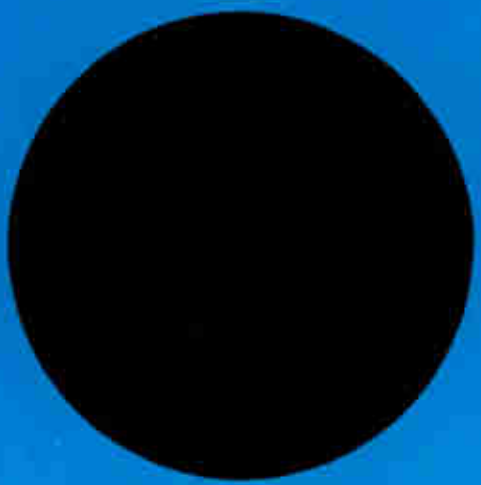
ELECTRONIC INDUSTRIES

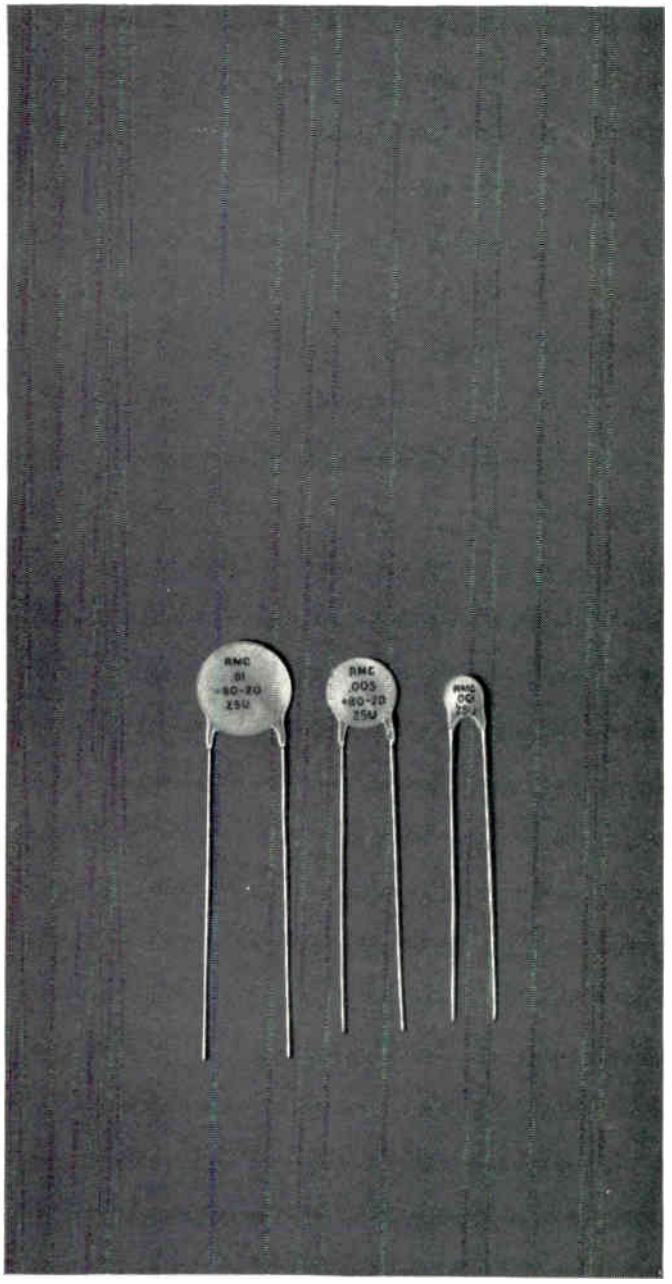


JULY 1963

Evaluating environmental testing

New electronic areas in U. S. A.

Encapsulating to military specs.



Make the change to small capacitors

RMC type SM DISCAPS

RMC Type SM DISCAPS are designed for use in applications where limited space is a prime consideration. Rated at 500 volts V.D.C., Type SM DISCAPS meet specifications of E.I.A. RS-198 for Z5U temperature characteristics. These subminiature capacitors can be specified with complete assurance of the quality, dependability and electrical performance built into all RMC DISCAPS. Write on your letterhead for additional information.

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS COMPANY

A DIVISION OF P. R. MALLORY & CO., INC.

GENERAL OFFICE: 4242 W. Bryn Mawr Ave., Chicago 46, Ill.

Two RMC Plants Devoted Exclusively to Ceramic Capacitors

FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Circle 1 on Inquiry Card

SHELBY A. McMILLION,
Publisher

BERNARD F. OSBAHR,
Editor

ELECTRONIC INDUSTRIES

RESEARCH WITH PURPOSE!

EVERYBODY BELIEVES IN BASIC RESEARCH. The controversial question is: How should it be carried out? We believe basic research should have a definite purpose, even to the extent of being product-oriented.

We have no quarrel with the concept of basic research. But we cannot see purely blue-sky probings, completely removed from any practical, social, technological, military, commercial or industrial application. Necessary and justifiable research includes the discovery and exploitation of fundamental laws of nature, bearing upon some important problem whose solution could unlock the wheels of technological progress. By contrast, research without roots in some persistent problem is costly, wasteful in manpower and resources, and downright ridiculous to support.

One of government's big names said the same thing just last month. At ceremonies opening a multi-million-dollar research laboratory in a defense-oriented systems company, John H. Rubel, Asst. Sec'y For Defense, first noted that all such laboratories are supported (directly or indirectly) by substantial government funds. Then he observed that:

> *Research should improve the company; what is good for the company is good for the country.*
>
> *An outstanding research laboratory becomes a point of assembly, and an opportune doorway for the development of outstanding men and women.*

They are both good points, well taken. But Mr. Rubel's principal arguments were even more cogent. Because funds for these laboratories come from taxpayers, he said, the government has a right to expect certain things in return for its money. Among them:

> *True research, and not just product improvement.*
>
> *Research in areas of likely interest and subsequent reward.*
>
> *The creation of an environment that brings out the most creative ability in each researcher.*

The Secretary is right. We can't afford to waste our best technological brainpower on research that has no prospect of practical results. Research should stop when it gets to be fruitless.

All research — yes, even basic research — should have a goal and a (fairly flexible) timetable. Let's not throw those research dollars down a bottomless test tube. No company can tolerate the luxury of waste in research where its own funds are employed. And neither can the government tolerate that kind of waste—if it is to keep faith with its citizens, and if democracy is to survive the inroading threats of those who would destroy it.

Research with a purpose. Or prepare to pay the consequences.

New from Sprague!

HIGH VOLTAGE • HIGH SPEED

2N1499B

GERMANIUM P-N-P

LOW COST HIGH VOLTAGE LOGIC SWITCH

AVAILABLE IN PRODUCTION QUANTITIES NOW!

check these key parameters	
BV_{CBO}	30 volts
BV_{CEO}	20 volts
I_{CBO} at 15V	3 μA max.
H_{FE}	40 min.
V_{CE} (SAT)	0.15 volts max.
f_T	150 mc min.

Significant process improvements in the manufacture of the popular 2N1499A provide substantial increases in performance, power, and reliability. Sprague's new 2N1499B Transistor features improvements in voltage, leakage current, gain, saturation, and speed.

For application engineering assistance, write to Transistor Division, Sprague Electric Company, Concord, New Hampshire. For technical data, write for Engineering Bulletin 30,223 to Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

SPRAGUE COMPONENTS

TRANSISTORS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
CAPACITORS	PIEZOELECTRIC CERAMICS	PACKAGED COMPONENT ASSEMBLIES
RESISTORS	PULSE-FORMING NETWORKS	BOBBIN and TAPE WOUND MAGNETIC CORES
MICROCIRCUITS	TOROIDAL INDUCTORS	SILICON RECTIFIER GATE CONTROLS
INTERFERENCE FILTERS	ELECTRIC WAVE FILTERS	FUNCTIONAL DIGITAL CIRCUITS

48T-132.63

SPRAGUE®
THE MARK OF RELIABILITY

'Sprague' and '②' are registered trademarks of the Sprague Electric Co.

ELECTRONIC INDUSTRIES

Vol. 22, No. 7 July 1963

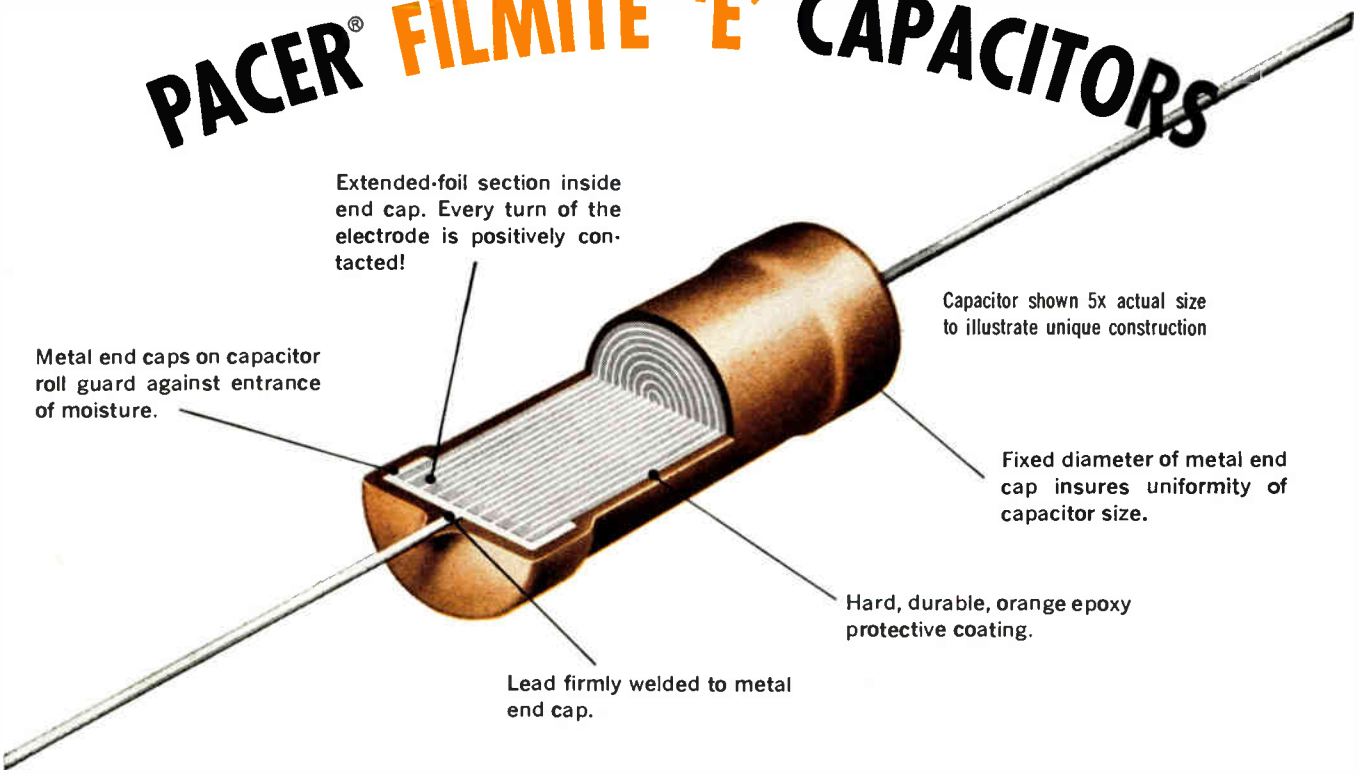
EDITORIAL FEATURES

DEPARTMENTS

ELECTRONIC INDUSTRIES, July, 1963. Vol. 22, No. 7. A monthly publication of Chilton Company. Executive Editorial & Advertising offices at Chestnut & 56th Sts., Phila. 39, Pa. (Area Code 215) SHerwood 8-2000. Controlled circulation postage paid at Phila., Pa. $1 a copy; Directory issue (June), $5.00 a copy. Subscription rates U. S. and U. S. possessions: 1 yr. $10.00; 2 yrs. $18.00. Canada 1 year, $12.00; 2 yrs. $20.00. All other countries 1 yr. $18.00; 2 yrs. $30.00.

Only from Sprague!

PACER® FILMITE® 'E' CAPACITORS



Multi-advantage Construction in a Low-cost Film Capacitor!

MINIFIED SIZE—
Rating for rating, Pacer Capacitors are almost one-third the size of conventional paper or paper-film tubulars, making them ideally suited for transistorized circuitry and other space-saving applications where small size with dependability is an important consideration.

BEST POSSIBLE NON-INDUCTIVE SECTION—
Metal end caps over extended foil sections assure non-inductive capacitors, since all turns of the electrode are contacted beyond question.

IMPROVED HUMIDITY RESISTANCE—
End caps act as effective moisture barriers. Capacitor sections are further protected by hard, durable, orange epoxy coating.

UNIFORMITY OF SIZE—
Unlike other epoxy-coated units, the end caps on Pacer Capacitors assure the rigid fixed diameters needed for use with automatic insertion equipment. The two smallest sizes are identical with resistor and diode sizes, making them especially suitable for 'cordwood' packaging.

Pacer Capacitors are available in selected ratings for fast delivery from your Sprague Electronic Parts Distributor

For complete technical data on Pacer Capacitors, write for Engineering Bulletins 2066 and 2067 to Technical Literature Service, Sprague Electric Co., 233 Marshall Street, North Adams, Mass.

SPRAGUE COMPONENTS

CAPACITORS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
TRANSISTORS	PIEZOELECTRIC CERAMICS	PACKAGED COMPONENT ASSEMBLIES
RESISTORS	PULSE-FORMING NETWORKS	BOBBIN and TAPE WOUND MAGNETIC CORES
MICROCIRCUITS	TOROIDAL INDUCTORS	SILICON RECTIFIER GATE CONTROLS
INTERFERENCE FILTERS	ELECTRIC WAVE FILTERS	FUNCTIONAL DIGITAL CIRCUITS

45-442 R2

SPRAGUE®
THE MARK OF RELIABILITY

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

ARTICLE HIGHLIGHTS

of this issue

New Electronic Areas of U.S. page 46

Ever since Sputnik the U.S. electronics industry has been accelerating rapidly. Now, with almost overnight velocity, technical advances and sprouting aerospace and defense markets are causing hundreds of firms to relocate, add-on, divide, merge or start anew, clear across the nation. And coming with this industrial and educational shuffling is a dispersal of opportunity.

Project Apollo's Command and Control page 58

Control requirements for our early space flights were quite simple compared to those of the Gemini and Apollo programs. Controlling the spacecraft in the lunar mission will require techniques used by the master chess player. Here's how and with what the Integrated Mission Control Center will do this.

An Evaluation of Environmental Testing page 70

This rapidly expanding field is plagued with serious problems that threaten its long-term growth. Shortage of trained personnel is the most pressing; some effort should go into setting up specialized training courses. And the accuracy of measurements still leaves much to be desired.

Random-Motion Testing of Electronic Components page 82

Equipment must now function under conditions that were hard to visualize a few years ago, and even more strenuous operating environments are ahead. The only way to make sure that productcs can withstand these levels is to test them under conditions that duplicate the actual operating environment. Methods of vibration testing are covered—particularly random-motion testing—the most vigorous of them all.

Improving the Accuracy of R-F Voltage Measurements page 87

Measurements that were difficult in the past can now be made easily and accurately with modern test instruments. Four types of measurements are described here—Q, bridge & null network, r-f filter, and harmonic distortion. The methods described will benefit the expert as well as the casual user.

Encapsulating to Military Specifications page 92

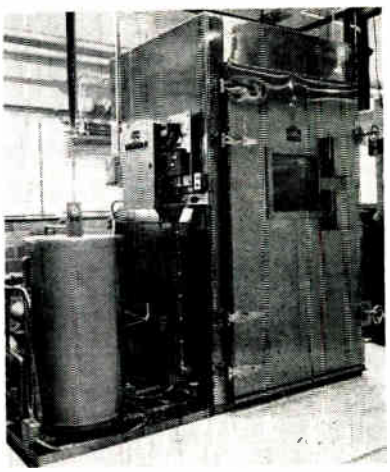
A wide range of considerations must be reviewed by the systems engineer before the encapsulation processes are specified. The resins considered for use should undergo wide study. Many of the restrictions on the encapsulating process are dictated by the electrical characteristics of the component involved.

Resistors for Precise Temperature Measurements page 97

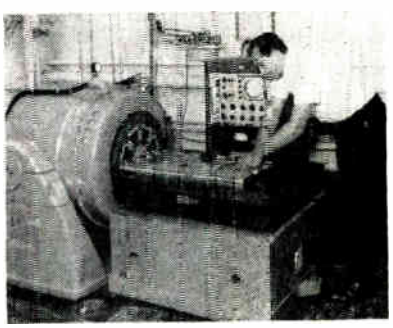
The advancement of guided missile and aerospace programs depends more and more upon the analysis of materials, components and fuels. For this analysis, precise temperature measurements are essential. The role that resistors play in making these measurements is described here.

Designing Active Tuned Filters page 158

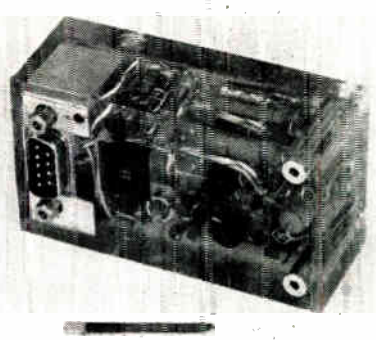
Low frequency, narrow band filters are often needed in control systems. Since passive filters are unwieldy at low frequencies, either active filters or demodulator-filter-modulator systems are used. A simple active filter is described here along with graphical design techniques.



Environmental Testing

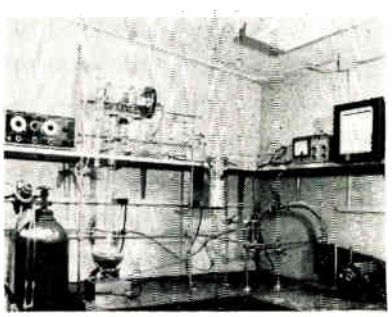


Random Motion Testing



Encapsulating

Insulation for Space Use



SHELBY A. McMILLION, Publisher

BERNARD F. OSBAHR, Editor

CREIGHTON M. MARCOTT
Executive Editor

JOHN E. HICKEY, Jr.
Senior Technical Editor

SMEDLEY B. RUTH
ANDREW MITCHELL
Associate Editors

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

DR. ALBERT F. MURRAY
Consulting Editor

SIDNEY FELDMAN
Contributing Editor

EDITORIAL PRODUCTION

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

EDITORS-AT-LARGE

Eastern Region

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

Western Region

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

WASHINGTON NEWS BUREAU

1093 National Press Bldg.
(Area Code 202) 393-3474
TWX—202 965-0675

GEORGE BAKER, Mgr.
NEIL R. REGEIMBAL
DAVID R. HEINLY

BUSINESS DEPARTMENT

ELMER DALTON
Advertising Promotion
& Circulation Manager

EDWARD G. SHAUD, Jr.
Marketing Manager

GORDON HERNDON
Production Manager

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

ELECTRONIC INDUSTRIES, July, 1963. Vol. 22, No. 7. A monthly publication of Chilton Company. Executive Editorial & Advertising offices at Chestnut & 56th Sts., Phila. 39, Pa. (Area Code 215) SHerwood 8-2000. Controlled circulation postage paid at Philadelphia, Pa. $1 a copy; Directory issue (June), $5.00 a copy. Subscription rates U. S. and U. S. Possessions; 1 yr. $10.00; 2 yrs. $18.00. Canada 1 year, $12.00; 2 yrs. $20.00. All other countries 1 yr., $18; 2 yrs. $30.00.

Electronic technology that works...

WIDE, WIDE RANGE FILTERS THAT REQUIRE LESS SPACE

By using barium titanate rolled tubes plus ferrite loading, technologists at Erie Resistor accomplished two important breakthroughs in filter design . . .

Wider range: 10kc to 2000mc.

Compact design: 0.343" diameter by 0.720" long.

These Erie wide range, low-pass filters offer efficient and compact RFI suppression in airborne communications, navigation, and identification-interrogation systems.

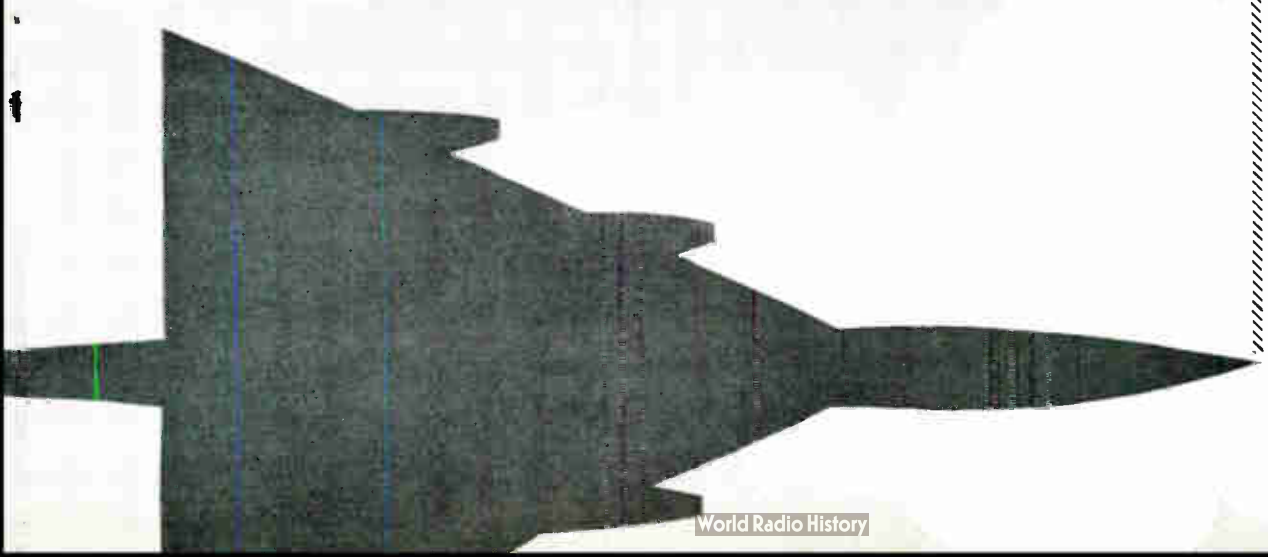
These new filters using Erie's ferroceramic techniques are another example of advanced research and production technologies at work at Erie Resistor . . . where reliability goals are 100% assured.

Tell us your ideas and needs for electronic components and assemblies to be resolved by Erie technological experience and staff. Address:

ERIE RESISTOR CORPORATION

644 West 12th Street
Erie, Pennsylvania

DESIGNER, PRODUCER AND MARKETER OF TECHNOLOGICAL PRODUCTS



RADARSCOPE

Analyzing current developments and trends throughout the electronic industries that will shape tomorrow's research, manufacturing and operation

COMPUTER DESIGNED OPTICAL SYSTEMS, saving great time and labor in early stages of lens design, have been developed on Armour Research Foundation's IBM 7090 computer. An optical system of nothing more than lens blanks can be the starting point for the design. All that is needed are final design-characteristics; the computer will refine the original system. The new designing method will help to determine manufacturing tolerances of high-performance optical components. Tolerances were once determined by trial and error. Research programs have been completed for analysis of existing optical systems.

ELECTRONIC INDUSTRIES ASSOCIATION, speaking through Norman A. Triplett, Distributor Relations Committee chairman, has voiced concern over a proposed change in the Small Business Administration's definition of the "small business nonmanufacturer" for government procurement. Triplett, vice president of Triplett Electrical Instrument Co., said that the proposed $2,000,000 annual volume limit is unrealistic to distributors. Many who qualify under the current 500-employe rule would be disqualified, and the smaller distributors doing less than $2,000,000 business would be unable to give the large inventories and quick service now available to Government contractors.

POWERFUL LIGHT BEAM

Westinghouse has developed world's hottest light beam, using super-sun-heat, high-pressure plasma jet sealed in a stainless steel vessel good up to 600 lbs. sq. in., including an elliptical mirror that beams three-fourths of energy through quartz lens. Beam can burn through steel in two seconds.

TRANSISTOR RADIO IMPORTS did not put 250 radio workers out of work at Philco's Sandusky, Ohio, Radio Plant, rules the U. S. Tariff Commission. The workers, through the International Union of Electrical, Radio and Machine Workers, had petitioned for adjustment assistance when Philco announced closing down of the Sandusky plant and shifting of its radio making to Plant 10 in Philadelphia. The workers blamed transistor radio imports for the plant closing. The Commission found (1) transistor radio imports are increasing (2) increased imports are not due in large to trade-agreement concessions (3) increased imports are not the major factor in closing of the Philco plant.

INTEGRATED CIRCUITRY MARKET should reach $1.2 billion by 1970, according to Dr. Robert L. San Soucie, vice president of Emerson's Electronics and Space Division. "Recent estimates place the integrated circuit market in 1970 at $780 million; but they do not include thin films. It is reasonable to assume that the problem of depositing active devices will be solved by then." He listed three main challenges facing systems designers and developers in the next 10 years: (1) develop and train engineers to invent circuits using unexploited substrate material features. (2) to integrate or not? Large firms will provide their own circuits. Small firms will buy blocks. The medium-sized firm will face a dilemma. (3) to develop component and subsystem test equipment philosophy, procedure and quality, giving customers assurance on over-all system reliability.

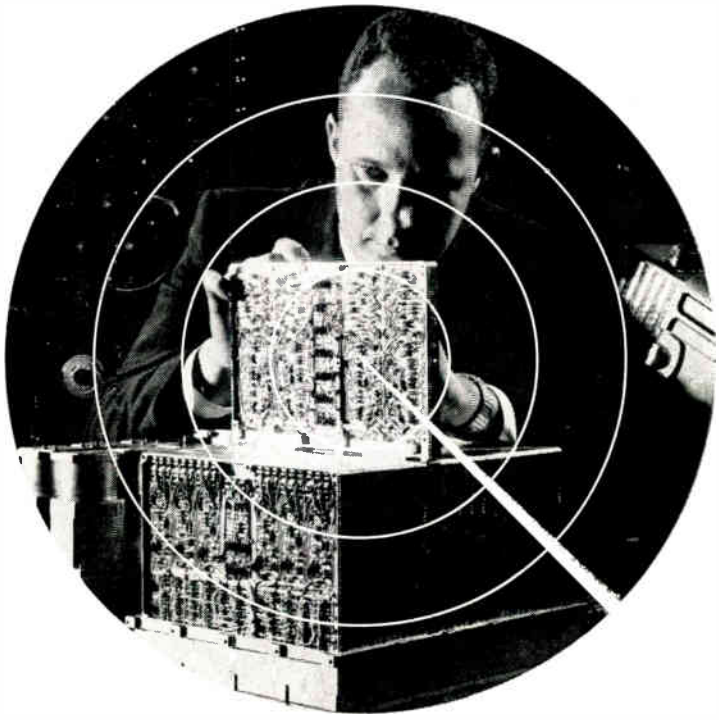
RADIO THROUGH ROCK is being pushed hard by DOD. Scientists at Air Force Cambridge Labs and in industry are stepping up efforts to perfect an underground radio system to link below-ground-level command posts with missile sites. Military planners admit that such posts are useless unless they can receive orders without jamming. Plans include a system of antennas buried a mile or more down to transmit RF signals through rock strata of the earth's crust. One scientist remarked that given suitable insulating rock, highly resistant and moisture-free, communications could be maintained half-way around the world. Signals would be much harder to jam and almost impossible to intercept. They would be immune to bombs.

MEDICAL ELECTRONIC EQUIPMENT of many types is being viewed for increased usefulness and application by St. Joseph's Hospital, Paterson, N. J., and DuMont Laboratories, division of Fairchild Camera & Instrument Corp. An agreement between DuMont's Medical Instrumentation Department and the hospital includes meetings, consultations, investigating and testing of new devices. Among specialties in the joint effort are artificial organs (total replacement of and supportive devices for), monitoring and stimulation of body functions, data storage and retrieval, diagnosis, and closed-circuit TV for communications and training.

NEW METALFORMING TECHNIQUE developed by General Dynamics Corp. uses split-second bursts of electromagnetic force to attach, shape, and assemble light to medium gauge electrically conductive metals. Major advantage is that tremendous speed of operation—20 millionths of a second—allows Magneform machine to deliver great force to work piece with only relatively small amount of energy transfer.

LASER CONTROL TECHNIQUE

RCA has disclosed a new means of internal control for beams emitted by solid-state lasers. The technique uses magnetic fields to turn, modulate and pulse the light from crystal lasers as the light is generated, and may lead to practical communications and radar pulsed at 100,000 times a second.



CENTAUR COMPUTER CHECKOUT

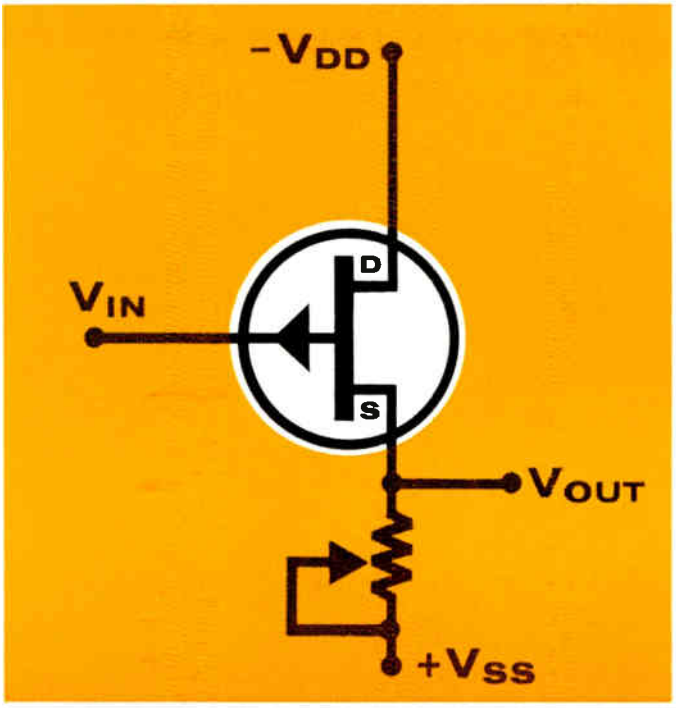
Technician checks circuit card of computer for NASA's Centaur spacecraft. The computer, gold-plated to minimize effects of extreme temperature change, is produced by General Precision. A $1.5 million contract with NASA calls for six solid state flight computers to guide Centaurs in planned space flights.

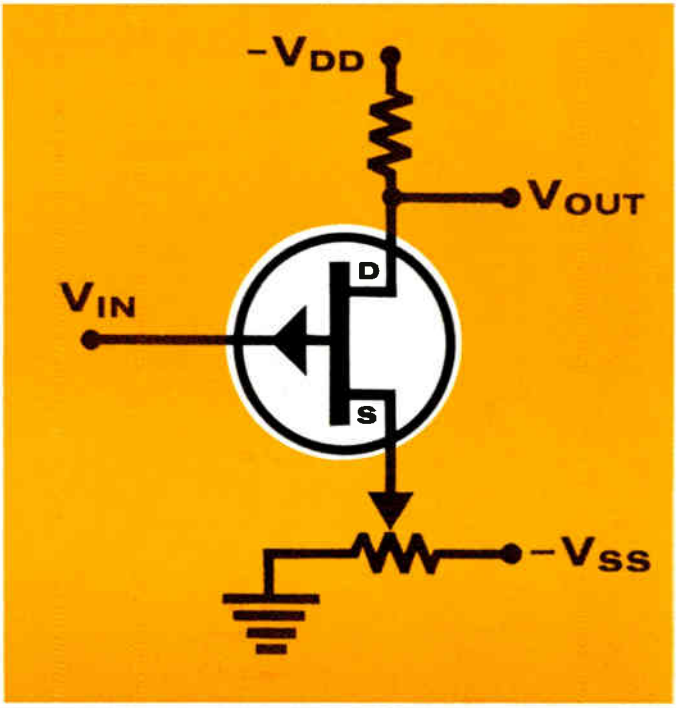
ELECTRONICS INDUSTRY has been challenged to invent a new home product which, comparable to radio and television, would make life easier, more pleasant and up our standard of living a notch. The challenge was made by L. Berkley Davis, G.E. vice president, who declared that the industry can offer the consumer something else that the American home will need—something entertaining, as educational or as useful as radio and television. "I don't know what it is but I challenge you to find it." With this new product the electronics industry could "see a future in the consumer market every bit as exciting as television has made it in recent years."

GROUND-BASED LASER BEAM will be reflected back to earth from the S-66 beacon satellite by 360 fused-silica corner reflectors. Corning Glass made the fused silica and Boxton-Beel, Inc., of Brooklyn, made the reflectors to be used in NASA's S-66, marking the first attempt at tracking a satellite with a pulsed ruby laser beam. The corner reflectors could last 60 years in space before radiation darkened them beyond usefulness. Fused silica resists browning under radiation and has near zero thermal expansion plus excellent optical properties. With future satellites, laser beams are envisioned as carriers of large amounts of space information.

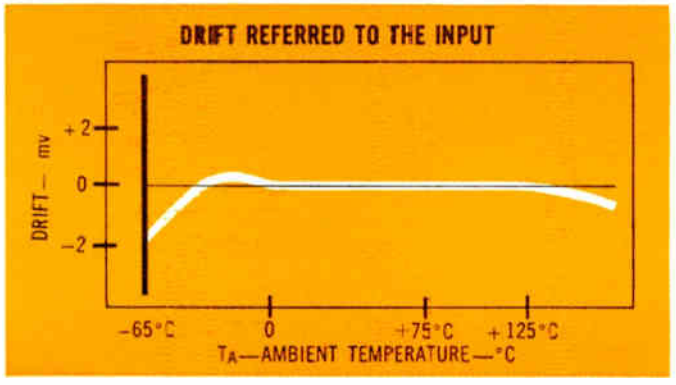
(More RADARSCOPE on Page 11)

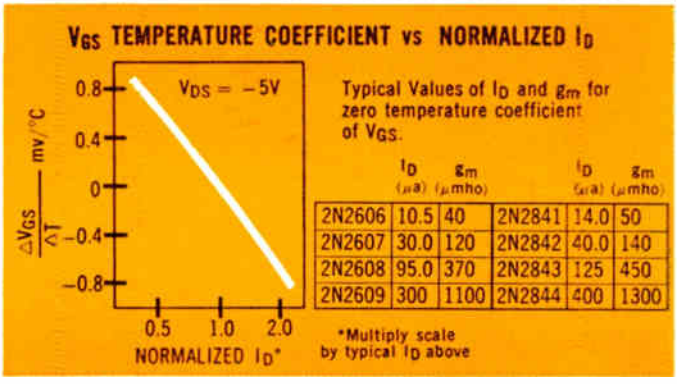
How to put Siliconix UNIFETs* to work . . .





DRIFT— LESS THAN 1 mv/100°C





	ID (μa)	gm (μmho)		ID (μa)	gm (μmho)
2N2606	10.5	40	2N2841	14.0	50
2N2607	30.0	120	2N2842	40.0	140
2N2608	95.0	370	2N2843	125	450
2N2609	300	1100	2N2844	400	1300

YOU NO LONGER HAVE TO MONKEY WITH DIFFERENTIAL AMPLIFIERS, MATCHING TRANSISTOR PAIRS, BATTLING STEADY STATE AND TRANSIENT THERMAL GRADIENTS. HERE IS A HIGH-INPUT-IMPEDANCE D-C AMPLIFIER THAT CAN BE BIASED TO NEARLY ZERO $\triangle V_{GS}/\triangle T$. UNIFETS ARE RADIATION TOLERANT, TOO. WRITE FOR FILE 100C. IT EXPLAINS THE WHOLE THING.

*Unipolar Field-Effect Transistors

Siliconix incorporated

1140 West Evelyn Ave. • Sunnyvale 14, California
Telephone 245-1000 • Area Code 408 • TWX 408-737-9948

RADARSCOPE

TWO-DIMENSIONAL COMPUTERS — high-speed, modular machines—are forecast by Walter W. Finke, president of Honeywell Electronic Data Processing. Computer role will remain important but total system, the new way of handling data, will be of greater importance. Computer "families," expandable vertically and horizontally to meet growing needs, will appear. High modularity and compatibility will permit small starts and easy expansion vertically. Horizontally, peripheral units will grow in importance in providing data. Job content will change at various management levels. New and unusual applications are creating new EDP management units. Managers will have more time to pursue creative and intangible aspects, as data collection, handling and interpretation functions are relegated to machine systems.

COPPER SPACE NEEDLES, 400 million of which are forming a radio space reflector 2,300 miles above us, will be destroyed within the next five years, says the Air Force. Project officials believe the orbiting belt of tiny copper fibers eventually will be "pushed" back into the atmosphere by sunlight and will burn up. Air Force hopes the short-life prediction will calm fears of "contaminating" space. According to predictions from astronomers, the needles, orbited in May, will completely circle the earth and become thoroughly intermixed by the middle of July. Designed for experiment with extremely short radio waves between two points on earth, some sources believe that the needles will not appreciably absorb incoming radiation of interest to astronomers.

ALTERING OF LASER FREQUENCIES by passing laser's beam through liquids and crystals has been achieved in the Ford Laboratories. The discovery allows laser beam control for communications and underwater radar in varied frequencies, since laser beams alone operate only in the red and infrared ranges. When a beam is passed through liquid nitrogen the frequency drops. When passed through a crystal the frequency is raised. By using various liquids it may be possible to produce beams of almost any desired frequency. Some scientists believe that a laser beam altered to green or blue frequencies may be used for underwater radar. To amplify laser signals, scientists suggest passing laser beam photons through a liquid with symmetrically shaped molecules, benzene for example.

MICROPOWER-LEVEL EQUIPMENT is forecast in a report from NASA's Lewis Research Center. A complete logic system with a power consumption of 10 microwatts per stage can be built for space craft using two newly developed micropower transistor logic circuits. Operating ranges of the circuits range from one to 100 Kc. and at power levels from one to several hundred microwatts. Microminiaturization problems, especially from heat, can be reduced with the micropower circuits. The report describes circuit analysis, parameters, design criteria, limitations and a variety of logic elements.

THERMIONIC CONVERTER, designed by RCA, has been tested successfully in the nuclear reactor at the Babcock & Wilcox Nuclear Development Center in Virginia. The converter, with an emitter area of 60 sq. cm., delivered a total of 38.5 Kw-hrs. during its 305-hour test, just over the 300-hour life required in the Navy Bureau of Ships contract. A brief peak 157 watts was reached as heat from nuclear fuel was converted into electricity at 10% efficiency. The converter, operated at 1350°C, advances progress in practical nuclear-thermionic power for many applications, such as a compact, reliable power source in an ocean bottom environment.

(More RADARSCOPE on Page 13)

COMBUSTION EXPERIMENTS FOR APOLLO

Some 115 materials that may be used in Honeywell-developed Apollo stabilization and control system are being tested for ease of ignition, duration and effect of burning, and toxicity of burn-products in a space capsule atmosphere. Here, technician observes overheat effect on an epoxy adhesive.

A little over a year ago, when Reeves first announced the production of Size 23 Synchros and Resolvers with 30 second accuracy, they were hailed as a major design breakthrough.

Today, 20-second units are available in production runs in the new HI-AC series of data transmission resolvers and synchros . . . 0.01% functional accuracy in the HI-AC compensated computing resolvers.

These instruments permit the design of highly accurate, yet greatly simplified, data transmission systems. Elaborate two speed synchro systems, or equally complicated digital encoder systems, can be dispensed with, because the desired accuracy is inherent in the HI-AC synchros themselves. Reliability is immeasurably improved, maintenance cut to a minimum; and space, weight and cost greatly reduced.

The Reeves HI-AC Series are the only Size 23 Resolvers and Synchros currently available in production quantities with this high order of accuracy. For complete information, write for Data File 307.

Qualified engineers who are seeking rewarding opportunities for their talents in this and related fields are invited to get in touch with us.

Reeves

REEVES INSTRUMENT CORPORATION

A Subsidiary of Dynamics Corporation of America, Roosevelt Field Garden City, New York

10RV63

RADARSCOPE

DATA BITS DISPLAYED IN COLOR, known as Color-Data, was unveiled for the first time by ITT in test transmission by telephone wire. Huntsville, Ala., queried ITT 7300 ADX System, in Paramus, N. J., which searched its memory and sent back data using Bell's Data Set 402, which transmits 8 levels of 600 bits per second. The data were fed into a datachrome projector and converted to alpha-numeric form in seven colors; query to color took mere seconds. The projector uses 35 MM black and white film; colors are had by separating white light with mirrors and recombining the prime colors. The heart of the whole set-up is the 7300 ADX.

MICROCIRCUITRY COMPETITION is now impossible to predict in view of the tremendous possibilities for further invention in both thin film and solid state silicon circuit techniques, reports Dr. C. G. Thornton, advanced development manager at Philco's Lansdale (Pa.) Division. New technology is appearing so rapidly that any talk about relative merits of one approach must include its impending changes. To remove limitations of thin films and solid silicons, Philco has found a way to insert active chips over substrates with electrodes alloyed directly to the thin film lands. A longer range project involves thin film active elements, such as field effect transistors and "hot electron" amplifiers, made directly from thin film materials. Dr. Thornton noted that hybrid construction is a partial solution to silicon's problem of changing electrical characteristics as temperature varies.

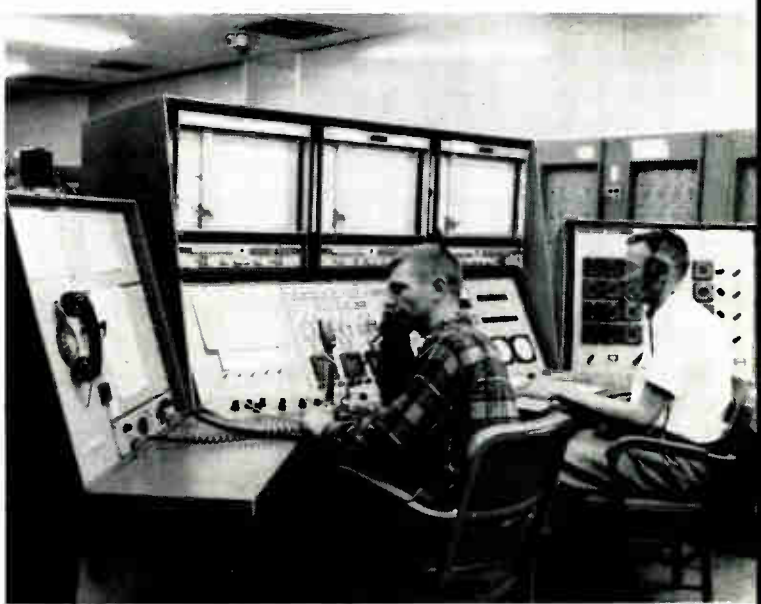
ATOMIC POWER TECHNOLOGY has turned the economic corner, making nuclear-reactor-produced electricity competitive with standard fuel plants. Developing mostly within the past six months, the gradual switch to nuclear power, using the water-cooled type of reactor, has been growing across the nation. Late in 1962, four major power companies contracted with Westinghouse for reactors to produce a total of 2,135,000 kw. Up to that time, the greatest civilian output capacity, building or built since 1954, was 1,516,000 kw among 23 reactors! Utility companies in many states, among them Hawaii, Minnesota, Nevada and several east coast states, are now looking into the atom and its potential.

NEW COMMUNICATION TECHNIQUE, demonstrated by MIT's Lincoln Laboratory, can transmit digital messages on toll-grade telephone circuits at rates three to four times as fast as current high-speed digital data transmission systems. Even at these high rates of speed, the technique affords almost complete protection against errors in transmission and reception. Known as SECO, the technique depends on equipment designed and built at Lincoln. The actual technique is sequential coding and decoding by which SECO can automatically detect and correct message errors and adjust its own transmission rate.

IMAGE ELECTRONICS is becoming one of the most useful tools in the hands of man, and in time will overshadow all other purposes, according to Dr. Elmer W. Engstrom, RCA president. In referring to opportunities, Dr. Engstrom said, in effect, that no field is more useful potentially than visual electronics, and there is no corner of the universe that can not one day be explored by electronic eyes. He also cited a pressing need for "inexpensive and inexhaustible energy sources," electronic experiments in plasma and other areas may one day tap unlimited powers of nuclear fission.

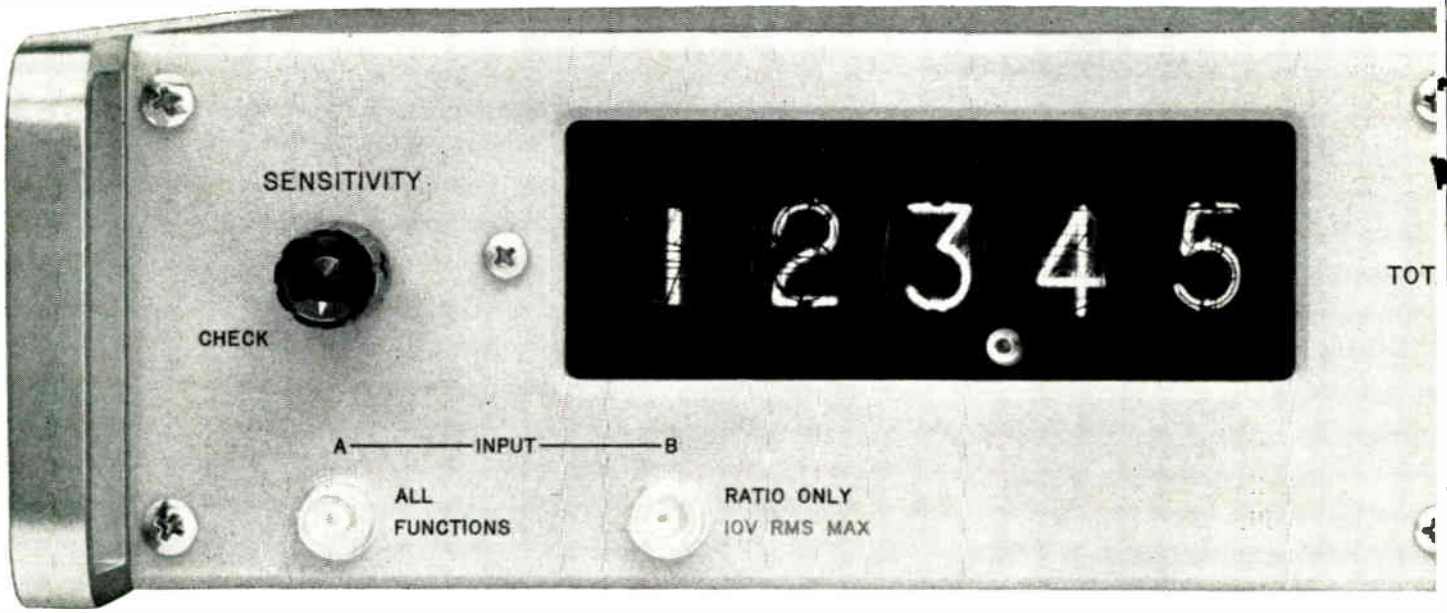
SUPER-ACCURATE YARDSTICK

An advanced GE tracking system — MISTRAM (Missile Trajectory Measurement) — gives Cape Canaveral greater ability to predict missile impact down Atlantic Missile Range. It also improves Air Force performance evaluation. The system is a huge "L" with one leg 19 miles long and includes 5 stations.



Direct readout in:

gpm, rpm, psi...



Measure, normalize, control... with the new

Today's most versatile electronic counter, in addition to measuring frequency and period and totalizing:

measures normalized rate

measures normalized time (period)

measures ratio

measures normalized ratio

measures time for N events to occur

counts N events, providing an output pulse at the start and end of the count

N may be set to any integer from 1 to 100,000

Gallons per minute, pounds per hour, revolutions per second or minute — any event that can be converted to an electrical pulse can be measured in the exact units that are most helpful to your application. The ability to select gate times on the hp 5214L Preset Counter permits normalizing of any measurement.

For example, connecting a tachometer generator to a rotating shaft produces an output which is applied to the counter. Presetting the counter gate permits direct measurement of rps or rpm. Thus, if the tachometer generator produces 100 pulses per revolution, the gate would be set at N = 1000 (0.01 sec) to measure rps or N = 600 (0.6) sec to measure rpm.

Besides making measurements common to most universal counters, the 5214L measures N periods; measures ratio; measures normalized ratio; measures time for N events to occur; counts N events. This versatility is achieved by using two sets of decades, one of which registers the signal being counted, the other, which may be preset to any integer from 1 to 100,000 by front panel thumb-wheel switches, controls the gate. The number N also may be remotely programmed. Separate output signals are available to operate external equipment whenever the gate opens or closes. Since the 5214L can count N events, it is particularly useful in batching.

The 5214L measures ratio over a wide range of frequencies and with a wide choice of normalizing factors. The reading displayed is N x A/B x Multiplier. Hence, input B can be used as an external time base input for extending gate time or for normalizing an input signal so that percent change of input signal A may be read directly. The 5214L measures the time in milliseconds for N events to occur—period and multiple period measurements are made easily.

The solid state 5214L incorporates display storage, for continuous display of the most recent measurement and a flicker-free presentation on long life rectangular Nixie tubes. The four-line BCD code output with assigned weights of 1-2-2-4 is convenient for systems use.

Call your Hewlett-Packard representative for assistance in applying the remarkable 5214L Preset Counter to your particular measuring, recording and control problem. He will offer a demonstration at the same time.

you name it!

hp 5214L UNIVERSAL PRESET COUNTER

SPECIFICATIONS

FUNCTIONS

Totalize (input A): Range, 2 cps to 300 kc; sensitivity, 0.1 volt rms sine wave; 1 volt negative pulse, 1 μsec minimum width; gate time, manual control; input impedance, 1 megohm, 50 pf shunt; capacity, 99,999 counts x Multiplier (1, 10 or 100); check, counts 1 kc, 100 cps or 10 cps

Rate (input A):

10 μsec to 1 sec, 10 μsec steps
100 μsec to 10 sec, 100 μsec steps
1 msec to 100 sec, 1 msec steps

Preset (input A): Input frequency range, 2 cps to 100 kc; preset range, 1 to 99,999; outputs, –30 volts to –1.3 volts transition at gate opening and gate closing; check, 100 kc counted, reads N

Time (input A): Input frequency range, 2 cps to 100 kc; reads, time for N events in msec; period and multiple period, reads time in msec for N periods; time base, 10 μsec, 0.1 msec, or 1 msec; accuracy, ±1 count ± time base accuracy ± trigger error*; check, 100 kc counted, reads time in msec for N cycles

Ratio (input A & B):

Input A: Frequency range, 2 cps to 300 kc
Input B: Frequency range, 2 cps to 100 kc; sensitivity, 0.1 volt rms sine wave; input impedance, 1 megohm; reads, $\frac{NA}{B}$ x Multiplier; accuracy, ± count; check, reads N x Multiplier (requires an input to B)

TIME BASE STABILITY

Internal:

Aging rate, < ± 2 parts in 10^6
+15°C to +35°C, < ± 20 parts in 10^6
–20°C to ±65°C, < ± 100 parts in 10^6
Line Voltage ± 10%, < ± 1 part in 10^6

GENERAL

Maximum Counting Rate: 300 kc**

Registration: 5 long-life rectangular Nixie tubes with display storage

Sample Rate: Time following a gate closing, during which gate cannot be reopened, is continuously variable from less than 0.2 sec to greater than 5 sec in rate mode

Operating Temperature: –20 to +65° C

Dimensions: 16¾" wide, 3-13/16" high, 13¼" deep

Printer Output: Output, 4-line BCD (1-2-2-4); 1-2-4-8 code on special order; print command, step from –29 volts to –1 volt

Price: $1475

*Trigger error (sine wave) = $\frac{0.3\% \text{ of one period}}{\text{number of periods}}$ for 40 db signal-to-noise ratio. Trigger error decreases with increased signal amplitude and slope.

**See detailed specifications under Functions

Data subject to change without notice. Price f.o.b. factory.

8475

HEWLETT PACKARD COMPANY

1501 Page Mill Rd., Palo Alto, Calif., (415) 326-7000. Sales and service representatives in principal areas. Europe, Hewlett-Packard S.A., 54 Route des Acacias, Geneva, Switzerland; Canada, Hewlett-Packard (Canada) Ltd., 8270 Mayrand St., Montreal, Que.

Circle 8 on Inquiry Card

PROGRESS REPORT on ALSIMAG® CERAMICS

MINIATURES
held to close tolerances without grinding

These AlSiMag parts are from present volume production without grinding. Significant dimensions and tolerances are indicated.

Continued gains in this area of precision production are of special interest to engineers working on micro-miniaturization. These are four primary advantages:

1. Steady, large volume production is possible.
2. Cost.
3. In many applications, the virgin surface of the ceramic has favorable electrical characteristics which would be modified by grinding or lapping.
4. Some intricate or difficult designs now become practical, though precision may not be of primary importance.

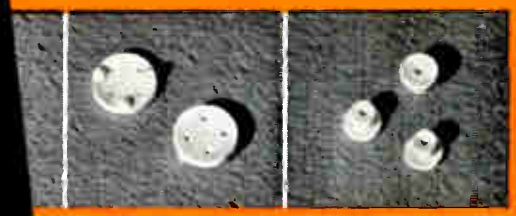
There are so many size and design configurations that it has not been possible to develop general statements covering the exact tolerances obtainable without grinding. These actual examples seem to be the best indicators.

Cooperation between your designers and our production engineers has often resulted in developing dimensional specifications acceptable to both groups. A complete statement of operating requirements is essential.

PRECISION METALLIZATION

Encouraging progress is being made on certain types of close tolerance metallization particularly in small sizes. If you have a requirement in this field, we suggest current inquiry.

Illustrations approximately actual size.



Holes .022 ±.002
Hole Centers .200±.005

Shank O.D. .127 ±.001
Hole .043 ±.001

O.D. .275 ±.005
Length .140 ±.005

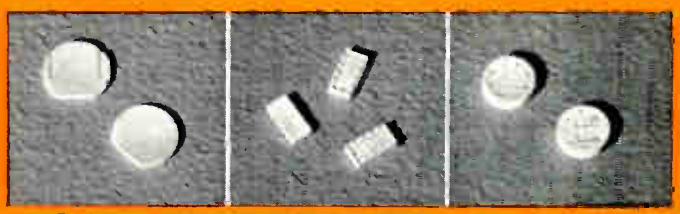
O.D. .475 $^{+.000}_{-.004}$
Thickness .080 ±.002

O.D. .325 ±.002
Thickness .100 ±.002
Hole .253 ±.002

Shank O.D. .118 ±.002
Hole .035 ±.003
Hole Centers .200 ±.003

.250 ±.003 Square
Thickness .020 ±.002

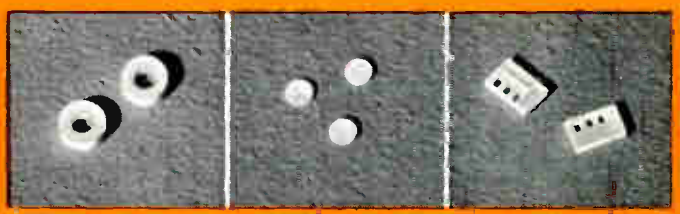
O.D. .205 ±.002
Hole .043 ±.001



Thickness .040
Slot Width .020 ±.002
Slot Depth .020 ±.002

Length .251 ±.002
Width .124 ±.002

O.D. .275 ±.0015
Holes .020 ±.0005



Thickness .089 ±.001
Hole .125 $^{+.0015}_{-.0000}$

O.D. .150 ±.005
Thickness .020 ±.002

Thickness .030
Width .170 ±.005
Length .280 ±.005

O.D. .120 ±.005
Thickness .032 ±.005
Counter Bore Diameter
.090 ±.005
Counter Bore Depth
.012 ±.002

O.D. .211 ±.002
Holes .031 ±.002
Thickness .055 ±.005

O.D. .235 $^{+.000}_{-.250}$
Holes .020 ±.002

American Lava Corporation

A SUBSIDIARY OF 3M COMPANY

PHONE 265-3411, CHATTANOOGA 5, TENN.

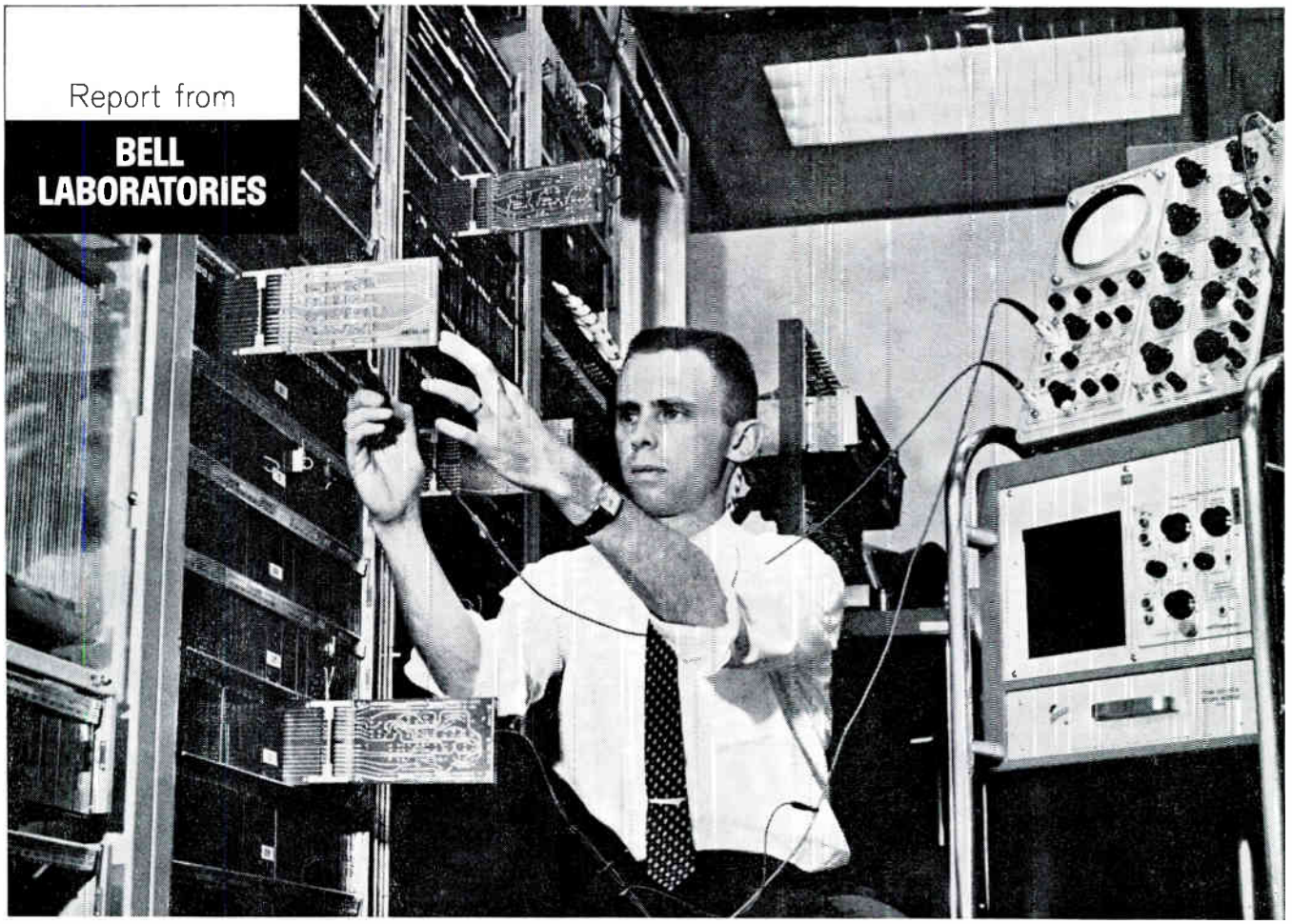
62nd YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining and Manufacturing Co. in these cities (see your local telephone directory): Boston: Needham Heights, Mass. • Chicago: Bedford Park, Illinois • Cleveland, Ohio Birmingham, Mich. • Laurens, S. C. • Los Angeles, Cal. • Minneapolis, Minn. • Metropolitan New York: Ridgefield, N. J. Up-State New York: Newark, N. Y. • Philadelphia, Pennsylvania • Richardson, Texas • South San Francisco, California **All export except Canada:** Minnesota Mining and Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

Circle 9 on Inquiry Card

Report from

BELL LABORATORIES



Bell Laboratories' E. G. Hughes tests printed circuit boards in experimental central office control equipment for 101-Electronic Switching System. The system automatically detects trouble, switching out a defective unit and switching in a duplicate unit so service is not interrupted.

High-Speed Switching System Provides New Telephone Services for Business

A new electronic switching system designed to meet the special needs of business customers has been developed at Bell Telephone Laboratories. This system provides many new telephone services such as a way for reaching a seven- or ten-digit number by dialing only three digits, setting up conference calls by dialing other customers into the conversation, and automatically transferring incoming calls from your phone to another by predialing special codes.

A notable feature of the new system is a high-speed control unit. Operating from a telephone switching center, the unit scans—thousands of times per second—all the telephone connections in dozens of business offices that may be located many miles apart. It spends only two-thousandths of a second in each office, but in that time it determines what has to be done and arranges for the necessary actions.

Another feature of the new system is the high-capacity memory. From this, the control unit can draw, in eight-millionths of a second, such specific instructions as how to handle a certain call.

The new switching system operates compatibly with existing electromechanical switching systems in the Bell System. Such Bell Laboratories inventions as the transistor are indispensable to its compactness and the high reliability of its operation. The system was developed for use by businesses as a private branch exchange, and a model has been installed by Western Electric for trial by two New Brunswick, New Jersey, companies.

BELL TELEPHONE LABORATORIES

World center of communications research and development

Objectivity

If you're tired of hearing about the "perfect" printed circuit connector, you're just the man we want to talk to.

We're here to offer you freedom of choice, because that's where objectivity begins. The boy blowing his last penny on candy wants to be able to choose between the 30-second delicacies and the stuff that lasts all afternoon. It's licorice versus jawbreakers, root-beer-barrels versus bubble-gum. They're all good, but none are perfect.

That's why we make such a variety of printed circuit connectors. Each type and style has its own special bailiwick. They're all "perfect" when they're applied properly.

OUR NEW BELLOWS-TYPE

Take the new Amphenol 225-series. This bellows-type connector has the smoothest, gentlest, most efficient mating action you'll find anyplace. Even after thousands of insertions, the delicate conductive surfaces of the printed board are unscathed by the 225.

The 225-series has remarkably low contact resistance, too. For the solder terminated style, it's under 25 millivolts at 5 amperes.

The bellows-type contact on the 225-series is split down the middle. You get two contact points for every interconnection. This helps keep the contact resistance low, of course, but it also conforms readily to irregular mating surfaces.

The 225 is convex. It meets and mates the printed circuit board with a wiping action that assures contact.

AND, FURTHERMORE

The 225-series contact is self anchored in the connector body. Contact faces will not distort at the slightest pull on the terminals.

The 225-series has twice the flexing range that you'll find on other bellows-type contacts. This means you can rock the board twice as far with no danger of contact distortion.

The 225-series does not waste valuable contact space with a polarizing key. The key is sandwiched in between contacts.

The 225-series can be terminated with solder lugs, taper pins, removable crimps, or Wire-Wrap* terminals.

Contact styles? Contact positions? Mounting provisions? Well, let's just say that there are over 100,000 combinations available in the Amphenol 225-series bellows-type connector.

WHO NEEDS IT?

And now for the facts of life. Some people simply don't need the 225-series. Some printed circuit boards are inserted once and never disturbed again. Some printed circuits are never subjected to pull on the terminations. Some printed circuits are not really so delicate that they must be protected from contact wear. Some printed circuit boards never get rocked. And in some applications, the space taken up by a conventional polarizing key is of no consequence. And so forth.

And that is why Amphenol makes Prin-Cir® connectors, Micro-Edge® connectors, Micro-Min® connectors, and specials that haven't been named yet. They are all printed circuit connectors. They are all "right" where the need dictates their use.

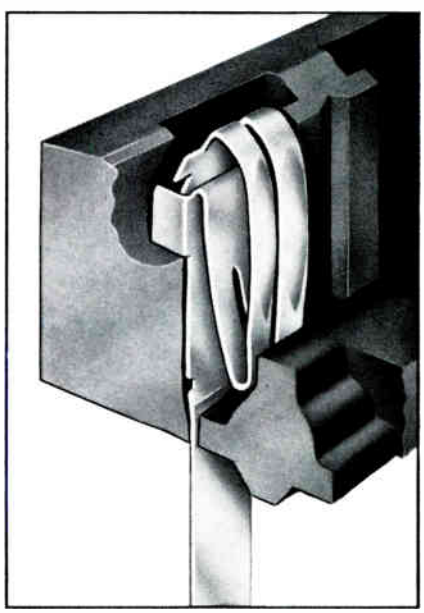
The hero of this story is the Amphenol Sales Engineer. He's the only man who has access to a complete line. Thus he's the only man who can look you in the eye and tell you exactly which printed circuit connector you need. Objectivity.

You won't hear Amphenol Sales Engineers telling you about perfect connectors. They don't have to. They know better.

*T.M. Gardner-Denver Co.

DETAILS, DETAILS

If you're *really* interested in seeing what a complete line of printed circuit connectors looks like, we invite you to write for our new 20-page catalog PC-1. Just contact your local Amphenol Sales Engineer, or write to Dick Hall, Vice President, Marketing, Amphenol Connector Division, 1830 South 54th Avenue, Chicago 50, Illinois.

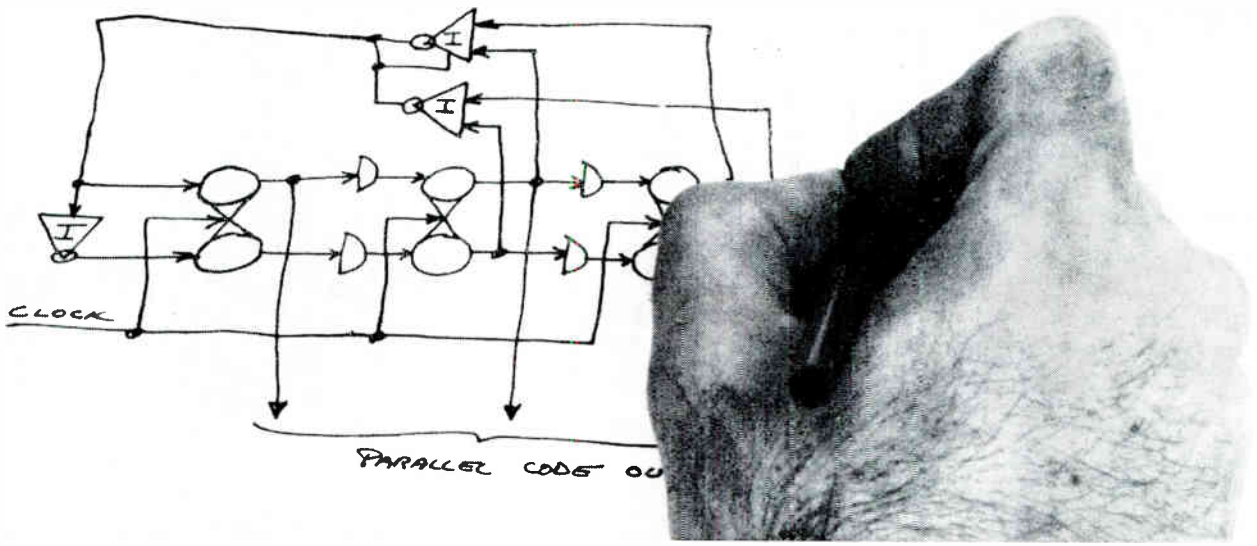


Problem: To make contacts that give an extremely low millivolt drop, yet do not mar printed circuit conductors, even after thousands of insertions.

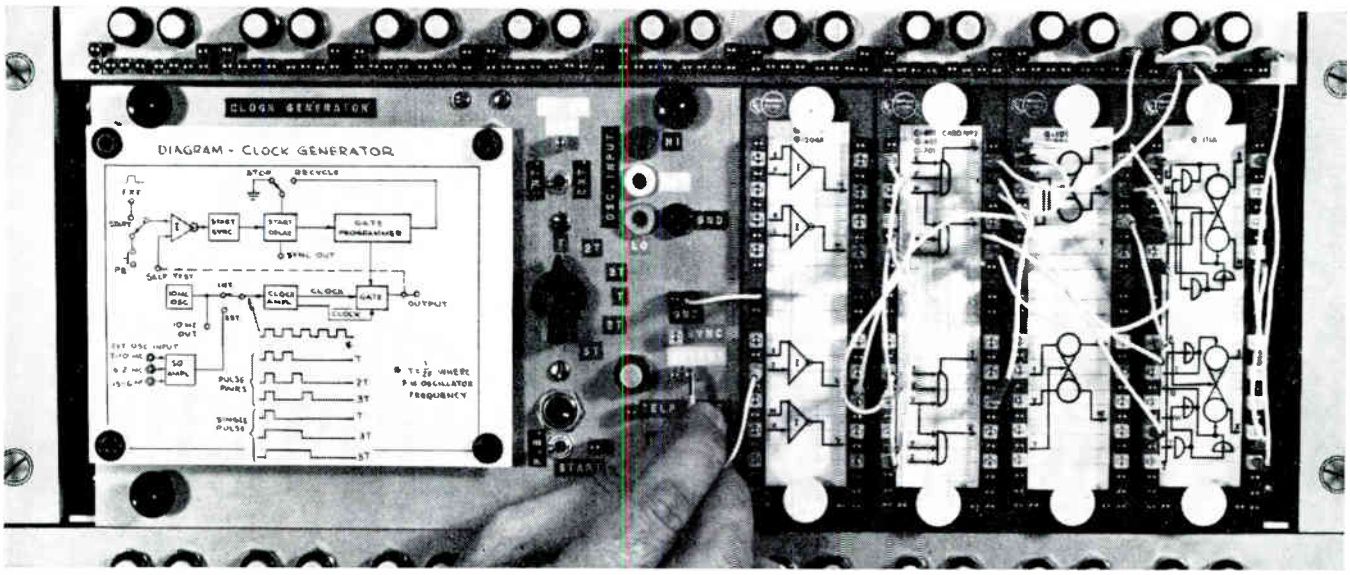
Solution: Bifurcated, convex faces for sure contact. Double spring action with wide flexing range. Then double-plate and polish so smooth they caress the mating surface.

AMPHENOL ***Connector Division*** / Amphenol-Borg Electronics Corporation


LATIKINS
BIG CHOICE
SUCKERS



WILL IT WORK AT 10 MC?



FIND OUT FAST WITH AN EECo HIGH-SPEED DIGITAL SYSTEM BREADBOARD

It looks good on paper. Now—what will be the effect of clock duty cycle? Wiring? Propagation delay?

You can get the answers *fast* with EECo system breadboard equipment—an exceptionally simple means of formulating and testing digital electronic circuits at clock speeds to 10 Mpps.

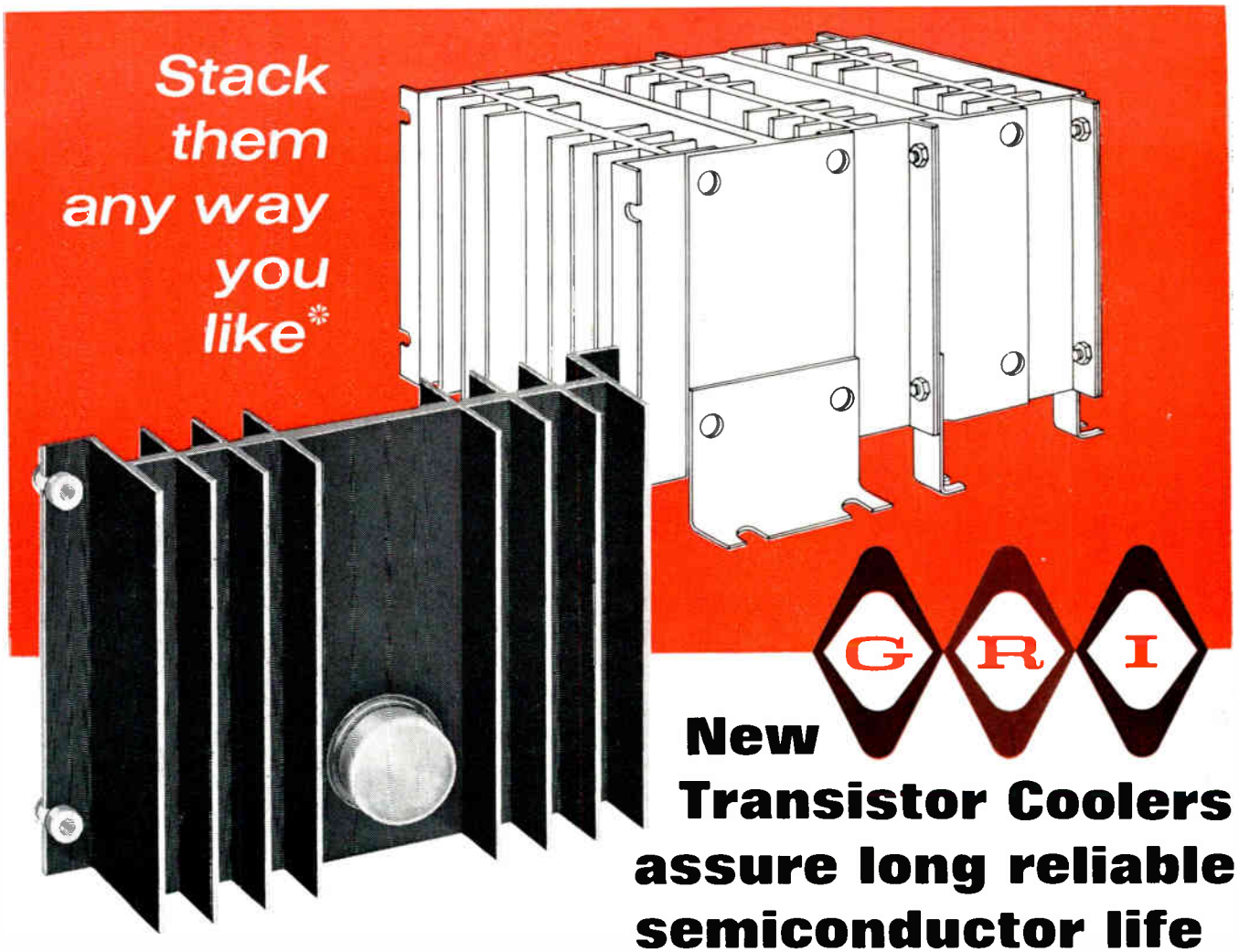
This versatile transistor equipment lets you patch up trial circuit combinations with the same catalog modules that go into the final system, perform tests at operating frequencies by pushing a button on the control panel, and get a "stop-action" look at the over-all logic flow.

The built-in clock generator permits fast set-up of a wide range of test conditions, and indicators give you an immediate reading on any part of the circuit. Plastic symbol cards further speed your work by giving you a road map of the system as you put it together.

You may operate the system slowly to check individual operations or at end-system speeds, introducing high-speed pulses either singly or in pairs. If you want to try an alternative design idea, a few minutes of patching will make your brainstorm a reality.

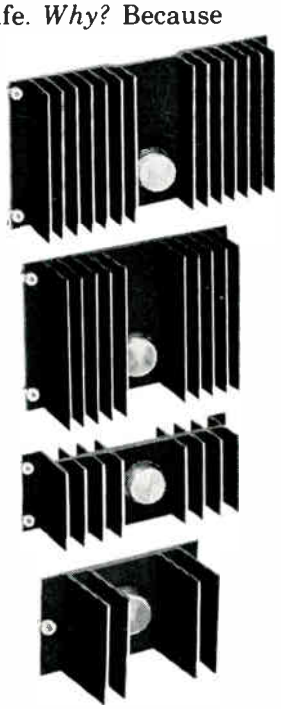
Discover for yourself this speedy route from paper to prototype. Write for our new breadboard brochure today.

ENGINEERED ELECTRONICS Company
1441 East Chestnut Avenue, Santa Ana, California
Telephone: 547-5651 Cable Address: ENGELEX



New Transistor Coolers assure long reliable semiconductor life

GRI lets you take control of the parameters which affect junction temperatures... lets you steer these temperatures to levels which will assure long, reliable semiconductor life. *Why?* Because GRI considers the *complete* heat dissipation problem. Here's what we mean:



Part 1--The GRI Heat Sink Line

The present GRI line contains 5 finned heat dissipators, available in several different models. For each of these models, careful engineering has established the optimum surface area, number of fins, fin size, fin spacing and fin configuration. As a result you are assured of maximum heat transfer per ounce of dissipator weight and square inch of surface area.

Part 2--Solving Insulation Problems

For the first time, GRI makes it possible to mount heat dissipators directly to the chassis without efficiency-robbing insulation. This problem has been solved by fabricating a special insulating material (Be.O.) with good heat transfer efficiency and high dielectric strength directly into the transistor mounting area. This integral insulation (patent applied for) eliminates two major barriers to thermal conductivity: (1) Need for using a mica or other wafer-type insulator; (2) Need for insulating heat dissipator from chassis if wafer insulation is not used. Additional efficiency is gained by surface grinding the insert material to perfect flatness. This allows the intimate interface contact necessary for maximum lowering of junction temperatures.

*Part 3--Shrouds and Stacking System Patent Applied For

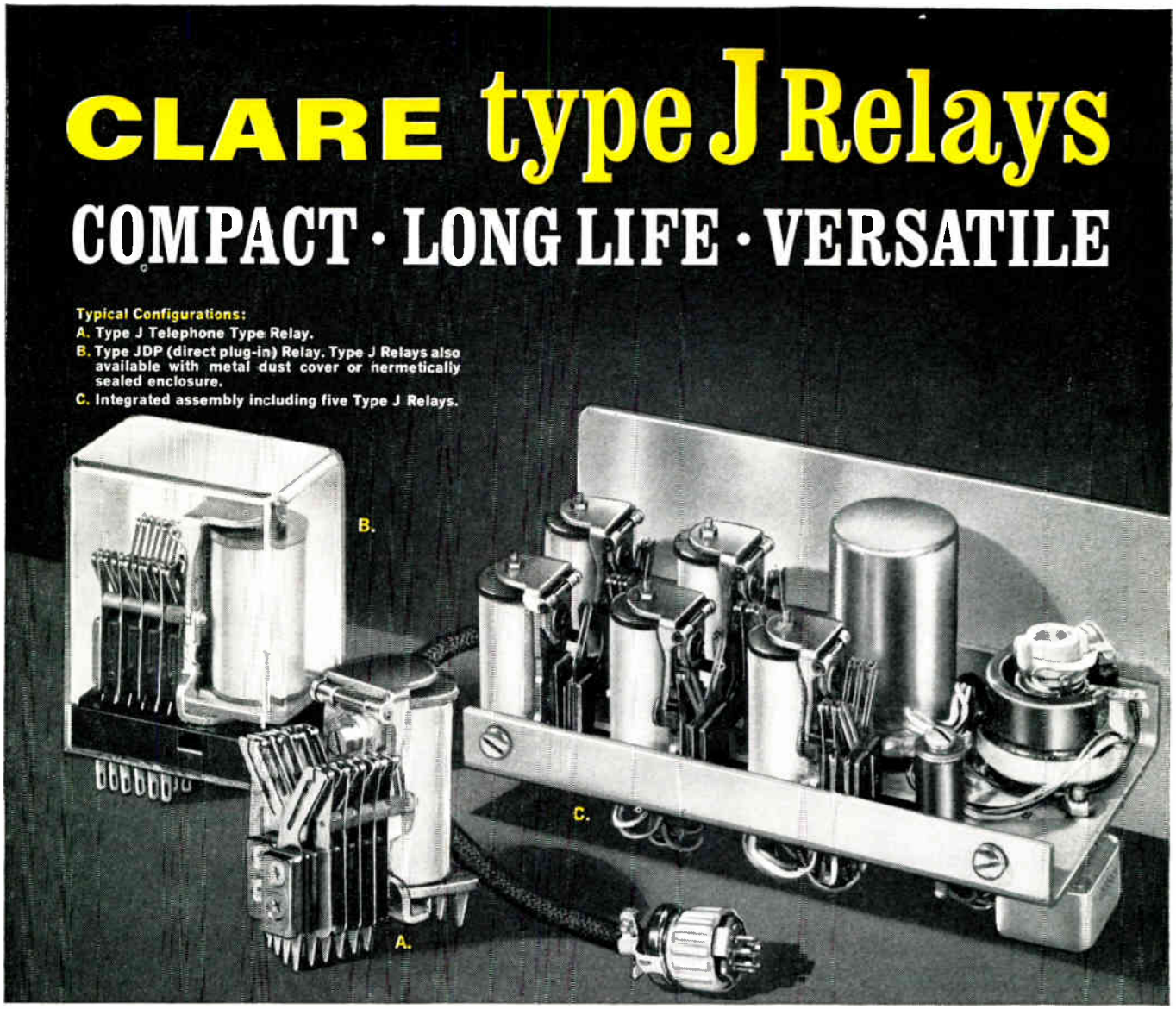
By using the "chimney effect" (i.e. a shroud specially designed to direct maximum air flow past the dissipating fins) it is possible to *improve heat transfer efficiency by more than 25 per cent with natural convection conditions.* And, GRI is the first to let you take advantage of this proven efficiency booster. A complete line of shrouds and mounting brackets is available for GRI transistor coolers. GRI shrouds and mounting brackets give you extra flexibility by allowing any number of coolers to be "stacked" (see illustration).

Complete information on solving your heat dissipation problems with GRI Heat Sinks is available. Write for catalog.

GEORGE RISK INDUSTRIES
678 15th Avenue, Columbus, Nebraska

CLARE type J Relays

COMPACT · LONG LIFE · VERSATILE



For applications which require a conventional telephone-type relay, the CLARE Type J offers versatility of performance and flexibility of installation that meet the requirements of the widest variety of industrial designs.

Stable operation and adjustment, together with consistent performance demonstrated in thousands of practical applications, make the CLARE Type J Relay an ideal component for an unusual number of control applications.

Optimum reliability of this relay is produced by such design features as:

- Twin contacts mounted on bifurcated springs which provide contact reliability by redundancy.
- Large armature bearing surface and glass teflon armature and spring bushings which guarantee long adjustment life.
- Hydrogen annealing of magnetic parts which assures magnetic stability.

Electrical and Mechanical Characteristics of Type "J" Relays

Contact Arrangements	Contact Ratings	Coil Resistance	Nominal Operating Voltages	Operate Time	Release Time
Forms A,B,C,D,E, up to 24 contact springs max.	Low level to 5 amps, 50W watts	Up to 21,000 ohms	Up to 300 vdc Up to 220 vac, 50-60 cps	Fast operate: 5 ms min. Delayed operate: 60 ms max.	Fast release: 5 ms min. Delayed release: 125 ms max.

For wired assemblies: available with solder, taper tab or direct plug-in terminals; dust-covered or hermetically-sealed. *For printed circuit board mounting:* with terminals on .10" spacing. *As integrated wired assemblies:* available produced from your circuits or "black box" requirements.

For more detailed information send for CLARE MANUAL 500. Clare Application Engineering will provide special features to meet unusual requirements.

Address: C. P. Clare & Co., Group 7DS, 3101 Pratt Boulevard, Chicago 45, Illinois, Cable Address: CLARELAY. In Canada: C. P. Clare Canada Ltd., 840 Caledonia Road, Toronto 19, Ontario. In Europe: C. P. Clare Ltd., 70 Dudden Hill Lane, London NW 10, England.

CLARE®
Relays and related control components

WASHINGTON TRENDS

ANTI-TRUST POLICY CHANGES PONDERED—New look for Justice Dept. anti-trust policy is expected under William H. Orrick, Jr., new head of the Antitrust Div. But there is some question over what it will be. Most observers say former anti-trust chief Lee Loevinger (now on FCC) was replaced because he concentrated on volume of prosecutions, didn't pay enough attention to detail. Others believe Loevinger was let out because he didn't push hard enough for volume. Whatever the reason, Atty. Gen. Robert Kennedy wants something new. It may be he wants to concentrate on a few top cases. From these cases could come guidelines for the rest of industry.

DEW LINE SECRETS LEAKED—News that AT&T gave the Russians maps showing undersea cables to U.S. DEW line sites drew sharp rebuke from at least one outraged congressman. Rep. Dan Flood (D., Pa.), hinting the matter could be criminal, demanded the cables be relaid and maps cancelled. Flareup came during recent hearings before a House defense appropriations subcommittee. Pentagon spokesman Brig. Gen. J. F. Raulor, Jr., told lawmakers it would do the Reds no good to cut the cables which provide communications links between U. S. Distant Early Warning radar stations. Raulor said recent cuts in the cable caused by Russian fishing trawlers were accidental.

SMALL FIRMS HOLD OWN—Small manufacturers are still getting about 16% of all prime contracts awarded by DOD. Congress has been trying to make it easier for them to bid successfully on more primes. But percentage remains the same. Reasons: Inability to perform on certain contracts, lack of capital, lack of manpower.

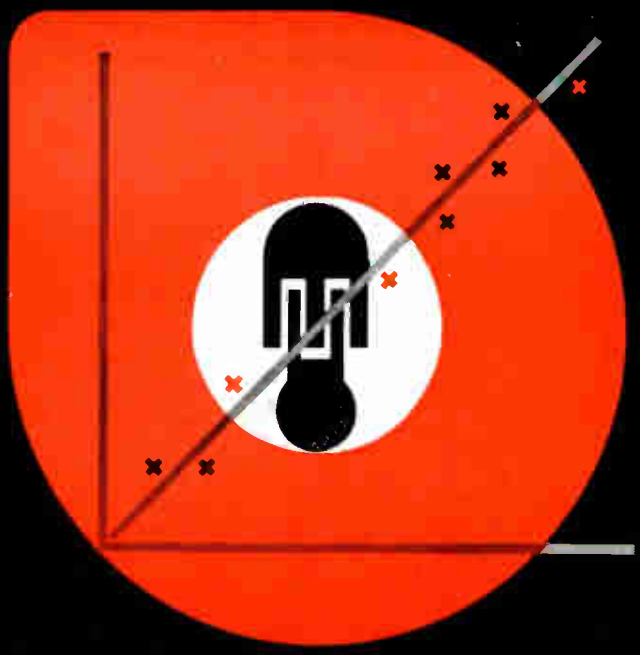
GOVERNMENT RESEARCH SWELLS—Research activities of the Federal Government, in non-defense areas as well as in weapons and spacecraft, are mushrooming. The Government, which spends much of its time surveying everything in sight, has just completed studying its own research programs. Compiled by the National Science Foundation, the new 600-page report is the first since 1956. It shows the growth and organization of government scientific activities for 40 government agencies. Covered are operations such as the TVA, P. O. Dept. and AEC. Report, "Federal Organization for Scientific Activities, 1962," (NSF 62-37) is available for $3.50 from the Supt. of Documents, Washington 25, D. C.

GLENN WANTS SPACE DATA CENTER—Astronaut John H. Glenn is prodding the Kennedy Administration and Congress to make more technical data available to industry. Glenn says an information gap is preventing full use of many discoveries made in the space and electronic fields. What's needed: Glenn says a National Information Center, which would close the gap between discoverers and the users of information.

CONTRACTOR PERFORMANCE MAY BE GRADED—Pentagon is working on plan to grade defense contractors on performance. Grades would play key role in contract awards and could swing deal to bidder with higher grade even though he might be underbid by competitor. Not much objection has been raised to the idea, though DOD suppliers insist the plan allow for such performance variables as labor trouble, interference from the military, added cost of record-keeping and paper work. Program would take into account cost, scheduling, and technical ability. Electronic contractors and subcontractors would keep promises or face a bad grade. It could mean tough sledding on future government contracts.

TIGHT AM/FM ALLOCATION PROPOSED—FCC is studying proposed changes in rules on current AM frequency freeze and coordination of AM and FM service. Agency would use AM frequencies only in areas now without adequate broadcast facilities, protect areas of current AM radio stations, limit the number of AM stations per area, and generally require new AM applications to meet strict criteria before being accepted. FCC is considering change in policies on duplicate AM/FM broadcasting, which it believes will help independent FM stations compete for advertising. Eventually, the agency wants to separate AM and FM broadcasting in each locale.

MOON RACE HELD COSTLY WASTE—Many Republicans are charging U.S. efforts to put man on moon is wasteful crash program. Conservatives and many liberals in Congress wince at $5.7 billion space budget asked for this fiscal year, recoil from official estimates that it may take another $15 billion before a U.S. astronaut reaches moon. Democrats and liberal Republicans argue more would be wasted if the program were slowed down, urge approval of all that space experts ask. The debate gets hot as soon as hearings on funds open. Pace of the moon program will be set by lawmakers' decisions in the next few weeks.



600 mc f_T Switches...120v V_{CB} Core Drivers...
100 mc Amplifier...All Available Now with

PHILCO SILICON PLANAR RELIABILITY

Philco's versatile line of Epitaxial Silicon Planar NPN Transistors enables you to upgrade reliability in transistor applications.

ULTRA HIGH SPEED SWITCHES

TYPE*	Maximum Ratings			Characteristics							
	T_J °C	V_{CB} volts	P_T @ 25° C., mw	I_{CBO} max., μa	h_{FE} min	$V_{CE(SAT)}$ max., volts	f_T min.	C_{ob} max., pf	t_s max., nsec	t_{on} max., nsec	t_{off} max., nsec
2N709	[illegible]	15	300	0.05	20	0.30	[illegible]	3	[illegible]	15	15
T-2877	300	15	300	0.05	20	0.30	[illegible]	3	8	15	15

*TO-[illegible] case—collector internally connected to case

CORE DRIVERS/PULSE AMPLIFIERS

TYPE*	V_{CB} max., volts	f_T @ 50 ma, mc	h_{FE} @ 150 ma
2N1893	120	50	40
2N1613	75	60	40

*TO-[illegible] case—collector internally connected to case

100 mc LOW-NOISE AMPLIFIER
Industry's Newest Silicon Amplifier Standard

TYPE	Power Gain	Max. Noise Figure	Min. BV_{CEO}
T-2857*	15db min. @ 100 mc	5db @ 100 mc	20 volts

The new [illegible] is Philco's first of a [illegible] Epitaxial Silicon Planar VHF and UHF amplifiers. Gain and noise measured under matched, neutralized conditions.

*TO-18 case with 4 leads—collector isolated from case

VERY HIGH SPEED SWITCHES

These Philco Types Feature Industry's Best Combination of Voltage, Switching Speed, and Beta.

TYPE†	Maximum Ratings					Characteristics							
	T_J °C	V_{CBO} volts	V_{CEO} volts	P_T @ 25° C mw	I_C ma	I_{CBO} μa	h_{FE} min.	$V_{CE(SAT)}$ volts	f_T min mc	C_{ob} max pf	T_s max. nsec	t_{on} max. nsec	t_{off} max. nsec
2N2710	300	40	20	[illegible]	500	[illegible]	40	[illegible]	[illegible]	4	15	[illegible]	35
2N2651	300	30	20	[illegible]	[illegible]	[illegible]	25	[illegible]	350	4	25	[illegible]	75
2N914	300	40	15	[illegible]	500	[illegible]	30	[illegible]	300	6	20	[illegible]	40 @ 200 ma
2N834	175	40	30**	[illegible]	[illegible]	[illegible]	25	[illegible]	35	4	25	[illegible]	75
2N784A	300	40	15	[illegible]	200	[illegible]	25	[illegible]	300	3.5	15	[illegible]	40
2N708	300	40	15	[illegible]	[illegible]	[illegible]	30	[illegible]	300	6	25	[illegible]	[illegible]
2N706	175	25	20*	[illegible]	[illegible]	[illegible]	20	[illegible]	300	6	[illegible]	[illegible]	[illegible]

*$V_{[illegible]}$ **V_{CES} †TO-18 case—collector internally connected to case

Whatever your silicon transistor application, evaluate Philco Planar Transistors.

For complete data, and new Reliability report, write Dept. E1763.

PHILCO®

A SUBSIDIARY OF *Ford Motor Company*

LANSDALE DIVISION, LANSDALE, PA.

SOLID-STATE CENTER U.S.A.™

Circle 16 on Inquiry Card

MARKETING

Facts and Figures Round-Up

EXEC. CHARGES U.S. NEEDS MORE TWO-BIT THINKING

A business executive charged that we should devote less attention to esoteric science and more to down-to-earth, two-bit thinking on how to stay competitive in world production.

John H. Morrison, president of Hitchiner Manufacturing Co., said that too much U.S. time, talent and money is allocated to scientific research and not nearly enough to advanced manufacturing technologies. He asked for a Presidential Production Council and appointment of a Presidential Production Advisor, on the same level as the President's Scientific Advisor.

He said the economic war that Khrushchev threatens is on the production front. The problems we face in Europe are not only tariff restrictions and money policies, but will we allow overseas markets to erode, or will we find new ways to produce at competitive prices despite lower wage rates abroad?

NEW TUNER FOR ALL-CHANNEL TV

By May 1, 1964—about 10 months from now—television set makers will have to make the complete production transition from VHF sets to all-channel VHF and UHF sets for sale in interstate commerce and the consumer market.

Among the latest technical developments to give the UHF move a helping kick is a solid state UHF tuner, announced recently by General Instrument Corp. The firm reports that the unit should "equal or better" the performance of its basic tube tuner model used as a standard UHF tuner by 15 set makers.

The new tuner, to be delivered during the current summer to makers of standard and portable TV sets, may be generally used in many sets being made this fall. As the year rolls on, the number of all-channel TV sets should rapidly spurt beyond the current 10% of total TV set productions.

Meanwhile, the FCC is clearing the tracks for further and faster development of UHF-TV.

MARKET MEN STUDY EFFECT OF EQUAL PAY ON PRICES

Marketing men are watching for the consequences and developments from the "Equal Pay Act of 1963, that prohibits discrimination based on sex in wages paid for employment in interstate commerce."

Managements of firms, where women often outdo men in tedious and painstaking assembly work, wonder how the higher wages will affect sales prices of electronic hardware. An example of price differential in one plant was $1.40 an hour for women and $1.55 for men.

Advocates of the bill call it "simple justice" and "essential to maintain and improve our living standard." Though similar bills had been offered, the current bill was passed in response to the needs of some 24,500,000 women workers who earn about $45 billion annually.

Congress indirectly employs nearly 500,000 women, 32.7% of all Federal white collar employees. Congress also funds R&D contracts for firms that employ women. In effect, Congress has increased the cost of defense procurement.

EIA, favoring laws against discriminatory wage practices based on sex, urged that: (1) enforcement provisions apply only to a single plant location, and (2) the penalty for violations which would blacklist Government contractors be eliminated.

The new law does not blacklist violators from Federal contracts.

CABLES VS. SATELLITES, UNDERSEA ACTIVITY GOING UP

When thinking of communications satellites versus undersea cables, businessmen tend to think—"a bird in the hand is worth, and all that." Their reason? Cables are practical, while satellites are still experimental.

Publicity has been lavished on satellites and the rush of activity in the international cable business has been generally overlooked, in spite of the fact that a new cable now connects Florida and Jamaica; an extension links with Panama.

At present the American Cable and Radio Corp., subsidiary of IT&T, uses the Florida-Jamaica-Panama Canal Zone cable to provide 22 telegraph circuits. The FCC has authorized AT&T and the Hawaiian Telephone Co. to run a second submarine telephone cable between California and Hawaii for increased service. The new Hawaii cable will link with new cables being laid between Hawaii and Japan, and with British cable being laid from Canada to Australia via Hawaii.

"Ocean telephone cables and satellites will surely be needed to carry the fast-rising volume of overseas communications," remarked AT&T board chairman Frederick R. Kappel.

Meanwhile, Gen. David Sarnoff, RCA board chairman, believes that the Communications Satellite Corporation should take over all U. S. international telephone, cables and satellites, to act as the "chosen instrument" of the U. S. Government in international communications.

PRIVATE PLANE RISE FOSTERS NEW MARKETS

As the private airplane business grows, so grows the aviation electronics business, and with it comes new electronics markets.

Robert P. Bauer, treasurer-controller of Cessna Aircraft Co. reports that the private aircraft industry has penetrated less than 5% of the available market. In 1962 the industry sold $137 million worth of light planes (nearly 7,000 units, compared with 2,300 sold in 1951).

The FAA forecasts that private aircraft will rise in numbers by 50% by 1968. In the 1962 fiscal, the FAA spent $12 million of its matching-grant airport funds in private airport development. For fiscal 1963 it will hit near $18.7 million. The conservative estimate for 1964 is $25 million.

Greater amounts are expected to be spent by respective states.

"CALL FOR PAPERS"

14th Nat'l Conf. of the PTG-VC, Dec. 5-6, 1963, Adolphus Hotel, Dallas, Tex. Papers to be concerned specifically with vehicular communications. Possible subject areas include vehicular systems, equipment, or circuit designs, uses of new types of components or related circuitry, interference reduction or spectrum utilization, VHF maritime and air-ground communications. Forward 500-word abstract by *Aug. 17, 1963*, to: Jack Germain, Motorola, Inc., 4501 W. Augusta Blvd., Chicago 51, Ill

ENGINEERING EDUCATION

Short courses of interest to engineers

Engineering Research

The 1963 Engineering Foundation Research Conferences will be held at Proctor Academy, Andover, N. H., *Aug. 5-30, 1963*. Conferences will focus on topics of current importance to the engineering profession. These include: "Technology and the Civilian Economy," *Aug. 5-9;* "Comminution," *Aug. 12-16;* and "Engineering in Medicine," *Aug. 19-23*. A fourth conference, *Aug. 26-30*, will concern urban transportation research. Registration fee is $100. For additional information, contact Dr. Harold K. Work, Director, Engineering Foundation, 345 E. 47th St., New York 17, N. Y.

Integrated Circuit Design

A course of instruction on integrated circuit design for high-level engineers will be held *July 15-Aug. 2, 1963*, at *Motorola Semiconductor Products Div.*, Phoenix, Ariz. The first section, *July 15-26*, will be a general review of integrated circuit design technology. Basic theory and design considerations will be taught. The second section, *July 29-Aug. 2*, will enable the engineer to set up a complete integrated circuit breadboard assembly operation. The first section costs $900 and the second, $3,000 per registrant. Contact: Mr. Lothar Stern, Manager, Technical Information Center, Motorola Semiconductor Products, Inc., Phoenix 8, Ariz.

CONFERENCE CANCELLED

The 1963 Microminiaturization Congress, scheduled for July 25-27 at the Sheraton-Park Hotel, in Washington, D. C., cancelled. Its sponsor was the American Watchmakers Institute.

COMING EVENTS

...in the electronic industry

JULY

July 14-19: Conv., Nat'l. Ass'n. of Power Engrs; Everglades Hotel, Miami, Fla.

July 15-17: 3rd Annual Rochester Conf. on Data Acquisition & Processing in Medicine & Biol., Univ. of Rochester, IEEE (PTG-BME); Whipple Audit., Univ. of Rochester Med. Ctr., Rochester, N. Y.

July 21-24: Amer. Astronomical Soc. Mtg.; Univ. of Alaska, College, Alaska

July 24-25: Annual Mtg., Amer. Ass'n. of Cost Eng'rs.; Sheraton-Palace Hotel, San Francisco, Calif.

AUGUST

Aug. 5-9: 8th Annual Tech. Symp., Soc. of Photo. Instrumentation Eng'rs.; Ambassador Hotel, Los Angeles, Calif.

Aug. 7-9: 12th Annual Conf. on the Application of X-Ray Analysis, Univ. of Denver Res. Inst.; Albany Hotel, Denver, Colo.

Aug. 11-15: Heat Transfer Conf. & Exh., ASME, AIChE; Somerset Hotel, Boston, Mass.

Aug. 11-17: Annual Ind. Res. Conf., Columbia Univ.; Arden Hs., Harriman, N. Y.

Aug. 12-14: AIAA Guidance & Control Conf.; Mass. Inst. of Tech., Cambridge, Mass.

Aug. 14-16: Symp. on Electronic Circuit Packaging, Univ. of Colo.; Univ. of Colo., Boulder, Colo.

Aug. 19-21: Cryogenic Eng'g. Conf.; Univ. of Colo., Boulder, Colo.

Aug. 26-28: Conf. on Simulation for Aerospace Flight, AIAA; Deshler-Hilton Hotel, Columbus, Ohio.

Aug. 26-28: Conf. on Physics of Entry into Planetary Atmospheres, AIAA; Mass. Inst. of Tech., Cambridge, Mass.

Aug. 26-28: 46th Summer Mtg., MAA; Univ. of Colo., Boulder, Colo.

Aug. 26-29: Pacific IEEE Gen'l. Mtg.; Davenport Hotel, Spokane, Wash.

Aug. 26-30: 68th Summer Mtg., AMS; Boulder, Colo.

Aug. 26-30: Annual Summer Mtg., Soc. for Ind. & Applied Mathematics; Univ. of Colo., Builder, Colo.

Aug. 26-31: Annual Mtg., Electron Microscope Soc. of America; Denver-Hilton Hotel, Denver, Colo.

Aug. 27-30: 18th ACM Nat'l. Mtg. & Exh.; Denver-Hilton Hotel, Denver, Colo.

SEPTEMBER

Sept. 8-13: AchS Fall Mtg.; New York, N. Y.

Sept. 9-11: 7th Nat'l. Conv. on Military Electronics (MIL-E-CON 7), IEEE (PTG-MIL); Shoreham Hotel, Washington, D. C.

Sept. 9-12: 18th Annual Instrument & Automation Conf. & Exh., ISA; McCormick Place, Chicago, Ill.

Sept. 10-12: Fall EIA Conf.; Biltmore Hotel, New York, N. Y.

Sept. 10-13: Ceramic-Metal Systems Fall Mtg., ACS; French Lick Hotel, French Lick, Ind.

Sept. 10-14: Electrical Insulation Conf., IEEE, NEMA; Conrad-Hilton Hotel, Chicago, Ill.

Sept. 11-13: SME Annual Fall Mtg. & Rocky Mountain Minerals Conf., AIME; Salt Lake City, Utah.

Sept. 12-13: 11th Annual Joint Eng'g. Mgmt. Conf., IEEE, ASME, AIIE, ASCE, and others; Biltmore Hotel, Los Angeles, Calif.

Sept. 16-18: Nat'l. Conf. on Antisubmarine Warfare, AIAA, ONR; San Diego, Calif.

Sept. 16-20: 13th Int'l. Mgmt. Cong., Int'l. Committee for Scientific Mgmt.; Waldorf Astoria, New York Hilton Hotels, New York, N. Y.

'63 Highlights

ICEAS, Int'l Conf. & Exh. on Aerospace Support, Aug. 4-9, IEEE, ASME; Sheraton - Park Hotel, Washington, D. C.

WESCON, Western Electronic Show and Conf., Aug. 20-23, IEEE, WEMA; Cow Palace, San Francisco, Calif.

NEC, National Electronics Conf., Oct. 28-30, IEEE, McCormick Place, Chicago, Ill.

NEREM, Northeast Research and Eng. Mtg., Nov. 4-6, IEEE; Commonwealth Armory, Boston, Mass.

Sept. 18-19: 12th Annual Ind. Electronics Symp., IEEE, ISA; Mich. St. Univ., E. Lansing, Mich.

Sept. 22-25: Nat'l. Power Conf., IEEE, ASME; Netherland-Hilton Hotel, Cincinnati, Ohio.

Sept. 23-24: Int'l. Conf., AIIE; New York, N. Y.

Sept. 23-24: Reg. Tech. Conf., SPE; Holy Cross College, Worcester, Mass.

Sept. 25-26: 2nd Annual Symp. on Physics of Failure in Electronics, Rome Air Development Ctr., IIT Res. Inst.; Ill. Inst. of Tech., Chicago, Ill.

Sept. 25-28: Materials & Eqpt. and White Wares Divs. Fall Mtg., ACS; Bedford Springs Hotel, Bedford, Pa.

Sept. 29-Oct. 2: 51st Nat'l. Mtg., Amer. Inst. Chem. Eng'rs.; Hotel America, San Juan, Puerto Rico.

Sept. 29-Oct. 3: Fall Mtg., Electrochemical Soc.; Hotel New Yorker, New York, N. Y.

Sept. 30-Oct. 3: Nat'l. Fall Mtg., AWS; Hotel Statler-Hilton, Boston, Mass.

OCTOBER

Oct. 1-2: Engineering Problems of Manned Interplanetary Exploration Mtg., AIAA; Cabana Motor Hotel, Palo Alto, Calif.

Oct. 1-2: SPE Reg. Tech. Conf. on Reinforced Plastics & Chemical-Electronics Symp.; Cleveland - Sheraton Hotel, Cleveland, Ohio.

Oct. 1-3: 8th Nat'l. Symp. on Space Electronics, IEEE (PTG-SET); Fontainebleu Hotel, Miami Beach, Fla.

Oct. 1-3: North Central Reg. Conf., NACE; Hotel President, Kansas City, Mo.

Oct. 2-4: Western Reg. Conf., NACE; Disneyland Hotel, Anaheim, Calif.

Oct. 2-4: Electronics Div. Fall Mtg., ACS; Riverside Hotel, Gatlinburg, Tenn.

Oct. 3-5: Refractories Div. Fall Mtg., ACS; Bedford Springs Hotel, Bedford, Pa.

Oct. 4-6: Amer. Radio Relay League Nat'l. Conv.; Cleveland, Ohio.

Oct. 6-8: Basic Sci. Div. Fall Mtg., ACS; Nat'l. Bureau of Standards, Washington, D. C.

Oct. 7-9: 9th Nat'l. Communications Symp., IEEE (PTG-CS); Utica, N .Y.

Oct. 7-10: 13th Annual Instrument Symp. & Res. Eqpt. Exh., Nat'l. Institutes of Health, Bethesda, Md.

Oct. 9-10: 1963 ERA/ISA Electronics & Instrumentation Exp.; Seattle Ctr. Display Hall, Seattle, Wash.

Oct. 9-11: 21st Annual Aerospace Electrical/Electronics Conf., Aerospace Electrical Soc.; Pan Pacific Audit., Los Angeles, Calif.

Oct. 9-12: Glass Div. Fall Mtg., ACS; Bedford Springs Hotel, Bedford, Pa.

Oct. 13-18: Semi-Annual Conv., SMPTE; Somerset Hotel, Boston, Mass.

Oct. 14-16: Materials Handling Conf., IEEE, ASME; Chamberlain Hotel, Ft. Monroe, Va.

Oct. 14-17: South Central Reg. Conf., NACE; Oklahoma City, Okla.

Oct. 14-18: Annual Fall Conv., Audio Eng'g. Soc.; Barbizon-Plaza Hotel, New York, N. Y.

Oct. 14-18: Nat'l. Mtg., Soc. for Applied Spectroscopy; El Cortez Hotel, San Diego, Calif.

Oct. 15-17: 9th Tri-Service Conf. on Electromagnetic Compatibility, IIT Res. Inst., U. S. Army, Navy and Air Force, IEEE (PTG-RFI); Ill. Inst. of Tech., Chicago, Ill.

Oct. 15-23: Anglo-American Conf., AIAA, Canadian Aeronautics & Space Inst., Royal Aeronautical Soc.; New Ocean House, Swampscott, Mass.

Oct. 16-18: Nat'l. Symp. on Vacuum Technology, Amer. Vacuum Soc.; Statler-Hilton Hotel, Boston, Mass.

Oct. 17-18: Reg. Mtg., AIIE; Dallas-Ft. Worth, Tex.

The high-voltage barrier to passivated PNP transistors has finally been broken —but it took a new manufacturing process to overcome the obstacles.

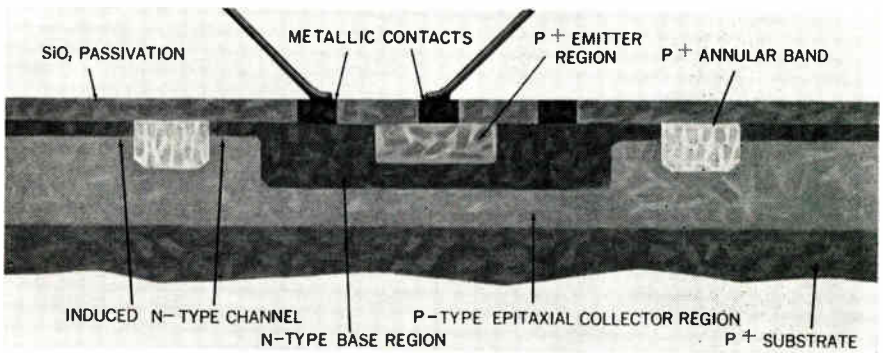
Now from MOTOROLA Epitaxial, Passivated PNP SILICON TRANSISTORS Made by the Annular* Process

Some new words are being added to the dictionary of semiconductor terms—words like Annular* and Band-Guard†, words that relate to a new manufacturing process which will have a strong influence on transistor design and promises to open new areas for transistor applications. The Annular manufacturing process provides a new degree of freedom from surface effects for semiconductor products.

For years, the industry had been working to design high voltage silicon PNP transistors with the low leakage currents normally associated with NPN types, surface passivated by the planar process. For PNP devices, planar techniques proved inadequate since any attempt to increase voltage ratings beyond approximately 20 volts (through increasing collector material resistivity) induced a phenomenon, called channeling, which actually increased leakage current far beyond tolerable levels.

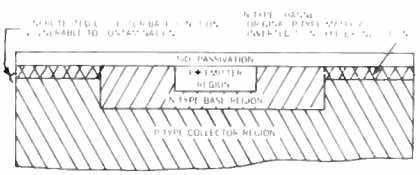
Channeling is a condition whereby the surface portion of a transistor collector region actually changes polarity and becomes an extension of the base region. The base-collector junction, therefore, rather than coming to the top surface where it is protected from the environment by a silicon oxide coating, extends to the unprotected edges of the transistor where it is subject to contamination and surface damage. This phenomenon circumvents the passivation advantages of planar designs and results in excessive leakage currents.

The formation of channels has been traced to effects of ionized or polarized particles on or within the passivating oxide coating which create an electrical environment that tends to alter the apparent polarity of the material directly beneath the oxide—an effect which is particularly pronounced in lightly doped P-type material. The channels are random in nature and erratic in characteristics, and can be highly sensitive to radiation bombardment.



Cross Section of Annular Transistor

As a result of channeling, some manufacturers have reverted to earlier silicon mesa structures or have deliberately circumvented the oxide passivation in planar transistors in order to produce high voltage devices. These methods have yielded high voltage ratings but other characteristics of the resulting transistors do not compare favorably with those of surface passivated devices.


Cross Section of Planar Transistor

Now, Motorola has overcome these obstacles—but it has taken a new manufacturing process to do so. Rather than trying to eliminate the channel, Motorola, in a new series of "Band-Guard" transistors, has deliberately introduced a channel whose controlled characteristics completely overshadow the variable effects of any randomly induced channel, thus providing a high degree of performance stability. Moreover the controlled channel is terminated close to the base region by a diffused annular band of the same polarity as the collector region but with a resistivity level impervious to channeling. The collector-base junction, therefore, is properly terminated underneath the oxide coating where it is protected against environmentally induced leakage currents. The resultant "Band-Guard" PNP silicon devices, for the first time, combine the low-leakage characteristics of passivated junctions with the high-voltage characteristics of non-passivated, or mesa structures.

And, if theoretical analysis of this process is confirmed by tests now in progress, they will prove to be more resistant to radiation, thus heralding improved performance and greater reliability of space equipment.

Though initially devised for the production of high voltage silicon PNP transistors, there are strong indications that the Annular process yields major benefits for NPN and field effect transistors and other semiconductor devices as well.

In view of these considerations, there is little doubt that the new, Motorola developed Annular process will take its place among the major milestones in the advancement of the semiconductor art.

*Patents Pending †Trademark of Motorola Inc.

NOW FROM MOTOROLA

2N2800 2N2838 2N722

HIGH VOLTAGE PASSIVATED

2N1132 2N2801 2N1132B

PNP SILICON TRANSISTORS

2N1132A 2N722 2N2837

. . . made by the new ANNULAR PROCESS

Four new Motorola PNP silicon transistors made by the Annular process and featuring high speed . . . high voltage . . . low leakage . . . and surface passivation and stability, are now immediately available as types 2N2800, 2N2801, 2N2837, and 2N2838. Called "Band-Guard" transistors, the new devices reflect performance advantages inherent in an Annular, oxide-passivated, epitaxially fabricated transistor.

Annular Process — Provides a new degree of freedom from surface effects of adverse environments. Gives a new degree of performance stability by eliminating sub-surface leakage paths to the unprotected edges of the device. Makes possible combined high voltage *and* true silicon oxide passivation.

Oxide Surface Passivation — Prevents contamination of the junction by external agents. Makes possible the low collector leakage current (1/10th that of other PNP units) of Motorola's "Band-Guard" transistors.

Epitaxial Structure — Gives lower saturation voltage (⅔ lower) and twice the frequency response (120 mc) of ordinary PNP devices.

Other types supplied as "Band-Guard" units include 2N1132, 2N1132A, 2N1132B, and 2N722.

Motorola passivated, epitaxial "Band-Guard" transistors are immediately available from your Motorola Semiconductor Distributor or District Office. For full electrical specifications write: Technical Information Center, Motorola Semiconductor Products, Inc., Box 955, Phoenix 1, Arizona.

"Band-Guard" Transistor Performance Ratings

Characteristic	2N2800 (TO-5 pkg)	2N2801 (TO-5 pkg)	2N2837 (TO-18 pkg)	2N2838 (TO-18 pkg)	Unit
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	50	50	50	50	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	35	35	35	35	Vdc
Collector Cutoff Current (V_{CE} = 25 Vdc, V_{BE} = 0.5 Vdc)	100	100	100	100	nAdc
DC Forward Current Transfer Ratio (I_C = 150 mAdc, V_{CE} = 10 Vdc)*	30-90	75-225	30-90	75-225	—
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 mc)	120	120	120	120	mc

*Pulse Test: Pulse Width ≤ 300 μsec, duty cycle ≤ 2%

. . . also supplied as "Band-Guard" types:

Characteristic	2N1132 (TO-5 pkg)	2N1132A (TO-5 pkg)	2N1132B (TO-5 pkg)	2N722 (TO-18 pkg)	Unit
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	50	60	70	50	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc pulsed)	35	40	45	35	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	1.0	—	—	1.0	μAdc
(V_{CB} = 50 Vdc, I_E = 0)	—	.5	.01	—	
DC Forward Current Transfer Ratio (I_C = 150 mAdc, V_{CE} = 10 Vdc)	30-90	30-90	30-90	30-90	—
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 mc)	60	60	60	60	mc

"new leader in Total Silicon Technology"

MOTOROLA Semiconductor Products Inc.

BOX 955 • PHOENIX 1, ARIZONA • A SUBSIDIARY OF MOTOROLA INC.

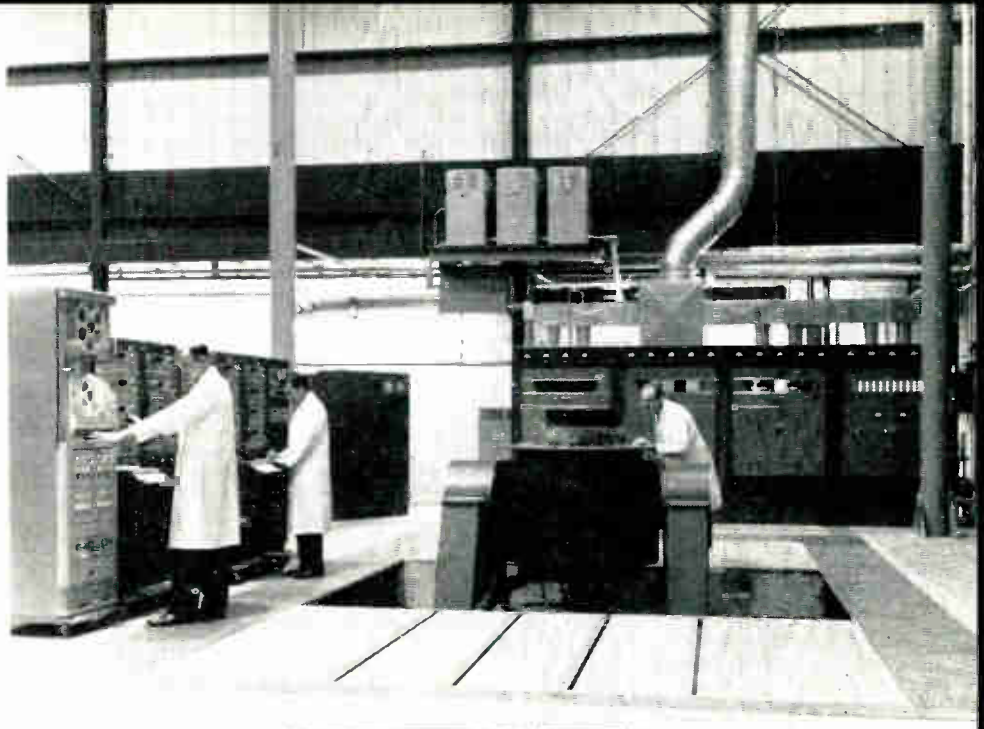
SNAPSHOTS... OF THE ELECTRONIC INDUSTRIES

DELICATELY BALANCED

Balanced on its 12 in. dia. stainless steel air bearing, satellite motion simulator at Westinghouse, Baltimore, Md., is being used to test a new satellite attitude control system. Simulator imitates the movement of a satellite orbiting the earth. Equipment is so delicately balanced on its air bearing that air movement in a normal room would disturb it so it is installed in a special air-conditioned room.

SHAKER SYSTEMS

Laboratory engineers (r) adjust data recording equipment for a test on the LTV Ling Electronics Div. (Garland, Tex.) L-200 shaker system. This system exerts 22,000 lbs of force and can drive a 100-lb test package to 100 G's. Driving the L-200 is a power amplifier which can also be used to operate an induction furnace that can heat a re-entry vehicle or component to more than 2,500 degrees F.

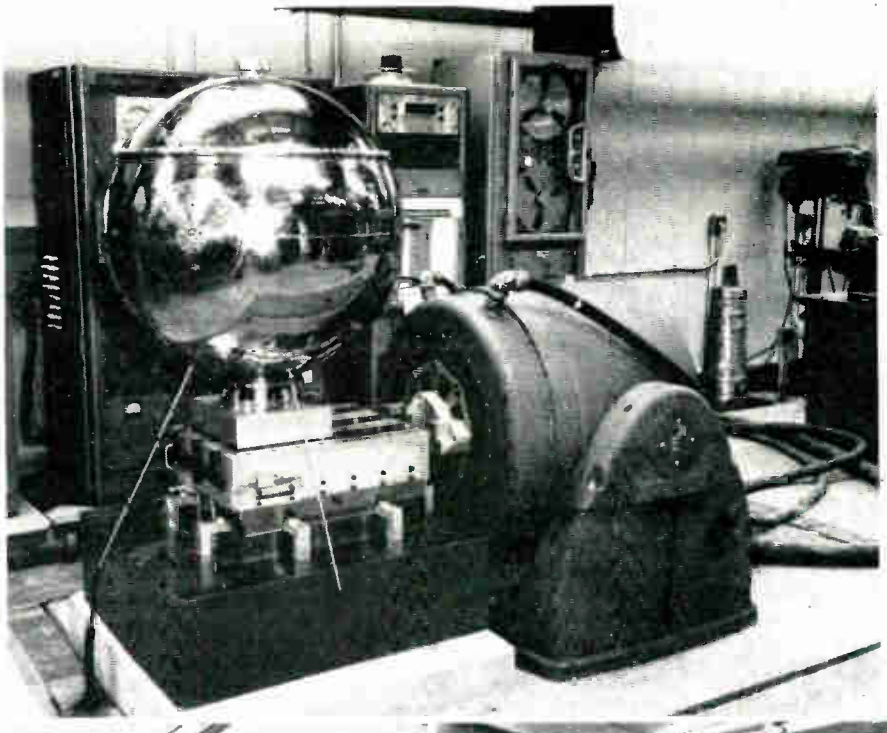


ALTITUDE-TEMPERATURE CHAMBER

Lab technicians at Fairchild Camera and Instrument Corp.'s lab in Syosset, N. Y., prepare vibration exciter for test inside altitude-temperature chamber. Entire 15 ft. wide wall has been lowered to permit movement of shaker into chamber by a powered gantry.

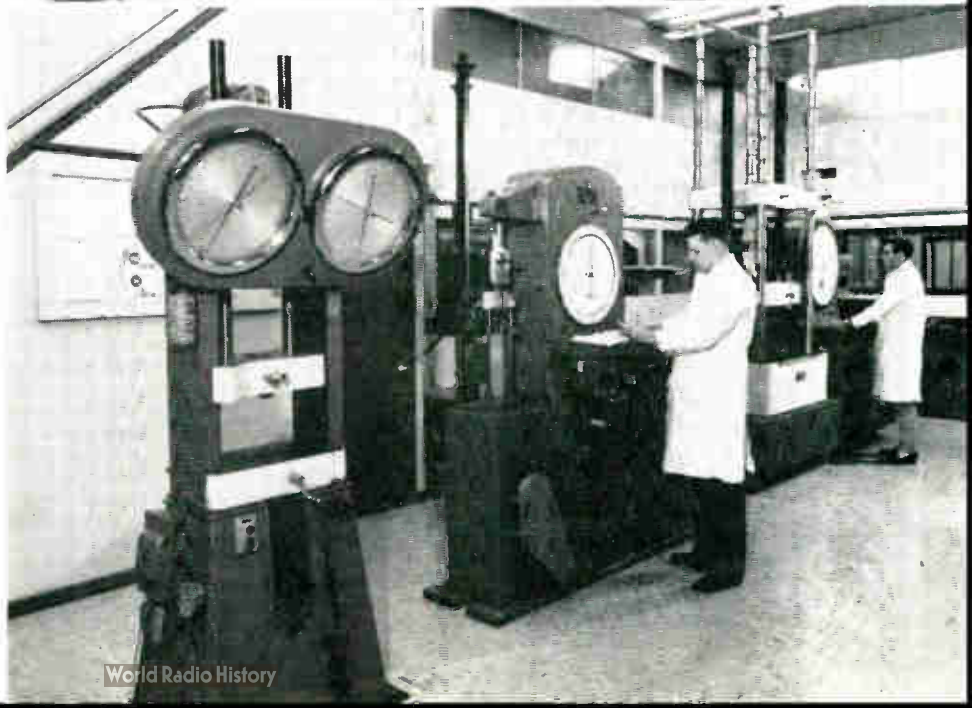
FLYING LABORATORY

Before NASA's Explorer XVII "flying laboratory" satellite went into orbit, it underwent a series of vibration tests at NASA's Goddard Space Flight Center, Greenbelt, Md. An MB Electronics (New Haven, Conn.) 10,000 pounds-of-force vibrator was used in the test. Right: satellite undergoes shake tests on "slippery" table in horizontal mode.



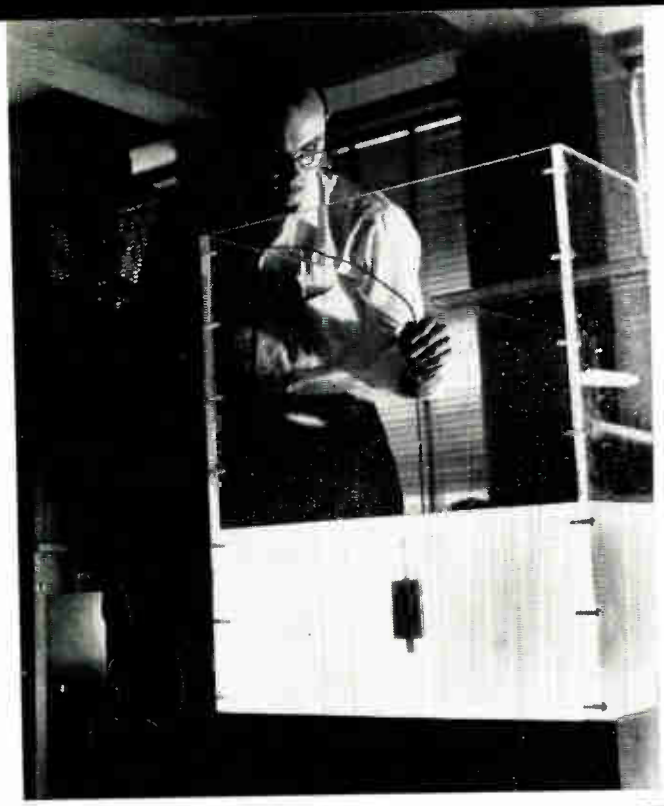
TENSILE TEST

Engineers at AMP, Inc. (r), use these machines to test the company's products. Tensile stresses can be measured from 0.10 ounce to 120,000 pounds with error of less than 0.5 percent at laboratory in Harrisburg, Pa.



More Snapshots on page 32

SNAPSHOTS . . . (Continued)

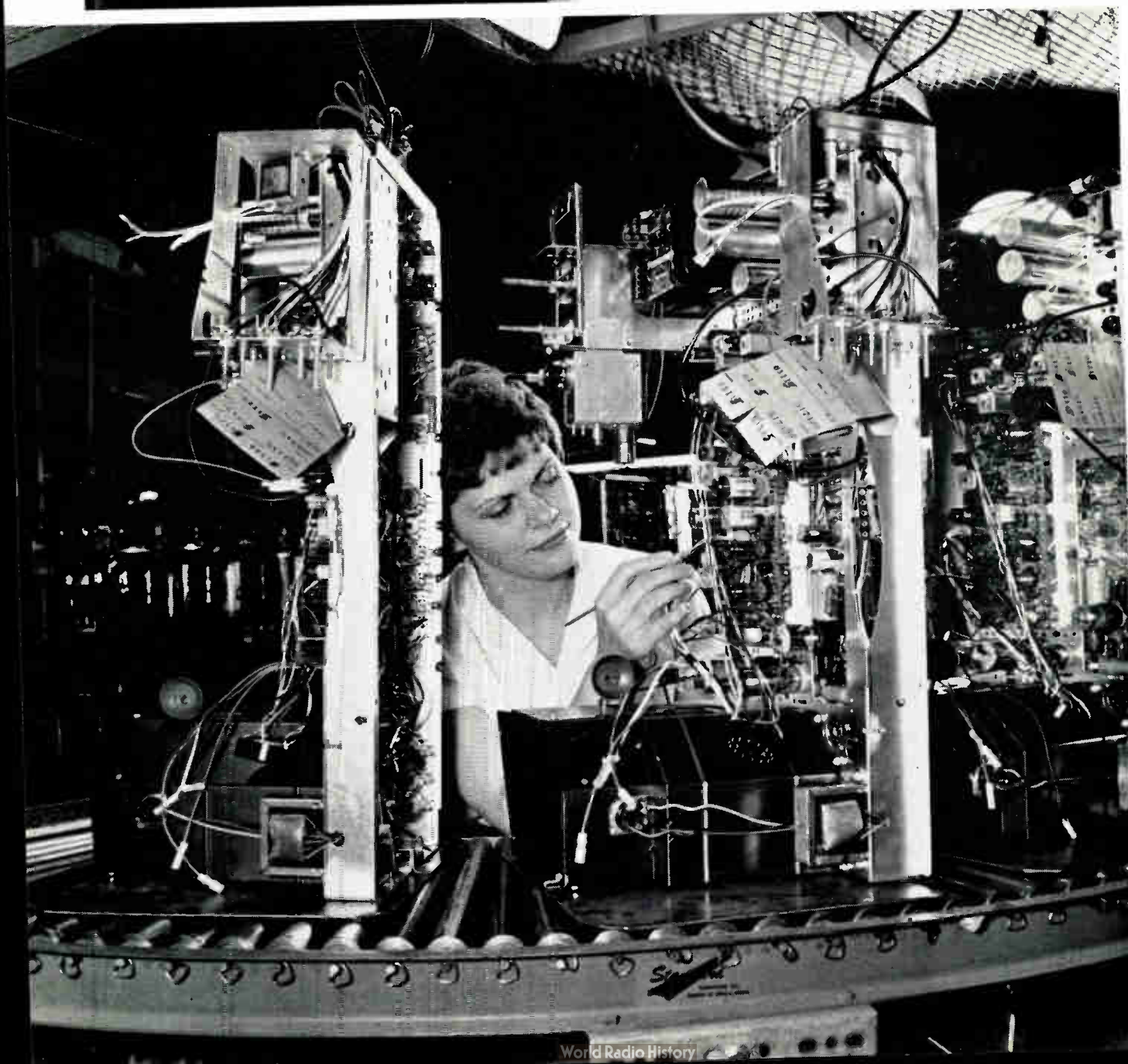


ULTRASONIC 'THERMOMETER'

Developed by scientists at the Westinghouse Research Laboratories in Pittsburgh, Pa., this ultrasonic "thermometer" can pinpoint underwater temperatures at extreme depths to 0.05°F. It does this with ultrasonic vibrations, which change in frequency with changes in temperature. The vibrations are converted to electrical pulses, which are sent to the surface of the water and are then counted.

COMPLEX CHASSIS

Complex chassis for color Silvertone television set is given thorough inspection by a "bank inspector" at the Warwick Manufacturing Corp., Zion, Ill. Inspector Mildred Kulin checks all connections and wire routings before chassis is allowed to proceed to next operation.



...comes through head heat unscathed!

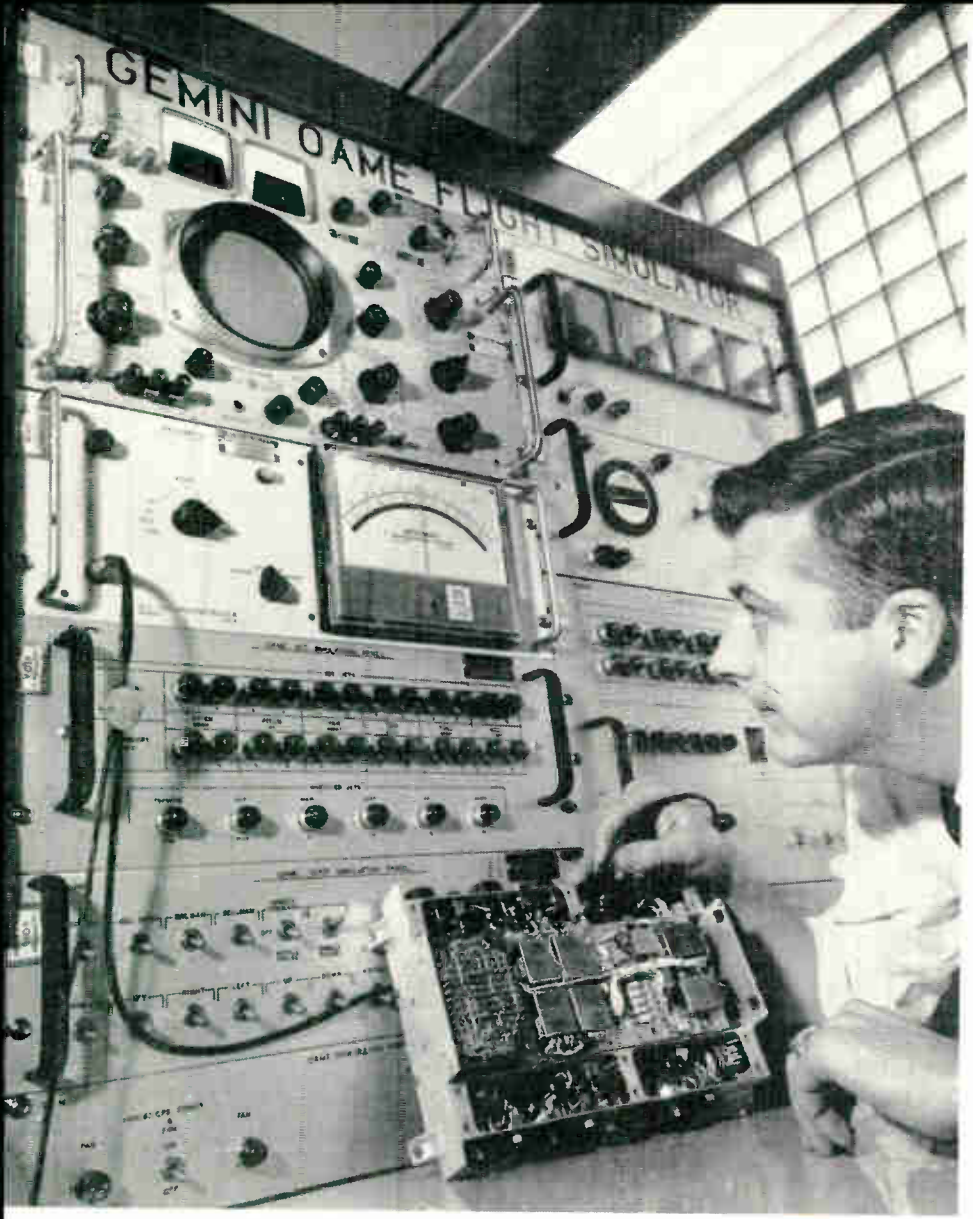
Higher and higher recording speeds mean instrumentation progress—and *problems!* Increased speed and tension on tape generates friction that concentrates heat around recording heads and can make ordinary tape unreliable. Signal dropout or distortion can result when this localized, high-temperature build-up separates recording oxides from tape backing.

"SCOTCH" BRAND Heavy Duty Instrumentation Tapes carry signals coolly through head-heat environments. They withstand temperatures from −40°F up to +250°F. They last *at least* 15 times longer than ordinary tapes. Their heavy duty oxides and binders are formulated to resist heat extremes, minimize ruboff. Exclusive Silicone lubrication eases head wear, tape wear. They offer 1000 times more conductivity than ordinary tapes to drain off dust-gathering static.

16 different "SCOTCH" Heavy Duty Tapes are available in 3 series. Polyester backings offered are .65, 1 and 1.5 mils. Choice of coating thicknesses includes .18 and .43 mils. "*400*" *series:* excellent high and low frequency resolution. "*500*" *series:* smooth, sharp resolution for broad band, other high frequency uses. "*900*" *series:* ultra-smooth surfaces for predetection recording systems, critical wide band needs.

TECHNICAL TALK Bulletin No. 3 explains temperature effects on recording tape, discusses heavy duty oxide and binder combinations. Free. Just write 3M Magnetic Products Division, Dept. MBR-73, St. Paul 19, Minn.

SNAPSHOTS . . . (Concluded)



MINIATURE BRAIN

Computer is dwarfed by flight simulator used to test it. Engineer C. Torborg tests the tiny computer which is called OAME (OH-ME) for Orbit Attitude and Maneuver Electronics. Computer is one of two that Honeywell (Minneapolis) builds for Gemini control system.

ENDURANCE TESTING

Cook Electric Co., Morton Grove, Ill., developed semi-automatic readout equipment (at left) to transmit data from the environmental chambers to electronic typewriter. Equipment was used to supply Corning Glass Works with data on thousands of glass resistors during a total of 4,000 hours of endurance testing.

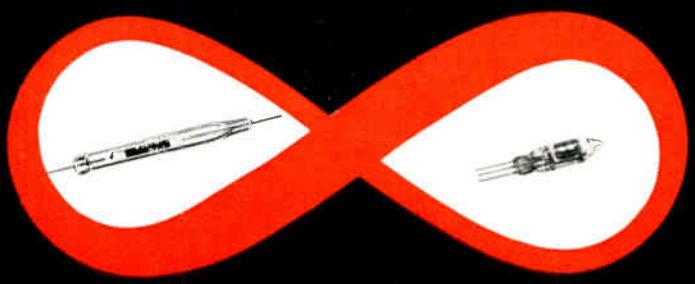
AUTOMATED MACHINE

Circuit board pattern was provided by master cylinder of this machine developed by Marosi Precision Products Co., Inc., El Cajon, Calif. New machine uses an electrolytic method of automatically removing unwanted metal from metal-clad boards. Conventional methods use an acid etching process which requires much hand work by labor. Machine makes use of Dow Chemical Co.'s new ion exchange resins. Friden, Inc., San Leandro, Calif., has purchased the first machine.

SLIM AND TRIM

Superconducting electro-magnet held by this young lady weighs only 19 pounds. It can create magnetic forces that would require a 600 pound Alnico V permanent magnet to duplicate. The new magnet was designed and produced by The Arnold Engineering Co., Marengo, Ill., a subsidiary of Allegheny Ludlum Steel Corp., Pittsburgh, Pa.

resistance = ∞ -1?



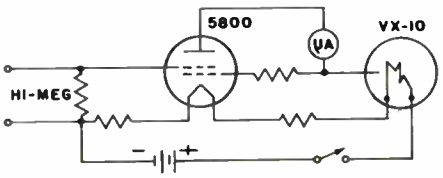
Not quite. But it's no trick at all to get values as high as 10^{14} ohms with famous Victoreen Hi-Meg Resistors, and input resistances to 10^{15} ohms with Victoreen Electrometer Tubes. They belong in your circuit if you demand exotic performance at a realistic price.

VICTOREEN

VICTOREEN

THE VICTOREEN INSTRUMENT COMPANY
5806 HOUGH AVENUE • CLEVELAND 3, OHIO, U.S.A.
Victoreen European Office: P. O. Box 654, The Hague

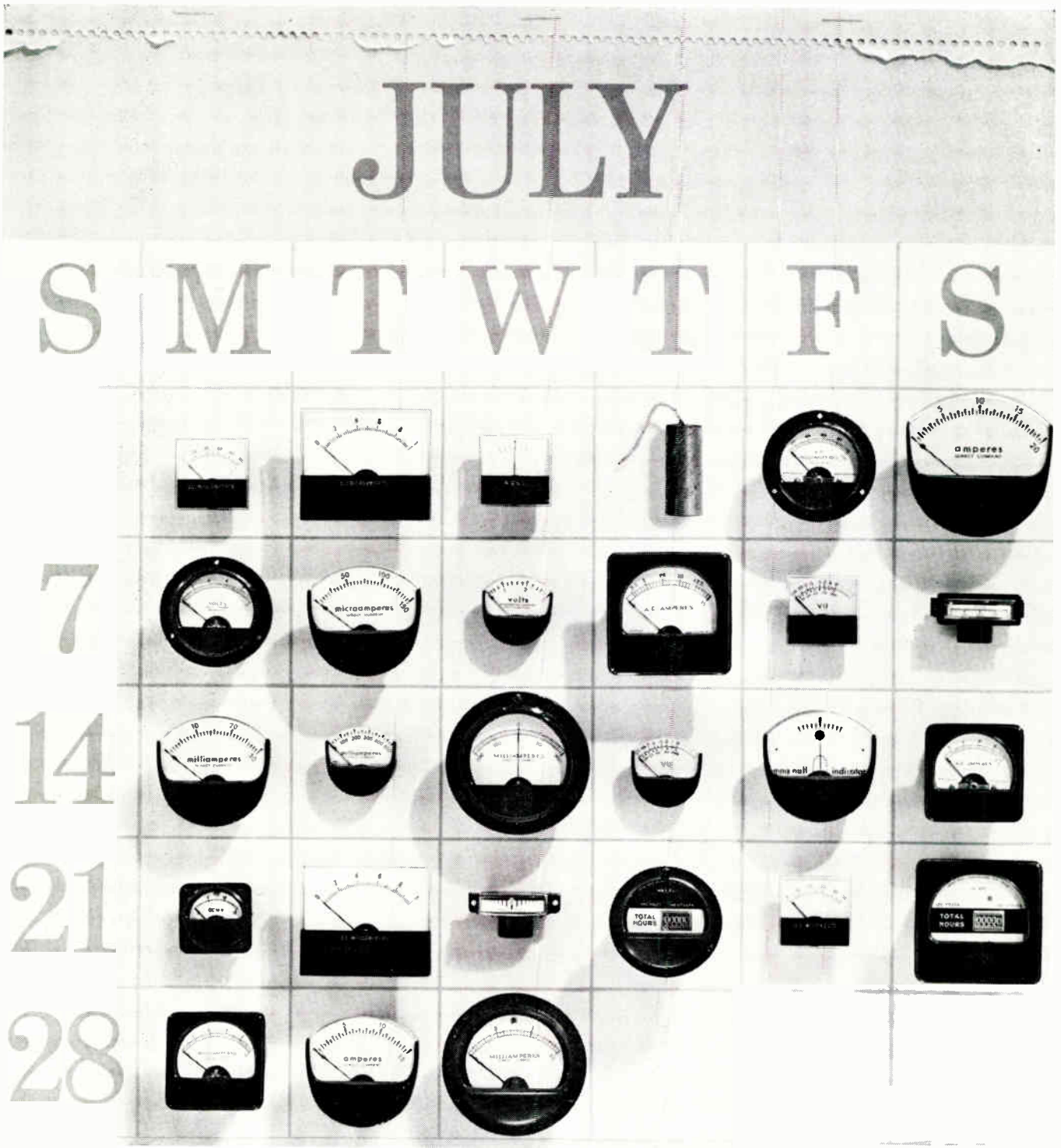
INSTABILITY OF THE DC LEVEL of electrometer tubes, particularly in a direct-coupled amplifier, has long been a disconcerting problem for design engineers. One factor contributing to this instability is the result of simultaneous application of plate voltage and filament voltage. Even the 10 mA filaments commonly used in these tubes require up to 1 second to come to full emission temperature. During this time the tube is operating in an emission-limited mode. Resulting instability may require from a few seconds to several hours for correction.



Victoreen has produced two Thermal Time Delay Relays to prevent this destabilization: The VX-10 and VX-69, each of which automatically provides approximately 1 second delay in the application of plate voltages.

Due to the high leakage resistance (10^{15} ohms) of the open contacts, these Thermal Time Delay Relays provide excellent means for remote switching of Hi-Meg Resistors and other high resistance circuits. This is particularly useful when a multi-range radiation detector must be located in a high radiation field precluding the possibility of manually adjusting zero or changing ranges. VX-69 provides isolation between thermal element and relay contacts, permits the switching of circuits which have no common electrical connection. VX-10 has control circuit and contact circuits electrically connected, making them particularly suitable for series operation with electrometer tubes. Filament reading for these tubes is nominally 1.25 volts at 10 mA.

Full details on request to
Applications Engineering Department
THE VICTOREEN INSTRUMENT COMPANY
5806 Hough Ave., Cleveland 3, Ohio, U.S.A.



Quick, off-the-shelf delivery of any standard Honeywell meter

(Any day. But never on Sunday)

Forty-eight Honeywell meter distributors from coast to coast stand ready to fill your orders pronto. And to give you quick, dependable service and parts replacement, we now have 15 repair and modification centers all across the country. For the name of the Honeywell meter distributor nearest you, write us at Honeywell, Precision Meter Division, Manchester, New Hampshire. We will also send you our latest catalog which includes our new rectangular-shaped MS series plus the broadest line of miniature meters in the business.

Honeywell

DIGITRONICS DIAL-O-VERTER D520 MAGNETIC TAPE TERMINAL WITH DOOR OPEN SHOWING CIRCUIT CARDS

Digitronics assures the reliability of their high-speed Dial-o-verter system

with ALLEN-BRADLEY quality electronic components

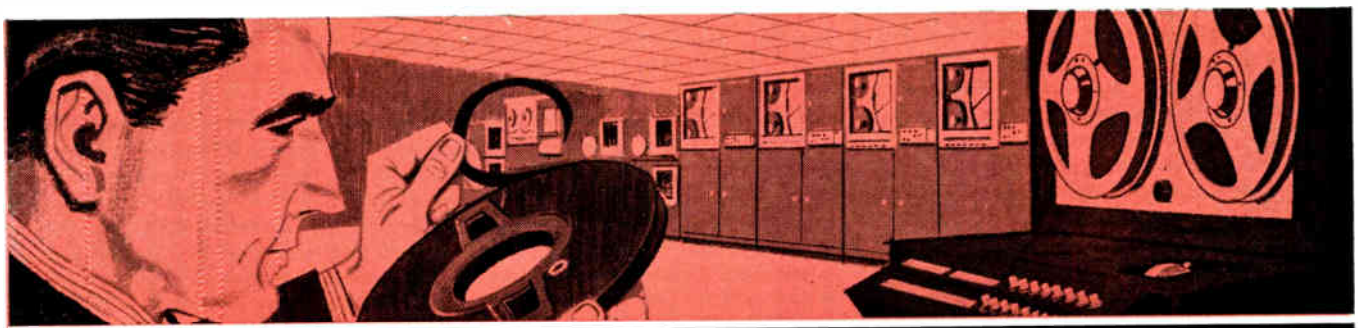
HIGH-SPEED HANDLING OF DATA DEMANDS UTMOST RELIABILITY!

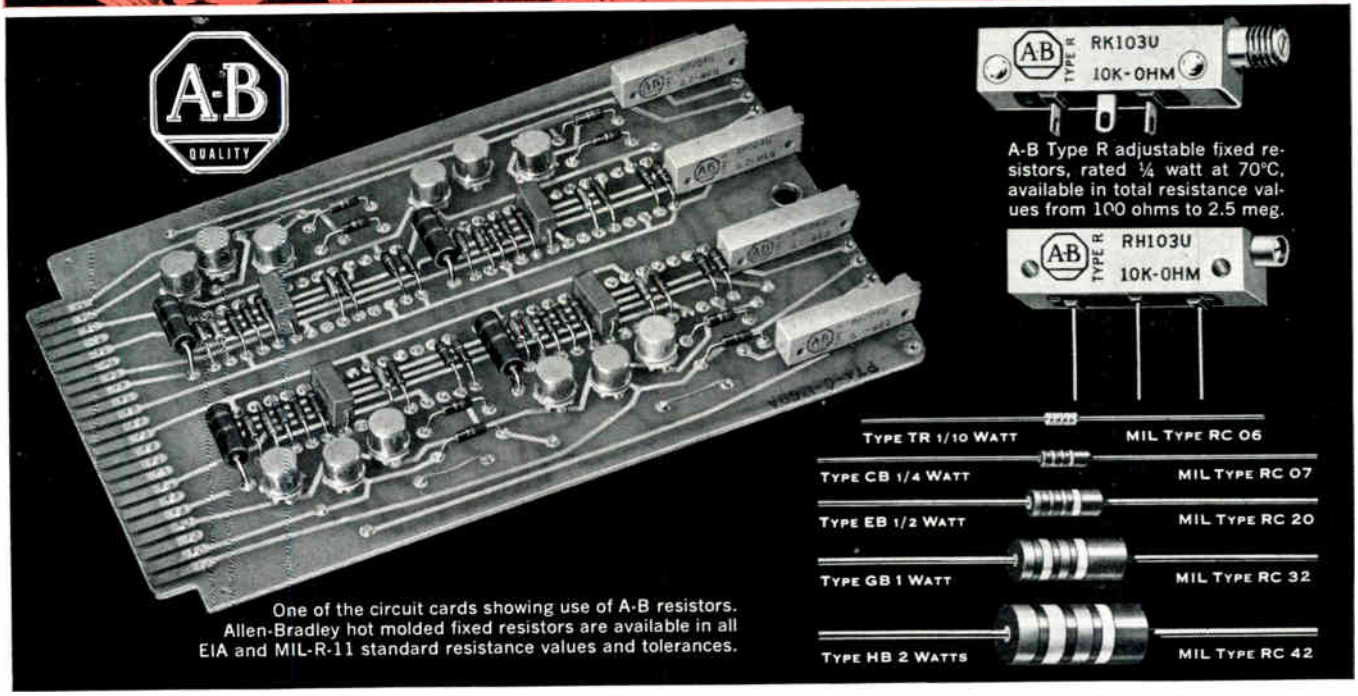
You don't need a Ph.D. to understand that the higher the data handling speed, the greater is the necessity for uninterrupted operation—even short delays lose volumes of information. Therefore, Digitronics Corporation uses Allen-Bradley fixed and adjustable hot molded resistors in their Dial-o-verter system.

A-B fixed resistors are so thoroughly reliable that even with the *billions* of Allen-Bradley fixed resistors in use, there's never been a *single* record of catastrophic failure! The key to such a phenomenal performance is to be found in A-B's hot molding technique—a process developed and used *only* by Allen-Bradley. It results in such uniform properties that long term resistor performance can be accurately predicted.

Allen-Bradley's Type R adjustable fixed resistors are also hot molded so that the solid resistance element, terminals, and insulating body are produced in a rugged unit structure. The molded case is both dust-tight and watertight—it is completely satisfactory for use where entire circuits are encapsulated. With almost infinite resolution, abrupt changes in resistance cannot occur during adjustment, and the moving element is self-locking in its "set" position.

Be sure your equipment has the reliability *only* Allen-Bradley hot molded resistors can give. For full details on all A-B quality electronic components, please write for Publication 6024. Allen-Bradley Co., 1342 S. Second Street, Milwaukee 4, Wis. In Canada: Allen-Bradley Canada Ltd., Galt, Ont.





One of the circuit cards showing use of A-B resistors. Allen-Bradley hot molded fixed resistors are available in all EIA and MIL-R-11 standard resistance values and tolerances.

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

WHAT'S NEW

NASA FACILITY GETS HUGE SPACE CHAMBERS

THE FIRST OF TWO HUGE SPACE CHAMBERS at NASA's Goddard Space Flight Center in Greenbelt, Md., has been completed and put to work testing spacecraft.

Each chamber is a stainless steel cylinder 33 ft. wide and 58 ft. high. Internal working dimensions are 27 by 40 ft., which leaves room to spare for such bulky vehicles as the 3,500 lb. Orbiting Astronomical Observatory satellite.

The tank now in operation is called the Dynamic Test Chamber. The second, a Space Environment Simulator (SES), is scheduled for completion in Nov.

The Dynamic Test Chamber will test mechanical spacecraft performance such as spinup, solar paddle erection, dynamic balancing and the testing of control systems that use gas jets to orient the vehicle.

The SES will achieve a pressure below 5×10^{-8} torr, about 100 billionth of an earth atmosphere. Mechanical and oil vapor pumps will remove most of the air. Cryogenic panels in which gaseous helium is circulated will condense most of the remaining molecules.

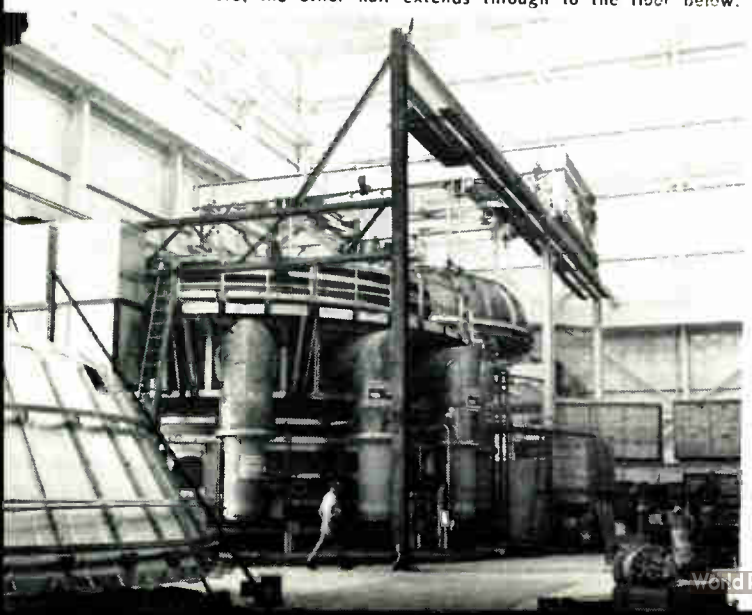
A feature of the SES will be solar simulation. A solar simulator will produce energy variable from 65 w/ft.^{2} (Mars orbit) to 130 w/ft.^{2} (Earth orbit). The simulation method being used could be extended to 265 w/ft.^{2} (Venus orbit).

Reflected energy from satellites under test in the SES will be absorbed by a black-painted aluminum heat sink, super cooled by liquid nitrogen. With the walls of the chamber thus performing in the manner of the infinite heat sink of space, the effect of intense sunlight and heat on exposed portions of a satellite and extreme dark and cold conditions on shaded portions can be simulated.

Honeywell's California Ordnance Center, Los Angeles, is prime contractor for the chambers.

Sunlight will be reproduced along with scorching heat by 127 powerful arc lamps at the top of this space chamber. Through a system of special lenses and reflectors, the lamps will simulate the sun's rays as they appear in certain areas of space.

Giant pumps leading from one of two space chambers will be used to help evacuate the chamber as it simulates conditions of outer space. About half of the 58-foot-high chamber is shown here, the other half extends through to the floor below.



NO HEAT DAMAGE

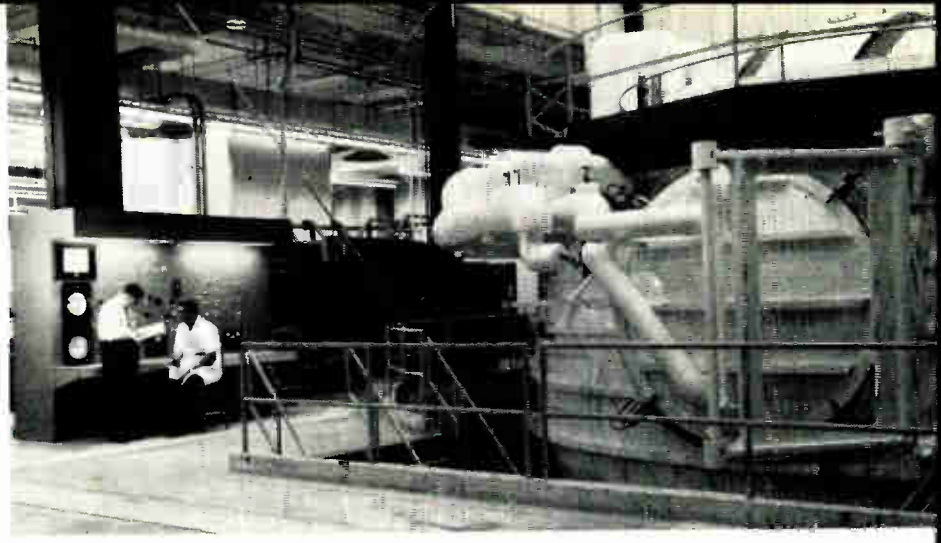
THE INFRARED BAKING OVEN solves the problem of drying assembled radar pedestals without the heat affecting the electronic components.

This dual-panel "oven" is hung on overhead tracks, and the voltage to individual infrared bulbs can be varied. These features allow different shaped objects to be dried.

The Bendix Corporation reports a 20% decrease in painting time by using the oven. Dust and dirt damage which is most critical in the first few hours of conventional drying have been virtually eliminated. The oven is manufactured by the Johnson-March Corp., Philadelphia, Pa.

By controlling the voltage to and the position of the lamps, assembled radar pedestals (right) can be painted in one operation without damage to electronic components within the pedestal.

TEST CHAMBER FEATURES BOTH COLD WALL AND SOLAR SIMULATION



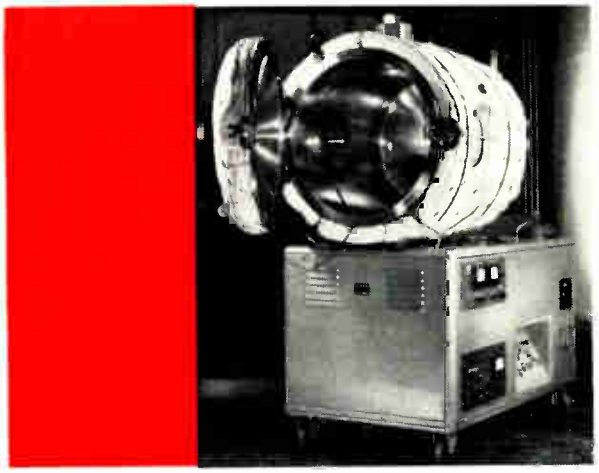
Large STL space chamber in a completed stage. Notice control console at left of picture and hydraulic locks on the door.

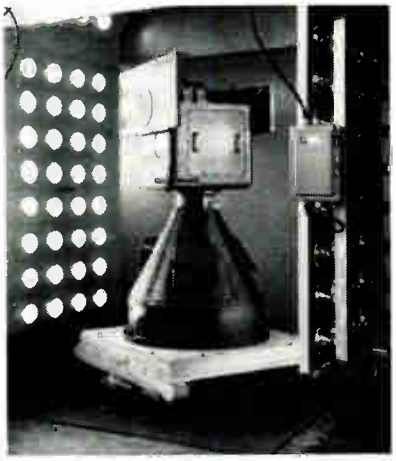
THE ENVIRONMENTAL TESTING FACILITIES at Space Technology Laboratories, Inc., Redondo Beach, Calif., are quite extensive. Equipment is available to subject a space vehicle to almost any known condition that it is likely to encounter in cis-lunar space, with the exception of micrometeorites, Van Allen radiation, and cosmic ray damage.

There are environmental chambers available at the laboratories for making altitude-temperature, altitude, temperature-humidity, temperature, vacuum and solar tests. A wide range of values and conditions can be duplicated.

In addition to the test chambers there are vibration exciters, temperature ovens, leak detectors, indicators, direct reading oscillographs, tape recorders, RFI screen rooms, a shock machine, a centrifuge, an accelerometer calibration system (optical) and an assortment of instruments which are used with all of this equipment.

A laboratory feature is its 30 ft. solar simulation chamber. This operational unit uses STL-designed carbon-arc solar simulators, collimated to 1 to ½° or better. The chamber has an ultimate vacuum of 1×10^{-9} torr. Vacuum with a test vehicle inside is 1×10^{-6} torr. A feature of the chamber is that it has both cold wall and solar simulation.





New ultra high vacuum and combined space environment chambers (above), developed by Cook Electric Co., simulate outer space for the testing of materials and components under orbital and ballistic conditions.

NEW CHAMBERS TO ASSIST MANUFACTURERS IN SPACE WORK

NEW ULTRA HIGH VACUUM and combined space environment facilities have been installed in Cook Electric Co.'s Inland Testing Laboratories at Morton Grove, Ill., and Anaheim, Calif. The new facilities will be used to simulate outer space for testing materials and components under orbital and ballistic conditions.

Each chamber provides test space 2½ ft. in diameter, 2½ ft. deep, and 12.3 ft.^{3} in volume, especially for testing electronic, electrical, hydraulic, pneumatic, and other small products or components. Each chamber is designed for vacuum conditions to 1×10^{-8} Torr (equal to 303 mi. altitude), with ultimate vacuum capability of 5×10^{-9} Torr or 378 mi. high.

The ultra-high vacuum chambers can simulate temperatures from −320 to +400°F. They can produce combined space environments that simultaneously simulate solar radiation and random or sine vibration at vacuum to 1×10^{-4} torr.

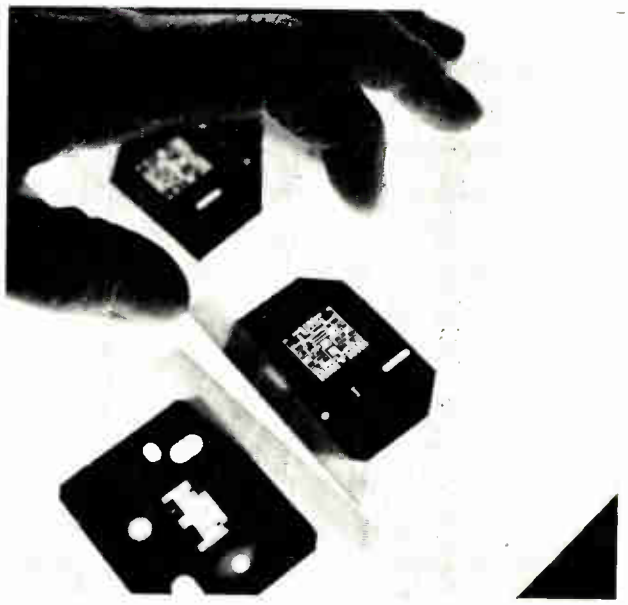
The chambers were developed to assist manufacturers in establishing design feasibility, material capability, and parts reliability for space conditions. The chamber has a 5 in. viewing window, two 6 in. utility penetrations, electrical and thermocouple penetrations, and light port for illumination.

WHAT'S NEW

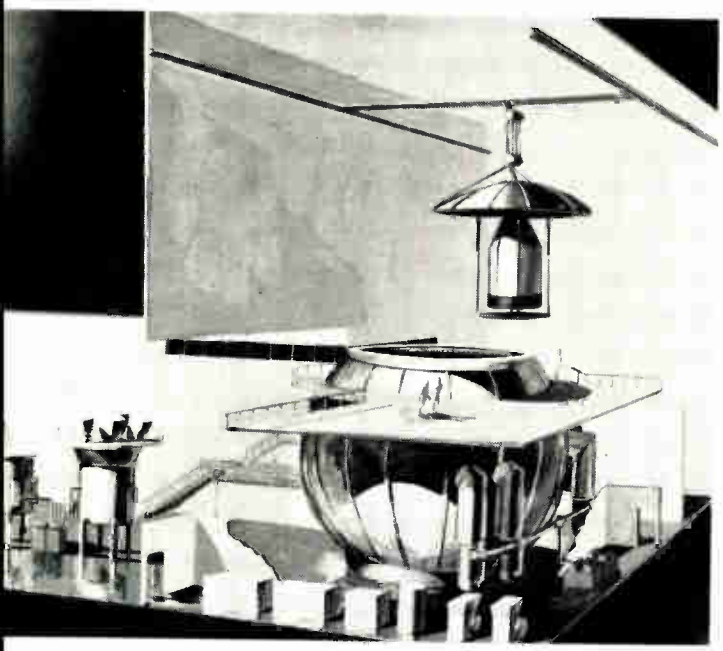
THIN FILMS & DISCRETE COMPONENTS

THE SIGNIFICANT BENEFITS of both thin-film circuitry and discrete components have been combined by General Precision Aerospace, Little Falls, N. J. They have developed the Micro-Block™ which uses thin-film resistors and capacitors deposited on a ceramic substrate and discrete transistors.

This combination has developed a 5w., ¼ cu. in. servo amplifier that is hermetically sealed and meets Mil specs. for standard units of the same performance capability. This amplifier has solved the heat-transfer problem that previously plagued thin-film amplifiers designed for analog equipment. General Precision Aerospace, General Precision, Inc., 1150 McBride Ave., Little Falls, N. J.



The best properties of thin-film and discrete components are combined in this servo amplifier designed for analog equipment.



The 30-ft. interior diameter can enclose a fully assembled space vehicle. It can simulate low pressure equivalent to 400 miles above the earth and also produce solar heating effects.

NEW SPACE SYSTEMS CENTER FEATURES EARTH-ORBIT SIMULATORS

DOUGLAS AIRCRAFT CO.'S new privately financed Space Systems Center at Huntington Beach, Calif. will be devoted to research and developmental testing of launching and spacecraft vehicles, including their components, materials and subsystems.

Detail design is nearly completed for three Earth-Orbit Simulators being built for the center. These

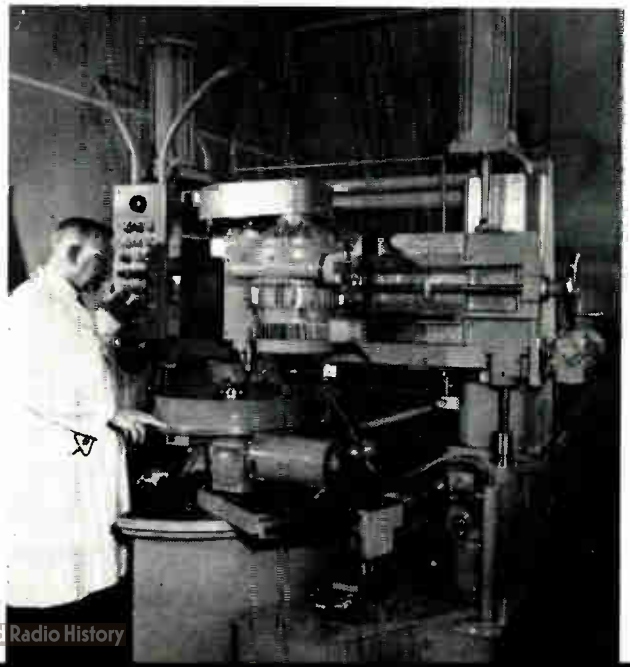
(Continued on page 52)

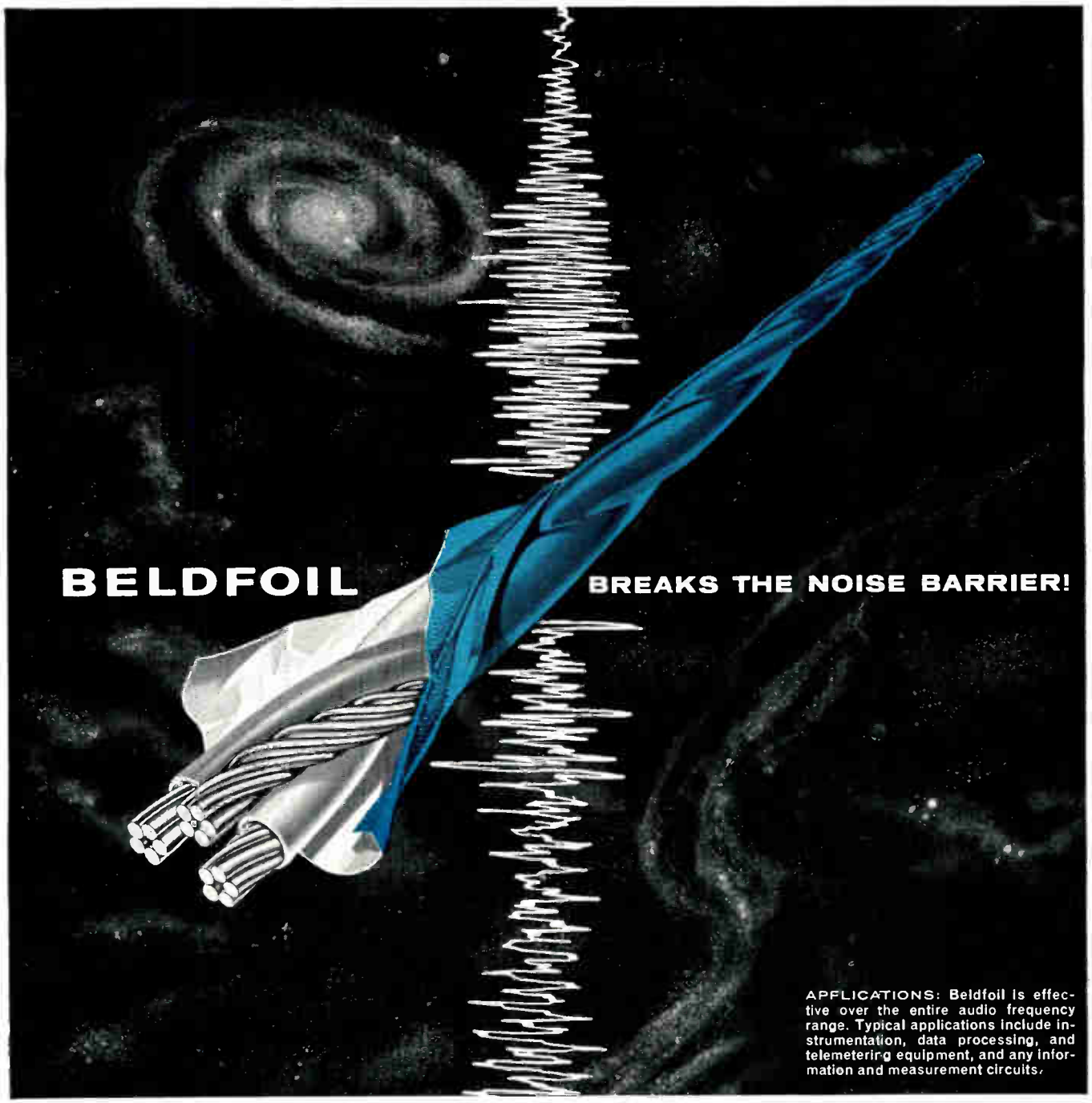
CAM GENERATING SYSTEM

CAMS CAN NOW BE PRODUCED without calculations or hand tooling. The machine tool system, which uses no master cam, tapes, or electronic components, produces cams by using a mechanical generator programmed directly from engineering information.

The operator takes data from an engineering drawing and translates it into a cutting program for the system to follow. This is accomplished through a pushbutton and dial-type programmer panel. The system cuts the cam automatically, and the operator need only change gears and gauge settings as various phases of the cut are accomplished. Sylvania Electronic Tube Div., Emporium, Pa.

Operator programs a cutting program into this mechanical and hydraulic system. The cam generator cuts cam automatically.





QUIET PERFORMANCE!

Yes, Beldfoil* shielding definitely breaks the noise barrier. It breaks the noise barrier by *being* a noise barrier. Beldfoil gives *total* shielding . . 100% isolation between adjacent pairs. For audio and radio frequency, it completely eliminates cross talk, spurious signal impulses . . and it's ideal for stationary or limited flexing. Beldfoil is lighter in weight, requires less space, and is usually lower in cost.

MINIATURIZES!

Beldfoil shielding reduces the diameter of multi-conductor cables . . by as much as 66⅔%. It gives design engineers extra space . . extra conduit space, extra raceway space, extra console and rack space. Beldfoil shielding means that you can "think small."

ASK FOR DATA SHEET. Get your copy of newly published bulletin 8-63-A and technical data sheet. They give complete information on Beldfoil shielding. Write Belden Manufacturing Company, 415 South Kilpatrick Avenue, Chicago 80, Illinois.

8-1-3

WHAT IS BELDFOIL? It's a lamination of aluminum foil with Mylar** that provides a high dielectric insulation. A patented Belden method of folding*** gives definite benefits. An inner fold creates a continuous metallic path around the surface of the cable. This eliminates any possible inductive effects. An outer fold tucks the cut edge of the aluminum under the Mylar. This gives complete isolation from other adjacent shielded cables.

Typical cross section looks like this.

*Belden Trademark Reg. U. S. Patent Office
**du Pont Trademark ***U. S. Patent 3,032,604

Belden
WIREMAKER FOR INDUSTRY
SINCE 1902 — CHICAGO

WHAT'S NEW

NEW TYPE TWT FOCUSING

A LOW-NOISE TRAVELING-WAVE TUBE available from G.E. features a new method of beam focusing. These tubes are more compact than other types of low-noise TWTs and are built for rugged use.

The key to achieving the very low-noise capabilities in a compact package lies in the single reversal permanent magnet beam focusing. Instead of a single uniform magnetic field along the tube axis, the field is reversed at the center of the tube as shown in Fig. 2a. In place of one permanent magnet, there are two main magnets and two ring-shaped aiding magnets which control the beam focus. (Fig. 2b.)

The single reversal (SR) tube is a compromise that retains the excellent low-noise figures of straight field permanent magnet tubes. By using the reverse magnets, shielding needs are eliminated, hence, compactness. One long straight magnet (in normal TWTs) creates an external magnetic field which requires bulky shielding or adequate spacing between the tube and other magnetic materials or sources. An interaction can cause beam defocusing.

Table 1 compares the three types of TWTs now available from G.E. The new TWT is not designed to directly replace any existing tubes, but rather to complement the line. The new addition will give the designer a better selection to meet his needs. The costs will be comparable to the existing lines of PM and PPM tubes. There are five X-band models available and additional X-band and C-band models will be introduced shortly.

Additional information is available from General Electric Company, Power Tube Division, Schenectady 5, N. Y.

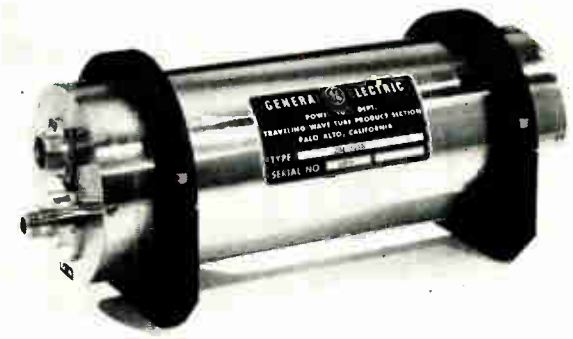


Fig. 1: The single reversal focused TWT has a frequency range of 7.0-11.0 gc. It has a max. noise figure of 8db.

Table 1
COMPARISON OF 3 TYPES OF G.E. TWT's

	PM (shielded)	PPM	SR
Freq. range (GC)	7.0–11.0	7.0–11.0	7.0–11.0
Noise db (max.)	10	12	8
Small sig. gain (min.)	25	25	25
Output, mw	5	5	5
Size (inches)	12x6.5x6.5	10x2.5x3.5	13x4
Weight (lb.)	18	3.5	8.6

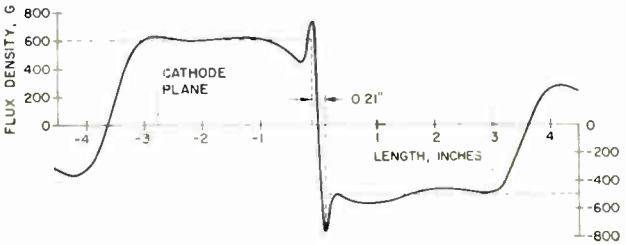
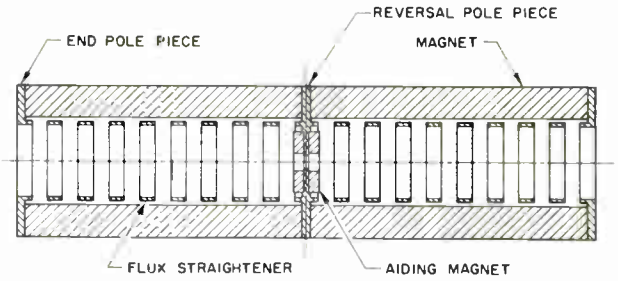


Fig. 2a (above): The magnetic field along the beam axis is plotted for a single reversal field TWT. Fig. 2b (below) is a sketch of a single reversal field PM circuit.



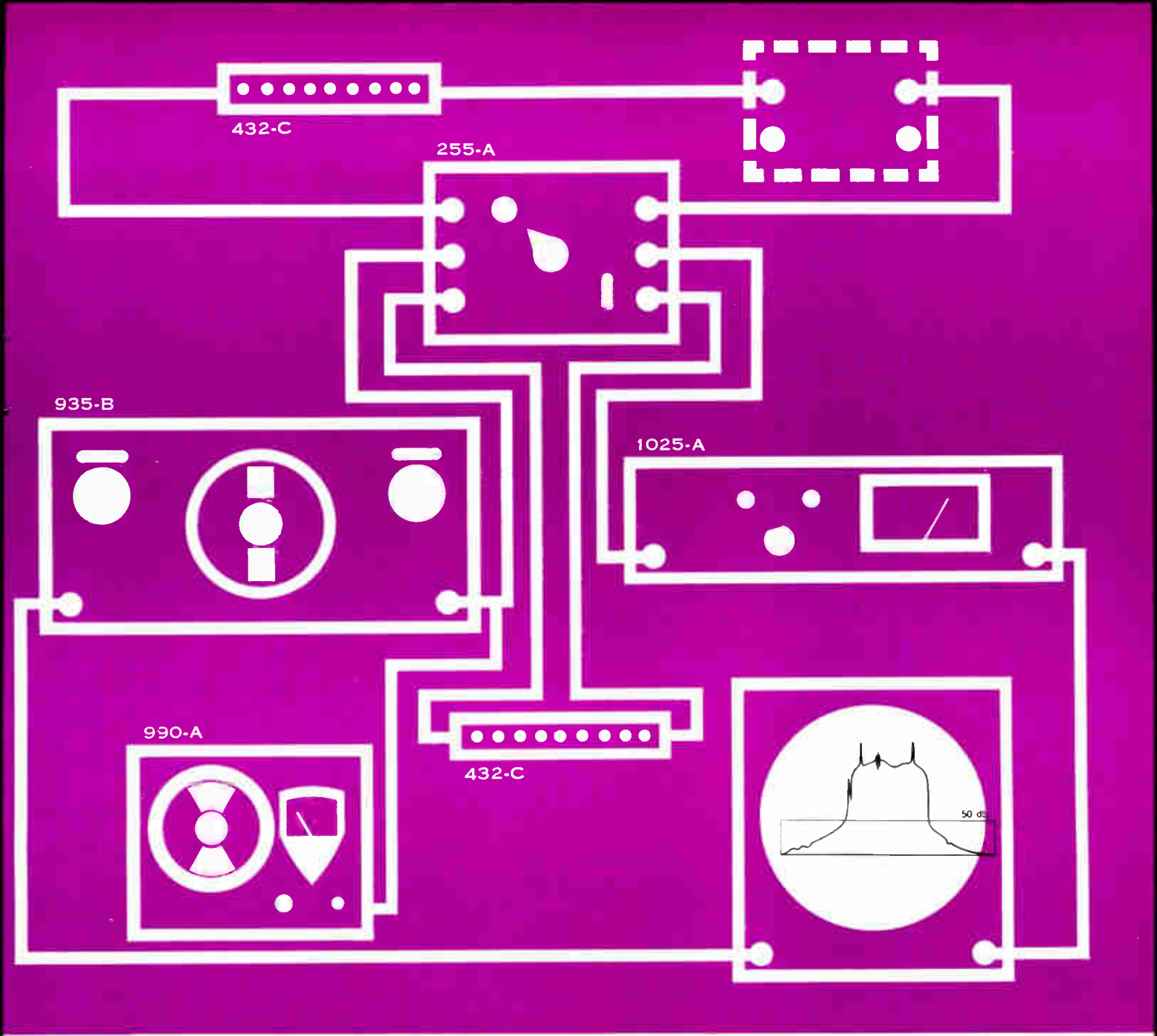
MINUTEMAN PROGRAM DEVICES CHECKED

Data logging on Fairchild's Multiparameter Tester provides device characterization prior to starting rugged tests.

PRIMARY PURPOSE of Fairchild Semiconductor's Reliability Improvement and Evaluation lab, Mountain View, Calif., is the testing of Fairchild devices for the Minuteman program and for any other specific reliability contracts which may be received from customers. Tests conducted in the lab are designed to simulate "worse case."

At certain periods during each production lot, samples are taken to the lab for tests. They are subjected to a Drop/Shock Test—a series of blows at a controlled force over a specified length of time. Another test is the Centrifuge Test in which the device is

(*Continued on page* 109)



Swept, Marked, Logged, Calibrated . . . by KAY

A sharp filter, swept and marked in frequency (fixed and variable) by 935-B and 990-A on the log amplitude display of the 1025-A, with calibrated level line set by the 432-C, switched in by the 255-A.

935-B Sweeping Oscillator
50 cps to 220 mc
Audio Video, VHF
Price: $1295.00

990-A CW Oscillator
4.5 to 220 mc
1.0V rms, AGC'd
Price: $373.00

1025-A Log Amplifier
200 kc to 220 mc
80 db Dynamic Range
Price: $795.00

432-C Attenuator
DC to 500 mc
0 to 101 db in 1-db steps
Price: $110.00

Write for complete catalog information

KAY ELECTRIC COMPANY
Maple Ave, Pine Brook, Morris County, New Jersey
Dept. EI-7 • CApital 6-4000

255-A Coaxial Electronic Switch
DC to 500 mc
70 db "off" at 200 mc
Price: $295.00

Circle 23 on Inquiry Card

CAREER NEWS FROM HUGHES

Aerospace Divisions in Culver City, California

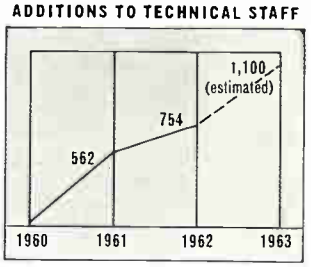
NEW AND CONTINUING PROGRAMS AND PROJECTS

F-111B PHOENIX Missile System
MMRBM (Integration, Assembly and Checkout)
SURVEYOR Lunar Landing Vehicle
SYNCOM Synchronous Communications Satellite
POLARIS Guidance
TOW Anti-tank Missile
VATE Automatic Checkout System
FALCON Missiles
HARD POINT DEFENSE

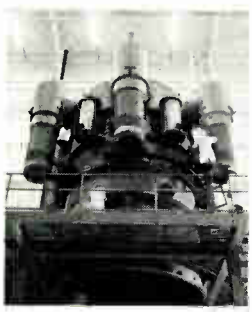
These examples of Hughes Aerospace activities are representative of *more than* 230 major product and service capabilities ranging from aerospace vehicles to ASW systems.

GROWTH OF THE TECHNICAL STAFF

Of the nearly 9,000 employees of these divisions, 2,600 are Members of the Technical Staff. Average length of experience is 10.0 years. Average age is 32 years.

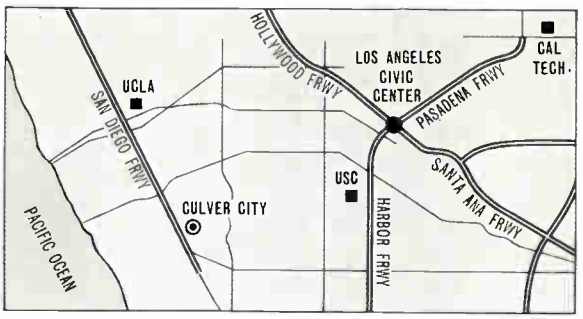


OUTSTANDING TECHNICAL FACILITIES



This giant environmental test chamber at Hughes new Space Simulation Laboratory is just one of a complete range of facilities maintained by the company for the Technical Staff. Hughes physical plant and professional atmosphere, unexcelled in industry, encourage individual achievement.

HUGHES/CULVER CITY & LOS ANGELES



Hughes Aerospace Divisions at Culver City offer engineers and scientists a unique combination of urban and suburban advantages. The plant is immediately adjacent to a major freeway. Los Angeles Civic Center is about a half-hour distant. Beach communities are just minutes away. Attractive residential neighborhoods are nearby. UCLA, USC and Cal Tech offer outstanding educational facilities.

IMPORTANT OPPORTUNITIES, steady growth, advanced facilities, fine living conditions—these are the advantages which Hughes Aerospace Divisions can offer you at Culver City.

Requirements include an accredited degree in E.E. or M.E. and specialized experience which can be related to development of aerospace vehicles. U.S. citizenship required.

For immediate consideration please airmail your resume *today*. We promise you a reply within one week.

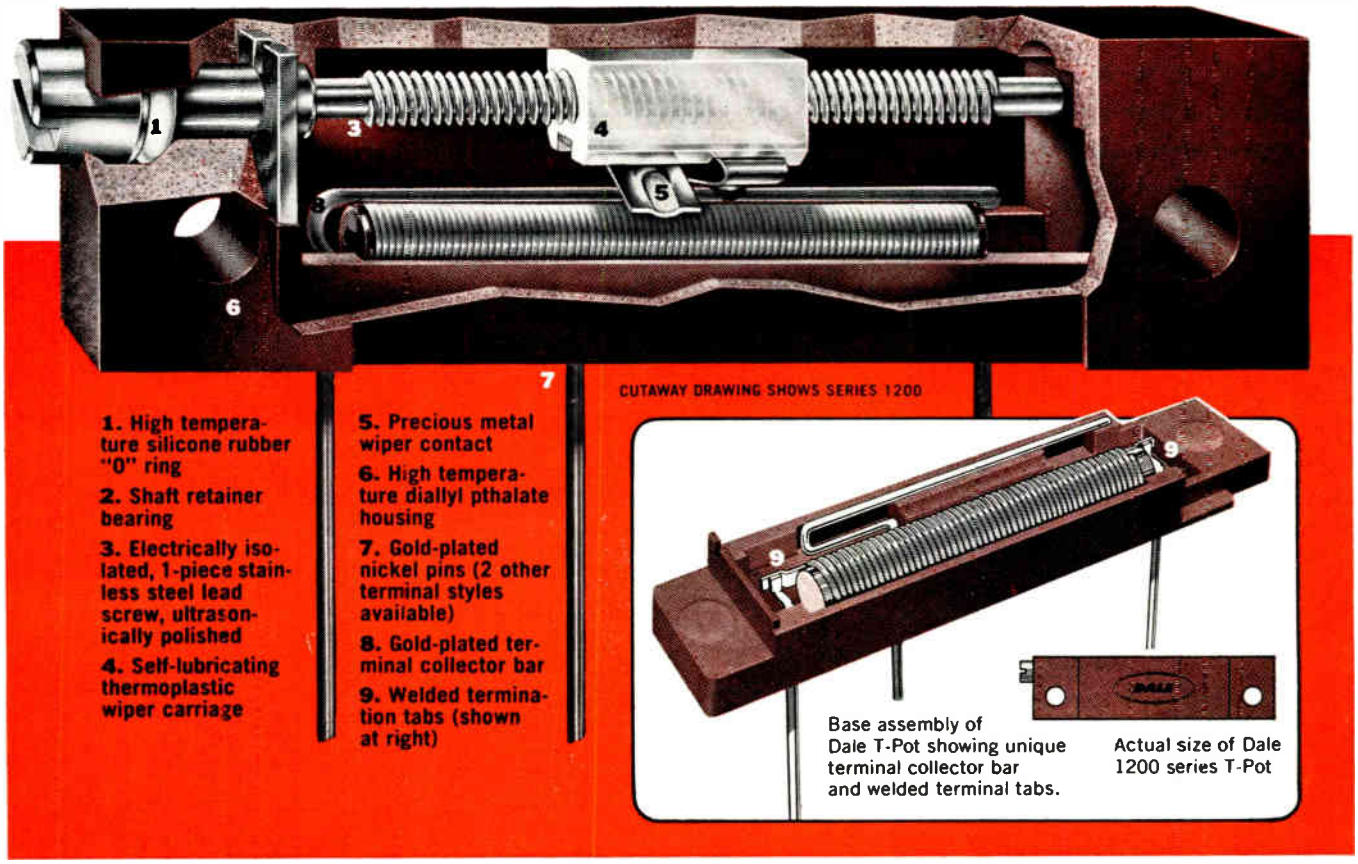
MR. ROBERT A. MARTIN
Head of Employment
Hughes Aerospace Divisions
11940 W. Jefferson Blvd.
Culver City, 75, California

Creating a new world with electronics

HUGHES
HUGHES AIRCRAFT COMPANY
AEROSPACE DIVISIONS
An equal opportunity employer

DALE ALL-NEW T-POT!

Rugged compact unit features PRECISION RELIABILITY



1. High temperature silicone rubber "O" ring
2. Shaft retainer bearing
3. Electrically isolated, 1-piece stainless steel lead screw, ultrasonically polished
4. Self-lubricating thermoplastic wiper carriage
5. Precious metal wiper contact
6. High temperature diallyl pthalate housing
7. Gold-plated nickel pins (2 other terminal styles available)
8. Gold-plated terminal collector bar
9. Welded termination tabs (shown at right)

The assignment—build a better T-Pot. The result—a new design which uses simplicity and rugged all-welded construction to achieve inherent reliability. This precision trimmer is now available to meet your most exacting requirements.

Here's how Dale "builds-in" reliability

HOUSING of high temperature diallyl pthalate provides maximum strength and environmental protection. Meets requirements of MIL-STD-202 and MIL-R-27208A.

RESISTANCE ELEMENT of maximum length and diameter provides highest resolution values available in this type trimmer. Both linearity and resolution are improved by Dale's unique winding process which achieves absolute captivation of individual turns of wire. Winding is formed over insulated copper mandrel which acts as high-mass heat sink, eliminating "hot spots" and providing uniform dissipation at high temperatures. Special Dale "captive-weld" process forms a mechanically strong, low-resistance termination, virtually unaffected by temperature extremes.

WIPER AND SCREW ASSEMBLY provides positive settings under all environmental conditions. Self-lubricating thermoplastic wiper carriage travels precisely on 25-turn stainless steel adjustment screw. Clutching provision at both ends prevents overtravel damage. Precious metal contacts maintain unvarying pressure assuring electrical reliability. High temperature silicone rubber "O" ring provides excellent environmental insulation.

COLLECTOR ASSEMBLY has 1-piece design eliminating additional connection requirement. Gold plating provides noise-free, non-oxidizing contact surface.

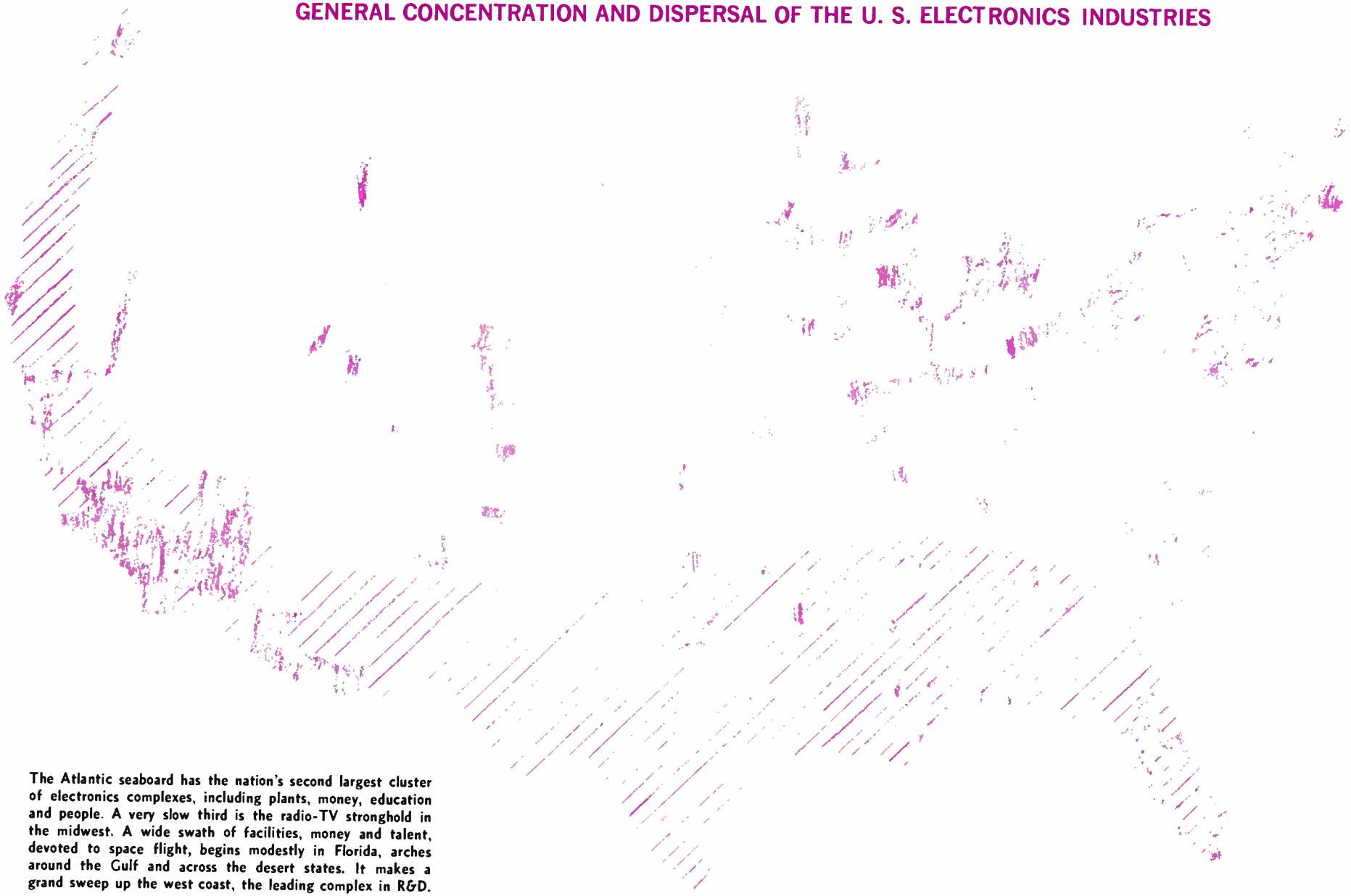
SPECIFICATIONS: Meets requirements of MIL-R-27208A • Rated at 1 watt at 70° C. • Operating temperature range –55 to 175° C. • Resistance range 10 to 100K ohms • Mechanical adjustment: 25 ± 2 lead screw revolutions • Temperature coefficient: Max. 0.007%/° C. • Tolerance ± 5% (others available) • Three terminations: weldable and solderable circuit pins; stranded teflon insulated leads and solderable lugs • 100% inspection and testing of critical electrical and physical parameters prior to shipment. **Special configurations and characteristics and completely non-magnetic units can be furnished to order.**

Write for Catalog B

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

VSMF — See our specifications in the microfilm catalog file

GENERAL CONCENTRATION AND DISPERSAL OF THE U. S. ELECTRONICS INDUSTRIES



The Atlantic seaboard has the nation's second largest cluster of electronics complexes, including plants, money, education and people. A very slow third is the radio-TV stronghold in the midwest. A wide swath of facilities, money and talent, devoted to space flight, begins modestly in Florida, arches around the Gulf and across the desert states. It makes a grand sweep up the west coast, the leading complex in R&D.

Ever since Sputnik the U. S. electronics industry has been accelerating rapidly. Now, with almost overnight velocity, technical advances and sprouting aerospace and defense markets are causing hundreds of firms to relocate, add-on, divide, merge or start anew, clear across the nation. And coming with this industrial and educational shuffling is a dispersal of opportunity.

INDUSTRY OPENS UP NEW AREAS OF U. S.

THE RAPID AND HIGH-POWERED GROWTH of the electronics industry has swept up hundreds of big and small electronics firms into a national game of musical chairs.

Without Federal deals in the billions to prop it up, the electronics business today would most likely be resting comfortably in a status quo rooted mostly in and around New York, Chicago and Los Angeles.

No doubt electronics managements would be playing marbles for the current $2 billion worth of markets in standard consumer products. But with nearly $15 billion riding on defense and aerospace action forecast by the end of 1963, the electronics situation is not only moving upward, but is also pogo-sticking around the country, down south, across the basin, into and out of the desert areas and up the Pacific coast.

Look at these statistics: 40% to 50% of DOD and NASA total procurement funnels into electronics in many cases: some 70% of the electronics industry dollar-intake (about $9 billion estimated for this year) is from defense and aerospace; which absorb some 10% of the estimated more than $570 billion current gross in national production, including all goods and services in the U.S.

Chief forces pulling the strings on this great movement of electronic plants, divisions and firms have been Russia plus the normal growth of population and industry.

Corollary factors have also contributed to the shuffling of electronics business, engineers, technicians, reluctant wives and families. These are:

1. New billions in U.S. R&D, test and evaluation, poured into the American economy.

2. Dispersal of industry, originally to lessen effects of possible air attach and decentralization in general.

3. Merging companies, plant consolidations, new businesses, folding businesses, plus usual bill-of-fare in manpower, water, power, wage rates and lower tax inducements.

The west coast, leading complex in U. S. R & D, naturally wants to keep a stranglehold on the largest single share of the defense and aerospace market, from 30% to 50%, depending on how you carve up the Pacific coast states. East coast firms are holding down 20% to 30%. The midwest, though, has been squeezed down to somewhere between 5% and 20% of the total, depending again on geography.

There is little doubt among the nation's electronics wisemen that the relatively poor showing by the midwest stems from its concentration on radio-TV production, a profitable though plodding business, at best. More alert firms in other and fast moving areas are sidling into more subtle, highly-engineered activities in missiles, spacecraft, ground-support and communications systems.

An agonizing reappraisal of things gave most midwestern states a big case of heartburn since they lost a pile in the scramble for defense and aerospace contracts. In 1960, at the National Electronics Conference, Stanford's Prof. Frederick E. Terman called the midwest area down for not "keeping stride with the rest of the electronics industry." He accused the midwest of neglecting its universities, faculties and students. He decried midwest electronics as "lacking the explosive character of the industry in the New England and Pacific coast areas."

At the 1962 NEC meeting, the exodus of scientific and engineering talent from the midwest was bewailed as leaving a "sterile desert." The accuser this time was Angus MacDonald, a marketing manager with the Military Electronics Division of Motorola, Inc.

By SIDNEY FELDMAN
Contributing Editor
ELECTRONIC INDUSTRIES

DISTRIBUTION OF PLANT LOCATIONS AND ELECTRONIC ENGINEERS IN THE U. S. BY MAJOR STATES

State	% of U. S. Plants	No. of Plants	% of U. S. Electronic Engineers
New York	18.68%	1,128	16.55%
California	17.00	1,027	25.64
New Jersey	10.53	636	7.21
Illinois	9.24	558	5.02
Massachusetts	6.87	415	5.60
Pennsylvania	6.38	385	7.29
Ohio	5.05	305	5.62
Connecticut	4.66	282	2.09
Minnesota	2.36	143	1.64
Indiana	2.35	142	2.29
Michigan	2.30	139	.72
Wisconsin	1.77	107	2.38
Florida	1.72	104	3.09
Maryland	1.05	64	2.50
Texas	1.02	62	3.97
Missouri	.81	49	1.24
Iowa	.46	28	1.13
Total: 17 States	92.25%	5,574	93.98%

Source: Electronic Industries, Market Research Department.

DISTRIBUTION OF NASA SPACE RESEARCH FUNDS IN PRIME CONTRACTS BY STATES

(In Thousands of Dollars: 000 missing)

	*FY 1961	FY 1962	FY 1963
Alabama	$ 67,290	$138,110	$234,028
Alaska	607	980	1,805
Arizona	2,437	3,941	7,262
Arkansas	27	44	80
California	274,993	459,289	830,704
Colorado	2,900	26,595	58,646
Connec'icut	4,063	6,575	12,116
Delaware	49	76	140
Florida	58,641	94,857	174,799
Georgia	3,244	5,247	9,669
Hawaii	178	294	542
Illinois	4,805	7,772	14,323
Indiana	1,370	2,221	4,092
Iowa	949	1,535	2,828
Kentucky	36	54	100
Louisiana	88	46,578	359,102
Maryland	23,125	47,463	78,480
Massachusetts	10,165	16,437	30,290
Michigan	8,079	13,074	34,092
Minnesota	1,977	3,200	5,898
Missouri	47,270	107,260	264,898
Nevada	55	87	160
New Hampshire	32	54	100
New Jersey	13,991	22,631	41,704
New Mexico	1,446	2,340	4,313
New York	51,181	82,785	152,553
North Carolina	150	239	441
Ohio	20,245	46,754	75,536
Oklahoma	374	610	1,123
Oregon	222	359	662
Pennsylvania	12,773	20,661	38,073
Rhode Island	92	152	281
Tennessee	1,054	1,709	3,149
Texas	14,653	44,243	73,225
Utah	31	54	100
Virginia	35,170	58,653	102,030
Washington	110	174	321
West Virginia	1,500	2,500	1,500
Wisconsin	783	1,263	2,327
District of Columbia	8,308	26,038	56,022
TOTALS (39 States and D. C.)	$674,463	$1,292,905	$2,667,514

*Fiscal Year

Source: National Aeronautics & Space Administration.

Area Trying to Pull Out of It

Still, the region has been trying to give itself a jolt here and there. Late in 1962 a group of midwest governors met in Chicago and tried to uplift scientific and industrial development by inducing more cooperation among midwest colleges as well as between colleges and industry.

Similarly, the Research Directors Association of Chicago has tried to upgrade management skills. The University of Chicago needled NASA for a research facility on campus, while Ohio legislators said "yes" to setting up the Ohio Research and Development Foundations to evaluate and increase the state's R&D capacity.

By late 1962, statistics showed Ohio, Indiana, Illinois, Michigan and Wisconsin leading the field in new defense contract awards, having won $3.2 million in prime contracts, during the 1962 fiscal, or 12.6% of the $25 billion total. In 1961 fiscal these states had won but $2.6 billion, or 11.8% of the total, compared to 32.4% during World War II.

Moving eastward, the Atlantic seaboard represents the nation's second largest cluster of electronics complexes. In the 1962 fiscal New England claimed 10.8% of DOD dollars, while the middle Atlantic scooped up 18.8%, nearly 30% total. Maine is growing in electronics activity, while New Hampshire gains from spin-offs in the Boston area. The heart of New England electronics, though, still arcs around Route 128, the "electronics highway," just outside Boston.

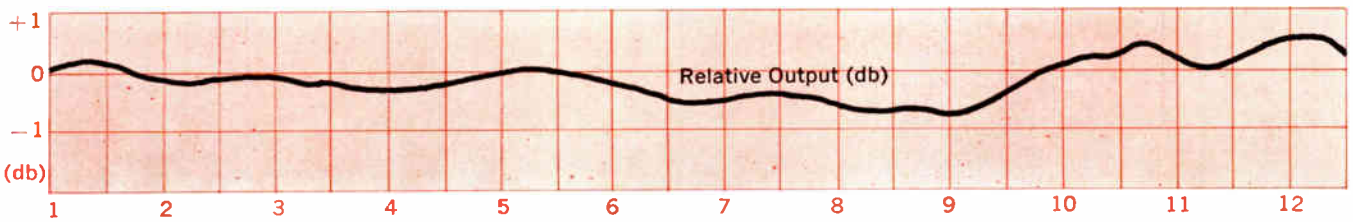
In an area including New York City, West Chester County, northern New Jersey, southern Connecticut, Long Island and outer reaches of metropolitan Philadelphia, lies the largest grouping of electronics industries in the east.

New York Region Stronghold

Inch-for-inch, New York City probably represents the largest and probably the oldest management stronghold of electronics companies and holding companies in the nation, including a sizable collection of our most outstanding blue-chip firms. From perilous days when communities reeled from calamities like the collapse of a Republic Aviation Corp. contract, Long Island has bounced back to where electronics manufacturers now employ some 30% of the Island's working force, pushing aircraft manufacturers into second place. Sen. Kenneth B. Keating (Rep.—N. Y.,) defended Long Island by accusing Temco Electronics & Missiles Co. of trying to lure New York electronics firms to Texas in return for subcontract awards. Texas retreated.

(*Continued on page* 50)

The Flattest RF Crystal Detectors Yet!



TYPICAL RESPONSE CHARACTERISTICS

Only ALFRED can give you a broadband crystal detector with a frequency response of less than ±1 db over the entire range from 1 to 11 Gc.

And only ALFRED has matched crystal detectors which have a flat frequency match of ±¼ db and square-law response of ±¼ db.

Here's how these painstakingly engineered and constructed crystal detectors provide a new standard of precision for:

Broadband Transfer Function Display RF component characteristics which vary with frequency may now be accurately displayed on an oscilloscope with the ALFRED Crystal Detector Model D 120.

Accurate Feedback Leveling A flat response ALFRED Crystal Detector may be used for automatic gain or power control. RF power is sampled with a directional coupler and detected with the ALFRED Crystal Detector. The detected signal is amplified and compared to a reference voltage. The resulting error signal is applied to the control electrode of the microwave tube or the control winding of a ferrite device in the RF circuit. In the past, marginal crystal frequency response limited overall control.

Reflection Coefficient Measurements In reflection coefficient measurements using reflectometers, directional couplers and crystal detectors are used to sample the incident and reflected power. The well matched frequency and square-law response of the ALFRED Matched Detectors makes possible measurements having substantially greater accuracy than has been previously possible.

SPECIFICATIONS

	Broadband Detectors	Matched Detectors		
	D 120	D 121	D 122	D 123
FREQUENCY RANGE	1 to 11 Gc (operates to 12.5 Gc)	1 to 4 Gc	4 to 8 Gc	7 to 11 Gc
FREQUENCY RESPONSE	±1 db	Pairs matched to ±¼ db from −4 to −40 dbm (D123 ±½ db)		
SENSITIVITY	150 mv/mw, no load	Greater than 100 mv/mw at rated video load (5 KΩ typical)		
SQUARE LAW	±1 db from −4 to −40 dbm	Pairs matched to ±¼ db from −4 to −40 dbm		
VSWR	2.2:1 max.	2.2:1 maximum		
PRICE	$90 per unit	$150	$200	$250

GET COMPLETE DETAILS—*ALFRED's policy is to publish* complete *specifications and guarantee them as stated. For complete information on ALFRED flat response crystal detectors, please contact your ALFRED engineering representative or write to:*

ALFRED ELECTRONICS
3176 Porter Drive • Palo Alto, California
Phone: (415) 326-6496

14

Psychologically, east coast firms seem to benefit from the nearness of Washington and Federal powers. This, among other reasons, may have something to do with the growing complex of Maryland and Virginia R&D firms, consultants, lobbyists, Washington associations, trade groups, manufacturer's representatives, and related technical, sales and marketing consultants.

Farther south, defense and aerospace firms have partly resolved the economic dilemmas of magnolia land. Thanks to missiles, rockets and electronics, the deep south has been transformed from "economic isolation" into an area probably growing a bit faster than the west coast.

The south's new-found prosperity is reflected in the Huntsville (Ala.) Industrial Expansion Committee. All due largely to NASA's George C. Marshall Space Flight Center, this operation has reoriented northern Alabama from cotton to aerospace. Now there are also dozens and dozens of prime and subcontractors in clusters of offices around the Marshall Center, somewhat like flies around the honeypot.

Florida Electronics Boom Area

Florida, the south's second boom area in electronics, now has many new defense and aerospace firms. Martin-Marietta, Orlando, is one prime attraction, again with peripheral clusters, luring component makers, environmental testers, and other electronic and quasi-electronic service companies.

A wide, rich swath of money, facilities and talent, all dedicated to space flight, begins in Florida and arches up around the Gulf of Mexico crescent to include Huntsville, the Mississippi Test Facility, the Michoud plant near New Orleans, the numerous Texas contractors, and on to the Pacific.

By far the largest and heaviest U.S. funded defense and aerospace electronic area is the west coast, which has been drawing heavy fire from other areas, which seek to recover or hold on to a great cult of the Federal R&D pie.

West coast activities line up like tiers along the Pacific shore, beginning in the north with Boeing's aerospace operations in Seattle, then south to Portland, and finally California's Palo Alto-San Francisco center, the Los Angeles area, and the still somewhat depressed San Diego area. Electronic programs in west coast states generally include or work closely with lesser defense and aerospace activities in Colorado, Utah, Nevada, Arizona and New Mexico.

Goings-on in defense and aerospace hardware and R&D have been paralleled by similar happenings in educational, corporate, trade and regional organizations. As the black box has evolved into groups of black boxes called systems, so have entire communities and regions been organized into systems to influence procurement and contract awards. In sum, electronics firms are chasing the government dollar; towns, cities, counties and states are inducing electronics firms to settle down, relocate, or consolidate plants in their community backyards.

Among such groups are county planning boards, regional plan associations, chambers of commerce, trade associations, and specifically chartered groups such as the North Star Research & Development Institute in Minneapolis, which hopes to attract new laboratories to the Minneapolis-St. Paul area. Other service businesses eyeing new plants include banks, railroads and public utilities.

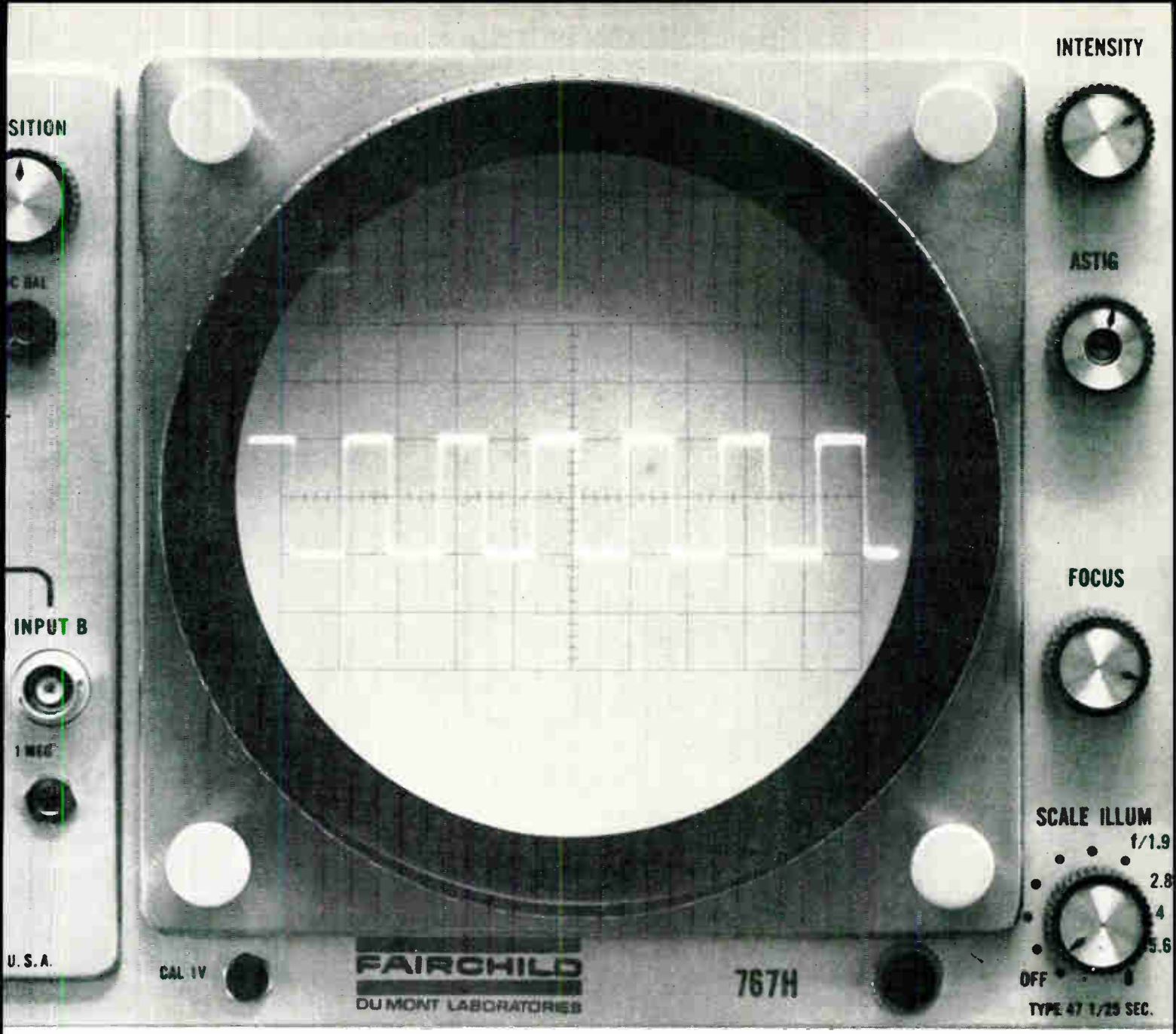
Education Centers Appreciated

Government, commerce and industry long ago appreciated the basic value of educational centers. The Pacific coast benefits from research activity at Stanford, University of California and Cal. Tech., among others. Similarly, New England has MIT and Harvard. New York has Columbia and New York University, and the Philadelphia region has the Franklin Institute, University of Pennsylvania, and Temple University.

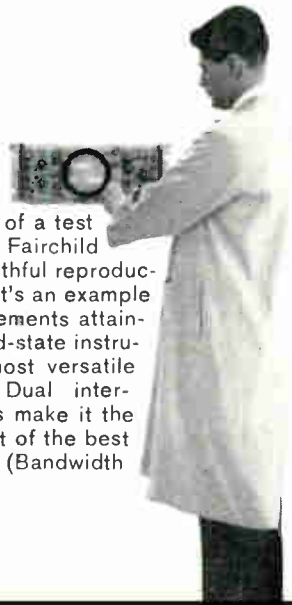
North Carolina boasts of its "Research Triangle" that draws upon engineering talent and laboratories from three great universities nearby. An ambitions example of "instant technology" is Gov. Nelson Rockefeller's proposal for a center of Science and Technology within the State University of New York complex, which is situated among more than a dozen upstate towns. As states and regions bid for electronics industry plants, so most cities in New York state are bidding for the proposed New York Tech.

From a marketing standpoint, electronic managements are confronted with a series of problems in covering geographically dispersed customer firms. Should they consolidate, relocate, buy up or merge with other firms in growing areas? Should they open regional warehouses, store centrally and ship by air freight, establish direct company agents, hire reps, or maintain roving sales engineers and maintenance men to service cast areas? Should they use direct mail and regional trade shows? Underfinanced firms often solve most of these problems by simply using Reps. In a tight squeeze, they usually will submit to merger, hoping to benefit from parent-company finance and guidance.

(*Continued on page 52*)



How square can you get?



This unretouched photo of a test pulse displayed on a Fairchild Type 767H scope is a faithful reproduction of the input signal. It's an example of the precision measurements attainable with these new solid-state instruments. ▪ Here is the most versatile scope you can buy. Dual interchangeable plug-in units make it the equivalent of six to eight of the best special purpose scopes. (Bandwidth of the plug-in used to make the trace shown here is dc-100 mc; rise time, 3.5 nsec.) The Fairchild 760 Series is available in bench, rack mount or portable configurations, and with 13 kv accelerating potential. ▪ Write for a new catalog on these and other precision instruments in the new Fairchild line. Or ask your nearby field sales engineer (offices in 39 cities) for a demonstration. Fairchild Scientific Instruments, Dept. 27, 750 Bloomfield Avenue, Clifton, New Jersey.

FAIRCHILD

DU MONT LABORATORIES

DIVISIONS OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

750 BLOOMFIELD AVENUE, CLIFTON, NEW JERSEY

Circle 25 on Inquiry Card

INDUSTRY OPENS (Concluded)

U. S. Largest Single Customer

The U.S. Government is obviously the largest single customer in the world. Since DOD and NASA are the largest individual Federal activities, many U.S. agencies hold the strings on funds flowing from Congress. Labor surplus or economically depressed communities are often given higher consideration for selection of qualified defense and aerospace contractors. Congress also has legislated to make sure that prime contractors subcontract certain parts of a total system's contracts both to depressed areas and to small businesses.

Most active in this effort are the Small Business Administration (SBA) and the Area Redevelopment Administration (ARA) which cooperate to help electronics firms and others. SBA aids with loans, management consultation and small business procurement matters.

ARA tries to help depressed areas lift themselves out of their holes but some competitors complain of ARA's bolstering of marginal competitors. Some communities proudly resist "handouts" and being called "depressed." Yet ARA has loaned several million dollars to electronics firms to help them start or maintain businesses, and to create work and hold job levels.

Managing DOD dollars involves modifications for force structures, geographic reassignment of forces, changes in systems and altered programs. As a result, switches and shifts, cutbacks and stretchouts, affect whole communities, the industry and national economy.

OEA Assists Communities

The Office of Economic Adjustment, in answer to President Kennedy's request to Defense Secretary McNamara assists local communities affected adversely by changes in our defense posture. The OEA, within the Office of the Assistant Secretary of Defense for Installations and Logistics, seeks to help communities by assessing material and human resources and weaknesses, and by encouraging long-term growth to satisfy community needs. Working with other U.S. agencies and offices, the OEA has helped communities wean themselves away from complete dependence on defense and aerospace contracts.

Sen. Clifford P. Case (Rep.-N. J.), is fighting the migration of electronics firms from New Jersey and other mid-Atlantic states to the South. He has decried rising unemployment resulting from industry being enticed southward by flat property tax exemptions, and he has called for codes of ethics.

Sen. Wayne Morse (Dem.-Ore.), has led successful delegations to lure industries into Washington, Oregon and northern California. The south's solidly re-elected congressmen have also done well for their constituent states since the birth of NASA in 1958.

The National Planning Association sees a continuing move of electronics firms into the west and southwest. Besides, California now has more people than New York. All areas of the nation have their welcome mats out for region-hopping electronics firms, divisions and new companies.

Reasons are basic. One-hundred new factory workers will mean: 100 new households with 359 more people, 91 more school children, 97 more autos, $710,000 more in personal income, $229,000 more in bank deposits, $331,000 more in retail sales, three more retail outlets, and 65 more people in service industries—including retailing.

* * *

NEW SPACE SYSTEMS CENTER

(Continued from page 40)

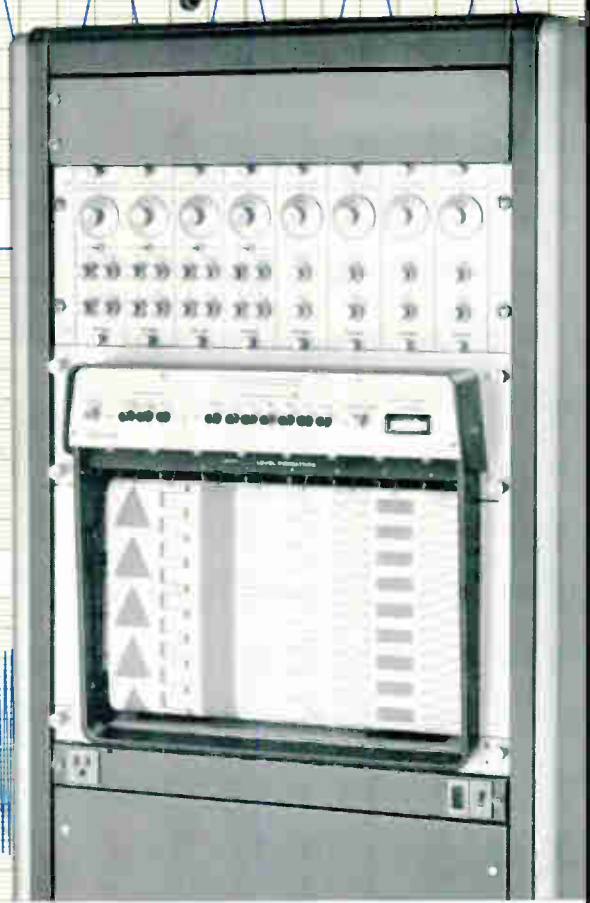
three units will include extensive cryogenic facilities and will be housed in a 30,000 sq. ft. building. A large portion of the building will have a 100 ft. ceiling.

Largest of the three units is a 39-ft. spherical chamber with a clear working space 30-ft. in interior diameter. It is large enough to enclose a fully assembled spacecraft. High vacuum created within this sphere will be equivalent to the low pressures experienced at altitudes in excess of 400 miles above the earth. Within its liquid nitrogen-cooled walls (temperatures as cold as −320°F), large test objects can be subjected to most of the conditions of space-flight including vibration and solar-heating.

Two smaller simulators, each with clear working test space 5 ft. in dia. by 5 ft. in ht., will be used for development-testing of sub-assemblies and components. The top-loading vertical cylinders are being built with identical top flanges so they can be fitted with solar-radiation simulation equipment. They are designed to attain an ultimate operating pressure of 1 or 2 X 10^{-9} Torr. As in the large unit, they will have liquid nitrogen-cooled walls.

All three chambers feature the high gas handling capacity of 20°K cryopumping.

Prime contractor for the Earth-Orbit simulator portion of the new facility is F. J. Stokes Corp., Phila., Pa.



precision and clarity never before achieved...

The new Brush Recorder Mark 200 made these incredibly crisp tracings. No other recorder in existence can match them. Note the line width. It never varies . . . regardless of writing velocity, regardless of chart speed. The writing mechanism is electrically signaled by the position-seeking "Metrisite" transducer . . . no parts to wear, infinite resolution, verifiable dynamic ½% accuracy. Traces are permanent, high-contrast, reproducible . . . on low cost chart paper. The Mark 200 has but three standard controls . . . attenuator, pen position, chart speed. Such fidelity, simplicity and economy are possible with no other direct writing recorder. *Available in both vertical and horizontal models* with interchangeable plug-in preamplifiers or signal conditioning push-button controls. Write for details . . . they'll speak for themselves.

brush INSTRUMENTS

DIVISION OF CLEVITE 37TH AND PERKINS, CLEVELAND 14, OHIO

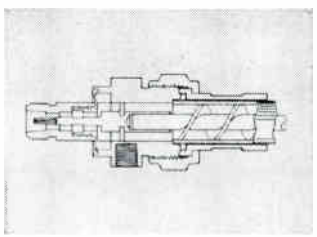
MATCHING PERFORMANCE STANDARDS
OF PHELPS DODGE COAXIAL CABLE

COAXIAL CONNECTORS

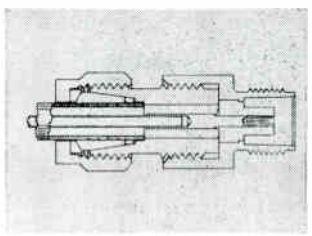
■ The high performance characteristics offered by five types of Phelps Dodge Electronics air dielectric, semi-flexible coaxial cable are protected by use of off-the-shelf connectors designed specifically for these cables. Matching and reactance compensating techniques are used to minimize electrical reflections capable of creating serious VSWR problems.

If your feed network demands the unusual, consider Phelps Dodge Electronics capability. Typical of several R & D programs now underway, high voltage cable-connector combinations are being developed. Gas pressurized 1⅝" diameter Styroflex® coaxial cable fitted with type LCF high-voltage connectors has been successfully tested with continual application of 50 KV DC.

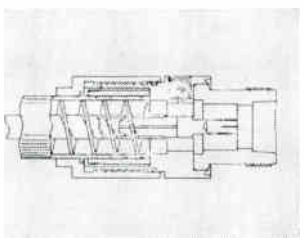
Pure-bred components as well as subsystem and system capability in sophisticated feed networks can be utilized for challenging assignments. When systems communications is the key to your project . . . see Phelps Dodge Electronics.



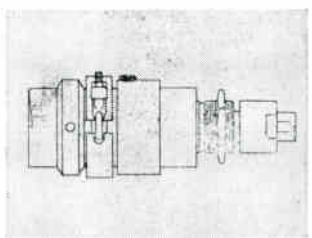
Design features include an uninterrupted wave surface path. Wirelok Connector shown is for Foamflex, Styroflex® and Spirafil cable in ⅜" to 3⅛" size.



Outer conductor joints are pressure butt type with electrical contact made on the inside diameter of the butt. This connector is for .180" and ¼" Foamflex.



High pressure spring fingers assure an encircling contact around the center conductor of the cable. Diagram is typical connector for Helical Membrane coaxial cable.



Resonant effects due to electrical contact within the center conductor typical in "basket" or "indented" designs are eliminated. Many special connectors are in stock.

PHELPS DODGE
ELECTRONIC PRODUCTS CORPORATION
60 DODGE AVENUE • NORTH HAVEN • CONNECTICUT

PD ELECTRONICS

All These Relays and Hundreds More From Ohmite's 12 Basic Models

USED THROUGHOUT INDUSTRY: General purpose, industrial controls, mobile equipment, aircraft systems, commercial devices, and military equipment requiring 1 to 25-amp contacts.

MANY CHOICES: High quality types, good economy units, unenclosed, plug-in, transparent enclosures, removable enclosures, dust-tight enclosures, hermetically sealed, miniature, sensitive, latching, indicator (light), U.L. approved, thyratron plate circuit models, and many special designs.

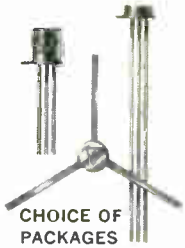
FULL SELECTION OF TERMINALS: Quick-connect (push on), octal plug, screw type, solder, binding post, Jones plug, and banana plug.

338 TYPES CARRIED IN STOCK: Units stocked fall in the 5 to 25-amp contact range, and include latching types with transparent enclosures, U.L. approved models, hermetically sealed units, and thyratron plate circuit relays.

Be sure to get a copy of relay Catalog 700

OHMITE
MANUFACTURING COMPANY
3662 Howard Street, Skokie, Illinois
Phone: (312) ORchard 5-2600

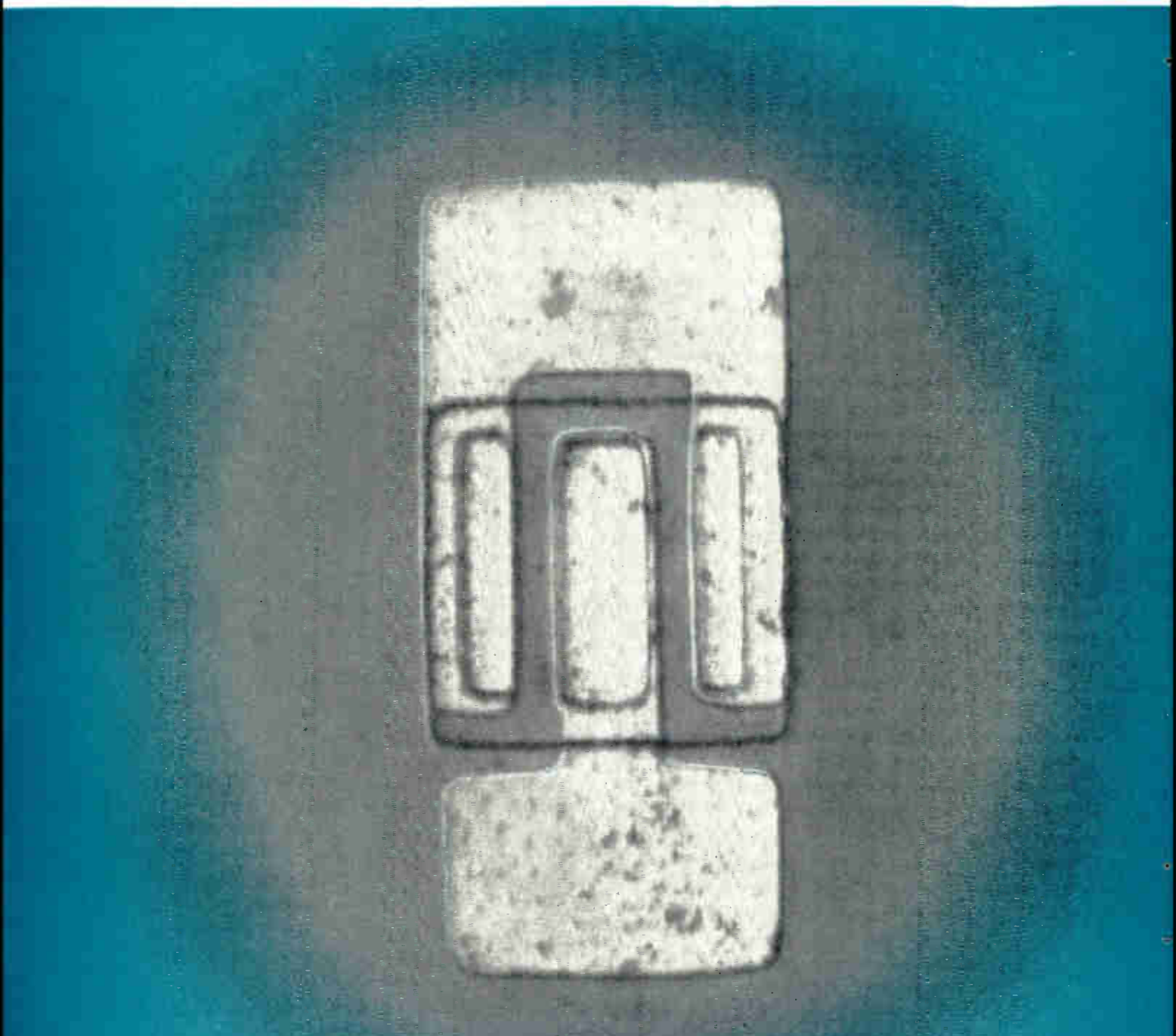
RHEOSTATS • POWER RESISTORS • PRECISION RESISTORS • VARIABLE TRANSFORMERS
TANTALUM CAPACITORS • TAP SWITCHES • RELAYS • R.F. CHOKES • SEMICONDUCTOR DIODES



This is the micropower transistor—a new silicon epitaxial planar device that offers higher efficiency at microwatts or milliwatts. As a switch, or as an amplifier, the type 2N2784 offers capabilities beyond any now available! Typical: 1 KMC bandwidth—higher beta level at microamperes, with reduced falloff beyond 10 milliamperes.

This performance stems from advanced device design and refined photolithographic techniques plus Sylvania's exclusive skills in epitaxial technology. Unusually small

Fastest silicon switch available: new 1 KMC



Epitaxial construction, new 3-stripe configuration, and small size, produce new high switching speed ($T_{on} + T_{off} = 12$ nanoseconds) with low saturation voltages (typically 0.2 volts).

junction sizes and spacings, low capacitances, result in improved frequency response for both switching and amplifier applications.

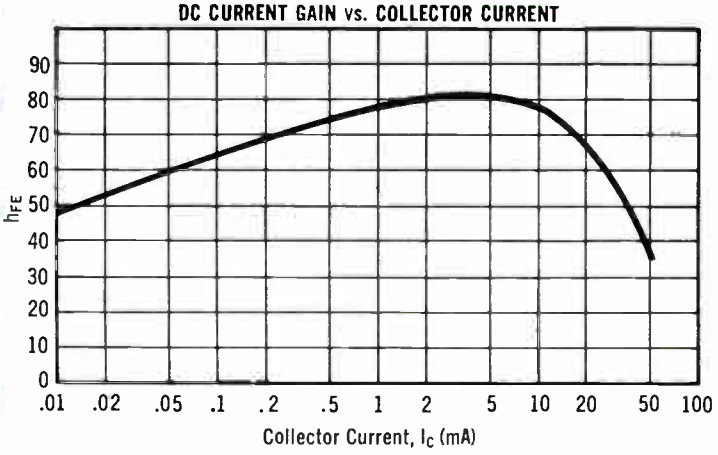
The Sylvania 2N2784 and the 2N709 and 2N709A, which are members of the 2N2784 family, are all available in your choice of three packages—the TO-18, TO-46 "pancake," and the new TO-51 co-planar package.

For more information, see your Sylvania salesman or write to Semiconductor Division, Sylvania Electric Products Inc., Woburn, Mass.

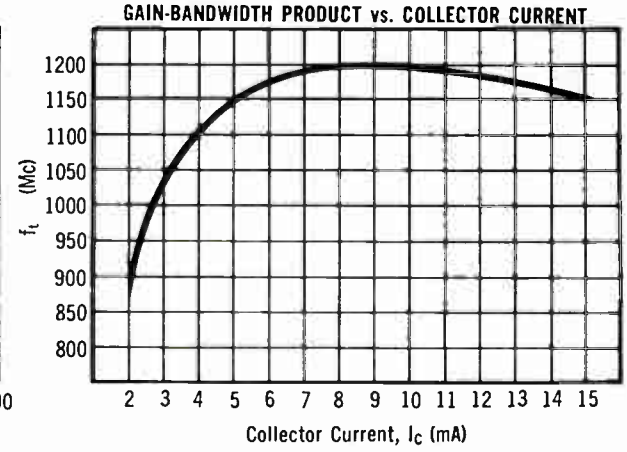
Sylvania epitaxial planar transistor 2N2784

SYMBOL	CHARACTERISTICS	2N2784 Min	2N2784 Max	2N709 Min	2N709 Max	2N709A Min	2N709A Max	TEST CONDITIONS	
h_{FE}	DC Current Gain	40	120	20	120	30	90	I_C=10mA	V_{CE}=0.5V
h_{FE}	DC Current Gain	20		15		15		I_C=30mA	V_{CE}=1.0V
h_{FE} (−55°C)	DC Current Gain	10		10		10		I_C=10mA	V_{CE}=0.5V
V_{BE} (sat)	Base Saturation Voltage	.70	.85 V	.70	.85 V	.70	.85 V	I_C=3.0mA	I_B=0.15mA
V_{CE} (sat)	Collector Saturation Voltage		.26 V		.30 V		.30 V	I_C=3.0mA	I_B=0.15mA
C_{ob}	Output Capacitance		3.0 pf		3.0 pf		3.0 pf	I_E=0	V_{CB}=5.0V
C_{TE}	Emitter Transition Capacitance		2.0 pf		2.0 pf		2.0 pf	I_C=0	V_{EB}=0.5V
I_{CBO}	Collector Cutoff Current		5mμA		50mμA		5mμA	I_E=0	V_{CB}=5.0V
I_{CBO} (150°C)	Collector Cutoff Current		5.0 μA		5.0 μA		5.0 μA	I_E=0	V_{CB}=5.0V
BV_{CBO}	Collector to Base Breakdown Voltage	15	V	15	V	15	V	I_C=10μA	I_E=0
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage	6.0	V	6.0	V	6.0	V	I_C=10mA (pulsed)	I_B=0
BV_{EBO}	Emitter to Base Breakdown Voltage	4.0	V	4.0	V	4.0	V	I_C=0	I_E=10μA
T_S	Charge Storage Time Constant		5.0 ns		6.0 ns		6.0 ns	I_C=I_{B1}=I_{B2}=5.0mA	
$t_{d}+$	Turn-on Time ($V_{BE(0)}$=−1.0V)		9 ns		15 ns		15 ns	I_C=10mA	I_{B1}=2mA
$t_{s}+$	Turn-off Time		9 ns		15 ns		15 ns	I_C=10mA	I_{B1}=I_{B2}=1.0mA
f_T	Gain-Bandwidth Product	1000	mc	600	mc	800	mc	I_C=5.0mA	V_{CE}=4.0V

DC CURRENT GAIN vs. COLLECTOR CURRENT



GAIN-BANDWIDTH PRODUCT vs. COLLECTOR CURRENT



SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

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

Circle 13 on Inquiry Card

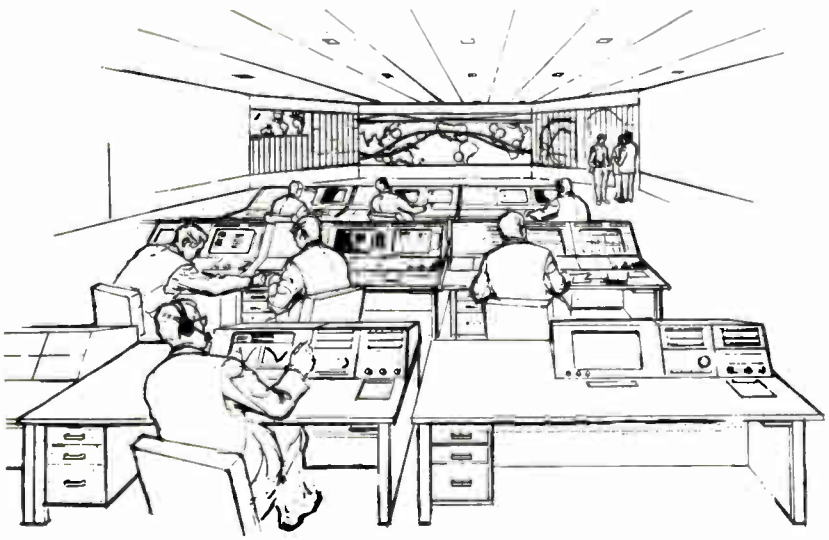
PROJECT APOLLO'S COMMAND AND CONTROL

Control requirements for our early space flights were quite simple compared to those of the Gemini and Apollo programs. Controlling the spacecraft in the lunar mission will require techniques used by the master chess player. Here's how and with what the Integrated Mission Control Center will do this.

The Integrated Mission Control Center to be provided by Philco Corp. to the National Aeronautics and Space Administration (NASA) in mid-1964 will bring to bear all of the electronic techniques of the mid-1960's. Perhaps for the first time the full capacity of digital electronics will be used to assist man in the real-time control of space experiments. The Integrated Mission Control Center (IMCC) will be located at Clear Lake, just outside of Houston. From that point the Manned Spacecraft Center flight operations personnel will control the Gemini rendezvous and Apollo earth-orbital and lunar missions. The experience gained on the earth-orbital flights conducted within the Mercury program has been used to lay the principles of control which will guide the astronauts in the far more involved space flights of the late 60's and early 70's.

The primary responsibility for control will lie with the Manned Spacecraft Center (MSC) personnel. Also, the Control Center, will provide to the decision-making personnel, information which has been processed by a complex of computers and displayed by a rapid and concise data presentation system.

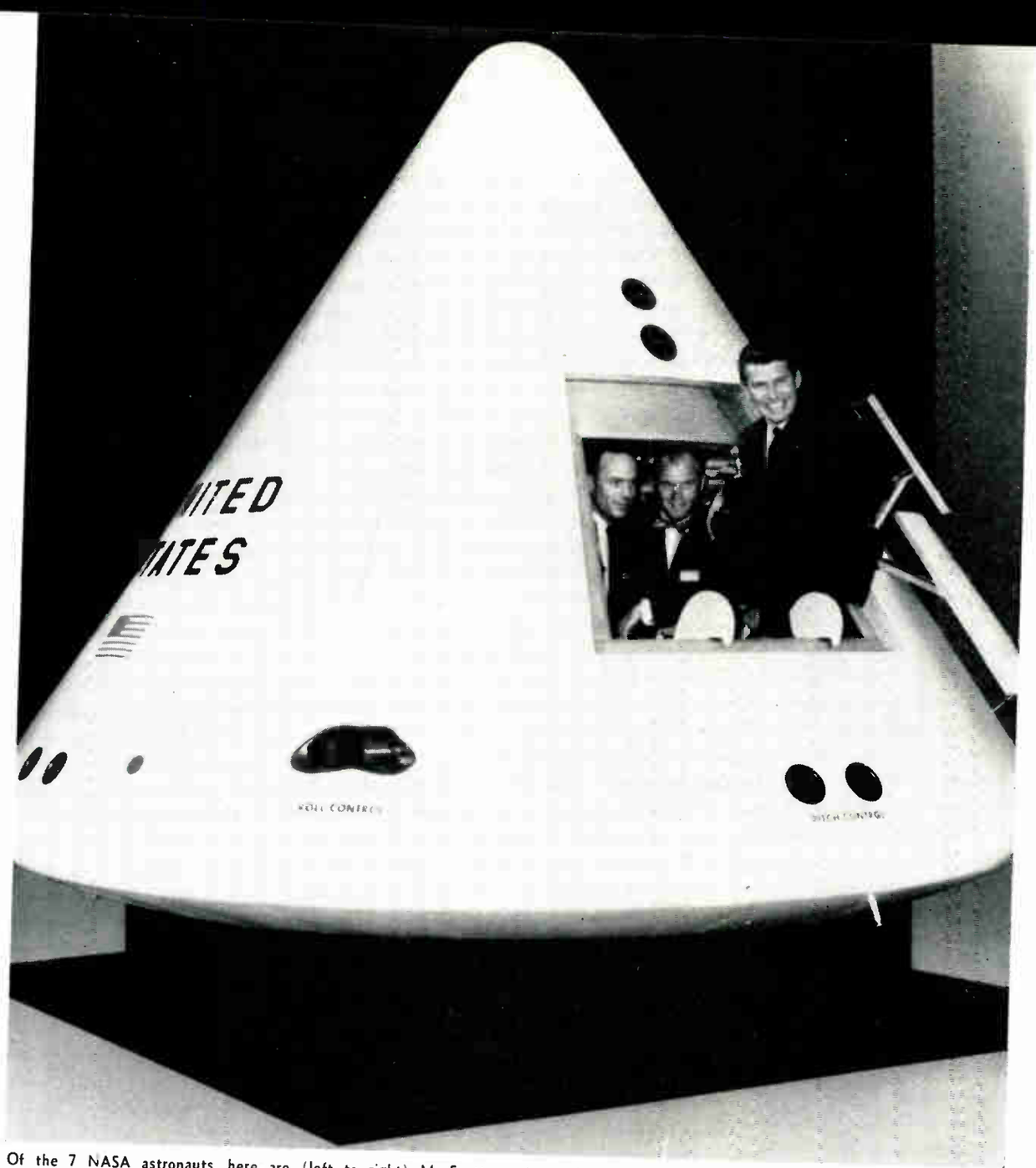
The IMCC itself will be located in a 3-story building at Clear Lake and will contain 2 complete control rooms and all of the electronic support equipment required for both. One of the Mission Operation Control Rooms (MOCR) will be assigned primarily to support actual flight tests, conducting each test from preparation many weeks before the flight, to the flight itself, the capsule recovery, and the post-flight analysis. See photograph. The other MOCR, identical to the first, will be used principally for simulations of future missions and the training of flight control personnel. The second MOCR will be able to insert contingencies or faults into simulated mission data, to test the reaction of the personnel, and to establish procedures in the event of a system mal-



Mission Operation Control Room (MOCR) as conceived for support of actual space flights. One other MOCR will be mainly for mission training and evaluation.

By Dr. WALTER B. LA BERGE

General Operations Mgr.
Philco-Ford Corp.
Philco Corp.
Subsid. of Ford Motor Co.
Houston 2, Tex.



Of the 7 NASA astronauts, here are (left to right) M. Scott Carpenter, John H. Glenn, Jr., and Walter M. Schirra, Jr., inspecting Apollo facilities. Project Apollo is under direction of NASA's Manned Spacecraft Center (MSC), Houston.

function. In addition to simulation and training for possibilities, the MOCR will be used to evaluate the control techniques for future missions.

Unification tasks define the technical interfaces between the NASA ground operating elements which support the flight. The task assigned under the contract recently let by NASA includes the provisioning of the IMCC and the support of the Manned Spacecraft Center. Philco, as the Systems Engineer, will be responsible for the working of the Integrated Mission Control Center. (See photograph, 8 flight phases.)

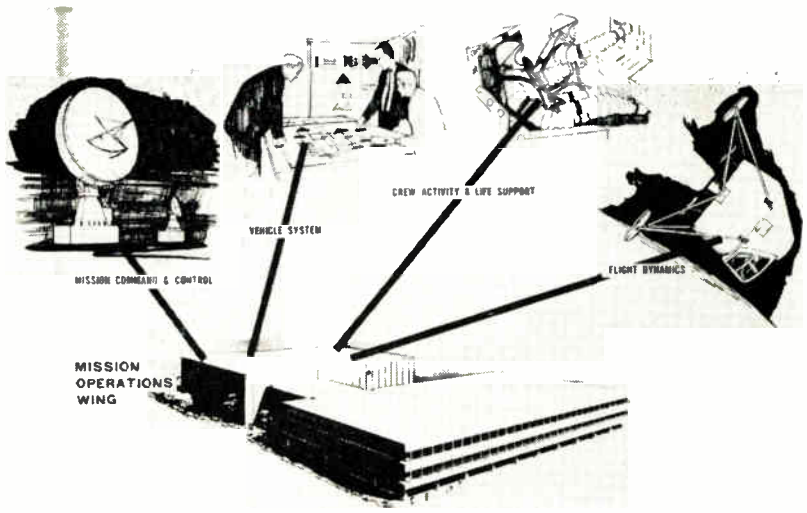
However, the responsibility for the computational system has been assigned to IBM as an associate contractor to NASA. The system for computation will consist of four 7094 computers and the support input-output equipment. IBM will also be responsible for the installation of the Gemini launch trajectory data system. Technical direction of these contracts is being handled by the MSC Ground Systems Project Offices.

Construction of the IMCC building was let under separate NASA contracts.

Operational Set-up

The IMCC has been divided into a complex of systems and subsystems. The Communications System in support of the IMCC will take inputs from

This depicts the role of the Integrated Mission Control Center (IMCC) in proposed multi-manned space flights which NASA has scheduled for mid-1964. A Philco Corp. team will provide the IMCC.



APOLLO (Continued)

the Launch Control Center and from the tracking stations making up the present Mercury network which, when augmented, will constitute the Near Space Instrumentation Facility (NSIF). It will also tie in the Deep Space Instrumentation Facility (DSIF) and the Recovery Control Centers, as these facilities are developed for the future missions.

The data from these ground facilities will be sent to the IMCC over a communications network which includes commercial-quality video, slow-scan TV, high-speed digital data, teletype data, voice and other circuits. These communication circuits will terminate in the IMCC and will be processed with a Remington Rand 490 Communications Processor.

The processor will route data and teletypewritten messages to either the computer complex or to the Message Center. The processor and its associated equipment will handle the cueing and priority routing of messages.

The communications system in the IMCC will contain a complete intercom and equipment able to produce a hard copy of messages having origin outside of or generated inside the IMCC.

Control and Display

The Control and Display subsystem will be designed to give the MSC flight controllers that information necessary for operational control of the flight. This IMCC subsystem is unlike the one used in the Mercury program because of the rather great technical differences between the present Mercury flights and those projected in this country's manned-spaceflight program for the next 10 years.

Following the critical-powered flight and insertion phases, Mercury Control monitors the systems and astronaut status to determine whether the flight will go the number of orbits scheduled. The ballistic nature of re-entry restricts zones of recovery in Mercury flights. In the future space missions, however, in-flight maneuvering greatly increases the complexity of recovery and the accuracy requirements on position data.

Also in the future missions, the critical portions will occur not only during the powered flight and insertion phases, but also during the orbit transfer and translunar injection maneuvers. The lunar operations and the super-circular entry velocities to be encountered in the Apollo missions add a whole new order of complexity to the control process.

Computational Functions

The control requirements for Mercury by comparison with those of Apollo are relatively quite simple and, as a consequence, were not mechanized in the depth which the IMCC will mechanize the control facility for these later missions. In many ways control of the spacecraft in the lunar mission will require the techniques used by the master chess players, as variations in the opening, during the boost and insertion phases, should reflect the optimum future course of action. It should be foreseen many moves ahead in the same way as a variation in one of the standard chess openings calls for a standard response known ahead by some 15 or 16 moves. In the same move, a variation in some of the parameters achieved in the insertion will have to reflect back into a series of changes in the lunar flight plan.

The computational system will be programmed so that one can, in fact, request the computers to provide a wide variety of plans which can be visually presented to the flight controllers. The display system will be one in which a wide variety of information is provided and a comparison made between the normal, or expected, information and that which is derived from telemetry or tracking data. The display system will provide a reference file of about 2,000 slides

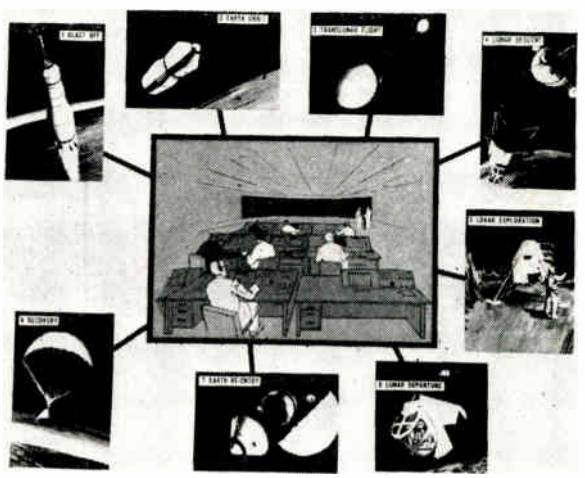
APOLLO (Concluded)

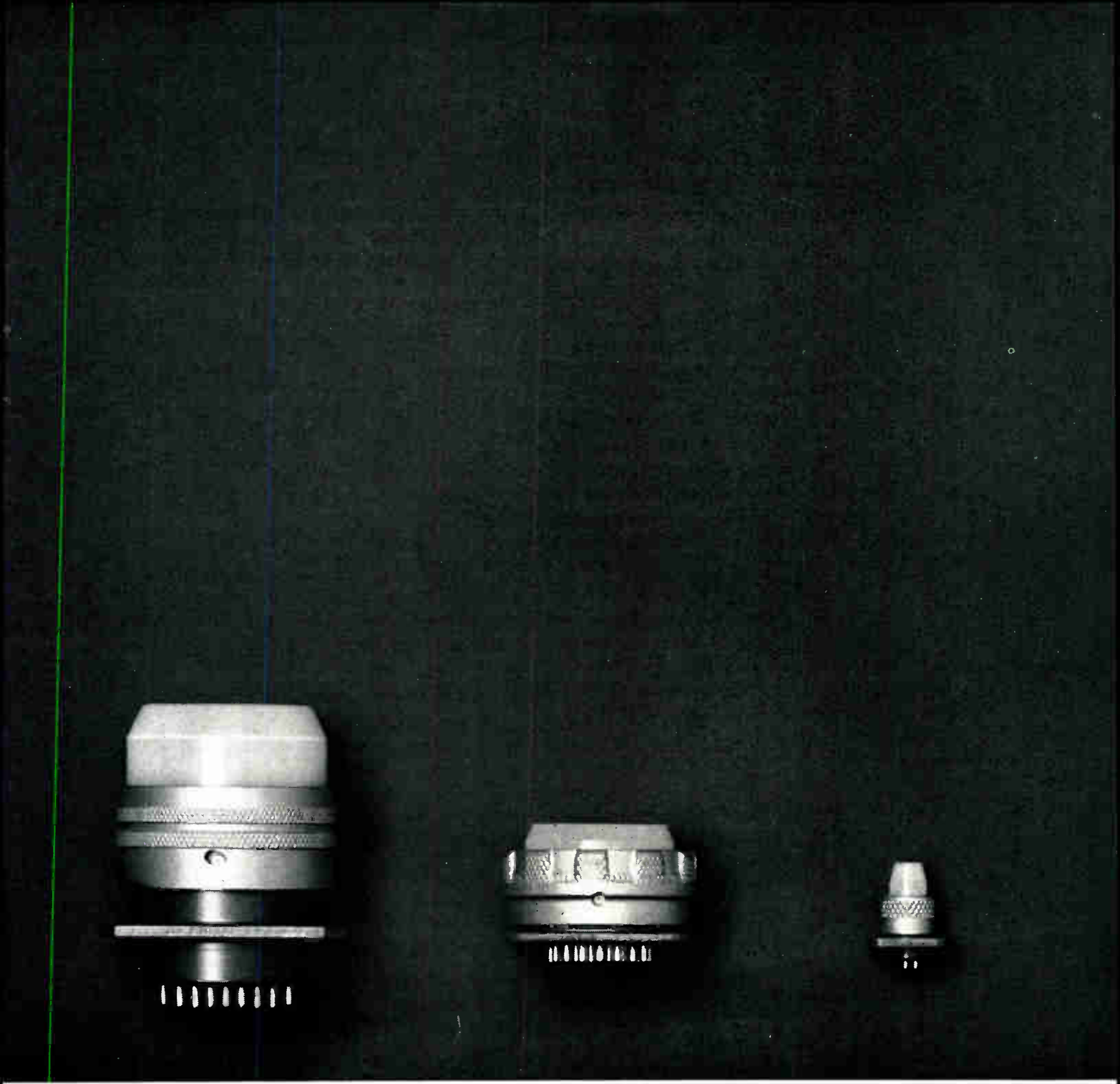
which will permit the TV projection of pre-recorded information on the expected characteristics of the flight. The actual data being developed in real time during the flight can be superimposed on the same picture.

The computational system will be programmed to examine incoming data and to register an alarm in those areas where a wide discrepancy exists between the acceptable and the actual values of parameters. The Control and Display system, previously mentioned, will provide on-call access to slide files and computer information from 28 different channels. The displayed information will be updated with new data as it is received. Photographic records of past information can also be presented. The display information provided from the computer and slide files will be routed throughout the IMCC by a high-resolution TV system. In addition to the TV modules there will be the large color displays utilizing high-intensity rear-projection devices which will describe information simultaneously from different data channels. This information can be superimposed on a changeable background. Network and ground system status will also be presented by large-screen color displays.

The simulation subsystem for the IMCC will perform the task previously described for training of personnel in techniques and develops procedures. The simulation system will provide the interface between the standard MOCR and the training equipment provided for Apollo and Gemini, as well as simulation representation of elements in the tracking and communications network, since these elements during tests may not be available for simulation during tests.

8 stages of a proposed lunar expedition are shown starting upper left. The MOCR is depicted in the middle. Projects include the 2-man earth orbit (Gemini) and 3-man lunar program (Apollo) to be controlled by NASA's Manned Space Ctr., Houston.





CONNECTORS ACTUAL SIZE

First we made a Pygmy.

Then we made a Pancake.

Now what's all this about a Dwarf?

It's a new series of connectors designed primarily for internal use. Quality and dependability are the same as in the bigger ones, despite smaller size.

The Dwarf connector incorporates gold plated contacts with .090 centerline spacing. Numerical contact identification. Uses 24 gage contacts with solder pots which will accommodate 22 gage wire. Shell styles include jam nut mounting receptacles, box mounting receptacles and straight plug assemblies. Contacts are molded into place within a stable high strength dielectric combination insert and shell material. Gasketing at the main joint provides contamination resistance.

Electrical characteristics include minimum flashover voltage 1800 VAC RMS: test voltage 1200 VAC RMS: working voltage 400 VAC RMS; current rating 3 amps: insulation resistance 50,000 megohms; minimum contact engagement .060".

Write us for information on current availability of our Dwarf, Pancake, or Pygmy® connectors, and any specific application. We're in Sidney, New York.

Circle 34 on Inquiry Card

Scintilla Division

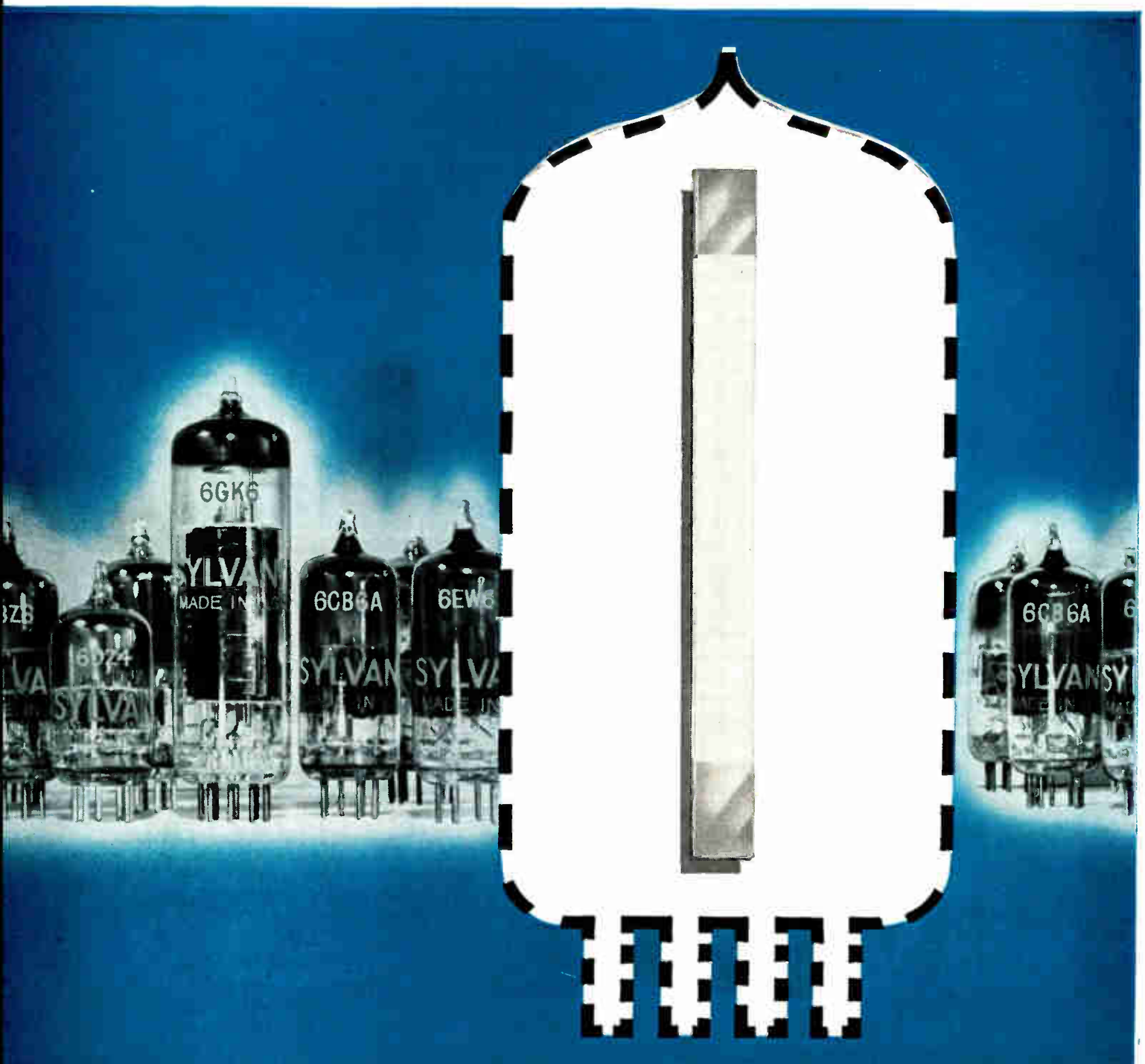
THE Bendix CORPORATION

Sylvania—first with the Sarong and Bikini cathodes—now announces a new development that significantly increases the reliability of Sylvania tubes. "Life-Boost Cathode" is the name...the secret is an ultra-pure, uniform alloy made possible by Sylvania's leadership in powder metal technology.

Contrasted to conventional melted alloys, the Life-Boost powder-metal alloy is so pure and uniform, with performance so predictable, that it eliminates any need for the usual "melt approval." Alloy uniformity inhibits the formation of leakage paths, which extends tube life. It also means better-controlled electron emission and regulated barium release throughout life—tube performance stays within specifications. Further, the new cathodes have 25% greater mechanical strength, which significantly reduces equipment failure in the field.

Precise control of alloy composition is the key. The basic pure nickel powder plus carefully controlled powdered reducing agents are thoroughly blended and immediately rolled into thin-gauge strip. Because no critical temperatures are involved, no impurities are introduced from crucibles and con-

New LIFE-BOOST* Cathode gives increased life, stability and



tainers, forging hammers or hot-rolling equipment. And the powder process permits previously impossible or hard-to-attain combinations of wanted properties, such as electrical passivity and mechanical strength at high temperature.

A planned conversion of Sylvania tubes to the Life-Boost Cathode is under way. For information on types available now, contact your Sylvania Sales Engineer, or write: Electronic Tube Division, Sylvania Electric Products Inc., Box 87, Buffalo, New York.

Sylvania Tubes uniformity

90 TYPES already have the LIFE-BOOST Cathode:

2AF4B; 3AF4B; 6AF4A, B; 2/3/6DZ4; 6GK6; 6BQ5; 6DQ5; 6/25CD6; 25DN6; 6/12/25BQ6GTB, A; 6V6; 12BZ6; 3/4/6CB6A; 4/6DE6; 6CF6; 3/6DE6; 5/6EW6; 6186; 7056; 5/6GM6; 32ET5A; 25EH5; 50B5; 6AH6WA; 6CU5; 6/12DT5; 6/12/25BK5; 6DT5; 6AU8, A; 6BH8; 7060; 8ET7; 6/8GN8; 10JY8; 6BL8; 6883A; 6080WA; 6080WB; GB-6080; 6AH6; 6BC5; 25F5; 35C5; 6AS5; 4/6BZ6; 6CB6A; 6082; 6GR7/SR-3213; 12BV7; 12BY7; 6/12DQ6B; 6J4WA; 12CA5; 12ED5; 50C5; 6BF5; 6CA5; 6ET7; 5687WA; 6AN5; 12DB5; 6K6; 6146; 6146A; 6159A; 6BL7GTA; 6/12AV5GA

Here's evidence of what it can do:

...In 6DZ4 UHF oscillator: No failures, greatly improved stability

Test: 40 tubes operated at 130 VAC for 1500 hours in 40 TV sets (4 models, 3 manufacturers represented).

Failures: None resulting in set failure. (Statistical estimate: 1% per 1000 hours at 130 V, or about 0.3% per 1000 hours at 117 V.) Failure rate for same tube made with conventionally prepared cathode material: 13.1%.

Oscillator Grid Current: After 1500 hours at 130 V, 90% of LIFE-BOOST Cathode tubes had grid current between 550 and 950 μA. Only about 38% of the tubes with conventional cathodes remained within these limits after period of test.

...in 6GK6, used for critical vertical output: TV set manufacturer reports improved stability

Test: More than 1000 hours at 135 VAC line.

Results: No leakage problems, no slump in characteristics; tube can be used in vertical socket as well as other sockets of customer's TV set line.

Sylvania tests show significantly reduced sublimation (formation of leakage paths), and improved plate current stability under accelerated life test and heater cycling conditions with over-voltages applied.

...in RF pentodes: Reduced grid emission, no insulation breakdown

RF pentodes BZ6, CB6, EW6 and others, when subjected to life testing, showed reduced grid emission levels after conversion to the LIFE-BOOST Cathode. Insulation levels during and at the completion of life showed little or no change—an indication of improved stability—and end-point failures due to breakdown were virtually nonexistent.

CIRCLE 12 ON READER SERVICE CARD

*Trademark

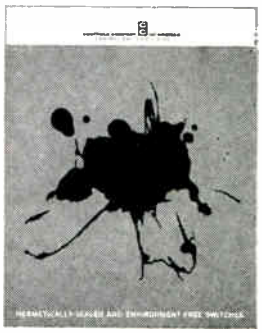
SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

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

SWITCHES SEALED AGAINST EVERYTHING—Whatever contaminant that black blob represents in your own application (oil, solvent, moisture, gas, dust, etc.) we have sealed switches that will operate reliably in the midst of it. Actually, you can easily select from over 10,000 different Hermetically-Sealed and Environment-Free models. For instance, our one-hole-mounting H-eleven series is designed with modules for actuators, terminations, and housings. You just pick the modules to fit your job; we'll quickly deliver the complete switch. Write for our free *Hermetic & E-F Switch Catalog #130.*



CONTROLS COMPANY OF AMERICA
CONTROL SWITCH DIVISION
1420 Delmar Drive, Folcroft, Pennsylvania

In FIXED COMPOSITION RESISTORS if it's news, expect it first from IRC

Only IRC Fixed Composition Resistors offer

5 WAYS TO SAVE ON WELDING

HERE'S WHY . . . IRC realizes that no single lead material satisfies all the welding techniques in use today. There is also a wide price differential among different materials. IRC offers 5 types of weldable leads . . . lets you choose the material and price that meets your particular need.

Compare the add-on prices of weldable leads. You will find IRC's to be significantly lower.

IRC's standard leads are alloy-plated copper. Many users weld these leads successfully and save the cost of premium materials.

Write for complete weldable lead pricing and derating information. International Resistance Co., Philadelphia 8, Pa.

**Typical add-on prices are for RC20 size.*

PERFORMANCE ADVANTAGES

IRC Type GBT's also provide

- Superior high frequency characteristics
- Lower operating temperature
- Outstanding load life
- Greater moisture protection
- Ranges to 100,000 megohms
- Stronger terminations
- Better resistance-temperature characteristics

IRC

THERMISTORS BY Fenwal Electronics

THE MOST COMPLETE LINE OF PRECISION THERMISTORS

1. GLASS COATED BEADS — used where small size, fast response, high precision, stability, and temperatures to 600°F are required.

2. GLASS PROBES — medium-small in size. Many of the advantages of beads but rugged, more easily mounted, useful in liquid media.

3. ISO-CURVE* INTERCHANGEABLE THERMISTORS — these units available in bead or glass probe configuration, follow standard curves over wide temperature range, and are completely interchangeable. Units match standard curves as close as ±½% of resistance or as required.

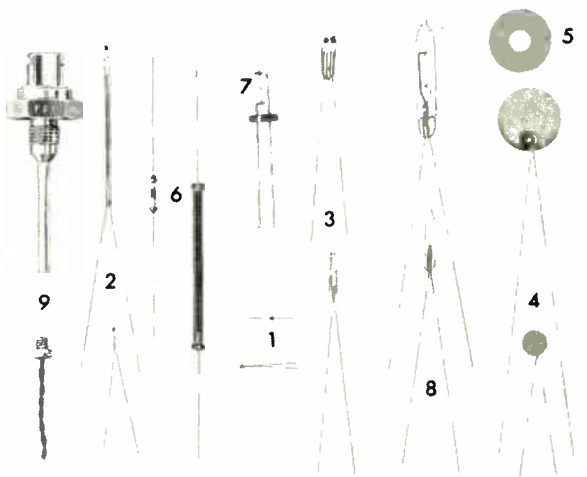
4. DISCS — used where medium power dissipation is a requirement and space not a problem. Useful to 300°F.

5. WASHERS — used where high power dissipation is a prime requirement.

6. RODS — these units have power dissipation intermediate between discs and washers and are also used where their physical shape is an asset.

7. MOUNTED BEADS — provide ease in using glass beads in such applications as gas chromatography, flow and vacuum measurement, etc.

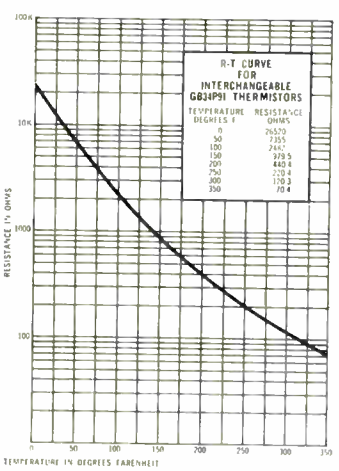
8. VACUUM AND GAS FILLED ASSEMBLIES — high power sensitivity for specialized circuit applications.



9. PROBE ASSEMBLIES — standard catalog types or built to specific military or commercial requirements.** We are experienced in design of probe assemblies for all fields of application including industrial control and indication, aerospace — specializing in telemetry applications, and oceanographic — featuring fast response, very high pressure, and interchangeability using our Iso-curve Thermistors.

The only completely interchangeable thermistors stable to 300°C.

F.E.I. Iso-curve thermistors have identical resistance-temperature curves, to permit complete interchangeability. Completely stable operation over long periods of time and at temperatures up to 300°C is assured only with Fenwal Electronics units. These curve-matched thermistors make it possible to achieve accurate, multi-point temperature indication or control through a single system, without need to calibrate each individual sensor. Replacement units are always available.



Here's help in applying thermistors... from Fenwal Electronics

- Complete thermistor engineering service backed by 20 years field experience.

- Thermistor Experimental Kits — to help you expedite operations at the breadboard stage. From $4.95 to $19.95.

- New Thermistor Computer — Resistance-Temperature computer reduces lengthy computations to single "slide-rule" setting. Yours for the asking.

- New thermistor bulletin.

- New Probe and Housing brochure — gives selection of probe designs.

FOR COMPLETE INFORMATION, OR THE NAME OF THE FENWAL REPRESENTATIVE IN YOUR AREA, WRITE:

Fenwal Electronics

63 FOUNTAIN STREET FRAMINGHAM, MASSACHUSETTS

** Probes can be supplied individually calibrated at all desired temperatures. When interchangeability is required, they can be supplied with identical resistance-temperature characteristics.

*PAT. APPLIED FOR

HIGH COERCIVE-FORCE ALNICO VIII... AVAILABLE from ARNOLD IN PRODUCTION QUANTITIES

Illustrated below, a typical group of Arnold-produced Alnico VIII parts for microwave applications. The range includes cylinders of 4" or more in diameter and 13 lbs. or more in weight for tubular-type straight field focusing magnets, down to rings as small as ½" diameter and less than an ounce in weight for TWT stacks.

Alnico VIII possesses the highest coercive force of all the Alnicos . . . it is available from Arnold in excess of 1400 oersteds if required, and is regularly inspected at 1280 oersteds minimum. In addition, its maximum energy product approaches that of Alnico V and its temperature coefficient is remarkably low.

This highly distinctive combination of parameters offers the designer many advantages: high field strength, high gap flux density, and the practical elimination of any need to provide for temperature compensation. In addition to widespread uses in microwave assemblies, Arnold Alnico VIII is also your logical choice for applications where the magnet must withstand strong demagnetizing fields, or where space restrictions limit its length.

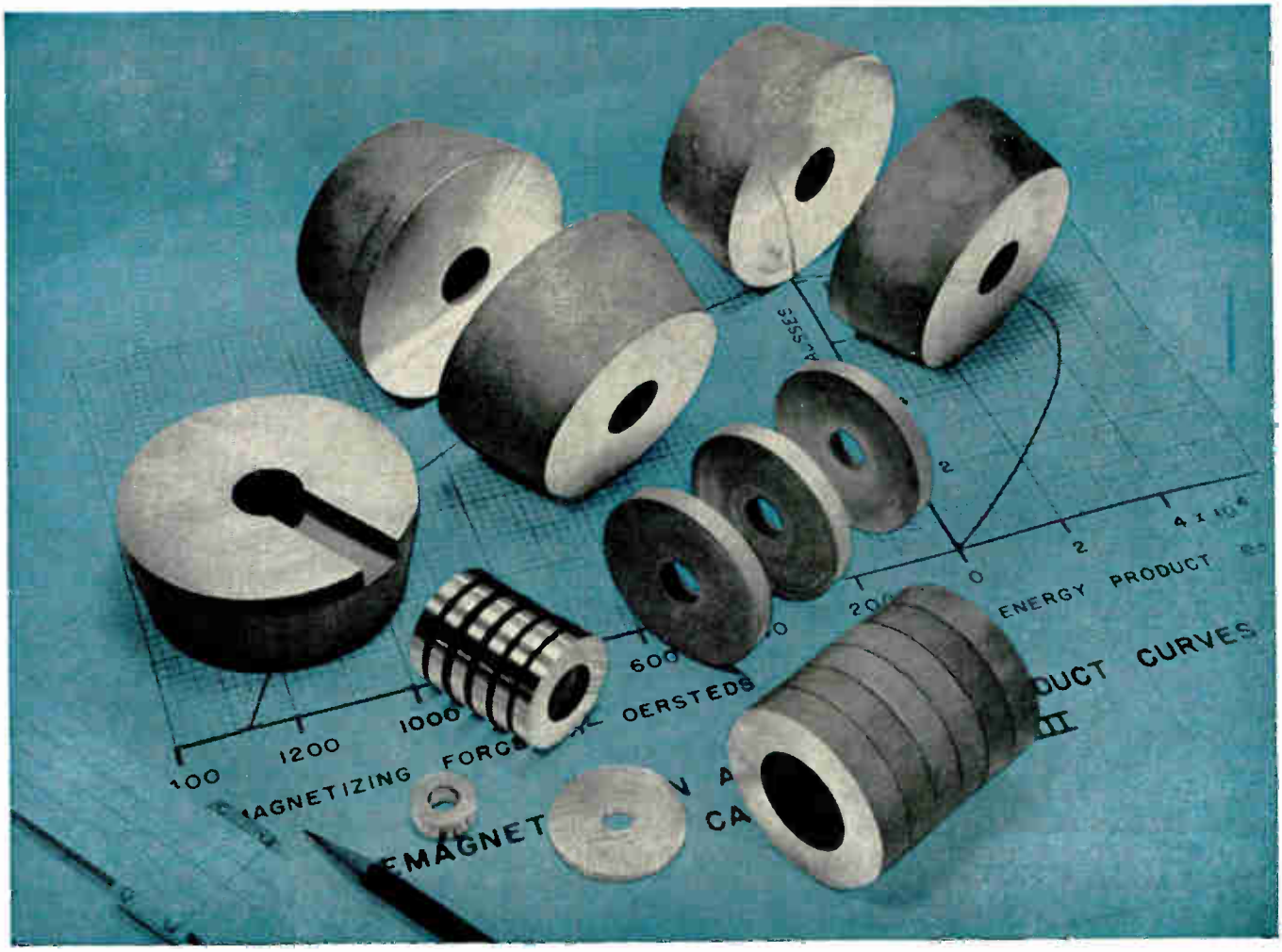
Alnico VIII is available from Arnold in sizes and shapes engineered to your requirements, and in production quantities. ● For more data, ask for Bulletin PM-119. *The Arnold Engineering Company, Marengo, Illinois.*

ADDRESS DEPT. EI-7

ARNOLD
SPECIALISTS In MAGNETIC MATERIALS

BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES
Find them FAST in the YELLOW PAGES

11-3037



AN EVALUATION OF ENVIRONMENTAL TESTING

This rapidly expanding field is plagued with serious problems that threaten its long-term growth. Shortage of trained personnel is the most pressing; some effort should go into setting up specialized training courses. And the accuracy of measurements still leaves much to be desired.

ENVIRONMENTAL TEST ENGINEERING plays a significant role in the development of weapon systems and contributes much to space exploration. In fact, success of most commercial products depends in great measure on the ability to perform properly under adverse conditions. It can be readily shown that this field of engineering directly influences every state-of-the-art advance in every technical discipline.

This article deals with the problems of this important field. Obstacles, needs and objectives are also covered.

* * *

The field of Environmental Engineering dates from 1930 but it was during WWII that this new industry suffered its most severe growing pains.

There was no single area of expansion. Temperature, sand and dust, rain, sunshine, fungus, vibration shock and humidity, literally all environments, were involved. Also, part of this rapid growth has resulted from the establishment of environmental labs in various branches of the military and government, and in private industry. Each has a role to play in broadening the scope of Environmental Test Engineering and producing better simulation methods.

Objectives

The Environmental Test Industry's survival and expansion depends on continued demonstration to prove its worth to management in product development. To do so, it must meet these three objectives:

1. To orient, train, and employ skilled engineers in this specialized field.
2. To improve the overall accuracy of its recommendations.
3. To establish and maintain standards, current with today's technology.

In many cases, a lab specializes in certain basic areas within the overall field. An aircraft firm establishes a dynamics or structures lab, devoted primarily to the study of vibration and flutter problems in airframes. An electronics firm develops a space simulation facility capable of supporting an entire capsule under environmental evaluation—emphasis is placed on cryogenics and solar radiation simulations. A jet engine or rocket motor manufacturer maintains an acoustic test facility to evaluate auxiliary equipment under extreme noise levels created by today's power plants.

First Problem

This wide diversification of environmental evaluation, and I have indicated only a few examples, leads to one of the basic problems facing a company which wants to establish and/or maintain an environmental lab. This problem plagues all branches of engineering to some degree—it is a shortage of competent professional and technical personnel. The disciplines needed are varied and range from mechanical, electrical, electronic, chemical, and metallurgical engineering to chemistry, physics, mathematics, and statistics. Each, of course, has its own formal training

By JOHN D. LOSSE
Group Head, Titan Evaluation Test
AC Spark Plug Div., General Motors
Dept. 40-30
Milwaukee 1, Wis.
—and Vice President,
Institute of Environmental Sciences

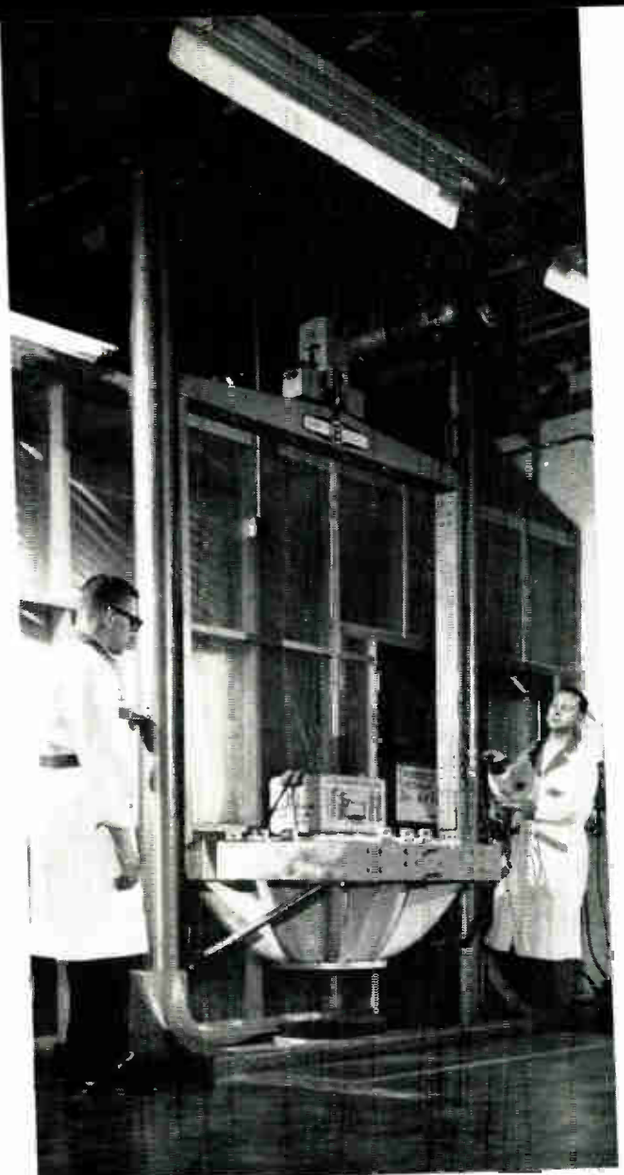
period in our colleges and universities. However, more is needed from an environmental engineer. He must be a specialist in more than one of the above. Cross-training of this type, leading to a degree in Environmental Engineering, is not now offered in any higher educational institution.

Special summer courses are given in specific fields of the environmental discipline, in an attempt to meet this need to at least a partial degree. Many manufacturers help fill the gap by offering special seminars. The Institute of Environmental Sciences, through its many local chapters, offers courses in Environmental Engineering, some of which are accredited towards graduate work. Recently, correspondence courses for technicians have been offered. Personnel thus trained, will then be able to assume repetitive chores now performed by environmental engineers; and these then will have more time for creative work.

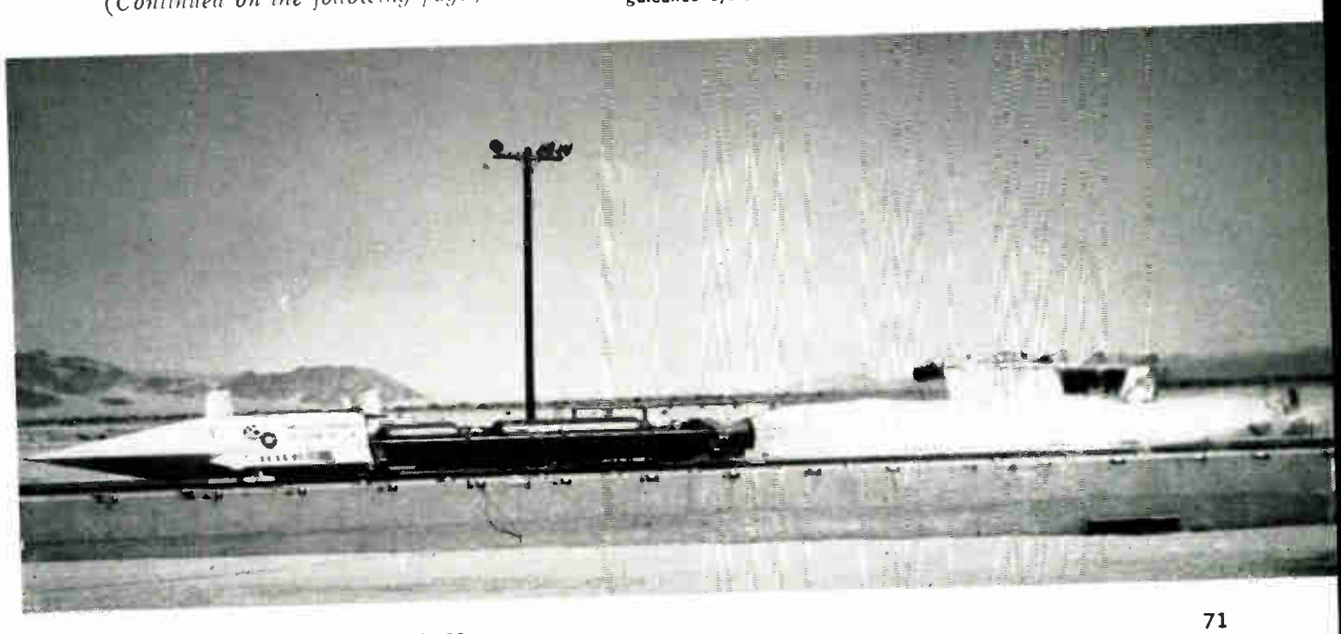
All of these efforts are helping to supply trained people; yet, there remains a definite shortage. Perhaps a four-year course should be established. Think for a minute of what this course should encompass. Should it provide training in all fields generally considered a part of the environmental field, or should a generalized elective course or option be given in one or more of the well established disciplines?

This question of how much and what type of training must not only be evaluated and answered, but it must be rapidly implemented to provide enough personnel for all the labs now in existence. Otherwise, the Environmental Test Engineering industry cannot continue to grow at the rate needed to meet expanding needs.

(Continued on the following page)



Half-sine shock pulse produced on a shock test facility at the AC Spark Plug Div., General Motors plant in Milwaukee, Wisconsin.



Sled (steady-state acceleration) test on the AChiever inertial guidance system at Naval Ordnance Test Station, Inyokern, Cal.

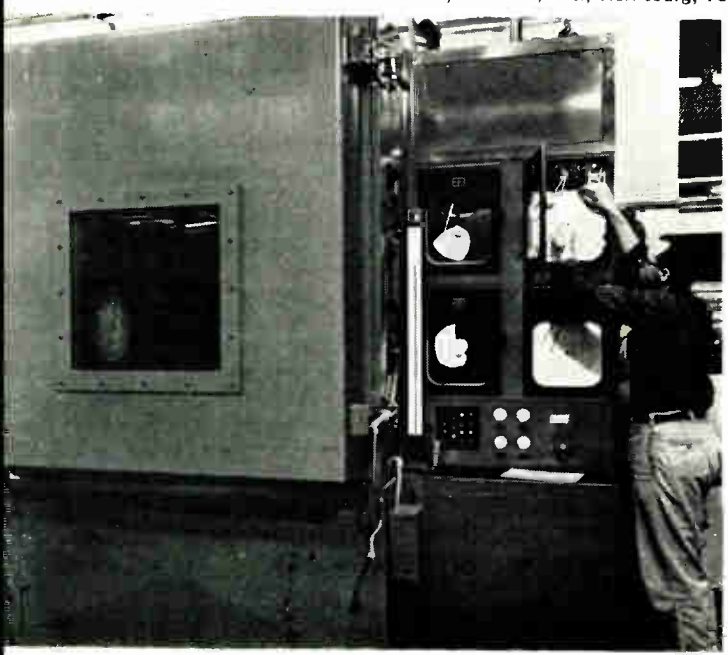
Second Problem

The second problem facing the industry is the accuracy of its work, specifically as it applies to the evaluation of true-to-life service needs and the simulation methods used. Severity of the simulated exposure must be such that costs are held to a minimum and answers given to designers promptly. Given this condition, accuracy in test design becomes paramount.

Test accuracy may be as simple as selecting the proper standard test procedure. Proper selection, of course, requires an understanding of the background needs and the purpose of test. Often, use of a standard procedure demands ingenuity to obtain full compliance with the accuracy needs, yet meet the limitations of existing equipment. If selection of the standard procedure has not become a pitfall, then one must determine whether the standard is strict enough to meet accuracy needs of the simulation.

For example, do existing standard procedures for temperature-humidity tests accurately produce results which are useful to the product designer? Are there precise dew points, with respect to temperature of the actual test specimen, where electrolysis and corrosion are more quickly induced? What about the percentages of oxygen or other corrosion-promoting agents in moisture under natural service conditions. Should these be controlled as precisely as pH is now controlled in standard tests, or should the control of pH be re-evaluated? Is there a meaningful correlation between long established humidity cycling tests and long term storage environments; and if so, how should the results be interpreted?

Worker makes adjustments to instruments of temperature-altitude chamber. Photo is courtesy of AMP, Inc., Harrisburg, Pa.



Space environment and its simulation is an obstacle to environmental engineers in that there are no well-established standard test procedures. Design of a space simulation test, thus needs much planning of each phase. This planning raises many questions. What part does the interreaction of low pressure, solar radiation, nuclear radiation, and alternate high and low temperature have on the operation of electronic equipment? Further, how does design of the simulator in the lab affect these interreactions? Are low temperature walls (in chambers providing temperatures less than 100°K) designed to insure that the article under test will see minimal radiated energy return? Can the test sample be placed at a great enough distance from these surfaces to avoid undue influence? Does the solar radiation simulation source have a proper wave length distribution over a large enough area to cover the test specimens? Does transfer of this radiation source through the port window distort this distribution? What effect will zero gravity have on these results?

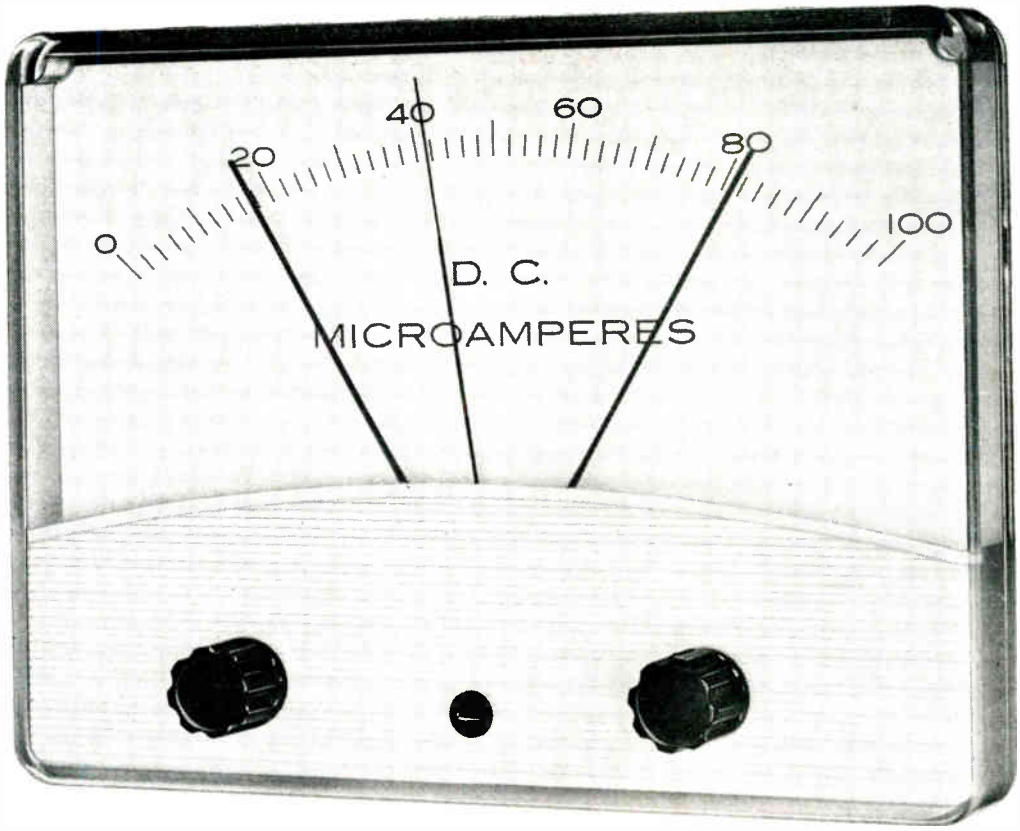
Accuracy, in its more common sense, is determined by measurements and the equipment used to make them. For example, voltages in a computer system must be more precise than in an automobile headlight. Measurement of these voltages under test is important and indicates overall test accuracy. A power supply with a stability of 0.01% would not be accurate enough to test many computer circuits. Yet, this degree of precision is unnecessary where automobile headlight testing is concerned. Thus, accuracy, and the use of it, have a great deal of influence on how the test is conducted. In testing the headlight, a power supply (battery) with the regulation found in an automobile electrical system, would be accurate enough in a life test on the headlight—or would it?

If the headlight test were to be repeated for a reliability analysis with test termination only at the time the filament burns out, voltage variation would have a direct influence on results. Thus, a more accurate power supply is actually needed. In the computer test, the same conditions would prevail, but the degree of accuracy becomes even more critical. A slight voltage shift could result in the wrong computation, resulting in a wrong stress design. This could possibly place someone's life in jeopardy.

Third Problem

A third problem is that of standardization of test methods and terminology. Standardization is of

(*Continued on page 76*)



From API: a totally new kind of meter-relay

Now . . . through a unique combination of fiber optics and solid-state electronics: a simpler and more reliable continuously indicating meter-relay.

With the first instrument application of fiber optics, API has achieved a contactless meter-relay that will respond without amplification to a signal change as small as 0.008 ua, 0.005 mv, or 0.750°F. The frictionless taut-band d'Arsonval measuring element is completely unhampered. The control phase involves no moving parts; only light pipes are positioned when changing set-points. Without restrictions or complicated moving parts, this versatile new controller has inherent reliability. Any electrically measurable variable can be monitored and controlled. Pyrometers are also available, with built-in electrical cold-junction compensation.

A single light source can serve one or two set-points; and since the lamp operates at far below rated power, lamp life expectancy is a minimum of four years. Fiber-optic light pipes permit a deadband adjustable down to zero (or even overlapping), and they eliminate the need for light-tight enclosures.

The optical meter-relay, through its solid-state output module, can provide on-off, time-proportioning, or modulating (SCR) control. Full-scale meter sensitivity may be as small as 3 ua or 2 mv. Optical meter-relays are available in 5- and 6-inch sizes as the pace-setting Stylist for flush mounting with bezel or in clear styrene as shown above.

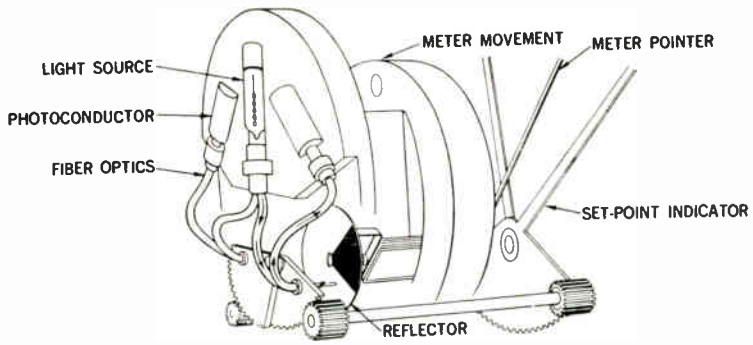
If you would like detailed technical information on this remarkable new meter-relay, write for our Bulletin 33. A copy is yours for the asking.

ASSEMBLY PRODUCTS, INC.

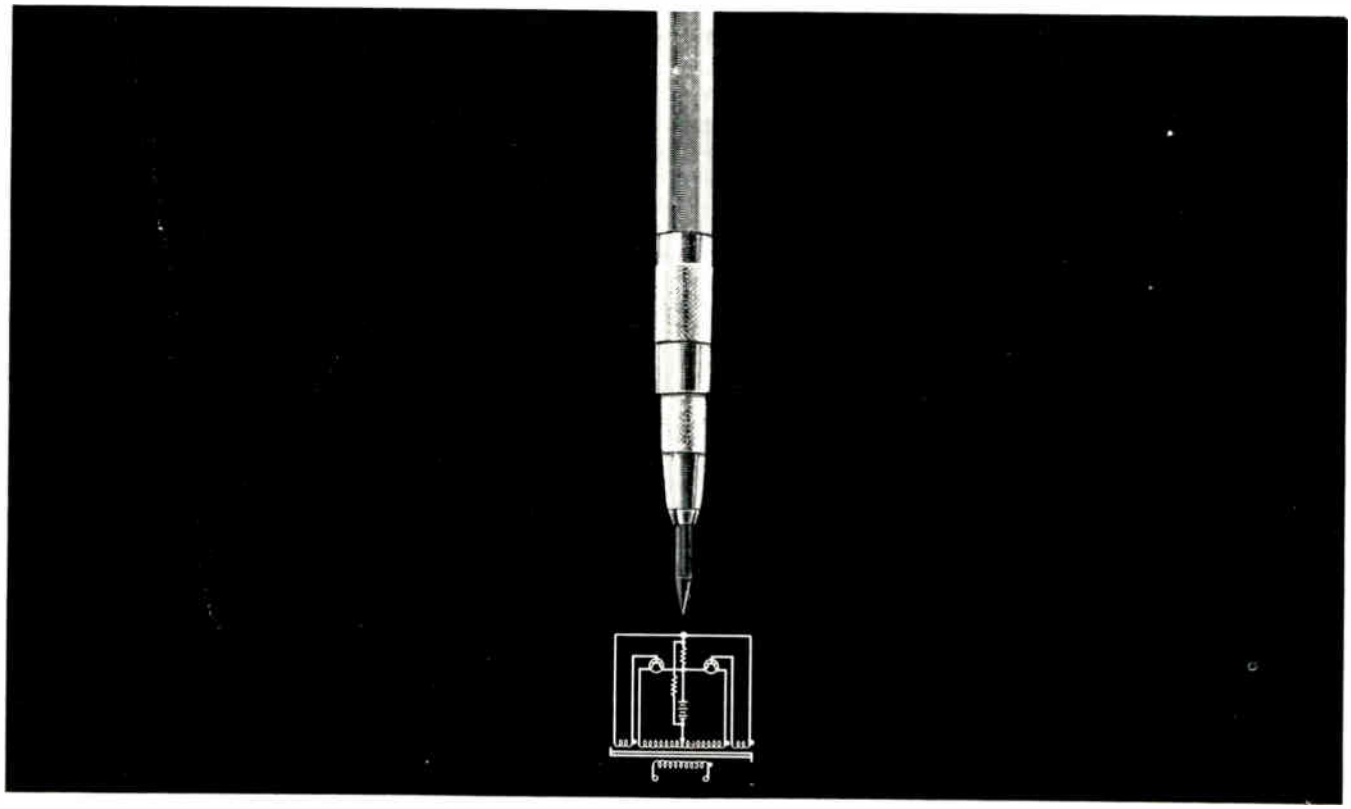
CHESTERLAND 92, OHIO

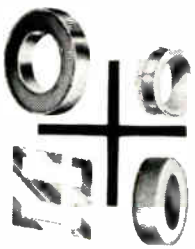
SA 2759

Light, supplied via fiber-optic channels, is reflected by a black-and-white segmented disc, carried by the meter signal coil, to change the conductivity of photoconductive cells. These open and close load relays through a solid-state output circuit.



Circle 36 on Inquiry Card





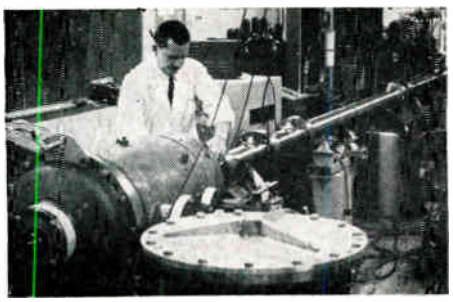
Designing for small size, high performance? Get more from magnetics

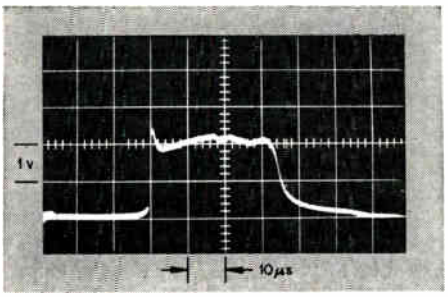
THE CORE: for miniaturization, conventional components often are eliminated in favor of tape cores. These in turn sometimes take a back seat to bobbin cores when used with transistors for multivibrators, oscillators, timing circuits. Same kind of choice holds true for 125 mu powder cores vs. 550 mu powder cores. On the other hand, when you consider winding, frequency, and temperature, it sometimes pays to select a larger core to achieve smaller overall circuit size. It may be that your particular problem can be solved by just such a design paradox. When it comes to "thinking small" the technical assistance offered by *the man from Magnetics* will help.

THE MORE: often, small size does not necessarily mean higher cost. When you use standardized core sizes you can actually *reduce* the component cost. You don't have to over-engineer or overspend, and what you want when you need it is generally in stock. We've found it good business (for you and us) to share what we've learned about the hundreds of high permeability components we design and produce...60 to 550 mu powder cores, laminations of various shapes and alloys, and tape cores in 8 alloys, 5 core cases. Simply contact *the man from Magnetics* next chance you get... or write your problem specifics on your letterhead to Magnetics Inc., Dept. EI-9, Butler, Pa.

TOTAL ASSISTANCE, SERVICE, SELECTION/GET THE MORE FROM MAGNETICS

MAGNETICS inc.





Super-orbital entry of a space vehicle—one returning to earth from a planet, rather than from an earth-orbiting mission—would result in searing *radiative* heating in addition to the more familiar *convective* type. As a spacecraft nose enters atmosphere, it pushes the thin air aside. A boundary layer is formed next to the skin. Ahead of that is a compressed mass of air; fronting that, a shock wave. The air behind the shock wave becomes incandescent, ionizes, and radiates to the heat shield. Within the boundary layer, friction heats the nose cone by convection.

Lockheed scientists believe that at higher than escape speed a blunt-nosed vehicle may be unable to sustain the radiative heating. Consequently, a return to the previously discarded sharp nose is indicated. Fluid mechanicists are calculating the heat load, determining how rapidly the nose will ablate and how to keep it sharp. Current shock tube tests are providing some clues.

Another research project in Lockheed's Fluid Mechanics Laboratories relates to the flow of buoyant fluids. A typical study program is the determination of how liquid hydrogen, stored in a tank in space, stratifies. This, in turn, determines the level of pressurization required in order to extract all of the fluid. Scientists made a mathematical model of what they think occurs inside the tank. With this as a guide, an actual tank was constructed to obtain measurements and photographs of the flow to verify their theories.

LOOK AT LOCKHEED... AS A CAREER

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

Then write for a brochure that gives you a more complete Look at Lockheed. Address: Research & Development Staff, Dept. M-46C, P.O. Box 504, Sunnyvale, California. Lockheed is an equal opportunity employer.

SCIENTISTS & ENGINEERS: In addition to positions relating to fluid mechanics, other important openings exist for specialists in: Inertial guidance • Orbit thermodynamics • Electromagnetics • Mission & trajectory analysis • Gas dynamics • Chemical and nuclear propulsion • Systems engineering

LOCKHEED

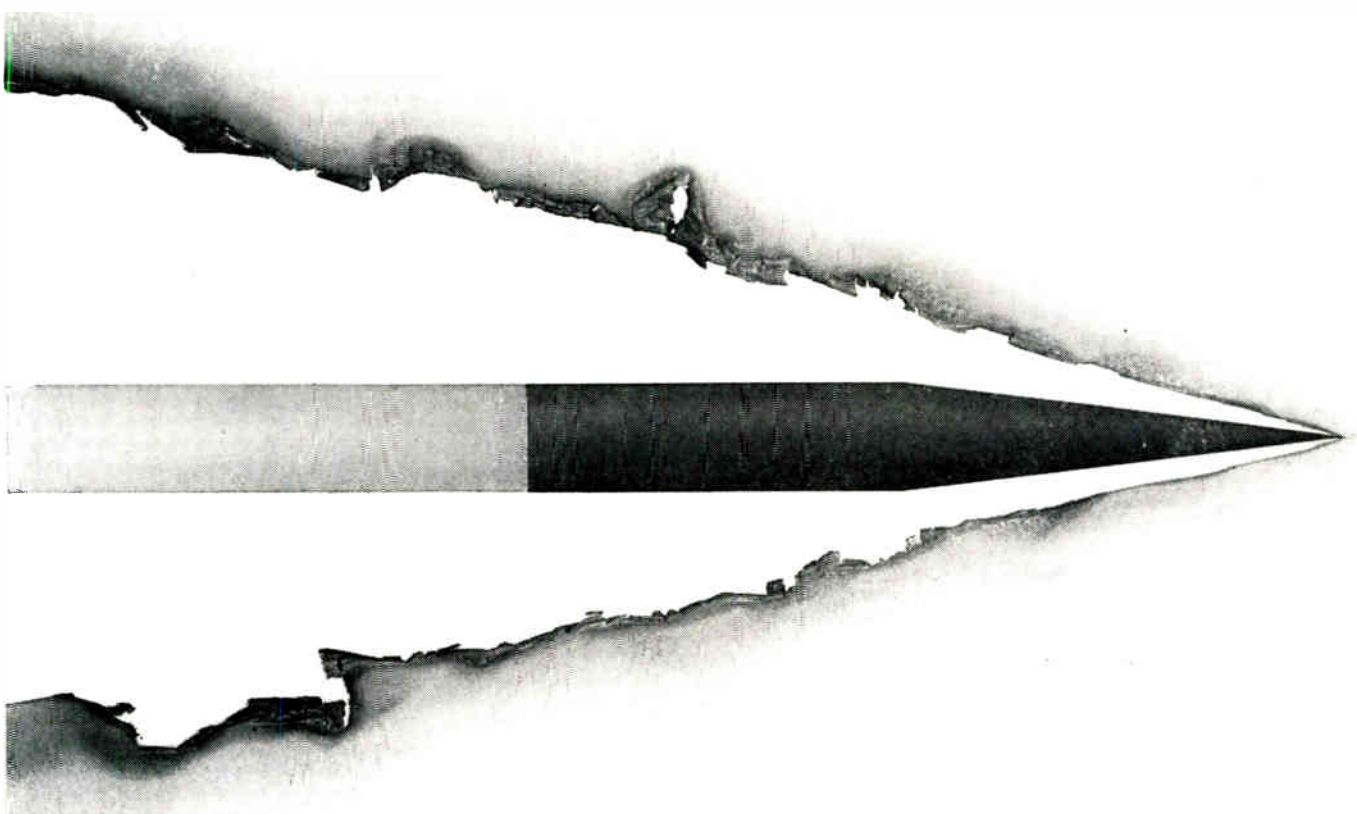
MISSILES & SPACE COMPANY

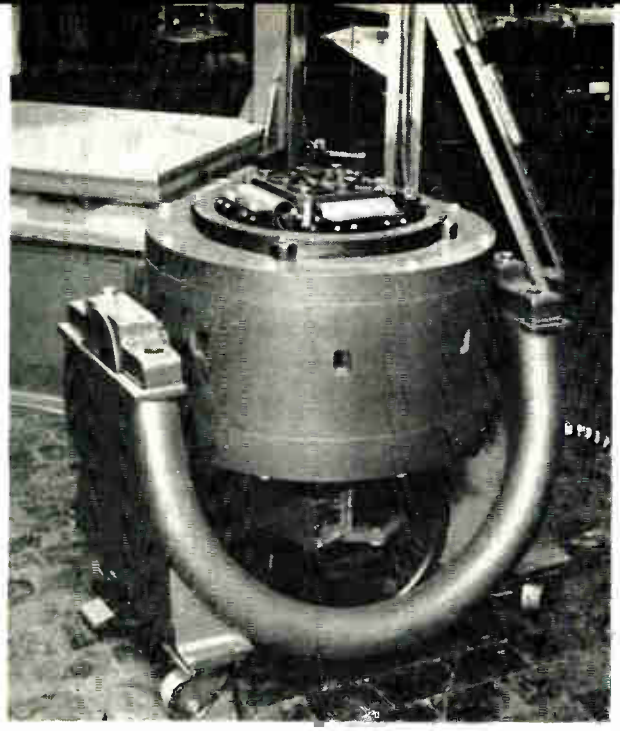
A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION

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

LOOK AT LOCKHEED IN FLUID MECHANICS:

Taming temperature extremes





A Calidyre Vibrator exerts a 1500 pound-force output on an assembly as part of a complete environmental test program. Courtesy of Burroughs Corp.

ENVIRONMENTAL TESTING (Concluded)

great value since it reduces overall costs. Yet, test methods are valueless if they are not repeatable: repeatable from the view point that no matter in what environmental lab the tests are performed or who performs them, the results will be the same if the item under test is the same.

Shock testing is a good example of the need for standardization (repeatability). Much has been written about shock testing. Special machines have been developed to assure that proper dynamic response is inherent in the machine. Methods of recording shock pulse data from these machines have been devised, all with one prime consideration in mind—repeatability. Headway has been made, yet much still remains to be done. The shock pulses are not yet exact simulations of service life. Those in service life have vastly varying amplitudes, durations, and frequency content.

Shocks experienced in service life directly affect design of common articles. Ordinary paper cartons could be made better if the normal shock handling cycles were better defined. This better definition of the shock pulse could provide undamaged contents, cheaper cartons, and save manufacturers much money. This is a very simple example of the value of standardization of testing. It also reveals the need for determining the actual service conditions with enough analytical information to devise a standardized test. This is a job for a qualified environmental engineer.

Going to a more complex subject, consider for a moment the field of vibration. Some authorities believe that vibration in service life bears little, if any, resemblance to the vibration evaluation used in the lab. Some environmental engineers propose the use of random vibration testing, others sine vibration, still others sine with random superimposed. Here we have three basic philosophies, each with merit but not completely compatible with either of the other two; and worse yet, not strictly representative of actual service conditions.

Standardization and definition of basic terminology is another element in this general industrial objective. A committee, under the American Standards Association, is now working to define the terms used in the industry. Their goal is to improve communication, not only within environmental engineering, but also with design engineers who must use environmental information in their work. This standardization of terminology is an industry need that must be met as soon as possible.

I do not intend to create the impression that there has been no standardization, but certainly more can be done. Much more must be done. One word of caution should be raised. Standards for the sake of standards are of little value. Each time a "new standard" is proposed or established, there is a pyramiding effect. This pyramid can be disastrous to the Environmental Industry. The "new standard" could be only a simple change in method. Nevertheless, the result may be compounded: new simulation equipment, or at least a major modification to existing facilities; and need for correlation of the results from the "new standard" with years of previous test data obtained with the previous method: much retesting might be needed to requalify the product; finally, correlation of the service life of the product to the results of the "new standard." Each of these needs created by the "new standard" involve expense either to the manufacturer who is trying to sell the product, or to the consumer who is purchasing the product. Yet, new standards are needed to allow the environmental engineer to do his job better.

Objectives presented in the areas of competent personnel, accuracy of simulation and standardization are by no means the only areas to be evaluated by the industry for their overall influence and growth.

Answers resulting from this evaluation must lead to improvements. For as fast as these problems are solved, new objectives of different scope will develop concurrent with advancement in technology. These objectives in turn must be evaluated and properly interpreted by an alert, aggressive, and progressive industry if the goal of producing better products at lower costs is to be achieved.

Bourns offers you 14 proven, off-the-shelf answers to MIL-STD-202A, Method 106 (cycling)—the most stringent humidity spec in the book. More than just "moisture-resistant" or "humidity-defying," these units are humidity-proof. No coatings or potting compounds are required.

The reliability of Bourns potentiometers is a matter of record in virtually every U.S. space and defense program. Don't MIL-SPECulate—SPECify Bourns!

UNITS READY FOR IMMEDIATE DELIVERY FROM FACTORY OR DISTRIBUTOR STOCK. WRITE FOR DETAILS!

BOURNS® Potentiometers

TRIMPOT® MODEL 3000 Micro-miniature, high-temperature, wirewound; 50Ω to 20K; 0.5W at 70°C.; Max. oper. temp. 175°C.

TRIMPOT MODEL 3001 High-temperature, RESISTON® carbon element; 20K to 1 Meg.; 0.20W at 70°C., Max. oper. temp., 150°C.

TRIMPOT MODEL 3010 High-temperature, wirewound; 10Ω to 100K; 1.0W at 70°C.; Max. oper. temp., 175°C.

TRIMPOT MODEL 3011 High-temperature, RESISTON carbon element; 20K to 1 Meg.; 0.25W at 50°C.; Max. oper. temp., 150°C.

TRIMPOT MODEL 224 High-temperature, wirewound; 10Ω to 100K; 1.0W at 70°C.; Max. oper. temp., 175°C.

TRIMPOT MODEL 3051 High-temperature, RESISTON carbon element; 20K to 1 Meg.; 0.25W at 50°C.; Max. oper. temp., 150°C.

BOURNS® MODEL 3250 Square, high-temperature, wirewound; 100Ω to 50K; 1.0W at 70°C.; Max. oper. temp., 175°C.

BOURNS MODEL 3251 Square, high-temperature, RESISTON carbon element; 20K to 1 Meg.; 0.50W at 50°C.; Max. oper. temp., 150°C.

BOURNS MODEL 3280 Square, micro-miniature, wirewound; 100Ω to 50K; 1.0W at 70°C.; Max. oper. temp., 175°C.

ALL UNITS SHOWN ½ ACTUAL SIZE

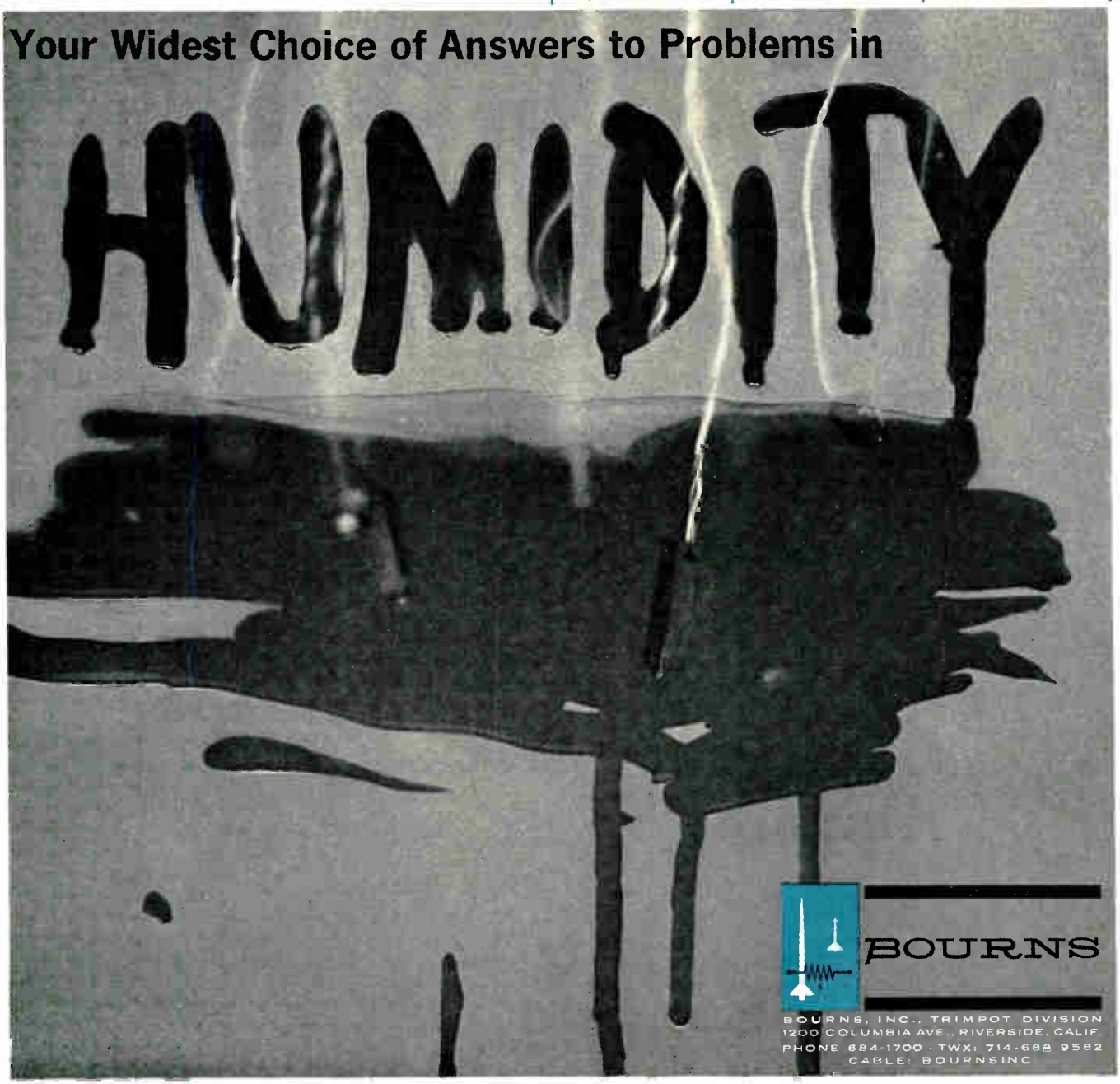
BOURNS MODEL 3281 Square, micro-miniature RESISTON carbon element; 20K to 1 Meg.; 0.25W at 50°C.; Max. oper. temp., 150°C.

BOURNS MODEL 3300 Single-turn, wirewound, micro-miniature; 50Ω to 20K; 0.5W at 70°C.; Max. oper. temp., 175°C.

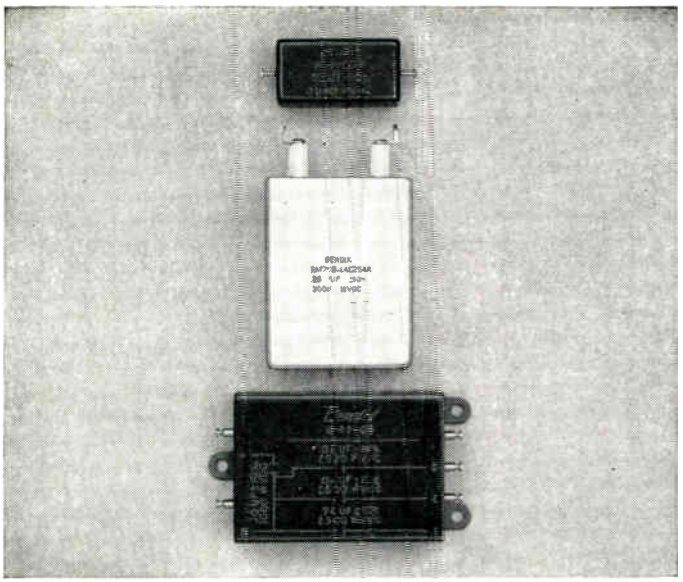
BOURNS MODEL 3301 Single-turn, RESISTON carbon element, micro-miniature; 10K to 1 Meg.; 0.25W at 70°C.; Max. oper. temp., 150°C

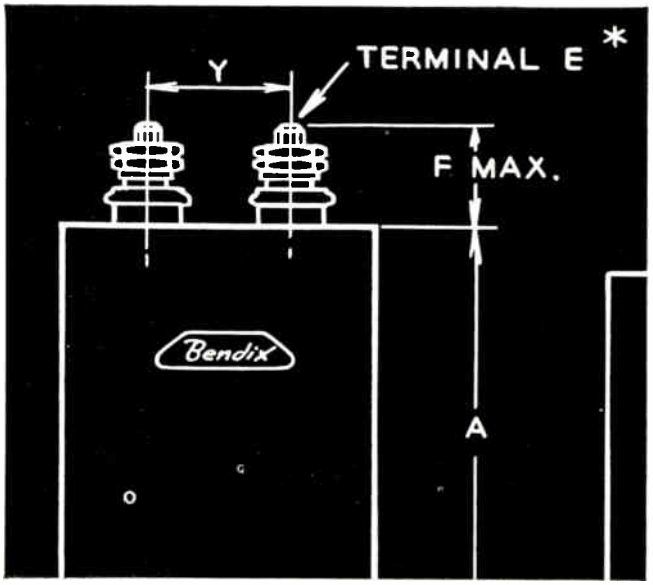
TRIMPOT MODEL 220 Sub-miniature, high-temperature, wirewound; 100Ω to 30K; 1.0W at 70°C.; Max. oper. temp., 175°C.

TRIMPOT MODEL 3020 High-power, high-temperature, wirewound; 3.75W at 70°C.; Max. oper. temp., 200°C.



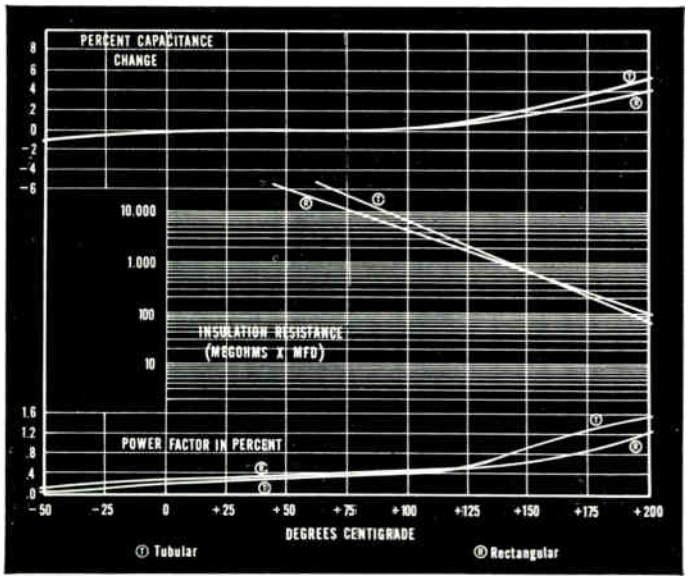
MANUFACTURER: TRIMPOT® & PRECISION POTENTIOMETERS, RELAYS; TRANSDUCERS FOR PRESSURE, POSITION, ACCELERATION. PLANTS: RIVERSIDE, CALIFORNIA; AMES, IOWA; TORONTO, CANADA

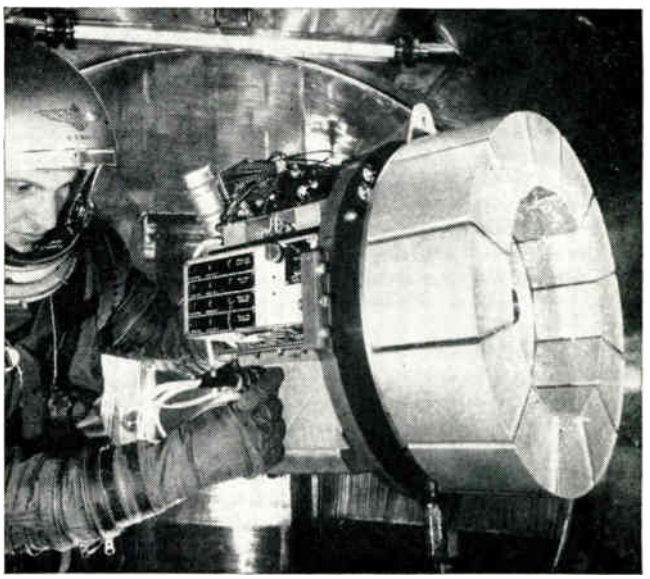




Our high-voltage capacitors

are smaller





offer superior electrical characteristics

and have impressed some pretty important people.

Our series of small, high voltage capacitors is designed for installations requiring a high degree of component reliability at operating temperatures as high as 200°C. We're proud of the fact that our capacitors are now being used on Republic's Plasma Space Engine.

The engine is designed for a variety of space applications. As a propulsion device, due to the low thrust-to-weight ratio, this engine can be used to maintain a satellite in a particular orbit, correct interplanetary vehicle course, or provide propulsion for a solar probe.

Bendix capacitors are ideal for applications such as this. They offer excellent qualities of radiation resistance. High temperature capability and mica-like electrical characteristics enable them to withstand extremely high orders of AC in small envelope size at all ambients under 200°C. For full details, write us in Sidney, New York.

Scintilla Division

THE Bendix CORPORATION

NEW Digital Frequency and Period Meter

Versatile input circuits minimize errors when measuring low-frequency signals

INPUT CIRCUITS LET YOU . . . . . ★ Set trigger level

★ Trade input impedance for sensitivity and improved noise rejection . . . choose between 100mv at 100kΩ or 1v at 1 MΩ

★ Select a-c or d-c coupling

★ Select positive or negative going slope

RANGES:

Frequency: dc to 300kc

Period: dc to 20kc; 1, 10, 100, or 1000 periods

Frequency Ratio: 1, 10, 100, 1000

★ Uses inherently reliable ring counting circuits — no fussy feedback circuits or complex decoding matrices to give trouble

★ Bright white-light easily read NUMERIK in-line Indicators

★ Equivalent open-circuit input noise of 5mv

★ Accuracy ± 1 count ± time-base-oscillator stability

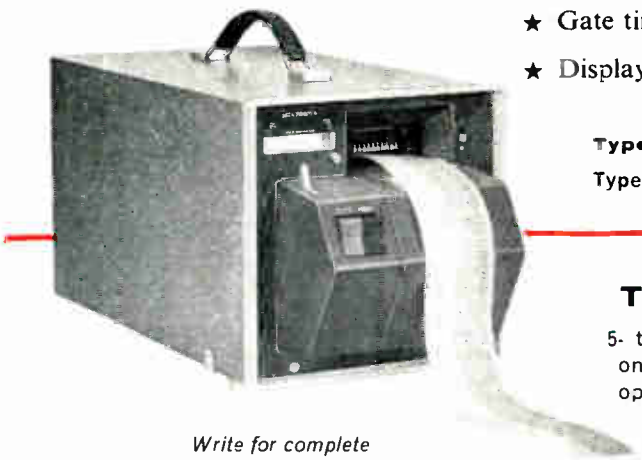
★ 100-kc time base with 1ppm/week stability

★ Gate times of 0.01, 0.1, 1.0, and 10 seconds

★ Display times of 0.16, 0.32, 0.64, 1.28, 2.56, 5.12 and 10.24 seconds

Type 1151-A, $1195

Type 1151-AP, with output for use with Type 1137-A Data Printer, $1250



Type 1137-A Data Printer

5- to 12-digit capacity with printing rates up to 3 prints per second. Available in rack or bench models for 115- or 230-volt operation. Price, $1350 for 115-volt bench version.

Write for complete information

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

In EUROPE
General Radio Overseas
Zurich, Switzerland

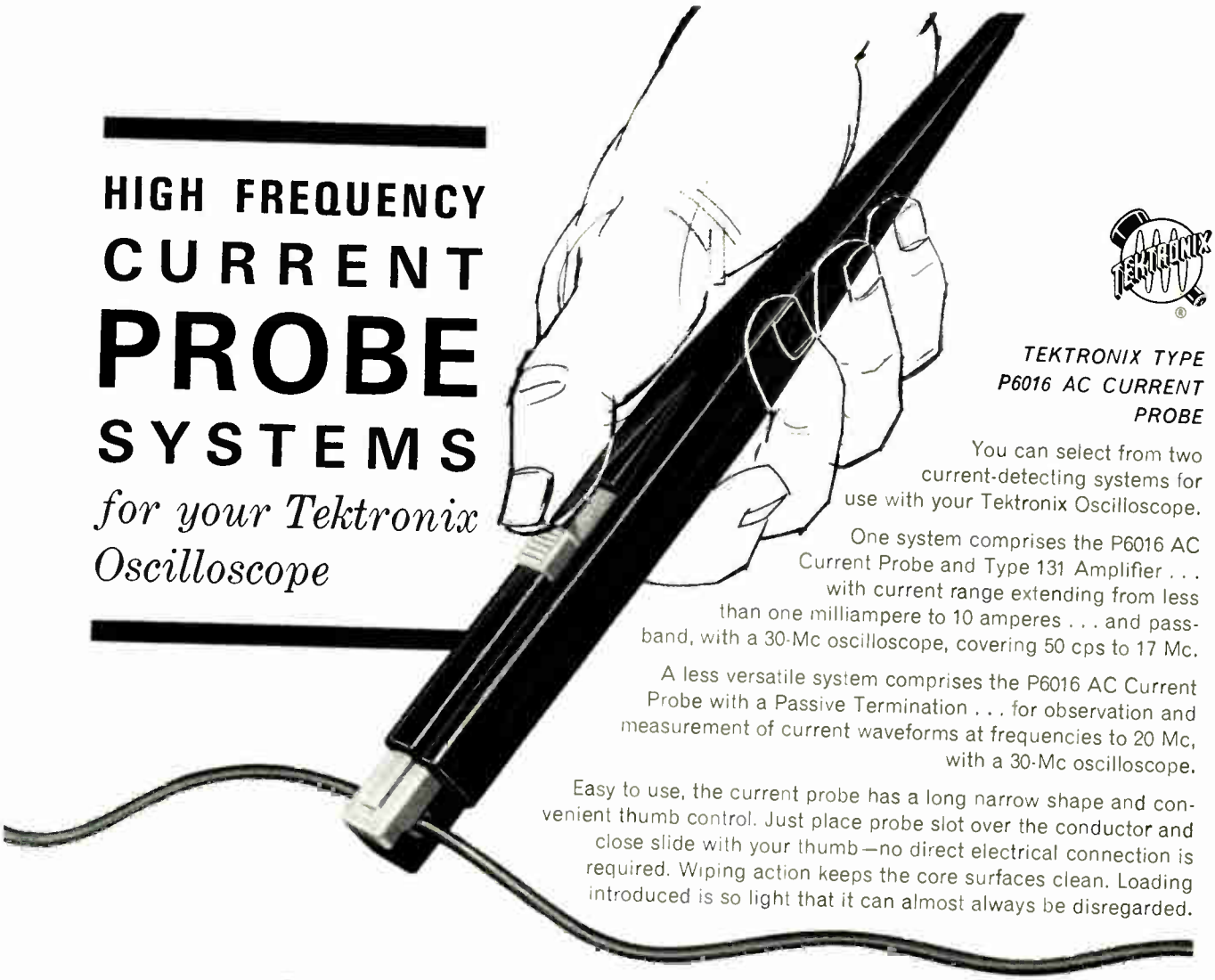
NEW YORK, N. Y., 964-2722 Ridgefield, N. J., 943-3140 | CHICAGO (Oak Park) 848-9400 | PHILADELPHIA, 424-7419 Abington, 887-8486 | WASHINGTON, D.C. (Rockville, Md.) 946-1600 | SYRACUSE 454-9323 | DALLAS FL 7-4031 | SAN FRANCISCO (Los Altos) 948-8233 | LOS ANGELES 469-6201 | ORLANDO, FLA. 425-4671

IN CANADA (Toronto) 247-2171

Circle 38 on Inquiry Card

HIGH FREQUENCY CURRENT PROBE SYSTEMS

for your Tektronix Oscilloscope



TEKTRONIX

TEKTRONIX TYPE P6016 AC CURRENT PROBE

You can select from two current-detecting systems for use with your Tektronix Oscilloscope.

One system comprises the P6016 AC Current Probe and Type 131 Amplifier . . . with current range extending from less than one milliampere to 10 amperes . . . and pass-band, with a 30-Mc oscilloscope, covering 50 cps to 17 Mc.

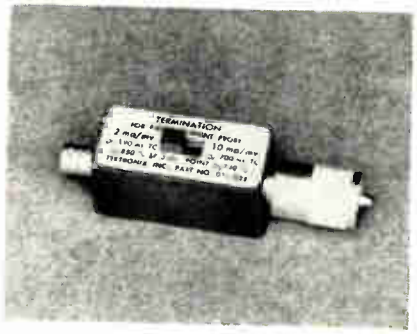
A less versatile system comprises the P6016 AC Current Probe with a Passive Termination . . . for observation and measurement of current waveforms at frequencies to 20 Mc, with a 30-Mc oscilloscope.

Easy to use, the current probe has a long narrow shape and convenient thumb control. Just place probe slot over the conductor and close slide with your thumb—no direct electrical connection is required. Wiping action keeps the core surfaces clean. Loading introduced is so light that it can almost always be disregarded.

P6016 and CURRENT PROBE AMPLIFIER

Sensitivity with 50 mv/div Oscilloscope Input: 1 ma/div basic sensitivity. 10-position switch provides calibrated steps from 1 ma/div to 1 amp/div, 1-2-5 sequence, accuracy within 3%. Continuous uncalibrated adjustment is possible by using variable control on the oscilloscope. **Noise:** Equivalent to a 100 μamp pk-to-pk input signal. **Risetime (with Fast-Rise Plug-In Unit in a Type 540-Series Oscilloscope):** 20 nsec (approximately 17-Mc passband at 3-db down). **Delay Time:** 40 nsec or less measured at the 50% pulse-amplitude points. **Low-frequency Response:** 50 cps at 3-db down. **AC Current Saturation Rating:** 15 amps pk-to-pk, decreasing to 8 amps at 400 cps, 400 ma at 50 cps. **Power Requirement:** 105-125 volts ac, approximately ½ watt at 117 volts (part number 015-030); 210-250 volts ac, approximately 1 watt at 234 volts (part number 015-045).

P6016 and PASSIVE TERMINATION



Sensitivity: Either 2 ma/mv or 10 ma/mv of oscilloscope sensitivity, accuracy within 3%. **Risetime (with Fast-Rise Plug-In Unit in a Type 540-Series Oscilloscope):** 18 nsec (approximately 20-Mc passband at 3-db down). **Delay Time:** 20 nsec or less measured at the 50% pulse-amplitude points. **Low Frequency Response:** At 2 ma/mv—about 850 cps at 3-db down (5% tilt of 10-μsec square pulse). At 10 ma/mv—about 230 cps at 3-db down (5% tilt of 35-μsec square pulse). **Maximum Current Rating:** 15 amps pk-to-pk.

COMMON TO BOTH SYSTEMS

Direct Current Saturation Threshold: ½ amp. **Maximum Breakdown Voltage Rating:** 600 v, with thumb slide closed. **Insertion Impedance:** After a step function has been applied to the conductor under test, the impedance inserted in series is: (1) 0.06 Ω after 50 nsec, (2) 0.04 Ω after 100 nsec, (3) 0.015 Ω after 1 μsec, and (4) 0.006 Ω after 10 μsec. Capacitance between conductor and probe case is typically 1 pf, depending upon wire size.

P6016 and CURRENT PROBE AMPLIFIER SYSTEM $235

For 117-volt operation, please order part number 015-030 — For 234-volt operation, please order part number 015-045.

P6016 and PASSIVE TERMINATION SYSTEM . . . . . $ 90

Note: P6016, Current Probe Amplifier, and Passive Termination can be ordered separately if desired. Other Current Probe accessories also available.

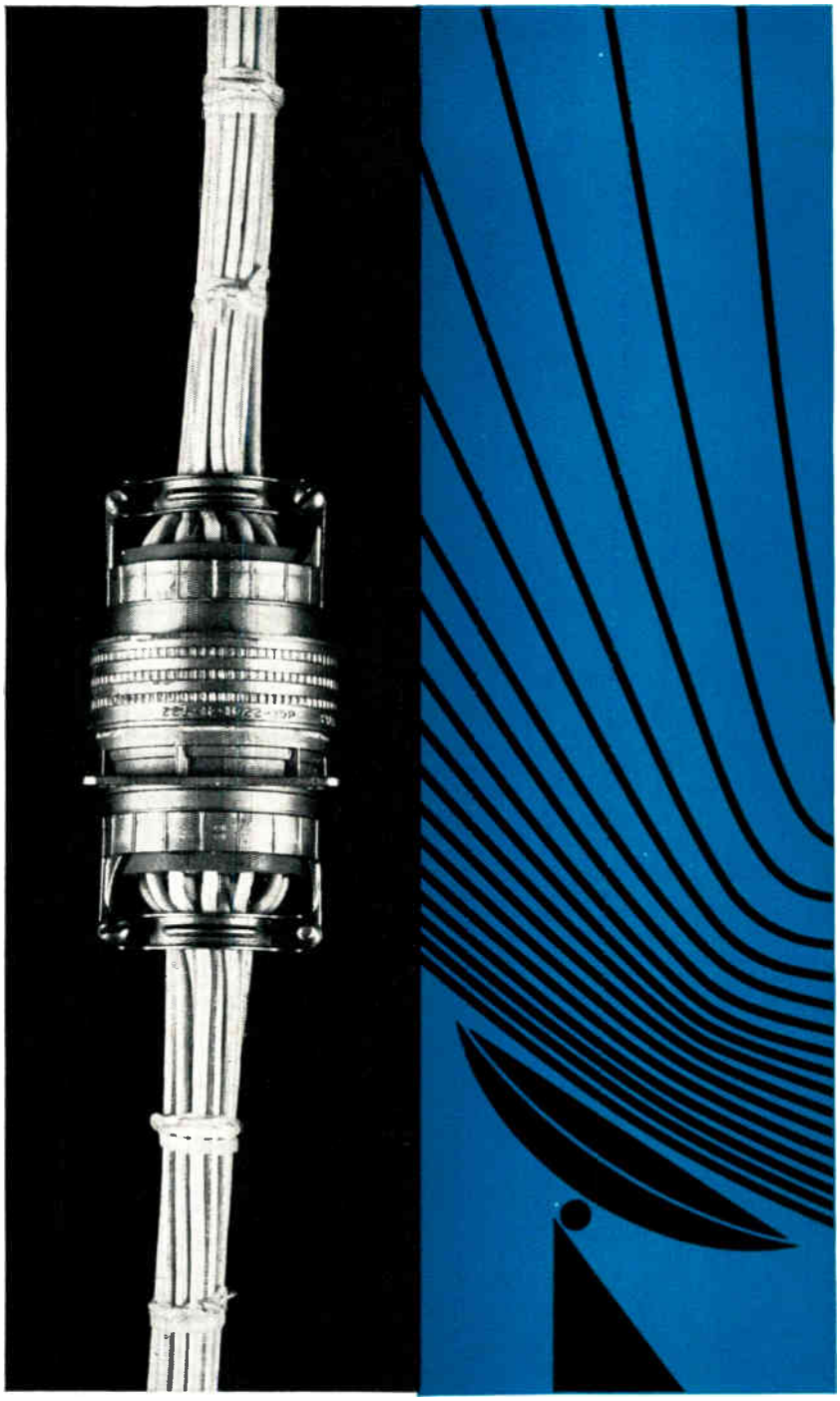
U. S. Sales Prices, f.o.b. Beaverton, Oregon

FOR A DEMONSTRATION, PLEASE CALL YOUR TEKTRONIX FIELD ENGINEER

Tektronix, Inc. / *P. O. BOX 500 · BEAVERTON, OREGON / (Area Code 503) Mitchell 4-0161 · TWX: 503-291-6805 · Telex: 036-691 · Cable: TEKTRONIX · OVERSEAS DISTRIBUTORS IN 27 COUNTRIES*

Tektronix Field Offices are located in principal cities throughout the United States. Please consult your Telephone Directory.

Tektronix Canada Ltd: Montreal, Quebec • Toronto (Willowdale) Ontario • Tektronix Ltd., Guernsey, Channel Islands



WHERE THE HIGHEST CIRCUITRY PERFORMANCE IS VITAL. For applications requiring reliable performance under severe environmental exposure, consider Miniature Pyle-Star-Line®, Mercury Series, Connectors. They have not only met but amply exceeded rigorous MIL-C-26500 B specifications. Their capabilities have been ably demonstrated for airborne electronics; checkout, test, and ground support equipment.

Design and material features which determine the performance of these connectors include: stainless steel shells for great strength, resistance to wear and corrosion, and unique contact retention system with collet fully supporting and positively retaining contacts in rigid insulators. Resilient insulator components provide resistance to most corrosive fluids and oils, complete sealing, and resistance to temperatures up to 392°F.

Available with threaded or bayonet shells, these connectors are offered in a wide range of insert configurations. Miniature connectors are also available hermetically sealed, and with shell accessories for RFI shielding.

Send for complete information on the Miniature Pyle-Star-Line connectors by requesting the newly up-dated M101 brochure. For consultation on applications, design ideas, reliability in performance, and promptness of delivery, The Pyle-National Company is the organization to contact.

CONNECTOR DIVISION, THE PYLE-NATIONAL COMPANY, 1334 NORTH KOSTNER AVENUE, CHICAGO 51, ILLINOIS

ALSO MFG. IN CANADA BY: PYLE-NATIONAL (CANADA) LTD., CLARKSON, ONTARIO

Pyle-National

Equipment must now function under conditions that were hard to visualize a few years ago, and even more strenuous operating environments are ahead. The only way to make sure that products can withstand these levels is to test them under conditions that duplicate the actual operating environment. Methods of vibration testing are covered—particularly random-motion testing—the most vigorous of them all.

RANDOM-MOTION TESTING OF ELECTRONIC COMPONENTS

THE NEED FOR VIBRATION TESTING of electronic components, subassemblies and even complete assemblies is great. It is so great that millions are spent each year to insure that these products conform to carefully thoughtout specifications developed by the armed forces. Adhering to these specs has been so effective in improving designs and weeding out below-par production models that the concept of vibration testing is now spreading rapidly from military to commercial products. This points out the importance of the material covered here.

* * *

Objective of the government specs is to subject electronic and other parts to a test environment that is as close as possible to actual equipment operating environment. Today, most vibration specs require that the component be subjected to random vibration during at least one phase of the test cycle (acceptance, qualification, etc.).

Sinusoidal Vibration

In the past, random motion was not specified because it could not be effectively simulated. Plain sinusoidal vibration was the standard requirement. At first, mechanical devices—motor-driven cams—were used to create sinusoidal vibration. These devices had a limited frequency range and state-of-the-art needs necessitated development of the electrodynamic vibration exciter.

The first electrodynamic exciters were nothing more than big loudspeaker elements without the cone. They were powered by normal rotary generators. This combination had an upper frequency limit of about 500 CPS. To push this limit higher, the generators were replaced by electronic amplifiers, (giant-size versions of hi-fi amplifiers) and the exciter improved to provide higher operating frequencies. The input signal came from a simple sine-wave source such as an audio oscillator.

Random Vibration

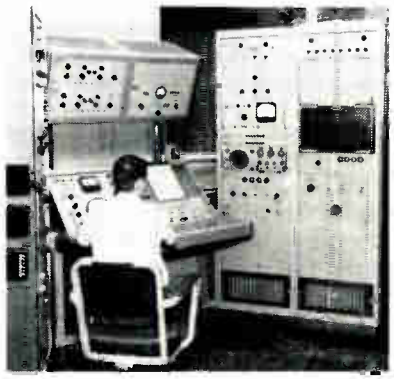
Random-motion or "random-noise" vibration describes the type of vibration that occurs in the most vigorous of all operating environments—a missile at blast-off.

Random-noise by definition is an acoustical or electrical quantity whose instantaneous amplitudes occur as a function of time according to the normal gaussian distribution or probability curve. A sigma value in random-noise signifies the ratio of instantaneous peaks that occur to the RMS noise value. For example, a random-noise of 3 sigma contains instantaneous peaks that are at least 3 times the RMS signal value. This random vibration is one of the most common forms of vibration. An example of this is experienced when driving your car down a cobblestone street.

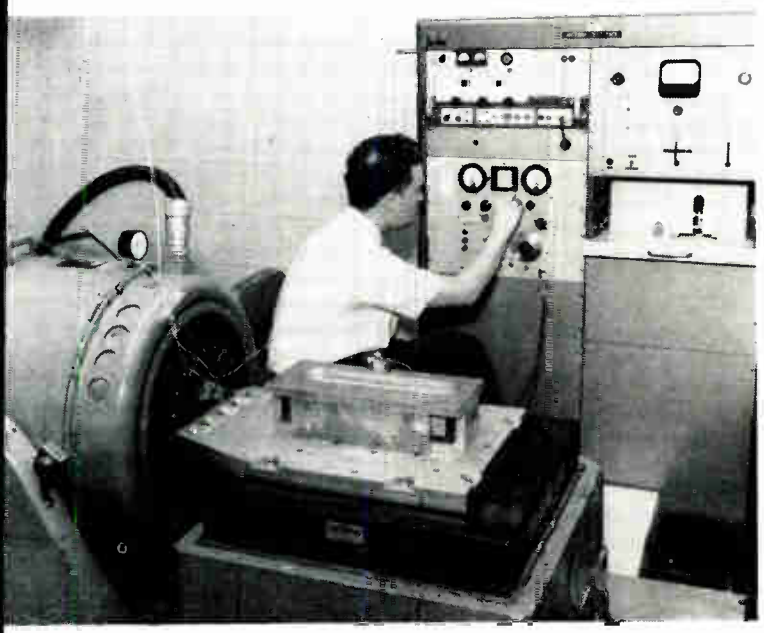
Generally, the laboratory source of the noise signal for random motion vibration is a gas-noise tube. Random noise should be gaussian in its distribution by definition. But, practically speaking, no actual random time function is truly gaussian because the signals are always processed through a device (control console or amplifier) that has a limited range.

The random noise generator selected must be calibrated for flat input. This is usually checked with a narrow-band analyzer. It must also be known that the output from the generator is gaussian. At the RSD lab, these checks are made with the Gulton Industries Model OR/WA/1 narrow-band analyzer or a Technical Products Model TP-627 analyzer, which have filters of 2, 5, 20 and 50 cycle bandwidths. The B&K Model 160 Probability Density Analyzer is used to check gaussian distribution.

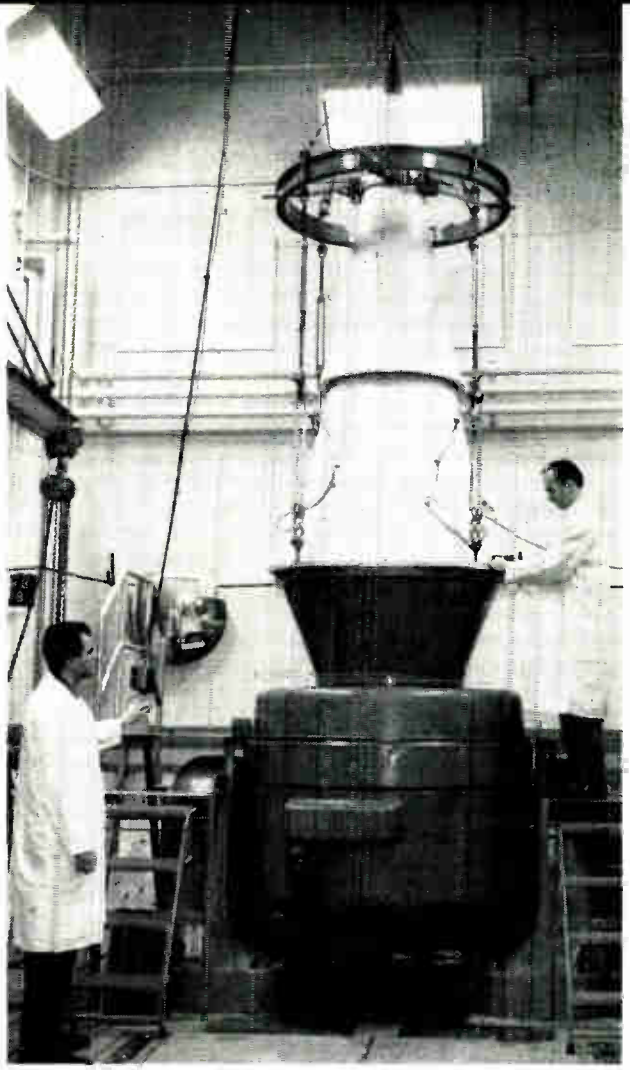
As the exciters and their power sources grew more



Control console for MB C125 system. Panel at extreme right contains automatic multi - filter equalization equipment. Before this type equipment was developed, it often took hours to compensate for the resonances that develop in the test object, fixture and exciter under vibration.



George Keeley monitors a random - motion vibration test on a microwave antenna for missile uses. The antenna, which is hidden by the enveloping fixture, was given a "functional" test with all proper inputs. To prevent the vibrations from the exciter affecting the other equipment in the lab, it has been anchored to a 15,000 - pound seismic block concealed under the floor.



A complete missile nose cone is prepared for random - motion vibration on an MB Electronics (New Haven, Conn.) Model C125 28,000 pounds - of - force exciter. This nose cone is filled with electronic equipment. Random - motion or "random - noise" vibration describes the type of vibration that occurs in the most vigorous of all operating environments — a missile at blast - off.

The authors, Rick Tuft (left) and Ron Ostrander (right).

By ROLAND J. OSTRANDER

Manager

and RICHARD H. TUFT

Supervising Engineer
Mechanical & Environmental Equipment Eng
Quality Control & Test Section
Re-Entry Systems Dept.
Missile & Space Div.
General Electric Co.
Phila. Pa,

sophisticated and powerful, designers and users became aware of the problems of resonances within the test object, the fixture to which it was attached and the moving coil of the exciter. During a sinusoidal test the acceleration levels were kept constant by servo control systems. With random vibration some other form of compensation was needed to insure that the test object was subjected to the desired forces at every point in the excitation band of interest.

So-called peak-and-notch filters were first used to balance out or compensate for the undesirable "peaks" and "notches" in the response of the exciter and its load. This was a time consuming method if the peak or notch was very sharp or the system under test was not linear. Occasionally the number of resonances exceeded the number of peak-notch filters, and the system (shaker-fixture-specimen) resonances could not be accurately compensated.

Because of this, "multi-filter equalization" was the next development in vibration testing. This method introduced an array of narrow-bandwidth filters across the broad frequency spectrum. The first approach used 50 cps bandwidth filters, with later approaches to 25 cps and now one maker offers 12.5 cps and mixed filter systems. At first, the filters were adjusted manually for each new type of test object. However, this again took time, particularly where the work load was heavy.

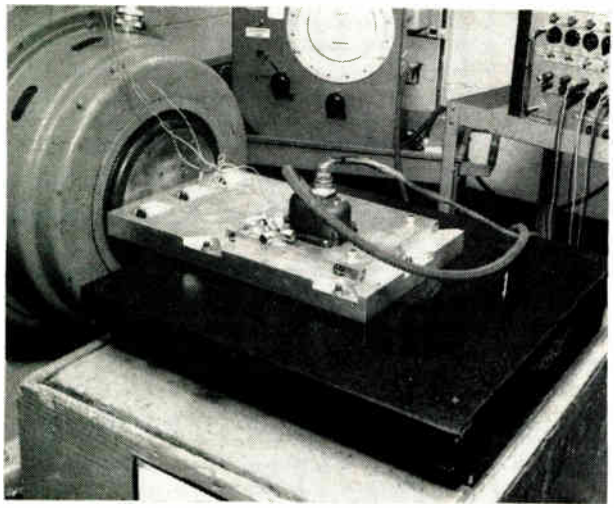
"Equalization" in Five Seconds

Automatic equalization of the filters in a matter of seconds is now considered the high-performance standard of the industry. Each equalization filter is automatically controlled, and set-up time has been almost eliminated. In these vibration test systems, loaded exciter response is displayed on a scope, while the filters are automatically adjusted to "shape" the input signal to the amplifier that powers the exciter. The result is an excitation pattern that follows the desired one, as specified.

It is this class of equipment that enables the engineer to perform all vibration tests called for in the specs, including the newest, "sine-random." In the latter, a sine-wave signal is superimposed on the random pattern to simulate the effect present in certain types of rocket motors.

The random-motion vibration tests described here do not represent the ultimate. Because many future missiles will have to be fired from underground silos, new higher acceleration levels have complicated the picture. This high level vibration is caused by noise created by the rocket gas turbulance around the missile as it is lifted out of the silo. This acoustic noise is transformed into mechanical vibration within the missile.

A pressure switch used in missiles is seen under functional test (see opposite page photo also). Exciter is an MB Model C10.



Getting Ready to Test

Even though the latest equipment has all sorts of automatic and time-saving features it doesn't mean that the test engineer's job has been made any easier. He must still play a complicated and essential role. In summary these are:

Selecting the proper vibration system.

Choosing or designing the proper fixture to mount the test object on the shaker or slide table.

Selecting the proper transducers.

Performing a shaker-fixture resonance search.

Preparing the proper inputs and measuring instruments if the test object must be tested functionally while undergoing vibration test.

Conducting the actual test.

Analyzing the data and preparing a report.

Making recommendations (when requested) to the designer or manufacturer to correct defects or failures discovered during testing.

Selecting the Proper Vibration System: Care must be taken in selecting an exciter system that is powerful enough to meet the needed test levels. Even a vibration exciter can be damaged by improper uses. This possibility must be avoided since vibration systems can cost up to $280,000.

To select the proper system, the mass to be vibrated must be known. This consists of (1) mass of the object to be tested, (2) weight of the fixture plus weight of the exciter armature. Less than 5 years ago when sine-wave testing was the mode,

it was easy to select the system. The vibration mass (in lbs.) times the desired acceleration (in g's) gave a figure in lbs. of force that set vibration system rating.

With random-motion testing in the picture, the formula f = ma still applies, but a slightly more complicated formula must also be used involving the bandwidth of vibration times spectral density. Fortunately, this formula has been reduced to chart form when bandwidth is constant. Thus only a few minutes are needed to learn the G RMS acceleration level and to apply it to the formula f = ma to find the system RMS force rating. Care should also be made to select a system, including an amplifier, capable of producing the 3 sigma peaks.

Fixturing: Picking the proper vibration system depends to some extent on the weight of the fixture selected. Obviously, it helps to keep the fixture weight as low as possible. For this reason, fixtures are usually made of aluminum or magnesium. Fortunately these metals also have good damping characteristics.

In most large environmental test labs, fixtures are standardized as much as possible to cut down on number and cost. These fixtures, which use standard bolt patterns, need less time to attach test objects to the slide table or exciter.

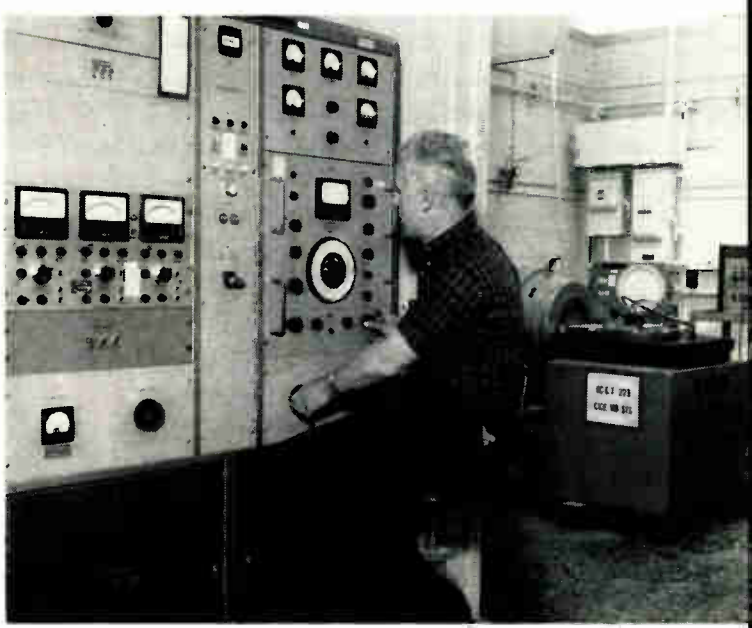
When these simple, flat plates can't be used, the lab must be given enough time to develop, make, and evaluate the more complex fixtures.

In designing a fixture for mounting the test object, one of the prime jobs is to cut down on "cross-talk." This "cross-talk" is the undesirable vibration in planes perpendicular to the one in which the object is being tested. When the test object is not properly fixtured, acceleration levels in the directions perpendicular to the normal direction will sometimes exceed the test vibration level, perhaps by as much as 500%.

At the RSD lab, efforts are made to keep cross-talk below a maximum of 50% of the vibration level in the test direction. Sometimes this requires designing special fixtures that are larger than the object under test.

Oil-film slide tables tend to cut down on cross-talk by restricting motion in the plane vertical to the test direction.

Shaker—Fixture Resonance Search: Before conducting the vibration test with an actual component, the shaker-fixture must be subjected to a resonance search. If necessary, a dummy component is designed and made that simulates within 2% the mass, center of gravity and mounting of the component to be tested. With the unit mounted on the fixture and shaker, the frequency band from 5 to 2000 CPS is manually or automatically swept at a rate slow enough to clearly identify the amplification and bandwidth of each resonance whose amplification is greater than 3 times the input. If necessary, the fixture is modified until, to the greatest extent possible, all resonances are eliminated. Vibration response shall be monitored through the entire frequency range in 3 orthogonal directions at each attachment point of the component to the fixture. Amplitude readings normal to the direction of excitation should not be greater than 50% of the maximum level in the direction of excitation. Maximum amplitude readings taken in the direction of the shake at the attachment points should not differ from each other by more than 50%.



A functional test under vibration is monitored. Test object is a pressure switch. Exciter produces 1200 lbs - of - force vector.

The transducer that measures the actual acceleration to which the test object is subjected is now attached at a point on the fixture that represents the best average of all possible attachment points. Generally a transducer (usually an accelerometer) is chosen that has a natural frequency much higher than that of the highest test frequency (we prefer at least 5 times higher) so that no sub-harmonics will affect its output.

All transducers should be calibrated periodically against a standard. Results of these calibration tests should be included in the data supplied to the organization for whom the component tests are performed.

Functional Tests: Frequently, the test object must be monitored for functional operation while it

RANDOM-MOTION TESTING (Concluded)

is vibrated. This is necessary, for example, when the test simulates blast-off and the object must operate during launch. When functional testing is not required, it is still necessary to check the operating performance of the object before and after the vibration test to see if its performance has been impaired.

Conducting the test

Once these preliminary steps are completed, the actual test can begin. Recording devices must be selected and tied into the transducers (and the test object if it is to be tested functionally). The object is now tested in the three orthogonal directions.

If the object passes the test, a report is issued to include the vibration system used, calibration dates, etc. However, if the object fails under test, then an elaborate failure analysis may be needed.

The test object that we at RSD usually refer to as a component, is actually a "black box" or an assembly of several smaller components. To learn why such an assembly failed, it must be opened and examined. Sometimes, this reveals a simple failure, such as a broken solder connection. This may be considered a random failure, calling for a duplicate subassembly from the same production lot to be requalified in the identical vibration environment.

However, if the cause of failure is not obvious, then it may be necessary to vibrate each component in the black box under the same vibration environment to determine the one or ones that caused the failure.

If the object that failed is an actual component itself, it must be dissected to find which part or segment was the source of failure.

Combined Environments

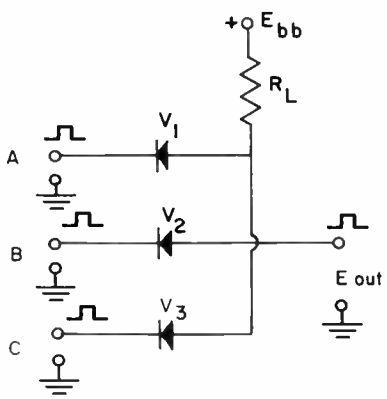
Combined environments are not new in vibration testing. At RSD, components are vibration tested inside hot or cold cabinets or inside high-altitude chambers. Obviously, equipment cost for such tests must be high. Usually the chamber must be big enough to enclose the exciter (plus slide table). The alternative, when possible, is to design a chamber in such a way that it can cover the exciter. This is no easy task, but chambers of this type have been used and are available.

CIRCUIT-WISE

DIODE "AND" GATE

THIS TYPE OF LOGIC CIRCUIT has two or more input circuits, and produces an output pulse only when suitable signals are applied to all input circuits. For a circuit with 3-inputs, a signal must be applied to input 1 *and* input 2 *and* input 3. Since signals must be applied to all inputs *simultaneously*, this circuit is also known as a *coincidence gate*.

A simple diode AND circuit is shown in figure. The diodes could be semiconductors as shown, or they could be vacuum-tube diodes. They are biased so as to conduct heavily (saturated) in the absence of an input signal. (The circuit is completed through the signal source itself.) Because of the low resistance of the saturated diodes and the high resistance of the load resistor R_L, the output voltage is clamped at approximately ground level. (The source resistance should also be low compared to R_L.) For proper operation, the input signal should be positive in polarity and of sufficient magnitude to overcome the power supply voltage so as to produce a reverse-bias condition. If such a pulse is applied to diode V_1, that



This simple diode AND circuit requires three simultaneous inputs.

diode will stop conducting. However, since V_2 and V_3 are still deep in saturation, the output voltage is still effectively clamped at ground level. Even if two of the input circuits are so energized, the third diode will still conduct, keeping the output voltage at ground potential. On the other hand, if a suitable positive signal is applied to *all* inputs simultaneously, all diodes are reverse-biased; no current will flow through R_L; and the output voltage will rise to the full supply value. When the positive signal is removed from one or more of the input circuits, the output level will once more revert to zero. A positive output pulse will be produced.

Similar operation could be obtained with negative input pulses, merely by reversing the diodes and using a negative supply source. The output this time would be a negative pulse.

Based on material from a new book, *General Electronics Circuits*, by Joseph J. DeFrance, published by Holt, Rinehart & Winston, Inc.

IMPROVING THE ACCURACY OF R-F VOLTAGE MEASUREMENTS

Measurements that were difficult in the past can now be made easily and accurately with modern test instruments. Four types of measurements are described here—Q, bridge & null network, r-f filter, and harmonic distortion. The methods described will benefit the expert as well as the casual user.

THE MODERN SENSITIVE R-F VOLTMETER with its semiconductor diode probe and chopper amplifier holds a key spot in high frequency instrumentation. About a decade ago its counterpart used a vacuum diode probe with its sensitivity held by contact potential to 1v. full scale. The r-f voltmeters had multiple scales, dc amplifiers with drift problems, frequency response related to the tube's transient time and the probe's rather low self-resonance, and bulky probes.

Now there are stable r-f voltmeters with a range in 6 decades from 300μv. to 300v., small size probes with a choice of adapters for probing, and accuracy past 1GC.

* * *

Since the sensitive r-f voltmeter is a rather new addition, it may be worthwhile to consider a few uses which may not be clear to occasional users.

Q Measurement

Resonance in the series circuit of Fig. 1 is read by a voltage maximum across the coil and capacitor (mostly across the capacitor). For circuit Q more than, say 10, the ratio at resonance of the capacitor voltage to that of the generator is very nearly the Q of the circuit, i.e., $Q = e_c/e_g$.

This circuit is the basis for some well-known Q meters used for finding impedance. Q is within 5 to 10%. In such meters the injection voltage is the product of a monitored current and a low resistance (0.02 to 0.04Ω). By design, the reactance of this mutual resistor is kept low. Since these instruments are calibrated for a constant injection voltage, any change in this mutual impedance will directly affect reading accuracy. The ideal internal impedance of this mutual element should be zero.

Measuring injection voltage at high frequencies (above, say 30MC) is as follows: The voltage between the low post and ground of a Q meter is not the voltage across the internal injection resistor unless the circuit is detuned. In Fig. 2 note that the inductance between the injection resistor and the low post is, at high frequencies, a major part of the resonant circuit. In practice the voltage at this low post may be as high as 0.2 to 0.3v. and will depend upon the part of the post that is contacted. At resonance the circulating current gives a real voltage rise across this part of the circuit. But, when the circuit is detuned, there is a negligible difference between the actual injection voltage and that voltage measured at the low post. To get this voltage at the higher frequencies, set the oscillator frequency to the desired value and adjust the injection level (usually 20mv.) at the low post with the circuit fully detuned. The improvement with this method of monitoring the injection voltage is shown for 2 commercial Q meters in Table 1. A further improvement was effected by using the r-f voltmeter to measure the resonant voltage across the capacitor, the Q being e_c/e_g. Two means are at hand to negate loading by the r-f voltmeter on the direct measurement of the

By RAYMOND E. LAFFERTY
Chief Engineer
Boonton Electronics Corp.
Morris Plains, N. J.

circuit Q. One method employs a voltage divider (ratio of 100:1) which raises the probe impedance to a high enough value to be sensibly infinite. The other uses an r-f voltmeter across the Q capacitor (hence the Q voltmeter) to calibrate it. Then the r-f voltmeter is disconnected and the internal Q voltmeter is used with its newly found correction. Either method yields a real improvement over adjustment of the injection voltage only. Table 1 lists typical values.

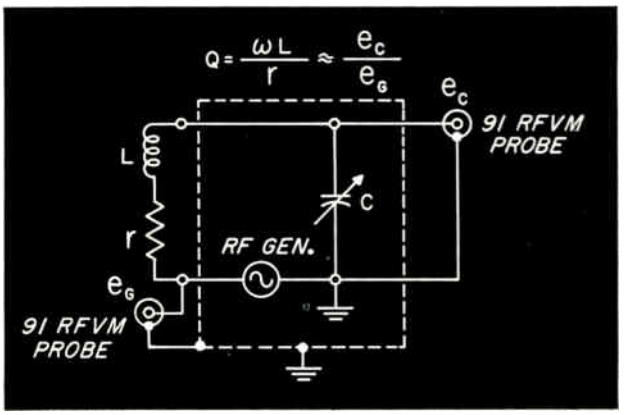


Fig. 1: Circuit for measuring Q includes method of reading 2 voltages whose ratio gives the value of the quality factor.

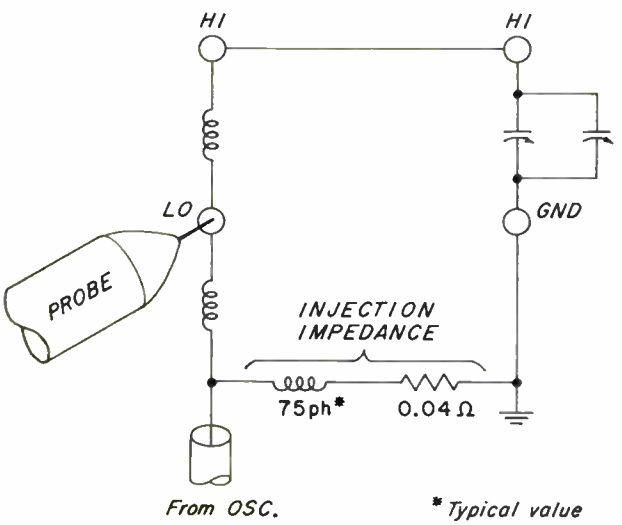


Fig. 2 (above): Pictorials in this schematic make clear how to measure injection voltage at high frequencies in a Q meter.

Fig. 3 (below): Here the r-f voltmeter can detect null. The signal is coupled to high Q circuit with improved sensitivity.

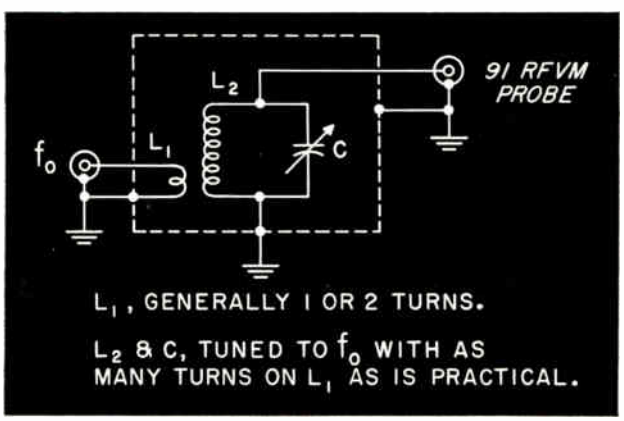


TABLE 1

f = 48 mc	Q Meter 1	Error	Q Meter 2	Error
Directly measured Q	167	28.5%	196	51%
Q after getting injection voltage of 20 mv.	143	10%	140	7.7%
Value of Q from e_c and e_g as measured with r-f voltmeter	131	0.8%	128	1.7%

Q by ΔC method = 130, Q by Δf method = 131

With a r-f voltmeter to check on the injection voltage, the normal voltage (0.2 to 5v.) which appears across the resonant circuit can be reduced for testing components like semiconductors. If the normal injection level of 20mv. is lowered to, say 1mv., Q circuit test voltage is then 10 to 250mv. This reduced voltage across the capacitor and test sample in parallel is outside the normal Q voltmeter's range, but within a sensitive r-f voltmeter's. When such parallel readings are made of the relative Q's before and after joining the specimen across the Q capacitor, no great loading error results by using the r-f voltmeter.

Accuracy of direct measurement, however, as in that of a coil's Q, will suffer from the finite shunt impedance of the probe. In such cases the circuit Q is best found with the known Q capacitor using the ΔC method.
That is,

$$Q = (2\,C_o/\Delta C)\sqrt{n^2 - 1}$$

where C_o = total tuning capacitance at resonance (includes probe capacitance)
ΔC = total change of capacitance above and below C_o to reduce E_o to a value, E
E_o = voltage across C at resonance
E = voltage across C when detuned
$n = E_o/E$
Q = circuit $Q = \omega L/r$

However, the ΔC method can be avoided if the capacitor voltage is greater than 30mv. The 100:1 voltage divider cited can then, with the voltmeter probe, help cut the shunting effect to a value less than that of the internal Q voltmeter. This will get a more exact Q, more so if the internal Q voltmeter is disconnected (the loading effect of the internal Q voltmeter is evident only at the extreme ends of the frequency range).

If a Q meter is not handy, a Q measuring circuit like that in Fig. 1 can be assembled using a calibrated variable capacitor, both coil and capacitor terminals, adequate shielding and low inductance leads. This last item is, perhaps, the most important detail in the Q circuit. When the injection voltage is read as shown in Fig. 1, it is not imperative that the injection circuit have extremely low impedance, but there is maximum current from its source at resonance, where any impedance in that circuit will cause a sharp decrease of the injection voltage. Further circuit change as added test samples or tuning to find the change in Q will also affect the magnitude of the injection voltage.

Holding this voltage constant will be easier with the impedance as low as practicable.

If only one r-f voltmeter is on hand, it should be alternated between the source and the capacitor voltages for each setting, while keeping the injection voltage constant and noting changes in the resonant voltage.

Another means of measuring the Q of a resonant circuit is described in the section on r-f filters. This method, which uses Δf, has merit when: 1. the circuit Q differs from the coil Q; 2. the Q of the circuit is effected by neighboring shields; or 3. the circuit make-up prevents easy connection to a Q meter.

Bridge & Null Network Measurements

Measuring circuits which need adjustment for minimum output voltage (null) are better for exact balance than the ones tuned for a maximum, or peak.

The r-f voltmeter is well suited for both uses. Its sensitivity, high input impedance, wide voltage range, and broad frequency range of hundreds of megacycles make it of value for bridge, bridged-tee, twin-tee, and resonant measuring circuits.

Null networks for measuring circuit parameters need a detector that can indicate the precise point of minimum output voltage, i.e., balance. Sometimes complex means are needed to show balance: minimum voltages of several μv. or less will generally require a sensitive, well shielded superheterodyne receiver. In some cases double detection is needed.

Engineers, who were forced to use such techniques, are aware of the complications which arise with such setups. Detectors of this type have severe drawbacks as to frequency coverage. R-F leakage can lead to gross errors and the proper grounding of all instruments is vital.

When less sensitivity will suffice (150 to 200μv.), a sensitive r-f voltmeter is an excellent null detector.

When the output impedance of the null network is low, the signal can be coupled to a simple, high Q, shielded resonant circuit with improved sensitivity when the voltmeter is across the resonant circuit. The circuit is shown in Fig. 3.

At frequencies too high for normal lumped constant resonant circuits, sensitivity can be increased by using a ¼-wave coax. line. For ease its length should be adjustable for tuning to the measuring frequency. If this type is not handy, a fixed line whose length is somewhat less than $\lambda/4$ can be electrically increased by a small variable capacitor connected at the voltmeter end.

The selective L-C circuits described will also furnish a degree of frequency discrimination. This is often needed in a null detector to reduce the bad effects of generator harmonics. The use of tuned transmission lines will give some discrimination only at the even order harmonics (even $\lambda/4$ multiples). Where this is not enough, it may be desirable to filter the output of the oscillator to reduce the harmonic content of the signal source.

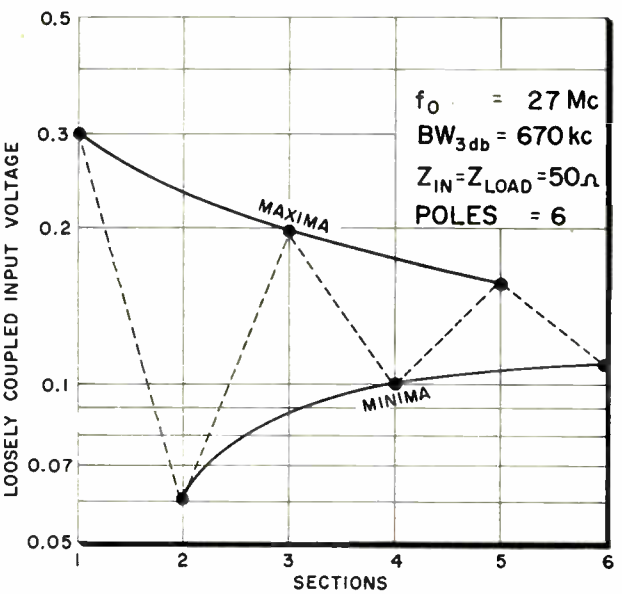


Fig. 4: Results of exact alignment of synchronously tuned, multiple band-pass filter with only generator and sensitive detector.

The author has been successful in using the BEC 91CA or 91D sensitive r-f voltmeter as a null detector for the GR Model (1602) admittance meter. The combination can be used to measure many UHF parameters.

R-F Filter Measurements

Engineers who design and study r-f filters have found the sensitive r-f voltmeter to be of great value.

The usual method for measuring attenuation of a filter employs a constant voltage generator of proper internal impedance (use a series resistor, if needed) to feed the filter—the output voltage is across a resistive termination. A second method is sometimes

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

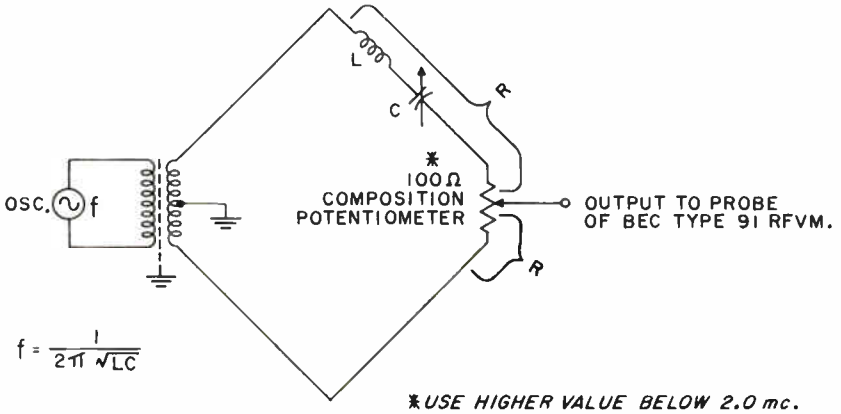


Fig. 6: Another circuit used to attenuate signal fundamental. It rejects better but is more complex than in Fig. 5.

R-F VOLTMETER (Continued)

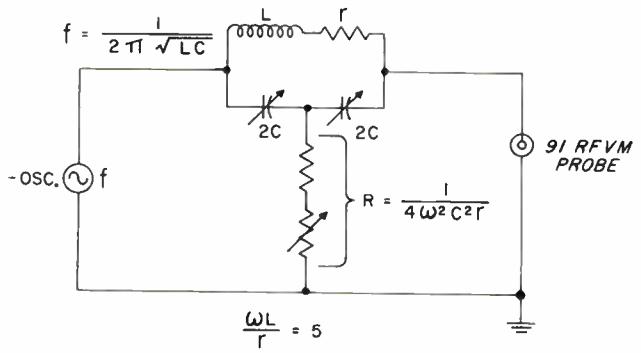
used in which the input to the filter is changed in accordance with the attenuation vs. frequency curve while keeping output constant. This method is best done with 2 r-f voltmeters and is desired where the filter elements may be non-linear (change value with signal level).

Owing to the wide band of these sensitive r-f voltmeters, it is possible for harmonic distortion in the generator output to cause gross errors in finding the pass band of both high-pass filters and band-pass filters. The trouble in a band-pass filter may occur when the generator is set to a sub-multiple of any frequency in the pass band (or to any frequency below ½ the cut-off frequency in a high-pass filter). To avoid these abnormal effects and get true response of such filters, a low-pass filter can be interposed between the generator and the filter under test.

A unique use of a non-resonant sensitive r-f voltmeter is for the exact alignment of synchronously tuned, multiple-resonant-circuit filters.

Dishal has shown[1] that the correct adjustment of a band-pass filter is possible with only a generator operating at f_o (the center frequency) and a sensitive detector loosely coupled to the input of the filter. The method is usable whether the filter elements be lumped or distributed for either low or uhf respectively, provided that each resonant section can be adjusted near f_o.

Fig. 5: Circuit to reject harmonic signal's fundamental (see Fig. 6).



In Ref. 1 is shown that, if all the resonant sections are completely detuned (10 or more pass-bandwidths from f_o) and if they are then tuned in numerical order, with the input section as 1, all odd-numbered sections will reflect a high resistance across the input terminals and all even-numbered sections a low resistance, when each section is tuned right.

Be careful with each adjustment, especially with the last few sections, since the voltmeter excursions of maximum and minimum converge much in the manner of a damp wave train. Typical values are given in Fig. 4.

The Q of the resonant circuit in each filter section is often required. To measure a circuit outside of its shielded compartment has little meaning, since the metal housing near the coil will affect the inductance and loss. The most accurate measurement of either the loaded or unloaded Q of each section is by the Δf method using a generator and voltmeter, both loosely coupled to the resonant circuit. Dishal recommends opposite modes of coupling for these instruments, with magnetic coupling from the generator and capacitive coupling to the voltmeter being best. The circuit Q is given by

$$Q = f_o/\Delta f \sqrt{n^2 - 1}$$

where $n = E_p/E$, E_p = maximum meter indication at resonance and E = meter indication when the generator is adjusted above and below resonance to f_2 and f_1 ($f_2 - f_1 = \Delta f$).

Harmonic Distortion

Harmonics in a r-f signal can be found with a tunable receiver and this method to study purity of waveform of a r-f signal source has been used for many years. Unfortunately, the results from this method are more qualitative than quantitative. Harmonic Distortion at r-f can be measured using the same principle used in the audio spectrum. This is not as well known as might be hoped, considering

1. Dishal, M., "Alignment and Adjustment of Synchronously Tuned Multiple-Resonant-Circuit Filters," *Proc. I.R.E.*, Vol. 39, pp. 1448-1451; Nov., 1951.

the present stress on RFI as well as the value of low distortion test signals to measure semiconductors.

In general, the method requires suppression of the fundamental and the measurement of the remnants, or harmonics, relative to the amplitude of the composite waveform.

Total harmonic distortion is,

$$\% \text{ Distortion} = 100 \frac{\sqrt{E_2^2 + E_3^2 + E_4^2 + \cdots}}{\sqrt{E_1^2 + E_2^2 + E_3^2 + E_4^2 \cdots}}$$

where E_2, E_3, etc., are the RMS values of the indicated harmonics, and E_1 is the RMS value of the fundamental.

The denominator of this equation is often given as the RMS value of the fundamental alone, but isolating the fundamental is a filtering problem and if the total harmonic distortion is less than 10%, the equation as given is satisfactory.

A grave error occurs if an average type rectifier is employed to measure the fundamental as well as the harmonic content, and in particular to obtain null at minimum output. Though it is clear from the equation that all voltages should be measured with an RMS meter and that error results with an average responding meter, MacDonald[2] has shown another error of greater meaning from using an average responding meter. It can be shown that a null network may be adjusted using an RMS meter, for elimination of the fundamental. Transferring to an average type meter and then introducing a small part of the fundamental, properly phased, will further reduce the average reading. This reading, of course, is invalid and errors of 10% and higher have been noted with an average type meter. Unfortunately, the error is not in a direction to make the distortion appear lower.

There are several circuits for eliminating the fundamental of a signal without significant attenuation of the harmonic content. Two circuits which have been proven are shown in Figs. 5 and 6. The circuit of Fig. 5 is the well-known bridged-tee. If frequency of the test signal cannot be adjusted, means should be made to allow either the inductance or the capacitance in the bridged-tee network to null the fundamental. In either case the resistance, R, must be adjustable to negate the effect of the resistance of the coil. Alternately adjusting, say the capacitance, and the resistance should result in suppression of the fundamental of 50 to 60db.

If more attenuation of the fundamental is needed, the circuit of Fig. 6 may be used. This is a series resonant bridge with at least 80db rejection. This circuit is more complex than the circuit of Fig. 5 in that a well balanced transformer is needed to drive the bridge. This circuit is used in the BEC Model 85 distortion meter and for signal frequencies up to 100MC.

Balance of the series resonant bridge is achieved in much the same way as for the bridged-tee network. Either reactance in the series resonant circuit may be adjusted for resonance along with a variable resistance which is changed to balance the bridge (it should be remembered that at resonance, the reactance disappears leaving only resistance in the right arms of the bridge).

The first reading for either circuit should be taken with the L-C circuit completely detuned to avoid attenuation of the fundamental. This gives the reference voltage (denominator of the above equation). This voltage should be as high as possible without causing any nonlinearity in the circuit components. Because this voltage will usually exceed 30mv., the voltage divider adapter should be used with the probe to assure operation of the probe diodes in the true RMS region (up to 3v. with the 100:1 adapter).

Ignoring the RMS region for this reading, however, will not normally have much effect upon the accuracy of the measurement. It is more important, for reasons given, that harmonics which remain after eliminating the fundamental be measured in the RMS region of the probe.

Assuming that precautions outlined above are observed, the percentage of harmonic distortion is simply,

$$\% \text{ Distortion} = 100\, E_1/E_2$$

where E_1 = signal voltage measured in the absence of the fundamental.

and E_2 = total voltage including the fundamental (reference voltage).

Some recent work on the reduction of harmonics in r-f signals has pointed up the advantage of making precise distortion measurements; particularly, the ability to measure the total harmonic content so that an adjustment to reduce say the second harmonic, which might increase the third harmonic, is noticed. It is clear that parasitic circuit parameters in an r-f oscillator can greatly change the purity of the output waveform. Such parameters are easily affected by small changes in layout, proximity, shielding, or other minor adjustments. Under such conditions it is most important to have a means to observe the effects of each modification. With such means, substantial improvements can be obtained with a minimum of effort and redesign.

2. MacDonald, J. R., "On Accurate Measurements with a Harmonic Distortion Meter," *I.R.E. Trans. on Audio*, Vol. AU-5, No. 6, pp. 160, 161.

ENCAPSULATING TO MILITARY SPECIFICATIONS

A wide range of considerations must be reviewed by the systems engineer before the encapsulation processes are specified. The resins considered for use should undergo wide study. Many of the restrictions on the encapsulating process are dictated by the electrical characteristics of the component involved.

THE NEED FOR RELIABLE ELECTRONIC COMPONENTS has spurred the development of advanced encapsulation systems able to meet strict military specifications. Encapsulation is also used in equipment for lightweight, dense packaging needs of the missile age. A typical material now available is silicone casting resin. This is a tough, transparent, reparable material for encapsulating a printed circuit assembly.

Designers must carefully study the environmental, electrical, mechanical and chemical specifications to establish basic needs for an optimum design. Environmental conditions generally include humidity, shock and vibration, and limits of ambient temperature. They frequently extend to altitude, corrosion, salt spray, fungus and corona. The systems engineer should make clear at the start all the end requirements which the unit must fulfill.

* * *

The entire cost structure of a component should be carefully reviewed in the early stages of design, as outlined in Fig. 1. This avoids possible added expense in tooling and production for what seemed a simple item at first. Production budgets are a major concern of management today. However, small increases in outlay on design and better materials will reduce final costs.

Selection of Resins

A designer must choose new materials with caution, and consider them less than reliable until proven worthy after testing and usage. The staff chemist provides a vital link between new product appraisal and full data release for engineering use.

Reference: Society of Plastic Engineers—Encapsulation Materials and Techniques Workshop, Newark, N. J.

A. Environmental Considerations: Resins considered for use in systems should undergo wide study. Tests include pot life, immersion, gel time, viscosity at various pressures and temperatures, general handling properties and ASTM shock test. Additional thermal shock tests are run on a unit set up as a company test standard and considered typical of shapes used to qualify in military testing. After thermal shock, samples are put to immersion tests, per MIL-STD-202B, Method 104A.

Moisture penetration can be avoided by using unfilled resins as impregnants. These materials show very low moisture absorption. The thixotropic, highly filled resins may then be used for outer coatings or potting. MIL-E-5272A typifies a humidity specification and procedure for military use.

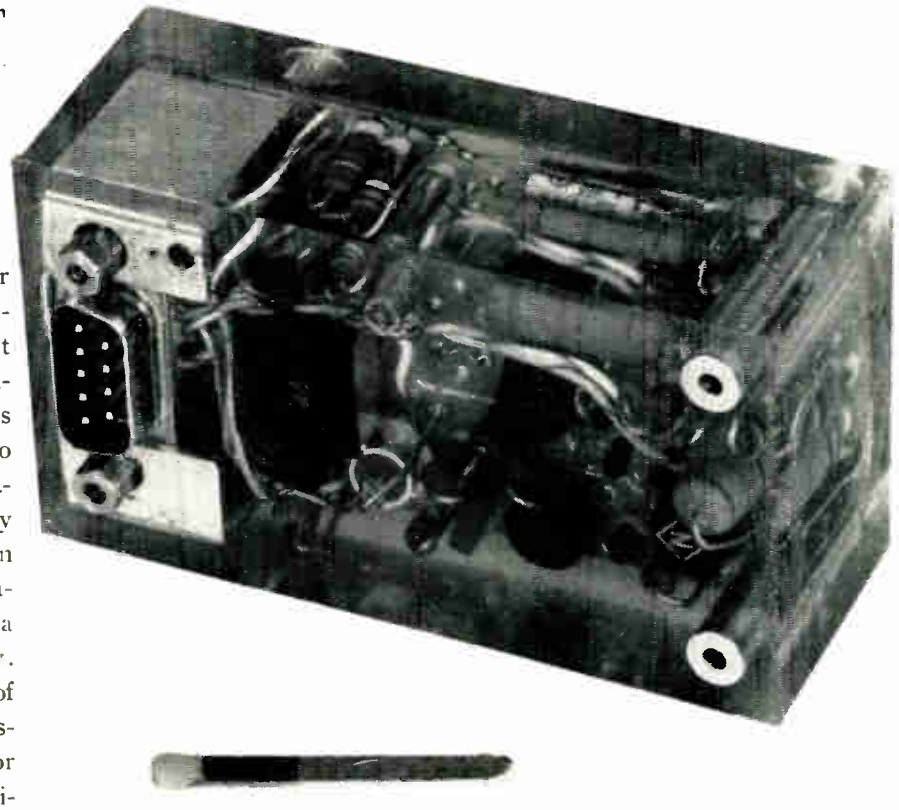
Added environmental design factors to consider:

1. That exposed metal surfaces are well protected from corrosion and galvanic effects by plating to MIL-F-14072 or MIL-E-15090B.
2. Descriptive marking on the surface of units should meet MIL-M-13231A.
3. Protective coatings over surface markings must meet MIL-T-173A.

Thorough knowledge of all related military specifications is essential.

By FREDERICK L. KOVED
Engineering Supervisor
Magnetic & Transformer Grp.
GPL Div.
General Precision, Inc.
Pleasantville, N.Y.

This printed circuit assembly is seen enclosed in silicone casting resin, a tough, reparable encapsulating material.



Selecting a resin system for temperature and humidity conditions needs technical judgment and consultation. Study of temperature effects on systems shows that resistivity of resins tends to drop with increasing temperatures. Plots of volume resistivity vs. temperature act as design guides, and show thermal degradation as an element affecting a component's life expectancy. Thermal conductivity, a trait of casting and impregnating systems, should be a design factor for improving overall heat dissipation of a unit.

B. Use of Fillers: With proper compounding, certain suitable fillers in resin systems can enhance the conductivity without degrading the electrical characteristics. Use of heat-conductive material is very helpful in power generating devices such as tubes or transformers. By using good heat dissipating materials, some of the more complex sinks and fins used in earlier equipments can be left out. Aluminum oxide as a filler in the units is put into the resin system in fine powder form.

Particle size and type of fillers have important effects. These 2 factors determine the amount of filler that can be compounded into a resin system and still produce a unit with viscosity suitable for a given component package.

C. Epoxy Sand: Epoxy-coated sand products found on the market have very good heat conductance which helped to reduce overall working temperatures of a component up to 25% with regard to pitch, waxes and similar potting materials.

D. Resin Shells: The designer may find preformed shells as a fine means to provide an outer protective coating while giving dimensional stability and mechanical rigidity to an assembly. A welded circuit and completed unit encapsulated in a shell is shown in Fig. 2.

Use of shells has in many instances eliminated molds, improved product appearance and cut tooling costs. An expanding market of standard size shells, in a variety of materials, makes this appear attractive. Fig. 3 illustrates the ready use of encapsulated shells in printed circuit assemblies.

Diallyl phthalate is fabricated in shell form and has excellent dielectric properties, very low moisture absorption and fine high temperature characteristics. It can be very easily molded or formed around metal with no problems as to thermal shock. Various fillers used in diallyl phthalate including nylon, glass, orlon and dacron have helped adjust its properties to meet particular needs.

E. Resin Stripping: The use of masking grease or spray mold release should be minimized. When needed for mounting surfaces, it should be confined to specific areas. Some components can be cleaned of excess resin, while the resin is hot, after the curing cycle is complete. The resin is easily cut away from certain areas.

F. Fillers: For an assembly without voids between elements, a paste composed of resin and asbestos short fibers should be specified as a filler. This unified thixotropic resin reduces possibility of cracking during thermal cycling. The material is normally gelled at 250° or 225°F for 1 hr. Usually a paste of 100 parts each of resin and filler short fibers is

used after mixing well to a homogeneous mass. Frequently, open-weave glass around cores and coils without adhesive backing serves as a binder for the resin.

Material Considerations

Selection of compatible component elements in a unit is a basic responsibility of the designer.

A. Common Problems:

1. Penetration of toroidal coils by resins may cause serious changes in network characteristics.
2. Glass or ceramic components may crack under the wrong coating material.
3. Wire coatings may suffer from chemical harm and result in coil failures.
4. Capacity specifications for a coil may be a problem if the dielectric properties of a certain resin are not suited to the frequency of operation.
5. Thermal expansion to excess can cause fine wire breakage.

B. Pre-treatment: All of these problems reflect the need for design selection of materials to cope with the component and system needs. Compatibility of the resin impregnating and coating systems with component elements such as nylon, Teflon and electro or centrifugal hot tin-coated metal brackets, has been successful through broad use of etching, priming, fastidious cleaning and selective use of filler materials. The power supply shown in Fig. 4 required pre-treatment of internal bracketry, capacitors, transformer and other components as described in this section. This provided a compatible system for the molding process.

Mylar and Teflon sheets are available with etched surfaces for better adhesion. All of these primed surfaces provide better anchorage for the resin, and help form dense impregnation in the component assembly. Adhesion of the epoxy to Teflon wire can be assured by etching in a prepared sodium bath. Fluoro-bond and Tetra-etch are commercial materials easily adapted for such use. Etching takes about 5 sec., and the solution can be removed by simple cleaning. A homogeneous bond is produced at the junction of the teflon wire and the resin.

In construction, kraft papers often provide a porous material as an anchor and base for resins. Paper may then be used beyond its basic temperature limit.

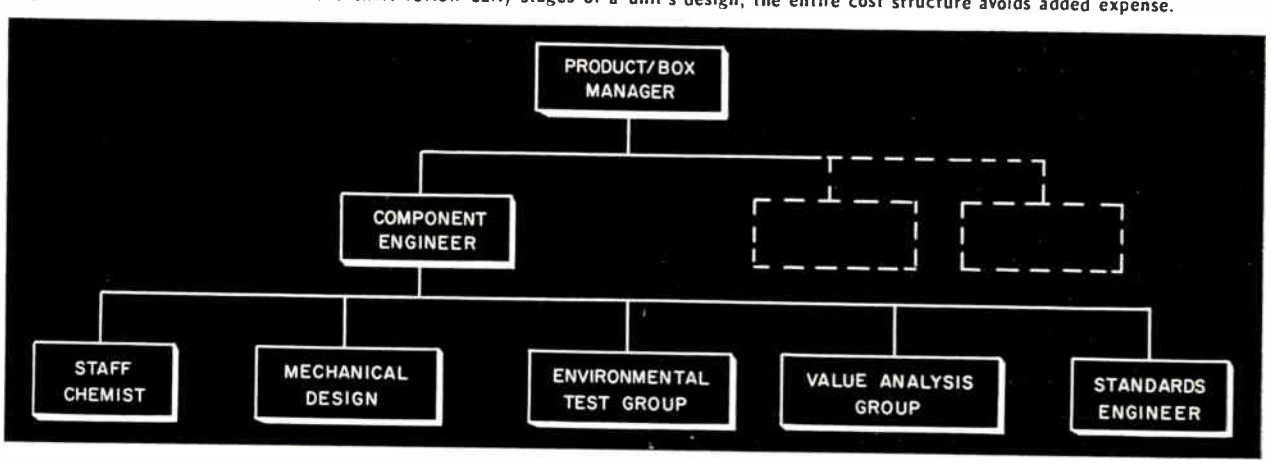
Treatment of metal brackets to provide good adhering surface includes immersion in a dilute solution of nitric and hydrochloric acid for 2 to 3 min., then a water rinse. Materials such as hypersils and banding clips can be cleaned by immersing in trichlorethylene and then dried.

Nylon can be primed to provide fine adhesion using Poly-prep. Exposure for 20 sec. and rinsing in water provides a good surface. The material should then be dried at 250°F for 10 min., since nylon has affinity for water.

C. Element Studies: A study of magnet wire coatings—formvar, soldereze coating, M-L and polythermaleze—was conducted for design engineers to determine compatibility with resin systems. These reports provide the designer with data needed to select wire types.

The life expectancy of the component is a prime factor. The life of a component, particularly of a transformer, depends asymptotically upon environmental stress. As an example, we find that for every 25° increase in the operating temperature of a transformer, the life expectancy is reduced to 1/8 to 1 10 of its original value. At some point where an element fails, life drops to zero. The misuse of a component has been known to be the major cause of failure in service.

Fig. 1: When all those shown on the chart review early stages of a unit's design, the entire cost structure avoids added expense.



Layer insulation was carefully examined for compatibility, their final temperature ratings, life expectancy and adhesion properties in a resin system. Other element materials as sleeving and diallyl phthalate bobbins, have been likewise studied.

D. Compound Preparation: Moisture absorption during assembly must be avoided. Preheating of components prior to impregnation should be clearly defined to remove moisture. The period of prebake and temperature depends on the thermal class and materials. An average prebake may be 250°F for 2 hrs. which will for the most part condition a unit for impregnation.

Designers must be on the alert for contaminants which cause substandard performance. Cleanliness is vital in all stages of material handling, assembly and test.

Rosin flux on or near terminals can provide space for moisture to enter the coil and cause thermal cracks or failure during immersion. Unclean terminal areas also have low insulation resistance. Poor manufacturing procedures in coil finishing give the same problems.

Resins should be stored in cold dry areas with mixing dates and expected pot life clearly marked on resin tubs. This is to insure that only fully effective resins are cast into units.

Detailed Considerations-Transformer Field

Below is a summary of detailed requirements in a design review as developed specifically for transformer design:

1. Designs were checked for increase or rise in temperature under operating conditions.
2. The complete assembly and pre and post heating needs for impregnation, were re-evaluated in line with the latest concepts of moisture absorption.
3. A study was made of the margin of safety involved in winding margins, layer insulation, magnet wire and other elements in view of possible conversion to updated materials.
4. Potting and impregnating materials were reviewed by the design group to reflect latest advances in the art. The need for compatibility of all materials to insure optimum performance was noted.
5. The specific mechanical method of packaging was studied with regard to costs and suitability to the encapsulation materials and process.
6. A review was made with the circuit engineer to learn the overall effect on the magnetic component if an adjacent component were to fail. When possible, an attempt is made to provide a safety factor in the component design. (*Continued on following page*)

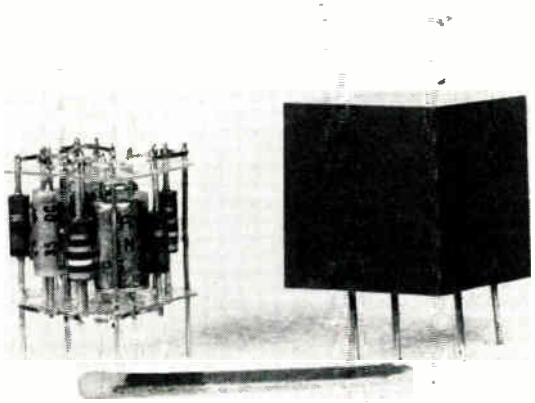


Fig. 2: This is a welded assembly before and after completed unit is made with a resin shell having dimensional stability.

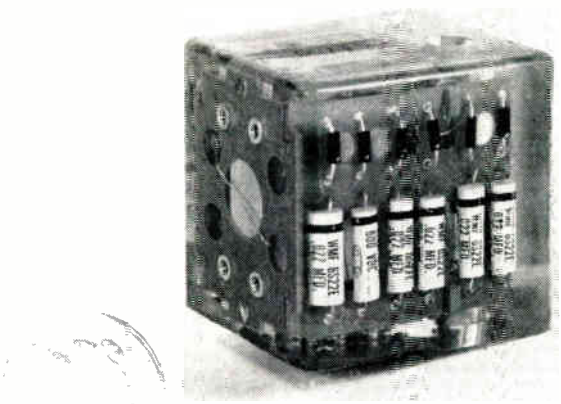
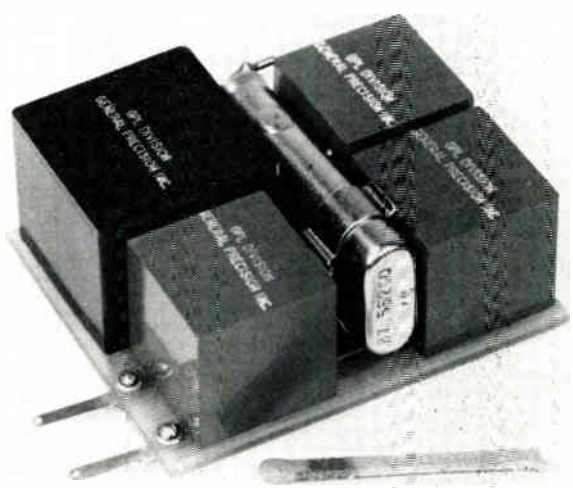


Fig. 3: The finished unit above illustrates the variety of material in standard size shells for printed circuit assemblies.

Fig. 4 (below): This power supply's mechanical and electronic parts were pre-treated. Problems and methods are in the text.



ENCAPSULATION (Concluded)

7. Manufacturing procedures and methods were cataloged to insure continuity of methods and techniques used for the encapsulation process. Of utmost importance to insure reliable units is that the simplest procedures be consistently used. When difficulties arise, the formulating procedures can be carefully examined and appraised.

A component's reliability reflects not only the design aspects but also the manufacturing, assembly and test techniques used in production.

A. Heat Degradation: Problems related to coil finishing of fine wire where heat embrittlement occurs at the junction of the flexible lead to the magnet wire, should not be blamed on the resin.

B. Electrical Test: During preliminary tests, insulation resistance testing can insure that the unit, prior to encapsulation, is of the highest quality.

Corona difficulties must be analyzed. Even the smallest of voids provides a point where the corona starts and then progressively impairs the coil. So it is of utmost value that the impregnation materials for high voltage units be carefully chosen and defined by the designer.

C. Component Pretreatment: Engineering data should have detailed instructions. Include preheating needs for the resin to insure a viscosity needed for a specific physical resin buildup. Some uses demand that the coils be wrapped well with porous tape, so that it seals off the end margins of a coil and forms a cup. This applies to a resin with low viscosity to be held within the coil.

Summary

Much study must precede the selection of a resin system and related materials for the final design. All environmental considerations, as discussed, are prime with respect to an integrated product able to achieve the stated life expectancy under extreme conditions of test.

It is highly important that a coordinated effort exist between the chemist and designer to insure that the unit and epoxy systems are wholly compatible. With the drive toward more compact, lighter components there will be more reliance upon resins to provide necessary moisture barriers, mechanical rigidity and protective coating for components.

A designer's horizon must be defined by a good knowledge of ready materials and the current state of the encapsulation art.

CIRCUIT-WISE

A SIMPLE HI-FI OUTPUT CIRCUIT

NORMAL HI-FI CIRCUITRY makes use of specialized circuitry, and hardware. The circuit shown in Fig. 1 can be built from parts likely to be on hand. It should have applications for other than hi-fi equipment.

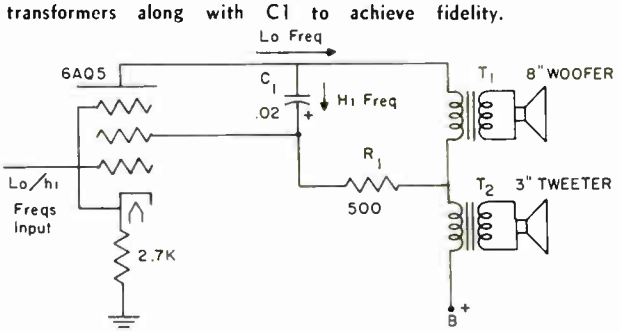
Basically this circuit operates with a single-end power tube stage in conjunction with two identical, inexpensive transformers. Either receiving or transmitting type tubes can be used. The "key" to this circuit is to select a reactance value to block low a-f, yet pass the high a-f to transformer T2. For example, assume the primary reactance of T1 is 5,000 ohms: using a rule of thumb axiom where X_c equals 1/10 of shunted value, for high end of passband, 20 KC

$$c_1 = \frac{1}{2\pi F_H X_C} = \frac{1}{6.28 \times 20 \times 10^3 \times 500} = 0.015^{+}\mu f$$

Be sure that adequate dc working voltage is allowed for C1.

As indicated in Fig. 1, when only low frequencies are present at the tube's input, the screen grid is effectively isolated from the plate. Hence, triode performance is accomplished (using a pentode) giving desired low distortion effect where it is important. At increasing frequencies C1 gradually decreases its reactance, thus shunting T1 primary winding reactance. Thus, the treble speaker uses the pentode's power sensitivity capability in a straight forward manner.

Fig. 1: Hi-Fi output circuit uses 2 identical, low-cost transformers along with C1 to achieve fidelity.



Submitted by E. G. FONDA, Deputy Manager, Philco-Houston, Houston, Texas.

The advancement of guided missile and aerospace programs depends more and more upon the analysis, under cryogenic environments, of materials, components and fuels. For this analysis, precise temperature measurements are essential. The role that resistors play in making these measurements is described here.

RESISTORS FOR PRECISE TEMPERATURE MEASUREMENTS

THE ANALYSIS, UNDER CRYOGENIC ENVIRONMENTS of materials, components and fuels is important to the advancement of guided missile and aerospace programs.

As temperatures reach the cryogenic range, many materials change some of their properties. Rate of change is not always constant; nor does it necessarily vary proportionately with the increase or decrease in environment temperature. Hence, it is essential that precise temperature measurements be made by a simple, dependable method, particularly as conditions approach absolute zero. Results of investigations involving resistors used in such methods are covered.

* * *

One accurate and simple method for measuring temperatures in the liquid helium range is the resistance thermometer. This device uses the increase in resistance shown by carbon resistors at cryogenic temperatures. It allows simple instrumentation, long leads and a small probe. But, it requires resistors with great stability and reproducibility, which show a fairly large temperature coefficient and have a resistance of between 1 K and 1 meg at these temperatures. Also, resistance in the desired range must follow a predictable curve so that results can be extrapolated.

Where resistors without these qualities have been used, difficulties have been encountered. M. H. Edlow and H. H. Plumb of the National Bureau of Standards, for instance, have reported that at 4.2°K, both encapsulated and unencapsulated carbon resistors took over 3 weeks to achieve their equilibrium resistance value to within 1/3 millidegree. However, where resistors with the necessary stability and reproducibility have been used, no problems were noted.

Special Calorimeter

In 1955, K. G. Ramanathan and T. M. Srinivasan of The National Physical Laboratory of New Delhi, India, were among the first to use resistance thermometers in their investigation of the specific heat (sp. ht.) of bismuth at down to 1.3°K. They developed a vacuum calorimeter with an accuracy of better than 3% between 4.2 and 1.3°K. In this apparatus the specimen was suspended within a hermetically sealed can. When cooled with liquid helium, the air in the container was frozen out. Heat was measured by thermally isolating the specimen and dissipating a known amount of electrical energy through a coil wound around it. Temperature rise was measured by means of a ½ w., 100 ohm resis-

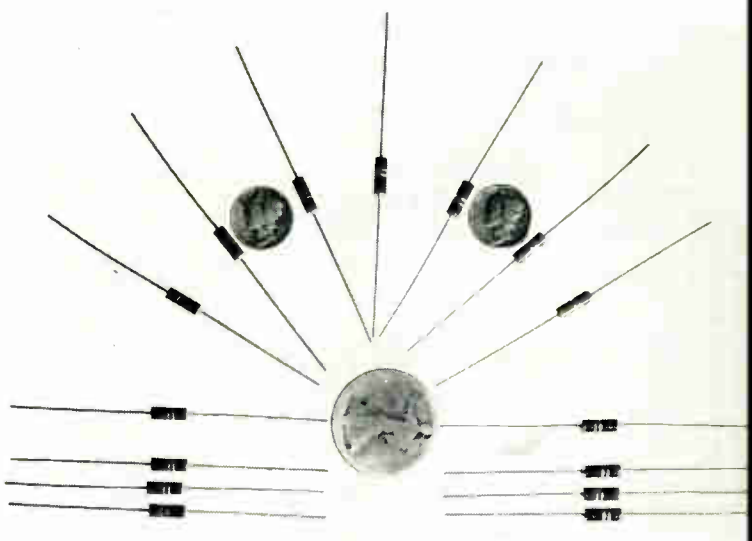


Fig. 1: Resistors for precise cryogenic temperature measurements are quite small as shown.

By GEORGE P. McKNIGHT
Mgr. Electronics Application Eng'g.
Speer Carbon Co.,
St. Mary's, Pa.

tor calibrated against the helium vapor pressure temperature scale, and used as a carbon resistance thermometer.

In 1957, using the same equipment they investigated the lattice and electronic sp. hts. of copper and silver.

Resistance Thermometer

In 1959, using the ½ w., 100 ohm resistor as a carbon resistance thermometer they investigated the atomic heats of gold, platinum and antimony at liquid helium temperatures, and Mr. Srinivasan investigated the lattice and electronic sp. hts., of zinc and cadmium.

In the U.S., a number of researchers are using resistance thermometers for work in the liquid helium range. Prof. R. W. Shaw, of Rensselaer Polytechnic Inst. reports that he is engaged in work that might be titled "Ultrasonic Attenuation in Superconducting and Normal Lead." It consists in "measuring the echo pattern when a burst of h-f (10 to 100 MC) sound is introduced into a specimen with parallel sides between which the sound bounces. These data can be interpreted in terms of the spectrum of energy levels available to the electrons in the material. The resistor is used as a secondary thermometer for control of constant temperature in the range above 4.2°K."

M. P. Garfunkel of the Univ. of Pittsburgh reports that he has been using a calorimetric method to measure microwave absorption of such metals as aluminum and zinc in the range of about ½°F to 2°F above absolute zero. The apparatus uses (at any one time) 5 resistors as the temperature sensing elements. These are calibrated against the vapor pressure of the rare isotope of helium, that is helium-three (He^3), to translate resistance values to temperature.

In testing resistors for use in his research, Mr. Garfunkel discovered that "resistors of different composition have different temperature ranges in which their sensitity is most appropriate. For example, while other carbon composition resistors are very useful as thermometers from 3°F above the absolute zero, Speer carbon resistors are most useful from about ½°F to 3°F above the absolute zero."

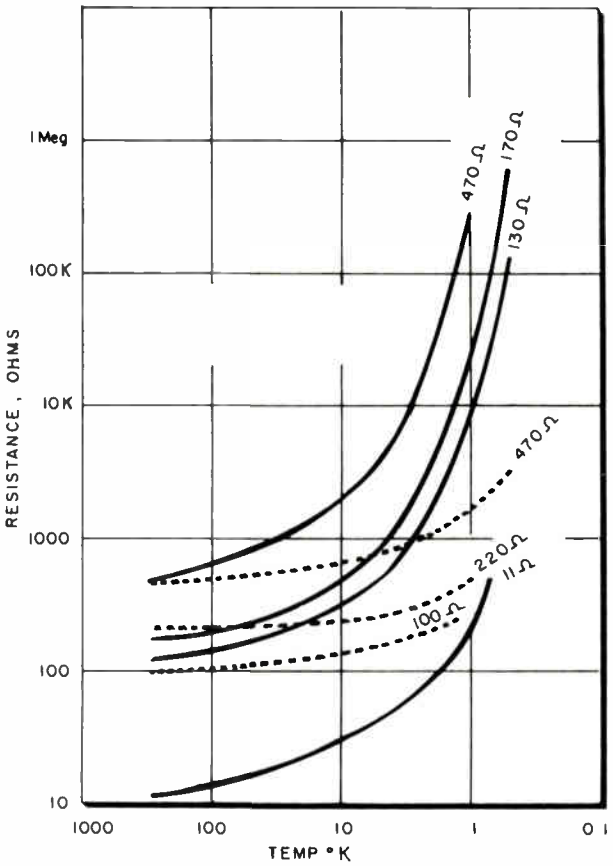


Fig. 2: Resistance-temp. characteristics of various manufacturers' resistors at very low temperatures were made by Prof. James Nichol of Amherst College to find units giving the greatest rate of change at near absolute readings.

Investigation of Characteristics

Investigation of characteristics of resistors for cryogenic temperature measurements was begun by Prof. James Nichol of Amhurst College in 1957. He requested sample resistors and information from Speer Carbon Co., Inc. Samples of several types were supplied. These exceeded his needs for a resistance of 1 K to 1 M at 4° A down to 0.10°K; a fairly large temperature coefficient in this range; good stability and reproducibility; and predictability of curve.

J. D. Gavenda of Brown Univ., who has been investigating the same areas as Prof. Nichol, reports, "thus far we have not been able to work much below 1° K, so we are still uncertain about the behavior of the resistors in this range. It appears, how-

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

Table 1

Temp.	Resistor A				Resistor B				Resistor C			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Room	14.0	14.0	14.0	14.0	54.4	54.2	54.2	54.2	111.8	111.75	111.8	111.8
Liquid Air	14.9	14.8	14.9	14.9	60.5	60.6	60.6	60.6	126.9	126.8	126.8	127.0
He Dewar	15.5	15.5	15.5	15.5	82.2	82.2	82.1	82.0	188.1	188.4	188.4	188.4

ever, certain types will be useful for this purpose.

"We have found one group well suited for measurements in the usual liquid helium range, 1.1° K. Different resistors from the same mixture have quite similar characteristics. We find that our calibration of one of this group is repeatable within a few thousandths of a degree after about seven months use entailing repeated cyclings between room temperature and helium temperatures."

Prof. Harold Forstat of Michigan State Univ. has supplied what he cautions is "very preliminary" information on the results of some tests he conducted in his search for "a resistor for low temperature measurements which would be reproducible on repeated cyclings from room temperature to liquid helium temperatures . . . Using an L and N type K-3 potentiometer, and 10 μa current through the resistor, I measured voltage drops across each . . . at room temperature, at liquid air temperature, and when placed inside a liquid helium storage container. In the latter it was not certain whether the temperature was exactly 4.2° K, but it was reasonably close to it. Each of the resistors was cycled four times. Results are shown in Table 1.

Finally, Prof. Harold Weinstock reports the following observations, made while at Cornell Univ.:

The Speer resistors are generally most useful for accurate direct measurement in the temperature region 1° K to 0.01° K. The feature which makes them desirable is their reproducibility (to within ¼%) from run to run even with cycling to room temperature and back. A typical 470 ohm, ½ w., type 1002 resistor has a resistance of about 1000 ohms at 4.2° K, 2500 ohms at 1°K, 8000 ohms at 0.3° K, and 18,000 ohms at 0.2° K. The resistors are calibrated by use of helium four vapor pressure, helium three vapor pressure, and the susceptibility of a paramagnetic salt. The resistances are measured by a sensitive, low power ac bridge.

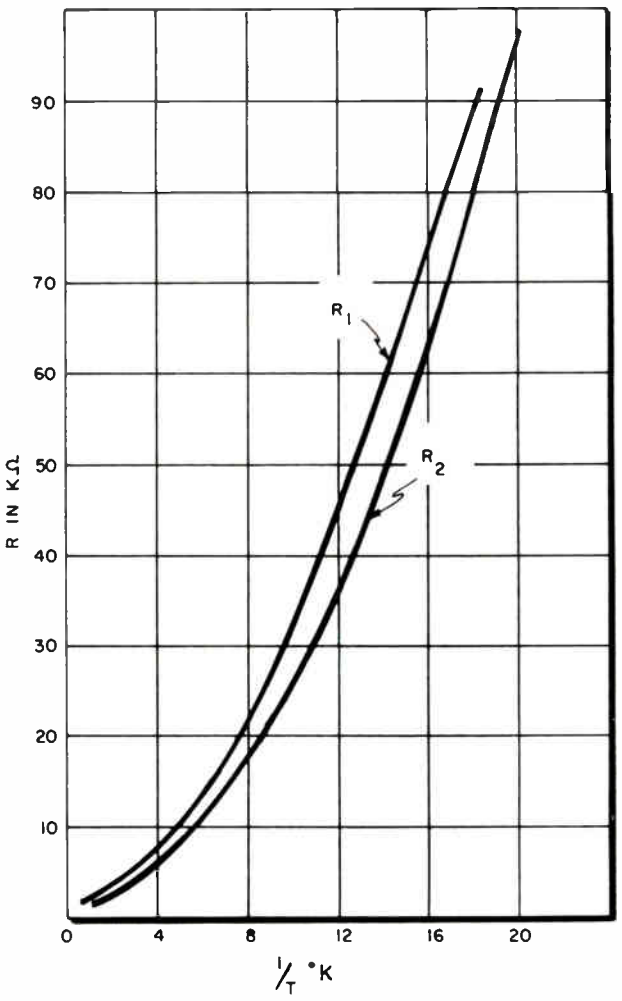


Fig. 3: Plot shows calibration of two 450 ohm Speer carbon resistors between temperatures of 1°K and 5 x 10^{-2} °K

References

Ramanathan, K. G. & Srinivasan, T. M., *J. Sci. & Med. Research*, 1957, 163, 277-279.

Srinivasan, T. M., *Proc. Indian Acad. Sci.*, 49, 61-65.

Ramanathan, K. G. & Srinivasan, T. M., *Proc. Indian Acad. Sci.*, 49, 55-59.

Ramanathan, K. G. & Srinivasan, T. M., *Phys. Rev.*, 99, 442-443.

Javitz, Alex E., *Electro-Technology*, 68 #3, 121-133.

Watson, J. F., Christian, J. L. & Hertz, J., *Electro-Technology*, 68 #5, 77-84.

Nicol, J. & Soller, T., *Bull. A.P.S.*, Series II, 2, 63, 1957.

LARGEST ELECTRON ACCELERATOR

AN ACCELERATOR ALMOST 2 MILES LONG will be constructed on a 480-acre site near Palo Alto, Calif., by the Stanford Linear Accelerator Center under contract with the U. S. Atomic Energy Commission. It will cost $114 million, take six years to construct and test, and require $20 million a year and 730 people to operate.

It will produce a beam of electrons with an energy of 20 billion electron volts. The resultant energy will be used for minute study of atomic particles in an effort to understand the mysteries of this sub-microscopic universe.

Electrons passing through the 10,000 ft long, 4 in. diameter copper tube, in a housing 25 feet below the surface, will be accelerated to a speed of close to 186,000 miles/sec. by a series of 240 klystrons spaced at intervals along the pipe. Each klystron will produce up to 24 million watts in 2.5 millionths-of-a-second bursts.

All of the copper products (about 1,000,000 lbs.) to be fabricated by Anaconda American Brass for this application will consist of special high purity OFHC (Oxygen-Free High Conductivity) copper.

Studies with insulating materials successfully used in most space shots led to the conclusion that basic improvements could be made in these materials to render them ideally suited for space. The story of these tests and the result—a new, improved insulation for space use—is told here.

AN IMPROVED INSULATION FOR SPACE USE

THE STUDY OF THE SIMULATED SPACE PERFORMANCE of those irradiated polyolefins already successful in many space experiments suggested that further improvements were possible, namely in the area of weight loss and condensables. A basic study of the chemical nature of this weight loss and outgassing showed it was possible to create a new insulating material specifically designed for space uses.

This article tells of these experiments, covers equipment used and describes a new insulation called Novathene.® Properties of this new insulation are compared with Teflon.®

* * *

Requirements of an electrical insulation for space uses are in many ways unique, and much more demanding, than those needed in earthly environments. Good physical and electrical properties, as well as flame and oxidation resistance, are essential.

The engineer designing for outer space must also be concerned with weight of the insulating material, its resistance to ionizing radiation, and its performance in an ultra high vacuum. As no such ideal insulation was in existence, irradiated polyolefins represented the best approach to a solution. Reasons for this selection are that such materials are lightweight, can be made flame resistant, can withstand temperature extremes, and have good radiation resistance. To date no other insulating materials have been developed which combine all of these properties.

The challenge has been to improve these materials even further, particularly in the area of minimizing weight loss and the release of potentially condensable materials at elevated temperatures in a high vacuum. Space vehicles are often delicately balanced objects. If an insulation shows even relatively low weight loss in a space environment, it may well change the center of gravity and throw the vehicle out of balance. Optical experiments are an important part of many space probes and the engineer must consider the interaction of the insulation material and any optical systems.

If the material, when heated, released volatile substances that might condense on a mirror—particularly if that mirror were at a lower temperature than the insulation—this clouding or fogging would impair the optical system. This problem can, at times, be minimized by careful design. Indeed, the only weakness in the space properties of certain irradiated polyolefins has been their outgassing and weight loss performance at elevated temperature and high vacuum conditions. This drawback has prompted development of an insulation that exhibits very small weight loss and condensables in high vacuum, at up to 250° F, while retaining the good characteristics of irradiated polyolefins.

Ingredients

In the manufacture of polyolefin insulating materials, 4 basic types of ingredients are compounded, fabricated, and later irradiated with electrons whose energy is much higher than ordinary chemical energies, *viz.*, 1 to 2 mev. These 4 basic components

By Dr. VINCENT L. LANZA
Director
Research and Development Div.
and Dr. E. C. STIVERS
Manager of Research
Raychem Corp.
Oakside at Northside
Redwood City, Calif.

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

are (1) the polyolefins themselves, (2) the flame retardant system, (3) antioxidants for protection of the polymer system at elevated temperatures in air, and (4) an "antirad" or radiation protectant. Incorporation of an antirad into a polyolefin composition whose final fabrication depends upon irradiation seems somewhat of an incongruity. Actually, certain compounds are used which are relatively poor antirads themselves. But these are transformed during manufacture into chemical species which act as potent radiation protectants.

If polyolefin insulations were to be developed for space use, it had to be determined which one of these 4 ingredient types caused release of volatiles at elevated temperatures. It was recognized that all materials contain small amounts of occluded substances such as water, carbon dioxide, etc. However, it was determined that for certain polyolefins these entrapped materials represented a very small portion of the total weight loss at elevated temperatures. This is contrary to the observed weight loss of irradiated polyolefins in high vacuum at room temperature where almost all weight loss is due to water, carbon dioxide, etc. Careful study led to building of new equipment which would permit detailed examination of insulating materials.

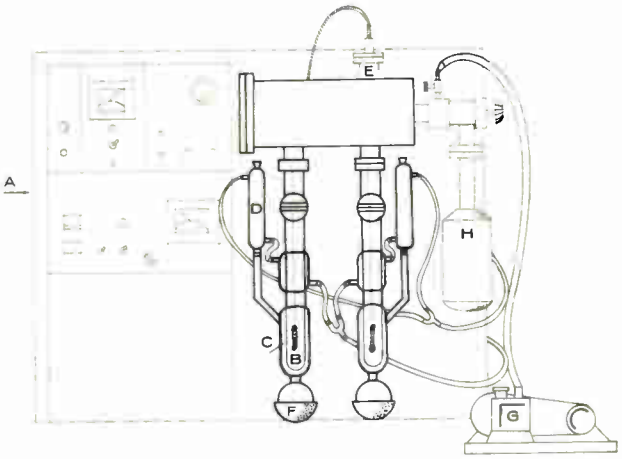
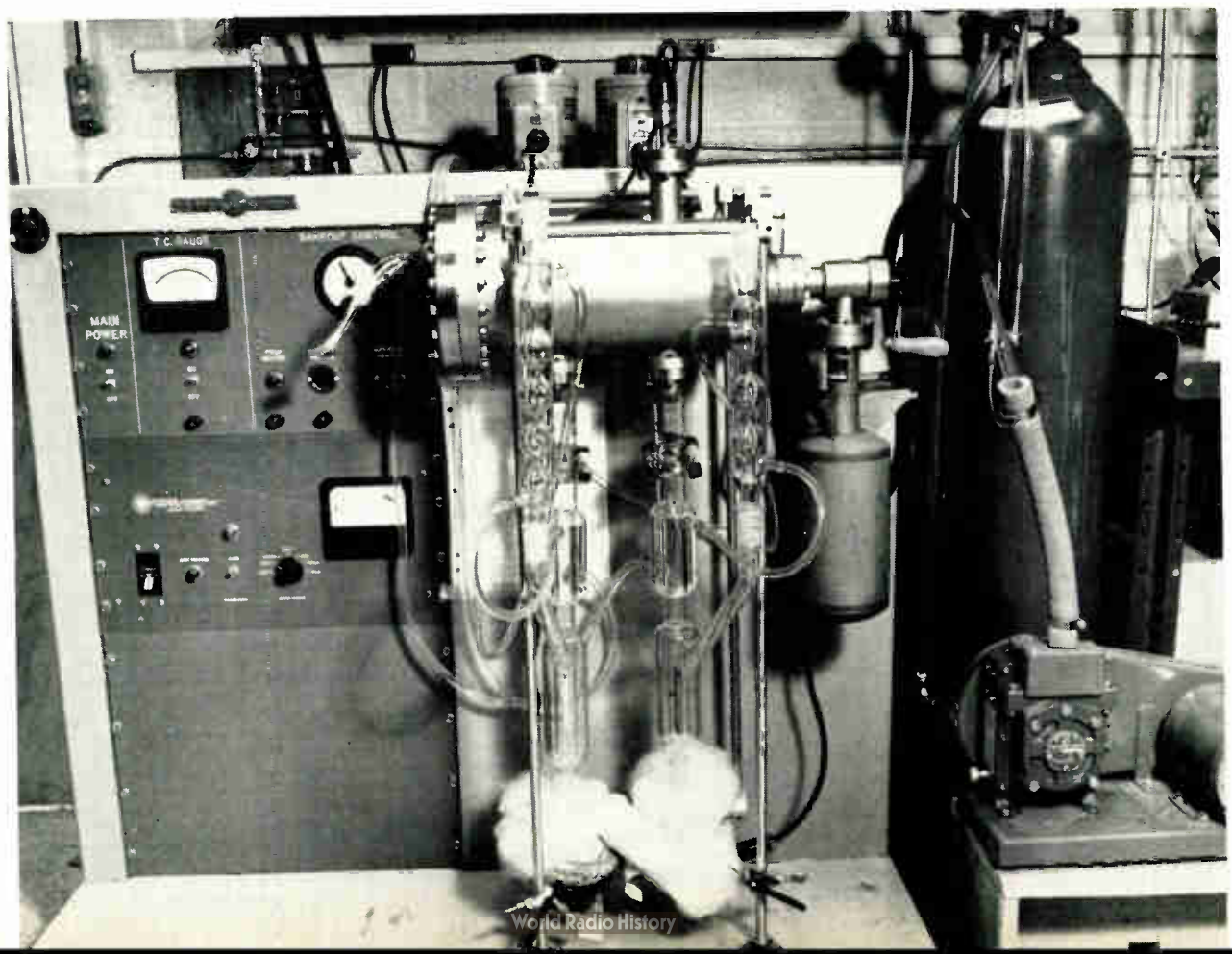


Fig. 2: Sketch of equipment shown photographically in Fig. 1. A-ion pump controls and vacuum gauge. B-sample placement. C-vapors of refluxing liquid. D-reflux condenser. E-thermocouple vacuum gauge. F-heating mantle. G-roughing pump. H-cryopump.

New Equipment

This new equipment was used to determine the outgassing nature of the material, as well as to gain a rough estimate of the weight losses encountered. In this system a 125 liter/sec. ion sputter pump was used equipped with a cryoforepump. The sampling tubes essentially consist of two jackets surrounding an evacuated chamber. The lower jacket contains the vapors above a refluxing organic liquid. Choice of liquid depends upon the temperature experimentally desired. This insures that the sample will be at an

Fig. 1: Photograph of gross weight loss and condensable equipment. See Fig. 2 for parts identification.



almost uniform temperature. Choice of this type of heating has proven more satisfactory than other methods in use such as infrared heating, Nichrome jackets, etc. These latter methods of radiant heating often must be at a higher temperature than the desired sample temperature to compensate for radiative losses. Use of these heating devices has often resulted in sample overheating. Thermocouples imbedded in the samples heated by the refluxing liquid method have shown a temperature discrepancy of less than 5°F at 250°F. Radiative heat losses can only occur from the surface of the upper end of the sample and are negligible. The upper jacket contains circulating tap water. This presents a sharp temperature gradient so that evolving materials can be condensed and concentrated in a narrow band.

Polyolefin materials of varying compositions were suspended in the lower chamber. A reasonable vacuum was first obtained (10^{-5} torr or lower), refluxing was started, and the samples attained temperature equilibrium within 10 min. of the time that the liquid was refluxing. After a given interval, generally 24 hr or longer, the vacuum observed inside the tubes was about 10^{-8} torr. With standard compositions, at 150°F and higher, visible condensate could be observed both at the upper portion of the air jacket and in the lower portion of the cooling chamber. The vacua were then broken and the samples removed and weighed to obtain gross weight losses. The samples of condensable materials were removed from the vacuum system by extracting with solvents. After removal of solvent, the extracts were examined spectroscopically to determine the chemical nature of the condensates. This method thus afforded a means of determining simultaneously the gross weight loss and the chemical nature of the condensables.

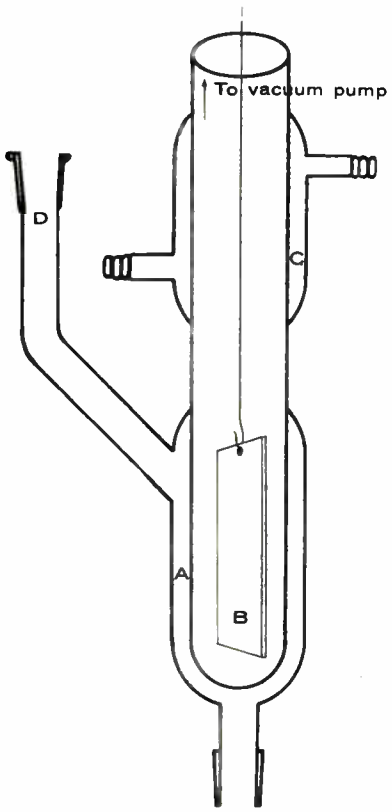
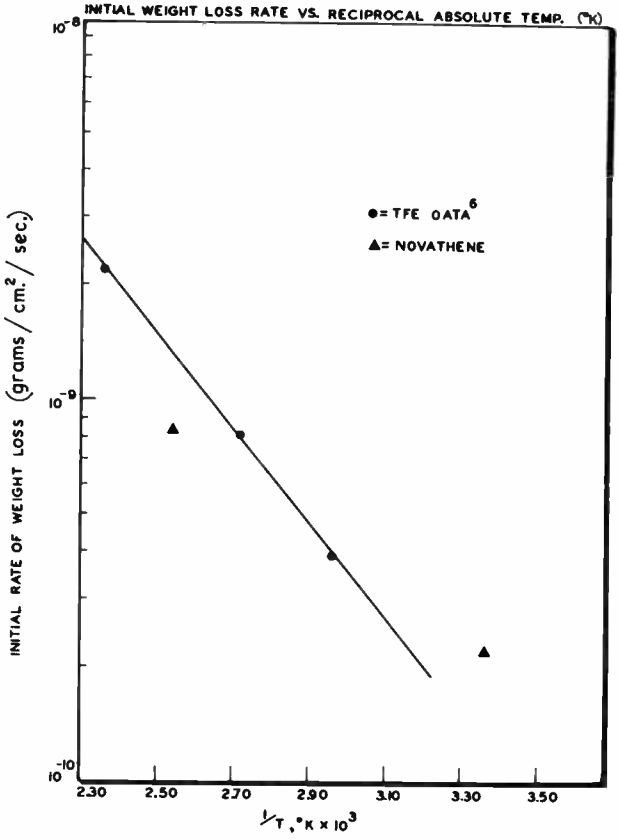


Fig. 3: Sketch shows tube containing sample for vacuum sample. A—reflux vapor jacket. B—sample. C—water jacket for cooling. D—reflux head.

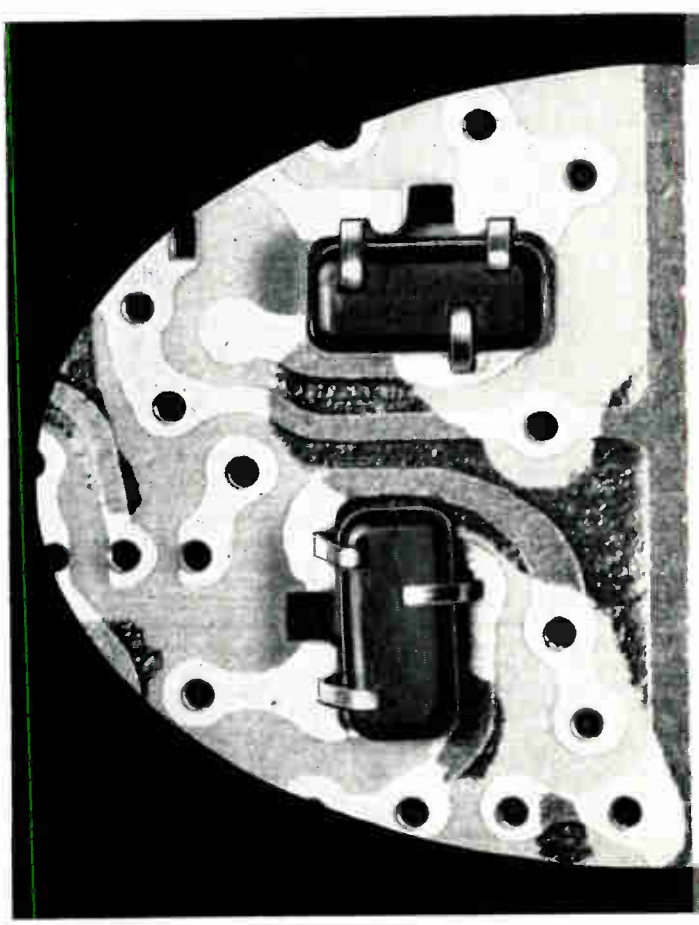
Fig. 4: The data for TFE was taken from a NASA report[6].



These early tests led to the conclusion that all four ingredient types used in a typical irradiated polyolefin insulation contributed to weight loss and to the release of condensables. Further testing showed that there were no commercial flame retardants, antioxidants or antirads available which would approach our goal of a non-outgassing insulation. These observations led to a detailed research project, for it appeared probable that components could be synthesized that would overcome this fundamental problem of volatility. Indeed, this turned out to be the case, for it was possible to create such non-volatile additives. As a result of these studies, Raychem built a plant where such additives are now in production.

The polyolefin aspect of the problem was studied

Cinch ELECTRONIC COMPONENTS



EXACT MATING *for* TO-18 *transistors with this* CINCH® *socket . . .*

ACTUAL SIZE

HIGHER RELIABILITY because there's no lead-bending

TO-18 transistor lead bending, with the attendant lessening of reliability, is a thing of the past. Cinch's TO-18 socket (part no. 131-73-02-062) for printed circuit board mounting has a contact-pin circle that exactly matches the lead configuration of all TO-18 transistors.

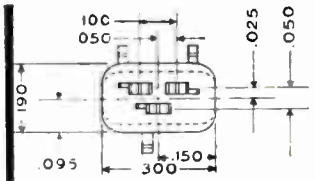
Here are the ways the Cinch TO-18 socket improves reliability.

Increased Wiring Accuracy Exact mating eliminates connection errors which may occur when transistor leads are bent to fit.

Reduced Breakage No component failure stemming from mechanical strain on the glass meniscus causing accidental destruction of the hermetic seal in the transistor base.

Better Vibration Resistance A true flush mount provides a firm seating of the transistor, appreciably increasing resistance to shock and vibration.

A true flush mount between transistor and socket



TO-18 socket dimensions

With the growing number of transistors designed to the TO-18 JEDEC specifications, this Cinch socket becomes an indispensable component.

For complete information, contact your local Cinch Representative, or write us direct.

CC-E315

CINCH MANUFACTURING COMPANY
1026 South Homan Avenue • Chicago 24, Illinois
Plants located at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; St. Louis, Missouri.
DOT A DIVISION OF UNITED-CARR FASTENER CORPORATION, BOSTON, MASSACHUSETTS

Circle 41 on Inquiry Card

INSULATION FOR SPACE (Continued)

in a like manner. It was found that these polymers varied profoundly in their outgassing characteristics both before and after irradiation. Amongst the vast

Table 1

Weight Comparison Between "Novathene" and TFE Wire and Cable Constructions

Type	Wire Size AWG	Weight "Novathene" Wire per 1000 ft. (in lbs.)	Wt. TFE Wire per 1000 ft. (in lbs.)	Percent Wt. Increase TFE over "Novathene"
Hook-up Wire	30	0.61	0.88	44
Hook-up Wire	26	1.16	1.51	30
Hook-up Wire	22	2.90	3.42	18
1 Conductor Cable with shield and jacket (.015")	22	5.30	6.79	28
2 Conductor Cable with shield and jacket (.015")	22	13.70	16.33	19
3 Conductor Cable with shield and jacket (.015")	22	18.40	21.74	18
RG-195A/U	30/27	11.10	19.60	76

Table 2

A Comparison of the Weight Loss of TFE and "Novathene" in a High Vacuum

Material	Wt. of Wire Sample (grams)	Temp. (°F)	Time in Vacuum (Hrs.)	Wt. Loss (%)
TFE[2]	2.0	212	100	0.04
TFE[8]	N.A.*	300	168	0.29
"Novathene"[9]	10.6	200	168	0.06
"Novathene"[9]	10.7	250	168	0.11
"Novathene"	13.6	200	100	0.07

* Not available.

Table 3

A Comparison of "Novathene" with Standard Irradiated, Flame Retarded Modified Polyolefin Insulation (Typical Properties – 20 AWG)

Property	"Novathene"	Standard Polyolefin
PHYSICAL		
Specific Gravity	1.18	1.15
Tensile Strength, psi	3000	3000
Elongation, %	150	120
Low Temp. Flexibility, °C	<−55	<−55
Abrasion Resistance to MIL-T-5438, 400 grit, 1 lb. wt. (Inches of tape)	30	30
Solderability	Excellent	Excellent
ELECTRICAL		
Dielectric Strength, volts/mil	900	800
Dielectric Constant	2.5	2.5
Volume Resistivity, ohm-cm	$>10^{15}$	$>10^{15}$
Insulation Resistance, megohms/1000 ft.	>100,000	>100,000
CHEMICAL		
Heat Aging, °C (continuous in air)	125	135
Heat Aging, °C (4 hrs. in air)	>225	>225
Flammability	Self-extinguishing	Self-extinguishing
Toxicity	Non-toxic	Non-toxic

spectrum of polyolefins, when the low molecular weight portion was removed, some polymers were found to have good outgassing and weight loss characteristics. These differences in vacuum performance were found to be dependent not only on molecular weight distribution of the original polyolefins, but also upon their propensity to undergo a negligible amount of chain scission during the irradiation step of fabrication. Thus it was possible to obtain a polyolefin system ideally suited for space.

New Insulation

A new insulation was made for space applications, using the proper polymer system and the synthesized non-volatile additives. This new insulation is now in production and is called "Novathene."

It seems appropriate in discussing this new material that we compare its properties, usefulness, and versatility relative to other possible space materials. One material which has received wide acceptance for non-space or terrestrial uses is poly(tetrafluoroethylene), (TFE).* It has also been considered for space uses and therefore it seems logical to make a comparison of these two insulations in space environments.

Weight of Insulation

In Table 1 are shown some comparisons of the two types of material, and it can be seen that, dependent upon the nature of construction, "Novathene" weighs much less per unit than TFE.

Radiation Resistance

As a result of the special non-volatile antirad system used in "Novathene," it can withstand large doses of ionizing radiation. In general, 500 megarads can be put in the insulation with essentially no effect on electrical properties and little change in physical properties. Loss of insulation elongation is perhaps a sensitive measure of radiation damage in polymers. At 500 megarads the elongation of "Novathene," while somewhat lower than its original value, is still well within the range of usefulness. At doses up to 2000 megarads, there are no significant changes in electrical properties.

It is a general conclusion that when TFE is irradiated in air, the polymer quickly degrades, and at absorbed dose levels as small as 1 or 2 megarads, the product is no longer useful.[2] If TFE is irradiated in a high vacuum, degradation occurs at a slower rate and it has been shown that at a dose of 8 megarads, TFE loses 88% of its original elongation.[3]

Only recently has there been concern about the

*Offered by E. I. du Pont de Nemours and Co., Inc. as Teflon®.

INSULATION FOR SPACE (Continued)

chemical changes that occur in polymers when irradiated. Reason for the concern is that when polymers are irradiated they almost always release gaseous substances which may corrosively interact with vehicle components. When polyolefins are irradiated, the gaseous products consist primarily of hydrogen and small amounts of low molecular weight hydrocarbons such as methane.

These gaseous fragments are chemically inert. In contrast, the nature of the products evolved during irradiation of TFE may present serious problems.

Florin and Wall[1] examined the nature of the gases evolved when TFE was irradiated in vacuum. They found the principal gases to be, after irradiation, silicon tetrafluoride and carbon dioxide. Amount of carbon dioxide found was much greater than could be ascribed to contamination. They observed on the average a G value* for production of SiF_4 of 0.2. If a space vehicle were to contain 25 lbs of TFE insulation, 1/6 gram of fluorine gas (2.6×10^{21} molecules) would be evolved in the vehicle for every megarad of radiation exposure.

It is believed[2] that the primary radical produced as a result of radiation is $-CF_2CFCF_2-$.

Since an important consideration in a vehicle is coating or damage of optical mirrors, lenses, and electrical contacts, and since we wished to study the corrosive nature of evolved gases in a high vacuum, a series of simple experiments was undertaken. Vacuum deposited copper and aluminum mirrors were chosen as being representative of vulnerable optical parts and other components in a space vehicle.

The mirrors were placed in glass ampoules to which was added one gram of insulation. The ampoules were then sealed under a high vacuum of 10^{-6} torr or less and then irradiated with γ-rays. After irradiation, the mirrors were examined microscopically for evidence of corrosion, and photomicrographs were taken within ½ hr of removal of the mirrors from the ampoules in order to minimize any oxidative effects. A copper mirror control irradiated to 100 megarads showed some slight pitting. Based on the observations reported here, and the work of others,[1] there is an indication that a serious potential corrosion hazard exists with TFE but not with "Novatheue."

Weight Loss and Outgassing

In an evaluation of the weight loss and outgassing performance of an insulation, there are several im-

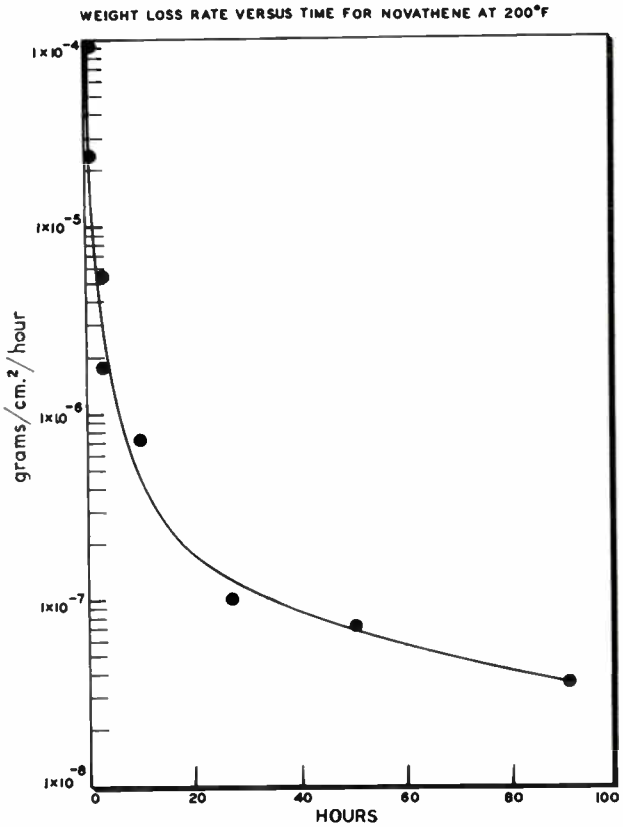
*G value is the yield of a particular chemical entity per hundred electron volts deposited in the system.

portant considerations. The first concerns itself with the total weight loss; the second, the initial rate of weight loss and the later steady state rate; and, finally, the extent of condensable materials evolved as a function of temperature.

Equipment designed to measure weight loss rate has a heating system which is essentially the same as that used in the gross weight loss and condensables experiments. A silicone oil diffusion pump was used to attain vacua of the order of 10^{-6} torr. Weight loss was continuously recorded by means of a Cahn RG Electrobalance® which is capable of measuring weight changes as small as 10^{-6} grams of 1 gram samples.

Initial rate of weight loss vs temperature for TFE and "Novathene" is shown in an accompanying graph. The TFE data is taken from a NASA report.[6] The units chosen to express weight loss rates are weight/area/time, because it is assumed by most field workers that weight loss rate is proportional to surface area. Initial weight loss for these materials is comparable and is almost certainly due to entrapped or occluded materials such as carbon dioxide and water. While no steady state rate loss data have been reported for TFE, experiments with "Novathene" have been done in our own as well as other labs.[7] Some results are shown in the accompanying graphs. It would be anticipated that TFE would show similar characteristics. Gross weight losses have been re-

Fig. 5: While no results are shown for TFE, it is anticipated that the characteristics would be similar to Novathene.



INSULATION FOR SPACE (Concluded)

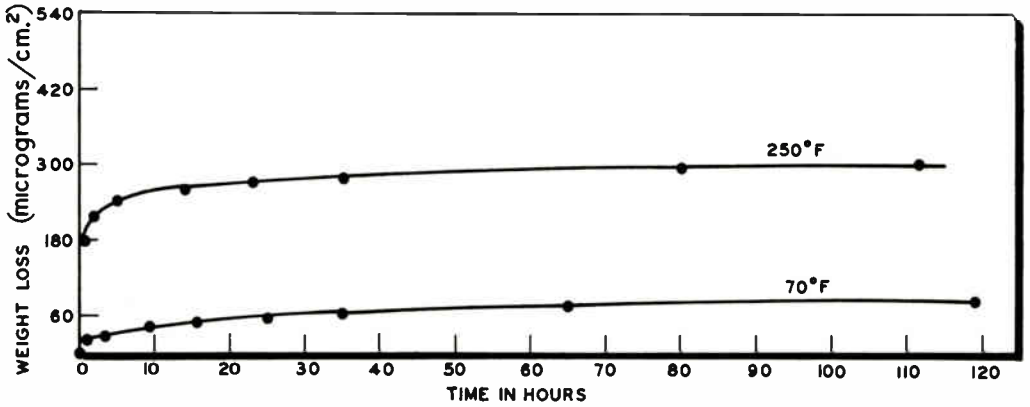


Fig. 6: Curves show weight loss vs. time for Novathene (20 AWG) wire.

ported for TFE and "Novathene" insulated wires, and results are summarized in Table 2.

It is interesting to note that the independent results of the 200°F tests on "Novathene" are in close agreement. It is apparent that both insulations show very small weight losses at temperature much higher than those encountered in space.

Condensables

The initial method used to determine condensables was to judge qualitatively the degree of condensation produced by heating samples up to 200°F for prolonged periods of time. It was found that both "Novathene" and TFE show negligible amounts of condensation after one week. Attempts were made to put these observations on a more quantitative basis by exposing chilled mirrors to a heated sample in the vacuum system and later to obtain reflectance spectra of the mirrors.

Reflectance spectra of the mirrors obtained from both TFE and "Novathene" exposure were, to all intents and purposes, identical with the control unexposed mirror. This showed that problems of condensables with TFE and "Novathene" are not to be expected in a space environment.

General Properties

It is important to examine the general physical,

electrical, and handling characteristics of the irradiated polyolefin, "Novathene." A comparison with a standard irradiated polyolefin used successfully in many space experiments is summarized in Table 3.

This table 3 shows that "Novathene" has general properties that are about the same as the standard irradiated polyolefins. No sacrifice in their general properties has been made.

Acknowledgements

We wish to thank the many of our staff members who contributed to this work, particularly Mr. J. Underwood who carried out many of the experiments.

References

1. R. E. Florin and L. A. Wall, *J. Res. Nat'l. Bur. Stds.*, 65A, 375, (1961).
2. C. E. Jolley and J. C. Reed, paper presented at Eleventh Annual Signal Corps Wire & Cable Symposium, Asbury Park, Nov., 1962.
3. R. Timmerman and W. Greyson, *J. Appl. Polymer Sci.*, 6, 456, (1962).
4. L. J. Frisco, "Dielectrics for Satellites and Space Vehicles," Final Report 3/1/59 to 2/28/62. Johns Hopkins Univ., Dielectrics Lab.
5. D. E. Kline and J. A. Sauer, *J. Polymer Sci.*, 1, 1621, (1963).
6. H. R. Gloria, W. J. Stewart, and R. C. Savin, *NASA Technical Note D-1329*, Dec., 1962.
7. G. R. Neff, Ardel Corp., Private communication. Publication in progress.
8. R. H. Suess and G. R. Neff, *Ardel Corp. Report #05132-A*, Feb. 7, 1963.
9. G. R. Neff, F. B. Weiler, R. W. Young, *Ardel Corp. Report #04033-I*, May 15, 1963.

MINUTEMAN PROGRAM

(*Continued from page 42*)

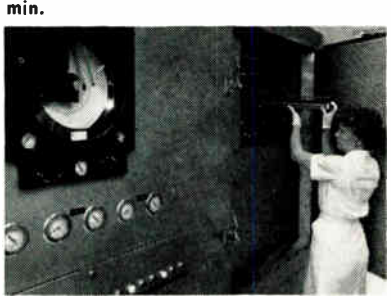
subjected to centrifugal acceleration of 40,000 g's for a specified time. In certain instances devices have been subjected to over 200,000 g forces.

In a Fatigue and Noise Vibration Test the sample is fastened to a vibration platform and subjected to simple harmonic motion over a wide frequency range for a measured time and several orientations.

When undergoing the Thermal Shock Test, the device is immersed in liquid baths ranging between +125°C to −65°C.

Other tests which are conducted at the lab are a Moisture Resistance Test, a Storage and Operating Life Test, a Solderability Test, a Salt Atmosphere Test, the Lead Fatigue Test and Parameter Readout Testing. The latter consists of testing for electrical characterization prior to, during and after nearly all the preceding tests.

Components are put into chamber for Thermal Shock Testing while under power operation. Range is —65 to +85°C in 20 min.



NEW TECH DATA

for Engineers.

Low Freq. Crystals

These crystal units replace tuning fork units and can be used as a stable freq. source in ultrasonic equipment, for equipment operating on counting and binary principles, for time calibration and for synchronous motor operation. They are available in 3 types: DJC (200cps to 15kc), LCP 3.7kc to 100kc and type FJCF X-cut flexure crystals. Design and applications information is included. Connolly & Co., Inc., 914 Rengstorff Ave., Mountain View, Calif.

Circle 115 on Inquiry Card

Resistor

Data sheet 1400 has illustrations, 5 dimensional drawings, complete electrical & mechanical specs., features and helpful ordering information on 1 1/16 in. dia. series 320 RV4 3w. variable resistor. Unique carbon-ceramic resistance element provides excellent heat sink qualities, and surpasses Mil-R-94B characteristic Y needs for stability, moisture resistance and thermal cycling. CTS of Berne, Inc., Berne, Ind.

Circle 116 on Inquiry Card

Servo Motors

Detailed data and specs. on the electrical and dynamic performance of control servo motors is presented in a comprehensive spec. catalog. The catalog, which includes characteristics charts and dimensional line drawings, is a ready-reference for designers of servo amplifiers and automatic control systems. Vernitron Corp., Farmingdale Div., 52 Gazza Blvd., Farmingdale, N. Y.

Circle 117 on Inquiry Card

12-Bit Serial Module

Data sheet DT-1 provides specs. and dimensional information on a 1 mc 12-bit serial-code generator RZ module. A write-read RZ circuit module is combined with a magnetrostrictive multi-tapped delay line to produce a serial pulse pattern from a single input pulse. The write amplifier drives the delay line which has up to 12 output taps, all electrically connected to a common lead. Deltime Inc., 608 Fayette Ave., Mamaroneck, N. Y.

Circle 118 on Inquiry Card

Resins

A bulletin describing the electrical properties of Epocast® epoxy potting and encapsulating resins, which include high temp. resins and semi-resilient types, is available from Furane Plastics, Inc., 4516 Brazil St., Los Angeles 39, Calif.

Circle 119 on Inquiry Card

Environmental Chambers

Brochure 6300, 40 pages, presents the latest data on environmental chambers for controlling atmospheric conditions. The brochure reviews 9 environmental uses and illustrates 62 models of chambers in 13 main types. These provide temps. from $-225°F$ to $+1000°F$ and simulate various conditions of altitude and humidity. Temperature and altitude conversion charts, metal shrinkage, and other environmental data are included. Webber Mfg. Co., P. O. Box 217, Indianapolis 6, Ind.

Circle 120 on Inquiry Card

Transistor Test Set

This Bulletin explains the modular construction of the Model 400-1805 test set and how it may very easily be expanded and adapted for a variety of semiconductor test purposes. The basic set is designed for volume testing of all important static parameters. It uses manual programming and limit setting. Trio Laboratories, Inc., Dupont Dr., Plainview, L. I., N. Y.

Circle 121 on Inquiry Card

Spectrum Analyzers

Catalog Digest G summarizes the specs. and applications of more than 100 new and standard panoramic spectrum analyzers. These analyzers cover 5cps to 44kc, response plotters, and associated equipment. Special instrument testing systems are available for SSB microwave, vibration, and low-freq. uses. Singer Metrics Div., The Singer Mfg. Co., 915 Pembroke St., Bridgeport, Conn.

Circle 122 on Inquiry Card

High-Vacuum Chambers

Bulletin 1-4, 14 color pages, contains information on an orbital simulator (HI-VOS) which subjects space vehicles to environments found 300 miles in space. The bulletin outlines other vacuum chambers used for testing components at various altitudes. One example is an 18-in. dia., cabinet mounted bell jar which provides vapor-free testing when pressure requirements are in the 1×10^{-7} torr range. Consolidated Vacuum Corp., a sub. of Bell & Howell, 4015 Fabian Way, Palo Alto, Calif.

Circle 123 on Inquiry Card

AC Ratio Reference Chart

This Ratiometry reference chart contains all the necessary symbols, formulas and definitions involved in ac ratio measurement calculations. Also included are representative circuit diagrams. North Atlantic Industries, Inc., Terminal Dr., Plainview, N. Y.

Circle 124 on Inquiry Card

Shaker

Bulletin 330-463 describes the Model 330 Shaker which has a force rating of 4000 lbs. The basic shaker design features an all copper cooling system for field and armature coils, and compensating conductor. They cool directly from a clean raw water supply. The shaker has a sealed cooling system, hermetically sealed body, and a vacuum port which allows venting directly into the chamber. Characteristics: Freq. range of 5 to 3000 cps; max. load for 100g vector is 15 lbs; and max. acceleration is 100g. Ling Electronics Div., Ling-Temco-Vought, Inc., 1515 S. Manchester Ave., Anaheim, Calif.

Circle 125 on Inquiry Card

Solid-State Indicator

Data sheet #291 describes the TML-7 series Memo-Lite indicator. A solid-state unit, it is designed for error indication, alarm actuation and logic element functions in computers, data processing and missile guidance systems. It turns on with a pulse as small as 2v. and 2μsec. Data provides mechanical and electrical specs., applicable Mil or Federal Specs., and optional circuitry. TEC-LITE Dept., Transistor Electronics Corp., Box 6191, Minneapolis 24, Minn.

Circle 126 on Inquiry Card

Temperature Chamber

The 1060X1 is an automatic, high-precision temp. chamber for accommodating long or floor mounted items. Applications include temp. testing in virtually all fields of engineering and physics. It provides precise or automatically cycled temp. environments in processes demanding precise temps. Conveyor belts can be run through the chamber for continuous testing or continuous industrial processing. Temp. range is $-100°F$ to $+600°F$ (to $-200°F$ with liquid nitrogen cooling). Precision is $\pm 1/2°F$. Non-Linear Systems, Inc., P. O. Box 728, Del Mar, Calif.

Circle 127 on Inquiry Card

Readout Cells

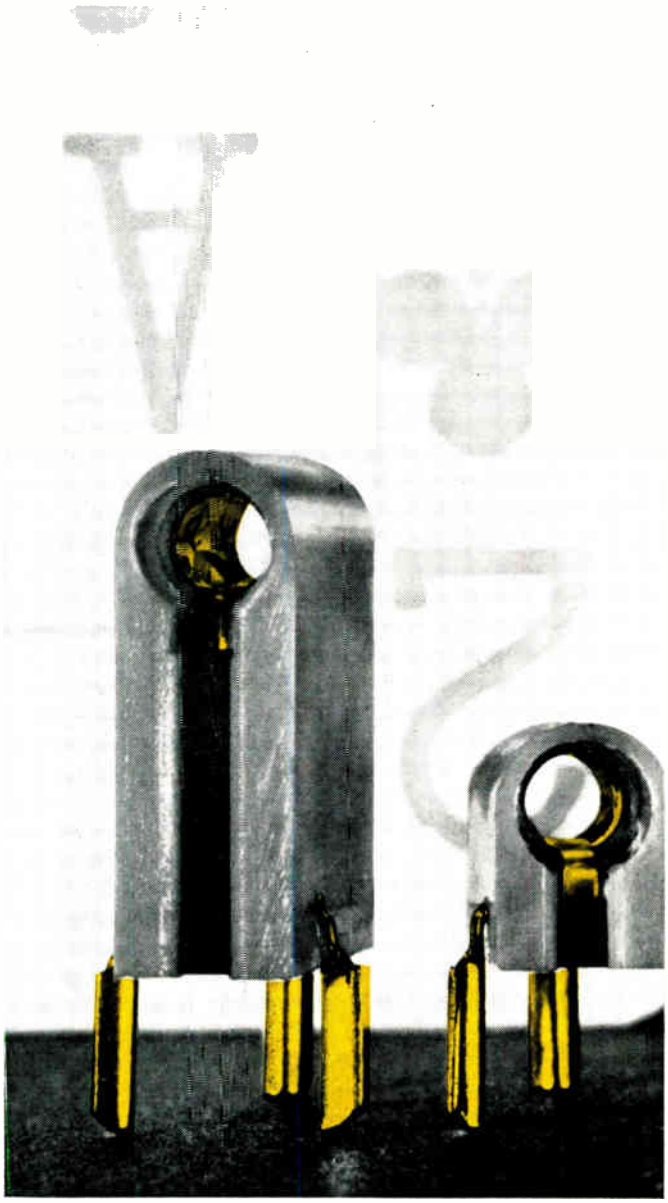
Brochure No. 63A lists advantages of using silicon photovoltaic readout cells in tape readers, punch-card systems and control applications. Included are illustrated graphs and charts. Solar Systems Inc., Skokie, Ill.

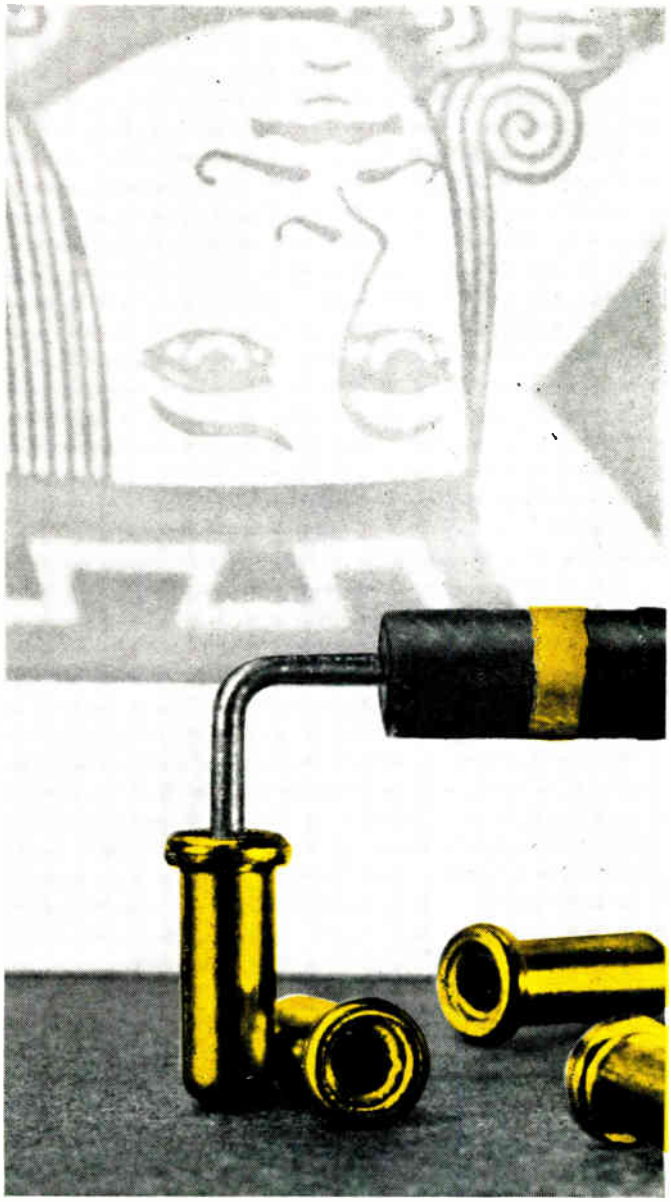
Circle 128 on Inquiry Card

Analog-to-Digital Converters

Bulletin SP157A, which describes 2 new high-speed, high-accuracy analog-to-digital converters, is available from Packard Bell Computer, div. of Packard Bell Electronics, 1905 Armacost Ave., Los Angeles 25, Calif.

Circle 129 on Inquiry Card





High . . . low . . . and jack!

Now, you've got pat-hand testing of printed circuitry that's hard to beat! Two and three-legged probe receptacles, high and low types, for testing circuit continuity. A reusable Matrix Jack for "burn-in" testing of components. Both very uncomplicated and both very good.

For instance, our reusable Matrix Jack is a natural for saving potfuls of money. It lets you test components without soldering with repeated use of the same board and . . . it can be used over and over again. No more burned components. No more wasted boards. Ever! It's so simple a solution to the problem, we're glad we thought of it first. Just a drawn brass cup with a built-in spring receptacle that accepts component leads of varying diameter and holds them steady and snug for maximum conductivity and true readings. Components can be hand inserted and removed.

The test probe receptacles can be mounted on board edge or in the middle of the board and their "V" shaped legs promote controlled solder wicking to hold them steady and straight and give you sure contact for reliable testing. Take just a few seconds now to get the run down of AMP features that take the element of chance out of printed circuit testing:

TEST PROBE RECEPTACLES

- 10 nylon housing colors for easy identification and location
- Recessed inserts—gold or silver plate
- Either end entry for probe
- Accepts standard .080 probe

REUSABLE MATRIX JACK

- Fits one hole size—.089
- Accepts wire leads—.018—.040
- Two ounce extraction force
- Eliminates solder and heat damage to boards and components

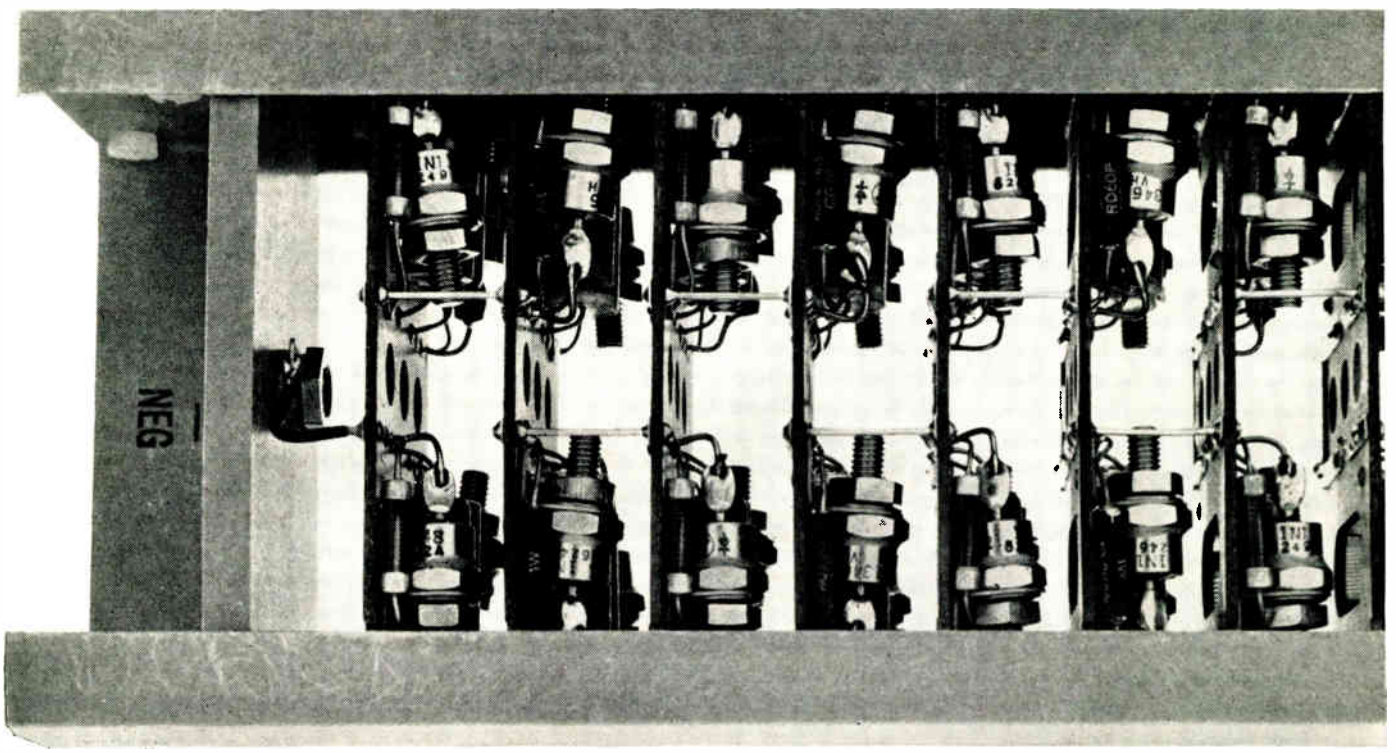
Want to see a sample or two? We'll send it along with detailed information immediately upon your request.

AMP
INCORPORATED
Harrisburg, Pennsylvania

AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

Westinghouse high voltage silicon rectifier assemblies:

NO GLASS TO BREAK
NO FILAMENTS TO BURN OUT
NO ARC-BACKS TO WORRY ABOUT
NO WONDER THEY HAVE RACKED UP 50,000,000 FAILURE-FREE HOURS!



NEW TECH DATA

Waveguide Window

A data sheet that summarizes capabilities in flange-mounted mica and solderable kovar glass waveguide windows is available from Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y. Types included cover freq. ranges in the S, C, X, Ku and Ka bands. All windows are supplied with protective coatings to meet salt-spray conditions. They will withstand temp. cycling between —196° to 175°C without affecting the seal characteristics.

Circle 130 on Inquiry Card

Semi-Flexible Resin

"Scotchcast" bands Nos. 280 and 281 are semi-flexible epoxy resin systems with high temp. capabilities sufficient for Class F (155°C) uses. It has good stability at high temps. and resistance to moisture. Applications include Class F insulation in transformers, coils and many motors. It is also useable as printed circuit board coating and as an electronic module compound. 3M Co., Dept. W3-295, 2501 Hudson Rd., St. Paul 19, Minn.

Circle 131 on Inquiry Card

Resistance Thermometer

The Series I and II germanium resistance thermometers have temp. ratings from 4° to 40°K and 1° to 100°K respectively. Both are available in 3 encapsulated, hermetically-sealed models: one for measurement of surface temps., a probe unit for internal uses, and a threaded insertion unit. They give good operations involving liquid hydrogen, helium, nitrogen, super conductivity, masers, etc. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Ave., Philadelphia 44, Pa.

Circle 132 on Inquiry Card

6KW Electron Welder

The 6 kw Hamilton-Zeiss welder can weld steel or aluminum 2 in. thick. At lower power settings, the welder can be used for microminiature work. The new machine has an optical viewer for aligning the beam and following the welding process, deflection systems for beam control, stainless steel clad work chamber, and an electrically powered variable-speed work table. Hamilton Standard, Windsor Locks, Conn.

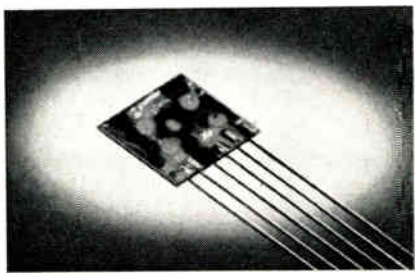
Circle 133 on Inquiry Card

Portable Instruments

Bulletin GEA-7783 describes portable indicators that measure electrical variables. Included is information on hook-on volt-ammeters as well as on portable ammeters, voltmeters, and wattmeters. General Electric Co., Schenectady, N. Y.

Circle 134 on Inquiry Card

Thin-film Microcircuits Now Being Made By Sprague Electric Co.



This typical Ceracircuit, shown in actual size, is a two-stage oscillator and gated amplifier.

THIN-FILM Ceracircuits, following a long period of research and development, are now in volume production, it was announced by the Sprague Electric Company.

These revolutionary linear and digital microcircuits allow great flexibility in choice of components and types of circuits. Chopping size, weight, and cost, while boosting reliability and power utilization, Ceracircuits are being used by alert design engineers in ever-increasing numbers.

Their ease of usability is remarkable. Containing familiar circuit elements such as capacitors, inductors, resistors, diodes, and transistors, Ceracircuits offer precision components with a wider choice of tighter parameters, assuring greater design freedom.

Custom Ceracircuits incorporate customers' own circuits, transforming present circuit methods to the reliable, space-saving thin-film technique.

Standard Ceracircuits, such as linear amplifiers, oscillators, NOR gates and drivers, indicators, binary counters, and clocks are immediately available for evaluation of ceramic-base Ceracircuits in customers' own equipment.

Sprague microcircuit specialists are available to discuss the transition of customers' circuits to thin-film. For complete information, write to Technical Literature Service, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

Circle 54 on Inquiry Card

NEW TECH DATA

Semiconductor Catalog

A new, 22-page condensed catalog covers more than 3000 standard industrial and Mil-type semiconductor products. It gives major electrical specs. for a full line of transistors, Mecl® integrated circuits, zener diodes, SCRs, gate-controlled switches, rectifiers and rectifier stacks, and provided mechanical characteristics and outline drawings. Technical Information Ctr., Motorola Semiconductor Products Inc., P. O. Box 955, Phoenix 1, Ariz.

Circle 135 on Inquiry Card

Core Memory

The RVS completes a memory cycle in 5μsec.; has an access time of 2μsec.; and a buffer cycle time of 3μsec. It is available with word capacities of 128, 256, 512, 1024, 2048 and 4096 (and with 8 to 40 bits/word in 2-bit increments). Operating modes: standard-random access with clear-write; read-regenerate, load and unload cycles. Split-cycle and sequential access are optional. Details available from Ampex Corp., 934 Charter St., Redwood City, Calif.

Circle 136 on Inquiry Card

Preamplifier System

A preamplifier system operates from 0.55 to 10.75gc. Each unit in the U11A-4/MWA-5 family or r-f wideband, low-noise preamplifiers includes on integral solid-state power supply for independent operation. The system is highly stable and operates under temp. variations ranging from −50°C to +50°C and ±10% line voltage operation. Applied Technology Inc., 930 Industrial Ave., Palo Alto, Calif.

Circle 137 on Inquiry Card

Connector Manual

Amform 3768-215 is an application manual on the 48-series miniature military connectors for electrical and electronic equipment in aerospace, instrumentation and industrial applications. They meet the requirements of Mil-C-26500 (USAF). This 16-page publication contains construction information, assembly procedures, selection guides, weights, dimensions and performance characteristics. Amphenol Connector Div., Amphenol-Borg Electronics Corp., 1830 S. 54th Ave., Chicago 50, Ill.

Circle 138 on Inquiry Card

Control Instruments

Bulletin 200, 20 pages, covers the comprehensive line of Veritrak panel instruments, transmitters, and modular computer units. It features: solid-state rather than mechanical rebalancing in transmitters; provisions for direct computer-control input; intrinsically-safe field circuitry; integral emergency power; and built-in facilities for field-to-control-room communication. Motorola Instrumentation and Control Inc., P. O. Box 5409, Phoenix 10, Ariz.

Circle 139 on Inquiry Card

NEW TECH DATA

Silicon Controlled Rectifiers

The new controlled rectifiers, designated RCA-2N681 through 2N689 and RCA-2N842A through 2N1850A, are all-diffused, 3-junction devices which meet mechanical and environmental requirements of Mil specs. The 2N681-2N689 may be used in applications requiring blocking voltage capabilities from 25 to 500 v and forward current capability of 10 or 25 amps. The 2N1842A-2N1850A can be used for 25 to 500v and forward currents of 10 or 16 amps. RCA Semiconductor and Materials Div., Somerville, N. J.

Circle 140 on Inquiry Card

Solid Tantalum Capacitors

Molded cylindrical solid tantalum capacitors in the same case sizes as ⅛ and ¼w. composition resistors are now available. The new capacitors, Series 1541D, are intended for use both in "cordwood-type" circuit modules as well as on printed wiring boards. Capacities range from 1.5μf at 6v. to 0.1μf at 75v. Complete performance characteristics as well as a list of standard capacitances in each voltage rating are given in Engineering Bulletin No. 3530, available upon letterhead request to the Technical Literature Service, Sprage Electric Co., Marshall St., N. Adams, Mass.

Accelerometer Calibrator

Model CS 101 accelerometer calibration system offers absolute accuracy of calibration to better than ±2.5%. The system introduces a probable error of 0.7% over the freq. range from 20 to 3500 cycles. Information is available from ITT Industrial Products Div., 15191 Bledsoe St., San Fernando, Calif.

Circle 141 on Inquiry Card

Linear Potentiometer

These wire-wound linear-motion potentiometers have integral limit switching. Ideal for use as a position transmitter for linear actuators, it replaces the usual combination of potentiometer and limit switches. Swiss American Aviation Corp., P. O. Box 1280, Municipal Airport, Wichita, Kans.

Circle 142 on Inquiry Card

Electron Probe

A new folder containing complete information on the new Norelco AMR/3 Electron Probe Microanalyzer is available from Philips Electronic Instruments, 750 So. Fulton Ave., Mt. Vernon, N. Y. Illustrated with diagrams, photos and charts, the folder gives modes of operation, design concept, specs. and areas of uses which include microsegregations, diffusion couples, thin surface layers, precipitates, biologicals, corrosion, atmosphere pollution, and microgeology.

Circle 143 on Inquiry Card

NEW TECH DATA

Chemicals

This brochure on chemicals for the aerospace industry covers safety engineered solvents, resin strippers, release agents and maintenance items for white rooms. Various procedures for cleaning, stripping and the use of these products in ultrasonic uses are included. Penetone Western, Inc., Dept. Sk-101, 1855 Industrial St., Los Angeles 21, Calif.

Circle 144 on Inquiry Card

Time-Delay Relays

Three spec. sheets describing standard time-delay relays and an electronic timing module are available from The A. W. Haydon Co., Electronic Systems Facility, 4060 Ince Blvd., Culver City, Calif. The ESF 311 crystal-can timing module has solid-state output and selectable time delays; the ESF 312 features 25msec. recycle time for aerospace environments; and ESF 313 has welded module construction.

Circle 145 on Inquiry Card

Electromagnetic Shielding

This booklet describes the features obtained from Polyform electromagnetic shielding, which can eliminate enclosures and other devices commonly used to provide shielding. Information includes photos and application data. Barber-Colman Co., Aircraft and Missile Products Div., Rockford, Ill.

Circle 146 on Inquiry Card

Varactor Diodes

The D4600 series micro-miniature silicon epitaxial varactor diodes are designed for high microwave freq. operation. Applications include parametric amplification, high-freq. multiplication, modulation, up-conversion, and capacitive tuning. The units have a thermally bonded contact and a welded hermetically sealed closure. Sylvania Electric Products Inc., 100 Sylvan Rd., Woburn, Mass.

Circle 147 on Inquiry Card

Self-Generating Accelerometer

The Model 25D21 permits reliable measurement of vibration for evaluating critical systems and components. It maintains specified performance without recalibration. It is not torque sensitive so mounting does not change its output. It weighs 0.9 oz.; has an amplitude linearity of ±1%; and a resonate freq. at 30KC. Clevite Electronic Components, div. of Clevite, 232 Forbes St., Bedford, Ohio.

Circle 148 on Inquiry Card

Memory Cores

This bulletin lists drive currents and output signals for 22 different cores, including 30 and 50-mil coincident current and word-select cores, lithium cores and wide temp. range Isodrive® cores. Electronic Memories, Inc., 9430 Bellanca Ave., Los Angeles 45, Calif.

Circle 149 on Inquiry Card

NEW TECH DATA

High-Power Potentiometer

Tech. data sheet on Daystrom 314 series subminiature rotary potentiometers provides specs. covering these single-turn units. This series presents a combination of capabilities in a tiny package ½ in. dia. by 11/32 in. and weighs 10 grams. Resistance values range from 10Ω to 50KΩ. Actual size photos, electrical, mechanical, and environmental specs. are given. Weston-Instruments & Electronics Div., 614 Frelinghuysen Ave., Newark 14, N. J.

Circle 150 on Inquiry Card

Microelement Transformers

Microelement transformers and inductors are available from Aladdin Electronics, 703 Murfreesboro Rd., Nashville, Tenn. These transformers and inductors are 0.135 in. high x 0.310 in. sq. Standard units in the wideband series are designed for use at freqs. as low as 5KC and as high as 45MC. Pulse transformers can handle pulses as wide as 7μsec. These microelements are compatible with commercially available capacitors, transistors, etc.

Circle 151 on Inquiry Card

Ultrahigh Vacuum Systems

Data Sheet 120.1 describes Model 120 ultrahigh vacuum system which produces and maintains pressure of 2×10^{-10} mm Hg. The low pressures are attained without additional bakeout during the pumpdown cycle and without cryogenic surfaces inside the chamber. Ilikon Corp., Natick Industrial Ctr., Natick, Mass.

Circle 152 on Inquiry Card

Terminal Blocks Connectors

A new 22-page catalog #G102 on terminal blocks, connectors, cable and conduit fittings, pre-insulated splice caps and tools is now available from Buchanan Electrical Products Corp., Hillside, N. J. Two features are included to aid the user in selecting terminal blocks: the first is a terminal block-selector chart and the second is a special foldout page with national electrical code tables.

Circle 153 on Inquiry Card

Silicone Resins

A new series of high-purity silicone resins protects the junctions of transistors, diodes, and rectifiers. The resins minimize surface leakage and reverse current caused by contamination of the semiconductor surface. At the same time the resins protect the junction mechanically. Dow Corning Corp., Midland, Mich.

Circle 154 on Inquiry Card

Miniature Coax.

Tech. Bulletin 102 describes a new coax with 100% shielding, low vswr, low attenuation, and a high power rating. Information includes data on construction, electrical and mechanical characteristics. Hitemp Wires Co., Westbury, L. I., N. Y.

Circle 155 on Inquiry Card

JFD PRECISION TRIMMER PISTON CAPACITORS ENABLE MOTOROLA'S FREQUENCY STANDARD TO ACHIEVE 1x10^{-11} SETABILITY

1×10^{-11} SETABILITY

5×10^{-11} AGING PER DAY

5×10^{-11} SHORT TERM STABILITY, 1 SECOND COUNTS

LESS THAN 2×10^{-10} 20° C ± 20° C

MODEL VCJ673 0.7 pf-12.0 pf ACTUAL SIZE

MODEL MC623 1.0-28.0 pf ACTUAL SIZE

The Motorola 1011 Silicon Solid State Frequency Standard provides precision tuning, navigational and communications systems measurements for military and industrial standards laboratories. With less than 5×10^{-11} crystal aging per day, the Motorola 1011 closely approaches atomic standard ultra-stability.

Because of its exceptional stability, the fine frequency adjust control is setable to 1 part in 10^{-11}. To help achieve this value, the JFD VCJ673 trimmer, a special modification of the JFD Super MAX-C was selected. The sealed interior construction of the JFD VCJ673 locks out all atmospheric effects. C of the unit is 0.7 to 12.0 pf. It offers a capacitance variation of 0.6 pf per full turn. Such variation is, in effect, again demultiplied by the diameter of the geared tuning mechanism for extreme tuning sensitivity. Stability is ± 50 PPM/°C. Its fine vernier adjustment is absolutely linear and repeatable to within ± 1%.

The coarse frequency adjustment uses a JFD MC623 MAX-C Trimmer Sealcap Capacitor for a C of 1.0 to 28.0 pf., in a very compact unit. JFD MAX-C Trimmer Capacitors meet or exceed all applicable performance or environmental requirements of Mil-C-14409A. The unit's rapid tuning characteristics speed setting to the required coarse tuning position.

Thousands of JFD trimmers are serving in demanding applications such as these. Why don't you put JFD trimmer experience to work in your present or projected products?

JFD ELECTRONICS CORPORATION
THE ≠ AMERICA KNOWS BEST!

Components Division
JFD ELECTRONICS CORPORATION, 15th Ave. at 62nd St., Brooklyn 19, N. Y. • DEwey 1-1000
JFD NORTHEASTERN, Ruth Drive, P.O.. Box 228, Marlboro, Mass. • HUntley 5-7311
JFD MID-ATLANTIC, 313 E. Broad St., Palmyra, N. J. • 609-665-0788
JFD MIDWESTERN, 6330 Hermione St., Chicago 46, Illinois • 775-5424,5425
JFD MIDWESTERN-OHIO, 7415 Montgomery Road, Cincinnati 36, Ohio • 513-421-1166
JFD WESTERN, 9 Morlan Place, Arcadia, California, • 213 HI 6-0312
JFD CANADA, LTD.. 51 McCormack Street, Toronto, Ontario, Canada • ROger 2-7571
STANDARD TELEPHONE & CABLES LTD.. Components Group, Capacitor Sales Dept., Footscray, Sidcup, Kent, England
LCC STEAFIX, 128 Rue de Paris, Boite Postale 51, Montreuil-sous-Bois, Seine, France
JFD ISRAEL, LTD.. Bldg. 23, Industrial Area B, Azur, Israel
DUCON CONDENSER PTY. LTD., Christina Road, Villawood, N.S.W., Australia

Variable Trimmer Piston Capacitors ■ Metalized Inductors ■ LC Tuners ■ Fixed Capacitors ■ Fixed and Variable Distributed and Lumped Constant Delay Lines ■ Pulse Forming Networks

SEE WHAT'S NEW AT JFD WESCON BOOTH NO. 3212, 3213

FREE! Use These Cards for:

- Catalogs, Bulletins, Literature • Design features of advertised products
- Information about new Products • New Tech Data for Engineers

YOUR NAME ..... TITLE .....

FIRM ..... Mail Stop or Div./Dept. .....

FIRM ADDRESS .....

CITY OR TOWN ..... ZONE ..... STATE .....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340
341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380
381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400

Please send me further information on the items I have circled above.
Postcard valid 8 weeks only. After that use own letterhead describing item wanted.

EI-09 JULY, 1963

FIRST CLASS
PERMIT NO. 2333
CAMDEN, N. J.

BUSINESS REPLY MAIL

No Postage Stamp Necessary If Mailed in U.S.A.

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

The Computer Center

P. O. Box 1970

Camden 1, New Jersey

FREE! Use These Cards for:

- Catalogs, Bulletins, Literature • Design features of advertised products
- Information about new Products • New Tech Data for Engineers

FIRST CLASS
PERMIT NO. 2333
CAMDEN, N. J.

BUSINESS REPLY MAIL

No Postage Stamp Necessary If Mailed In U.S.A.

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

The Computer Center

P. O. Box 1970

Camden 1, New Jersey

YOUR NAME ..... TITLE .....

FIRM ..... Mail Stop or Div./Dept. .....

FIRM ADDRESS .....

CITY OR TOWN ..... ZONE ..... STATE .....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340
341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380
381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400

Postcard valid 8 weeks only. After that use own letterhead describing item wanted.
Please send me further information on the items I have circled above.

EI-09 JULY, 1963

FREE! Use These Cards for:

- Catalogs, Bulletins, Literature • Design features of advertised products
- Information about new Products • New Tech Data for Engineers

YOUR NAME ..... TITLE .....

FIRM ..... Mail Stop or Div./Dept. .....

FIRM ADDRESS .....

CITY OR TOWN ..... ZONE ..... STATE .....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340
341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380
381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400

Please send me further information on the items I have circled above.
Postcard valid 8 weeks only. After that use own letterhead describing item wanted.

EI-09 JULY, 1963

FIRST CLASS
PERMIT NO. 2333
CAMDEN, N. J.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

The Computer Center

P. O. Box 1970

Camden 1, New Jersey

FREE! Use These Cards for:

- Catalogs, Bulletins, Literature • Design features of advertised products
- Information about new Products • New Tech Data for Engineers

FIRST CLASS
PERMIT NO. 2333
CAMDEN, N. J.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

The Computer Center

P. O. Box 1970

Camden 1, New Jersey

YOUR NAME ..... TITLE .....

FIRM ..... Mail Stop or Div./Dept. .....

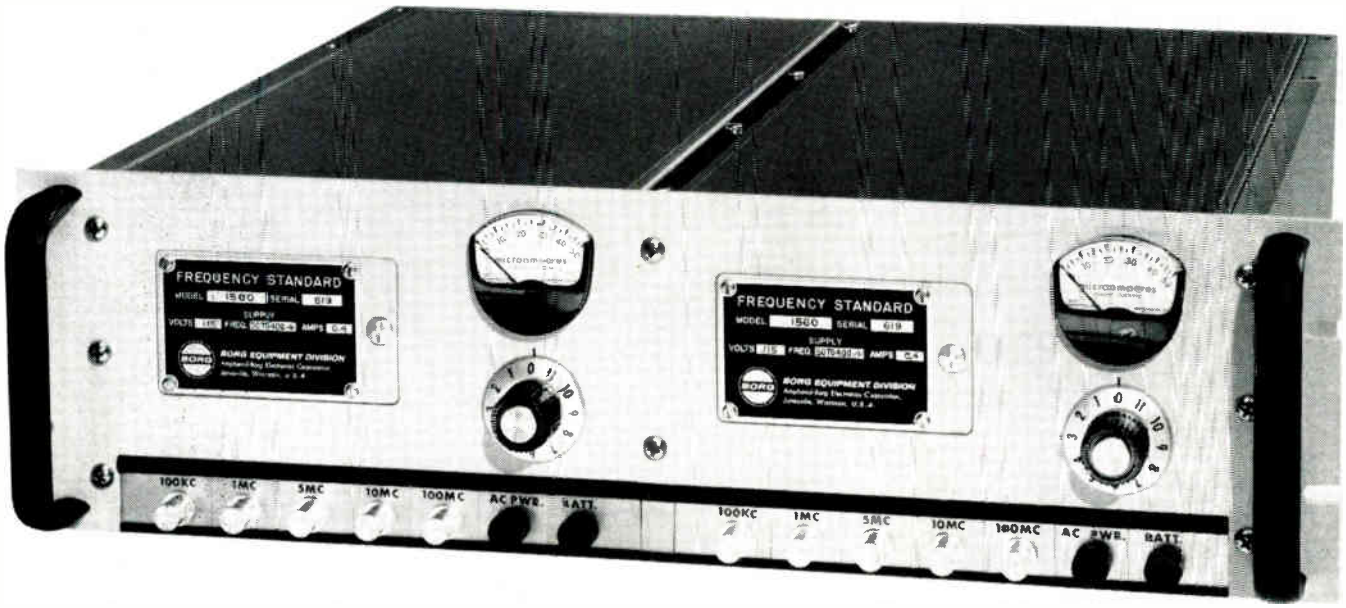
FIRM ADDRESS .....

CITY OR TOWN ..... ZONE ..... STATE .....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340
341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380
381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400

Please send me further information on the items I have circled above.
Postcard valid 8 weeks only. After that use own letterhead describing item wanted.

EI-09 JULY, 1963



MTBF > 10,000 Hours

That's the kind of reliability you can expect from this new Borg Frequency Standard. What's more . . .

IT'S MODULAR—You can easily plug in extra modules, multipliers up to 100 mc or dividers down to 1 pulse per second*.

IT'S COMPACT—2 units fit 5¼" panel space.

IT'S STABLE—Down to 5×10^{-12} for short term (see specs below for long and short term stability).

And it is designed to meet MIL-E-16400D.

Fully transistorized, 1560 Series offers the highest demonstrated reliability of any commercially available frequency standard. Stability? Dual ovens hold the 5mc overtone crystal temperature to within ±0.005°C. All semiconductors are silicon or tetrode type.

Rechargeable standby battery (good for +10 hrs) lets you carry unit to remote project sites or airship it anywhere without shutdown.

Oven and oscillator available as a separate module for your system.

If you need precision timing—for communications or weapons systems, navigation, radar, laboratory, or commercial use—you're a postage stamp away from the best source. Borg Equipment is the world's largest manufacturer of precision frequency standards.

BORG EQUIPMENT DIVISION
Amphenol-Borg Electronics Corporation,
Janesville, Wisconsin

SPECIFICATIONS: Transistorized Frequency Standard, Borg 1560 Series

FREQUENCY STABILITY
Long Term: 5×10^{-10} per day after 21 days operation
Short Term: 5×10^{-12} rms average of 1 second counts

OUTPUT FREQUENCY
5mc plus options (1 pps to 100mc)

HARMONIC DISTORTION
—40db

FREQUENCY ADJUSTMENT
Fine 1×10^{-7} digital dial, 1 count equals 1×10^{-10} Coarse 1×10^{-6}

METERING
12 selected circuits

TEMPERATURE RANGE
−20°C to +50°C (−4°F to 122°F)

POWER CONSUMPTION
14 watts from 60 volt line

DELIVERY in 30-60 days

*Some budget-minded project engineers, finding a gaping hole in their appropriations, have ordered Borg Frequency Standards, knowing that they can get plug-in multipliers, dividers, power supplies, and battery packs later.

Circle 59 on Inquiry Card

NEW TECH DATA

Oscilloscope Systems

Short-form catalog AN-C-501, 12 pages, describes single- and dual-trace main frames and a wide variety of plug-in units. Type 1220 features both preview and storage targets for use in integrating and displaying low-level repetitive signals from high-noise backgrounds. Specs. and photos are included on a complete array of dual-channel plug-ins for both portable and rack-mounted scope main frames, and information is given on recording cameras. Analab Instrument Corp., Cedar Grove, N. J.

Circle 156 on Inquiry Card

Quartz Accelerometer

Model 808 piezoelectric accelerometer features a crystalline quartz transducer element. It is a versatile instrument for precision, vibration, shock, and acceleration measurements over extremely wide ranges of amplitude and freq. Instrument Corp., 8989 Sheridan Dr., Clarence, N. Y.

Circle 157 on Inquiry Card

Power-Aging Systems

Bulletin 2026 describes modular power-aging systems, M8 series which have the following characteristics: temp. ranges from —195° to 150°C and higher; better than ±2°C control; and building-block expansion capabilities as testing needs grow. Wyle Laboratories, 133 Center St., El Segundo, Calif.

Circle 158 on Inquiry Card

Solar Cells

A radiation-resistant solar cell has been developed by International Rectifier Corp., 233 Kansas St., El Segundo, Calif. Designated "N on P" silicon solar cells, they meet the radiation requirements of NASA specs., and have a spectral response similar to the blue type "P on N" cells. Efficiencies range up to 10.5% under space conditions. Bulletin SR-280.

Circle 159 on Inquiry Card

Instruments

Bulletin 60-63, "Precision Instruments for Industry" describes the complete line of Biddle-Gray bridges, potentiometers, resistance standards and related equipment. Information includes photos and operating characteristics. James G. Biddle Co., Township Line & Jolly Rds., Plymouth Meeting, Pa.

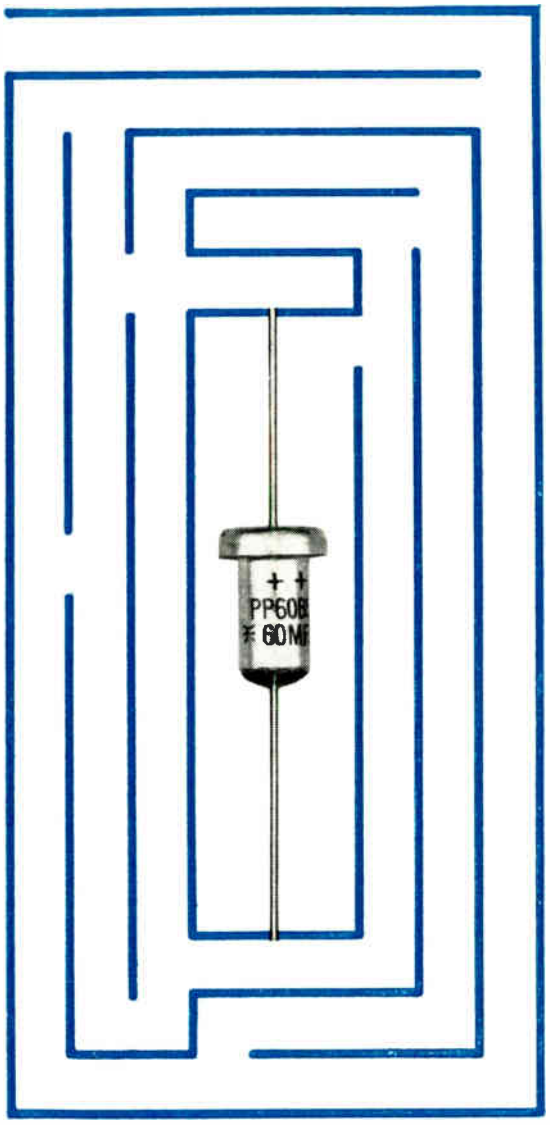
Circle 160 on Inquiry Card

Germanium Transistors

This guide lists a wide range of DAP diffused alloy power and pnp alloy power transistors by type number, with information on their pertinent electrical characteristics and case type. Transistor outline drawings are illustrated for all case types. Bendix Semiconductor Div., South St., Holmdel, N. J.

Circle 161 on Inquiry Card

How long have you been looking for component quality ?



Do you break out in a cold sweat every time a new rocket is tested at the Cape? Do you have the feeling that you're groping your way through a maze of unsubstantiated claims and vague specifications in order to find reliable components? We may be able to offer you ease.

We don't make flashy stuff. Sometimes we're the last manufacturer to introduce a new product. But when our engineers finally get around to releasing something—whether it's technical information, tantalum capacitors, zener diodes, or silicon controlled rectifiers—you can believe it, you can depend on it.

We know what you're going through. We have the same trouble trying to find suppliers who can make materials to our specifications—who can offer us something more than a hearty handshake and a warm promise.

Fortunately, the metallurgical know-how of Fansteel means that we can depend on the best quality of basic tantalum anodes, leads, and other refractory metal parts that go into our products. All materials, however, whether from Fansteel or other sources, have to meet the standards of our Quality Assurance Center.

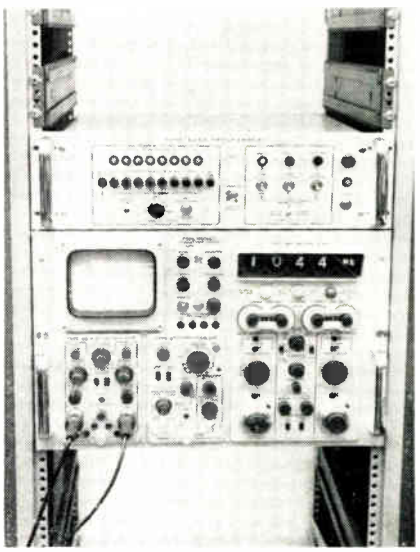
We think we have an advantage over other component manufacturers. Our customers agree with us.

FANSTEEL
METALLURGICAL CORPORATION
RECTIFIER-CAPACITOR DIVISION
North Chicago, Illinois.

NEW PRODUCTS

READOUT SCOPE PROGRAMMER

Non-sync time: min., 0.125 sec./program; max., 10.5 sec./program.

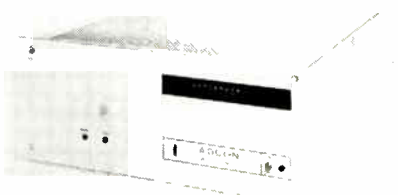


Programmer Type 262 offers programming simplicity, compatibility with automatic measurement systems, and can accommodate auxiliary equipment. Program cards allow parameter measurements of amplitude, time, start-to-stop time intervals, A or B signal commands, or first or second pulse selection. Measurement sequence can be manual or automatic. Programmer used with Type 567 Readout Oscilloscope. Tektronix Inc., P. O. Box 500, Beaverton, Ore.

Circle 162 on Inquiry Card

CONVERTERS

Allows six input options and independent register outputs.



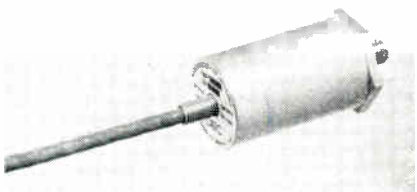
Models 631, 632 & 651 analog-to-digital converters have input options of high and low multiplexer, sample and mold inputs, single-ended or differential inputs. Features: successive or incremental approximation, and independent register outputs which can perform bit/bit information transfer in serial fashion under external clock control. Redcor Corp., 7760 Deering Ave., Canoga Park, Calif.

Circle 163 on Inquiry Card

NEW PRODUCTS

ACCELEROMETER

Low impedance accelerometer features integral electronics. Amplitude linearity 1%.

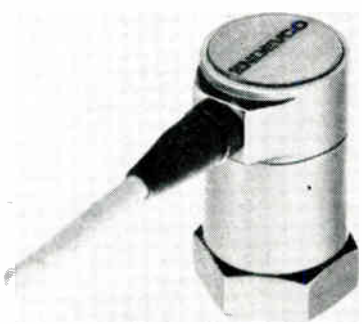


Type 4-280 uses miniature impedance-matching electronics. It combines piezoelectric sensing element and emitter-follower into a single unit less than 1 cu. in. volume. Eliminates noise and signal attenuation normally associated with crystal transducers. Features: 100Ω output impedance; operating to 250 peak-g from 6 to 6000CPS over temps. from −65°F to +200°F. Voltage sensitivity 20 peak-mv/peak-g at 77°F and 100CPS with a 50KΩ load; output voltage is limited to 14v. peak-to-peak without distortion at room temp. Consolidated Electrodynamics Corp., subs. of Bell & Howell, 360 Sierra Madre Villa, Pasadena, Calif.

Circle 164 on Inquiry Card

DC ACCELEROMETER

Provides a freq. response from 0 to 2KC (5%) over entire temp. range.



The Model 2260 dc accelerometer uses piezoresistive strain gauge elements. Provides full freq. response over temp. range of −65°F to +250°F with no phase shift, and covers the dynamic range to ±250g. It will directly drive galvanometers without auxiliary amplification. Unit is less than 1.5 oz.; has a full-scale output of ±250mv (min.), and is 1.1 in. high x 5/8 in. hex base. Sensitivity is less than 3% total deviation from 0°F to +165°F. Technical Services, Endevco Corp., 801 S. Arroyo Pkwy., Pasadena, Calif.

Circle 165 on Inquiry Card

DIMMER

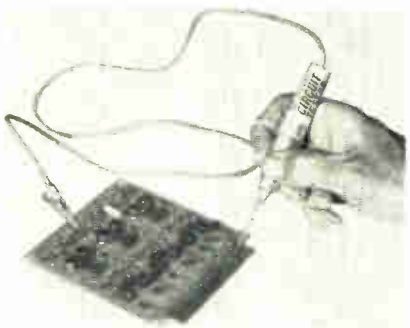
The lens is removable and can be hot-stamped to suit the user.

Model 8551DS features light output that can be dimmed to ¼ full output or to zero by rotating the lens. It is used with T-1¾ in. midget flange based bulbs. The single-terminal screw-mount body mounts in ⅜ in. dia. hole in any material 1/16 in. through ⅜ in. An insulated model for 2 terminal application is also available for a 27/64 in. dia. hole. The Sloan Co., P. O. Box 367, Sun Valley, Calif.

Circle 184 on Inquiry Card

CIRCUIT TESTER

Checks the electrical continuity of non-energized circuits.



The Pro-Glo circuit tester consists of a plastic case containing a battery, lamp, a pointed probe, and a 3 ft. wire with an alligator clip. In use, the clip is connected to ground or common circuit point and the probe touched to various other circuit points. When resistance between points is less than about 1Ω, an integral lamp glows. On open or high resistance circuits, no glow appears, and if continuity is poor, the lamp glows dimly. AMF Instrument Div., American Machine & Foundry Co., P. O. Box 929, Alexandria, Va.

Circle 185 on Inquiry Card

SEALED THERMISTORS

Hermetically sealed units withstand shock and vibration and may be used up to 400°C.

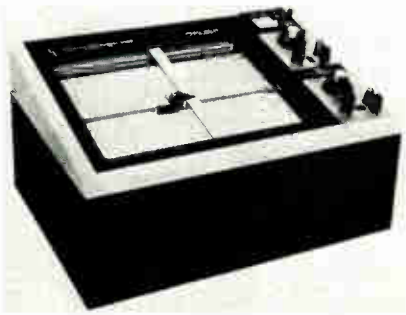
This miniature thermistor is hermetically sealed in shock-resistant glass; is 0.150 in. long and 0.070 in. in dia.; and is used in temp. compensation, measurement, control and time-delay uses. They are well suited for automatic insertion into printed-circuit boards. Thermistor material grades with temp. coefficients from −3.3 to −5.1%/°C are available in resistances ranging from 2000Ω to 1 megohm. Specialty Resistors, Magnetic Materials Sec., General Electric Co., Edmore, Mich.

Circle 186 on Inquiry Card

NEW PRODUCTS

X-Y RECORDER

Sensitivity from 1mv/in. to 10v./in. at an 0.25% accuracy; uses zener reference volt



The HR-96T is an 8 1/2 x 11 in. X-Y recorder. The input impedance is 100KΩ; is has a switch-selectable time sweep on the X-axis from 0.05 in./sec. to 2 in./sec.; 10 in./sec. pen speed; and an electric pen lift. Houston Instrument Corp., 4950 Terminal Ave., Bellaire 101, Tex.

Circle 187 on Inquiry Card

DIGITAL THUMBWHEEL SWITCH

Rated at 100,000 revolutions, it cannot hang up between positions.

Digital thumbwheel switch has provision for the installation of diodes or resistors on its printed-circuit connector. Designed to convert decimal dial indication to coded electrical output (unit has 1-2-4-2 and 1 common output). Model 109 is suited to uses in digital computer systems, test equipment and ground support equipment. Engineered Electronics Co., 1441 E. Chestnut Ave., Santa Ana, Calif.

Circle 188 on Inquiry Card

BEAM POWER PENTODE

Capable of power outputs up to 100w. in push-pull class AB circuits.

Type 8417 offers good linearity, reduced distortion, and high-power sensitivity, thus requiring low-drive voltage for max. power output. Dissipation ratings are 35w. for plate and 5w. continuous for the screen, with allowable max. of 8w. Transconductance is 25,000μmhos. Westinghouse Electronic Tube Div., Elmira, N. Y.

Circle 189 on Inquiry Card

NEW PRODUCTS

VIBRATION MEASURING SYSTEM

Used where phase and distortion information cannot be recorded conventionally.

The VMS unit creates exact slow-motion replica of accelerometer signals while accelerometer signal sweeps from 10CPS to 10KC. Any slow motion from 1/3 to 3CPS can be chosen, and it then remains fixed even though the accelerometer sweeps. Replica can be recorded on any oscillograph. Unit has 5ma full-scale output to drive galvanometers directly, or 5v. full scale for high impedance devices. Chadwick-Helmuth Co., 111 E. Railroad Ave., Monrovia, Calif.

Circle 166 on Inquiry Card

CAPACITOR TEST UNIT

Measures and prints out tantalum capacitor characteristics in 8 sec.

The test set compares the capacitance and dissipation factor characteristics of unknown capacitors with the known values of standard capacitors. The results are presented as a percentage difference and printed out. Leakage current of the unknown capacitors are recorded in μa. Features: measurement range to 330μf and 120v.; measurement accuracy: capacitance to within 0.5%; dissipation factor to within 0.5%; leakage current to within 2%; accepts boards with 15 tantalum capacitors. Radio Corp. of America, Harrison, N. J.

Circle 167 on Inquiry Card

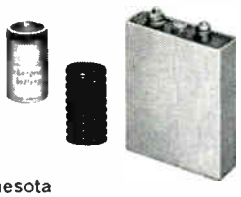
What won't you think of next?

A battery-operated rotating "whisk-er"? To replace the ever present whisk broom of the plate umpire? Hardly. It's part of the time-honored ritual of the game—to relax while the ump meticulously whisks every corner. That makes the elimination somewhat improbable.

Our point is this—your present design problem may seem just as improbable, just as the drill, shaver, mixer and other cordless products did a few years ago. But Gould-National research engineers developed a package of concentrated power using NICAD® Hermetically Sealed Rechargeable cells that helped to make these products a reality.

Have a design problem that could be solved with NICAD portable power? Write us, we may be able to help you solve your problem.

GOULD NATIONAL **NICAD BATTERY DIVISION**

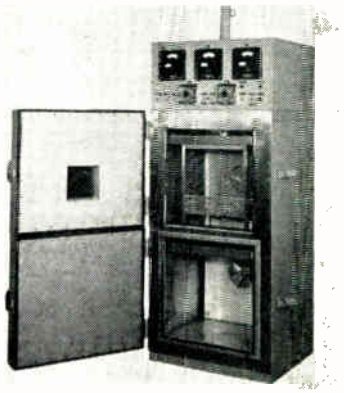


GOULD-NATIONAL BATTERIES, INC. / St. Paul 1, Minnesota

NEW PRODUCTS

THERMAL SHOCK CHAMBER

Performs thermal shock testing within the −100°F to +300°F range.

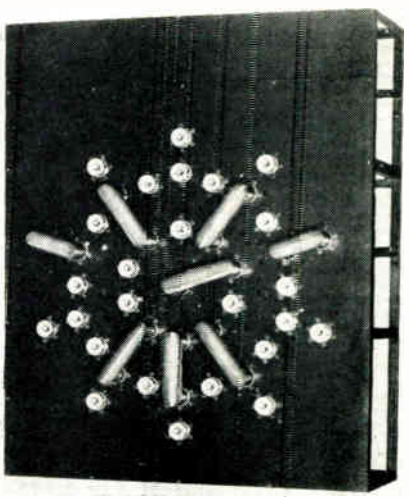


This environmental test chamber performs the thermal shock portions of Mil-202B, Methods 102A and 107A. Operation is completely automatic with cycling timers for each test phase. The heating system is a series of electric heaters located behind baffling. Cooling is supplied by liquid CO_2. The interior is 16 gauge stainless steel with 16 gauge galvanneal exterior. Conrad, Inc., Holland, Mich.

Circle 168 on Inquiry Card

COAXIAL PATCH PANEL

Completed panel is 67 x 84 x 24 in. For 3⅛ in., 50Ω transmission lines.



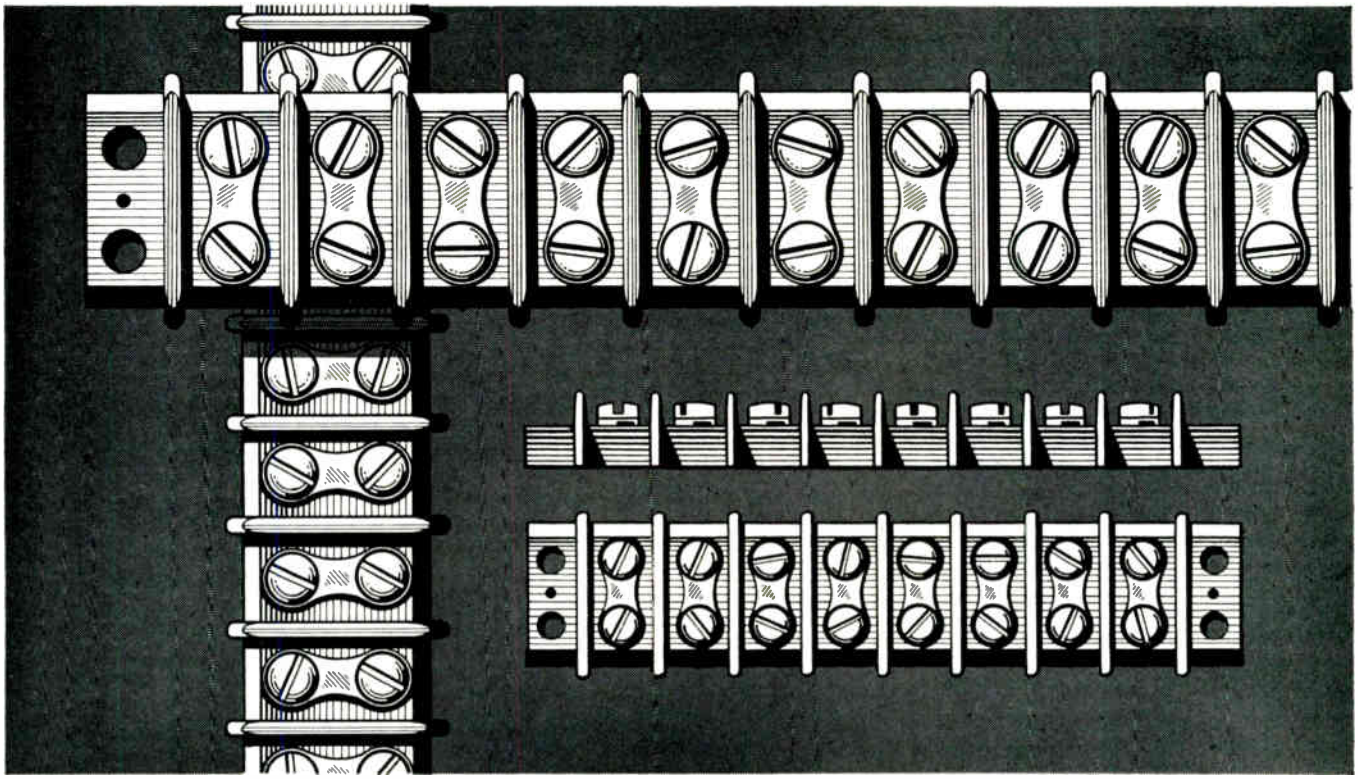
The type 27935 10 x 10 patch panel features a panel layout of terminals in 3 concentric circles and a dummy load connection at the center of the panel. This layout allows any transmitter to be connected to any of the 10 antenna terminals or the dummy load. An interlock system requires positive "U" link contact and locking before the interlock circuits are activated. Andrew Corp., P. O. Box 807, Chicago 42, Ill.

Circle 169 on Inquiry Card

NEW GEN-PRO 700 SERIES INDUSTRIAL TERMINAL BOARDS

ALL SIZES AVAILABLE NOW FOR TIMED DELIVERY AS NEEDED

Superior features • Competitively priced • Conveniently packaged



When you need terminal boards for any application, rely on Gen-Pro's great new 700 Series for the quality and interchangeability you want—on Gen-Pro's unique timed delivery for prompt as-needed shipments. Greater length—up to 46 terminals—permits a larger number of connections than ever before possible. Thicker, stronger barriers with rounded corners reduce breakage—creepage path is longer—saddle plates available for more secure mounting. All sizes and variations in number of stations—packaged in lots of 5, 10 and 20. The boards of your choice are delivered from stock in the quantities you require—when you need them. All types of hardware and special molding compounds are available in addition to standard-purpose phenolic. Write today to Dept. SMMD for illustrated literature.

Your assurance of quality.
700 Series terminal boards are subject to the same rigorous quality control procedures as Gen-Pro's famous 400 Series — the finest commercial terminal boards available anywhere today.

700 SERIES TERMINAL BOARDS

Model No.	Voltage, RMS	Terminals
740	1200	1-46
741	1600	1-39
742	2500	1-30
764*	1600	1-46

*6/32 screws

GEN PRO

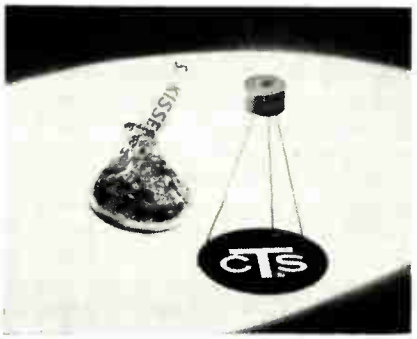
GENERAL PRODUCTS CORPORATION
UNION SPRINGS, N.Y.

TWX No. 315-999-1455
Phone: (area code 315) TT9-7367

NEW PRODUCTS

CERMET TRIMMER

Resistive range of 100Ω to 500KΩ. Ceramic substrate allows high overload.



CeraTrols® Series 385 has infinite resolution, good high-freq. characteristics, 1/2 to 5 oz. in. turning torque, 1 lb. in step torque and −65° to +175°C operating temp. range. Rating is ⅛w. at 125°C derated to zero load at 175°C with a max. of 200vpc across resistance element. Dia. is 11/32 in. Trimmer exceeds performance specs of Mil-R-94B. CTS of Berne, Inc., a sub. of CTS Corp., Berne, Ind.

Circle 170 on Inquiry Card

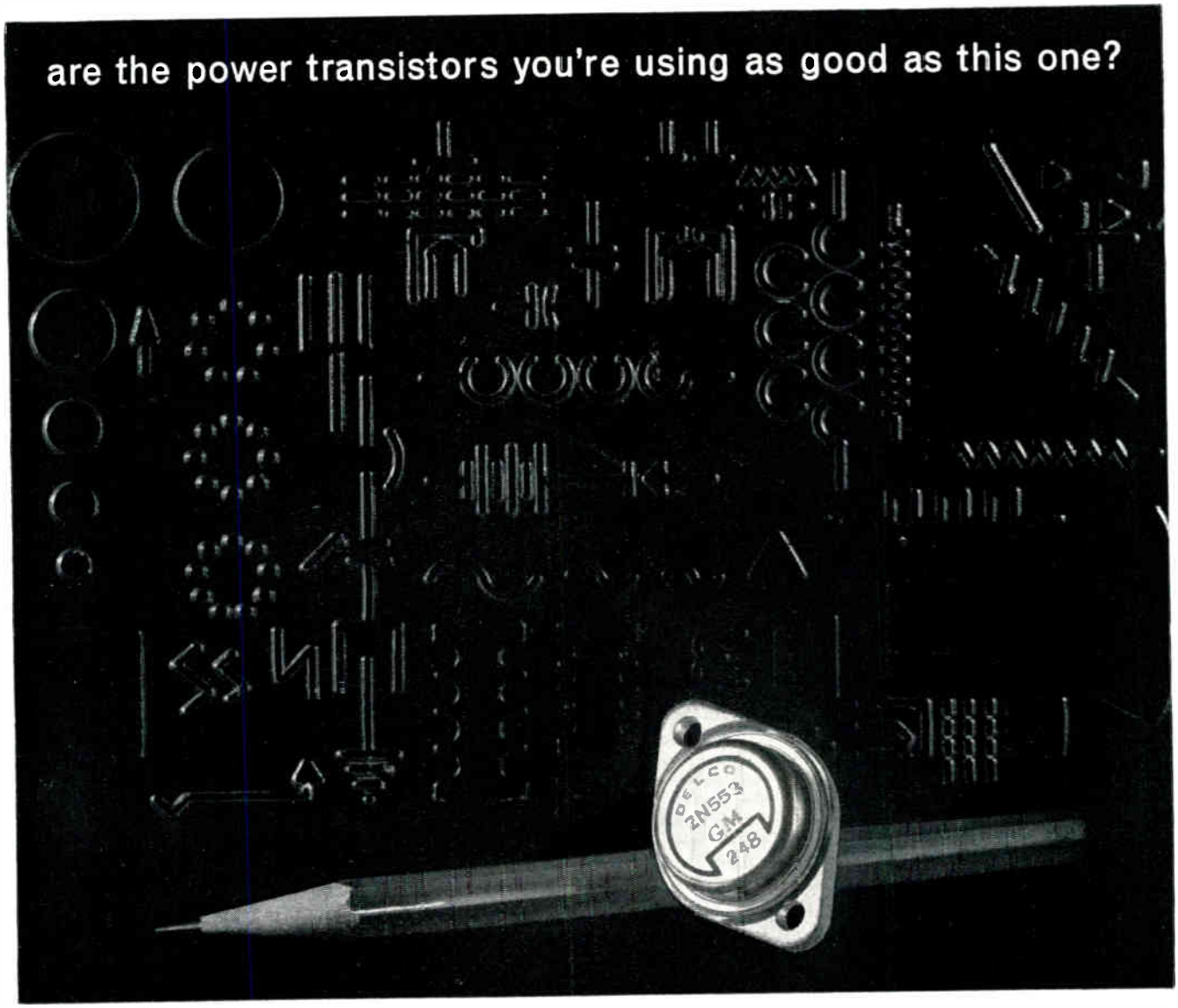
PRECISION FILM RESISTORS

A new tool for use in proto-type design; resistance values are 20Ω to 301KΩ.

Proto-Pak is an assortment of 101 values of precision X4C metal film resistors. The assortment is packaged in transparent vials, marked as to value and quality and housed in a metal cabinet. The X4C resistor is in ⅛w. package size, but is rated up to ½w. Electra Mfg. Co., Independence, Kans.

Circle 171 on Inquiry Card

are the power transistors you're using as good as this one?



Meet the Delco Radio family of 2N553 high power transistors. This group gives you a wide selection of highly reliable 4-5 amp. power transistors. The perfect choice for direct coupled circuits because of their extremely low collector diode bulk leakage current. Regulator applications? None better than Delco's 2N553. These units have unique thermal stability. Order a handful or a carload and you get uniform high quality. Prove it to yourself and improve your product as a bonus. Contact one of our Sales Offices listed below or your nearby Delco Radio Semiconductor Distributor.

Type	I_C Max Amps	V_{CEO} @ I_C Volts @ Amps	V_{CBO} @ I_{CBO} Volts @ ma	h_{FE} @ I_C Amps	V_{EBO} @ I_{EBO} Volts @ ma	V_{CE} (sat) @ I_C Volts @ Amps	V_{BE} Volts	f_{ae} kc	Thermal Resistance
2N553	4	40 .300	60 2	40/80 .500	40 2	0.9 3.0	1.5	25	1.5° C/watt
2N663	4	25 .300	50 12③	25/75 .500	20 4	1.0 3.0	1.5	15	2.0° C/watt
2N665	5	40 .300	80 10	40/80 .500	40 2	0.9 3.0	1.5	20	2.0° C/watt
2N665 Sig C	5	40 .300	80 10	40/80 .500	40 2	0.9 3.0	1.5	20	2.0° C/watt
2N297A	4	40 .300	60 3	40/100 .500	40 3	1.0 2.0	1.5	2	1.5° C/watt
2N297A Sig C	4	40 .300	60 3	40/100 .500	40 3	1.0 2.0	1.5	2	1.5° C/watt
2N1971	4	40 .300	60 2	25/60 .500	40 2	0.9 3.0	1.5	25④	1.5° C/watt
2N256	3	30① .003②	30 3④	15 .500	30 8	1.0 1.0		100⑤	2.0° C/watt
2N307	3	35① .015②	35 5④	20 .200	10 2	1 0 .200		3	2.0° C/watt

① V_{CER} ② I_{CER} ③ @ 85°C ④ Typical ⑤ fab

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

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

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

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

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

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

General Sales Office: 700 E. Firmin, Kokomo, Ind., Gladstone 2-8211—Ext. 500 • Area Code 317

DELCO RADIO
DEPENDABILITY
RELIABILITY

Division of General Motors, Kokomo, Indiana

NEW PRODUCTS

REFLEX KLYSTRONS

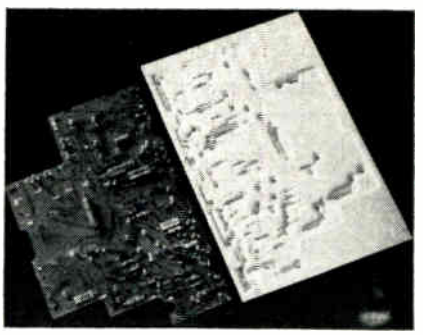
Mechanically tuned by calibrated micrometer freq. tuner.

Types QKK1148 through QKK1153 operate in the 50 to 101GC range and feature single-mode operation for full band coverage and single-vernier tuning. Low operating voltages allow operation from a single power supply. The r-f output is through a waveguide sealed by a mica window. Recommended for high resolution radar, spectrum analysis spectroscopy, maser amplifier pumping, and harmonic generation of submillimeter waves. Raytheon Co., Microwave and Power Tube Div., Foundry Ave., Waltham 54, Mass.

Circle 182 an Inquiry Card

CIRCUIT-BOARD TOOL

Allows component crimping and soldering in one operation.



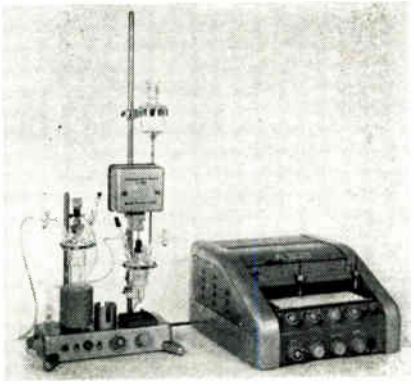
This plastic handling tool facilitates the fabrication of circuit boards. During assembly, the plastic tool is fitted over the circuit board after the components have been placed in position. The board can then be turned over for all hand operations without dislodging any components. General Dynamics Corp., 1 Rockefeller Plaza, New York 20, N. Y.

Circle 183 an Inquiry Card

NEW PRODUCTS

POLAROGRAPHIC ANALYZER

Offers versatility for both dc and ac polarography. Accuracy, ½% of full scale.

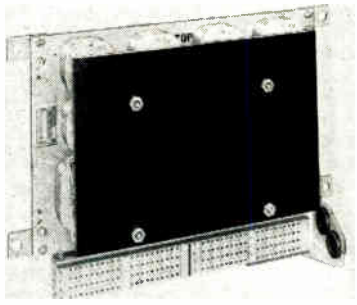


The Polarecord, Model E 261-R, is used for the following polarography: normal dc, stripping analysis, controlled (rapid) dropping dc and for the new ac technique. This versatility is possible because the chart speeds, voltage scan speeds and compensation facilities have been placed in one basic instrument with recorder. Performance data: max. sensitivity, 0.0001μa/mm; voltage and current accuracy, 0.2%; and response time, 250-mm/sec. Brinkmann Instruments, Inc., 115 Cutter Mill Rd., Great Neck, L. I., N. Y.

Circle 172 on Inquiry Card

DECODER

A max. of 64 outputs are possible with 6 inputs to the decoder.



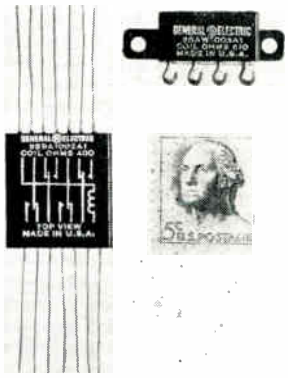
Bulletin 1640 Decoder decodes 6, 7, and 8 track codes or a 6-digit binary number. Operating time (measured on the output terminals) is less than 4msec. Outputs and inputs are electrically isolated. Using the decoder as a binary or a binary-coded decimal selector, it can control the indexing of a table, conveyer, tool changer or classifying systems. It can also be used in multiplexing. Allen-Bradley Co., 103-A W. Greenfield Ave., Milwaukee 4, Wisc.

Circle 173 on Inquiry Card

NEW PRODUCTS

CAPSULAR RELAY

Life rated at 200,000 operations at low-level loads; 100,000 at rated loads.

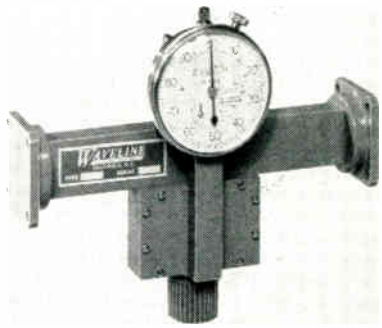


Two versions of Unimite™ capsular relay are available. The 2-pdt Dua-Mite™ and 4-pdt Quadra-Mite™ relays feature all-metal, all-welded contact capsule. Dua-Mite dimensions are 0.8 x 0.4 x 0.4 in. Quadra-Mite is 0.93 x 0.8 x 0.4 in. Operation time is 3msec. for the Dua-Mite; 5msec. for the Quadra-Mite. Each will switch up to 1a. resistive load at 28vdc or 115vac. Inductive load capacity is 0.25a. at 28vdc or 115vac. Overload capacity exceeds the requirements of Mil-R-5757D. They operate at amb. temps. from −65°C to +125°C. General Electric Co., Schenectady 5, N. Y.

Circle 174 on Inquiry Card

PHASE SHIFTERS

Units have a maximum VSWR of 1.10 over the entire waveguide freq.



A complete series of min. loss phase shifters are available in the freq. range of 3.95 to 26.5gc. The calibrated or uncalibrated versions provide a phase shift variation of 180°. They have an insertion loss of less than 0.5db, and contain a precision dial that measures the vane position to within 0.0005 in. The drive mechanism has a multiple lead screw that minimizes backlash and assures a high degree of accuracy and resetability. Waveline Inc., Caldwell, N. J.

Circle 175 on Inquiry Card

NEW PRODUCTS

SWEEP-SIGNAL GENERATOR

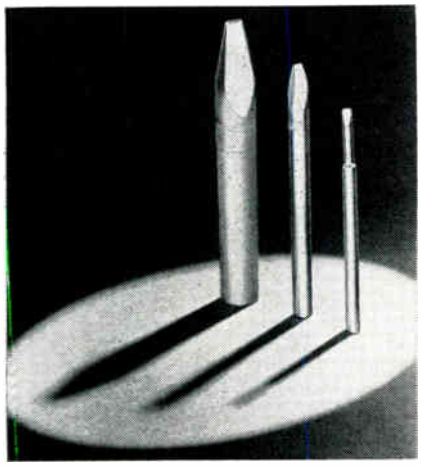
Sweep time: CW operation is 100 to 0.01 sec. Power variations below ±0.5db.

The 630 series sweep-signal generator provides precise freq. tuning plus known absolute power output over a 60db range during sweep or CW operation. Available in 3 ranges: 1-2, 2-4, and 4-8Gc. Freq. is adjustable over the entire range. Balanced bolometer assures constant power output over wide temp. range. Specs: r-f power at least 1mw; residual FM is less than 0.003% peak of highest freq.; drift is ±0.01%/hr.; symmetrical sweep is 0 to ±5% of range about any center freq.; sq. wave operation, 100 to 0.5 sec.; Alfred Electronics, 3176 Porter Dr., Palo Alto, Calif.

Circle 176 on Inquiry Card

SOLDERING TIPS

Extra tinning protects against pitting, oxidation and amalgamation.



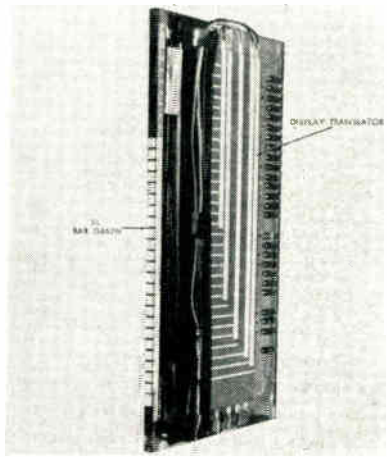
The addition of 11 soldering tips—six in 3/16 in. dia. and five in ¼ in. dia.—expands the Armor Clad line to 27 different sizes. The tips come in different shapes in sizes from 3/16 in. to ⅞ in. dia. Shanks are nickel-plated to prevent sticking at high temp. They fit all irons that use plug-type tips. Stanley Works, New Britain, Conn.

Circle 177 on Inquiry Card

NEW PRODUCTS

ELECTROLUMINESCENT GRAPH

The brightness of this unit is up to 30 ft.-lamberts. Suitable for aircraft inst.

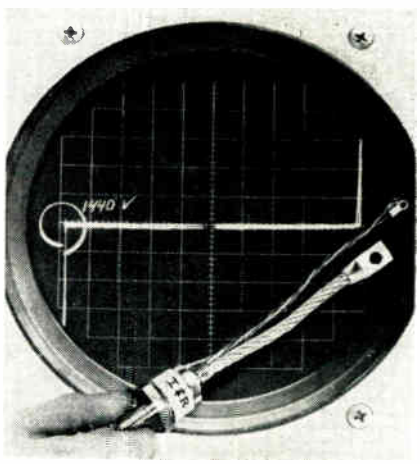


This electroluminescent bar graph unit uses nonlinear resistor materials deposited in layers as logic matrix to reduce the number of electronic components. A display translator receives digital information and translates it into display segments, thereby activating the graph to show actual measurements. Sylvania Electric Products Inc., 730 Third Ave., New York 17, N. Y.

Circle 178 on Inquiry Card

1500-VOLT SCR

Eliminates the need for ignitrons, thyratrons, and motor-generator sets.



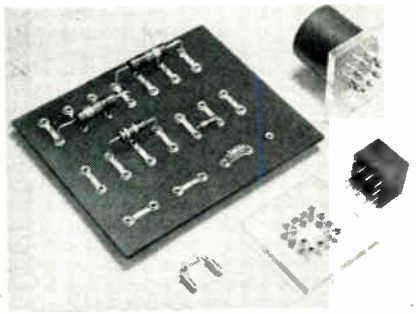
The 70a. (110a RMS) epitaxial rectifiers are assembled in the JEDEC TO-48 package and have bulk avalanche capabilities from 1000 to 1500v. They provide low leakage currents in the order of 500μa @ 25°C, and 1ma @ 125°C prior to avalanche. The devices assure built-in protection against high voltage surges. International Rectifier Corp., 233 Kansas St., El Segundo, Calif.

Circle 179 on Inquiry Card

NEW PRODUCTS

REUSABLE BOARD JACKS

Allows hand mounting and prevents damage to components during "burn-in" test.

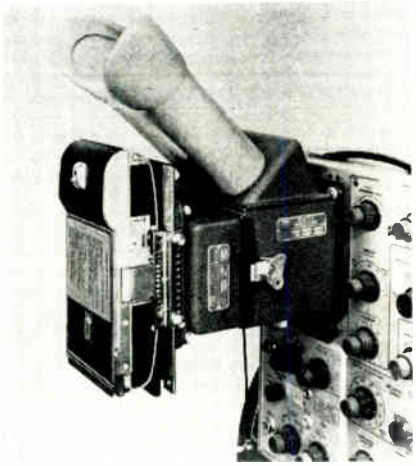


This jack consists of 2 parts: a drawn cup which is hand, dip or wave soldered in the board, and a spring receptacle in the cup which holds the component lead in place. They provide the economical solution for testing transistors, diodes, capacitors and resistors. Component and test fixture damage during removal is eliminated and frequent replacement of printed boards is unnecessary. One jack size accepts components with leads from 0.018 to 0.040 in. AMP Inc., Harrisburg, Pa.

Circle 180 on Inquiry Card

OSCILLOSCOPE CAMERA

Offers two object-to-image ratios: 1:0.9 and 1:0.7. Fits any standard 5 in. scope.



The K-5 Oscillotron is an oscilloscope recording camera which allows synchronization of the shutter opening with phenomena on the CRT. It features variable focus, vertical or horizontal format, flat-field f/1.9 lens and new, lighter die-cast aluminum construction. Has standard Polaroid back. Direct binocular viewing of CRT while recording is possible. Beattie-Coleman, Inc., 1046 N. Olive St., Anaheim, Calif.

Circle 181 on Inquiry Cord

LETTERS

"R&D By-Products"

Editor, ELECTRONIC INDUSTRIES:

We have read Mr. J. K. Slapp's article in the May, 1963 issue, "Look Before You Leap—With R&D By-Products" with interest. Mr. Slapp is to be complimented for presenting an easily understood brief for early systematic evaluation of product and market potentials.

As marketing consultants specializing in the electronics industry, we take exception to one point. Mr. Slapp represents the cost of depth market surveys as ranging from $10,000 to $100,000.

The cost of a survey is largely determined by the nature and amount of information one requires, the degree of urgency and the desired levels of accuracy and reliability. These affect the experiment design and often "select" the methods of data acquisition and reduction. One can "solve" a marketing problem at a reasonable cost by one approach. If a client is misled into or squeezed by circumstance into a rush job, if a client over-engineers the standards of accuracy and reliability, if a client insists on answers to low-priority questions, if a client insists on the privilege of paying for a "name," costs can be greatly inflated.

We have brought in product studies *in depth* for costs as low as $5,000 (fee and operating costs). Studies on marketing problems of a different nature have cost even less. In the main, our projects cluster around or below the low end of Mr. Slapp's range. We would have to become involved in a complex problem involving several sub-projects, each with high order of magnitude in requirements in accuracy, in order to even start approaching the high end of his cost range.

These statements may be incomprehensible to those who equate price with quality. Our work is never "quick and dirty," but it is realistically tailored to a client's need. The purpose of a study is to solve a client's problem, not to satisfy the researcher's academic urges nor to subsidize a fancy front.

It's not our intent to criticize Mr. Slapp. We wish to correct the inference readers might draw and act upon. Rather than accept the sug-

(*Continued on following page*)

LETTERS

(*Continued from preceding page*)

gested cost range as definitive proof for the exclusion of external services, managements who are at the stage of considering studies should go out for some estimates. While we cannot speak for our competitors, we assume that there are others qualified to do the job who would welcome the opportunity to quote.

We're prejudiced of course. But we believe that marketing managements must recognize that there are gaps in their in-house skills and abilities. It takes more than some natural talent and a file of "how-to" articles to equal the skill of a professional. And a systematic cost comparison of home talent and external skill will show that the difference is a worthwhile premium for a professional job.

Warren K. Schoonmaker
Schoonmaker Associates
2 Washington Sq.
Larchmont, N. Y.

"Unionism or Professionalism"

Editor, ELECTRONIC INDUSTRIES:

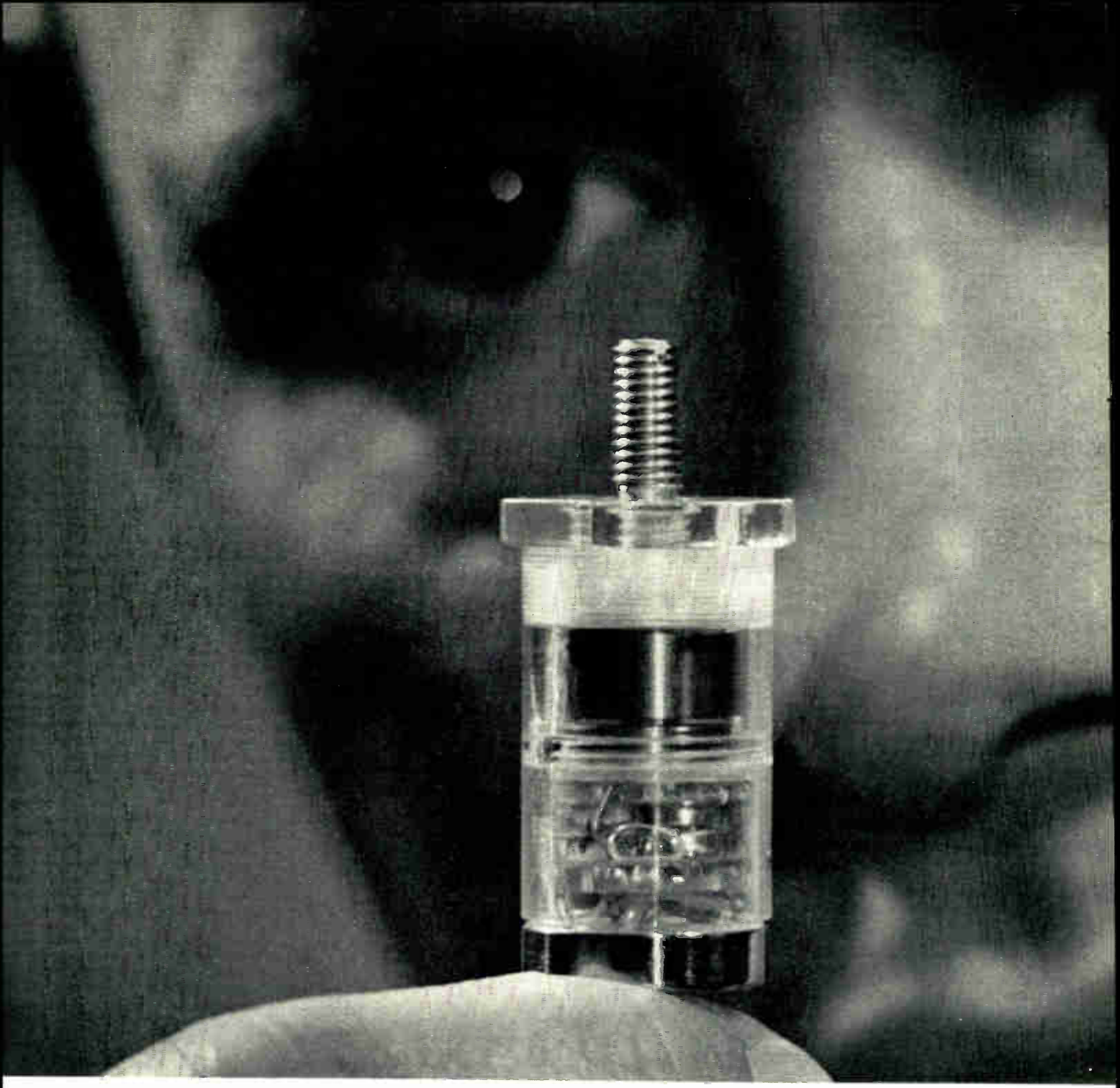
We would like to take this opportunity to comment on the editorial in the April 1963 issue of Electronic Industries.

To start with, the very title of this editorial, "Unionism or Professionalism?, is misleading . . . the implication being that there is an incompatibility between the two terms. This implication is not substantiated in the body of the editorial. We believe that in fact these are not two distinct choices but rather are only possible simultaneously. An examination of the facts of engineering employment will demonstrate that engineers are sorely in need of organization in order to protect their professional interests.

Your editorial mentions the American Medical Association as possibly a desirable type of organization. It is generally recognized that the AMA functions like a union in protecting and advancing the interests of its members while rather callously disregarding other interests in the community.

The technical societies are operated by management interests, for management interests and certainly are not

(*Continued on page* 145)



Above, Plastic Encapsulated Model

Small Size...Low Impedance...Completely Isolated

World's smallest combined piezoelectric accelerometer and emitter follower

Now—for the first time—get the true performance of a piezoelectric accelerometer with the output of an amplifier—from a single low impedance unit, CEC's 4-280. Mount it, use it like any accelerometer... but read or record the output directly with no intervening electronic equipment required. It's a convenient package—case isolated—actually improving performance, and able to stand environmental extremes.

The 4-280 contains an integral miniature emitter follower achieving output impedance of less than 100 ohms. Transistorized, the 4-280 allows long cables from accelerometer to direct readout equipment with no loss in performance.

CEC's 4-280 contains a point-loaded seismic system housed in stainless steel, with an integral cable and mounting stud. Not cable sensitive, it's ideal for missile acceleration measurement in missile launching vibration testing.

Features: frequency response, 6 to 6000 cps, ±5%; flat temperature response, ±5% from −65°F to +200°F; linearity, ±1%; voltage sensitivity, 20 mv/g; acceleration range, 250g; shock, 1000g.

Call or write CEC for Bulletin 4280-X5.

ACTUAL SIZE

CEC

Transducer Division

CONSOLIDATED ELECTRODYNAMICS

A Subsidiary of Bell & Howell • Pasadena, California

Circle 85 on Inquiry Card

LETTERS

(*Continued from page* 143)

representative of the interests of the working engineer. Technical societies are dependent on industry support and we feel that it is not likely that industry will support an organization that is truly concerned with improving the lot of the working engineer.

Your editorial does mention a problem that unions have concerned themselves with while other groups do not notice the problem or pretend there is none. This is the problem of job insecurity. However, your editorial fails to make clear that this problem is most acute for the older engineer, the less desirable employee. A seniority or job tenure system is not likely to be adopted by the industry without some form of compulsion, such as a union may be able to create.

Finally, we would like to commend you on bringing this problem into print and suggest that you allow all sides of the story to be made known. We would further suggest that you could best serve the interests of the *whole* electronic industry and *all* the people in it by pursuing this matter and including articles from unionized engineers and those groups that have a genuine interest in the working professional engineer.

Chester Smykowski
(former Vice-President for Engrg.)
Technical Engineering and Clerical Federation
Local 471, IUE-AFL-CIO
2 Court Square
Long Island City 1, N. Y.

"Unionism or Professionalism"

Editor, ELECTRONIC INDUSTRIES:

Regarding your editorial "Unionism or Professionalism" you suggest that engineers adopt a counterpart of the American Medical Association if Engineering is to become a really recognized profession. Yet, what is the AMA? One of the duties of its local chapters in the fixing of minimum fees that its members are to receive for their services. Due to the unilateral negotiation involved here this is a rather militant form of unionism, i.e., the public (their employees), are not

(*Continued on page* 146)

LETTERS

(*Continued from page* 145)

invited to the negotiation. As I see it, the major difference between the professional society and the union is that the society is usually organized for the self employed—the aim is the same, recognition, security, dignity, and a reasonable compensation for their services.

You speak of Unionism as a threat —threat to whom? It is a fact that in comparable vocations the employees who have turned to collective bargaining earn a higher wage, the turnover and labor shortages are less, and (contrary to circulated propaganda) the productivity is greater in the majority of cases. Also, incentives and unionism can and do exist. Of course, in many crafts, increasing one's knowledge and pride of workmanship are the initial incentives for most individuals, regardless of income. A good example is the schoolteachers of our nation who labored for years at substandard salaries. Many were forced to turn away from their chosen profession, but most of them stuck it out and eventually realized that collective bargaining was needed to improve their wages and working conditions. It stands to reason that a person who will do their best at a sub-standard income will do at least as well with an increased income.

I believe that economics is also partially at the root of the present labor shortage in electronics. I know of many engineering and tech school graduates who studied for years while working and then found upon graduating they could not afford the necessary cut in income to use their education.

Yes, I believe an organization is necessary for engineers but it's going to take more than so called professional recognition to raise salaries, and negotiate contracts with security clauses. It's going to take some hard-nosed bargaining to take the engineering profession out of the gypsy status from which it has sunk. Of course if "Guild" or "Society" sounds better than "Unionism," so be it.

E. R. Powell
Press Secretary
Local No. 4, Broadcast Engrs.
St. Louis, Mo.

EDITOR'S MAIL BOX

ELECTRONIC CIRCUIT DIAGRAMS can be prepared by mechanization. The system produces complex diagrams through the use of photographic typesetting machines. Lines, symbols and words are put on photo film by machine keyboards, instead of being drafted tediously by hand in ink.

Complex diagrams can be produced by the machines as sharp, uniform master copies on film in about one-fourth the usual time. The heart of the system is a Harris-Intertype Corp. photographic typesetting machine. The system was developed at Westinghouse Defense Center's electronic division.

A TWO-CAMERA TV SYSTEM has been designed to reach down, scan and accurately show conditions in boreholes for geologists and others drilling into the earth's crust. This technique will indicate what rock fractures look like, what minerals are present, why recovery of oil was poor, or even how the drilling bit was lost.

Capable of reaching 5,000 feet into earth, one camera looks downhole and the other views sidewalls. In smaller-diameter holes where the camera is close to the wall, an amazing amount of detail can be seen on the screen.

Cameras were developed by the Lawrence Radiation Lab. of the University of California.

A TELEVISION SYSTEM that sends pictures of bank depositors' signatures over ordinary telephone lines has been put into operation in Philadelphia by the Provident Tradesmens Bank & Trust Co. The "Videx" system sends pictures between the bank's central signature file and its headquarters. A typical transmission takes 20 seconds. System was developed by ITT.

A 9-WATT CONTINUOUS WAVE LASER has been announced by Airco, Inc., New York 17, N. Y. Intended as a research tool, the new laser is to be applied commercially—with the development of more sophisticated units—in two major fields: welding of light gauge metals, and chemical synthesis.

The new laser is a four-level type in which a dysprosium-doped calcium fluoride crystal is excited by four xenon high-pressure lamps in a cloverleaf-type cavity. An extensive liquid nitrogen cooling system is used to dissipate heat generated during operation. A continuous laser, rather than the pulsed (intermittent) type, provides the uniform heat needed for high-quality welds.

EDITOR'S MAIL BOX

TRANSOCEAN COMMUNICATIONS still appear best by cable to AT&T. Modern cable transmission techniques coupled with better amplifiers can handle more messages than past cable systems.

We recently made a tour of AT&T's new and only cable ship C. S. Long Lines. AT&T feels that its cable-laying program is extensive enough to own its own cable-laying ship instead of hiring other ships, as in the past. The decision to spend over $19 million for the vessel plus the cost of the cable and vessel operation is interesting in light of recent discussions and general interest in communications satellites.

LOGIC CIRCUITS using wide-tolerance tunnel diodes, operating at speeds measured in billionths of a second, have been practically applied. The UNIVAC Div. of Sperry Rand Corp. says the circuits are being used in TUDAT (Tunnel Diode Arithmetic Tester), basically a serial adder and subtractor using several coaxial cable registers.

A tunnel diode and a "charge storage" or enhancement diode combination made TUDAT possible. This hybrid produces a circuit with the speed capabilities of a tunnel diode circuit, but with voltage and component tolerances typical of transistor circuits. Another advantage is a fan-in and fan-out of 3 to 5 permitting easy logic implementation.

FIRST MICROELECTRONICS CONFERENCE is tentatively scheduled for December 10-11 at the University of Pennsylvania by EIA in cooperation with the university. Major areas to be covered are linear and digital integrated circuitry, microsystems packaging, new devices, and microwatt electronics.

AN ELECTRONIC MEMORY that can instantly select and read any one of nearly a billion characters of data has been developed by Burroughs Corp., Detroit, Mich.

Any item in the electronic disk file can be located in 1/50th of a second. The file has a capacity of 960 million characters, but can fit the memory needs of even smaller businesses because of its modular design.

Speed of the new file comes from independent read-write heads over each "track" or band of information on every disk.

PLAN YOUR "WESCON" ACTIVITIES

in this 12-page booklet.

Copies will be bound into our August Wescon issue.

Additional copies will be distributed from our booth #2612

HIGHLIGHTS OF THE "SHOW PLANNER" ARE:

- Diary type pages for listing who or what to see each day of the show.
- Pages for noting daily expenses and entertainment charges.
- Locator map of San Francisco's hotels and motels.

WATCH FOR THE PLANNER. TAKE IT WITH YOU!

ELECTRONIC INDUSTRIES • a chilton publication

DU MONT FORECASTS TV TRANSMISSIONS TO BLIND

A future TV system may bypass the human eye, send electronic impulses to the brain, and enable the blind to actually "see" the pictures, Dr. Allen B. Du Mont stated recently.

Dr. Du Mont, TV pioneer and senior technical consultant, Du Mont Laboratories, predicted TV uses in industry, transportation, medicine, education and "almost every possible field of endeavor."

But he had a completely different view of military TV potential. "Because there will no longer be military establishments as such in 1988," he said, "TV will no longer have application. . . . We will either have gone too far with our nuclear lunacy, or the essential problems of peace and mutual existence will have been solved."

"Reaching out as far as possible," he said, "there are outstanding electronic scientists who are firmly convinced that we will eventually be able to feed electrical waves directly to the human brain—and to feed them with such precision that, in combination with the human nervous system, a blind person will actually enjoy TV pictures.

"We will electronically bypass the human eye, and yet achieve the same stimuli to the correct parts of the nervous system," Dr. Du Mont said.

He foresees the miniaturization of TV receivers through micro-circuitry and improved display devices so that "We will, without doubt, see very small, compact TV receivers — small enough to fit into one's side pocket or a lady's purse—similar to the small a lady's purse."

WESTINGHOUSE DEVELOPS AF SPACE POWER SYSTEM

A thermoelectric space power system for the Air Force is being developed by the Aerospace Electrical Div., Westinghouse Electric Corp., Lima, Ohio.

Working under a $94,000 contract from the AF Aeronautical Systems Div., the Westinghouse unit is to design, construct and test a ground unit that can produce 10 w. of power.

No batteries are to be used with the system. Instead, during the daylight part of an orbit, lithium hydride will store heat for use by the thermoelectric generator during the dark portion. System design requirements call for 55 min. in daylight and 35 min. in the earth's shadow.

GEMINI TAPE RECORDER

Miss B. Miller holds tape recorder built by RCA Surface Communications Div. for Gemini spacecraft. The 10 w. recorder will tape 4 hrs. of telemetry data aboard craft, play it back in 11 min. The unit weighs 12 lbs.

SPACECRAFT PARTS EXCEED MIL-SPEC. FAILURE RATES

Failure rates below Mil-spec. for parts and components have been achieved at General Electric's Space Technology Center, Valley Forge, Pa. in 2 Air Force-sponsored tests.

In the first test series, 100% screened Mil-spec. components and subsystems withstood from 1 to almost 7 months of space environmental and operating conditions.

In the second, new design and testing methods and standards for parts and materials resulted in a considerable failure rate improvement. Both test series included design-level vibration as well as heat and vacuum equal to space conditions.

The first test involved 14,950 components, or 85% of a spacecraft's electronic hardware. As a result of the screening and controlled use of the parts, failure rates better than Mil-spec. were achieved here, too.

An infrared earth-sensing subloop, consisting of IR sensor, bolometer power supply and horizontal computer (1,300 electronic parts), underwent nearly 7 months (4,848 hours) of continuous thermal cycling and vacuum test. Vacuum was maintained at 10^{-5} mm mercury and temperatures cycled 3 times a day between 32° and 104°F.

In the second test, new design standards were written for materials, electronic packaging, circuit design, structures, and electromechanical and mechanical uses.

Spacecraft Dept. representatives went into the market and individually surveyed and selected procurement sources.

WESCON CHAIRMAN HONORED

Donald C. Duncan (r), Pres. of Duncan Electronics, Costa Mesa, Calif., is honored on retirement as Chmn. of 1962 Western Electronic Show and Conv. Burgess Dempster, Chmn. of Los Angeles Ccl., Western Elec. tronic Mfrs. Ass'n., presents the plaque.

CAMERA PHOTOGRAPHS FROM REAR OF CRT

A modified CRT enables Army scientists to take improved photos of a video display and still keep the tube face in view.

Designed by the Army Electronics R&D Lab., Ft. Monmouth, N. J., and General Dynamics Corp., the experimental tube is used to record and analyze oscilloscope patterns.

A 2-in. transparent porthole in the tube's normally opaque rear section allows a camera to take photos of the tube display while the operator views from the front. Previously, the camera used to be in front while the operator watched through a small port.

The image from the back is 2-3 times brighter than from the front, and fine picture details show up more clearly.

In another photographic development, a way to take pictures and develop them in .1 to .01 sec. by flashing light onto an electrostatically charged film has been announced by General Electric Co.

The dry-processed pictures have surprisingly little grain and can be developed and "erased" simply by heating the film. Film then can be reused. So fine is the resolution that as many as 144 sharp photos can be produced in a space of 2 sq. in. The film can be made either sensitive or insensitive to nuclear radiation.

The "PPR" film can be left in the open before use, even in bright sunlight, without damaging its image-recording qualities.

BUSINESS ELECTRONIC PHONE EXCHANGE GETS FIRST TRIAL

An electronic telephone switching system for private business exchanges developed by Bell Telephone Laboratories, Holmdel, N. J., will soon be given its first trial at a New Brunswick, N. J., firm.

Two groups of equipment make up the system—a switch unit for the customer's office, and a central control unit in a telephone exchange. Each switch unit handles 200 phone lines, and 32 switch units can be connected to a central unit.

A switch unit contains a time-division switching network, line circuits, and the trunk terminal equipment for the customer's office. A cabinet, about the size of 3 ordinary 5-drawer file cabinets, holds the equipment.

The control unit acts according to information in both semi-permanent (program) and variable (scratchpad) memory system. Each system contains switching instructions in magnetized spots on metal program cards. The scratchpad memory governs selection of the program card needed at any stage of the call.

Program cards can be replaced.

DATA HELP FOR AF

Col. T. E. Peddy (1), Chief of Data Mgmt., AF Logistics Command, and Maj. Gen. C. W. Cecil, AFLC Controller, inspect the first of thirty 301 computers RCA will deliver to AFLC to replace punched card equipment at 10 key U. S. cites. J. R. Wall, an RCA representative, is seated at the console.

UNIVAC SYSTEM PROVIDES OFF-LINE DATA PROCESSING

Univac Div., Sperry Rand Corp., has introduced a computing subsystem that can perform off-line data processing for large scale Univac systems.

Called Univac 1050, it is a solid-state, character addressable system with a maximum capacity of 32,768 6-bit alphanumeric characters and 4.5 sec. memory time.

COLOR TV CENTER SLATED BY RCA AT WORLD'S FAIR

The RCA exhibit will serve as the 1964-65 New York World's Fair's official color TV communications center.

Among its features: a gallery where visitors will view all that goes into producing color programs; a color TV network, linking the Center to 200 receiving points within the Fair grounds; a "see yourself in color" demonstration; a color TV mobile unit that will move about to pick up events of interest for transmission over the system; and listening rooms for stereo and hi-fi enthusiasts.

NSIA COMMITTEE TO CUT DEFENSE COSTS

The National Security Industrial Association has appointed a Value Assurance Committee to help accelerate cost reduction programs in defense spending.

G. T. Willey, Vice President and General Manager for the Orlando, Fla., Div. of Martin Co., was named chairman. The Committee was appointed at the request of Thomas D. Morris, Asst. Sec. of Defense for Installations and Logistics.

HIGH-RESISTANCE FILM HAS LOW TEMP. COEFFICIENT

Thin films with sheet resistivities of 10,000 ohms/sq. have been produced at Bell Telephone Laboratories, Holmdel, N. J., by sputtering tantalum in an oxygen-argon atmosphere.

This high sheet resistivity means that a 100 megohm resistor can now be made on .02 sq. in. of substrate.

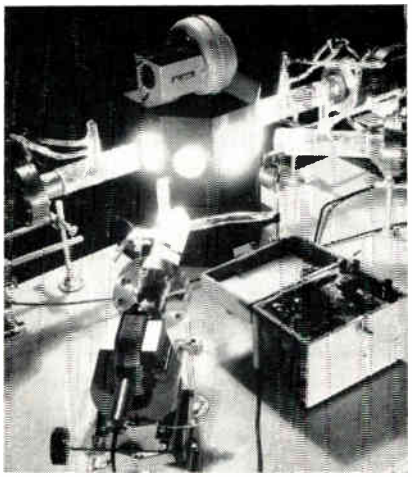
(Ohms/sq. equals ohms per square. It is proportional to the specific resistance of the material and inversely proportional to the film thickness. The term "square" is a dimensionless quantity that represents a square area of the film. For a given film thickness, any square area of the film has the same resistance value.)

By controlling the pressure of oxygen during sputtering in argon, stable, high-precision tantalum resistors with low temp. coefficients were obtained. A tantalum resistor thus sputtered has a sheet resistivity of 1,000 ohms/sq and a temp. coefficient of resistance of —500 ppm per deg. C. A tantalum resistor with sheet resistivity of 10,000 ohms/sq. had a temp. coefficient of resistance of —2,000 ppm per deg. C.

Sputtered thin films are made by bombarding a metal cathode with ionized inert gas molecules. The metal atoms dislodged from the cathode redeposit on a nearby surface to form a thin film.

Bell Labs recently showed that sputtering tantalum thin-film resistors in a partial nitrogen atmosphere increased their stability and reliability. The oxygen sputtered films offer electrical properties that complement those of nitrogen-sputtered films, which are limited to resistivities less than 200 ohms/sq.

SPACE PAINT TEST



Inorganic paint samples on ends of glass tubes undergo ultra-violet radiation in test at Hughes Aircraft Co., Culver City, Calif. Hughes developed thermal control paints to combat heat and cold found in space. One was used on Syncom; others will be on Surveyor, OSO and Apollo satellites.

TUNNEL-DIODE MEMORY HAS 600 NANOSEC. CYCLE

A tunnel-diode memory installed in a STRETCH computer by IBM Corp. fetches and stores data in a cycle time of 600 nanosec. In tests, cycle times have been lowered to 200 nanosec., 3 times the speed needed by STRETCH.

The memory's capacity is 17 computer words of 74 bits each, or 150 regular letters or numbers. The 200 nanosec. cycle enables the memory to process over 45 million letters or numbers/sec.

Basic component in the memory is a tiny circuit containing the diode, a resistor and an inductor, all in a plastic cell. A total of 1,258 of these cells are mounted on two 4½ x 16 in. printed-circuit cards, which are plugged directly into the computer. This design permits easy maintenance and affords high reliability.

NEW Subscription Order

I wish a new complimentary Subscription to

ELECTRONIC INDUSTRIES

Company Name _____ Mail Stop or Div./Dept. _____

Name _____ Position/Title _____

Company Address _____

City _____ Zone _____ State _____

IMPORTANT

FOR OUR STATISTICAL RECORDS PLEASE CHECK **THE ONE** APPROPRIATE CATEGORY THAT BEST DESCRIBES YOUR COMPANY OR DEPARTMENT. Failure to do so will delay your subscription.

- ☐ Mfr. of non-military electronic receiving and transmitting equipment.
- ☐ Mfr. of non-military electronic instruments, measuring, control and test equipment.
- ☐ Mfr. of non-military electronic computers, data processing, analysers, business machine.
- ☐ Mfr. of Guided Missiles and Accessories; Aircraft and Accessories, All Type of Military Products and Equipment.
- ☐ Mfr. of electronic components, parts, tubes and like products.
- ☐ Mfg. Co. (non electronic) using any of the above equip. in mfr., research or development work.
- ☐ Broadcasting or telecasting station.
- ☐ Commercial communication user (Tel & Tel, Police, Airports, Recording Studio, Etc.).
- ☐ Independent research, test, design laboratories and independent consultants—not part of a mfg. Co.
- ☐ Gov't Bureaus, Gov't laboratories, Gov't research center, military installation.
- ☐ Wholesaler, mfg. representative, service firm.
- ☐ University (educational) Public Library.
- ☐ Other (Please explain) .....

CHANGE OF ADDRESS

I wish to continue receiving ELECTRONIC INDUSTRIES
Change my address as indicated.

OLD

Paste wrapper imprint here, or . . .
Write in *complete* old address

NEW

Company _____
Mail Stop or Div./Dept. _____
Title/Position _____
Company Address _____
City _____ Zone _____ State _____
Signature _____

IMPORTANT

FOR OUR STATISTICAL RECORDS PLEASE CHECK **THE ONE** APPROPRIATE CATEGORY THAT BEST DESCRIBES YOUR COMPANY OR DEPARTMENT. Failure to do so will delay your address change.

- ☐ Mfr. of non-military electronic receiving and transmitting equipment.
- ☐ Mfr. of non-military electronic instruments, measuring, control and test equipment.
- ☐ Mfr. of non-military electronic computers, data processing, analysers, business machine.
- ☐ Mfr. of Guided Missiles and Accessories; Aircraft and Accessories, All Type of Military Products and Equipment.
- ☐ Mfr. of electronic components, parts, tubes and like products.
- ☐ Mfg. Co. (non electronic) using any of the above equip. in mfr., research or development work.
- ☐ Broadcasting or telecasting station.
- ☐ Commercial communication user (Tel & Tel, Police, Airports, Recording Studio, Etc.).
- ☐ Independent research, test, design laboratories and independent consultants—not part of a mfg. Co.
- ☐ Gov't Bureaus, Gov't laboratories, Gov't research center, military installation.
- ☐ Wholesaler, mfg. representative, service firm.
- ☐ University (educational) Public Library.
- ☐ Other (Please explain) .....

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed In U. S. A.

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES
Chilton Company
Chestnut & 56th Sts
Philadelphia 39, Pa.

Att: Circulation Dept.

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed In U. S. A.

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES
Chilton Company
Chestnut & 56th Sts.
Philadelphia 39, Pa.

Att: Circulation Dept.

The Systems Engineering Section of ELECTRONIC INDUSTRIES

ELECTRONIC SYSTEMS

ELECTRONICS SIMPLIFIED

RCA's new Dynamic Demonstrator, displayed at recent Electronic Parts Show in Chicago, can be used to explain the operation of a transistor radio. To simplify understanding, each component is mounted near its symbol on the large diagrammed board. The complete circuit is visible, can be traced as it is explained.

The FCC has proposed a joint committee to promote UHF television. Called "Committee for the Full Development of UHF Broadcasting," the group will represent the FCC and various industrial groups interested in UHF. At FCC's request, Congress has already enacted Public Law 87-529 giving the FCC power to require all TV receivers shipped and sold to the public across state lines to be capable of handling all frequencies allocated for TV broadcasting.

An FAA rule restricting use of FM portable radios on U. S. civil aircraft has been made permanent. The rule had been a temporary measure since May 1961, after FAA tests showed FM radios in aircraft interfere with operation of VHF radio navigation equipment. Final action was deferred pending evaluation of test results. The rule prohibits operation of FM radios during flights in airliners and other commercial craft. It also prohibits their use on other civil aircraft when the VHF navigation gear is operating.

FCC accepts design service areas for AT&T's Wide Area Data Service (WADS) but suggests that aspects of WADS's proposed flat charge rates are unreasonably discriminatory between customers, and their legality is not established. WADS offers teletype communications on an area basis rather than point to point as on regular TWX. WADS would allow customers a choice of six progressively larger service areas within which calls could be placed (the largest U. S.) at full time, measured time and receiving only.

United States Information Agency has ordered nine 250,000-watt short wave transmitters from Collins Radio. The transmitters, new functional types, allow frequency change within 20 seconds, instead of from two to 15 minutes per transmitter in previous designs. They will have "pre-set" capabilities where changes can be pre-determined and executed on command, and will supplement USIA's program to improve its world signal quality. The transmitters will be installed in Agency facilities at Bethany, Ohio, and at Delano and Dixon, Calif.

General Dynamics/Astronautics has delivered first components for Glotrac, advanced satellite and spacecraft tracking system, to Cape Canaveral. Glotrac (Global Tracking Network) is a range and range-rate tracking system with a 23,000-statute-mile range. It can determine a vehicle's flight velocity to better than one half foot per second and its position within 100 feet. The initial system will have stations at Cape Canaveral; Atlantic, North Carolina; Bermuda; San Salvador; Antigua; and Grand Turk.

NAB has asked FCC to drop a log rule requiring AM and FM facilities to be inspected five days a week by a first-class engineer. NAB says the rule will impose an unnecessary burden on broadcasters without public benefit or improved performance. They observed that some small stations perhaps don't keep a first-class engineer full-time and are violating FCC rules. But the majority should not suffer for the miscreant few. NAB does support the use of automatic logging devices for more accurate records of a station's technical operations.

PUSH-BUTTON LESSONS

United Air Lines passenger agent selects button on Teleregister Instamatic agent set, which has been set up as an instructive unit. Answers are recorded on cards as agent operates machine and refers to programmed lesson. Complete program is stored in Instamatic "memory drum" at United's Denver Center.

Low frequency, narrow band filters are often needed in control systems. Since passive filters are unwieldy at low frequencies, either active filters or demodulator-filter-modulator systems are used. A simple active filter is described here along with graphical design techniques.

For Sub-audio Control systems

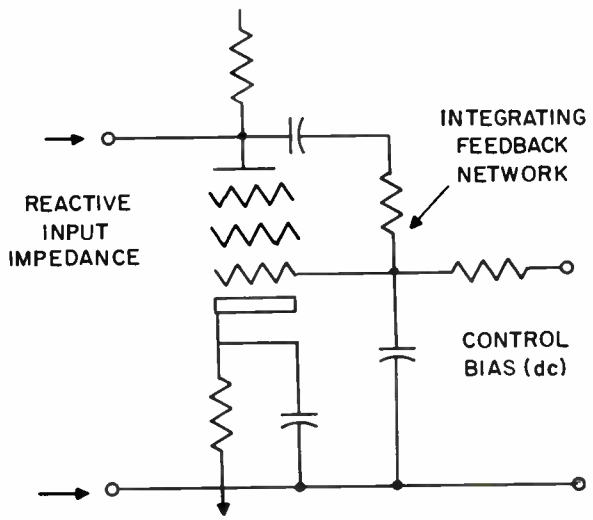
DESIGNING ACTIVE TUNED FILTERS

NARROW BAND FILTERS are very useful for harmonic analysis, separation of signals and noise, and filtering the modulation on a carrier signal. It is usually necessary to vary the center frequency of these filters, manually or automatically, to track the desired signal.

At the sub-audio frequencies used in control systems, passive inductor-capacitor circuits are too heavy and bulky for most uses. As an example, a 16 cycle tuned filter with a 1.6 cycle bandwidth, a 50,000 ohm generator impedance, and a gain of one-half would require a 4 μf capacitor and a 25 henry inductor. The inductor would weigh about 1 lb. and occupy six cubic inches.

In some cases, filtering is obtained by demodulating the signal, filtering this output with an R-C network, and remodulating the resultant signal. These circuits tend to be complex, to generate noise or drift, and to attenuate the signal. Active circuits using parallel or bridged-T networks are common, but are unsatisfactory when the center frequency must be varied.

Fig. 1: A familiar inductive reactance-tube is shown below.



The circuit described here uses a reactance amplifier to simulate a variable inductance. The reactance amplifier is often used to modulate the frequency of a tuned circuit. If enough gain is provided, it can completely replace the inductors, resulting in a light weight, high Q, variable tuned filter. In the 16 CPS filter mentioned above, the inductor may be replaced with three stages of amplification; the frequency may then be varied with a potentiometer.

Reactance Amplifier

The familiar inductive reactance-tube circuit, shown in Fig. 1, simulates an inductance by drawing a reactive current in response to voltage signals at the input terminals. The integrating effect of the plate-grid feedback network creates the reactive current. Losses in the tube plate resistance and load resistor, and the departure from ideal of the integrating network, result in a finite Q.

For high Q operation, the circuit requires more gain than can be obtained in a single stage. Since the tuned filter will normally be used with an amplifier, a portion of the voltage gain of that amplifier may be used in the reactive feedback loop.

Fig. 2 is the simplified drawing of a suitable reactance amplifier; the driver amplifier is shown as a current source, since both pentodes and transistors are best handled that way. The amplifier includes a single predominant time lag, represented by τ, which must be placed in the feedback path. The reverse in polarity, implying an odd number of amplifier stages, is also essential.

By HERBERT D. DEPEW
Engineering Staff Specialist
General Dynamics/Pomona
Pomona, Calif.

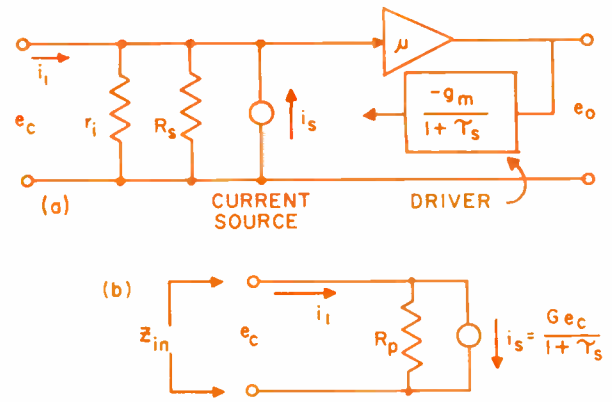


Fig. 2: Simplified drawings of a suitable reactance amplifier.

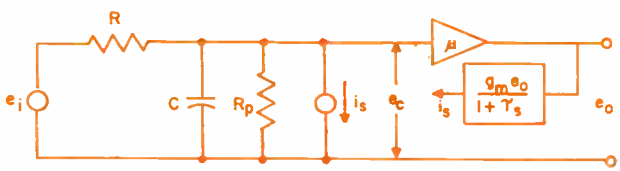


Fig. 3: Drawing of an active tuned circuit is shown above.

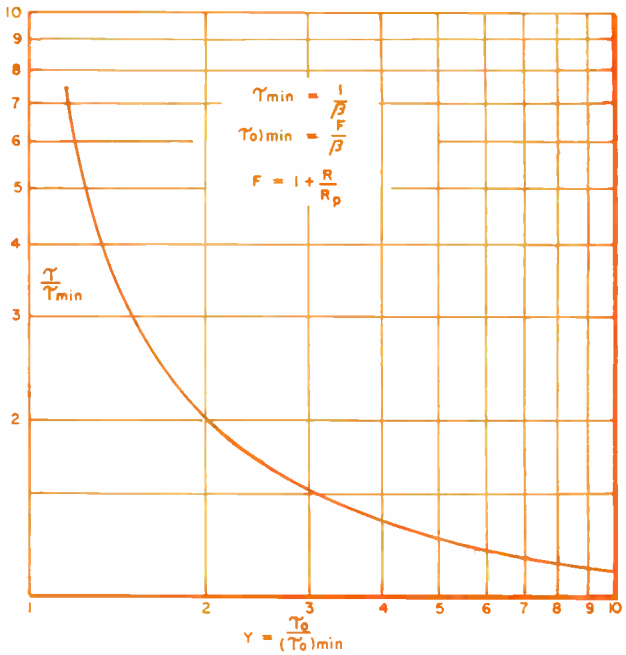


Fig. 4: The proper relationship between time constants is shown.

The total open loop impedance of this circuit includes the feedback driver source impedance R_s, and the amplifier input impedance r_i. Since these appear in parallel they may be lumped together as shown in Fig. 2b. The source impedance (R_s) is the parallel combination of tube (or transistor) impedance, r_p, and the operating load resistance, R_L. Thus:

$$R_s = \frac{r_p R_L}{r_p + R_L} \quad \text{and} \quad R_p = \frac{r_i R_s}{r_i + R_s}$$

For simplicity, the overall gain G is defined as the product of the forward gain (μ) and the feedback gain (g_m). Since μ is unitless, the gain G is in the form of a transconductance. It is important to place as much of the gain as possible in the forward path, since the maximum voltage swing that may be handled without distortion is determined by the driver stage. The output voltage of the circuit (e_o) cannot exceed the maximum driver swing divided by the driver gain.

Active Tuned Circuit

Fig. 3 is a drawing of the active tuned circuit. The transfer function to the input of the amplifier is:

$$e_c/e_i = \alpha_o \left\{ \frac{1 + \tau s}{1 + \alpha_o [\tau_o + F \tau] s + \alpha_o \tau \tau_o s^2} \right\}$$

$$= \frac{\alpha_o (1 + \tau s)}{1 + (2\zeta/\omega_o) s + s^2/\omega_o^2} \qquad (1)$$

where:

$$\alpha_o \equiv \frac{R_p}{R + R_p + R R_p G} = \frac{1}{F + R G} = \text{dc response} \qquad (2)$$

$$\tau_o \equiv R C \qquad (3)$$

$$F \equiv (1 + R/R_p) \qquad (4)$$

$$\omega_o = \sqrt{\frac{1}{\alpha_o \tau \tau_o}} = \text{Damped natural frequency (rad/sec)} \qquad (5)$$

and:

$$\zeta = \frac{1}{2} \sqrt{\frac{\alpha_o}{\tau \tau_o}} \left[\tau_o + F \tau \right] = \text{damping ratio} \qquad (6)$$

The damped natural frequency (ω_o) and the damping ratio (ζ) are always fixed by the filter requirements. If the needed bandwidth (defined between -3db points) is known, the damping ratio is given by

$$\zeta = \frac{\beta}{2\omega_o}, \text{ where } \beta = \text{bandwidth} \qquad (7)$$

If the circuit is to be used for low pass filtering of the modulation on a carrier, the damping ratio is related to the *equivalent* filter time constant (τ_e) by:

$$\zeta = \frac{1}{\omega_o \tau_e} \qquad (8)$$

Two other parameters of interest are the gain at resonance, defined as α_R, and the ratio of resonance gain to gain at dc, defined as $\rho \equiv \alpha_R/\alpha_o$. These parameters are found by substituting $s = j\omega_o$ and $\theta_o \tau$ into Eq. 1:

$$\alpha_R = \frac{\alpha_o \sqrt{1 + (\omega_o \tau)^2}}{2\zeta} = \frac{\alpha_o \sqrt{1 + \theta_o^2}}{2\zeta} \qquad (9)$$

$$\rho = \frac{\alpha_R}{\alpha_o} = \frac{\sqrt{1 + \theta_o^2}}{2\zeta} \qquad (10)$$

TUNED FILTERS (Continued)

In general, it is necessary to satisfy requirements for the four dependent parameters ω_o, ζ, α_R, and ρ by proper selection of the independent parameters R, C, R_p, G, and τ. The dc rejection ρ may be ignored if the forward amplifier includes ac coupling capacitors which block the dc signals. However, dc coupling is often used in transistor amplifiers.

Eliminating α_o between Eqs. 5 and 6:

$$\tau = \frac{\tau_o}{\beta\,\tau_o - F} = \frac{1}{\beta - F/\tau_o} \quad (\beta = 2\,\zeta\,\omega_o = \text{bandwidth}) \qquad (11)$$

Eq. 11 gives a relation between time constants which satisfies Eqs. 5 and 6 simultaneously. Since τ must be positive, it is necessary that:

$$\tau_o > F/\beta$$

and consequently the minimum value of τ_o is:

$$(\tau_o)_{min} = F\,\beta \qquad (12)$$

from Eq. 11 the minimum value of τ occurs at $\tau_o = \infty$ and is:

$$\tau_{min} = 1/\beta, \quad \textit{Then if:} \qquad (13)$$

$$\gamma = \tau_o/(\tau_o)_{min}, \qquad (14)$$

$$\tau\ \tau_{min} = \frac{\gamma}{1-\gamma}. \qquad (15)$$

Eq. 15 is plotted in Fig. 4. Solving Eq. 11 for τ_o and substituting into Eq. 5 gives:

$$\alpha_o = \frac{\beta\,\tau - 1}{F\,(\omega_o\,\tau)^2} = \frac{2\,\zeta\,\theta_o - 1}{F\,\theta_o^2} \qquad (16)$$

and substituting Eq. 16 into 9:

$$F\,\alpha_R = \frac{2\,\zeta\,\theta_o - 1}{2\,\zeta\,\theta_o^2}\sqrt{1+\theta_o^2} \qquad (17)$$

Eqs. 10 and 17 are plotted in Fig. 5. Fig. 4 shows the required relationship between time constants and Fig. 5 shows the minimum value of τ (in terms of θ_o) that will satisfy a requirement either for α_R or for ρ. The absolute minimum value for θ_o corresponds to $F\alpha_R = 0$, and can be derived directly from Eq. 13. The amplifier gain can be found from Eqs. 2 and 16:

$$RG = F\left|\frac{\theta_o^2 - 2\,\zeta\,\theta_o + 1}{2\,\zeta\,\theta_o - 1}\right| \qquad (18)$$

or:

$$G = \left(\frac{1}{R_T}\right)\left|\frac{\theta_o^2 - 2\,\zeta\,\theta_o + 1}{2\,\zeta\,\theta_o - 1}\right| \qquad (19)$$

where $R_T = \dfrac{R\,R_p}{R + R_p}$ = total parallel resistance.

Eq. 19 shows that the minimum value for the gain G occurs at $\theta_o = 1/\zeta$ and at the maximum possible value of R_T. The magnitude of the gain penalty incurred by not optimizing θ_o is found by letting $\theta_o = K/\zeta$, where $K > 0.5$, and solving for $R_T G \zeta^2$:

$$R_T G\,\zeta^2 = \frac{K^2}{2\,K - 1} - \zeta^2 \qquad (20)$$

Eq. 20, plotted in Fig. 6, shows the importance of optimizing θ_o (if gain is critical), and shows that for high Q circuits:

$$G \approx 1/R_T\,\zeta^2 \qquad (21)$$

if $\theta_o \approx 1/\zeta$. If the optimum value of θ_o is substituted into Eq. 17:

$$(F\,\alpha_R)_{opt} = 0.5\sqrt{1+\zeta^2} \approx 0.5 \text{ (for small } \zeta). \qquad (22)$$

Therefore:

$$\alpha_R \approx 0.5/F \qquad (23)$$

Eqs. 19 and 23 show conflicting requirements on the value of R: it should be large to reduce the required amplifier gain, and small to maximize the overall gain at resonance. Selection of R should be based partly on the available forward amplifier gain in the practical circuit.

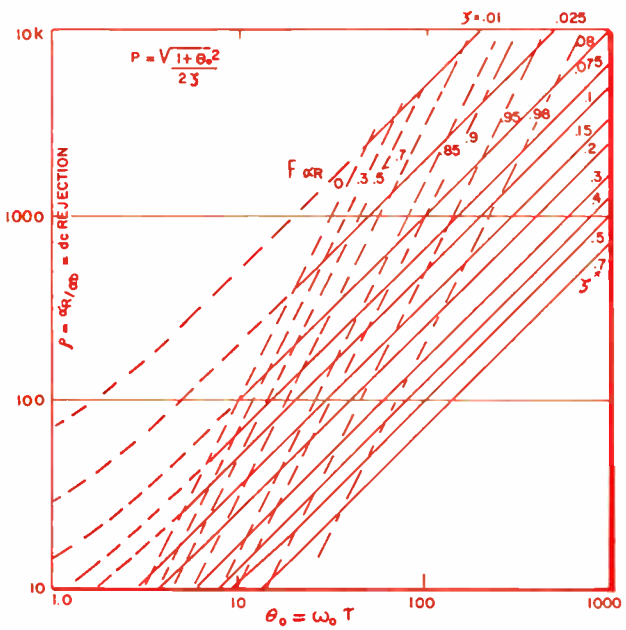
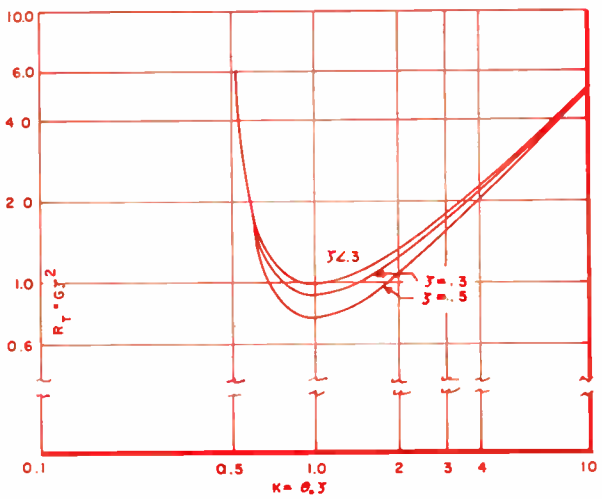


Fig. 5 (left): Eqs. 10 and 17 are plotted showing minimum τ.

Fig. 6 (below): Curves show the importance of optimizing θ_o.



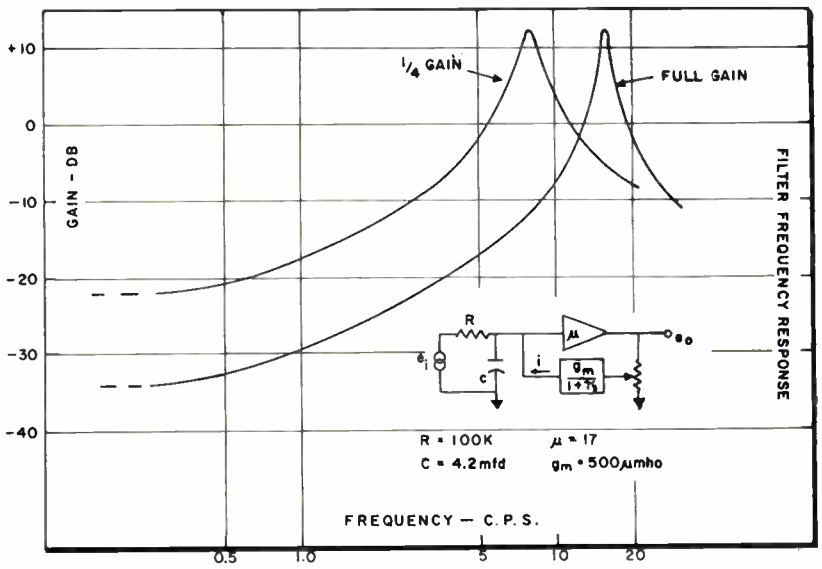


Fig. 7: The response at two frequency extremes of a circuit with the parameters derived by the equations given in the text is shown.

Variable Frequency Operation

Eqs. 5 and 6 show that the resonant frequency and damping ratio are functions of three possible controlled variables: α_o, τ, and τ_o. The bandwidth, from Eqs. 5 and 6 or from Eq. 11:

$$\beta = 2\zeta\omega_o = \frac{\tau_o + F\tau}{\tau\tau_o} \tag{24}$$

is independent of the value of α_o. From Eqs. 2, 6 and 9 the resonance gain is:

$$\alpha_R = \frac{\tau}{\tau_o + F\tau}\sqrt{1 + \alpha_o(\tau_o - \tau)} \tag{25}$$

or, since the two time constants are of the same order of magnitude and $\alpha_o << 1$:

$$\alpha_R \cong \frac{\tau}{\tau_o + F\tau} \tag{26}$$

which is also independent of the value of α_o. Consequently, if α_o is controlled, the frequency can be varied while the bandwidth and gain at resonance are held constant. From Eq. 2:

$$\alpha_o = \frac{1}{F + RG} = \frac{1/F}{1 + RG/F} = \frac{1/F}{1 + R_T G} \tag{27}$$

but from Eq. 21, $R_T G \approx 1/\zeta^2 >> 1$, so that:

$$\alpha_o \cong \frac{1}{FR_T G} = \frac{1}{RG} \tag{28}$$

or is inversely proportional to the feedback gain G. Substituting 28 into 5:

$$\omega_o \cong \sqrt{\frac{RG}{\tau\tau_o}} = \sqrt{\frac{G}{C\tau}} \tag{29}$$

Therefore, the resonant frequency of the circuit is proportional to the square root of the feedback gain, which may be varied electronically or by means of potentiometers. Note from Eqs. 28 and 29 that, when designing a variable frequency filter, the highest frequency should be used to determine the overall gain, while the lowest frequency should be used to check the dc rejection ratio ρ.

Design Procedure

The best way to show the design procedure is with a numerical example. Assume the requirements for a tuned filter are:

ω_o : 8–16 cps = 50–100 rad/sec
β : 1.6 cps = 10 rad/sec
$\rho \geq 40$

1. At the highest frequency, the damping ratio is:

$$\zeta = \frac{\beta}{2\omega_n} = \frac{10}{200} = 0.05$$

2. Find the junction of the $F\alpha_R = 0.5$ line (Eq. 22 and the $\zeta = 0.05$ line in Fig. 5. This shows that θ_o (max. freq.) = 20 and ρ (max.) = 200.
3. Follow the $F\alpha_R = 0.5$ line down to $\theta_o = 10$ (half frequency); the minimum ρ is 50, which is adequate. (If it were not adequate, the procedure would be to move up the constant ζ line to a satisfactory ρ (min.) which gives θ_o (min.), and then up to $2\theta_o$ (min.) to obtain values of θ_o and $F\alpha_R$ to use in the following steps. Also enter Fig. 6 with $K = \theta_o\zeta$ to find a value of $R_T G\zeta^2$ to use in place of Eq. 21.
4. The amplifier time constant is:

$$\tau = \theta_o\,\omega_o = \frac{20}{100} = 0.2 \text{ sec}$$

$\tau_{min} = 1/\beta = 0.1$ sec (from Eq. 13)
$\tau/\tau_{min} = 2$, and from Fig. 4: $\gamma = 2$.

5. (τ_o) min $= F/\beta = 0.1\,F$ sec.
$\therefore\ \tau_o = \gamma(\tau_o)$ min $= 2(0.1F) = 0.2\,F$ sec.

From this point the procedure depends upon the circuit to be developed. Assume a vacuum tube circuit with a pentode driver, including current feedback to stabilize the gain. The driver plate resistance may then be neglected. If the input resistance

TUNED FILTERS (Concluded)

is one megohm and a load resistor of 100K is used:

$$6. \quad R_\rho = \frac{10^6 \times 10^5}{1.1 \times 10^6} = 91\ K$$

and assume a (tentative) R = 100K:

$$R_T = \frac{10^5\ (91)\ 10^3}{1.91 \times 10^5} = 47.5\ K$$

$$F = 1 + R/R_\rho = 2.1$$

$$7. \quad C = \tau_o/R = 0.2\ F/10^5 = 4.2\ \mu fd.$$

$$8. \quad G = 400/R_T = 8400\ \mu mho \quad \text{(from Eq. 21)}$$

$$9. \quad \alpha_R = 0.5/F = 0.24 \quad \text{(from Eq. 23)}$$

Under the operating conditions assumed, a typical pentode may have a g_m of about 2500 μmho. Assuming this is reduced to 500 μmho by current feedback, the required forward gain is:

$$\mu = 8400/500 \cong 17$$

which can be obtained easily with two stages including negative feedback. The overall gain at resonance will be:

$$10. \quad (e_o/e_i)\ \omega_o = 0.24 \times 17 = 4,$$

or eight times the gain of the passive filter mentioned in the introduction. Fig. 7 shows the response at the two frequency extremes of a circuit with the parameters derived above.

Stability

The amplifier has been assumed to have a flat frequency response except for the predominant time lag. If there are coupling capacitors, they dynamic stability is assured by the choice of a positive damping ratio. If there are coupling capacitors, they must be selected so that the phase shift due to them is negligible at and near the desired resonant frequencies. High pass networks tend to increase the bandwidth and increase stability; low pass networks do the reverse and should be avoided.

Eqs. 5 and 24 show that the values of α_o, τ, and τ_o must be constant to maintain constant bandwidth and resonant frequency. The components that determine these parameters must be appropriately chosen for stability against aging, temperature changes, and drift in polarizing potentials.

ENGSTROM OUTLINES FUTURE OF AUTOMATION

"Technical means for achieving widespread automation are already at hand, but economic and social considerations will determine the rate at which we proceed," Dr. Elmer W. Engstrom, RCA President, recently told a conference on automation education and training in Cranfield, England.

"Automation is most beneficial in an expanding economy in which new job opportunities become available for persons temporarily dislocated by the introduction of automatic techniques," he added. "This dislocation can be minimized by retraining employees and improved education for those who enter the labor force.

"The principal revolution will occur in management techniques, as a result of the need for management concepts based on fully integrated enterprises operated constantly at or near their productive capacity," Dr. Engstrom continued.

"Tomorrow's management will face an interesting reversal of the traditional relationship between supply and demand. In most manufacturing industries today, production facilities can be operated economically at less than capacity whenever there is a slackening of market requirements. With the automated enterprise, productive facilities will have to be operated constantly at near optimum capacity in order to realize an adequate return on the far greater investment.

"This is already the case with highly automated petroleum and chemical plants," Dr. Engstrom pointed out, "and even with many of the new electronic computer and data processing facilities."

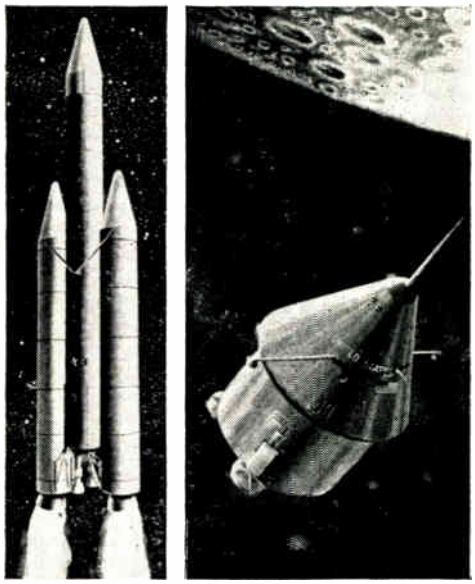
He said present-day management increasingly requires a comprehensive and penetrating understanding of the new tools of automation in order to invest wisely, and that both the organization and its members must be prepared in advance for technical change in order to insure maximum benefits with minimum dislocation.

EIA SPLITS DIVISION

The Electronic Industries Assoc. has split its former Tube and Semiconductor Div. into two divisions, raising the number of EIA divisions from five to six. The others: military equipment, consumer products, industrial electronics, and parts.

AC SPARK PLUG, THE ELECTRONICS DIVISION OF GENERAL MOTORS, OFFERS ENGINEERS AND SCIENTISTS . . .

OPPORTUNITY FOR GROWTH IN THE INERTIAL GUIDANCE AND NAVIGATION FIELD



AC has assembled one of the finest technical teams in the country. They are providing intellectual stimulus for such outstanding projects as APOLLO Navigation-Guidance, TITAN II & TITAN III Inertial Guidance and the B-52 C&D Bombing Navigation System. AC will also provide intellectual and professional stimulus for you. You enjoy the satisfaction of accomplishment at AC . . . not only in the job you do, but the advancement that comes from achievement. As a member of a division of General Motors, you will share outstanding corporate benefits.

Review the opportunities listed below. Then contact us for an immediate evaluation of your qualifications.

MIDDLE WEST—Milwaukee

(Systems Design, Development, Manufacturing)

SYSTEMS ANALYTICAL ENGINEERS—Perform analytical studies of inertial guidance systems, including analysis of system performance requirements, writing system model and error allocation specifications, conducting system simulations on digital and/or analog computers, conducting trajectory studies, and preparing guidance equations. BS, MS or PhD in EE, math and physics plus 2-5 years experience depending upon education.

SYSTEMS MECHANIZATION ENGINEERS—To design and mechanize inertial guidance systems or subsystems. BS, MS or PhD in EE, math or physics with minimum of 2 years aircraft or fire control experience employing closed loop systems, switching circuits and digital techniques.

CIRCUIT DESIGN & ANALYSIS ENGINEERS—To design and/or analyze servo amplifiers, DC operation amplifiers, power converters, feedback amplifiers and pulse circuits. Will work in the area of inertial measurement unit electronics. BSEE plus 3-5 years experience in above field required.

DIGITAL COMPUTER ENGINEERS—Logic design, evaluation of logic techniques, evaluation of memory storage, development of programming format and define computer subsystem functional block diagrams and input-output devices. BS or MS in EE or math and physics and 3-7 years experience in logic circuit design of digital computers.

GYRO ENGINEERS—Thermal and stress analysis of gyro instruments. Analytical ability and 2-5 years gyro design experience necessary. BS or MS in ME or EE required.

RADAR SPECIALISTS—Circuit design and analysis of airborne radar systems. Prepare functional block diagrams and define subsystems, analyze and test error budgets, perform analog and digital computer simulations including interfacing of associated subsystems and aircraft performance characteristics. BS or MSEE and 5-10 years radar-radio systems experience.

SCIENTIFIC PROGRAMMERS—Concerned with simulation of guidance and control systems, electronic system design and logic designs. Will perform satellite and trajectory studies, numerical and statistical analysis and systems calibration. BS or MS in engineering, physics or math with 1-3 years experience.

SYSTEMS ENGINEERS—To assist in interface of Apollo airborne and ground support equipment, including the development of test circuits to ensure proper GSE checkout before interface. BSEE, plus 2-3 years related experience required.

MECHANICAL DESIGN & DEVELOPMENT ENGINEERS—To assist in the design and development of Apollo ground handling equipment, Titan GSE consoles, drawers and other hardware. BS or MSME and 2-3 years related experience required.

EQUIPMENT DESIGN ENGINEERS—Design and development of transistorized electronic airborne and GSE equipment on Titan and Apollo projects. BSEE or ME with 2-5 years design experience.

DEVELOPMENT ENGINEERS—Perform engineering development, product support and coordinate design changes. BSEE or ME required.

WEST COAST—Los Angeles

(Advanced Concepts Laboratory-Research & Development)

SENIOR SCIENTIFIC PROGRAMMERS—To assist in trajectory analysis and guidance simulation problems. Strong mathematical background and experience on 7090 desired.

SENIOR MECHANICAL ENGINEER—Design of inertial guidance system hardware. BS or MSME with extensive background in thermodynamics and a minimum of 5 years related experience required.

For further information, write or send resumé to Mr. G. B. Raasch, Director of Scientific and Professional Employment, Dept. 5753, AC Spark Plug Division, General Motors Corporation, Milwaukee 1, Wisconsin.

AC SPARK PLUG

The Electronics Division of General Motors

An Equal Opportunity Employer

EAST COAST—Boston

(Advanced Concepts Laboratory—Research & Development)

INERTIAL & SPACE SYSTEMS ENGINEERS—To engage in the analysis, synthesis and mechanization and/or evaluation of advanced inertial navigation systems. Will perform optimization studies, error analyses and systems configuration studies in the field of space navigation, avionics, and attitude control systems. Advanced degree or BS with analytical systems background required. Two or more years experience in inertial systems preferred.

DIGITAL SYSTEMS ENGINEER—To engage in the adaptation of digital techniques to inertial navigation and avionics systems. BSEE and 3-5 years experience in the design of digital control systems required.

ELECTRONIC ENGINEER—To design and develop semiconductor pulse circuits, logic circuits, digital analog circuits and precision DC amplifiers, BS or MS plus 3-5 years experience in above field. Experience in the area of precision electrical measurement desirable.

SR. MECHANICAL ENGINEER—Responsible for the development of inertial instruments through the use of analysis and experimental verification. BSME plus 3-5 years experience in the design and development of precision electromechanical devices.

ELECTRONIC ENGINEER—To design transistor feedback and servo amplifiers, and low level switching circuits. BS or MS and 3 or more years experience in the above field desirable.

MECHANICAL ENGINEER—Design of miniature inertial platforms and gimbal systems. BS and 3-5 years experience in above field and inertial instrument application.

SR. METALLURGIST—To work in an expanding group conducting development programs and evaluation of both metallic and non-metallic materials as applied to inertial sensing devices. BS or MS with 3-5 years experience in metallurgical or related area.

MATHEMATICAL ANALYSTS—To perform analysis as required in the development of inertial components and systems. BS or MS in applied mathematics plus 1-3 years experience in the development of inertial components and systems. BS or MS in applied mathematics plus 1-3 years experience in the field of mathematical analysis.

PHYSICISTS & ENGINEERS—Excellent positions are available for Senior Physicists and Engineers preferably having advanced degrees and experience in the theoretical and experimental development of precision devices. The particular area of investigation relates the application of mechanics, electricity, nucleonics and physical phenomena to inertial measurement components such as gyros and accelerometers.

PROFESSIONAL OPPORTUNITIES

Reporting late developments affecting the employment picture in the Electronic Industries

Design Engineers
Development Engineers
Administrative Engineers
Engineering Writers
Physicists
Mathematicians
Electronic Instructors
Field Engineers
Production Engineers

SCIENTIFIC RESEARCH CENTER PROJECT

Pittsburgh's massive new research center—to be known as Panther Hollow—will span a mile-long ravine and will have this appearance when the center is completed.

DEANS REPORT NEED FOR MORE FELLOWSHIPS

A survey of engineer college deans points up the need for three times the number of available graduate fellowships, according to the Engineering Manpower Commission of Engineers Joint Council.

The EMC says the survey follows close on the heels of recommended Federal assistance for graduate training in engineering, mathematics and physical sciences.

Deans who responded, 136 in all, represent 90% of engineering colleges offering graduate courses. They reported 3,160 current graduate fellowships, with only 33 going unused, largely because of special provisions or limitations. They reported that nearly 6,500 additional fellowships would be used.

One-third of these would include money only for the student, and two-thirds with money for both student and the college. Several deans stressed the necessity for various forms of support to stimulate physical and faculty resources at the graduate level.

Some schools offered information by curricula breakdown. Data showed that about 15% of current fellowships are in electrical engineering. Of new fellowships desired, about 40 schools reported that of 75% of new fellowships, used in five new major curriculums, about 21% would be in electrical engineering.

SBA LOAN TO INCREASE JOBS IN PENNA. TOWN

Fisher Electronics, Inc., of Lewistown, Pa., in an area of substantial unemployment, will be able to employ about 150 additional people as a result of a development loan announced by the Small Business Administration.

The SBA approved a loan for nearly half-a-million dollars for Mifflin County Industrial Development Corp., of Lewistown, which will use the funds to build additional factory space for Fisher, makers of electronic components and high fidelity systems.

500 TECH. MEN SEEKING ENGINEER CERTIFICATION

More than 500 technicians throughout the nation have applied for certification from the newly established Institute for the Certification of Engineering technicians.

Dr. Merritt A. Williamson, dean of engineering at Pennsylvania State University, and chairman of the Institute's Board of Trustees, said that nearly 200 technicians have been certified in one of three grades: junior engineering technician, engineering technician, and senior engineering technician, with minimum experience requirements of two, seven and seventeen years respectively.

The Institute, sponsored by the National Society of Professional Engineers, was organized in 1961 to provide recognition for those members of the technological manpower team who work for engineers and often supervise other technicians and craftsmen.

CONN. CITY OFFERED AS NASA CENTER SITE

Willimantic, Conn., has been suggested as a suitable location for the proposed National Aeronautics and Space Administration Electronics Research Center.

Sen. Thomas J. Dodd (D.-Conn.) attacked what he called a "predetermined, arbitrary and tailor-made criteria" which would automatically place the NASA center in the "Boston area."

In offering the city of Willimantic, Sen. Dodd stressed its "good fortune" in being centrally located and easily accessible to and from universities, technical institutions and industrial research complexes, between Boston and New York City, including areas of Massachusetts, Rhode Island, Connecticut and New York state.

FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 168.

Motivation patterns are peculiar things. An engineer's tangled motivational matrix may send him clear across the nation to accept a job—or keep him rooted in his present location. Although many reasons cause him to move, an engineer is usually driven more by one or two dominant factors, as recent surveys disclose.

JOB SEEKERS' MOTIVATIONS: RECOGNITION, CHALLENGE, ETC.

THOUGH MANY THINGS WILL MOVE A TECHNICAL PROFESSIONAL in his never-ending quest for the ideal job, only a few prime movers are of current importance—challenge and recognition among them.

Yet, from recent surveys it is becoming more evident that the advantages and benefits offered by a company must at least match the desires of today's technical man who is swept up in the competitive tide among aerospace and defense firms for the best talent available. In some instances, motivators such as location, salary and educational advantages do come into focus.

Scientist or engineer—the technical professional is generally driven by a group of needs rather than by a single motive, although one or two large motives may dominate. Motives operate in bunches. Job motivation patterns come in three basic forms—job selection, job satisfaction and job retention—each with its own bunch of motives, which may fluctuate in value as often as the technical man changes his job.

If you could peer into our technical man's mind you might find his motives, not like neatly stacked blocks, but rather like tangled vine branches, entwined in every degree of intimacy.

Recognition and challenge are the factors that will motivate a scientist/engineer to devote enormous energy to his work.

As would be expected, most studies show that the technical professional is serious-minded, conscientious, and, if motivated properly, will devote enormous energy to his work.

Because he is dedicated, the technical professional usually pays close attention only to the "essentials" in his career. Some of his major career values are challenge, stimulating work, achievement, recognition, ascending degrees of responsibility, autonomy and independence.

Interesting Work Rates High

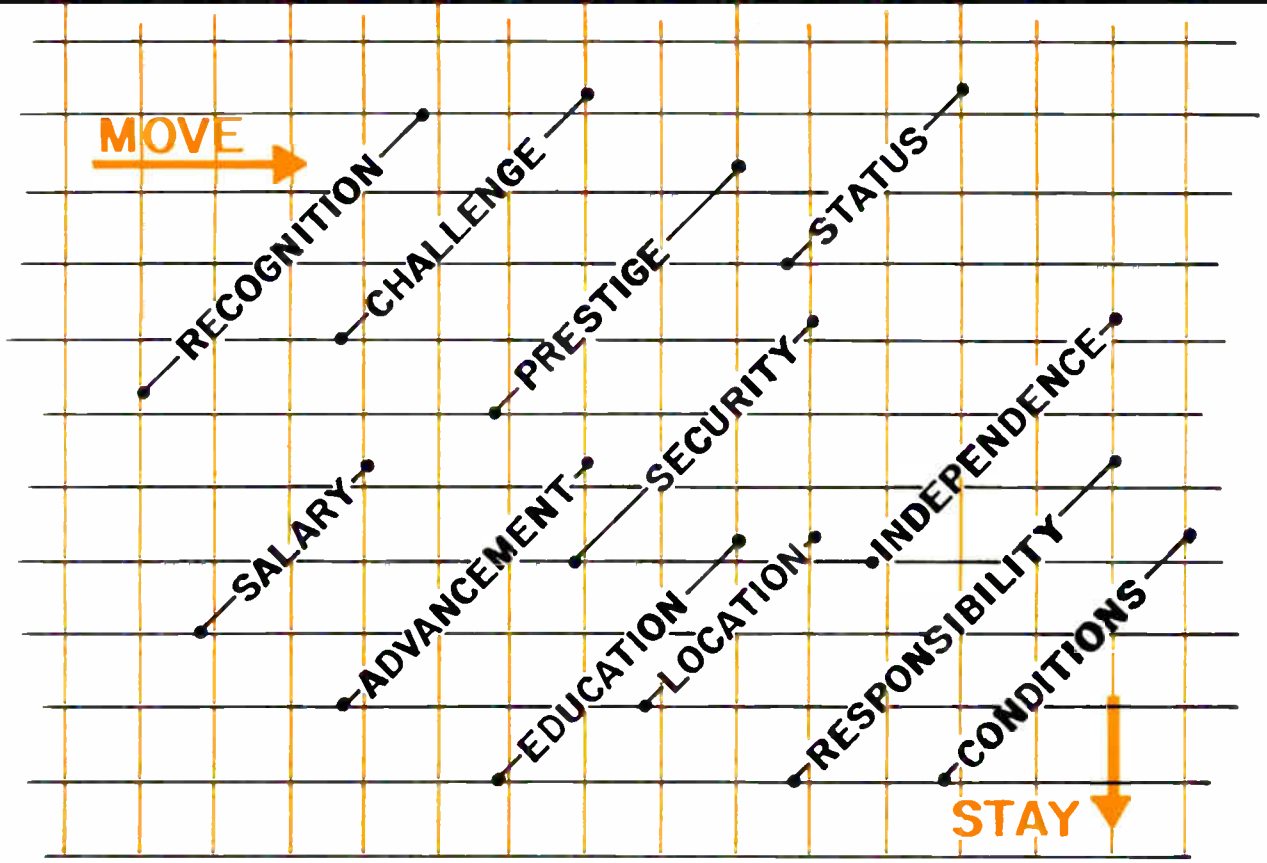
In most recent studies by Deutsch & Shea, sometimes conducted among as many as 3000 technical people at one time, "opportunity for interesting work" has rated consistently as the most important value. This is followed closely by "creative work," "opportunity for diversified work," and "challenging opportunity."

So strong was "opportunity for interesting work" that it was labeled the prime factor in job acceptance by 92% of scientist/engineer respondents in one study, and by an average of 84% in three others. The main reason for leaving previous jobs was "very little job challenge and responsibility." No matter how the employment apple is sliced, the nature of the work and its challenging flavor always show up at the core.

It is not unusual to find a technical professional willing to overlook shortcomings in standard benefits in a new job if he is given demanding work and professional challenge—and especially the opportunity to create his own challenging work. He is apt to leave a firm where challenge is missing, even though job benefits may be ample.

It follows then that the less a technical man is per-

By EUGENE RAUDSEPP
Director of Psychological Research
Deutsch & Shea, Inc.
New York City



A scientist/engineer will stay with or change his job for a variety of reasons as his motivational matrix (above) shows.

sonally involved in his work, the more important become work climate factors such as company policies, administrative procedures, working conditions, status symbols, personal relations and supervisory practices. These climate factors can never elicit that necessary extra initiative and effort. Only job challenge can do that.

Recognition Important

Most comments in recent morale studies point up the need for forms of recognition and the woeful lack of them. The reason for the emphasis on recognition among engineers and scientists is not hard to understand when we remember that a technical man's professional standing is directly related to and tied in with his chosen life work.

If a technical man is working on self-satisfying projects that could be considered as important additions to existing knowledge, he can write and publish papers and articles, and be recognized by his colleagues. With most engineers this is the second most important factor. Accomplishments bolster self-esteem, demonstrate abilities to colleagues and management, and justify a technical man's choice of career to himself.

In university laboratories recognition from peers is regarded as crucial. Considered just as important is recognition from industrial management, and when it is not given, effectiveness can be seriously undermined in a technical man.

Almost every survey is replete with comments like, "We are treated like hired hands," or "The personnel department thinks I'm just another factory hand." The feeling of being looked on as mechanics is widespread among engineers and scientists.

Prestige, Recognition Related

The engineer's need for recognition is wrapped in the same bundle with his constant push for prestige. When neither is forthcoming, the tendency of many engineers is to regard management as an attractive career alternative. Scientists, however, often consider administrative careers as a last resort.

Traditionally, management has felt that conditions should be the same for all employees. Reality seems to demand, however, that technical professionals be granted some special privileges and rewards, to separate achievers from non-achievers.

Management might consider giving different treatment to various technical groups. Engineers and scientists cover a spectrum of functions, ranging from R&D, through design and operations, to administration and sales. Despite these obvious functional differences, the same sets of rules are continually foisted on all without consideration for the special needs and requirements of each group.

A deep-rooted, faulty interpretation of democracy and human quality permeates our culture to this day. During the time of Jacksonian Democracy the strange and powerful notion that any man is as able as another gained a foothold and fostered the idealiza-

(Continued on page 169)

ELECTRONIC INDUSTRIES Professional Profile

The ELECTRONIC INDUSTRIES Job Resume Form for Electronic Engineers

Name _____ Tel. No. _____

Street Address _____ Zone _____

City _____ State _____

☐ Single ☐ Married ☐ Citizen ☐ Non-Citizen Date of Birth _____

Will Relocate ☐ Yes ☐ No. If Yes ☐ Another City ☐ Another State

Salary Desired to Change Jobs in present area _____

Salary Desired to Change Jobs and relocate in another area _____

Professional Memberships _____

College or University	Major	Degree	Dates

RECENT WORK EXPERIENCE

Company	Div. or Dept.	Title	Dates

SIGNIFICANT EXPERIENCE AND OBJECTIVES

STATE ANY FACTS ABOUT YOURSELF THAT WILL HELP A PROSPECTIVE EMPLOYER EVALUATE YOUR EXPERIENCE AND JOB INTERESTS. INCLUDE SIGNIFICANT ACHIEVEMENTS, PUBLISHED PAPERS, AND CAREER GOALS.

Mail to: ELECTRONIC INDUSTRIES—Professional Profile—56th & Chestnut Sts.—Philadelphia 39, Pa.
This resume is confidential. A copy will be sent only to those Companies whose number you circle below.

800 801 802 803 804 805 806 807 808 809 810

JOB SEEKERS' (Continued)

tion of the average man. The person with exceptional talent often has had a rough time of it as a result.

This fallacy led the scientist Leo Szilard to remark recently, "I'm all in favor of the democratic principle that one idiot is as good as one genius, but I draw the line when someone takes the next step and concludes that two idiots are better than one genius."

Effort Not Really Rewarded

The indictment that effort is not really rewarded in our culture can be attributed to the levelling process visited on us by our sacredness of mediocrity. We are still undemocratic toward our gifted. Time-honored organizational policies even today discriminate against our skilled technical professionals who deviate from the so-called average.

Some critics say ability-grouping would be undemocratic, favoring only the well-endowed. Actually, it would depend on one's performance and accomplishment, and would have to be a proposition strictly earned through effort and ability. Others say we should perhaps re-evaluate our social concepts and direct our society toward and aristocracy of worth—not of birth.

The technical professional is usually an independent and inner-directed person. He has a self-directing attitude toward his work and is happiest when he is little supervised. Although he knows he will often have to work with a team, he does demand that his company show confidence in his ability to assume greater responsibility.

Our engineer naturally likes money. What is important to the technical man is the feeling that his earnings are at least equal to those of his associates.

Society Judges Success

The technical professional is aware that our society measures his success by earnings, house, car, clothes and other price tags. He also knows that his organizational status is measured by office, carpet thickness, title and number of people he supervises. He may not be obsessed with such popular success measures but he is definitely influenced by them, especially if he is a family man.

Location has become less important, though studies indicate that it still has motivating power, running on the heels of salary. Climate is the important feature, followed by education facilities, and professional and cultural opportunities. For married engineers the main concern is excellent environment for his family, including better-than-average schools.

The dedicated professional knows that the more he knows and learns, the more he is capable of, and the greater are his chances to move ahead. He is

(Continued on page 172)

ANALOG COMPUTERS

For the first time midshipmen at the U. S. Naval Academy receive instruction in the use of analog computers. In the Academy Weapons Department computer laboratory an instructor explains operation of a new, time-saving, transistorized analog computer.

G. E. VACUUM PRODUCTS UNIT FORMED

General Electric Co. has formed a vacuum products operation in Schenectady, N. Y., to develop, make, and market high-vacuum equipment for space, electronic and industrial uses.

G. E. has been carrying on vacuum research for some time at its Research Laboratory at Schenectady.

245,000 SCIENTISTS LISTED

The National Science Foundation reports that the new scientific registration now underway will total about 245,000 scientists. In 1960 there were 201,000, of which about 118,000 had advanced degrees.

Final results of the 1960 count also showed that about 7% of the scientists were women.

PERSONNEL SELECTION TRACT

"A New Approach to Selecting Personnel" is the title of a pamphlet published by a Chicago management consulting firm. It tells how to select a man able to do multiple tasks for a key job. Copies are free. Write: Curt L. Sonneborn & Assoc., Inc., 200 S. Michigan Ave., Chicago 4, Ill.

$$$ for Circuit Designs

Have you come up with any simple or unique circuit designs lately? Do you think that they would be useful to fellow engineers? If so, why not send them to us for possible publication? We pay our usual space rates for those accepted. Please keep them as concise as possible and send to: Circuit Design Editor, ELECTRONIC INDUSTRIES, 56th & Chestnut Sts., Philadelphia 39, Pa.

ELECTRONIC INDUSTRIES Advertisers – July 1963

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

JOB SEEKERS' (Concluded)

then concerned about graduate study when choosing a job.

Education Desires Vary

Surveys tell us that single technical men are far more interested in further education opportunities when job hunting than are married engineers with families. We might qualify a bit here by saying that as a rule older married men with several dependents and community roots are less likely to move from one area to another even though educational facilities are available as part of the new job. This does not necessarily mean (although it sometimes does) that their desires for extra degrees wane as the families increase and they get older. It simply means that the young and single engineer—comparatively footloose and free—is able to choose his educational opportunities wherever they happen to lie.

Studies further show that men with two or more dependents tend to be less interested in graduate study opportunities as a re-location motivator. Advanced education rates very high among unmarried engineers in their first four years in the field, and even outranks salary as a motivator in the zero to two-year group. After the technical man has six years or more of experience the advance education lure to other jobs begins to fall off sharply.

Good working conditions and adequate facilities are not major factors. Still, the firm that provides up-to-date equipment and ample lab room surely has it all over the firm that does not.

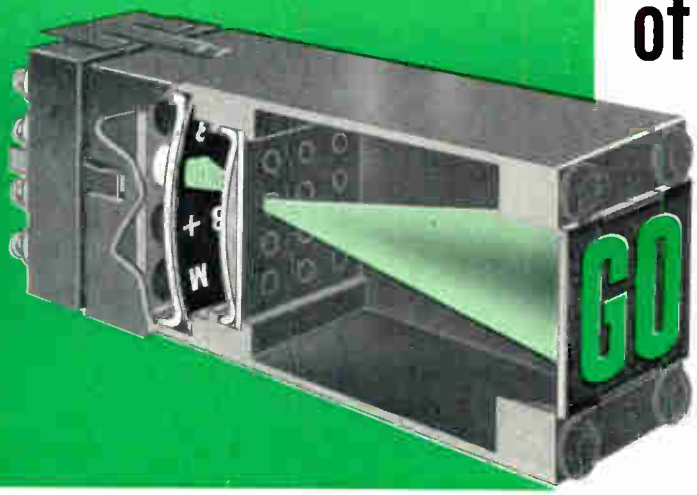
Much of today's shortage of scientists and engineers, and general professional dissatisfaction, may stem from the fact that technical men often must give excess time and effort to routine, low-grade chores which they feel should be handled by technical aids, another status factor. Firms able to give their professionals adequate technical and secretarial help report an encouraging rise in morale.

Job Security Not Vital

Engineers know that a healthy salary rise comes with almost every job change these days. Thus, many young engineers capitalize on their mobility and treat each job merely as a springboard, except perhaps where graduate study is a factor.

Once a vital factor in the engineering profession, job security is now rarely mentioned, although there are many who still think and feel that it has considerable importance in certain fields. Many industry spokesmen believe that today's imbalance between technological supply and demand will continue for many years to come, and will make getting another job relatively easy.

Improve the readability of your display systems with double-brilliant, clear characters ...and color



Only IEE one-plane readouts give you such versatile displays

IEE rear-projection readouts provide bright, distinct characters, *all on the same plane*, to assure maximum readability of data displayed. An improved lens system in the Series 120 and 220 readouts doubles brightness without increasing cost. Typical brilliance of units with 6-volt, type 328 lamps is now 50 foot-lamberts as compared to 27 foot-lamberts for previous units. Normal lifetime is 500 hours. By reducing operating voltage to 5 volts, lamp life is extended 10 times to 5,000 hours, and brilliance is reduced only to its former adequate light level of 27 foot-lamberts. Single lamp life up to 50,000 hours can be obtained by operating 6-volt, type 349 lamps at 5 volts. Similar results are obtained in these units using 14 and 28-volt lamps.

Any message that can be photographically reproduced—numerals, letters, multi-digits, multiple words, symbols, colors—all can be displayed on IEE readouts.

Up to 12 messages can be presented individually or in combination by each readout with maximum character heights of 5/8". Write for your copy of the IEE Readout Display Selector Guide.

Series 230 front plug-in readout assemblies are ideal for systems that require message changes. Inserts with new message displays can be changed quickly and easily. Accessibility from the front of a panel makes lamp replacement easy, allows permanent wiring and eliminates the need for flexible cabling.

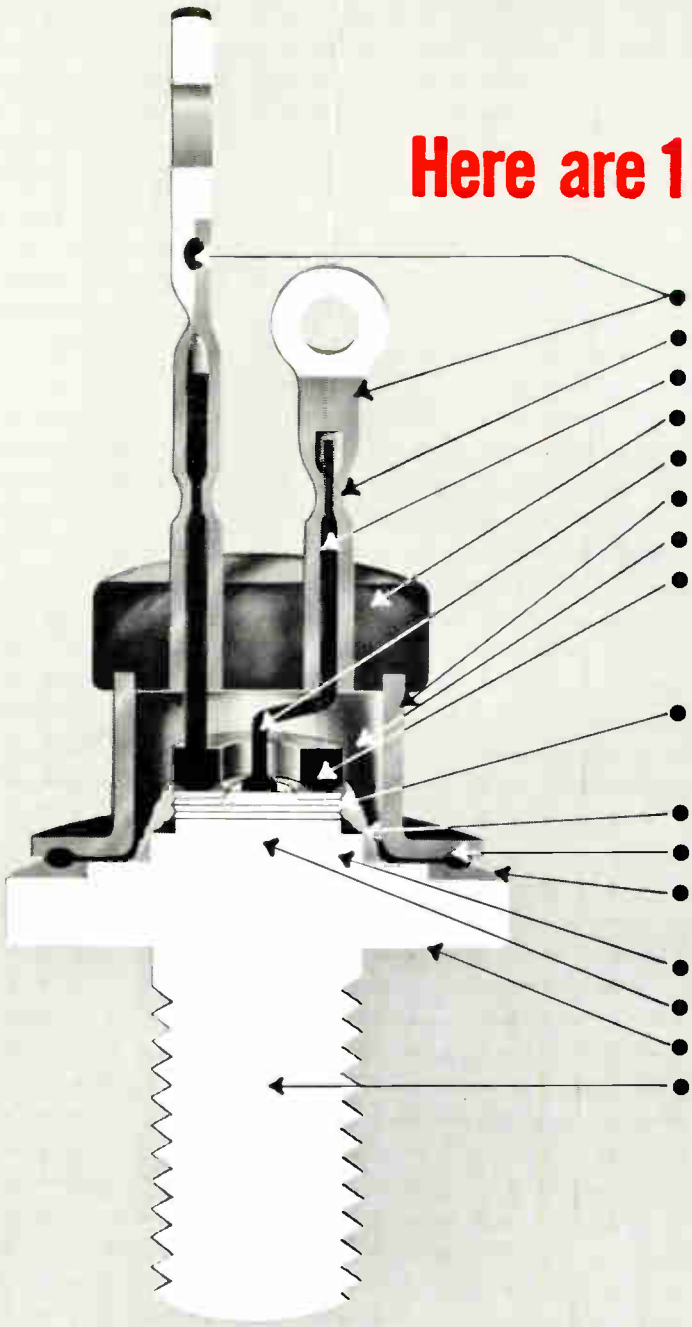
INDUSTRIAL ELECTRONIC ENGINEERS, INC.

5528 Vineland Avenue • North Hollywood, California • Phone: (213) 877-1144 • TWX: (213) 769-1636

Circle 110 on Inquiry Card

NOW SWITCH WITH RCA SILICON CONTROLLED RECTIFIERS

Here are 16 solid reasons why



- Welded construction
- Intimate ohmic contact
- Rugged leads
- Dense glass
- Concentric gate lead
- Kovar seal
- Ultra-dry inert atmosphere
- Massive copper lead for uniform current-density. Annular ring for internal heat sinking
- N (Cathode), P (Gate), N (Base), P (Anode) — All diffused structure; Symmetrical gate-cathode design
- Multi-coat encapsulation
- Welded seal
- Steel weld ring—brazed and integrally cold-headed with stud
- Stress-isolating pedestal
- Direct solder construction
- Flat surface for thermal contact
- Sturdy zirconium alloy stud

Check the outstanding construction and operating features of RCA's two new families of silicon controlled rectifiers...RCA 2N681 to 2N689 and RCA 2N1842A to 2N1850A...all-diffused, SCR's for power control and electrical switching applications in industrial apparatus and military equipment.

FORWARD CURRENT	BLOCKING VOLTAGE								
25 Amp (RMS) 16 Amp (Avg) @ 65°C	25	50	100	150	200	250	300	400	500
	2N681	2N682	2N683	2N684	2N685	2N686	2N687	2N688	2N689
16 Amp (RMS) 10 Amp (Avg) @ 80°C	2N1842A	2N1843A	2N1844A	2N1845A	2N1846A	2N1847A	2N1848A	2N1849A	2N1850A

These RCA Silicon Controlled Rectifiers are designed for use in your circuits at their full ratings—full current at peak reverse and peak forward blocking voltage. And RCA brings you all these big operating advantages: • Application tested for 100% safety margin on surge current • Very low thermal resistance • Forward voltage drop measured at high current (100 Amps for 2N681 family) • Installation torque capability = 50 inch-lbs • Tight control of firing characteristics • Long term operating stability • 100% aging at maximum ratings and 100% dynamic testing.

Call your RCA Representative today for complete details on these rugged new RCA SCR's... or write RCA Semiconductor and Materials Division, Commercial Engineering Section 1J-7, Somerville, N. J.

Write today for your free copy of this new RCA Application Note SMA-16 "Circuit Factor Charts For Use In Applications With RCA Silicon Controlled Rectifiers"

AVAILABLE THROUGH YOUR RCA DISTRIBUTOR

The Most Trusted Name in Electronics

Circle 111 on Inquiry Card