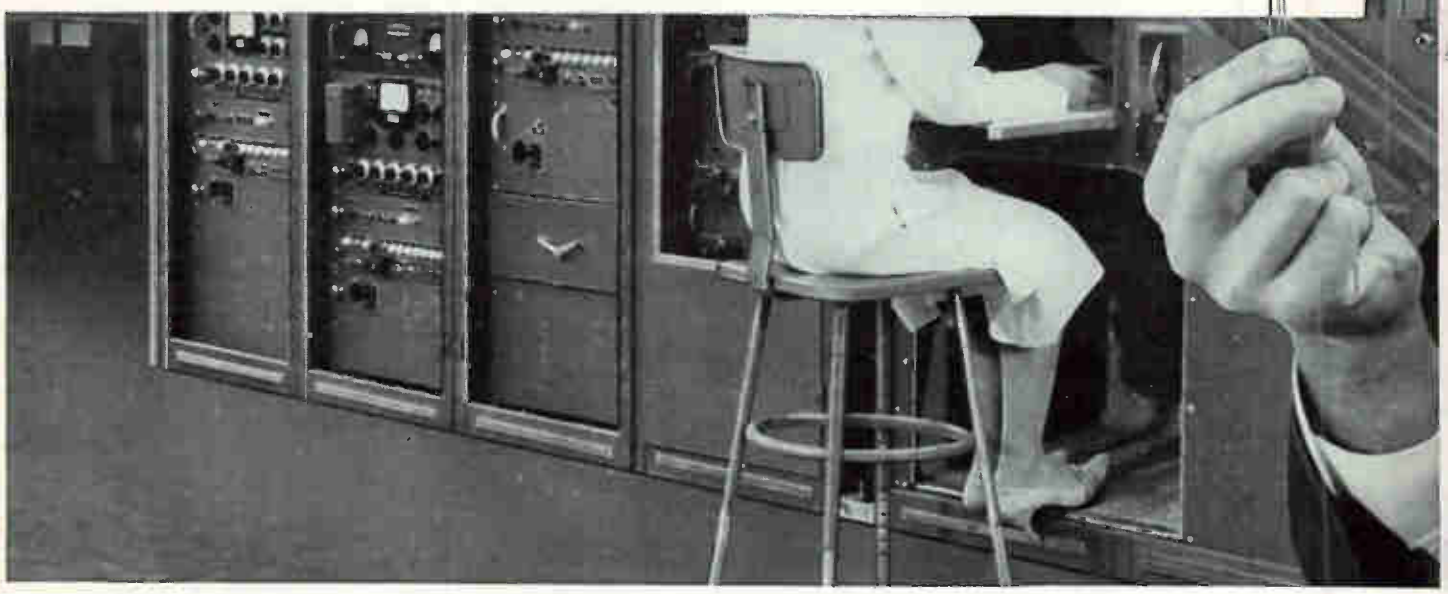
AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENN.
60TH YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory): Boston: Newton Center, Mass. • Chicago: Bedford Park, Ill. • Cleveland, Ohio • Dallas, Texas • Los Angeles, Cal. New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle, Wash.
All other export: Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

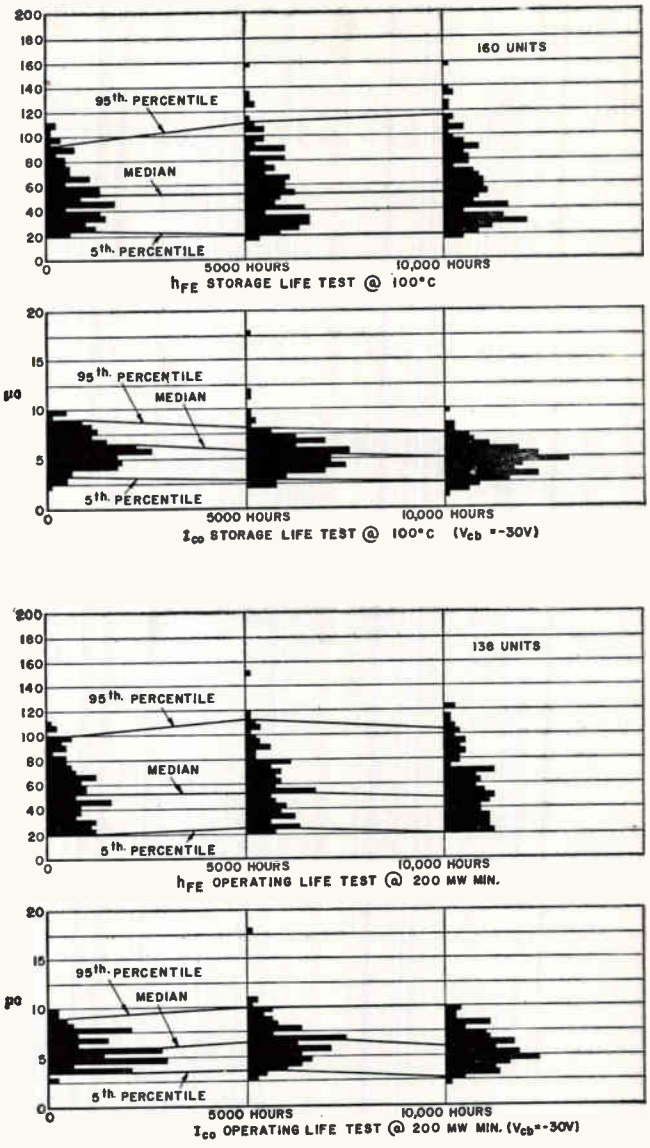


The industry's most stable low-frequency PNP transistors!



The man in the picture, Hugh Lowry, General Electric authority on semiconductor applications

TO-5 Type	Max. V_{CBO}	Max. V_{CER}	Max. I_C	Max. P_t	Max. Cutoff I_{CO} @ V_{CB}	20 ma h_{FE} Min.	Max.	h_{FE} Min.	Max.	V_{CE} (SAT)	V_{BE}	Max. C_{OB}
2N524	45v	30v	500 ma	225 mw	10μa 30	19	42	16	41	.070v	.255	40
2N525	"	"	"	"	" "	34	65	30	64	.075v	.243	"
2N526	"	"	"	"	" "	53	90	44	88	.080v	.230	"
2N527	"	"	"	"	" "	72	121	60	120	.090v	.216	"
2N1413	35v	25v	200 ma	200 mw	12μa 30v	25	42	20	41	.070v	.255	40
2N1414	"	"	"	"	" "	34	65	30	64	.075v	.243	"
2N1415	"	"	"	"	" "	53	90	44	88	.080v	.230	"



General Electric 2N1414 and 2N525 Series carry complete parameters backed up by 10,000-hour life tests

You don't buy a "pig in a poke" when you standardize on General Electric low-frequency PNP germanium alloy transistors, Series 2N1414 and 2N525. Parameters are completely spelled out, including "Minimum," "Typical" and "Maximum" values, and are backed up by 10,000-hour life tests on 138 units to date (see curves above). In fact, 300 new units start life-test each week.

The new lower-priced 2N1413, 2N1414 and 2N1415 types are designed for industrial audio amplifiers and low-frequency switching applications where cost is a prime consideration.

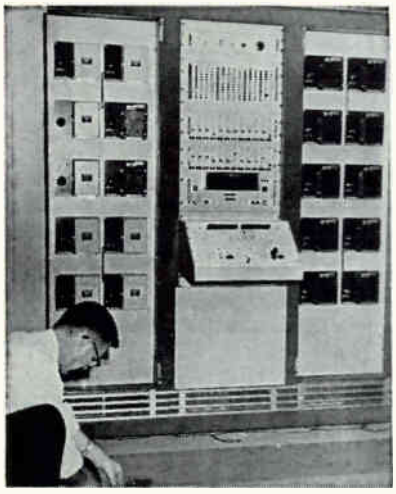
To assure top reliability under adverse environments, all units are hermetically sealed and subjected to 100 hours of high-temperature bake and a detergent pressure leak test. The transistor base is welded to the case for greater thermal efficiency.

For proved reliability in low-frequency PNP's, at a very pleasant price, see your G-E Semiconductor District Sales Manager or Authorized Distributor. General Electric Company, Semiconductor Products Department, Electronics Park, Syracuse, N. Y. *In Canada:* 189 Dufferin St., Toronto, Ont. *Export:* International General Electric Co., 150 E. 42nd St., N. Y. C.

GENERAL ELECTRIC

Scanning Last Week's IRE Show

Improved solid-state devices and materials, advanced microwave equipment and instruments featuring high precision and digital readout are among the highlights of the recent exhibition



Transistor and component tester (TACT) by Texas Instruments performs up to 9,000 tests an hour, up to 24 tests per component

HERE'S WHAT a team of ELECTRONICS editors found technically interesting as they combed the IRE Show last week:

Systems. Sending electrocardiograph signals over phone lines without electrical connection was demonstrated by Mnemotron Corp. The system uses air coupling at both ends. A sound transmitter with a 1-v input sensitivity is connected to the electrocardiograph and the whole unit clipped to a telephone transmitter. Data are transmitted by pulse-frequency-modulated sound as a soft continuous beep of varying pitch. A data sound receiver clipped to the earpiece of the phone at the receiving end reconverts the pfm sound to electrical form. The 0.5-v output can be fed to an electrocardiograph, stripchart or magnetic recorder, or oscilloscope. Accuracy and linearity are claimed to be 0.2 percent.

Dallons Labs exhibited a chimpanzee in a six-foot transparent sphere simulating a space capsule. Electrodes cemented to the ape's skin fed cardiac signals to a transmitter worn on his belt. A receiver-recorder external to the sphere reproduced the chimp's electrocardiogram although he moved.

Components. Tokyo Radio Coil Labs. showed their small i-f coil. Called the Type 7 AC (7 mm sq), it was made possible by skilled hand production, sells for about 20 cents.

Litton exhibited a continuous rotation potentiometer. This gives a ten-turn potentiometer the advantages of a single-turn unit. After the 3,600 deg turn, an automatic switch lifts the wiper and returns it without any output.

DeMornay-Bonardi cited their 8-mm interferometer, that is used to measure complex permitivity of liquids, gases and solids.

C. P. Clare displayed their use of reed relays in logic modules. The modules perform logic operations in the 1 to 3-millisec range.

Carborundum's positive temperature coefficient thermistors are said to function over a wide operating temperature range. They are designed for many applications.

Pacific Semiconductor showed a laminar transistor, that is said to perform as well as epitaxial transistors. The laminar unit is made by triple diffusion giving it considerable physical strength.

Microwave Associates showed a coaxial duplexer, a passive unit that switches antenna to either transmitter or receiver with instantaneous recovery time. Capabilities of these units are from 215 Mc to 1,155 Mc.

International Resistance displayed their metal-film resistor, made for Minute Man. It was designed to function with no more than one failure in 250 million unit hours.

Instruments. Hewlett-Packard introduced a time interval counter able to measure time between two electrical events with an accuracy of 10 nsec. The firm also drew attention with their modular package format for instruments allowing compact stacking on the bench, and

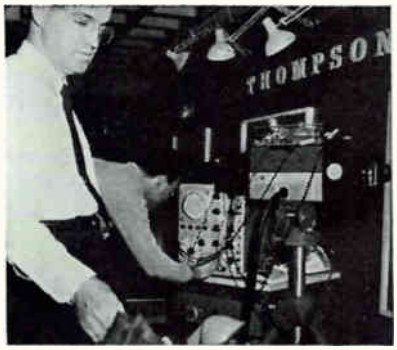
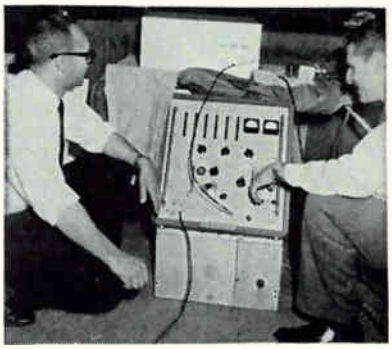
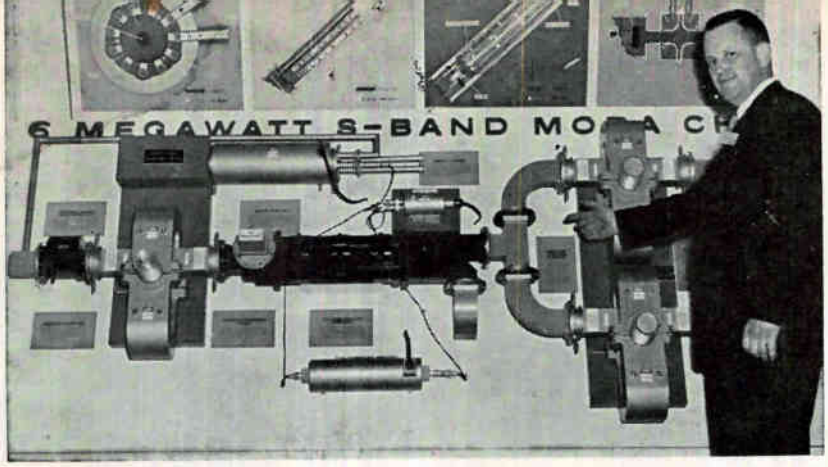


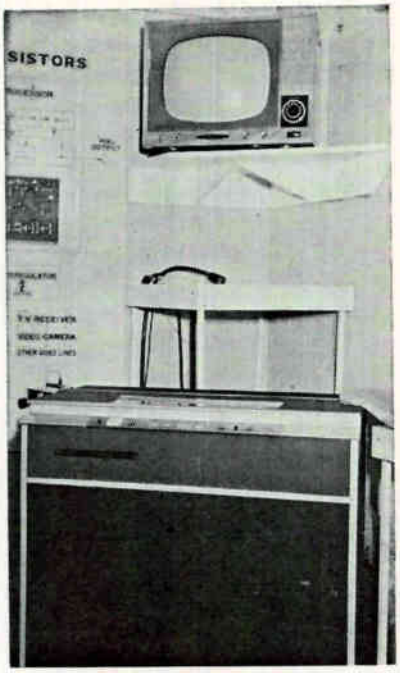
Image converter camera by STL converts optical image to electron beam, gates beam to achieve 2½-nanosecond exposure time



Rubidium frequency standard by STL has long-term stability of 1 part in 10^{10}. Reference is optically pumped rubidium cell



Six-megawatt-peak S-band amplifier by Raytheon uses type-O backward-wave oscillator, two traveling-wave tubes, three Amplitrons



Video tape recorder by Sony is smaller than an office desk, uses 96 transistors. Tunnel diodes are used in memory head. Program showed a Japanese chorus line

rack mounting of these instruments directly in the same package sold for bench use.

Measurements Co. introduced a direct dial reading frequency meter, accuracy is ± 100 cps, coverage from 25 to 475 Mc, using L-C filters and internal crystal oscillator. Design is based on an earlier, meter-readout-of-last-digit model, accuracy ± 20 cps.

Texas Instruments has entered the small instrument field. They showed a line of solid-state, high-repetition rate pulse generators using tunnel diodes. The instruments have repetition rates of 3 to 25 Mc and 25 to 100 Mc; rise and fall times of less than 4 nsec; pulse width of 8 nsec at half pulse height. They also displayed a 0.1-percent accuracy solid-state analog to-digital converter.

Waveforms Inc. displayed a mounting format that allows their miniature, wide range audio oscillators and a-c voltmeters to be included four across in a 19-inch rack.

Tektronix introduced a four-channel d-c preamp with 20-mv sensitivity, with application in medical and microwave fields. Rise time is 20 nsec. They also showed an operational vertical amplifier plug in unit, with switch selection of internal input and feedback capacitors and resistors; as well as provisions for front panel, external connection of shaping components. A new dual beam scope was displayed; and a line of cameras designed to function with their oscilloscopes, which feature interchangeable prefocused lens, and rotatable backs.

Gertsch introduced a solid-state complex ratio bridge for phase measurement. Accuracy, in phase 0.01 percent, quadrature 0.1 percent; unit is completely self contained.

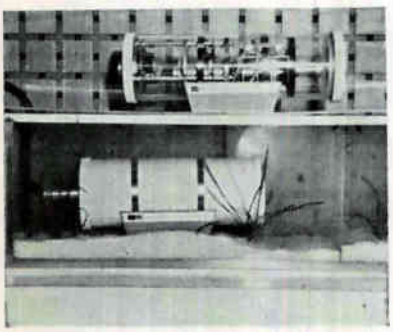
RFL showed an a-c/d-c calibration transfer standard with better than 0.05-percent accuracy.

Production. Doall demonstrated a semiconductor crystal slicer that cuts with the inside edge of a ring-shaped diamond wheel reversing the usual technique. The wheel is eight mils thick, so has a yield of about 50 12-mil-thick wafers per crystal inch. Unmounted, the wheel is flexible. But when it is stretched in a revolving, ring-like cutting head, the wheel becomes stiff.

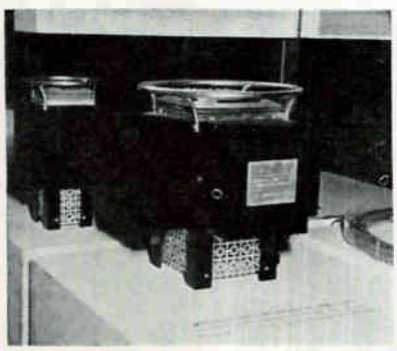
A machine that cuts and notches or forms transistor leads was shown by Design Tool. Leads can be bent for insertion into a variety of socket configurations or printed-circuit hole patterns. The demonstration setup bent leads in a sickle shape so that after insertion in a p-c board, the leads were locked in place on the conductors on the underside of the board.

George Stevens had a new bobbin coil winder. Bobbins are continually loaded three at a time on a revolving drum. The drum presents the bobbins to three winding heads, which wrap the wire around the bobbins as the bobbins remain stationary on spring-lock spindles. Wound bobbins are ejected into a tray. Production rate is 981 coils per operator hour.

Materials processing equipment included an electric-beam vacuum evaporator by Kinney Vacuum. It



Ruggedized, moisture-proof tv camera by Kintel is shown operating underwater. It uses 7 transistors, operates on either 525 or 729 lines



Thermoelectric generator by Westinghouse puts out 40 watts. Propane gas heats hot junction to 450 C. Convection cools cold to 125 C

can handle tungsten and other difficult materials. MRC Manufacturing Company had an arc melter for reducing sponge and metal fragments to buttons for rolling and fabricating. It processes several small charges in a single loading, in an inert gas or soft vacuum atmosphere. Lepel High Frequency Laboratories showed crystal-growing equipment in which floating zone and vertical crystal pullers could be interchanged.

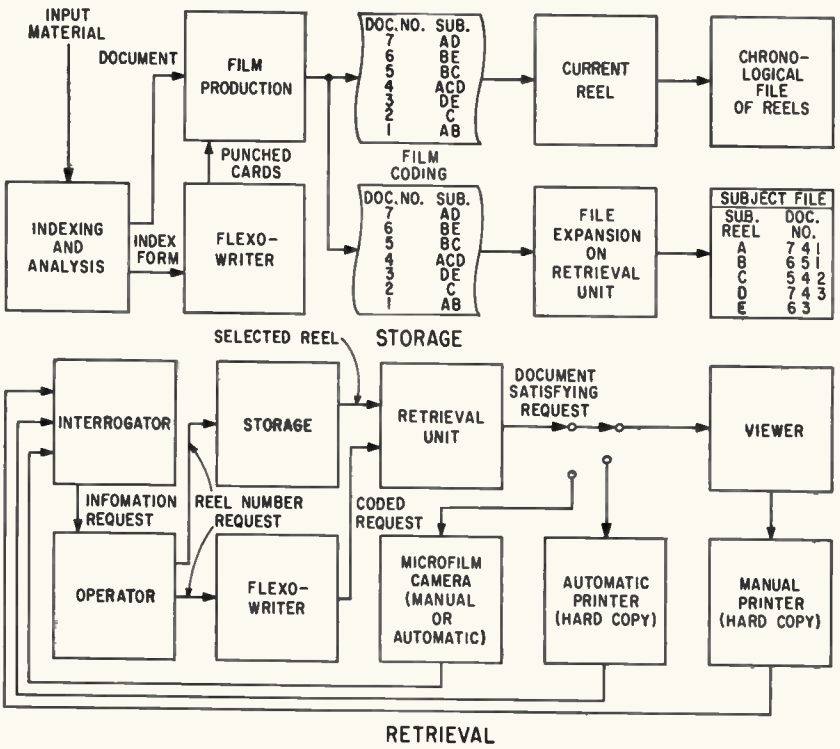
Roller-Mike's semiconductor dice classifier presents dice one at a time, through a vacuum pickup, to an air gage. Sorting trays are under the meter scale. The dice discharge tube follows the scale pointer and drops the dice wherever the pointer stops.

Among the hand tools were soldering tweezers for miniature and microminiature assembly work, from Oryx Company, and a handheld pneumatic wire clipper that can be operated by a portable gas supply, from Utica Drop Forge and Tool.

Philco showed transistor production equipment, automatic transistor test equipment and its Project Virtue life-test storage racks (ELECTRONICS, Feb. 24, 1961, p 72).

Several materials suppliers were selling silicon, germanium or intermetallic single crystals, including infrared materials. Crystals prepared by the floating-zone method are now generally available. W.E.B., M.T., L.H.D., G.S., J.M.C.

Balun by Schutter Microwave is designed to switch Army communications transmitters, can handle up to 50 Kw in range 4 Mc to 50 Mc



Storage and retrieval functions of system combine electronic and optical techniques. Six informational requests can be handled simultaneously

Information Retrieval System Cuts Storage Space, Speeds Access

A MACHINE capable of automatically searching stored information at a rate of 6,400 pages a minute has been developed by FMA, Inc. Called FileSearch, the system can also store 1½ million microfilmed pages normally requiring 40 four-drawer file cabinets in a single file cabinet.

Production schedules have been established at the company's El Segundo, Calif. plant. Sale of the first system has been to the Navy's Bureau of Ships for April delivery. Cost of the system will be slightly over $100,000.

Documents are indexed by an analyst who uses a set of words or numbers to describe the contents. These descriptors can vary from a single accession number to a complex group of words and relationships giving information about date, source of document, author's name and subject matter.

Each kind of description is identified by a special character called a tag. Index terms can vary in length up to 12 characters and as many descriptor words as necessary can be used.

The indexed information from the analyst's code sheet is punched into a card on a Flexowriter. Punched card and associated page are then sent to a recorder consisting of a planetary microfilm camera and a recording table with additional provisions for recording the index code on film. The code is placed on film at the same time as the first page of the document is recorded. Operator places first page of document on the table and inserts the punched card into a reader which actuates the camera.

A maximum of 56 alphabetic characters can be stored in the code area on the edge of each frame. Each alphabetic character

has a parity check bit, thus seven bits are required to represent one character. Each two-character row of code has 14 bit positions and a timing mark.

Reels can be dedicated to certain subjects, the inexpensive film reproduction allowing a copy of material concerning both subjects A and B to be recorded on each of the reels dedicated to A and B, respectively. More than 200 transistorized circuit boards are required for search and retrieval operations.

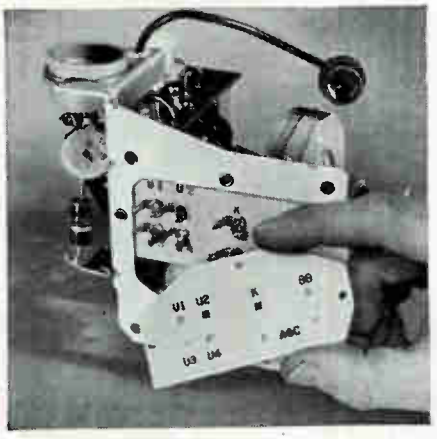
As shown in the block diagram, the original seven documents have become 14. This file expansion is done in a retrieval unit. The working film is placed in the unit and searched on the basis of subject A. When a match is found, a 1:1 copy of the document is made with the copy camera. Strips of film are produced which are then spliced onto the appropriate subject reels.

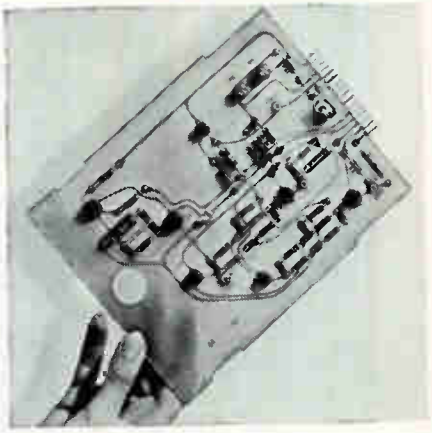
When the informational needs of the user are translated into library language, the request is then coded into machine language on a Flexowriter and the resultant punched card inserted into the system machine. The appropriate reel of microfilm is manually inserted into the machine and then searched automatically.

The film is read at the rate of 200 feet a minute which is equivalent to 6,400 pages a minute. Code bits on the film are sent to circuits which compare this information with the request code. Each descriptor read from the film is compared with the contents of six request registers and the results are stored until the first-of-code character from the next document is sensed. The comparison results are sampled and associated according to AND, OR and AND NOT characters punched in the card. The film transport is then stopped and the first page positioned for viewing and printing. After the selected document is copied or examined, the circuits are reset and the search process continues.

When a match with a request is made, the selected material can be displayed on a viewing screen, reproduced in hard copy form or automatically recorded on microfilm in cases where large volumes of information are requested.

Taylor glass-base laminates pop right out as design materials in many applications

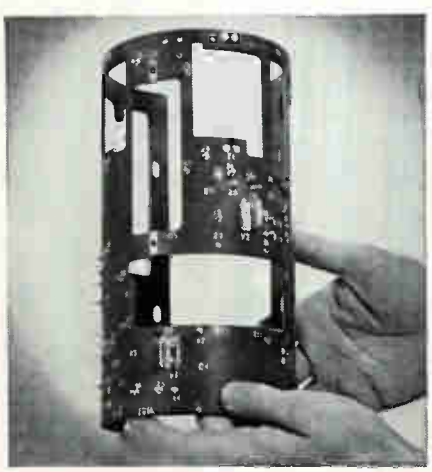




There are good reasons for investigating Taylor glass-base laminated plastics as high-strength-to-weight materials in your design. They offer light weight, corrosion resistance, electrical and thermal insulation, and ease of fabrication.

For example, glass-fabric-base laminates have the highest mechanical strength of all laminated plastic materials. They have been successfully used in the fabrication of critical parts, including aircraft parts and bases for printed circuits. They are most valuable where extremely low moisture absorption, increased heat resistance and superior electrical properties are required.

Taylor Fibre produces a number of different glass-base grades in sheet, rod and tubular form, and copper-clad. Those with phenolic resin are recommended for mechanical and electrical applications requiring heat resistance. Those with melamine are characterized by their excellent resistance to arcing and tracking in electrical applications. They also have good resistance to flame, heat and moderate concentrations of alkalis and most solvents. Those with silicone exhibit very high heat resistance, combined with good mechanical and electrical properties. They also have highest arc resistance. Those with epoxy offer extremely high mechanical strength, excellent chemical resistance, low moisture absorption, and high strength retention at elevated temperatures.



Technical data about these and other Taylor laminated plastics are available. Ask for your copy of the Taylor Laminated Plastics Selection Guide. Taylor Fibre Co., Norristown 40, Pa.

Taylor
LAMINATED PLASTICS VULCANIZED FIBRE

Russian Television Inspects Wells

Soviet-designed television pickup unit for inspection of well sides uses semiconductors and miniature components. Metallic cylinder is 1,690 mm long, 60 mm in diameter (Sovfoto)

Converter to Provide Five Watts for 10 Years

ATOMIC ENERGY COMMISSION has asked Royal Industries, Los Angeles, to design an isotopic power supply capable of providing five watts of energy continuously for 10 years.

Royal is to provide a prototype by yearend.

Energy will be derived from radioactive decay of cesium-137, whose half-life is in excess of 25 years. Westinghouse Electric will construct the thermoelectric converter on a subcontract from Royal Industries.

Company spokesmen say power cost will average out to two cents per watthour.

Decline in the specific output of the cesium-137 will be offset by building higher capacity into the converter at the start. A special circuit will drain off excess power as long as it is produced.

Lebanon Reports Rising Tv Sales

BEIRUT—Television receiver sales in Lebanon have been averaging about 1,000 units a month since tv broadcasting started here in 1959, according to Lebanese government survey. Approximately 75,000 people are listening to broadcasts each night on an estimated 16,000 receivers.

Two tv stations are operating in Beirut, with a third channel available from Egypt since Cairo's first station began operations last July. The Cairo transmissions are being received in good order about 60 to 70 percent of the time. Under favorable conditions, some reception is picked up from Cyprus. This fringe reception, say observers, is stimulating sales of antennas.

The tv receivers being used in Lebanon are primarily of West German manufacture. A number are from the Netherlands. Somewhat less than five percent are American made. Small quantities are from the United Kingdom, Russia and Hungary.

Transmitter Ordered For N. Y. UHF Test

CONTRACT for a 50-Kw uhf television transmitter to be installed on the 80th floor of New York City's Empire State Building has been signed by Radio Corporation of America and the Federal Communications Commission.

Also, FCC has issued a request for quotations to install vhf-uhf tv receivers at 1,000 New York City sites. Bids should be in by April 5.

About 100 receivers will be used by the Commission which will move them from place to place. Ten color sets will be included.

A measurements contractor will work with receiver installers and make checks and observations on two uhf and two vhf channels. Also to be tested are vhf and uhf antennas both for indoor and outdoor use.

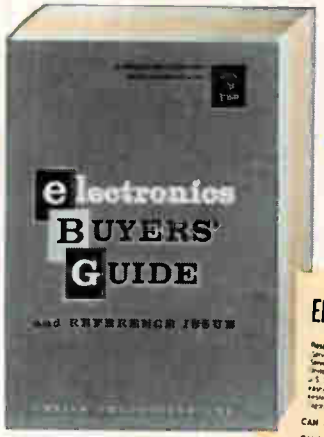
The transmitter installation, which will be on a lease basis, is the first step in FCC's $2-million test to determine the feasibility of metropolitan uhf tv (see ELECTRONICS, p 32 June 3, 1960).

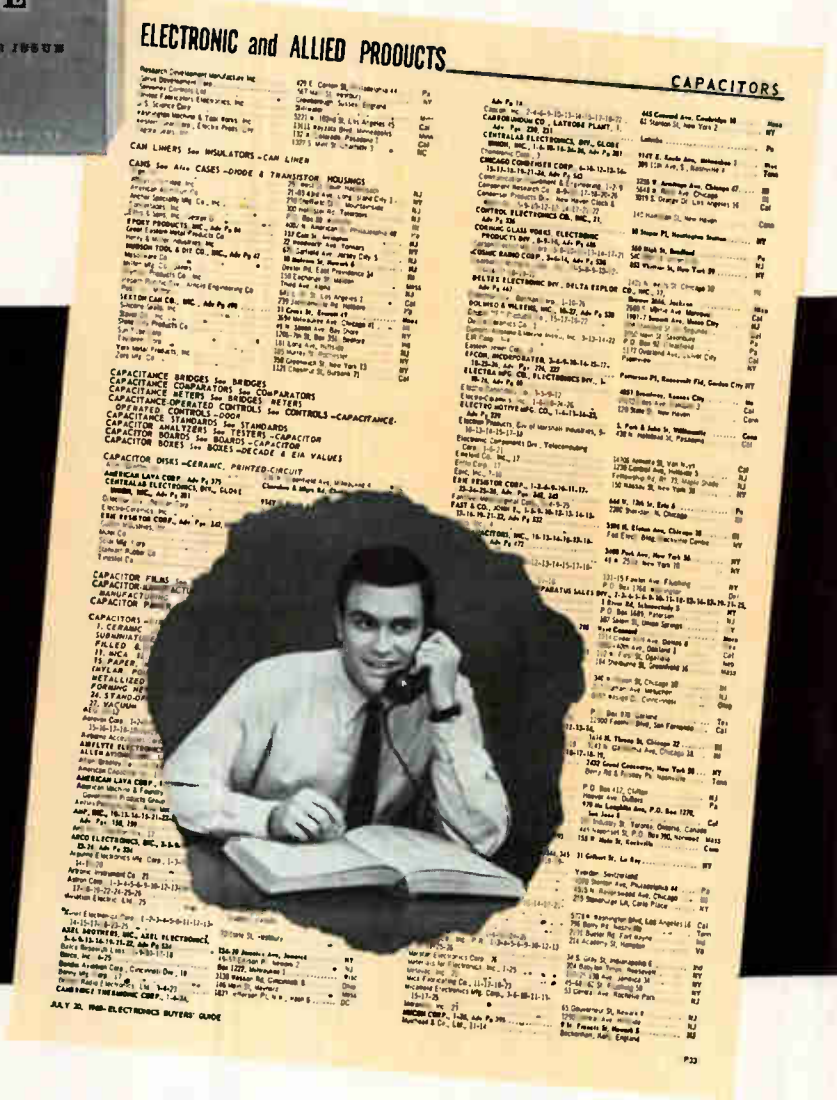
Classed by RCA as its highest powered uhf tv transmitter, the unit is slated to be installed by August 1. There will be a two-month test period. The contract will run until June 31, 1962, with option for renewal.

The amount for leasing and installation of the transmitter, which will operate on channel 31, is $377,584. Provision is made for a dismantling charge of $135,615, if the transmitter is not otherwise disposed after the test period.

The test is being made by FCC to determine whether uhf television can be rejuvenated.

IT'S WHAT'S "INSIDE" THAT COUNTS!





EXCLUSIVE!

SPECIFIC PRODUCT LISTINGS SAVE TIME

No matter how many products a company makes, each is listed (after verification each year by questionnaires) under its specific heading. More than 3,000 products are cross-indexed so that all company products are easy to find (eliminates unnecessary duplicate listings). Advertisers' names and page numbers are in bold face type which lead the user to the advertising pages for complete product specifications.

Typical page from Product Listings Section

EXCLUSIVES make electronics buyers' guide the most used electronics catalog-directory!

- Specially edited 64-page Reference Section assures extra use.
- 1961 EBG will contain the annual "Index of Editorial Articles" which have appeared in regular weekly issues of **electronics**, with abstracts of important features.
- Most reliable, most used catalog-directory in the industry. It's the 53rd issue of **electronics**. You know what you get: 52,286 circulation is audited ABC.
- 21 years of publication plus annual verification of product listings by the industry itself gives EBG accuracy, completeness and authority second to none.
- 648 advertisers in 1960 made EBG "electronics Social Register."

A hard-selling follow-through for your advertising in the weekly issues of **electronics.**

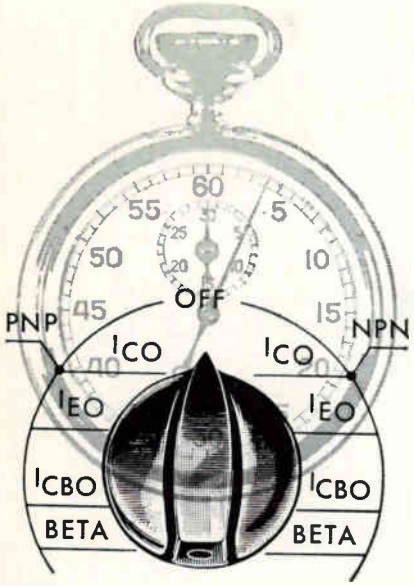
1 page costs $980; ⅔ page costs $666.67; ⅓ page costs $343.34 @ 13x rate

electronics buyers' guide and reference issue The electronic engineer's Basic Buying Book

A McGRAW-HILL PUBLICATION, 330 West 42nd Street, New York 36, N.Y.

CLOSING DATES FOR 1961 ISSUE: Published, July 20. Space Reservations, April 16. Copy to Set, April 23. Complete Plates, May 1. Inserts at Binders, May 31. O.18

Write for complete facts today!



IN SECONDS...

"assembly line" check-out of PNP and NPN transistors with one selector switch!

MRC's new T-340 Transistor Tester offers unparalled check-out simplicity. Simply set in range values for series to be tested, plug in sample unit, index selector switch through function parameters . . . and read corresponding test values directly from meter. Takes only seconds. For receiving inspection or production testing, only four parameters need checking—Beta, I_{CBO}, I_{CO}, and I_{EO}. No special connections, time-consuming adjustments or calculations. Other features: parallel test leads for in-circuit check out or trouble shooting—ripple-free test voltages—a special 0-10 VDC range scan of low collector voltage region for matching oscillator circuit transistors.

MODEL T-340 TRANSISTOR TESTER

Price **$295.00** *Delivery from stock.*

MRC

MAGNETIC RESEARCH CORPORATION

Armour Stabivolt Division

3160 W. EL SEGUNDO BLVD., HAWTHORNE, CALIF.

Engineers Design Educational Kits

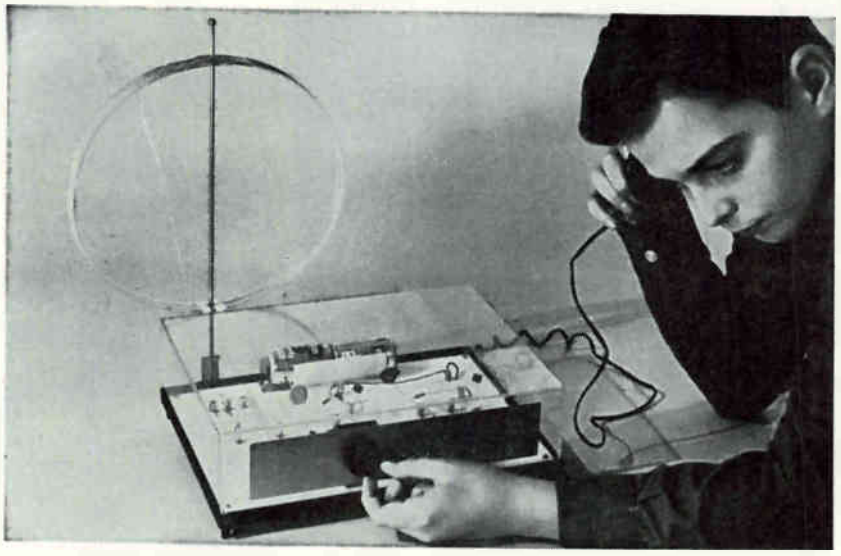
ELECTRONIC educational kits for youngsters 8 to 17-years will be an ever-increasing market. So it seems to GE's Radio and Television division, which has assigned a team of electronics and mechanical engineers to design kits and manuals that are planned not only to teach basic and advanced electric and electronic theory but also to give the youngsters some insight into design principles and techniques.

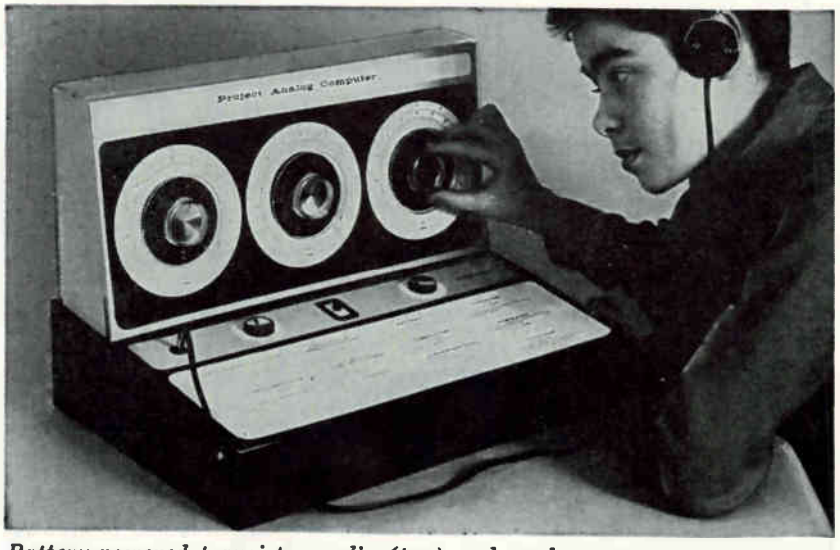
Slated for sale starting next June, several advanced models of the kits were on exhibit at the National Toy Fair held recently in New York City. The fair was used to initiate a sales campaign.

The philosophy of fun first and education second has not been followed by GE. But, they emphasize that while no atempt has been made to sugar-coat the subject matter covered by the kits, the kit manuals are organized on a graded principle in which each step leads to the next in logical sequence.

A group of writers not connected with the company and experienced in explaining science in laymen's terms worked with the engineering team to prepare the presentation of the manuals.

The pause technique used makes the youngster learn while he is constructing or experimenting. Outlook here is that this approach will be of most interest to the more intelligent youngsters who represent a continuing market for more





Battery-powered transistor radio (top) and analog computer are among GE electronic education projects

advanced kits, a line which the firm plans on expanding.

Spokesmen for company maintain that presenting circuit design alternatives is a challenge to the engineers designing the kits. The designers try to show the reasons for such techniques as using coupling capacitors and to give insight into optimizing bias, impedance matching, optimizing load and other fine points of design.

A pathway approach takes youngsters through basic electricity, to electronic circuits and into the groupings of circuits into electronic systems. Complicated mathematics is avoided with the limitation being set at Ohm's Law and Kirchoff's Laws. Transistors are discussed with some explanation of junction theory and the movement of charges. Subjects such as radio-wave propagation are explained.

Meanwhile, RCA's Electronic Trainer is being made available to the high-school and college market. Using this device, the instructor starts with basic circuits and builds an operable electronic system. Each circuit is built on an individual schematic panel on which components are plugged in. When the panels are plugged together, the student can observe the function and operation of individual circuits and the system. Radar, television, microwave, test equipment, f-m, and other systems can be built with the trainer. At present, RCA has reported no intention of entering the popular market.

For junior and senior high schools, Bell Labs has made available, as a public service, a wave machine demonstrating wave theory, as well as a solar-cell unit prepared for instructional purposes.

New Deck Radio System For British Carriers

ESSEX, ENGLAND—New carrier flight deck system which permits voice communication between vessel flight control center and deck crews has been announced here.

Signals are fed to a magnetic coupling loop encircling the carrier's flight deck. Crew members carry a receiver that picks up the audio signal, amplifies it and feeds it to an earphone in ear protector.

first from triolab ...

a new standard of precision in AC VTVMS

now measure both complex and sine waves with 0.25% accuracy

'Til now, no VTVM has been able to measure complex waves with high laboratory standard accuracy. Average-reading and peak-reading instruments are subject to significant distortions created by spikes and harmonics.

New triolab Model 120 achieves direct-reading, true RMS values of both sine and complex waves with deflection directly proportional to the square of the current—by use of a special dynamometer movement.

- **DIRECT-READING** No knobs to twist or tedious balancing.
- **INSTANT MEASUREMENT** No sluggish, thermo-couple response.
- **HIGHEST LEGIBILITY** Full 7" custom-calibrated, mirror scale.
- **CONSTANT OVERALL GAIN** For long life.
- **DIAMOND BEARINGS** For perfect balance, smooth scale motion.

Ranges: 10MV to 500V rms, full scale. Input impedance: 1 meg. Fundamental freq. response: 50-2000 cps. Accuracy (above 50% electrical deflection): ¼% f.s. at 400 cps; ½% f.s. at all other frequencies. Power: 115 VAC, 50-400 cps.

AVAILABLE RACK-MOUNTED OR PORTABLE

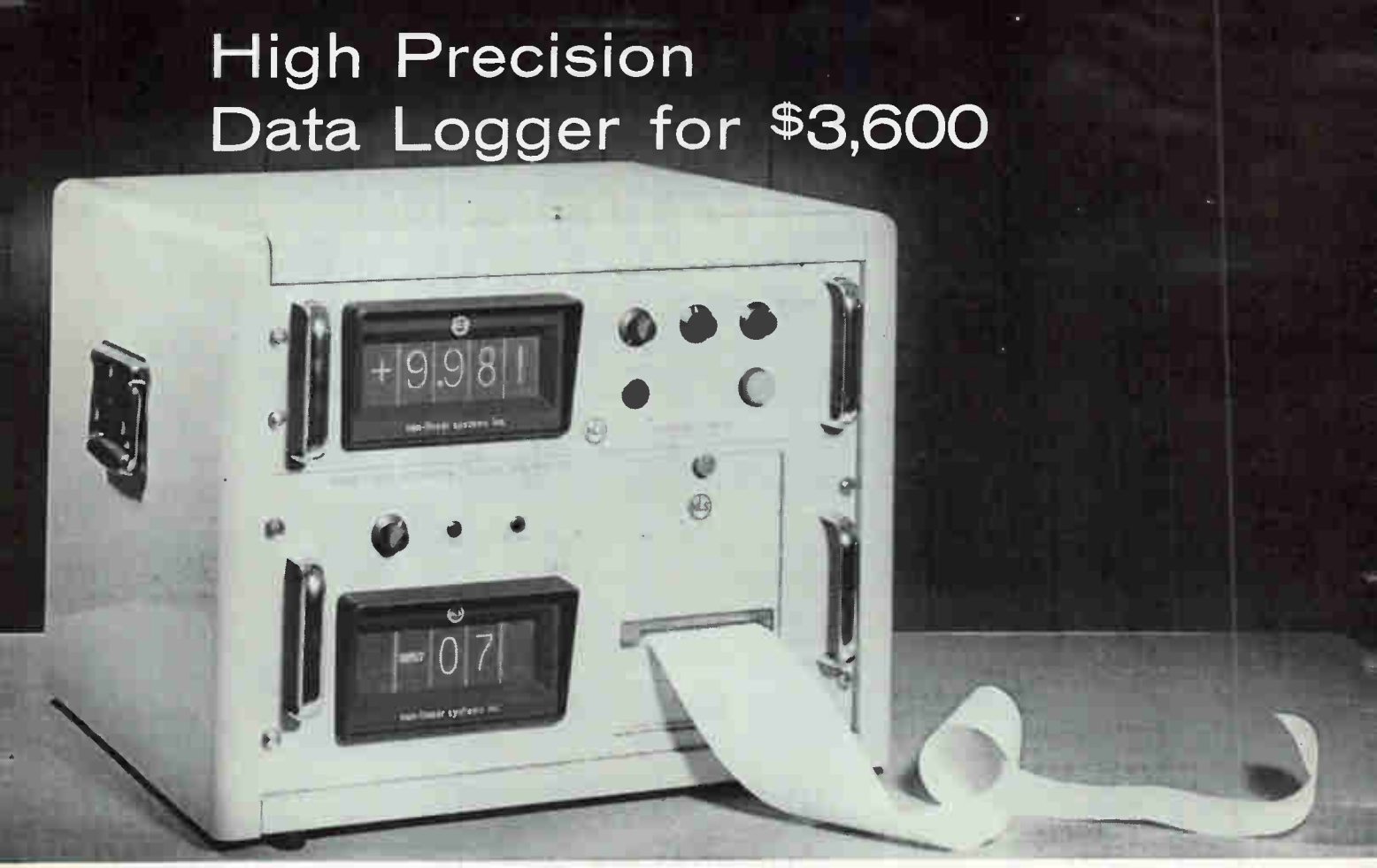
triolab other laboratory and build-in miniature precision instruments can help you. Write for Catalog E3-B.

triolab

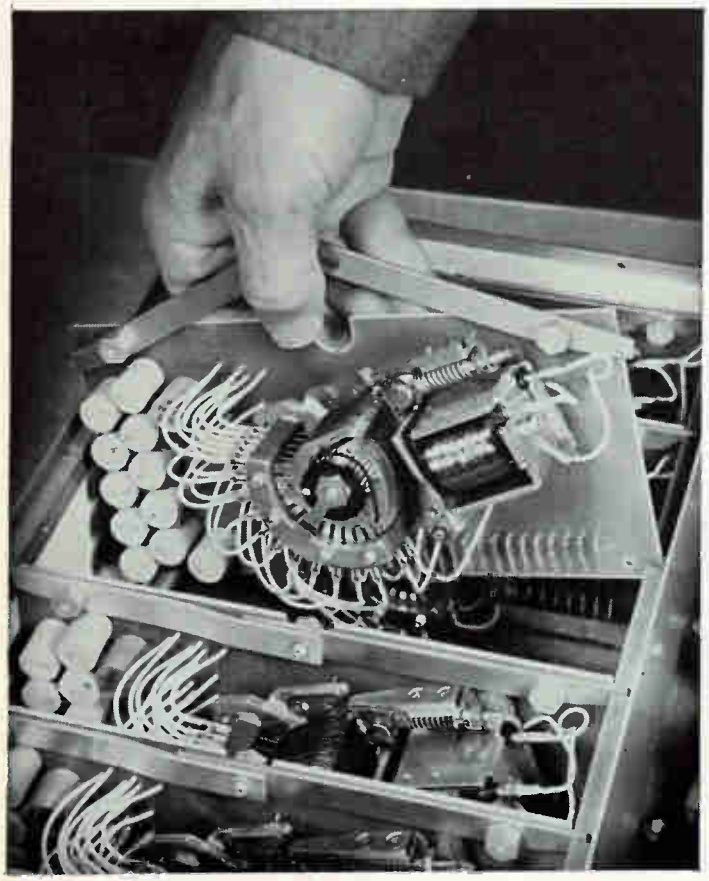
TRIO LABORATORIES, INC., Plainview, L. I., N. Y.
Export Dept: EMEC, 127 Grace St., Plainview, N.Y.

CIRCLE 25 ON READER SERVICE CARD

High Precision Data Logger for $3,600

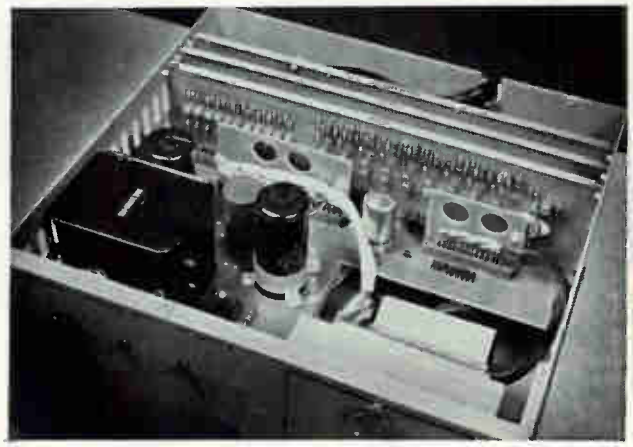


The RS2 Recording Digital Voltmeter — now in volume production at Non-Linear Systems, Inc. — scans up to 20 double-pole input channels . . . measures DC voltage from ±0.001 to ±999.9 with ±0.01% accuracy . . . and records input channel number and the 4-digit voltage measurement. Uses include research and development, quality control, environmental and reliability testing.



Plug-in stepping switches in the digital voltmeter section of the RS2 permit replacement of all switches and decade resistors in minutes instead of days. The plug-in feature allows almost instant trouble-shooting by the substitution method.

Volume production and simplified controls of the RS2 account for its low cost — half to a third less than custom-built units.



Note the compact, plug-in modular design of the scanner-printer section of the RS2.

CIRCLE 26 ON READER SERVICE CARD

NLS Reports on Low-Cost, Standard Data Logger

A low-cost automatic data logger built as an integrated scanning, measuring and printing system – the RS2 Recording Digital Voltmeter – is now in volume production at Non-Linear Systems, Inc.

This economy-priced NLS logger is designed for applications requiring high accuracy and low cost without need for the higher speed and greater input capacity of higher cost NLS systems. Simplified controls offer several automatic and manual modes of operation.

While utilizing many circuits field-tested for six years in thousands of NLS digital voltmeters, the RS2 has undergone extensive testing as a standard, complete system. It is delivered ready to use, without need for additional engineering or complex interconnections.

Call your NLS regional office or representative for a demonstration, or write NLS.

RS2 BRIEF SPECIFICATIONS

Visual Indication: 4-digit voltage reading with correct polarity and range. 2 digits for input channel identification.

Range-Polarity Indication: automatic

Functions: scanning up to 20-double-pole channels; measuring DC voltage from ±0.001 to ±999.9 in ranges of ±9.999/99.99/999.9; printing channel number, 4-digit reading, polarity and decimal point placement.

Accuracy: ±0.01% of full scale on each range.

Speed: 2 seconds average for each data point scanned, measured and recorded.

Scanner Operation Modes: AUTO CYCLE – system continually repeats automatic scanning cycle from channel 00 to 19. ONE CYCLE – system automatically stops after scanning channel 19. PRINT – one input is measured without advancing scanner. Scanner may be manually advanced one channel at a time by depressing front panel ADVANCE button.

AC Voltage: Use NLS AC/DC Converter.

Low-Level DC: Use NLS Model 140 Preamplifier.

Input Impedance: 10 megs on all ranges.

Size: 14" high, 15¼" deep for 19" rack.

Delivery: From stock. 30 days, maximum, should stocks become depleted.

NLS

Originator of the Digital Voltmeter

non-linear systems, inc.

DEL MAR, CALIFORNIA

CIRCLE 27 ON READER SERVICE CARD

March 31, 1961

London-Moscow Tv Link Is Possibility

LONDON—Hopes for a permanent link between Moscow and London tv networks were raised here last week following comment by an official of the British organization negotiating with the USSR.

Leonard Matthews of Associated Television Ltd. said recent developments might result in a lasting tie-in between the West's Eurovision and the East's Intervision.

A link being built will let both nations see transmissions from the British Trade Fair in Moscow and the Russian Trade Fair in London.

The completed network will run from Moscow to Leningrad to Tallinn and then across the Gulf of Finland to Helsinki where it will tie in with Eurovision.

Some equipment in the system's Russian portion may be French-built CSF microwave gear, which the Soviets have purchased.

The Moscow tv transmissions, on 625 lines, will be sent to Tolsford Hill, England, before being converted to the British 405-line standard.

Where British transmissions will be converted to the Russian system has not been decided.

Magnavox Co. Enters Transistor Organ Field

A NEW ENTRY in the electronic organ field, Magnovox Co., Fort Wayne, Ind., will introduce a transistorized organ in the popular price field this July (see ELECTRONICS, p 40, Nov. 11, 1960).

The instrument will feature a large number of voices, and individual tone generators for every note.

The firm has surveyed the market, finds annual retail sales have reached about $185 million, predicts a market of $500 million within a decade. Electronic organs now surpass pianos in dollar volume, are pressing closely on unit sales.

The Magnavox organ will be sold directly to franchised dealers, by a separate division that has been created to manufacture, promote and sell the line. Ultimately the entire line will range in price from $795 to $1,500.

Microwave Surveying System in Use

MICROWAVE SURVEYING system is being used by San Diego State College. Manufactured by Cubic Corp. and called Electrotape, the system consists of two tripod-mounted units having parabolic antennas which are set up at opposite ends of the distance to be measured. Microwave signals are beamed between the two stations. Time lapse between signal transmission and reception is displayed numerically to give precise indication of linear distance.

Radio Checks Heartbeat

Combination photo: f-m transmitter on 1-lb belt lets University of Michigan researchers check athlete's heartbeat rate on cardiogram

PRODUCTION QUANTITY TI SIL

MAXIMUM 12 nsec t_{on}

MAXIMUM 40 nsec t_{off}

$V_{CE(sat)}$ PRACTICALLY INSENSITIVE TO TEMPERATURE . . . CONSTANT 1 VOLT FROM −55 to +170°C

The fastest silicon switcher in the industry! Design today with Texas Instruments new 2N743 and 2N744 silicon epitaxial transistors and get *two-times faster switching than possible from any other commercially available silicon transistor!* This outstanding new epitaxial series gives you an optimum combination of ultra-fast switching times, temperature-stable R_{CS}, very low collector capacitance, and high f_T, to make the 2N743 and 2N744 *ideal for application in current ranges from 1 to 100 ma.*

Utilize the low R_{CS}/high current characteristics of these new epitaxial units to *replace large size medium-power transistors* and cut your overall switching times as much as two-thirds. Cut cost and reduce the complexity of your NOR logic designs with the new TI 2N743 series — these new epitaxial units give you a guaranteed I_{CEX} of 30 µa at a V_{CE} of 10 volts and V_{BE} of 0.35 volts to eliminate additional circuits previously required for an I_{B2} turn-off source in your computing systems.

Apply the new 2N743 and 2N744 to your designs today and get *guaranteed d-c betas at three current levels.* The 2N744 gives you a guaranteed h_{FE} of 20 at 1 and 100 ma and a 10-ma beta spread of 40 to 120, while the 2N743 features a minimum h_{FE} of 10 at 1 and 100 ma, and 60 maximum at 100 ma.

New TI 2N743 and 2N744 silicon epitaxial transistors are immediately available from distributor stocks or in mass production quantities at prices competitive with conventional silicon mesa and micro-alloy transistors.

Compare the 2N743 and 2N744 with conventional transistors!

Parameter	Approx. Test Conditions	TI 2N743	TI 2N744	2N834	2N706B	2N708
T_s(nsec)	$I_{B(1)} = -I_{B(2)} = I_C = 10$ ma	14	18	25	25	25
t_{on}(nsec)	$I_{B(1)} = 3$ ma, $I_{B(2)} = -1$ ma, $I_C = 10$ ma	11 (TYP)	10 (TYP)	35	40	35
t_{off}(nsec)		22 (TYP)	25 (TYP)	75	75	75
t_{on}(nsec)	$I_{B(1)} = 40$ ma, $I_{B(2)} = -20$ ma, $I_C = 100$ ma	12 6 (TYP)	12 6 (TYP)	NO SPEC	NO SPEC	NO SPEC
t_{off}(nsec)		40 18 (TYP)	45 23 (TYP)	NO SPEC	NO SPEC	NO SPEC
$V_{CE(sat)}$	$I_B = 1$ ma, $I_C = 10$ ma, $T_A = +170$°C	0.35 v	0.35 v	No High Temp. Guarantee (0.19 v MAX. @ 25°C)	No High Temp. Guarantee (0.4 v MAX. @ 25°C)	No High Temp. Guarantee (0.4 v MAX. @ 25°C)
I_{CEX}	$V_{CE} = 10$ v, $V_{BE} = +0.35$ v, $T_A = 100$°C	30 µa	30 µa	No Guarantee	No Guarantee	10µa (MAX.) @$V_{BE} = +0.25$ $V_{CE} = 20$ v $T_A = +125$°C

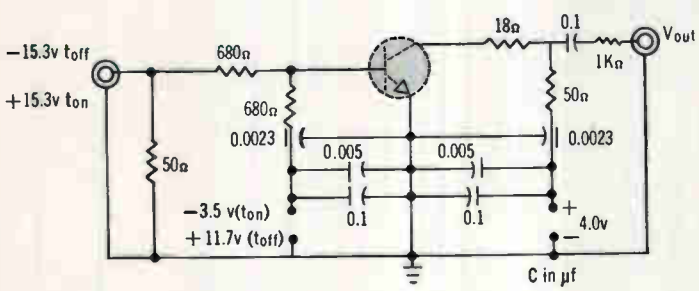
NOTE: All limits are max. unless otherwise noted.

ICON EPITAXIAL TRANSISTORS

@100 ma

MAKE YOUR OWN COMPARISON FROM THESE TYPICAL CIRCUITS

50-ma SWITCHING CIRCUIT



USE THE TI 2N743 TO SWITCH IN 1/3 THE TIME!

2N706

t_{on} = 10 nsecs

t_{off} = 50 nsecs / 60

2N743

t_{on} = 7 nsecs

t_{off} = 15 nsecs / 22

USE THE TI 2N743 TO DOUBLE POWER OUTPUT AND EFFICIENCY!

2N706

P_{out} = 225 mw

Eff = 32%

P.G. = 6 db

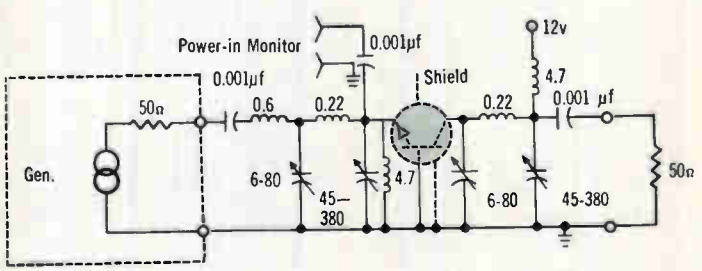
2N743

P_{out} = 500 mw

Eff = 65%

P.G. = 6 db

70-mc POWER AMPLIFIER



IN TI DISTRIBUTOR STOCKS — 3D — DEPTH · DELIVERY · DEPENDABILITY

INDUSTRY'S BROADEST LINE OF TRANSISTORS

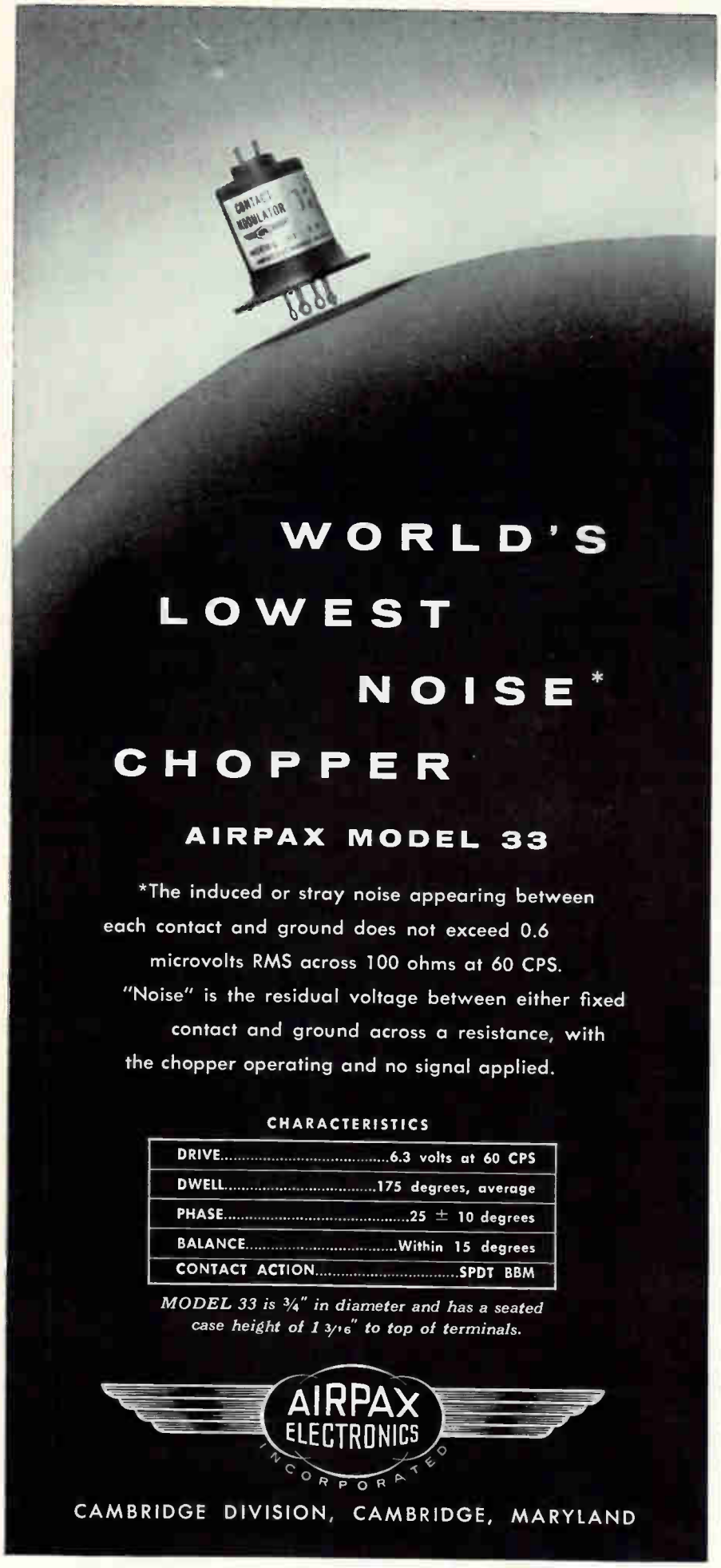
SEMICONDUCTOR-COMPONENTS DIVISION

TEXAS INSTRUMENTS

LIMITED — DALLAS ROAD • BEDFORD, ENGLAND

INCORPORATED — P. O. BOX 5012 • DALLAS 22, TEXAS

CIRCLE 29 ON READER SERVICE CARD



MEETINGS AHEAD

Apr. 4: Automatic Control, AIEE; Northeastern Univ. Graduate Center, Boston.

Apr. 4-6: Electromagnetics and Fluid Dynamics of Gaseous Plasma, IRE, IAS, U. S. Defense Research Agencies; Engineering Societies Bldg., New York City.

Apr. 4-7: Audio Engineering Society; Ambassador Hotel, Los Angeles.

Apr. 5-7: Global and Space Environments, Institute of Envir. Sciences; Sheraton Park Hotel, Wash., D. C.

Apr. 5-7: Materials and Electron Devices Processing, ASTM Committee F-1; Benjamin Franklin Hotel, Philadelphia.

Apr. 11-12: Instrument Automation - Electronics Exposition, Ohio Valley; Cincinnati Gardens, Cincinnati, O.

Apr. 11-13: Ultrapurification of Semiconductor Materials, Air Force Cambridge Research Laboratories; New England Mutual Hall, Boston.

Apr. 17-19: Instrumental Methods of Analysis, ISA; Shamrock-Hilton Hotel, Houston, Texas.

Apr. 17-21: Strain Gage Techniques, Southwest Research Institute; San Antonio, Texas.

Apr. 18-19: Organic Semiconductors, Inter-Industry Conf., Armour Research Foundation of Illinois Inst. of Tech., and ELECTRONICS, McGraw-Hill; Terrace Casino, Morrison Hotel, Chicago.

Apr. 19-21: Southwestern IRE Conf. and Elec. Show, SWIRECO; Memorial Auditorium, Dallas.

Aug. 22-25: WESCON, L.A. & S.F. Sections of IRE, WCEMA; Cow Palace, San Francisco.

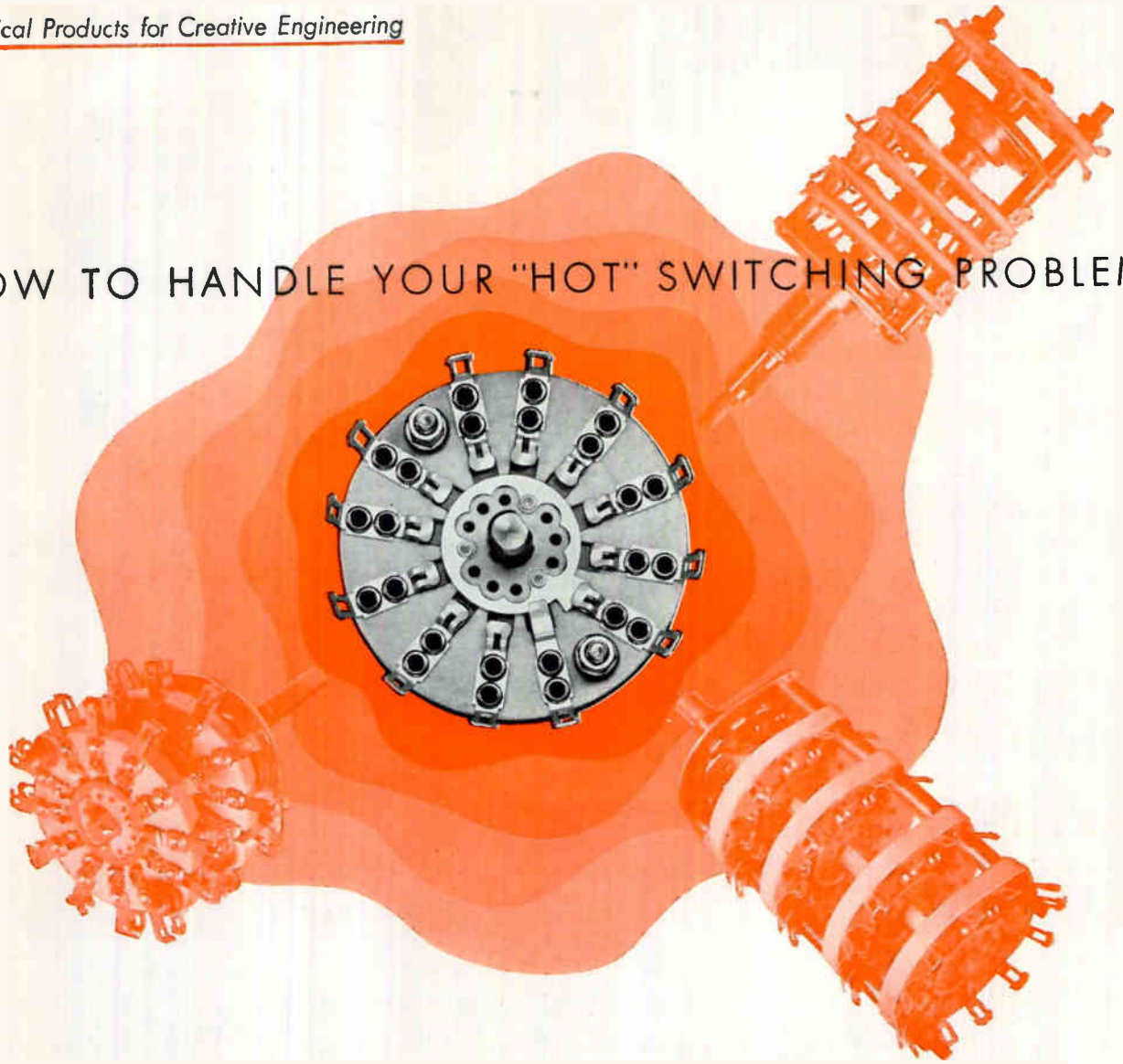
Sept. 11-15: Instrument-Automation Conf., 2nd Exhibit, ISA; Sports Arena, Los Angeles.

Oct. 9-11: National Electronics Conf., IRE, AIEE, EIA, SMPTE; Chicago.

Nov. 14-16: Northeast Research & Engineering Meeting, NEREM; Commonwealth Armory and Somerset Hotel, Boston.

Practical Products for Creative Engineering

HOW TO HANDLE YOUR "HOT" SWITCHING PROBLEMS



160° C

OAK HIGH TEMPERATURE SWITCH SECTIONS have the stamina to stand up under a constant ambient temperature of 160°C. In fact, their clips have been life-tested for more than 800 hours at this temperature and still maintained their tension. There are several reasons why Oak high temperature switch sections perform with such exceptional reliability. First, positive contact is maintained by Oak's special double-wiping, spring clip contact design. Next, Oak has developed a special alloy that's downright reluctant to lose its spring tension at these high temperatures. Last, Oak *rolls* a .0006" layer of gold on this clip to doubly-assure exceptional stability and contact performance. You can order these sections in ceramic or Mycalex insulation for Types FIX, HC, DHX, DHC, NC, JC, DLX, FC, and FX switches. For more information, contact your local Oak sales representative or send details of your application to our Applications Engineering department.

Creative Engineering • Quality Components

OAK MANUFACTURING CO.

CRYSTAL LAKE, ILLINOIS • Telephone: Crystal Lake 459-5000

OAK ELECTRONICS CORPORATION (Subsidiary) • Culver City, California

ROTARY AND PUSHBUTTON SWITCHES • TELEVISION AND FM TUNERS • SUBASSEMBLIES
APPLIANCE CONTROLS • CHOPPERS • ROTARY SOLENOIDS • VIBRATORS

TANTALUM CAPACITORS...NEW HEIGHTS IN RELIABILITY
ENGINEERED BY PYRAMID

When Pyramid tantalum capacitors with proven dependability are incorporated into essential electronic equipment you manufacture . . . greater reliability of your product is assured.

To design engineers searching for miniature electrolytic capacitors with unusual capacitance stability and a low dissipation factor over a wide temperature range, soundly constructed tantalum capacitors are gratifying discoveries.

If the equipment you make demands small capacitors with explicit reliability and peak performance, look to Pyramid for tantalum capacitors that meet your most exacting requirements.

For full details write or call: Sales Department

PYRAMID ELECTRIC COMPANY
DARLINGTON, SOUTH CAROLINA

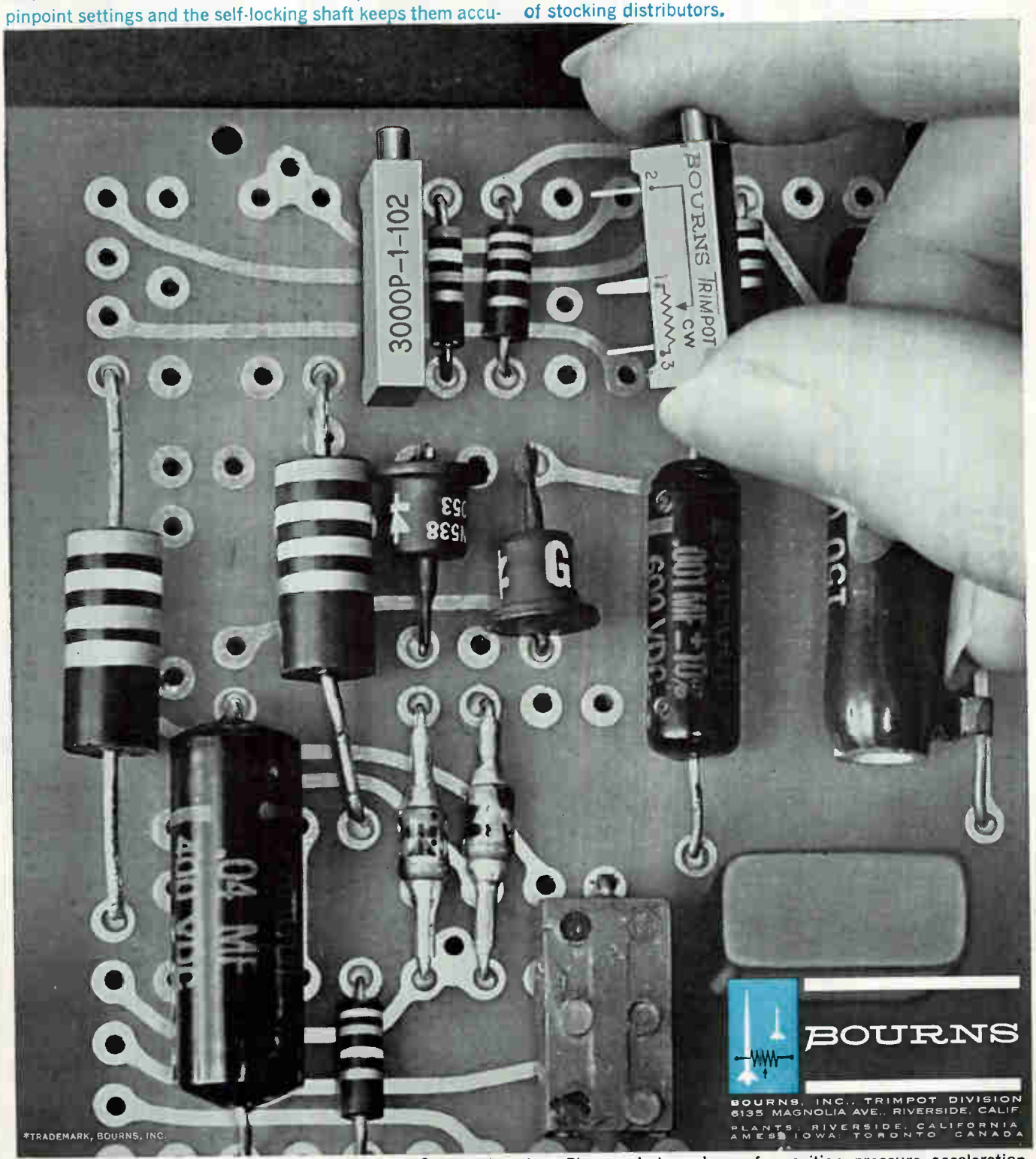
Canada: Wm. Cohen, Ltd., 8900 Tanguay Street, Montreal
Export: Morhan Exporting Co., 485 Broadway, N.Y.13,N.Y.

Now—an Even Smaller High-Temperature Trimpot® Potentiometer

Here, just ¾" in length, is a wirewound potentiometer that is completely humidity-proof and operates at 175°C! Ideal for your printed circuit applications, it withstands 30G vibration and 100G shock, dissipates 0.5 watt at 70°C (0.2 watt at 125°C), and has tapered pins for quick, easy mounting.

Sealed against humidity in a high-temperature plastic case, the Model 3000 exceeds the requirements of MIL-STD-202A, Method 106. The 15-turn screwdriver adjustment permits pinpoint settings and the self-locking shaft keeps them accurate. For maximum stability, the unit incorporates a ceramic mandrel. Reliability is outstanding. The exclusive Silverweld* bond between terminal and resistance wire is virtually indestructible under thermal or mechanical stress.

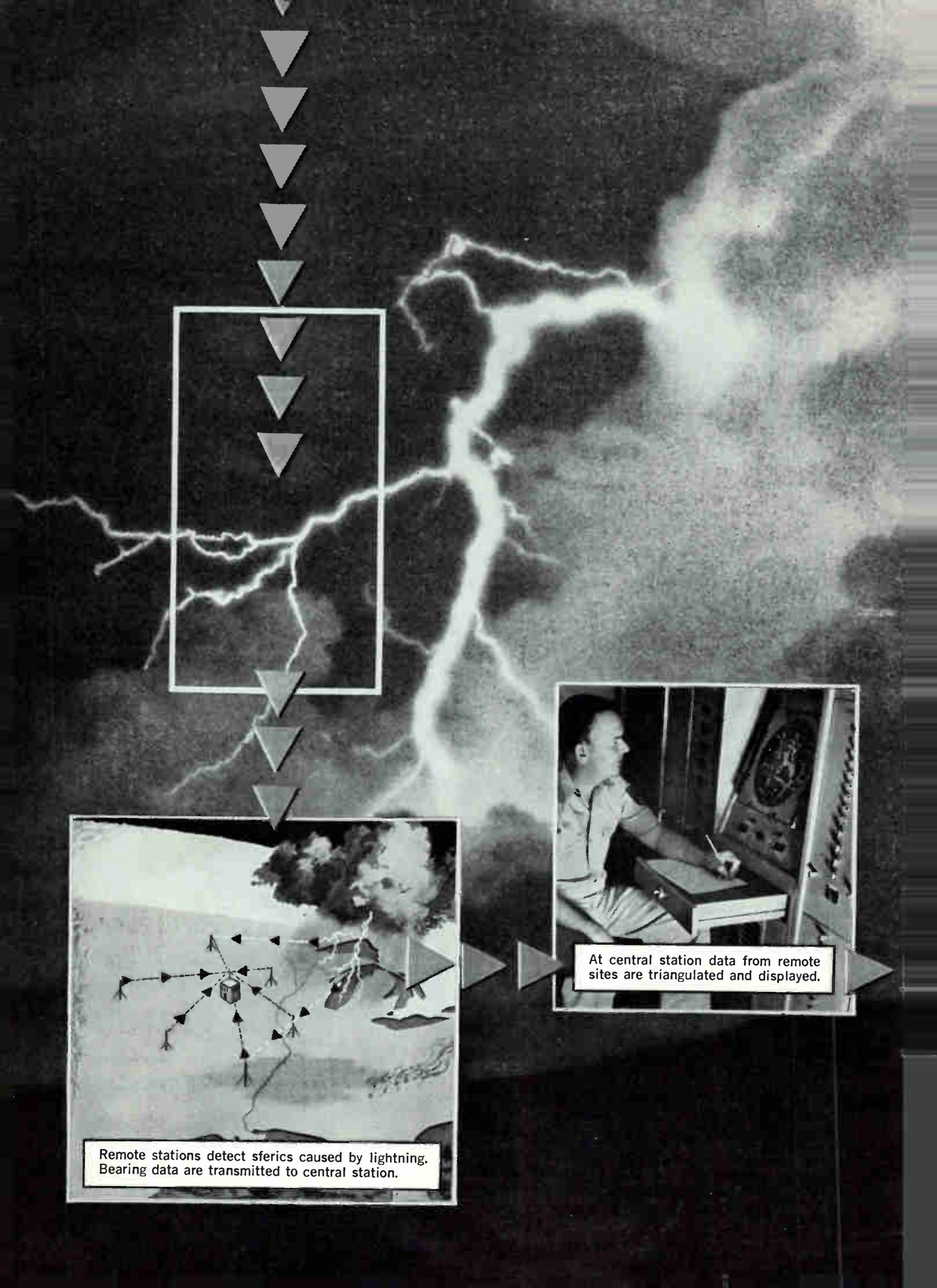
Available within 24 hours from factory and distributor stocks the Model 3000 is stocked in resistances of 50 ohms to 20K. A Resiston* carbon version, Model 3001, is available with resistances of 20K to 1 Meg. Write for complete data and list of stocking distributors.



Exclusive designers and manufacturers of Trimpot® potentiometers. Pioneers in transducers for position, pressure, acceleration.

CIRCLE 33 ON READER SERVICE CARD

CIRCLE 34 ON READER SERVICE CARD→

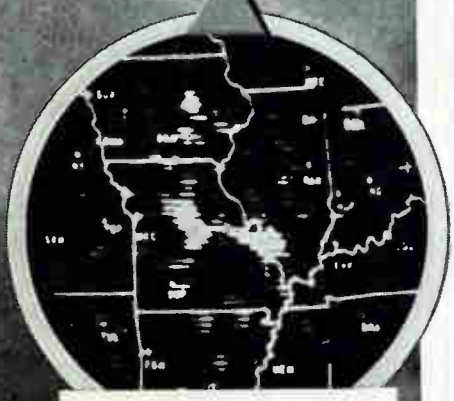

Remote stations detect sferics caused by lightning. Bearing data are transmitted to central station.
At central station data from remote sites are triangulated and displayed.

Now... Forecasting by Lightning

New Lockheed Electronics weather system spots storms up to 2,000 miles away

When a storm is brewing, lightning may send warnings hours before it is detected by weather radar. Lightning flashes (sferics) give valuable clues to weather conditions, but until recently, weathermen had no effective way of detecting and locating sferics at long range.

Now, Lockheed Electronics has produced, in conjunction with the Army Signal Corps and Air Force, a unique system that pinpoints all lightning flashes within a 4,000-mile area.



Flashes of light on kinescope indicate lightning's location.

Remote antennas pick up radio signals generated by sferics. Processing equipment converts the signals into directional data and transmits the information to the Air Force's Severe Weather Warning Center in Kansas City, Missouri. There, after triangulation, the signals are traced on a display which gives the storm's location and path.

Continuing research is leading to use of sferics as an aid in forecasting tornados and for plotting severe storms in mid-ocean where present forecasting devices cannot be used.

LEC is contributing importantly in a variety of ways to development of equipment to advance meteorological knowledge. Among current projects are high performance radiosondes and wind data conversion systems.

MINDING THE FUTURE

LOCKHEED ELECTRONICS COMPANY

Plainfield, New Jersey

ENGINEERS AND SCIENTISTS:
For unique position advancement opportunities, please contact our Professional Placement Office.

Zero burnout time and minimum "haloing" are combined in CDF's new grade 614 glass fabric epoxy laminate at no increase in price over conventional NEMA G-10 grades. Available plain or copper-clad, 614 is a cold punch material that is also superior in flame retardancy, has excellent trichloroethylene vapor resistance and low moisture absorption. The grade is distinguished by its opacity and its tan color.

Result: Another example of CDF leadership in meeting critical military and industrial applications while effecting important customer savings!

Typical properties of 614 (1/16" thickness):

Burnout Time, sec.	0
Water Absorption	0.10
Flexural strength, psi, lw	75,000

(Copper-clad 614 meets MIL-P-13949B, Type GF Plain meets NEMA G-10; approval pending for MIL-P-18177B, Type GEE. Also pending under NEMA proposed FR-4)

CDF CONTINENTAL-DIAMOND FIBRE

CONTINENTAL-DIAMOND FIBRE CORPORATION, NEWARK, DELAWARE • A SUBSIDIARY OF THE Budd COMPANY

INLAND

first with solid state 100-watt d-c amplifier

Inland's new **Model 579.35** d-c amplifier has a high power output of 100 watts when used with low impedance loads requiring direct current. And this completely transistorized amplifier is packaged in a hermetically sealed can only 2½" x 3 3/16" x 2½".

Designed for use with d-c torquers, in one typical application Model 579.35 provides 65 db power gain between the output of a d-c driver stage and the input terminals of a permanent magnet torque motor. This amplifier has these outstanding performance characteristics:

- The d-c output has magnitude and polarity proportional to the input signal.
- All amplifier circuits use a combination of silicon and germanium transistors (all-silicon models also available).
- Amplifier null and gain are stable and independent of temperature.

Inland also makes a complete line of rotary amplifiers for matched use with Inland's distinctive pancake shape d-c torquers.

A brochure on this new high-power amplifier is available. For your copy and complete data on Inland torquers and amplifiers, write Dept. 12-3.

TYPICAL SPECIFICATIONS

Maximum Power Output, watts (6 ohm load)	100
Power Gain	4,000,000
Current Gain	200,000
Voltage Gain	15
Frequency Response	DC to 1000 cps
Input Impedance, ohms	50,000
Dimensions, inches	2½ wide 3 3/16 long 2½ high
Operating Temperature Range in °C	minus 50° to plus 50°

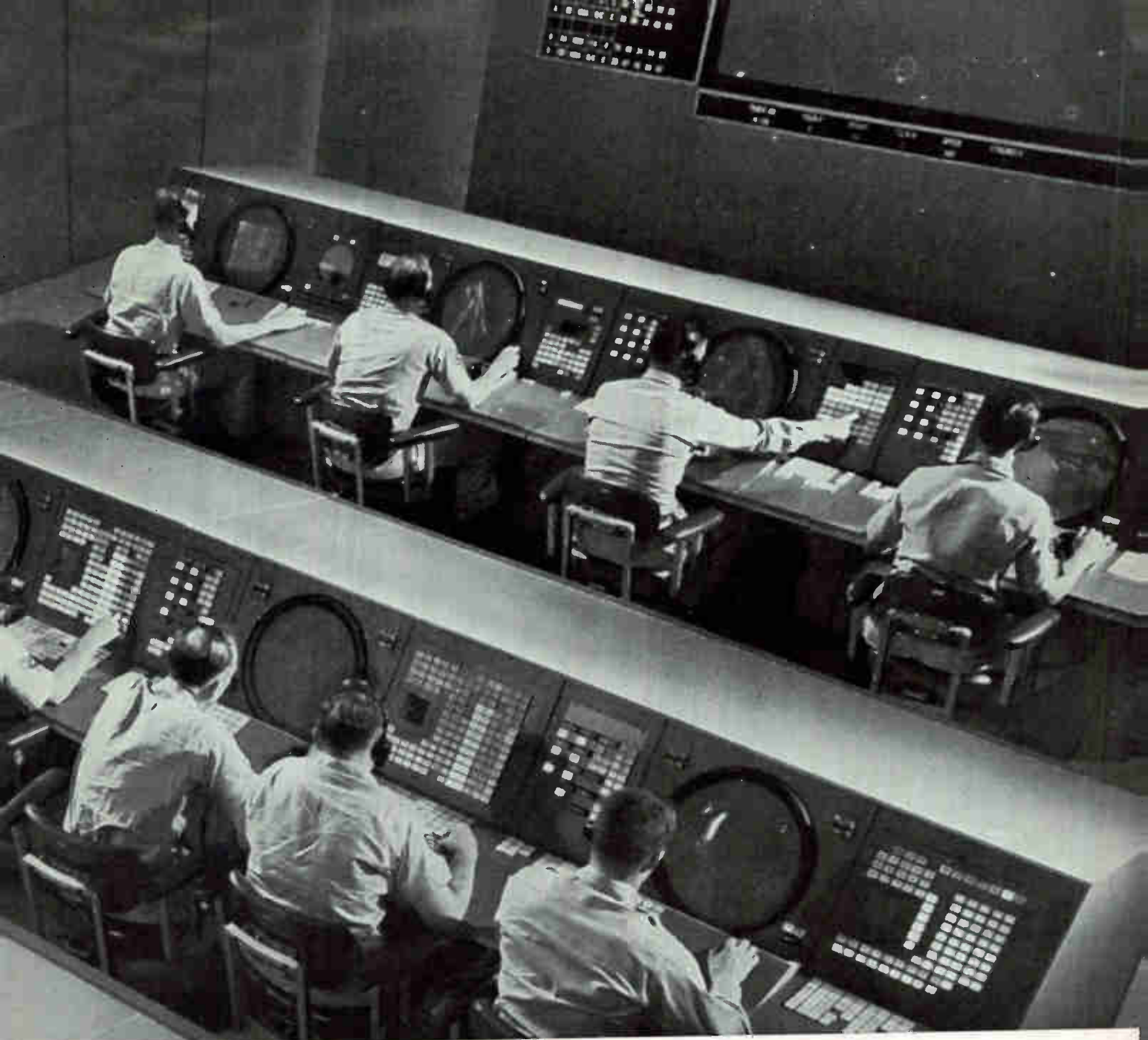
INLAND MOTOR

INLAND MOTOR CORPORATION OF VIRGINIA • A SUBSIDIARY OF KOLLMORGEN CORP., NORTHAMPTON, MASS.

CIRCLE 37 ON READER SERVICE CARD

CIRCLE 38 ON READER SERVICE CARD→


AN ACHIEVEMENT IN DEFENSE ELECTRONICS



412L Strengthens Air Defense By Integrating Airspace Management

Rapid coordination of all phases of military airspace management is a major problem of air defense. This simulated operations room depicts the heart of the Air Force's 412L Air Weapons Control System—a single, semi-automatic electronic complex which coordinates radar stations, data processing and display centers and weapons bases into a unified network.

Within seconds, 412L will provide the vital detection and tracking data to human decision makers. Precious time will be gained since computations leading up to the final decisions will be done automatically. In addition, 412L is a highly flexible system designed for use throughout the Free World. It will operate in mobile as well as fixed environments.

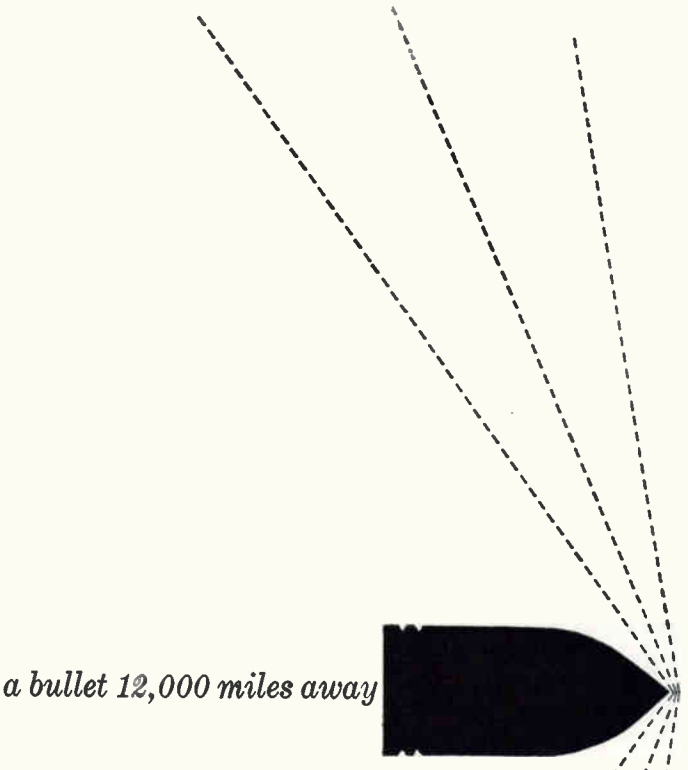
Currently going into prototype production, 412L has already anticipated technological advances. And, importantly, new equipment can be integrated into this versatile Air Weapons Control System in the future, assuring a complex which will remain combat-ready for many years.

176-05

Progress Is Our Most Important Product

HEAVY MILITARY ELECTRONICS DEPARTMENT
DEFENSE ELECTRONICS DIVISION • SYRACUSE, NEW YORK

GENERAL ELECTRIC



To recall a bullet 12,000 miles away *requires Motorola systems reliability*

THE B-70 M&TC major system management contract places in the hands of a single contractor, Motorola, an unprecedented responsibility: positive recall of a Mach 3, nuclear deterrent force. At speeds over 2,000 mph—faster than a rifle bullet—crew and aircraft safety, as well as mission success, demand integration of myriad electronic functions with simplified controls and displays. ☆ The integrated M&TC system includes the functions of world-wide command communications (LRR) linked to the SAC Command Network; line-of-sight, short-range communications (SRR); improved tactical air navigational aids (TACAN); air-by-air IFF; air-by-ground IFF; aerospace ground support equipment (AGE); air-to-air rendezvous equipment; instrument landing system (ILS); and crew intercommunications. ☆ Motorola's role as a major electronic system contractor for the B-70 Valkyrie's Mission and Traffic Control typifies its systems management capabilities. Detailed information is available on request.

Military Electronics Division **MOTOROLA**

Qualified technical personnel are invited to apply

CHICAGO 51, Illinois, 1450 North Cicero Avenue
SCOTTSDALE, Arizona, 8201 East McDowell Road
RIVERSIDE, California, 8330 Indiana Avenue

HOLDS ITS RATING IN HIGH AMBIENTS

Most overload-protection devices have to be de-rated for elevated temperatures. As the ambient goes up, usable load capacity goes down. This is an inherent characteristic of thermal-type devices.

The Heinemann circuit breaker is magnetically actuated. It senses overcurrent not through a heat-sensitive bi-metal strip, but through a solenoid coil. The calibrated current capacity of the coil is unaffected by temperature.

If you put a Heinemann breaker in a hot, component-packed equipment enclosure (even next to a bank of tubes), it will

carry 100 per cent rated load without tripping. It will trip only when it's supposed to. And always at the precise overcurrent value specified.

These temperature-stable characteristics are common to the entire line of Heinemann hydraulic-magnetic circuit breakers. You can have any of them (including the subminiature Series VP shown here) in any integral or fractional rating you need, from 0.010 amps on up, and with any of several inverse time delays. Our Engineering Guide, Bulletin 201, will give you detailed information.

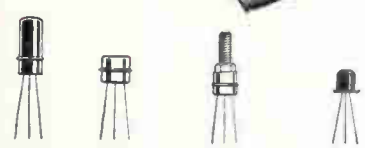
HEINEMANN ELECTRIC COMPANY ◆ 176 BRUNSWICK PIKE, TRENTON 2, N. J.

CIRCLE 41 ON READER SERVICE CARD

IN THE MOST EXACTING APPLICATIONS

PHILCO MADT®

SWITCHING TRANSISTORS



In TO-1 CASE:
2N501—Ultra high speed switch
2N501A—Military version of 2N501

In TO-9 CASE:
2N1204—Ultra high speed, high current switch
2N1495—High voltage, high speed, high current switch
2N1499A—High speed, low cost switch (MIL version available)
2N1500—Ultra high speed switch (MIL version available)
2N1754—Very low cost, high speed switch

In TO-31 CASE:
2N1494—High power version of the 2N1204

In TO-18 CASE:
2N768—Ultra high speed switch for very low power circuits
2N769—World's fastest switch
2N779A—Ultra high speed switch—very high beta
2N846A—Ultra high speed switch

Immediately available in quantities 1-999 from your Philco Industrial Semiconductor Distributor

The Industry's Strongest Record of PERFORMANCE and RELIABILITY

In high-speed computers, control systems, guidance systems and many other critical military and industrial switching applications, Philco's patented high-frequency Micro Alloy Diffused-base Transistors are used more widely than any other type. There are many reasons for this broad acceptance. Philco MADTs are available in a full range of types, each designed and produced to tight specifications for specific applications. They are manufactured by Philco's patented Precision-Etch* process on the world's first fully-automatic transistor production lines . . . under rigid quality control. Philco MADTs have proved their outstanding performance capabilities and reliability in *billions of transistor hours of actual field operation* . . . far more than any other type of transistor.

There is a Philco MADT to meet your requirements . . . offering the advantages of cadmium junctions for cooler operation . . . low collector capacitance . . . low saturation voltage . . . high beta with good linearity . . . excellent frequency response . . . low hole storage time . . . and excellent temperature stability.

Specify Philco MADTs with complete confidence. For full information on any specific type write Dept. E33161.

*Trademark Philco Corp.

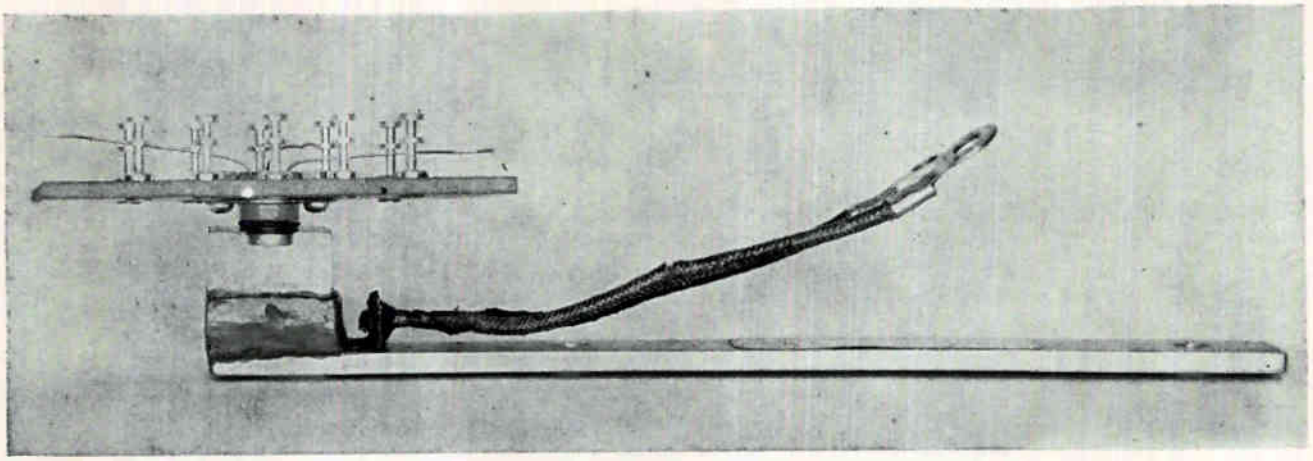
PHILCO®

Famous for Quality the World Over

LANSDALE DIVISION, LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.®

electronics
March 31, 1961



Side view of assembly showing transistor mounted on phenolic base. Transistor case fits into cavity of cooler block

Cooling Transistors With Thermoelectric Elements

Thermoelectric coolers can be used for local cooling of hot transistors. Results of using these elements on transistors operated below and above their maximum rated junction temperatures are discussed

By J. R. FORTIER, Semiconductor Dept., Westinghouse Electric Corp., Youngwood, Pa.,
C. S. THOMPSON, Advanced Development Dept., Magnavox Co., Fort Wayne, Ind.

PRESENT TRANSISTORS have a limiting junction temperature and power ratings associated with ambient temperatures. When the ambient is near the rated junction temperature, the circuit designer can either operate the device at a reduced rating and use more transistors or he can cool the transistor case so that the device can be operated at its maximum rated characteristics.

In many circuits only a few transistors enclosed in a chassis are thermally overloaded. To avoid the expense and the weight-volume increase of refrigerating the entire chassis, thermoelectric coolers can be used for local cooling of the hot transistors. Thermoelectrics are active cooling systems—they cool to a temperature below ambient. They do not compete with passive systems that only limit the temperature rise above ambient.

In a joint study, Westinghouse and the Magnavox Company evaluated the thermoelectric spot cooling of germanium transistors in an electronic circuit. The Westinghouse semiconductor department designed and fabricated the transistor cooler to meet the requirements of a typical Magnavox application, and the units were then evaluated by Magnavox over a wide range of operating conditions.

The thermoelectric cooler used in this study cooled the jacket of the transistor below the point normally reached for any given ambient temperature and heat dissipation. Data from these tests show that, on the average, two and one-

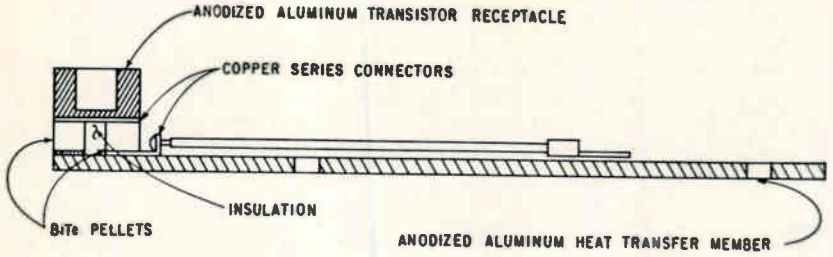


FIG. 1—Design details of thermoelectric transistor cooler (Westinghouse WX819)

half times more heat can be dissipated in a transistor equipped with the transistor cooler than with a transistor situated in a stagnant or slowly moving air stream with no cooling facilities.

The cooling unit was designed to fit over and surround the transistor jacket (see Fig. 1). The diameter of the cavity in the cooler is 0.338 ± 0.003 inch and the cavity depth is 0.340 ± 0.003 inch. A transistor with a type TO5 case fits into this cavity. Thermally conducting silicone grease was used to fill up the space between the jacket and the cavity. The photo shows a transistor mounted on a phenolic base with the cooler placed over the transistor. The transistor jacket fits in the cavity of the cooler block. The metallic strap extending to the right is the thermal conductor from the hot side of the thermoelectric unit to a heat sink.

Maximum efficiency required mounting the aluminum hardware on the thermoelectric module to form a sandwich assembly (see Fig. 1). For minimum height, the thermoelectric pellets were spread apart and the cold-side well was lowered to within one-sixteenth inch from the hot side. This reduction in the insulation resulted in an additional heat leak from the hot to the cold side of the unit that effectively increased the loading of the thermoelectric module by almost 10 percent.

The thermoelectric cooler design incorporates two couples of bismuth telluride thermoelectric pellets connected electrically in series and thermally in parallel. Under load the coolers produce a transistor jacket temperature of 50 C while operating at 16 amperes. The temperature rise through the strap will cause the hot-side temperature to rise to 85 C. A shorter path to the heat sink will allow the thermoelectric cooler to achieve either a lower cold-side temperature or the same temperature of 50 C at a reduced cooler operating power. This would also increase the improvement ratios.

The one-watt loading and 35 C ΔT is beyond the capability of a single couple, but is less than the capability of two couples. Since couples cannot be sub-divided, two full couples are used and operated at a reduced current of 16 amperes rather than the usual optimum of 20 amperes.

For test, it was assumed that the transistor was, before the addition of the thermoelectric cooler, subject to overheating because it was located inside a chassis at a temperature too high to permit the desired heat dissipation. It was also assumed that the transistor cooler is added under the operating condition that the heat sink is at the same temperature as the ambient atmosphere and further that it can be described as an infinite heat sink.

The thermoelectric cooler acts as a heat pump, removing heat from the cavity containing the transistor and delivering this heat to another location where provisions are made to remove the heat.

It was assumed that some part of the metal chassis is available as a heat sink. The metal strap on the transistor cooler is only one of many possible configurations of metallic thermal conductor that may be attached to the chassis body and will serve to conduct heat away from the thermoelectric cooler. The ambient atmosphere is at a temperature too high to dissipate heat by jacket-to-atmosphere contact. Therefore, the chassis is never at a temperature higher than the air contained inside. The chassis body will absorb the small amount of heat from the thermoelectric cooler and conduct this heat to the main body of the equipment carrier (aircraft, tank or other such massive structure) without appreciably raising its temperature, thus satisfying the definition of infinite heat sink. The transistor operates at a temperature depressed below the ambient and thus operates under a greater heat load than would be otherwise possible.

Figure 2A shows plots of jacket temperature against energy dissipated in the transistor at various values of thermoelectric junction currents and at a constant heat-sink temperature of 30 C. The vertical line at the right expresses a limitation placed on the transistor used and is determined by consideration of voltage breakdown within the transistor junction. The line sloping downward to the right is again a transistor limitation imposed by need for maintaining the junction temperature at or below 150 C for this transistor. No operating condition should exist whose data plot extends to the right of either limiting line. These limiting lines are determined by the transistor characteristics. For other transistors similar limitations would be in force but their plot would occupy different positions on the curve sheet indicating different limiting values.

The plot sloping upward to the right shows the rise in jacket temperature with increasing values of energy dissipation in the transistor, without any cooling attachment and operating in a free space ambient of 30 C. Maximum energy which can be dissipated is about 0.55 watt. With the transistor cooler placed over the transistor jacket and the conducting strap thermally connected to an infinite heat sink at the ambient temperature of 30 C, the dependence of jacket temperature upon transistor heat dissipation is given by the curve $I = 0$ amperes, I being the thermoelectric junction current indicating that the body of the cooler is in place but the current has not been turned on.

Below the $I = 0$ plot are other

plots showing the progressively lowered temperature ranges in the jacket temperature-transistor heat dissipation curve as the cooler current is increased. At the low ambient and heat sink temperature for which this data was obtained, nothing is to be gained by using more than about 5 amperes cooler current. Twenty-two amperes is the maximum recommended current for this thermoelectric cooler. Maximum improvement ratio is defined as the maximum allowable transistor heat dissipation with the cooler, divided by the maximum heat dissipation without any cooler. The improvement ratio is 1.82.

The effect of operating at higher heat-sink temperatures is shown by the succeeding curves. In figure 2B the heat-sink temperature is 50 C. Maximum improvement ratio is 2.13.

In Fig. 2C heat-sink temperature is 71 C, significant in military specifications. Improvement ratio is 2.45.

Figure 2D shows the results of tests run on cooler at a heat sink temperature of 90 C, the highest temperature at which the tests were conducted. Improvement ratio is 2.82.

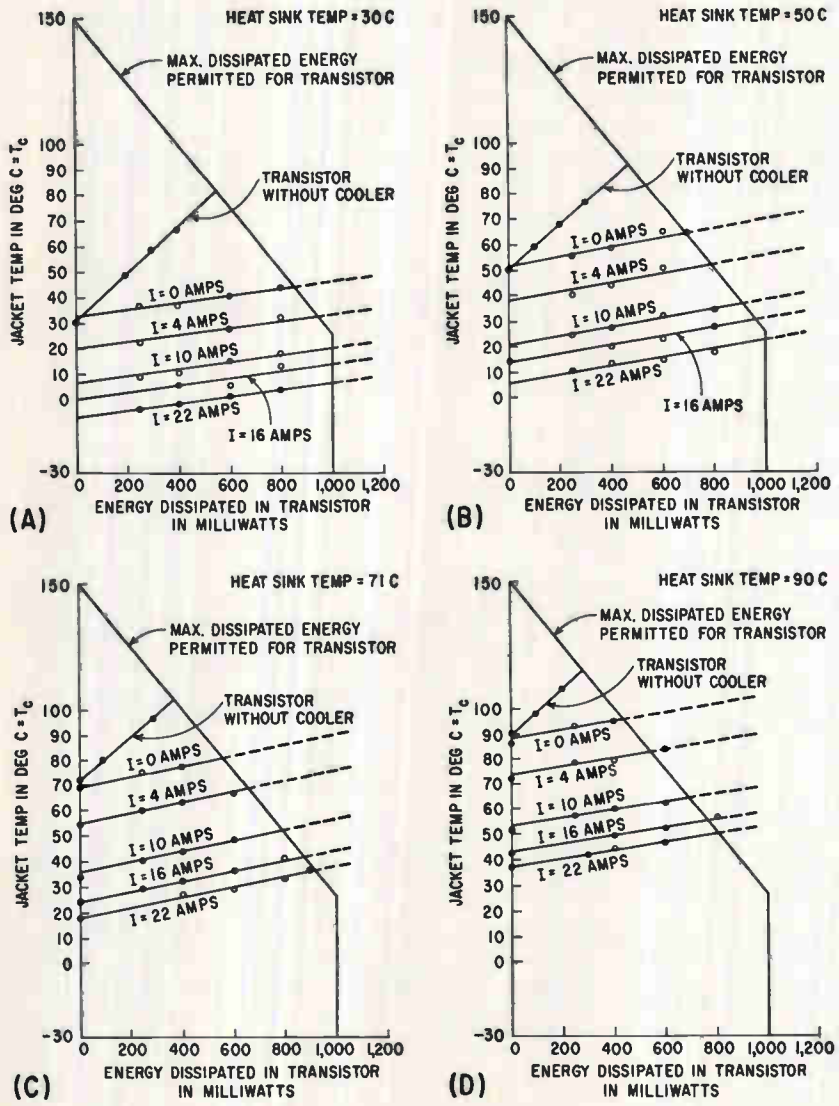


FIG. 2—Jacket temperature plotted against energy dissipated with heat sink at 30 C (A); jacket temperature against energy dissipated with heat sink at 50 C (B); jacket temperature against energy dissipated with heat sink at 71 C (C); and jacket temperature against energy dissipated with heat sink at 90 C (D)

Other low-power germanium transistors require only that the cooler cavity dimensions change. Larger power units require thermoelectric coolers with increased capacity and possibly a variation in the transistor mounting technique. Higher-temperature silicon transistors demand that the thermoelectric unit be designed and fabricated for use in higher ambient conditions. There can be many variations in the treatment of the heat rejected from the cooler.

Thermoelectric coolers using larger modules and identical techniques have been successfully subjected to a series of tests selected from military specifications. This thermoelectric transistor cooler design should also perform satisfactorily when subjected to these conditions. Military specifications investigated are: thermal cycling, −65 C to +100 C (50 times), MIL-Std. 19500B, Para. 40.14; vibration, 30 g (3 planes), MIL-Std. 19500B, Para. 40.20; vibration fatigue, 20 g, MIL-Std. 19500B, Para. 40.18; shock, 500 g (3 planes), MIL-Std. 202A machine cycling 180 Jan; salt spray, 96 hours, MIL-Std. 202A method 101A test condition A; and humidity, 10 days, MIL-Std. 202A method 106.

Using slightly different materials and designing a thermoelectric cooler to reject heat to an ambient of 150 C proves valuable for silicon transistors rated for a maximum temperature of 135 C. Similarly, coolers designed for rejecting to an ambient range of 200 to 250 C open up new applications for transistors of the 175 to 200 C class.

The improved current-voltage ratios of the newer low-current small-area thermoelectric pellets facilitate the designing of power supplies for the devices.

These power supplies become lighter and more compact. Units can also be designed to operate off existing power sources in electronic systems.

Comparison with other cooling methods shows that the thermoelectric cooler increases the permissable heat dissipation effectively, and does so with less additional mass and volume within the chassis.

DESIGNING AMPLIFIERS

Nonlinear feedback loop provides a way to modify the characteristics of a transistor amplifier. Results of such modifications are increase of amplifier's dynamic range and attainment of an exponential response. Here are the design criteria

By JAMES C. LOONEY
Assistant Professor, Dept. of Electrical Engineering, Oregon State University
Corvallis, Oregon

THE PERFORMANCE of certain high-gain amplifiers, such as those used in null detectors and in the video sections of radar receivers, can be improved by a nonlinear element in a feedback loop. With nonlinear feedback, it is possible to obtain an amplifier that can handle a large dynamic range of input signals without saturating or blocking. The characteristic of this amplifier is a voltage gain that varies instantaneously and inversely with input-signal amplitude. Thus, for small input signals the voltage gain is maximum and as the input-signal amplitude increases, the voltage gain decreases to unity or less. The voltage ratio of the largest to smallest signal handled by this amplifier may be 10^5 to 10^8.

Along with their large dynamic range, these amplifiers have another common characteristic in that some distortion can be tolerated at large signal levels. Thus, these amplifiers should be easier to obtain than conventional amplifiers with a large dynamic range. However, if a large signal is applied to the input of a high-gain linear amplifier, successive stages will be either cut off or saturated, causing the amplifier to block for a period following the large signal. Thus, the amplifier cannot amplify small signals during that period.[1] This blocking arises when there is a change in the amount of energy stored in the coupling and bypass capacitors. The change in energy is due to nonlinear resistance that results from cutoff, saturation or grid current

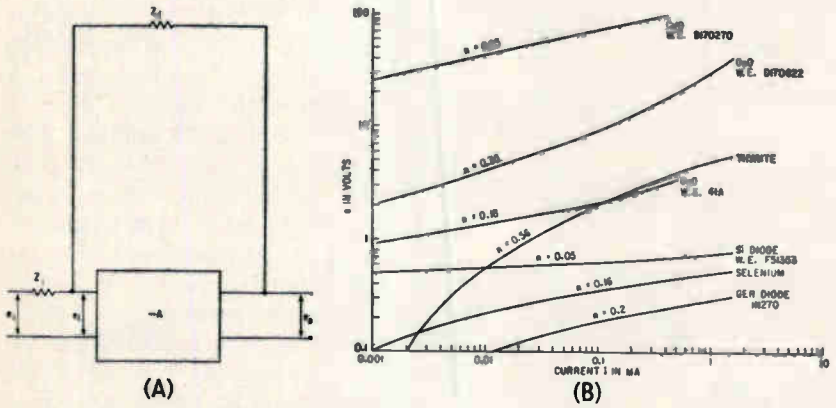


FIG. 1—Basic feedback amplifier (A) can use components such as in (B) for component Z_f

TABLE I — DATA AND CALCULATIONS FOR FIG. 2

h Values at I_c = 1 ma, V_c = 5 v

h_{11} = 5,500 ohms
$h_{12} = 5 \times 10^{-4}$
h_{21} = 200
$h_{22} = 3.4 \times 10^{-6}$ mhos
A Without Feedback, $R_i = 0$

$$A = \frac{h_{21} R_L}{h_{11} + R_L (h_{11} h_{22} - h_{12} h_{21})}$$

= 158; Measured A = 165

For R_i = 10,000, h_{11} = 15,500 and A = 53.7; Measured A = 54

TABLE II—EFFECTS OF FEEDBACK ON AMPLIFIER

Feedback	Z_i	Z_o	A_i	A_v
Series Current	I[a]	I	No Influence	Stabilized
Series Voltage	I	D[b]	No Influence	Stabilized
Parallel Current	D	I	Stabilized	No Influence
Parallel Voltage	D	D	Stabilized	No Influence

(a) Increased; (b) Decreased

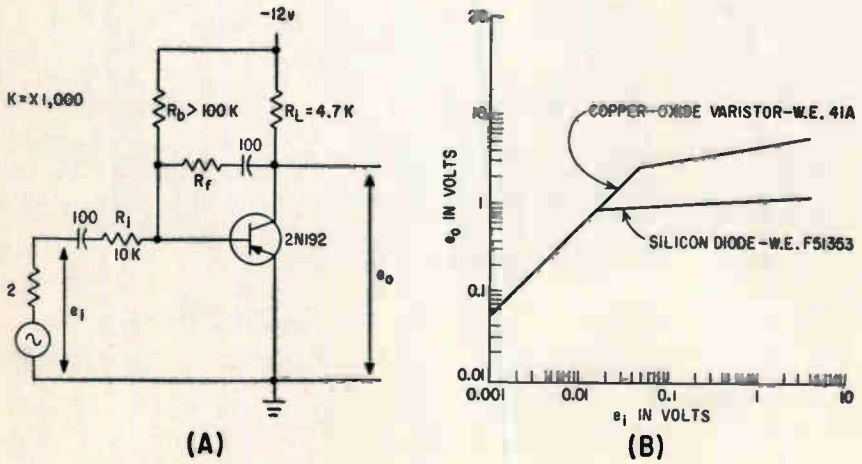


FIG. 2—Single-stage amplifier has nonlinear feedback element (A); voltage responses for two different R_f types (B)

WITH NONLINEAR FEEDBACK

flow in vacuum tubes, and cutoff or saturation in transistors. Blocking can be eliminated by restricting the amplifier to a linear region of operation, but doing this is incompatible with a large dynamic range.

A nonsaturating amplifier with a large dynamic range can be obtained by using nonlinear elements in one or more feedback paths in the amplifier. The result is an amplifier with an overall gain that varies instantaneously and inversely with input signal level. Usually the gain is maximum for small input signals and decreases to unity or less at large signal levels. The way the gain varies depends upon the application. For a null amplifier, the gain should have a smooth exponential or logarithmic variation from maximum to minimum. For a pulse amplifier, the gain might be constant up to some signal level and then change to less than unity to give a limiting action. The gain variation is determined almost completely by the nonlinear functions of the elements in the feedback paths.

Figure 1A shows a single-loop feedback amplifier that has the feedback circuit commonly used with operational amplifiers in analog computers. Its voltage transfer function is approximately

$$e_o/e_i = -Z_f/Z_i \qquad (1)$$

If input impedance Z_i is constant, the voltage ratio is directly proportional to the impedance in the feedback path Z_f, provided the assumptions in the derivation are true. The case investigated treats Z_i as a constant resistance and Z_f as a nonlinear resistance. The limits of e_o/e_i, as Z_f approaches infinity or zero, are: $-A$ and zero; that is

$$\text{limit} \quad e_o/e_i = -A, \text{ as } Z_f \to \infty \qquad (2)$$

$$\text{limit} \quad e_o/e_i = 0, \text{ as } Z_f \to 0 \qquad (3)$$

with the condition that $Z_i >> 0$. Where Z_i is small

$$\text{limit} \quad e_o/e_i = -1, \text{ as } Z_f \to 0 \text{ and } Z_i \to 0 \qquad (4)$$

Since nonlinear resistance Z_f is a two-terminal device, it is usually described in voltage and current. An equation that describes many types of nonlinear resistances is

$$e = Ki^n \qquad (5)$$

where K is a constant and n may be either a constant or a variable. Since the conventional definition of impedance is not applicable to nonlinear impedances, the definition that will be used is

$$Z = e/i \qquad (6)$$

where Z is the instantaneous impedance, e the instantaneous voltage and i the instantaneous current. If Eq. 5 is rearranged to give,

$$i = e^{1/n}/K^{1/n} \qquad (7)$$

and Eq. 7 is substituted in Eq. 6,

$$Z = K^{1/n}e/e^{1/n} \qquad (8)$$

Let $Z = Z_f$ for Fig. 1A. From Eq. 8 and Eq. 1,

$$e_o = -(K^{1/n}\, e_o/Z_i\, e_o^{1/n})\, e_i$$

where e of Eq. 8 is e_o, since e_i is ≈ 0. Simplifying

$$e_o = (-K/Z_i{}^n)\, e_i{}^n = -K'\, e_i{}^n \qquad (9)$$

where $K' = K/Z_i{}^n$.

Be careful when using Eq. 9 since it is subject to the limitations of Eq. 2, 3 and 4 and the assumptions in Eq. 1. A feature of Eq. 9 is that, except for the constant, it describes the same curve as Eq. 5. Thus, the gain of the feedback amplifier will have the same characteristic curve as that of the nonlinear impedance in the feedback path. Consequently, one way of obtaining a gain characteristic is to find a nonlinear element with the same characteristic curve and insert it in the feedback path. The value of K' depends on Z_i and K. Thus, K' can be set arbitrarily by using the corresponding value of Z_i.

If the value of Z_i is restricted, K' can also be varied by applying only a small fraction of the amplifier output voltage to the feedback element.

Among the electron devices whose characteristics can be described by Eq. 5 are semiconductor and vacuum-tube diodes, copper-oxide and selenium rectifiers, thermistors and silicon-carbide or Thyrite varistors (Fig. 1B). Since the approximate value of n, which is the slope of the curve, is given on each curve, K can be evaluated by substituting the values of e, i and n in Eq. 5. If the characteristic is not a straight line, the value of K will apply only to the portion of the curve for which the value of n applies.

The amplifier shown in Fig. 2A has the voltage-gain calculations shown in Table I. Figure 2B shows the voltage-gain characteristics of the amplifier with two different nonlinear elements in the feedback path. These curves are calculated from Eq. 9. The line with a slope of unity in the left side of Fig. 2B represents the constant maximum gain of the amplifier without any feedback. This is the limit given by Eq. 2. A discrepancy exists between the calculated and measured values of the curves on the right side of Fig. 2B; this discrepancy is caused by the approximate value of exponent n obtained from Fig. 1B. Another possible source of error is that the value of the forward gain, $-A$, of the amplifier is not large

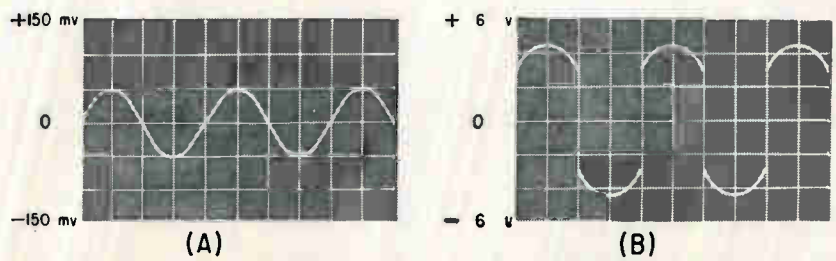


FIG. 3—Output waveforms for Fig. 2 amplifier with WE D170622 feedback component, for input of 2 mv p-p (A) and of 2 v p-p (B)

as is assumed in the derivation of Eq. 1.

A 60-cps sinusoidal input to the amplifier produced the output waveforms shown in Fig. 3. The instantaneous voltage gain can vary from approximately 50 for small signals to less than unity for large signals.

Two important characteristics of this single-stage amplifier are its ability to handle a large dynamic range of input signals, and large instantaneous variations in signal level without blocking.

Figures 4A to 4D show the four basic feedback circuits that can be obtained with a single feedback loop.[2] The first word of the circuit description characterizes the feedback connection to the input and the second word of the description applies to the output-circuit connection. Parallel-voltage means that the feedback signal is proportional to the output voltage and is connected in parallel with the input signal. Figures 4E to 4H show an example of each of the four basic circuits.

The properties of the amplifier depend upon the feedback. Table II shows how the amplifier characteristics are changed for each of the four types of feedback.[2] If a nonlinear element is used in the feedback path, the characteristics shown in Table I will vary with signal amplitude. For the parallel-voltage feedback circuit, both input and output impedance decrease as the signal level increases. If it is more desirable to have the input impedance increase for large signal levels, this characteristic may be obtained with the series-voltage feedback circuit. However, the series-voltage circuit is not suitable for resistance-coupled single-stage amplifiers.

There is a problem when a coupling capacitor is used in series with the nonlinear feedback element. When the supply voltage is initially turned on, the capacitor will have to charge to the steady-state d-c voltage from collector to base of the transistor. For the capacitor to acquire a charge, current must flow in the feedback path through the nonlinear resistance. Because of the feedback, the time constant is multiplied by the amplifier gain. Thus, the effective time constant can be large at small signal levels because the nonlinear resistance is large at these levels. Consequently, there may be a long time interval before the amplifier attains its d-c operating point. This problem may be minimized by adding a voltage divider between the coupling capacitor and the nonlinear element as shown in Fig. 5. Charging current for the capacitor is supplied by the voltage divider instead of through the high nonlinear resistance *(NLR)*. Design of the voltage divider involves a compromise, since its impedance should be high compared to the output impedance of the amplifier and yet low compared to the small-signal impedance of the nonlinear element. The d-c voltage level supplied by the voltage divider is so designed that there is no d-c voltage across the nonlinear element under normal operating conditions. It is undesirable to have a d-c voltage across the nonlinear element because this causes nonsymmetry between the positive and negative halves of the output waveform.

An amplifier with a large dynamic range usually requires a

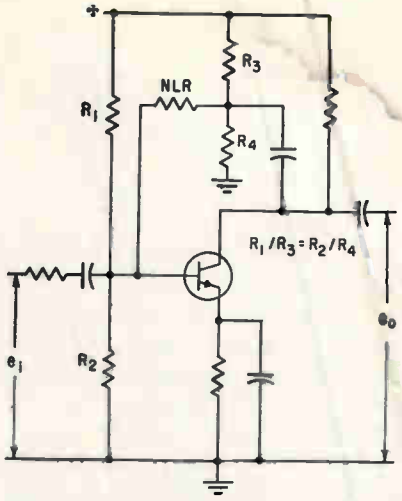


FIG. 5—Single-stage amplifier with nonlinear feedback

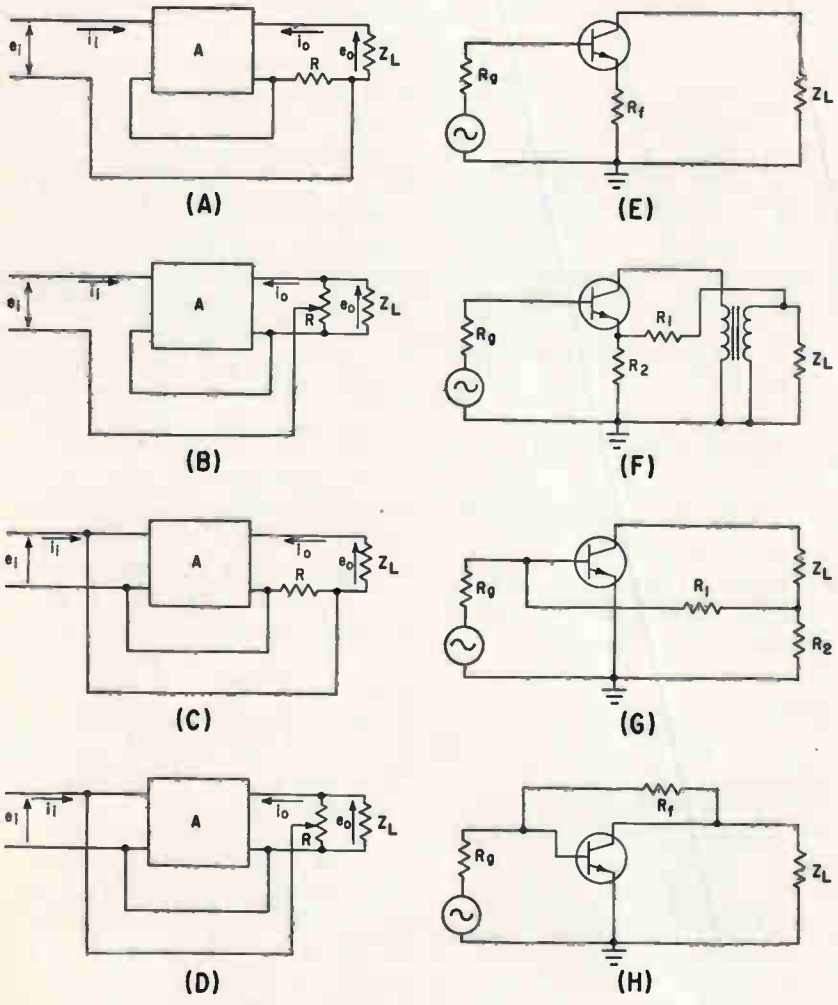


FIG. 4—Amplifiers with series-current (A) and (E), series-voltage (B) and (F), parallel-current (C) and (G), and parallel-voltage (D) and (H), feedback

number of stages of amplification to have a useful output for small input signals. Because of instability, feedback loops in amplifiers are usually limited to either one or two stages of amplification. A number of feedback stages may then be placed in cascade to obtain a high amplification. The stages in cascade may or may not be identical, depending upon the application. Since the response of an amplifier with nonlinear feedback is

$$e_1 = K_1 e_i^{n_1}$$

the output response of two stages in cascade is

$$e_2 = K_2 e_1^{n_2} = K_2 (K_1 e_i^{n_1})^{n_2}$$
$$e_2 = K_2 K_1^{n_2} e_i^{n_1 n_2}$$

If the stages are identical, then

$$e_2 = K^{n+1} e_i^{n^2}$$

The output response of three stages in cascade is

$$e_3 = K_3 e_2^{n_3} = K_3 (K_2 K_1^{n_2} e_i^{n_1 n_2})^{n_3}$$
$$e_3 = K_3 K_2^{n_3} K_1^{n_2 n_3} e_i^{n_1 n_2 n_3}$$

For k identical stages,

$$e_k = K^{1+n+n^2+\ldots+n^{(k-1)}} e_i^{n^k}$$

The exponent of the cascaded circuit is the product of the individual stage n values. Theoretically there are an infinite number of cascaded circuits that could be used to get a value of n. Practically, the designer can use combinations of available nonlinear elements to obtain the characteristic of a nonlinear element that is not available.

The response of two identical stages in cascade is shown in Fig. 6A. Each stage has a maximum gain of 20 db and an exponent of 0.5. The final slope of the second-stage output is 0.25; this slope is the product of the individual stage exponents. As the input signal becomes small, the gain of the first stage reaches its maximum value of 20 db. It then becomes a linear amplifier with an $n = 1$. As the input is decreased below the breakpoint of the first stage, the second stage also reaches its maximum gain limit and becomes a linear amplifier. The range of input signal between the breakpoints of the two stages is equal to the input-signal range that produces the maximum gain of the second stage. This would also be true if the stages were not identical. This amplifier would satisfy a requirement for $n = 0.25$ over the last two decades of input signal.

The shape of the curve of the second stage output suggests that it should be possible to get a piecewise approximation of a curve that has a variable n. Figure 6B shows how a logarithmic function might be approximated by two nonidentical nonlinear feedback amplifiers. The characteristics of the amplifiers are found from straight lines drawn to approximate the curve. The second stage $n = 0.38$ and the overall $n = 0.16$, so the first stage $n = 0.42$. The required maximum gain of the second stage is 18.5 db, which is the interval between the breakpoints. The maximum gain of the first stage depends upon the value of K and can be found from the region of the curve where both stages are linear. The gain in db for this region is the sum of the two individual maximum gains.

The exponent of a nonlinear amplifier can be changed from less than unity to greater than unity by changing the position of the nonlinear element in the feedback loop. For example, when the nonlinear element is used in a shunt path in the feedback loop shown in Fig. 7A, the amplifier's gain increases with increasing signal level. This feedback circuit can be used to obtain a square-law response. However, this circuit has a disadvantage in that it allows the amplifier to block on large input signals. Blocking can be eliminated by adding another feedback loop with a series nonlinear element as shown in Fig. 7B. To be effective, the exponent of the series nonlinear element must be smaller than the reciprocal of the effective exponent of the rest of the circuit.

Since the characteristics shown in Fig. 1B are not straight lines, the values of n are not constant. This curvature can be advantageous in finding values of n. The exponent value depends upon the region of operation on the characteristic curve and this can be changed by varying the fraction of output voltage applied to the feedback loop. In using diode nonlinear elements, connect two in parallel and in opposing-polarity directions.

The above discussion has shown how nonlinear feedback can be used in a voltage amplifier to prevent blocking and to obtain a gain characteristic that varies with signal amplitude.

Good results were obtained with an experimental amplifier using either of two types of nonlinear elements in a feedback loop. A large dynamic range was obtained and feedback eliminated.

Cascaded nonlinear amplifiers can obtain one or more nonlinear functions, depending on the feedback-loop configuration.

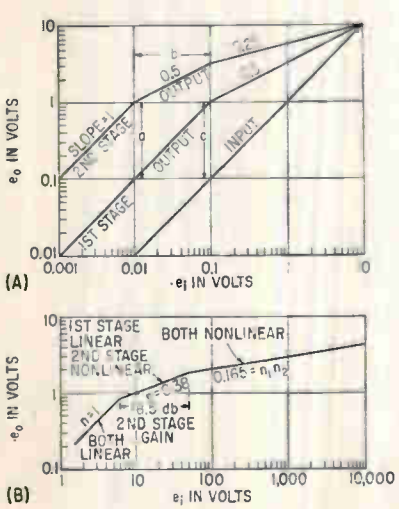


FIG. 6—Response of identical stages (A). Non-identical stages (B) approximate $e_o = K \log e_i$

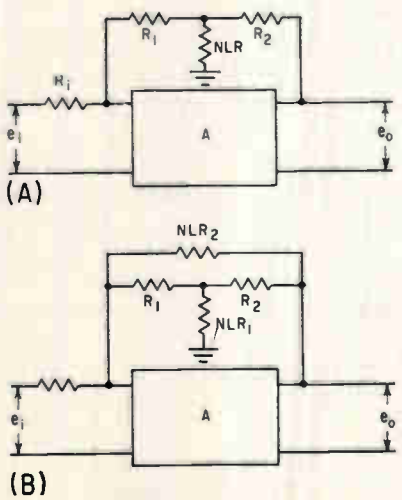


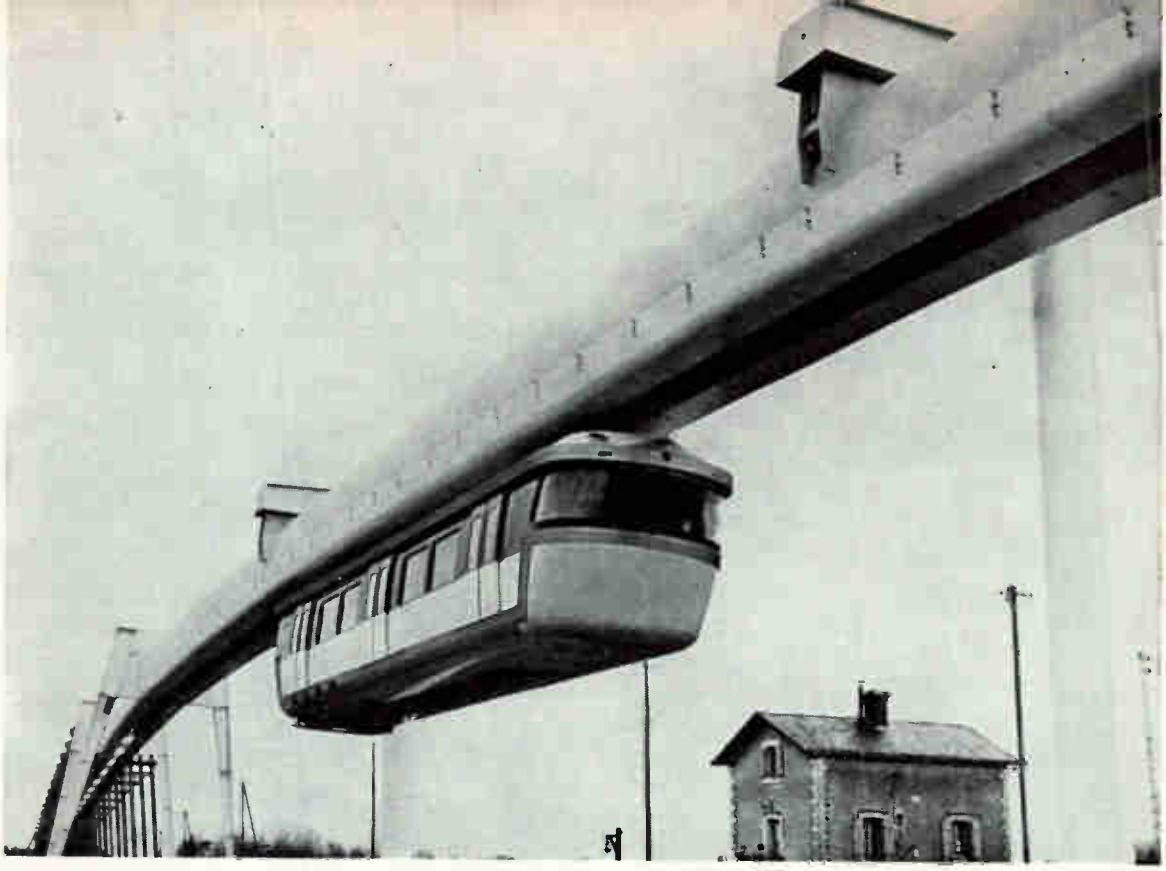
FIG. 7—Amplifier with shunt (A) and amplifier with both series and shunt (B) nonlinear components

REFERENCES

(1) G. E. Valley and H. Wallman, "Vacuum Tube Amplifiers," p 113, McGraw-Hill, N. Y., 1948.
(2) P. Kaufmann and J. J. Klein, Flow Graph Analysis of Transistor Feedback Networks, *Semicon Prod*, p 37, Oct. 1959.

BIBLIOGRAPHY

L. H. Dulberger, Pulse Amplifier with Nonlinear Feedback, ELECTRONICS, 31, p 86, Nov. 7, 1958.
S. J. Solms, Logarithmic Amplifier Design, *IRE Trans on Instrumentation*, 1-8, p 91, Dec. 1959.



Experimental French monorail has been built near Orleans to prove hardware and system concepts

ELECTRONIC SIGNALING for

By JEAN JUITIER,
Director, Signaling Dept.,
Ets. Saxby, Paris, France

SIXTEEN major French companies have cooperated in building an experimental rapid transit monorail system at Chateauneuf-sur-Loire, about 15 miles east of Orleans. The mile-and-a-quarter, million-dollar experimental line has no regular passenger services; it was built so that potential customers could be shown full-scale hardware. The monorail has a split-girder track and an aircraft-type car slung from rubber-tired bogies. A double-pendulum system corrects side sway by rotating the car in the direction of sway. The car has a top speed of 63 mph, with acceleration and braking good enough for 90-second headway between trains in a complete system.

Although the split-girder track and the rubber-tired bogies give the car fast, quiet performance, they create problems in signalling. Conventional railroad techniques, based on electrically isolated sections of steel rails, with cars using steel wheels, could not be used. Therefore, special electronic methods were developed for block entry-exit counting, displaying block signals in the driver's cab and automatic emergency braking.

In the bogie-counting block control system, a photocell detects entry of the car into the block. A radiation counter tube, excited by a cobalt-60 source on the bogie, registers the car's exit. Entry and exit signals are counted in a conventional relay totaliser, whose output controls the block signal. See Fig. 1.

Source of the entry signal is a modulated light beam. The pulsed light is picked up by the photocell in a receiver on the track; cell output is amplified to energize the entry-counting relay for the block, through a linking transformer. The linking transformer is a safety device required by French railroad regulations; it ensures that only pulses from the photocell (and not, for example, a shorted connection in the last stage of the amplifier) will hold the relay energized.

When a car enters the block, its two bogies each interrupt the light beam and thereby deenergize the counting relay twice. Until the two entries are cancelled out by exits, the occupation relay controlled by the totaliser shows the block occupied.

The exit signal originates from a cobalt-60 source mounted on each bogie. Radiation is sensed by a Geiger tube, whose output is amplified to energize the exit-counting relay. Thus when the car leaves the block, two exit signals cancel the two entry counts. Amplifier circuits for both entry and exit are conventional.

Although the cobalt-60 and Geiger tube combination has worked well on the experimental line and presents no physiological hazard, it has a psychological drawback. A 2,000 Mc oscillator on the bogie would be used as the exit-signal source in a passenger-carrying system.

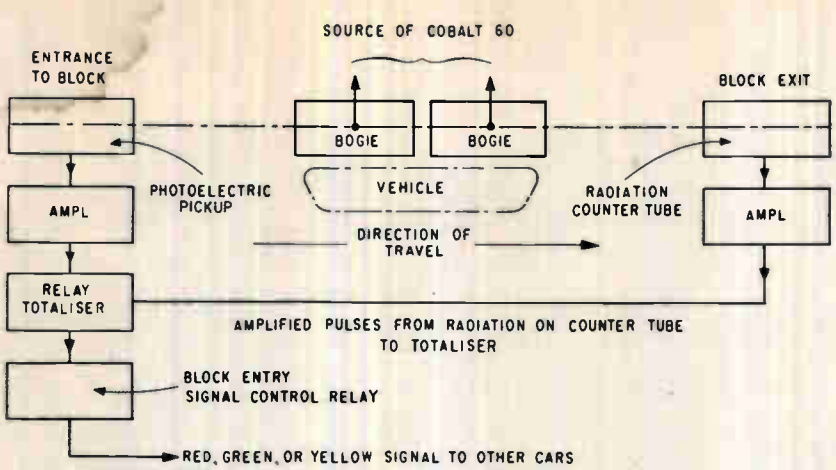


FIG. 1—Entrance of car into block is sensed photoelectrically, exit is sensed with Geiger-Mueller tube

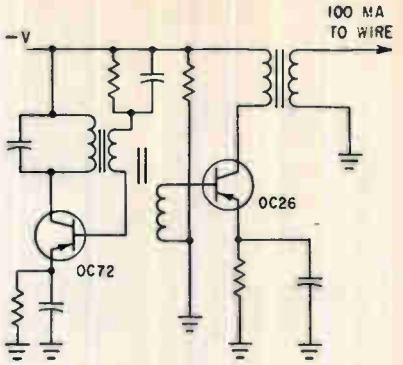


FIG. 2—Simple oscillator generates car control signals

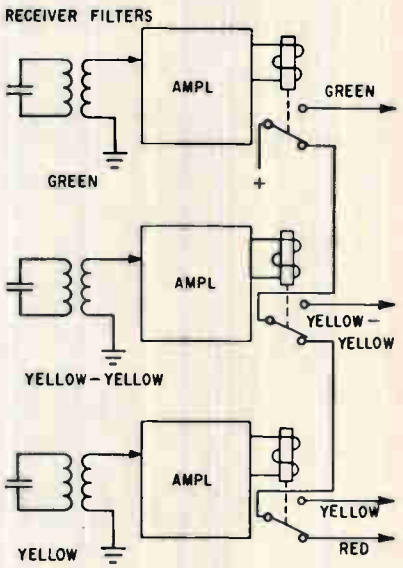


FIG. 3—Frequency-selective receivers control cab signal lights and automatic braking

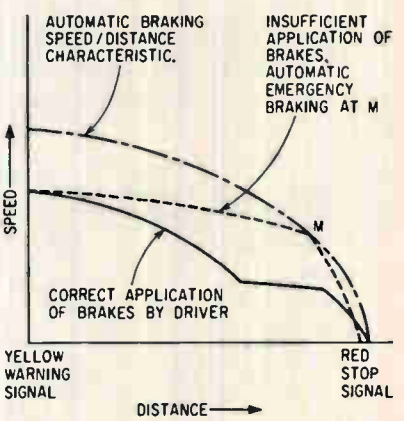


FIG. 4—Automatic braking occurs when car operator does not respond adequately to signals

Simple electronic circuits are used on experimental French monorail system to control traffic flow, keep track of trains and control braking. Absence of signal indicates a stop

Experimental Monorail

Conditions established by the bogie-counting system for the block ahead are displayed in the driver's cab: a green light for clear track, red for stop, one yellow for caution and two yellow for slow down.

The signals displayed in the cab originate in transistor oscillators (Fig. 2). One set of oscillators is used for each block; the signals are transmitted over a single wire running inside the split girder. Signal frequencies are 14.5 Kc for green, 11 Kc for yellow, 8.5 Kc for yellow-yellow (slow down) and 0 Kc (no signal) for red.

Frequency-sensitive receivers on one bogie of the car detect the signals on the transmission wire. There are three receivers, each linked to a transistor amplifier and a decoding relay (Fig. 3). Contacts of the three decoding relays, in their deenergized positions, are in series. Thus a red signal is established when there is no signal on the transmission wire.

In addition to providing instructions to the driver, the signals are inputs for a speed control system, still in an early stage of development, that will automatically apply brakes. When the yellow caution or yellow-yellow (slow down) relay is energized, a servo-driven potentiometer starts to generate a signal that represents the acceptable speed/distance characteristic. This signal is compared with the output of a tachometer mounted on the bogie; if the tachometer output is too high, the speed comparison unit energizes a control relay that applies the brakes (Fig. 4).

For switching movements in stations or for voluntary entry into an occupied block, the driver can override the automatic brake control, but top speed is then limited to 10 mph.

In a complete monorail installation, a train describer would be needed to indicate the number of the train in each zone. Track-switching equipment, tied directly to the console for the short experimental line, would require long-distance remote controls. Techniques are available for both these problems: train describers are classic railroad equipment and frequency-modulation remote controls are already in use on some lines of the French National Railways.

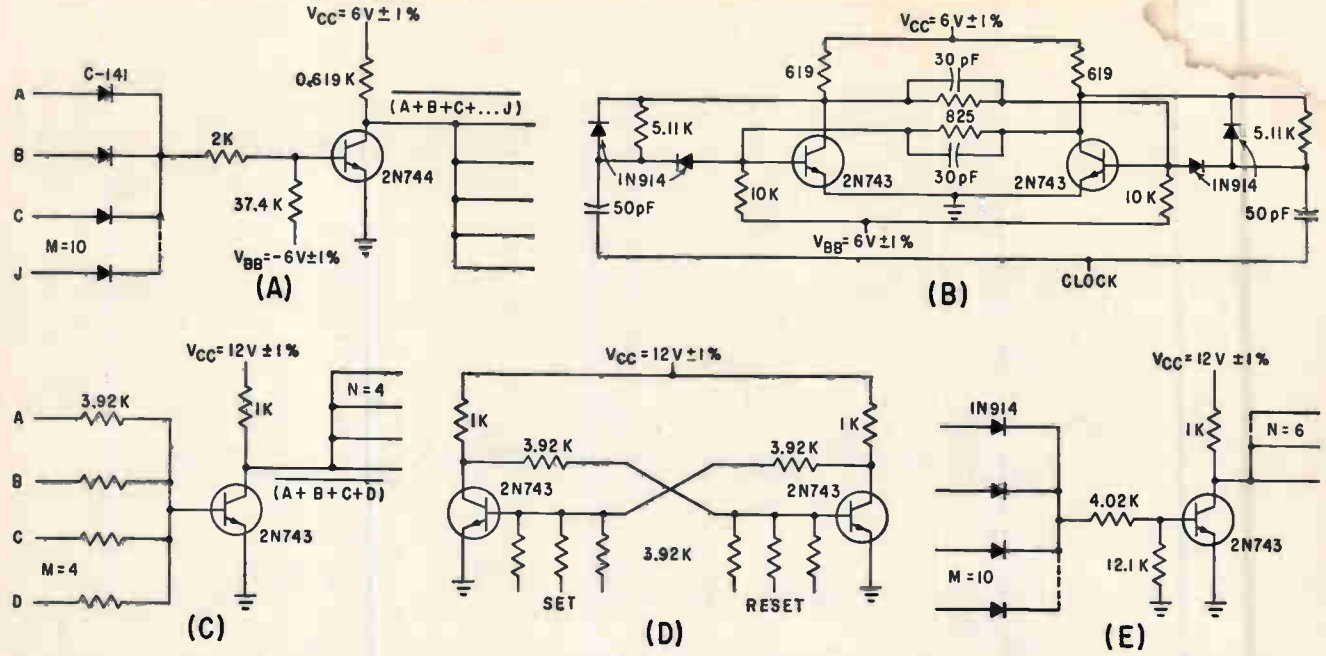


FIG. 1—Transistor and diode NOR *gate (A); 10-Mc flip-flop for use from −55 C to +125 C (B); medium-speed TRL* NOR *gate with single power supply (C); direct-coupled TRL flip-flop with single power supply (D); and TDL* NOR *gate using single supply (E)*

Using Epitaxial Transistors in Switching and R-F Circuits

By DONALD HALL,
Semiconductor Components Div.,
Texas Instruments Incorporated,
Dallas, Texas

THE epitaxial transistor is characterized by low saturation voltages, linear characteristics at low voltages and reduced storage time in switching circuits. The circuits in this article illustrate how these characteristics may be used in equipment. The applications considered are high-speed computers and vhf amplifiers.

Computer circuits for operation under two different environmental conditions are shown. The normal military environment is −55 C to +125 C, while most commercial computers require operation from −40 C to +55 C. Both applications benefit from the characteristics of silicon epitaxial transistors.

The vhf amplifier circuits illustrate epitaxial transistor performance in this area. They are not, as shown, designed for the full military temperature range, but rather illustrate the transistor's advantage over more conventional types. The transitors are capable of operation from −55 C to +175 C.

The first group of circuits are those for computers. The epitaxial transistor's low storage time and low saturation voltage are advantageous in these applications. The 2N743 and 2N744 silicon epitaxial transistors have parameters guaranteed at 10 ma and 100 ma and three temperatures: −55 C, +25 C and +170 C. These guarantees allow d-c designs to be completed directly from the data sheets. The transistors also have I_{CBX} guaranteed at +100 C, allowing simplified circuit designs over commercial computer temperature ranges.

Figure 1A shows a transistor-diode NOR gate with the 2N744 and C-141 silicon computer diodes. This circuit was designed, using worst-case analysis, for −55 C to +150 C operation. A low-leakage diode such as the C-141 is necessary for operation over this wide temperature range. Type CG ¼ glass hermetic resistors, because of their ability to dissipate 60 mw at +150 C, also contribute to the circuit performance. The circuit operates at rates up to 8 Mc with two cascaded logic stages over the entire temperature range.

A flip-flop for 10-Mc operation over a −55 C to +125 C range is shown in Fig. 1B. This circuit will drive another directly. The trigger should provide 3 volts for proper operation. The addition of an emitter follower following this circuit would give improved wave shapes and allow operation to +150 C.

Several characteristics of silicon epitaxial transistors make them particularly suitable for simplified computer circuit designs over temperature ranges common in commercial use. The low saturation voltage, normal silicon forward emitter-base voltage and low leakage allow operation without a turn-off base current supply.

The NOR gate in Fig. 1C is ap-

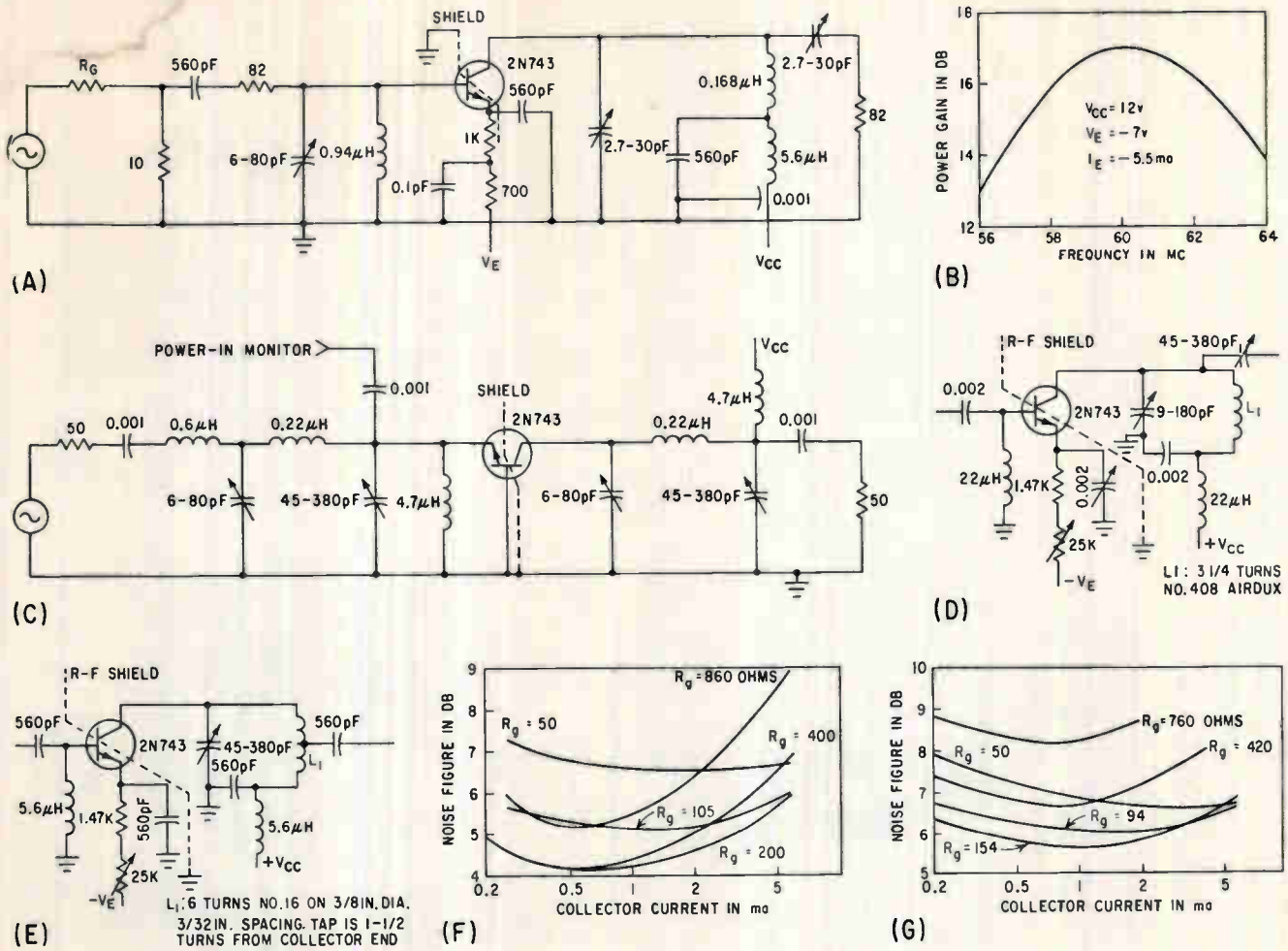


FIG. 2—Small-signal 60-Mc amplifier (A) and frequency response curve (B) for average of 10 units; 70-Mc class-C power amplifier (C); 30-Mc r-f amplifier (D); 60-Mc r-f amplifier (E); curves of noise figure versus collector current for an average of ten 2N743 transistors at 30 Mc (F) and at 60 Mc (G) with a V_{cc} of 10 v

plicable to medium-speed, commercial temperature range applications. The maximum design temperature is +100 C where the transistor I_{CEX} is guaranteed less than 30 μamp at V_{CE} = 10 v and V_{BE} = + 0.35 v. The low storage time allows medium-speed operation without a turn-off base bias supply. Operation down to −55 C can be obtained by using the 2N744 which has an h_{FE} of 20 at this temperature. The circuit operates at a collector current of 10 ma, the region of maximum gain and high switching speed. The maximum operating frequency is 1 Mc for 2 cascaded logic stages.

Two NOR circuits may be combined as in Fig. 1D to form a direct-coupled flip-flop. The extra resistors can be eliminated.

Another type of logic circuit suitable for use with the silicon epitaxial transistor is the transistor-diode NOR gate in Fig. 1E. The low leakage and low storage time allow the normally required base turn-off supply to be eliminated while retaining medium-speed operation over a wide temperature range. This logic is inherently faster than transistor-resistor logic because overdrive is not as severe. The 1N914 diodes feature high speed and low leakage compatible with the silicon epitaxial transistors. The maximum operating frequency is 2 Mc for two cascaded logic stages.

Three vhf circuits are indicative of the epitaxial transistor's low collector-base capacitance, high f_T and good characteristics at low voltages.

A small-signal, 60-Mc amplifier is illustrated in Fig. 2A. The 2N743 is operated common-emitter at the signal frequency and common-base for biasing. The 82-ohm resistors approximate the input resistance of the transistor. The frequency-response curve in Fig. 2B shows the gain per stage unneutralized to be 17 db. This circuit is suitable for communication and pulse application.

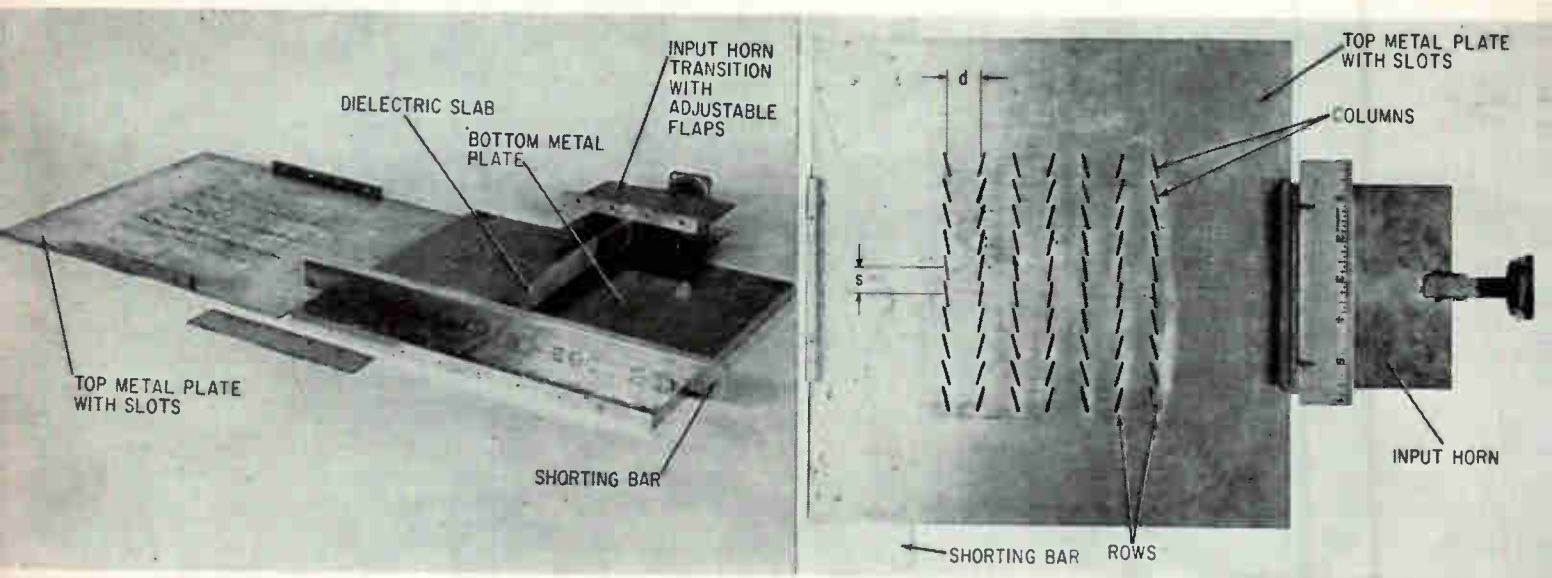
A vhf amplifier capable of 0.5 watt output at 70 Mc is shown in Fig. 2C. The outstanding features are gain and efficiency at a low supply voltage (12 v). These are due to the good high-frequency parameters at low voltages and the high current-handling capability in such a small mesa structure.

The last application for the silicon epitaxial transistor is a low-noise r-f amplifier. Circuits are shown for both 30 Mc (Fig. 2D) and 60 Mc (Fig. 2E). The various values of source resistances were obtained with L-section networks and a standard 50-ohm noise diode. The circuits are not necessarily optimized, but as constructed are capable of excellent low-noise performance.

The curves of noise figure plotted against collector current in Fig. 2F and 2G allows the effects of various source resistances to be observed. In each case, values of generator resistance on each side of the optimum value are shown.

Hybrid H-Guide Feeds Flush-

Two-dimensional array of slot radiators can be excited by a hybrid H-guide mode. Antenna can be flush mounted, consists of minimal number of components and has inherent monopulse characteristics



H-guide antenna with top plate removed (left) with complete H-guide antenna shown at right

TWO-DIMENSIONAL slotted aperture antennas can be excited by a hybrid H-guide mode launched by a horn transition completely flush with the radiating aperture. Such an antenna has been operated at X-band.

The H-guide mode antennas have inherent monopulse characteristics and are applicable in the millimeter region where low-loss and high-power handling capabilities of other transmission-line media usually deteriorate. This new antenna assembly uses a minimum number of components.

The H-guide structure shown in Fig. 1A is an open transmission line consisting of two metal plates supported by a dielectric slab of rectangular cross section. The properties of modes that can propagate on this line have been investigated[1-6,7].

Although many H-guide modes possess favorable transmission characteristics, one of these modes, HEM_{11} (antisymmetric hybrid electromagnetic mode of the first order and the first rank[3]) deserves attention. The H-guide supporting this mode exhibits initially low metallic loss decreasing with frequency increase, high power handling capability superior to that of a rectangular waveguide at the same frequency, absence of longitudinal currents eliminating the necessity of choke flanges, and simplicity of mode excitation.

Figure 1B illustrates the field components of the HEM_{11} mode in an H-guide and a TE_{10} mode in the rectangular waveguide and suggests a straightforward method of excitation by a tapered horn.

The energy propagates along the dielectric slab in a loosely bound wave. If the width H of the metal plates is sufficiently large, practically all the energy is contained within the H-guide structure. For a loosely-bound wave, the dielectric loss is small and a decreasing attenuation characteristic versus frequency results. This property makes the H-guide attractive at millimeter wavelengths.

The fields outside the dielectric decay exponentially in the y-direction. In the dielectric, they are

Mounted Antennas

By GEORGE N. VORONOFF,
Microwave Design Engineer
Dalmo Victor Co.,
Belmont, California

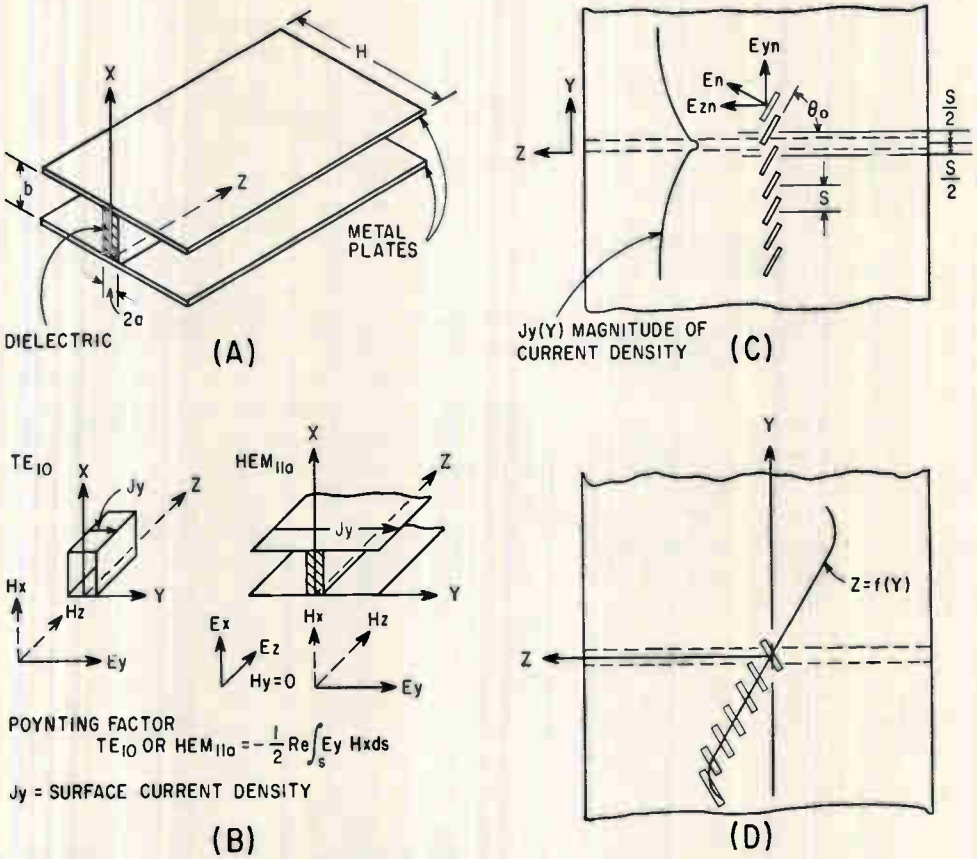


FIG. 1—Configuration of H-guide (A) and field components of rectangular waveguide and H-guide (B). Controlling amplitude of feeding coefficients (C); phase control is shown at (D)

described by portions of sine and cosine functions. The field distribution is such that if a metal wall is placed at the center of the dielectric ($y = 0$), the boundary conditions are satisfied, propagation of the mode is undisturbed and the only effect of the wall is a small increase in attenuation. Placement of the metal wall suppresses even modes which may be excited by discontinuities. These modes have longitudinal currents. It also allows treating the H-guide structure with one input or as two identical half H-guide structures with two independent inputs. This last property is important in monopulse application.

The exponential decay of the fields may be slow or rapid depending on the dielectric constant of the slab and its width $2a$. The transverse currents in the metal walls may extend a considerable distance from the center of the H-guide making possible excitation of a two-dimensional slot array.

Consider a single row of inclined slots in an H-guide metal plate, spaced S distance apart and placed along the y axis as shown in Fig. 1C. The energy propagates in the z direction in HEM_{11a} mode so that only a single y component of current exists. Since the degree of slot coupling depends on the current density intercepted by the slot and the component of length transverse to the current lines, the E_z component of the electric field at the n^{th} slot can be expressed by proportionality

$$E_{zn} \propto J_y(y) \sin \theta_n \cos \theta_n \qquad (1)$$

where θ_n is the angle of inclination of the n^{th} slot with respect to the z axis, n is an integer 0, 1, 2, 3, . . . and $J_y(y)$ is the surface current density equal to $C \cos Ky_2 a \exp [Ky_2 a (1 - |y/a|)]$ where C is an arbitrary constant, $Ky_1 a$ and $Ky_2 a$ are the transverse distribution parameters in the dielectric and air regions respectively, and a is one-half the dielectric width.

Equation 1 can be written in terms of slot spacing S and normalized with respect to E_{z0}.

The normalized voltage feeding

coefficients thus become

$$A_n = E_{zn}/E_{zo} = (\sin 2\,\theta_n/\sin 2\,\theta_o) \exp[-Ky_2a\,(ns/a)] \quad (2)$$

As seen from Eq. 2, the control mechanism of aperture illumination is modification of exponential decay by adjustment of relative slot angles. Theoretically, the Ky_2a factor in the exponent of Eq. 2 can be made arbitrarily small to excite slots far removed from the center of the H-guide.

For the $HEM_{11\delta}$ mode, Ky_2a and Ky_1a are related by

$$Ky_2a = (Ky_1a/\epsilon_r) \tan Ky_1a \quad (3)$$

where ϵ_r is the relative dielectric constant of the slab and the limits on Ky_1a are $0 \leqq Ky_1a \leqq \pi/2$. Further, Ky_1a is related to the dielectric width, relative dielectric constant and free-space wavelength (λ_o) by the expression

$$(Ky_1a)^2[1 + (\tan Ky_1a/\epsilon_r)^2] = \pi^2\,(2a/\lambda_o)^2\,(\epsilon_r - 1) \quad (4)$$

Two-dimensional arrays can be realized by placing additional rows of slots d distance from each other with reversed angles of inclination in each successive row so that constructive interference of E_z would result in some prescribed direction. The advantage of reversing the slot angles is that the broadside radiation is achieved at $\lambda_{gh}/2$ instead of $d = \lambda_{gh}$.

The array will then consist of the slotted rows parallel to the y axis and columns parallel to the z axis. To minimize cross-polarization (E_y component), the angle θ_n has to be large. The E- and H-planes for this array are defined as normal planes containing the z and y axes respectively.

The angular beam tilt from the normal in the E plane can be calculated from

$$\sin\phi = (\lambda_o/\lambda_{gh}) - (\lambda_o/2d) \quad (5)$$

where λ_o is the free-space wavelength, λ_{gh} is the H-guide wavelength and d is the row spacing.

H-guide wavelength can be calculated from

$$\lambda_{gh} = \lambda_o/\sqrt{1 - (\lambda_o/2b)^2[1 - (Ky_2ab/\pi a)^2]} \quad (6)$$

where b is the separation of the metal plates.

The propagation of the $HEM_{11\delta}$ wave is assured if $b > b_o$ where[7]

$$(b_o/\lambda_o) = (1/\sqrt{\epsilon_r})(\sqrt{\epsilon_r^2 + \tan^2 Ky_1a}/\sqrt{\epsilon_r + \tan^2 Ky_1a}) \quad (7)$$

If the columns are displaced in the z direction in such a way that the slots of a row lie on a curve $z = f(y)$, such as shown in Fig. 1D, then the phase of each column can be described by function

$$\psi = (2\pi/\lambda_{gh})\,f(y) \quad (8)$$

Consequently, $f(y)$ and A_n can be chosen to generate a desired radiation pattern in the H-plane.

The E-plane radiation pattern can be synthesized by adjusting the feeding coefficients in a column by varying the slot inclination angles along a column. An array of this type then incorporates in itself sufficient degrees of freedom to generate any radiation pattern in space.

Little can be said at present about the magnitude of the slot conductance and their dependence on the parameters of the H-guide. Experiments indicate that the H-guide slots behave like shunt elements. It is reasonable to assume that for loosely-bound waves, the angular dependence is similar to that of slots in a narrow wall of a rectangular waveguide.

An experimental model has been built to test the design. The two-dimensional array consists of 70 slots of seven rows and ten columns. The relative slot angles in a row were chosen to give a cosine on 10 db pedestal aperture distribution in the transverse plane. All rows are identical.

The spacing of rows (d) and columns (s) is $\lambda_{gh}/2$ and $\lambda_o/2$ respectively at the design frequency. It was found that the slots resonated at a frequency that was lower than the design frequency and coupled out approximately 30 percent of the incident power as was determined by the insertion loss method. A short was placed against the tip of the dielectric slab at 3/4 λ_{gh} from the last row of slots. The mode was launched by a horn transition with adjustable flaps. It was found that the shape of the radiated patterns was highly dependent on the flap positions of the horn. Study revealed quadratic phase errors across a row; H-plane radiated patterns were taken at an optimum position of the flaps and were compared with the calculated pattern shown in Fig. 2A. Within the region of the main beam, the experimental pattern is in agreement with the calculated pattern. Experimental sidelobes are 17 db below the peak of the main beam. H-plane patterns were calculated from the normalized feeding coefficients obtained from Eq. 2 using design parameters $2a$, b and ϵ_r of the experimental model.

The E-plane pattern (not shown), has a broadside pencil beam somewhat distorted because the row spacing was no longer $\lambda_{gh}/2$ at the test frequency.

The slotted plate of 70-slot array was rotated 90 degrees with respect to its original position. With the plate rotated, the slot angles were large with respect to the transverse current components so that most of the incident power was radiated. The insertion loss measurements relative to the unslotted H-guide were made. The output power level for the slotted H-guide was 25 db down as compared to the unslotted H-guide of the same dimensions. The array was fed by a tapered horn transition and terminated by a dry load. The principal polarization was transverse to the array axis consequently the E-plane was parallel to the y axis and the H-plane was parallel to the z axis.

The H-plane pattern shown in Fig. 2B, exhibits a 44-degree forward beam tilt from the normal. The beam tilt phenomenon can be explained as follows. With the plate in the original position, slots in the transverse rows were spaced at $\lambda_o/2$. The rows were spaced approximately $\lambda_{gh}/2$ apart and were mirror images of each other. The radiation was then broadside for resonant or non-resonant operation. With the plate rotated by 90 degrees, transverse rows became longitudinal columns in which the slots did not reverse angles of inclination.

The beam tilt from the normal was consistent with $\phi = \sin^{-1}(\lambda_o/\lambda_{gh})$ where λ_o is free space wavelength and λ_{gh} is the H-guide wavelength. The E-plane cut through the peak of the beam is shown in Fig. 2D.

If a thin longitudinal metallic septum is placed at the center of the dielectric, boundary conditions are satisfied and $HEM_{11\delta}$ propagation remains undisturbed. It is then

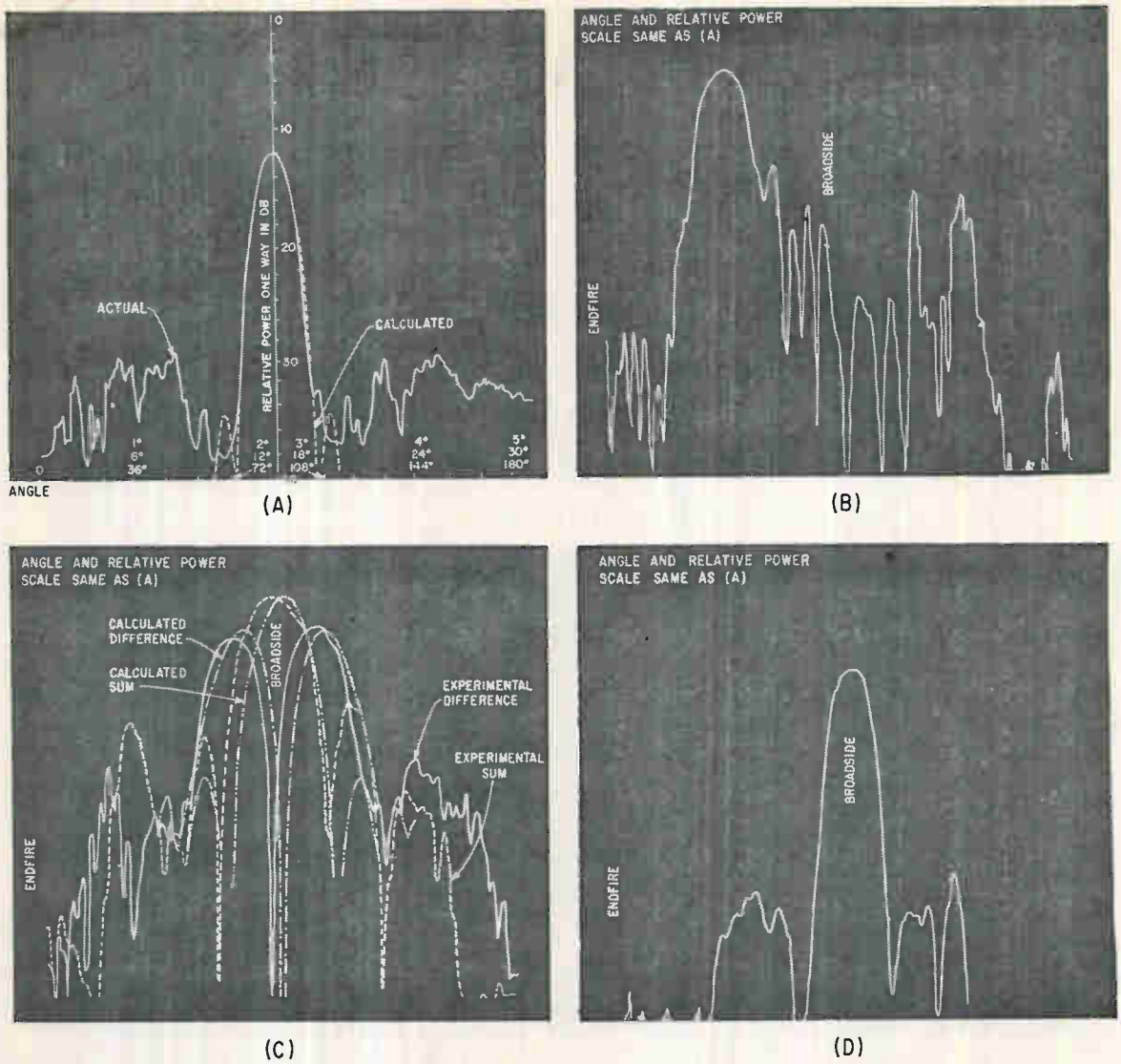


FIG. 2—Experimental and calculated H-plane radiation patterns (A), slotted plate rotated 90 degrees (B), H-plane monopulse patterns of 30-slot array (C) and E-plane cut through beam maximum (D)

possible to feed two halves of the aperture independently and obtain phase monopulse operation in one plane.

The aperture of 70 slots was reduced to 30 slots, 6 slots wide and 5 slots long by taping up the remaining slots with aluminum tape. The short was placed at some odd multiple of $\lambda_{gh}/4$ from the last row of slots. The aluminum tape in the middle of the dielectric provided sufficient isolation for the purpose of the experiment. Each half of the aperture was fed by a symmetric arm of an E-plane folded hybrid T. Reduction of 70 slot aperture was necessary to minimize the phase error that would result from the oversimplified feeding arrangement. Experimental sum and difference H-plane patterns are compared with theoretical patterns in Fig. 2C. Examination shows that the experimental patterns are displaced from the theoretical pattern by approximately 4 degrees which indicates the presence of phase error, either between the apertures or in the transition. With this discrepancy taken into account, the positions of the beams and of the first side lobe of the sum pattern agree with the calculated pattern. The null of the difference pattern is in excess of −32 db. The beamwidths of the experimental pattern are in good agreement with the calculated beamwidths.

The results of the experiments appear signficant in that they establish that H-plane two-dimensional arrays are possible and may serve as a basis for a new generation of flush-mounted antennas.

REFERENCES

(1) F. J. Tischer, The H-Guide A Waveguide for Microwaves, IRE Convention Record, Pt. 5, p 44, 1956.
(2) F. J. Tischer, Properties of the H-Guide at Microwaves and Millimeter Waves, IRE WESCON 1958 PGMTT, Aug. 1958.
(3) R. A. Moore and R. E. Beam, A Duo-Dielectric Parallel Plane Waveguide, *Proc. NEC*, 12, p 689, Apr. 1957.
(4) John W. E. Griemsmann and L. Birenbaum, A Low-Loss H-Guide for Millimeter Wavelengths, MRI Symposium Proceedings on Millimeter Waves, New York, 1959.
(5) M. Cohn, Propagation in a Dielectric-Loaded Parallel Plane Waveguide, IRE Trans on Microwave Theory and Techniques, MTT-7, p 202, Apr. 1959.
(6) M. Cohn, TE Modes of the Dielectric Loaded Trough Line, IRE Trans on Microwave Theory and Techniques, MTT-8 p 449, July 1960.
(7) M. Cohn, Propagation in Partially Dielectric Loaded Parallel Plane and Trough Waveguides, The Johns Hopkins University, Tech. Report No. AF-78, July 1960.

Moving-Target Simulator Tests Tracking Radars

By K. L. CHAPMAN,
Western Electric Co., Inc., Winston-Salem, N. C.

Versatile moving-target generator can simulate many variations of the radar echoes that a tracking radar will encounter in field operation

THE ARTIFICIAL-ECHO generator described in this article supplies a signal that has all the characteristics of a moving-target radar echo. This signal is used to test automatic-tracking radars under simulated normal and extreme conditions.

Signal strength is variable, allowing tests of sensitivity to weak targets and tests of agc action for strong targets. The artificial echo is variable in time with respect to the start of the receiving portion of the radar cycle, the speed of variation being controllable. Time variation provides an echo that moves in either an increasing or decreasing range direction at any speed between the minimum to more than the maximum automatic-tracking rate of the radar under test. The simulation of target-angle movements tests the automatic angle-tracking circuits and antenna mechanism of the radar. Dimension of the echo pulse conform to the characteristics of the electronic gates used in the radar automatic-tracking control circuits.

The artificial-target generator can simulate targets traveling at speeds up to several thousand mph and can simulate any target strength between a weak, barely detectable signal to a strong echo from a nearby target. The artificial echo may be moved to any point, up to the maximum range of the radar, and stopped. This facility can be used to adjust or test the automatic tracking circuits.

During the adjustment and performance testing of automatic fire-control radar systems, it is necessary that an isolated target be available so that the echo received by the radar system is free of adjacent echos from surrounding targets. This isolation is necessary to determine the magnitude and polarity of angle-error voltages produced by off-target conditions without spurious responses due to adjacent targets. The angle-tracking modulation that is present at off-target conditions in elevation or azimuth is simulated by amplitude modulating the echo with a variable-amplitude variable-phase generator or oscillator. The amount of modulation is proportional to the angle deviation from an on-target condition; the phase indicates the off-target direction.

This test set is useful also as a signal generator for signal tracing in the radar receiver. An i-f pulse can be applied to the converter input for checking the i-f amplifiers and the circuits that follow. The video pulse can be used for the video amplifiers.

Figure 1 shows the target generator circuit and waveforms. The synchronizing-trigger-pulse voltage is obtained from the radar set under test and starts the timing circuit. The phantastron, whose pulse width is controlled by the delay diode and the motor-driven precision potentiometer, generates a pulse. The two-phase motor driving the potentiometer through speed-reduction gears controls the rate-of-change of the pulse width, which may be either increasing or decreasing, depending on the direction of the motor-shaft rotation. Voltage for the fixed phase of the two-phase motor is obtained from the single-phase source by a capacitor phase shifter. The variable voltage applied to the other motor phase is controlled by a variable autotransformer and reversing switch. The speed-reduction gear ratio provides convenient control of the artificial echo speed from below the minimum to above the maximum

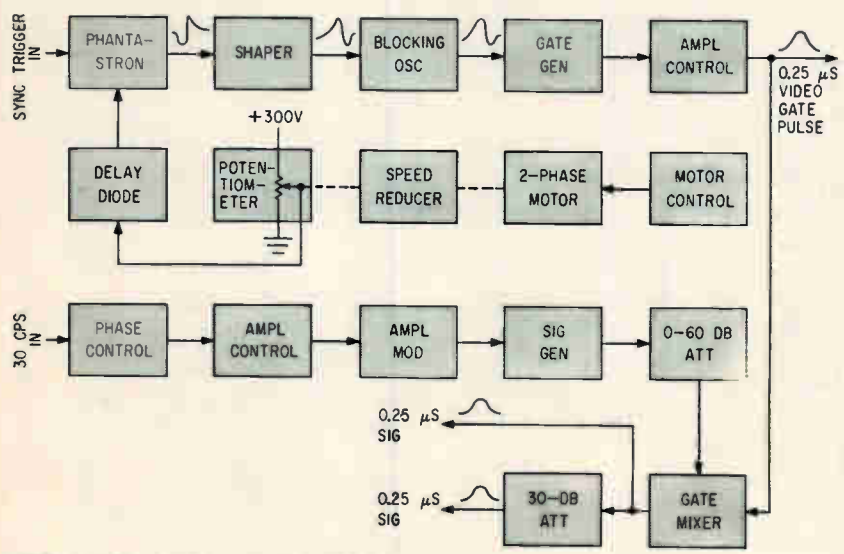


FIG. 1—Moving-target generator

"IMAGINATION IS MORE IMPORTANT THAN KNOWLEDGE"

Albert Einstein

There are some who might argue this point with Einstein. But this much is certain: Wherever new knowledge is sought, imagination lights the way. And surely, only imagination of rare quality could have led Einstein to formulate his principle of relativity.

Einstein applied the insight of imagination to basic science. But imagination can be just as powerful in the creation and application of technology. And nowhere, perhaps, is imagination challenged over so wide a range in both science and technology as in the problems of electrical communications.

At Bell Telephone Laboratories, scientists and engineers range far and deep in search of the answers. They probed deep into solid-state physics to discover the transistor principle, and they speculated and synthesized in an entirely different area of knowledge to create the giant microwave system that carries your TV programs across the country. They study ways to protect the giant molecules in plastic cable sheath, and they explore the basic information content of speech to devise better ways to transmit it. They devise ultrasensitive amplifiers to capture radio signals from distant places, while they conceive and develop new switching systems of unprecedented capabilities. Side by side with the development of transoceanic cable systems they are exploring the possibilities of world-wide communications via man-made satellites.

By exploring every pathway to improved electrical communications, they have helped make your Bell System communications the world's best and they will work to keep it so.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS
RESEARCH AND DEVELOPMENT

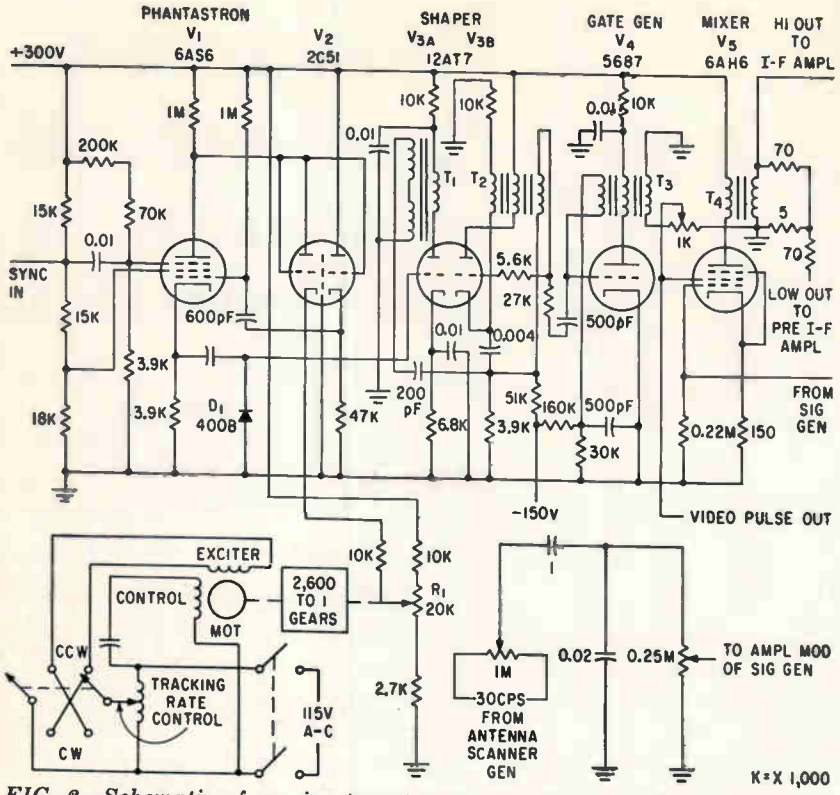


FIG. 2—Schematic of moving-target generator does not show the signal generator, which is a commercial unit

tracking speeds of the radar set.

The phantastron pulse is shaped for triggering a blocking oscillator whose output controls a gate generator. The gate pulse, shaped like a radar echo, causes the mixer to pass a pulse of amplitude-modulated c-w from the signal generator. The signal generator is amplitude modulated by a voltage from a radar-antenna scanner generator or an oscillator. This voltage is phase shifted by a phase control calibrated in degrees-off-target in azimuth and elevation. The phase-shifted and amplitude-modulated i-f pulse, which is shaped like a radar echo, is available at a high level at the gated mixer output for injection into the high-level stages of an i-f amplifier or available through an attenuator for injection into the low-level mixer converter of the radar. A video gate pulse is available for signal tracing through the radar's video amplifier.

The variable time-delay circuit consists of phantastron V_1, (Fig. 2), dual diode V_2 and precision potentiometer R_1 driven by the two-phase motor. The phantastron tube is held at cut-off until a positive trigger is applied to the suppressor grid. The phantastron then conducts until its plate voltage reaches the same potential as the cathode potential of delay diode V_2. The cathode potential is set by the movable arm of R_1. Potentiometer R_1 varies the d-c voltage controlling the delay diode that determines the time delay between the synchronizing trigger pulse input to V_1 and the positive excursion of V_1 output pulse. The output pulse is capacitance coupled to the shaper.

In the shaper circuit, the negative-going portion of the phantastron output pulse is eliminated by diode D_1. The positive-going portion of the pulse triggers blocking oscillator V_{3A}. The blocking oscillator output pulse is ten times the amplitude of the trigger pulse and several times its duration and has a rounded peak on the positive excursion. This pulse triggers blocking oscillator V_{3B}, which produces a still-higher-amplitude positive pulse that is more rectangular in shape and that has much less negative overshoot than the output of V_{3A}. Tube V_{3B} output triggers gate generator V_4, another blocking oscillator.

The gate generator output is a high-amplitude positive pulse of rounded-peak triangular shape without any negative overshoot and duplicates the appearance and dimensions of a received radar echo pulse. The smoothly rounded peak reaches a positive amplitude of 300 v and is fed through an amplitude control potentiometer to the screen grid of the gated mixed tube (V_5).

Tube V_5 remains cut-off until the positive gate pulse is applied. During the short interval the gate pulse permits V_5 to conduct, the amplitude-modulated c-w signal at intermediate frequency that is present on the control grid takes over control of V_5 electron stream. This produces an amplitude-modulated i-f pulse having the same shape as the gate pulse applied to the screen grid of V_5. The output level of the i-f c-w signal generator is controlled by a variable attenuator that permits selection of any signal level from as low as several μv to as high as one volt for application to the control grid of V_5. A fixed attenuator between V_5 plate output transformer and the test set output jack provides low-level signals for the input-to-high-gain stages of the radar.

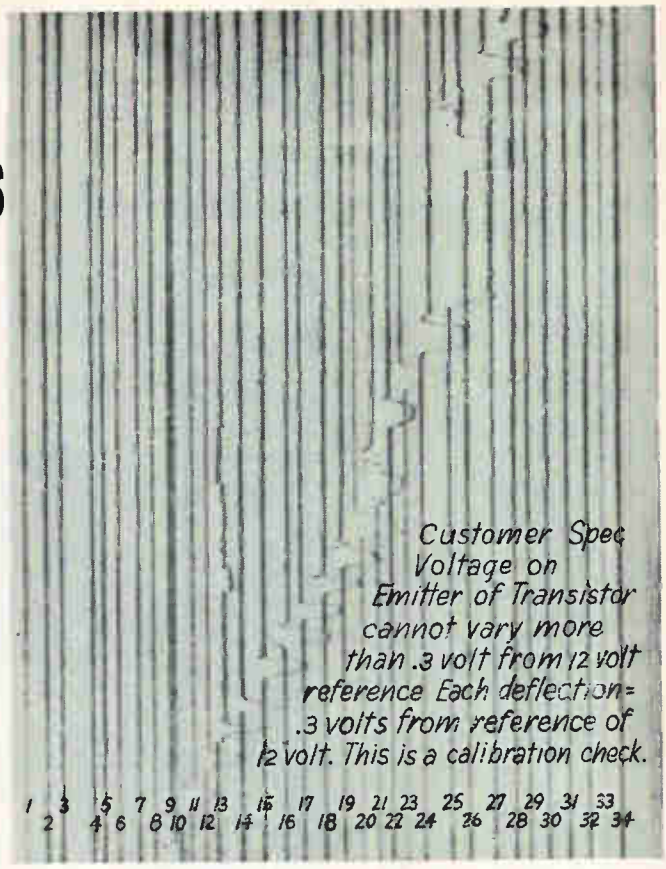
The antenna-angle simulator circuit receives a signal from the position-indicating antenna-scanner generator. This signal is fed through phase and amplitude controls to the amplitude modulator of the c-w i-f signal generator. The phase control is used to simulate the degree of off-target-angle error in azimuth and elevation.

The artificial echo generator is simple to use. The operator adjusts the test set controls to produce the type of artificial echo having the desired characteristics, then observes the movement of the artificial echo on the radar indicator screen while manipulating the radar set controls to intercept, lock on and automatically track the moving artificial target. Changing aspects of a moving target may be simulated by varying the speed, direction, amplitude and phase controls of the test set. Since the range of artificial target speed rate is determined by the ratio of the speed-reduction gears between the driving motor and the precision-delay potentiometer, the ratio may be selected to produce a faster or slower rate of speed of the artificial target to suit the speed capabilities of the radar under test.

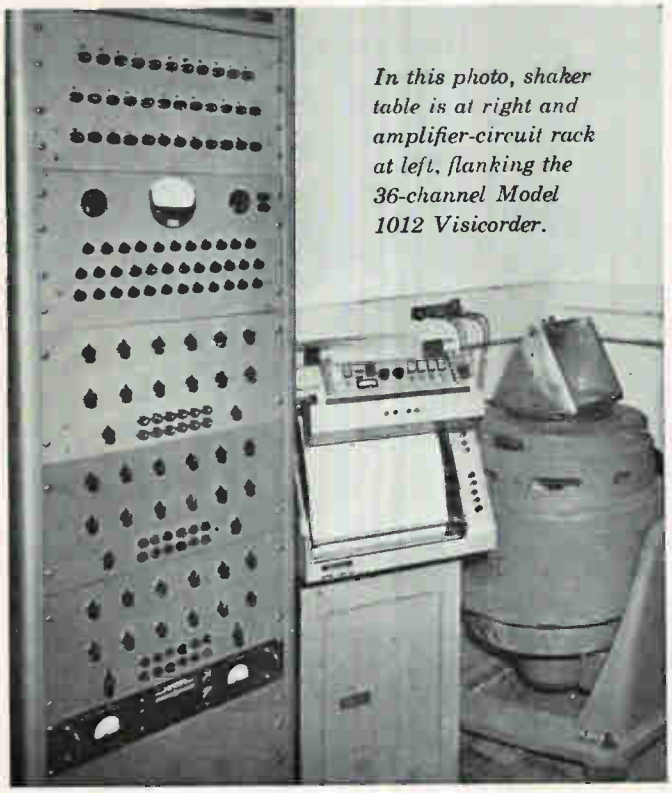
The VISICORDER records transistor torture

Transistors often have to work under incredibly severe environmental conditions. Production-testing them gave engineers at Honeywell's Semiconductor Division a chance to exploit the great versatility of the 36-channel Visicorder oscillograph Model 1012.

A certain order of transistors had to withstand vibrations of 10G at 10 to 2,000 cps without failing during the test or as a result of it. A standard test had been to measure the transistor's performance, next subject it to non-active vibration (not in any circuit), and then re-measure. This approach was obviously deficient as it did not reveal *operating* characteristics during test, nor did it disclose *intermittent*-type failures.



Unretouched record of vibration test on 36 transistors, each active in its own circuit during test.



In this photo, shaker table is at right and amplifier-circuit rack at left, flanking the 36-channel Model 1012 Visicorder.

The customer's quality requirements were stringent (AQL = .4%) and the large test sample required ruled out the use of an oscilloscope. The 3-hour test would have made a battery of scopes and operators necessary; transient defects would be missed due to eyestrain, fatigue, etc.

The Model 1012 Visicorder was chosen for the task as it simultaneously measures and records 36 channels of test information throughout the test period. The Visicorder instantly and directly records transients, no matter how random.

A Visicorder record like this is always a welcome supplement to your test data—your customer will be able to read it quickly and with full understanding. And it is a *permanent* record which *he* can show to *his* customer, if necessary.

For further information on how Visicorders can help to solve your instrumentation problems, contact your nearest Honeywell sales office without delay. Or write for Catalogs HC 906, 1012, 1108 and 1406, to:

Minneapolis-Honeywell, Heiland Division, 5200 East Evans, Denver 22, Colorado, SK 6-3681—Area Code:303

HONEYWELL INTERNATIONAL

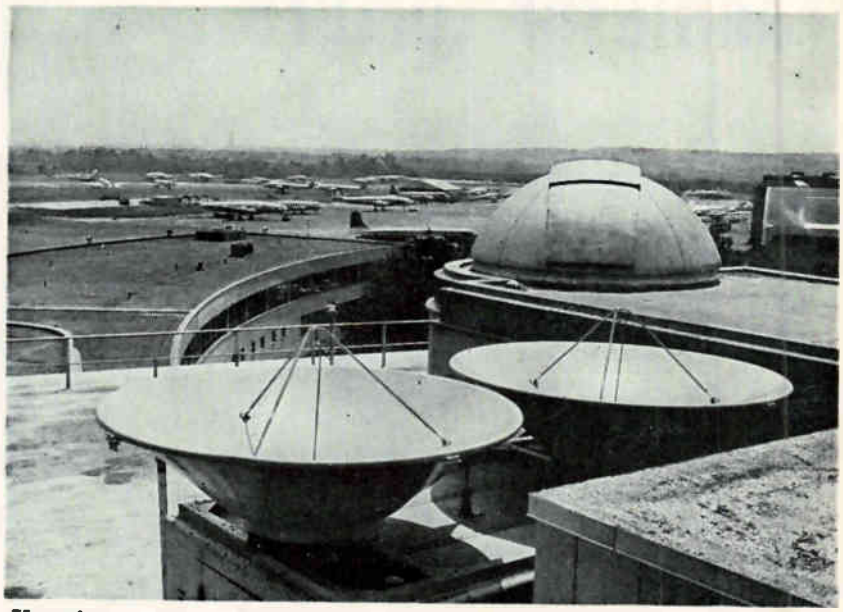
Sales and Service offices in all principal cities of the world.

Honeywell

H Industrial Products Group

Radar Measures Cloud Characteristics

By IRWIN MARSON,
Olympic Div., Siegler Corp.
Long Island City, N. Y.



Use of separate transmitting and receiving antennas in K_a band radar at Washington National Airport isolates crystal mixers from transmitted pulses by more than 95 db

INFORMATION about the vertical cross sections of passing clouds is provided by a new weather radar that looks straight up. Propagation characteristics at the operating frequency selected for the system provide more detailed information about cloud structure. Meteorologists can obtain permanent facsimile recordings as well as observing the crt display.

The system, officially designated AN/TPQ-11 Cloud Detecting Set, operates in the K_a band (35 Gc). Clouds are largely transparent to transmissions at these short wavelengths, enabling the radar to penetrate them. Radar return results from scattering of the transmitted signals from water droplets and ice particles of which clouds are composed.

Typical information furnished by the system that aids in weather forecasting includes cloud height and cloud thickness. Resolution of the system is also sufficient to permit observation of such details as bands and streamers.

The system includes separately housed transmitter and receiver units, each with its own antenna. The control console, also a separate package, has been designed for operation by meteorologists with limited training in electronics. A data converter housed in the console and the facsimile recorder complete the system.

Transmitter pulse repetition frequency is 500 pps and duration of the transmitted pulse is one microsecond. A type 5789 magnetron is used to deliver a peak power output of 25 Kw.

By using separate transmitting and receiving antennas, the mixer crystals are isolated from the transmitted pulse by more than 95 db. This technique was used because past experience indicates that delicate microwave crystals used for the K_a band could have limited life expectancy. However, a single antenna may be incorporated in future designs that would operate in conjunction with improved ferrite circulators and T-R tubes.

The receiver uses a single-conversion superheterodyne circuit with an afc system incorporated for frequency stability. The received 35-Gc signals are beat in a single mixer with the output signal from a VA97 klystron local oscillator. The resulting 60-Mc intermediate-frequency signal is amplified in a two-section i-f amplifier. The first section is a preamplifier with an 8-Mc passband. Output from the preamplifier is coupled through an attenuator to a post amplifier having a 2-Mc passband. Since wide bandpass is not required, the 2-Mc bandpass of the main i-f amplifier limits degradation of performance because of noise.

The afc error signals are derived from a separate crystal mixer that also provides a 60-Mc output. This signal is fed to a preamplifier with an 8-Mc bandpass. Amplifier output is applied to an f-m discriminator that in turn drives a conventional diode-phantastron circuit to change oscillator frequency.

Radar echoes are displayed on an A scope in the console. Height is displayed vertically with signal deflection to the right and range marks to the left. Operating range of the system can be set at 15,000, 30,000 and 60,000 feet. Range marks can be set at intervals of 2,500 or 5,000 feet. The facsimile recorder is provided with the same range marks as those displayed for the operator on the crt.

The data converter samples the received signal for a period of one microsecond during each sweep of the radar. The sampled signal is then stretched over the 2-millisecond pulse interval at the pulse repetition rate of 500 pps.

The recorder sweeps at a rate of one radar range sweep per second. Resolution of 500 feet is realized for the one-microsecond sample, which is compatible with system bandwidth.

The antennas, mounted facing upward on a rigid shelter, are

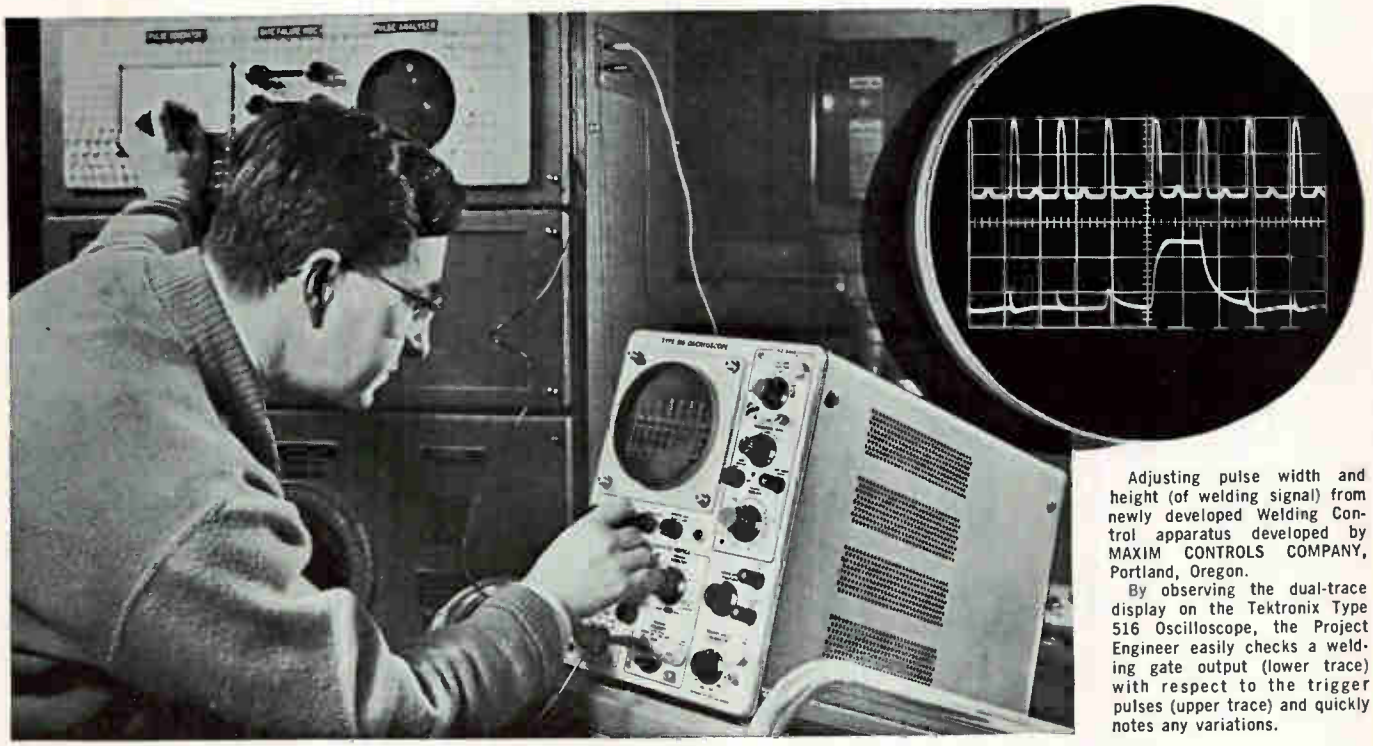
TEKTRONIX TYPE 516 OSCILLOSCOPE

Used in *Development* of High-Speed Welder

New, high-speed, precision welder developed at MAXIM CONTROLS COMPANY utilizes a controlled gate pulse—rather than capacitance decay—for joining high-temperature alloy materials, such as those used in manufacturing structural "honeycomb" cores.

In development of this new welder the Tektronix Type 516 Oscilloscope was used for critical timing and amplitude measurements. It was used by the Project Engineer for monitoring the time length of individual welds—since as many as six welds can be set to occur simultaneously or any number, sequentially—and for observing the constant amplitude and width of gate signals—thus assuring uniform bonds at speeds up to 2000 welds per second.

For your own research and development projects, consider the Type 516 Oscilloscope. Its dual-trace facility—with independent controls for each amplifier channel—permits you to position, attenuate, or invert the input signals as necessary for detailed analysis of their relative amplitudes, phase differences, time-delay characteristics. Its extremely reliable performance ideally suits the Type 516 for laboratory applications within the dc to 15 mc range.



Adjusting pulse width and height (of welding signal) from newly developed Welding Control apparatus developed by MAXIM CONTROLS COMPANY, Portland, Oregon.

By observing the dual-trace display on the Tektronix Type 516 Oscilloscope, the Project Engineer easily checks a welding gate output (lower trace) with respect to the trigger pulses (upper trace) and quickly notes any variations.

Dual-Trace, DC to 15 MC

Type 516 Specifications

4 Operating Modes
Both channels electronically switched — either on alternate sweeps or at a free-running rate of about 150 kc. Or each channel separately.

Vertical Amplifier
Frequency Response—dc to 15 mc (at 3 db down).
Risetime—23 nanoseconds.
Sensitivity—50 mv/div to 20 v/div in 9 calibrated steps.
Continuously variable uncalibrated from 50 mv/div to 50 v/div.
Constant Input Impedance—at all attenuator settings.

Sweep Range and Magnification
Linear Sweep—0.2 μsec/div to 2 sec/div in 22 calibrated rates.
Variable uncalibrated from 0.2 μsec/div to 6 sec/div.
Sweep Magnification—5X-magnifier extends calibrated sweep rate to 40 nsec/div.

Triggering Facilities
Fully automatic or amplitude-level selection (preset or manual) on rising or falling slope of signal, with AC or DC coupling, internal, external, or line—also, high-frequency sync to 20 mc.

Tektronix Cathode-Ray Tube
5-inch crt at 4 KV accelerating potential provides bright trace on 6 div by 10 div viewing area—each div equals 1 cm.

Amplitude Calibrator
11 square-wave voltages, from 50 mv to 100 volts, peak-to-peak, available from front panel.

Regulated Power Supplies
All critical dc voltages electronically regulated.

Size and Weight
13½" high x 9¾" wide x 21½" deep—approximately 39 pounds.

Type 516 Oscilloscope (50-60 cycles) **$1000**

SPECIAL MODELS AVAILABLE

Type 516 MOD 101 (50-400 cycles) **$1035**

Type 516 MOD 108B (significantly improved writing rate at 6-KV on 6 div by 10 div viewing area—each div equals 0.85 cm) **$1075**

(prices f.o.b. factory)

For a demonstration of the Type 516 Oscilloscope in your own dual-trace (or single-trace) application, call your Tektronix Field Engineer.

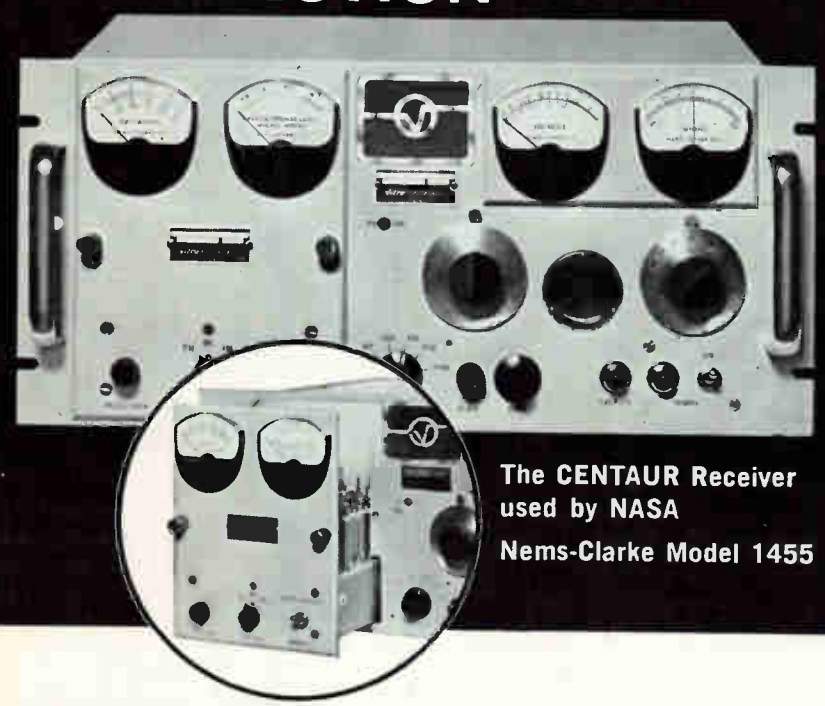
Tektronix, Inc. P. O. Box 500 • Beaverton, Oregon • Phone Mitchell 4-0161 • TWX—BEAV 311 • Cable: TEKTRONIX

TEKTRONIX FIELD OFFICES: Albuquerque, N. Mex. • Atlanta, Ga. • Baltimore (Towson, Md.) • Boston (Lexington, Mass.) • Buffalo, N.Y. • Chicago (Park Ridge, Ill.) • Cleveland, Ohio • Dallas, Texas • Dayton, Ohio Denver, Colo. • Detroit (Lathrup Village, Mich.) • Endicott (Endwell, N.Y.) • Greensboro, N.C. • Houston, Texas • Indianapolis, Ind. • Kansas City (Mission, Kan.) • Los Angeles Area (East Los Angeles, Calif., Encino, Calif. • West Los Angeles, Calif.) • Minneapolis, Minn. • New York City Area (Albertson, L.I., N.Y. • Stamford, Conn. • Union, N.J.) • Orlando, Fla. • Philadelphia, Pa. • Phoenix (Scottsdale, Ariz.) Poughkeepsie, N.Y. • San Diego, Calif. • San Francisco (Palo Alto, Calif.) • St. Petersburg, Fla. • Syracuse, N.Y. • Toronto (Willowdale, Ont.), Canada • Washington, D.C. (Annandale, Va.).

TEKTRONIX ENGINEERING REPRESENTATIVES: Hawthorne Electronics, Portland, Oregon • Seattle, Washington. Tektronix is represented in twenty overseas countries by qualified engineering organizations.

In Europe please write Tektronix Inc., Victoria Ave., St. Sampsons, Guernsey C.I., for the address of the Tektronix Representative in your country

MODULAR TELEMETRY RECEIVER FEATURES MULTIPLE BANDWIDTH SELECTION



The CENTAUR Receiver used by NASA

Nems-Clarke Model 1455

Designed to provide a selectable bandwidth capability for PCM, the 1455 most nearly approximates a "universal" telemetry receiver. IF/Demodulator Modules are available in bandwidths ranging from 100 KC to 1.5 MC. Each module contains 3 independent demodulators. Selectable by a front panel switch, they are: Foster-Seeley Discriminator, Phase-Lock Detector, and AM envelope detector. As a further refinement in signal-to-noise ratio enhancement, the video amplifier incorporates a video bandwidth filter having a 6 db per octave roll-off adjustable from 20 KC to 1.2 MC by means of a front panel switch. This receiver is capable of **optimum** reception of any known type of telemetry signal. Features: 5 MC pre-detection recording output, playback input terminals, and integral VFO, automatically actuated by a micro-switch on the crystal socket. The modulation sensitivity and deviation meter scales provide output voltages and meter deflections which are essentially the same percentage of bandwidth in all modules.

Available as an accessory unit is the Nems-Clarke IFC 1400 Pre-Detection Converter which permits use of the 1455 with stationary-head instrumentation tape recorders for pre-detection recording.

Vitro ELECTRONICS A DIVISION OF VITRO CORPORATION OF AMERICA

PRODUCERS OF NEMS-CLARKE EQUIPMENT

919 JESUP-BLAIR DRIVE, SILVER SPRING, MARYLAND / 2301 PONTIUS AVENUE, LOS ANGELES 64, CALIFORNIA

64 CIRCLE 64 ON READER SERVICE CARD

equipped with tubes for draining water. Nitrogen gas injected into the waveguides keeps them dry. Only one tank of gas should be required throughout the life of the equipment because of the small amount of leakage from the waveguide.

Operation of the equipment beyond setting desired range or other conditions requires that the main power switch be thrown on. After magnetron warm-up time, high voltage is applied to the transmitter. With the transmitter operating, the automatic frequency control system locks the receiver on the correct frequency.

One application of the new radar will be to provide information to the AN/FMQ-5 Automatic Weather Station, which was also developed by the Olympic division of Siegler.

Accelerator Will Use High-Power Klystrons

PROPOSED two-mile long linear accelerator will use klystrons that provide as much as twenty-four megawatts peak power output. The proposed accelerator will use 240 of these klystrons to achieve energies of 10-20 bev.

Preliminary design and development work is being carried out at Stanford University under prime contract to the Atomic Energy Commission. Congress appropriated $3 million last fall for the present preliminary work. If the entire project is approved, final cost is estimated at $100 million and the accelerator could be completed in six years.

Subcontracts for the klystrons have been awarded to Sperry Gyroscope and RCA, with a subcontract for development of a power supply modulator system also going to RCA. Each company is scheduled to supply six of the klystron amplifiers before the end of the year.

The tubes will incorporate improvements on basic Stanford klystron designs. Peak power output of 6 to 24 megawatts is specified with a minimum operating life of 2,000 hours. The designs must also permit mass production and easy maintenance.

The power modulator system in

conjunction with the klystrons will provide microwave power to drive electrons through the accelerator's 4-inch diameter, 10,000-foot long pipe. The electrons traveling at about the speed of light will acquire tremendous energy in the form of increased mass. They will bombard nuclear targets at the end of the pipe.

Physicists expect the electron bombardment to produce all known particles and possibly create new ones. The accelerators would also permit studies of secondary particle production, possible limits to theories of quantum electrodynamics and measurements of nuclear structure. The present 1 bev linear accelerator at Stanford has yielded the most accurate known measurements of size and charge distribution of neutrons and protons.

Tuning Technique Gives Wide Frequency Choice

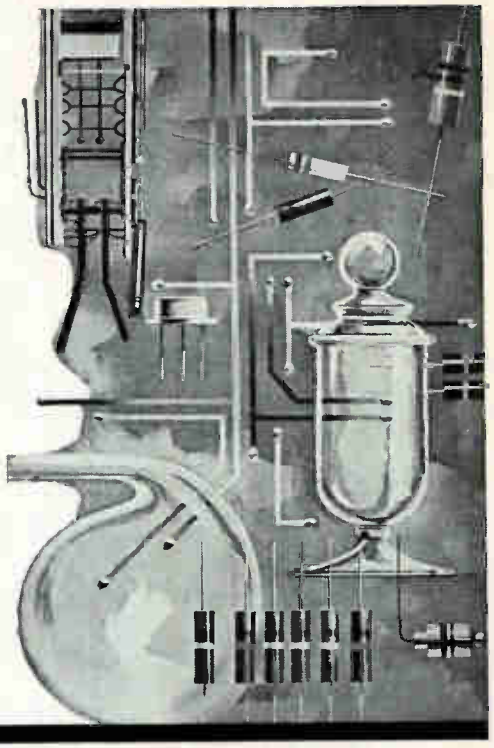
SINGLE-SIDEBAND transceivers use digital tuning to lock on any of 2,800 frequencies from 2 to 30 Mc. The tuning technique is expected to reduce operator errors as well as simplify and speed the tuning process. Frequency stability is said to be 1 part in 10^7 per week.

The transceiver is the first of a line of single-sideband communications equipment developed by the Stromberg Carlson division of General Dynamics. Power output levels will be available from 100 watts to 1 Kw (peak envelope power), and digital tuning will be incorporated in all units.

Tuning consists of selecting each digit corresponding to 10, 1, 0.1, 0.01 and 0.001 megacycles. A separate tuning knob is used for each digit. Rotating the controls selects fixed tuning components, eliminating the need for positioning the shaft of a variable tuning element.

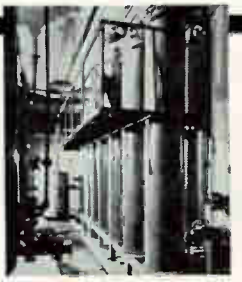
Maximum use is made of semiconductors in the equipment. Heat-sink cooling through radiating fins on the front panel provides for heat dissipation. Modular construction is used throughout the transceivers to facilitate servicing.

Production is up...costs are down on the high purity rare earths...



YTTRIUM OXIDE & GADOLINIUM OXIDE

...for advanced ceramic-electronic applications



At the Lindsay Division, Yttrium and Gadolinium salts are separated from rare earth concentrates by the ion exchange technique.

LINDSAY rare earth chemicals offer a whole new spectrum of characteristics for the manufacture of ceramics and cermets which are stable at high temperatures and which exhibit well-defined electronic properties. Typical application—high purity Yttrium Oxide and Gadolinium Oxide, are being used as raw materials for yttrium-iron garnets in microwave circuit design. These, and other rare earths with intriguing electronic properties, are being studied for use as thermionic emitters, ceramic dielectrics, getters, and various potential semiconductor applications. Your consideration of these materials need not be hampered by cost, availability, or degree of purity. LINDSAY CHEMICAL DIVISION, the leading source of rare earth chemicals, can supply your needs in commercial and highest purities, and in large or small quantities.

Write today for complete technical data.

LINDSAY RARE EARTH CHEMICALS

TRONA *American Potash & Chemical Corporation*

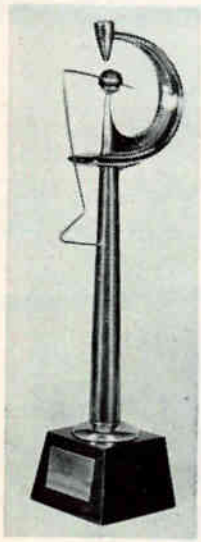
99 Park Avenue, New York 16, New York

CIRCLE 65 ON READER SERVICE CARD 65

Top Designers Receive Minnie Awards

BACK IN 1957, Miniature Precision Bearings[1] originated an awards program to increase awareness of significant advances in the field of miniaturization. Since then these Minnie Awards (we suggest this name) have attempted to create a better understanding of miniaturization, to point a way towards new horizons in miniaturization through research, and to simplify future efforts in this area.

Criteria established for the miniaturization awards include ingenuity in solving basic miniaturization problems of broad interest to industry; new design concepts having wide potential application; and developing or manufacturing new types of components or assemblies that extend the frontiers of miniaturization.



The Minnie Award

The first prize, a bronze sculpture that symbolizes miniaturization, was won this year by the electronic watch[2] that hums (ELECTRONICS, p 35, Oct. 28, 1960). This watch, now known to millions, was selected from among 117 entries. The award presentation was made at the Waldorf Astoria Hotel in New York, at a recent dinner. The event was attended by over 200 people that included the top designers of military and commercial electronics. General B. A. Schriever, Commander of the Air Research and Development Command, was the guest speaker.

Our readers may remember that the design concept of the watch involved the use of a tuning fork and miniature coil arrangement to act as transducer; an electronic circuit that employed a transistor, and a capacitor and associated resistor that interacts with a 1.3-v mercury cell and two driving coils.

In addition to the top award, ten certificates of excellence were presented. These awards were:

• A working two-phase, four-pole electrical motor less than $\frac{1}{64}$-in. in size[3]. The mechanical handling and coil winding methods employed in the micromotor have wide potential application in microminiature mechanical assemblies and inductive electronic components.

• The Compactron[4], a vacuum tube which combines into one unit the functions performed by several vacuum tubes, thus opening the way to smaller size, better performance and lower costs. Because three Compactron devices do the job of eight transistors or six miniature tubes, fewer components perform the same functions in less space.

• The TIMM circuits[5], Thermionic Integrated Micro Modules, tiny ceramic modules which contain not only electron tube elements, but also associated circuitry such as capacitors, resistors and inductors. These circuits permit exceptionally high practical, working (as opposed to theoretical) component densities.

• A micro-miniature a-c timing motor[6]. At the present time a 115-v, 400 cycle timing motor operates from less than one-half watt of power, and with a diameter of $\frac{3}{8}$ inch. Length of the motor is $\frac{9}{32}$-in., and to the best of knowledge, this is the smallest synchronous a-c motor available.

• A thin-film digital differential analyzer computer[7] that demonstrates that system-oriented application of thin-film techniques have resulted in a compact, accessible computer which promises to have better reliability than can be achieved with current techniques.

• A 40-bit memory plane[8] that makes possible, by automated methods, the fabrication of microminiature computer memories with packing densities of 3 million interconnected cryotrons per cubic foot.

• Contributions to miniaturization in broad range of achievements and products[9]. These include application of photo-etching techniques, use of electrostatics for the placement of microminiature components, processes for production of large numbers of semiconductor single-crystal spheres, and development of a production line capable of automatically constructing complete devices with numbers of components in the magnitudes of 10^9 to 10^{10}.

• An electrohydraulic valve[10] that provides hydraulic muscles for miniaturized electronics.

• A sub-miniature vane pump cartridge[11] for electronic cooling, at low power sources, for transferring small quantities of liquids or gases.

• A surgical suture needle[12] made of 0.008-in. wire that required two years of development. Diameter of needle and suture approximate each other, minimizing bleeding and trauma.

The 1957 miniaturization award was presented[13] for techniques in developing components utilizing photolithographic processes and printing techniques. In 1958, the award was given for significant contributions to the development of the SNAP III, a five-pound radioisotope-fueled generator.[14]. The 1959 award was given for a sputtered tantalum technique in producing microminiature components and circuits[15].

REFERENCES TO AWARDS

(1) H. D. Gilbert, President, Miniature Precision Bearings, Inc., Keene, New Hampshire.
(2) W. O. Bennett, Vice President of Research and Engineering, Bulova Watch Company, Inc., Flushing, New York.
(3) W. H. McLellan, Electro-Optical Systems, Inc., 125 North Vinedo Avenue, Pasadena, California.
(4) R. R. Perkins, General Electric Company, 200 Main Ave., Clifton, N. J.
(5) A. P. Haase, Manager, Development Engineering, General Electric Co., Receiving Tube Dept., 316 East 9th St., Owensboro, Kentucky.
(6) R. W. Perkins, A. W. Haydon Company, 232 North Elm St., Waterbury, Conn.
(7) J. E. Richardson, Research and Devel. Labs., Aerospace Engineering Divi-

PRICES REDUCED 41%

FOR SERIES 2N1671

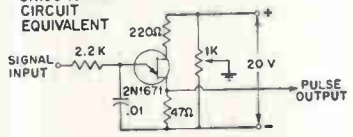
UNIJUNCTION TRANSISTORS

CONDENSED SPECIFICATIONS OF UNIJUNCTION TRANSISTORS 2N1671, A, B

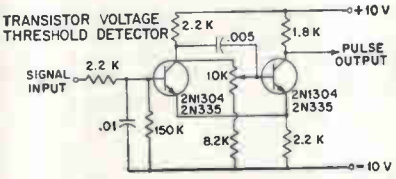
Maximum Total Power Dissipation		450 mw
Operating Temperature Range		−65°C to 140°C
Intrinsic Standoff Ratio (η)		0.47 to 0.62
Interbase Resistance (R_{BB})		4.7K to 9.1K ohms
Peak Point Emitter Current (I_{EP}) (V_{BB}=25 volts)	2N1671,A	25 μa max.
	2N1671B	6 μa max.
Emitter Reverse Current (I_{EO}) (V_{EB2}=30 volts)	2N1671,A	12 μa max.
	2N1671B	0.2 μa max.
Base—One Peak Pulse Voltage	2N1671A,B	3 volts min.

Typical Circuit Comparisons Because of its unique characteristics, one unijunction transistor can often replace two or more conventional transistors with significant savings in overall circuit cost. You can simplify circuit configurations and at the same time achieve improved stability over a wide temperature range.

UNIJUNCTION CIRCUIT EQUIVALENT



TRANSISTOR VOLTAGE THRESHOLD DETECTOR



Transistor Voltage Threshold Detector

2 transistors*
1 potentiometer
2 capacitors
6 resistors

Unijunction Circuit Equivalent

1 unijunction transistor
1 potentiometer
1 capacitor
3 resistors

PREVIOUS SA[illegible] germonium transistors)
[illegible].20 (*silicon transistors)

Now save $187 *[germanium transistors]*

$1067 *[silicon transistors]*

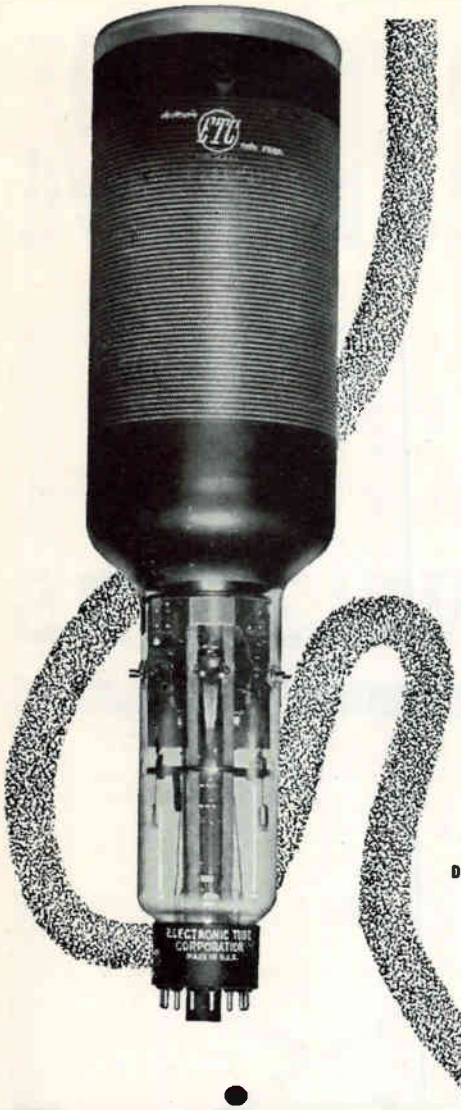
Positive internal atmospheric control and new surface stabilization techniques have made possible major improvements in unijunction stability, reliability, *and* cost. So G-E unijunction transistors . . . which are already famous for silicon performance at germanium prices . . . are now priced 41% less for the new 2N1671 Series!

For complete technical information and life test data, call your G-E Semiconductor District Sales Manager today! Or write to Semiconductor Products Department, Section 25C92, General Electric Company, Electronics Park, Syracuse, New York. In Canada: Canadian General Electric Company, 189 Dufferin Street, Toronto, Ontario. Export: International General Electric Company, 150 E. 42nd Street, New York 17, New York.

For immediate delivery at factory-low prices in quantities up to 999, call your G-E semiconductor distributor

GENERAL ELECTRIC

CIRCLE 67 ON READER SERVICE CARD



ETC

CRT OF THE MONTH

New! ETC Type 52SBP— *dual-gun, 5" electrostatic focus and deflection.*

Pattern distortion problems common to many 10 Kv post-accelerator tubes are eliminated in this new ETC design through separate astigmatism, geometry-adjust, wall, and shield electrodes. A spiral accelerator affords latitude in operating voltages with little or no change in distortion. Note in addition, the extremely high vertical sensitivity and high light output. Two completely separate electron guns are provided.

Deflection Factors:

D_1 & D_2 (horiz.).....85 to 105 v dc/in
D_3 & D_4 (vert.).....17 to 21 v dc/in.

pacing trends

IN CATHODE RAY TUBE DESIGN

...since 1937

Over 100 standard types... many specials... produced for oscilloscopes and critical display instrumentation. 1 to 10 guns; square, round, or rectangular faces; high resolution; spiral band for radar, fire control, counter-measures, guidance—where quality control counts most. Submit your application details for an engineering review.

electronic tube corporation
1200 E. MERMAID LANE, PHILADELPHIA 18, PENNA.

sion, Hughes Aircraft Co., Culver City, California.
(8) H. E. Cooley, Manager of Engineering Lab., International Business Machines Corp., Federal Systems Division, Command Control Center, Kingston, New York.
(9) A. Goodman, Sandia Corp., Division 7223, Albuquerque, New Mexico.
(10) G. W. Lewis, Spard Division, The Electric Autolight Co., 511 Hamilton St., Toledo, Ohio.
(11) D. G. Snow, Vickers Inc., Division of Sperry Rand Corp., Detroit, Michigan.
(12) J. H. Jacobson, M.D., University of Vermont College of Medicine, Burlington, Vt., jointly with Ethicon Inc., subsidiary of Johnson and Johnson, Somerville, N. J.
(13) Diamond Ordnance Fuze Laboratories, Washington, D. C.
(14) The Martin Company, Nuclear Division, Baltimore, Md.
(15) D. A. McLean, Bell Telephone Labs., Murray Hill, N. J.

Supplying Demands For Intermetallics

ANOTHER MAJOR chemical company[1] is now involved in a long range program to help fill the electronic industry's chemical requirements in the III-V intermetallics. Electronic chemicals are receiving intensive research, and new products will be added.

At the recent IRE show, Monsanto displayed and discussed samples of single crystal gallium arsenide produced by the major crystal growing techniques, and R. A. Staniforth, assistant director of development discussed each of these techniques with this columnist. He suggested that the float zone technique offered the best method of obtaining a really high purity material, the Czochralski method produces material with the lowest dislocation densities, and the gradient freeze technique allows the highest doping levels. Monsanto now joins[2] in offering single crystal gallium arsenide with mobilities of 3,000-5,400 cm^2/volt-sec and carriers of 1×10^{16} to 5×10^{17} per cm^3.

Staniforth believes it is probable that the float zone method will make possible a material which will open up gallium arsenide transistors.

In a recent discussion with the director of technical planning for one electrochemical research group[3] the dearth of properly qualified electrochemical-electronic engineers was a matter of some concern. Some key educators at top engineering universities feel that frontiers in electronics can be pushed ahead by revising engineering training to steer some of their

brightest students into these areas of research.

Steps in these directions already have been taken by Northwestern, Stanford, Cornell and the University of Cincinnati, and have come about in response to demands created by the needs for advanced training in these fields.

REFERENCE

(1) Monsanto Chemical Company, 800 North Lindbergh Blvd., St. Louis 66, Mo.
(2) M. F. Tomaino, What Lies Ahead for Gallium Arsenide?, ELECTRONICS, p 144, Feb. 17, 1961.
(3) J. H. Hayner, Director of Technical Planning, Patterson Moos Research, a Division of Leesona Corp., Jamaica, N. Y.

Precision Resistors For Digital Computers

A DEMAND is created in analog-to-digital conversion, where a resistor with a fast rise time is needed to follow a square wave as closely as possible. Existing resistors take four or five times longer to reach these square waves.

A key factor in the development of a wire-wound resistor to fit this bill involves a wire-winding technique that accurately lays down the wire turns so that virtually no voltage differences are created between adjacent turns of wire.

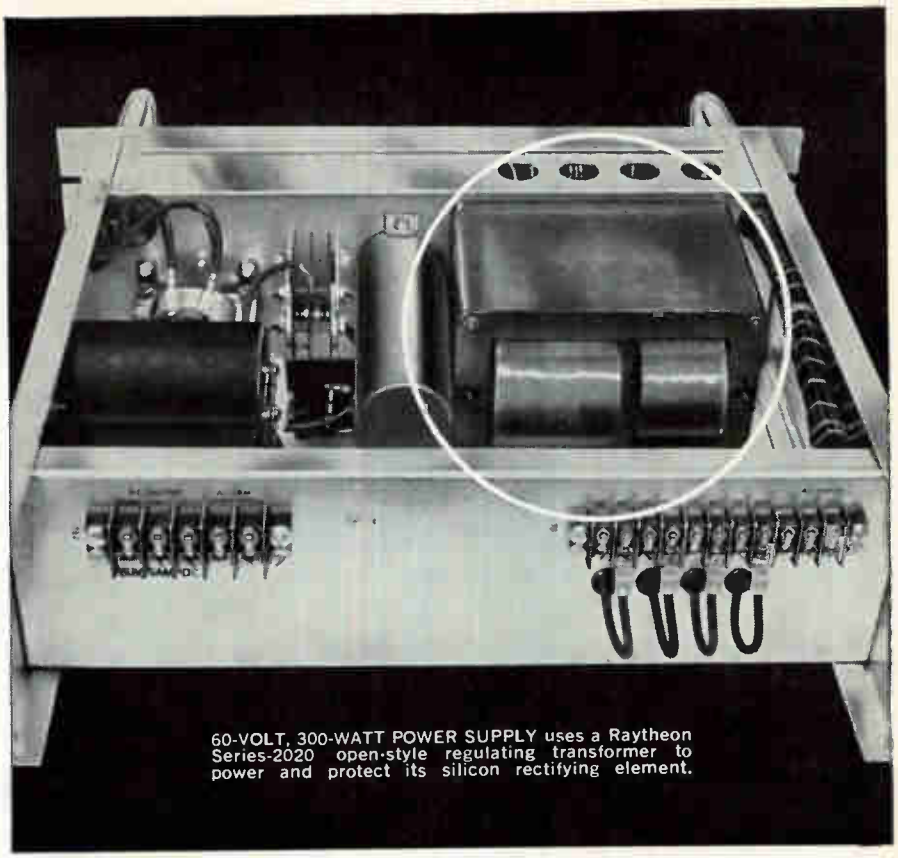
This problem was solved by a technique that produces high-frequency resistors that have resistance values as high as one megohm[1]. These new units are guaranteed to an accuracy of 0.005 percent, and exhibit a rise time of less than 0.2 μsec, and a capacitance of less than 0.1 picofarads. These components will find growing applications in high-speed switching networks and digital computers.

Inductive and capacitive effects are virtually eliminated by equal layer windings that give small voltage gradients which reduce capacitance and use of pi windings. The winding direction is alternated as the wire proceeds from one pi section to another. Thus when current flows it will also reverse direction in each pi, cancelling inductance effects within the unit.

Reon will soon announce details on a precision wire-wound resistor that measures ⅛ x ⅛ in.

REFERENCE

(1) Leon Resnicow, Reon Resistor Corp., 155 Saw Mill River Rd., Yonkers, N. Y.


60-VOLT, 300-WATT POWER SUPPLY uses a Raytheon Series-2020 open-style regulating transformer to power and protect its silicon rectifying element.

POWER • PROTECTION • REGULATION
ALL THREE
IN ONE TRANSFORMER!

Does your power transformer protect semiconductor rectifiers?

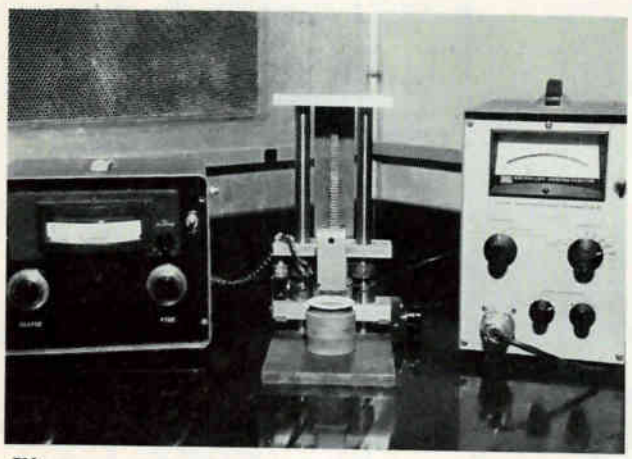
How do you protect the silicon and germanium rectifiers in that advanced design power supply? Do you use elaborate circuitry or —like many power supply designers—are you using a Raytheon 2020 Voltage Regulating Transformer?

These versatile units provide stabilized voltages within ±1% and are available in any of 2,020 standard models for solid-state and vacuum-tube rectifiers. You match your exact requirement from a full range of standard designs and ratings from 20 to 20,000 VA.

Write today for Catalog 4-265 with convenient Selection Guide and Power Supply Design Data. Raytheon Company, Commercial Apparatus & Systems Division, Keeler Avenue, South Norwalk, Connecticut.

RAYTHEON
RAYTHEON COMPANY
COMMERCIAL APPARATUS & SYSTEMS DIVISION
Raytheon voltage regulators are also available from your local Raytheon distributor

CIRCLE 69 ON READER SERVICE CARD



Electronic voltmeter speeds measurement of wafers

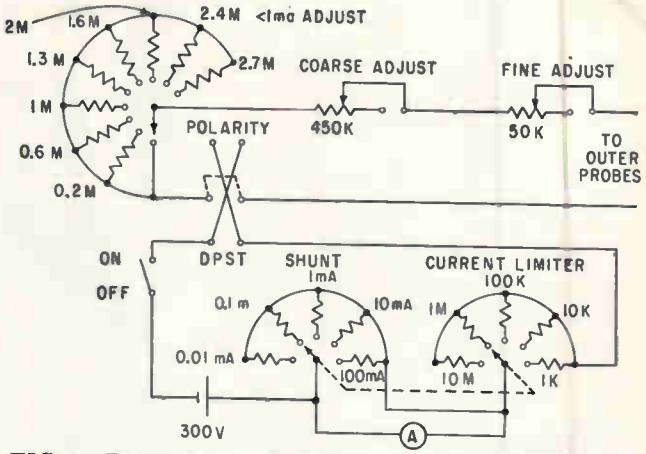


FIG. 2—Power supply for four-point probe resistivity set

Probe Shows Silicon Resistivity Accurately

By DAVID J. VALLEY, Chief Development Engineer, Allegheny Electronic Chemicals Co., Bradford, Pa.

RESISTIVITY, A FUNDAMENTAL semiconductor property, must be accurately controlled in the material used for semiconductor devices. Measurements precise enough for control can be made by carefully designed instrumentation.

The four-point probe' technique of resistivity measuring is generally accepted in the industry. The probe and power supply design used here insures better than five percent accuracy and is suitable for rapid testing of large volumes of single crystal silicon wafers as well as single crystal ingots.

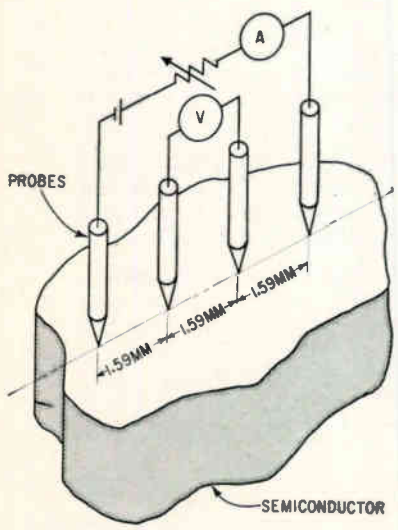


FIG. 1—Basic four-point probe circuit

To measure resistivity, the probes spaced 1.59 mm apart are brought in contact with the crystal surface (Fig. 1). A unit current is passed through the two outer probes and the voltage measured across the two inner probes is equivalent to resistivity. The specimen must be large compared to the probe spacing and the probes must be removed from any edge.

Allegheny's probe assembly has two carriages on ball bushings which ride on vertically-supported, hardened steel shafts. The probe head mounted to the upper carriage has four chrome-plated needles, precisely mounted in a Teflon block. The probes are backed up with individual beryllium-copper cantilever springs. The springs make electrical contact and allow the points to accommodate small irregularities on the specimen.

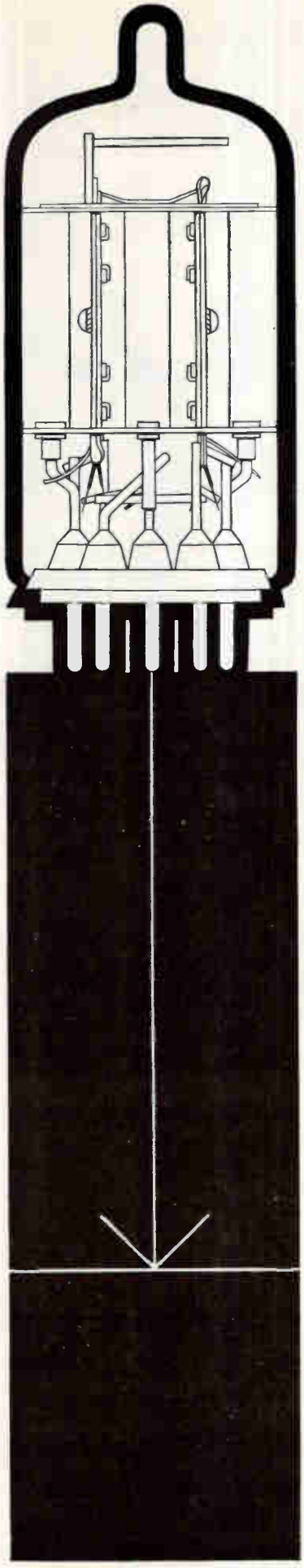
The lower carriage contains the positioning mechanism. Rotating the knob provides vertical positioning through a rack and pinion assembly. Constant pressure loading of the needles on the specimen is achieved by the extension of a constant force spring (Neg' Ator, Hunter Spring Co.) which connects the carriages.

Another feature of the probe is automatic current switching, by a limit switch located between the carriages. This prevents arcing by providing an open circuit make and break of the needle contacts on the specimen.

The specimen to be measured is placed under the probes and the apparatus lowered by turning the knob until the needles make contact. Further turning causes the two carriages to separate, applying the force (two pounds) of the constant force spring to the needle contacts. At this point, the normally open limit switch closes and current flows through the measuring circuit. A friction clutch on the pinion shaft holds the lower carriage in place.

The power supply (Fig. 2) is constructed with fixed resistors, selector switches, two precision variable resistors, an ammeter with one percent accuracy and a 300-volt battery. The series resistance of the probe circuit can be varied between 750 ohms and 3.2 megohms ± 2 ohms. The high resolution allows precise setting.

Resistivity measurements range over nine orders of magnitude. In silicon work, the commonest range is 0.001 ohm-cm to 100 ohm-cm. A 1-ma current is convenient for this range. Currents as low as 10 μa



ECC83
12AX7

high gain double triode

Double Triode having separate cathodes, primarily intended for use as a resistance-coupled amplifier or phase inverter.

characteristics (each section)

V_a	100	250 V
I_a	0.5	1.2 mA
V_g	− 1.0	−2.0 V
g_m	1.25	1.6 mA/V
μ	100	100
r_a	80	62.5 kΩ

'Mullard' is the trademark of Mullard Ltd.

Mullard
ELECTRONIC TUBES

BRITAIN'S FIRST CHOICE FOR FIRST EQUIPMENTS

SUPPLIES AVAILABLE FROM

IN THE U.S.A.
International Electronics Corporation
81 Spring Street, New York 12, N.Y.
Worth 6-0790

IN CANADA
Rogers Electronic Tubes & Components
116 Vanderhoof Avenue,
Toronto 17, Ontario.
Hudson 5-8621

MULLARD OVERSEAS LTD., MULLARD HOUSE, TORRINGTON PLACE, LONDON, ENGLAND

are used for higher resistivities. Currents up to 100 ma can be used for resistivities below 0.001 ohm-cm. Fig. 3 is a resistivity function plot showing the operating line for a four-point probe with 1.59 mm spacing.

The power supply is equipped with a polarity reversing switch useful in determining the presence of spurious voltages, such as photovoltaic effects or r-f pickup, and for detecting rectifying contacts. If the voltage reading is the same in both polarities, irregularities are assumed to be absent.

Two voltage measuring systems are employed. The setup for single crystal ingot includes a potentiometer (Leeds & Northrup K-3). When used with a highly-sensitive gal-

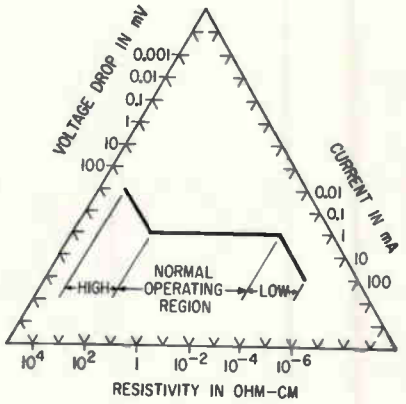
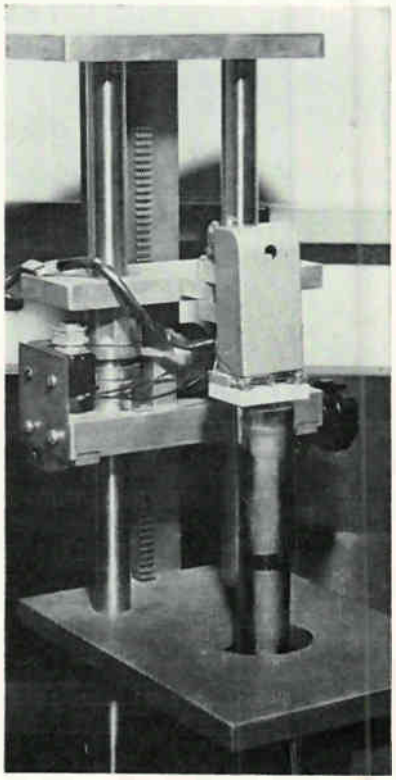


FIG. 3—Probe operating regions



Measurement of single crystal ingot

Since 1942 the Bird Electronic Corporation has met the challenge of a constantly growing electronic industry. Today, enlarged engineering facilities demonstrate our intention to maintain leadership in our field. A wide range of coaxial line instruments and accessories are being designed to meet a variety of specifications; and new applications are continuously being sought.

In addition to experience and established leadership, Bird has the physical facilities to produce and dependably deliver coaxial line instruments and accessories meeting your highly exacting requirements.

BIRD ELECTRONIC CORP.
CHurchill 8-1200 (Cleveland)
30303 Aurora Road, Cleveland 39, Ohio
Western Representative:
VAN GROOS COMPANY, Woodland Hills, Calif.

NEW BINARY DECODING DIGITAL READOUT

BINA-VIEW

Translates Direct—Coded Binary-to-Decimal and Alpha-numeric

Self-Decoding. The new Bina-View Digital Readout accepts any BCD or teletype code up to six bits, does its own translating, and displays the proper character. There are no auxiliary translators, relays, or diodes required.

Low Power. The Bina-View Digital Readout may be operated with as little as ten milliwatts per bit of signal power. It may be connected directly into computers and other electronic equipment.

Character Storage. The Bina-View Digital Readout will continue to display the last character entered after the signal-input power has been removed.

Memory and Verification (Optional). When required, contact closures may be provided for verification that the input signals have been properly accepted.

Practical. The Bina-View Digital Readout offers clear distinct characters, high even brightness, and wide viewing angle. Extremely durable and vibration-free, it is designed for thousands of hours of trouble-free operation.

Prices start at $50.00 each

Now, with the new Bina-View, digital readouts take on an added dimension. Here is a readout that operates direct from binary input, has its own retentive memory, and offers one-plane in-line presentation. Realistically priced and designed with the user in mind, it is not to be confused with other readout devices on the market. The Bina-View Digital Readout fills the long-standing need for a fast, accurate, binary operated display in the fields of digital computers, missile checkout systems, ground support equipment, etc. Its ability to operate within a wide range of binary codes makes it the most versatile readout available today.

Available in individual units or assemblies. Write today for complete detailed specifications.

Representatives in principal cities.

INDUSTRIAL ELECTRONIC ENGINEERS, Inc.
Engineers & Manufacturers of Fully Automatic Systems & Digital Readouts
5528 Vineland Avenue, North Hollywood, California

CIRCLE 200 ON READER SERVICE CARD

FIRST CHOICE OF ALL 4!

Because to use the BUYERS' GUIDE an engineer need only (1) look up the product he wants to buy in the Product Listings, where all known manufacturers of the product are alphabetically included (manufacturers who are advertisers are listed in bold-face type with page numbers of their advertisements) (2) turn to the advertising pages of manufacturers of the product for specifications (advertisers list all their product lines and product specifications in one place) (3) turn to the Manufacturers' Index and find the local sales office (local sales offices are listed alphabetically by States with addresses and phone numbers).

Gives more to all 4! **electronics BUYERS' GUIDE** and Reference Issue

Money

alone is not a true measure of an engineer's satisfaction

But you can't eat satisfaction! That's why our pay scale matches anyone's and, in many instances, is better.

However, an engineer's *inward* fulfillment comes from a difficult job well done, not just from counting the digits on his check. Satisfaction from whipping a problem, finding the answer, making the answer work. Call it what you will, pride, ego, or what have you, it remains *the* most necessary ingredient a good engineer must possess. Our engineers have it and their fine creative performances show it.

Because RCA West Coast continues its rapid expansion movement, we're looking for this kind of satisfied engineer right now. Are you one of these:

Advanced Systems Engineers, Development and Design Engineers, and Project Engineers with experience in these areas: Electronic Countermeasures, Data Processing and Computer Systems, and Missile Ground Support Systems.

For more about us and your profitable future, follow the advice in the box at right.

RCA
WEST COAST

Call collect or write:
Mr. T. M. Ripley
EMpire 4-6485
8500 Balboa Blvd.
Dept. 361-C
Van Nuys, California

RADIO CORPORATION OF AMERICA
WEST COAST MISSILE AND SURFACE RADAR DIVISION

The name you know is the place to grow!

EQUAL JOB OPPORTUNITY For All Qualified Applicants

SPECIFIC OPENINGS AT RCA WEST COAST ARE:

SENIOR COMPUTER SYSTEMS ENGINEERS
To lead studies in new organizational concepts, pattern recognition and machine learning. Will be a member of high level Research and Development team working on RCA Sponsored Programs.

SENIOR COMPUTER ENGINEERS
To lead applied research studies on kilomegacycle computer circuits. Will work with advanced R & D team.

DIGITAL SYSTEMS ENGINEERS
For design and application of digital data processing equipment to military systems. Also for conceptual design, synthesis, and analysis of military systems utilizing digital techniques.

ECM ENGINEERS
For project equipment utilizing new and unique high frequency and video circuit techniques.

SYSTEMS OPTIMIZATION ENGINEERS
For application of operation analysis and other analytical techniques. Advanced degree.

OPERATIONS ANALYSTS
For development of large scale systems concepts. Familiarity with logical and/or mathematical models for data processing systems necessary. Advanced degree in Mathematics preferred.

DESIGN AND DEVELOPMENT ENGINEERS
For control equipment, display equipment, and design of analog and display circuits.

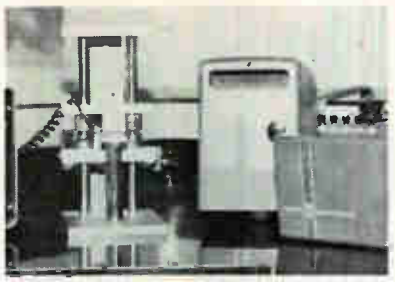
SENIOR LOGIC DESIGN ENGINEERS
To design entire computer systems. Advanced degree preferred.

SENIOR ENGINEERS
For relay logic and relay switching design and application to advanced digital techniques.

PROJECT ENGINEERS
For technical project management of development and design engineering and customer liaison and manufacturing. Responsibilities include project direction, control and proposals for improvement and extension of digital system capabilities.

PROJECT ENGINEERS
For visual data handling and analog data processing, employing direct view storage techniques, alphanumeric readout devices and projection systems.

For complete details on these positions contact Mr. O. S. Knox at RCA West Coast.



Ingot measuring setup

vanometer, the most critical measurements can be made. The other setup has a high-impedance, high-sensitivity electronic voltmeter (Kiethley 150A). It makes rapid measurements on large numbers of single crystal wafers with little loss of accuracy.

To maintain continued accuracy, the equipment is periodically checked with precision resistors and calibrated standard resistivity samples. As additional safeguards, stray a-c fields must be eliminated and temperature and light levels should be kept constant. The equipment is used in an air-conditioned, electrically isolated room. Specimens must be carefully prepared, by fine sandblasting or lapping.

REFERENCE

(1) L. B. Valdes, Resistivity Measurements on Germanium for Transistors, Bell Telephone System Monograph 2261.

Harness Molding Raises Reliability, Is Faster

HARNESS MOLDING technique that puts a covering of air-tight, waterproof vinyl on aircraft cables has been reported by the Convair Astronautics Division. Wires are cut to length and metal connector tips are soldered or crimped on. The wires are bundled, wrapped spirally with quarter-inch vinyl strips and laid in channels in an aluminum mold. The mold is covered with a flat plate. An air gun is used to force coating material into the mold. Curing, by heating the mold, bonds the coating with the windings. Connector plugs can be molded directly to the harness ends. Convair says the method improves reliability by giving environmental protection and distributing strain on the harness. Molding is also faster than hand-tying and identification numbers molded in eliminate tagging.

Straits Tin Report

100% tinplating of silicon diodes meets rigid military specifications for resistance to corrosive salt spray and provides optimum solderability of these hermetically sealed units, according to one manufacturer. In addition, tinplating protects against adverse environmental conditions, including corrosion resulting from excessive humidity.

Photo courtesy International Rectifier

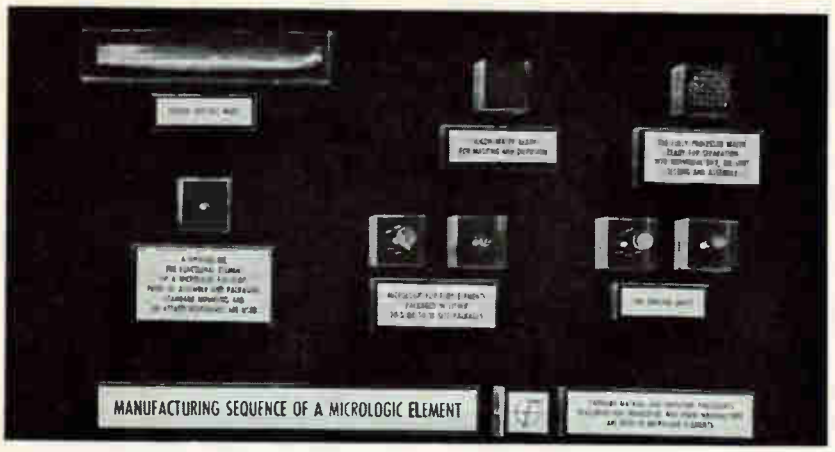
Another capacitor maker recommends consideration of hot-dip tinning, plus centrifugal spinning. This method provides a fine solderability base and increased corrosion resistance. It also affords longer shelf life in storage.

Solder clad miniature base tab stampings can speed transistor production. Each replaces two components used to make ohmic junctions to germanium or silicon transistor triodes. They consist of a layer of high purity solder alloys metallurgically bonded to a base tab conductor such as Kovar, nickel or nickel-iron. Solder and base ratio is 6:1.

Free Bulletin
Write today for a free subscription to TIN NEWS—a monthly bulletin on tin supply, prices and new uses.

The Malayan Tin Bureau
Dept. T-64C, 2000 K Street, N.W., Washington 6, D.C.

New On The Market



Integrated Circuits
SIZE AND COST REDUCTION

INTEGRATED microminiature circuits that should lead to reductions in both size and cost of solid-state digital computers are announced by Fairchild Semiconductor Corp., 545 Whisman Rd., Mountain View, Calif.

Micrologic elements may allow 90-percent reduction in the size and 70-percent reduction in cost of the logic section of a computer.

The first device, a flip-flop, is now available. Five other devices in the family—gate, half-shift register, buffer, half adder, and counter adapter—will be made available during 1961. Together, the six elements can be used to build the complete logic or arithmetic section of the computer.

Introductory price of the flip-flop is $120, but this will be reduced as production increases.

The flip-flop is made by diffusing the transistors and resistors for many units into a single slab of silicon. Metallic intraconnections are then deposited and the slab is cut into the individual micrologic elements. These elements are then mounted in a JEDEC TO-5 or TO-18 size package with eight-leads.

Operation is at bit rates in excess of 1 Mc; average power dissipation is 30 mw; temperature range is −55 to 125 C.

CIRCLE 301 ON READER SERVICE CARD

Seven Nuvistor Triodes
AND ONE TETRODE

DEVELOPMENTAL nuvistor types, now available on a sampling basis from RCA Electron Tube Div., Harrison, N. J., are: A-15211, double-ended triode for r-f amplifier service through 1,200 Mc; A-15239C, triode for uhf tv; A-15253, industrial triode with mu of 100; A-15259, industrial triode with mu of 170 for applications requiring low grid current; A-15247-A, low-mu industrial triode for 12 to 28 volt plate supply; A-15212, flexible-lead version of the RCA-7586 nuvistor triode; A-15218A, low-noise triode with mu of 205; A-2659, tetrode.

These last two types were specially designed for miniature sonobuoys for antisubmarine warfare. They have a special heater that operates over a wide range of voltages.

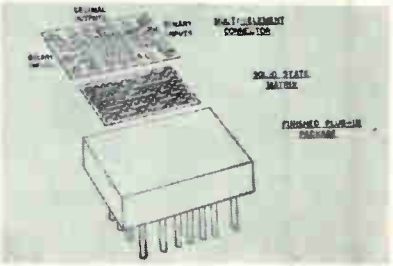
CIRCLE 302 ON READER SERVICE CARD

250-Watt Zener
6 TO 30 VOLTS

A 250-WATT silicon zener diode is in pilot production at Standard Rectifier Corp., Santa Ana, Calif. The 250-watt zeners will be available in the 6 to 30-volt range, with typical dynamic impedance of the higher voltage units being 0.06 ohm, and less at the lower voltages.

Stud and flange mounting packages are available. Applications include systems surge protection, power-supply regulation and laboratory work. Sample quantities are available at $60 to $70 each.

CIRCLE 303 ON READER SERVICE CARD

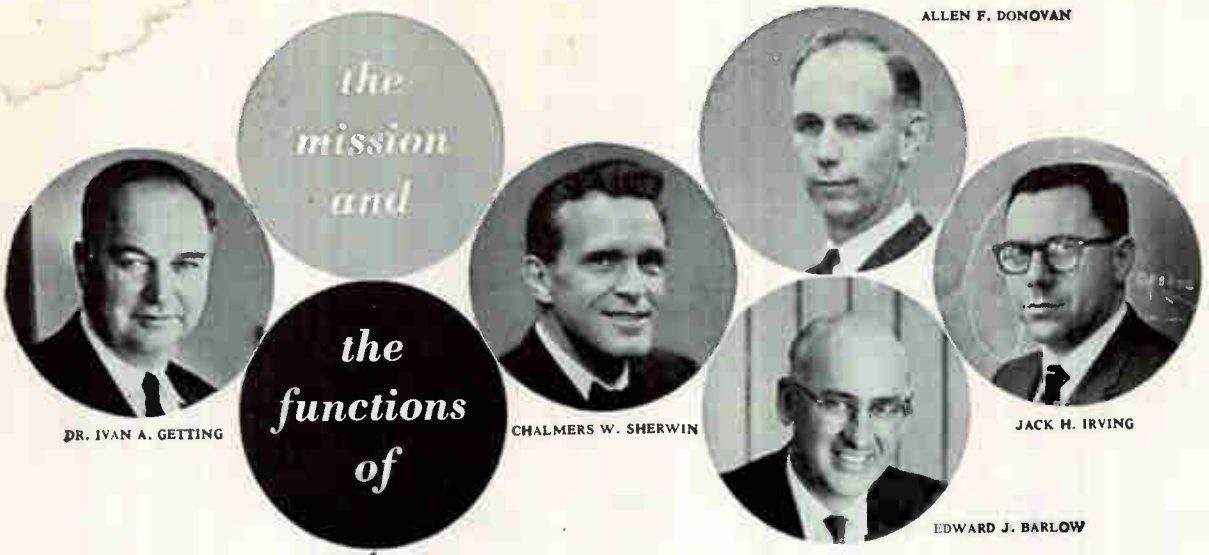


Low-Cost Modules
FOR COMPUTERS

FIRST Bipco module available is a binary coded decimal-to-decimal converter using 4-2-2-1 code. The device contains 40 silicon diodes and is designed to drive a Nixie indicator tube directly from binary coded decimal inputs.

Typical specifications for the individual diodes are: minimum forward current at 1 v = 10 ma; maximum inverse current at 100 volts and 25 C = 5 microamp; peak inverse voltage = 200 volts. Units are available from the Burroughs Corporation, Electronic Tube Division, Plainfield, New Jersey, at $45 in small quantities.

In the manufacture of a diode module, a single silicon wafer is diffused to form a large planar



AEROSPACE CORPORATION

present genuine challenge to scientists and engineers of demonstrated competence

"To preserve our free institutions, it is absolutely essential that the United States find the most effective means of advancing the science and technology of space and also of applying them to military space systems. This is the mission of Aerospace Corporation."

IVAN A. GETTING
PRESIDENT
AEROSPACE CORPORATION

In accomplishing its mission, this nonprofit public service organization performs the unique role of space systems architect. Aerospace Corporation provides scientific and technical leadership to the science/industry team responsible for developing complete space and ballistic missile systems on behalf of the United States Air Force.

Specific responsibilities of the new corporation include advanced systems analysis, research and experimentation, initial systems engineering, and general technical supervision of new systems through their critical phases.

The broad charter of Aerospace Corporation offers its scientists and engineers more than the usual scope for creative expression and significant achievement, within a stimulating atmosphere of dedication to the public interest.

Aerospace Corporation scientists and engineers are already engaged in a wide variety of specific systems projects and forward research programs, under the leadership of scientist/administrators including corporation president Dr. Ivan A. Getting, senior vice president Allen F. Donovan, and vice presidents Edward J. Barlow, William W. Drake, Jr., Jack H. Irving, and Chalmers W. Sherwin.

Aerospace Corporation is currently seeking scientists and engineers capable of meeting genuine challenge and with proven ability as:

- SENIOR ELECTRONICS ENGINEERS
  - Communications systems
  - Guidance electronics
  - Data processing systems
  - Radio techniques
  - Electromechanical design
  - Information theory
  - Sensing systems
- SPACE VEHICLE SPECALISTS:
  - Senior power systems engineer
  - Sr. flight performance analyst
  - Re-entry aerodynamicist

Those qualified and experienced in these and related fields are urged to direct their resumes to:

Mr. James M. Benning, Room 110
P.O. Box 95081, Los Angeles 45, Calif.

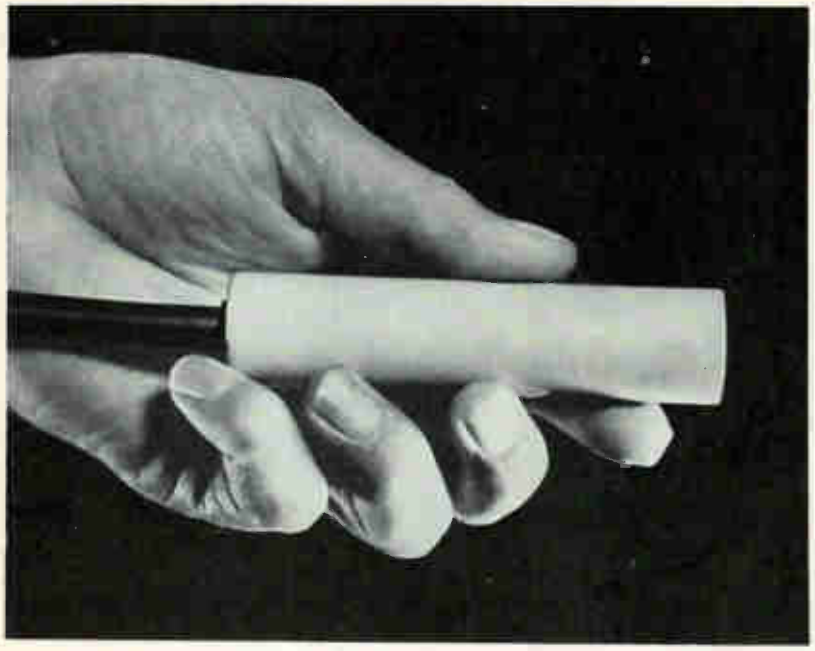
A new and vital force

AEROSPACE CORPORATION

engaged in accelerating the advancement of space science and technology

diode. From this wafer, elements are fabricated simultaneously in a pattern. The array is joined to a circuit plate that provides input and output connections.

CIRCLE 304 ON READER SERVICE CARD



Fiber Optic Cathode-Ray Tube

ALLOWS HIGH-SPEED FILM READOUT

MINIATURE precision crt has for its face a precision array of fiber light pipes. Individual light pipes are coated on the vacuum side with phosphor, are excited from an electron gun in the tube. Digital deflection voltages can generate a digital code on the face of the crt.

The recording film or light-sensitive material can be placed adjacent to the face of the crt, without using supplementary optical systems. Code matrix of the EID11 Tube is 32 elements by 32 elements, providing 1,024 bits of information. The tube is a magnetically shielded, complete crt using low-voltage acceleration, low-voltage electrostatic focus and deflection.

The tube is available from Display Devices Dept., Litton Industries, 960 Industrial Road, San Carlos, Calif.

CIRCLE 305 ON READER SERVICE CARD

PNPN Photocell

360 MA LOAD AT 200 V

THE Photran is a highly efficient light-actuated *pnpn* silicon switch, having over 10 megohms resistance when off and under 10 ohms resistance when triggered on by light. Output is determined primarily by the load and is independent of light input at all intensities above the triggering level.

With a diameter of 0.185, and 0.2 inch long, the photocell can deliver up to 300 ma at up to 200 volts, with an efficiency exceeding 98 percent. The output is high enough to

allow direct actuation of a load without intermediate relays or amplifiers.

Applications include counting, sorting, power control, limit switching, programming and optical logic control. The photocell is available from Solid State Products, Inc., 1 Pingree St., Salem, Mass.

CIRCLE 306 ON READER SERVICE CARD

Four New Compactrons

TOTAL NOW 6 TYPES

FOUR new Compactron multifunction tubes are now available from General Electric Receiving Tube Dept., Owensboro, Ky.

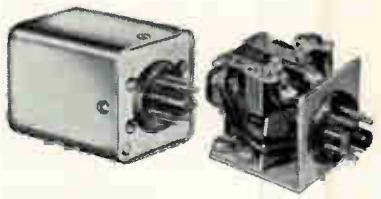
The 6FJ7 is designed for use as a combined vertical-deflection oscillator and amplifier in television receivers.

The 6B10 functions similarly to the 6CG7 conventional receiving tube, plus two selenium diodes. Two high-mu triodes and a medium-mu triode are contained in the 6K11, with characteristics similar to 12AU7 and 12AX7 receiving tubes. The tube has separate pin connections for all three cathodes, grids and plates.

The 6AX3 operates similarly to the 6AX4GTB conventional receiving tube.

Two types were registered previously: the 6C10 is designed for use where high voltage-gain is required; the 6D10 is for oscillator mixer, grounded-grid amplifier, and automatic frequency control service.

CIRCLE 307 ON READER SERVICE CARD



Plug-In Base Relays

COMPACT AND LIGHT

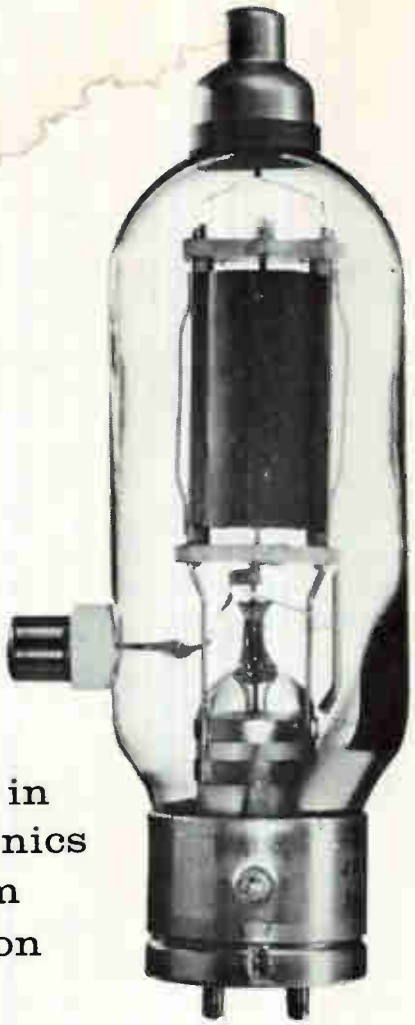
OHMITE MFG. CO., 3631 Howard St., Skokie, Ill., has available two plug-in relays with popular (115 v a-c) coil rating. The dpdt contacts are each rated at 15 amperes. Model DOSEPX-5T is enclosed in a dustproof, drawn aluminum cover. The DOSPX-1T is unenclosed. Plugs on both models are standard octal types which fit standard octal v-t sockets.

CIRCLE 308 ON READER SERVICE CARD

High-Speed Transistors

GOLD-DOPING TECHNIQUE

GERMANIUM *pnp* transistor PADT-40 has an average total switching time of 135 nsec and a minimum time of 80 nsec, measured in a con-



Ideas in Electronics from Norton

The electronics industry became a giant before it became a baby.

This outstanding growth has been largely due to the development of new materials — *refractory* materials with a great range of electrical properties. The prime source of these *idea refractories* is Norton Company.

For example, refractory fused alumina has high constant resistivity, to assure minimum leakage between elements in TV, radio and radar tubes. The same material is a recent innovation for transistor potting. Norton silicon carbide is an essential component in lightning arrestors and other non-linear resistors because of its variable voltage-current relationship. Silicon carbide is also finding new uses in microwave absorption, and as single crystals in high temperature rectifiers and transistors.

Fused magnesium oxide, used in most heating elements for electric ranges, has gained acceptance in such areas as advanced thermocouple design and infrared transmission.

Norton offers a wide choice of super-refined refractories, including oxides, borides, nitrides and carbides, and is ready to work with you in engineering materials to meet your needs. But above all, Norton offers ideas in every field in which refractory materials play a part.

Write NORTON COMPANY, Refractories Division, 682 New Bond Street, Worcester, Massachusetts.

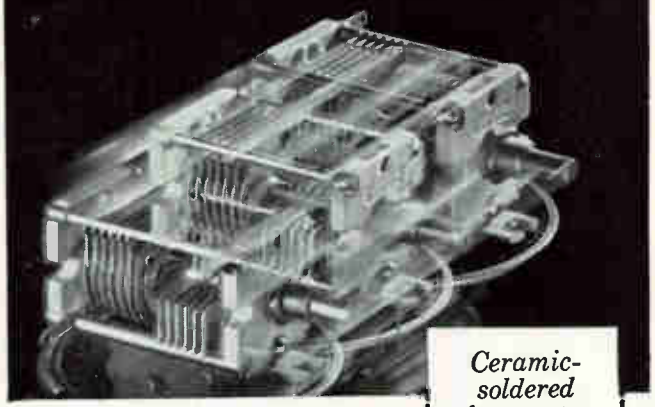
NORTON

REFRACTORIES

Crystallizing ideas into products

CIRCLE 204 ON READER SERVICE CARD

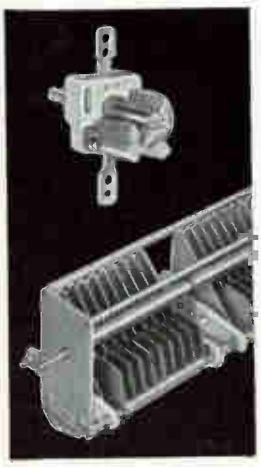
THESE RUGGED JOHNSON VARIABLES WITHSTAND TERRIFIC VIBRATION and SHOCK!



Parts can't break loose... capacity can't fluctuate!

Set your frequency... these tough Johnson "L" variables will hold it—even under severe conditions of shock and vibration! Designed to provide outstanding strength, rigidity and operating stability —rotor bearings and stator support rods are actually soldered directly to the heavy 3/16" thick steatite ceramic end frames. Parts can't break loose . . . capacity can't fluctuate!

Specially designed split-sleeve tension bearing and silver-plated beryllium copper contact provide constant torque and smooth capacity variation. Plating is heavy nickel —plate spacing .020", .060" and .080" spacing as well as special platings, shaft lengths and terminal locations in production quantities.



A complete variable capacitor line . . . from tiny sub-miniatures to large heavy duty types!

From the tiny Type "U" sub-miniature, which requires less than 0.2 sq. in. for chassis or panel mounting—to the rugged heavy-duty "C" and "D" types . . . the Johnson variable capacitor line is designed for more capacity in less space—offers you one of the widest standard capacitor lines in the industry! For detailed specifications on all Johnson variable capacitors, write for your free copy of our newest components catalog, described below.

New Catalog

Write today for our newest electronic components catalog—complete specifications, engineering prints and current prices on:

• CAPACITORS • TUBE SOCKETS • CONNECTORS • PILOT LIGHTS
• INSULATORS • KNOBS, DIALS • INDUCTORS • HARDWARE

E. F. JOHNSON CO.

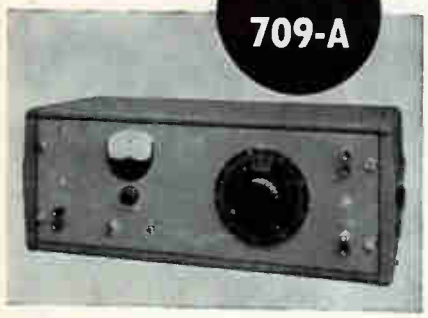
2014 Tenth Avenue S.W. • Waseca, Minnesota

CIRCLE 79 ON READER SERVICE CARD

TIC OF ACTON

BROADBAND SECONDARY PHASE STANDARD

TYPE 709-A



FEATURES . . .

- **Phase Angle Continuously Variable from 0° to 360°**
- **20 cps to 20 kc Range of Operation**
- **Good Inherent Stability**
- **Quick, Easy Operation with a Minimum Number of Controls**

DESCRIPTION . . .

Type 709-A, when supplied by an external sinewave oscillator supplies two sinusoidal voltage signals whose phase relationship can be varied smoothly from 0° to 360°. The frequency of the external oscillator can be 20 cps to 20 kc. The type 709-A is used to calibrate phase meters and other phase measuring instruments that operate at audio frequencies.

SPECIFICATIONS . . .

Frequency Range: 20 cps to 20 kc
Accuracy of Phase Angle:
± 1° from 20 cps to 10 kc
± 3° from 10 kc to 20 kc
Output Voltage Range: 0.5 to 5 volts (rms)
Output Impedance: Low (from cathode follower)
Power Supply: 105-125 volts, 50-60 cycle electronic-regulated, self-contained supply requiring approximately 100 watts

For full details on specifications, wire or call . . .

TECHNOLOGY INSTRUMENT CORP. OF ACTON

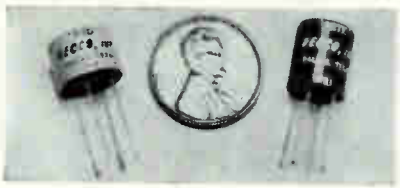
TIC OF ACTON FORMERLY ACTON LABORATORIES, INC.

533 MAIN STREET, ACTON, MASS.

servative current driven saturated switching circuit. In voltage driven saturated switching circuits, typical total switching times of 9 nsec are readily obtainable.

The PADT-40 has a thin, deeply diffused base region and a collector region gold-doped for low stored charge. The deep diffused thin base makes the electrical properties dependent on the bulk properties of the transistor and not on surface effects. Current gain and switching time are relatively independent of temperature. The transistor is available from Amperex Electronic Corp., Semiconductor and Special Purpose Tube Division, 230 Duffy Avenue, Hicksville, L. I., N. Y.; price is approximately $2.50.

CIRCLE 309 ON READER SERVICE CARD



Transformers
SPACE-SAVING

DECCO, INC., 2025 Farrington, Dallas 7, Texas. The Buds and Mites are miniaturized transistor transformers. Units are encased in drawn steel cans with nickel alloy leads on standard 0.1 in. spacings for rapid p-c board mounting. The Bud configuration is only $\frac{5}{16}$ in. high and the Mite unit is $\frac{3}{4}$ in. diameter. A total of 42 designs can be supplied as standard units.

CIRCLE 310 ON READER SERVICE CARD

Silicon Transistor

CRYSTALONICS, INC., 249 Fifth St., Cambridge, Mass. The field-effect transistor is a three terminal amplifying device with very high input and output impedances.

CIRCLE 311 ON READER SERVICE CARD

Thermistor Beads
REFLECTIVE TYPE

VICTORY ENGINEERING CORP., 524 Springfield Road, Union, N. J. Bead thermistors when coated with a highly lustrous metallic finish, enable customers to obtain absolute temperature values instead of average temperatures due to infrared or other heat sources. The metallic finish is a highly polished reflector that protects the thermistor bead from radiation. There is no loss of sensitivity or electrical characteristics.

CIRCLE 312 ON READER SERVICE CARD

Frequency Meter
AND DISCRIMINATOR

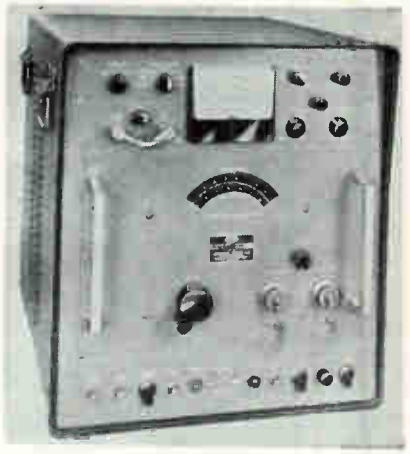
GENERAL RADIO CO., West Concord, Mass. Type 1142-A frequency meter and discriminator has a frequency range of 3 cps to 1.5 Mc; accuracy, ± 0.2 percent; readings independent of input waveform. Interpolator feature permits readings to 3 significant figures; linear pulse-count discriminator for deviation and incidental f-m measurements; residual f-m more than 100 db below full output; output for recorder. Price is $495.

CIRCLE 313 ON READER SERVICE CARD

Lamp Adapter

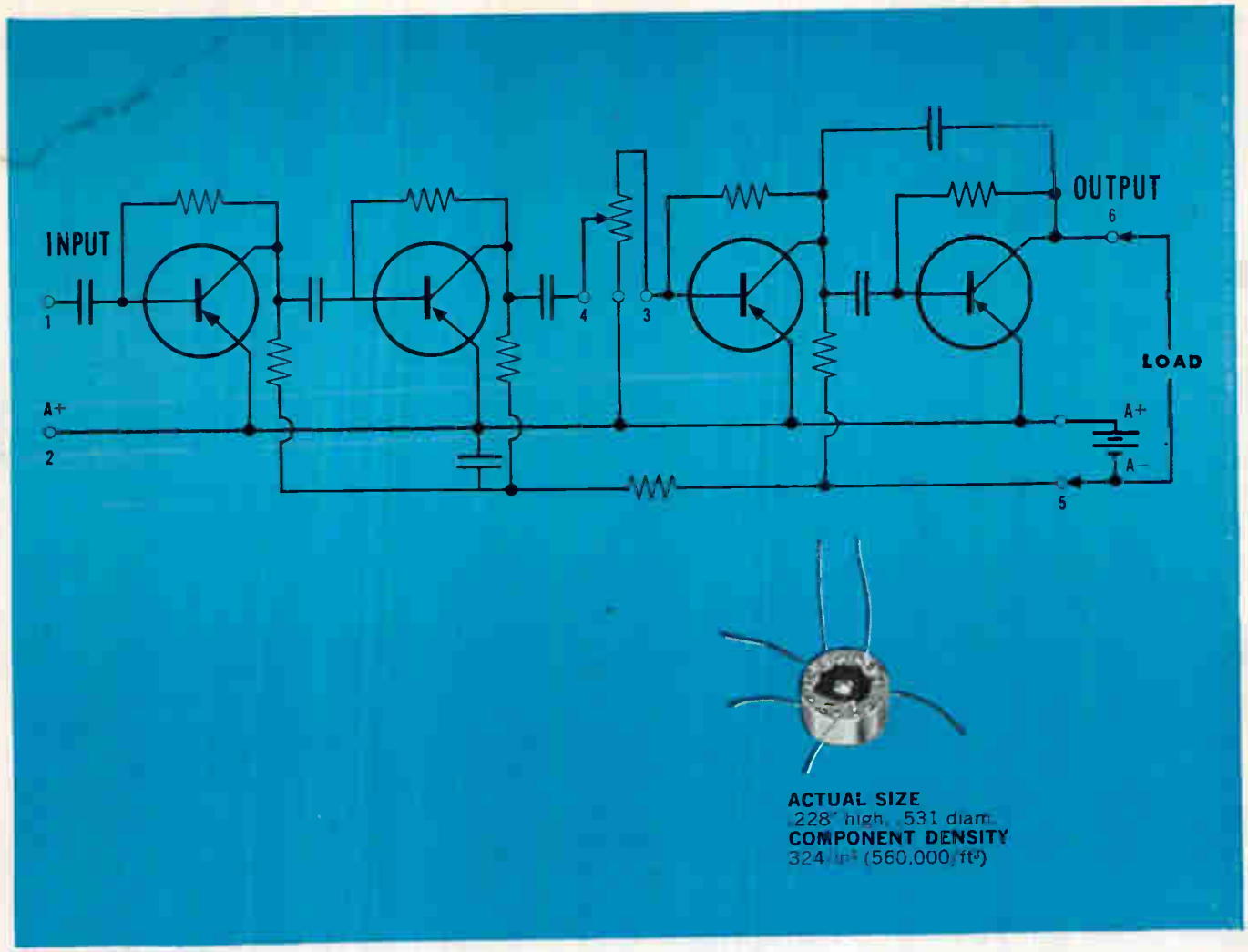
INDUSTRIAL ELECTRONIC ENGINEERS, INC., 5528 Vineland Ave., North Hollywood, Calif. Lamp adapter holds T-1 ultraminiature incandescent lamps and fits any standard miniature bayonet base socket.

CIRCLE 314 ON READER SERVICE CARD



R-F Tuning Unit
PLUG-IN

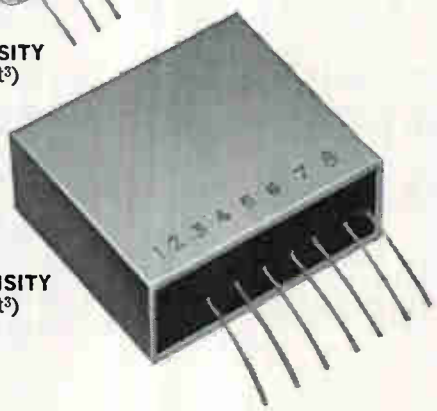
POLARAD ELECTRONICS CORP., 43-20 34th St., Long Island City 1, N. Y., has developed a plug-in tuning unit for use with its microwave receiver model R. Model RE-T's frequency range is 45,300 Mc to 84,200 Mc



ACTUAL SIZE
.228" high, .531 diam.
COMPONENT DENSITY
324 in³ (560,000/ft³)

PEC* miniaturized transistor amplifiers are production units at Centralab

1⅛" x ⅝" x ¼"
COMPONENT DENSITY
120/in³ (208,000/ft³)



1 7/16" x 1⅛" x 19/32"
COMPONENT DENSITY
19.8/in³ (34,200/ft³)

*trade mark

Laboratory curiosities? Absolutely not! These miniature amplifiers are available NOW as standard production units, at realistic prices.

Use them confidently in dozens of applications, in audio, instrumentation, and specialty products. They permit practical circuit miniaturization in your current projects, thanks to the CENTRALAB PEC technique that achieves component densities as high as 2,500,000 per cubic foot.

These units range in output from 0.5 mw. to 3 mw., and can be supplied with frequency curves to meet your specific requirements. For detailed specifications and application information, write to CENTRALAB and request Technical Bulletin 42-1018.

Centralab®

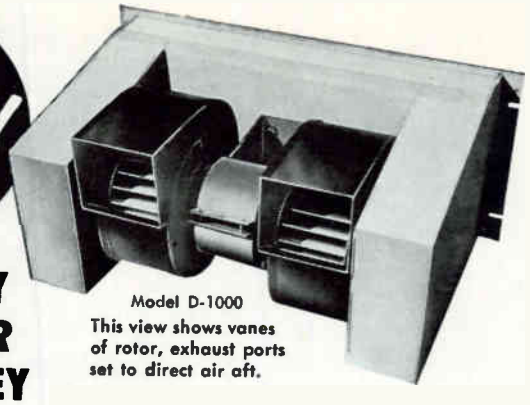
THE ELECTRONICS DIVISION OF GLOBE-UNION, INC.
914C E. KEEFE AVENUE • MILWAUKEE 1, WISCONSIN
CENTRALAB CANADA LTD. • AJAX, ONTARIO

Y-6123

ELECTRONIC SWITCHES • VARIABLE RESISTORS • CERAMIC CAPACITORS • PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS

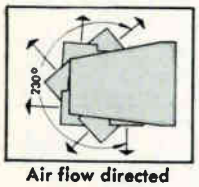
CIRCLE 83 ON READER SERVICE CARD 83

New!

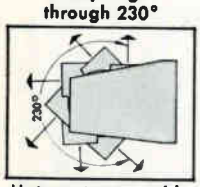


Model D-1000
This view shows vanes of rotor, exhaust ports set to direct air aft.

A REVOLUTIONARY *ALL-ANGLE* BLOWER TO SAVE YOU MONEY



Air flow directed at any angle through 230°



Motor-rotor assembly turned end-for-end gives this pattern

These remarkable new MIL quality *All-angle* blowers will not only do your cooling jobs more efficiently by more accurately directing air to your exact needs, but their inherent versatility can eliminate purchase of special blowers for many of your applications.

You can rotate their twin scrolls to the angle of your choice through 230°—or, by simply reversing the motor-rotor assembly end-for-end in its housing, create a new and equally diverse air flow pattern.

• Assured 400 CFM output • Mounts as 8¾" x 19" standard EIA rack panel—14" max. depth • MIL quality heavy duty construction and finish—or finish to Customer specs • Easy maintenance without removal from cabinet • Interference-free operation per MIL-I-16910A • Cushion mounted for quiet operation • Sealed ball bearings for long life • Cleanable filter—disposable available.

Ask for complete data—our Bulletin D-1000 ORegon 8-7827

ONE SOURCE . . . for VENTILATED RELAY RACK CABINETS, CONTROL CONSOLES, BLOWERS, CHASSIS, CHASSIS-TRAK, RELATED COMPONENTS

WESTERN DEVICES, INC.
600 W. FLORENCE AVE., INGLEWOOD 1, CALIF.

CIRCLE 201 ON READER SERVICE CARD

Send for **FREE** **New 1961 EICO Electronics Catalog**

EICO, 3300 N. Blvd., L.I.C. 1, N. Y. E-3C
☐ Send free 32-page catalog & dealer's name
☐ Send new 36-page **Guidebook to HI-FI** for which I enclose 25¢ for postage & handling.
Name .....
Address .....
City ..... Zone .... State .....

EICO® 3300 N. Blvd., L.I.C. 1, N.Y.
. . . praised by the experts as BEST BUYS IN ELECTRONICS

CIRCLE 84 ON READER SERVICE CARD

MODEL **4005** *with* AMBITROL V-I

CONSTANT VOLTAGE
CONSTANT CURRENT
with
PROGRAMMABLE CROSSOVER

$143.50 F.O.B. FACTORY

Other Models Available Write For Catalog

*TM

Model 4005 is a 1-40 volt, 500 ma, regulated DC power supply incorporating AMBITROL.* The AMBITROL* circuit will switch *automatically* to either voltage regulation or current regulation at any point predetermined by the operator, with continuous control of voltage or current to .05%.

Power Designs inc.
1700 SHAMES DRIVE
WESTBURY, NEW YORK
EDgewood 3-6200 (LD Area Code 516)

CIRCLE 202 ON READER SERVICE CARD

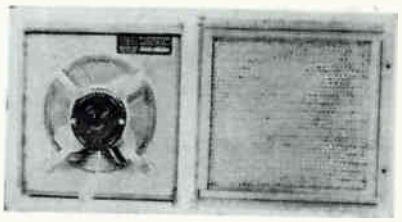
having a sensitivity between −50 dbm to −65 dbm. The tuning head enables the receiver to be used from 400 Mc to 84,200 Mc. Front panel Unidial automatically tracks local oscillator and a linear frequency-dial achieving ±1 percent frequency dial accuracy.

CIRCLE 315 ON READER SERVICE CARD

Crystal Filter

ELECTRONIC LABORATORIES CORP., 4221 Spencer St., Torrance, Calif. Features a 2.0 cps bandwidth at 100 Kc center frequency. The filter is housed in an oven thermostatically controlled to maintain 135 C.

CIRCLE 316 ON READER SERVICE CARD



Panel-Mounted Fan
FOR RACK EXTERIORS

MCLEAN ENGINEERING LABORATORIES, P.O. Box 228, Princeton, N. J. Model 1PB65W is a panel-mounted fan for installation on the outside of electronic racks. It is designed to pressurize the cabinet with air filtered through a permanent, washable-type filter. Unit uses a minimum of cabinet area. The filter may be serviced without removing the fan mounting bolts. It moves 295 cfm, and is equipped with a ball bearing motor which meets CC-M-636A specs.

CIRCLE 317 ON READER SERVICE CARD

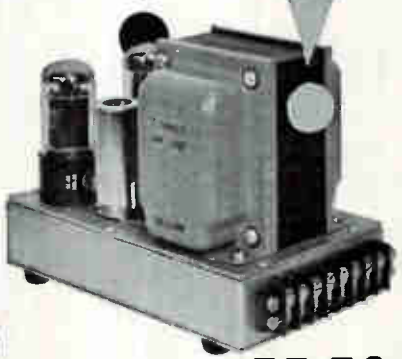
Power Source
FOR TUNNEL DIODES

ELECTRONIC RESEARCH ASSOCIATES, INC., Cedar Grove, N. J. Model TD6M is intended for both lab and factory powering of tunnel diodes or similar devices which require

POWER SUPPLIES

VALUE

QUALITY



RS305A

@ $55.50

For original use . . . For incorporation into laboratory equipment . . . In 55- to 400-cycle systems. The Trans Electronics Model RS305A Power Supply provides voltage regulation of .05% load and .05% line over the entire 225- to 325-volt range. Operating current range 0-50 ma, continuous duty, with filament output of 6.3 volts CT AC @ 3 amps. Units feature low ripple and noise (5 mv peak to peak); fast recovery time (25 to 50 microseconds). Three versions of Model RS305A offer, respectively, modular construction in package 5 x 4⅛ x 6½ inches; rack-mounting; and rack-mounted models with 3¼-inch meters, in case with 3½-inch panel height. Input is 105-125 volts AC.

SPECIFICATIONS

model*	voltage range	current ma	filament volts/amps	price
RS-110 RR-110 RM-110	0-100	6-100	6.3/3	$108.00 133.00 169.00
RS-205 RR-205 RM-205	150-225	0-50	6.3/3	55.50 80.00 115.00
RS-217A RR-217A RM-217A	150-225	0-175	6.3/8	87.50 112.50 147.50
RS-305 RR-305 RM-305	225-325	0-50	6.3/3	55.50 80.00 115.00
RS-317 RR-317 RM-317	225-325	0-175	6.3/8	87.50 112.50 147.50
RR-450 RM-450 DUAL TRACKING	+300-400 —300-400	0-50	6.3/2 6.3/1.5 6.3/1.5	155.50 196.00
RR-473 RM-473 DUAL TRACKING	+300-400 —300-400	0-25	6.3/2 6.3/1.5 6.3/1.5	140.00 175.00
RS-505 RR-505 RM-505	300-5002	0-50	6.3/3	81.50 106.50 141.50
RR-303 RS-303	0-300 0-300	0-500 0-500	6.3/15 6.3/15	320.00 360.00
RR-550 RM-550	300-500 300-500	0-500 0-500	6.3/15 6.3/15	310.00 350.00

TRANS ELECTRONICS, Inc.

7349 Canoga Avenue, Canoga Park, California

CIRCLE 209 ON READER SERVICE CARD

from TELEMETRICS added PRECISION & FLEXIBILITY

Model 301

THE NEW SERIES 300 PULSE SIMULATORS SOLID STATE... PAM, PDM PAM/NRZ

The Telemetrics 300 Series of Solid state Electronic Signal Simulators offers a selection of PAM, PDM, and PAM/NRZ units with extreme flexibility for precision calibration and checkout of telemetry ground stations, data transmission systems, and data reduction equipment . . . in the field . . . in the laboratory. The four models in the series: ESS-301, with PAM, PAM/NRZ only, 8-channel subcommutation; ESS-302, with all the PAM features except subcommutation; ESS-303, with PAM, PAM/NRZ, PDM, subcommutation; ESS-304 with PDM only, and subcommutation. In all models, "pre-programmable" patch panels provide complete flexibility to create any form of signal output within the unit's design limits. Standard plug-in digital logic units simplify maintenance. Standard rack mounting; 7" front panel height.

SPECIFICATIONS, ESS-301

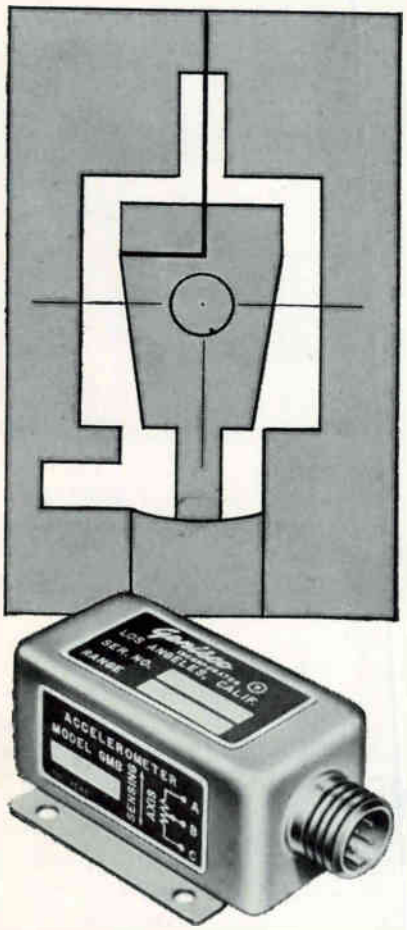
INPUT	115v, 3 amp
OUTPUT	0 to +10v variable 0 to —10v variable 0 to +1v fixed
BASE LINE	Reference level: 0 Adjustable —2v to +2v
MASTER PULSE	IRIG Standard 2 or 3 full scale or absence of 2 pulses.
CALIBRATION	Switchable in steps of 0, 50%, 100% Continuously variable 0 to 100%
OUTPUT WAVE TRAIN	PAM, PAM/NRZ, optional PDM
FRAME LENGTH	Any number of pulses, up to 1054 channels per frame by patching
SUBCOMMUTATOR	8 Channels
RATES	10 pps to 60,000 pps
ACCURACY	Selectable information accurate within ±.15% full scale.

Telemetrics, Inc.

12927 SOUTH BUDLONG AVENUE, GARDENA, CALIFORNIA

CIRCLE 85 ON READER SERVICE CARD

SELECTIVE
Gas-Damped
SENSITIVITY



GENISCO
GMB SERIES
ACCELEROMETERS
for airborne applications

- CONSTANT DAMPING
- POTENTIOMETER PICKOFF OR SWITCH CONTACTS

Genisco's GMB Series Accelerometers feature the advantages of gas damping which remains constant over wide temperature ranges for extreme accuracy and consistency. These units are ruggedly designed and constructed to operate reliably under conditions of high vibration and shock. The GMB Series Accelerometers are hermetically sealed units, available with either precision potentiometer pickoff or switch contacts . . . Standard or custom models.

Genisco
INCORPORATED
2233 Federal Ave., Los Angeles 64, California

highly stable d-c power at very low voltages. Unit provides an adjustable output over the range 0-6 v d-c. Current rating is 0-100 ma. Internal impedance is less than 0.01 ohm at d-c, lower at higher frequencies. Ripple is less than 1 mv rms.

CIRCLE 318 ON READER SERVICE CARD

Communication Tower
SELF-SUPPORTING

ROHN MFG. CO., Box 200, Peoria, Ill., announces a 170-ft self-supporting communication tower. Addition of 3 heavy duty 20 ft sections to the basic self-supporting Rohn design gives the extra height and support needed to increase the rating so it can be used for bigger and heavier jobs.

CIRCLE 319 ON READER SERVICE CARD

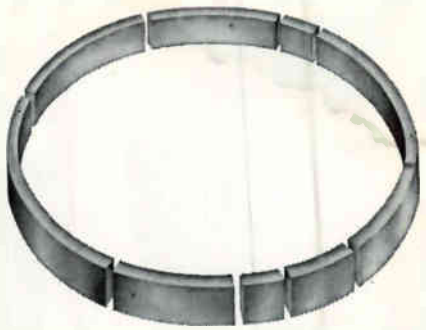
Solder

ALPHA METALS, INC., 56 Water St., Jersey City 4, N. J. For printed circuit boards and semiconductor devices, Alpha AAA solder reduces inherent inclusions, produces oxide-free connections, and minimizes drossing.

CIRCLE 320 ON READER SERVICE CARD

Transistor Tester
TIME SAVING UNIT

SIERRA ELECTRONIC DIVISION, Philco Corp., 3885 Bohannon Drive, Menlo Park, Calif. Model 219B provides convenient measurement of the transistor beta parameter while the transistor remains in the circuit. Betas from 1 to 120 are measured in four overlapping ranges. With



There's really not much to custom-designing rotary switches...

It's a matter of routine . . . when you have talented engineers with lots of experience... first quality materials... and advanced manufacturing techniques.

Fortunately, The Gamewell Company has all three. When customers' specifications come in, our engineers get busy. The precious metal ring, heart of a Gamewell Rotary Switch, is designed with as many segments as required. Brushes are provided which assure smooth, trouble-free action with either MAKE-BEFORE-BREAK or BREAK-BEFORE-MAKE contacts. Then a highly versatile arrangement of terminals connecting to ring segments is devised for the periphery of the switch housing. And so on, depending on requirements.

The end result is a highly versatile, reliable switching component. Cased in special plastic, it's inherently fungus resistant and stable at high temperatures. It can be used with confidence over a wide range of environmental conditions.

Gamewell is well qualified to design rotary switches for circuit sampling, programming, digital generators and various electronic data processing systems. *Your* specs will receive prompt attention.

Write to THE GAMEWELL COMPANY, 1385 Chestnut Street, Newton Upper Falls 64, Massachusetts. *A Subsidiary of E. W. Bliss Company.*

The Gamewell SG-270 Switch is available with diameters of ⅝", 1¼", 1⅝", 2", 3" and 5" in various mounting styles.

BLISS Gamewell®
PRECISION POTENTIOMETERS
"INTEGRALS OF HIGH PERFORMANCE"

CIRCLE 206 ON READER SERVICE CARD

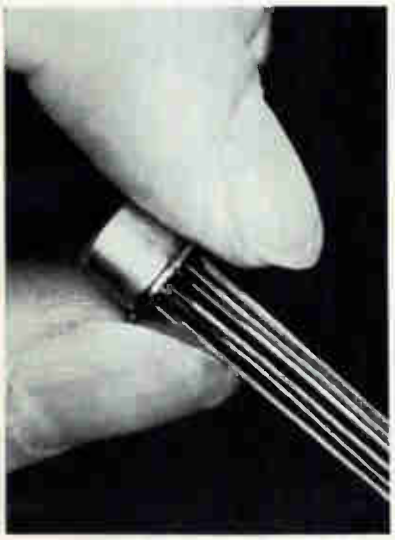
the transistor removed, model 219B not only reads beta but also indicates leakage current (I_{co}) in two ranges: 0-50 and 0-500 μa.

CIRCLE 321 ON READER SERVICE CARD

Switching Transistor

SYLVANIA ELECTRIC PRODUCTS INC., 730 Third Ave., New York 17, N. Y. Silicon switching transistor has a total switching time of 46 nsec in a 2N706A test circuit with standard conditions.

CIRCLE 322 ON READER SERVICE CARD



Logic Circuits

IN TO-5 CASE

COMPUTER NOR logic circuit with three diodes, RC coupling network, transistor and two resistors in a package no larger than TO-5 size transistor is announced by Semiconductor Div., Raytheon Co., 215 First Ave., Needham, Mass.

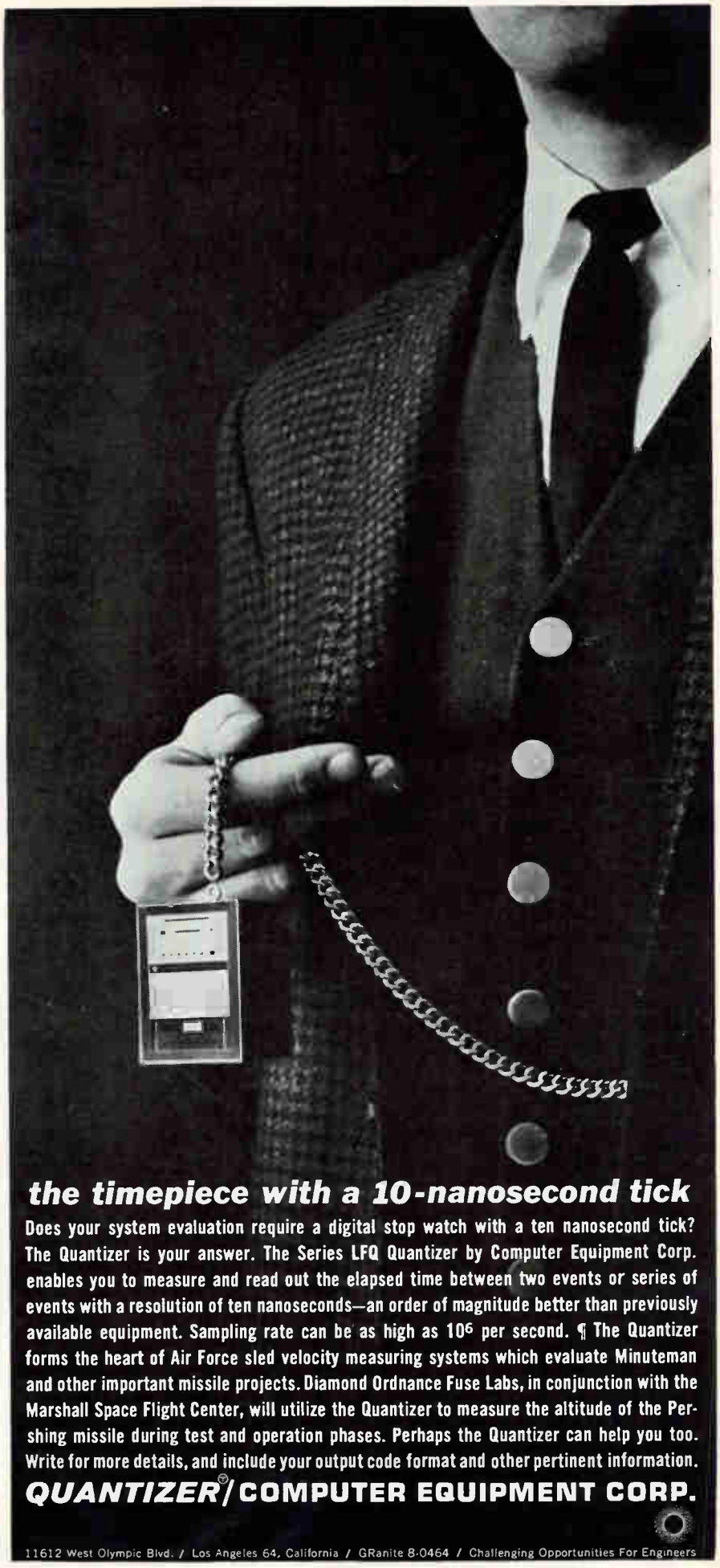
The NOR logic unit is a basic building block for computer logic systems that require a minimum number of interconnections and small, compact circuits. The integration of functions and the use of silicon semiconductor material provides increased reliability.

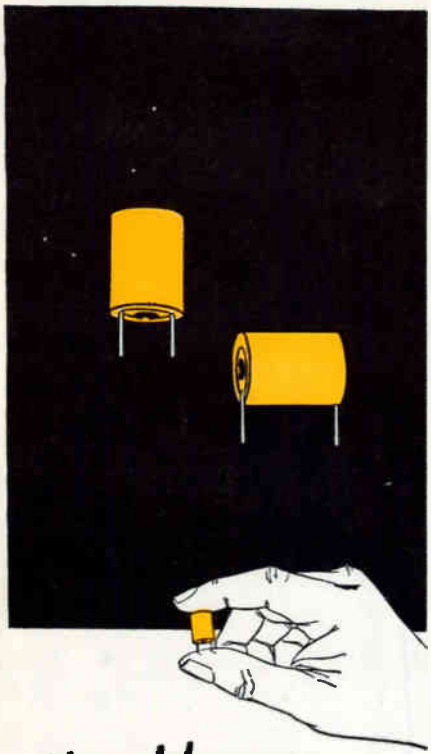
CIRCLE 323 ON READER SERVICE CARD

Relays

LEACH CORP., Controls Div., Azusa, Calif. Two microminiature relays, a solid state time delay and an MS-approved rotary crystal can, are available.

CIRCLE 324 ON READER SERVICE CARD





New Miniature

VARIABLE INDUCTOR

FOR VERTICAL OR HORIZONTAL MOUNTING IN PRINTED CIRCUIT BOARDS

This new, ultra tiny Variable Inductor, with amazing subminiature characteristics, has stable inductance at extreme temperature variations and high reliability, along with light-weight and miniature size features.

- **INDUCTANCE RANGE:** 0.10 to 4700 μH
- **INDUCTANCE ADJUSTABLE:** ±20%
- **ENVIRONMENTAL:** Encapsulated in epoxy resin for protection against climatic and mechanical conditions.

WRITE TODAY
Free Descriptive Literature Available

ESSEX ELECTRONICS
DIVISION OF
NYTRONICS, INC.
150 Springfield Ave., Berkeley Heights, N. J.
CRestview 3-9300

CIRCLE 88 ON READER SERVICE CARD

Literature of the Week

TRANSISTOR TESTER Monitor Systems Inc., an Epsco subsidiary, Fort Washington, Pa. Bulletin describes a semiautomatic transistor tester which classifies semiconductors by specifications at speeds of 30 to 60 tests per second.
CIRCLE 325 ON READER SERVICE CARD

SWITCHES The Daven Co., Livingston, N. J. A description of the company's line of switches, both standard and special types, is available in a 48-page catalog.
CIRCLE 326 ON READER SERVICE CARD

GERMANIUM DIODES Hughes Aircraft Co., Semiconductor Div., Newport Beach, Calif., has published a single data sheet which graphically records the typical characteristics of nanosecond germanium diodes at 25 C.
CIRCLE 327 ON READER SERVICE CARD

VIBRATORS James Electronics, Inc., 4050 North Rockwell St., Chicago 18, Ill. Specifications are given on a vibrator specifically designed for citizens band equipment.
CIRCLE 328 ON READER SERVICE CARD

MAGNETIC TAPE Sangamo Electric Co., Springfield, Ill. "A New Concept In Magnetic Tape Instrumentation," a 7-page catalog, describes the tape handling, speed control, and performance features of the company's instruments.
CIRCLE 329 ON READER SERVICE CARD

GENERATORS Tektronix, Inc., P.O. Box 500, Beaverton, Ore., has published a booklet on square-wave generators, a pulse generator and trigger takeoff, and a pretrigger pulse generator.
CIRCLE 330 ON READER SERVICE CARD

TAPE SPOOLER Electronic Engineering Co., 1601 East Chestnut Ave., Santa Ana, Calif. Automatic tape handling device is covered in a single data sheet.
CIRCLE 331 ON READER SERVICE CARD

PRECISION PRODUCTS Bowmar Instrument Corp., 8000 Bluffton Rd., Fort Wayne, Ind. Five

MICO *Precision Apparatus*

NEW HEAVY DUTY 2 & 3 DIMENSIONAL ENGRAVER

FOR
Engraving Nameplates
Fine Routing Work
Profiling Small Objects
Making Small Dies and Molds

UHF COAXIAL WAVEMETERS

2-75 Centimeter Range

Send for Illustrated Catalogs
MICO INSTRUMENT CO.
77 Trowbridge St. Cambridge 38, Mass.
CIRCLE 203 ON READER SERVICE CARD

IS YOUR ADVERTISING SELLING THE BIG 4 ?

Tough competition and smart selling demand that the electronics man be reached and *sold* wherever you find him: *Research, Design, Production, and Management.* Only **electronics** is edited to interest and influence all four key buyers. Put your advertising where it works *hardest*.....

in **electronics**

groups of precision products illustrated in the company's folder are mechanical components, counters and indicators, timing and programming devices, electromechanical devices, and servo packages.

CIRCLE 332 ON READER SERVICE CARD

AXIAL LEAD RESISTORS Ohmite Mfg. Co., 3649 Howard St., Skokie, Ill. Commercial listings of 3, 5 and 10 w vitreous-enameled, wirewound resistors with revised resistance values appear in stock catalog 30 B.

CIRCLE 333 ON READER SERVICE CARD

TRANSISTOR AMPLIFIER Centralab, the Electronics Div. of Globe-Union Inc., 900 Keefe Ave., Milwaukee 1, Wis. Bulletin gives electrical and physical specifications of TA-12-B 4-stage transistor amplifier, an ultraminiature audio amplifier.

CIRCLE 334 ON READER SERVICE CARD

NETWORK DESIGN General Resistance, Inc., 430 Southern Boulevard, New York, 55, N. Y. A design data outline form aids choice of resistor networks, according to mechanical or electrical design requirements.

CIRCLE 335 ON READER SERVICE CARD

CARD READER Uptime Corp., 175 Commerce St., Broomfield, Col. Booklet describes the Speedreader 2000 which uses a card-to-tape system to translate from 400 to 3000 cards per minute.

CIRCLE 336 ON READER SERVICE CARD

CUP CORES General Ceramics Corp., Keasbey, N. J. An engineering bulletin provides data on a ferramic cup core assembly for applications requiring temperature stability.

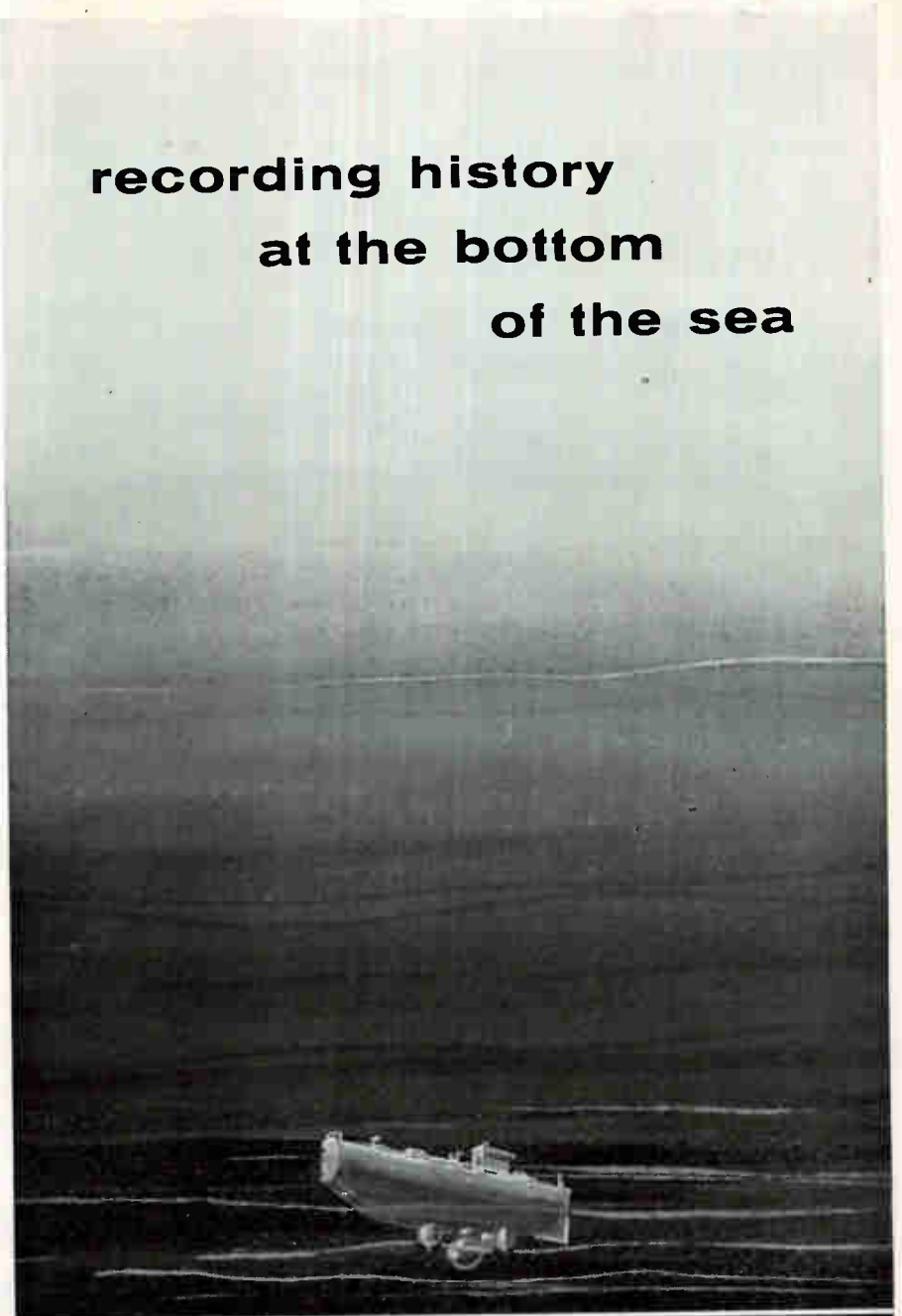
CIRCLE 337 ON READER SERVICE CARD

ENCODER TRANSLATION Harvey-Wells Electronics, Inc., 14 Huron Drive, Natick, Mass. An 8-page technical brochure on shaft encoder translation is available.

CIRCLE 338 ON READER SERVICE CARD

RESISTANCE ELEMENTS CTS Corp., Elkhart, Indiana. Data sheet gives technical information on high temperature resistance elements for modules.

CIRCLE 339 ON READER SERVICE CARD



Far below the surface, in a sealed steel ball on the *Trieste* bathyscaph, a new chapter in undersea history is being recorded—on magnetic tape. Operating in an environment of 99% relative humidity, a high-performance instrumentation tape recorder captures a permanent record of depth, temperature, ambient noise, and voice.

The recorder, Precision Model PS-207 as shown at right, was modified for the application by Lockheed Aircraft Corporation, Sunnyvale, Calif., and supplied by them to the Naval Electronics Laboratory, San Diego, for the *Trieste* installation.

For details on Precision PS-200 series analog and digital recorders for other applications, write:

PRECISION INSTRUMENT COMPANY
1011 Commercial Street • LYtell 1-4441 • San Carlos, California
Cable: PRINCO, San Carlos, California • TWX: SCAR BEL 30

Representatives in principal cities throughout the world

CIRCLE 89 ON READER SERVICE CARD

Solid State Materials Corp. Moves

TO KEEP PACE with the rapid advance of solid state technology and business demands being made upon the company, Solid State Materials Corp. of East Natick, Mass. recently moved into its new building in the East Natick Industrial Park.

The building has 3,800 sq ft of space, was constructed to house all facilities for the growing of single crystal materials for solid state electronics, and for the design, development, and construction of crystal growing equipment.

The firm is currently engaged in the research and growth of silicon, germanium, and intermetallic compounds, including arsenides, antimonides, and phosphides. Other materials produced are ferrites, garnets, ferroelectrics, and paramagnetics, including sapphires, rubies, silicates, cyanides, chlorates, ethylsulfates, and spinels.

These crystals can be grown to specific resistivities with a wide variety of doping elements, specific orientations, close mobility tolerances, and carrier concentrations. In addition, an expanding line of standard crystals has been made available for prompt delivery, the company says.

The firm is also engaged in the production of crystal growing equipment, including flame fusion, vertical pull, floating zone, and temperature gradient furnaces.

A. E. Rosenberg Joins Epsco, Incorporated

ALLEN E. ROSENBERG has been appointed operations manager for the components division of Epsco, Inc., Cambridge, Mass. He comes to Epsco from the Raytheon Co., where he was engineering manager, Circuit Pak Department.

Marchisio Assumes New Position

HERMES ELECTRONICS CO., Cambridge, Mass., has appointed Robert G. Marchisio as general manager for the Itek-Hermes Electronics Division.

Marchisio comes to Itek from CBS Electronics, where as vice president and general manager, he had full responsibility for that firm's multi-million dollar semiconductor operations, employing 1,200 persons.

McLean Engineering Adds New Wing

MCLEAN ENGINEERING LABORATORIES of Princeton, N. J., has added a new wing to its present building. Company manufactures fans and blowers for electronic ventilating and cooling applications.

The new extension adds 7,000 sq ft of production area to the 25,000 sq ft of the building which was completed six years ago. The wing will also permit expansion of the company's R&D departments and will accommodate an expanded version of the firm's air flow test chamber.

Allen Avionics Names Norman Wunderlich

ALLEN AVIONICS, INC., Mineola, N. Y., has announced the appointment of Norman E. Wunderlich as vice president and marketing director.

Associated with the electronics industry since its infancy, Wunderlich, immediately prior to this appointment, was owner of Wunderlich Radio Co., engineering consultants.

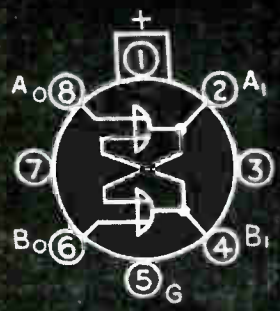
Central Electronics Appoints Adams

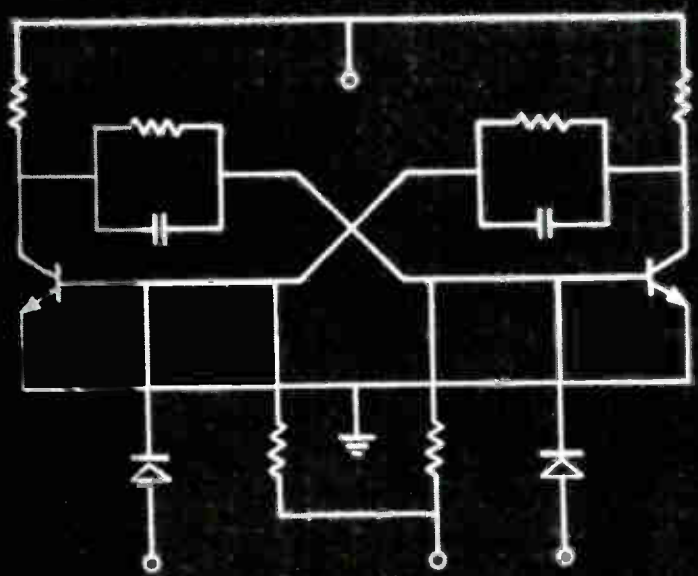
CENTRAL ELECTRONICS, INC., Chicago, Ill., a wholly-owned subsidiary of Zenith Radio Corp., announces the appointment of John H. Adams as vice president and general manager.

For a period of almost two years prior to joining Central Electronics, Adams was general sales manager of the Kleinschmidt division of Smith-Corona Marchant, Inc. He served also as assistant to the vice

CIRCLE 91 ON READER SERVICE CARD→

A NEW SYMBOL





Worth learning because it represents a front-running achievement in microminiaturization. The symbol represents a microminiature "flip-flop." It is a solid-state integrated circuit incorporating all the functions shown in the equivalent conventional circuit. Yet it occupies one transistor package. It makes a 95% saving in space.

The symbol is one of six. There are a series of these functional micrologic elements: flip-flop, gate, buffer, half adder, half-shift register and counter adapter. Entire computer logic systems can be built wholly from combinations of these six building blocks. They are directly interconnectable. Design time is minimal.

The schematic is symbolic of the device. The physical realization of such a highly practical micrologic concept is symbolic of its maker — Fairchild Semiconductor Corporation. The company's repeated success in the development of advanced semiconductor devices has been based on the funded knowledge, abilities and esprit de corps of our entire staff. We are proud of our newest development. We are prouder yet of the creative approach of our scientific staff that accomplished it.

A wholly owned subsidiary of Fairchild Camera and Instrument Corporation

FAIRCHILD
SEMICONDUCTOR CORPORATION

545 WHISMAN ROAD • MOUNTAIN VIEW, CALIFORNIA • YORKSHIRE 8-8161

GUDELACE®...

the lacing tape with a NON-SKID tread

You can't see it, but it's there! Gudelace is built to grip—Gudebrod fills flat braided nylon with just the right amount of wax to produce a non-skid surface. Gudelace construction means no slips—so no tight pulls to cause strangulation and cold flow.

But Gudelace is soft and flat—stress is distributed evenly over the full width of the tape. No worry about cut thru or harshness to injure insulation . . . or fingers.

Specify Gudelace for *real* economy—faster lacing with fewer rejects.

Write for free Data Book.
It shows how Gudelace and other Gudebrod lacing materials fit your requirements.

GUDEBROD BROS. SILK CO., INC.

ELECTRONICS DIVISION
225 West 34th Street
New York 1, New York

WEST COAST OFFICE
2833 S. Olive Street
Los Angeles 7, Calif.

EXECUTIVE OFFICES
12 South 12th Street
Philadelphia 7, Pa.

CIRCLE 205 ON READER SERVICE CARD

GREAT THINGS ARE HAPPENING IN SUNNYVALE, CALIFORNIA
Where 69 Industries have located in the past ten years.

S.F. Examiner
Sunnyvale Gets GE Nod
PALO ALTO TIMES
$4 million building
$1.5 Million Lab Planned in Move

S.F. Examiner
Missile Expansion
$4 Million Lab for Lockheed Plant
Sunnyvale Plant to Expand

BIG LOCKHEED ADDITION TOLD
Sunnyvale Daily Standard

GE to Build $1 Million Laboratory at Sunnyvale
Sunnyvale Daily Standard

San Jose Mercury
$4 Million Expansion At Lockheed

$4 Million Building Up for Bid

GE Plans Two New Bay Facilities
SAN FRANCISCO CHRONICLE
Lab for Sunnyvale

$4 Million Lockheed Annex
SAN FRANCISCO CHRONICLE

SUNNYVALE FACTS—On an average of every 60 days during the last ten years a new industry located in Sunnyvale and found desirable land and adequate labor. An efficient, understanding city government provides a healthy atmosphere and taxes have remained low. Sunnyvale was selected as the site of the International Science Foundation, Science Center. This important concept fills a major gap in the large scale co-ordination of science and industry. The University of California has accepted 4 acres of land and plans to develop an Extension Center. General Electric will bring its Computer Development and Research Laboratory to this location.

Write for detailed, illustrated brochure E: *All inquiries held confidential.*
SUNNYVALE CHAMBER OF COMMERCE, SUNNYVALE, CALIF.

CIRCLE 92 ON READER SERVICE CARD

president and general manager, and as a member of the division's operating committee.

Adler Electronics Advances Auditore

CARMEN J. AUDITORE has been promoted to the new post of manager of systems planning with the military products division of Adler Electronics, Inc., New Rochelle, N. Y. Formerly a project manager, he has been with Adler since 1953.

The systems planning group was organized to meet Adler's expansion in the fields of transportable and fixed communications, and ground support systems.

CWS Waveguide Elects Schutter

CARL W. SCHUTTER has been elected vice president and general manager of CWS Waveguide Corp., Lindenhurst, Long Island. He will also continue as chief executive consultant engineer to the company, which manufactures microwave components for the radar and communications industries.

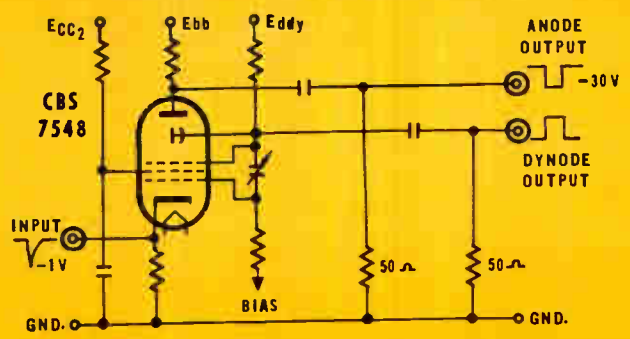
IBM Promotes John Opel

INTERNATIONAL BUSINESS MACHINES CORP. has announced the promotion

CIRCLE 93 ON READER SERVICE CARD→

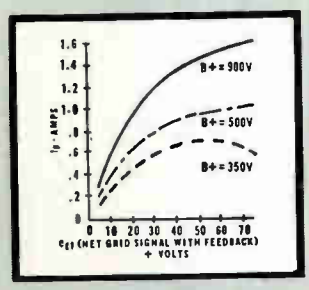
New CBS Advanced Instrument Tubes SOLVE TWO MAJOR CIRCUIT PROBLEMS

• *Ultrafast Pulse Amplification*



CBS 7548 in triggered pulse amplifier

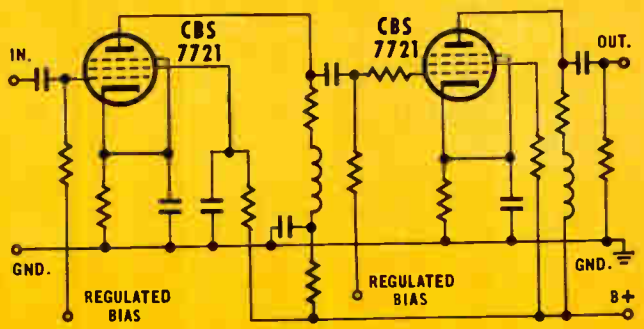
The CBS 7548, a mass-produced long-life secondary-emission pentode, makes possible state-of-the-art advances in generating and amplifying extremely fast rise-time pulses delivering high currents to low impedances. Because the tube can amplify with or without phase inversion, it can be used where conventional circuits would be impractical. For example, in triggered or distributed amplifiers and in impedance-transforming cathode followers. The long life has been achieved through development of a new refractory dynode surface.



CBS 7548 supplies high output over wide voltage range.

As a pulse generator-amplifier the 7548 has a 3 ns rise time with a 1 ampere pulse output. The tube offers a gain-bandwidth product of 350, transconductance of 26,000 μmhos, and 3.4 $\mu\mu$f output capacitance.

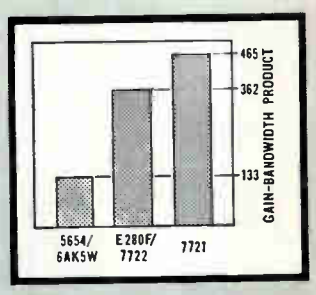
• *High-gain Wideband Amplification*



CBS 7721 in wideband amplifier

New CBS 7721 frame-grid pentode offers the highest figure of merit for gain-bandwidth product ever achieved . . . 465! With such unequalled performance, you can now design wideband i-f and video amplifiers using fewer stages, tubes, passive components and interconnections to achieve greater reliability and reduced cost.

The 7721 has a transconductance of 36,000 μmhos; a lower-cost companion type tube, the 7722/E-280F, has 26,000 μmhos. These extremely high transconductances result from true frame-grid construction. Mechanical strength is provided by the welded molybdenum frame, and superior electrical characteristics by the tightly wound, precisely positioned fine tungsten wire.



Comparison of gain-bandwidth products

CBS 7721, 7722, 7548 all have coil heaters, high-conductivity gold-plated base pins, standard 9-pin miniature bases. Call your nearest sales office for complete data.

CBS ELECTRONICS
Danvers, Massachusetts
A Division of Columbia Broadcasting System, Inc.
Tubes • Semiconductors • Audio Components • Microelectronics

Sales Offices: Danvers, Mass., 100 Endicott Street, SPring 4-2360 • Newark, N. J., 230 Johnson Avenue, TAlbert 4-2450 • Melrose Park, Illinois, 1990 N. Mannheim Road, EStebrook 9-2100 • Los Angeles, California, 2120 S. Garfield Avenue, RAymond 3-9081 Minneapolis, Minnesota, The Heimann Co., 1711 Hawthorne Avenue, FEderal 2-5457.

inter-industry conference on

ORGANIC SEMICONDUCTORS

April 18 and 19, 1961
The Morrison Hotel, Chicago, Illinois

co-sponsored by

ARMOUR RESEARCH FOUNDATION
of Illinois Institute of Technology

and **electronics**
a McGraw-Hill publication

Technical sessions of invited and contributed papers on the present state and future potential of organic semiconductors in the electronics, chemical, and semiconductor industries.

Invited papers will cover the following areas:

David Fox, State University of New York
Theoretical Aspects of Electrical Transport

R. G. Kepler, E. I. DuPont de Nemours and Company
Conductivity in Anthracene Single Crystals

Jan Kommandur, National Carbon Research Laboratories
Characteristics of Charge-Transfer Complexes

Oliver Le Blanc, General Electric Research Laboratories
Interpretation of Conductivity in Molecular Crystals

Herbert A. Pohl, Princeton University
Electrical Properties of Pyrolyzed Polymers

Marvin Silver, Office of Ordnance Research
Surfaces and Contacts in Organic Semiconductors

For further information contact James J. Brophy, Co-Chairman, Physics Division, Armour Research Foundation, Technology Center, Chicago 16, Illinois.

of John R. Opel to director of communications, corporate staff, succeeding Dean R. McKay who recently was elected vice president.

Opel joined IBM in 1949 and served in various executive posts in the data processing division before being appointed administrative assistant in the office of the president in 1959.

Tenney Engineering Realigns Divisions

TENNEY ENGINEERING, INC., Union, N. J., has organized independent divisions for its aerospace and environmental equipment, with Frank H. Gardner and Martin Schletter as managers of the respective operations. Both Gardner and Schletter are veteran development engineers at Tenney. Company manufactures simulation devices.

PEOPLE IN BRIEF

William W. Garstang leaves the Allen-Bradley Co. to join Centralab as manager of special products. **Edson B. Gould III** advances at Hughes Aircraft Co. to manager of reliability and quality for the semiconductor division. **Sol Wiener** of Polarad Electronics moves up to chief value engineer. **Turner V. Stokes,** formerly with Vitro Electronics, joins Communication Electronics as a senior electronic engineer. **William G. Dunn** transfers from North American Aviation to Tenney Engineering as manager of the newly formed acoustics division. **Yujiro Yamamoto,** previously associated with UCLA, heads recorder engineering at Borg-Warner Controls. **T. H. Abrahams,** ex-Douglas Aircraft, named chief engineer of the instrument division of Hoffman Electronics Corp. **Edward Webster** leaves Pt. Mugu, Calif., Pacific missile range to become military projects manager at PRD Electronics. **Thomas E. Daniels** promoted at Collins Radio to military systems sales manager for the Texas Div. **Samuel Cogan** of Auerbach Electronics advances to manager of equipment development.

electronics

WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

ATTENTION: ENGINEERS, SCIENTISTS, PHYSICISTS

This Qualification Form is designed to help you advance in the electronics industry. It is unique and compact. Designed with the assistance of professional personnel management, it isolates specific experience in electronics and deals only in essential background information.

The advertisers listed here are seeking professional experience. Fill in the Qualification Form below.

STRICTLY CONFIDENTIAL

Your Qualification form will be handled as "Strictly Confidential" by ELECTRONICS. Our processing system is such that your form will be forwarded within 24 hours to the proper executives in the companies you select. You will be contacted at your home by the interested companies.

WHAT TO DO

1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely.
6. Mail to: D. Hawksby, Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

COMPANY	SEE PAGE	KEY #
APPLIED PHYSICS LAB. The Johns Hopkins University Silver Springs, Maryland	77*	1
BAUSCH & LOMB INC. Rochester, New York	80*	2
CHRYSLER MISSILE DIV. Detroit, Michigan	79*	3
ERIE ELECTRONICS DIV. Erie Resistor Corp. Erie, Pa.	96	4
FEDERAL ELECTRIC CORP. A Div. of I T & T Corp. Paramus, New Jersey	61*	5
PHILADELPHIA NAVAL SHIPYARD Philadelphia, Pa.	96	6
PRATT & WHITNEY AIRCRAFT Div. of United Aircraft Corp. West Palm Beach, Florida Middletown, Connecticut	96	7
SIKORSKY AIRCRAFT Stratford, Connecticut	81*	8

* These advertisers appeared in the 3/24/61 issue.

(cut here) (cut here)

electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

Personal Background

NAME .....

HOME ADDRESS.....

CITY..... ZONE..... STATE.....

HOME TELEPHONE.....

Education

PROFESSIONAL DEGREE(S).....

MAJOR(S) .....

UNIVERSITY .....

DATE(S) .....

FIELDS OF EXPERIENCE (Please Check) 3311

☐ Aerospace	☐ Fire Control	☐ Radar
☐ Antennas	☐ Human Factors	☐ Radio—TV
☐ ASW	☐ Infrared	☐ Simulators
☐ Circuits	☐ Instrumentation	☐ Solid State
☐ Communications	☐ Medicine	☐ Telemetry
☐ Components	☐ Microwave	☐ Transformers
☐ Computers	☐ Navigation	☐ Other .....
☐ ECM	☐ Operations Research	☐ .....
☐ Electron Tubes	☐ Optics	☐ .....
☐ Engineering Writing	☐ Packaging	☐ .....

CATEGORY OF SPECIALIZATION

Please indicate number of months experience in proper block(s)

	Technical Experience (Months)	Supervisory Experience (Months)
RESEARCH (pure, fundamental, basic)	....	....
RESEARCH (Applied)	....	....
SYSTEMS (New Concepts)	....	....
DEVELOPMENT (Model)	....	....
DESIGN (Product)	....	....
MANUFACTURING (Product)	....	....
FIELD (Service)	....	....
SALES (Proposals & Products)	....	....

CIRCLE KEY NUMBERS OF ABOVE COMPANIES' POSITIONS THAT INTEREST YOU

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

career positions of unusual scope and interest in

CONNECTICUT or FLORIDA

Pratt & Whitney Aircraft's Florida Research and Development Center at West Palm Beach, Florida and its Connecticut Aircraft Nuclear Engine Laboratory (CANEL) in Middletown, Connecticut has interesting and challenging work in Instrumentation and Controls associated with the development and testing of advanced turbojets, rocket engines, and indirect cycle liquid metal reactor system.

FLORIDA OPPORTUNITIES

ELECTRONIC ENGINEERS:

One to five years' experience in electro-mechanical, electrohydraulic, and electro-pneumatic servo control systems; systems design with good mechanical background.

Instrumentation operations experience with oscillograph, strip chart and digital data acquisition systems desirable.

INSTRUMENTATION ENGINEERS: (BSME or BSEE)

One to five years' experience in the operation of shock tubes and the analysis of shock tube data, particularly as applied to investigations in transient pressure responses in pneumatic systems. Experience in the operation of random control vibration equipment including mounting fixtures and accelerometer systems.

Three-year minimum experience directly related to gas and liquid flow measurements including turbine and variable area type flowmeters, venturi and orifices.

CONNECTICUT OPPORTUNITIES (CANEL)

INSTRUMENTATION ENGINEERS:

Present programs involve the design, development, and application of sophisticated high-temperature instrumentation for liquid metal systems, process control, nuclear research and control, and data reduction.

Of particular interest are engineers with one to five years' experience in one or more of the following fields of instrument development or application: Nuclear measurement, reactor control, chemical process control, instrumental analysis, heat treating furnace control, aircraft powerplant control, and test instrumentation. Design or application experience with an instrument manufacturer may also be applicable.

Please submit complete resume, including minimum salary requirements, to:

Mr. J. W. Morton, Office 65
Pratt & Whitney Aircraft
West Palm Beach, Florida
— or —
Mr. L. T. Shiembob, Office 65
Connecticut Aircraft
Nuclear Engine Laboratory
Box 611, Middletown, Connecticut

All replies will be handled promptly and in complete confidence.

PRATT & WHITNEY AIRCRAFT
Division of United Aircraft Corporation

CIRCLE 378 ON READER SERVICE CARD

ELECTRONIC ENGINEERS

for

Shore Installations

PHILADELPHIA

Responsible for fixed and mobile radio, radar, sonar, navigational aids, etc., at Naval Shore Activities in the East.

About 25% travel, with all travel costs paid and $12. per diem.

$7560—$8860 to start, plus excellent benefits of career civil service (up to 26 days paid vacation, 13 days paid sick leave, for example).

B.S. with 3 yeors experience. Submit resume to: Industrial Relations Officer, Philadelphia Naval Shipyard, Philadelphia 12, Pa.

CIRCLE 379 ON READER SERVICE CARD

Wanted Electrical or Electronic Engineering

Graduate, between 25 and 32 years of age for sales engineering work by manufacturer of electronic components, including High Speed Relays, Choppers, and Pressure Switches.

Location: Chicago or Cleveland
Write Harry E. Beane, Vice President

THE BRISTOL COMPANY
Waterbury 20, Connecticut

TRANSFORMER ENGINEER

With experience in the design and development of Hi-Frequency and Pulse transformers for commercial and military applications.

Ideal opportunity for ambitious man to develop full potential of present small department. Salary—open. Location—Erie, Pa. Call or send resume to: Chief Engineer

Erie Electronics Division
Erie Resistor Corporation
645 West 12th Street Erie, Pa.

CIRCLE 380 ON READER SERVICE CARD

MANUFACTURERS' REPRESENTATIVES

IN THE ELECTRONIC INDUSTRY

SAMUEL K. MACDONALD, INC.
manufacturers representatives over 25 years
1531 SPRUCE STREET, PHILA. 2, PA.

Territory:
Pennsylvania • New Jersey
Delaware • Maryland
Virginia • West Virginia
District of Columbia

Other Offices:
Pittsburgh
Baltimore
Washington, D.C.

CIRCLE 381 ON READER SERVICE CARD

SELLING OPPORTUNITY WANTED

Manufacturers representative In New York area, excellent contacts in aircraft, instrumentation and process industries seeks line in instrument, components and test equipment field. RA-6395, Electronics, Classified Adv. Div., P. O. Box 12, New York 36, N. Y.

MEMO TO . . . ENGINEERS, SCIENTISTS

• • •

Ask Yourself These Questions:

Am I advancing at a satisfactory rate in the Electronics industry?

Is my experience, background and technological 'knowhow' being put to its fullest use?

Ponder a moment . . .

If the answer is 'NO' to either question, we refer you to the Employment Opportunities advertisements in this publication. Contact these companies directly . . . or use ELECTRONICS WEEKLY QUALIFICATION FORM on the preceding page to establish immediate contact with the proper Personnel Dept. executives in these advertising companies.

INDEX TO ADVERTISERS

Audited Paid Circulation

* See Advertisement in the July 20, 1960 issue of Electronics Buyers' Guide for complete line of products or services.

JUST PUBLISHED

SCIENCE IN SPACE

Edited by LLOYD V. BERKNER, Chairman; and HUGH ODISHAW, Executive Director; both of Space Science Board, National Academy of Sciences

Today's advances in space knowledge . . . and tomorrow's almost limitless opportunities for experiment and research in all areas of space science are authoritatively presented in this unique volume. Many of the world's leading scientists explore the interests and needs of research in physics, astronomy, geology, geophysics, and the biological sciences. They provide a stimulating report on experiments with various types of spacecraft . . . applications within reach—in weather forecasting, communications, and geodesy . . . man's role in space . . . and other areas of space science. From information on gravity and the use of rockets and satellites for upper atmosphere investigation . . . through consideration of fields and particles in space . . . to data on life sciences, and the Moon, planets, and stars—this comprehensive volume covers the broad spectrum of space investigation . . . offers exciting vistas of scientific advances and applications. **439 pp., 106 illus. and tables, $7.00**

PRINCIPLES OF INERTIAL NAVIGATION

Just Published. Covers basic theory, components, system errors, autonavigators, etc. **By C. J. Savant, Jr., Hughes Tool Co.; R. C. Howard, Giannini Cont. Corp.; C. B. Solloway, Jet Prop. Lab.; and C. A. Savant, Northrop Corp. 249 pp., 166 illus., $9.75**

ELECTRICAL PRINCIPLES OF ELECTRONICS

Just Published. Provides electrical principles and calculating techniques to help you analyze and apply circuits more effectively. **By A. Gillie, Ward School of Electronics. 532 pp., 336 illus., $10.00**

TRANSISTORS

Theory and Applications

Helpful facts on transistor principles, manufacture, and uses. Discusses silicon and germanium types. **By A. Coblenz, Transistor Prod. Co., and H. L. Owens, Signal Corps Eng. Labs. 313 pp., 115 illus., $6.50**

FREE EXAMINATION

McGraw-Hill Book Co. Dept. L-3-31
327 W. 41st St., New York 36, N. Y.

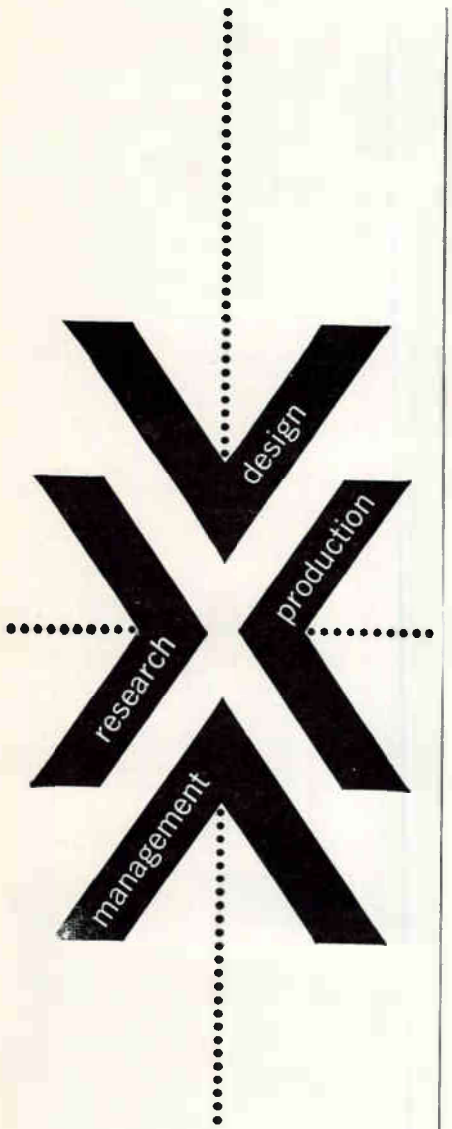
Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep plus few cents for delivery costs, and return unwanted book(s) postpaid. (We pay delivery costs if you remit with this coupon—same return privilege.)

☐ Berkner & Odishaw—Science in Space—$7.00
☐ Savant et al.—Prin. of Inertial Nav.—$9.75
☐ Gillie—Elec. Prin. of Electronics—$10.00
☐ Coblenz & Owens—Transistors—$6.50

Name .....
Address .....
City .....Zone ....State .....
Company .....
Position .....

For price and terms outside U. S. write McGraw-Hill Intl., N.Y.C. 36 L-3-31

CIRCLE 97 ON READER SERVICE CARD



it's read more by all 4!

electronics magazine covers engineering and technically interpreted market trends every week. Government, military and economic developments, new applications, and technical data you'll want to file and keep. Subscribe now and read it first (don't be low man on a routing slip). Mail the reader service card (postpaid) to **electronics**, the magazine that helps you to know and to grow! Rates: three years for $12; one year for $6; Canadian, one year for $10; foreign, one year for $20. Annual **electronics** BUYERS' GUIDE (single issue price $3.00) included with every subscription.

subscribe today to

lectronics

ADVERTISERS INDEX

This index and our Reader Service Numbers are published as a service. Every precaution is taken to make them accurate, but ELECTRONICS assumes no responsibilities for errors or omissions.

electronics

Audit Bureau of Circulations

Associated Business Publications

Audited Paid Circulation

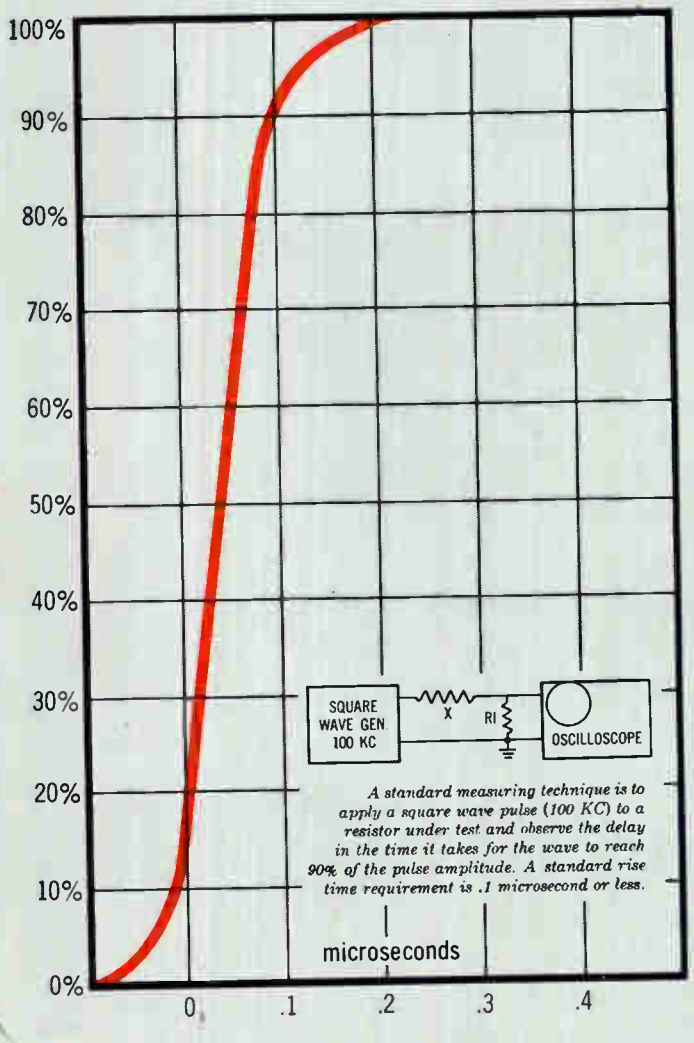
BRUCE A. WINNER
Advertising Sales Manager

R. S. QUINT, Assistant Publisher Buyer's Guide and Business Manager; FRED STEWART, Promotion Manager; B. ANELLO, Marketing Service Manager; RICHARD J. TOMLINSON, Production Manager; GEORGE E. POMEROY, Classified Manager; HUGH J. QUINN, Circulation Manager.

ADVERTISING REPRESENTATIVES: NEW YORK Donald H. Miller, Henry M. Shaw, George F. Werner; BOSTON William S. Hodgkinson, Donald R. Furth; PITTSBURGH Dovid M. Watson; PHILADELPHIA Warren H. Gardner, William J. Boyle; CHICAGO Harvey W. Wernecke, Martin J. Gallay; CLEVELAND P. T. Fegley; SAN FRANCISCO T. H. Carmody, R. C. Alcorn; LOS ANGELES D. A. McMillan, Marshall Freeman; DENVER J. Patten; ATLANTA M. Miller; HOUSTON Joseph C. Page Jr.; DALLAS Robert T. Wood; LONDON D. S. McDonald; FRANKFURT Stanley R. Kimes; GENEVA Michael R. Zeynel.

BRANCH OFFICES: National Press Bldg., Washington 4, D.C.; McGraw-Hill Bldg., Copley Square, Boston 16; Four Gateway Center, Pittsburgh 22; Six Penn Center Plaza, Philadelphia 3; 520 North Michigan Avenue, Chicago 11; 55 Public Square, Cleveland 13; 68 Post Street, San Francisco 4; 1125 West Sixth St., Los Angeles 17; 1740 Broadway, Denver 2; 1301 Rhodes-Haverty Bldg., Atlanta 3; Prudential Bldg., Holcombe Blvd., Houston 25; 901 Vaughn Bldg., Dallas 1; 34 Dover Street, London, England; 85 Westendstrasse, Frankfurt/Main; 2 Place de Port, Geneva.

Now-
Fast Rise Time
Resistors
for Computers!



DAVEN'S new High-Speed resistors!

Daven has developed a new **wire wound** resistor for applications requiring exceptionally fast rise time. By controlling the winding techniques and the geometry of the form on which the resistor is wound, high frequency resistors can be made approaching... **and often equalling**... carbon and metal film units.

This high frequency operational capability, plus high resistance accuracy, low temperature coefficients, long term stability, zero voltage coefficients and low noise characteristics, make Daven's new High-Speed resistors ideal for a wide variety of fast rise-time applications. Examples: pulse circuits, AC (broad band) networks, AC (broad band) computers, AC voltage dividers, precision wide band attenuators, AC decade boxes, video amplifiers.

Type	Diameter*	Length	Min. R	Max. R	Tolerance
1301	¼	½	5K	150K	1% to .1%
1302	⅜	¾	5K	150K	.05%
1303	¼	¾	5K	250K	1% to .1%
1304	⅜	¾	5K	250K	.05%
1305	¼	1"	5K	500K	1% to .1%
1306	⅜	1"	5K	500K	.05%
1307	⅜	1½	500K	1 Meg	1% to .05%

*Diameter ± 1/64"

For complete details on the new High-Speed resistors, write today!

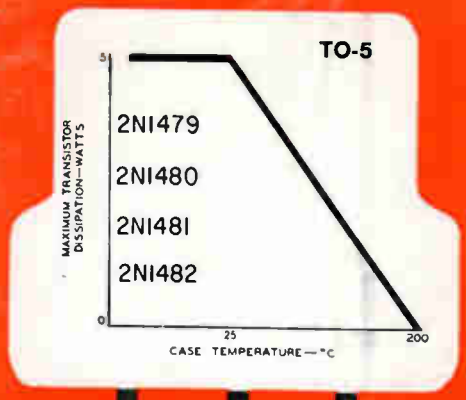
THE DAVEN COMPANY, Livingston, New Jersey

RESISTORS

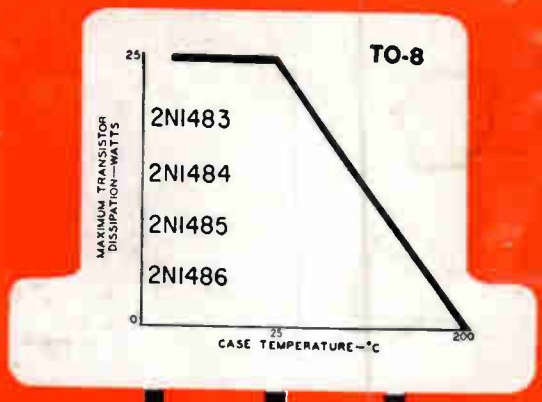
A SUBSIDIARY OF GENERAL MILLS

TODAY, MORE THAN EVER, THE DAVEN (D) STANDS FOR DEPENDABILITY

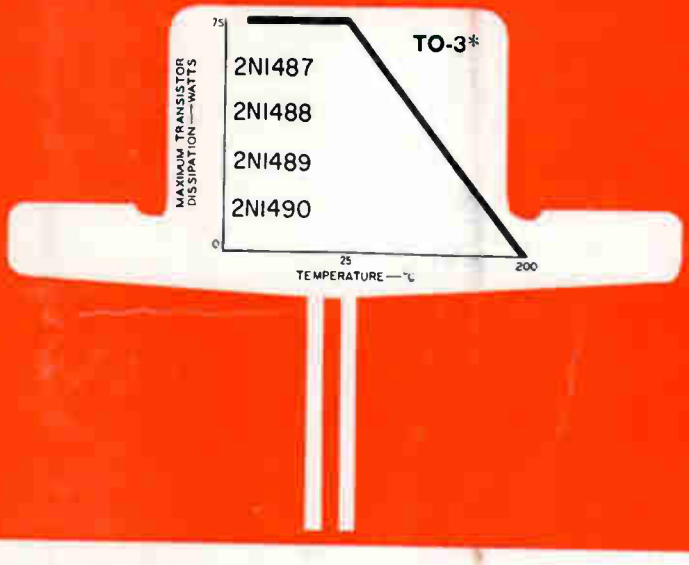
MEDIUM POWER

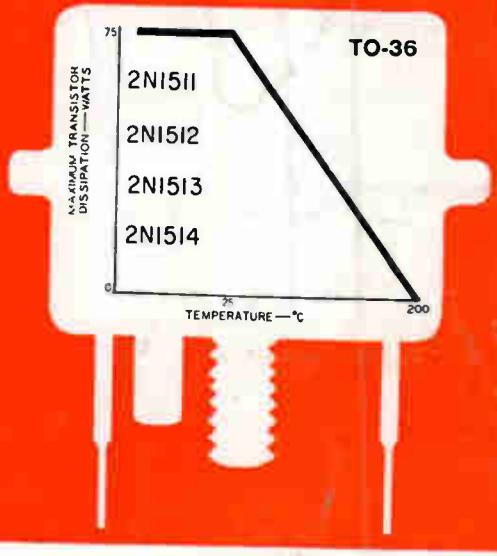


INTERMEDIATE POWER



Upgrade Industrial Circuit Designs With These RCA 200°C Silicon Power Transistors





HIGH POWER

New high-temperature ratings on 16 popular RCA silicon transistors for improved performance in military and industrial applications at no increase in price

MAXIMUM RATINGS, Absolute-Maximum Values:

	2N1479 2N1481	2N1480 2N1482	2N1483 2N1485	2N1484 2N1486	2N1487 2N1489 2N1511 2N1513	2N1488 2N1490 2N1512 2N1514
COLLECTOR-TO-BASE VOLTS	60V	100V	60V	100V	60V	100V
COLLECTOR-TO-EMITTER VOLTS With base open (sustaining voltage)	40V	55V	40V	55V	40V	55V
With emitter-to-base reverse biased (V_{EB}=1.5 volts)	60V	100V	60V	100V	60V	100V
EMITTER-TO-BASE VOLTS	12V	12V	12V	12V	10V	10V
COLLECTOR CURRENT (Amps.)	1.5a	1.5a	3a	3a	6a	6a
EMITTER CURRENT (Amps.)	1.75a	1.75a	—3.5a	—3.5a	—8a	—8a
BASE CURRENT (Amps.)	1a	1a	1.5	1.5a	3a	3a
TRANSISTOR DISSIPATION: (Watts) At case temperature of 25°C	5w	5w	25w	25w	75w	75w
At case temperature of 100°C	2.86w	2.86w	14.1w	14.1w	43w	43w
CASE TEMPERATURE RANGE: (°C) Operating and Storage	—65 to +200°C					

*Similar to TO-3

Here are 16 RCA N-P-N diffused-junction silicon power transistors immediately available in quantity, to meet the more exacting performance requirements of today's industrial and military equipment.

Check out the remarkable improvements these RCA high-performance industrial transistors now offer:

- *14 percent increase* in maximum operating temperatures — up to 200°C.
- *Up to 66⅔ percent increase* in dissipation capability — up to 75 watts.
- *Up to 30 percent decrease* in thermal resistance — to 2.33°C/watt.
- *Up to 50 percent increase* in minimum beta.
- *Up to 30 percent reduction* in beta spread.

All of these features provide greater flexibility in the design of power switching devices such as dc-to-dc converters, inverters, choppers, solenoid and relay controls; oscillators, regulators, and pulse amplifiers; and class A and class B amplifiers for servo and other audio frequency applications.

Call your RCA Semiconductor Field Representative today for full particulars on these silicon power types. For your copy of the new RCA 25-page Application Guide on RCA Silicon Power Transistors send 50 cents to RCA Semiconductor and Materials Division, Commercial Engineering, Section D-19-NN-5, Somerville, N.J.

AVAILABLE THROUGH YOUR RCA DISTRIBUTOR

RCA SEMICONDUCTOR & MATERIALS DIVISION . FIELD OFFICES EAST: Newark, N. J., 744 Broad Street, HUmboldt 5-3900 • Syracuse 3, New York, 731 James Street, Room 402, GRanite 4-5591 • NORTHEAST: Needham Heights 94, Mass., 64 "A" Street, Hillcrest 4-7200 • EAST CENTRAL: Detroit 2, [illegible] 14 New Center Bldg., TRinity 5-5600 • CENTRAL: Chicago, Ill., Suite 1154, Merchandise Mart Plaza, WHitehall 4-2900 • Minneapolis, Minn., 5805 Excelsior Blvd. • WEST: Los Angeles 54, Calif., [illegible] 1074, RAymond 3-8361 • Burlingame, Calif., 1838 El Camino Real, OXford 7-1620 • SOUTH: [illegible] do, 1520 Edgewater Drive, Suite 1, GArden 4-4768 • SOUTHWEST: Dallas 7, Texas, 7905 [illegible], FLeetwood 7-8167 • GOVERNMENT: Dayton, Ohio, 224 N. Wilkinson St., BAldwin [illegible] ington, D.C., 1725 "K" Street, N.W., FEderal 7-8500.

RCA The Most Trusted Name in Electronics
RADIO CORPORATION OF AMERICA