ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION

Know your Accelerometers

Also in this issue . . .

- Developments in Klystron Oscillators
- Microwave Ferrites
- Designing H.V. Power Supplies

May 1962

COST CUTTING CERAMICS FOR TRANSISTOR CIRCUITRY

RMC Magnacaps®

SPECIFICATIONS

3 VOLT MAGNACAP

Capacitance μf. 1 Kc., .05 vrms max. @ 25° C.	Tolerance %	Dissipation Factor (% Max.) 1 Kc., .05 vrms max. @ 25° C.	Insulation Resistance Min. @ 100% Rated DC Voltage R = E/I	Diameter Max. (Inches)	Thickness Max. (Inches)	Lead Spacing ± .035"
.05	+80 −20	3%	60,000 ohms	.265	.156	.250
.10	+80 −20	3%	30,000 ohms	.265	.156	.250
.22	+80 −20	3%	13,600 ohms	.310	.156	.250
.47	+80 −20	3%	6,270 ohms	.425	.156	.250
1.0	+80 −20	3%	3,000 ohms	.615	.156	.375
2.2	+80 −20	3%	1,360 ohms	.880	.156	.375

12 VOLT MAGNACAP

Capacitance μf. 1 Kc., .05 vrms max. @ 25° C.	Tolerance %	Dissipation Factor (% Max.) 1 Kc., .05 vrms max. @ 25° C.	Insulation Resistance Min. @ 100% Rated DC Voltage R = E/I	Diameter Max. (Inches)	Thickness Max. (Inches)	Lead Spacing ± .035"
.05	+80 −20	7%	800,000 ohms	.310	.156	.250
.10	+80 −20	7%	400,000 ohms	.380	.156	.250
.22	+80 −20	7%	180,000 ohms	.575	.156	.375
.47	+80 −20	7%	85,000 ohms	.800	.156	.375
1.0	+80 −20	7%	40,000 ohms	1.045	.156	.375

25 VOLT MAGNACAP

Capacitance μf. 1 Kc., .05 vrms max. @ 25° C.	Tolerance %	Dissipation Factor (% Max.) 1 Kc., .05 vrms max. @ 25° C.	Insulation Resistance Min. @ 100% Rated DC Voltage R = E/I	Diameter Max. (Inches)	Thickness Max. (Inches)	Lead Spacing ± .035"
.02	+80 −20	7%	10 megohms	.380	.156	.250
.05	+80 −20	7%	10 megohms	.520	.156	.375
.10	+80 −20	7%	10 megohms	.695	.156	.375

For applications requiring capacitors with ultra high values and low power factors specify RMC MAGNACAPS. These new units combine the miniature size, reliability and lower costs always associated with ceramic capacitors. Write today on your letterhead for additional information on MAGNACAPS.

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ELECTRONIC INDUSTRIES

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

Do Two Wrongs Make A Right?

IN the recent hearings on UHF-TV in Washington, it was not easy to sort out who was for what—or why—and perhaps we shouldn't be too surprised. We are seeing the culmination (we hope) of a decade of fumbling, on the part of both government and industry, but mostly the former, and it is understandable that everyone is anxious to cover up past mistakes.

Our prime concern is with the specific request by the FCC—for legislation that will force the TV manufacturers to produce only receivers that will handle both UHF and VHF signals. We are strongly opposed to this legislation, because it represents government tampering with the principles of free enterprise.

Let us take a look at history. . . . In 1952, UHF television broadcasting began. The FCC opened the frequency band from 470 MC to 890 MC, for commercial and educational television operations. This UHF band, with 70 channels, was heralded as the answer to the demands for truly competitive television broadcasting. This, however, turned out to be a rosy dream, a bubble that burst.

The cards were stacked at the outset —because the fledgling UHF broadcasters were forced to compete with established VHF-TV stations in a market nearly saturated with VHF receivers. Equally important, entertainment talent was already in the hands of the VHF interests, so that it was not even possible to offer superior viewing fare. In brief, there was thus no market for UHF-TV.

When it was found out that UHF-TV could not survive in direct competition with VHF, a patchwork remedy of "de-intermixture" was tried. Areas were to be VHF-only, or UHF-only. This approach might have been successful but for one thing; the UHF areas were, for the most part, less populated areas that could support only a few stations, while the VHF areas were large metropolitan areas that could easily support many stations. And now these large areas were closed to UHF.

Up to this point, the FCC had made two important allocation decisions, and both of them had apparently missed the mark of providing a UHF-TV receiver audience. Now, the FCC is trying to set up iron-clad protection against a repetition of those failures. They want legislation that will force the TV set manufacturers to produce only receivers that will handle both UHF and VHF signals.

UHF-TV channels should be put to effective use. On this we are in hearty accord. But we disagree with the proposed legislation on TV set manufacturers.

As the FCC plans this shift, there will be a transition period of six years, during which VHF stations will be broadcasting on both the VHF and UHF bands. After that, all telecasting will be UHF.

For the next six years, then, VHF stations will be on the air, and probably transmitting slightly better pictures than the UHF outlets; VHF seems to have some inherent advantages.

For the person who buys a UHF-VHF receiver today, and uses it for four, five, six years, there may never come a time when he needs the UHF capability for which he paid $30 extra at the time of purchase. This is hardly fair.

For many years our "free-enterprise" system of broadcasting has been highly successful technically. Industry and government have both shared the responsibilities. The FCC has allocated the spectrum space for operation and the manufacturers have mass-produced equipment that operates efficiently under mutually agreed-on technical systems. Mass production in a highly competitive atmosphere has kept the price ranges of such equipment within relatively easy reach of all.

We believe that this mode of operation should continue because we believe it to be best in the long range public interest!

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ELECTRONIC INDUSTRIES

Vol. 21, No. 5 **May, 1962**

FRONT COVER: The use of accelerometers has become almost common place in the design of airborne vehicles. Many words have been written about accelerometers, however, the mounting aspect has been mentioned only lightly. A poor mounting can distort the response very badly. The drawing represents an accelerometer with an almost perfect reproduction of the input shown by the curves.

MONTHLY NEWS ROUND-UP

NEW PRODUCTS & TECH DATA

DEPARTMENTS

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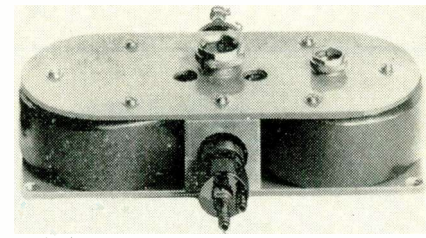
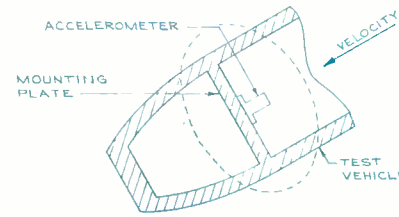
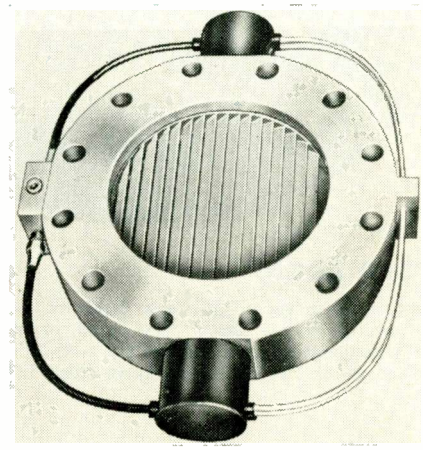
Highlights of this issue



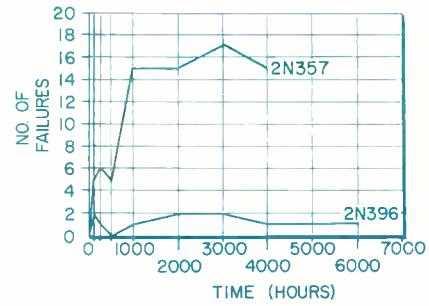
Klystron Oscillators



Accelerometer Response



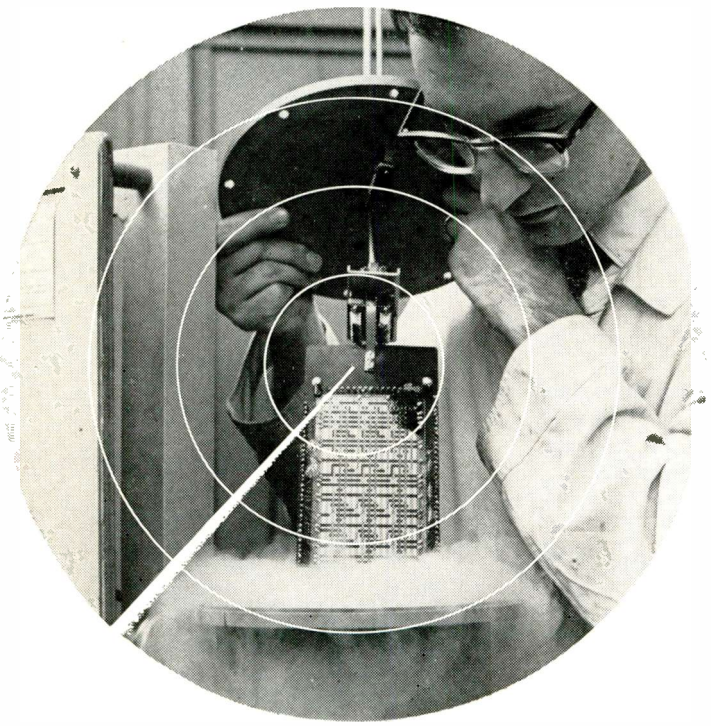
Thermoelectric Baffle



Long Term Reliability

Chemicals

RADARSCOPE



COLD LOGIC

Enshrouded in vapor, GE's new cryogenic associative memory circuit is lowered into a Dewar flask used to maintain a liquid helium bath temperature of approximately —452° F. The memory device is composed of five thin-film layers from 3,000 to 10,000 A. thick.

OF THE 6,178,000 TV SETS manufactured last year, only 6% left the factory equipped to receive UHF signals. At the recent hearings in Washington it was estimated that only 7.8% of the total number of TV receivers in use can receive UHF TV programs.

NEW HIGH VACUUM DEPOSITION SYSTEM capable of making thin film integrated microcircuitry in production quantities has been announced by Lear, Inc., Santa Monica, Calif. The new machine produces up to 500 tailor-made thin film microcircuits in a single two-hour vacuum cycle, depending on complexity of the circuit. The corporation has established a proposed license/lease agreement to cover the equipment, training and service program.

ADVERTISED COMPETITIVE BIDDING for government contracts has fallen drastically. It now accounts for less than 13% of defense purchases. Sen. William Proxmire, (D., Wis.) provides these figures, and adds that the DOD is trying to do something about it. Small business firms are the victims of this trend. Small firms are able to secure nearly 50% of the procurement purchased through advertised competitive bidding. They win less than 10% of non-competitive procurement.

AS ENGINEERING SALARIES INCREASE they, paradoxically, seem to become less important. More is being heard these days about the opportunities to do creative work; the opportunities for advancement; and opportunities to grow with the firm.

THE ENGINEER'S INSISTENCE that his local area have facilities for postgraduate instruction has been generally recognized by area development people. Not so well recognized is that engineers are even more sensitive about the educational facilities that are available for their children. A number of the more remote areas have filled the first need adequately, only to find that engineers are being lost because they will not tolerate the poor quality of the local teachers.

MAGNETICS is finding new applications in logic circuits, replacing transistor logic in some applications. The type telemetering system developed by Solid-State Systems Div. of Motorola in Phoenix, Ariz., utilizes multiaperture ferrite cores, each performing a stated logic function without any external component. Each core, practically the size of a dime, is the functional equivalent of a circuit board containing transistors, diodes, resistors, and capacitors. The core is immune to environmental effects and set for no appreciable degradation of performance with age.

COMMUNICATIONS SATELLITE

In a room lined with pyramids of foam plastic that absorb radio energy, C. A. Haas, Bell Labs engineer at Hillside, N.J., inspects model of the Telstar experimental communications satellite. The chamber simulates the radio environment of space to test antennas.

ORGANIC SEMICONDUCTORS may bring the next technological breakthrough. More than 50 firms are researching the possibilities in addition to several government programs. The Russians claim to have already produced stable, electrically conductive materials by subjecting resins to ionizing radiation. In this country, research is centering on organic materials such as anthracene, a crystal derived from coal tar. Two classes of materials are being studied: molecular crystals and polymers. Among the applications foreseen for organic semiconductors are: fuel cells, photocells, switches, solar batteries and heat pumps. A definitive study of the subject is available from OTS, U. S. Dept of Comm., Washington 25, D. C. (Order #PB 181 037—50¢)

ARE ENGINEERS PROFESSIONALS? The National Society of Professional Engineers is up in arms over the ruling by the Wage Hour Division of the Dept. of Labor that would classify only those engineers who passed a minimum salary requirement test as "professionals." The Labor Dept. exempts only doctors and lawyers from the minimum salary test. Mr. Paul H. Robbins, Executive Director of the National Society of Professional Engineers claimed that it would be difficult to sell engineering as a profession to young people, when, following the long and difficult period of preparation, the registered engineer's professional status would be measured by the yardstick of his salary. NSPG wants the Labor Dept. regulations amended to exclude engineers from the salary test, on the same basis as lawyers and doctors.

THE SHORTAGE OF ENGINEERS was brought to the attention of the Senate last month by Sen. Claiborne Pell (D., R. I.). He was reporting the results of a survey that he had undertaken of 174 engineers at the United States Naval Underwater Ordnance Station in Newport. "The greatest single factor," he said, "at least in the minds of the engineers themselves, appears to be a down-grading by society in this country of the status of the engineering profession. This seeming lack of prestige in the minds of young people preparing for professions is disturbing, because the quantity and quality of our scientists and engineers in the years ahead, in large part, will help determine where we stand in our technological competition with other nations." One third of the large group of engineers polled said that inadequate high school preparations together with the difficulty of the engineering curriculum was the main reason why few young men are attracted to the profession. Of the engineers surveyed, only one third gave an unequivocal "yes" to the question: "Would you advise your son to become an engineer?" Approximately 16% of the engineers stated explicitly that the lack of prestige of the profession was the major factor in keeping engineering enrollments low.

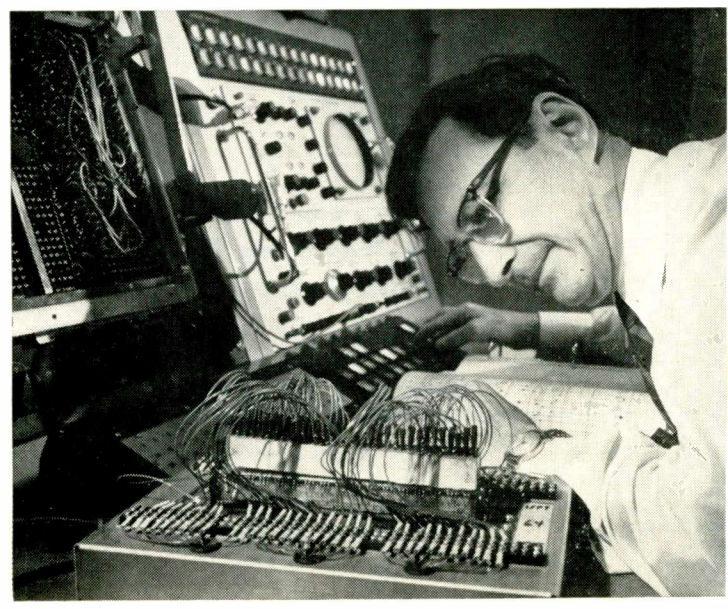
U. S. EXPORTS of scientific and industrial instruments reached a peak of $427 million during 1961, an increase of 26% over the previous peak reached in 1960. The foreign market in 1961 represented 8.2% of domestic production, as compared with 7.5% the previous year. Ratio of exports and imports is about the same for both years—approximately 10 to 1. U. S. products are competing in foreign markets despite an unfavorable price differential.

DEMAND FOR ENGINEERS is increasing rapidly. At this point it is well ahead of last year; some 50% higher, judged by the number of lines of recruitment advertising appearing in newspapers and technical journals. Deutsch & Shea, N. Y. ad agency, supplies the figures.

ENGINEERS CAN NO LONGER BE POLLED by unions seeking to represent them without prior indication that a substantial number of the engineers are interested in being unionized. The National Labor Relations Board last month handed down a ruling in a case involving the General Instrument Corp. An original plan to organize 15 technical employees had been expanded, at the company's request, to include 17 professionals as well, though they had not shown any interest in being organized. The NLRB in a subsequent review said that this was illegal, that professionals could be polled for their sentiments only after they had shown substantial interest in being organized.

PRODUCTION TECHNIQUE

Test set-up for Weld-Pak modules is shown at Raytheon Company. The Weld-Pak technique, used by firm to produce electronics for Polaris advanced guidance systems, reportedly increases reliability and sharply decreases the size and weight of electronic equipment.



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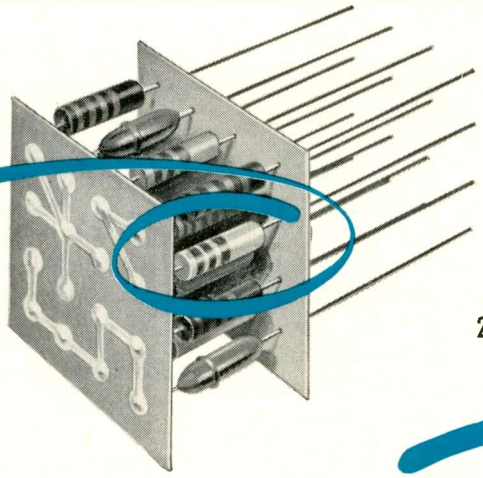

Module and components 2x actual size

SUBMINIATURE CERAMIC CAPACITORS ESPECIALLY DEVELOPED FOR "CORDWOOD" PACKAGING

Sprague's ALL-NEW Type 252C Tubular Ceramic Capacitors give you a combination of features found in no other single capacitor!

- TINY! Only ¼" long, and less than ⅛" in diameter
- Size is compatible with diodes and resistors for "cordwood" packaging
- Can be furnished on lead tape for automatic insertion
- Extremely stable – very little capacitance change with temperature
- High insulation resistance, high dielectric strength
- Stand up under extreme humid atmospheric conditions
- Available now in standard ratings from 5 pF to 360 pF, 100 vdc
- Operating temperature range, −55 C to +85 C
- Standard capacitance tolerances; ±20%, ±10%, ±5%

For complete technical data on Type 252C Ceramic Capacitors, write for Engineering Bulletin 6151 to Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

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As We Go To Press...

Scientists Discover New Atomic Particle

An atomic particle, the anti-xi-minus or anti-cascade-hyperon, has been discovered by two teams of scientists working independently at the Atomic Energy Commission's Brookhaven Nat'l Lab. (BNL), Upton, L. I., N. Y., and at the European nuclear research center (CERN) lab in Switzerland.

The Brookhaven team used a separated beam of 3.3 billion electron volts (Bev) anti-protons produced in a tungsten target in the lab's 30 Bev Alternating Gradient Synchrotron (AGS). The newly discovered particle has a mass about 40% greater than that of a proton, and a positive electrical charge. It exists for less than a billionth of a second.

Engineer Tells of Solar Thermionic Power System

According to a General Electric engineer, a solar thermionic power system producing 1 kw of power for every 40 lbs. of weight can be developed.

David L. Purdy, an energy conversion systems engineer in the company's Missile and Space Vehicle Dept. presented this conclusion in a paper at a meeting of the AIEE.

GUIDED MISSILES

Test pilot Bart Warren holds air-to-air guided missiles, the HM-55 (l) and the HM-58 Falcons, which are being developed for the Swedish Air Force by Hughes Aircraft Co. of Culver City, Cal. Missiles will be manufactured in Sweden to Hughes' design. The HM-55 is radar guided and the HM-58 is infrared guided.

REMOTE CONTROL

Dr. T. W. Robinson, at Highland Ave. Baptist Hosp., Birmingham, Ala., reads a Visicorder recording heart pulsations of patient in West End Baptist Hosp., across town. Connection has been "dialed" by telephone.

Learning Machine Being Developed by G.E.

A machine the size of a small suitcase that learns in much the same manner as a child learns has been demonstrated by GE. In the past, only the human brain has performed such basic learning.

Still a crude electronic box, the machine learns from its mistakes and remembers them when a "punish lever" is pushed—a process more advanced than today's computers can execute.

After six or eight punishments, it learns to correctly answer coded questions put to it.

System Transmits Voice And Data Simultaneously

A flexible, economical capability for simultaneous voice-data transmission has been unveiled for RACEP, the wide-band communications system developed by the Martin Marietta Corp.

RACEP's voice-data feature will accommodate 70 subscribers simultaneously in any combination or afford more than 700 subscribers full use of their system for voice and/or data transmission at all times.

Transmission of low-speed teletype data (up to 100 words per min.) will further enhance the multi-use capability of RACEP without the additional equipment needed for simultaneous transmissions through other communications systems.

Voice-data transmission can be relayed via RACEP to any desired distance with airborne, mobile or fixed land-based RACEP units acting as transponders.

Use Metric System Here, Lockheed Official Urges

The U. S. must switch over to the metric system in the near future for urgent national security reasons, both military and economic, warns a major missile-space company official.

"Our medieval measurement system is a major stumbling block for the United States in today's highly competitive space age. It handicaps us in both military and economic competition," said D. J. Murphy, Assistant General Manager of Lockheed Missiles & Space Company's General Services Div.

This is believed to be the first such statement in support of metric measurement from a major U. S. maker of industrial hardware—the category of business which would be hardest hit by such a change, and the group which traditionally opposes it.

The Lockheed executive said the change should be gradual, but appropriate legislation should start now. "We recognize that under a move to grams and centmeters, a large proportion of familiar objects —nuts, bolts, packing cases—would have to be rescaled. Many industries would face a ten-year parts problem," he noted.

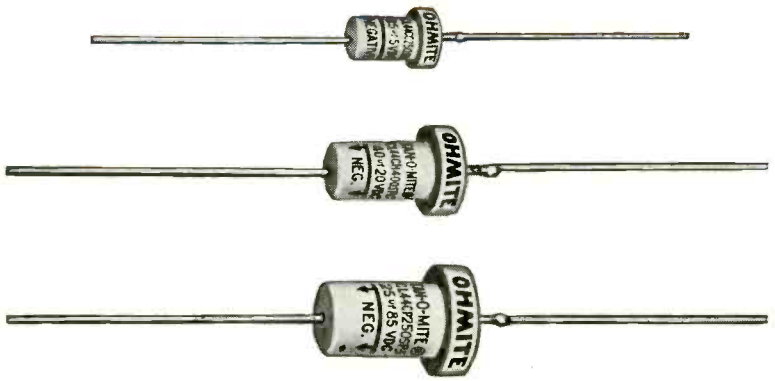
However, he said under present conditions, the U. S. builds weapons systems for which spare parts cannot be found in the countries where they are often intended to be used. The nation seeks to establish a close-knit group of Allies, and back them up with equipment. Yet "trying to match unmatchable parts in a local combat situation with no local source of supply will be maddeningly and dangerously frustrating," Murphy warned.

Continued use of present measurements, he added, "can directly affect the standard of living of all Americans." He called the English system of measurements "a crippling sales obstacle" to U. S. firms seeking to sell in the world market.

Loss of sales in foreign markets, the Lockheed official said, will affect the U. S. balance of payments, and, as a result, raise the price of many commodities to U. S. consumers.

More on Page 9

Yes, they are available... from OHMITE



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125°C

MIL-C-3965B, CHAR. "C" TANTALUM SLUG CAPACITORS

Ohmite can supply *all three* sizes of "hat shape" capacitors for use in equipment requiring MIL-C-3965B units. The 29 *basic* stock values as listed at right are the uninsulated type, CL44, with an "S" tolerance of −15 +20%.* They are available also from stock as insulated units, CL45, with plastic sleeves. A "T" tolerance of −15 +50% can be supplied on both types.

Standard tolerance "K," ±10%, is offered on commercial units. Special closer tolerances also furnished.

Ohmite manufactures a big, full line of tantalum slug, foil, and wire capacitors for all pertinent MIL specifications as well as commercial applications. Complete details are covered in Bulletins 148, 152, and 159. *Why not write for a set now?*

*"S" tolerance, as furnished by Ohmite, is closer than the MIL "S" tolerance of −15 +30%.

BASIC STOCK MIL VALUES

Mfd	DC Rated Volts	Case Size	MIL Designation
30	4	T1	CL44CB300SP3
140	4	T2	CL44CB141SP3
330	4	T3	CL44CB331SP3
25	5	T1	CL44CC250SP3
20	7	T1	CL44CD200SP3
100	7	T2	CL44CD101SP3
250	7	T3	CL44CD251SP3
15	10	T1	CL44CE150SP3
70	10	T2	CL44CE700SP3
170	10	T3	CL44CE171SP3
10	17	T1	CL44CG100SP3
8	20	T1	CL44CH080SP3
40	20	T2	CL44CH400SP3
100	20	T3	CL44CH101SP3
5	33	T1	CL44CJ050SP3
25	33	T2	CL44CJ250SP3
60	33	T3	CL44CJ600SP3
4	40	T1	CL44CK040SP3
20	40	T2	CL44CK200SP3
50	40	T3	CL44CK500SP3
3.5	50	T1	CL44CL3R5SP3
15	50	T2	CL44CL150SP3
40	50	T3	CL44CL400SP3
2.5	70	T1	CL44CN2R5SP3
11	70	T2	CL44CN110SP3
30	70	T3	CL44CN300SP3
1.7	85	T1	CL44CP1R7SP3
9	85	T2	CL44CP090SP3
25	85	T3	CL44CP250SP3

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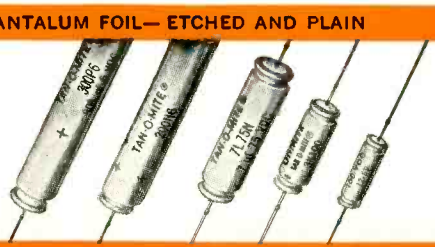
TANTALUM FOIL— ETCHED AND PLAIN



TANTALUM WIRE

Mountain Used to "Bend" Signals in Experiments

Using a mountain top to "bend" microwave signals, IBM computer communications engineers at San Jose, Calif., have performed low-power microwave transmission of data over the horizon at high speeds without using relay stations.

Over-the-horizon microwave transmission is being used for TV and telephone communications by various organizations. But in order to carry these signals over obstructions such as mountains and buildings, such applications require very high transmission power and large antennas.

In the San Jose experiments, computer data is being transmitted over a mountain at speeds as high as 500,000 bits of information/sec. with power as low as 16 w, using small antennas.

The technique is called "knife-edge diffraction." It means using the narrow ridges of a mountain range to deflect radio signals.

Computer data can be transmitted at low power because binary signals are used. Binary code tolerates more random noise, distortion and interference for acceptable operation than quality speech and TV signals standard in common carrier communications.

The experimental link is now operating between a Monterey transmitter and a San Jose receiver 45 miles away.

(*More News on Page* 15)

SIMULATOR

A scale model of the first electronic flight and tactics simulator of the Republic F-105D fighter-bomber installed in Europe, is presented to Col. J. D. Berry of the 36th Tactical Fighter Wing, Bitburg Air Base, Germany. H. McGraw, representing the manufacturer—ACF Industries' Electronics division Riverdale, Md.—makes the presentation.

Electronic SHORTS

A contract for maintenance and operation of the 7,500-mile U. S. Army Pacific Scatter Communication System has been awarded Page Communications Engineers, Inc., Washington, D. C. The system, using ionospheric and tropospheric scatter propagation, extends from Hawaii to the Philippines and Okinawa. Under the contract, Page will provide engineers, technicians, emergency parts, training, site support, antenna upkeep, data analysis, and diesel-generator operation and overhaul.

California Institute of Technology's Jet Propulsion Laboratory has contracted Marshall Laboratories of Torrance, Calif., to build a prototype magnetometer for the Surveyor Lunar Landing vehicle. The triaxial fluxgate instrument will measure lunar fields over a range of 0 - 150 gammas. The magnetometer will have a digital readout and will weigh less than nine pounds.

Department of the Navy has awarded Interstate Electronics Corp., Anaheim, Calif., a contract to design, develop, and fabricate a Portable Ship Instrumentation Package (POSIP). Primary function of POSIP is receiving and recording in-flight telemetry data during Polaris missile testing. This mobile system can be transported by truck, rail, or air to dockside locations and easily installed aboard most ships.

A contract for SARAH personnel recovery systems has been awarded to Simmonds Precision Products, Inc. of Tarrytown, N. Y., by the USAF. The SARAH system will be used for air-sea rescue operations by the Pacific Air Command of the USAF. SARAH (Search And Rescue And Homing) consists of two major components—a miniature transmitter attached to the life vest of flight personnel, and a special receiver-indicator aboard searching aircraft. System enables rescue groups to locate and "home in" on crash survivors.

A contract for 38 electronic flash approach systems (EFAS) has been awarded Sylvania Electric Products Inc., by the FAA. The systems, a series of brilliant flashing lights that guide landing planes to safety during periods of poor visibility, will be installed at 36 commercial airports in the U. S. Two systems will be assigned at a later date. An EFAS system consists of a center-line row of flashing "strobeacon" lights installed at 100-ft. intervals, beginning at a point 3,000 ft. from the start of the runway.

Minneapolis-Honeywell's Aeronautical Div. has been selected by the Autonetics Div. of North American Aviation, Inc., as an additional source supplier of gyroscopes for the Air Force's Minuteman ICBM. Initial contract for tooling and the first gyros is in excess of $1 million. Minuteman uses two-axis gas bearing gyros as sensors for the inertial guidance system. The gyros were developed and manufactured solely by Autonetics prior to the selection of Honeywell as a supplier.

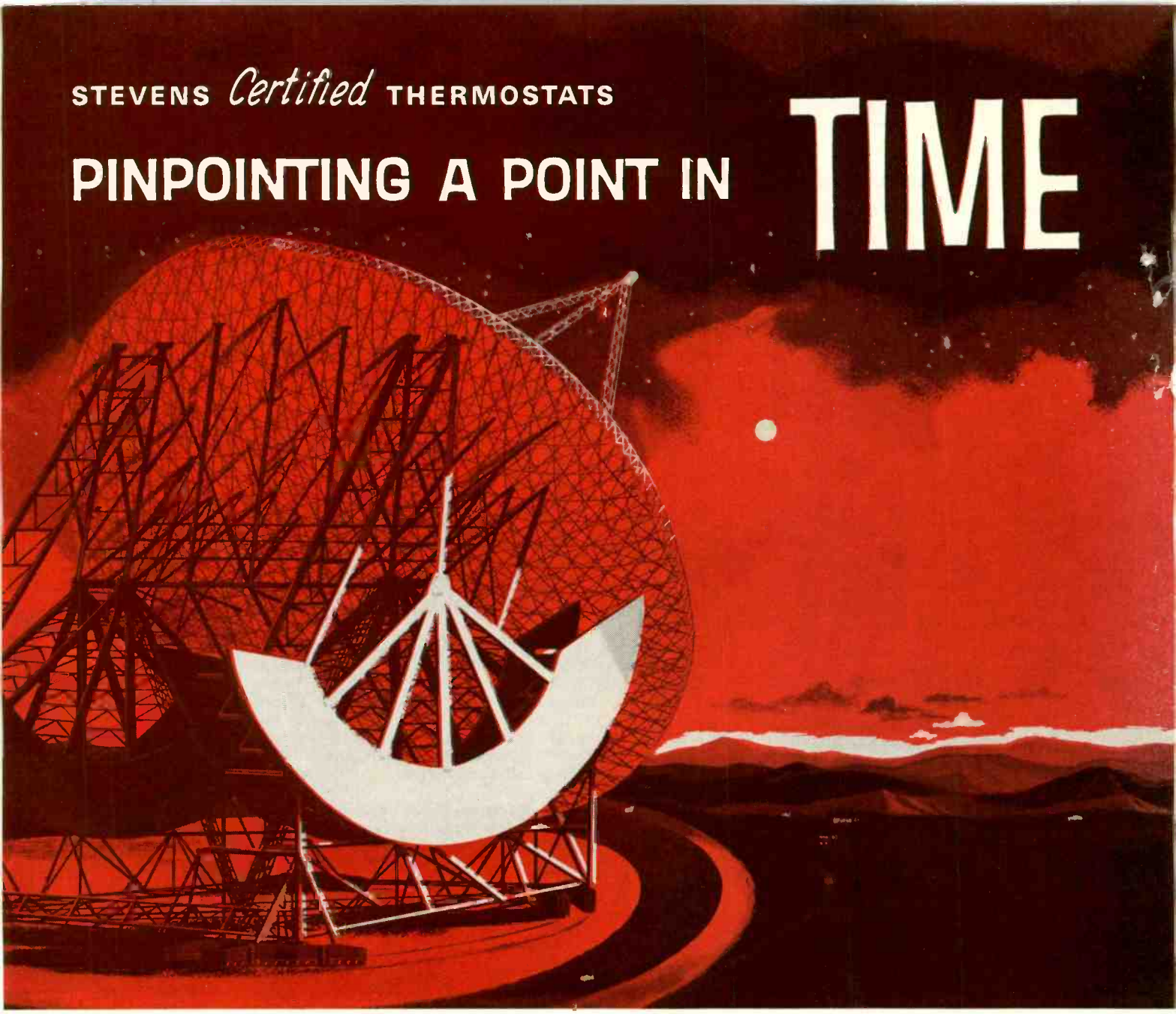
A new sensor developed by G.E.'s Missile and Space Vehicle Dept. determines dangerous levels of oxygen or hydrogen. Device, which might be used in space capsules, incorporates operating principles of hydrogen-oxygen fuel cell by combining hydrogen with oxygen to produce electricity and water. Amount of hydrogen or oxygen present in terms of an electric current can be read on a milliammeter. Sensor gives meaningful readings at currents far less than those required for a power-producing cell.

A new tape recorder that can monitor 22 simultaneous conversations on a single tape is being installed by the FAA in seven Air Route Traffic Control Centers across the country. Produced by Webcor, Inc., Chicago, the new unit will help solve a critical air-traffic control problem: the monitoring and storage of all conversations between aircraft pilots and airfield towers. These average 572 per min., around the clock, throughout the U. S.

General Electric scientists have announced that high-power beams of intense light have been generated by a ruby cylinder at a rate of ten bursts a second. It is believed the first time a Laser beam has been pulsed rapidly and at high power. This makes it possible to apply the Laser to optical radar under actual field conditions. The rapid-pulsing Laser operates at much higher power than the continuous-beam Laser.

STEVENS *Certified* THERMOSTATS

PINPOINTING A POINT IN TIME



TYPE A. Hermetically Sealed, Semi-Enclosed. Equal or exceed Specs MIL-E-5272C, MIL-T-5574A, MIL-STD-202A. Bulletin 3000-1.

TYPE MX. Hermetically Sealed, Semi-Enclosed. Standard differentials 2° to 6°F; 1° to 4°F special. Bulletin 6100. Also TYPE AX. Hermetically Sealed, Semi-Enclosed. Similar to above but to close on temperature rise. Bulletin 3200.

Circle 4 on Inquiry Card

A-6129A

THE giant electronic cyclops that peers into the limitless reaches of infinite Space can pinpoint a point in Time billions of years ago.

It is a finely balanced, sensitive instrument of utmost precision. A complex of electrical systems wherein even the most minute malfunction cannot be tolerated.

Designers and manufacturers of complicated electronic systems — sensing, control, communications — have learned to eliminate the unpredictable with Stevens *Certified* Thermostats. The product of creative engineering, they are backed by the most stringent environmental-test and quality-control programs in the industry.

You owe it to yourself — and your product — to look into Stevens *Certified* Thermostats *first*.

STEVENS *manufacturing company, inc.*

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STEMCO®

THERMOSTATS

Coming Events in the electronic industry

May 10-11: Plastics in Electrical Insulation Workshop, Newark Sec., SPE; Military Park Hotel, Newark, N. J.
May 10-11: Midwest/North Central Regional Mtg., IES; Radisson Hotel, Minneapolis, Minn.
May 11-12: Annual Mtg., American Inst. of Chemists; Edgewater Beach Hotel, Chicago, Ill.
May 11-22: 6th Annual U. S. World Trade Fair; Coliseum, New York, N. Y.
May 12: Quality Control & Reliability Conf., L. I. Sec., ASQC; Hofstra College, Hempstead, L. I., N. Y.
May 13-17: Conf. on Impact of Gov't R&D on Industrial Research, IRE; Broadmoor Hotel, Colorado Springs, Colo.
May 14-15: Canadian Regional Mtg., IES; Winnipeg, Canada.
May 14-16: Joint Distr. Mtg., AIEE; Erie, Pa.
May 14-16: Nat'l. Aerospace Electronics Conf. (NAECON), IRE, PGANE; Dayton Biltmore Hotel and Memorial Hall, Dayton, Ohio.
May 14-16: Joint Tech. Soc.—Dept. of Defense Symp. on Thermionic Power Conversion; Antlers Hotel, Colorado Springs, Colo.
May 15-16: 4th Annual Mtg. Council on Medical TV; Clinical Center, Nat'l. Institutes of Health, Bethesda, Md.
May 16-17: Plastics Injection Molding Workshop, Central Ohio Sec., SPE; Ohio State Univ., Columbus, Ohio.
May 16-18: Spring Mtg. on Experimental Mechanics in the Space Age, Soc. for Experimental Stress Analysis; Sheraton-Dallas Hotel, Dallas, Tex.
May 17-18: Heat Transfer Conf., Brookhaven Nat'l. Lab. and AEC; Brookhaven Nat'l. Lab., Upton, N. Y.
May 17-18: Pulp and Paper Conf., AIEE; Hilton Inn, Atlanta, Ga.
May 17-18: Pacific Northwest Regional Mtg., Illuminating Eng'g Soc.; Davenport Hotel, Spokane, Wash.
May 17-19: Nat'l. Conf., American Inst. of Industrial Engrs.; Ambassador Hotel, Atlantic City, N. J.
May 19-20: ARRL Roanoke Div. Conv.; Roanoke, Roanoke, Va.
May 20-23: Nat'l. Mtg. of the American Inst. of Chemical Engineers; Baltimore, Md.
May 20-23: Annual Mtg. of the Radiation Research Soc., Colorado Springs, Colo.
May 20-24: 43rd Int'l. Conf. & Annual Expos. of the Nat'l. Office Management Assoc.; San Francisco, Calif.
May 21-22: South Pacific Coast Regional Mtg., Illuminating Eng'g Soc.; U. S. Grant Hotel, San Diego, Calif.

Highlights '62

WESCON, Western Electronic Show and Conf., Aug. 21-24, IRE, WEMA; Memorial Sports Arena and Statler-Hilton Hotel, Los Angeles, Calif.
NEC, Nat'l. Electronics Conf., Oct. 8-10, IRE, AIEE, EIA, SMPTE; McCormick Place, Chicago, Ill.
NEREM, Northeast Research and Eng'g Mtg., Nov. 5-7; IRE; Boston, Mass.

May 21-23: Hydraulic Conf., ASME; Bancroft Hotel, Worcester, Mass.
May 21-23: 8th Nat'l. Aerospace Instrumentation Symp.; Marriott Motor Hotel, Twin Bridges, Washington, D. C.
May 21-24: 1962 Electronic Parts Distributors Show; Conrad Hilton Hotel, Chicago, Ill.
May 22-23: Appliance Tech. Conf., AIEE; Deshler-Hilton Hotel, Columbus, Ohio.

Highlights '63

IRE Int'l. Conv., Mar. 25-28; Coliseum and Waldorf-Astoria Hotel, New York, N. Y.
WESCON, Western Electronic Show and Conf., Aug. 20-23, IRE, WEMA; Cow Palace, San Francisco, Calif.
NEC, Nat'l. Electronics Conf., Oct. 21-23, IRE, AIEE; McCormick Place, Chicago, Ill.
NEREM, Northeast Research and Eng'g Mtg., Nov. 4-6, IRE; Boston, Mass.

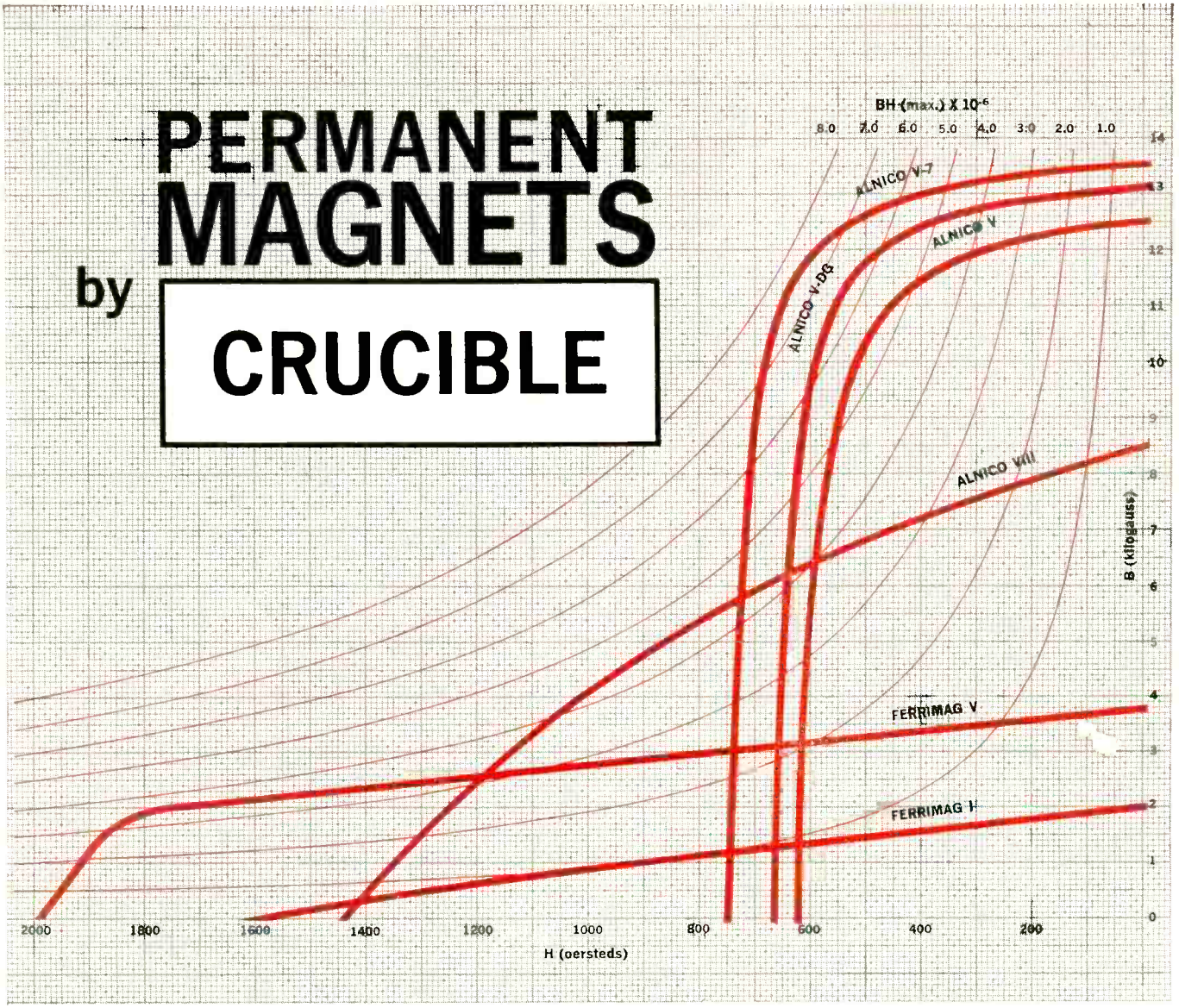
May 22-24: Nat'l. Microwave Theory & Techniques Symp., NBS, IRE-(PGMTT); Boulder, Colo.
May 22-24: Conf. on Self-Organizing Systems, ONR(ISB), ARF; Museum of Science & Industry, Chicago, Ill.
May 23-25: Nat'l. Telemetering Conf., ISA, ARS, IAS, AIEE, IRE; Sheraton-Park Hotel, Washington, D. C.
May 23-25: EIA 38th Annual Conf.; Pick-Congress Hotel, Chicago, Ill.
May 23-25: Atomic Energy Commission & Brookhaven Nat'l. Lab. Annual Corrosion Symp.; Brookhaven National Lab., Upton, N. Y.
May 23-25 American Soc. for Quality Control Annual Conv. & Exhib.; Netherland Hotel, Cincinnati, Ohio.
May 23-26: Acoustical Soc. of America Spring Mtg.; Hotel New Yorker, New York, N. Y.
May 24-25: Inter-Mountain Regional Mtg., Illuminating Eng'g. Soc.; Western Skies Hotel, Albuquerque, N. M.
May 24-26: IRE 7th Regional Conf.; Seattle, Wash.
May 24-27: 1st Biennial Southwest Air, Space & Electronic Expos.; Market Hall, Dallas, Tex.

INTERNATIONAL

May 2-4: European Corrosion Conf., SCI, CFC; Paris, France.
May 7-11: Symp. on Radiation Damage in Solids and Reactor Materials, IAEA; Venice, Italy.
May 21-25: Symp. on the Thermodynamics of Nuclear Materials, IAEA; Vienna, Austria.
May 28-29: Soc. of the Plastics Industry Annual Canadian Section Conf.; Chateau Frontenac, Quebec City, Canada.
May 28-30: 2nd Annual Conf. & Exhib. of the Canadian Nuclear Assoc. on Heavy Water Reactors, CNA; Ottawa, Canada.
June 4-8: 12th Annual Mtg. Soc. of Physical Chemistry, SCP; Paris, France.
June 4-9: Conf. on the Corrosion of Reactor Materials, IAEA; Salzburg, Austria.
June 10-15: Summer Annual Mtg., ASME; Hotel Frontenac, Quebec, Canada.
June 11-24: 9th Int'l. Electronics & Nuclear Exhib. & 7th Nuclear Congress, NCNR; Rome, Italy.
June 25-30: Symp. on Electromagnetic Theory & Antennas; The Technical University of Denmark, Copenhagen, Denmark.
June 26-29: 3rd Int'l. Symp. on Rarefied Gas Dynamics, U. of C.; Paris, France.
July 22-28: 8th Int'l. Cancer Congress, IUC; Moscow, USSR.
Aug. 5-11: 2nd Int'l. Congress of Radiation Research, ARR; Harrogate, Yorkshire, UK.
Aug. 26-Sept. 1: 10th Int'l. Congress of Radiology, ISR; Montreal, Que., Canada.

(*Continued on page* 13)

PERMANENT MAGNETS by CRUCIBLE



DESIGNED FOR EVERY INDUSTRY

For consistently higher energy product in any size of magnet from a fraction of an ounce to hundreds of pounds—

For coercive forces ranging from 400 to over 1,400 oersteds—and for energy values up to 7½ million gauss-oersteds or greater—

For an equally wide variance in physical and mechanical properties—

Crucible's magnet engineering staff can develop exactly the right magnet for your application.

Whether you need performance characteristics that must be specially designed for your product or any of the wide range of Alnico Magnets available from stock, let Crucible help with your design.

Crucible's "Permanent Magnet Handbook," one of the most comprehensive texts available on this subject, contains completely detailed data on magnet measurements, ferromagnetism, magnetization, demagnetization and electromagnetic theory. Performance and property data of over 60 magnet materials are also included. For your copy, send check or purchase order for $10.00 (plus 40¢ tax if you are located in Pennsylvania) to Crucible Steel Company of America, Dept. EI2, Box 88, Pittsburgh 30, Pa.

CRUCIBLE STEEL COMPANY OF AMERICA
MAGNET DIVISION P.O. Box 32, Harrison, New Jersey

Coming Events

(*Continued from page* 11)

Aug. 27-Sept. 1: 3rd Int'l. Congress, on Information Processing, Munich, Germany.

Aug. 27-Sept. 1: 3rd Int'l. Congress, Icas; Stockholm, Sweden.

Sept. 3-7: Int'l. Symp. Information Theory, IRE, PGIT; Brussels, Belgium.

Sept. 7-12: Int'l. Conf. on Crystal Lattice Defects, including Section on Radiation Damage, PSJ; Kyoto, Japan.

Sept. 13-14: Symp. on Advanced Gas-Cooled Reactor, BNEC; London. UK.

Oct. 20-26: World Power Conf.; Melbourne, Australia.

Oct. 22: Plastics vs. Corrosion, Ontario sec., SPE; Toronto, Ont., Canada.

Apr. 30-May 4: 1962 Int'l. Television Symp., Montreux, Switzerland.

Oct. 22-23: CIA/IAS Mtg.; King Edward Hotel, Toronto, Ont., Canada.

Nov. 12-14: Radio Fall Mtg., IRE, (PGBTR), RQC, ED, EIA; King Edward Hotel, Toronto, Ont., Canada.

ENGINEERING EDUCATION

Short courses of interest to engineers

Nondestructive Testing

Sacramento State College and the Sacramento Chap. of the Soc. for Nondestructive Testing is offering "Principles of Nondestructive Testing." **Dates: June 11-22, 1962.** Detailed instructions will be given on the theory, procedures, equipment, application and interpretation of findings for 12 major nondestructive tests. For more information contact: Dr. George N. Beaumariage, Jr., Summer Institute of Nondestructive Testing, Div. of Engineering, Sacramento State College, 6000 Jay St., Sacramento 19, Calif.

Human Relations

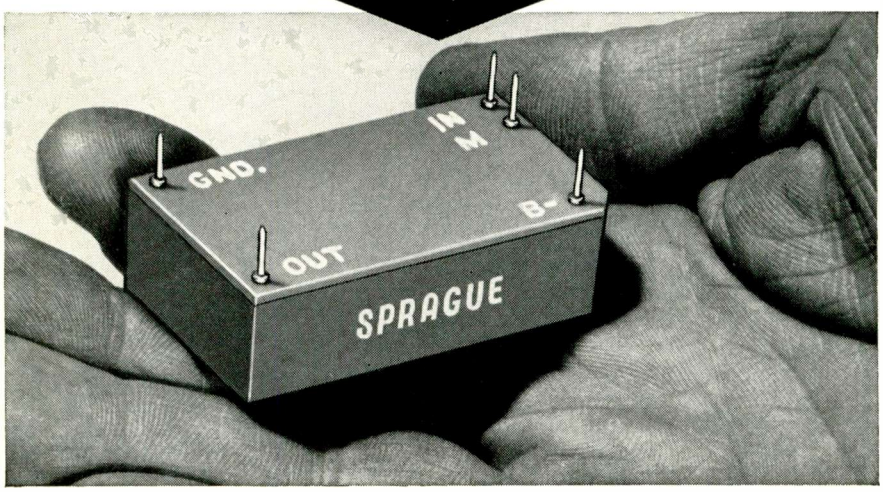
University of California Extension's 5th Annual "Leadership Laboratory" in human relations and supervisory skills for managers and leaders will be held at the Ojai Valley Inn, Ojai, Calif., from **May 27 through June 2, 1962.** Contact: Univ. of Calif. Engineering and Physical Sciences Extension, Los Angeles 24, Calif.

Operations Research

Purdue University is offering "Mathematical Techniques of Optimization," **June 4 to 14, 1962.** Course is divided into 2 parts: Deterministic Optimization Techniques; and Optimization in the Face of Risk, Uncertainty, or Competition. Contact: Div. of Adult Education, Purdue Univ., Lafayette, Ind.

Circle 6 on Inquiry Card ➔

Something
NEW
in counting techniques!



Sprague type 73Z1 core-transistor
DECADE COUNTERS

Sprague's Special Products Division, the largest and most complete facility in the magnetics industry, offers a simple yet versatile, low-cost yet reliable component for counter applications. Counting to speeds of 10 kc, the 73Z1 decade counter provides an output signal for every 10 input pulses, then resets in preparation for the next cycle. For higher counting, two or more counters may be cascaded. Typical characteristics are shown in the following table:

CHARACTERISTIC	INPUT	OUTPUT
Amplitude	1.5 to 8 volts	6.5 volts min.
Pulse Width	1 μsec min.	50 μsec nom.
Impedance	100 ohms	20 ohms

Utilizing two rectangular hysteresis loop magnetic cores and two junction transistors to perform the counting operation, the 73Z1 counter is encapsulated in epoxy resin for protection against adverse environmental conditions. It has five terminals—B+ (12v ±10%), input, output, ground, and manual reset.

The 73Z1 decade counter is available as a standard item. However, "customer engineered" designs can be supplied when other counting cycles, speeds, and package configurations are required for special applications.

Other Special Products Division components for the digital equipment industry include: LOGILINE 5 mc/s digital circuits; 1 μsec access time memory; magnetic shift registers and logic components; computer pulse transformers; switching transformers; precision toroidal inductors.

For complete technical data or application assistance on the 73Z1 counter or other Sprague components, write to Special Products Division, Sprague Electric Co., 233 Marshall Street, North Adams, Massachusetts.

SPRAGUE®
THE MARK OF RELIABILITY

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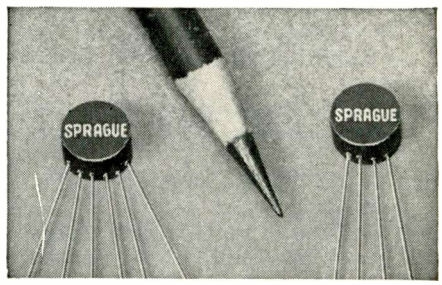
4S-292

Circle 7 on Inquiry Card

New Nanosecond* Pulse Transformers for Ultra-miniature, Ultra-high Speed Applications



Digital circuit designers will find the new Sprague Type 43Z Nanosecond Pulse Transformers of considerable interest. These tiny transformers have been carefully designed for the all-important parameter of minimum rise time at high repetition rates up to 10 mc.

The new Type 43Z series is comprised of a broad line of 72 pulse transformers in 10 popular turns ratios. They are Sprague's latest addition to the most complete listing of pulse transformers offered by any manufacturer for use in digital computers and other low-level electronic circuitry.

Type 43Z Pulse Transformers are designed so that the product of leakage inductance and distributed capacitance is at a minimum. They are particularly well suited for transformer coupling in transistor circuits since transformers and transistors are very compatible low impedance devices. Nanosecond transformers are equally suitable for transmission line mode of operation, in twisted-pair transmission line coupling, and in regenerative circuits.

The epoxy-encapsulated "pancake" package is excellent for both etched wire board or conventional chassis mounting. To simplify etched-board design, these ultra-miniature pulse transformers are available with leads terminating at the side or the bottom of each unit.

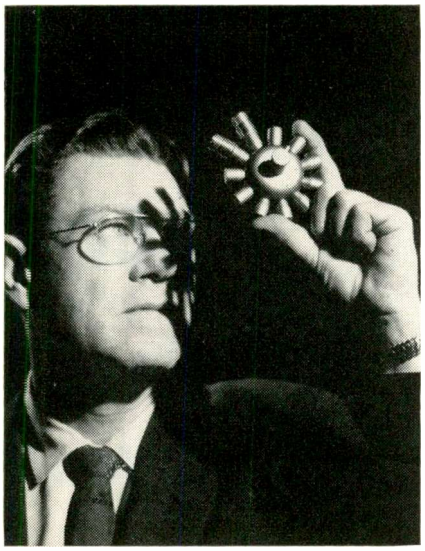
For complete technical information on Type 43Z Nanosecond Pulse Transformers, write for Engineering Data Sheet 40235 to Technical Literature Section, Sprague Electric Co., 233 Marshall St., North Adams, Mass.

*millimicrosecond

Circle 8 on Inquiry Card

As We Go To Press . . .

NEW MICROWAVE TUBE



Raytheon Co. space Amplitron delivers more power per pound. Radical design permits use of single small magnet for the tube which delivers 25w, yet weighs only 16 oz. Efficiency of 60%, combined with light weight and compact design make the new Amplitron ideal for space communications systems.

New Nuclear Power Station Authorized

The Atomic Energy Commission has authorized construction of the world's first high temperature, gas-cooled nuclear power station at Peach Bottom in Southeastern Pa. It is on the system of the Phila. Electric Co.

The plant will be built by Phila. Electric and 52 other investor-owned electric utility companies located throughout the U. S. and organized as High Temperature Reactor Development Associates, Inc. When completed in mid-1964, the 40,000-kw prototype plant will represent the first commercial application of a new, advanced concept of nuclear power generator, known as the High Temperature, Gas-cooled Power Reactor (HTGR). The HTGR system has been under development since 1957 by General Dynamics Corp.'s General Atomic Div. of San Diego, Calif.

Printing Register System Developed

Schaevitz Engineering Pennsauken, N. J., has developed a printing register system particularly useful to the sheet-metal or plastic lithographing industry, where wasted stock can amount to a sizeable loss.

The system instantaneously monitors and controls the sheet position as it is fed against the mechanical end or side stops of the press. Each sheet is placed in the exact or correct position for the printing impression.

Space Fuel Cell Passes Initial Test

A primary hydrogen-oxygen fuel cell battery at G.E.'s Direct Energy Conversion Operation at Lynn, Mass. has passed tests which should lead to the practical use of fuel cells as electrical power sources for space vehicles.

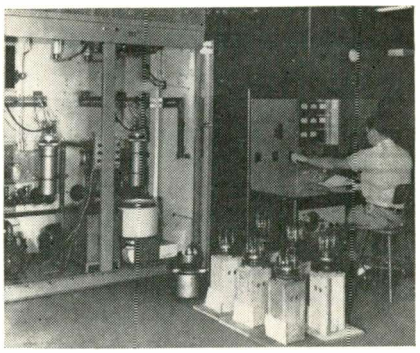
A 25 w. battery completed its initial test phase on schedule by delivering rated output for 50 hrs. under conditions closely approaching those expected in an extended orbital flight. This is the first major step toward flight in an orbiting vehicle under development by G.E.'s Missile and Space Vehicle Dept. as part of the Air Force Aeronautical Systems Div.'s Project HOPE (Hydrogen Oxygen Primary Extraterrestrial Fuel Cell Program).

British Program System Being Marketed Here

A new computer programming system designed to control mass production lines is being introduced in the U. S. by Sealectric Corp., Mamaroneck, N. Y.

Called the Sealectroboard, it enables pre-setting of controls for varied industrial processes. Its possible uses include remote switching for atomic power plants, telephone channel allocations, textile loom operations, skyscraper lighting and hotel reservation networks. It has been used in programming both digital and analog computers.

TUBE TESTER



A linear amplifier test set for testing low mu factor, high perveance, high-power audio, and ultrasonic power tubes is shown in operation at the Westinghouse electronic tube division, Elmira, N. Y. Operator at the equipment console is matching two water-cooled tubes.

Project to Seek High Voltage Switch

A research project is now underway at Cornell University to develop a switch which can immediately interrupt extremely high voltage electrical arcs.

The project director, Asst. Prof. Ravindraneth Sudan, Cornell School of Electrical Engineering, notes most power switches now used operate in oil or compressed air. He is experimenting to see if there is any advantage to interrupting currents under extremely high voltages in vacuums.

The information emerging from the current research, he says, may be useful in designing more compact and efficient switches for high voltage power circuits.

COMPUTER LABORATORY

Dr. R. R. Brown, director of the Computer Sciences Laboratory, recently opened at the University of Southern California, is shown at the console of the Honeywell 800. USC is using the computer for educational and research purposes. Honeywell, which has established its West Coast Education Center at USC, uses the computer for training personnel, for demonstrations and for other work with customers in the area.

As We Go To Press . . .

"Freedom Fleet" to Get New Echo Depth Sounder

Fifty vessels of the Navy's "Freedom Fleet," the Military Sea Transportation Service, will soon be outfitted with a new and improved type electronic echo depth sounder. First of the new units, developed by Raytheon Co. on the basis of operational requirements expressed by M.S.T.S., have been delivered.

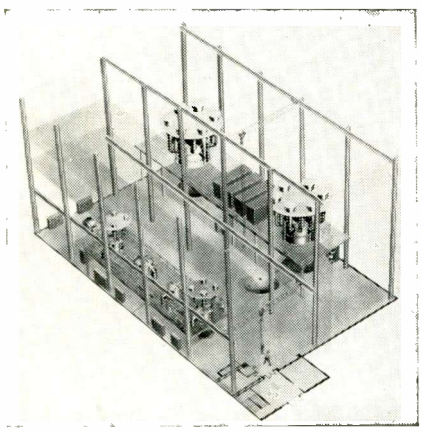
The echo depth sounders, known as the DE-714/715, give shipmasters instantaneous readings of the depth of water on a flashing light indicator and a simultaneous continuous graph of the ocean or harbor floor for navigation purposes.

M.S.T.S operates a fleet of more than 100 deep sea freighters, passenger ships, tankers, and special purpose vessels that support all U. S. forces throughout the free world and perform oceanographic survey and research functions.

Research Project Started

Electro - Optical Systems, Inc., Pasadena, Calif., has started work on an applied research program to determine the feasibility of using the tunnel mission effect to manufacture transistor-like devices. The company is working under an $89,-056 contract with the Aeronautical Systems Div., USAF Systems Command.

SIMULATION CHAMBERS



Artist's sketch shows arrangement of space chambers in the new space environmental lab being built by Hughes Aircraft Co. in El Segundo, Calif. Four of the chambers will be installed initially, with room for two more. The largest, with a test volume of 14 ft. in diameter by 15 ft. high, can accommodate a full-size Surveyor spacecraft for study under a space environment.

Says Tests Prove Existence of 'Heliosphere'

The profile of space—rather hazy at present—has been brought into sharper focus through analytical studies of data gathered in a series of high-altitude rocket probes recently conducted by NASA.

Dr. William B. Hanson, Lockheed Missiles and Space Co. physicist, says the data, which he analyzed for NASA, revealed the existence of a new sphere of gaseous matter composed primarily of helium ions surrounding the earth.

In a report appearing in a recent issue of the *Journal of Geophysical Research*, Hanson named his discovery the "heliosphere." It separates the ionosphere from the protonosphere, he said, beginning at an altitude of about 750 miles and extending for at least 1250 miles.

It had been believed that the oxygen ions, of which the ionosphere is largely composed, extend to the protonosphere.

Radar System Guides Close-Support Aircraft

First helicopter-transportable radar system for guiding and controlling close-support tactical aircraft during amphibious operations has been delivered to the Marine Corps.

This ground-based system automatically guides attack aircraft against enemy targets in close-support of Fleet Marine Force amphibious assault troops, day or night, and in all types of weather.

Designated the Radar Course Directing Central AN/TPQ-10, the new bombing system was developed for the Marine Corps by G.E.'s Heavy Military Electronics Dept. in Syracuse, N. Y., under the direction of the U. S. Navy Bureau of Ships.

Fast Warm-Up Tube Developed

A "fast warm-up" time of 1.3 sec. has been attained in a heater-type developmental receiving tube made by General Electric Co. at its Receiving Tube Dept.

Normal warm-up time for conventional radio and television tubes is about 11 sec. and for the ceramic type tube under experimentation is 25 sec.

Circle 10 on Inquiry Card →

counting selection logic with CLAREED® con

Meeting modern challenges of speed and reliability has created additional problems for the designer. *Solid state* devices have contributed one great asset—extremely high speed. This speed is not essential to many applications—and the single output nature of the device and the lack of isolation between input and output place certain limitations upon solid state design.

The *relay*, too, has had certain obvious limitations, such as its low speed and its single input characteristics. Obviously, there has been real need for a device which combines multiple input, multiple output, complete input and output isolation, and reasonable speed.

Such a device is the Clareed Control Module, a new control component in which magnetic flux is the decision-making element. Combinations of flux levels and flux polarities generated by multiple-wound coils open and close the Clareed switches. Decision-making capabilities may be extended by using a number of Clareed switches in one coil assembly for contact logic. Combinations of normally open, normally closed, and transfer Clareed switches may be varied for output requirements. Data handling speeds up to 250 bits per second are feasible.

The Clareed Control Module offers these major design advantages:

1. Multiple-input and multiple-output capabilities, making possible logic at both input and output.
2. Complete isolation between input and output. The output is the contact closure. This contact can handle:
   - Low Level Analog Signals
   - Other Digital Signals
   - AC or DC Power to 15va
3. Operation on voltages up to 48 vdc.

This folder will introduce Clareed Control Modules and show some basic applications. More detailed literature is offered on the back page of this folder.

a few notes

CR Clareed®

Ø The symbol phi indicates flux.

½Ø The flux magnitude not sufficient to operate, but sufficient to hold all the Clareeds in a coil after initial operation.

1Ø The flux magnitude sufficient to operate all the Clareeds in a coil.

Plus on the dotted end of a coil indicates flux in the direction shown.

"X" and "Y" Coils:—have no specific meaning other than a convenient method of designation.

MATHEMATICAL NOTATIONS:—Boolean algebraic expressions are used.

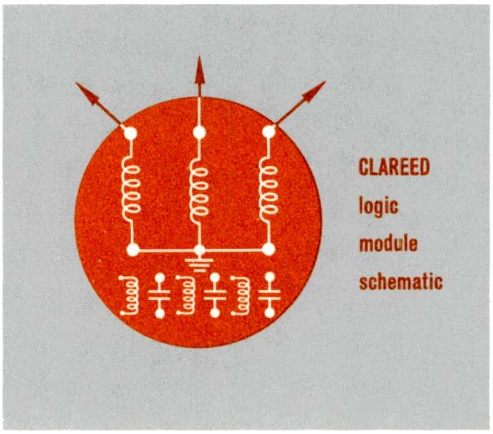
T The Boolean algebra symbol showing the path (all contacts) is closed and transmission is possible.

T′ The Boolean algebra symbol showing the path (all contacts) is open and transmission is not possible.

SOME INTERESTING APPLICATIONS

is composed of three Clareed Switches, each enclosed in an independent winding; these three units are enclosed in a larger coil having three separate windings of equal resistance and turns. Each inner coil influences only the Clareed switch it encloses; each of the three windings of the outer coil influences all Clareed Switches equally. Thus, the "open" or "closed" state of each switch is governed by four windings.

In normal use, the three windings on the outer coil are the three "Logic" inputs to the Module, and the individual inner coils are used to bias the switches as required in the specific application.



CLAREED logic module application

In a switching system, outputs based upon the logic of three or more inputs are often required. An example of this requirement is the check circuit "one of three," "one of six," or "one of nine." A single Clareed Logic Module accomplishes the "one of three" check rather simply, as indicated in diagram at right.

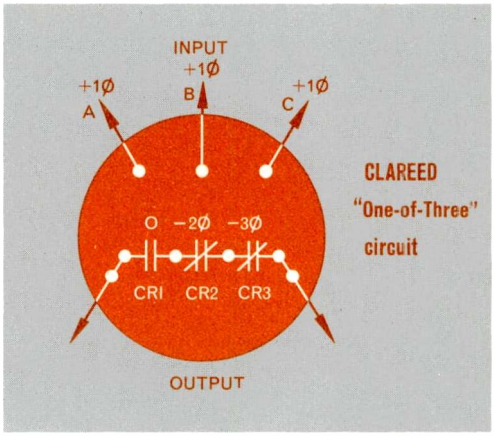
It is apparent that the outputs of three of these "one of three" circuits, when used as inputs of another "one of three" circuit, will produce a "one of nine" check.

Operation of this "one of three" check circuit is as follows:

With one input of +1ø: contact CR1 sees +1ø and closes. Contact CR2 sees +1ø+ (−2ø) = −1ø and stays closed. Contact CR3 sees −2ø and stays closed. Continuity exists and an output is obtained.

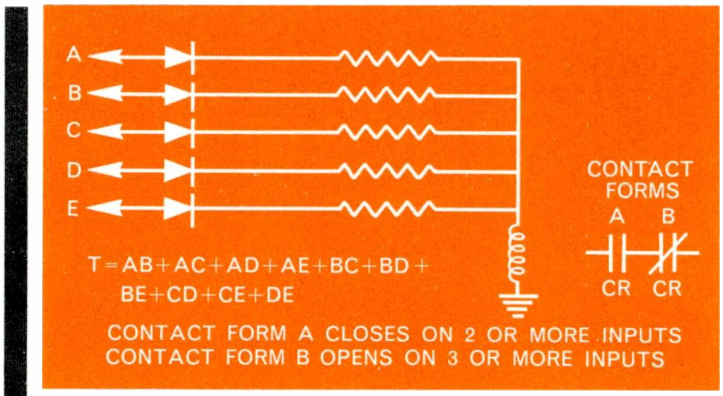
With two inputs of +1ø each; Contact CR1 sees +2ø and closes. Contact CR2 sees 0 flux and opens. Contact CR3 sees −1ø and stays closed. No output is obtained.

With three inputs of +1ø each: Contact CR1 sees +3ø and closes. Contact CR2 sees +1ø and stays closed. Contact CR3 sees 0 flux and opens. No output is obtained. A "one of three" check has been established.



A full binary coded decimal adder-subtracter may be constructed, using only seven Clareed Logic Modules. Merely changing the polarity of only one input makes the conversion from addition to subtraction. A schematic of this circuit is shown in the Logic Application Manual, offered on the back page of this folder.

An Interesting Application

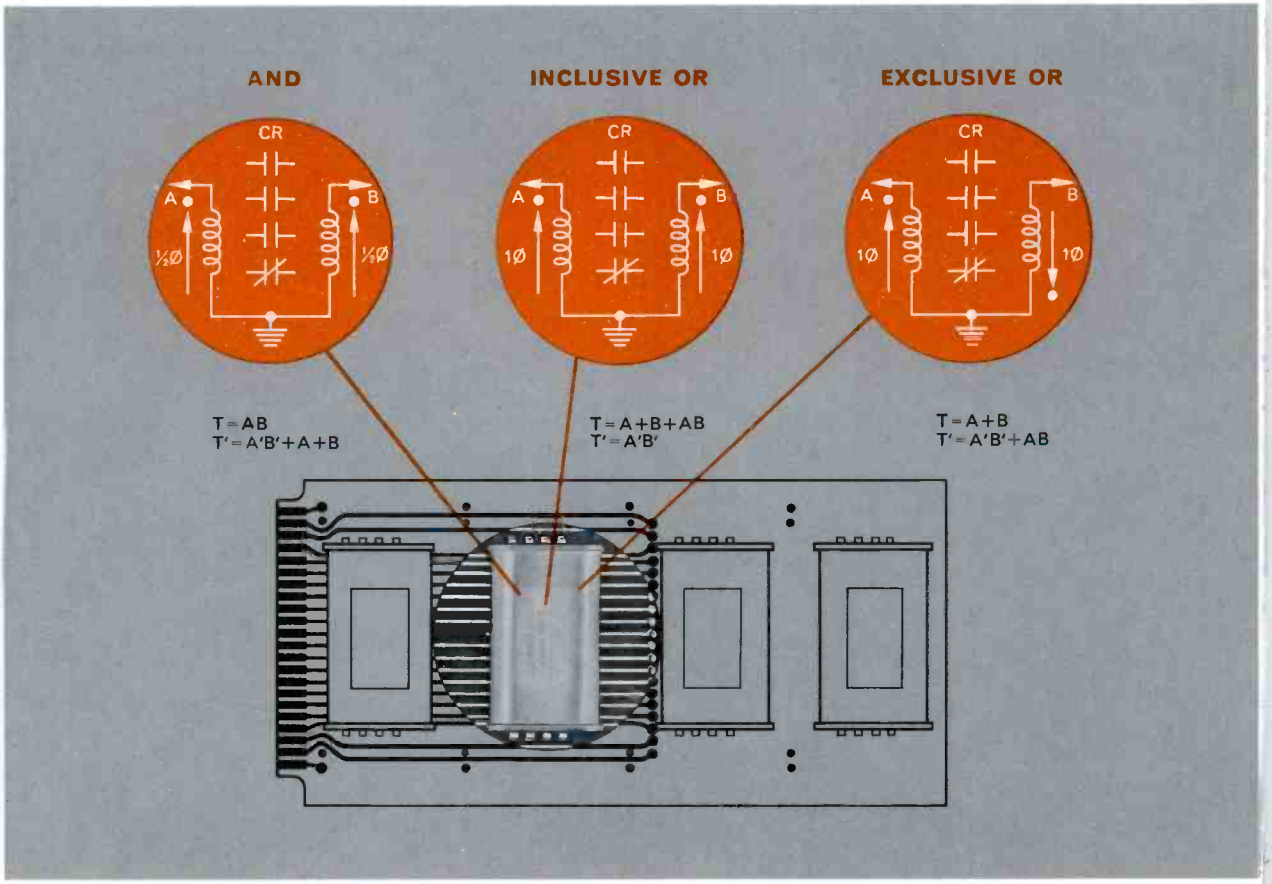


To perform 2 out of 5 logic, five inputs, five resistors and a simple Clareed Control Module with normally open and normally closed contacts are used. This circuit has useful application as a 2 out of 5 code check in a translator. The unique characteristic of the design is that it provides 100% check, not just parity check.

logic with CLAREED® control modules

CLAREED simple logic

The basic logic functions AND, inclusive OR, exclusive OR are fundamental to logic circuitry. All of these may be performed by the same Clareed Control Module, having one double-wound coil plus one or more Clareed switches. The magnitude and/or polarity of coil fluxes produces the AND, inclusive OR, or exclusive OR response. The inverse of all these functions is achieved by using a normally closed Clareed switch as output instead of a normally open Clareed switch.



CLAREED complex logic

The simple Clareed logic device shown above is capable of all logic functions which can possibly be performed with solid state devices. Like them, it must be cascaded to perform more complex logic. But the Clareed Control Module differs from solid state in that a single device is capable of performing all functions. Its functions are readily changed—by reversing a coil connection... using a normally closed or a normally open Clareed switch... or applying full current or half current to the coil windings. This logic device also has complete isolation between input and output with low level or power handling capability on the output.

More complex logic may be performed by another Clareed Control Module—the Clareed Logic Module. This module is practicable because there is no need for mechanical coupling between Clareed switch contacts and each switch can be independently controlled even though several switches are under the magnetic influence of a common outer coil. Each Clareed switch is an isolated two-terminal output device, with various windings acting as inputs. These Logic Modules perform input logic in the flux within the device, as well as output logic in the contacts of multiple switch assemblies. Interconnections between switches make the Logic Module equivalent to a large number of AND, OR, NOR, etc., since it combines many cascaded stages within one unit.

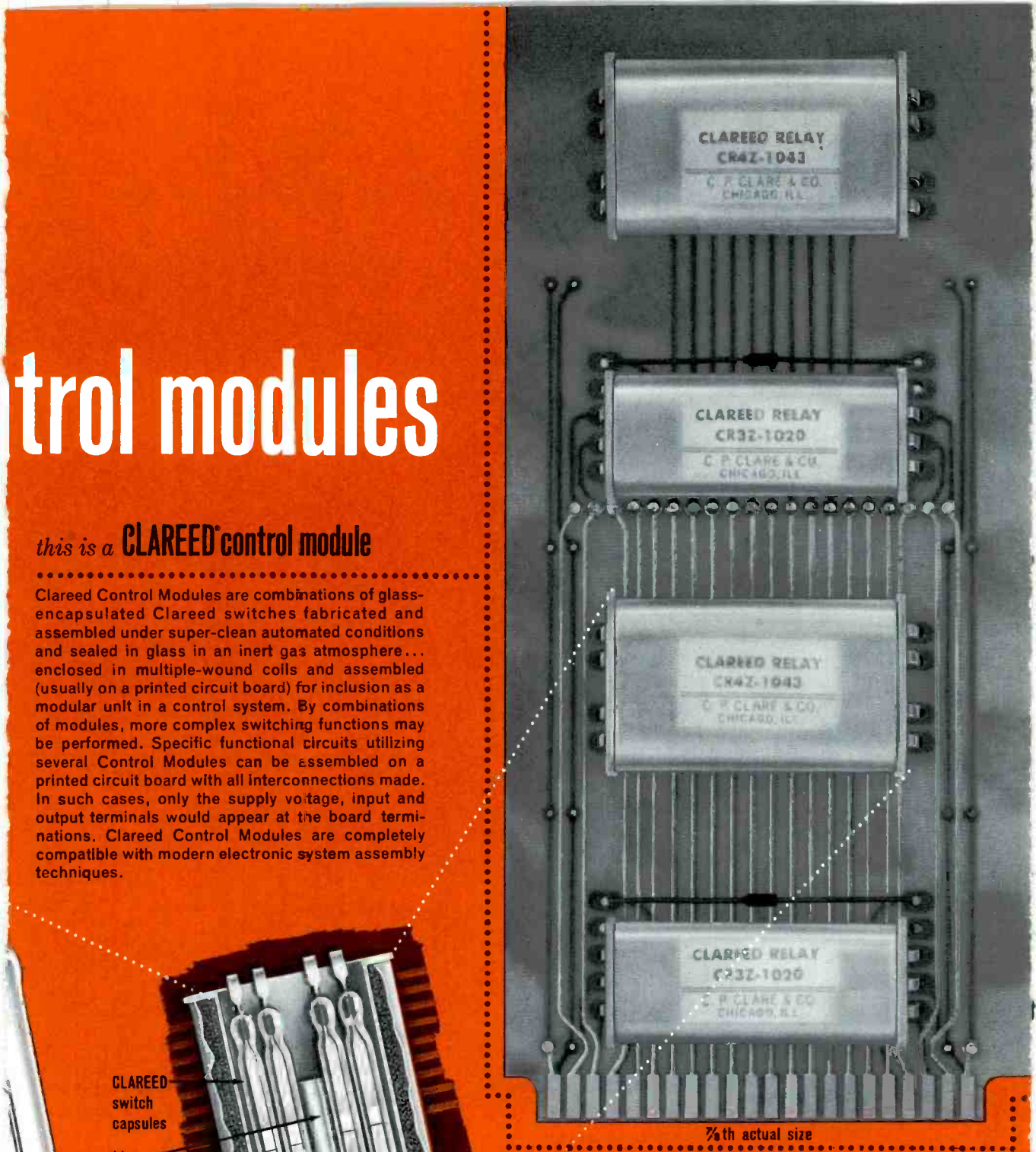
The Clareed Logic Module (see schematic)

For Detailed Application Data and Engineering Assistance... see back page of this folder

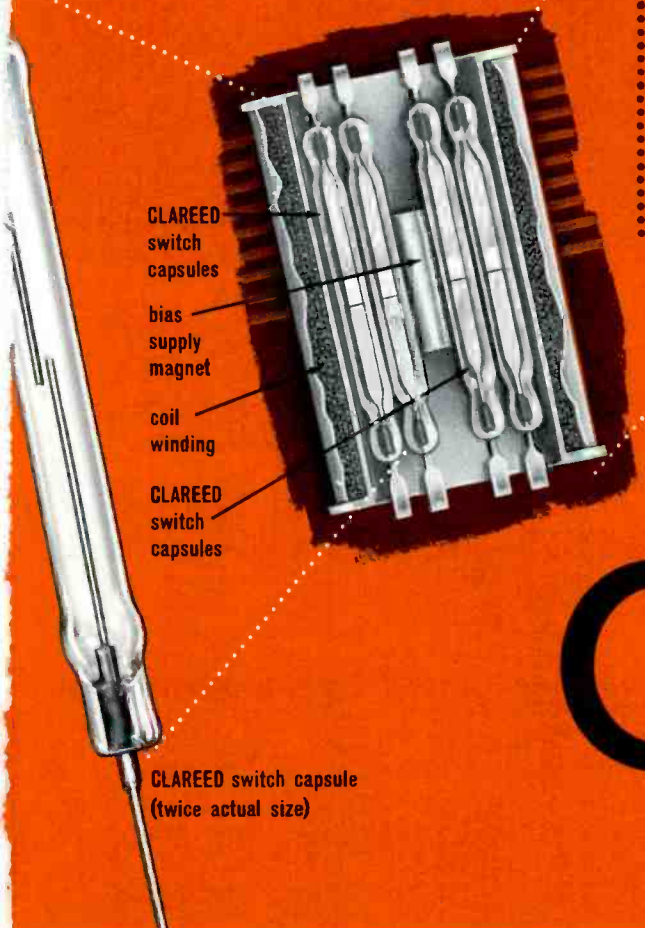
trol modules

this is a CLAREED® control module

Clareed Control Modules are combinations of glass-encapsulated Clareed switches fabricated and assembled under super-clean automated conditions and sealed in glass in an inert gas atmosphere... enclosed in multiple-wound coils and assembled (usually on a printed circuit board) for inclusion as a modular unit in a control system. By combinations of modules, more complex switching functions may be performed. Specific functional circuits utilizing several Control Modules can be assembled on a printed circuit board with all interconnections made. In such cases, only the supply voltage, input and output terminals would appear at the board terminations. Clareed Control Modules are completely compatible with modern electronic system assembly techniques.



7/8th actual size



CLAREED switch capsule (twice actual size)

C. P. CLARE & CO.

reliable control components

selection with
CLAREED® control modules

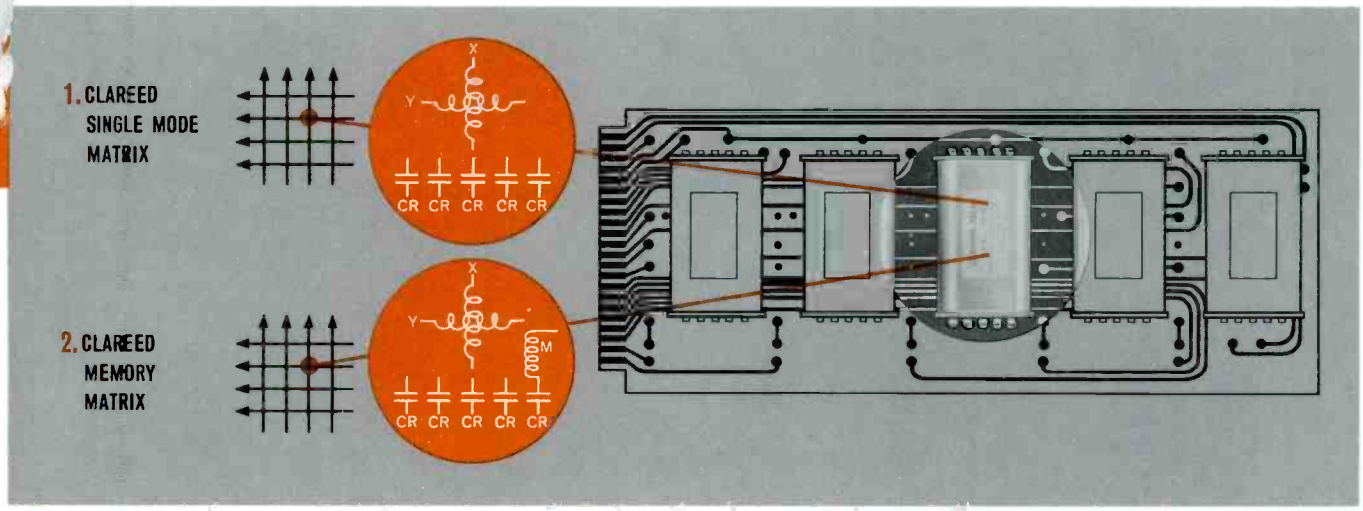
The standard method of random selection has been the crossbar—a combination of coils and coincident mechanical linkages which actuate contact pileups arranged in a fixed matrix form.

A crossbar built of Clareed switches utilizes only magnetic flux both to detect coincidence and to actuate Clareed contacts. The only moving parts are the glass-sealed Clareed contacts themselves.

A group of double-wound Clareed coils is arranged in matrix form. Coincident current in the two windings of a coil will close the Clareed switch at that crosspoint. This assembly built on printed circuit boards, forms the equivalent of the mechanical crossbar. It is called the Clareed Single Mode Matrix (1). It can be expanded in any direction to any desired extent simply by adding selection control modules of the same type.

The addition of a third winding for memory flux and use of one Clareed switch from each crosspoint creates the Clareed Memory Matrix (2). A fourth winding makes available an entirely new concept in selection systems, the Clareed Two-Mode Matrix (3).

A Two-Mode Matrix operates with normally open crosspoint contacts in mode one and normally closed crosspoints in mode two. In mode one the "X" and "Y" windings, when energized in coincidence, close the contacts in a normal manner, as in a single-mode matrix. In mode two, every contact is closed by its "P" coil and held in this position by the "M" coil. Then by coincident selection, using the proper "X" and "Y" coils, one crosspoint is selected and its contacts are opened. By successive coincident selection, any desired number of crosspoints can be selected and their contacts opened.

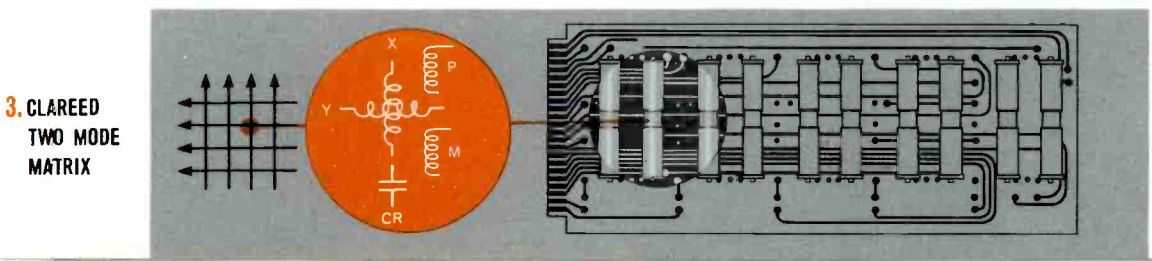


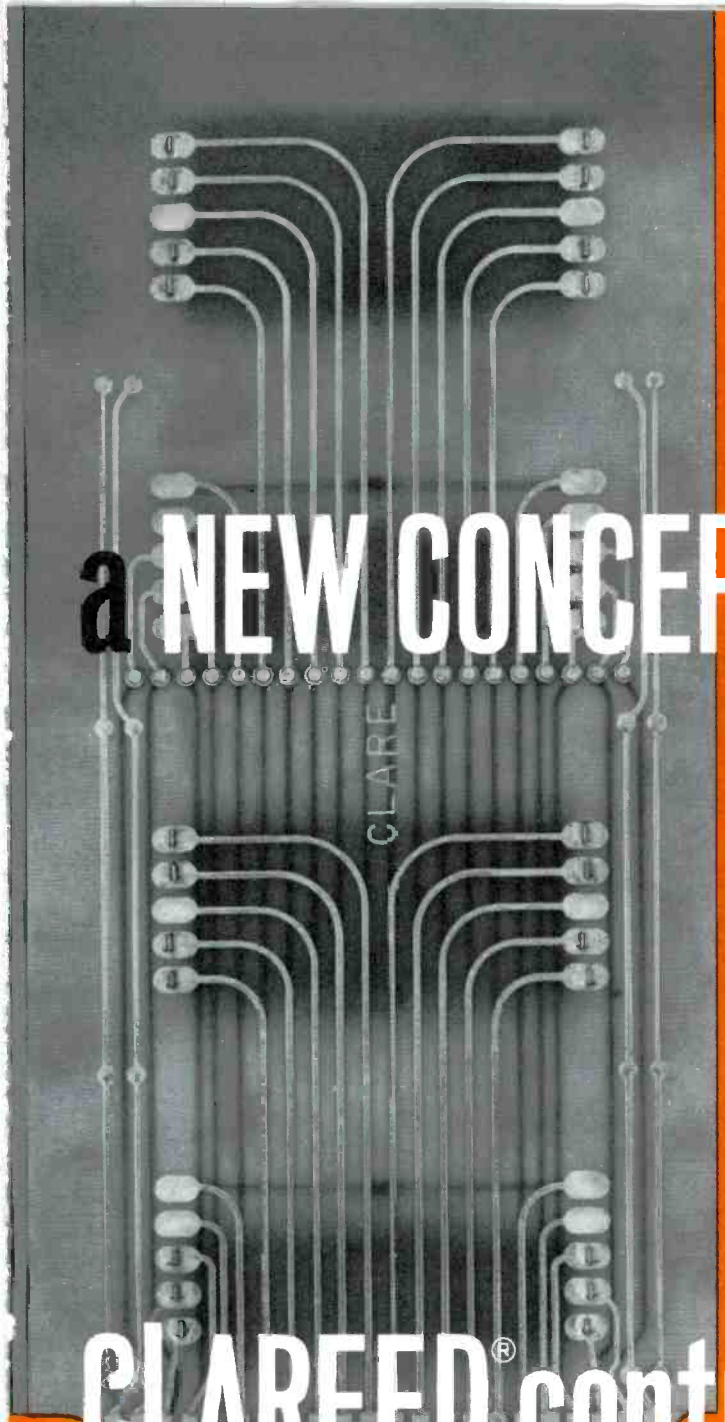
A Clareed Two-Mode Matrix has many applications. For purposes of explanation and concept, consider this simple checkout system:

In the checkout of a 100-conductor cable, it is necessary not only to check each conductor for continuity but also to test the leakage resistance and voltage breakdown of each conductor to all other conductors and ground.

This can be accomplished by using a Clareed Single Mode Matrix at one end of the cable and a Two-Mode Matrix at the other end. With both matrices in mode one operation, the ends of any single conductor can be selected and checked for continuity. With the Two-Mode Matrix in mode two, all conductors are electrically bundled together at one end and tied to ground. Using the ability of mode two to open any crosspoint, the conductor to be checked can then be isolated from the group at this end and individually contacted by the Single Mode Matrix at the other end. This allows the conductor to be tested for high voltage breakdown and leakage resistance in relation to the whole group and ground.

Having the capability of isolating one or any combination of crosspoints, the Clareed Two-Mode Matrix may also be applied to more complex circuits having interconnections and components common to several terminations. All of these terminations can be isolated from any other group of terminals by use of the Two-Mode Matrix.



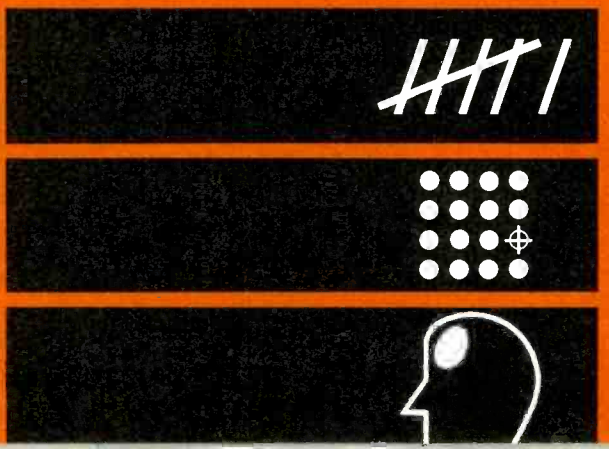


a NEW CONCEPT in design...

CLAREED® control modules

with multiple input and multiple output

MAKE POSSIBLE SIMPLER, MORE RELIABLE CIRCUITS FOR



counting

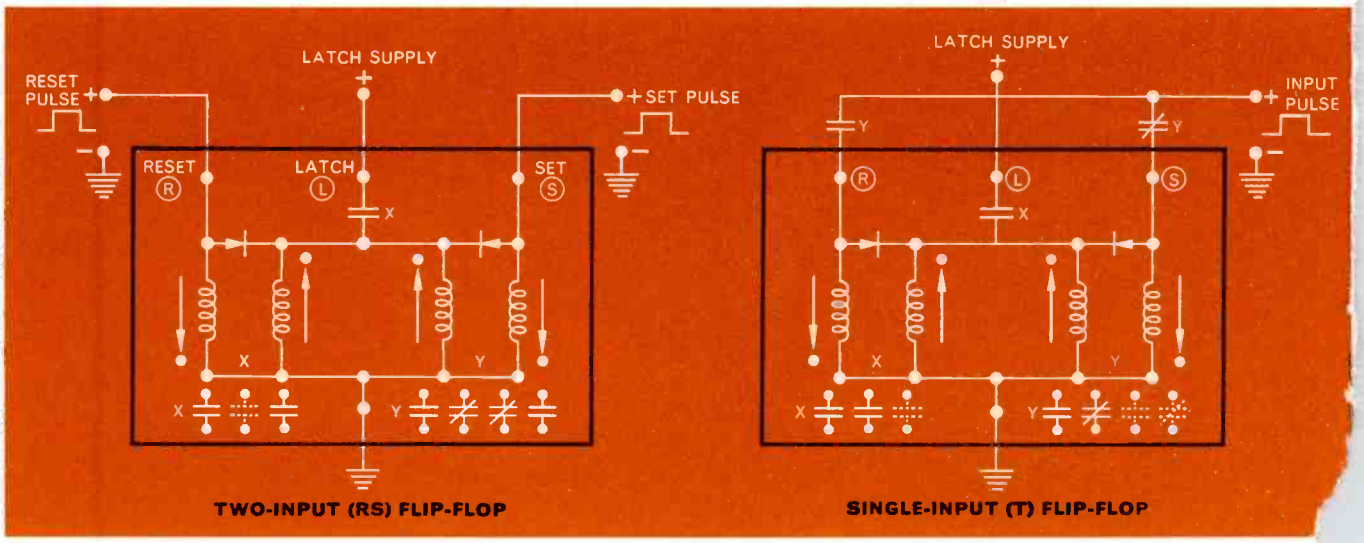
selection

logic

counting with CLAREED® control modules

Counting is effectively performed by the flip-flop, one of the most versatile of the Clareed Control Modules.

Control Modules with double-wound coils can perform as two input flip-flops. These Modules can be interconnected to construct pulse dividers, binary counters, shift registers, parallel-serial code converters, serial-parallel code converters, etc. Two-input (RS) and single-input (T) flip-flops are shown schematically below.



The "X" and "Y" coils of the two-input (RS) flip-flop are double wound and are diode coupled in opposition so as to produce zero flux when both windings are energized. One winding of each coil is connected to one Clareed switch of the "X" coil for latching.

Circuit Analysis of the basic Clareed flip-flop shows:

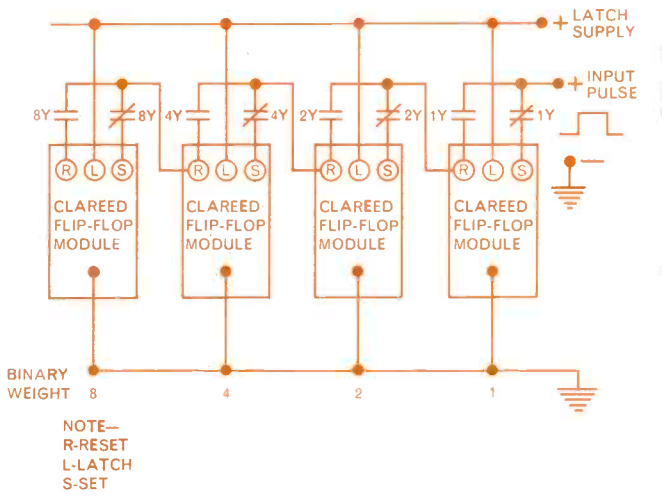
1. Presence of the *set* pulse energizes both windings of "Y" but only #2 winding of "X", causing the "X" Clareed switches to operate.
2. Removal of the set pulse causes #1 winding of "Y" to de-energize, thereby allowing "Y" Clareed switches to operate.
3. Presence of the reset pulse energizes both windings of "X", causing "X" Clareed switches to release. The #2 winding of "Y" remains energized through the "X" diode and the "Y" Clareed switches remain operated.
4. Removal of the reset pulse causes the "Y" Clareed switches to release, and the circuit is prepared to receive condition "1" above.

The single-input (T) flip-flop shown utilizes normally closed and normally open Clareed switches of the "Y" coil to alternately steer the input pulse to the *set* and *reset* inputs.

binary counter

A Binary Counter can be constructed by interconnections as shown at right. Each flip-flop is given a binary weight assignment. "1 Y", etc. beside a contact shows that the contact is in the "Y" coil of the Number One stage, etc.

The additional Clareed switches in each stage provide a weighted binary output proportional to the number of input pulses. These outputs can handle up to 15 volt amperes with complete isolation. The counter can be reset to zero by momentary interruption of the latching supply. The Binary Counter can also be built with magnetic memory so that any loss of power will not destroy its count.



For Detailed Application Data and Engineering Assistance... see back page of this folder

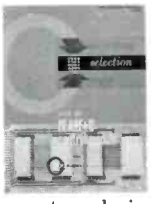
for additional **application information...**

on

counting

Combinations of electromagnetically-operated Clareed assemblies can perform a wide variety of switching functions such as ring counters, add-subtract, binary counting, shift register, etc. The Application Manual entitled "Counting with Clareed Control Modules" shows detailed characteristics and a number of useful applications.

selection



Present day selection system design is based upon the application of well-chosen components, often built into a modular form. The ideal module can perform a variety of functions by merely changing interconnections. The Application Manual entitled "Selection with the Clareed Control Module" is a comprehensive technical manual designed to give the engineer valuable aid in creating new and usable selection circuits.

logic

The Clareed Logic Module, a new concept in which the logic is performed in flux fields, opens new possibilities for simple solutions to complex applications of "three input logic." It offers flexibility with only one component, simplicity in circuit design and wiring... isolation between input and output and high-power gain...and high reliability.

The Application Manual entitled "Logic with the Clareed Control Module" contains application information and other design aids of value to the design engineer.

for your copies of these Application Manuals, use indicated Reader Service number—or call or write:

application engineering

Clareed Control Modules offer interesting solutions to many problems in counting, selection and logic. For detailed analysis and engineering recommendations, indicate your needs to:

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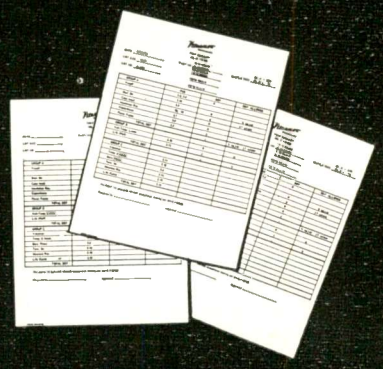

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DISSIPATION FACTOR

MIL. REQUIREMENT	ACTUAL PERFORMANCE
2.5% *for all values*	1.5% *for values thru 680 mmf.*
	2.5% *for values 820 thru 10,000 mmf.*

TEMPERATURE COEFFICIENT

MIL. REQUIREMENT	ACTUAL PERFORMANCE
+30% −56% *for all values*	±10% *for values thru 680 mmf.*
	±15% *for values 820 thru 10,000 mmf.*

CK Capacitors are checked 100% for dissipation factor and capacitance, and to insure that the parts stay within tolerance, only 2/3 of the available capacitance band is used. Parts are checked for Insulation Resistance after being subjected to a seal test consisting of exposure in live steam for 2½ hours under 15 p.s.i. Parts are also gauged 100% for physical dimensions.

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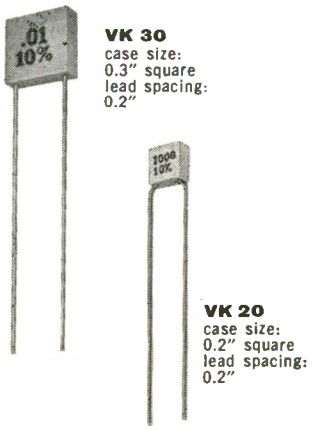
Conforms with MIL-C-11015/18/19



VK 30
case size:
0.3" square
lead spacing:
0.2"

VK 20
case size:
0.2" square
lead spacing:
0.2"

- **10–10,000 mmf**
- **−55° C to 150° C**
- **200 VDC rating**

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Lower V_{SAT} requires less dissipation—easier circuit design.

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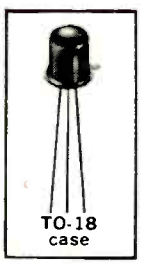
Lower C_{ob} means faster switching at low currents.

Higher f_T.

MAXIMUM RATINGS:	PHILCO 2N2400	2N711	PHILCO 2N2401	2N711A	PHILCO 2N2402	2N711B
V_{CBO}	−12 v	Same	−15 v	Same	−18 v	Same
V_{CES}	−12 v	Same	−15 v	−14 v	−15 v	Same
V_{CEO}	−7 v	NONE	−10 v	−7 v	−12 v	−7 v
V_{EBO}	−1 v	Same	−1.5 v	Same	−2 v	Same
Dissipation	150 mw	Same	150 mw	Same	150 mw	Same
ELECTRICAL CHARACTERISTICS:						
I_{CBO} (V_{CB} = −5v)	3 μa max	Same	1.5 μa max	Same	1.5 μa max	Same @−10 V_{CB}
h_{FE} (V_{CE} = −0.5 v) (I_C = −10 ma)	30 min	20 min	50 min	25 min	60 min	30 min
h_{FE} (V_{CE} = −0.5 v) (I_C = −50 ma)			40	40@−0.7 V_{CE}	50	40@−0.7 V_{CE}
V_{CE} (SAT) (I_C = −10 ma, I_B = −0.4 ma)	0.22 v max	0.50 v max	0.20 v max	0.30 v max	0.20 v max	0.25 v max
V_{CE} (SAT) (I_C = −50 ma, I_B = −2 ma)			0.30 v max	0.55 v max	0.25 v max	0.45 v max
V_{BE} (I_C = −10 ma, I_B = −0.4 ma)	0.27 min 0.36 max	0.34 min 0.50 max	0.27 min 0.36 max	0.34 min 0.50 max	0.27 min 0.36 max	0.34 min 0.45 max
V_{BE} (I_C = −50 ma, I_B = −2 ma)			0.38 min 0.48 max	0.45 min 0.75 max	0.38 min 0.48 max	0.45 min 0.70 max
C_{ob} (V_{CB} = −5 v, I_E = 0, f = 4 mc)	4.0 pf max	7.5 pf max	4.0 pf max	6.0 pf max	4.0 pf max	6.0 pf max
f_T (V_{CE} = −7 v, I_C = −10 ma)	150 mc min	Same @−5 V_{CE}	200 mc min	150 mc min @−5 V_{CE}	250 mc min	150 mc min @−5 V_{CE}
t_{on} (max)	75 nsec	100 nsec	75 nsec	Same	75 nsec	Same
t_s (max)	140 nsec	200 nsec	120 nsec	Same	100 nsec	Same
t_f (max)	130 nsec	150 nsec	110 nsec	Same	100 nsec	Same



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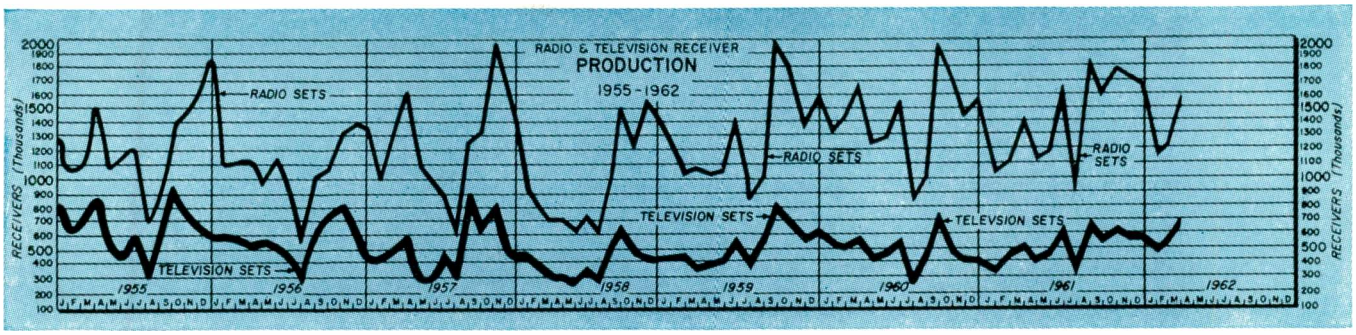


GOVERNMENT ELECTRONIC CONTRACT AWARDS

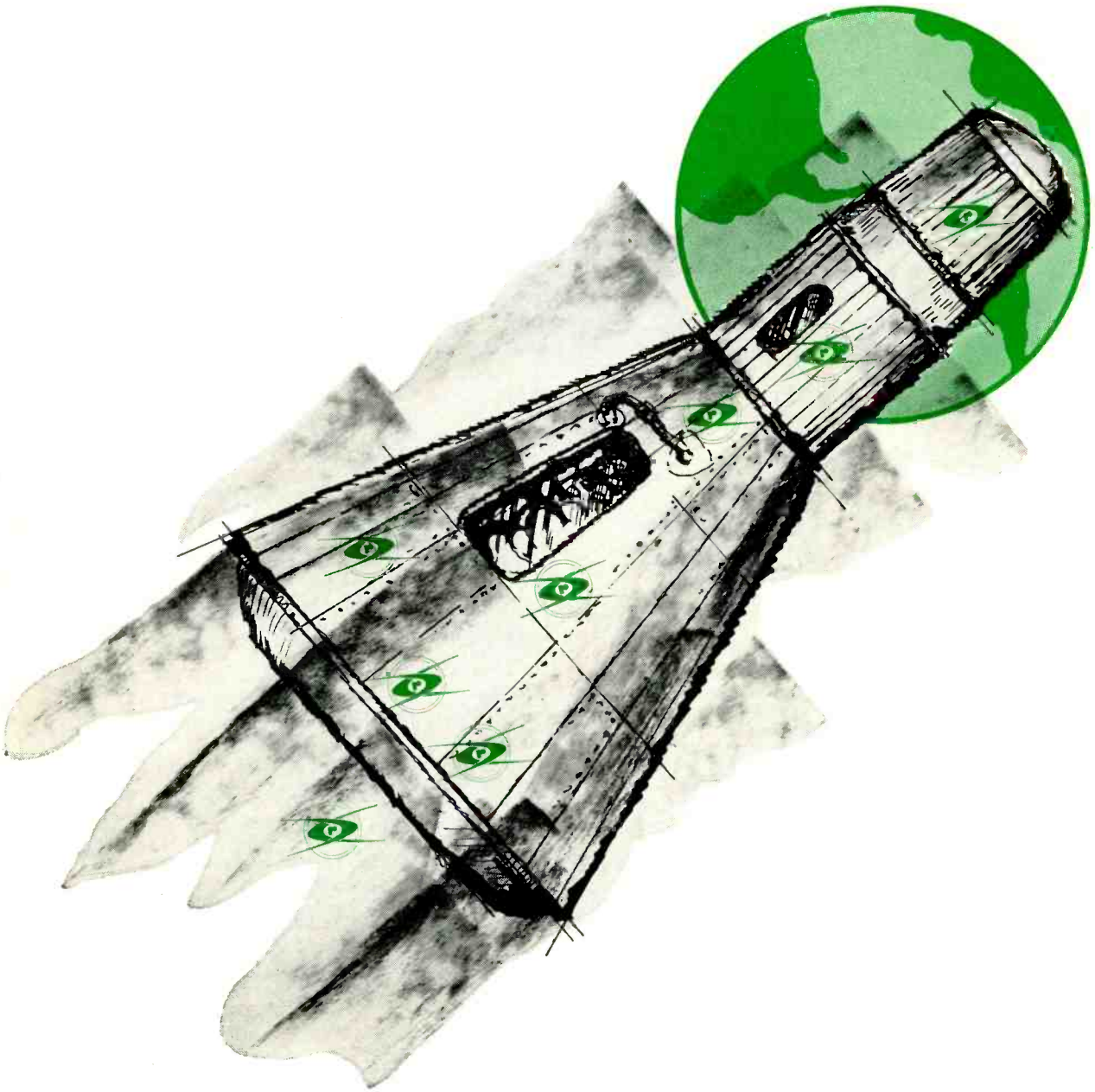
This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in March, 1962.

Accelerometers	64,375
Actuators	216,506
Amplifiers	2,477,875
Antenna Systems	1,639,413
Antennas	121,729
Batteries	25,199
Cable assembly	252,505
Calibrators	67,108
Capacitors	107,304
Chaff, countermeasures	397,562
Communications equipment	1,981,230
Computers	2,335,249
Connectors	956,240
Controls	324,596
Converters	159,077
Caunters, radiation	323,440
Couplers	148,280
Data processing equipment	879,350
Detectors	383,917
Drone system	500,000
Filters	248,746
Global tracking network	2,500,000
Gyros	553,755
Headsets	401,914
Indicators	946,968
Loudspeakers	500,000
Meters	246,435
Microphone assemblies	47,971
Multicouplers	344,622
Navigation equipment	500,000
Oscillators	51,120
Oscillographs	29,650
Oscilloscopes	61,023
Radar	8,801,455
Radiac set	565,144
Radio set	12,907,134
Radiosonde set	497,663
Radomes	2,500,000
Receivers	1,070,388
Receiving systems	52,160
Recorder/Reproducer	219,514
Recorders	100,165
Regenerators, time code	99,950
Relay assemblies	82,887
Relays	537,529
Repeaters, telephone	254,364
Resistors	104,345
Semiconductor device diodes	82,384
Signal generators	236,328
Simulators	282,081
Sonabuoys	22,047,473
Spectrum surveillance system	352,581
Switches	101,590
Switching equipment	1,307,490
Synchras	176,382
Target location system	133,091
Telegraph equipment	444,250
Telemetry equipment	607,939
Telephone set	226,522
Teletype equipment	185,060
Test equipment	778,038
Test systems	311,311
Tracking system, beacon	53,008
Transceivers	2,131,904
Transducers	82,026
Transmission systems	4,955,445
Transmitters	867,816
Tubes, electron	4,468,700
Tubes, klystron	567,270
Tubes, magnetron	153,950
Tubes, TW	77,314
TV equipment	302,835

Japanese Exports of Electronic Products to the U. S., 1960 and Jan.-Sept. 1960 and 1961

PRODUCT	Quantity in thousands of units			Value in thousands of dollars[1]		
		Jan.–Sept.			Jan.–Sept.	
	1960	1960	1961	1960	1960	1961
TOTAL				94,013	63,053	78,386
TV receivers and chassis	10	3	12	507	132	954
Radio receivers and chassis, total	7,870	5,248	7,685	69,315	47,987	49,986
Tube type	881	536	1,475	6,277	3,896	9,559
With 3 or more transistors	4,155	2,945	2,879	55,130	39,001	31,725
Other	2,834	1,767	3,331	7,908	5,090	8,702
Radio-phonographs	39	21	50	1,252	648	1,720
Sound recorders and reproducers	199	93	437	6,068	3,311	9,312
Tape recorder parts and recording tape				267	178	298
Amplifiers	97	66	70	765	466	609
Microphones	248	170	246	446	293	376
Speakers	1,940	1,156	2,149	2,023	1,442	1,555
Capacitors	16,604	11,509	22,024	972	695	1,157
Receivers (earphones)	2,724	1,917	2,664	573	396	536
Electron tubes and parts:						
Receiving tubes	16,289	10,651	12,691	4,470	2,918	3,344
Other		14	250	129	17	217
Transistors	3,415	1,235	3,773	1,758	821	1,603
Semiconductor devices, other	776	123	2,842	88	22	227
Electronic components, other				3,545	2,452	3,868
Phonograph parts and accessories				973	688	681
Other electronic products				862	587	1,943

[1] Converted to U. S. dollar equivalents at the rate of 360 yen = U. S. $1.00.
Source: Data obtained by the U. S. Embassy, Tokyo, from the Japanese Ministry of Finance.



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heat shrinkable tubings...

Used throughout the Friendship 7 Capsule

performed **A-OK ALL THE WAY**

RAYCLAD TUBES
INCORPORATED
REDWOOD CITY, CALIFORNIA

A SUBSIDIARY OF
RAYCHEM
CORPORATION

News Briefs

Capsule summaries of important happenings in affairs of equipment and component manufacturers

EAST

GENERAL ELECTRIC CO.'S POWER TUBE DEPT., Schenectady, N. Y., has been awarded a $101,000 contract by the Navy Bureau of Ships for an advanced R&D program, designed to increase the reliability and life of cesium vapor-filled thermionic converters. The program is expected to be completed in 12 months.

G-V CONTROLS INC., Livingston, N. J., has announced purchase of **UNI-SEAL, INC.**, Garwood, N. J. Uni-Seal, which manufactures hermetic glass-to-metal seals, will continue operation at its Garwood plant. A major expansion of facilities is already under way.

AMERICAN ELECTRONIC LABORATORIES, INC., Lansdale, Pa., has been awarded contracts totaling $670,000. The awards include a development contract from Patrick AFB for $352,581 for a Mobile Spectrum Surveillance System. Another research contract, from Rome Air Development Center, is for $124,605 for studies in Control Techniques in High RF Fields.

RAYTHEON CO., Lexington, Mass., has been awarded contracts totaling $4.7 million by the Boston Ordnance District for continued development and production of the Hawk missile system. Schedules call for $2 million to be spent on high power illuminator parts and components for the NATO Hawk missile system program; $1.6 million is scheduled for production of Range Only Radars, used to align the missiles on targets; the remaining $1.1 million is to be used on development and testing programs.

AMERICAN SPEEDLIGHT CORP., Middle Village, N. Y., has purchased the entire Megalume line of photographic products from **VITRO CORP. OF AMERICA**, New York, N. Y., for an undisclosed amount of cash.

CONTINENTAL CONNECTOR CORP., Woodside, N. Y., announces the termination of its exclusive sales agreement with **DeJUR-AMSCO CORP.** for the sale of Continental Connectors. Also announced in the expansion plans is the purchase of a 23,000 sq. ft. building adjoining its main plant at Woodside.

AMERICAN MACHINE & FOUNDRY CO., GREENWICH ENGINEERING DIV., GOVERNMENT PRODUCTS GROUP, Stamford, Conn., has announced the opening of a new Environmental Laboratory. The laboratory, which will be used for AMF and outside company environmental test programs, is designed for analysis of the effects of environment on components for aerospace ground equipment and for missile and aircraft operations.

RESISTO CHEMICAL CO., INC., Wilmington, Del., has announced the acquisition of management control in **CWS WAVEGUIDE CORP.**, Lindenhurst, L. I., N. Y. The acquisition involved an exchange in stock, with Resisto gaining an approximate one-third interest in CWS.

MEPCO, INC., Morristown, N. J., has established a high-reliability test center in Livingston, N. J. The center will be used to test high reliability metal film, carbon film and power resistors. Covering 15,000 sq. ft., it is located at 70 Okner Parkway, Livingston, N. J.

CUSTOM COMPONENTS, INC., Caldwell, N. J., has added 21,000 sq. ft. of new production facilities to its present plant. **FERRO-MAGNETIC CORP.**, a Custom subsidiary, will use the facility for ferrite processing operations.

RADIO CORP. OF AMERICA, New York, N. Y., has announced that it will lease two buildings totaling more than 100,000 sq. ft. at its Space Center near Princeton, N. J. The buildings will be used for engineering and administrative activities, and are expected to be completed this fall.

RADIATION SERVICE CO. sub. of **RADIATION, INC.**, Melbourne, Fla., has acquired the two-way radio maintenance and installation activity of **COASTAL COMMUNICATIONS CO., INC.**, Sarasota, Fla. Radiation Service will operate from the new facilities at 2037 12th St., Sarasota, Fla.

The Atomic Energy Commission has selected the **MARTIN MARIETTA CORP.**, Baltimore, Md., to design, build and ground-test a nuclear powered electrical generator. Designated SNAP-11, the generator is intended for use in Project Surveyor spacecraft.

BRANSON CORP. Whippany, N. J. has announced acquisition of approximately 20 acres in Denvill, N. J. Current plans calls for tripling of present manufacturing and engineering facilities.

DEARBORN ELECTRONIC LABORATORIES, INC., Orlando, Fla., has announced plans to double its present plant facilities. Construction, now underway, is scheduled to be completed in August. The new addition will contain automatic equipment, purchased in Europe, to be used in winding capacitor sections. The equipment is expected to increase production rates in excess of 4 times present levels.

RADIATION INC., Melbourne, Fla., has received a $1,500,000 USAF contract to provide two high-gain, wideband telemetry antenna systems for use on the Atlantic and Pacific missile ranges.

MIDWEST

THE NATIONAL CASH REGISTER CO., Dayton, Ohio, and **GENERAL TIME CORP.**, New York, N. Y., have entered into an agreement under which NCR will market General Time's recently developed "Transacter" data-collection systems. Under terms of the agreement, NCR will market and service Transacter systems in the U. S., Canada and in various overseas countries in which NCR has operations.

ALLIED CHEMICAL CORP.'s GENERAL CHEMICAL DIV., New York, N. Y., has announced that construction has been completed on a new plant at Metropolis, Ill., to produce sulphor hexafluoride, a gaseous insulator.

THE BENDIX CORP.'s CINCINNATI DIV., Cincinnati, Ohio, has announced the purchase of a 46-acre tract of land on which they will build a new plant and consolidate their scientific instruments and radiation products operations. The plant will be ready for occupancy by the end of 1962.

METHODE MANUFACTURING CORP., has moved its tube socket and shield operation to a new plant. Situated on a 200,000 sq. ft. site, the plant is approximately 24,000 sq. ft. and has provisions for future expansion. The plant is located at 1700 Hicks Rd., Rolling Meadows, Ill.

WEST

PACKARD BELL COMPUTER CORP., Los Angeles, Calif., has opened a new research and development center at 325 N. Muller Ave., Anaheim, Calif. With the addition of the 20,000 sq. ft. facility, the corporation's facilities now total 110,000 sq. ft. The center will be headquarters for a product development organization and data systems department.

CONSOLIDATED ELECTRODYNAMICS CORP., sub. of **BELL & HOWELL CO.**, Pasadena, Calif., has received orders totalling over $1 million from **SYLVANIA ELECTRONIC SYSTEMS, DIV. OF SYLVANIA ELECTRIC PRODUCTS, INC.** The order is for digital magnetic-tape recorders, which will be used in Sylvania's MOBIDIC (Mobile Digital Computer), AN-MPQ32 and 9400 computers.

GERTSCH PRODUCTS, INC., Los Angeles, Calif., has been awarded a contract in excess of $400,000 by the **AC SPARK PLUG DIV. of GENERAL MOTORS CORP.** The contract is for production of Gertsch CRB-6 complex ratio bridges, which will be used in the Air Force's B-52 program.

SANTA BARBARA RESEARCH CENTER, sub. **HUGHES AIRCRAFT CO.**, has announced plans to occupy a 48,000 sq. ft. building in the Santa Barbara Research Park, Santa Barbara, Calif. Plans call for construction of the building to be completed by September 1962. It will house research and engineering laboratories, infrared components manufacturing, and administrative offices.

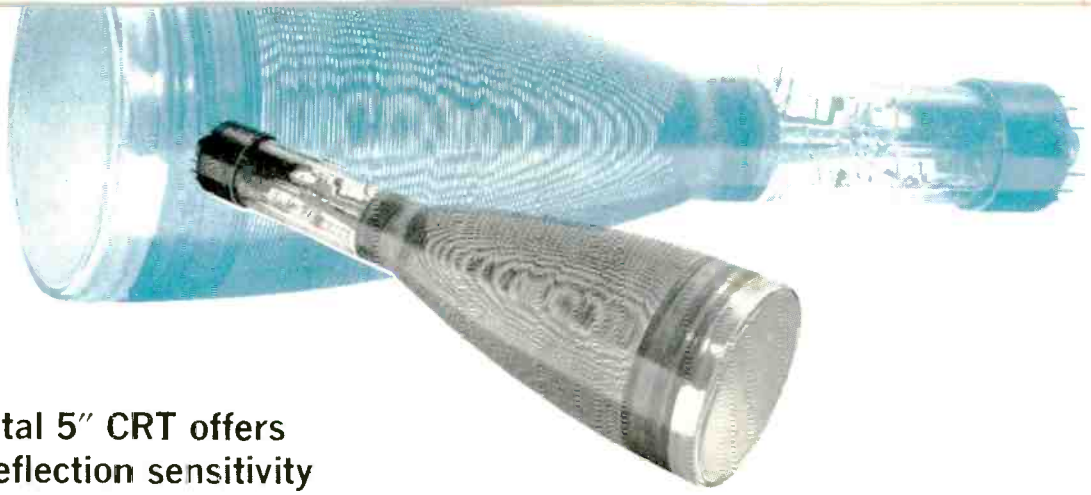
INTERNATIONAL ELECTRIC CORP., of Paramus, N. J., awarded a $2 million subcontract to **COLLINS RADIO CO.**, Dallas, Tex., for construction of data transmission equipment to be used at U. S. strategic missile sites.

GENERAL TELEPHONE & ELECTRONICS CORP., Mountain View, Calif., has received a $1.2 million contract for development and production of a new miniature electronic security system for the USAF's Minuteman ICBM. The award was made to the **RECONNAISSANCE SYSTEMS LABORATORIES (RSL)** of Sylvania Electric Products Inc., a sub. of GT&E, by the USAF Ballistic Systems Div., Englewood, Calif. The Reconnaissance Systems Laboratories also announced construction of a 77,000 sq. ft. addition to its present 56,000 sq. ft. facility. The new addition is expected to be ready for occupancy this summer.

RESISTRON LABORATORIES, INC., Santa Monica, Calif. has launched a $350,000 expansion program. Construction has begun on new, 30,000 sq. ft., plant facilities at 3860 Centinela Blvd. Plans call for completion in 45 days.

NASA's Goddard Space Flight Center, Greenbelt, Md., has awarded a research and development contract in excess of $3 million to **MOTOROLA, INC., MILITARY ELECTRONICS DIV.**, Scottsdale, Ariz., for the Goddard Range and Range Rate Tracking System. The system is expected to play a major role in NASA's future deep and near-space satellite tracking operations.

PLANNING RESEARCH CORP., Los Angeles, Calif., has been awarded a NASA contract for an independent reliability assessment study of orbiting geophysical observatories.

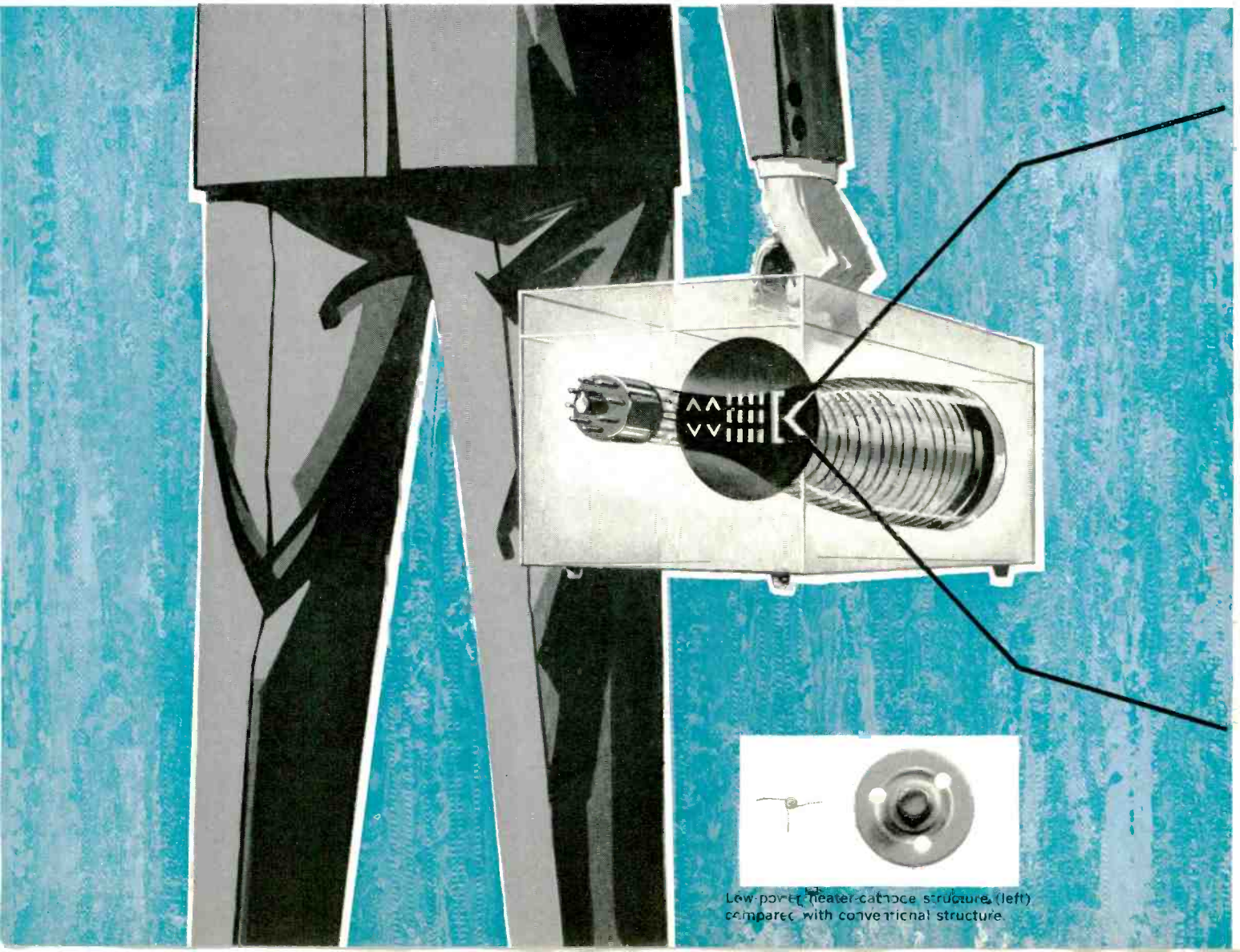


New!
Developmental 5″ CRT offers ultra-high deflection sensitivity

If your 'scope equipment requires dramatically superior performance—design around the new extraordinary SC-3351 by Sylvania. Here's why: design data indicates extraordinary sensitivity—deflection factors for 1D2 of 30Vdc/inch, and 3D4 of 6.5Vdc/inch (at 7 cm of scan)—better than a 2 to 1 improvement in deflection sensitivity over the best commercially available 'scope tubes at a slight increase in length (20″ max.). Too, SC-3351 offers, as an option, the Sylvania low-power heater. It features an internal helical resistance coating providing uniform increase in accelerating voltage. In addition, utilizing high efficiency screen phosphor and operating voltage of 10KV, SC-3351 demonstrates exceptionally high writing speed and accuracy. Where high performance in high frequency portable equipment is a prime requisite—consider the outstanding advantages of SC-3351.

CIRCLE 12 ON READER-SERVICE CARD

NEW! Sylvania low-heater-power



Low-power heater-cathode structure (left) compared with conventional structure.

Typical Operating Conditions

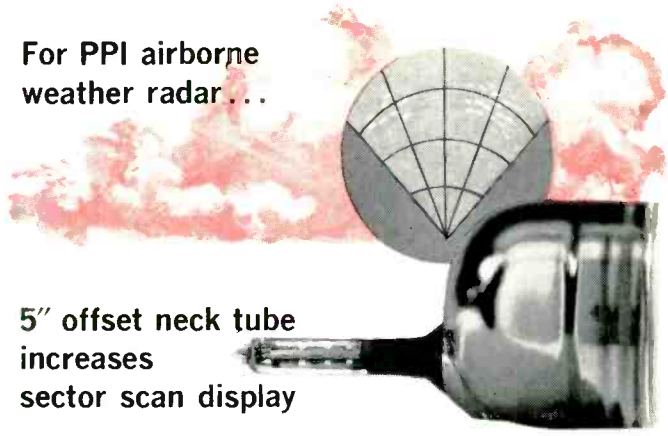
A3 Voltage	3 KV
A2 Voltage	1 KV
A1 Voltage	0 – 300 V
Eco	–30 to –90 V
Line width @ 1A3 = 10 μA	0.4 mm
Deflection factor	
1D2 approx.	30 V/in.
3D4 approx.	26 V/in.

New! Developmental type SC-3377 for compact, efficient 'scope designs!

Designed for transistor drive requirements, the Sylvania SC-3377 features low-power heater, 3½" square face for optimum use of display space, and high deflection sensitivity. It has an internal helical resistance coating to provide a uniform increase in accelerating voltage from deflection plates to the screen. It is electrostatically focused and deflected. Overall length is 13¾", neck diameter is 1⅝".

CIRCLE 13 ON READER-SERVICE CARD

For PPI airborne weather radar . . .

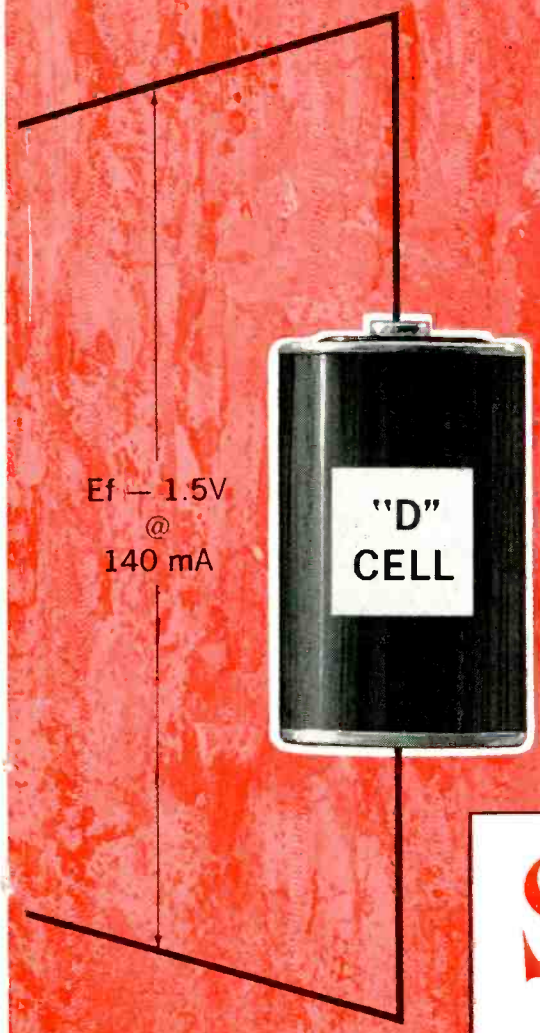


5" offset neck tube increases sector scan display

Sylvania SC-3180 provides "large-screen" display from a relatively small cabinet. The tube neck is set off-center, enabling the gun to sweep over a larger screen area than a conventional, centered gun. SC-3180 is available with the Sylvania low-power heater or a 6.3V, 300mA heater. Additional features include: flat focus characteristic allowing optimum focus of range rings and target; 9" length; small diameter neck; 9-pin miniature base; electrostatic focus; magnetic deflection; aluminized screen.

CIRCLE 14 ON READER-SERVICE CARD

CRT's for transistorized designs!



Now available in three new CRT's—a unique low-drain heater-cathode design! Pill-size and pancake-shaped, this Sylvania development heralds a fresh new outlook for the design of compact, lightweight, high performance 'scope or radar equipment.

Amazingly, power requirements (1.5V·140mA) are less than 6% of conventional CRT heaters. Equipment temperatures, therefore, are cooler—life expectancy is enhanced. Immensely smaller in size and mass, Sylvania low-power heater is practically immune to the "knocks" of portability. What's more, performance is easily comparable to larger 6.3V, 600mA heaters.

To illustrate typically low drain on battery supplies: a #6 cell operating two hours a day provides between 350 to 400 hours of life, even the common "garden variety" D battery provides 15 hours of life.

Remarkably enough, the Sylvania low-power heater is adaptable to virtually any existing CRT type. If you are transistorizing your 'scope equipment, capitalize on its many advantages. Ask your Sylvania Sales Engineer for full information. For technical data on the three new types, write Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main Street, Buffalo 9, New York.

SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

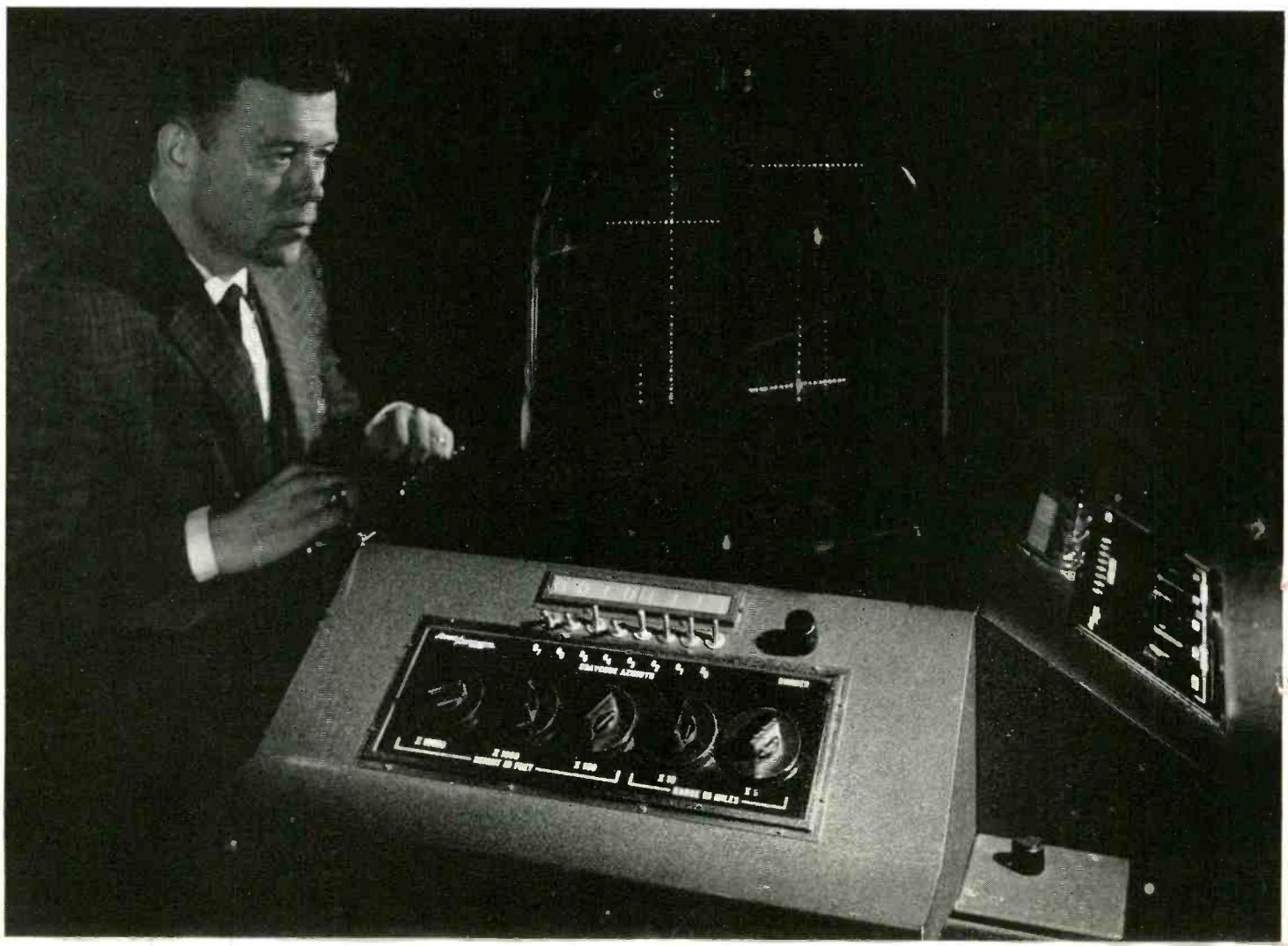
Snapshots . . . of the Electronic Industries

SPACE LAMPS

New feature of the space suit worn by Astronaut John H. Glenn, Jr., was a set of fingertip lights. While in orbit, Glenn used the lights —one each on the glove tips of the index and middle fingers of each hand—to read instruments and charts. B. F. Goodrich engineers added the bulbs to the suit design after the sub-orbital flights.

3-D DISPLAY DEVICE

New three-dimensional (3-D) display shows tracked objects, such as aircraft, spacecraft, or submarines, in their true perspective—height (or depth), range, and azimuth. Unlike equipment developed in the past, it does not require special optics or viewing lenses to be put to practical use. Unit is made by Avco Corp., Cincinnati, Ohio.

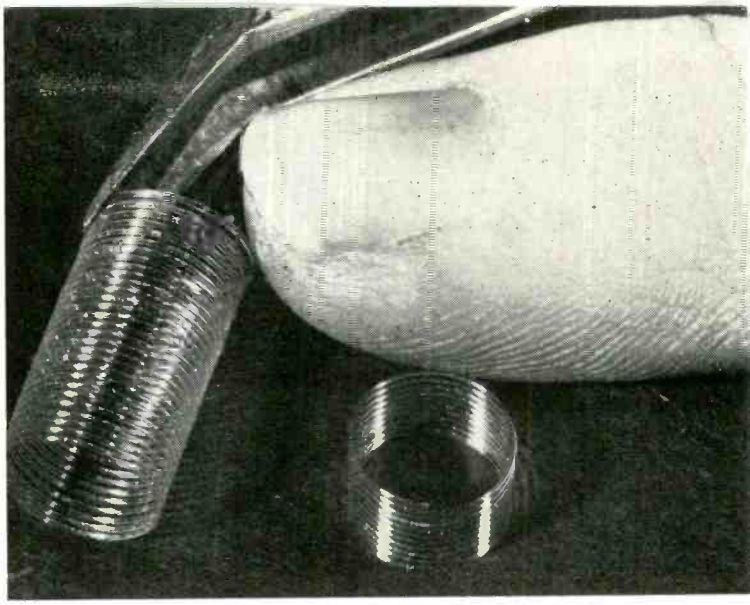


SILICONE FLUID

GE chemist examines samples of new GE XF-1053 silicone dielectric fluid and silicate ester following evaporation-weight loss tests in oven at 400° F. New fluid (1), showed less than 20% weight loss after 160 hours, while silicate ester crystallized after 60 hours.

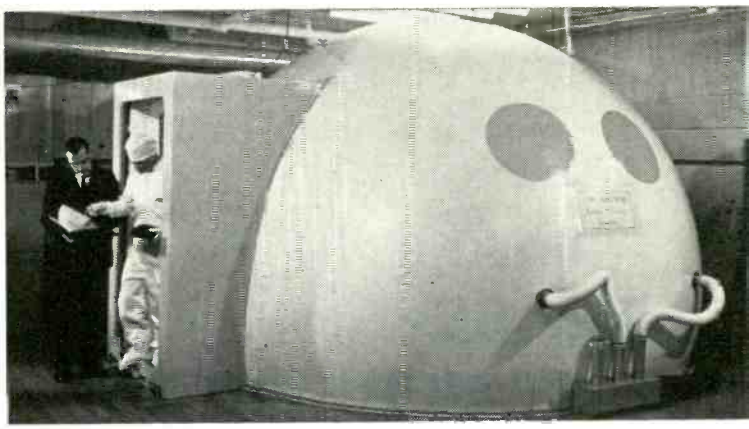
FUSED QUARTZ

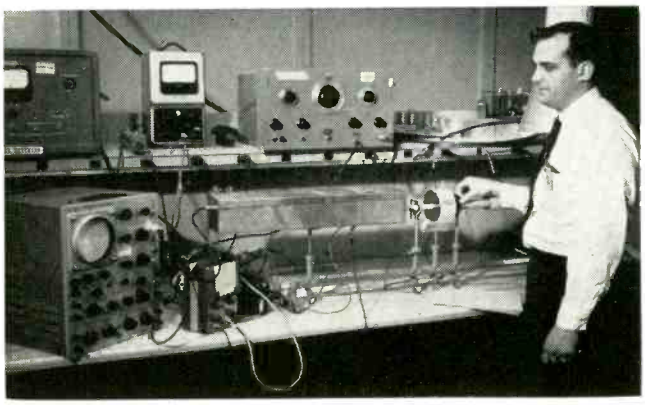
Coiled springs made from quartz by Lockheed Missiles & Space Co. engineers are capable of such discriminating measurements as the gain in weight of feeding bacteria.



PLASTIC "IGLOO"

Inflated plastic "igloo" was designed and built by Tung-Sol Electric Inc. The air-conditioned facility is a special laboratory where critical experiments are conducted in an absolutely clean environment.



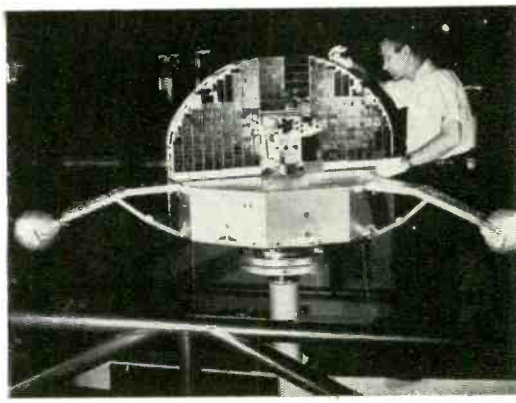


LIGHT MODULATION

Aircraft Armaments, Inc. (Cockeysville, Md.) engineer, Melvin C. Watkins, adjusts a polarizer in a system used to modulate a beam of light at microwave frequencies. The modulator consists of an electro-optic crystal placed within the electrical field of a microwave cavity. A depth of modulation of 10 to 30% has been estimated.

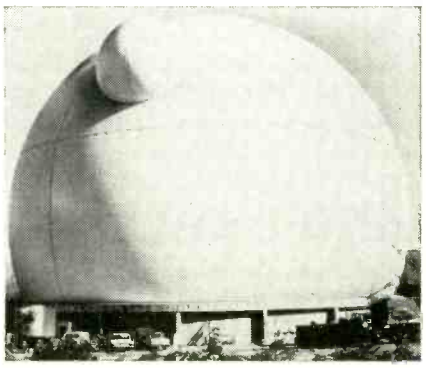
OBSERVATORY

Orbiting Solar Observatory receives final check at Ball Brothers Research Corp., Boulder, Colo. The OSO-1 is now orbiting the earth and reporting weather conditions on the sun. The satellite airframe is made entirely of Alcoa aluminum.



CAPACITOR TESTS

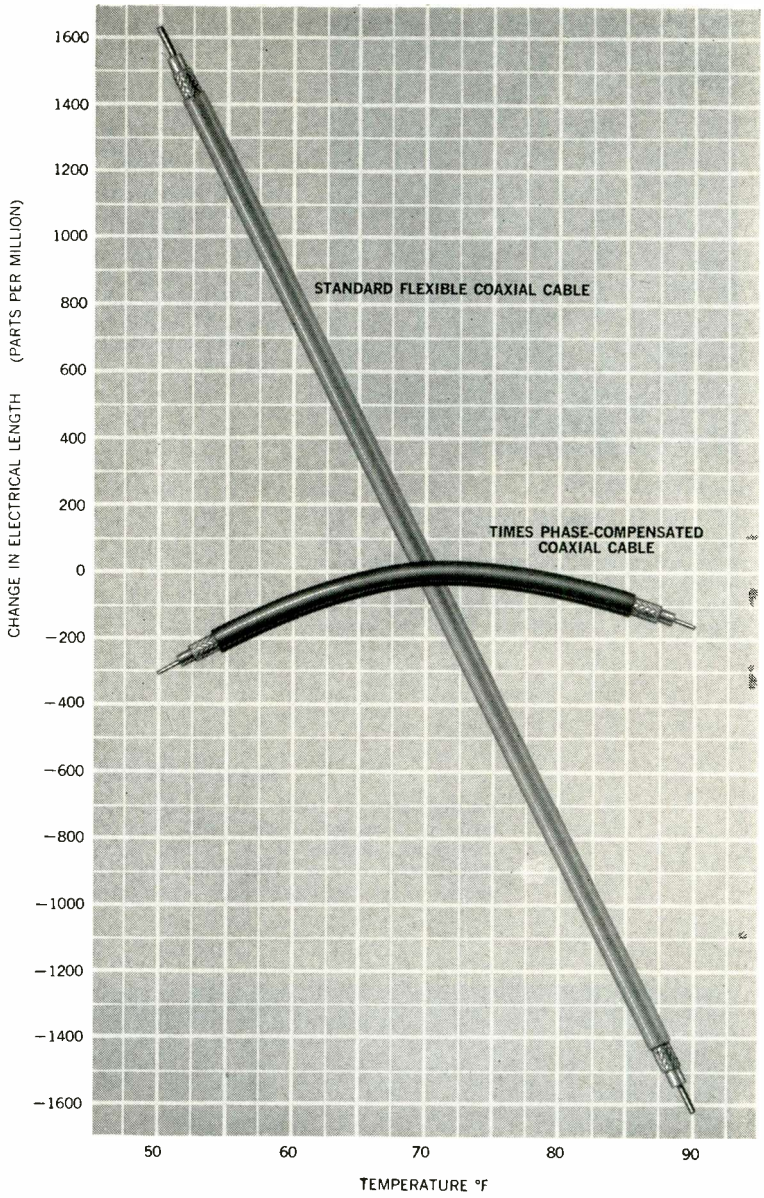
To assure optimum performance of their solid tantalum capacitors, Kemet Co., Division of Union Carbide Corp., resorts to a variety of rigorous tests. Here a rack of 100 capacitors is placed in a 30-rack oven for baking at 125°C at rated voltage. During tests, measurements are made on capacitance, leakage, and dissipation.



"NOSY"

Air-supported radome houses a 300-ton communications antenna, part of Bell Telephone Labs' Project Telstar. Shown here is the temporary radome used during construction. Foundations for radome and antenna were designed and built by Burns & Roe, Inc., New York.

now! a PHASE-COMPENSATED flexible coaxial cable



new TIMES cable exhibits virtually no change in electrical length with temperature variations

To solve the problem in standard flexible coaxial cables of electrical length changes due to temperature variations, Times has developed a new self-compensating, phase-stable cable.

Designed specifically for use with advanced radar systems, this new phase-compensated cable produces less than 20 parts per million change per degree centigrade temperature variation. It virtually eliminates phase shift and permits signals to be relayed with minimal distortion.

Times' new phase-stable cable is a major achievement in the art of perfecting coaxial cables. It provides an ideal solution for applications in which phase change cannot be tolerated, and where precise signal accuracy is a must. The basic technique used in developing this cable is now being applied to even more sophisticated problems.

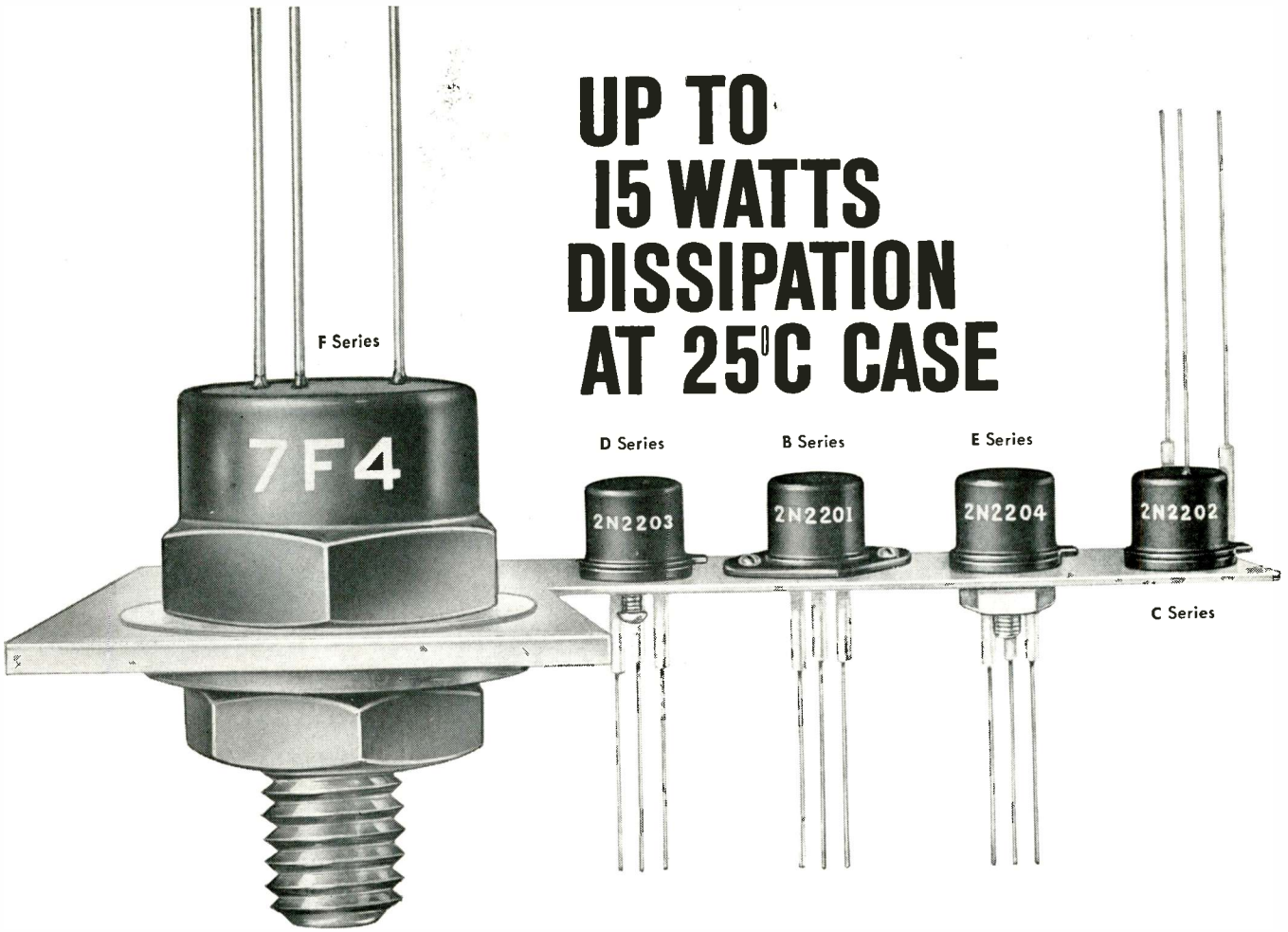
The phase-compensated cable is another example of Times' ability to design, engineer and produce cable and cable assemblies for critical transmission system applications. Times will also manufacture cable and assemblies cut to precise electrical length, as well as special cables and assemblies for industrial and commercial applications. When you need assistance with your transmission system problems, wire or write Times' Sales Manager, Dept. 51.

*A DuPont Trademark

TIMES WIRE AND CABLE
Division of The International Silver Company
Wallingford, Connecticut

TRANSMISSION SYSTEM DESIGN AND ENGINEERING • STANDARD & SPECIAL PURPOSE COAXIAL CABLE • MULTICONDUCTOR CABLE • COMPLETE CABLE ASSEMBLIES • TEFLON* HOOK-UP WIRE

UP TO 15 WATTS DISSIPATION AT 25°C CASE



For high power dissipation in a small area, these new General Electric silicon mesa power transistors have no equal for aircraft servo or missile applications. Four combinations of electrical characteristics are available in five different package designs to meet your particular circuit requirements. And all feature (except 7F series) 15 watts power dissipation at 25°C case temperature.

Industrial types 2N2196, 2197 in the diamond package are also available. Your General Electric Semiconductor Products District Sales Manager will be happy to give you complete details. Or write Semiconductor Products Department, Section 13EI22, General Electric Company, Electronics Park, Syracuse, New York. In Canada: Canadian General Electric Co., 189 Dufferin Street, Toronto, Ont. Export: International General Electric Co., 159 Madison Avenue, New York 16, New York.

RATINGS AND CHARACTERISTICS (25°C unless otherwise specified)

		B Series C Series D Series E Series F Series	7B1 7C1 7D1 7E1 7F1	7B2 7C2 7D2 7E2 7F2	7B3 7C3 7D3 7E3 7F3	2N2201 2N2202 2N2203 2N2204 7F4	
Voltage Collector to Base (max.)	V_{CBO}		80	80	120	120	volts
			Min. Max.	Min. Max.	Min. Max.	Min. Max.	
Collector to Emitter Saturation Voltage (I_C = 200 ma, I_B = 40 ma)	$V_{CE\ (SAT.)}$*		1.7	1.7	1.7	1.7	volts
Alpha Cutoff Frequency (V_{CB} = 30 V, I_E = 30 ma)	f_{hfb}		← (15 mc *typical* for all types) →				
Forward Current Transfer Ratio (V_{CE} = 10 V, I_C = 200 ma)	h_{FE}*		12 36	30 90	12 36	30 90	
(V_{CE} = 15 V, I_C = 1 ma)	h_{FE}*		4	10	4	10	
AC Forward Current Transfer Ratio (V_{CE} = 30 V, I_C = 30 ma, f = 1 KC)	h_{fe}		12	30	12	30	
(V_{CE} = 30 V, I_C = 30 ma, f = 1 mc)	h_{fe}		4	10	4	10	

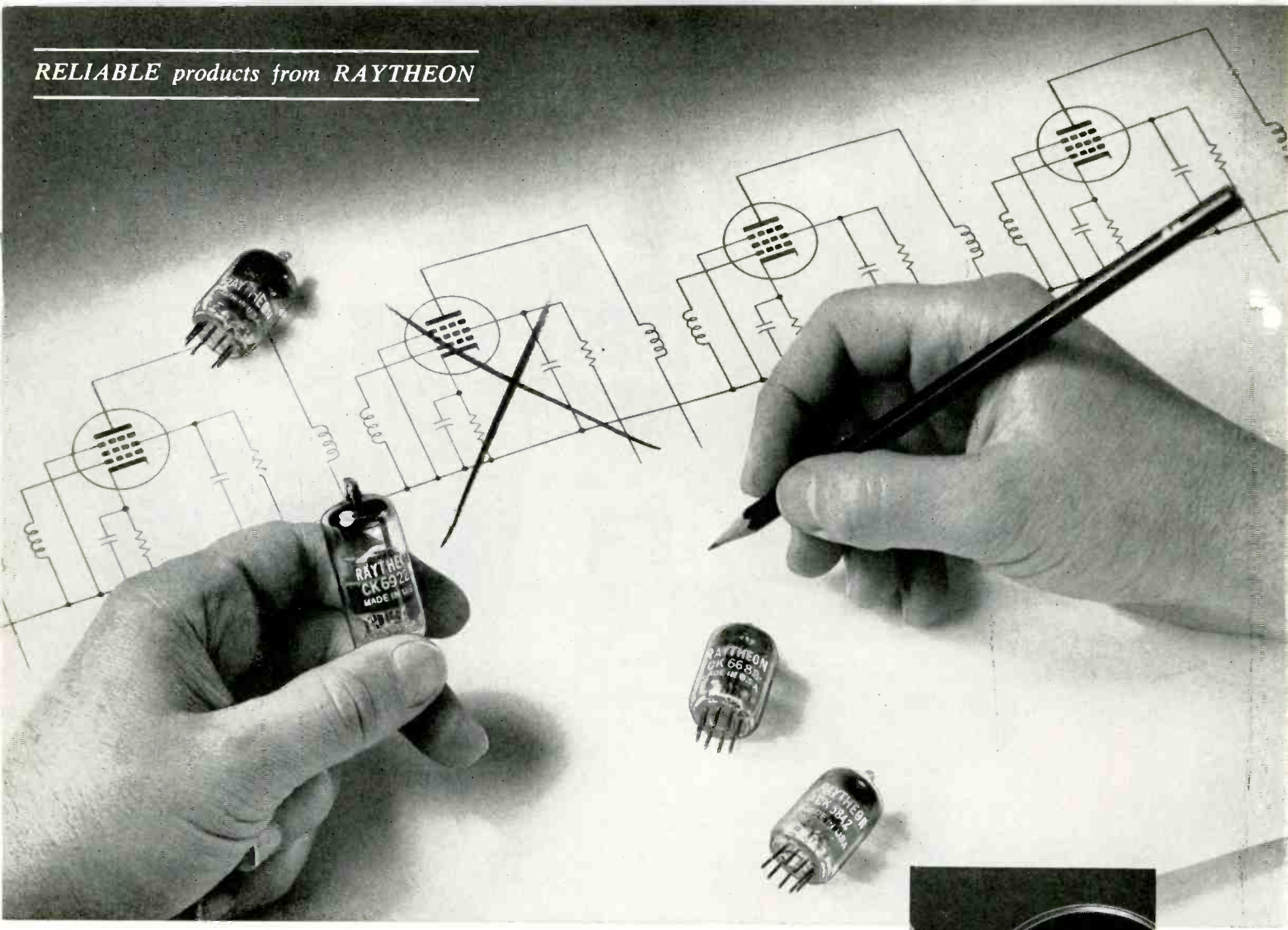
* Pulsed Measurement at Duty Cycle, 300 μsec pulse width.

AVAILABLE THROUGH YOUR G-E SEMICONDUCTOR DISTRIBUTOR

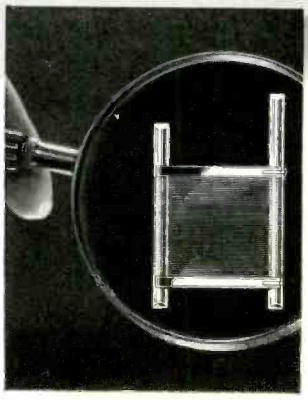
GENERAL ELECTRIC

Circle 19 on Inquiry Card

RELIABLE products from RAYTHEON



Now design with fewer stages using high-gain, low-noise Frame Grid tubes from **RAYTHEON**



The higher gain bandwidth product and lower noise of Raytheon frame grid tubes mean more reliable performance with fewer tubes. The rigid frame grid design and precision spacing of windings assures minimized spread of characteristics and greater uniformity even under extremely rugged service.

Note these typical noise and Gm figures for Raytheon frame grid miniature tubes:

Type	Noise Figure at 60 mc	Gm (μmhos)
CK5842	2.5	25,000
CK5847	3.3	13,000
CK6688	3.2	16,500
CK6922	2.5	12,500 per section

For complete technical data on Raytheon's line of frame grid tubes, please write to: Raytheon, Industrial Components Division, 55 Chapel St., Newton 58, Mass.

For Small Order and Prototype Requirements Contact Your Local Franchised Raytheon Distributor.

Circle 20 on Inquiry Card

RAYTHEON

INDUSTRIAL COMPONENTS DIVISION

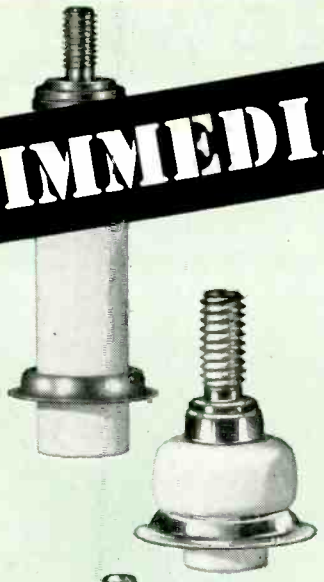
Newton, Massachusetts

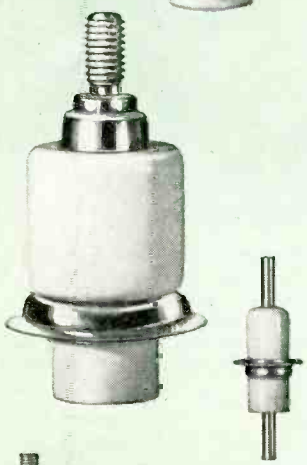
IMMEDIATE DELIVERY

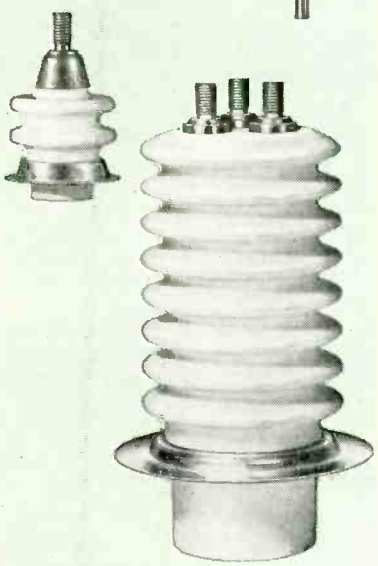
of ALITE®

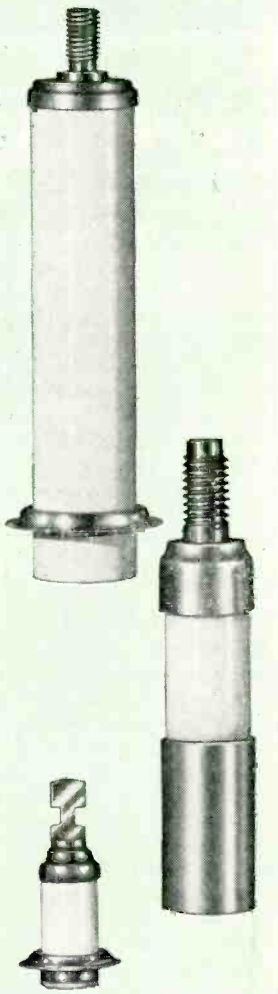
STANDARD HIGH ALUMINA BUSHINGS

In Over 100 Types and Sizes









More than 100 sizes of standard Alite high voltage terminals, feed-throughs, cable end seals and high amperage bushings are stocked for immediate, "off-the-shelf" delivery to simplify design problems, save time and help reduce costs.

One of these standard Alite high alumina ceramic-to-metal hermetic seals may be just the answer to your problems of reliability and maintenance where service conditions are extremely severe or critical.

- Alite hermetic seals — tested for vacuum-tightness with a high sensitivity helium mass spectrometer — are adaptable to virtually any assembly procedure, such as welding, brazing or soldering.
- Alite's mechanical strength and thermal-shock properties far exceed those of glass or porcelain.
- Alite retains its dielectric properties at elevated operating temperatures.
- Alite's smooth, white glaze resists build-up of contaminants on surfaces — easy to see, easy to clean.

From ceramic formulation to finished part, every manufacturing step is handled within our own plant. Strict quality control assures absolute adherence to specifications, utmost uniformity and reliability.

* * * *

When special bushings are called for, it is often possible to save time and money by modifying one of the standard units. However, when necessary a team of Alite engineers stands ready to help you by designing new bushings.

Write for these free helpful brochures. Bulletin A-40R illustrates, describes and gives complete specifications of standard Alite bushings, both high voltage and high amperage. Bulletin A-8 provides detailed descriptions of Alite formulations.

235-H

ALITE DIVISION

U. S. STONEWARE

BOX 119 ORRVILLE, OHIO

Circle 17 on Inquiry Card

EI's International News

ENGLAND

British Police Use Portable Radar

Marconi "PETA" (Portable Electronic Traffic Analyser) equipment is now being widely used by the police forces of Britain. Thirty constabularies have purchased Marconi traffic radar and the majority of the equipments are in day-to-day use.

General police strategy is to use the radar speed check as a deterrent, and not as a trap. Motorists are usually warned by road signs placed at county boundaries and in some cases also by notices displayed on either side of the actual monitoring point.

Cable Faults Located by Radar

Equipment called the Pulse Echo Fault Locator, using a new method of direct presentation of results on a cathode ray tube, can locate faults in undersea cables more quickly, easily and accurately than formally possible. It is able to pinpoint the area of a fault to within 80 yds. in normal underwater conditions. The equipment, being installed to maintain the Commonwealth round-the-world cable, can also be used for land cables and for tests in cable manufacture.

The locator sends a pulse along the cable at speeds of 100,000 mi./sec. Any fault in the cable causes a "reflection" or "echo" back to the source of the pulse. A double-beam cathode ray tube displays the reflected pulse on the upper trace against crystal controlled markers on the lower trace, which represent nautical miles of cable distance. Horizontal relationship of the two traces provides a direct reading of cable distance against a calibration graticule.

Equipment was designed by the British Post Office Engineers' Dept.

New Series of Radiation Detectors Are Introduced

A new series of silicon solid state radiation detectors capable of detecting alpha particles, electrons, protons, heavy ions, deuterons and tritons, has been introduced by the Electronics Dept. of Ferranti Ltd., England.

Designated the ZNS 30 series, these metal encapsulated devices, which are made of high resistivity silicon, are available in a range of voltages from 50-200 volts. The active area of each device is 5 mm. diameter; body length is 6.8 mm. and body diameter is 8.5 mm.

RUSSIA

Russians Claim Automated Subway

According to an article translated from the Soviet publication "Knowledge is Strength," Moscow commuters have been traveling on subway trains that run without motormen.

"Last summer," the article says, "the first system in the world for the automatic control of a subway train was undergoing tests in the Moscow subway." An electronic computer played the role of the motorman. Actually, these test runs included a motorman who will ride the trains until the Russians can be sure everything will work properly. The motorman does not drive the train—but only accompanies it.

"The time is not far away," Soviet authorities claim, "when there will not be a single motorman on the subway. Their place will be occupied by television transmitters, and all trains will be controlled from one dispatcher's station." (Published by the Office of Technical Services, U. S. Dept. of Commerce, translation is OTS No. 61-31620, price $1.25.)

"IBM SHOPPING"

French housewife shops with punched cards in the 'Superdis,' a supermarket in Nice. Shoppers take an IBM punched card from the display shelf with each item they select. At the checkout point an IBM tabulating machine receives the cards and prints an itemized invoice.

SWEDEN

Swedes Order Radar System

A Swedish government contract award to Selenia S.p.A., Italian affiliate of Raytheon Co., calls for one of Europe's most sophisticated weather radar networks.

Seven of the 14 radars, to be produced at Fusaro (outside Naples), Italy, will be installed in vans to serve as mobile weather stations.

The radars track balloons and storms to give data on wind velocities of storms and approaching fronts, range and location.

Two Foreign Firms Barred from U.S. Export

Two firms, one in Austria and the other in Sweden, have been barred indefinitely from all U. S. export transactions for refusing to answer questions concerning their disposition of U. S.-made electronic equipment. This announcement was made by the Bureau of International Programs, U. S. Dept. of Commerce.

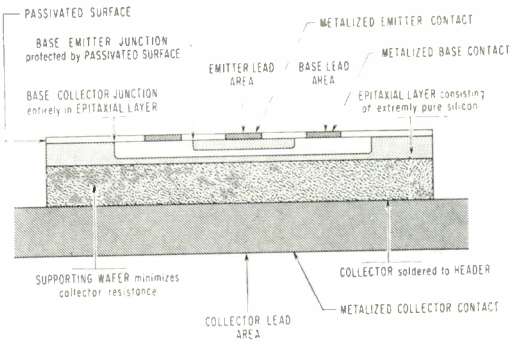
The Bureau's two denial orders cover two unrelated transactions involving a total of $5,000 worth of electronic equipment. One of the instruments, a $2,000 oscilloscope, was licensed for export to Sweden only;

(*Continued on Page* 40)

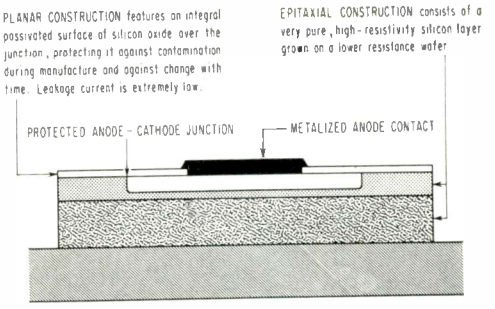
U. S. EXHIBIT

Fairgoers at the Indian Industries Fair in New Delhi examine a signal generator manufactured by The Triplett Electrical Instrument Co., of Bluffton, Ohio. Holding the generator is a bilingual student serving as a translator - demonstrator in the U. S. Pavilion.

SILICON PLANAR EPITAXIAL



TRANSISTORS



DIODES

PNP TRANSISTORS

2N995 RF and switching device with f_T typical of 150 mc and operation specified to 20 mA with low saturation resistance.

2N996 Same as 2N995 but with f_T typical of 230 mc and operation specified to 60 mA with low saturation resistance.

NPN TRANSISTORS

2N2368 2N2369 High speed saturated switch with f_T typical of 650 mc and operation specified to 100 mA.

2N2297 High current/Low saturation resistance RF or Driver transistor with f_T typical of 90 mc and operation specified to 1 amp.

2N914 High current saturated switch with f_T typical of 370 mc for logic or driver applications. Specified to 500 mA.

2N918 RF amplifier with available power gain at 200 mc of 15 db minimum. NF @ 200 mc = 6 db typical. Oscillator — up to 1.5 kmc with 300 mW power dissipation.

DIODES

FD-6 series High speed/High conductance diodes with controlled forward conductance up to 300 mA at 1.0V with 2 nsec t_{rr}. For core matrices, avalanche circuitry, logarithmic amplifiers and for pulse applications.

The broadest line in the industry

Fairchild offers the broadest line of Silicon/Planar/Epitaxial transistors and diodes in the industry. Fairchild's Planar uniformity also makes possible and practical many combinations of these devices in matched pairs and quads, or any of a number of special assemblies. Once you've determined your design needs, call your nearest Fairchild Sales Office, or write to the Mountain View address.

Send for complete specification sheets

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A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

S.J.C.C. Booths 1 and 2
NAECON Booths 406 and 407

Circle 57 on Inquiry Card

International News

(*Continued from page* 38)

the others were licensed only for use in Western Europe. The Bureau's Investigations Staff has reason to believe that all of the instruments were reshipped to unauthorized destinations—probably the Soviet bloc.

One order was issued against Tore Hesselgren and his firm, Hesselgren Instrument, an electronics consulting and manufacturing company of Stockholm, Sweden. The other named Allkor Industrie und Kommerz Import-Export-Buero of Vienna, Austria, and its director, Rudolf Rhol.

GERMANY

West German Sales Representative Appointed

Kirchfeld K. G. of Dusseldorf, West Germany, is now sales representative for the Defense Products Division of Fairchild Camera and Instrument Corp. This was announced by Robert Bruce, division general manager.

Kirchfeld K. G. will serve as exclusive representative for the division in the West German market. It will handle the sale of reconnaissance and mapping systems, data processing, display and interpretation systems, communication and special radar systems, and a variety of electronic test and ground support equipment designed and produced by the division.

MODERNIZATION

These 23 airport locations are scheduled for modernization by Page Communications Engineers, Inc., Washington, D.C. Work will be done under a $2 million contract with the Imperial Ethiopian Govt. Modernization calls for air-to-ground and point-to-point communications serving domestic and international airlines. Page will also provide and install navigational aids to enable jet aircraft to serve Ethiopia by the end of the year. (Broken lines on map indicate point-to-point communications between airports.)

Wanted:

GEOLOGIST

with 4 years' experience on MARS or SATURN

Job function: to direct expansion of present line of precision switches and indicator lights to include controls suitable for extraterrestrial applications.

Write for details of present product line.

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

Manufacturers of the Electrosnap and Hetherington full line of switches, controls and indicators for all military and commercial applications. All standard units stocked for immediate delivery by leading parts Distributors.

Tele-Tips

A RUBY LASER will be used by Univ. of Mich. physicist P. A. Franken to bounce a light beam off the moon. Light from the laser will be beamed at the moon through the university's 37-in. reflecting telescope. In the approximately two and a half seconds it will take for the light to reach the moon and return, an end prism will be slipped into place at the telescope's output end to reflect the light echo into an extremely sensitive light-measuring device.

JOURNEY TO MARS will probably be attempted in the 1980's, predicts the National Aeronautics and Space Administration. The 300,000,000-mi. round trip will be achieved in a 15-man spaceship which will be electrically propelled. The total trip will take about 572 days, including 29 days for exploring the planet.

"GEGENSCHEIN" is a new word in the lexicon of space scientists. Dr. M. L. Stehsel, of Aerojet-General, describes it as a 160,000-mi. long glowing, gaseous "tail" trailing off behind the earth. On moonless nights, just about midnight, it appears as a faint glow in the sky. "Gegenschein" means "counterglow."

RUSSIAN SCIENTISTS are "preparing" to fire an underground rocket. The missile will be radio-controlled, and will penetrate over 100 miles into the earth. One of the scientific puzzles that it may solve is whether the center of the earth is solid or liquid. Russian scientists recently came up with the theory that it is solid.

DEFENSE MARKETING conferences are becoming more and more popular among electronics industry leaders because of the increasing amount of military electronics contracts being issued. Latest is the first "Management Conference on Marketing in the Defense Industries" sponsored by Boston College's Bureau of Business Research and the Defense Marketing Group, AMA, May 8th in Boston.

(*Continued on page* 46)

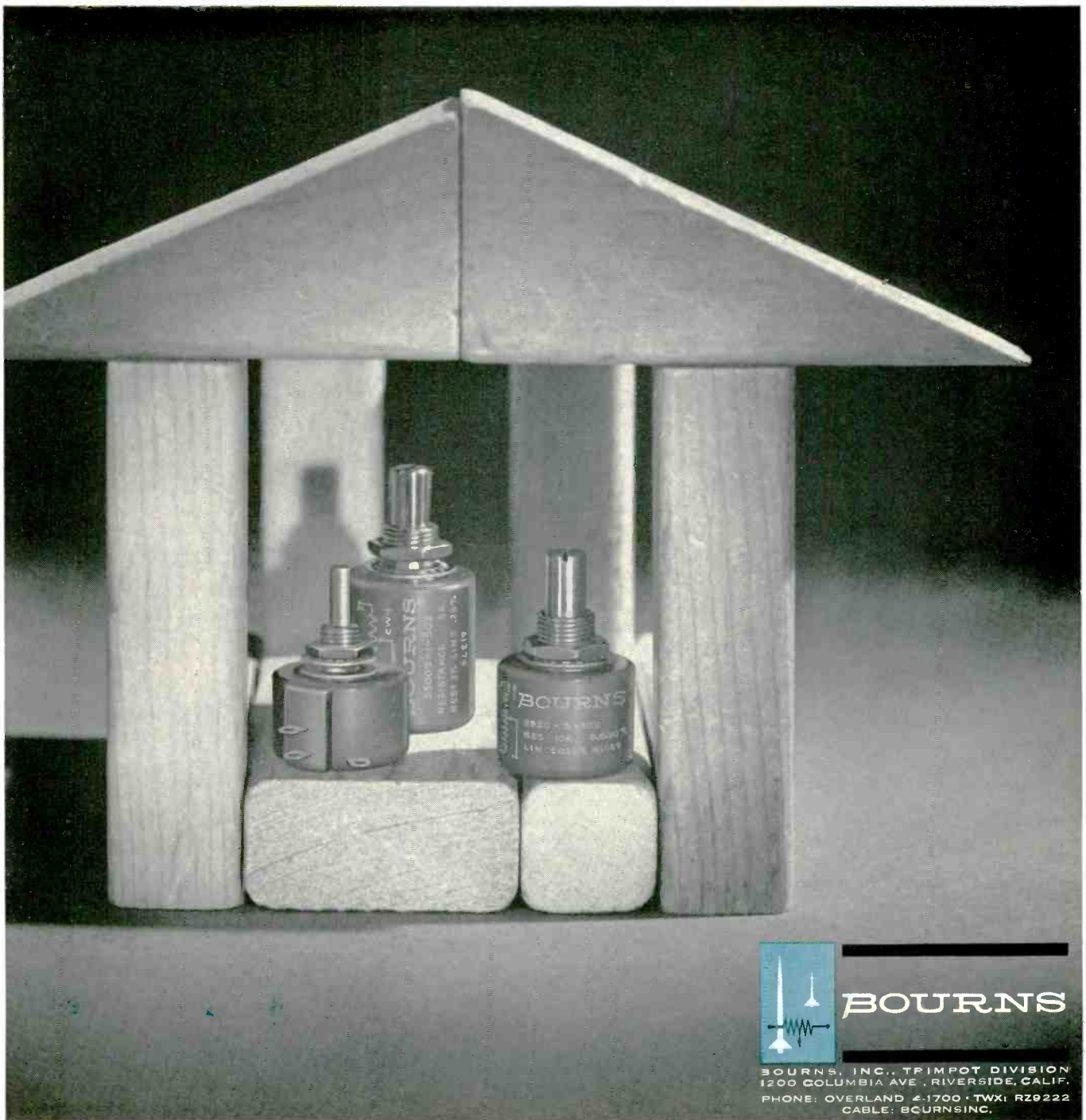
Now—3-Turn, 5-Turn And 10-Turn Precision Potentiometers From The Same Reliable Source

NUMBER 23 — NEW PRODUCT SERIES

Now Bourns gives you a choice of military-quality industrial potentiometers. In addition to the proven 10-turn Model 3500, Bourns offers you the 3-turn Model 3510 and the 5-turn Model 3520. All of these ⅞"-diameter potentiometers are shorter than comparable units available elsewhere, yet have resistance elements that are 20% longer.

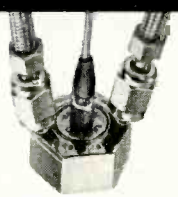
They incorporate the exclusive, indestructible Silverweld® multiwire termination, and are subjected to 100% inspection and the rigorous double-check of the Bourns Reliability Assurance Program. Write for complete data.

	3-TURN	5-TURN	10-TURN
Standard Resistances (Others available on request)	200 Ω to 50K ±3%	200 Ω to 75K ±3%	500 Ω to 125K ±3%
Meets Steady-State Humidity Requirements (Optional feature meets MIL-STD-202B, Method 106 Cycling Humidity)	Yes	Yes	Yes
Standard Linearity	±0.3%	±0.3%	±0.25%
Power Rating @ 70°C	1.0W	1.5W	2.0W
Operating Temp.	−65° to +125°C	−65° to +125°C	−65° to +125°C
Mech. Life (Shaft Revolutions)	600,000	1,000,000	2,000,000



Plants: Riverside, California; Ames, Iowa; and Toronto, Canada. Manufacturers: Trimpot® potentiometers; transducers for position, pressure, acceleration.

ENDEVCO TRANSDUCERS, AMPLIFIERS AND CATHODE FOLLOWERS

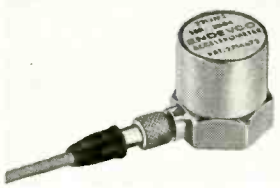


2200°F ACCELEROMETER

MODEL 2206 ACCELEROMETER measures vibrations at high temperature (2200°F at base) such as encountered in rocket motors, combustion chambers and turbines. This liquid-cooled Endevco transducer will measure accelerations up to 1,000 g's and provides large output of 12 pk-mv/pk-g with high resonance frequency of 20 Kc.

INSULATED MOUNTING STUDS

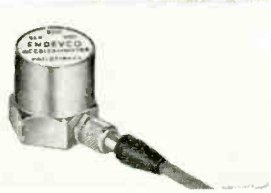
MODELS 2980B* (10-32/10-32) and 2983B* (10-32/¼-28) MOUNTING STUDS may be used with all old and most new models of Endevco Accelerometers. These studs provide complete electrical isolation from structural ground. Removable studs eliminate the complete rebuilding required when an integral stud is damaged. *(Reg. U.S. Pat. Office)



HERMETIC SEAL ACCELEROMETERS

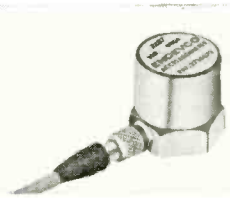
MODEL 2213M5 ACCELEROMETER meets MIL-E-5272C. Basic design is the widely used Model 2213. Sensitivity 43 pk-mv/pk-g. Rated to +230°F. Endevco designs meet Grade A hermetic seal defined in MIL-S-8484 (USAF). Resonance frequency 30 Kc.

MODEL 2235 ACCELEROMETER uses PIEZITE® Element Type VII rated to +350°F. Sensitivity 25 pk-mv/pk-g. Frequency response ±5% to 8 Kc.



REQUIRES NO ELECTRONICS

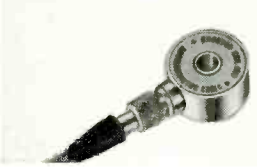
MODEL 2215 ACCELEROMETER measures vibration from below 10 cps to above 5 Kc without any auxiliary equipment except a standard vacuum tube voltmeter or oscilloscope. Extremely high internal capacity of 9500 pf means that cables of 100 feet and over have minimum effect on sensitivities. This accelerometer's high capacity virtually eliminates any cable noise problem so that very low g levels can be accurately resolved. Sensitivity is 8 pk-mv/pk-g.



HIGH OUTPUT—SUBMARINE LOW NOISE TESTS

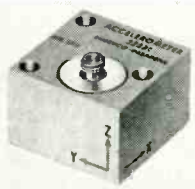
MODEL 2217 ACCELEROMETER provides a high sensitivity of 72 pk-mv/pk-g and a wide frequency range (resonance frequency is 35 Kc). A hermetic seal extends its usefulness and the weight is only 1.1 ounce. An even higher sensitivity of 350 pk-mv/pk-g is available in the MODEL 2219 ACCELEROMETER.

Endevco Model 2870 Measuring System for very low noise tests incorporates the (Model 2217 Accelerometer) with shielding, shielded preamplifier, and battery power supply.



RING SHAPE ACCELEROMETER

MODEL 2221C ACCELEROMETER is a small, light-weight unit (11 grams, including mounting screw) which may be installed close to bulkheads, in corners and in locations inaccessible for transducers of conventional design. Full 360° of connector orientation is possible. It is electrically isolated from the structure whether the 6-32 insulated mounting screw is used or whether it is cemented. Model 2221C features a new PIEZITE® Element Type VI which provides 13 pk-mv/pk-g sensitivity with 950 pf capacity and a nominal resonance frequency of 30 Kc.



TRIAXIAL ACCELEROMETER

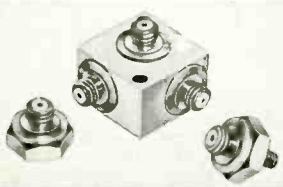
MODEL 2223C ACCELEROMETER is designed for applications requiring triaxial measurements in limited space; i.e., "in-flight" environments. The simplicity of mounting for three axis measurements saves time in the lab. Three new Endevco PIEZITE® sensing elements Type VI (an exclusive development of Endevco electroceramics) are mounted in mutually perpendicular planes. Size: 1" x 1" x ⅝"; Weight: 1.4 oz. Model 2223C provides 10 pk-mv/pk-g nominal sensitivity with 950 pf capacity and a resonance frequency (nominal) of 30 Kc. Electrical isolation prevents ground-loops so often encountered in flight applications.

TOP CONNECTOR ACCELEROMETER

MODEL 2224C ACCELEROMETER is a small, light-weight (0.56 oz.) transducer with connector at top to permit installation in radially restricted locations. Both mechanical and electrical isolation are provided when used with Endevco insulated mounting studs. With the use of the new Endevco PIEZITE® Type VI Sensing Element the sensitivity and internal capacity have been approximately doubled. The Model 2224C provides 10 pk-mv/pk-g nominal sensitivity with 950 pf capacity and a resonance frequency of 25 Kc. Temperature range —65°F to +350°F. Dimensions 9/16" hex base x 0.52" high.

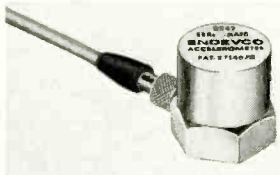
SHOCK ACCELEROMETER

MODEL 2225 ACCELEROMETER accurately measures shock and impact transients because of high resonance frequency of 80 Kc (Nominal). Dynamic range of this new transducer is a maximum sinusoidal 10,000 g and a maximum shock of 20,000 g with a 75 μsec half sine pulse. This high g range together with the low sensitivity make it ideal for high level shock testing. Nominal sensitivity is 0.6 pk-mv/pk-g with 300 pf external capacity. This new Endevco product weighs only 0.46 oz. (13 grams) and is 0.52" high with a 9/16" hex base.



MICROMINIATURE ACCELEROMETERS

MODELS 2226, 2227, and 2228 Accelerometers provide a new dimension in microminiature accelerometers without sacrificing the essential accuracy, sensitivity, and ruggedness which are necessary to obtain good data. They have an output of approximately 5.0 pk-mv/pk-g with six-foot cables. The Model 2226 is designed for cement mounting with weight of only 2.75 grams. Size 3/8" hex x 3/16" high. The Model 2227 has 6-32 integral stud. Weight 3.1 grams. Size same as 2226 plus 3/16" stud. The Model 2228 is triaxial with electrical isolation. Weight is 16.5 grams. Size 0.6" x 0.6" x 0.42". All above dimensions exclude connectors.



HIGH TEMPERATURE ACCELEROMETER

MODEL 2242 ACCELEROMETER measures vibration and shock at +500°F (and even higher for brief exposures) without cooling or correction. It is very stable and has no sensitivity change (hysteresis) after successive heat runs. Sensitivity changes ±5% or less from —320°F to +500°F. These unique characteristics are made possible by Endevco's PIEZITE® Element Type II. Sensitivity is 10 pk-mv/pk-g and resonance frequency is 40 Kc.

MODEL 2242-M5 ACCELEROMETER incorporates provision for inserting a calibration current through a precision resistor built into the base of the accelerometer. The case is hermetically sealed by resistance welding. Thermal radiation shielding is provided by a double-walled case.

HIGH PERFORMANCE ACCELEROMETERS

MODEL 2234 FOR USE TO 500°F.
MODEL 2233 FOR USE TO 350°F.

These new accelerometers have a unique compression design which completely separates the active elements from the case. High sensitivity at high temperatures is another outstanding characteristic. Hermetic seal. Cross axis sensitivity is 3% maximum. Resonance frequency is 35 K cps. Sensitivity is 38 pk mv/pkg with high capacity of 1130 pF including 10 ft. cable. Calibration at 500°F is provided for each Model 2234.

REPRESENTED IN CANADA BY MEL SALES LTD.

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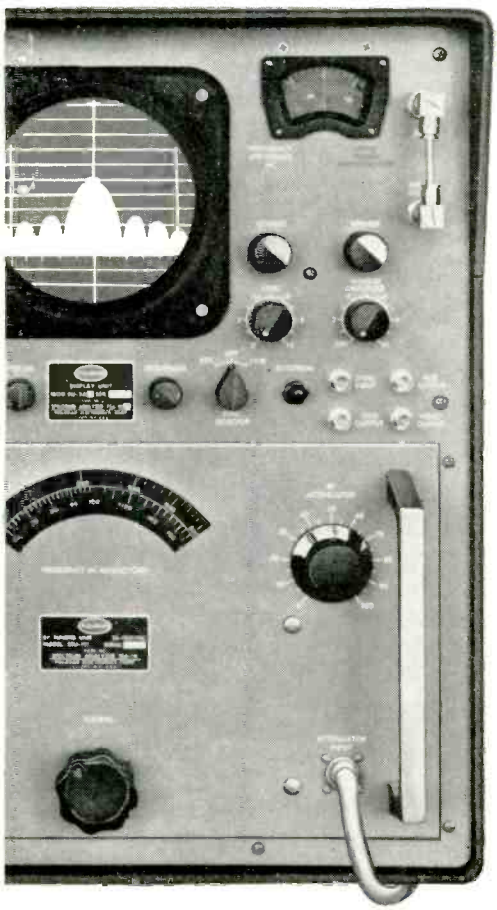
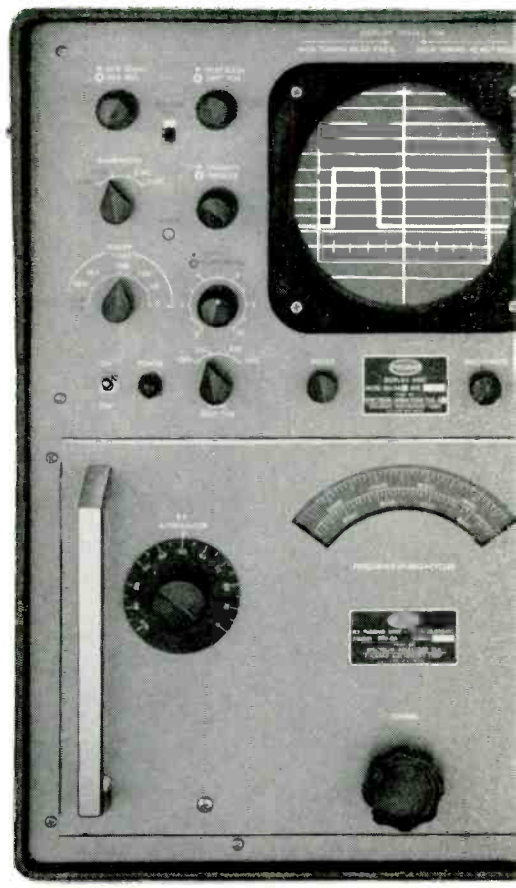
SOMETHING SPECIAL HAPPENS WHEN THESE SPECTRUM ANALYZERS ARE TURNED ON!



YOU GET 200 KC TO 80 MC DISPERSION IN THIS WIDE DISPERSION MODEL TSA-W

There are many **specialized** signal analysis jobs that can be done properly only with **specialized** analyzers. Polarad's Model TSA-S Synchroscope Analyzer (on the right) is a perfect example. With it, you can examine **both** the **time** domain as well as the **frequency** domain with the same instrument —eliminating the need for external scopes.

Model TSA-W (on the left) allows you to examine very narrow and very wide pulses because of its wide range resolution and dispersion. Best of all, these **specialized** instruments are also **general purpose** spectrum analyzers that cost less than universal frequency models, if you are working at specific frequencies. Ask your Polarad Representative for a demonstration. Just mail the coupon!



YOU SEE PULSED SIGNALS IN THE TIME DOMAIN IN THIS SYNCHROSCOPE MODEL TSA-S

SPECIFICATIONS—TSA-W
Five sensitive plug-in tuning units

FREQUENCY: 10 to 44,000 mc

DISPERSION: 200 kc to 80 mc (2 ranges)

RESOLUTION: 2 to 80 kc variable

INTERNAL MARKER: ±40 mc

SCREEN DISPLAY: Linear or log 80 mc dispersion, displays pulses as narrow as 0.1 μsec. For wide pulses, dispersion may be adjusted down to 200 kc

SPECIFICATIONS—TSA-S
Five sensitive plug-in tuning units

FREQUENCY: 10 to 44,000 mc

DISPERSION: 400 kc to 25 mc

BANDWIDTH: 5 kc, 50 kc, 500 kc and 5 mc

INTERNAL MARKER: ±14 mc

SWEEP RATE SYNCHROSCOPE: 2, 10, 100, 1,000, 10,000, 100,000 μsec per screen diameter

SENSITIVITY: to −95 dbm

POLARAD
ELECTRONICS CORPORATION
43-20 34TH STREET, LONG ISLAND CITY 1, NEW YORK

Circle 35 on Inquiry Card

A B C D E F
1 2 3 4 5 6 7 8 9 10 11 12

POLARAD ELECTRONICS CORPORATION:
43-20 34th Street, Long Island City 1, New York

POLARAD
PROVEN RELIABILITY

Gentlemen:
Please send me further information and specifications on:

- ☐ Model TSA-W Spectrum Analyzer
- ☐ Model TSA-S Spectrum Analyzer
- ☐ Spectrum Analyzer Techniques Handbook

My application is _____

Name _____

Title _____ Mail Station _____ Dept. _____

Company _____

Address _____

City _____ Zone _____ State _____

Tele-Tips

(*Continued from Page* 42)

CREATIVENESS is getting a great deal of attention from government quarters. One of the latest studies, just completed by the U. S. Naval Research Laboratory, is a complete bibliography. It includes about 1,400 citations of books, articles and conferences discussing research and invention in the physical sciences. Copies of the 161-page study, entitled "Creativity in R & D in the Physical Sciences," is available from OTS, U. S. Dept. of Commerce, Wash. 25, D. C. (Order #AD 265 477.) $3.00.

JATO BOTTLES have been used since the early days of WW II to provide extra propulsion for short take-offs of airplanes. Now they are being turned to another, reverse application. They are being used to provide "stop" power. Tests indicate that they can be of particular value on wet or icy runways, and for quick stopping in emergency landings on short, inadequate runways.

ELECTRONIC SENSING device that automatically distinguished potatoes from stones and clods has been developed by the Dept. of Agriculture and Fisheries for Scotland. In the prototype unit, a beam of ionizing radiation was divided into two horizontal parallel beams. Each beam is modulated with pulses of opposite polarity so that they cancel. Potatoes in the beam have no effect, but stones or clods disturb the balance.

TEACHING MACHINES got only qualified approval from the Navy. Tests were undertaken by the U. S. Naval Training Device Center on the use of the Skinner Teaching Machine in teaching basic electricity. Their opinion: ". . . the use of teaching devices can shorten the lesson time in some cases, if the programmed lesson is paced effectively." Programmed textbooks are often as effective as teaching machines, i.e. the machine gave no evidence of a motivational effect.

(*Continued on Page* 50)

"Really demanding specifications call for DALE *Type RS Resistors"*

You can place the utmost confidence in Dale precision resistors even when today's new and unprecedented standards of "missile reliability" are the goals towards which you are designing.

Under any and all conditions, Dale resistors retain their stability because it has been "firmly infixed" by Dale design and methods of manufacture . . . methods which have now reached new levels of achievement as part of Dale's super-high reliability development program.

SPECIAL PROBLEMS? Let us help you with your requirements for special resistance products. We make modifications of standard products, resistor networks, matched pairs, etc. Send us your specs.

PROMPT DELIVERY. Whether your need is for a short "test run" or a large production release, Dale offers prompt service, direct from the factory and through a widespread network of distributors.

Write for Dale Resistor Catalog A

DALE ELECTRONICS, INC.

DALE

1304 28th Ave., Columbus, Nebr.

A subsidiary of THE LIONEL CORP.

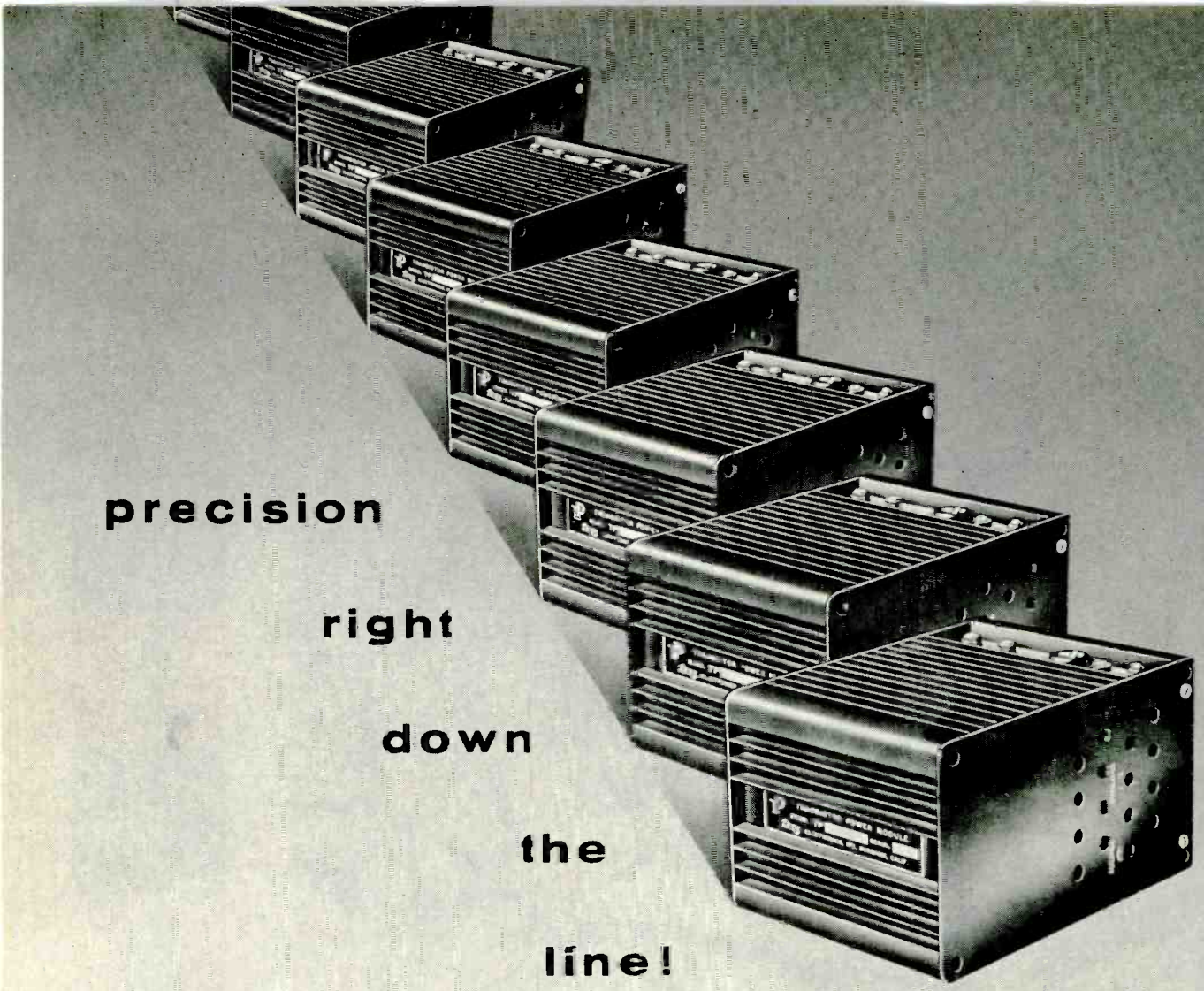
DALE **TYPE RS** RESISTORS

WIRE WOUND • PRECISION • POWER

Designed for advanced electronic circuits where space is at a premium. Three configurations: Type RS with axial leads and in most ratings and resistances shown; Type RLS with radial leads; Type RSE for clip mounting.

- Rated at ½, 1, 2, 2½, 3, 5, 7, 10 watts
- Resistance range from .05 ohm to 175K ohms, depending on type
- Tolerance 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3%
- Temperature coefficient within 0.00002/degree C.
- Operating temperature range from —55° C. to 275° C.
- Smallest in size, ranging from 5/64" by 5/16" to 3/8" by 1-25/32". Ten choices
- Completely protected, impervious to moisture and salt spray
- Complete welded construction from terminal to terminal
- Silicone sealed, offering high dielectric strength and maximum resistance to abrasion
- Meet functional requirements of MIL-R-26C

Circle 98 on Inquiry Card



precision

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the

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New TRANSISTOR POWER MODULES

5 — 41 Volts — Up to 3.5 Amps!

Typical Ripple: 80 Microvolts!

Ambient Operating Temperature to 50°C!

Adjustable Overload Protection with Automatic Recovery!

Complete data and specifications in BULLETIN TP-660. Send for it!

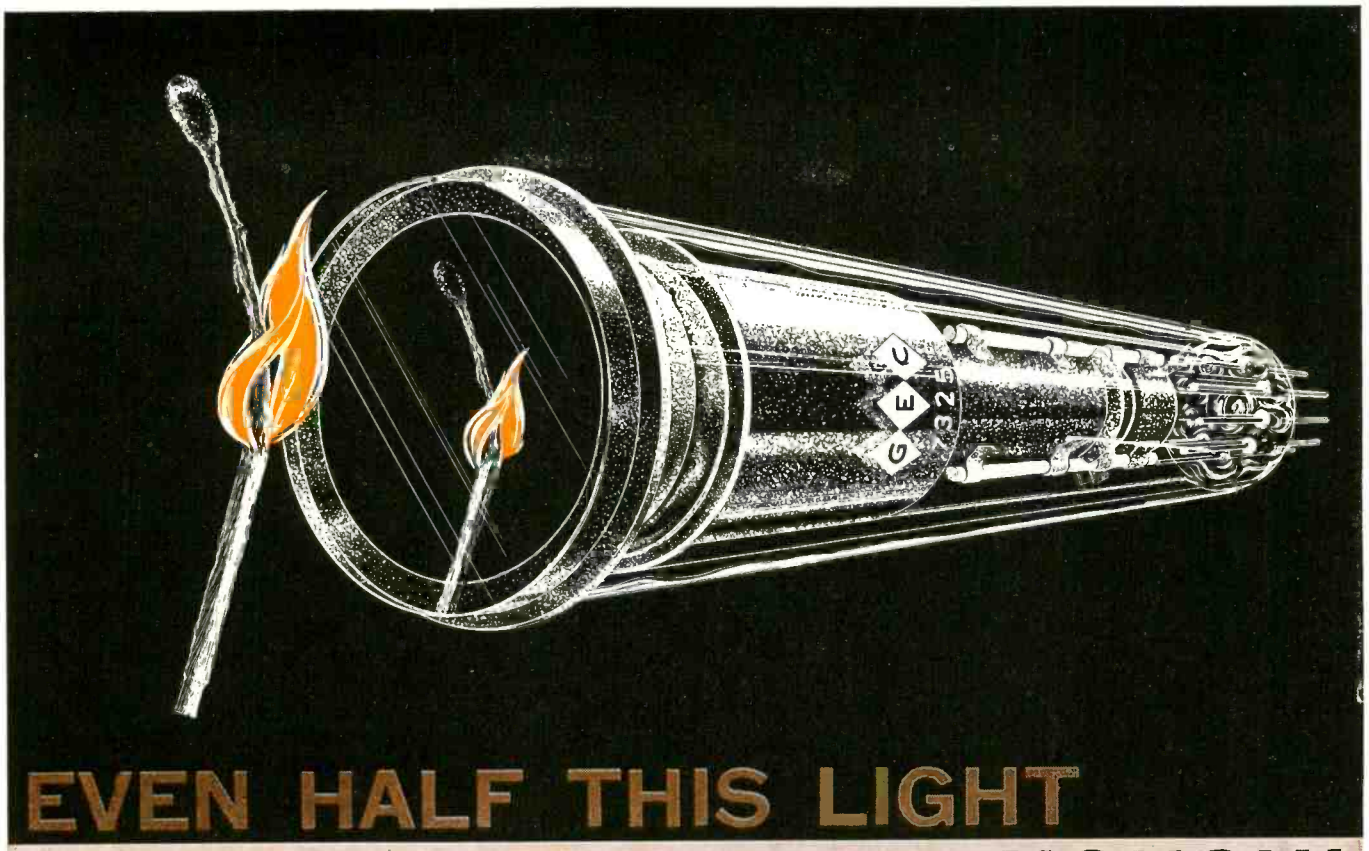
ACDC ELECTRONICS, INC.

2979 North Ontario Street, Burbank, California.

Victoria 9-2414

TP

Transistor Power Module



EVEN HALF THIS LIGHT IS MORE THAN ENOUGH!

Actually less than 0.1 foot candle of illumination on the faceplate is all that's required for excellent television pickup with a GEC 7325 Vidicon.

The new GEC 7325 is the world's most sensitive Vidicon with superior low lag characteristics. It represents the latest advance in Vidicon Camera Tubes, and incorporates major improvements resulting in performance which surpasses all similar type tubes.

The high sensitivity improvements have been incorporated in several other GEC Vidicons to satisfy a wide range of applications:

GEC 7226 Short length with low power heater.

GEC 7226A Ruggedized version of the 7226.

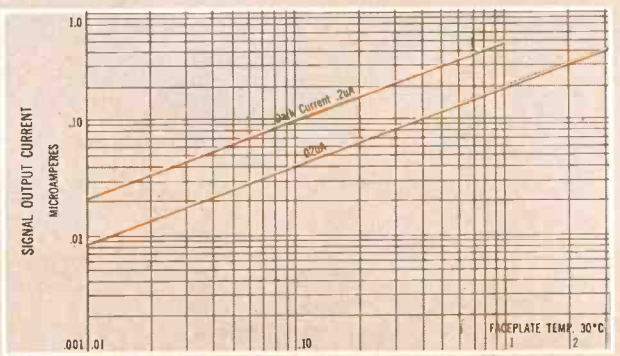
GEC 7336 Broadcast quality live pick-up with provision for dynamic focus.

GEC 7522 Electrostatic Focus and Deflection requiring no external deflection and focus components.

GEC 1343 Ruggedized Electrostatic Focus and Deflection Vidicon with same electrical characteristics as the 7522.

GEC 7697 For industrial cameras with low target voltage requirements.

All of these tubes have the same high sensitivity and low lag characteristics found in the GEC 7325.



TYPICAL LIGHT TRANSFER CHARACTERISTIC

For complete information on these high sensitivity tubes contact GEC by writing to:

. . . . where tube research begins

GENERAL ELECTRODYNAMICS CORPORATION

4430 FOREST LANE • GARLAND, TEXAS • BROADWAY 6-1161

Circle 30 on Inquiry Card

← Circle 29 on Inquiry Card

Tele-Tips

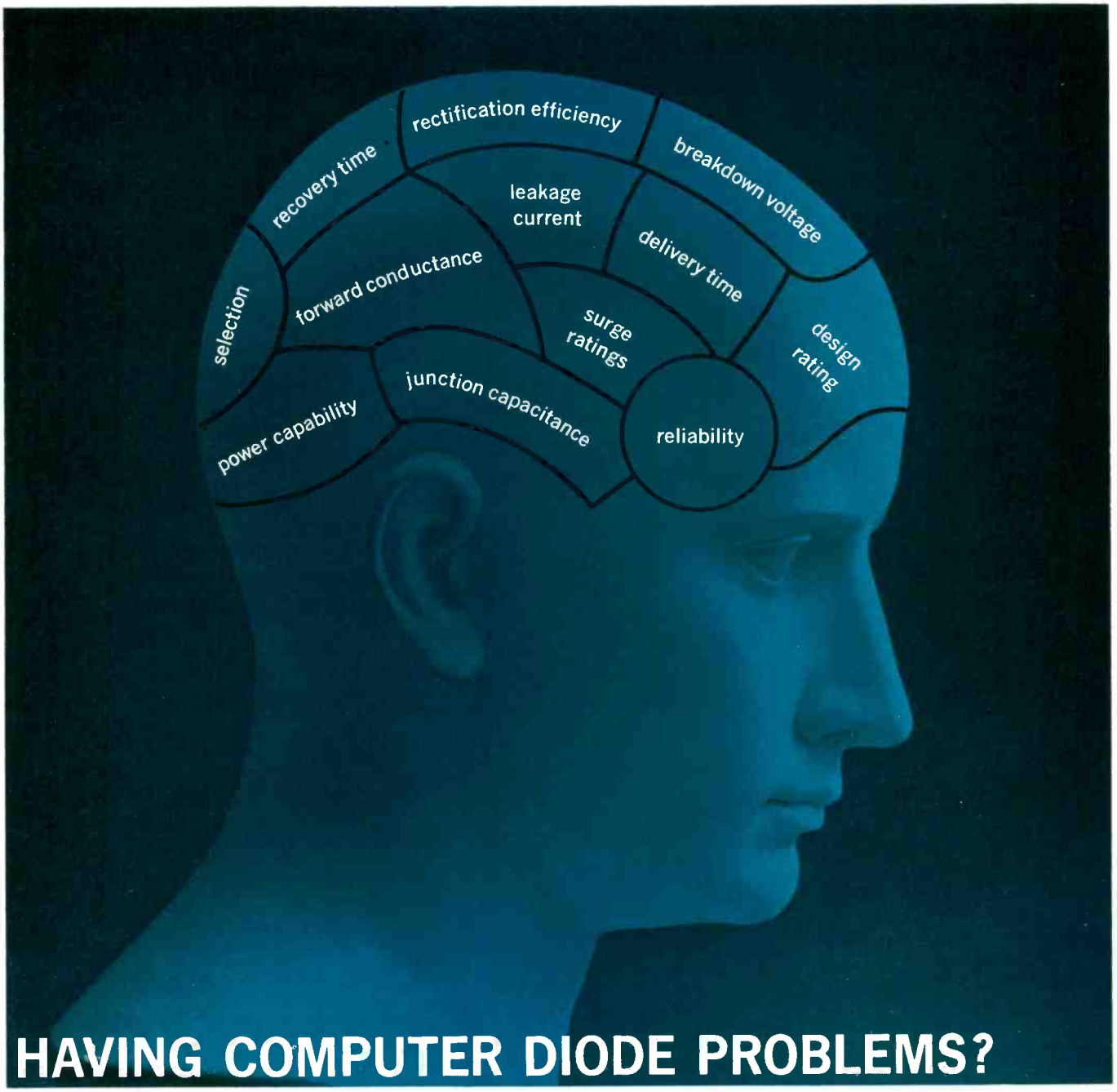
(*Continued from page* 46)

A VOLUNTEER FIRE DEPARTMENT in a Colorado town was discovered using an unlicensed two-way radio. The fire chief said he would welcome a letter from the Commission to strengthen his repeated request to local authorities for money to modify the equipment to meet FCC requirements. He got the letter.

NATURE OF INTERFERENCE on TV Channel 2 in Chicago indicated that it came from an electronic gadget. A germicidal lamp was discovered in a room above a nearby flower shop where it was being used to overcome paint smells. The owner turned if off and clearer pictures resulted for the neighborhood.

A RHODE ISLAND RACE TRACK asked FCC assistance to determine if radio was being used there to flash race results. Monitoring failed to observe any suspicious signals, but an old barn near the track invited investigation. There state police, track officials and FCC engineers found a man in the hayloft watching the races through high-powered binoculars. Beside him were two small radio sets. The man was arrested by the police. The next morning two walkie-talkies were found abandoned in the vicinity.

THE JAPAN EIA exhibited at the 4th International Conference on Medical Electronics which was held last year in New York City. Apparently the investment in exhibit space was well worth it. A recent market study by Japan External Trade Organization shows that that country's export of medical electronic equipment to the United States can easily grow from its present 10% if producers will simply change their marketing methods. Japan's production of medical electronic equipment in 1961 will probably be about $3.5-million or better—more than twice that of the previous year.



HAVING COMPUTER DIODE PROBLEMS?

NEW HUGHES® ULTRA-FAST DIODES CAN PROVIDE THE ANSWERS.

Family Type	Silicon Diffused Planar Diodes	Germanium Gold Bonded Diodes	Germanium Point Contact Diodes	Silicon Alloy Diffused Diodes
Typical Types	1N3064 1N914 1N902 series	1N995 1N695A HD1800 series	HD1610 HD1640 HD1670	1N658 1N643 1N837 series
	Range	Range	Range	Range
Reverse Recovery Time* (nanosec.)	2.0 to 8.0	3.0 to 10.0	0.3 to 0.8	10.0 to 80.0
Forward Conductance @ + IV (milliamps)	5 to 20	100 to 400	3 to 20	5 to 200
Breakdown Voltage (volts)	20 to 100	10 to 50	10 to 30	30 to 300
Junction Capacitance @ zero V (picofarads)	1.0 to 6.0	1.0 to 4.0	1.0 to 3.0	1.0 to 6.0

*Measured under standard switching circuit conditions using sampling scope.

For further information, call your nearest Hughes representative; or write Hughes Semiconductor Division, Marketing Department, Newport Beach, California.

Creating a new world with Electronics

HUGHES

HUGHES AIRCRAFT COMPANY

SEMICONDUCTOR DIVISION

DIODES • TRANSISTORS • RECTIFIERS • PACKAGED ASSEMBLIES • ELECTRONIC COMPONENTS

HERE NOW IN QUANTITY!

RCA MEETS UNPRECEDENTED DEMAND FOR 2N2102, FIRST "UNIVERSAL" TRIPLE-DIFFUSED PLANAR SILICON TRANSISTOR.

RCA now announces mass-production availability of the 2N2102, the "universal" triple-diffused planar silicon transistor designed for widest possible application in military and industrial equipment. It can replace up to 40% of all silicon transistors now on the market and will cover a vast majority of your Small-Signal and Medium-Power Applications.

The RCA 2N2102 features high switching speed, high pulsed beta (h_{FE}) at I_C = 1 amp, and controlled beta from I_C = 10μa to 1 ampere. It has high breakdown-voltage ratings, high dissipation ratings, low saturation voltages and low output capacitances.

RCA's line of triple-diffused silicon planar transistors now includes the 2N699 and 2N1613.

Call your RCA Representative today or write RCA Semiconductor and Materials Division, Commercial Engineering, Section D-50-NN, Somerville, N.J.

RCA-2N2270, New Economy Version of RCA "Universal" Triple-Diffused Planar Silicon Transistor Now Available in Production Quantities.

Now you get many of the performance and versatility features of RCA's 2N2102 in a new economy version, the RCA 2N2270. The 2N2270 offers one of the greatest price/performance values in transistors today. The 2N2270 features operation at high junction temperatures—up to 200°C...very low output capacitance—15 pf max...high minimum gain bandwidth product—60 Mc...useful in applications from dc to 20 Mc...JEDEC TO-5 package.

AVAILABLE THROUGH YOUR RCA DISTRIBUTOR

RCA®

The Most Trusted Name in Electronics

Build Greater Reliability Into Industrial and Military Designs With These RCA Semiconductor Products

THROUGH ADVANCED TECHNOLOGY RCA HAS ADDED EVEN GREATER RELIABILITY TO A BROAD RANGE OF INDUSTRIAL SEMICONDUCTOR PRODUCTS FROM GERMANIUM POWER TRANSISTORS TO HIGH-VOLTAGE SILICON RECTIFIERS.

RCA INDUSTRIAL GERMANIUM POWER TRANSISTORS...

6 New MIL Versions...RCA announces the USA-2N1183, 2N1183A, 2N1183B, 2N1184, 2N1184A, 2N1184B, military versions of the popular germanium p-n-p intermediate-power transistors. These military versions are similar to the commercial prototypes but meet the requirements of military specification MIL-S-19500/143 (Sig. C) dated Oct. 10, 1960. RCA will continue to market the commercial versions for a wide variety of applications in industrial and military equipment.

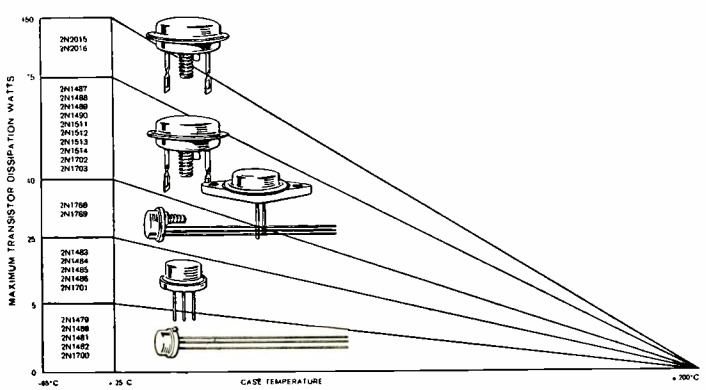
Improved 2N174 Family...All 11 types, 2N174, 2N173, 2N277, 2N278, 2N441, 2N442, 2N443, 2N1099, 2N1100, 2N1358, 2N1412, provide 150 watts dissipation plus thermal resistance (junction to case) of only 0.5°C/watt (max) and lower reverse leakage currents. Now, both the 2N1358 and 2N174 are available in MIL versions...USA 2N1358 and JAN 2N174. USA 2N1358 meets MIL-S-19500/122 (Sig. C), June 19, 1961. JAN 2N174 meets MIL-T-19500/13A, Jan. 8, 1958.

RCA INDUSTRIAL SILICON HIGH-FREQUENCY TRANSISTORS...

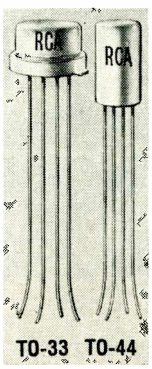
2N1491, 2N1492, 2N1493...offer high voltage and dissipation ratings. They operate over wide ranges of ambient temperature in video-amplifiers and in large-signal power-amplifier circuits.

RCA 200°C SILICON POWER TRANSISTORS...

24 Types At Prices Starting As Low As Comparable Germanium Power Types...This silicon power line, immediately available at low prices to meet your industrial and military applications requirements, offers beta-control up to 10 amperes, extremely low saturation resistance—as low as 0.25-ohm max., and power to 150 watts. For detailed application information on the design of military and industrial equipment using RCA Silicon Power Transistors, send for new 28-page Silicon Power Transistor Application Guide (Price: 50 cents per copy). Write to RCA Semiconductor and Materials Division, Commercial Engineering, Section **D-50-NN**, Somerville, N. J.



New Low Prices On RCA 2N2015 and 2N2016—10 Amp Silicon Power Units...Mass production economies make 200°C Silicon Power Transistors available at lower prices than ever before. These popular types incorporate the following outstanding features: 0.25-ohm max saturation resistance at $I_C = 5$ amp...Beta of 15 to 50 at $I_C = 5$ amp...Min. beta of 7.5 at $I_C = 10$ amp.



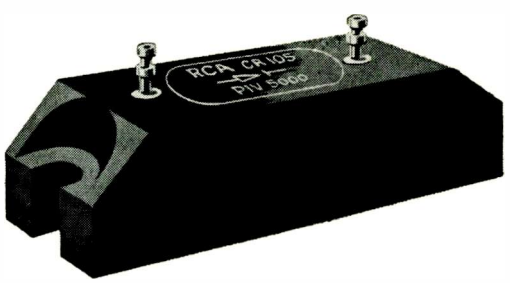
MIL VERSIONS OF RCA INDUSTRIAL DRIFT-FIELD TRANSISTORS...

RCA Industrial Drift-Field Types 2N274 and 2N384 are available in Military Versions...USA 2N274 and JAN 2N384. USA 2N274 meets MIL-T-19500/26 (Sig. C), Oct. 3, 1957. JAN 2N384 meets MIL-S-19500/27C, Dec. 19, 1961.

RCA's Industrial Drift-Field Family includes 2N274, 2N384, 2N1023 in the JEDEC TO-44 package, and the 2N1066, 2N1224, 2N1225, 2N1226, 2N1395, 2N1396, 2N1397 in the JEDEC TO-33 package. They feature a maximum junction temperature rating of 100°C, a maximum transistor dissipation rating of 120 mw in free air at 25°C.

RCA HIGH-VOLTAGE SILICON RECTIFIERS...

Now with transient ratings up to 20% over PRV; cover the full range from 1,200 to 10,000 PRV. RCA's broad line of 10 encapsulated, multi-cell rectifiers with integral voltage-equalizing networks, offers outputs up to 825 ma DC for military and industrial applications. These rectifiers are designed to meet military mechanical and environmental test specifications. Custom designs are available for higher voltage, higher temperature, higher current, oil submersion, special packaging requirements.



CR101-1200 PRV
CR102-2000 PRV
CR103-3000 PRV
CR104-4000 PRV
CR105-5000 PRV
CR106-6000 PRV
CR107-7000 PRV
CR108-8000 PRV
CR109-9000 PRV
CR110-10,000 PRV

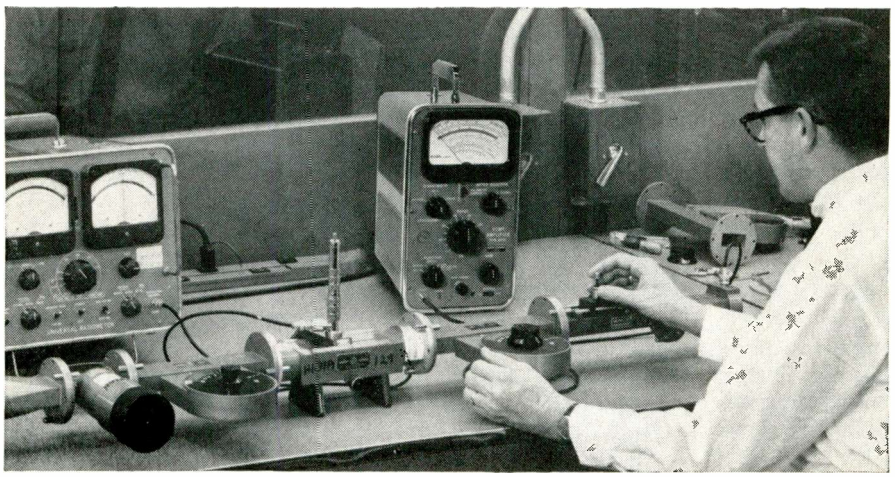
Now with transient ratings up to 20% over PRV at 125°C free-air temp.

CALL YOUR RCA REPRESENTATIVE TODAY FOR FULL PARTICULARS ON RCA INDUSTRIAL SEMICONDUCTOR PRODUCTS. For further technical information an any of the types shown, write RCA Semiconductor and Materials Division, Commercial Engineering, Section **D-50-NN**, Somerville, N.J.

RCA SEMICONDUCTOR & MATERIALS DIVISION FIELD OFFICES... EAST: Newark, N.J., 744 Broad St., HU 5-3900 • (Camden-Philadelphia Area) Erlton, N.J., 605 Marlton Pike, HA 8-4802 • Syracuse, N.Y., 731 James St., Rm. 402, GR 4-5591 • Baltimore, Md., EN 9-1850 • **NORTHEAST:** Needham Heights 94, Mass., 64 "A" St., HI 4-7200 • **SOUTHEAST:** Orlando, Fla., 1520 Edgewater Dr., Suite #1, GA 4-4768 • **EAST CENTRAL:** Detroit 2, Mich., 714 New Center Bldg., TR 5-5600 • **CENTRAL:** Chicago, Ill., Suite 1154, Merchandise Mart Plaza, WH 4-2900 • Indianapolis 5, Ind., 2132 East 52nd St., CL 1-1405 • Minneapolis 16, Minn., 5805 Excelsior Blvd., WE 9-0676 • Denver 11, Colorado, Continental Terrace Bldg., Suite 301, 2785 N. Speer Blvd., 477-1688 • **WEST:** Los Angeles 22, Calif, 6801 E. Washington Blvd., RA 3-8361 • (San Francisco Area) Burlingame, Calif., 1838 El Camino Real, OX 7-1620 • Seattle 4, Wash., 2250 First Ave. S., MA 2-8816 • **SOUTHWEST:** Dallas 7, Texas, 7905 Carpenter Freeway, ME 1-9720 • **GOV'T:** Dayton, Ohio, 224 N. Wilkinson St., BA 6-2366 • Washington, D. C., 1725 "K" St., N.W., FE 7-8500 • **RCA INTERNATIONAL DIVISION,** 30 Rockefeller Plaza, New York 20, N. Y. Cable Address: RADIOINTER, N. Y.

Circle 160 on Inquiry Card

☐ VSWR measurements of extreme precision
☐ FXR coax switch cuts Norden Laboratory test time
☐ How to reduce your cable inventory



VSWR measurements of extreme precision

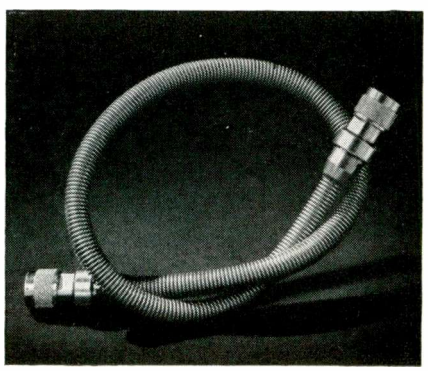
FXR's Model B813T VSWR Amplifier is a fully transistorized portable standing-wave amplifier with a full-scale maximum error at 5 db of ±0.05 db. We think it's the most accurate on the market.

The unit is designed for use on battery power for applications in the field where power is not available or in the laboratory where line noise might cause inaccuracies in measurement. Where power is available, however, the unit can be operated from the line in the normal manner.

Calibrated range of the B813T is 75 db. Normal, expanded and compressed meter scales are provided and can be used interchangeably without the need for readjustment of the gain control. The unit has special circuitry for bolometer protection and a meter display for bolometer resistance checking and current adjustment.

Other features of the B813T include controls and circuitry for selective meter damping, bandwidth selection and frequency peaking, range selection in 5-db steps, battery voltage checking and self-contained charging. Price: $285.00. *For more information circle Reader Service Card 73.* ■

Need a high temperature cable for nuclear application?



AMPHENOL ultra-high temperature flexible rf cable is capable of continuous operation at 1000°F with short excursions to higher temperatures.

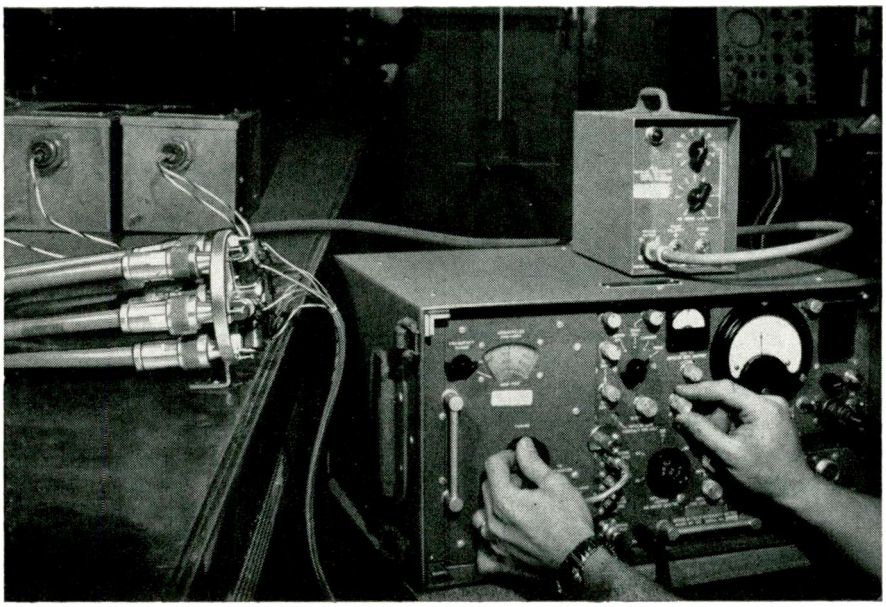
Application engineered for aircraft and missile temperature environments, the cable is a completely sealed rf transmission system consisting of inner and outer conductors separated by a dielectric of modified semi-solid silica.

Over all is a protective-sealed metallic-convoluted jacket. Cable ends are terminated at the factory with hermetically sealed 1000°F Series N plugs. System is resistant to nuclear radiation and is ideal for reactor use.

DATA

Altitude Insensitive-Moisture Resistant	Capacitance: 30.0 f/ft.
Resistant to Shock and Vibration	Velocity of Propagation: 69.0%
Resistant to Nuclear Radiation	Voltage Breakdown: 3500 Volts RMS
Connectors: Series N Plugs	Maximum Operating Voltage: 1000 VRMS
Impedance: 50 Ohms	Weight: Cable, 17½ lbs pr 100 ft.
	Connectors, 2½ ounces each

1000°F flexible rf cable is available in standard lengths up to 200 feet. Part number is 777-502. Specify length desired in order or quotation request. Length is measured from connector mating end to connector mating end. *For more information circle Reader Card 74.* ■



FXR coax switch cuts Norden Laboratory test time

Norden, a division of United Aircraft Corporation, operates an environmental test laboratory at its Norwalk, Conn., plant.

Faced with an ever-increasing number of systems requiring noise and interference tests under military specifications, Norden engineers asked FXR to design a 50-ohm resistor-terminated coaxial switch that would have identical electrical characteristics through each of six outputs. Now, to check different channels, instead of disconnecting and connecting cable, Norden engineers just flick a small knob. All unused channels are grounded through 50-ohm terminations, with no significant crosstalk to interfere with the measurements being recorded.

The result is a faster, more convenient test procedure. If you're running noise tests under MIL-I 6181B, 6181D, 26600 or 19610 you'll find that this new coaxial switch will save hours of tedious work.

Maybe you have some other unusual rf switching problem. Why not ask us about it? *For more information circle Reader Service Card 71.* ■

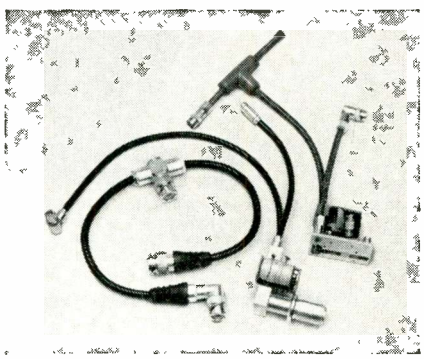
How to reduce your cable inventory

Most people we know cut up the cable they purchase, then put connectors on each end.

Why not let us make your cable assemblies? As the only major manufacturer of coaxial cable and coaxial connectors, FXR can probably save you money. We can certainly save you time.

How? Well, for one thing, you don't have to inventory so much cable or so many connectors. You don't have to set up production facilities for making these cable assemblies. And, you don't have to worry about quality control. We can produce sophisticated electrical assemblies to your rigid specifications. We have the people, facilities, and know-how to guarantee quality.

FXR manufactures Amphenol coaxial cable, Amphenol and "ipc" coaxial connectors and DK coaxial switches. Together, they constitute the industry's broadest line of coaxial components. Why not let us put them together for you? *For more information circle Reader Service Card 72.* ■



The RF Products and Microwave Division Amphenol-Borg Electronics Corporation; 33 East Franklin Street, Danbury, Connecticut.

FXR™

Letters to the Editor

"Junction Theory—"

Editor, ELECTRONIC INDUSTRIES:

You published my manuscript, entitled "Junction Theory for Silicon Logarithmic Diodes," in the January, 1962 issue of ELECTRONIC INDUSTRIES. Since that time, I have received several letters pointing out two errors in printing: In Figure #1, the locus should be labeled $-60°C$ instead of $60°C$. Also the references given do not apply to this article.

Raymond J. Schulte
Chief R & D Engineer

Controls Company of America
Electron Division
811 West Broadway Road
Tempe, Arizona

Nuclear Radiation

Editor, ELECTRONIC INDUSTRIES:

As a result of an advertising reprint I became aware of your projected series of articles on the reliability aspects of nuclear radiation. I have read the first article "Basic Effects of Nuclear Radiation," by J. R. Crittenden, January 1962, and find it informative. I would appreciate a reprint of this article . . . Also, it seems probable that the remaining articles in this series will be of value to us, so if possible I would appreciate preprints or reprints, as they become available.

Merval W. Oleson
Head, Field Engineering Section
Structures Branch
Mechanics Division

U. S. Naval Research Laboratory
Washington 25, D. C.

On Space For ETV

Editor, ELECTRONIC INDUSTRIES:

As a school board member I want to commend you on the several times here and in the past that you have supported ETV spectrum space. Here is a great new tool; when we learn how to use it best.

Your worry about preemption of ETV frequency channels in the future is well taken; but may I suggest the possibility of a more immediate usurpation or preemption of a large part of the future ETV assignment to our school boards country wide; and that is air based ETV operations proposals by MPATI.

Within the month the MPATI-Airborne operation has been reorganized to accept public school moneys for a 5-year 20 to 30 million dollar area wide, 6 states, with great publicity;

(*Continued from page* 62)

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VERSATILE PERFORMER

SANGAMO 470 SERIES

MAGNETIC TAPE INSTRUMENTATION

FEATURES ALL NEW ELECTRONICS MODULES

MAGNETIC TAPE INSTRUMENTATION

THE SANGAMO 470-SERIES RECORDER/REPRODUCER offers new flexibility for general purpose instrumentation through the use of electronic modules that give 4 speeds of both FM and Direct record and reproduce capability in a single module with simple toggle switch selection. A front panel meter and selector switch permit monitoring of FM and Direct input and output signal level as well as head current level. Levels can be easily adjusted by attenuators on the module panel. Test signals may be inserted through front panel jacks which automatically disconnect permanent signal inputs.

The 470-Series is available with either normal bandwidth (Model 471) or extended bandwidth (Model 472) frequency response capabilities, and is adaptable to 7 or 14 channels of record/reproduce electronics in a single cabinet, and can be expanded to 28 channels in a second cabinet for growth potential . . . for Direct, FM, PCM and Digital modes.

Sangamo speed control and tape handling make it possible to achieve magnetic tape instrumentation system accuracies heretofore considered unattainable. The transport offers both reel to reel and continuous loop operation capability without the use of adaptors.

For complete information on this Versatile Performer, write, wire, or phone:

SANGAMO ELECTRONIC SYSTEMS

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

ES62-1

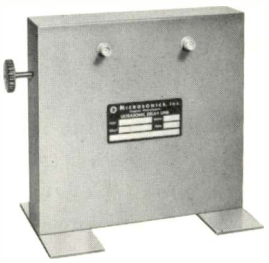
MICROSONICS

DELAY LINES

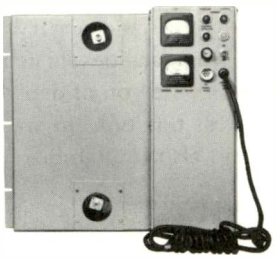
MICROSONICS

. . . unexcelled source for ultrasonic delay lines

NEW VARIABLE DELAY LINE Microsonics' new ultrasonic variable delay lines are continuously adjustable from 5 to 200 μsec with longer delays possible. Multiple variable outputs may be adjusted together or separately as well as through an adjacent output, over a limited range. Other characteristics: Frequency—20 to 60 mc; Band width—8 to 20 mc; Spurious—30 to 40 db.



NEW TEMPERATURE CONTROLLED ULTRASONIC DELAY LINES Microsonic temperature-controlled delay lines are for use as recirculating memories in systems where a phase coherent storage loop is a prerequisite. They may be used for IF Cancellors, Long Time Integrators, Delay Line Filters, Time Compression and Real Time Spectral Analysis. These controlled systems provide temperature excursions not greater than .01°C. Short term stability shall not exceed .003°C/minute over a twelve-hour period. Units have been furnished with .007°C stability over two weeks.



Microsonics has been selected time after time by major system manufacturers to develop and build ultrasonic delay line equipment. Systems using Microsonics delay lines include ASR-2, 3, 4, 5; UPS-1; FPS-30; SPS-38; SPS-6; ARSR; CPN-18; HAWK; APQ-72; MPS-23. Many of these applications have required advancements in the state of the art.

All of Microsonic's ultrasonic delay lines are hermetically sealed and meet the most rigid military environmental tests of shock, vibration, temperature and altitude.

Inquiries should be made directly to:

MICROSONICS INCORPORATED

Hingham Industrial Center, Hingham, Massachusetts

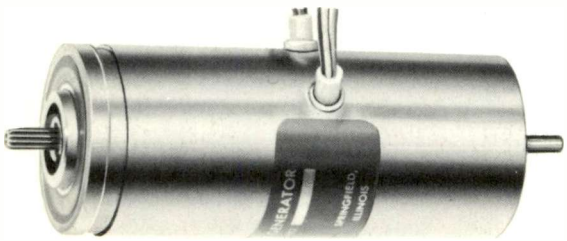
SANGAMO MICROSONICS

PRECISION

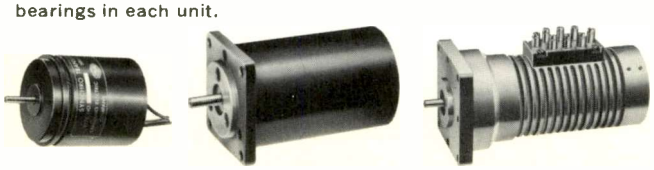
MOTORS

SANGAMO PRECISION MOTORS

NEW—SIZE 5 and SIZE 8 SERVO MOTORS. A size 5 (0.5" dia.) and size 8 (0.75" dia.) control motor, motor generator and synchronous motor have recently been added to Sangamo's extensive line of Precision Motors. Both units are designed for 400 cps excitation and are manufactured of corrosion resistant stainless steel. The size 8 can be provided with integral gear reducers.



NEW FEATURE ADDED TO SIZE 10 and 11 MOTOR GENERATORS Sangamo's standard size 10 (.938" dia.) and size 11 (1.062" dia.) servo motor generators are now available with a rear shaft extension to permit mechanical coupling and/or speed checks after the unit is installed. Positive alignment is assured by the use of three ball bearings in each unit.



SYNCHRO | SYNCHRONOUS MOTOR | GEARED MOTOR GENERATOR

We at Sangamo have been designing and producing AC servo motors, Induction Generators, Motor Generators, Drag Cup motors, Synchronous motors, Synchros, and PM Generators for more than 20 years.

We can supply—on short notice—hundreds of designs for both 60 and 400 cycle input sources with frame sizes ranging from size 5 to size 25. The materials, finishes, and performance of these units are tailored to meet applicable military specs. Most of our motors and motor generators are available with integral reduction gear ratios, and selected current designs can be furnished to operate at total temperatures of up to 200°C.

This is sure: whether it's a "stock" motor or a special requirement motor, if it comes from Sangamo it is ultra-reliable, competitively priced, and delivered on time.

Write for complete information.

SANGAMO PRECISION MOTORS

SANGAMO ELECTRIC COMPANY

SPRINGFIELD, ILLINOIS

PM62-1

SPECIFY ARNOLD IRON POWDER CORES . . .

COMPLETE RANGE OF SIZES AND SHAPES FOR YOUR DESIGNS

Arnold offers you the widest range of shapes and sizes of iron powder cores on the market.

In addition to toroids, bobbin cores and cup cores—typical groups of which are illustrated below—Arnold also produces plain, sleeve and hollow cores, threaded cores and insert cores, etc., to suit your designs. Many standard sizes are carried in warehouse stock for prompt shipment, from prototype lots to production quantities. Facilities for special cores are available to order.

The net result is extra advantage and assurance for you. No matter what shapes or sizes of iron powder cores your designs require, you can get them from a single source of supply—with undivided responsibility and a single standard of known quality. And Arnold's superior facilities for manufacture and test assure you of dependably uniform cores, not only in magnetic properties but also in high mechanical strength and dimensional accuracy.

● For more information on Arnold iron powder cores, write for a copy of our new 36-page Bulletin PC-109A. *The Arnold Engineering Company, Main Office and Plant, Marengo, Illinois.*

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ARNOLD
SPECIALISTS in MAGNETIC MATERIALS

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

2541

← Circle 38 on Inquiry Card

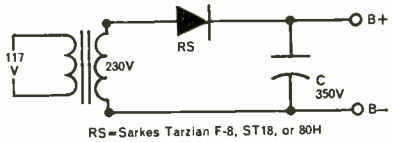
Circle 39 on Inquiry Card

TARZIAN DESIGN IDEAS

Reliability at low cost in power supplies...

● Many circuit refinements and improvements are made practical by the availability of (a) small size silicon rectifiers rated up to 800 volts at 500 to 750 milliamperes, and (b) compact high voltage silicon rectifier stacks with peak inverse ratings to 10,000 volts. A dozen units of the first group and four of the latter are listed below. All are available at realistic cost and will increase reliability over tube supplies.

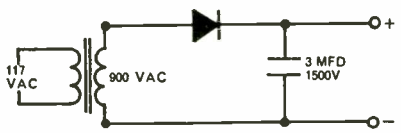
1A. Half Wave Power Supply for Television/Stereo/Electronic Use



RS=Sarkes Tarzian F-8, ST18, or 80H

Output: Volts DC	MA DC	C
290	250	150 Mfd
280	500	200 Mfd
270	750	200 Mfd

1B. Half Wave 1,000 Volt Power Supply

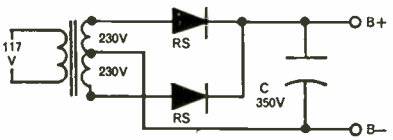


RS=Sarkes Tarzian S-5521

Output: Volts DC — MA

1,000 — 120 ma @ 25 degrees C
1,000 — 60 ma @ 100 degrees C

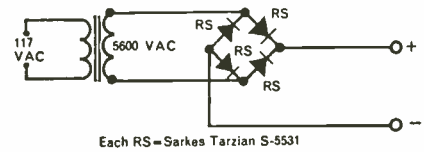
2A. Full Wave Power Supply for Color Television/Stereo/Electronic Use



Each RS=Sarkes Tarzian F-8, ST18 or 80H

Output: Volts DC	MA DC	C
310	500	50 Mfd
290	1,000	50 Mfd
280	1,500	50 Mfd

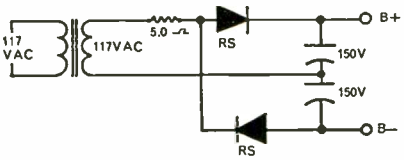
2B. Full Wave 5,000 Volt Power Supply



Each RS=Sarkes Tarzian S-5531

Output:
5000 VDC @ 150 ma @ 25 degrees C
5000 VDC @ 50 Ma @ 100 degrees C

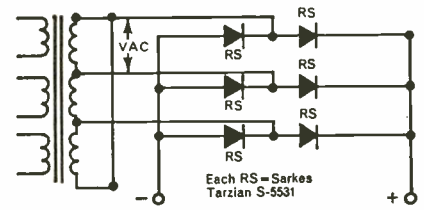
3A. Full Wave Voltage Doubler for Television/Stereo/Electronic Use



Each RS=Sarkes Tarzian 40H, F-4 or ST14

Output: Volts DC	MA DC	Each C
290	300	100 Mfd
280	500	100 Mfd
270	750	100 Mfd

3B. Three Phase 7,500 Volt Power Supply

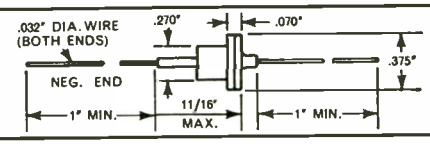
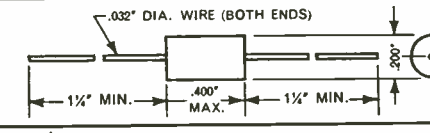
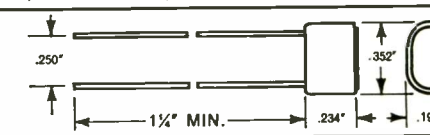
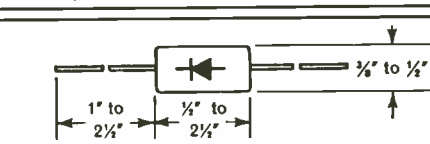


Input: 5700 Volts AC per phase

Output:
7500 VDC @ 200 ma @ 25 degrees C
7500 VDC @ 65 ma @ 100 degrees C

Three general circuits are shown for each of the two groups mentioned above to suggest some of the possibilities. For example: 1-A, a simple half-wave circuit operating off a 230 volt line or with a 1 to 2 step-up transformer, delivers between 270 and 290 volts with a capacitive input; 2-A, with two rectifiers in a full wave circuit with a center tap transformer, delivers approximately 300 volts across a wide range of current ratings; and so on. Similiarly the high voltage rectifiers let you design compact half wave and full wave supplies at moderate cost.

SARKES TARZIAN LOW CURRENT RECTIFIERS

TARZIAN TYPE	MAX. PRV	MAX. RMS VOLTS	MAX. DC MA 55° C	MAX SURGE AMPS	DIMENSIONS
20H 40H 60H 80H	200 400 600 800	140 280 420 560	750 750 750 750	75 75 75 75	
F-2 F-4 F-6 F-8	200 400 600 800	140 280 420 560	750 750 750 750	75 75 75 75	
12 14 16 18	200 400 600 800	140 280 420 560	750 750 750 750	75 75 75 75	
S-5518 S-5521 S-5529 S-5531	1,000 3,000 4,000 10,000	700 2,100 2,800 7,000	200 150 50 25	20 15 5 5	

Whatever your application, let Tarzian engineers consider it for practical recommendation. Catalog available on request.

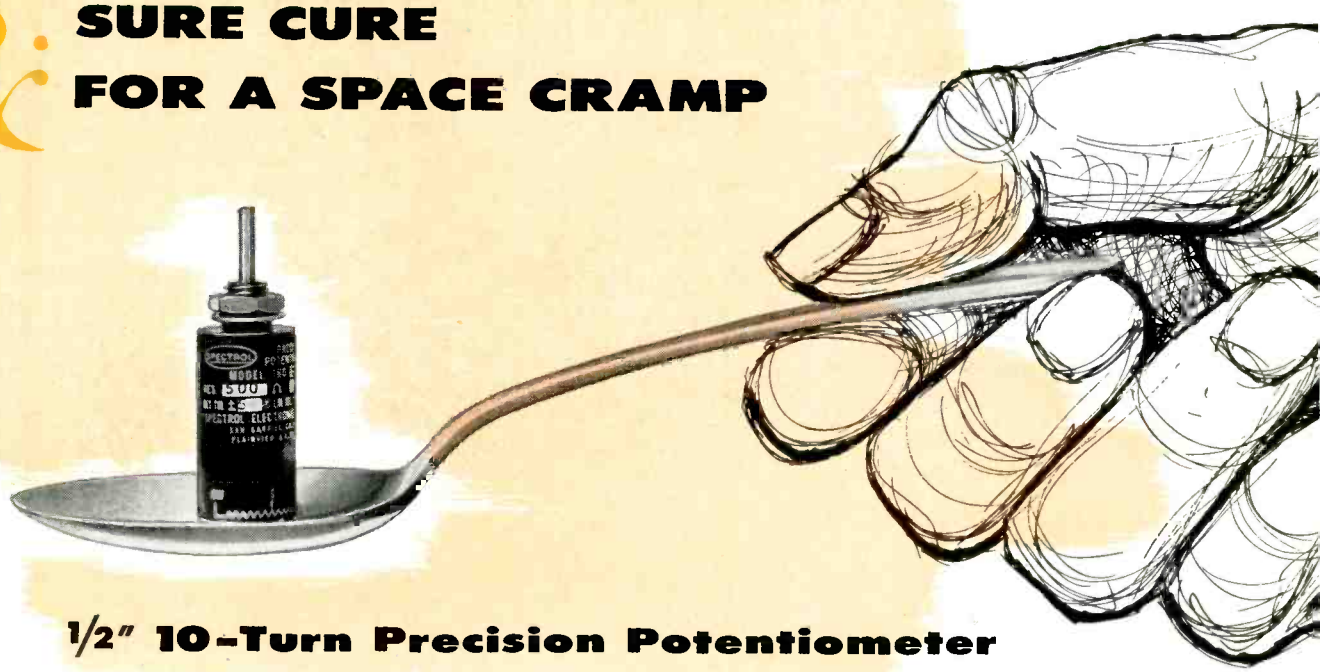
SARKES TARZIAN, Inc.

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

SEMICONDUCTOR DIVISION • BLOOMINGTON, INDIANA

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

Rx SURE CURE FOR A SPACE CRAMP



1/2" 10-Turn Precision Potentiometer

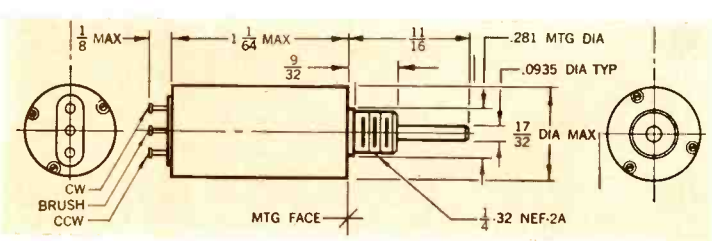
Spectrol's new miniature 10-turn precision potentiometer is a ½" diameter pot with terminals located on the rear housing lid, eliminating side projections. Available in either bushing, servo or screw mount, the Model 160 is ideally suited for applications where excellent resolution is needed in a small package. Compatibility with a size 5 servo motor makes servo control a natural for the Model 160.

The anodized aluminum case combines ruggedness with rapid heat dissipation and all taps and terminations are welded rather than soldered. Its mechanical stops withstand forces to 20 ounce/inches.

Having 12 inches of helical resistance element, the Model 160 is available in resistances to 155K ohms. A true precision device, the Model 160 has a standard linearity tolerance of ±0.5%, but can be supplied to ±0.1%.

Special features available on the Model 160 include: zero based or terminal based linearity, shorted sections, special shafts, additional taps, special electrical and mechanical rotation, limited non-linear functions and other custom electrical and mechanical requirements.

In short, there's a Model 160 for virtually any application calling for precision in a small package. Delivery is 30 days for standard models, 6 weeks for specials.



KEY SPECIFICATIONS

DIAMETER 17/32" Max.
STANDARD RESISTANCE RANGE 15Ω to 115K (special to 155K available)
STANDARD RESISTANCE TOLERANCE ±5% (special to ±2%)
NUMBER OF TURNS Ten
POWER RATING 2.5 watts at 40°C
LINEARITY ±0.5% (special to ±0.1%)
ROTATIONAL LIFE MIL-R-12934B Symbol 6 (2,000,000 shaft revolutions)
TEMPERATURE RANGE −55°C to +125°C (special to +150°C)
NOISE 100Ω ENR Max. per NAS-710
SHOCK 30G per MIL-STD-202B, Method 202A
VIBRATION MIL-STD 202B, Method 204A, Condition A (10G to 500 cps)
HUMIDITY MIL-T-5422E (10 cycles)
SALT SPRAY MIL-STD-202A, Method 101A, Condition A (96 hours)
LOAD LIFE 1000 hours per MIL-R-19A
TORQUE 0.5 oz./in. starting; 0.4 oz./in. running
WEIGHT 0.5 ounce
BASE PRICE 1-9 quantities, $32 for bushing type. $40 for servo type.

Other standard models of Spectrol miniature potentiometers, as well as standard precision potentiometers and trimmers are available from your nearby Spectrol distributor. For complete technical information, contact your Spectrol engineering representative or write directly to the factory.

The World's Broadest Line of Precision Potentiometers

SPECTROL

ELECTRONICS CORPORATION

1704 South Del Mar Avenue, San Gabriel, California
Adams Court, Plainview, L. I., New York
P. O. Box 130, Brampton, Ontario

Circle 41 on Inquiry Card

Letters to the Editor

(*Continued from page* 56)

and without telling we Board Members enough of the long-term country wide implications, that these air based ETV channels expanded to country wide application each usurps or preempts 20 to 30 repetitions of the same frequency channel across the country of the ground-based arrangement as now used for commercial entertainment TV.

Do we board members spend the public school tax money to extend air based ETV and preempt or usurp 20 or 30 times as many ground based ETV possibilities for other school systems across the country that may have as much or more need for their own particular type of program? Many different needs exist in different places; but with air based ETV there can only be one program at a time; in the limit country wide. With ground based ETV there may be 20-30-40 different programs simultaneously be ing used by school systems across the country. The preemption of these frequencies starts when air based ETV starts as a regular bill-of-fare at the end of this coming semester. (We are only in the first experimental semester now—when the new organization has already been organized—without giving us the whole story.)

So I commend you for your caution on the preemption of ETV channels and suggest a second look at the situation of the new air based ETV incorporation, as of Jan. 8. If the whole picture is considered for the long pull ahead my contention is that the long time cost per pupil per year per subject will be less for ground based than for air based.

Lloyd P. Morris

2947 N. 78th Court
Elmwood Park, Ill.

Transistor Analysis

Editor, ELECTRONIC INDUSTRIES:

We are currently engaged in a development and application program concerning solid state devices. It would be of great assistance to us if we could secure 2 copies of the serial article, "Junction Transistor Analysis for Circuitry" which appeared in the December 1961-January 1962 issue of ELECTRONIC INDUSTRIES.

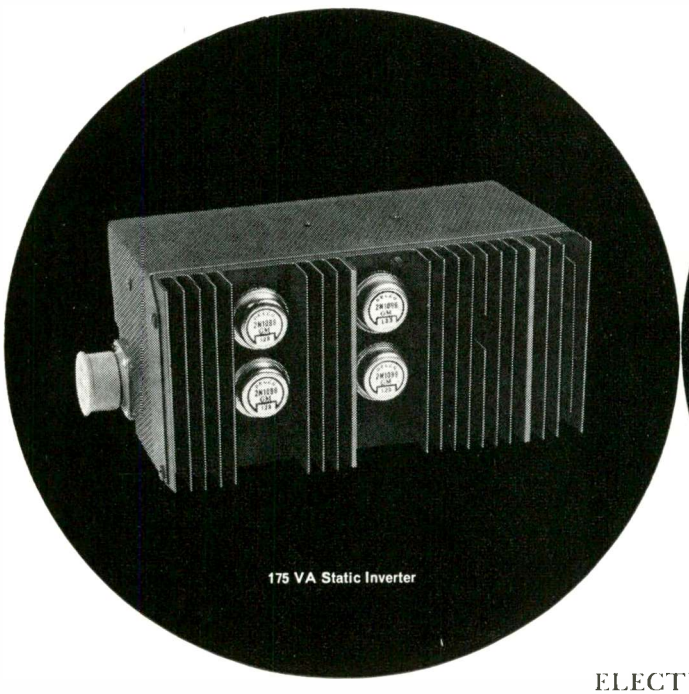
One of the copies is for my file and the other is for distribution to Engineering. The Engineering copy will be filed in our Technical Library for future reference.

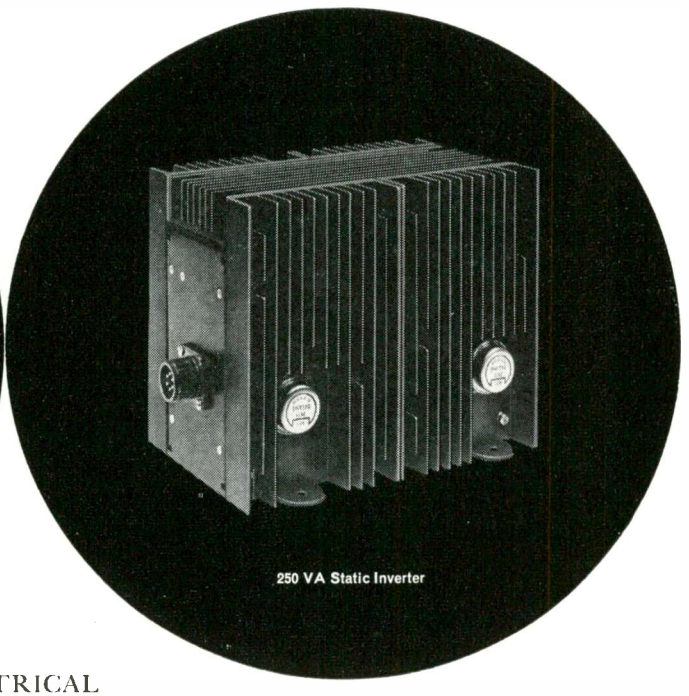
R. A. Stevens
Sr. Electronics Engineer

FMA Inc.
142 Nevada Street
El Segundo, California

PRECISION WITH SIMPLICITY
FROM DELCO RADIO

That's the big feature in Delco Radio's new 175 VA and 250 VA static inverter power supplies. These *all-transistor* units offer increased reliability through simplified circuits. Both static inverters are designed for either airborne or ground applications and will withstand overload and output short circuit conditions indefinitely, delivering at least 110% of rated output before going into overload protection. Units automatically recover to full output upon removal of overload and short circuit. Units are designed to meet the environmental requirements of MIL-E-5272C. For further information on military electronics write Delco Radio's Military Sales Department.


175 VA Static Inverter


250 VA Static Inverter

ELECTRICAL
SPECIFICATIONS

175 VA STATIC INVERTER

Input
Voltage: 27.5 VDC ± 10% per MIL-STD-704

Output

Power:	175 VA single phase 0.5 lag to 1.0 power factor
Voltage:	115 V adjustable from 110 to 120 volts
Regulation:	1-volt change for any variation of load between zero and 110% of full load, and input voltage between 25 VDC and 30 VDC
Frequency:	400 ± 1 cps. Frequency changes less than 1.0 cps. for all environment, load and input voltage variation
Distortion:	Less than 5% total harmonic
Efficiency:	80% at full load

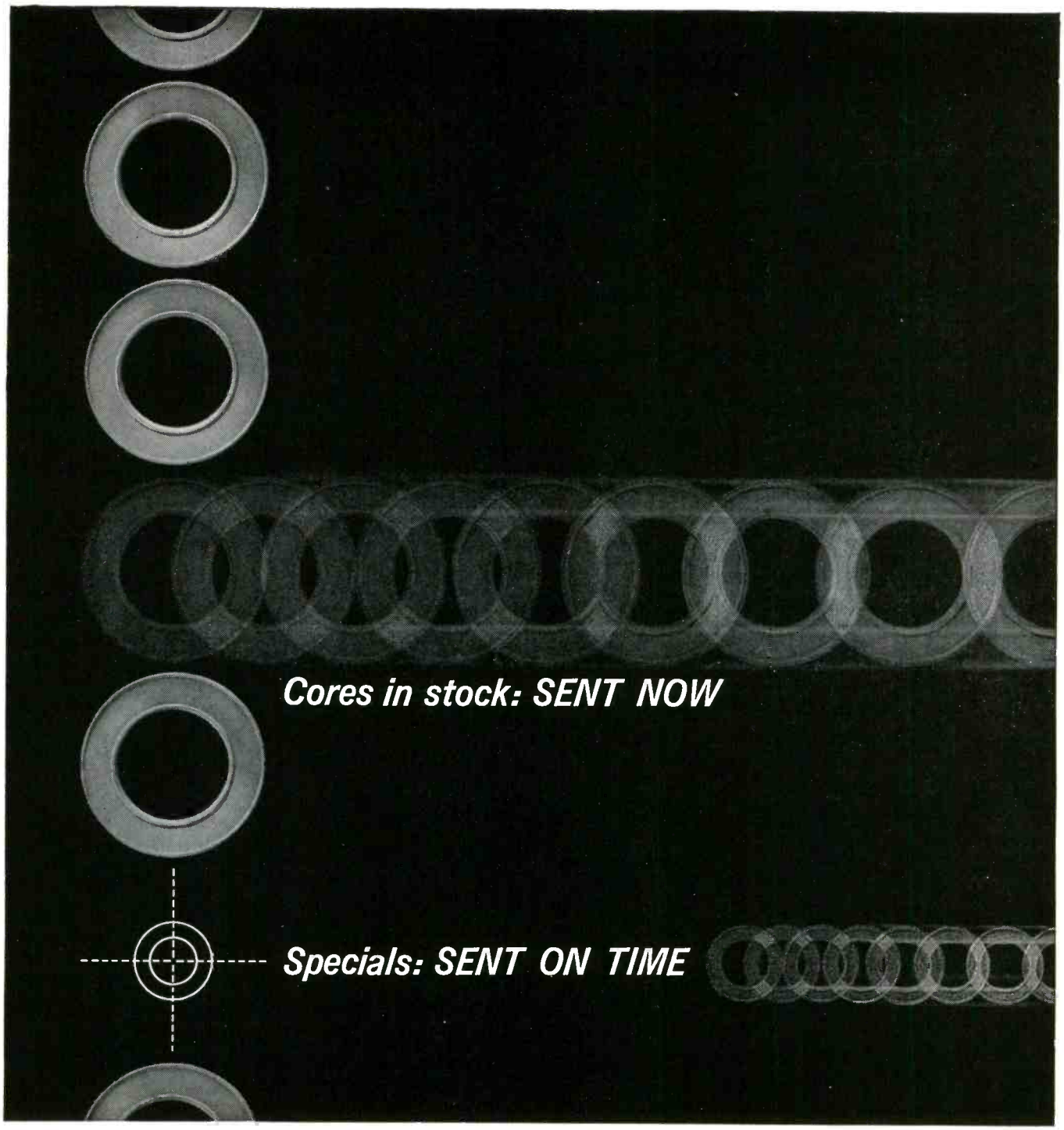
250 VA STATIC INVERTER

Input
Voltage: 27.5 VDC ± 10% per MIL-STD-704

Output

Power:	250 VA single phase 0.6 lag to 1.0 power factor
Voltage:	115 V adjustable from 110 to 120 volts
Regulation:	0.7 volt for any variation of load between zero and 110% of full load, and input voltage between 25 VDC and 30 VDC
Frequency:	400 ± .5 cps. Frequency changes less than 1.0 cps. for all environment, load and input voltage variation
Distortion:	Less than 5% total harmonic
Efficiency:	80% at full load

DELCO RADIO
DEPENDABILITY
ELECTRONICS
Division of General Motors • Kokomo, Indiana



BOTH ADD UP to assurance that *your* production will proceed on schedule no matter what kind of cores you need. Specials? Cores from Magnetics Inc. are sent ON TIME . . . exactly when promised.

Here's why we're so positive about delivery dates: tape wound cores specially made to exacting customer specifications account for nearly half of the millions we manufacture. The experience we've gained through the years in making these specials enables us to forecast *our* production time accurately . . . then ship to you on the date stated in our acknowledgment.

The standards . . . cores stocked in depots in Butler, Pasadena and New York . . . are sent as soon as your order is received. Most of the time it is a "same day" shipment . . . whether it's Permalloy 80, Supermalloy, Orthonol® or Magnesil® cores in anodized aluminum, phenolic or G.V.B. boxes.

What's more, *all* cores are tested to our published guaranteed limits using A.I.E.E. standard tests procedures.*

As we said at the top . . . on-time shipment of specials, immediate shipment on stocked cores, tested units . . . it all adds up to assurance.

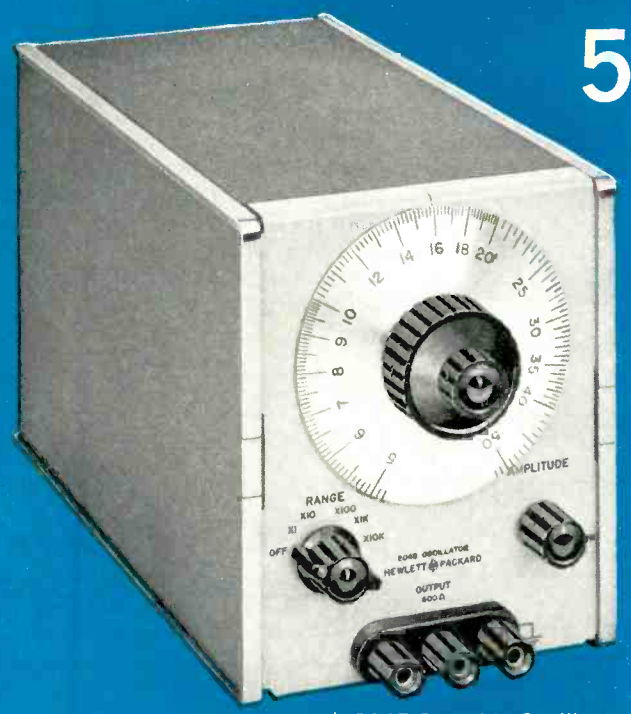
Want proof? We'll shoot a sample stock core to you as soon as we receive your name on your letterhead. (If you have a special in mind let us know the specs and the quantity. We'll tell you the cost and delivery time.) Write Magnetics Inc., Dept. EI-02, Butler, Pa.

**C.C.F.R. Test per A.I.E.E. #432.*

MAGNETICS inc.®

Use it on the bench—carry it anywhere!

New hp High Stability Oscillator



hp 204B Portable Oscillator

5 cps to 500 KC

Unique frequency, amplitude stability in this compact, light weight, solid state oscillator!

The unusual stability of the new hp 204B combines with solid state design and battery operation to give you one of the most useful, reliable, versatile oscillators available today. Because the 204B is fully transistorized, internal heat is small and warmup drift is negligible. In addition to battery operation, the 204B is operable on ac, with an ac power pack available at extra cost.

Frequency stability over the entire 5 cps to 500 KC range is better than ±0.03%/°C from 0° to 55°C. Amplitude stability over rated frequency range and output levels is better than ±0.1% over 8 hours of operation at constant line voltage and temperature*; better than ±0.2% for line voltage changes of ±10%; better than ±0.1%/°C, 0-55°C.

Output of the 204B is fully floating, isolated from both power line ground and chassis. Balanced and unbalanced loads, and loads referenced either above or below ground, can be driven by this versatile oscillator. Low impedance circuits drive the 600 ohm output, effectively isolating the oscillator stage.

SPECIFICATIONS

Frequency Range:	5 cps to 500 KC, 5 ranges, 5% overlap, vernier control
Dial Accuracy:	± 3%
Frequency Response:	± 3% with rated load
Output Impedance:	600 ohms
Output:	10 mw (2.5 v rms) into 600 ohms; 5 v rms open circuit
Output Control:	Continuously variable bridged "T" attenuator with at least 40 db range
Distortion:	Less than 1%
Noise:	Less than 0.05%
Power Source:	4 battery cells at 6.75 v each, 7 ma drain, life at least 300 hours
Power Accessory Available:	AC power supply can be installed in place of batteries. Optional at extra cost.
Dimensions:	6 - 3/32″ x 5 - 1/8″ x 8″. 6 lbs.
Price:	hp 204B, $275.00

7063

Designed in the new hp instrument module packaging, the 204B is only 6-3/32″ high, 5⅛″ wide and 8″ deep; weighs just 6 pounds! A new rack mount adapter holds three 204B oscillators or other hp instruments of the new modular design.

*On battery operation, stability −1% during battery depolarization, less than 30 minutes.

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1501 Page Mill Road, Palo Alto, California, U.S.A.
Cable "HEWPACK" DAvenport 6-7000
Sales representatives in all principal areas

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Cable "HEWPACKSA" Tel. No. (022) 26.43.36

Circle 45 on Inquiry Card

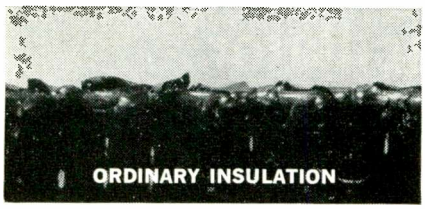
HOW YOU CAN REDUCE COSTS AND BUILD MORE DEPENDABLE EQUIPMENT WITH

NEW Fibremat® BRAND ELECTRICAL INSULATIONS

THE SECRET IS IN THE WEB

The construction of "Fibremat" is entirely different from ordinary insulations. It's formed from a web of non-woven polyester fibers and uses no adhesives or any other bonding agent.

This unique non-woven construction gives "Fibremat" many important advantages. It has built-in stretch to conform snugly to irregular shapes and thus eliminate gapping and voiding in coil wrapping. It wraps faster and easier and looks neater. The random distribution of polyester fibers gives equal strength in all directions and assures elongation flexibility without breakdown.

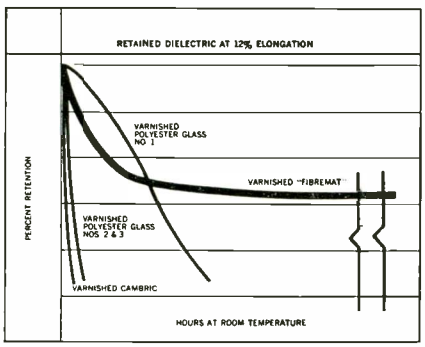


Ordinary woven materials when stretched create points of stress where filaments cross each other. Elongation produces a scissor-like action that weakens the structure, tends to tear the film and rupture the insulation coating. Unsupported areas of varnish "floating" between the weaves are particularly apt to be weakened and give way.

"Fibermat", because the pattern of fibres is non-woven, will not result in a scissoring action when stretched. And because the fibers are distributed throughout the web the entire insulating film is supported.

"FIBREMAT" RETAINS ITS ELECTRIC STRENGTH

There's a vast difference between the electric strength of materials "in the carton" and "on the job." The important factor is the effective electric strength of the material after it's been stretched and stressed during application.



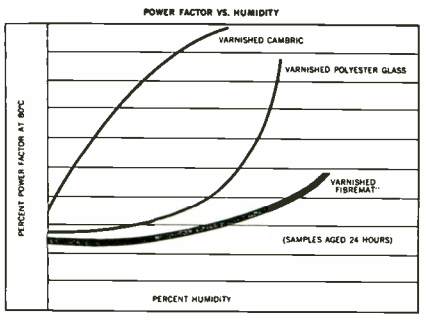
At 12% elongation "Fibremat" retains a substantially greater percentage of its original electric strength than either woven cambric or polyester-glass materials. This basic ability to retain electric strength means less insulation thickness is needed with "Fibremat" to attain the same electrical performance achieved with heavier layers of old style materials. Less insulation and less labor is required to finish a component. Insulation costs are reduced!

"FIBREMAT" RESISTS SOLVENT ATTACK

Solvents generally used in impregnating or dipping process can often cause insulation failure. This is particularly true with woven fabrics where relatively large areas are left unsupported and the varnish film tends to swell and flake away from the base fabric. The uniform dispersion of fibers in "Fibremat," however, provides support for all areas of the varnish film and prevents this solvent-caused breakdown.

"FIBREMAT" IS MOISTURE RESISTANT

There's no prebaking to drive out moisture when you use "Fibremat". The non-hygroscopic polyester base fabric in "Fibremat" resists moisture and the non-woven web construction prevents moisture absorption from wicking. Continuous filament woven fabrics act as wicks and offer a direct path for moisture to follow. In moist or humid environments "Fibremat" outperforms varnished cambric or polyester-glass materials.



"FIBREMAT" MEANS DEPENDABILITY

Today, "Fibremat" is being successfully used on all types of automatic taping machines and has proven itself outstanding on hand-taping operations requiring extra tensile strength. It can be impregnated with varnishes, epoxies and other liquid insulators; resists salt water, acids, alkalies, alcohols, hydrocarbons, and oils; is non-corrosive. Use "Fibremat" for wrapping form wound coils, layer and phase insulation, slot liners, and high voltage cables. **For complete information, write: 3M Co., Electrical Products Division, St. Paul 6, Minn., Dept. ECO-52, or phone and ask for "Fibremat" at any branch office listed below.**

ATLANTA, 451-1661; BOSTON, HI 9-0300; BUFFALO, TX 4-5214; CHICAGO, GL 8-2200; CINCINNATI, EL 1-2313; CLEVELAND, CL 2-4300; DALLAS, DA 7-7311; DETROIT, 875-7111; LOS ANGELES, RA 3-6641; PHILADELPHIA, PI 2-0200; NEW YORK, OX 5-5520; ST. LOUIS, WY 1-1320; ST. PAUL, PR 6-8511; SAN FRANCISCO, PL 6-0800; SEATTLE, MU 2-5550.

Irvington Division

3M MINNESOTA MINING & MANUFACTURING CO.

"FIBREMAT" IS A REGISTERED TRADEMARK OF 3M COMPANY, ST. PAUL 1, MINN.

a compact,

NEW A-C SUPPLY

The W5MT3VM model joins the ever-growing line of Variac® Autotransformers with meters. Consisting of a 5-ampere Variac Autotransformer and 0-150v voltmeter housed in a metal case, this unit will find many uses in your lab or shop as a continuously adjustable a-c supply. The W5MT3VM also incorporates a manual-reset overload protector; on-off switch; convenient carrying handle; 3-wire line cord and outlet receptacle; and DURATRAK* brush-contact surface found only on Variacs, for proven reliability and long, trouble-free life.

W5MT3VM Metered Variac . . . $54 with voltmeter
0-140v, 0.70KVA at 5 amperes rated current; only 8½ lbs.

*U. S. Pat. No. 2,949,592

Five Other Metered Models Available (0 to 140 volts at currents to 10 amperes)

W5MT3A VOLTMETER/AMMETER COMBINATION

W5MT3AW VOLTMETER/AMMETER/WATTMETER COMBINATION

W5MT3W VOLTMETER/WATTMETER COMBINATION

	Type	Current Ranges	Wattage Ranges	Price
5-Amp Models	W5MT3A	0-1, 0-5	—	$ 89
	W5MT3W	—	0-150 0-750	$112
	W5MT3AW	0-1 0-5	0-150 0-750	$150
10-Amp Models	W10MT3A	0-2 0-10	—	$110
	W10MT3W	—	0-300 0-1500	$138

Write for the VARIAC Catalog

GENERAL RADIO COMPANY

WEST CONCORD, MASSACHUSETTS

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Circle 47 on Inquiry Card

Personals

Dr. Charles M. Judson — named Head, Advanced Analytical Development Section, Analytical and Control Div., Consolidated Electrodynamics Corp., Pasadena, Calif.

Dr. Thomas E. Tice — appointed Chief Engineer, Antenna and Microwave Group, Military Electronics Div., Western Center, Motorola, Inc., Scottsdale, Ariz.

Robert L. Stone—appointed Manager of Engineering, energy storage and high voltage dc capacitors and pulse-forming networks, Cornell-Dubilier Electronics, Div. of Federal Pacific Electric Co., Newark, N. J.

Dr. David Zeheb—appointed Chief Electronics Engineer, Weston Instruments Div., Daystrom, Inc., Newark, N. J.

Dr. D. Zeheb

R. S. Modjeska

R. Scott Modjeska—appointed Research Director in Physical Sciences, Cinch Mfg. Co., Chicago, Ill.

Thomas J. Kehoe—named Manager of Application Engineering, Scientific and Process Instruments Div., Beckman Instruments, Inc., Fullerton, Calif.

Howard H. Manko—named Director of Solder Research and Development, Alpha Metals, Inc., Jersey City, N. J.

Hoffman Electronics Corp., Semiconductor Div., announces the following appointments: George E. Deaderick—named Director of Solar Operations; **Richard E. Pangburn**—appointed Chief Industrial Engineer; and **Tom E. Mumford**—promoted to National Field Sales Manager.

E. Stanley Ogden — named Plant Manager, Selectrons, Ltd., New York, N. Y.

Minneapolis-Honeywell's Aeronautical Div., announces the following Apollo Program appointments: **Oreland A. Thornsjo** — named Director; **Lincoln Hudson**—appointed Engineering Manager; **Peter P. Lundquist** — named Systems Project Engineer; and **Alex B. Chudyk** — appointed Operations Manager.

(*Continued on page* 70)

NEW! *from* CLARE

ACTUAL SIZE

a miniature plug-in Mercury-Wetted Contact Relay

...Available for bridging or non-bridging applications

The CLARE HGS Switch Capsule

The remarkably long life...billions of operations...of the HGSL relay is the result of a design principle whereby a film of mercury on the contacts of the HGS switch capsule (shown) is constantly renewed by capillary action from a mercury pool. The switch is sealed in glass in a high-pressure hydrogen atmosphere.

This new, smaller-than-ever, CLARE HGSL mercury-wetted contact relay gives you all the long life, reliability and high contact rating found only in CLARE HGS relays...in a plug-in package less than 2 inches high and ⅝ inch dia.

It is an ideal relay for commercial and military electronic equipment which employ wired chassis assemblies. It is also useful for PCB assemblies which have right-angle adapted seven-pin miniature sockets.

The new HGSL relay is an assembly of the standard HGS mercury-wetted switch capsule surrounded by the HGSM (module-sized) coil. These exceedingly small units are enclosed in a round metal can with a seven-pin miniature glass and metal plug termination. Normally, the enclosure is crimped to the plug but it may be hermetically sealed if desired. Either the HGS 1000 series capsule (Form D, bridging) or the HGS 5000 capsule (Form C, non-bridging) are available for this assembly.

For complete information send for Data Sheet CPC-14.

See your nearest CLARE representative or address C. P. Clare & Co., 3101 W. Pratt Blvd., Chicago 45, Illinois. Cable Address CLARELAY. In Canada: C. P. Clare Canada Ltd., 840 Caledonia Road, Toronto 19, Ontario. In Europe: Eurcpelec, les Clayes-sous-Bois (S.-et-O.) France.

C. P. CLARE & CO.

Relays and related control components

Personals

(*Coontinued from page* 68)

Daniel C. Buck—appointed to the position of Fellow Engineer, Westinghouse Electronic Tube Div., Elmira, N. Y.

Dr. Wilford E. Morris — named Chief Research Engineer, Scintilla Div., The Bendix Corp., Sidney, N. Y.

Phillip A. Weygandt—promoted to Commercial Engineer of Shockley Diodes, Clevite Transistor, Waltham, Mass.

Richard B. Glickman—appointed Director of Engineering and Head of the newly-formed Defense Products Div. of ColorTran Industries, Burbank, Calif.

Kurt Stern—appointed Project Engineer, Airtron, a div. of Litton Industries, Morris Plains, N. J.

Dr. Ralph L. McCreary — named Manager, Systems Research Laboratory, Motorola Inc., Riverside, Calif.

Dr. R. L. McCreary

A. Gutterman

Arthur Gutterman—named Product Manager, Power Control Dept., Trak Electronics Co., Inc., Wilton, Conn.

Arthur Frielich—promoted to Engineering Product Manager, North Atlantic Industries, Inc., Plainview, N.Y.

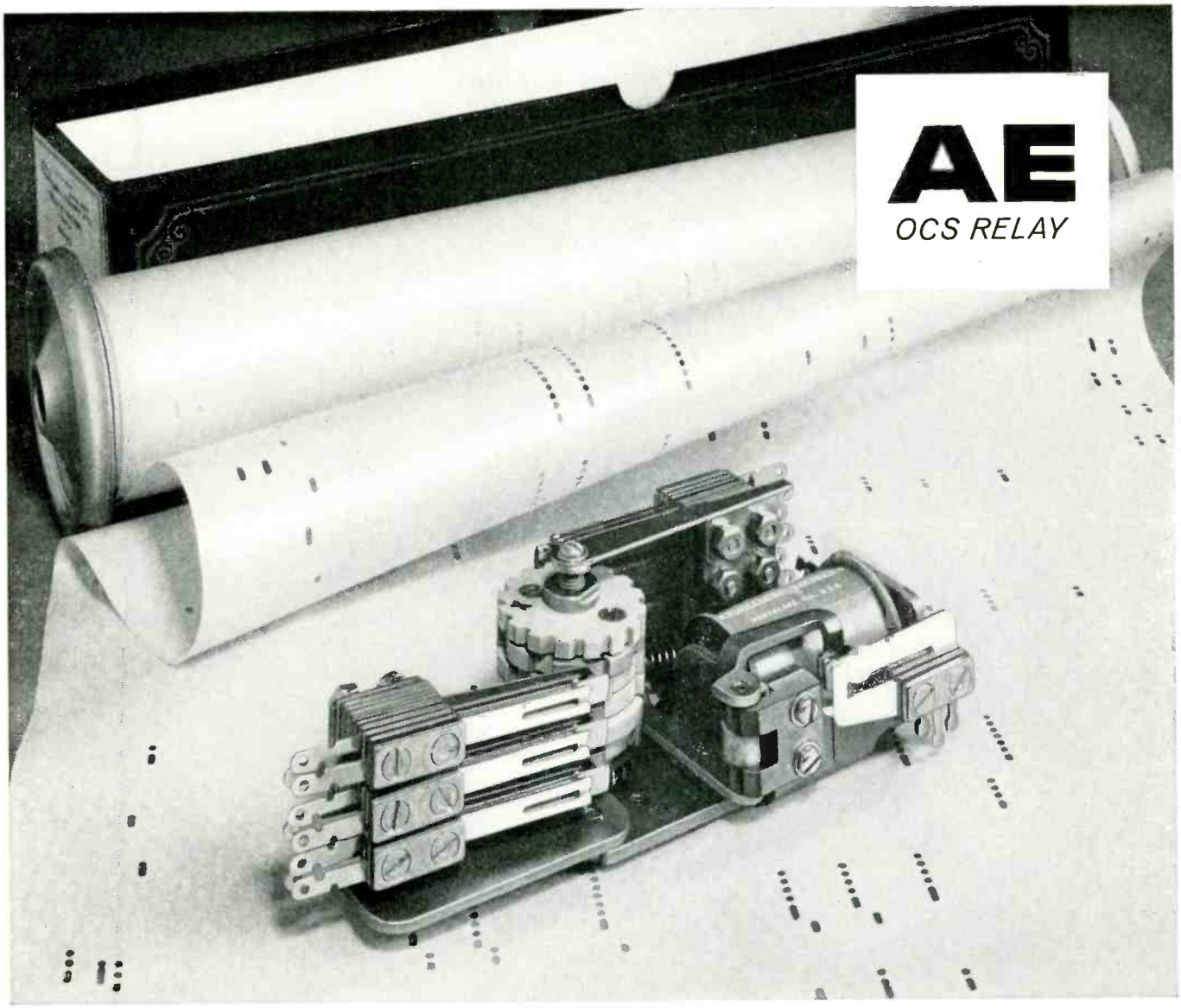
Norman L. Appel—named Production Engineering Manager, Electronic Tube Div., Allen B. Du Mont Laboratories, Clifton, N. J.

Harold Lipschultz—appointed Manager of Manufacturing Engineering, New Bedford Div., Aerovox Corp., New Bedford, Mass.

Antenna Systems, Inc., Hingham, Mass., announces the following appointments: **Vaudie W. Vice, Alan G. Williams, Charles R. Sims, Mickey L. Hudspeth,** and **Hershel Sterling**—named to the Systems Engineering Staff for Tracking Antennas.

Dr. Frank Herman—named Consulting Scientist, Lockheed Missiles & Space Co., Palo Alto, Calif.

Halmar Electronics, Inc., Columbus, Ohio, announces the following appointments; **Richard H. Dawley**—named Product Sales Manager; and **Kenneth M. Povenmire** — appointed Chief Project Engineer.



Looking for a pint-size programmer?

If you're short on space but long on the need for fancy cycling in your circuit design, AE's fast-stepping OCS switcher will solve the problem.

Though it's no larger than a pack of king-size cigarettes, it can do the work normally assigned to a whole battery of relays. And, unlike relays and electron tubes, it never loses its stored memory in the event of power failure or circuit interruption.

The AE Series OCS will follow or initiate a prescribed series of events or cycles at 30 steps per second impulse-controlled, or 65 steps per second self-interrupted. Any programming sequence can be set up on one to eight cams with as many as 36 on-and-off steps per cam. And each cam, tailored to your specifications, will actuate as many as six contact springs.

Whether your designs call for relays or stepping switches, AE circuit engineers are ready to work with you in arriving at the most economical solution to any circuit transfer problem. We're also equipped to supply prewired and assembled, custom-built control packages, or aid you in developing complete control systems.

• • •

For full information on the Series OCS, write for Circular 1698-K to the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

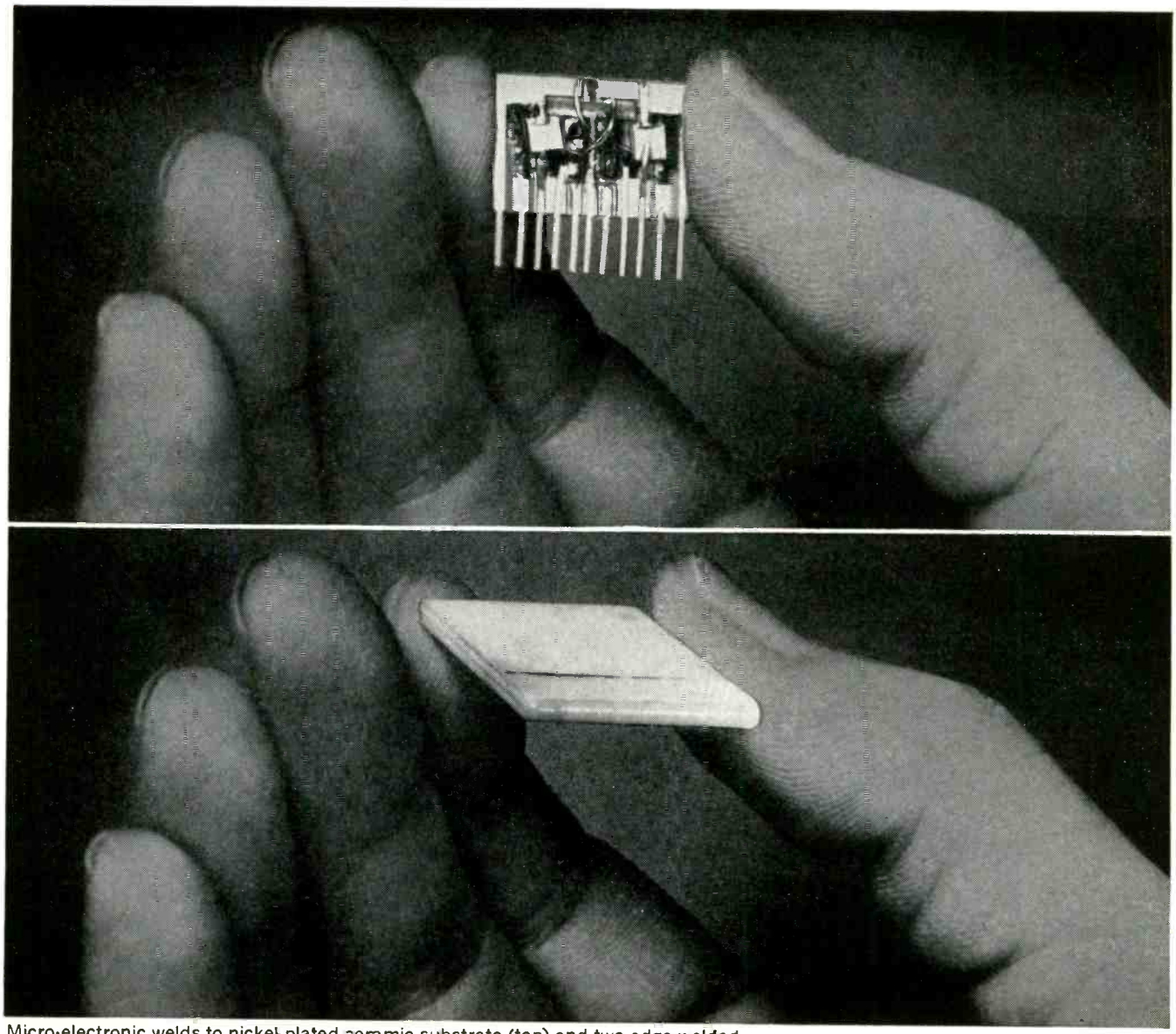
AUTOMATIC ELECTRIC

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

Circle 55 on Inquiry Card



Micro-electronic welds to nickel-plated ceramic substrate (top) and two edge-welded aluminum oxide ceramic wafers (bottom) show versatility of Hamilton-Zeiss Welders.

ELECTRON BEAM WELDING . . .
a new world of design at your fingertips

Hamilton-Zeiss Electron Beam Welders produce ultra-precise microminiature welds which set new standards of connection reliability. They also permit fabrication with difficult-to-join materials such as ceramics, refractories, and titanium. The Hamilton-Zeiss process allows designers of micro-electronic circuits and components to achieve optimum packaging density, reduced weight, and increased reliability.

The three exclusive Hamilton-Zeiss features which make these advantages possible are:

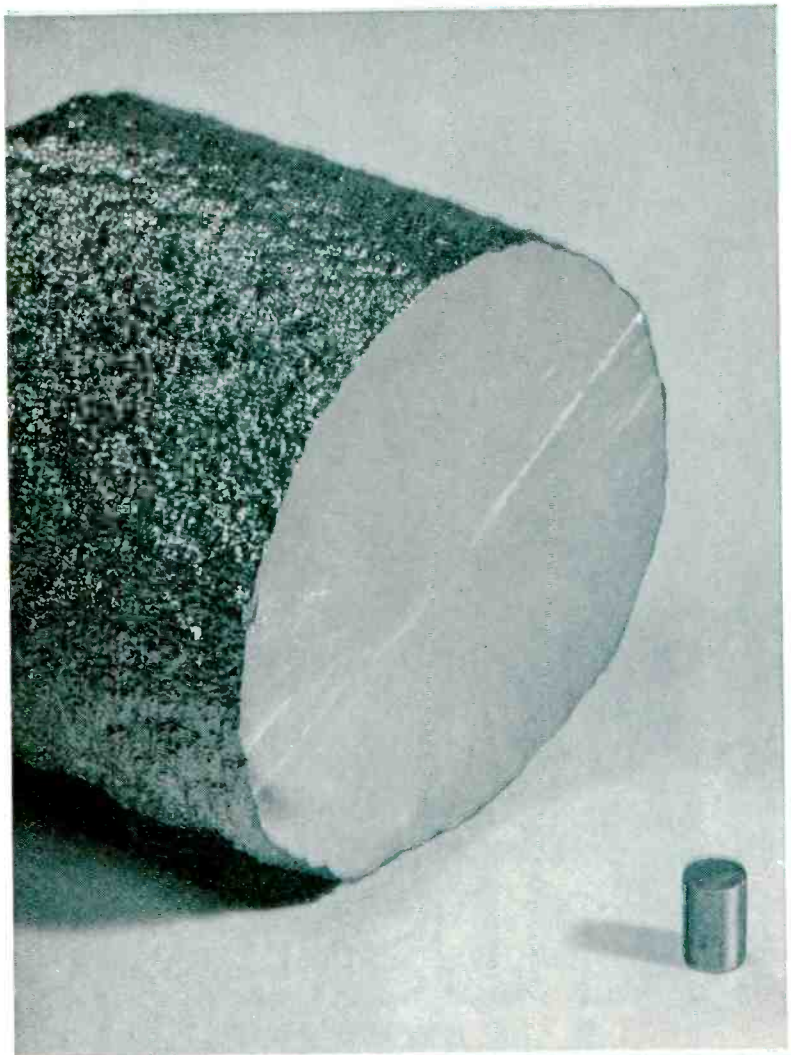
- Small beam diameter with high power density (37½ million watts per square inch).
- Optical viewing system which shows exact position of the beam on the workpiece at all times (40 mag.).
- Precise, repeatable control of beam energy, position, and penetration.

The process also permits component encapsulation and contamination-free joints of high structural integrity because the work is performed in a vacuum.

For full technical data on Hamilton-Zeiss Electron Beam Welder, write or wire: Electron Beam Systems, Hamilton Standard Division, United Aircraft Corporation, Windsor Locks, Connecticut.

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION

Three steps to rho



Specify Dope-sil* . . . for easy, consistent, on-target resistivity

If you use the Czochralski technique for growing single crystal silicon, you should consider this simple, three-step procedure for accurate, reproducible doping:

Step 1: Use nomograph to determine total atoms of dopant required.

Step 2: Select Dope-sil pellets containing the required total doping atoms. Dope-sil is the Dow Corning trademark for accurately pre-measured doping modules.

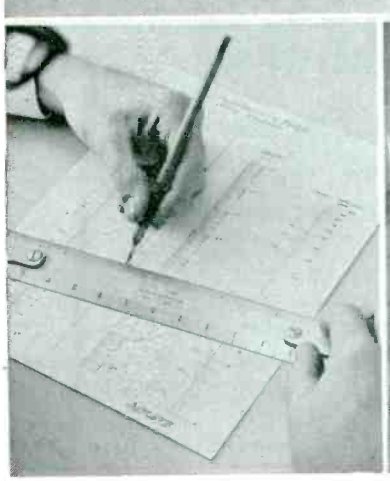
Step 3: Add the Dope-sil pellets to your prepackaged Dow Corning hyper-pure silicon crucible charge.

And that's it! No need for long, involved calculations. No need for a delicate laboratory balance, the weighing of powders, grinding . . . other involved procedures.

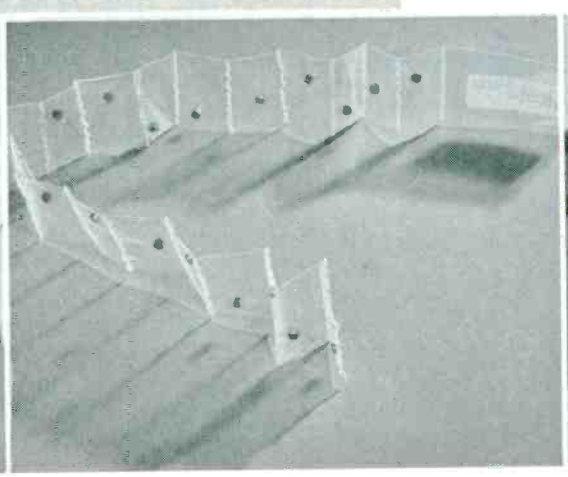
How about accuracy? Resistivities are on-target . . . within closer tolerances than the accepted industry practice.

For more information on Dope-sil, on prepackaged Dow Corning crucible charges, and copies of these easy-to-use nomographs, write Hyper-Pure Silicon Division, Dept. 4105.

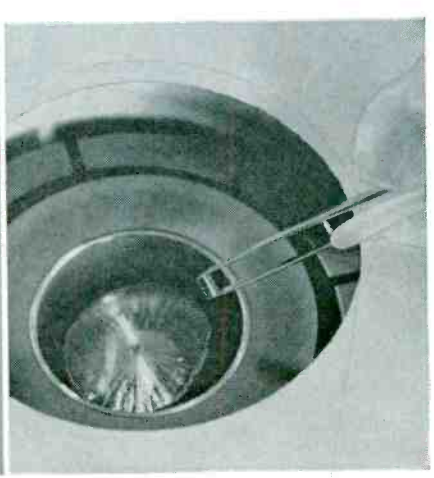
*Trademark for Dow Corning's doping modules



STEP 1



STEP 2

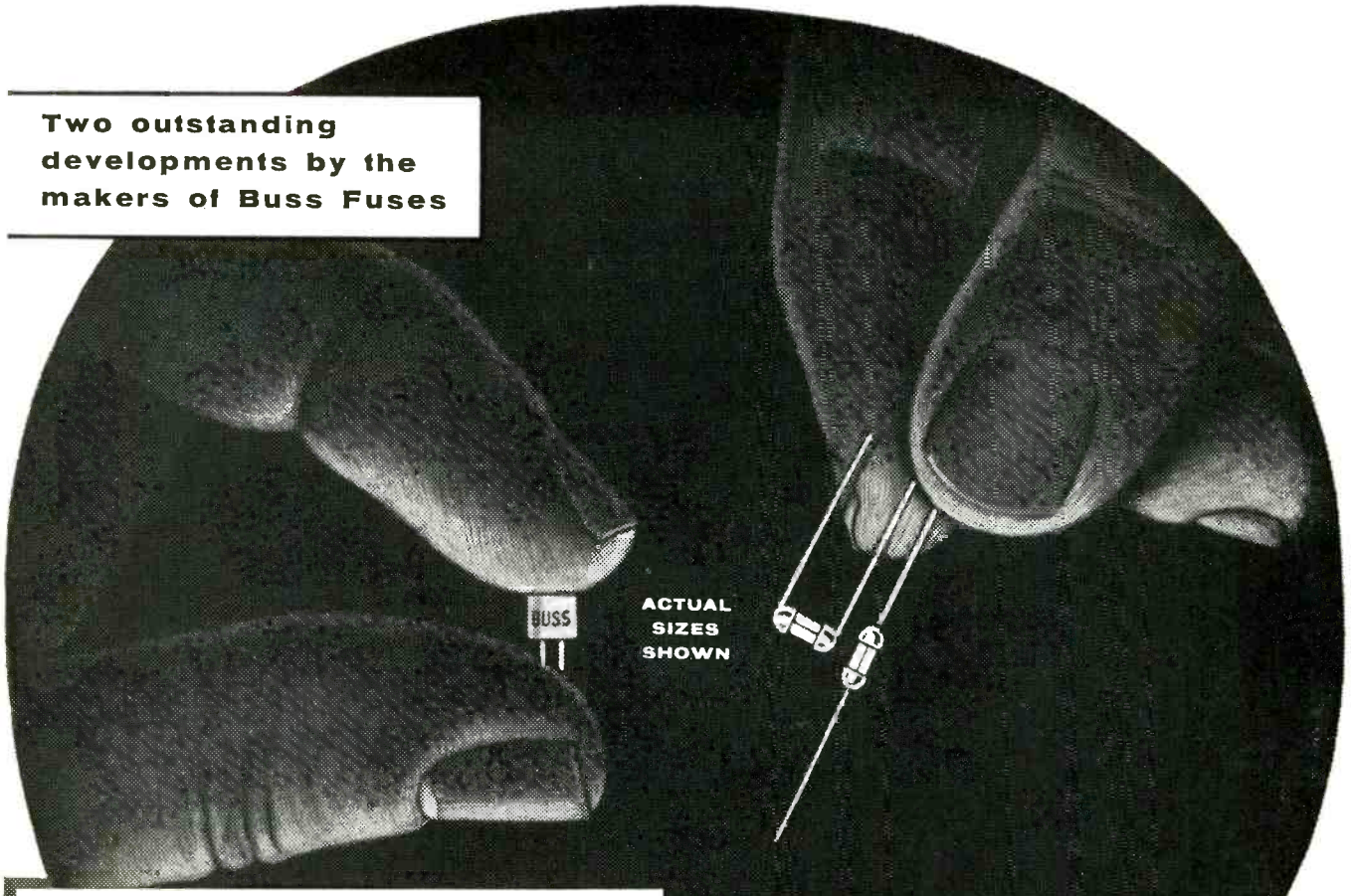


STEP 3

Dow Corning CORPORATION

HYPER-PURE SILICON DIVISION • HEMLOCK, MICHIGAN

Two outstanding developments by the makers of Buss Fuses



TRON FUSES by BUSS

Give Design Engineers New Possibilities in Sub-Miniaturization

Tron fuses are so tiny they can easily be used—to protect miniaturized devices—or gigantic multi-circuit electronic devices—without sacrifice of space.

Tron fuses are extremely reliable under high shock and vibration conditions. They are not affected by atmospheric conditions.

Tell us your design problem and let our engineers help you select the right type Tron fuse for your application.

Bussmann Mfg. Division • *McGraw-Edison Co.* • **St. Louis 7, Mo.**

DESIGNED FOR SPACE-TIGHT APPLICATIONS

Prong type GMW TRON fuses

Diameter: .270 inch; Length of Body: ¼ inch

Fully insulated ceramic body isolates fusible element from effect of dust, corrosion, and moisture.

Exploded view of GMW-HWA fuse & holder combination with AF knob.

Transparent window permits visual inspection of fusible element.

Prong type contacts mount directly into printed circuit boards.

Available in ratings from 1/200 to 5 amps. for use on circuits of 125 volts or less where available fault current would not exceed 300 amps.

The holder for BUSS GMW fuses can be *mounted on panel*—or, terminals can be inserted thru holes in *printed circuit board* and soldered into circuit.

A knob for holder is available. It makes holder waterproof from front of panel.

Pigtail type GLN & GLX TRON fuses

Body size only .140 x .300 inches

Fuse element is hermetically sealed. Fuses may be potted or encapsulated without danger of sealing material affecting operation.

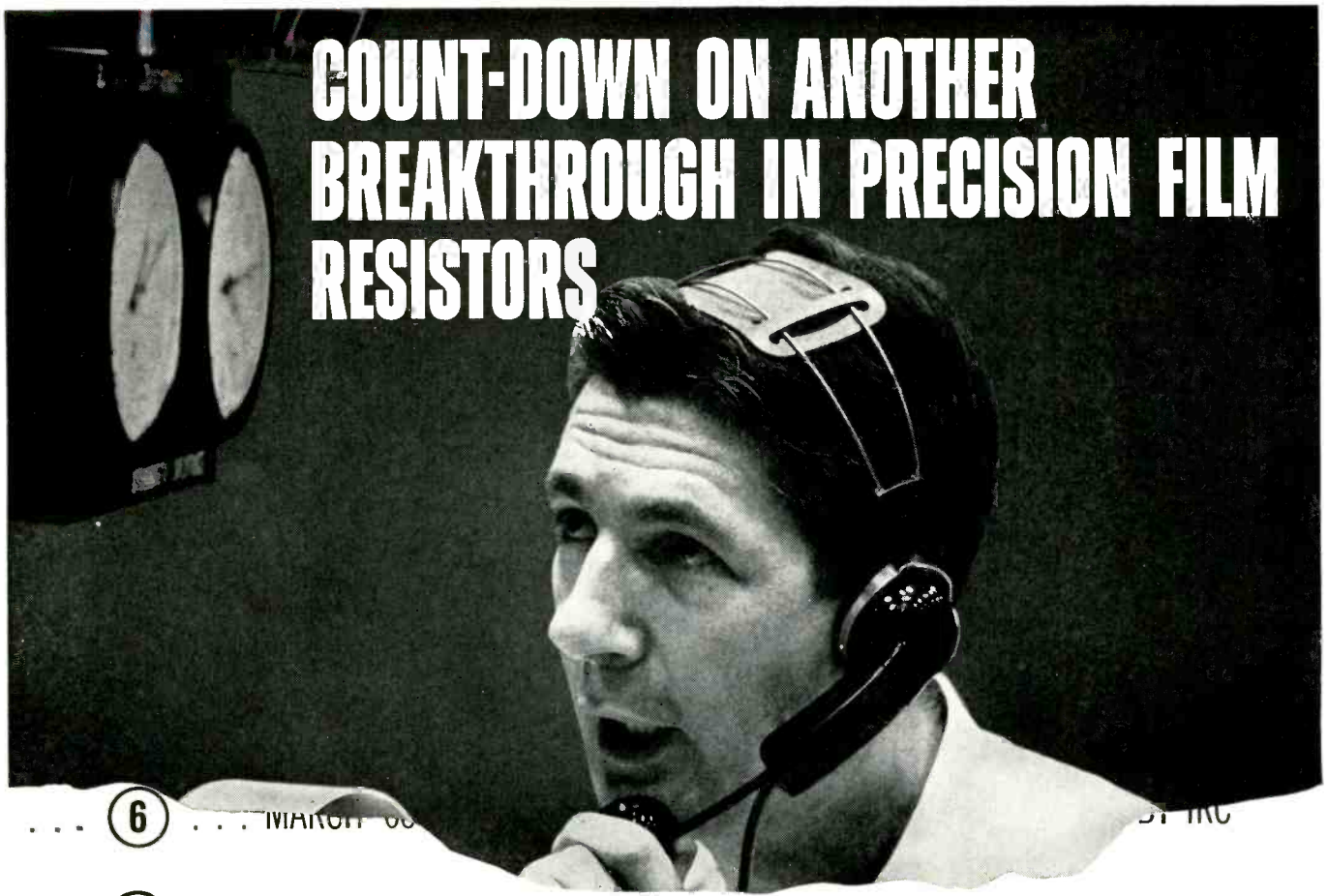
Fuses are self-protecting and operate without exterior flash or venting. They may be teamed in one capsule or replacement unit with such components as resistors or condensers.

Made with axial pigtails, or with right angle pigtails.

Available in ratings from 1/20 to 5 amps. for use on circuits of 125 volts or less where available fault current is not over 50 amps.

BUSS—THE COMPLETE LINE OF FUSES AND FUSE MOUNTINGS OF UNQUESTIONED HIGH QUALITY.

In PRECISION FILM RESISTORS if it's news, expect it first from IRC



COUNT-DOWN ON ANOTHER BREAKTHROUGH IN PRECISION FILM RESISTORS

. . . (6) . . . MARCH '60 . . . BY IRC

. . . (5) . . . AUGUST '60 MATERIALS BREAKTHROUGH WITH MOISTURE RESISTANT M-COAT BY IRC . . . STILL UNSURPASSED . . .

. . . (4) . . . FEBRUARY '61 PRODUCTION BREAKTHROUGH PROVIDES MOLDED METAL FILM AT DEPOSITED CARBON PRICES FROM IRC . . . STILL UNMATCHED

. . . (3) . . . JULY '61 MINIATURIZATION BREAKTHROUGH PROVIDES RN55 RESISTORS IN RC07 SIZE BY IRC . . . STILL EXCLUSIVE . . .

. . . (2) . . . SEPTEMBER '61 RELIABILITY BREAKTHROUGH! MINUTEMAN DOCUMENTED RELIABILITY RELEASED TO INDUSTRY BY IRC . . . STILL UNCHALLENGED

. . . (1) . . . **UNMOLDED T-0 METAL FILM RESISTORS AT DEPOSITED CARBON PRICES...** WITH EXCLUSIVE MOISTURE RESISTANT M-COAT

IRC scores again. You can now use premium performance Precision Metal Film Resistors with M-Coat for as little as 9 cents.

Revaluate your deposited carbon requirements. Premium quality Metal Film Resistors are no longer too costly for your higher performance demands. International Resistance Co., 401 N. Broad St., Philadelphia 8.

CAPSULE SPECIFICATIONS
MIL-R-10509
CHARACTERISTIC B—exceeds all requirements.
CHARACTERISTIC C—meets or exceeds all requirements except for ±50 ppm. T.C.
CHARACTERISTIC D—meets or exceeds all requirements.
CHARACTERISTIC G—meets or exceeds all performance requirements without hermetic sealing.

TEMPERATURE COEFFICIENT: within ±150 ppm.
DESIGN TOLERANCE: approximately 5 times tighter than deposited carbon (MIL-R-10509, Char. B) resistors; 20 times tighter than carbon composition (MIL-R-11) resistors.
RESISTANCE TOLERANCE: 0.5% and 1%.
COST: Same as unmolded deposited carbon resistors.

IRC *pacemaker in film resistors*

Books

Thermoelectricity: An Introduction to the Principles

By D. K. C. MacDonald. Published 1962 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N.Y. 133 pages. Price $6.50.

Book provides an understanding of the fundamental concepts and principles involved in the study of thermoelectricity in solids and of conduction in general. A helpful book to all who are interested in the subject, it is of special interest to the following two groups: first, to experimental physicists working in some field connected with electron transport; secondly, to theoreticians who might wish for a survey of thermoelectricity and related questions.

Magnetic Amplifier Analysis

By David L. Lafuze. Published 1962 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N.Y. 252 pages. Price $9.75.

Covering both half and full wave amplifiers book develops a systematic procedure for analyzing magnetic amplifier circuits in general. Thus it represents a significant contribution to a field in which the literature is largely a collection of special cases. By mastering the material contained in the book and combining it with manufacturers' data on magnetic cores, rectifiers, etc., the reader will be able to design amplifiers that will meet any given specification.

Electronic Drafting Handbook

By Nicholas M. Raskhodoff. Published 1961 by The MacMillan Co., 60 Fifth Ave., New York 11, N.Y. 400 pages. Price $14.75.

Author shows how to prepare every kind of electronic drawing: schematics, wiring diagrams, working installation drawings of electronics and communication systems and equipment, tube-base diagrams, interconnection, and outline drawings.

A section with photographs and figures introduces the beginner to the basic electronic and mechanical components. Typical drafting-room practices, techniques of drafting, and checking procedures for mechanical and circuit drawings are fully covered.

Scientific Foundations of Vacuum Technique, 2nd Edition

By Saul Dushman. Revised by members of the Research Staff, G.E. Research Laboratory, J. M. Lafferty, Editor. Published 1962 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N.Y. Price $19.75.

Book explores and incorporates the basic science of all the operations involved in the production and measurement of high and ultrahigh vacuum. It contains not only practical information on the technology, but also the background information necessary for a sound understanding of the applicability of modern techniques and future advances in the

(*Continued on page* 82)

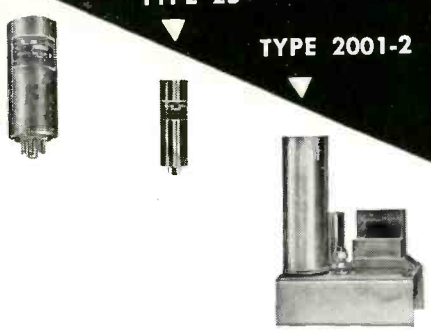
FREQ STDS.

AND PRECISION FORK UNITS 1 TO 40,000 CYCLES

TYPE 10
1⅜"x1⅜"x⅜"

This frequency standard (360 or 400 cycles) is accurate to ± 50 parts per million at 10° to 35°C. Aging has been greatly minimized.

External power of 1.4 volts at 6 microamperes powers the unit.

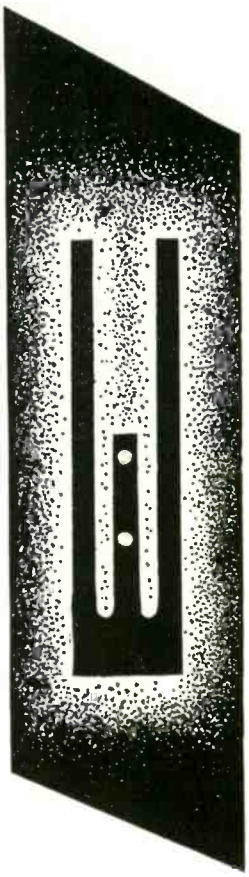


TYPE 2007-6 FREQUENCY STANDARD

Transistorized, Silicon type
Size, 1½" dia., x 3½" H., Wt., 7 oz.
Frequencies: 360 to 1000 cy.
Accuracies:
2007-6 ± 0.2% (—50° to +85°C)
R2007-6 ± .002% (+15° to +35°C)
W2007-6 ± .005% (—65° to +85°C)
Input: 10 to 30V DC at 6 ma.
Output: Multitap, 75 to 100,000 ohms

TYPE 2001-2 FREQUENCY STANDARD

Size, 3¾" x 4½" x 6" H., Wt., 26 oz.
Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at +20° to +30°C
Output: 5V at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V, at 5 to 10 ma.
Accessory Modular units are available to divide, multiply, amplify and power this unit.



TYPE K-5A FREQUENCY STANDARD

Size, 3½" x 3" x 1¾"
Weight, 1½ lbs.
Frequency: 400 cycles
Accuracy: .03%, —55° to +71°C
Input: 28V DC ±10%
Output: 400 cy. approx. sq. wave at 115V into 4000 ohm load (approx. 4W)

TYPE 25 PRECISION FORK

Size, ⅝" dia. x 2⅜"
Weight: 2 ounces
Frequencies: 200 to 1000 cy.
Accuracies:
R-25T and R-25V ± .002% (15° to 35°C)
25T and 25V ± .02% (—65° to 85°C)
For use with tubes or transistors.

INQUIRIES INVITED

For over 20 years we have made frequency standards and precision fork units for applications where consistent accuracy and rugged dependability are vital. Shown are just a few typical examples.

Some users integrate our products with instruments of their own manufacture. In other cases we develop complete assemblies to meet special needs.

You are invited to submit any problems within the area of our activity for study by our engineering staff.

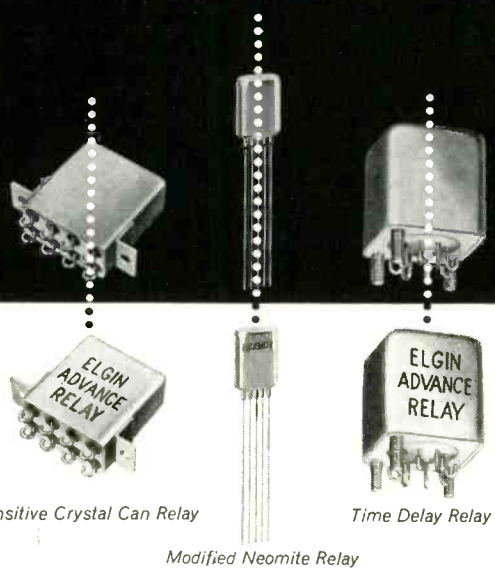
ATP

AMERICAN TIME PRODUCTS
DIV. OF BULOVA WATCH COMPANY, INC.
61-20 Woodside Ave., Woodside 77, L. I., N. Y.
WESTERN OFFICE, 234 N. LAKE AVE., PASADENA, CALIF.

Circle 61 on Inquiry Card

ELGIN ADVANCE RELAYS

new generation elgin advance relays for new applications



Sensitive Crystal Can Relay *Time Delay Relay*

Modified Neomite Relay

Here are three new generation, Elgin Advance military relays that are up-to-the-minute-state-of-the-art! Each is an improvement of an existing Elgin Advance relay, specially designed and manufactured to provide features that meet new requirements for *miniature size, low power and highest reliability.* These specifications tell important basic facts:

Sensitive Crystal Can Relay . . . VRS Series—Designed in accordance with the requirements of MIL-R-5757D. Operating Power 40MW • Vibration 20g's to 2000cps • 50g's Shock • Operate Time 10 milliseconds maximum

Modified Neomite Relay—The world's smallest relay in production—*occupies less than 1/20 cubic inch* • Vibration 30g's to 2000cps when mounted with 6B346000 bracket • Shock 50g's • Ambient Temperature Range −55°C to +85° C • Life Expectancy 100,000 operations minimum at rated load and 85°C.

Time Delay Relay—Occupies less than 1 cubic inch. Time Delay Range (seconds) .025 to 180 as specified • Input Voltage 18—31 VDC . . . 115V—400cps • Reset Time 10 milliseconds • Operating Current 20ma before contacts closed, 30ma after contacts closed.

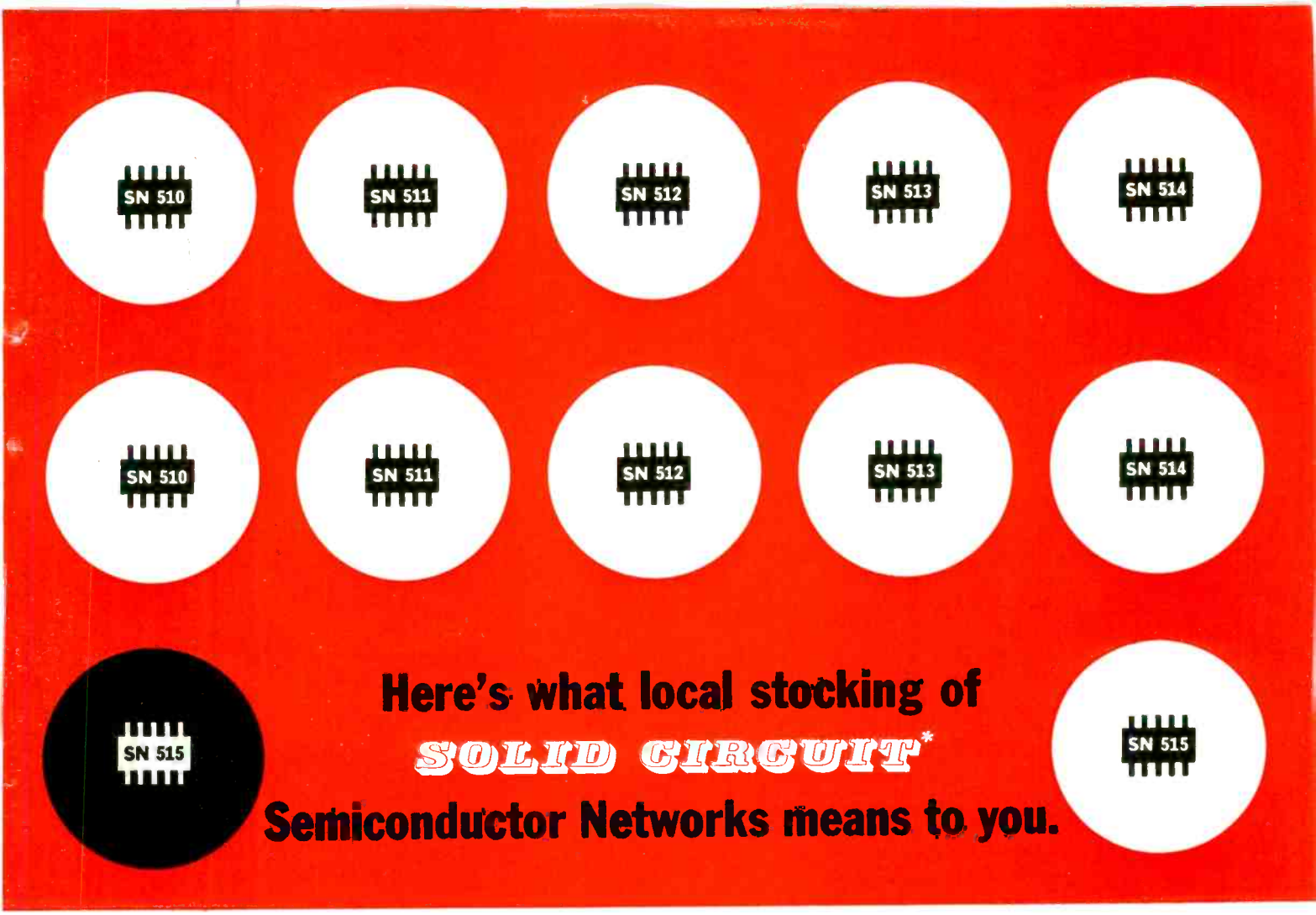
Write now for the complete specifications and other information!

controls DIVISION

2435 NORTH NAOMI STREET • BURBANK, CALIFORNIA

ELGIN INDUSTRIAL GROUP national watch company

OTHER DIVISIONS: SYSTEMS • COMMUNICATIONS • RESEARCH AND DEVELOPMENT • MICRONICS • PRECISION PRODUCTS



Here's what local stocking of SOLID CIRCUIT* Semiconductor Networks means to you.

Immediate off-the-shelf delivery means **Solid Circuit*** semiconductor networks can help you solve **today's** microminiature circuit problems **today.** ■ Your digital design ideas can be put into immediate production — with these Series 51 units — SN 510/511, Flip-Flop, Counter, Shift Register; SN 512/513, NOR/NAND; SN 514, Multiple NOR/NAND; and SN 515 Exclusive OR. ■ Series 51 local availability together with volume production assures a solid back-up for your tightest delivery schedules. ACTUAL SIZE

Get complete specifications from your authorized TI Distributor — Today.

LOW POWER DRAIN	**3-5 mw @ V_{cc} = 3 volts**
PROPAGATION DELAY	**@ +3v 70-450 nsec** **@ +6v 30-300 nsec**
POWER SUPPLY	**+3 to +6 volts**
OPERATING TEMPERATURE RANGE	**−55°C to +125°C**

*Trademark of Texas Instruments Incorporated

COMPONENTS DIVISION
CAPACITORS, DIODES,
RECTIFIERS, RESISTORS,
SEMICONDUCTOR NETWORKS,
SILICON CONTROLLED RECTIFIERS

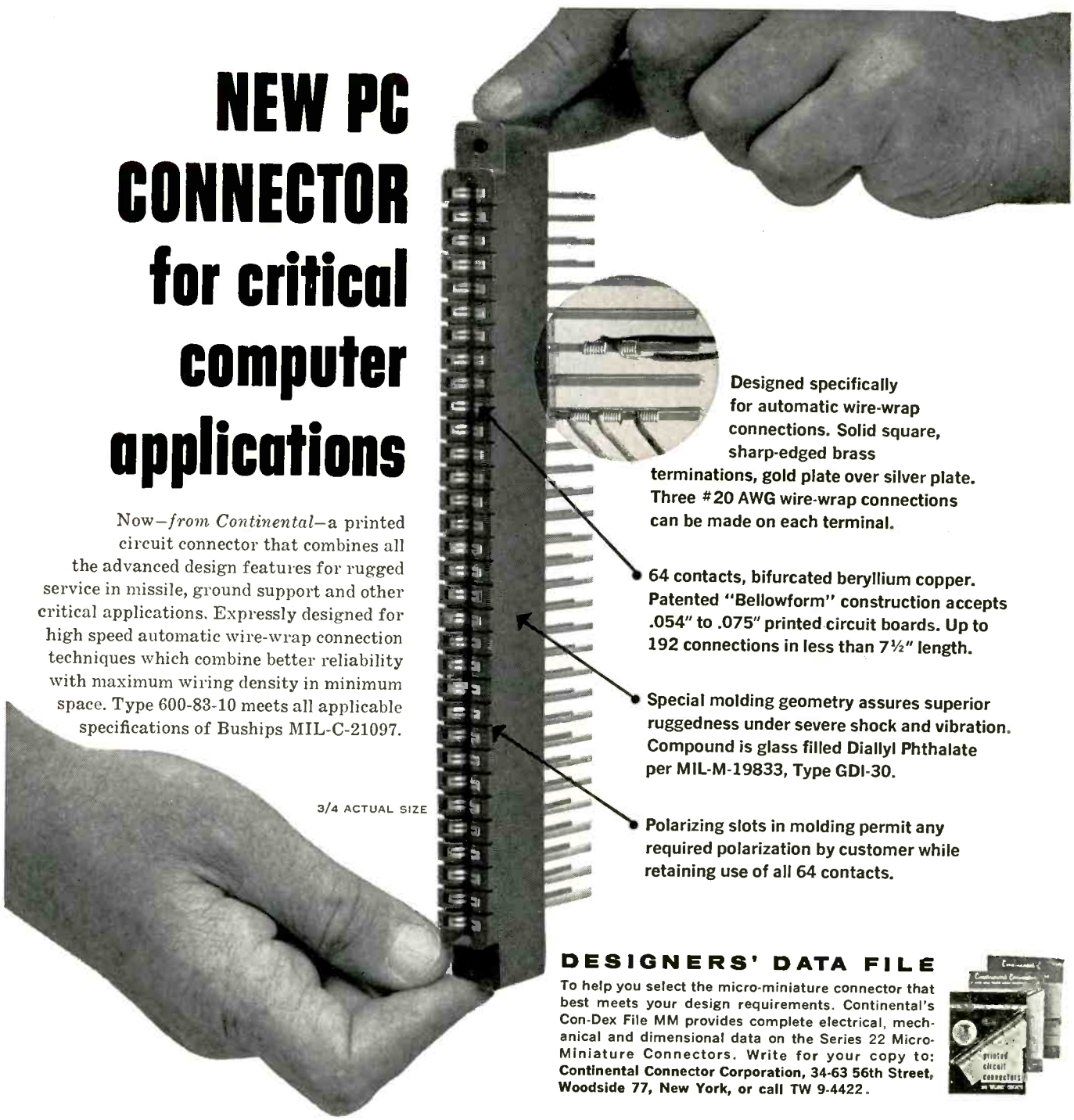
TEXAS INSTRUMENTS
INCORPORATED
13500 N. CENTRAL EXPRESSWAY
P. O. BOX 5012 • DALLAS 22, TEXAS

Circle 63 on Inquiry Card

19050

NEW PC CONNECTOR for critical computer applications

Now—*from Continental*—a printed circuit connector that combines all the advanced design features for rugged service in missile, ground support and other critical applications. Expressly designed for high speed automatic wire-wrap connection techniques which combine better reliability with maximum wiring density in minimum space. Type 600-83-10 meets all applicable specifications of Buships MIL-C-21097.



3/4 ACTUAL SIZE

Designed specifically for automatic wire-wrap connections. Solid square, sharp-edged brass terminations, gold plate over silver plate. Three #20 AWG wire-wrap connections can be made on each terminal.

64 contacts, bifurcated beryllium copper. Patented "Bellowform" construction accepts .054" to .075" printed circuit boards. Up to 192 connections in less than 7½" length.

Special molding geometry assures superior ruggedness under severe shock and vibration. Compound is glass filled Diallyl Phthalate per MIL-M-19833, Type GDI-30.

Polarizing slots in molding permit any required polarization by customer while retaining use of all 64 contacts.

DESIGNERS' DATA FILE

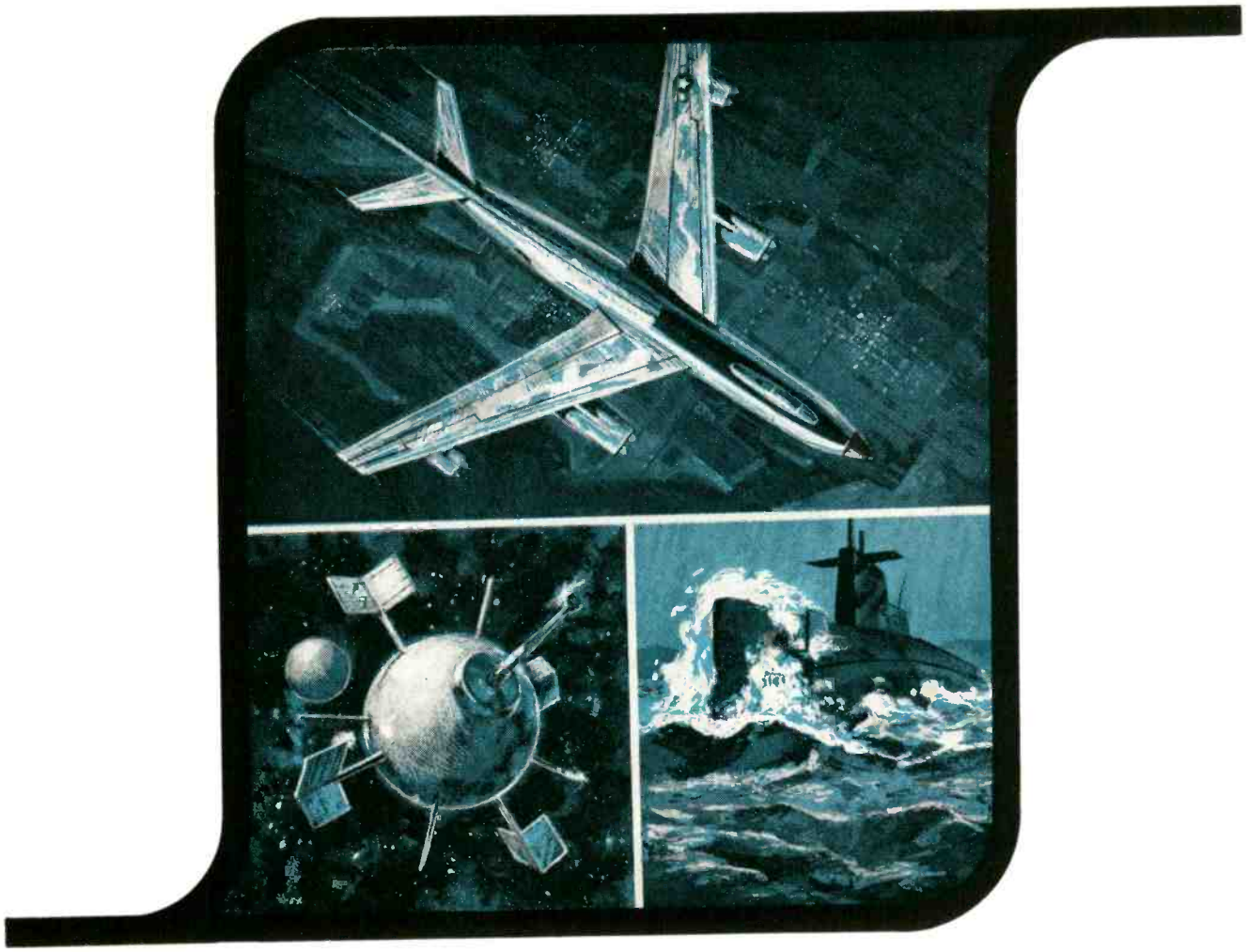
To help you select the micro-miniature connector that best meets your design requirements. Continental's Con-Dex File MM provides complete electrical, mechanical and dimensional data on the Series 22 Micro-Miniature Connectors. Write for your copy to: **Continental Connector Corporation, 34-63 56th Street, Woodside 77, New York, or call TW 9-4422.**

MICRO-MINIATURE • SUB-MINIATURE • MINIATURE • PRINTED CIRCUIT • RIGHT ANGLE PIN & SOCKET • CENTER SCREWLOCK

CONTINENTAL CONNECTORS

CONTINENTAL CONNECTOR CORPORATION • WOODSIDE 77, NEW YORK

First as a matter of record . . . SCOTCH® BRAND Instrumentation Tapes



Space a problem? Get 25% longer playing time with "SCOTCH" BRAND Thin-Coat Heavy Duty Tapes!

"More tape in the same space" tells the story of "SCOTCH" BRAND Thin Coat Heavy Duty Instrumentation Tapes! For recorders used in airborne, shipboard, or data reduction applications, wherever space is at a premium, these super-thin tapes offer 25% more playing time than tapes of standard heavy duty coating thickness; or make possible the use of smaller recorders. Yet there is improved resolution with no sacrifice of backing strength.

Special high potency oxides in a smooth .18 mil coating effect a 60% reduction from standard Heavy Duty Tape coating thickness, improve head-to-tape contact and high frequency response.

Heavy Duty "Thin Coats" have an oxide and high temperature binder formulation that minimizes rub-off, withstands temperatures from −40°F to as high as 225°F. They have approximately 1,000 times greater conductivity, last a minimum of 15 times longer than ordinary tapes. Silicone lubrication protects against head wear, extends tape life.

A choice of seven Thin Coat Heavy Duty Tapes is available, all with .18 mil oxide thickness, and polyester backing. *The* "*400*" series features long wear, excellent high and low frequency resolution. The backing: No. 490 is .65 mil, No. 491 is 1.0 mil, No. 492 is 1.5 mil. *The* "*500*" series assures sharp resolution of extremely high frequencies, with long life, smooth travel. The backing: No. 591 is 1.0 mil, No. 592 is 1.5 mil. *The* "*900*" series, for use on Mincom CM-100 and CMP-100 Recorder/Reproducers, provides ultra-smooth recording surfaces for extremely short wave length requirements. The backing: No. 991 is 1.0 mil, No. 992 is 1.5 mil.

Consult your nearby 3M representative for helpful technical details. Or write: Magnetic Products Division, Dept. MBR-52, 3M Co., St. Paul 1, Minn.

Books

(*Continued from page 76*)

production measurement, and utilization of vacua. Aside from including all of the important progress accomplished in high vacuum research since the first edition was published, extensive references to the original literature provide guides for further study in each of the areas presented.

Classical Electrodynamics

By John David Jackson. Published 1962 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N.Y. 641 pages. Price $13.00.

Offering a thorough, detailed exposition of electromagnetic theory, book provides solid foundation needed for more advanced or specialized study—and develops much of the mathematical apparatus of modern theoretical physics.

Special theory of relativity is developed in the exposition and used extensively in subsequent chapters. Book also features extensive and detailed discussion of applications to modern physics magnetohydrodynamics, Cerenkov radiation, relativistic particle motion, synchroton radiation and plasma physics.

Elements of Infrared Technology

By P. W. Kruse, L. D. McGlauchlin, and R. B. McQuistan. Published 1962 by John Wiley & Sons, Inc., 440 Park Ave., South, New York 16, N.Y. 448 pages. Price $10.75.

Book covers the nature of infrared radiation and the performance of infrared components. Each major area of the subject — generation, transmission, and detection—is treated in detail, both descriptively and mathematically. Although primary emphasis is placed on underlying theory, the book includes information on measured characteristics of specific components and materials now in use.

BOOKS RECEIVED

Synchro Engineering Specification Catalog

Available free of charge from The Bendix Corp., Montrose Div., South Montrose, Pa.

Commercial Sound Installer's Handbook

By L. G. Sands. Published 1962 by Howard W. Sams & Co., Inc., 2201 East 46th St., Indianapolis 6, Ind. 288 pages. Price $4.95

Supplement No. 1 to ARINC Report No. 306

Published by ARINC, 1700 K St.,N.W., Washington 6, D.C. Price $1.00 to non-ARINC members or subscribers.

Supplement No. 3 to ARINC Characteristic No. 521B & Supplement No. 1 to ARINC Characteristic No. 544.

Published by ARINC, 1700 K St., N.W., Washington 6, D.C. No charge.

(*Continued on page 88*)

TUNG-SOL PRESS-FIT DIODES RATED TO 30 AMPS

NEW RELIABILITY/ECONOMY IN SILICON RECTIFIERS

Now it is possible to have the advantages of the most reliable stud-mounted diodes with the convenience and economy of press-fit assembly.

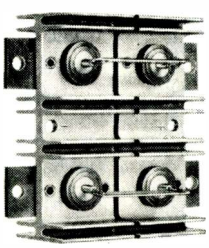
COMPACT, SMALL SIZE, INTERCHANGEABLE. Available in both polarities; one heat sink can carry more than one diode. Easily installed with hand tools or automatic machinery. Eliminate the need for mounting hardware.

RELIABILITY. Tung-Sol 30 amp press-fit silicon rectifiers are available as types 1N3659-1N3665, with ratings and characteristics as indicated below. The only press-fit diodes with welded cases and ceramic-to-metal seals to minimize leakage and resist thermal shock. Environmental testing through thousands of operational thermal cycles verifies stability of characteristics. Also available are lower current rectifiers in the same construction, types 1N3491-1N3495.

Electrically these units are the equivalent of the best available stud mounted diodes with comparable ratings. Write for complete technical information. Tung-Sol Electric Inc., Newark 4, N.J. TWK: NK193

	1N3659	1N3660	1N3661	1N3662	1N3663	1N3664	1N3665	Unit
Transient Peak Reverse Voltage.....	100	200	350	450	600	700	800	V
Repetitive Peak Reverse Voltage.....	50	100	200	300	400	500	600	V
Max. Rectified Output Current								
@ 100°C. case.....	30	30	30	30	30	30	30	A
@ 150°C. case.....	25	25	25	25	25	25	25	A
Max. Peak one-cycle Surge Current 60 cps..	400	400	400	400	400	400	400	A
Max. Full Load Reverse Current, Full Cycle average, 150°C. case.	5.0	4.5	4.0	3.5	3.0	2.5	2.0	mA
Max. Operating Temperature Range.....	———			—65°C.to + 175°C.			———	

INTEGRATED CIRCUITS. Tung-Sol supplies modular rectifier assemblies which embody the many practical features of the press-fit diodes. Typical is the single phase bridge assembly shown; from a package measuring only 1 9/16" x 3 1/4" x 3 1/2", outputs to 55 amperes are possible.



TUNG-SOL®

SALES OFFICES: ATLANTA, GA.; COLUMBUS, OHIO; CULVER CITY, CALIF.; DALLAS, TEXAS; DENVER, COLO.; DETROIT, MICH.; IRVINGTON, N. J.; MELROSE PARK, ILL.; NEWARK, N.J.; SEATTLE, WASH. CANADA: TORONTO, ONT.

the magnificent trifle

news about solders, fluxes, preforms special alloys, lead and tin products

alpha

alpha metals, inc. 56 Water Street, Jersey City, New Jersey • HEnderson 4-6778
Los Angeles, Calif. • Alpha-Loy Corp. (Div.) Chicago, Ill. • Alpha Metals, Inc. (U. K.) Ltd., London, Eng.

new bar solder cuts printed circuit joint rejects

Use of a recently developed Vaculoy® bar solder cuts printed circuit joint rejects from 1 in 500 to 1 in 5,000. The primary reason for this amazing performance is the fact that the new bar solder is significantly freer from oxide forming elements.

Here are some of the other advantages offered by Alpha Vaculoy solder:

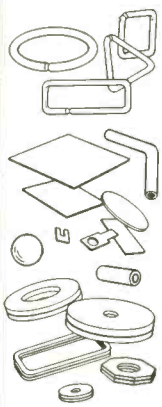
1. Substantially less dross.
2. Increased bath life.
3. Less inherent inclusions.
4. Improved wetting.
5. Brighter joints.
6. More finished units per pound.

Alpha's new Vaculoy solder was developed specifically for electronic and computer printed circuit applications. It conforms to latest revisions of Federal Specification QQS-571 and ASTM.

Its initial cost is pennies per pound more than ordinary solders, but in terms of effective joints and man-hours, Vaculoy costs appreciably less. Full information on request.

Circle 51 on Inquiry Card

automatic soldering with solder preforms

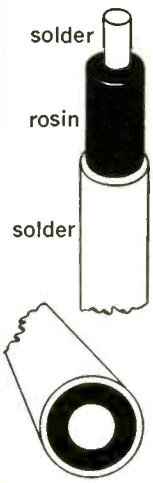


Automatic soldering requires solder preforms of controlled alloy content, size and shape. The right preforms can increase production, guarantee product precision, cut labor costs and provide stronger, smoother joints.

Alpha's experience can help you secure the correct solder preforms for every job and achieve the maximum effectiveness and economy from automatic soldering. Alpha solder preforms are available in discs, rings, spheres, washers, pellets and an almost limitless variety of forms. Both solid and flux filled forms can be supplied. The Alpha "Guide to Automatic Soldering with Solder Preforms" is yours for the asking.

Circle 52 on Inquiry Card

Cen-Tri-Core® solder...more joints per lb.



The use of Alpha Cen-Tri-Core® "energized" rosin-filled solder results in more joints per pound as well as higher quality. Here's why:

1. No rosin voids or skips.
2. No cold joints or rejects.
3. Fast-acting, non-corrosive flux provides simultaneous "wetting flow" and "take."
4. Solders to poorly plated or oxidized parts.

Cen-Tri-Core® rosin-filled solder is available in 8 flux percentages, in diameters from .010" and in all alloys of tin and lead as well as in tin-lead-silver for soldering silver fired ceramic parts. It conforms to latest revisions of Federal Specification QQS-571, Mil Std. 6872 and ASTM. Test its superiority for yourself by writing for a generous engineering sample suitable for fifty reliable connections. No cost or obligation.

Circle 53 on Inquiry Card

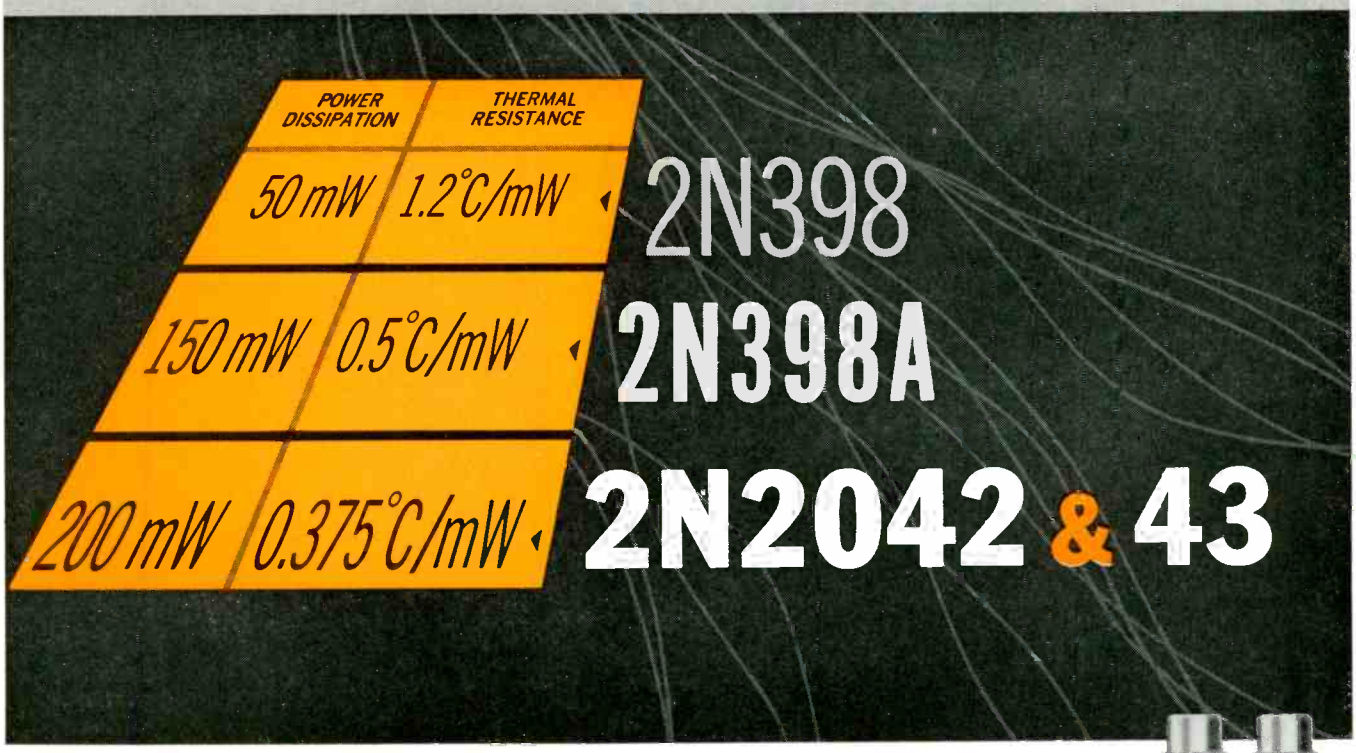
wave fluxing and foam fluxing improved with activated liquid rosin flux

Even oxidized surfaces normally resistant to soldering can now be soldered quickly, efficiently and safely with Alpha's new printed circuit flux. Its instant wetting action and excellent capillarity properties are extremely important for printed circuit dip soldering, automatic wave fluxing and installations requiring foam fluxing.

Alpha's fluxes meet all government specifications. Full information on this new series of activated liquid rosin fluxes for critical soldering applications is yours on request.

Circle 54 on Inquiry Card

The 2N398 was good . . . The 2N398A was better . . .



BUT LOOK AT THESE NEW HIGH VOLTAGE MILLIWATT TRANSISTORS FROM MOTOROLA

Whether It Has Been Five Years or Five Days Since You Selected a Milliwatt Transistor, It Will Be Worth a Few Minutes of Your Time to Read This —

Motorola's two latest PNP germanium milliwatt transistor types – the 2N2042 and the 2N2043 – offer power dissipation of 200 milliwatts . . . four times that of the 50 mW 2N398 types.

Here are devices with a minimum collector voltage of 105 volts. Here are devices whose breakdown voltages immediately suggest the answer to low power converter applications where a safeguard in voltage is desirable.

And here, in this series, is a device in a TO-5 package that dissipates *1/5 W without a heat sink* . . . an ideal unit as a driver for Nixie tubes, for power output stages, or for other high voltage applications.

Another "plus benefit" of these new devices is their maximum junction temperature of 100°C, rather than the usual 85°C of most milliwatt germanium devices. This higher operating condition – or safety factor – meets the requirements of many military equipments, as well as commercial equipment, and quality industrial applications, where temperatures of this order may not be expected but where the designer can have this extra safeguard at no extra cost.

NEW MOTOROLA 2N2042 and 2N2043 AUDIO TRANSISTORS

- 105 Volts
- 200 mW power dissipation in free air
- 200 mA
- 100°C maximum junction temperature
- Unique internal design with Quad-Mounted Substructure for greater mechanical ruggedness and high reliability
- Hermetically sealed
- Also available — 2N2042A & 2N2043A MEG-A-LIFE types with certified reliability

If you would like more information about Motorola milliwatt transistors – their design and specifications – contact your nearest Motorola District Office, or write: Motorola Semiconductor Products Inc., Technical Information Department, 5005 East McDowell Road, Phoenix 8, Arizona.

MOTOROLA
Semiconductor Products Inc.

A SUBSIDIARY OF MOTOROLA, INC.

1820

5005 EAST McDOWELL ROAD • PHOENIX 8, ARIZONA

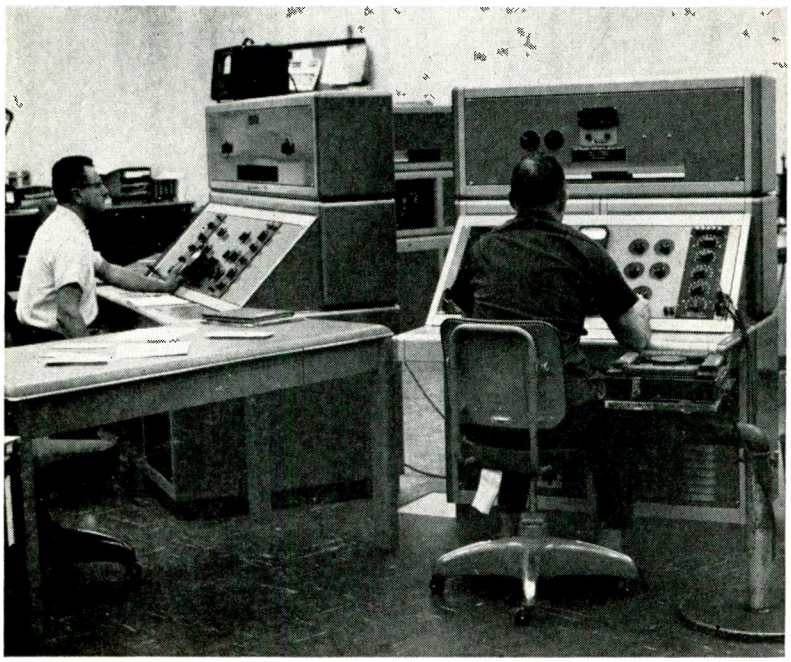
LOOK TO MOTOROLA FOR ALL YOUR SEMICONDUCTOR REQUIREMENTS

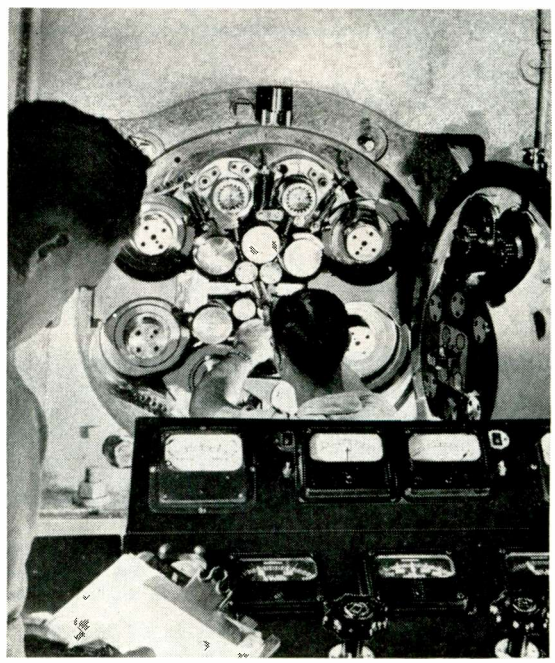
POWER TRANSISTORS • MESA SWITCHING & AMPLIFIER TRANSISTORS • MILLIWATT TRANSISTORS • SILICON RECTIFIERS • ZENER DIODES

Circle 68 on Inquiry Card

New steels are born at Armco

For High Frequency Components Armco Thin Electrical Steels Offer Extra Advantages of Selectivity and Consistent Uniformity





Three different Armco grades with consistently high magnetic quality enable you to achieve most effective performance of 400 to 2000 cps and higher frequency apparatus.

Optimum design and lowest cost demand magnetic materials precisely suited to requirements. That's why Armco produces three different thin electrical steels in a range of thicknesses. You are offered a unique combination of magnetic and physical properties. These include exceptionally high permeability, low hysteresis loss, high lamination factor, and minimum interlaminar loss. You can also select a type and thickness that most effectively meet your specific requirements.

Armco TRAN-COR® T—Non-oriented grade; 7 and 5 mil thicknesses

Armco ORIENTED T—Oriented grade; 6, 5, 4, 2, and 1 mil thicknesses

Steel — For Better Electrical Apparatus

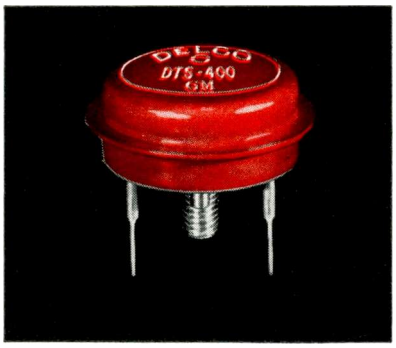
Armco ORIENTED TS—Super-oriented with very high permeability; 4 mil thickness

The obvious advantage of consistent uniformity is assured with Armco Thin Electrical Steels for two reasons. Properties are fully developed at the mill. Special processing rigidly controls magnetic quality and size tolerances.

Use the exceptional magnetic properties and extra advantages of Armco Thin Electrical Steels to improve the performance and cut costs of high frequency equipment you manufacture. Write us for complete information. **Armco Division, Armco Steel Corporation, 2022 Curtis Street, Middletown, Ohio.**

ARMCO **Armco Division**

400 V_{CE}



IT'S HERE! A SILICON POWER TRANSISTOR WITH V_{CEO}, V_{CBO} AND V_{CES} OF 400 VOLTS

DELCO RADIO'S ACHIEVEMENT PERMITS DRAMATIC SIMPLIFICATION OF CIRCUIT DESIGN

IDEAL FOR MILITARY USE WHERE HIGH TEMPERATURE & VOLTAGE TRANSIENTS ARE ENCOUNTERED

VIRTUALLY IMMUNE TO FAILURE IN 24VDC AND 28VDC SWITCHING AND REGULATOR CIRCUITS

PERMITS OPERATION FROM 110 AND 220 AC LINE SOURCES FOR POWER CONTROL APPLICATIONS

SAMPLES AVAILABLE. CALL OR WRITE:

Collector diode voltage V_{CBO} .....400 Volts	Base current (continuous).....1 Amp.
Emitter diode voltage V_{EBO} .....5 Volts	Maximum junction temperature.....150°C
Emitter current (continuous).....5 Amps.	Minimum junction temperature.....—65°C

PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
I_{CBO}	V_{CBO} = 400V T = 125°C	—	—	10	ma
I_{CEO}	V_{CEO} = 400V	—	—	10	ma
I_{CES}	V_{CES} = 400V	—	—	10	ma
R_{Sat}	I_C = 5 amp, I_B = 1 amp	—	0.15	0.25	ohm
h_{FE}	V_{CE} = 5V, I_{CE} = 5A	10	—	—	
R_{th}		—	0.5	—	°C/watt

Electrical characteristics @ T_C = 25°C unless otherwise noted.

Union, New Jersey
324 Chestnut Street
MUrdock 7-3770

Detroit, Michigan
57 Harper Avenue
TRinity 3-6560

Santa Monica, California
726 Santa Monica Blvd.
UPton 0-8807

Syracuse, New York
1054 James Street
GRanite 2-2668

Chicago, Illinois
5750 West 51st Street
POrtsmouth 7-3500

General Sales Office: 700 E. Firmin, Kokomo, Indiana, GLadstone 2-8211—Ext. 500

Division of General Motors

DELCO RADIO
DEPENDABILITY
RELIABILITY

Circle 70 on Inquiry Card

Books

(Continued from page 82)

RCA Power Tubes-Booklet PG-101E

Published 1961 by Electron Tube Div., Radio Corp. of America, Harrison, N.J. 46 pages. Optional list price $0.75.

Lunar Exploration and Spacecraft Systems

Edited by R. Fleisig, E. A. Hine & G. Clark. Distributed by Plenum Press, Inc., 227 West 17th St., New York 11, N.Y. 224 pages. Price $10.00.

Mark 2 Standard Frequency Selection System, ARINC Specification No. 410

Published 1961 by Aeronautical Radio, Inc., 1700 K St., N.W., Washington 6, D.C. 58 pages, paperback. Price $1.00.

Your Future in Electronic Engineering

By Sol Levine. Published 1961 by Popular Library Inc., Educational Book Div., 355 Lexington Ave., New York 17, N.Y. 159 pages, paperback. Price $0.50.

Radio Frequency Interference

By R. B. McDowell. Published by McDowell Electronics, Inc., 105 Forrest St., Metuchen, N. J. Price $3.50.

Proceedings of the Eigth National Symposium on Reliability & Quality Control

At Washington, D.C. Jan. 9-10-11, 1962. Published 1962 by the Editorial Dept. of the IRE, 1 East 79th St., New York 21, N.Y. 549 pages, paperback. Price $5.00 while in print.

Transistorized Voltage Regulators, Application Guide, ICE-254

Published 1961 by Semiconductor and Materials Div., RCA, Somerville, N. J. 12 pages. Price $0.25.

TRANSLATIONS

Photoneutron Method of Determining Beryllium

By Kh. B. Mezhiborskaya. Translated from the Russian. Available from Consultants Bureau Enterprises, Inc., 227 West 17th St., New York 11, N.Y. Price $12.50.

Electromagnetic Waveguides and Cavities

Translated from the German. Published by Pergamon Press, Inc., 122 East 55th St., New York 22, N.Y. 656 pages. Price $13.50.

Computing Methods, Volumes 1 & 2

By I. S. Berezin and N. P. Zhikov. Translation Editor, A. D. Booth. Translated from the Russian. Vol. 1—447 pages, $10.00. Vol. 2—533 pages, $12.50.

Photoelectrets and the Electrophotographic Process

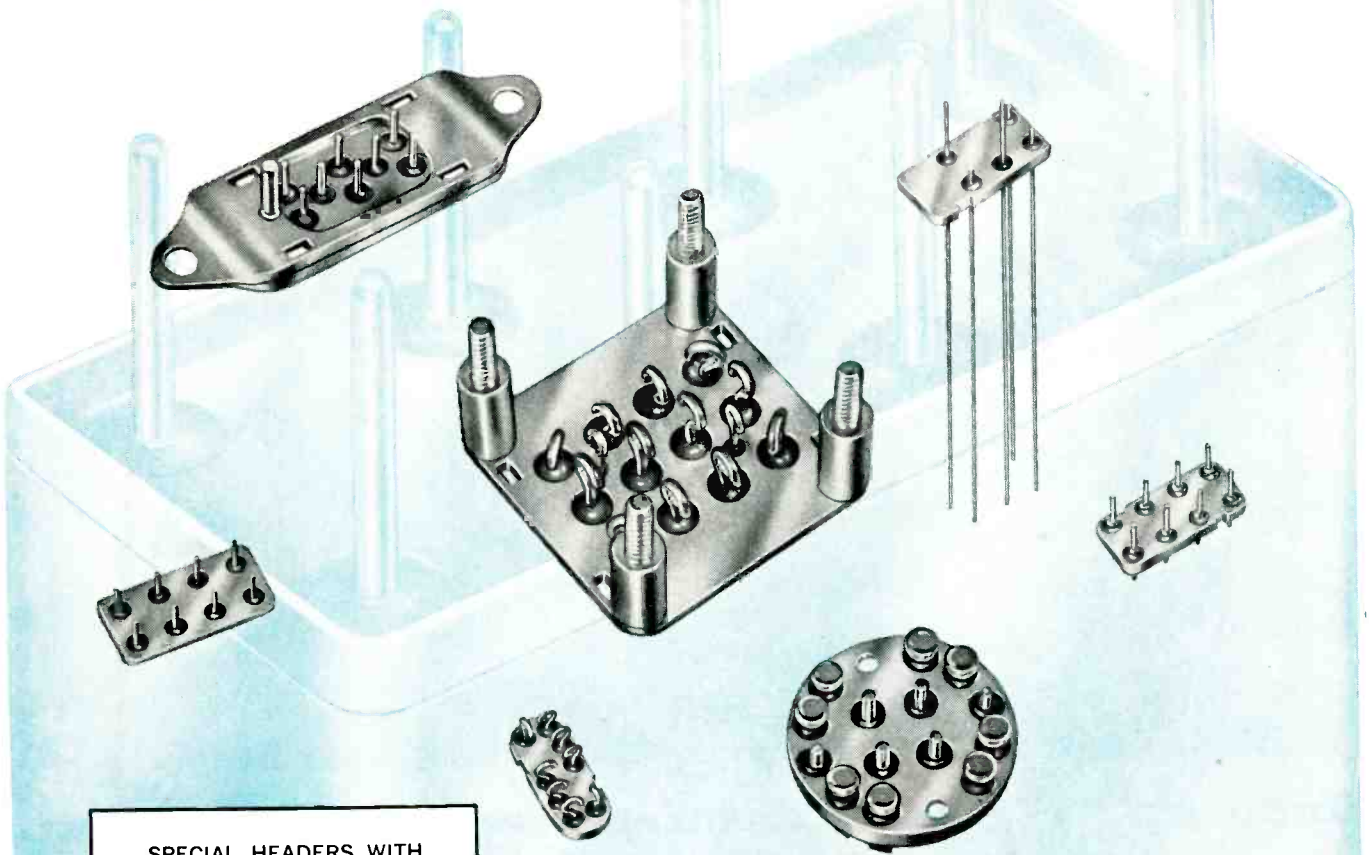
Translation of a Soviet book by V. M. Fridkin & I. S. Zheludev. Available from Consultants Bureau Enterprises, Inc., 227 West 17th St., New York 11, N. Y. 200 pages. Price $12.50.

Transatom Bulletin, Vol. I, No. 1, Dec. 1960

Translations of nuclear literature collected by the European Atomic Energy Community, the United Kingdom Atomic Energy Authority and the United States Atomic Energy Commission. Published monthly, the Bulletin is available on a subscription basis from "Transatom," c/o Euratom, 51 rue Belliard, Brussels, Belgium, at $8.00 a year, air mail $16.00.

Relay News from ELECTRICAL INDUSTRIES

NEW E-I HERMETICALLY SEALED RELAY HEADERS



SPECIAL HEADERS WITH SPADED WIRE LEADS
can be supplied at lower cost than with round type leads

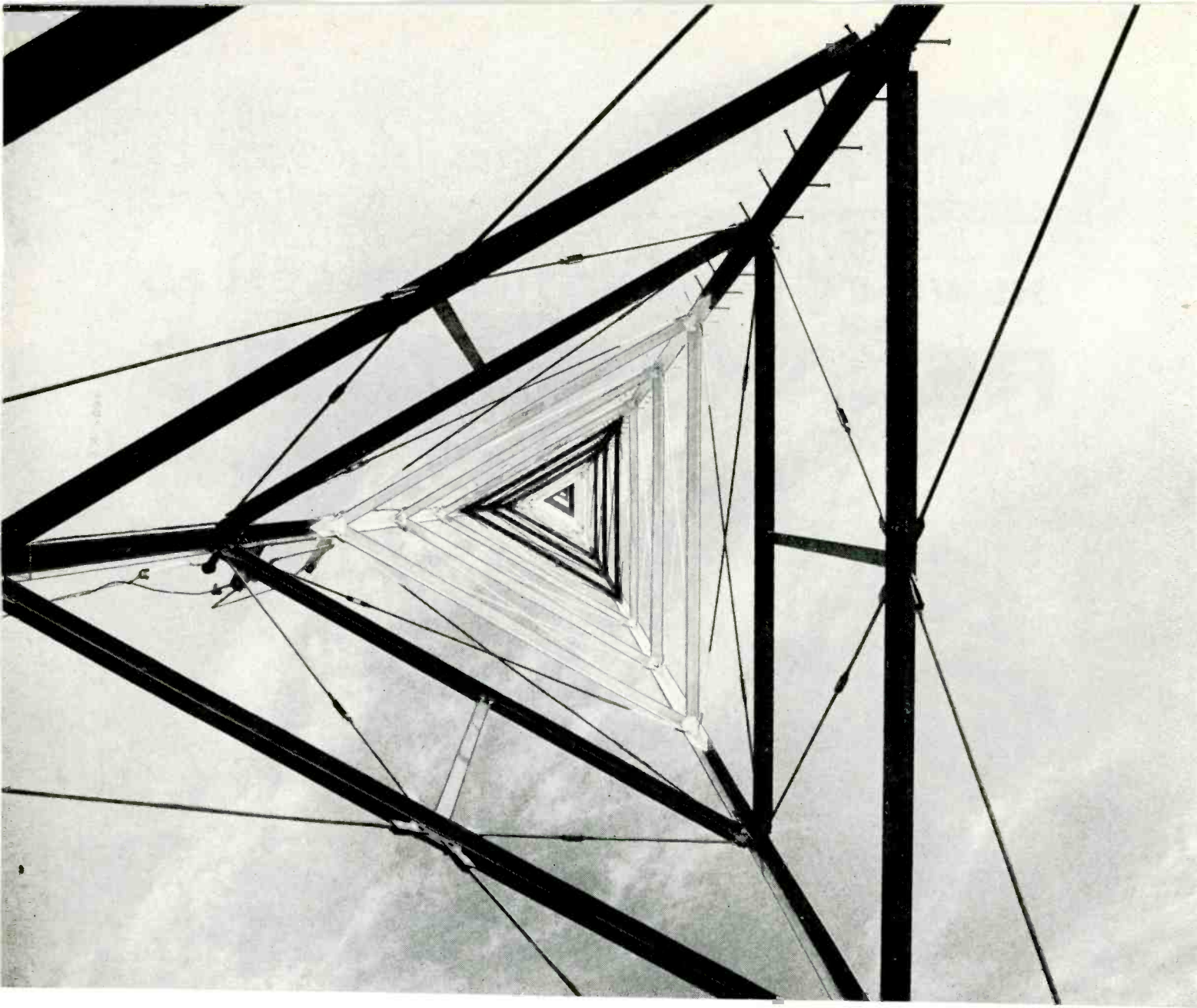
MODULAR TYPE HEADER SUITABLE FOR HELI-ARC WELDING

- Available in a Wide Range of Configurations
- Header Thicknesses down to .050 Inches
- Increased Torque Resistant Wire Available

E-I headers, featuring ruggedized compression seals, can be produced to your exact specifications to meet practically any type of relay application. In many cases, standard E-I tooling can be utilized at a considerable saving. Brazed contacts are available if required. Standard finishes available include hot solder dipped, electro-tin, nickel and gold. Special plating on order. Call or write E-I for quotations on your specific requirements!

ELECTRICAL INDUSTRIES
691 CENTRAL AVENUE, MURRAY HILL, NEW JERSEY
Division of Philips Electronics & Pharmaceutical Industries Corp.

PATENTED IN CANADA, NO. 523,390; IN UNITED KINGDOM, NO. 734,583; LICENSED IN U. S. UNDER NO. 2561520



Inductrol® regulator assures precise voltage control at station KCSJ's television transmitter

G-E INDUCTROL REGULATOR

- Automatic voltage control accuracy of ±1%
- Smooth, stepless voltage control
- Drift-free controls
- 100% overload capacity up to 1 hr.
- 98 to over 99% efficiency
- Load power-factor, frequency, and temperature compensated
- No harmful waveform distortion
- Rugged, compact design

Circle 77 on Inquiry Card

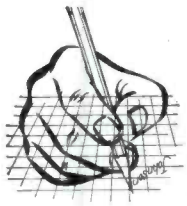
In the transmitter building at the base of television station KCSJ's 977-foot tower near Pueblo, Colorado, a General Electric Inductrol voltage regulator precisely controls input to all electronic equipment. Before the Inductrol regulator was installed, frequent line-voltage drops of as much as 25 volts had to be corrected manually. Now, according to Chief Engineer Kenneth Renfrow, "The Inductrol regulator automatically holds our input range within two volts and has functioned 28 months without control adjustment, or maintenance. It can't be beat for our type of operation."

A General Electric Inductrol regulator will benefit *your* operation, too. Designed on the inherently simple and reliable *induction* principle, Inductrol regulators can be used to hold fluctuating voltage to precise limits or to provide a variable voltage output from a relatively constant supply. Applications include radar, communications equipment, rectifiers, computers, laboratory equipment, and many others.

For full information, call your G-E Sales Engineer. Or write for Bulletins GEA-7690 and GEC-1450C to General Electric Company, Section 457-09, Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC



Time after time engineers specify Johnson components!

Whatever the choice . . . a tiny, color-coded nylon Collet Knob – or a flexible shaft coupling to handle both axial and angular shaft offset . . . time and time again design and development engineers specify Johnson components!

Manufacturers of more than 5,000 items for all segments of the electronic industry, Johnson offers a wide line of connectors; tube sockets; air variable capacitors; plus the hardware items described at the right. In addition, a complete line of heavy duty RF components is available for broadcast transmitting, RF heating, antenna phasing, and other commercial applications.

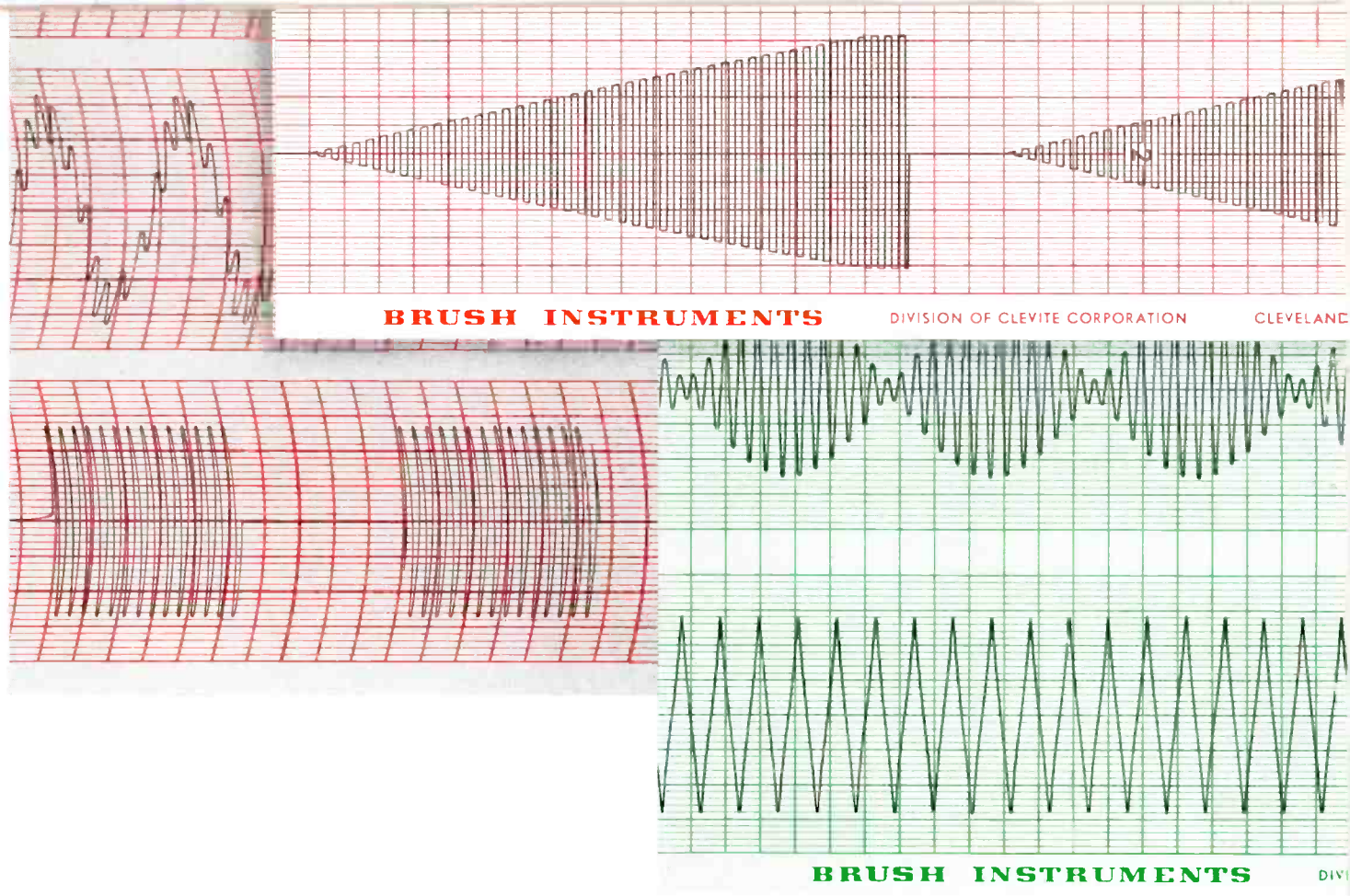
Equipment in this line includes: fixed and variable inductors; antenna phase sampling loops; isolation filter inductors; tower lighting filters; feed-thru bowl insulators; static drain chokes; RF contactors; and heavy duty make-before-break switches. For information on the Johnson RF component line, write for Catalog 560 – for detailed specifications on all other Johnson electronic components, write today for our newest components catalog!

E. F. JOHNSON COMPANY
3021 TENTH AVENUE S.W. • WASECA, MINNESOTA

INSULATORS—Low loss, high-voltage breakdown in either steatite or porcelain. High quality with heavy nickel-plated brass hardware – suitable for exposed applications. A complete line for immediate delivery from stock includes: Thru-panel Bushings and Insulators; Antenna Strain and Feeder Types; Cone and Stand-off Insulators; Lead-in Bushings; and Feed-Thru Bowl Assemblies.

PILOT LIGHTS – Over 47 separate assemblies immediately available from parts distributors throughout the country for original equipment or in-the-field replacement. Continuous indication neon types; models for high and low voltage incandescent bulbs; standard or wide angle glass; and lucite jewels. Specials, including types meeting military specifications, also available in production quantities. Detailed specifications listed in Pilot Light catalog 750 a – write today for your copy.

COLLET KNOBS AND DIALS – Rugged molded nylon body – fresh, modern styling – available in 13 colors. For 1/8" shafts – ideal for laboratory or test instruments. Four types: Basic Knob; Pointer Knob; Dial Knob, 10-0/180°; and Dial Knob, 10-0/270°. Other Knobs and Dials – Distinctive matching line of knobs and dials with brass inserts. Molded of tough, black phenolic to MIL-P-14 specifications. Metal dials and pointers are etched, satin aluminum, anodized finish. **SHAFT COUPLINGS** – Flexible and rigid types for coupling 1/4" to 1/4"; 1/4" to 3/8"; and 3/8" to 3/8" shafts. **FLEXIBLE SHAFTS** – 3" to 6" lengths for out of line or up to 90° angular control. **PANEL BEARINGS** – For use on 1/4" shafts and panels up to 3/8" thick. **CRYSTAL SOCKETS AND CERAMIC PLUG** – For low capacity, high voltage and high temperature operation. Glazed steatite, Grade L-4 or better. DC-200 impregnated. **RF CHOKES** – High quality construction. For 1.7 to 30 mc range and VHF.



it pays
to use

Engineered chart paper

Engineered details make the difference in chart paper. And only Brush chart paper is engineered as an integral part of the rigid specifications for today's Recording Systems. Imitation papers cannot match the special processing of paper surface to minimize pen friction; the unusual dimensional stability and tensile strength; the perfect alignment attained by winding and then rewinding the rolls; the carefully controlled printing conditions. Eliminate chance—specify *Brush* and you'll know your records will be accurate, permanent, easily read and reproduced. Stocks available from branches and sales representatives throughout the U. S. and Canada. Write for samples of actual tracings on Brush Chart Paper. Ask for "Brush Engineered Recording Supplies".

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

Next month

ELECTRONIC INDUSTRIES

5TH ANNUAL ALL-REFERENCE ISSUE and Directory of Electronic Products

REFERENCE SECTION

To facilitate reader usage, an entire new format has been adopted in this year's issue. Reference material has been sectionalized into ten major topic areas . . . each containing up-to-the-minute information. These areas are:

- The Electronic Industry (Overall Review)
- Tubes and Semiconductor Devices
- Data Processing and Automation
- Measurement and Test Equipment
- Electromechanical Components
- Electronic Components
- Materials and Hardware
- Military Electronics
- Space Electronics
- Microwave

CONTINUING FEATURES

The following popular features have been revised and updated:

- The 1962 Receiving and Power Tube Interchangeability Chart
- High-Power & High-Frequency Semiconductor Device Specifications
- The 1962 Military Electronic Procurement Guide
- Coming Events Calendar

DIRECTORY SECTION

Over 6000 electronic companies and the more than 3100 products produced are listed. Product-headings guide the reader to specific interest items.

Many other information-packed sources such as New Electronic Standards, Marketing Statics, Government Contract Award data and Roster of Associations Serving the Electronic Industries.

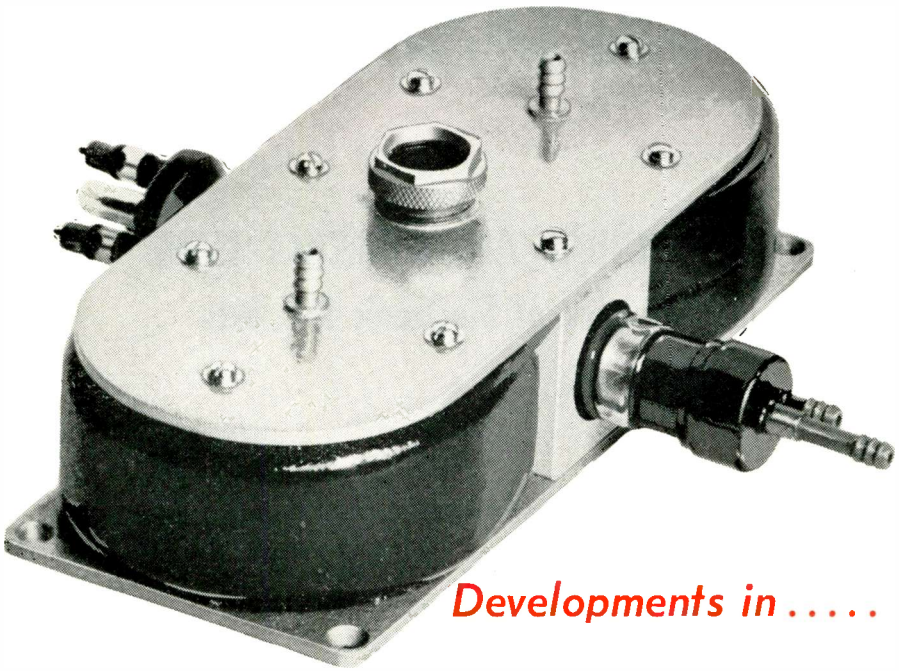
Watch for these coming issues:

***JUNE**
All-Reference Issue

***AUGUST**
Annual WESTERN Issue

***NOVEMBER**
Annual MICROWAVE Issue

Fig. 1: Floating drift tube klystron capable of 30-50 watts CW at 8 millimeters.



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Developments in . . . . .

Klystron Oscillators

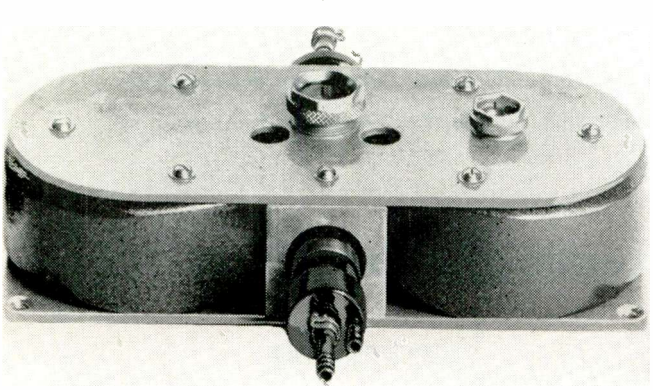
IN an outline of the present state-of-the-art, let's refer to history, uses, and technical problems encountered in developing tubes in the millimeter wave range.

Floating Drift

The first mathematical analysis of the floating drift tube klystron also gave detailed results obtained from a demountable tube operating at 3 GC.[1] Later, Bell and Hillier[2] developed a floating drift tube klystron operating at 35 GC with a minimum power output of 10 watts.

Klystrons have been produced with CW power ranging from 50 watts at 20 GC to 0.5 watts at 80 GC. The majority of these are floating drift tube klystrons with efficiencies higher than that of reflex oscillators. Experimental klystrons have produced power in excess of 95 watts at 35 GC.

Fig. 2: This 4 mm drift tube type harmonic generator produces 500 mw.



Millimeter wave tubes have found uses as microwave spectroscopy signal sources, maser pumps, power sources for CW or pulsed doppler radars, harmonic generators, local oscillators, in gas plasma experiments, commercial moisture detectors, inter-satellite communication systems, ballistic missile to ground telemetry systems, as well as signal sources for antenna design experiments.

Originally, floating drift tube construction was used to obtain high efficiency without using two or more cavities. Only one cavity was necessary, with a field free drift space provided by a drift tube of the correct dimensions, supported in the cavity's center. This design provides higher efficiency and power handling capability than any equivalent reflex oscillator, Also, hysteresis and mode distortion are almost completely absent.

Present Design

Now, a Pierce gun is used. This has a current density of more than 50 amp/cm^2. In 8 mm tubes, a beam of more than 100 ma passes through a tunnel 0.022 inches in diameter. This beam has a current density at the cathode surface of only 0.6 amp/cm^2.

The output frequency is not critically dependent on any voltages applied to the tube; therefore, the output can be frequency stabilized. It has been feasible to stabilize the frequency within 2 KC at 35 GC.

The cavity is water cooled, so, the frequency drift with ambient temperature is small. A 50°C change produces only a 2 MC change; the change is less than 2 MC for a 1°C change in water temperature.

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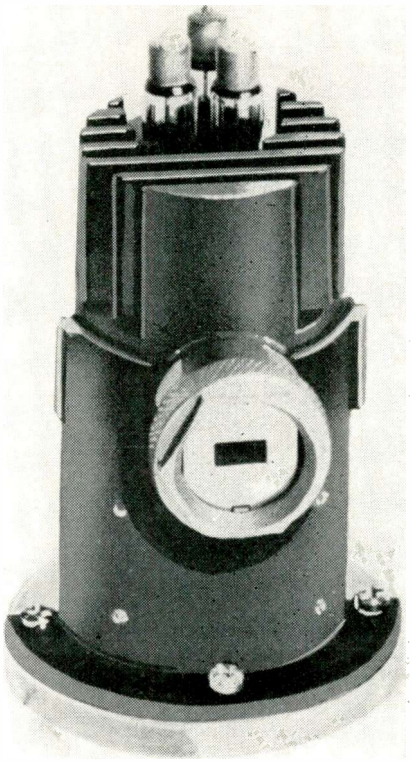

Fig. 3: An 8 mm reflex klystron designed as an extremely stable pump source for parametric amplifiers. Two hundred milliwatts are available over a 200 MC tuning range.

Within the last seven years, stepped-up R & D has produced advances and breakthroughs in power generation and measurement problems above 20 GC. As a result, reflex and floating drift tube klystrons now operate beyond 80 GC.

for Millimeter Waves

To make these klystrons, many new methods were developed. For millimeter tubes, the cavity and drift tube dimensions are extremely small; a change of 0.0001 inch in dimensions can result in a frequency change of 40 MC at 35 GC. Cold hobbing techniques are used to guarantee uniform dimensions. As a result, it is now possible to produce fixed frequency tubes operating within 20 MC of each other at 35 GC.

Millimeter tubes are exhausted and "baked out" at 700°C until the pressure is less than 5 x 10^{-7} mm of Hg. To enable these high "bake out" temperatures to be reached, the tube is enclosed, during the exhausting process, in an evacuated container. This is necessary because the tube's metal envelope becomes slightly porous at these temperatures; and, if inert gasses were used instead of a vacuum, they could diffuse through the envelope. This porosity is, in fact, a considerable advantage because it enables a much higher degree of "out-gassing."

Tubes at specific spot frequencies in the band 33 to 37 GC are often required; therefore, methods were developed which allow cavities to be adjusted after manufacture. The demand for a tunable version led to a tube capable of giving a minimum output of 10 watts CW over a tuning range of 1500 MC at center frequencies of 35 ± 2 GC.

After developing these tubes, an urgent demand arose for CW power greater than 1 watt at 6 mm. A floating drift tube klystron, capable of giving greater than 2 watts at this frequency, was the result. Power output from some of these tubes has been in excess of 3.5 watts. Experiments show output improvement is possible by gun modification. This will allow tubes to be made with a minimum output of 10 watts. A tunable version has an output in the order of 2 watts, tunable over approx. 2,000 MC. The methods used in these tubes are similar to those used in the 8 mm tubes.

Requirements for power at 4 mm led to some experiments with a tube scaled from 6 mm. As a result, a harmonic generator has been developed. This tube uses a floating drift tube 8 mm cavity to bunch the beam, which is then used to excite a 4 mm cavity. These tubes produce 4 mm r-f power greater than 0.5 watts CW. A version can be varied ± 750 MC.

Reflex Klystrons

Besides the floating drift tube klystrons, reflex oscillators have been developed. These are capable of giving greater than 250 mw output at 8 mm; 1 w at 12 mm. Between these values, tubes can be made without difficulty which are capable of giving at least 250 mw, with a minimum 500 MC tuning range. These air cooled tubes are also baked at 700°C during exhaust. This insures long life and low noise operation.

References

1. Chodrow, *Proc. IRE*, Jan. 1953.

2. Bell, R. M., and Hillier, N., "An 8mm Klystron Power Oscillator," *Proc. IRE*, Sept. 1956, pp. 1155-9.

COVER STORY

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In the many words that have been written about accelerometers the mounting aspect has been mentioned only lightly. If the mounting is not given careful consideration, however, the response may be severely distorted. In extreme cases, the readings may even be worthless.

Effects of Mounting on

ACCELEROMETERS have received widespread editorial coverage. However, one aspect in their application has been explored only lightly. It is the effect of the mount on which the accelerometer is fastened. Under some conditions the mount responds so that the accelerometer response faithfully reproduces the input acceleration. Under other conditions the mount distorts the accelerometer response, making the recording worthless.

Except for a few instances, in which the shock motion of a body can be studied by direct comparison of its position with respect to a stationary reference, most of the shock measurements are made with accelerometers mounted on the body under study. The accelerometer may be an electromechanical type which converts its response into an electrical signal. Or, it may be a strictly mechanical type which scribes its intelligence on a rotating surface or on a stationary surface, in which case only the peak response is obtained. In either case, almost all the pickups are single-degree-of-freedom systems (Fig. 1). Their performance can be determined from the differential equation:

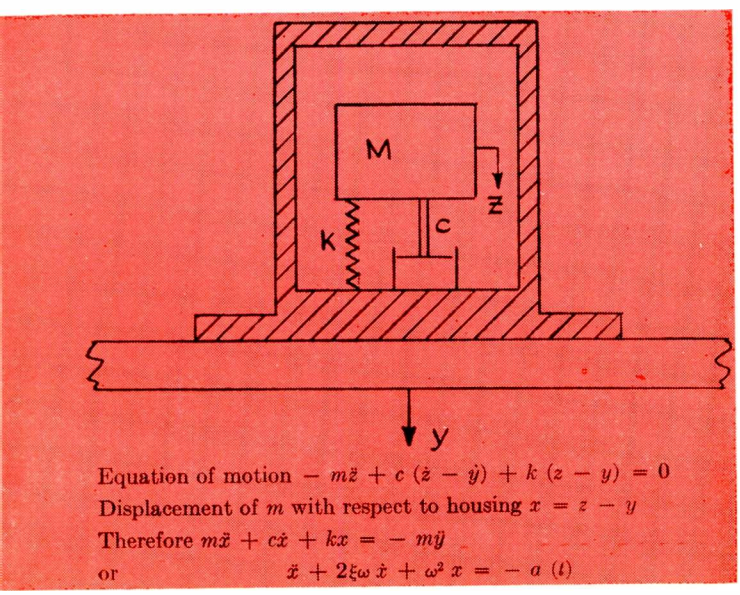
$$\ddot{x} + 2\xi\omega\dot{x} + \omega^2 x = -a(t) \qquad (1)$$

Many types of pickups such as the piezoelectric, bonded strain gages, and the mechanical gages do not employ damping. Others such as the unbonded strain gage, do, but find it difficult to provide effective damping in the high shock range. In these instances Eq. 1 reduces to:

$$\ddot{x} + \omega^2 x = -a(t) \qquad (2)$$

The remarks in the remainder of this article are devoted to the pickups whose motion is described by Eq. 2.

Fig. 1: Almost all accelerometers are like the one shown here. The basic equations associated with this unit are listed below.



Basic Equation and Solution

Eqs. 1 and 2 have been studied by many authors. Refs. 1 and 2 are two of the more complete works in this field. In applying the results of these works, it is tacitly assumed that the structure on which the accelerometer was mounted faithfully transmitted the shock input to the accelerometer. This assumption is not valid for all loading situations. This can be seen by considering the case when the natural period of the plate is longer than the rise time of the input pulse. Here, the plate does not have a frequency response high enough to follow the input pulse and, hence, distorts it. Since the accelerometer is mounted to the plate, it can only respond to the motion of the plate. Therefore, it cannot give an accurate indication of the input shock. However, knowing the characteristics of the accelerometer mount, as well as the accelerometer, we can determine, with some degree of accuracy, the actual input to the structure under study.

A typical application is given in Fig. 2. For many situations the equivalent mechanical system is given by Fig. 3. The resulting equations of motion are:

$$\left.\begin{aligned} m_m\ddot{x}_m + (k_m + k_a)x_m - k_a x_a &= k_m y \\ -k_a x_m + m_a\ddot{x}_a + k_a x_a &= 0 \end{aligned}\right\} \qquad (3)$$

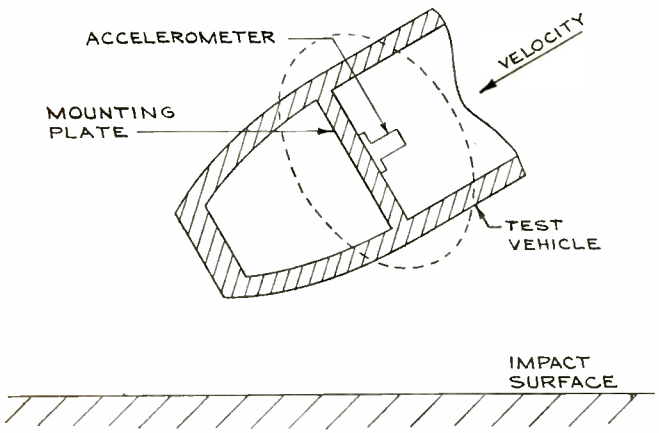


Fig. 2 (l.): Sketch illustrates a typical accelerometer application.

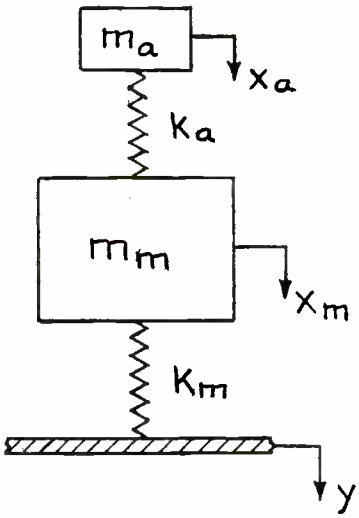


Fig. 3 (r.): The equivalent mechanical system of the encircled portion of Fig. 2.

Accelerometer Response

The response of the accelerometer is the displacement of its mass, x_a, relative to its housing. In the case under study, the housing is firmly attached to the plate. Therefore, the accelerometer response, x, is given by:

$$x = x_a - x_m$$

The acceleration indicated by the accelerometer in Laplace form is:

$$\bar{a}_a = -\omega_a^2 \bar{x} = \frac{\omega_a^2 \omega_m^2 \bar{a}}{p^4 + \left[\omega_m^2 + \omega_a^2\left(1 + \frac{m_a}{m_m}\right)\right]p^2 + \omega_a^2 \omega_m^2} \quad (4)$$

In all practical cases with which we are concerned in acceleration measurements, the ratio m_a/m_m is very small. (Some of the newer piezoelectric pickups weigh only a few grams.) For the case under study, assume that this ratio is 0.01.

In order to study Eq. 4, it is necessary to assume an input acceleration. A pulse that has proven quite useful is the half-sine pulse shown in Fig. 4. The time solution to Eq. 4 is:

$$a_a = \frac{A\,\omega_m^2\,\omega_a^2\,\omega_i}{(\omega_i^2 - \omega_m^2)(\omega_a^2 - \omega_m^2)(\omega_i^2 - \omega_a^2)} \left[\frac{\omega_i^2 - \omega_a^2}{\omega_m}\sin\omega_m t + \frac{\omega_a^2 - \omega_m^2}{\omega_i}\sin\omega_i t - \frac{\omega_i^2 - \omega_m^2}{\omega_a}\sin\omega_a t\right] \quad (5)$$

for $t > \frac{\tau_i}{2}$

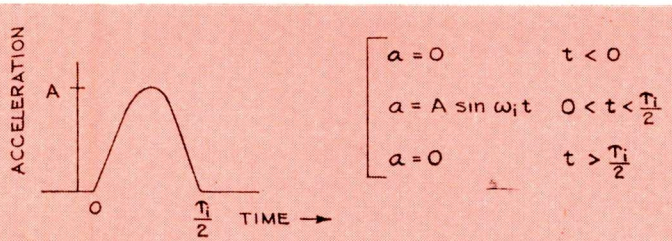
$$a_a = \frac{A\,\omega_m^2\,\omega_a^2\,\omega_i}{(\omega_i^2 - \omega_m^2)(\omega_a^2 - \omega_m^2)(\omega_i^2 - \omega_a^2)} \left[\frac{\omega_i^2 - \omega_a^2}{\omega_m}\left\{\sin\omega_m t + \sin\omega_m\left(t - \frac{\tau_i}{2}\right)\right\} - \frac{\omega_i^2 - \omega_m^2}{\omega_a}\left\{\sin\omega_a t + \sin\omega_a\left(t - \frac{\tau_i}{2}\right)\right\}\right] \quad (6)$$

Interpretation of Results

At first glance Eq. 5 and 6 appear hopelessly complex. However, by taking limiting cases some insight into the behavior of the system can be obtained. Table 1 presents this study.

In establishing the relationships of Table 1 it was necessary to assume that one of the 3 frequencies involved was considerably higher than the other two

Fig. 4: A half-sine pulse input with the associated math.

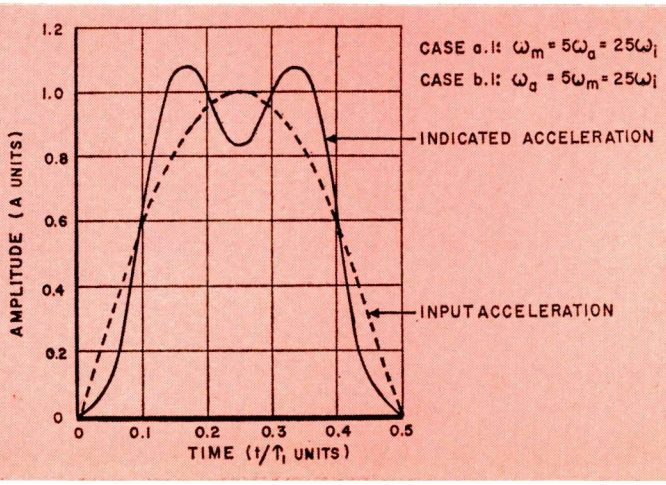


LaPlace transform of input pulse.

$$\bar{a} = \int_0^\infty a(t)\,\epsilon^{-pt}\,dt = \int_0^{\frac{\tau_i}{2}} A \sin\omega_i t\,\epsilon^{-pt}\,dt$$

$$\bar{a} = \frac{A}{p^2 + \omega_i^2}\left[1 + \epsilon^{-p\frac{\tau_i}{2}}\right]$$

Fig. 5: Input acceleration is reproduced for cases a. 1 & b. 1.



Accelerometer Mountings

and, in turn, a second frequency was considerably higher than the third, i.e.,

$$\omega_1 >> \omega_2 >> \omega_3, \text{ or } n_1 = k_1 \omega_2 = k_2 \omega_3$$

where k_1 and k_2 are large positive numbers and $k_2 >> k_1$. Several calculations were made using Eq. 5 and 6 with the arbitrarily chosen parameters of $k_1 = 5$ and $k_2 = 25$. The values were chosen smaller than the above assumptions to determine the variations produced. The results are shown in Table 2. Plots of the above cases are presented in Figs. 5 through 7. The situations considered are related to realistic conditions in Table 3.

From Table 2 we see that for the a.2 and b.2 cases, the frequency restrictions are not as severe as indicated by the analysis. For the frequency conditions chosen, the indicated velocity changes were within 1% of the actual. For cases a.1 and b.1, the indicated peak acceleration was 8% greater than the actual, and the resulting pulse shape was considerably distorted (Fig. 5). For cases c.1 and c.2, the indicated velocity change was 6% greater than that indicated by the analysis.

Concluding Remarks

From the preceding analysis, we see that the effect of the mount is very important. It must be considered in planning and analyzing shock measurements. As a minimum effort, the important frequencies of the mounting surfaces should be determined from either shock or vibration inputs. Before complete quantitative analyses on the effects of the mounting can be made, a large number of numerical solutions to Eq. 5 and 6 are required. The effects of different pulse shapes also should be determined.

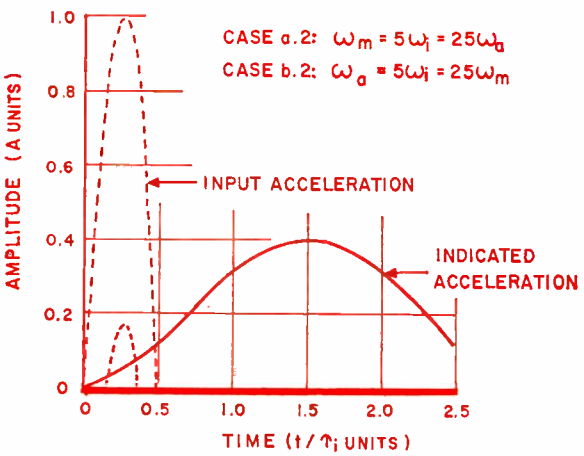


Fig. 6: Indicated acceleration is not the same as input for cases a. 2 & b. 2.

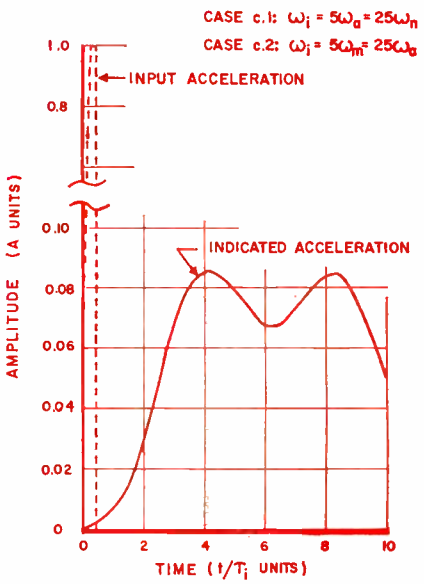


Fig. 7: Cases c.1 & c. 2 do not follow the input acceleration.

Table 1

Case	Freq. Relationship	Output		Remarks
a.1	$\omega_m >> \omega_a >> \omega_i$	$a_a = A \sin \omega_i t$	$0 < t < \frac{\tau_i}{2}$	Input reproduced exactly.
		$a_a = 0$	$t > \frac{\tau_i}{2}$	
a.2	$\omega_m >> \omega_i >> \omega_a$	a_a is very small	$0 < t < \frac{\tau_i}{2}$	Max. indicated acceleration divided by accelerometer natural frequency equals velocity change of input pulse.
		$(a_a)_{max.} = \omega_a \Delta V$	$t > \frac{\tau_i}{2}$	
b.1	$\omega_a >> \omega_m >> \omega_i$	$a_a = A \sin \omega_i t$	$0 < t < \frac{\tau_i}{2}$	Input reproduced exactly.
		$a_a = 0$	$t > \frac{\tau_i}{2}$	
b.2	$\omega_a >> \omega_i >> \omega_m$	a_a is very small	$0 < t < \frac{\tau_i}{2}$	Max. indicated acceleration divided by *plate* circular natural frequency equals velocity change of input pulse.
		$(a_a)_{max.} = \omega_m \Delta V$	$t > \frac{\tau_i}{2}$	
c.1	$\omega_i >> \omega_a >> \omega_m$	a_a is very small	$0 < t < \frac{\tau_i}{2}$	Same as b.2.
		$(a_a)_{max.} = \omega_m \Delta V$	$t > \frac{\tau_i}{2}$	
c.2	$\omega_i >> \omega_m >> \omega_a$	a_a is very small	$0 < t < \frac{\tau_i}{2}$	Same as a.2.
		$(a_a)_{max.} = \omega_a \Delta V$		

Nomenclature

$a(t)$ = instantaneous acceleration input pulse.
a_a = acceleration indicated by accelerometer.
c = damping coefficient.
k_a = spring constant of accelerometer.
k_m = equivalent spring constant of mount.
m_a = mass of accelerometer.
m_m = equivalent mass of mount.
t = time.
x_a = displacement of accelerometer mass.
$\dot{x}_a$ = differential with respect to time of x_a.
$\ddot{x}_a$ = differential with respect to time of $\dot{x}_a$.
ΔV = velocity change of input pulse.
ξ = ratio of actual damping to critical = $C/2\sqrt{mk}$.
$\tau_i/_2$ = duration of input half-sine pulse.
ω = circular natural frequency.
ω_a = circular natural frequency of accelerometer.
ω_i = equivalent circular natural frequency of input pulse.
ω_m = circular natural frequency of mount.
y = input displacement.

References

1. Frankland, J. M., "Effects of Impact on Simple Elastic Structures," David Taylor Model Basin Report No. 481.
2. Levy, S. and Kroll, W. D., "Response of accelerometers to Transient Accelerations," *Journal of Research of National Bureau of Standards,* Volume 45, No. 4, October 1950, Research Paper 2138.
3. Gardner, M. F. and Barnes, J. L., "Transients in Linear Systems," Volume 1, 1942, New York, *Wiley.*
4. Carslaw, H. S. and Jaeger, J. E., "Operational Methods in Applied Mathematics," First Edition 1941, *Oxford University Press.*

Table 2

Case	a.1	a.2	b.1	b.2	c.1	c.2
ω_m equal to	25 ω_i	25 ω_a	5 ω_i	ω_m	ω_m	5 ω_a
ω_i equal to	ω_i	5 ω_a	ω_i	5 ω_m	25 ω_m	25 ω_a
ω_a equal to	5 ω_i	ω_a	25 ω_i	25 ω_m	5 ω_m	ω_a
Peak a_a	1.08 A	0.99 $\omega_a\Delta V$	1.08 A	0.99 $\omega_m\Delta V$	1.06 $\omega_m\Delta V$	1.06 $\omega_a\Delta V$
Peak a_a (from Table 1.)	A	$\omega_a\Delta V$	A	$\omega_m\Delta V$	$\omega_m\Delta V$	$\omega_a\Delta V$

Table 3

No.	Typical Impact Situation	Typical Values $\tau_i/_2$ Imp. Dur.	f_i equiv.	f_m	f_a	Remarks
1	a. Shock Wave phase of Water Entry b. Hard Target Impact of Bombs	20 μs	25,000 CPS	5,000 CPS nose plates	1000 CPS mechanical accelerometer	Case c.2—Accelerometer response greatly reduced; however, a measurement of velocity change can be obtained from the peak indication (Fig. 7 and Table 2).
2	a. Shock Wave phase of Water Entry b. Hard Target Impact of Bombs	20 μs	25,000 CPS	1000 CPS plate near ctr. of bomb	5,000 CPS Usable range of 25 KC crystal gage	Case c.1—Same remarks as No. 1.
3	a. Soft Target Impact of Bombs b. Water Entry of Streamlined Bombs c. Aircraft Ejection d. Torpedo-Submarine Impact e. Wooden Carrier Deck Impact	20 ms	25 CPS	725 CPS Medium Freq. Mount	125 CPS Low Freq. Mech. accel. used for high sensitivity	Case a.1—Accelerometer indicates acceleration with approx. an 8% error (Fig. 5 and Table 2).
4	Same as No. 3	20 ms	25 CPS	125 CPS Low Freq. Mount Char. of Aft sections	725 CPS mechanical accelerometer. Higher sensitivity than No. 1	Case b.1—Same remarks as No. 3.
5	a. Steel Carrier Deck Impact b. Some rough handling situation c. Medium Target Impacts	1/2 ms	1000 CPS	200 CPS Medium Frequency Cushioning System	5000 CPS High Freq comp. to be protected from shock	Case b.2—Shock sensed by component reduced by 60% (Fig. 6). If component is an accelerometer, accurate determination of velocity change can be obtained.
6	Same as No. 5	1/2 ms	1000 CPS	5000 CPS High Freq. Mount	200 CPS Low Freq. large components	Case a.2—Same remarks as No. 5.

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Chemicals for the Electronic Industries

More and more, disciplines are merging to advance technology. The chemical industry, once just a supplier, is now a full research partner in advancing solid-state electronics. Here's what it is doing.

EVER since the transistor's advent, the electronic industry has faced endless challenges to produce smaller and more sensitive components with new peaks of precision and performance. Meeting these demands has required a new relationship between electronic and chemical manufacturers—one in which the chemical industry becomes the research partner of its electronics counterpart.

If we were to take a single "starting point" in assaying the influence of chemistry on the electronics revolution it would probably be hydrofluoric acid (HF). The etching of semiconductors, the cleaning of metal tube parts, the etching of TV tube faces prior to application of phosphors, and the etching of quartz oscillator crystals are just a few of its uses. HF forms soluble fluorides with the substances it etches or cleans —fluorides which may be washed away leaving a scrupulously clean surface.

In the etching of semiconductors, for instance, a variety of germanium and silicon fluorides are the waste products formed. However, impurities in the HF itself may remain on the surface of the device and contribute to a costly rejection rate. Even reagent-grade HF, until recently the purest form known, is simply not pure enough.

Electronic HF

To help cut rejection rates due to chemical impurities, we developed an ultra-pure electronic-grade of hydrofluoric acid. The purity specifications of this product typify the degree of progress the chemical industry is called upon to achieve in keeping abreast, and ahead, of the exacting needs of electronics.

Let's trace the production of this electronic-grade product. Fluorspar and sulfuric acid are the raw materials.

The purest anhydrous HF is selected for final processing. The acid is run through distilled water and the solution distilled for reagent-grade and finally, ultra-pure electronic HF. This electronic-grade HF process results in a product with impurities held to the lowest level ever attained. Specifications for electronic-grade HF, for instance, establish maximum limits for lead and boron for the first time. This purity level exceeds stringent American Chemical Society specifications, and would have been impossible to meet just a few years ago. Today it means fewer rejects for electronic manufacturers.

Other Chemicals

The first sale to an electronic manufacturer undoubtedly involved aluminum nitrate for the early radio tubes. Some lines included nearly 1,000 high purity reagents and fine chemicals by 1948 when the transistor was quietly ushered in.

Recent developments include a high purity, high concentration manganese nitrate chemical, "tailor-made" to enable production of tantalum capacitors, with fewer rejects.

In a current project, sample quantities of 3 specially-prepared ultra-pure solvents were sent to a few electronic firms. These chemicals, acetone, isopropyl alcohol, and methyl alcohol, are used in the washing and drying of semiconductor devices. They will be tested on production lines to find whether, and just how much, their added purity cuts rejection rates and adds to reliability.

This example of chemical-electronic cooperation forms a good departure point to view the new analyti-

cal methods required to insure electronic-grade purity.

Take the ultra-pure solvents an an example. Two analytical methods were devised: one to detect traces of ionic impurities; the other, traces of nonionic impurities. Together they make it possible to control impurities to a degree surpassing all previous standards.

The former test is based upon resistivity measurements. It owes its development to studies made under plant conditions which indicated a correlation between solvent resistivity and purity.

The latter method, detecting such organic, film-forming impurities as wax, complements the resistivity test. Here, a tank holding gallons of solvent is slowly "taken down" below its boiling point until only a thimbleful remains. This is poured into a scrupulously clean quartz boat and evaporated to dryness. Any change in electrical conductivity of the surface of the quartz, due to possible film formation is measured.

Thousands of dollars worth of specialized equipment beyond the usual analytical balances, pH meters, microscopes, refractometers, flash point apparatus, ASTM distilling apparatus, and the many other instruments common to nearly all laboratories, is devoted to analytical work.

Other Applications

Till now, we have dealt mainly with "electronic-grade" chemicals for semiconductors. These ultra-pure chemicals, however, are also well known in the production of radio and TV picture tubes, ferrites, fluorescent lights, capacitors, power transformers and other equipment.

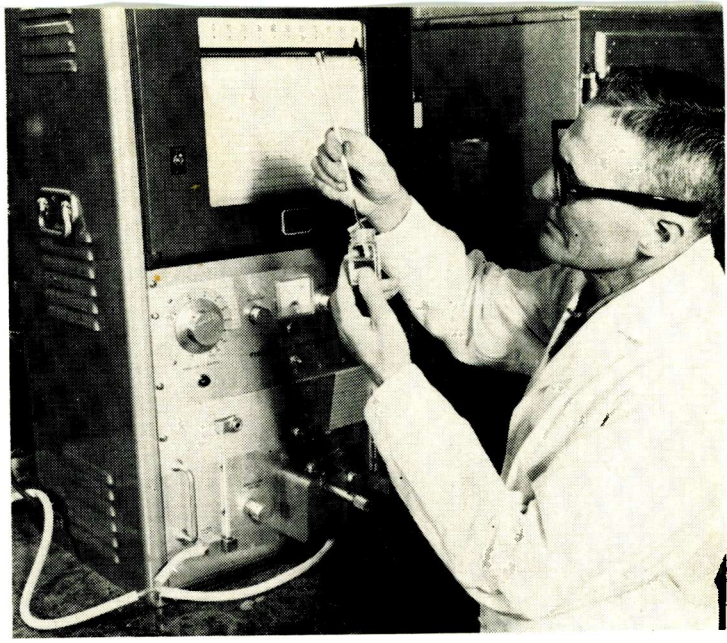
A pertinent development in this respect is the gaseous dielectric, sulfur hexafluoride (SF_6), the first commercial compound to be made from elemental fluoride. It was introduced by General Chemical in 1947. Believed to combine the finest dielectric and physical properties, this fire-and-explosion-proof gas has won widespread use replacing oil in power transformers. Temperature range is $-63.8°$ C. to 150° C. It is also employed as gaseous dielectric in X-ray tubes, wave guides, coaxial cables and other equipment. A projected use for SF_6 is in high voltage underground transmission lines.

Earlier this year, we began production of perfluoropropane (C_3F_8). This gaseous dielectric features excellent thermal stability at high temperatures and can be used at up to 200° or 250° C., or above the 150° C. suggested limit for SF_6. However, because of its carbon content, C_3F_8 must not be used where it would be subjected to excessive arcing or corona.

Halogenated fluorocarbons, lower-strength dielectrics, are advantageous where a coolant effect is desired.

In still another area of electronics, General Chemical supplies the nickel nitrate, cadmium nitrate, and potassium hydroxide electrolyte used for nickel-cadmium batteries. General is also the major supplier of elemental fluorine, the most powerful rocket fuel oxidizer and a prime example of chemicals which are supplied in tonnage quantities.

A development in which the division is currently playing a cooperative research role involves single crystal ferrites for microwave amplifiers. Our technical service specialists are also called upon to provide continuous assistance to firms dealing with fluoroborate plating baths for printed circuitry.



Gas chromatography is used in detecting major and trace constituents in the manufacture of chemicals for the electronic industry.

Packaging

Of immense practical value, packaging innovations are of particular importance regarding savings in shipping costs and warehousing space. Added safety in handling is also featured. Our latest package is a featherweight, polystyrene case that cradles 4 five-pint bottles of reagent acid more gently than eggs in a supermarket carton. Added strength and superior cushioning of the case enable it to exceed stringent ICC drop test requirements.

Last May, our new acid carboy, incorporating an expanded polystyrene overpack for 13-gallon bottles, captured the "best of show" award of the Society of Packaging and Handling Engineers. Advantages include a 40% reduction in tare weight and 30% increase in the number of carboys that may be loaded for shipments in a given space.

Other packaging innovations include a polyethylene "Saftepak" for electronic and reagent-grade hydrofluoric acid, and "Halon" fluorohalocarbon caps to replace old-fashioned ground glass stoppers for oleum and other hard-to-handle fuming acids.

Handling and Waste Disposal

A prime consideration of many electronic firms undoubtedly lies in the efficient, safe handling of chemicals and in waste disposal.

One firm was concerned with the disposal of waste hydrofluoric acid, particularly so because this was done within a few hundred feet of a reservoir. A brief study showed the customer was using ineffective marble chips to neutralize the HF waste, and the service engineer recommended caustic soda which ended the possibility of contamination.

While not always occupied with potential hazards of this nature, the customer engineering service is continually active in designing such articles as piping and carboy storage racks, and has, in at least one instance, designed the chemical handling portion of a customer's plant.

* * *

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For Alloy Transistors . . .

Proving Long Term Reliability

How reliable are transistors?
That is the inevitable question asked by design engineers.
To help answer this question, high quantity long term life tests were run.
Here are data from those tests which let the user determine the degree of reliability to be expected.

DURING 1958, extensive studies were made of transistor types and their associated failure rates. Vendors could supply only short term data and failure rates based on low quantity tests.

At the start of 1959, long term, high quantity life test were started on two types chosen for standardization. These tests were a part of the combined efforts of Radio Corp. of America and General Electric Co.—a subcontract on the BMEWS project.

The types were chosen because their makers gave the best reliability data at that time. The tests were to gain reliable failure rate information; also, data on characteristic changes of alloy junction transistors. They were designed to yield the basis for optimum parameter de-rating; naturally, this was to be with respect to device dissipation and junction voltage when operated at room temperatures. The tests were also to establish failure rates for reliability prediction.

Table 1
Number of Units on Test
(Same for 2N357 and 2N396)

Voltage Level (Volts)	Power Level (milliwatts) 75	150	200
6	1800	1050	600
12	1400	750	550
16	1050	600	450
20	900	550	350

Test Conditions

Some of the more outstanding conditions for these tests were:

1. Failure—cessation of transistor action or catastrophic failure.
2. Four voltage levels: 6, 12, 16, and 20 v.

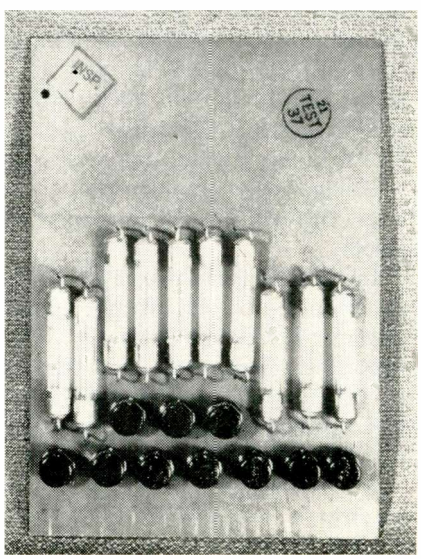

Fig. 1: Typical module contains ten units and ten fuses. Board design minimizes the three lead connections of the transistors.

Table 2

Failure Distribution

Voltage Level (Volts)	Power Level (milliwatts) 2N357 50	100	150	Total	2N396 75	150	200	Total
6	7 .43%	9 .95%	12 2.2%	28 .9%	0 0%	0 0%	3 .5%	3 .08%
12	3 .24%	0 0%	8 1.6%	11 .45%	1 .07%	3 .4%	2 .36%	6 .27%
16	3 .32%	0 0%	22 5.4%	25 1.3%	1 .09%	0 0%	1 .22%	2 .097%
20	4 .49%	6 1.2%	5 1.6%	15 .93%	1 .1%	0 0%	0 0%	1 .055%
TOTAL	17 .37%	15 .57%	47 2.7%	79 .87%	3 .058%	3 .1%	6 .3%	12 .127%

3. Three power levels:
   2N396—75, 150, 200 mw
   2N357—50, 100, 150 mw.
4. Units were cycled "on" 50 min.; "off," 10 min.
5. Temperature: 25° ±3°C, air conditioned.
6. No shock or vibration.

These conditions duplicated actual field conditions as much as practicable.

The tests used a factorial method of statistical design to determine lot size at each level. This lot size was to yield a failure rate based on an 80% confidence level with a ±20% accuracy. The number of each type required was 10,050—Table 1. The test duration was 10,000 hrs because the BMEWS reliability specification was based on 10,000 hr increments. The power supply was so regulated that load removal during "off" or "on" cycling would not produce voltage overshoot exceeding one volt at 6, 12, and 16 volts; 0.2 volt at 20 volts. Measurements to be made at the test unit collector.

These parameters were periodically measured during the life test:

Groups A parameters: h_{FE}, I_{CBO}, I_{EBO}, BV_{CEO}, BV_{EBO}, BV_{CBO}, at 0, 125, 250, 500, 1000, 2000, 3000, 4000, 5000, 6000, 7500, and 10,000 hrs.

Group B parameters: f_{ab}, r_b, C_{ob}; at 0, 2000, 5000, and 10,000 hrs.

Group C parameters, at 0 and 10,000 hrs:
1. Common emitter collector characteristics.
2. Collector saturation characteristics
3. Common emitter input characteristics.

Test Modules

The life test facility consists of test modules, life test chassis, test racks, power supplies and cyclic controls. Each module, Fig. 1, contains 10 units and 10 fuses. The board design minimizes the three-lead connections of the 10 transistors; thus, it helps to reduce reactive effects when measuring at h-f.

The test module fuses protect the power supply and prevent thermal "run away" on one device from affecting the others. Life test circuits for all test module-mounted units are in a life test chassis. A common base configuration for each device with no collector load resistance was used, Fig. 2.

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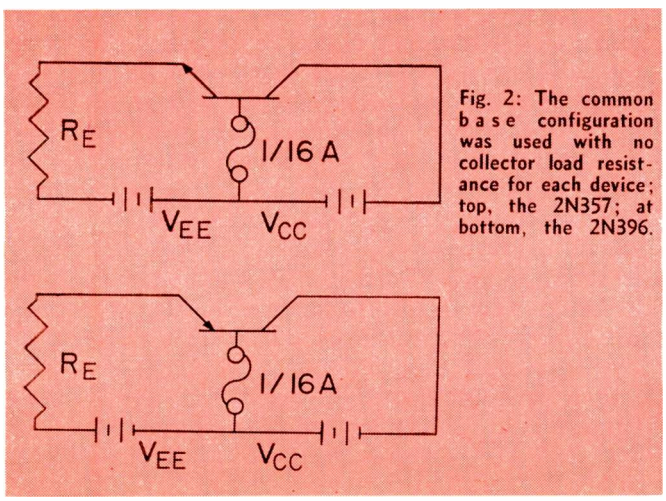
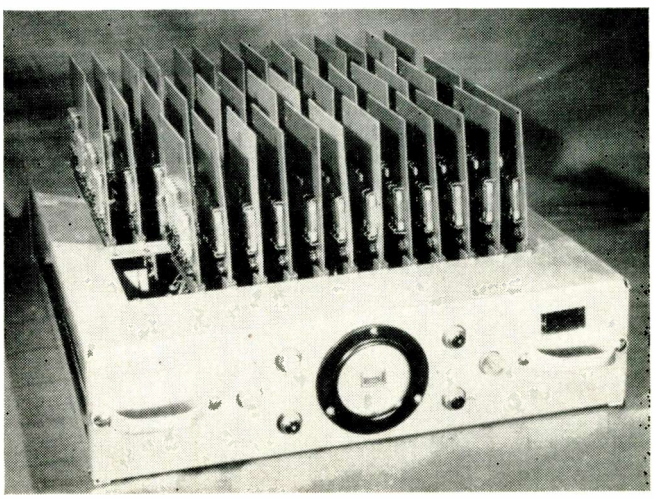


Fig. 2: The common base configuration was used with no collector load resistance for each device; top, the 2N357; at bottom, the 2N396.

Fig. 3: This life test chassis holds 400 module-mounted transistors.



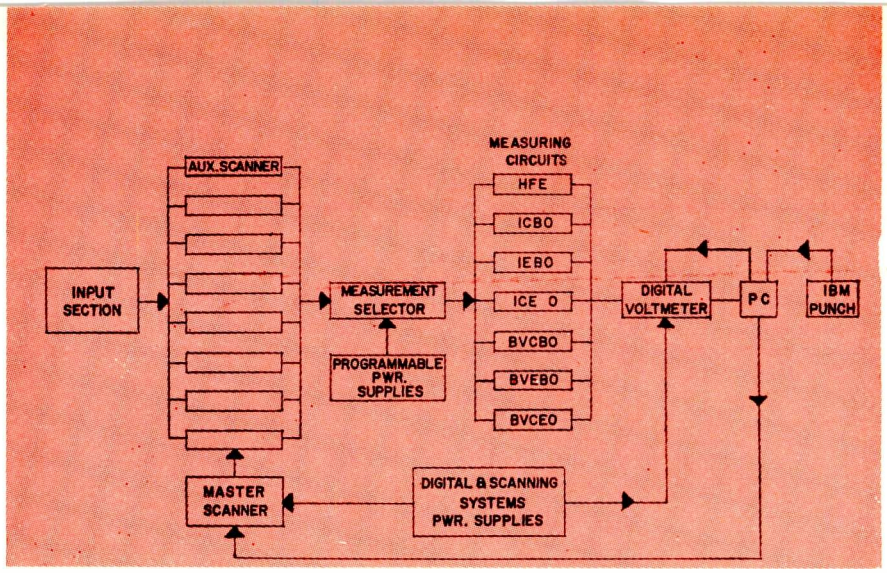


Fig. 4: Functional diagram of the automatic transistor test set shows the relationship of the principal circuits for measurement.

Reliability *(Continued)*

Table 2 shows the component values used. Various collector supply voltages and emitter resistances provided the power levels.

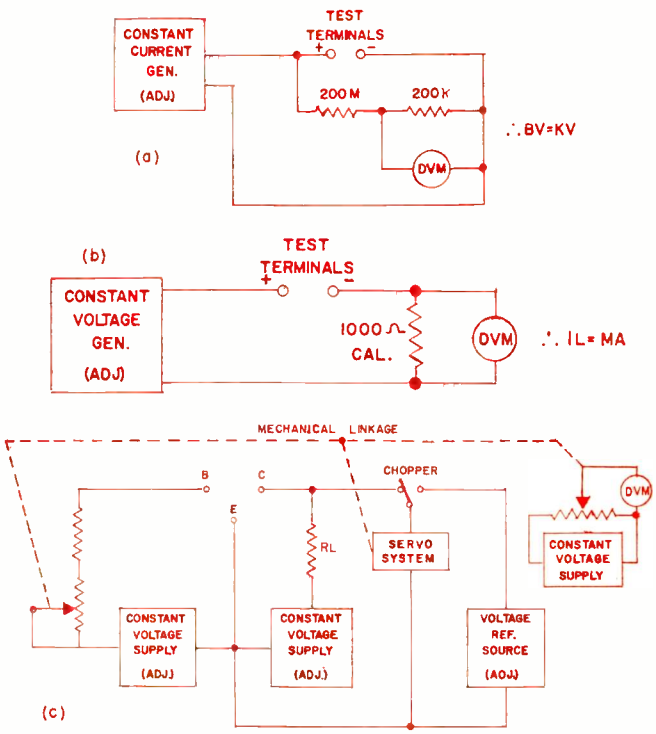
A typical chassis, Fig. 3, holds 40 boards. Elapsed time meters on each chassis indicate the total of "on" hours. Pilot lights provide a positive indication of "on" and "off" portions of an operating cycle.

There are 31 chassis for each 10,050 units under test. All are located within 5, standard 19-inch racks using less than 200 sq. ft. The five-rack area also contains the power supplies and the time control panels.

Problems

In starting a large quantity life test, many problems are encountered. A rather common one was oscillations with use of dc voltages. Each chassis when first tested showed several strong oscillations present. Judicious use and placement of capacitors removed these.

Fig. 5: The various measuring circuits of the transistor test set: (a) voltage breakdown; (b) leakage current; and (c) current gain.



Cyclic power switching is done by synchronous motor driven banks of micro-switches. These switches were adjusted to remove collector voltage last and to apply it first, to any specific chassis group, to minimize transients. Micro-switch contact "bounce" and loading effects on power supply regulation produced voltage transients. These were eliminated by circuit transient suppressors and capacitors.

There are common emitter and individual collector power supplies for each 10,050 unit groups. Collector supply load change is minimized by cycling to "off," only 1 of the 3 dissipation groups at a time.

While building the test facility, an automatic measurement console was developed for accumulating all dc measurement data.

Test Console

The console's "heart" is a four-place, self-balancing, digital voltmeter. This voltmeter with a 400-channel (two-wire) scanner, an input section, plug-in measurement circuits, programmable power supplies, manual and automatic system controls, and an IBM 024 punch form the console.

The input section contains 40 printed board connectors. These mate with the test modules. Thus, the input section connects 400 units to the scanner. The scanner output presents its selected input to a manually chosen measurement circuit. A shorting relay provides safe, automatic stepping through a chosen sequence of devices for each measurement. This relay provides a short circuit between the scanner output connectors and the measurement circuit. The short is maintained during scanning. Thus, voltages are "zero" across the unit just prior to removal from the measurement circuit until replaced with the next unit. This allows all measurement voltage conditions at the device to be approached from the "zero" level.

Another safeguard for NPN devices during current gain measurements was also used; because, the specified conditions were 200 ma I_c and 0.25, V_{ce}. In the actual circuit, a load resistance and collector supply of 20 v. is used. To minimize dissipation and safeguard the test device, its collector emitter connections are shunted with a silicon diode. This prevents V_{ce} from exceeding about 0.75 v.

The usual method is to insert each board into a curve tracer test socket and view the output curves for each unit, before insertion into the automatic test set.

The automatic test set, Fig. 4, has circuits for measuring voltage breakdown, leakage current, and current gain, Fig. 5. The current gain module affords a direct digital readout of current gain.

Overall accuracy of automatically establishing specified conditions, over a range of 5 to 200, is better than 5%.

Localized air conditioning maintains the ambient temperature at 25°C ±3°C. Thermally operating power-disconnects prevent air conditioning malfunctions from causing possible destruction of the 20,100 units. A temperature of 28.5°C. at the sensing point will activate the thermal disconnects, removing *all* power.

By April 1961, 6500 hrs were on 10,050 2N396's. This amounts to 65,325,000 transistor hours. Automatically recorded data is on 100,000 IBM cards.

About 51,000,000 transistor hrs were on the 10,050 2N357's—about 100,000 measurements taken.

Data Analysis

Data analysis showed significant information other than parameter levels and distributions. A close look indicated that an alarmingly high number of reject units were those ending with the digit "0". All test devices are identified by a consecutive set of numbers from "000" to "399" for each chassis.

Random failures, if in sufficient quantity, would be expected to contain approximately equal quantities with identification numbers ending in 0-9. This called for a close study of the entire facility. The study pinpointed the only possible fault area: the console.

A thorough check revealed all sections to be working as required. Frequent checking revealed no transients or equipment malfunctions. As the test progressed, the number of "0" failures increased. When this type accounted for 60 to 72% of the total failures of each transistor type, it accounted for only 0.1% of the measurements in the "0" positions.

This infrequent malfunction forced us to reduce all accumulated data to that of units whose number ended with 1-9 and to disregard all others, good or bad, with a "0". This resulted in a 10% reduction in the total number of units and operating "on" time from that anticipated. All data on the "0" units has been deleted. This has reduced the confidence of each test to 80%, ±25% accuracy.

Fig. 6, shows that the 2N357 failure rate is essentially constant after the 1000-hr interval, with a slight peaking at 3000 hours. The 2N396 curve shows one failure per thousand hours for the 10,000 units after the 3000-hour interval; proof positive of its reliability.

The failures at each voltage and power level are shown in Table 3. The corresponding percentage of failures are also shown. The percentage figures can be divided by a factor of five to calculate the percent per thousand hours. This indicates an average failure rate of 0.17% per thousand hours for all 2N357 units on test.

Under actual field operating conditions in BMEWS equipment, the 2N357 failure rate is 0.071% per thousand hours. This rate is based on several thousand units which have accumulated 30,000,000 transistor hours. In the field equipment, the 2N357's are oper-

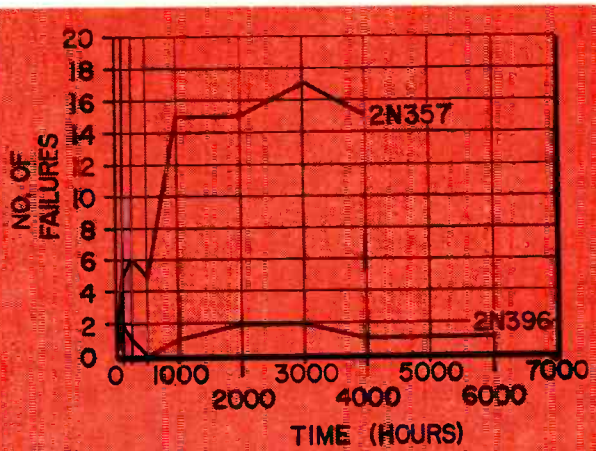


Fig. 6: The failure rates for the two types of transistors tested.

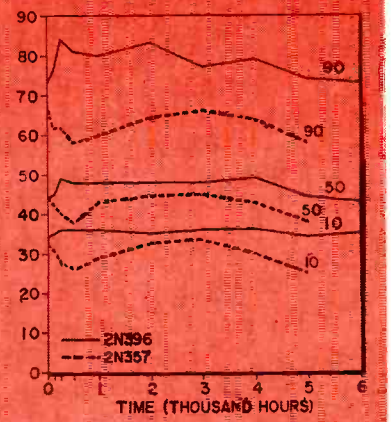


Fig. 7: The resultant hrs curves for the devices after 5000 hrs.

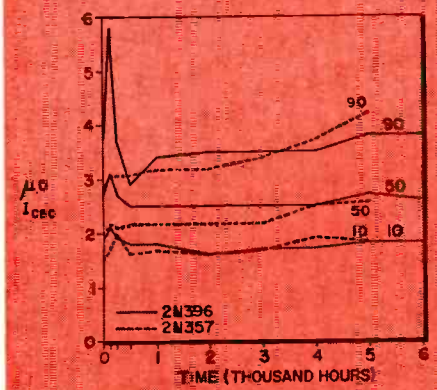


Fig. 8: The I_{CBO} percentile curves as a function of time for both types tested.

Table 3

Component Values

V_{CC} (V)	V_{EE} (V)	R_E (Ω) 2N357	R_E (Ω) 2N396	W_T (mω) 2N357	W_T (mω) 2N396
6.0	12.5	1430	983	50	75
12	"	2870	1910	50	75
16	"	3830	2550	50	75
20	"	4870	3160	50	75
6.0	"	732	475	100	150
12	"	1470	976	100	150
16	"	1960	1270	100	150
20	"	2430	1620	100	150
6.0	"	487	357	150	200
12	"	976	732	150	200
16	"	1300	953	150	200
20	"	1650	1270	150	200

Reliability *(Concluded)*

ated at 12 and 16 v, with 50 mw dissipation. Note the failure rates in Table 3 for the 2N357 at 12 and 16 v, 50 mw dissipation, which shows 0.05% and 0.06% per thousand hours, respectively. The correlation is very good.

The *total* percentage is 0.12 or 0.024% per thousand hours for the 2N396. Field data after 154,000,000 transistor hours has resulted in a failure of 0.027% per thousand hours. This correlates very well with the total failure rate.

The question then follows, why doesn't the 2N357 data correlate accordingly? There are a few reasons for this. The few field 2N357 failures have been verified. The 154,000,000 figure for the 2N396 has a higher degree of confidence than does the 30,000,000 figure for the 2N357. Other authors have stated that one should expect a 10 to 1 factor of field failures to laboratory failures. This holds true here as far as the total failures are concerned when comparing the failures at 12 and 16 v at 75 mw dissipation.

Failure Analysis

Some failures have been analyzed; others will be. Analysis gives no positive evidence of any detectable failure mechanisms. Results have shown failures to contain poor soldering, poor quality of workmanship, and moisture present in the case. This is no criticism of the makers when the overall failure rates are considered. No units were specially selected; all were procured from stock at random. There were no special purchase specifications except that all shipments meet prevailing EIA specifications for the 2N357 and 2N396.

Fig. 7, shows the change in I_{CBO}. These curves are for the 10, 50, and 90 percentiles. From time zero to 1000 hours, the curves are very erratic. As may be expected, the I_{CBO} increases with life but the 50 and 10 percentile curves seem to stabilize.

Fig. 8, shows the resultant curves of h_{FE} after 5000 hours. The trend indicates no detrimental degration. These support the choice of 1000 hours aging, or burn-in, prior to use.

Use of such test data as these will meet the design engineers' future needs for alloy types used in controlled environments.

With the tremendous number of transistor types on the market today, this type of test proves to be an important factor in obtaining logical and reliable curves for standardization and reliability predictions.

* * *

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Solid-State in Vacuum Systems . . .

Developing

IN light of Table 1, the equipment described here is a baffle rather than a trap; because, the contemplated chevron temperatures will not permit trapping of air, CO, CO_2, H_2, O_2, N_2, in measurable amounts. The baffle's primary function is recovery of 'back-streaming' pump vapour, so that the working vacuum remains free of pump fluid contamination.

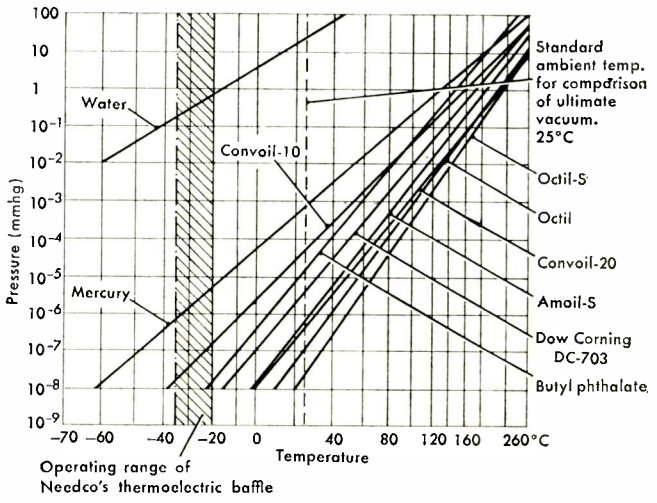
When a diffusion pump reaches a base pressure in the system, it has produced an equillibrium condition in which the number of particles flowing into the pump's mouth equals the number flowing out and back towards the vacuum space. It is then that a cold baffle is necessary; not to further lower the system pressure, but rather to prevent system contamination.

The baffle is designed to operate through a wide range of chevron temperatures—down to —25°C or —35°C. This temperature is adequate for condensing the commonly used diffusion pump fluids. Fig. 1.

Operation

The baffle's refrigeration effect is achieved by the

Fig. 1: Characteristics of the vapors of various pumping fluids.



The thermoelectric baffle is a new idea in cooling high vacuum components—so important in new electronic, metallurgical, and space techniques! This solid state device needs almost no maintenance and eliminates compressors.

a Thermoelectric Baffle

Frigistor thermoelectric cooling assembly. This consists of several thermoelectric Neelium couples.

Upon current reversal, the Frigistor will act as a heat pump. It then raises the baffle temperature from —35°C to room temperature within 45-60 seconds. This allows the cooling member to defrost.

This baffle does not bring to vacuum technology a new tool, but rather a better baffle for use in a diffusion pumping system. In general, a diffusion pumping system, using a refrigerated baffle, but *not* a refrigerated trap (which actually is a cryogenic pump), has been typical of uses in vacuum metallurgy, vacuum deposition of metals, and other fields. The limitation of this baffle's use is the same as any other presently available refrigerated baffle; but, its overall operating ease and economy provide a much more flexible system. Also, the principle of a solid state device with no moving parts, ensures maximum reliability.

Installation Economy

The thermoelectric baffle is a self-contained, solid state refrigeration device which does not require extensive, costly and often trouble giving refrigeration-compressor equipment. The important saving to the user is that extensive production space is not required for auxiliary equipment. Also, the normal maintenance problems of compressor types are eliminated.

Conventional refrigerator equipment requires pressure-refrigerant lines and heavy duty power lines for the compressor motor. The thermoelectric baffle needs only a power drop cord to supply the Frigistor unit through the compact and readily accessible power supply control supplied with the baffle, Fig. 2.

Cooling water is required for the thermoelectric baffle; however, since it must be supplied for the diffusion pump, preferred practice dictates that the cooling water be supplied to the baffle in series with the diffusion pump. Thus, the only additional piping required may be a flexible hose connection from the baffle outlet to the diffusion pump inlet. Great activity and many units could make compressor noise a very objectionable factor. Transmitted vibration may also be annoying, if not actually dangerous. Neither of these 'nuisance' factors apply to the thermoelectric baffle because no rotating or reciprocating parts are required.

The solid state Frigistor is permanently assembled to the baffle internal sleeve ring at the factory. There is no damage which can be done to the unit unless through accident or intent.

The baffle's power supply is also a solid state device. As such, it has great stability both electrically and mechanically; therefore, unless extremely mistreated, it should give trouble-free service for an in-

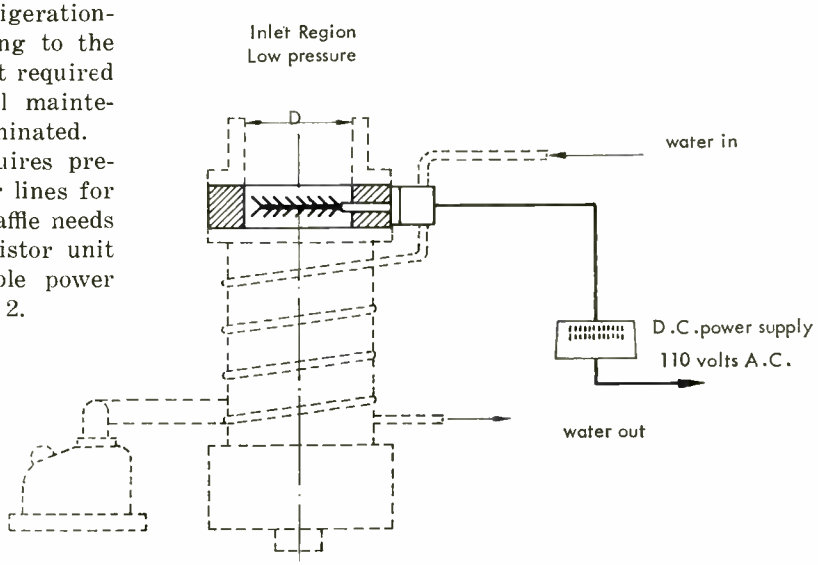


Fig. 2: Connection of the thermoelectric baffle in a vacuum system. Here's how a new standard adopted by certain manufacturers to increase efficiency with a larger bore molecular pump fits the ASA Std.

Class		Dimension D (inches)			
ASA Std.	4	6	10	16	20
New Std.	5¼	7	11		
Special		9	12	32	36

definite period. Except for occasionally checking water connections, maintenance is negligible.

By comparison, mechanically refrigerated baffles have the maintenance problems found in mechanical equipment, namely, refrigerant fluid loss due to leakage, motor and wiring failure, worn-out gland and valve packings, and compressor and fan drive-belt replacement. All such equipment needs routine and periodic maintenance. This requires personnel.

Operating Cost

Water cost comparing the two systems, depends primarily upon whether or not the mechanical refrigeration equipment size and location dictate the use of water cooling. In both cases, the same amount of water will be required for the diffusion pump. Since the baffle uses the same water as the diffusion pump, there is no increased cost. It is obvious that where the water requires treatment prior to use, a water cooled mechanical refrigeration system will have an additional appreciable operating cost.

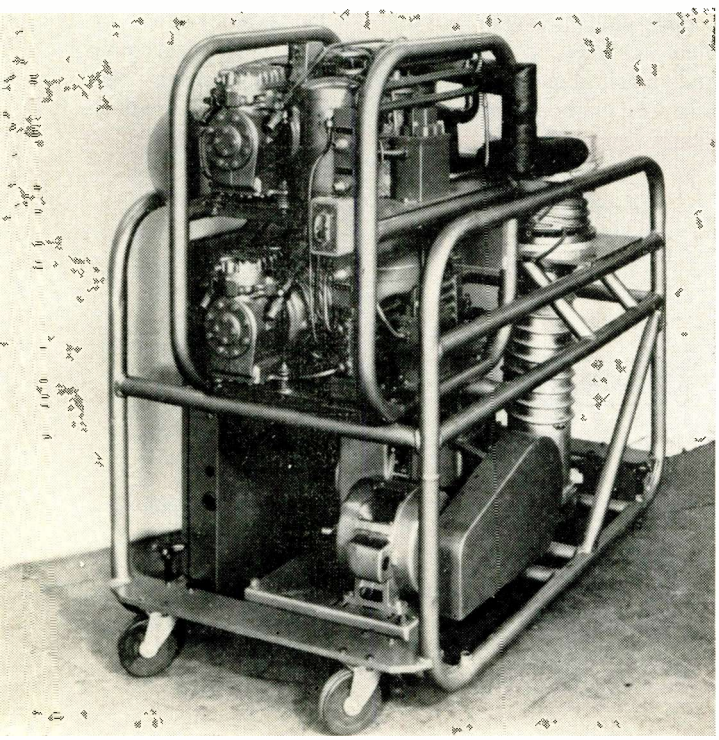
Baffle Trap Development

Baffle trap development was characterized by this philosophy:

(a) The necessity of obtaining the proper temperature drop on the baffle chevron.

(b) The necessity of avoiding any contamination of the high vacuum system by exposure raising insulated components of thermoelectric module.

Several resins had a high degassing ratio which resulted in a 'dirty vacuum' system. These made it impossible to obtain proper vacuum of 10^{-5} to 10^{-7} or 10^{-8}.



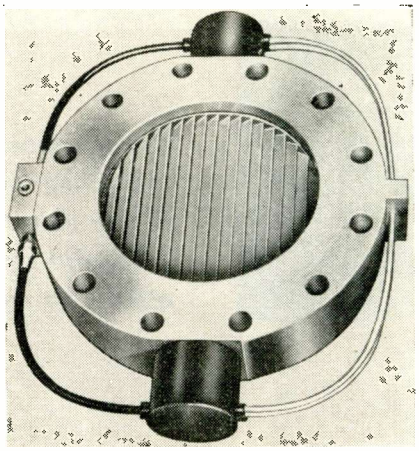


Fig. 4: Thermoelectrically cooled, 10 inch diameter baffle of the new design.

It was extremely difficult to solve these two aspects at the same time. It is obvious from literature and experiment descriptions done in the U.K. and in the U.S.S.R. (Thermoelectric High Vacuum Trap for Pump N-5 by Kolenko, Towber, Juref and Scherbina) that other workers were unable to solve this problem successfully.

Our laboratories stated that there appeared to be 2 or 3 approaches which would offer a solution to this problem:

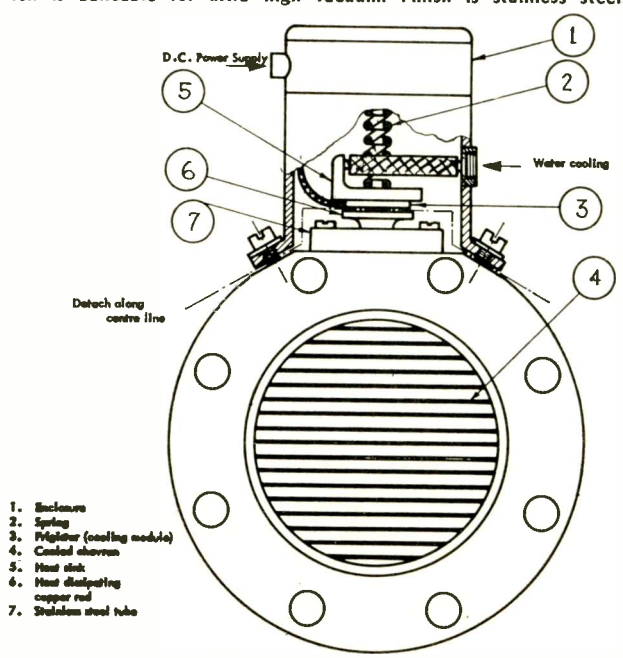
(a) Direct water cooling of the Frigistor. This is technically feasible, but we must insulate the hot junctions from the water to avoid any possibility of galvanic corrosion.

(b) Improvement of the heat exchange surfaces between the water and the heat sink, by using a more efficient heat exchanger, e.g., one made up from pin-plate, or perhaps by tapping the holes in the existing heat exchanger with a coarse thread, to increase the area of the copper-water interface.

(c) Improvement of heat exchange surfaces between the Frigistor and heat sink by using a new

Fig. 3 (left): Conventional cascade Freon compressor for a 6 inch diameter baffle assembled on a standard diffusion pump.

Fig. 5 (below): Thermoelectrically cooled, 7 inch diameter baffle which is bakeable for ultra high vacuum. Finish is stainless steel.



method of Frigistor assembly.

During evaluation of the first baffles, some degradation of the ΔT cooled chevrons was observed for a short period. This was very discouraging; but, after some depressing results, a proper solution was found in record time.

A study proved the theory that the contact between a Frigistor and cold member deteriorates during cycling.

Investigations of the mechanical stability of epoxy-mica-epoxy bonds between the Frigistor cold face and the cooled face were conducted by assembling a Frigistor with this bond between a heat sink and a copper plate. The Frigistor current was set to its optimum and them cycled—15 min. "on," 15 min. "off." The copper plate temperature was recorded continuously for 84 hrs. The record shows that the bond deteriorated quite rapidly over the first few hours, then slowly throughout the test. The deterioration was caused by mica delamination under the sheer stresses imposed by the temperature difference (57°C) between the Frigistor faces.

To overcome this effect, another sample was prepared in which the epoxy was replaced by a new method of attachment under constant pressure. The cycling test was repeated for 15 hrs. (three times the period in which the initial deterioration occurred in the previous test). The record showed no deterioration. The test simulated several years of service.

Evaluation

Thermoelectric baffles have been produced and used in industrial and laboratory systems for continuous exploration. Some baffles have been evaluated by independent institutions. Here is the evaluation by Radio Corp. of America, Electron Tube Div., Lancaster, Pa., Report of March 6th, 1961, entitled "Evaluation of Needco Thermoelectric Device—A 10″ diameter Chevron Type Baffle."

"With the baffle in place, there was no evidence of oil backstreaming after twelve days of running with the baffle cooled.

"The surface temperature of the chevrons under rated power conditions was —20°C.

"An appraisal of the baffle from the general standpoint would comment its simplicity of construction and a design conducive to ease of maintenance."

Because the thermoelectric field is developing very fast, improved material is already available. We have developed a new Frigistor thermoelectric module based on the low thermal loss concept. ΔT is not less than 65°C. This enables us to build baffles with a ΔT of 45°C between the cooling water and chevrons located in the vacuum system. We expect even better results in the near future, using cascade connection of the Frigistors.

New Concepts

During development we received inquiries for large size 32 in. diam. chevron baffles to be used in large quantities with a diffusion pump for servicing chambers of high vacuum orbital simulators. These simulators would provide information on systems operation as affected by low pressures and outgassing of their electrical and mechanical components. A design concept has been approved in which several standard Frigistors cool chevrons through heat dissipation rods. Frigistors, thermally parallel and electrically in series, are connected to the same power supply.

Table 1

Definitions

BAFFLE

A system of cooled walls, plates, or tubing placed near the inlet of a vapor pump to condense backstreaming vapor at a temperature below that of the room and return the fluid to the boiler. The baffle plates may be located in the 'head' of the pump or in a separate housing attached to the inlet.

TRAP—(Refrigerated)

A system of cooled walls, plates, or tubing placed beyond the baffle or the condenser to reduce the partial pressure of vapor migrating from the pump, or from the vacuum system, and from which the condensed vapor cannot return to the pump boiler.

—Comm. on Standards, American Vacuum Society

Table 2

Power Consumption

	Freon Cooled Baffle	Thermo-Electric Baffle	Annual Saving
Condition 1	150 w (1314 kwh/yr)	10 w (87.6 kwh/yr)	(1226.4 kwh)
Condition 2	410 w (3591.6 kwh/yr)	40 w (350.4 kwh/yr)	(3241.2 kwh)
Condition 1:	1/6 hp compressor	F-8 Frigistor	
Condition 2:	1/3 hp compressor	F-32 Frigistor	

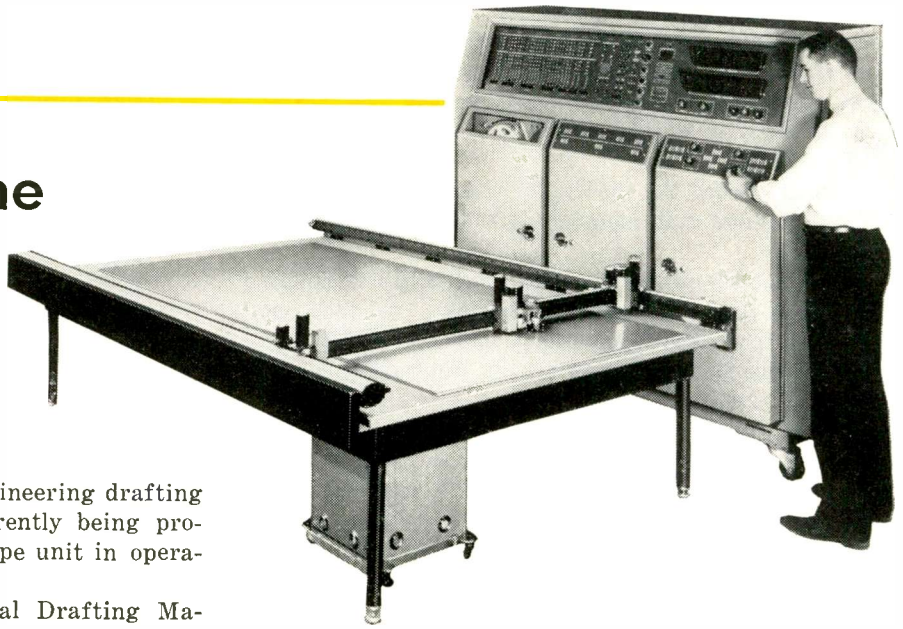
More rigid requirements have already been established for thermoelectric baffles. Baffles for ultra high vacuum, suitable for baking in the range 350°-450°C, are being designed. Previous baffles did not have this provision because the thermoelectric module was permanently attached to the baffle top and soldered with Bismuth-tin eutectic solder which quickly deteriorated at temperatures higher than 126°C. A patent application has been made.

The patent claims, "The cooling unit is easily detachable from the baffle with chevron, creating a totally closed vacuum at all times. The cooling unit is connected with the baffle top by four screws. By removing these four screws the cooling unit is detached. Thermal contact between cooled chevron and detachable cooling unit is obtained by pressing cooling modules (Frigistors) against the surface of heat dissipating copper rods entering the vacuum compartment of the baffle by a vacuum sealed stainless steel enclosure. Constant pressure between these two heat conducting surfaces is assured by a spring employed between Frigistors, heat sink, and cooling unit enclosure."

When baking, the cooling unit is detached. After the system is cooled and requires further work of the diffusion pump, the thermoelectric cooling unit is again attached. The thermoelectrically cooled bakeable baffle for ultra high vacuum, Fig. 5, is made from stainless steel No. T-304 with a provision to apply an aluminum soft wire gasket on the flat ground upper and lower flange surfaces. The thermoelectrically cooled system is completely insulated. Only the stainless steel surface has to be degassed during baking.

What's New

Drafting...by the numbers!



Engineer checks controls of the Orthomat.

A NEW numerically controlled engineering drafting machine, the Orthomat, is currently being produced to order, based upon a prototype unit in operation for nearly a year.

The machine is made by Universal Drafting Machine Corp., 1825 East 18th St., Cleveland 15, Ohio.

The Orthomat automatically translates complex mathematical formulas defined on punched or magnetic tape into accurate engineering drawings at speeds up to 200 in./min. It is designed to operate independently or as an integral part of total computer engineering systems, correlating with other numerically controlled data, production and inspection machines.

The device is a coordinate, continuous-line contouring plotter, capable of drawing straight lines, angles, curves, circles or ellipses. It draws on paper, vellum, cloth, mylar or metal, up to 60 in. x 144 in. It has a single or automatic indexing hex turret (optional) for mounting a variety of stylii. Controls permit automatic reduction or blow-up of drawings (¼, ½, full and twice size) and "mirror image" reversal.

The Orthomat can serve the draftsman, the engineer, and the production department.

Designed for office environment, the Orthomat system is composed of (1) a numerical control director to supply command pulses and (2) a drafting machine with complete control for all motions of a variety of scribing devices.

The numerical control director may be any manual or tape (punched or magnetic) input device which can supply incremental X & Y pulses of 1 mil value at a controlled rate, plus auxiliary signals to control the stylii. The drafting machine consists of an aluminum table with desk top linoleum surface, a vacuum chuck, a large scale digital X-Y plotter, and all necessary electronic control circuits and power supplies.

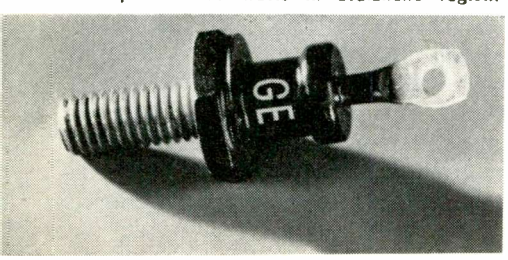
Construction is based on light-weight rigid gantry design. Drive is via pinion and precision racks.

Controls govern X, Y and Z motion, jogging, stepping in 0.001 in. increments, feedrate override of speed, stylus indexing, and dash-line generation. Actual position is readout for any two of X, Y and Z axes to the nearest 0.001 in. Zero positioning is automatic, and readouts may be reset to zero anywhere on the board to accommodate dimensioning of drawings in which the 0-0 position is off the table. Maintenance features include use of solid state components and a built-in test panel for quick pinpointing of any malfunction.

Self-Protecting Rectifier

THE weakest spot in conventional silicon rectifiers is the perimeter of the silicon pellet where the rectifying junction comes out to the surface. This is where transient circuit voltages have historically squeezed through, causing overheating and melting in a very localized area. It is sufficient to permanently impair or destroy the rectifier's reverse blocking ability.

The General Electric 12 amp ZJ218 rectifier dissipates 3900 watts in avalanche region.



General Electric Company's Rectifier Component Dept. has developed a semiconductor which protects itself against these damaging transients. It has a non-destructive internal avalanche breakdown that occurs across the entire junction area. Thus, protecting the junction surface and eliminating destructive local surface heating. It has effectively its own-built-in zener diode protection even at voltages beyond 1200 volts.

The first Controlled Avalanche Rectifier to be released by G.E. is the 12 amp ZJ218. These are presently available in sample quantities. Others in this series will be released in the future.

Testing Packaged Circuits

INCREASINGLY competitive conditions within the past few years have resulted in a trend toward more and more complex manufacturing methods. As a result, component makers have developed increasingly sophisticated preassembled circuit packages. These packages are custom designed to the manufacturers' requirements. They require only plugging into the printed circuit board or wired chassis.

Although such modular units offer the equipment maker substantial savings in production time and cost, their complexity imposes upon the supplier increasingly severe problems in quality control.

A typical example of this problem, and its solution, is the production testing equipment developed by the Jeffers Electronics Div. of Speer Carbon Co., Inc., for their PAC system. This system is a unitized assembly circuit for modular electronic assembly. It is designed primarily for use in printed wiring applications, and permits the insertion, as a group, of a wide range of capacitors and resistors in simple or complex circuitry.

Each unit is based on assemblies ⅛ in. in dia., and ⅜ in. long. Mounting bases are high-grade low K phenolic with 0.200 in. center to center spacing of devices. It has achieved wide acceptance since its high component density permits an appreciable reduction in printed circuit board or chassis area; as well as, drastically reduced assembly costs and reduced stocking and inspection.

On this special automated equipment, a semi-skilled operator tests more than 2,000 custom-made, packaged assembly circuits per hour.

Requirements for the production test equipment were complex. Tolerance requirements varied widely. A high rate of 30,000 tests/operator/hr., with near perfect reliability and operated by non-engineers, was required to keep pace with manufacturing capacity.

A survey of available equipment was unsuccessful;

(*Continued on page* 210)

Computers Assist in Bearing Selection

PLANES will fly more safely, farmers will farm more efficiently and space vehicles will orbit more surely as a result of a new digital computer used by The Fafnir Bearing Co., New Britain, Conn.

For the first time, designers can be assured of selecting the correct bearing; because, they will know more accurately in advance how it will meet the stresses and strains likely to be encountered under a wide range of conditions.

Ball bearings are relatively simple structures; but, their analysis and performance prediction is exceedingly complicated. The standard formulas are still adequate for most situations. But, today, scientific break-throughs have created complexities in bearing use beyond anything previously envisioned.

The trend to higher loads and greater speeds, together with operation at temperatures ranging from close to absolute zero up to several thousands of degrees Fahrenheit, and in unusual atmospheres—or in no atmosphere at all—presents a challenge that requires the most sophisticated treatment.

These questions defy ordinary analysis.

To predict bearing performance it is necessary to know precisely how the rolling elements in the bearing share the load. What makes the problem so difficult is that a rolling-element bearing is what engineers call a statically-indeterminate, non-linear spring system. Also, the rolling element motions give rise to centrifugal and gyroscopic forces which must be considered. Add to these the deflections of the shaft and supporting structure under load, and you have some idea of the problem complexity.

Engineers are now able to express all these factors in mathematical language.

The simple formulas are actually special simplified cases of the new general theory. This theory was originally programmed for the IBM-704 computer. Recently, the theory was reprogrammed for the IBM-7090 computer which, in this instance, is about six times faster than the 704.

Mathematically, the solution is so very complex that it would be almost impossible to solve the equations by hand, even if time allowed.

The instructions to the computer are contained in a single deck of punched cards called the object deck. Individual problems are prepared by punching the bearing design characteristics, the load and speed conditions and other pertinent data, on another set. Only a few punched cards are needed to describe an entire bearing system; their preparation takes but a few minutes. The second set of cards is placed behind the object deck and the complete package is then fed to the computer. Any number of separate problems can be stacked behind the object deck.

The extreme speed of computation permits study of the effects of many design parameters; thus the optimum bearing installation can be found for any use.

* * *

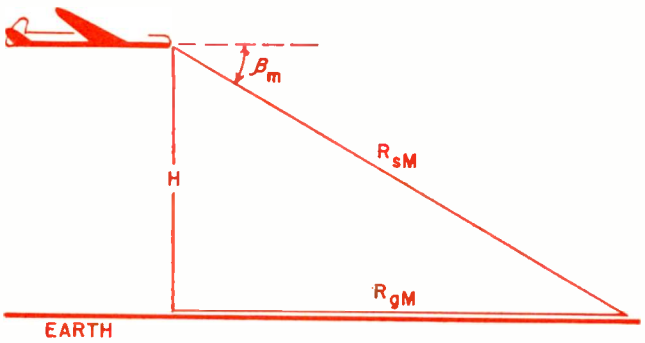


Fig. 1: The Idealized cosecant-squared pattern lies uniformly along the surface of the (flat) earth.

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For Airborne Operations . . .

Adjusting Radar Antenna Tilt

When an antenna has a cosecant-squared gain variation, its tilt affects the adjustment of other controls. Because of the interdependence of the settings which can be made by an operator, a straight-forward procedure has been developed to determine the tilt angle, within the narrow limits required, for uniform ground painting over an extended area.

THE antenna tilt setting for a navigational or reconnaissance radar set is dependent upon the antenna pattern. For the purposes of this article we shall assume that the proper antenna pattern for even illumination of the terrain is of the cosecant-squared type; identical conclusions are reached no matter which alternative pattern is taken as the best for uniform ground painting.

Variation of the tilt control changes the maximum range at which a target of fixed reflectivity may be detected, and alters the quality of ground painting. These two factors will be treated in turn before describing the operating procedure.

Maximum Range

In Fig. 1 an idealized cosecant-squared antenna pattern is drawn with its toe or peak at a depression angle of β_m. The gain function for this pattern is

$$G = G_o \frac{csc^2 \beta}{csc^2 \beta_m} \qquad (1)$$

This report was prepared while at the Search Radar Branch, Aerial Reconnaissance Laboratory, Wright-Air Development Center, Ohio, under RDO 112-158.

The maximum slant and ground ranges (R_{sM} and R_{gM}, respectively) when the toe lies at β_m are

$$R_{sM} = \frac{H}{\sin \beta_m} \doteq \frac{H}{\beta_m} \qquad (2)$$

$$R_{gM} = \frac{H}{\tan \beta_m} \doteq \frac{H}{\beta_m} \qquad (3)$$

where H is the aircraft altitude. If the range is measured in nautical miles, altitude in thousands of feet, and angle in degrees, these equations become

$$R_{sM} \doteq R_{gM} = 9.424 \frac{H \text{ (thousands of feet)}}{\beta^\circ_m} \text{ naut mi} \qquad (4)$$

The maximum range is, therefore, directly proportional to altitude and inversely proportional to the depression angle of the toe of the pattern. Their relation is tabulated in Table 1. The range-to-altitude ratio is presented in the second column for the condition that the units of height and range are the same. The third column lists the range in naut. mi. for an altitude of 1000 feet. For other values it may be multiplied by the aircraft altitude in thousands of feet.

The maximum range obviously depends not only upon the antenna pattern, but also upon the tilt angle. For example, if the aircraft is at 10,000 feet and β_m in Fig. 1 is 10°, then the maximum range is 9.4 naut. mi. Now, if we want to see a target at 18.8 miles, the peak of the beam must be placed at 5° by introducing 5° of positive tilt, as illustrated in Fig. 2. Since the pattern is pictured as if it extends in space over the

Table I

β_m (degrees)	$\frac{R_{gM}}{h}$	$R_{sM} \doteq R_{gM}$ (naut mi)
1°	57	9.4
2°	29	4.7
3°	19	3.1
4°	14	2.4
5°	11	1.9
6°	9.5	1.6
7°	8.1	1.3
8°	7.1	1.2
9°	6.3	1.1
10	5.7	0.94

Table of maximum range for different values of β_m. The middle column lists the ratio of ground range to altitude; thus for $\beta_m = 6°$ and $h = 2$ naut mi, the maximum range is 19 naut mi. The last column gives the maximum range for $h = 1000'$; multiply by the aircraft altitude in thousands of feet to obtain the value for other altitudes.

earth's surface, a sketch has been added of the tilted pattern drawn to a new scale so that its peak lies at the maximum range illuminated.

Another problem arises when a target is lost in system noise, so that it is necessary to increase the magnitude of the received signal. This may be accomplished by placing the peak of the beam on the target, as illustrated in Fig. 3 for a target lying at a depression angle of 2 β_m. As in Fig. 2 a sketch of the tilted pattern has been added, which is drawn to a new scale with its peak at the maximum range illuminated.

Ground Painting

The final criterion of the quality of ground illumination is the appearance of the terrain below the aircraft on the radar display. When above a relatively level area where the ground return is of uniform intensity over the entire radar scope, we naturally say that the ground painting is uniform. Actually the antenna illumination of the ground need not be uniform to achieve this result because of the dependence of ground reflectivity upon the angle of incidence of the radiation and varying sweep overlap on the PPI display. To compensate for these effects, the cosecant-squared antenna pattern may be modified or electronic circuitry may be introduced.[1] For purposes of our discussion, however, we shall assume that the ideal cosecant-squared beam, as drawn in Fig. 1, provides the desired quality of ground painting.

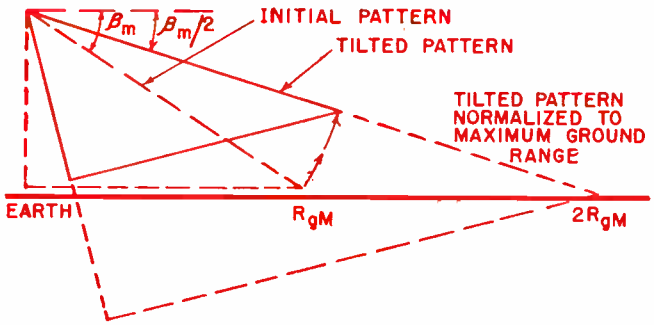

Fig. 2: Positive tilt is equal to half of β_m.

As illustrated by the drawings of Figs. 2 and 3, a radar display is adjusted so that a target located at the maximum range given by Eq. 4 appears at a comfortable viewing level on the radar scope, then

1. Positive tilt results in excessive illumination of the terrain at closer ranges; i.e., terrain displayed in the central region of the radar scope appears too bright; and

2. Negative tilt results in inadequate illumination of the terrain at closer ranges; i.e., the ground painting is dim at the center of the scope and brightens gradually to the maximum range.

The Real Antenna

Real antennas can only approximate the ideal pattern discussed to this point, as illustrated by the pattern for an airborne radar antenna in Fig. 4. This antenna has a beam which approximates the cosecant-squared type with its peak at 7°. According to the table, the range: altitude ratio is, then, 8.1. But since the gain is not zero for depression angles less than 7°, the ground painting does not disappear immediately beyond the maximum range; it slowly fades out. In fact, the decrease in gain is so gradual that on flight tests between 3000 and 20,000 feet essentially even ground painting is observed out to a range equal to twelve times the altitude. At even lower altitudes longer relative ranges are obtained, while at altitudes in excess of 20,000 feet, the ratio decreases in value.

Operating Procedure

In operating a radar system with a cosecant-squared beam, or some modification thereof, the optimum tilt setting may be established by the following procedure:

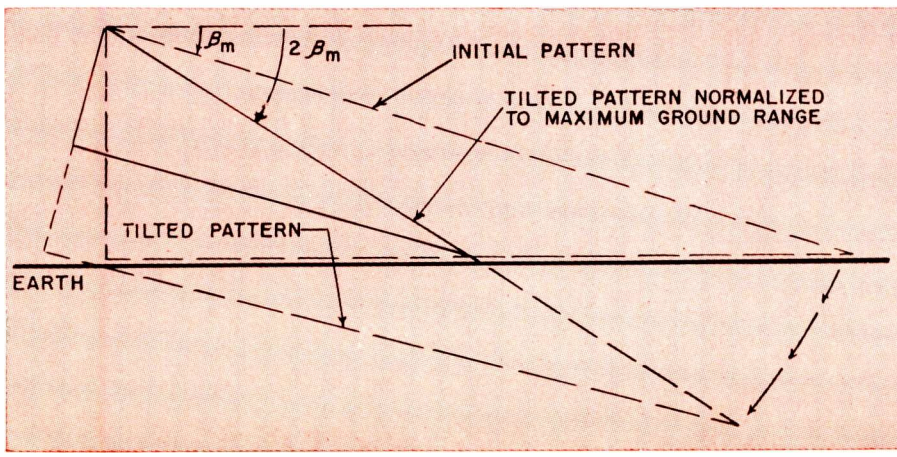

Fig. 3 (I.): Negative tilt equal to β_m.

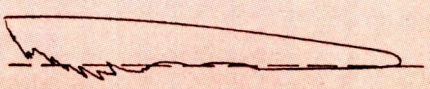

Fig. 4: Pattern of cosecant-squared antenna.

Antenna Tilt *(Concluded)*

1. While flying over relatively level ground set the antenna tilt at 0°.

2. Run the scope range out beyond the farthest ring of solid ground return.

3. Adjust the tilt so that the ground painting at near and far ranges achieves its most uniform quality. Increase the scope range while doing this if necessary.

4. Set the scope range according to the flight requirement, which presumably does not exceed the range: altitude ratio for uniform ground painting.

5. Readjust tilt slightly to make the display uniform, if necessary. This final adjustment usually does not exceed one degree.

The above method establishes a unique tilt angle for purposes of navigation or reconnaissance. Only if special targets are sought should this setting be changed, i.e.:

1. If a distant target is to be located, use positive tilt.

2. If a near target is lost in system noise, use negative tilt.

Another important exception to the operating procedure occurs when it is desired to retain a specified range at any altitude. For example, if a constant range of 24 naut. mi. is to be obtained with a system having the antenna of Fig. 4, there is no difficulty so long as the altitude exceeds 2 naut. mi. At lower altitudes, however, the antenna must be tilted upward in order to secure coverage to the maximum range (see Fig. 2). Then, to compensate for the excess illumination at closer ground ranges, a suitable sensitivity-time-control circuit must be incorporated. This circuitry is independent of any video antishading as the latter is designed about the sweep speed and overlap on the CRT. The former, on the other hand, depends upon the antenna pattern and tilt, and is placed in the i-f channel to prevent limiting of strong signals. The apparent complexity of these requirements may be largely avoided by designing the equipment so that proper tilt and compensating circuitry are ganged to the altitude control in the ground-range-sweep circuit. The operator then need make only occasional minor adjustments, as automatic compensation takes care of the predictable gross changes.

Acknowledgment: This report was prepared at the suggestion of Mr. Leolin Long, Chief, Surveillance Branch. His critical discussion of several sections were of great benefit in clarifying the presentation.

* * *

[1] A brief discussion of different antenna patterns is given in S. Silver, "Microwave Antenna Theory and Design," MIT Radiation Laboratory Series No. 12, *McGraw-Hill Book Company, Inc.*, New York, 1949, pp. 468-471. Electronic compensation for PPI shading is described in D. Levine, "Better Resolution Through PPI Shading," *Electronic Industries*, vol. 18, pp. 103-105, November, 1959.

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A Discussion

TO simplify discussion, it is advantageous to functionally group microwave ferrites, Table I. This table relates the significant effect with the type of device application.

Losses in Ferrites

The discussion of any ferrite application and especially those at microwave frequencies requires discussion of dielectric and magnetic loss mechanisms.

Dielectric Losses

There is a difference between the loss due to damping of polar lattice vibrations and loss due to high electrical conductivity. The latter is most significant to ferrite performance.

Conduction by mixed valences is cited, today, as the principal cause of conductive losses. This mechanism is typified by divalent and trivalent iron ions in a ferrite which is deficient in oxygen because of composition or sintering processes. Ascribing losses primarily to mixed valence mechanisms may be a gross oversimplification in most cases.

The divalent iron in a ferrite being sintered may form a solid solution or displace from the spinel lattice other divalent ions which form a second phase. This is the case with magnesium ferrite.[1] Here the divalent ion displaces magnesium ions from the spinel lattice which ions form separate crystals of magnesium oxide (periclase) and result in a very high conductivity ferrite.

A look at the phase diagram of most ferrites indicates a narrow region of oxygen content over which the composition can contain only a single spinel phase. Fig. 1.

For the magnesium-manganese system, there is no region in the vicinity of the stoichiometric composition where a single spinel phase may exist.* Close examination may reveal that many ferrites reported to have high or peculiar loss properties and behavior were beset by polyphase problems. These problems made either analysis or deficiency correction extremely difficult.

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* Private comm. with Dr. Davis of Raytheon.

J. B. Brauer

N. O. Korolkoff

Of Microwave Ferrites

Though their use is not increasing very quickly, these devices are becoming more and more popular. This article not only defines the primary loss mechanisms in ferrites, but also presents current trends, recent progress, and future developments.

Some of the means employed to prevent the effects of oxygen loss have been:

a. Sintering in oxygen, or other gases, at the ferrite's decomposition pressure.

b. Use of additives such as copper and vanadium to reduce sintering time and/or temperatures.

c. Introduction of a small amount of an ambivalent ion such as manganese or cobalt, which is more readily reduced at high temperature than is trivalent iron.

d. Replacement of appreciable amounts of the iron with another element such as aluminum which exists only in the trivalent state. This affects the resulting ferrite in several ways—increasing the lattice stability, decreasing the available oxygen which can be lost during sintering, and introducing interfering ions in the easy conduction paths which might otherwise exist.

Magnetic Losses

In ferrites, there is the familiar domain structure in which the elementary dipoles are all aligned and adjacent domains are separated by boundaries. In the boundaries, or Bloch walls, the spins gradually change direction. This wall has a thickness dependent upon conditions for minimizing the damping associated with spin exchange energy and the anisotropy. Magnetization of a ferrite results in alignment of the magnetic vectors with the applied field and growth of those domains favorably oriented with respect to the field. The effective permeability of a ferrite is the result of both effects, domain wall movement, and domain rotation.

Pringle[1] gives the following treatment for ferrites at microwave frequencies:

"The initial permeability, μ_i, has real and imaginary components due to damping forces and is usually expressed as $\mu_i = \mu_i' - j\mu_i''$. Where damping is small at low frequencies ($\mu_i'' = 0$) we can write:

$$\mu_i - 1 = 4\pi M_s^2 \left(\frac{1}{ad} + \frac{2}{3 M_s H_e}\right)$$

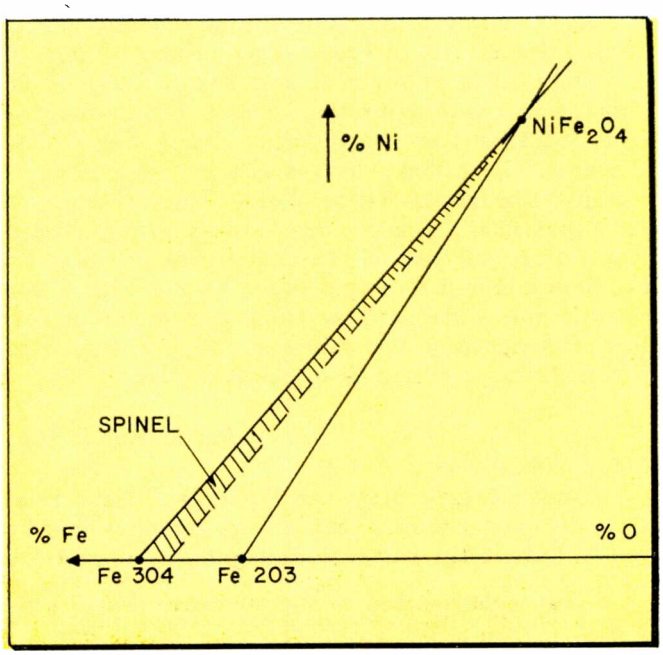
Here, ad = constants involving the stiffness in domain wall motion and domain size, respectively,

M_s = saturation magnetization, and

H_e = effective internal field within a domain.

Polder and Smit[2] show H_e to lie between the value of the anisotropy field, H_a, and $(H_a + 4\pi M_s)$. H_a is

Fig. 1: This is the single spinel phase region for nickel ferrite.



Microwave Ferrites (Continued)

TABLE I

Faraday Rotation	Phase Shift	Resonance Absorption	Second-Order Effects	Non-uniform Spin Wave Modes
Switch	Gyrator	Resonance Isolator	Frequency Doubler	Ferromagnetic Amplifier
Circulator	Field Displacement	Circular	Mixer	Limiter
45° Rotational	Isolator	Polarizer	Detector	
Isolator	Frequency Modulator			
Amplitude Modulator				

given by $4K_1/3M_s$ where K_1 is the first order crystalline anisotropy constant. Referring to the above equation, the first term represents the contribution due to domain wall movement and the second due to domain rotation. Both processes lead to resonances in the μ_i'' frequency spectrum. Rado, at al[2], gives the resonance angular frequency for domain wall movement as:

$$\omega_1 = \gamma\,(8\,\pi\,a)^{1/2}\,(A/K)^{1/4}$$

where γ is the gyromagnetic ratio, and A the exchange interaction energy per unit volume. Snoek[4] shows that the resonance angular frequency for pure domain rotation (from $\omega_2 = \gamma H_e$) is

$$\omega_2 = \frac{8\,\pi\,\gamma\,M_s}{3\,(\mu_i - 1)}$$

where μ_i is the initial permeability at low frequencies.

The condition for elimination of low field loss in an unsaturated ferrite medium is $f > f_{lim}$ where

$$f_{lim} = \frac{\gamma}{2\,\pi}\,(H_a + 4\,\pi\,M_s)\,.$$

For high field devices, the limiting frequency is that at which the field required for resonance equals the saturation field, and this is intimately connected with ferrite geometry.

Generally, magnetic losses in devices using alternating fields in the hundreds of kilocycles to tens of megacycles can be categorized as primarily domain resonance losses at low fields and hysteresis losses at high fields (near saturation). Both of these arise from "stiffness" of the domains and domain walls. Hysteresis losses may be reduced by reducing anisotropy although the low field losses may remain high for a particular frequency due to resonance in domain rotation or wall motion. The anisotropy constant K_1 can be minimized by employing a ferrite with a low Curie temperature such as NiZn ferrite[5], or by adjusting composition is a solid solution of two ferrites with anisotropy constants of opposite sign.‡

Device Applications

Low Field Devices

In such devices, from the Polder and Smit relation, the low frequency limit can be extended only by reducing both the saturation magnetization and the anisotropy. One method used to reduce saturation magnetization is substitution of a non-magnetic ion for part of the iron as is done in the ferrite aluminates.

High Field Devices

In high field devices, to eliminate low field loss, H_{sat} must be less than H_{res} and the condition for zero low-field loss becomes $\omega > \gamma\,H_a$. In a typical Ni ferrite with $\gamma = 3.22$ MC/oersted and H_a of about 400 oersted, the minimum frequency is about 1300 MC. Lax [7] writes a relation for maximum reverse to forward ratio in a resonance isolator at a frequency f as

$$R = \frac{(4\,f)^2}{\gamma\,\Delta\,H}$$

which shows the importance of narrow line width at low frequencies for a given front-to-back ratio. Broadband applications can be seen to require broad line width ferrites with fairly low γ; and narrow band applications with high back-to-front ratios require ferrites with narrow line width and low γ. Pringle[1] reports X-band isolators with power ratios in excess of 120:1 using a ferrite such as ($Ni_{0.975}\ Co_{0.025}\ Fe_2O_4$). More recently, ferrites such as Trans-Tech 414 have been used in X-band isolators exhibiting 20 to 40 db isolation (depending on power level) with ½ to 1 db insertion loss, respectively.

In high power devices, account must be taken of non-linear effects, Fig. 2. A typical resonance isolator investigated by Pringle[1] using MgMn ferrite strips against the broad faces of a rectangular wave guide is such an example. Lowering and broadening of the resonance absorption peak and appearance of a subsidiary absorption peak are explained by Suhl[8]. He states that as excitation of higher order spin wave modes which grow exponentially at the expense of uniform precession when the r-f field exceeds a certain threshold value. Threshold for saturation of the main resonance peak is given by

$$h_{crit} = \Delta\,H\,\sqrt{\frac{2\,\Delta\,H}{4\,\pi\,M_s}}$$

indicating the desirability of broad line width ferrites if these absorption anomalies are to be avoided.

High peak power uses require broad line width ferrites with a high Curie temperature (for high average powers); and, high power cw uses show the additional need for high resistivities.

‡ Typical of this technique is the NiCo ferrite system[6] using a small amount of Co ferrite which has a large positive K_1 is a Ni ferrite solid solution which has a small negative K_1.

Intermediate Field Devices

Non-reciprocal phase shift is based on the interaction of the microwave magnetic field with the Larmor precession of magnetization of a ferrite biased with a dc magnetic field. Fig. 3 shows typical phase and attenuation characteristics plotted as a function of the dc field strength. Such non-reciprocal devices as isolators and circulators make use of the difference in propagation constant for positive and negative circular polarization. The variation in propagation with applied field is used in switches and modulators.

In non-reciprocal phase shift devices, one must work with fields large enough to saturate the medium, but well removed from the resonance peak. Ignoring low field losses, Lax[7] gives a relation for maximum figure of merit (in terms of differential phase shift/loss) at a frequency f as

$$F_{max} = \frac{2}{\gamma \Delta H}$$

At lower frequencies there is more overlap of the low field losses and resonance losses, Fig. 3. The amount of overlap can be reduced by using material with a narrow resonance line width. Because of the low field losses, the figures of merit involving only line width are inaccurate below S-band. Ferrites for use in this range should show low saturation magnetization. In transverse devices operated above S-band, the ferrite is usually saturated so resonance loss predominates. Therefore, a narrow line width is of primary importance.

Devices Using Non-Linear Effects

In ferrimagnetic amplifiers and other devices based on non-linear effects, narrow line width and high saturation magnetization are desirable to reduce pumping power. The narrow line widths are desirable in connection with mixers and doublers, depending on second-order terms in the time crystal materials. The inherent stability of the garnet structures would indicate greater ease in obtaining the needed higher resistivities.

Current Trends

While the ferrite's microwave properties have been applied to a large number of useful devices, new and improved devices are vitally needed in several areas.

Considerable effort is currently being given to extending ferrite uses down to L-band and UHF. Availability of low noise microwave amplifiers has stimulated attempts to achieve lower insertion loss in conventional devices, particularly circulators. The advantages of inertialess antenna beam steering have aroused interest in the use of ferrites for rapid phase shifting or switching. Studies of high power effects indicate that ferrites may be useful for limiting, harmonic generation, and microwave delay techniques. Uses of ferrites and anti-ferromagnetic materials to millimeter wave devices are being studied.

Several requirements must be met by ferrite phase shifters for them to find practical application in electronically scanned antenna arrays. For a planar array, the phase shift taper across the array must be linear and must be an accurately known function of the applied signals from the scanning programer. Also, it must be possible to change the phase taper rapidly with a minimum of driving power. Successful use of ferrite phase shifters requires materials with very little variation of saturation magnetization with temperature. The requirement for uniform behavior of all the phase shifters in the array makes it desirable to use materials whose properties are closely reproducible from batch to batch. The difficulty of achieving this in polycrystalline ferrites would make it worthwhile to consider using long single crystals.

For millimeter-wave devices operating at fields below resonance, a high saturation magnetization is the main requirement. For conventional ferrites, resonance at 70 GC would occur for a field of approx. 25,000 oersteds. This requires an extremely bulky and power consuming room temperature magnet. Superconducting magnets[9, 10] would solve these problems, but the associated cryogenic equipment might be undesirable. The high anisotropy fields in certain ferrites can be used to aid the applied field, thereby alleviating the external magnet requirements. Barium ferrite has a uniaxial field of about 17,000 oersteds, which adds directly so that resonance at 70 GC requires an additional applied field of only 8000 oersteds[11, 12]. Antiferromagnetic materials also have high effective internal fields. Chromic oxide and manganese fluoride appear applicable to millimeter devices, although they must be used at liquid nitrogen and helium temperatures, respectively.[13]

Harmonic generation of millimeter waves has been demonstrated using single crystal YIG spheres to obtain conversion efficiencies of a few per cent for doubling from 70 to 140 GC with input powers of a few kilowatts.[14]

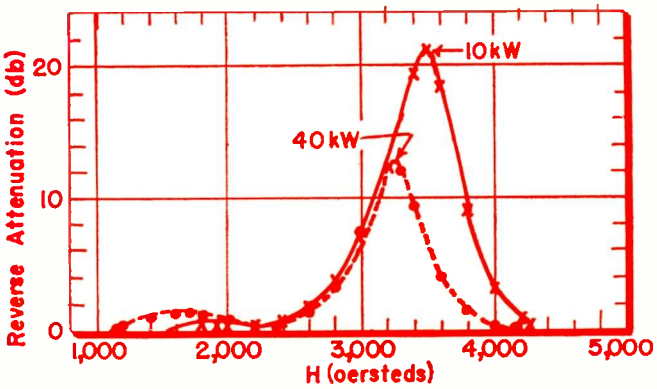
In addition to the non-linear behavior mentioned in the preceding section, other high power effects occur which have application to devices. The resonance broadening and appearance of a subsidiary absorption are shown in Fig. 2. For lower frequencies, coincidence of the main and subsidiary resonance occurs and an expression for critical power[15] may be written as:

$$P_{crit} = K \frac{(\Delta H)}{(M_s)^2}$$

At higher frequencies, the critical power is expressed by

$$P_{crit} = K \frac{-(\Delta H)^3}{M_s}$$

Fig. 2: Power level effect on resonance absorption for Mg-Mn ferrite.



Microwave Ferrites *(Continued)*

This means that the critical power in single crystal YIG with M_s = 1780 gauss and ΔH of about one oersted may be a few microwatts at frequencies below 3300 MC and a few milliwatts at higher frequencies. Broadening of the main resonance results in reflection limiting in a magnetic resonance filter, and the appearance of the subsidiary resonance results in absorption limiting. While restricting the power handling capability of ferrite devices, this limiting may be used to advantage for stablizing the output level of cw sources or for preventing cw amplifier saturation.

This high power effect has been described previously as due to excitation of higher order spin wave modes. It has been shown that the spin waves are coupled to phonons[16, 17]. Bommel and Dransfeld[18] used this fact to make a transducer between a microwave cavity and a quartz rod for propagation of acoustic waves at microwave frequencies. Availability of long single crystals of garnets might stimulate some experiments in the use of garnets as sonic delay elements at microwave frequencies.

Progress in Materials

The past year saw the first device marketed which uses a single crystal ferrimagnetic oxide. Using a concept suggested by DeGrasse, the Watkins-Johnson Company has developed a tunable filter operating over 2-4 GC which uses a single crystal YIG sphere. Using the same concept, work on ferrimagnetic limiters is being done in many laboratories. The use of single crystal ferrites of higher saturation magnetization will permit higher frequency operation of both device types. Lithium ferrite is now the best candidate for this latter use.

The growth of single garnet crystals has been further perfected. Nielsen has obtained crystals, from a flux, Fig. 4, which weigh up to 95 g. each and are 80% sound. Kramarsky (not published) has grown crystals of YIG with ferro-magnetic resonance line widths approaching 0.2 oe. at room temperature.

Nothing representing a striking breakthrough has occurred recently in polycrystalline ferrite compositions. Progress has mostly been in the processing techniques where efforts have been made to minimize losses and ensure uniformity and reproducibility in ferrites.

The magnitude of the low field loss due to domain wall motion can be reduced by the use of fine-grained ferrites, in which the crystallite size is less than the size of a single domain. However, it is still necessary to dilute the ferrite to prevent interaction between the crystallites which will cause a considerable increase in the line width.

One very promising improvement has been reported by Malinofsky.[19] He has prepared nickel ferrite by the flame spray technique, and has achieved particle sizes less than the domain size of the material. The domain rotation loss observed in most ferrites near 1000 MC was completely suppressed. This result could be important to those microwave applications where low field losses are a problem.

Although not strictly materials, the observation by Hartwick, Peressini, and Weiss[20] that the subsidiary resonance in YIG crystals can be completely suppressed by modulating the dc field is extremely important. This experiment was performed to test a prediction of Suhl's[21]. It holds out promise of increasing the signal level at which ferrites can be used

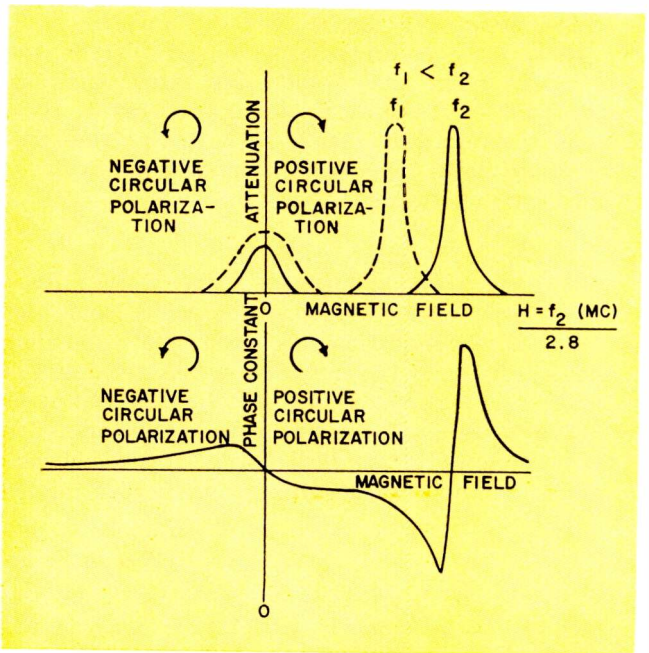


Fig. 3: Some typical phase and attenuation characteristics plotted as a function of the direct current field strength which is applied.

Weiss[22] has also suggested that the proper modulation of the dc field might lead to early appearance of subsidiary resonance. This would make very low level limiters possible.

The problem in ferrites remains much the same, i.e., reproducibility, poor loss characteristics, etc. In addition, the increasing use of high power levels in radar systems compound these difficulties. It is possible that there are still ferrite systems and processing techniques left which will drastically improve ceramic ferrite performance, but much work has been done and the performance of most compositions can be predicted fairly well. Thus, barring discovery of a new system, the power levels above which ferrites cannot be used are probably in sight. For instance, Schlomann, et al,[23] has suggested the upper limit of

several megawatts peak power for resonance isolators.

The problem of making low loss, low saturation, high Curie temperature ferrites for S- and L-band devices has not been completely solved although gadolinum substituted YIG has come into use more and more.

In the single crystal growth field one big problem remains—the growth of sound, large crystals of ferrites and substituted garnets which are stoichiometric and of uniform composition. In other words, the problem of the growth of large, uniformly stoichiometric crystals of high melting oxide solid solutions has not been solved.

Observations

There is a point which can hardly be overemphasized in light of much of the past effort in developing ferrite materials and uses. Significant advances in any of these areas require not only efforts in developing ferrites with microwave properties tailored for particular applications, but also investigations of the physical mechanisms affecting the microwave properties. Recent years have brought significant advances in ferrite theory and a greater understanding of their behavior in microwave and other uses. Much of this resulted from the observations made in carefully conducted empirical investigations. However, a tremendous amount of effort devoted to experimentation or "development of improved ferrites" has been of dubious, if any, value. For example, some extensive programs on low loss ferrites were conducted to establish quantitative correlation with processing parameters without a close look to determine that what was believed to be single phase material actually contained an extremely glossy second phase.

Some considerations which might serve as suggestions for future effort in the area of ferrite materials are:

a. The effect of materials purity as well as oxygen stoichiometry on conductive behavior. This would involve a rather detailed treatment of conduction processes, and definition of constitutional diagrams to differentiate between single phase and "spinel-plus" compositions.

b. Preparation and study of single crystals in representative ferrite classes and serious attempts to bring polycrystalline properties near those of the single crystal. Rupprecht (not published) has shown that losses in the ceramic form of $SrTiO_3$ dielectrics can be brought to within a factor of two times the single crystal properties by control of purity and post sintering anneals.

c. Survey of ferrite properties over respectable temperature and frequency spectra. A spot check of ferrite properties at a single frequency well below the intended frequency for use may be hopelessly inadequate in many cases. In this regard, it seems somewhat depressing to receive manufacturers, literature on a "microwave ferrite" with property data given only at 20 MC. Goodwin (not published) has conducted extensive measurements on a number of commercial ferrites and garnets at 77°K and 4.2°K.

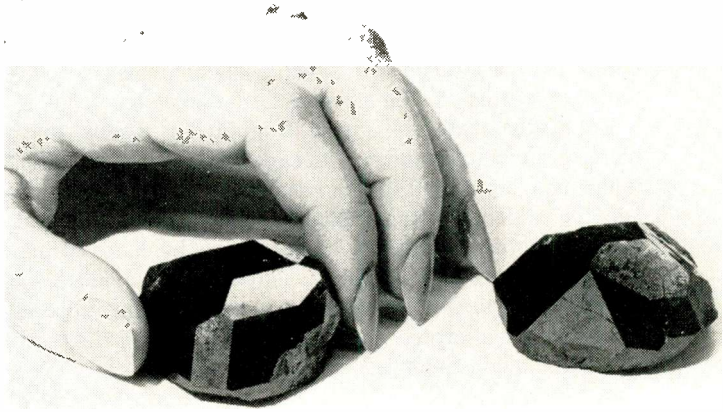


Fig. 4: These crystals, obtained from a flux, weigh up to 95 gms. each.

d. A first look at thiospinels or ferrites based on other unusual spinel systems.

e. Consideration of topotactical grain orientation, magnetic anneal, or other means for achieving orientation in ferrites for specific purposes.

References

1. Pringle, D. H., and Hepburn, W. D., "Solid State Phys. in Elect. and Telecom.," Vol. 3, Part 1, *Proc. of 1958 Int. Un. of Pure and Appl. Phys.*, Brussels, 1958.
2. Polder, D., and Smit, J., *Rev. Mod. Phys.* 25, 89 (1953).
3. Rado, G. T., Wright, R. W., and Emerson, W. H., *Phys. Rev.* 80, 273 (1950).
4. Snoek, J. L., *Physica's Grav.* 14, 207 (1948).
5. Wijn, H. P. J., Gevers, M., and van derBurgt, C. M., *Rev. Mod. Phys.* 25, 91 (1953).
6. Whitehead, C. W., and Will, M. S., Admiralty Internal Report, July 1957.
7. Lax, B., *Proc. IRE, N. Y.*, 44, 1368 (1956).
8. Suhl, H., *Phys. Rev.* 106, 384 (1957).
9. Kunzler, J. E., Buehler, E., Hsu, F. S. L., and Wermick, J. H., "Superconductivity in Nb_3Sn at High Current Density in a Magnetic Field of 88K Gauss," *Phys. Rev.* Letters 6, 89 (1961).
10. Arp, V. D., Kropschot, R. H., Wilson, J. H., Love, W. F., and Phelan, R., "Superconductivity of Nb_3Sn in Pulsed Fields of 185 Kilogauss," *Phys. Rev.* Letters 6, 452 (1961).
11. Brady, I., and Collins, T., "Ferromagnetic Line Width of Single Crystals of Barium Ferrite," Tech. Rept. 2116, DA Task Nr. 3A99-15-001-01, U. S. Army Signal Research and Development Lab., Ft. Monmouth, N. J. (1960).
12. DeBitetto, D. J., duPre, F. K., Brockman, F. G., Steneck, Jr., W. G., "Hexagonal Magnetic Material for Microwave Applications," Third Quarterly Report, Contract No. DA 36-039-SC-85379, Philips Laboratories, Irvington-on-Hudson, N. Y. (1960).
13. Heller, G. S., Stickler, J. J., Thaxter, J. B., "Antiferromagnetic Materials for Millimeter and Submillimeter Devices," Report No. 82-G-0023, AF 19 (604)-7400, MIT Lincoln Lab. (1960).
14. "Investigation of Microwave Non-linear Effects Utilizing Ferromagnetic Materials," 13th Quarterly Report, Contract DA 36-039-SC-73278, Melabs, Palo Alto, Calif. (1960).
15. Suhl, H., "The Non-linear Behavior of Ferrites at High Microwave Signal Levels," *Proc. IRE* 44, 1270 (1956).
16. Scholmann, E., "Generation of Phonons in High-Power Ferromagnetic Resonance Experiments," *J. Appl. Phys.*, 31, 1647 (1960).
17. Turner, E. H., "Interaction of Phonons and Spin Waves in Yttrium Iron Garnet," *Phys. Rev.* Letters, 5, 100 (1960).
18. Bommel, H., and Dransfield, K., "Excitation of Hypersonic Waves by Ferromagnetic Resonance," *Phys. Rev.* Letters 3, 83 (1959).
19. Malinofsky, W. W., Babbit, R. W., *J. App. Phys.*, Supplement 32, No. 3, 2375 (1961).
20. Hartwick, T. S., Peressini, E. R., Weiss, M. T., *Phys. Rev.* Letters, 6, 176 (1961).
21. Suhl, H., *Phys. Rev.* Letters, 174 (1961).
22. Weiss, M. T., presented at a conference on ferromagnetics and ferroelectrics, California Inst. of Tech., 23 Feb. 61.

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Design Information for . . .

Regulating and

Part One of Two Parts

IN designing high-voltage power supplies, voltage regulation is a prime consideration. However, voltage stabilization is also very important. Many times the two terms are used rather carelessly; it is wise, therefore, to be precise and accurate.

Carefully stated, Voltage Regulation means maintaining a constant output voltage from a power supply when the input voltage is constant, and the load current is varied. Voltage Stabilization means maintaining a constant output voltage when the load current is constant, but the input voltage is variable. In practice, a single problem is seldom encountered. However, to analyze and to design the circuitry, the two must be considered separately.

Low-Voltage Supplies

Many engineers have been exposed to design experience in the areas of regulation and stabilization of low-voltage power supplies (voltages below 400 v). Here, a standard gas tube operating in the glow-discharge mode can be used as a shunt regulator. A simple circuit is shown in Fig. 1. There are applications needing a more precise degree of voltage regulation or stabilization, or involving greater currents than the simple circuit can control. In this case, the engineer is likely to design a circuit using this same type of glow-discharge tube or a zener diode as a reference voltage. The output of the power supply is then divided down to a value approximating that of the reference. This fractional output is compared to the reference voltage and an error signal developed. This error signal can be amplified and applied as grid bias to a series pass tube, Fig. 2.

High-Voltage Regulation

In the past, low-voltage designs were not easily applied to high voltage. This was true because gas discharge regulator tubes, operating in the glow mode, are limited to about 150 v each. For voltages higher than 150, glow-discharge VR tubes must be stacked.

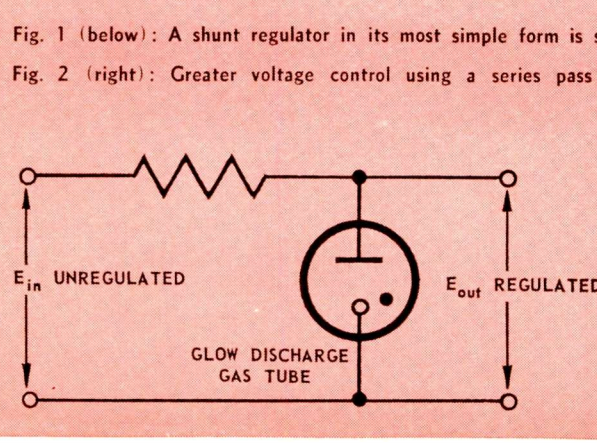
When the pass tube concept is to be used, a problem of the availability of an adequate pass tube arises. The plate voltage capabilities of the pass tube must be at least equal to the sum of the unregulated voltage excursions, plus the minimum operating plate voltage. The plate current capacity must be at least equal to the sum of the load and the reference currents. The tube should have a high transconductance as well as a high mu, since the regulation of the final circuit is about proportional to the transconductance of the pass tube. Its stabilization is about proportional to the amplification factor of the pass tube.

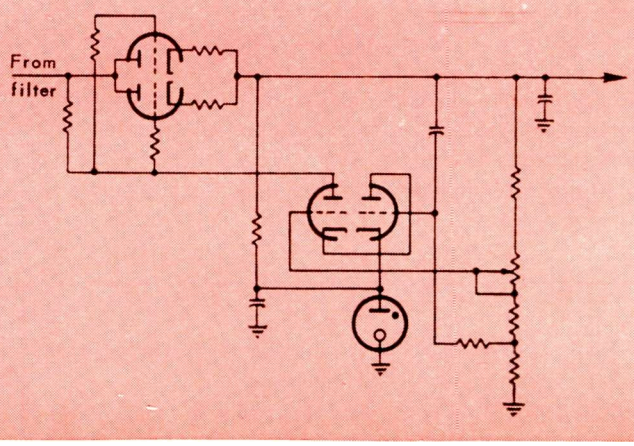
Components are now available which permit applying the low voltage design ideas to HV operation.

First, there are the Corotrons, Fig. 3. They are a family of gas discharge tubes operating in the corona mode of discharge. These tubes can be used at high voltage as shunt regulators in about the same way that glow-discharge VR tubes are used at low voltage. Due to recent improvements they also qualify as reference tubes.

Secondly, there is a family of voltage pentodes and triodes, with plate voltage capabilities up to 10 Kv and

Fig. 1 (below): A shunt regulator in its most simple form is shown.
Fig. 2 (right): Greater voltage control using a series pass tube.





Voltage regulation and stability are the prime considerations in the design of power supplies. In the design of high voltage power supplies these problems have been considered particularly formidable. Only, however, because the components suitable for this work, as well as the design techniques, have not been fully understood.

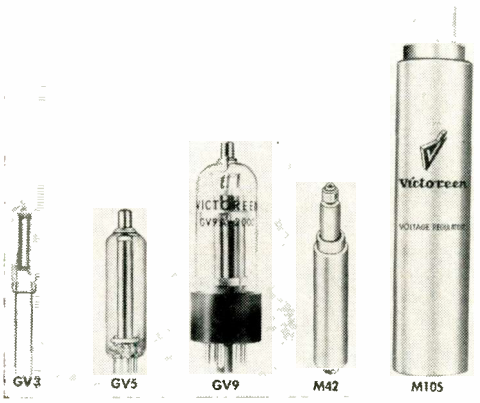


Fig. 3: HV power supply control tubes.

Stabilizing HV Power Supplies

having high transconductance and high mu, which qualifies them as good pass tubes. There are points that are alike and unlike between the normal VR tube, which operates in the glow mode of discharge, and the Corotron which functions in the corona mode.

This can be shown by briefly describing the gas-discharge phenomenon. First, picture 2 coaxially positioned cylindrical electrodes. For reasons to be explained later, the geometries of the electrodes in Fig. 4 will be restricted so the ratio of the diameters of the outer cylinder to the inner cylinder exceeds "e" (about 2.78). In practice, the ratio is never less than 3:1.

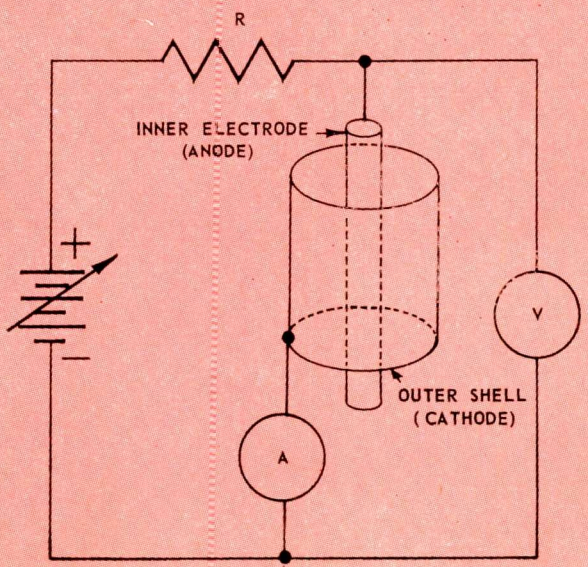
These cylinders are enclosed in an envelope which has been evacuated and filled with an ionizable gas. The gas used is hydrogen since it is best for our purpose. Connect this tube to a circuit as in Fig. 4. A variable input voltage is applied to the tube through a series resistor and the outer cylinder is made negative with respect to the inner cylinder. In effect, the outer cylinder is the cathode and the inner cylinder or rod is the anode.

Assume the current through the tube is monitored by an "ideal" microammeter and the voltage across the tube is monitored with an "ideal" voltmeter. By "ideal" we mean that the voltmeter consumes no power and the microammeter is of practically zero resistance.

Tube Ionization

As the voltage source is slowly increased from zero to higher values, assume a plot is made of the volt-ampere characteristics of the tube, with current displayed on the horizontal axis and voltage displayed vertically. Until a certain voltage at the supply has been reached, there will apparently be no current flow through the tube, and the voltage across the tube is the same as the supply. However, a close look would reveal that in the presence of some external ionizing events (such as radioactivity) there are minute currents flowing. The magnitude is proportional to the amount of external energy to which the tube is sub-

Fig. 4: Basic circuit is used to show operation of Corotron.



HV Power Supplies
(Continued)

Table 1

Typical Voltage and Current Data for the Type GV4S Series Corona Tubes

Type	Nom. Voltage @ 100μa Test Point	Tolerance	Current in Microamperes Min.	Max.	Peak	Regulation* (Max.)	Altitude (Feet)
GV4S-400	400V	± 6V	10	200	300	4V	72,000
GV4S-600	600V	± 9V	10	300	400	7V	70,000
GV4S-800	800V	± 12V	10	400	500	10V	68,000
GV4S-1000	1000V	± 15V	10	500	600	20V	65,000
GV4S-1200	1200V	± 18V	15	600	800	30V	65,000
GV4S-1600	1600V	± 24V	20	800	1000	50V	60,000
GV4S-2000	2000V	± 30V	20	1000	1200	75V	55,000
GV4S-2400	2400V	± 36V	25	1000	1400	90V	50,000
GV4S-2600	2600V	± 39V	30	950	1500	90V	50,000
GV4S-2800	2800V	± 42V	30	900	1600	95V	47,000
GV4S-3000	3000V	± 45V	30	850	1750	95V	45,000
GV4S-3200	3200V	± 48V	35	750	1800	85V	42,000
GV4S-3400	3400V	± 58V	35	750	1900	90V	40,000

* This regulation is the change in voltage over useful range of current from min. to max.

jected. This device is actually an ionization chamber.

If the source voltage is increased, the current flowing as a result of the ionizing energy is also increased. This is due to gas multiplication. This tube is now operating as a proportional counter. If the collecting voltage is increased until the gas multiplication produces pulses of equal amplitude for all ionizing events, regardless of initial energy, the tube is acting as a Geiger tube. The current is now proportional to the number of events-per-unit of time rather than total energy. The current depends upon the external energy —it would be zero without that energy.

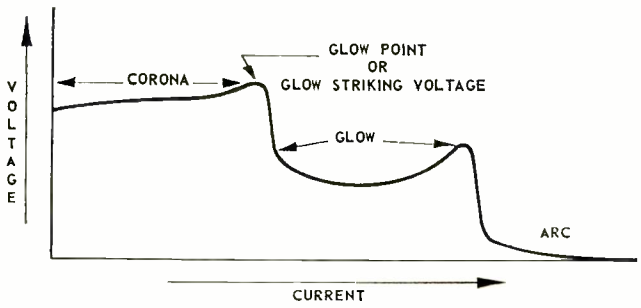


Fig. 5: Curve shows the volt-ampere characteristics of a Corotron.

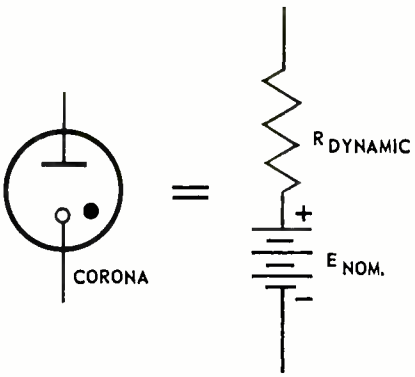


Fig. 6: The equivalent circuit for a gas discharge tube in the corona mode.

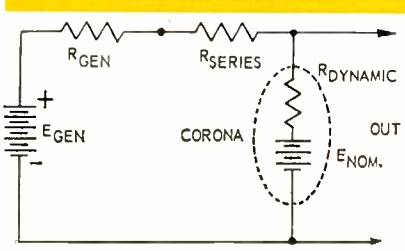


Fig. 7: A simple circuit used to analyze the tube in Fig. 6.

If the source voltage is increased to a value where the resulting electric field ionizes the gas near the anode, current will flow without the external energy. As the source voltage is increased, the current through the tube increases, but the voltage across the tube remains almost constant, rising only slightly. The tube is now operating in the corona mode of discharge and the ionization is mainly due to the electric field. A close look reveals a faint glow around the anode. Also, as the current increases, this visible glow around the anode increases in both intensity and distance from the anode.

If the current is further increased, there will be a slight increase in voltage across the tube. However, the entire difference between the voltage across the tube and the voltage of the source now appears across the series resistor. This region of the volt-ampere characteristic offers good means of using the tube as a VR. However, if this current is increased even more, a sudden discontinuity appears, the voltage rises abruptly, and takes a sharp dive downward. Fig. 5. This is known as the "glow point" for the tube.

Observing the tube at this point, the area of visible light suddenly shifts from its position around the anode to one discreet spot on the cathode. The tube then operates as a negative glow tube, and the mode of discharge is known as "glow" mode. The spot at which this glow occurs is that spot on the cathode which exhibits the lowest work function.

Ionization appears at the cathode where the ions have been so accelerated that they bombard the cathode with enough energy to produce secondary emission from that spot. As the current through the tube is increased, voltage across the tube diminishes, and the area where visible glow appears starts to spread. Eventually the complete cathode is again

(*Continued on page* 124)

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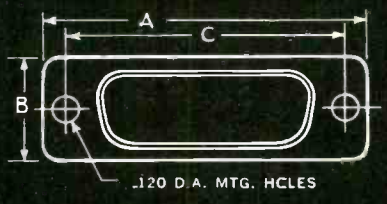

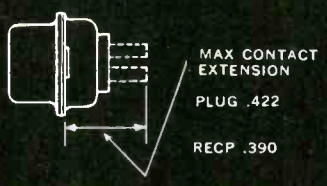

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9	DESM— 9P	DESM— 9S	1.213	.494	.984
15	DASM—15P	DASM—15S	1.541	.494	1.312
25	DBSM—25P	DBSM—25S	2.088	.494	1.852
37	DCSM—37P	DCSM—37S	2.729	.494	2.500
50	DDSM—50P	DDSM—50S	2.635	.605	2.406

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(*Continued from page* 122)
covered by this glow. Further increase of current produces an expansion of the glow toward the center of the tube.

The VA curve, Fig. 5, reveals positive slope instead of the negative one which had been exhibited. The tube is now operating in the abnormal glow region, while that portion which exhibited the negative slope is known as the "normal glow" region.

Further increase of current through the tube will result in another sharp discontinuity. Here the voltage across the tube takes another very low drop. This action is accompanied by light streamers crossing from the cathode to the anode and completely enveloping the space between the anode and cathode. The tube is now operating as an arc discharge tube and added current flow results in a decrease in voltage across the tube.

Obviously, a gas-discharge regulator can be built to operate in the corona mode just as normal VR tubes are made to operate in the glow mode.

Design Procedure

There are, however, some points of dissimilarity which would slightly alter the design procedure for using these tubes. For instance, if a tube were to be operated at 2000 v, one question might be asked: "What is the firing voltage?" This is a fair question, since one of the main problems in designing a circuit using a glow-tube regulator is the availability of a voltage that would be equal to the peak which precedes the glow mode. (This is shown in Fig. 5.) Otherwise the tube would never operate in the glow region. This peak is called "striking or starting voltage" for the glow tube, or the "glow point" for the corona tube.

Looking at the curve in Fig. 5 shows there is no discontinuity just before the corona mode, and that the striking or starting voltage will be identical with its operating voltage. This does not mean that a difference is not needed between the unregulated and the regulated voltage. If it were simply a matter of "voltage regulation" then no difference would be required—since the shunt tube would merely change its current by an equal but opposite amount when the load current was changed. However, this again assumes a power supply with theoretical zero source-impedance.

Voltage stabilization, on the other hand, assumes a varying unregulated voltage and a constant load current. For example, Fig. 6 is the equivalent circuit for a gas discharge tube in the corona mode. It consists of a dc voltage exactly equal to that of the tube's starting voltage in series with a resistor, which is the dynamic resistance of the tube. Here, dynamic resistance being ΔE over ΔI, is in other words, the slope of the regulating curve. Applying simple math to the circuit (Fig. 7) shows that any change in the source voltage will divide itself between the series resistor and the dynamic resistance of the regulator tube. The change is in direct proportion to their respective resistances. Therefore, the best stabilization ratio is produced when the ratio between the series resistor and the dynamic resistance of the tube is a maximum. This implies a large over-voltage at the source, compared to that at the load.

The next question asked is "How much capacity can be placed across this corona voltage regulator to reduce the ac dynamic resistance of the output of the supply?" Basically, when a capacitor is placed across a glow tube, a relaxation oscillator is developed which destroys the whole circuit as a regulator. However, it makes good saw-tooth generator. Naturally one would think that this same pitfall should be avoided with the corona tube.

On second thought we are reminded that negative resistance is required for a relaxation oscillator. Since the corona tube exhibits only positive resistance, it cannot be used as a saw-tooth generator. Capacitance, therefore, can be used to reduce the ac impedance of the output of the supply—provided that, under no circumstances is the current through the tube permitted to exceed the glowpoint, even as a result of transients or ripple.

Table 1 gives data on the various models of one series of corona tubes and lists several values of current for individual tube types. If the output of a power supply, which is regulated by a corona tube operating in very low-current regions, is observed on an oscilloscope, noise and hash are seen. A minimum current is needed to sustain a steady, noise-free discharge. In fact, these tubes have been used as noise generators below this value. This is known as a region of low-current instability. To eliminate noise when the tube is used as a shunt regulator, the tube must be operated only at current levels above the published minimum.

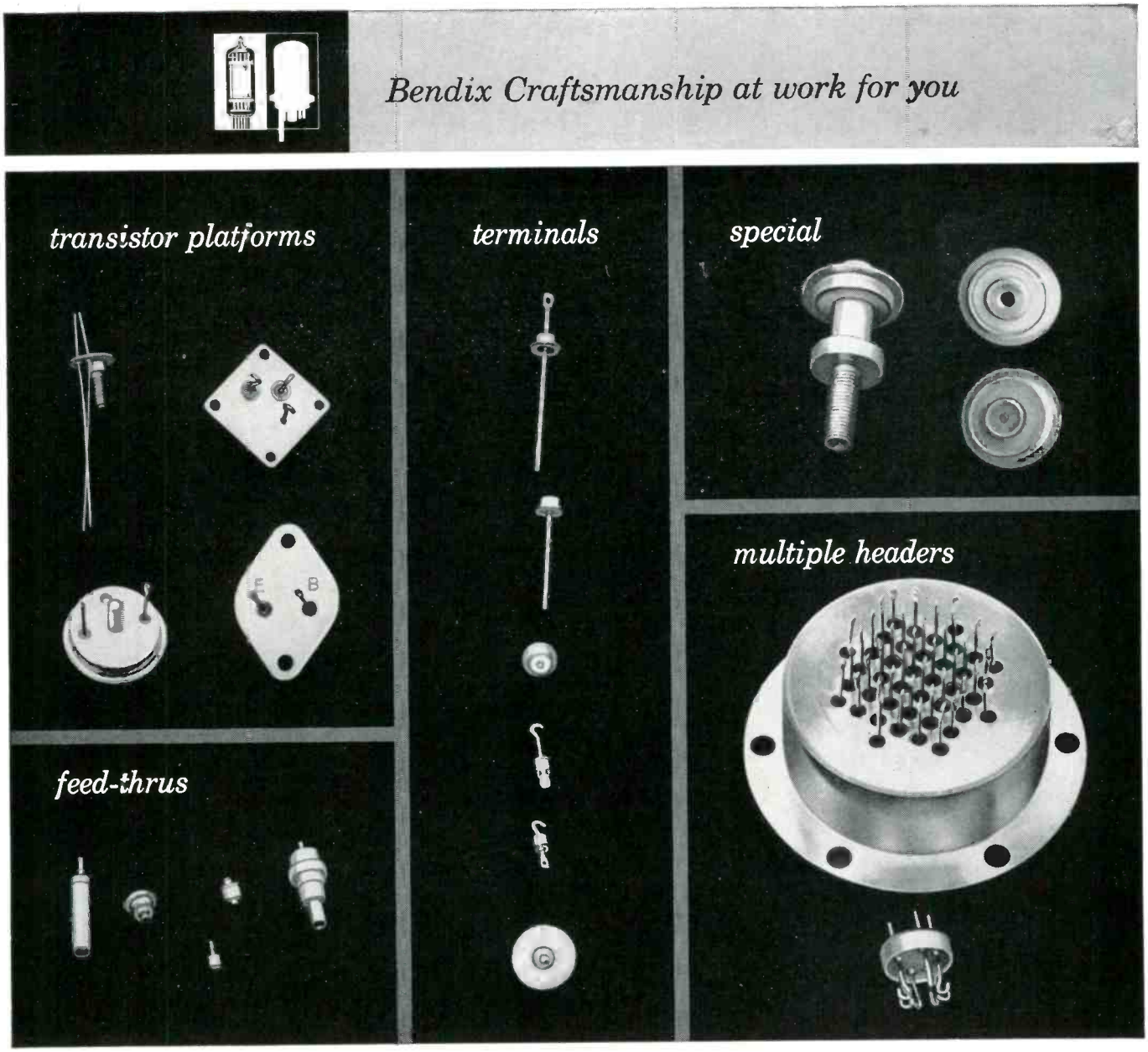
The maximum current allowed is that value of current at which continuous steady-state operation can be done with no harmful effect to the tube. This value is well below the glow point. Each envelope has a maximum wattage dissipation limit to preserve safe operating temperature. Therefore, steady-state operation should never exceed the maximum current.

Since there is, however, a spread between the maximum and the glow point, transients which produce very little heating may be allowed to occur in this region. A value of peak current (well below the glow point) is listed as the current to which transients may force the tube to operate. The duty cycle of these transients must be so short that very little heating results.

The column in Table 1 called "regulation" shows the slope of the regulation curve from the minimum to the maximum current listed. This could also be expressed in ohms of dynamic resistance.

Observing these points of difference between the corona tube and the glow tube, it becomes a simple matter to translate glow-tube circuit design techniques into corona tube circuit design for higher voltages.

(*To be Continued*)



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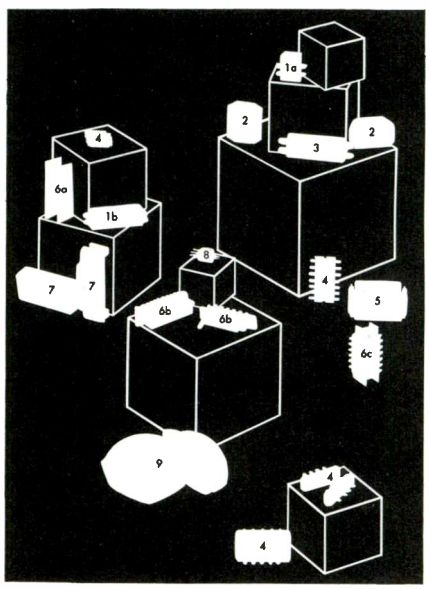

Amphenol connectors shown on the opposite page are: **1**—Min-Rac 17 with (a) crimp-type contacts and (b) solder-type contacts **2**—94 Series **3**—Micro-Ribbon **4**—126 Series Rectangular **5**—93 Series **6**—Blue Ribbon with (a) barrier polarization, (b) pin polarization and (c) keyed shell and barrier polarization **7**—126 Series "CNI" **8**—126 Series Hexagonal **9**—Circular Blue Ribbon

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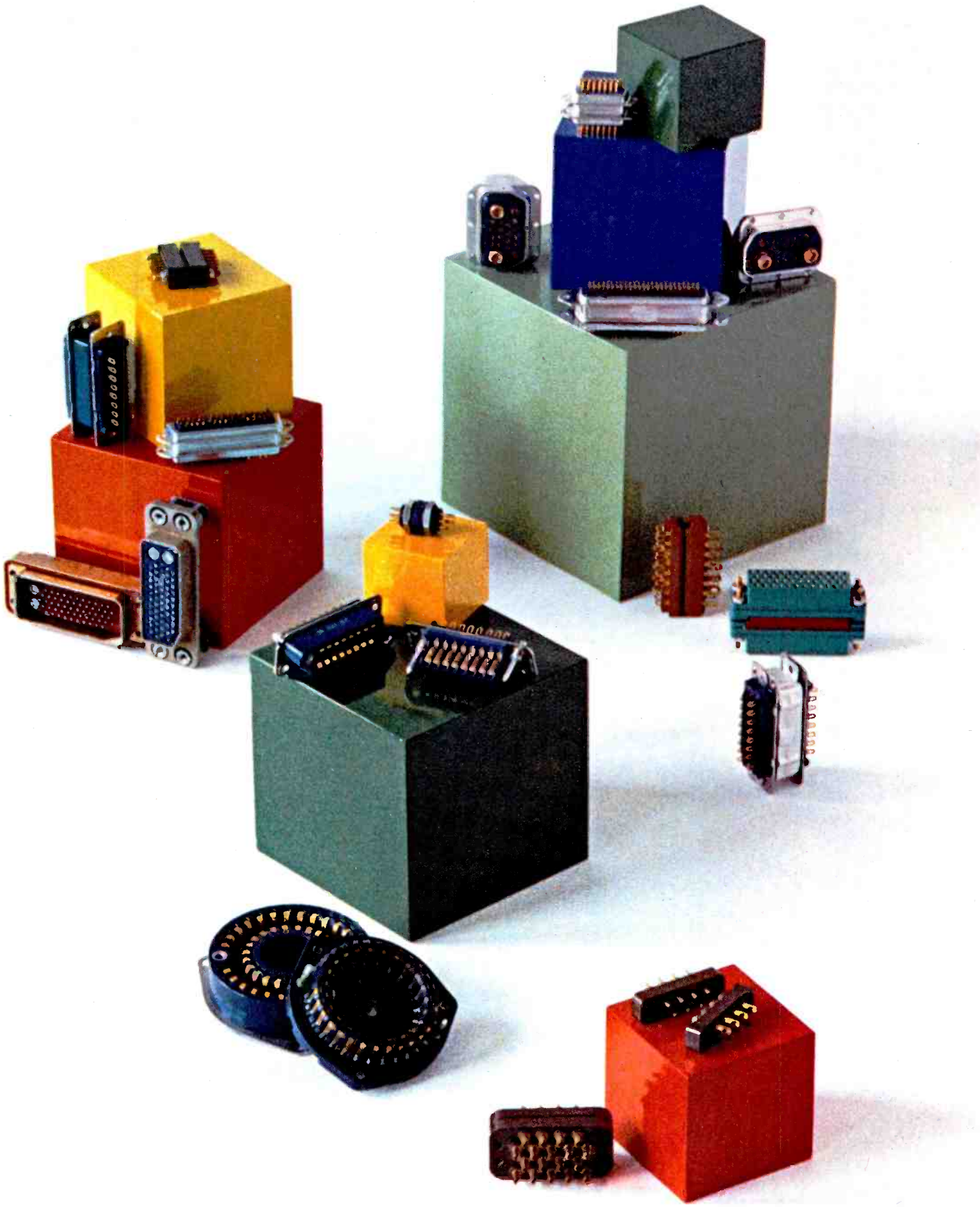

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						Minimum	Maximum
1N3152 & 1N3153*	5.5 Vdc	1.0 μAdc**	1.1 Vdc	4	2Ω	3.55 pf	4.45 pf

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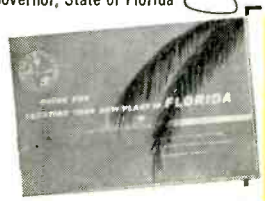

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Relaxation

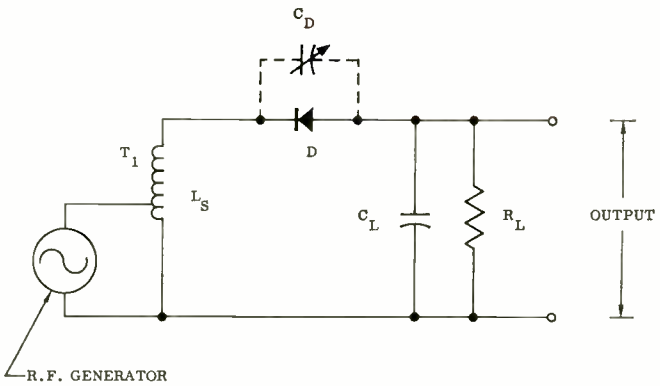


Fig. 1: The basic circuit for relaxation oscillation is simple.

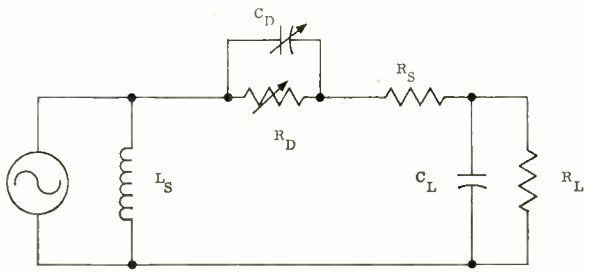


Fig. 2: Equivalent for relaxation oscillation circuit of Fig. 1.

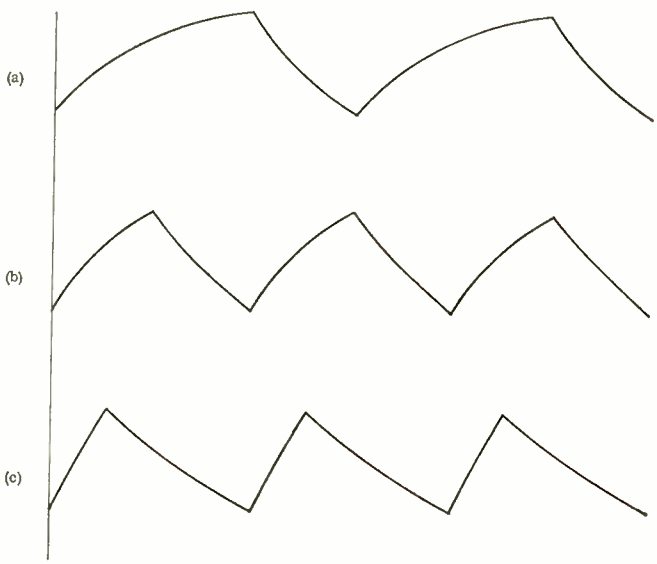


Fig. 3: Some typical waveforms observed at frequencies below 5 KC.

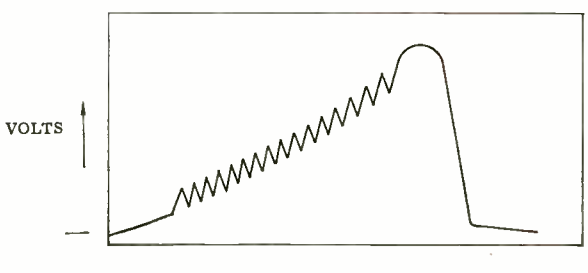


Fig. 4: Relaxation oscillation with r-f sweep generator as driver.

A JUNCTION diode in a circuit with an r-f driving frequency can show strange traits, e.g., relaxation oscillation. For a given diode and driving frequency, the relaxation oscillations can be varied from the low audio range to the megacycle region; but, they are always less than the driving frequency.

The oscillation depends on the delay in setting up the diode depletion layer when switching from a forward conducting state to a reverse bias condition by the r-f voltage source. This delay is reflected in the diode capacitance which is inversely proportional to the depletion layer width.

Varying the R_L and C_L time constant, Fig. 1, changes the oscillation frequency. When the nonlinear diode capacitance, C_D, is resonant with the inductance, L_S, at the driving frequency, we have the basic condition for relaxation oscillation. This article describes the operation theory and discusses the diode traits contributing to this phenomena.

Basic Circuit

The basic circuit for relaxation oscillation, Fig. 1, is simple; but, the operating theory is somewhat complex. It requires an understanding of diode traits.

Here are the conditions for oscillation:

(a) L_S and C_D form a parallel resonant circuit ($C_L >> C_D$).
(b) T_1 steps up the driving voltage from a low impedance r-f signal generator.
(c) The driving frequency f operates on the l-f side of the parallel resonant circuit.
(d) C_D varies with the dc bias developed across the diode due to rectification.
(e) R_L is relatively large and the output frequency changed by varying C_L.

The output frequency is variable over a wide range. Fig. 3 shows typical waveforms. In Fig. 4, a sweep

Experiments have revealed a relaxation oscillation characteristic when junction diodes are driven by an r-f voltage source. This article describes the circuit and operating principles for generating these oscillations.

Oscillations with Junction Diodes

frequency shows oscillations on the l-f side of the resonant circuit. The oscillations occur only after a certain dc self-bias develops across R_L and C_L. This bias also appears across the diode. This established the minimum static value of C_D.

A sharp voltage drop, Fig. 4, occurs as the frequency sweeps past the peak resonant point. This action is bistable; and, it can be obtained by varying the r-f voltage amplitude or frequency. This bistable action has no significance for relaxation oscillation.

General Operating Theory

A P-N junction is an internal boundary within a single crystal of germanium or silicon, in which the two regions have been doped with different kinds of impurities. Such a device allows current flow with ease in one direction but with difficulty in the other. This is shown by the diode equation:

$$I = I_S - I_S\left[\left(\exp\frac{qv}{kT}\right) - 1\right]$$

where, I_S = reverse saturation current
V = voltage across diode
q = electronic charge
T = absolute temperature
k = Boltzman's constant

With this characteristic, Fig. 5, the diode has a low

(*Continued on page* 134)

Fig. 5: Diode static V-I characteristic. The dotted line indicates curve when switched rapidly from forward conducting to reverse bias.

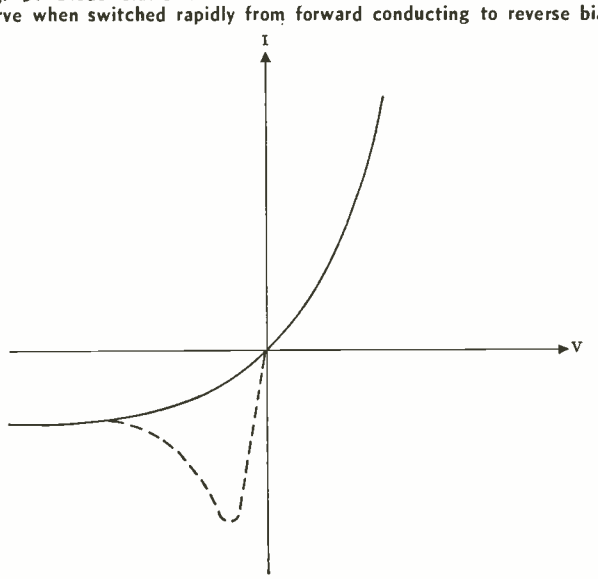
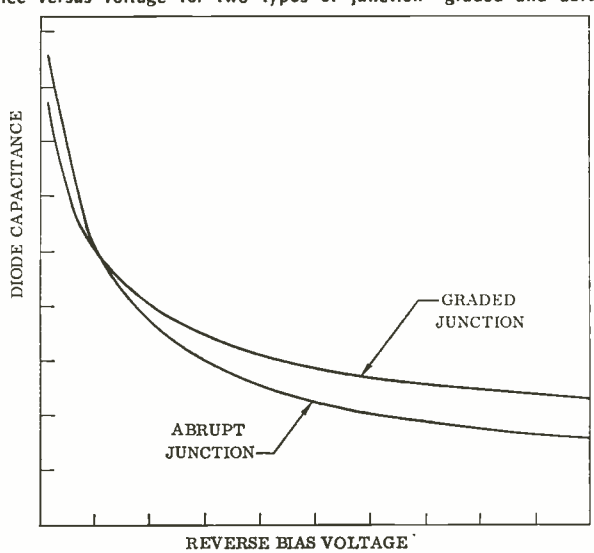


Fig. 6. The typical static characteristic curves for diode capacitance versus voltage for two types of junction—graded and abrupt.



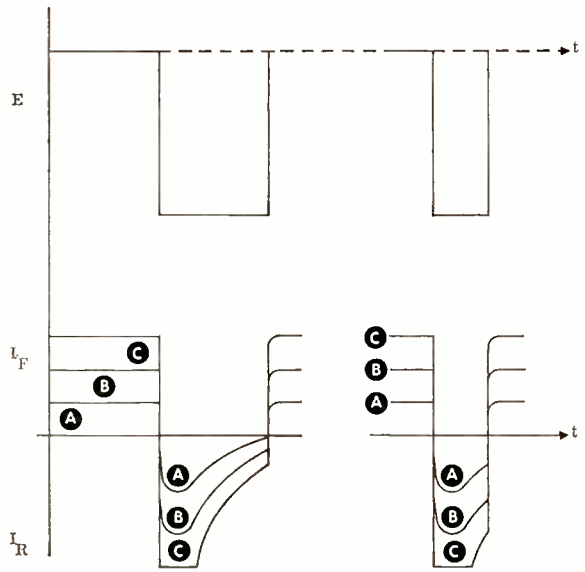


Fig. 7: The recovery characteristics of a junction diode to a long pulse and a short pulse for various values of forward current. With the large forward currents, the recovery time becomes greater.

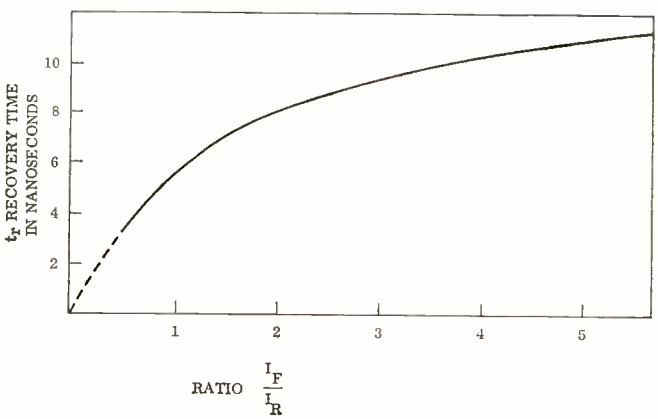
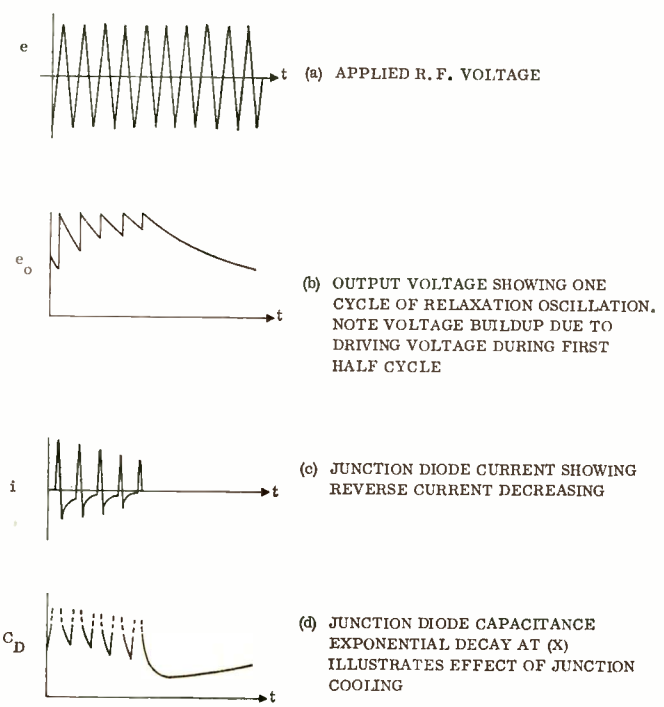


Fig. 8 (above): Typical variation of recovery time with the ratio of maximum forward current to maximum reverse current for a diode.

Fig. 9 (below): Some typical waveforms show the relationship of current, voltage, and diode capacitance during one cycle of oscillation.



Junction Diodes *(Continued)*

forward resistance and a high backward resistance. This relatively complex concept is more easily understood if the movement of charged carriers is treated as if it were due to electrons and holes. In either end of the diode both carriers exist. The majority carriers in one end will be electrons; in the other, holes. A thin layer between the P-N junction is practically free of holes and electrons. This region is known as the depletion layer.

Diode Capacitance

The capacitance of the junction is very nearly that of a parallel plate capacitor. This capacitor's dielectric constant would be equivalent to that of the junction material: its thickness, that of the depletion layer.

$$C = \frac{K \phi A}{d} \text{ (farads)} \qquad (2)$$

where, K = relative permitivity of the junction
ϕ = permitivity of free space
A = junction area
d = effective thickness of junction

At zero bias, an electrostatic potential difference exists across the depletion layer, although no actual voltage can be measured at the junction. As the voltage across the diode is increased, in the forward direction, the depletion region is narrowed. This corresponds to the replacement of charges in the transition region. Electrons are built up on the N side; holes, on the P side. The narrowing of the junction is equivalent to that of the parallel plates of a capacitor coming closer together—increasing the capacitance. As the applied voltage is made negative, the depletion layer widens, capacitance reduces. This small signal junction capacitance, a non-linear function of the applied voltage under static conditions, is given by:

$$C = \frac{C_o}{\left(1 - \frac{V}{\phi}\right)^N}$$

where, C_o = capacitance at zero bias
ϕ = a constant depending on whether silicon or germanium is used
V = bias voltage
N = a constant which is ⅓ for graded junctions and ½ for abrupt junctions

A typical curve is shown in Fig. 6

Recovery Time

When a diode is rapidly switched from a forward conducting state to a reverse voltage bias condition, the current does not immediately fall to saturation, Fig. 5. This curve shows the diode's static, or I-f, traits. Under high speed switching, the curve appears as the dotted line. The time required for the current to attain equilibrium has been loosely named "recovery time." During this time, the reverse current flow is initally large; in a short time, it decreases to its

(*Continued on page* 134)

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normal value. The initial reverse current flow and the recovery time depend on several factors, one of which is the amount of current flowing prior to voltage reversal, Fig. 7. With large forward currents, the recovery time becomes greater. Fig. 8 shows the effect of the ratio maximum forward current to maximum reverse current, (I_F/I_R), on recovery time.

When the junction is forward biased, an excess of minority carriers is built up on either side of the depletion region. If the voltage of an initially forward biased diode is quickly reversed, the minority carriers in the depletion layer do not tend to keep moving in a forward direction, but rather they come under the influence of the reverse voltage. These carriers are subsequently drawn out of the depletion region. This action is not instantaneous, however, and the sudden reversal and decay of current due to these carriers represent the diode "recovery time." Their activity is one factor affecting the time required for the depletion layer to stabilize to its static value.

A second factor contributing to this delay lies in the rapidity with which a diode cools off after injection of a current pulse. After the reverse current bias recovers to its saturation value, the depletion layer does not immediately stabilize. This additional delay can be attributed to the thermal time constant of the junction. The shorter the time constant, the more rapid the depletion layer recovers. When the heating effect of the successive current pulses is greater than the thermal time constant, the diode depletion layer will not stabilize between pulses. However, as the successive current pulses become smaller, the junction is heated less with each pulse. Since the depletion layer is temperature dependent, the combination of reverse current recovery time plus the thermal delay contribute to the total delay required for C_D to stabilize to its static value.

Analysis of Operation

With the foregoing theory in mind, a detailed analysis of the relaxation oscillation can be made.

Oscillation occurs after a certain dc output level has been reached. During the first phase of oscillation, the voltage builds up to a peak. At the peak, the r-f voltage is cutoff such that very little appears across the transformer secondary, Fig. 1. C_L slowly discharges to a point whereupon the r-f voltage recovers and the operation repeats itself.

During the first phase, the voltage buildup is caused by current pulses which become successively smaller. While the energy supplied is greater than the energy lost between pulses, the voltage continues to build up. As the current pulses become smaller, the time between a pulse ending and the next pulse beginning becomes longer. Also, the amount of junction heating is reduced with each pulse.

All these factors contribute to C_D seeking a smaller value with each smaller pulse. As C_D becomes smaller, the operating point on the resonant curve (of L_S and C_D) moves lower. At a certain point, rectification cannot take place on the next pulse. The diode ceases to conduct, goes to its saturation value of reverse current, and cools off to ambient temperature. The value of C_D is reduced to its static value and the operating point on the resonant curve moves to a lower point. C_L discharges through R_L.

As the reverse voltage across the diode decreases, C_D increases with the operating point moving up on the resonant curve. When just a slight amount of rectification can take place, the operating point moves even higher due to the increase in diode capacitance C_D. The cycle then repeats itself. Waveforms showing the complete cycle are shown in Fig. 9.

Conclusion

P-N junction diodes possess a voltage sensitive non-linear capacitance characteristic. This effect is used to achieve gain in some parametric amplifiers. The relaxation oscillations described here are not to be confused with the operating mechanism used by parametric amplifiers. However, the non-linear capacitance characteristic is common to their modes of operation.

There has been a general misconception that the depletion layer is set up immediately upon application of a reverse bias voltage following a forward conducting state. Two factors contributing to this delay are the minority carrier storage time (recovery time) and the thermal time delay. The end result gives a delay in setting up the depletion layer and the associated diode capacitance. This delay is fundamental in causing the relaxation oscillations.

The oscillations can have pronounced nuisance effects in semiconductor diode use as frequency and phase detectors. In those uses where the non-linear diode capacitance is a significant part of the operating circuit, this effect can be troublesome. In such cases, the Q of the diode capacitance can be lowered by inserting a small resistor in series with the diode. This reduces the effect of the non-linearity.

In h-f uses, where pairs of junction diodes are used, the thermal time delay caused by relatively large forward current pulses can cause drifting and general instability. Thus it is desirable to limit the flow of current through each diode by means of a series resistor. This serves to keep junction heating and recovery time to a minimum, Fig. 8.

The relaxation oscillation described here is only one of many effects attributed to the P-N junction diode. During laboratory tests the efficiency of conversion was relatively low. Further work will be required to establish the optimum operating conditions before this effect can be put to practical use.

Bibliography

Keizer, E. O., "A Carrier Energized Bistable Circuit Using Variable Capacitance Diodes," *RCA. Rev.*, pp. 475-485, Dec. 1957.

Shockley, W., "The Theory of P-N Junctions in Semiconductors and P-N Junction Transistors," *Bell System Tech. J.*, Vol. 28, pp. 435-489, July 1949.

Schulz, D., "Transient Response of Variable Capacitance Diodes," *IRE Trans. on Component Parts*, pp. 49-53, Vol. CP-7, June 1960.

Hurley, R. B., *Junction Transistor Electronics*, J. Wiley & Sons, Inc.

Torrey & Whitmer, *Crystal Rectifiers*, MIT Radiation Lab Series, Vol. 15.

Sproull, R. L., *Modern Physics*, J. Wiley & Sons, Inc.

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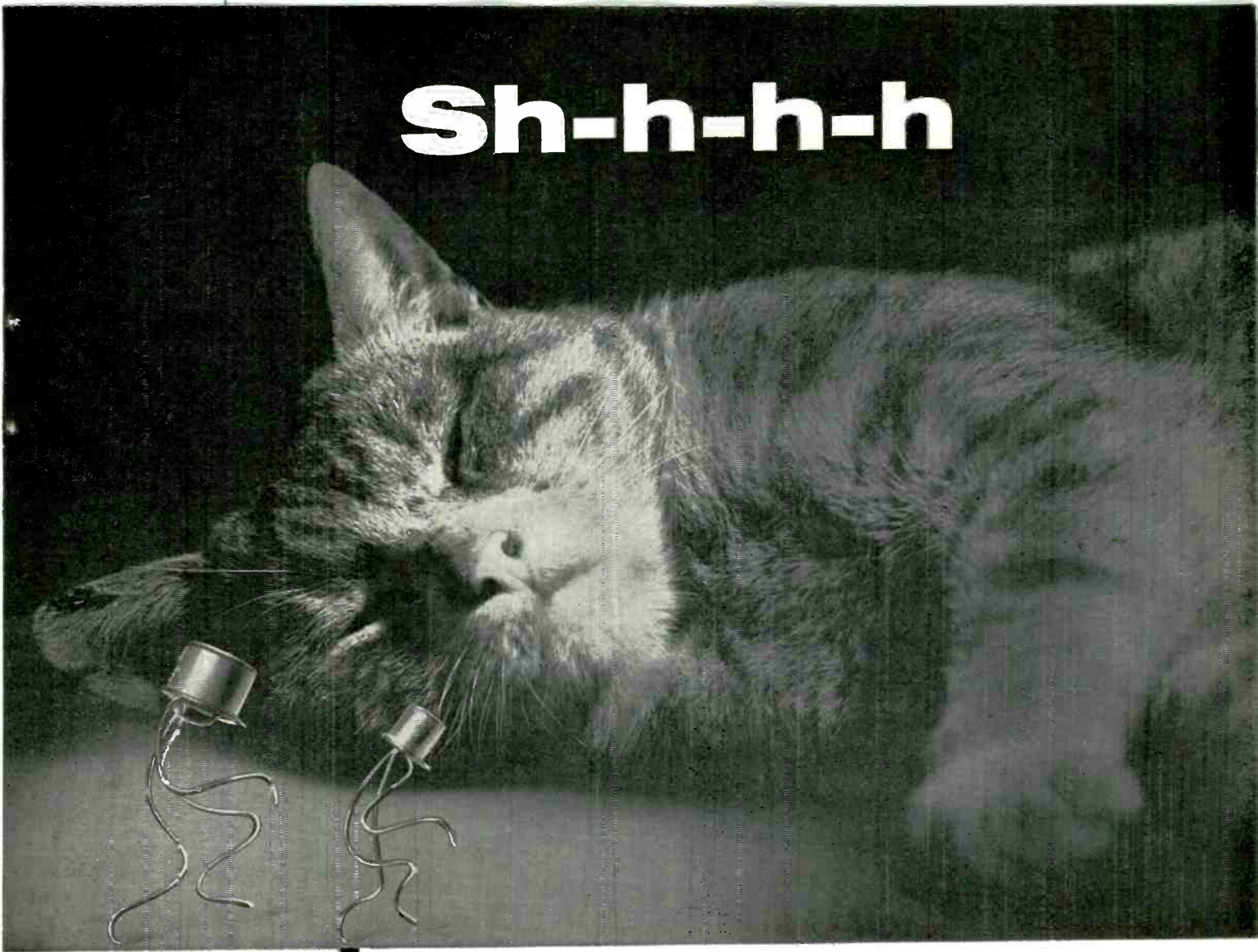

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LOW NOISE

PNP Silicon Alloy Transistors in TO-5 and new TO-18 cases feature useable amplification at very low output current levels.

This low noise unit is designed for applications where noise must be at a minimum, as in low level preamplifier stages. High current gain at low collector currents provides useful amplification while voltage and current guarantees low noise performance. Extremely low leakage currents are exhibited over the operating −65°C to + 175°C temperature range.

The new low level amplifier PNP silicon alloy transistor features high current gain at even lower currents, but with a slightly higher noise figure.

Write for complete specification.

Circle 99 on inquiry Card

SPERRY

SEMICONDUCTOR

DIVISION OF
SPERRY RAND CORPORATION
NORWALK, CONNECTICUT

SEMICONDUCTOR INTEGRATED NETWORKS (SEMI-NETS*)
TUNNEL DIODES. MESA AND ALLOY SILICON TRANSISTORS AND DIODES
SALES OFFICES: CHICAGO, ILLINOIS; LOS ANGELES, CALIFORNIA; OAKLAND, NEW JERSEY; MEDFORD, MASSACHUSETTS; SYKESVILLE, MARYLAND; BETHPAGE, L. I., NEW YORK

SEMICONDUCTOR OPPORTUNITIES AVAILABLE TO QUALIFIED ENGINEERS

*Trade Mark, Sperry Rand Corporation

Analog Computer To Control Reactor

A contract to produce a large-scale analog computer for simulation and control of the TORY II-C reactor has been awarded to Electronic Associates, Inc., Long Branch, N. J. TORY II-C is the nuclear power source for the U. S. Atomic Energy Commission's Project Pluto ramjet missile. The contract was awarded by the Lawrence Radiation Laboratory of the University of California and covers a 300-amplifier computer system consisting of a number of special purpose computers.

Each of the various individual special purpose computers that will make up the system will serve a particular function. Primary uses will be those of controlling the various functions of the nuclear reactor during test. Other units in the system will be concerned with the simulation of the reactor systems for operator training.

Nikola Tesla Letters Acquired By Columbia

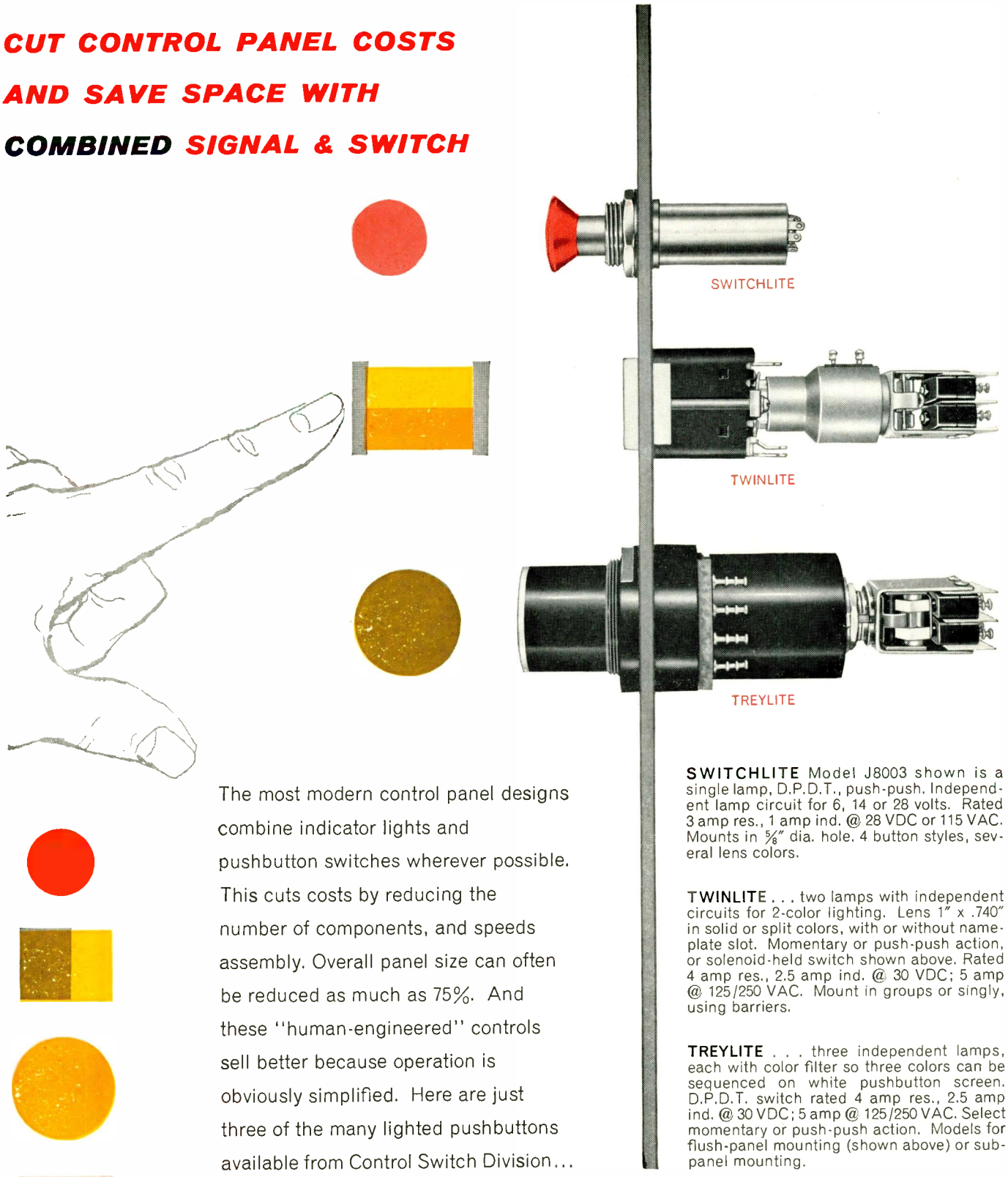
A collection of letters in which inventor Nikola Tesla, predicted developments in the electronics field, has been acquired by Columbia University and is now on exhibit there.

Tesla, who patented 700 electrical inventions, including the induction motor, was already in 1908 experimenting with interplanetary communication. He firmly believed most of the planets were inhabited. He also had visions of harnessing the sun's rays and utilizing the energy of the sea.

COMPUTER COURSE

Working at the console of an RCA 301 computer are Brian Chorlton (l), David Rodway (r) and Alice Vickers, all of England. Thirty-one representatives of International Computers and Tabulators Ltd. (I.C.T.) of England are taking a cram course in American Computer operation at RCA, Cherry Hill, N. J. I.C.T. recently signed an agreement to purchase 50 RCA electronic data processing systems.

CUT CONTROL PANEL COSTS AND SAVE SPACE WITH COMBINED SIGNAL & SWITCH



The most modern control panel designs combine indicator lights and pushbutton switches wherever possible. This cuts costs by reducing the number of components, and speeds assembly. Overall panel size can often be reduced as much as 75%. And these "human-engineered" controls sell better because operation is obviously simplified. Here are just three of the many lighted pushbuttons available from Control Switch Division...

SWITCHLITE Model J8003 shown is a single lamp, D.P.D.T., push-push. Independent lamp circuit for 6, 14 or 28 volts. Rated 3 amp res., 1 amp ind. @ 28 VDC or 115 VAC. Mounts in ⅝" dia. hole. 4 button styles, several lens colors.

TWINLITE . . . two lamps with independent circuits for 2-color lighting. Lens 1" x .740" in solid or split colors, with or without nameplate slot. Momentary or push-push action, or solenoid-held switch shown above. Rated 4 amp res., 2.5 amp ind. @ 30 VDC; 5 amp @ 125/250 VAC. Mount in groups or singly, using barriers.

TREYLITE . . . three independent lamps, each with color filter so three colors can be sequenced on white pushbutton screen. D.P.D.T. switch rated 4 amp res., 2.5 amp ind. @ 30 VDC; 5 amp @ 125/250 VAC. Select momentary or push-push action. Models for flush-panel mounting (shown above) or subpanel mounting.

CONTROLS COMPANY OF AMERICA

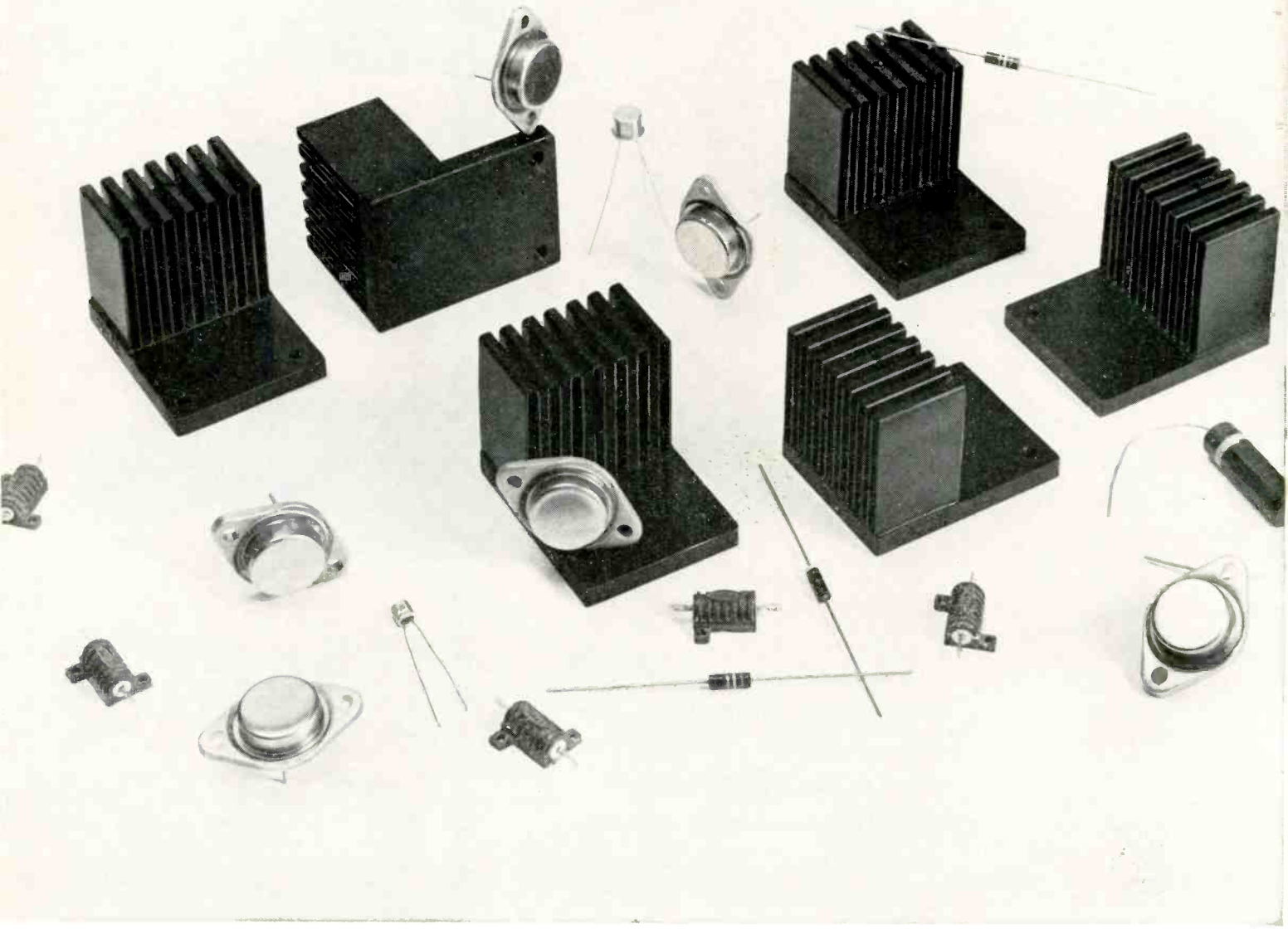
CONTROL SWITCH DIVISION

1408 Delmar Drive • Folcroft, Pennsylvania • Telephone LUdlow 6-7500 • TWX SHRN-H-502

Write for FREE CATALOG on LIGHTED SWITCHES.

Manufacturers of a full line of switches, controls and indicators for all military and commercial applications. All standard units stocked for immediate delivery by leading parts Distributors.

ALL THIS...



Westinghouse high gain silicon transistor

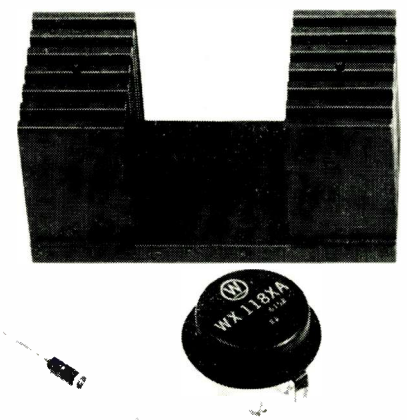
GAIN OF 1000 OR MORE AT 2 AMPS ■

COLLECTOR CURRENT—10 AMPS ■

TRUE VOLTAGE RATINGS TO 150 VOLTS ■

HARD SOLDERED CONSTRUCTION FOR THERMAL FATIGUE RESISTANCE ■

NOW REPLACED BY THIS



simplifies circuitry, gives 5 times greater reliability, costs 2/3 less

Westinghouse now offers a complete family of high-gain silicon power transistors which provide a gain of 1000 or more at 2 amps . . . with guaranteed minimum gain of 400 at 10 amps (WX 118 X series) . . . a guaranteed minimum gain of 100 at 10 amps (WX 118 U series). They have power dissipation of 150 watts, operate at temperatures to +150° C. These devices offer great advantages in increased reliability, space, weight, and cost savings. They are ideally suited for applications in high power, high efficiency regulators, amplifiers, and switching circuits. For full information call your nearest Westinghouse representative, or write to Semiconductor Dept., Youngwood, Pa. **You can be sure . . . if it's**

SC-1062

Westinghouse

For immediate "off-the-shelf" delivery, order from these Westinghouse Distributors:

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ACK SEMICONDUCTOR, INC.
Birmingham 5, Ala./FA 2-0588
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DENNY-HAMILTON ELECTRONICS
San Diego, Calif./AC 4-3451

CANADA

CANADIAN WESTINGHOUSE CO., LTD.
Hamilton, Ontario/JA 8-8811

New Tech Data for Engineers

Directional Couplers

These Broad-Wall Multi-Hole Directional Couplers cover from 7.0-12.4GC in 2 overlapping bands. Model WR112 (large X) and WR90 (small X) waveguides have: mean coupling accuracy within ±0.4db; max. coupling variation vs. freq. of ±0.5db; and 30db min. directivity over the specified bands. Included are specs., photographs, and outline drawings. Microwave Development Laboratories, Inc., 15 Strathmore Rd., Natick Industrial Center, Natick, Mass.

Circle 250 on Inquiry Card

Glass Inductors

Representative curves of Q factor vs. freq. are shown in Ref. File CE-5.02, which describes Corning metallized glass inductors in panel mount and printed circuit styles. Corning Electronic Components, Corning Glass Works, Bradford, Pa.

Circle 251 on Inquiry Card

AC Motors

Bulletin 420.3, 4 pages, describes the Frame 330 line of ac special application motors for small power tools, commercial appliances, business machines and similar uses. Included are a rating chart, specs., and dimensional data on this line of 1/100 through 1/3 HP motors. Small Motors Div., Robbins & Myers, Inc., Springfield, Ohio.

Circle 252 on Inquiry Card

Solid State Chopper

Tech. bulletin, F-4000, 4 pages, contains complete environmental performance data, mechanical and electrical characteristics, typical circuit configurations, and dimensional drawings on "PHOTOCOM"—all solid state, photo sensitive choppers, relays and switches for low level instrument modulator and demodulator uses. James Electronics Inc., 4050 N. Rockwell St., Chicago 18, Ill.

Circle 253 on Inquiry Card

Vibration Testing

Tech. paper describing the "thruster cluster" technique of vibration testing of large packages or complete assemblies is offered by Ling Electronics, div. of Ling-Temco-Vought, Inc., Dept. TC 262, 1515 So. Manchester Ave., Anaheim, Calif. Containing illustrations and diagrams, the paper shows how thrusters are arrayed in push-pull setups or adjustable bolt circles for vibrational testing of packages or assemblies too large for any single shaker.

Circle 254 on Inquiry Card

Metal Film Resistors

Coaxial Termination Type Carbon and Metal Film Resistors are described in tech. data available from Film Resistors Inc., sub. of Nytronics, Inc., 242 Ridgedale Ave., Morristown, N. J. Information include outline drawings, specs., and photographs. These coaxial termination resistors are for use at microwave freqs.

Circle 255 on Inquiry Card

Flat Flexible Cable

This 8-page bulletin features over 20 photographs, diagrams, charts and tables on POLYSTRIP Multi-conductor Flat Flexible Cable. The cable offers space savings of up to 7-to-1 and weight reductions of up to 10-to-1. Bulletin S-10 available from International Resistance Co.'s Plastic Products Div., 401 N. Broad St., Philadelphia 8, Pa.

Circle 256 on Inquiry Card

Cable Connectors

A simple permanent compression connector for grounding, terminating and insulating the braid of shielded and coaxial cable is described in an 8-page booklet available from The Thomas & Betts Co., Inc., Elizabeth, N. J. Included in the booklet is a guide to selection of the proper inner, outer, flag type and R-F adapter sleeves.

Circle 257 on Inquiry Card

Silicon Rectifiers

Tech. data is available on a series of 70a stud mounted silicon diffused junction rectifiers, designed for requirements in the 40 to 100a range. North American Electronics, Inc., 71 Linden St., W. Lynn, Mass.

Circle 258 on Inquiry Card

Selective Amplifiers

Series 200 Bulletins describe a series of vacuum tube selective amplifiers designed to be used with RC feedback networks at audio and subaudio freqs. down to 0.01CPS. White Instrument Laboratories, P.O. Box 9006, Allandale Sta., Austin 17, Tex.

Circle 259 on Inquiry Card

Semiconductor Testers

Catalog #101, 18 pages, covers reliability assurance test facilities for electronic component parts; dynamic semiconductor test equipment; production test equipment; specialized power supplies; and vacuum exhaust stations for power tube production. Wallson Associates, Inc., Dept. CP, 912 Westfield Ave., Elizabeth, N. J.

Circle 260 on Inquiry Card

Portable SCR Tester

The Model R-102 Controlled Silicon Rectifier Tester will quickly determine the vital characteristics of any SCR. Tests include: gate voltage to fire—up to 5v; gate current to fire—up to 50ma; and anode-cathode or anode-gate leakage—up to 8 megs. Requirements are 115v, 60cps. Size: 5¼ x 7 x 3 in. Weight: 2½ lbs. Power/Radiation, Inc., Box 616, Suffern, N. Y.

Circle 261 on Inquiry Card

Electron Tube Sealing

Tung-Sol Electric Inc., 1 Summer Ave., Newark 4, N. J., is offering Tung-Sol Tips which describes a sealing process for electron tubes. Called Polyoptic Sealing, it avoids many contamination problems by sealing the tube after it has been evacuated or pumped out to vacuum conditions.

Circle 262 on Inquiry Card

Harmonic Generators

PRD Electronics, Inc., 202 Tillary St., Brooklyn 1, N. Y., is offering tech. data containing a performance graph, schematic diagram and photograph which describes the PRD 6611 Series of Varactor Harmonic Generators. Information includes freq. ranges, power handling capacity, and harmonic outputs.

Circle 263 on Inquiry Card

Constant Force Springs

This 12-page, 2-color booklet contains over 30 design uses for NEG'ATOR springs. The booklet describes the operating characteristics of this long-deflection, constant-force spring. Forms include: constant-torque spring motor; clip; clamp; and expanded scale. Functions covered include counter balancing, driving, retracting, returning, tensioning and loading, transmitting motion and providing compact direct-reading scale of great length. Bulletin 310R. Hunter Spring, div. of AMETEK, Inc., 1 Spring Ave., Lansdale, Pa.

Circle 264 on Inquiry Card

Strain Measurements

"X-ray Strain Measurement Techniques for Ceramic Bodies" is a 6-page bulletin, available from Philips Electronic Instruments, 750 So. Fulton Ave., Mt. Vernon, N. Y. The bulletin includes a short introduction and explanation of theory, and sections devoted to surface crystals vs. interior crystals, X-ray diffraction corrections, reduced X-ray penetration and surface crystals. Included are photographs, charts, drawings, tables and graphs.

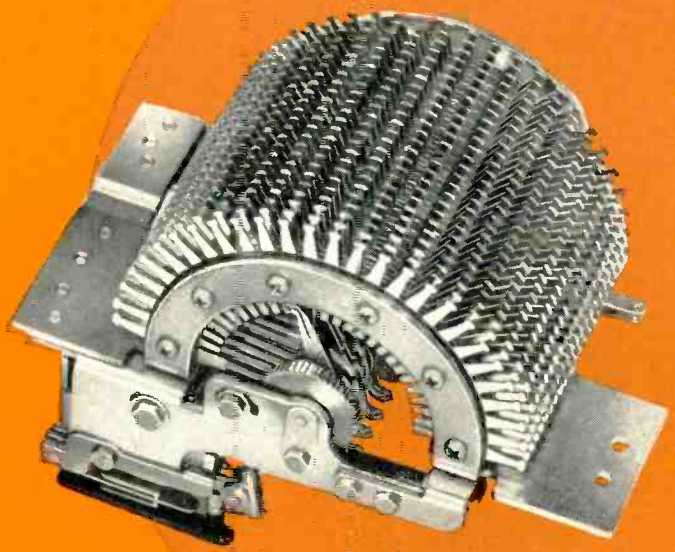
Circle 265 on Inquiry Card

Circle 88 on Inquiry Card →

CLARE Stepping Switches

give designers—

- *more levels per switch*
- *more levels in less space*
- *more simplified circuitry*
- *NO synchronization problem*

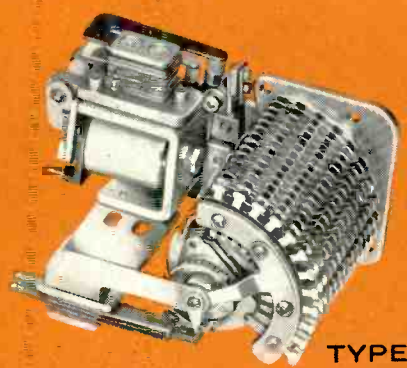


TYPE 26

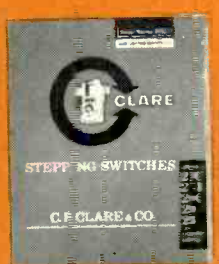
Type for type, **CLARE** Stepping Switches provide more levels per switch . . . more levels per inch of height. The 12-level, 52-point, switch shown (**CLARE** Type 26), for instance, is 4 11/16 in. high. It has four more 52-point levels than comparable 52-point switches, yet it is but 13/16 in. higher than a comparable 8-level, 52-point switch. The smaller (Type 211), five-level, 33-point switch provides twice the levels of any comparable 33-point switch.

This greater working capacity per switch . . . and per inch . . . of **CLARE** Stepping Switches permits more simplified circuitry and avoids synchronization problems which arise when multiple stepping switches are necessary to do what is often a one-switch job with these high-capacity **CLARE** units.

CLARE Stepping Switches include a full line of spring-driven cam-operated or direct-drive switches with capacities from 10 to 52 points. **CLARE** engineering will cooperate with designers to develop special switches to meet unique requirements.



TYPE 211



For precise stepping switches famous for long life, high capacity and freedom from maintenance

IT HAS TO BE CLARE

Send for DESIGN MANUAL 202A

C. P. Clare & Co., 3101 W. Pratt Blvd., Chicago 45, Illinois. Cable Address: CLARELAY. In Canada: C. P. Clare Canada Ltd., 840 Caledonia Road, Toronto 19, Ontario. In Europe: Europelec, les Clayes-sous-Bois (S. et O.), France

C. P. CLARE & CO.

Relays and related control components

New Tech Data for Engineers

Noise Techniques

"The Application of Low Frequency Noise and Statistical Techniques," a 6-page bibliography contains a useful chart which breaks down the references according to problem field and random variable. Elgenco, Inc., 1231 Colorado Ave., Santa Monica, Calif.

Circle 266 on Inquiry Card

Test Equipment

Kearfott Div., General Precision, Inc., Little Falls, N. J., is offering a brochure, 6 pages, 2 colors, entitled "Ground Support Equipment Capabilties." Included is information on Kearfott's capabilities in the ground support equipment area and also information on automatic test equipment, such as a fixed resistor tester, navigational system field checkout system, precise angle indicator, angle position simulators, tumble rate test stand, and synchro and resolver bridges.

Circle 267 on Inquiry Card

Fixed Pad Attenuator

This line of Fixed Pad Attenuators features the following specs.: freq., 0-4000MC; power, 2w (average); VSWR, 1.15 (max.); and attenuation variation, ±0.05 db/db. Connector types are N, C, BNC, and TNC. Astrolab Inc., 120 Morris Ave., Springfield, N. J.

Circle 268 on Inquiry Card

Accelerometers

Tech. data is available on Series-6000 Accelerometers and transistorized amplifiers designed for high shock and vibration analysis work. This 6-page, 2-color brochure includes photographs, specs., and descriptions of the Series-6000, featuring high sensitivity over wide-temp. ranges of −250 to +500°F; and seismic resonant freq. of 80 to 140KC, depending on sensitivity. Electra Scientific Corp., Electra Way, Fullerton, Calif.

Circle 269 on Inquiry Card

Electrical Steels

Design Manual P.O. 5461P contains information on oriented electrical steels for transformer cores and related uses. In addition to 41 full-page data curves, on the various electrical properties of the 4 lattice-oriented electrical steels, information includes product descriptions and selection, effect on transformer design, surface insulation, physical, mechanical and magnetic properties, the stress-relieving anneal, core design, testing methods and use of the data curves. Write on company letterhead to: Armco Steel Corp., Middletown, Ohio.

Adhesive-Sealant

HYSOL Epoxi-Patch Kits are described in Bulletin A-500 available from HYSOL Corp., Olean, N. Y. Covered are typical applications of bonding and sealing jobs in the production and repair of parts made of metals, wood, glass, plastics and ceramics. Complete information on the properties of 5 basic formulations, and their colored versions, are also listed.

Circle 271 on Inquiry Card

Magnetic Wire

Formvar insulated magnetic wire is recommended for use where toughness, abrasion resistance and resistance to solvents are required. The wire features good flexibility, adherence and dielectric properties. Hudson Wire Co., 62 Water St., Ossining, N. Y.

Circle 272 on Inquiry Card

Semiconductor Boats

Bulletin 107A gives complete tech. data on Duramic M120FT fixtures, jigs, and boats for use in induction, torch and oven brazing, welding, soldering, heat treating, sintering and semiconductor processes. M-120FT has a max. operating temp. of 2000°F. Duramic Products, Inc., 426 Commercial Ave., Palisades, N. J.

Circle 273 on Inquiry Card

Infrared Measurements

Bulletin 7000-2 describes an external source accessory which permits the use of Beckman IR-4 or IR-7 Infrared Spectrophotometers for measuring the emission of any external source or infrared radiation. Included is a photograph, line drawings, optical diagram, and specs. Scientific and Process Instruments Div., Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif.

Circle 274 on Inquiry Card

Thermoconductivity

Brochure 21688D, 4 pages, describes the Therma Bridge Sensing Detectors, available from Industrial Instruments Inc., 89 Commerce Rd., Cedar Grove, Essex Co., N. J. Information includes circuit diagram, physical specs., geometry, sensitivity, reliability, life, and sensing element types.

Circle 275 on Inquiry Card

Hookup Wire

Tech. data is available on thin wall extruded teflon hookup wire to Mil-W-16878, Type ET in 7 and 18 strand constructions. Tensolite Insulated Wire Co., Inc., West Main St., Tarrytown, N. Y.

Circle 276 on Inquiry Card

Power Supplies

"Solid State Power Supplies," 4 pages, contains data on the history, staff, facilities and reliability policy of Power Sources, Inc. Information also includes a breakdown on a line of fully transistorized power supplies. Power Sources, Inc., Northwest Industrial Park, Burlington, Mass.

Circle 277 on Inquiry Card

Carbon Resistors

A catalog describing Cambell Industries' FIXTOHM Deposited Carbon Precision Resistors is available from Clarostat Mfg. Co., Dover, N. H. Specs. on all ratings from ⅛ to 2w, 6Ω to 100 megs are provided, as well as dimensional drawings, power derating and temp. coefficient of resistance curves.

Circle 278 on Inquiry Card

Transistor Adaptor

Tech. data, 4 pages, on a transistor adaptor and accessories for measurement of H, Y, and Z parameters from 30-3000MC is described in tech. data available from Rohde & Schwarz, 111 Lexington Ave., P.O. Box 275, Passaic, N. J.

Circle 279 on Inquiry Card

Delay Timers

Tech. data on the Betachrons® Self-Powered Nuclear Delay Timers is available from Leesona Moos Laboratories, div. of Leesona Corp., 90-28 Van Wyck Expressway, Jamaica 18, N. Y. The Betachrons, based on the Krypton 85 nuclear battery, are entirely self-powered, small, resistant to shock, vibration and acceleration.

Circle 280 on Inquiry Card

Phase-Lock Discriminator

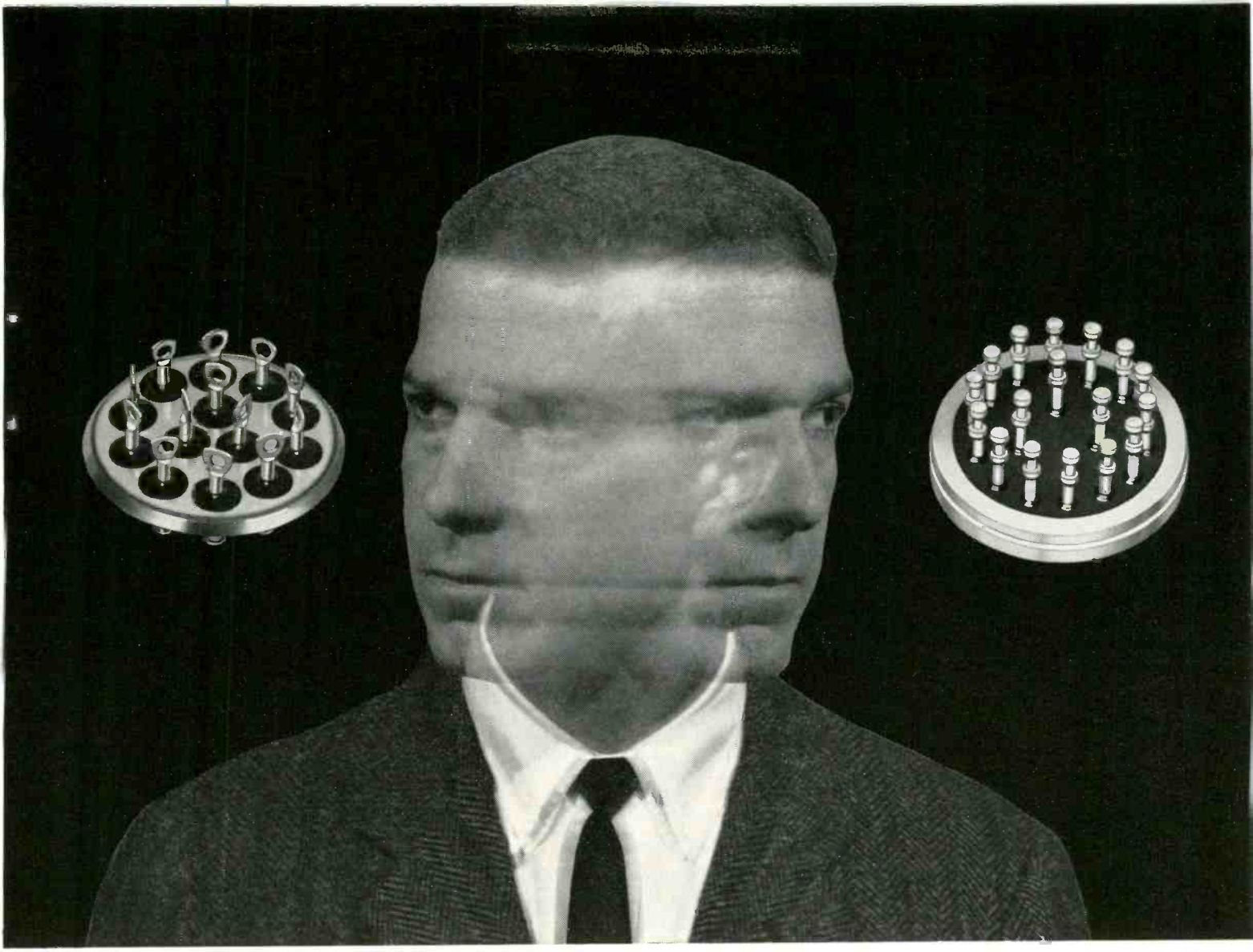
Tech. data is available on Model 0447 Phase-Lock Discriminator with tracking loop, and output filter parameters controlled by a plugable selector, available in several percentages of total IRIG bandwidth for each channel. Hallamore Electronics Div., The Siegler Corp., 714 N. Brookhurst St., Anaheim, Calif.

Circle 281 on Inquiry Card

Comparator

Model ZC-3 provides a sensitive method of comparing the reflection coefficient of a dummy load or reference device with the component under design or test. It covers from 50-1500MC (with useful operation up to 2000MC and below 50MC). It has an accuracy of 5% over the pass band, and a typical VSWR resolution as low as 1.1 to 1. Applied Technology, Inc., 930 Industrial Ave., Palo Alto, Calif.

Circle 282 on Inquiry Card



If you're "comfused" about compression and fusion in glass-to-metal terminals...

. . . join the group. It's a complicated subject made no easier by manufacturers who beat the drum for only one type, while you hear conflicting claims from a competitor.

At Fusite we make the very best of both types. We select from four different glasses, eight different metals and ten different finishes to make more different combinations than you can shake a stick at.

The specific combination of glass, metal and finish decides whether a terminal depends on fusion or compression between glass and metal for its hermetic properties.

Which is best for you?

We wouldn't even hazard a guess until we know something of how the terminal will be used. We'll make some strong recommendations once you've provided us with some simple basic information. To make it quick and easy for you to zero in on the best terminal for your needs, there's a data sheet questionnaire in the front of our new catalog. May we send you a copy?

Write Fusite Department G-2.

Circle 89 on Inquiry Card

INSULATE ELECTRICALLY · GLASS TO METAL · FUSITE · TERMINALS · PROTECT PRODUCT PERFORMANCE · SEAL HERMETICALLY

THE FUSITE CORPORATION

6000 FERNVIEW AVENUE • CINCINNATI 12, OHIO

Fusite Corporation, Cincinnati, O.

Woodford Mfg. Co., Versailles, Ky.

Fusite N. V., Konigweg 16, Almelo, Holland

Fusite GmbH, Dieselstrasse 5 Karlsruhe, W. Germany

Tech Data

for Engineers

Silicon Rectifiers

This line of miniature stacked silicon rectifiers is rated at 300ma average rectified current and 1500-10,000 peak inverse volts. Information includes outline drawings, charts and max. ratings. Diodes, Inc., 7303 Canoga Ave., Canoga Park, Calif.

Circle 283 on Inquiry Card

Eyelets Bulletin

Eyeleting, as an efficient method of fastening and assembly in a wide variety of industries, is the subject of an 8-page, 2-color bulletin available from the Fastener Div., United Shoe Machinery Corp., Shelton, Conn. Bulletin E-105.

Circle 284 on Inquiry Card

Telemetering System

Tech. data is available on a Model 502A/B Digital Telemetering System, designed for fault alarm reporting and monitoring. The system converts any number of parallel binary inputs (points) from 2 to 40, into PCM NRZ duration modulated serial code. ASCOP, Div. of Electro-Mechanical Research, Inc., P.O. Box 44, Princeton, N. J.

Circle 285 on Inquiry Card

Ball Bearing Testing

Power Instruments Inc., 7352 No. Lawndale Ave., Skokie, Ill., is offering a 4-page catalog containing specs. on their "spin testing" ball bearing testing equipment. The equipment features a test rate of 150 bearings/hr. which can be graded and sorted at a cost of 1/10th of conventional methods. The repeatability runs about ±3% of an average for good bearings.

Circle 286 on Inquiry Card

Ferrite Core Handlers

This 4-page brochure, describing 3 different models of a Ramsey Automatic Ferrite Core Handler is available from Rese Engineering, Inc., A and Cortland Sts., Philadelphia 20, Pa. The core handlers automatically feed toroidal ferrite cores to an electrical test circuit and then mechanically sort the tested cores into accepted or rejected classifications.

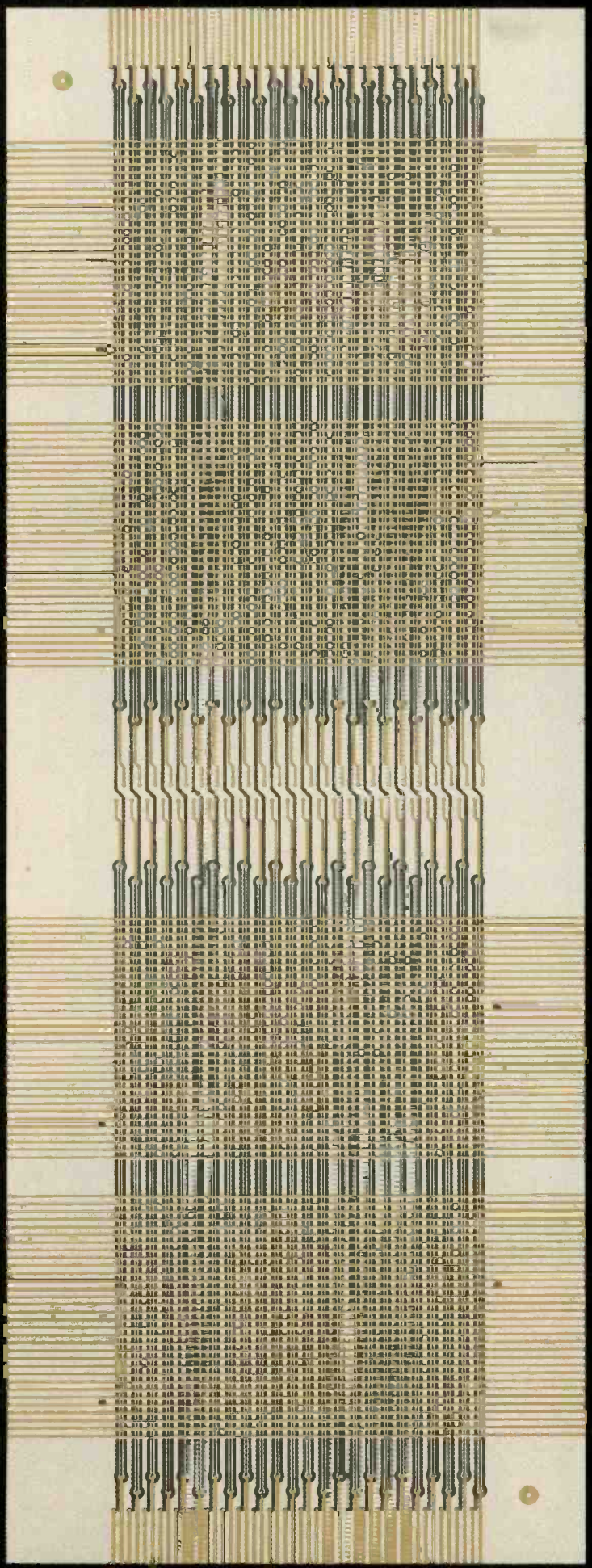
Circle 287 on Inquiry Card

Strain Gage Measuring

This 8-page, short form catalog illustrates and describes instrumentation for use in most bonded and unbonded strain gage measuring systems as well as mv/v transducer applications. Information is included on a disc indicator, indicating recorder, two types of switching units, automatic calibration indicator, two strain indicators, switching and balancing unit, strain-time indicator, etc. Catalog No. 4400-A available from the Electronics Div., Baldwin-Lima-Hamilton Corp., 42 Fourth Ave., Waltham 54, Mass.

Circle 288 on Inquiry Card

Circle 93 on Inquiry Card →



Another first from

Burroughs Corporation

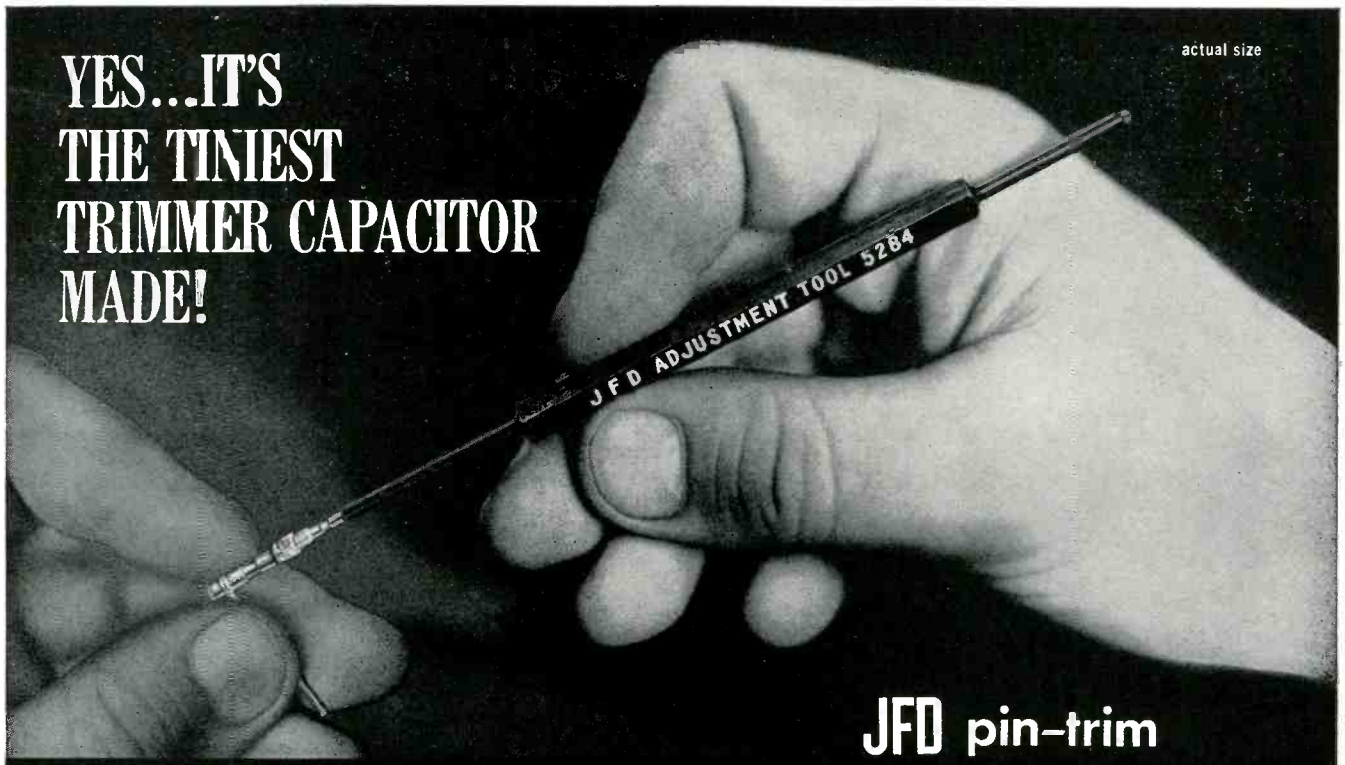
3072 bit thin film memory plane

Burroughs' new high density thin film plane is the most advanced memory device commercially available. This 128 word-24 bit/word plane operates to 5 mc and is priced at under $.50 per bit, making it ideal for the fastest memory applications. With a background of experience in manufacturing and marketing thin film memory planes, Burroughs once again leads the way in advanced memory techniques. Write for complete technical data on the new high density thin film plane, Type BIP 1001.

ANOTHER ELECTRONIC CONTRIBUTION BY
Burroughs Corporation
ELECTRONIC COMPONENTS DIVISION
PLAINFIELD, NEW JERSEY

Burroughs

YES...IT'S THE TINIEST TRIMMER CAPACITOR MADE!



JFD pin-trim

If you are designing for missile environments or applications requiring more capacity in less space, look in to the Pin-Trim. It provides a practicable solution to the challenge of end-product miniaturization with high operational stability.

The new Pin-Trim delivers: (1) more capacitance per cubic centimeter than any other conventional piston trimmer; (2) 75 per cent less weight and 50 per cent less volume than JFD's own miniature trimmers; (3) greater sensitivity; (4) finer adjustment.

If you are looking for maximum compactness between stacked circuit boards, or less stray capacitance in a given area, check the JFD Pin-Trim specifications for your subminiature trimmer applications.

For further data, call your local JFD Field office or your JFD franchised Industrial Distributor.

- Overall diameter: 1/8 inch. Overall length above panel: 3/8 inch to 1 inch.
- Double the sensitivity of JFD standard trimmers. Special adjust mechanism provides 102 turns per inch for extra fine adjustment.
- Increased maximum to minimum capacitance ratio per unit (minimum: 0.5 pf.).
- Operating temperature −55° to +125°C.
- Low temperature coefficient of capacitance.
- Anti-backlash design for precise tuning resolution.
- Low inductance for high frequency use.
- Ultra linear tuning assures accurate alignment—absolute repeatability. Standard slotted end for screwdriver adjustment.
- Rugged shock and vibration resistance.
- 500 V. DC working voltage.
- 10^4 megohms insulation resistance.
- Q factor of 500 (measured as per JFD #5178).
- 0.5 inch ounce tuning torque.
- Meet or exceed applicable performance requirements of MIL-C-14409A.

JFD Adjustment Tool No. 5284 (illustrated) available at 85¢.

Model*	Capacitance Range MMF Measured Per JFD #5177 Min.	Max.	D.C. Working Volts	Dielectric Strength Measured For 5 Seconds at 50% R.H. at Max. Rated Cap.	Insulation Resistance Measured After One Minute at 500V. D.C. and 50% R.H.	Q Factor Measured Per JFD #5178	Unit Weight Grams	Dimen.** Max. ±1/32
PT901	0.5	2.0	500	1000	10^5 Megohms	500	0.62	3/8"
PT902	0.5	3.0	500	1000	10^5 Megohms	500	0.64	1/2"
PT903	0.5	5.0	500	1000	10^5 Megohms	500	0.79	3/4"
PT904	0.5	7.0	500	1000	10^5 Megohms	500	0.94	1"

*** These units are also available in the same capacitance values for printed circuit boards in models PT911, PT912, PT913 and PT914.**

**** Length front of panel.**

U.S. Patent No.: 2,922,093 Canadian Patent No.: 604,810

JFD ELECTRONICS CORPORATION

Components Division • 6101 16th Avenue, Brooklyn, New York • Phone DEwey 1-1000 • TWX-NY25040

JFD WESTERN
P. O. Box 3416
Van Nuys, Calif.
Phone: EMpire 4-4131

JFD MIDWESTERN
P. O. Box 588
Skokie, Illinois
Phone: 675-1140

JFD NORTHEASTERN
Ruth Drive, P. O. Box 228
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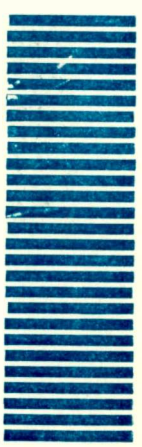

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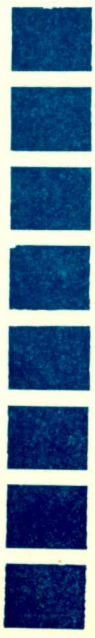


Tech Data

for Engineers

Laser

Tech. data is available on the Trident Lightweight Laser, Series 500. It is a self-contained unit for producing short pulses of coherent optical energy from a ruby laser crystal. Laser pulses, from 0 to 500 μ sec., can be obtained at energy levels over 0.1 joules. The unit weighs 28 lb. and can be plugged into any standard 115vac, 60 CPS outlet. Trident Corp., div. of Maser Optics, Inc., 89 Brighton Ave., Boston 34, Mass.

Circle 327 on Inquiry Card

Tape Conversion Service

Electronic Engineering Co. of California, Box 58, Santa Ana, Calif., is offering a 4-page brochure describing their Computer Tape Conversion Service. Information covers conversion data formats, conversion equipment, data checking while conversion is under way, paper tape conversions, and conversion times.

Circle 328 on Inquiry Card

Solenoids

Catalog SE-A contains information on Cannon solenoids, designed to meet the high volume and low cost requirements of business machines, computers, and similar products. Cannon Electric Co., Advertising Dept., 3208 Humboldt St., Los Angeles 31, Calif.

Circle 329 on Inquiry Card

Switchboard Instruments

Bulletin GEZ-3428, 4 pages, describes G-E's line of ammeters and voltmeters designed to save panel space. Information includes applications, mounting, important features, specs., dimensions and ordering data. General Electric Co., Schenectady 5, N. Y.

Circle 330 on Inquiry Card

Power Supplies

Universal Electronics Co., 1720 22nd St., Santa Monica, Calif., is offering a 6-page index, to their line of power supplies, for quick selection of any desired instrument. The bulletin lists approx. 18 specs. on each supply.

Circle 331 on Inquiry Card

Ultrasonic Cleaning

Product Bulletin 100 gives information and specs. on National Ultrasonic Heavy-dutyline tanks, heated tanks, drop-in tanks, Freon cleaning tanks and side-mounted tanks both 1 and 2 side. National Ultrasonic Corp., 95 Park Ave., Nutley 10, N. J.

Circle 332 on Inquiry Card

Machining Thermoplastics

This 8-page booklet outlines recommended procedures for machining and finishing thermoplastic sheets, rods and tubes. Procedures discussed include sawing, routing, drilling, turning, shearing, punching, grinding and finishing. Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich.

Circle 333 on Inquiry Card

New Tech Data for Engineers

Ferrite Chokes

National Radio Co., Components Div., Dept. P, Melrose 76, Mass., is offering data sheet CO-4 on their Ferrite Bead Chokes. Information includes typical curves for choke impedance and ac resistance.

Circle 289 on Inquiry Card

Porcelain Bushings

This 6-page brochure contains information on wet-process porcelain insulating bushings for high-temp. service. The brochure covers 10 standard types, intended for military and commercial high-voltage transformers and capacitors. Included are photographs, dimensional drawings, and tables of electrical and dimensional data. Ceramaseal, Inc., New Lebanon Center, N. Y.

Circle 290 on Inquiry Card

Wire-Wound Resistors

Bulletin P-1 gives electrical and mechanical specs. of precision wire-wound units encapsulated in flat, rectangular configurations for printed circuit high-density packaging. Kelvin Electric Co., 5907 Noble Ave., Van Nuys, Calif.

Circle 291 on Inquiry Card

Voltage Control

Bulletin F-761 describes LEDEX Transient Control and Transient Protected Silicon Bridge Rectifiers. Transient Control levels 1400v spikes, from ac or dc sides, to 200 v. The Transient Silicon Bridge Rectifier is rated at 100vac output, 50a surge for 8msec. Ledex Inc., 123 Webster St., Dayton 2, Ohio.

Circle 292 on Inquiry Card

Relay

Weighing 1/10 oz., and occupying less than 1/20 cu. in., this transistor can sized Babcock BR-5 relay is designed to switch dry circuit to 1a loads, with the same sensitivity as SPDT relays of larger size. Babcock Relays, a div. of Babcock Electronics Corp., 1645 Babcock Ave., Costa Mesa, Calif.

Circle 293 on Inquiry Card

Oscillogram Processor

Type 23-109B Oscillogram Processor is completely self-contained, needing only electric power for operation. The compact, motorized unit develops and dries oscillograms under normal or daylight conditions without danger of fogging. Consolidated Electrodynamics Corp., sub. of Bell & Howell, 360 Sierra Madre Villa, Pasadena, Calif.

Circle 294 on Inquiry Card

Silicon Rectifiers

Tech. data is available on epoxy encapsulated silicon rectifiers, types CODI 531 to 538. Included are characteristics, max. ratings, and outline drawings. The units feature a max. forward voltage drop @ 500ma of 1.1v and max. ratings for inverse voltage range from 100 to 800v. Computer Diode Corp., 250 Garibaldi Ave., Lodi, N. J.

Circle 295 on Inquiry Card

Component Holder

STYRO-CLIP is a component holder for breadboarding. By pushing a STYRO-CLIP into a foam board and inserting the component lead wires between the coils of the STYRO-CLIP springs, a circuit may be made quickly and easily. Cache Valley Electronics, Inc., P.O. Box 344, Logan, Utah.

Circle 296 on Inquiry Card

Phase Detectors

Precision Millimicrosecond Phase Detectors, featuring freq. ranges of 15-400MC and 15-1500MC and a resolution time of less than 10^{-13} sec., are described in tech. data available from AD-YU Electronics Lab., Inc., 249-259 Terhune Ave., Pasasic, N. J. Input sensitivity is 10 mv or better with an external receiver, and the input signal can be CW, pulse modulated or amplitude modulated.

Circle 297 on Inquiry Card

Muffin Fan

Tech. data including photographs, a noise level chart and specs., on an actual-size cardboard cut-out of the Rotron Gold Seal Muffin Fan is available from Rotron Mfg. Co., Inc., Woodstock, N. Y.

Circle 298 on Inquiry Card

R-F Choke

Tech. data is available on a line of epoxy encapsulated miniature and subminiature r-f chokes with inductances from 0.1μh at 4000ma to 10,000μh at 80ma. Essex Electronics Div. of Nytronics, Inc., 550 Springfield Ave., Berkeley Heights, N. J.

Circle 299 on Inquiry Card

Voltage Regulator

Tech. brochure, LVR-1000 highlights the Solatron, an electronic-magnetic line-voltage regulator. Designed to cover the 3 to 100kva range. the Solatron has a response time of approx. 10cps for ±10% line voltage changes from nominal and load changes of 100%. Its efficiency is 95% at full load. Photograph, outline drawings, complete specs. and description are included. Sola Electric Co., 1717 Busse Rd., Elk Grove Village, Ill.

Circle 300 on Inquiry Card

Precision Potentiometers

This folder catalog includes an 8-page brochure on precision potentiometers of the linear single-turn and multi-turn types. Also included are 13 single loose-leaf data sheets dealing with individual potentiometers, and information on a one turn counter, Model CM-3. Aircraft/Electronic Controls Div., General Controls Co., 1320 So. Flower St., Burbank, Calif. Catalog No. 608.550.

Circle 301 on Inquiry Card

Power Supply Modules

Custom/Power prefabricated, regulated power-supply modules are designed to provide in a wide variety of combinations, power supplies to custom specs. Specs. for the modules are: Input, 105-125vac, 60/440CPS; Output, 5—30vdc, 0—30a; Stability, ±0.1% or ±6mv/24 hrs. Custom/Power, a div. of Trio Laboratories, Inc., Dupont St., Plainview, L. I., N. Y.

Circle 302 on Inquiry Card

Semiconductor Bases

Bulletin A-101 describes ceramic metal bases designed for multiple mounting of semiconductors within existing package outlines. The bases are suitable for use in temps. up to 1700°C. Advanced Vacuum Products, Inc., 440 Fairfield Ave., Stamford, Conn.

Circle 303 on Inquiry Card

Power Amplifier System

Tech. data describing a line of power amplifiers, for use with oscillograph recording equipment, is available from Columbia Research Laboratories, Inc., McDade Blvd. & Bullens Lane, Woodlyn, Pa. Specs. on Series 8010 include an input impedance of 1000megs shunted by 20pf; phase shift of ±1.5° from 20CPS to 20KC; power output, 10v p-p at 300ma p-p.

Circle 304 on Inquiry Card

Microfilm

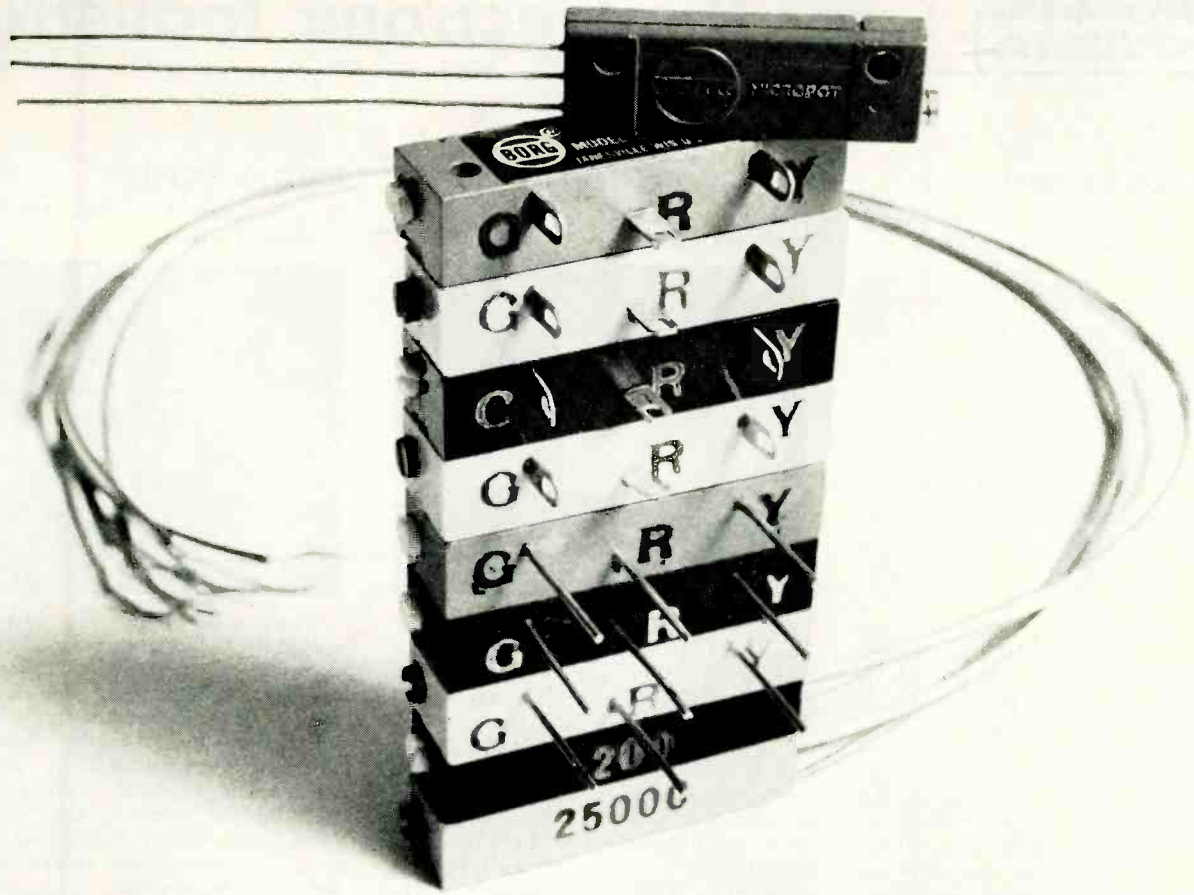
Information on microfilming of engineering drawings, records, and other documents is contained in Tech. data, 6-pages, 2-colors, available from Bay Microfilm, Inc., 4009 Transport St., Palo Alto, Calif.

Circle 305 on Inquiry Card

Printed Circuit Board

Tech. data is available from R G Circuits Co., 15216 Mansel Ave., Lawndale, Calif. on their Model AX-101 ANGLETRON—a printed circuit board with walls (edges) containing metallic strips that go around corners without a break or interruption. Specs. and a photograph included.

Circle 306 on Inquiry Card



The complete Borg Trimmer line starts at the top

Everything must start someplace. The complete Borg line of Trimming Micropot® potentiometers can be said to start with its latest addition, the subminiature (1″ x 3/16″ x 5/16″) 2700 series. This new Micropot is not only tiny, but a high-temperature, humidity-proof model as well.

However, if a quarter of an inch isn't important to your application, there are six other Borg Trimmer series from which to choose:

2800—High temperature, humidity proof, wirewound.

990—High temperature, wirewound.

992—General purpose, wirewound.

993—General purpose, carbon.

994—General purpose, humidity proof, wirewound.

995—General purpose, humidity proof, carbon.

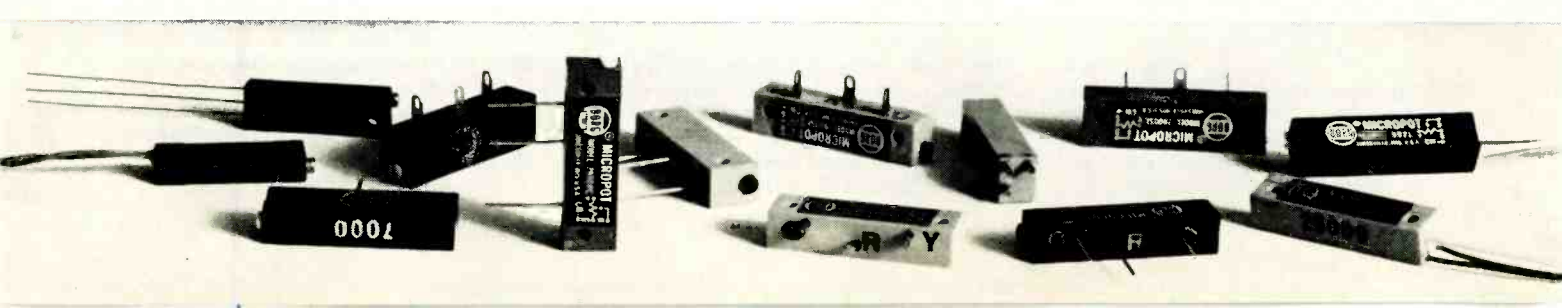
Here are some of the advantages offered by Borg Trimmers: 1. Single-piece, welded terminations. 2. Low-mass contacts. 3. 100% noise test. 4. 100% contact resistance check. 5. 100% ratcheting test. 6. Resistances from ten ohms to one meg.

Selecting the right Borg Trimmer can be a lot easier if you'll call your nearby Borg technical representative or Amphenol-Borg Industrial Distributor. Or, if you prefer, write directly to R. K. Johnson, Sales Manager:

Circle 96 on Inquiry Card

BORG

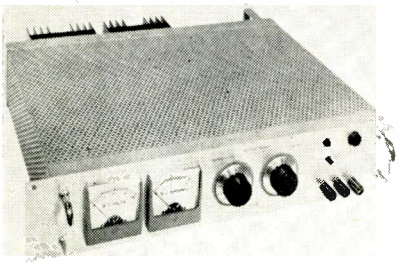
BORG EQUIPMENT DIVISION
Amphenol-Borg Electronics Corporation, Janesville, Wisconsin.



New Products . . . for the Electronic Industries

ADJUSTABLE POWER SUPPLY

This transistorized dc power supply is for bench and laboratory use.

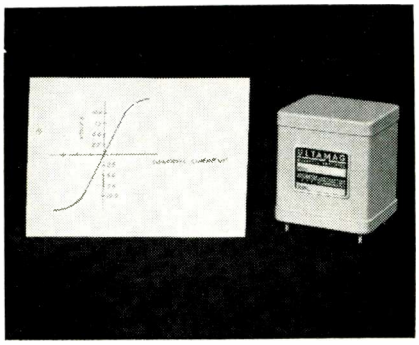


Designated QSA, it uses a static magnetic preregulator. It has ±0.05% static line regulation, 0.05% static load regulation, and reduces ripple and noise to less than 1mv RMS. Response time is less than 50μsec. for 10% line change at any load, and less than 50μsec. for ½ max. load at any line. The QSA's rating is 36vdc at 3a. Other ratings will be available as stock items in the near future. The unit measures 3½ in. in height. Sola Electric Co., 1717 Busse Rd., Elk Grove Village, Ill.

Circle 307 on Inquiry Card

DC/DC MAGNETIC AMPLIFIERS

Line of ruggedized instrument units measures 8 cu. in. and weighs 9½ oz.

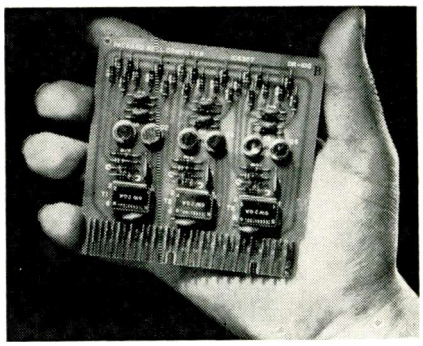


They are dc to dc and operate in the 1 to 10μw control range, giving an output of ±10v across a 1KΩ load. Called ULTAMAG™-Twenty Line, the series operates in a temp. range of −55° to +100°C. Storage temps. are from −65° to +125°C. The series is potted in epoxy resin and hermetically sealed. They operate on 115v (±10%), 400CPS. The units meet all Mil specs. applicable to magnetic amplifiers. Military & Computer Electronics, Inc., 900 N.E. 13th St., Ft. Lauderdale, Fla.

Circle 309 on Inquiry Card

DIGITAL MODULES

Plug-in cards hold data transmitter or data receiver.



These plug-in modules permit low cost data transmission via cable over distances to 1000 ft. The modules operate at 200KC and are complete, except for a power supply, on 4 x 4 in. etched circuit cards. Model DT 100, the transmitter, can transmit, simultaneously, on 3 channels. Model DR 100, the receiver, also has 3 circuits, transformer coupled at the input, for ground and power isolation between transmitter and receiver. Packard Bell Computer Corp., 1905 Armacost Ave., Los Angeles 25, Calif.

Circle 311 on Inquiry Card

PRESSURE TRANSDUCER

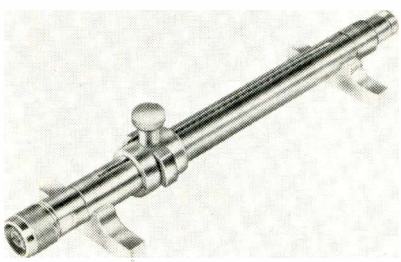
Series SST offers 1.5vdc output for 10vdc excitation.

This series of high-output, semiconductor, strain-gage pressure transducers includes high-line low-differential models. Available in either super-strength aluminum alloy or stainless steel construction, the ASAT is designed for airborne uses where size and weight are critical; the ASST is for extremely corrosive environment conditions. The Series SST is impervious to thermal shock conditions and will not exhibit "overshoot." LUNAR Engineering Corp., 1501 Calle Valle, San Clemente, Calif.

Circle 308 on Inquiry Card

COAXIAL SCREW TUNER

Line of 8 models covers the freq. range from 300MC to 12GC.

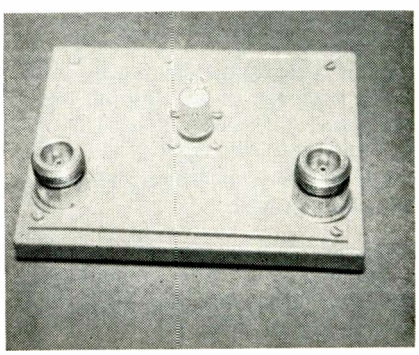


This Screw Tuner, using the impedance transformation characteristic of a coaxial line section and the capacitive reactance of a probe, tunes out reflected voltages from a load. It features simplicity of operation. In actual practice, covergence can usually be obtained with only one adjustment of both the carriage position and the screw probe penetration. Specs.: Characteristic impedance—50Ω; Correctable VSWR—5 to 1; and Insertion loss—0.5db. Astrolab, Inc., 120 Morris Ave., Springfield, N. J.

Circle 310 on Inquiry Card

COAXIAL SWITCHES

High power, low loss, solid state units switch in less than 1μsec.



These switches are for receiver protection. Designed for uses from 100 to 2000MC, these reactive coaxial transmission line units handle more than 10kw peak power in the isolating state. Operating temperature is −55° to +65°C. A typical unit, Model SL5, operates over the band 1250-1350MC and has a minimum of 25db isolation in the forward bias state and a maximum of 0.5db loss in the back bias state. Hyletronics Corp., 185 Cambridge St., Burlington, Mass.

Circle 312 on Inquiry Card

STACKPOLE—proved in service!

When it comes to stringent service requirements, Stackpole measures up! Designed to meet or exceed every MIL-R-11 requirement, Stackpole Coldite 70+ Fixed Composition Resistors bring in addition extra load life, and moisture and humidity resistance to a host of industrial applications.

For Extra Dependability, we mold Coldite 70+ resistance elements and outer insulating shells of similar materials. A completely new process then forms them into a solid, homogeneous structure that defies catastrophic failure or erratic resistance changes in severe environments.

Easiest of All to Solder by Dip or Iron, Coldite 70+ Resistors are unequaled for production line efficiency. They're the only resistors, whose leads are solder dipped — not once, but *twice* — besides the usual tin coating. That's why leads stay smooth and tarnish-free even after months in storage.

Today's Best-Looking Resistors, Coldite 70+ combine handsome, glossy finish and uniform, easily-read color codes. Their attractive appearance easily survives scrubbing with solvents. They're available in MIL-R-11 Type RC-20 (½ watt), Type RC-32 (1-watt), and Type RC-42 (2-watt) in all standard resistance values and at ordinary resistor prices.

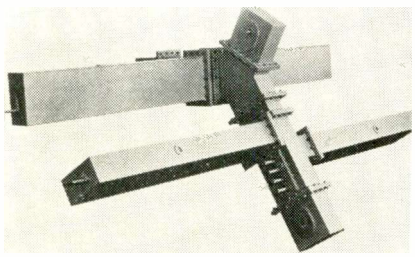
Electronic Components Division
STACKPOLE CARBON COMPANY
St. Marys, Penna.

CERAMAG® FERRITE CORES • VARIABLE COMPOSITION RESISTORS • SLIDE & SNAP SWITCHES • CERAMAGNET® CERAMIC MAGNETS • FIXED COMPOSITION CAPACITORS • BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT ELECTRICAL CONTACTS • GRAPHITE BEARINGS, SEAL RINGS, ANODES • HUNDREDS OF RELATED CARBON & GRAPHITE PRODUCTS.

New Products . . . for the Electronic Industries

TUNABLE DIPLEXER

Covers the 755-985MC freq. range (waveguide size WR 975).

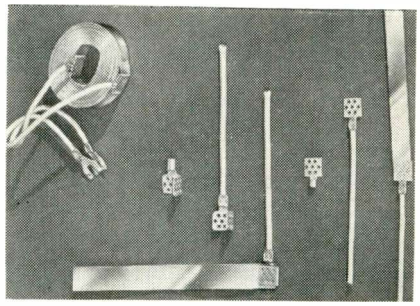


It's tunable over the entire band, can be tuned and locked in just 30 minutes, has a calibration scale which is visible through a pressurized window, and meets all FRC-39 specs. It has an 80db rejection at the center freq., a less than 0.5db pass band insertion loss, and an input VSWR into any terminal of less than 1.2 over ±3MC about the pass band freq. The freq. separation is normally 10%, and power handling capacity is 10kw. Antenna Systems Inc., Hingham, Mass.

Circle 313 on Inquiry Card

FOIL TERMINATIONS

A simple, effective method for terminating aluminum foil.

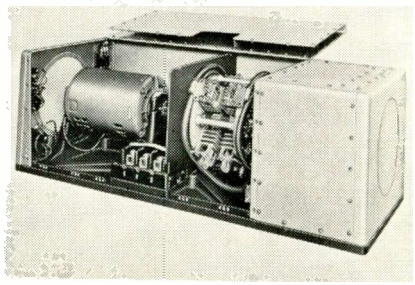


The TERMI-FOIL terminal is designed to reduce costs and improve performance of electrical equipment using aluminum foil and strips. It eliminates surface preparation. When the terminal is pressed into the foil by flat surface dies, tab projections pierce the foil, then fold over, securely riveting the foil to the surface of the terminal. The terminal will cover aluminum sheeting from 0.002 to 0.035 in. and can be spliced to 12-10 size wire. AMP INC., Harrisburg, Pa.

Circle 315 on Inquiry Card

RECTIFIER TESTER

Model 902 uses less power in testing semiconductor rectifiers.

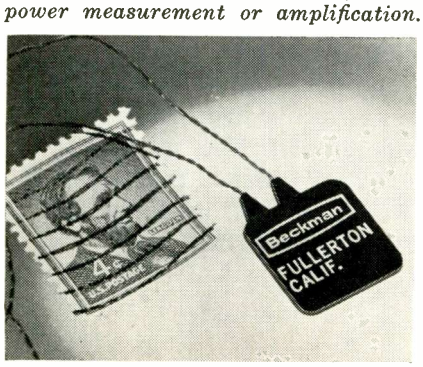


Applying forward current and PIV to the diodes for more than 170°/half cycle, without the large power consumption usually required, is possible with the Daven Model 902 precision motor-driven synchronous switch. Internally protected against overload and overheating, the Model 902 is rated at 200a average forward current and 5000v PIV. Power consumption at this rating is less than 3kw. It will operate unattended for 5000 hrs. The Daven Co., 530 W. Mt. Pleasant Ave., Livingston, N. J.

Circle 317 on Inquiry Card

THIN-FILM HALL GENERATOR

For multiplication, division, and power measurement or amplification.

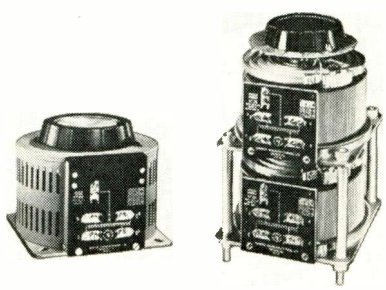


Model 80B is ⅝ in. square. It has typical input impedances of 100 to 600Ω. The standard unit has a semiconductor film 0.00028 in. thick, vacuum deposited on a substrate plate 0.012 in. thick. It accepts 2 inputs, a current and a magnetic flux field, and the output is a voltage proportional to the vector cross product of the 2 inputs. Additional uses include magnetic field measurement and digital readout. Helipot Div., Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif.

Circle 314 on Inquiry Card

VARIABLE TRANSFORMERS

Now available with no-overvoltage feature, in gangs and enclosed.

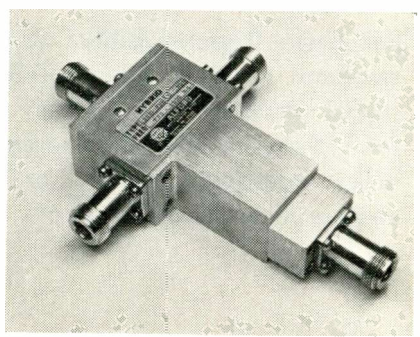


The no-overvoltage version of Ohmite's 20a, VT20, designated "VT20N," delivers just line voltage at max. setting, but the current is 25a. Both the VT20 and VT20N are now available with "B" type enclosure, a basic ventilated metal cover protecting the windings, track and brushes but exposing the transformer's terminal panel. The VT20 and VT20N also available from stock in ganged assemblies of 2 or 3. Larger gangs can be made to order. Ohmite Mfg. Co., 3679 Howard St., Skokie, Ill.

Circle 316 on Inquiry Card

HIGH-FREQUENCY HYBRID

AMCI type 2210-750 provides high performance in small space.



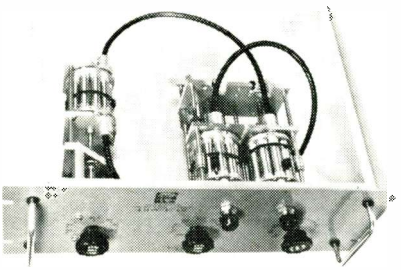
Contained in a rigid, lightweight aluminum housing, it measures 5 27/32 x 4 1/16 x 1⅛ in. including the 4 Type N connectors. It has a rated min. isolation of 40db over the freq. range of 750 to 1050MC. Max. SWR at the parallel end is 1.3, and at the series end is 1.45. CW power rating is 100w at the parallel end, and 10w at the series end. A complete line, including units operating from 45 to 5000MC and capable of up to 30kw CW, are available. Alford Mfg. Co., 299 Atlantic Ave., Boston, Mass.

Circle 318 on Inquiry Card

New Products

R-F STEP ATTENUATORS

These 2 units feature compactness, precision, and rugged construction.

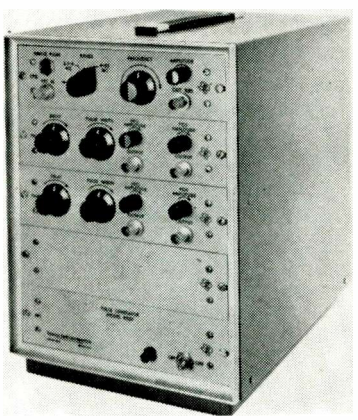


Stoddart R-F Step Attenuators use the "Pull-Turn-Push" turrent control. They are for use with standard 50Ω coaxial cable circuits, and are available in either 2 or 3 turret models. These attenuators have high accuracy from dc to 3GC with a very low phase shift characteristic at i-f freqs. up to 160MC. VSWR is less than 1.5 overall. Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif.

Circle 358 on Inquiry Card

PULSE GENERATOR

Model 6507 Plus/Minus unit has 2 independent pairs of plus/minus outputs.



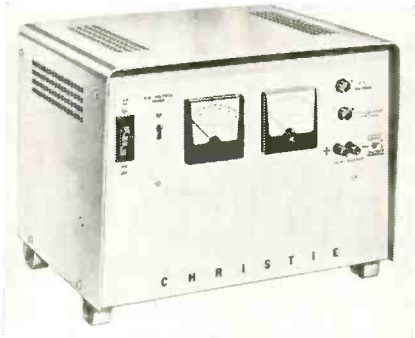
Width and delay of each pair of outputs are coincidently variable—the width from 20 to 1000nsec. and the delay from 20 to 1000nsec. with respect to the clock. Amplitudes are independently variable from 0 to +5v and 0 to −5v. Rise time is 6nsec. Pulse repetition freq. variable from 2.5 to 25MC. Designed to work into an impedance of 93Ω. Model 6507 consists of 4 modules: power supply, clock pulse, and 2 plus/minus modules, house in a metal cabinet measuring 8½ x 12 x 12½ in. high. Texas Instruments Incorporated, Industrial Products Group, P. O. Box 66027, Houston 1, Tex.

Circle 359 on Inquiry Card

New Products

DC POWER SUPPLY CHARGER

Line of wide-range units for lab., or automatic battery charging.

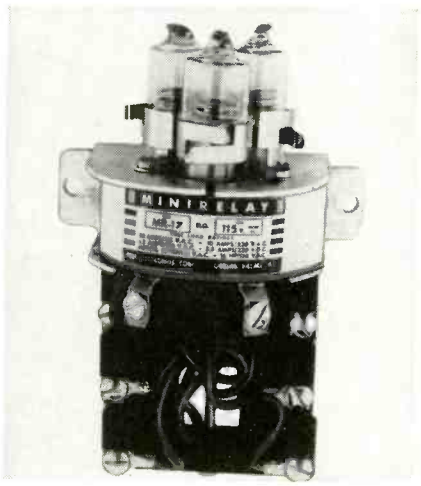


Six models offer a continuous voltage adjustment range of 1 to 145vdc and up to 50a. Standard ac supply source required is 115v, 1 θ 60CPS. Unit available for 230v, 1 θ, for 50, 60, or 400CPS and even for all 3 freqs. combined. All models are regulated against line and load variations and have an adjustable automatic battery charging and other constant voltage or constant current uses. Christie Electric Corp., 3410 W. 67th St., Los Angeles 43, Calif.

Circle 344 on Inquiry Card

MERCURY RELAYS

For use in control circuits, such as motor, lighting, or heating.



The MR-17, 3PST Minirelay, has mercury-to-mercury contacts for silent, maintenance-free operation. Hermetically sealed in an inert gas atmosphere, there are no contacts to pit, stick or corrode, even after millions of operations. Each tube of the MR-17 is rated 20a at 115vac, 10a at 230vac and 5a at 440vac. The 3ϕ motor rating is 2 HP at 115 or 230vac. It measures 5 x 2½ x 3¼ in. Ebert Electronics Corp., 212-26 Jamaica Ave., Queens Village 28, N. Y.

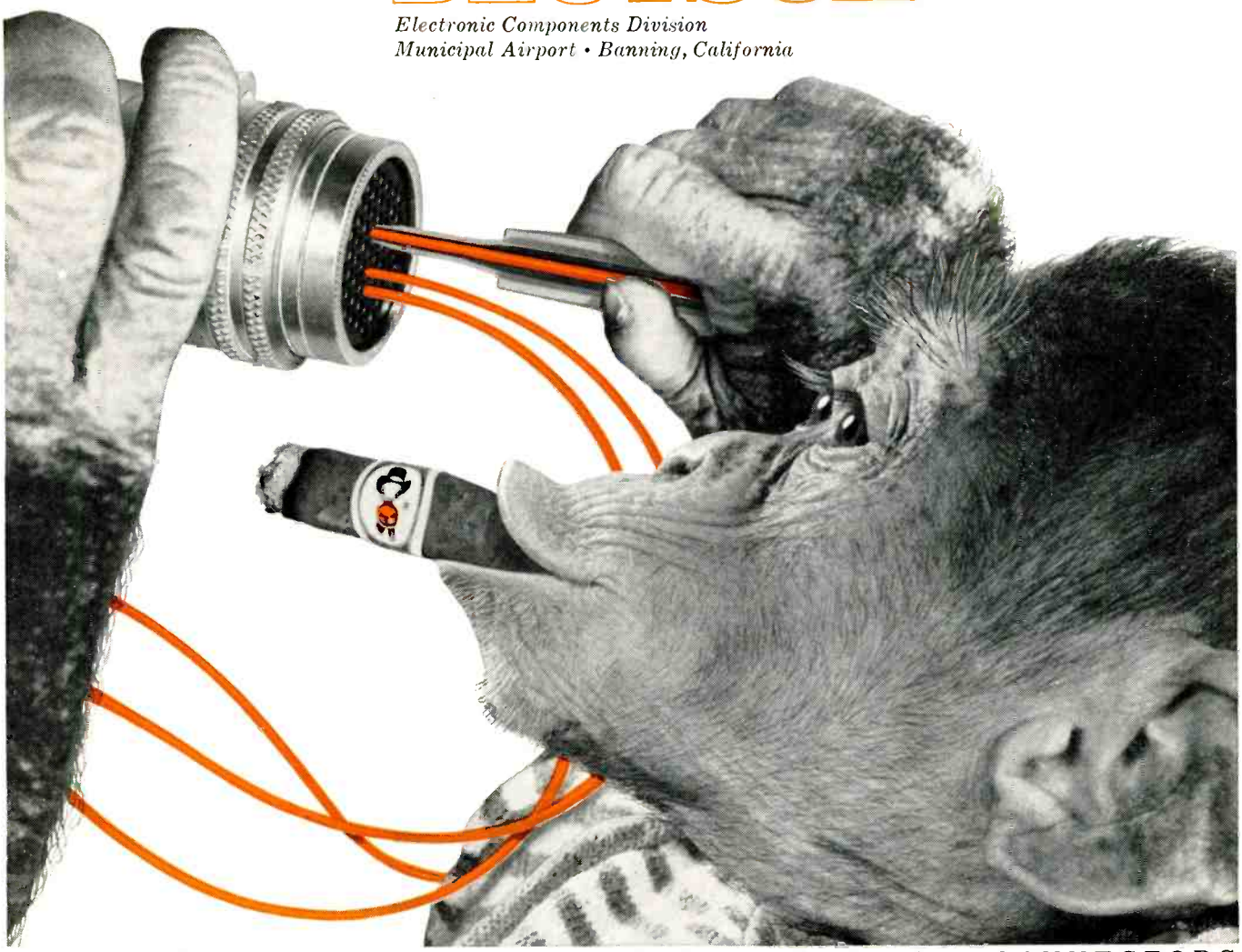
Circle 345 on Inquiry Card

Take the Monkey Business Out of Connector Assembly with the Rugged MDR

No need to monkey around with delicate inserts found in so many electrical connectors today now that the new Deutsch Rigid is available. This rugged design with its solid plastic insert makes multiple contact connector assembly easy as falling out of a tree. And look at all the features the MDR has inherited from its space age relatives: crimp-type contacts that snap in and stay in, a reliable Deutsch ball-lock coupling mechanism that just needs an easy push to connect and gentle pull to disconnect, plus interchangeability with other Deutsch connector series. But for complete facts on this little beauty, contact your local Deutschman today or write for Data File U-5.

DEUTSCH

Electronic Components Division
Municipal Airport • Banning, California



ADVANCED SPECIFICATION MINIATURE ELECTRICAL CONNECTORS

New Products

SCR TESTER

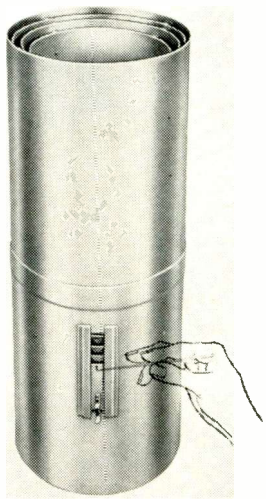
Model R-102 is for production, incoming inspection and quality control.

This portable unit determines the gate voltage required to fire the SCR (up to 5v); the gate current required to fire the SCR (up to 50ma); and the anode-cathode or anode-gate leakage (up to 8megs). It comes complete with color coded test leads, and operating instructions. The unit operates from 115v, 60CPS. Size is 5¼ x 7 x 3 in. Weight is approx. 2½ lbs. Power/Radiation, Inc., Box 616, Suffern, N. Y.

Circle 319 on Inquiry Card

MAGNETIC SHIELDS

Designed for use with Dewar flasks in cryogenic research.



This line of diversionary Netic and Co-Netic magnetic shields use 2, 3 or 4 concentric cylindrical shields, one inside the other. The shield illustrated is 36 in. high and 15 in. O.D. It consists of 3 inner shields of high permeability Co-Netic alloy and 1 outer shield of heavy gauge Netic alloy. For viewing the sample under cryogenic test, a multi-section viewing port is provided. Magnetic Shield Div., Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill.

Circle 320 on Inquiry Card

SPERRY microwave memo

ACTUAL SIZE

Now . . . SPERRY packs 10 W output, 60 db gain into a 10 cu. in. TWT

Because of the space age demand for smaller, more rugged components with outstanding performance characteristics, the new STX-186 is now available on 60-day delivery from Sperry Electronic Tube Division.

This new X band traveling wave tube is ideally suited to the rigors of aerospace application. It delivers a minimum 10 watts of CW output across X band, at gain levels up to 60 db. Yet it is only 10½ inches long, weighs only 12 ounces, and occupies only 10 cubic inches of payload space. Rugged metal-ceramic construction enables the PPM focused STX-186 to withstand the shock, vibration, and altitude extremes of the most demanding aerospace environments.

Designers can realize maximum benefit from the tube's small size by adapting mounting and cooling arrangements to meet specific environmental demands. Cooling may be air, heat sink, or liquid.

BROAD APPLICATION POSSIBILITIES

In addition to its small size and physical ruggedness, the STX-186 boasts performance characteristics that open a broad range of application possibilities.

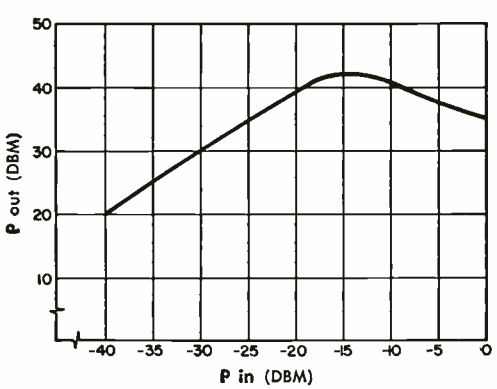
Across the entire band of 7 to 11 Gc, this new TWT delivers a minimum 10 watts CW at up to 60 db gain. The dynamic range of broadband signal amplification extends 25 db below saturation. These characteristics make the STX-186 eminently suitable for rocket, drone, and aircraft application in radar augmenter, ECM, or comunications systems.

IMMEDIATE AVAILABILITY

Sperry is now producing the STX-186 in quantity, and limited numbers are available within 60 days of receipt of order.

A NEW TECHNICAL BROCHURE, WHICH DESCRIBES THE CHARACTERISTICS OF THE STX-186 IN DETAIL, IS NOW AVAILABLE. FOR YOUR FREE COPY, WRITE TO SPERRY ELECTRONIC TUBE DIVISION, SEC. 134, GAINESVILLE, FLORIDA.

To avail yourself of the outstanding performance of this new tube, place your order now. Your Cain & Co. salesman, who represents Sperry Electronic Tube Division, will be happy to provide application assistance and quotation. Or you may communicate directly with us at Great Neck, N. Y.



Typical drive curve STX-186 at 9 Gc

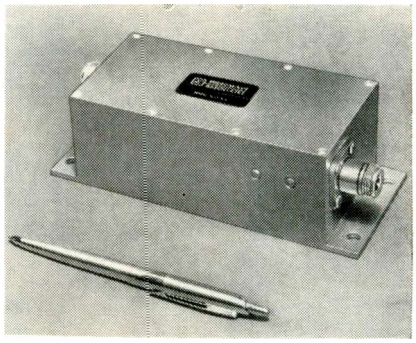
SPERRY ELECTRONIC TUBE DIVISION

GAINESVILLE, FLA. / GREAT NECK, N. Y.
SPERRY RAND CORPORATION

New Products

FREQUENCY MULTIPLIER

For use in signal generators, telemetering or beacon transmitters.

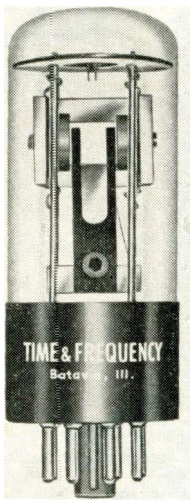


The MA-8028 is a high efficiency, passive solid state freq. multiplier. It can be driven with 3w CW power at about 36-40MC and will deliver 200mw at the 32nd harmonic in the L-band range. The bandwidth is 1.25%. Three stages, featuring a compact lumped-circuit design are used, 2 of which are quadruplers and the third stage a doubler. The body, of aluminum construction, is 5⅜ x 2¾ x 2 in., excluding mounting pads and connectors. Weight is under 2 lbs. Microwave Associates, Inc., Burlington, Mass.

Circle 321 on Inquiry Card

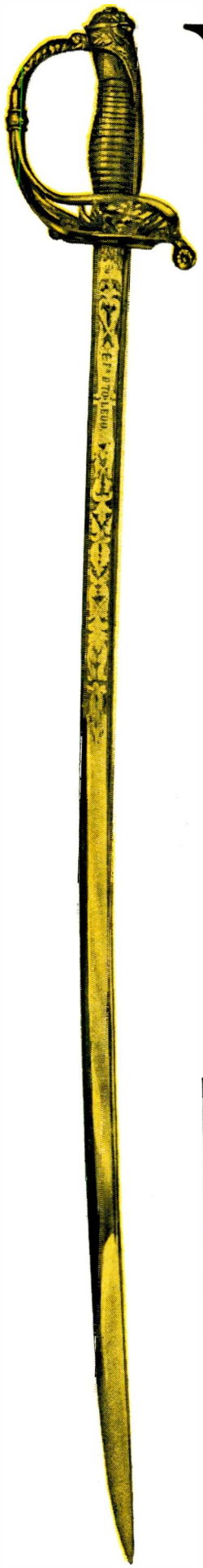
TUNING FORK OSCILLATOR

Model Tf-9 has a freq. range from 400CPS to 12KC.



Its entire circuit is molded into a standard base, and sealed in a high-vacuum glass tube, after outgassing and washing with an inert stable gas. The tube is 1⅛ in. dia. and 2¾ in. high. Its accuracies are: ±0.0001% (one part per million) at 26°C, ±0.005% (fifty parts per million) at from −54°C to +125°C. Other models are available enclosed in steel containers to meet Mil specs. for resistance to vibration, shock, acceleration and environmental change. Time & Frequency, Batavia, Ill.

Circle 322 on Inquiry Card



QUALITY

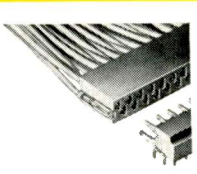
The famed Toledo blade or the AMPin-cert*
Blade Connector depends on quality built to last.
From precision crimped receptacle contacts to gold over nickel plating,
the AMPin-cert Blade Connector offers feature after feature
for maximum performance capabilities,
long-lasting reliability and lowest applied costs.
And the AMP-Blade* Connector doesn't split hairs
when it comes to meeting and even exceeding
the most stringent applicable requirements—military or commercial.
Check this partial listing of features and compare.

FEATURES:
- Crimped contacts insure uniformity of connections.
- Gold over nickel plating assures lasting reliability.
- Encapsulated male tab member prevents misalignment of contacts.
- Staked down male tab housing eliminates board warpage.
- Guide pins assure positive mating of connector halves.
- Raised barrier section and large contact cavities avoid moisture entrapment.
- Three large areas of contact between receptacle contact and male tab.
- Built-in egg crate construction and crimp, snap-in receptacle contacts eliminate sleeving and soldering.
- Not pre-loaded . . . buy and use only the receptacle contacts you need.
- Terminated by high speed crimping machines or hand tools.

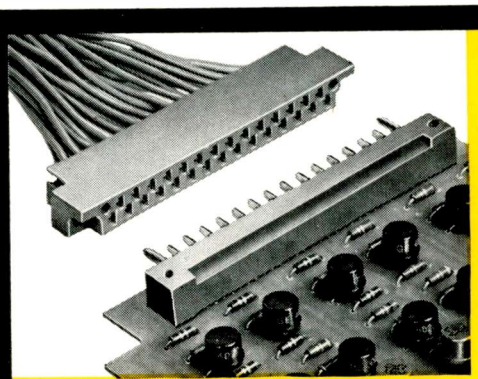
For complete information on AMPin-cert blade-type
printed circuit connectors, write today!

*Trademark of AMP INCORPORATED

AMP



Cross-Section View



AMP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England France • Holland • Italy Japan • Mexico • West Germany

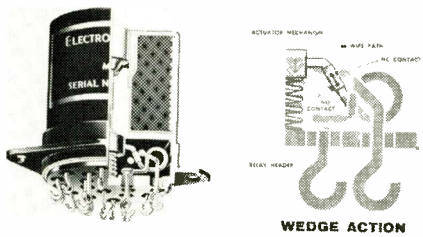
AMP
INCORPORATED
Harrisburg, Pennsylvania

Circle 106 on Inquiry Card

New Products

RELAY

Mark II Type 1000 series meets Mil-R-5757D for 125°C operation.

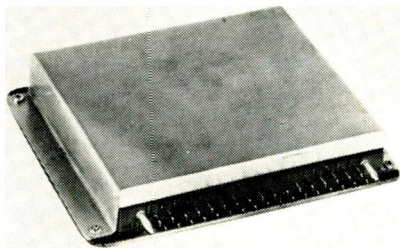


The Type 1000 relay using "Wedge Action," has a powerful plunger type solenoid to actuate 6 moving contacts. These movable contacts are positioned between 2 rigidly mounted stationary contacts. In either the energized or de-energized position, contact pressure increases between the moving contact and the fixed contact. Low contact resistance, 0.015Ω is assured by electrodeposited 24K gold over an electrodeposited fine silver base. Electro-Tec Corp., 1 Henderson Dr., W. Caldwell, N. J.

Circle 323 on Inquiry Card

SOLID STATE OR-GATE

Model 0-121-DC features 2 dual input and 2 triple input gates.



Seven extra inputs are provided for external connection by the user. This or-gate operates from dc to 1MC. The terminal arrangement is a 35-pin AMP Blade connector. Nominal logic levels are 0 (true) and −5 (false). In the OV condition the signal source must supply up to 1.5ma. Input capacitance is less than 20pf. Voltage shift (output signals) per stage is less than ±0.3v. Model 0-121-DC, DC logic module, will drive 3 or-gates like itself. Digital Design Corp., Box 21, Clay, N. Y.

Circle 325 on Inquiry Card

HUMIDITY INDICATOR

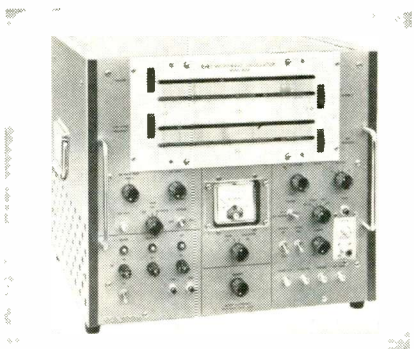
Designed for laboratory and field applications.

The Jelrus PORTO - HYGROMETER is a portable battery-operated humidity indicator. By pushing a button, instantaneous and direct relative humidity (R.H.) is read from 30% to 100% with a single electronic sensor and dial. Extension rods of varying length permit direct reading of R-H in hard-to-get-at spots, within ±5%. The unit is unaffected by barometer changes. It will withstand rough use. Jelrus Technical Products Corp., 2020 Jericho Tpke., New Hyde Park, N. Y.

Circle 324 on Inquiry Card

MICROWAVE OSCILLATORS

These swept oscillators, Series 620B, cover from 126GC.



They have built-in Levelers which hold power output to approx. ±0.75 db over the entire freq. range and nominally to ±0.1 over any 100MC interval. All Series 620B oscillators also feature symmetrical freq. deviation about any center freq. These oscillators have very low residual FM and drift stability. Min. power output is 10mw. Freq. range adjustable freq. markers and sweep time can be seen at a glance. Alfred Electronics, 3176 Porter Dr., Stanford Industrial Pk., Palo Alto, Calif.

Circle 326 on Inquiry Card

PREVENT MAGNETIC TAPE DEGRADATION

with NETIC CONTAINERS

during storage or shipping

Widely accepted since 1956 in military and industrial applications for protecting valuable tapes from detrimental magnetic environments. Long life rugged containers come in many sizes and shapes . . . are non-shock sensitive, non-retentive, require no periodic annealing. Request Data Sheet 104.

MAGNETIC SHIELD DIVISION
Perfection Mica Company / Phone EVerglade 4-2122
1322 No. Elston Ave., Chicago 22, Ill.

Circle 108 on Inquiry Card

What could YOU do with this Sensitive Abrasive?

CRATEX® RUBBERIZED ABRASIVES

Without significantly changing dimensions of the workpiece, CRATEX® deburrs, smooths, cleans and polishes easy and hard-to-reach surfaces.

The unusual performance of Cratex results from its cushioned chemical rubber base. It is slightly compressible; shaped in a variety of forms, including Wheels, Points, Blocks, Sticks and Cones. First quality Silicon Carbide abrasive particles are evenly distributed throughout the base and each Cratex shape is available in 4 grit textures: (C) coarse; (M) medium; (F) fine; (XF) extra fine.

Typical Cratex applications include:

- precision finishing without loss of tolerances,
- cleaning out and finishing intricate designs,
- relieving stress concentration,
- radiusing,
- removing surface blemishes.

You can count on CRATEX® to do the same dependable job, time after time.

A comprehensive Cratex catalog and price list is available on request, without charge. Product and performance data provided may suggest how Cratex will benefit you in terms of time-saving cost reduction and quality improvement.

CRATEX® MANUFACTURING COMPANY, INC.
1600 ROLLINS ROAD BURLINGAME, CALIF.

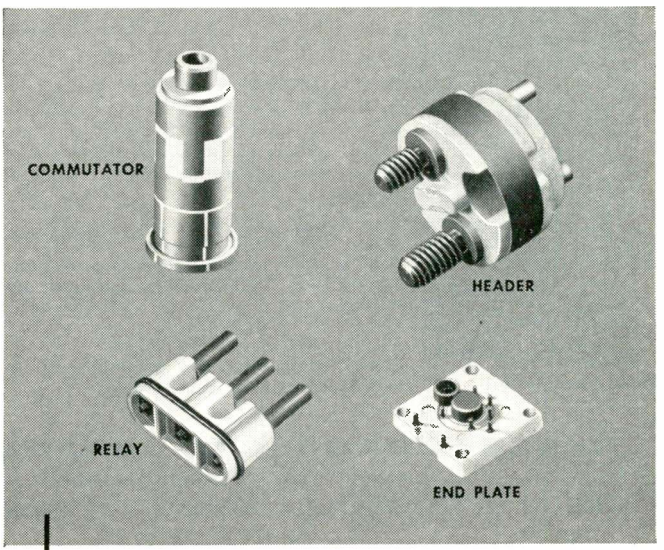
Cratex is sold through leading industrial distributors.

Circle 109 on Inquiry Card

NOW UNLIMITED DESIGN FLEXIBILITY

FOR

TERMINALS and HEADERS SWITCHES and RELAYS



HAVEG develops new method for manufacturing HERMETIC SEALS of complicated design with ceramic type materials

Look at the complicated and challenging design configurations of HAVELEX parts pictured above. All are made possible with Haveg's *new* method of hermetically sealing inserts into ceramic-like HAVELEX during the molding cycle.

- Inert materials used in HAVELEX do not "out-gas" and can be sealed in Nitrogen.
- HAVELEX will not track since it is inorganic.
- Stainless Steels, Nickel iron and even cold rolled steels have been successfully used and can be plated gold, silver, tin and nickel.
- Dimensional stability and excellent electrical and arc properties between 600°F and 1000°F fill that important "temperature gap" in molded materials.

Learn more about HAVELEX and how it can help you solve some of your problems. For latest technical data, write to HAVELEX Sales Mgr., Dept. EI-25.

HAVELEX

HAVEG

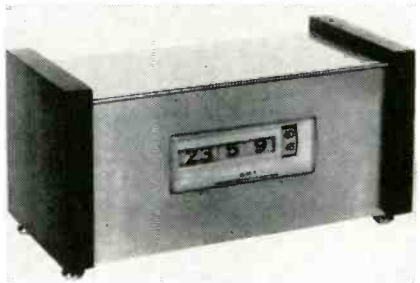
HAVEG INDUSTRIES, Inc. • 336 Weir Street • TAUNTON, MASS.

Circle 110 on Inquiry Card

New Products

DIRECT READING CLOCK

It features a G.M.T. 24 hour direct reading digital display.

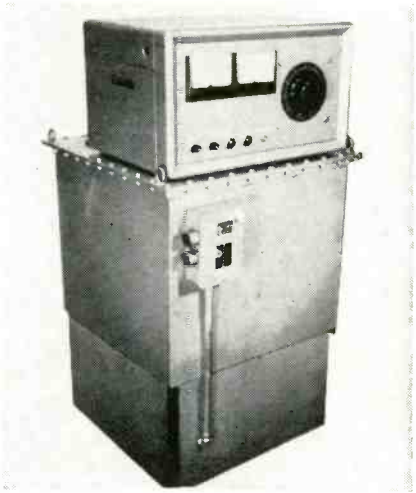


The #920-24H Vanguard Tymeter Clock offers precise time automatically. It is for use in laboratories, testing facilities, or wherever exact time is essential. The Vanguard displays seconds, minutes, 10 minutes and hours. It is housed in a polished stainless steel case with walnut wood ends. It measures 3⅞ x 7¾ x 3¾ in. Weight is 3 lbs. The motor and cord are UL approved. A 1-year guarantee comes with the clock. Pennwood Numechron Co., 7249 Frankstown Ave., Pittsburgh 8, Pa.

Circle 334 on Inquiry Card

HIGH VOLTAGE SUPPLY

Model HVA 300-303 has a 30kvdc, 30ma output with 0.01% RMS *ripple.*



Input requires 105 to 125vac, 60CPS. The instrument and control center, mounted on the high voltage assembly tank, may be used at a remote point. The instrument and control center contains complete metering, overload protection, switches and indicators, as well as the output control. The high voltage assembly tank with casters measures 24 x 24 x 40 in. The control center measures 21 9/16 x 14⅞ x 13 in. Plastic Capacitors, Inc., 2630 N. Clybourn Ave., Chicago, Ill.

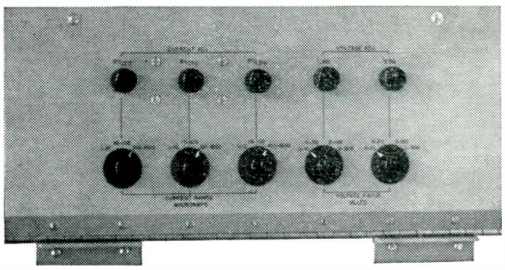
Circle 335 on Inquiry CARD

ACCURACY

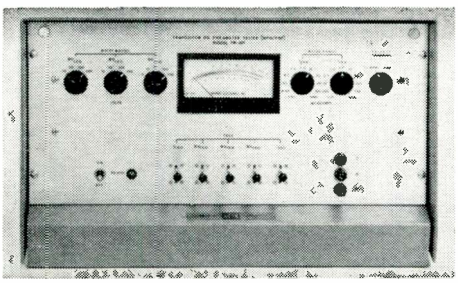
BETTER THAN 1% OF FULL SCALE!

Your product can only be as perfect as the equipment that tests it! That's why more and more semiconductor manufacturers and users are specifying Indamer.

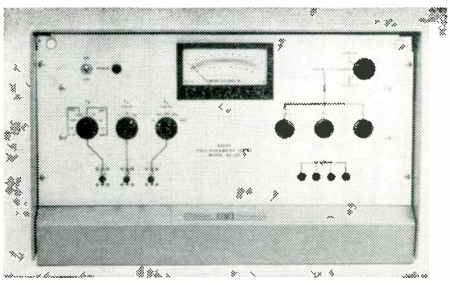
Accuracy and *reliability* are two vital factors that best describe Indamer's full range of manual testers. Precision built instruments with *self-calibrating* controls are designed for easy access inside the chassis. Match an Indamer tester to your requirements by writing for specific data sheets.



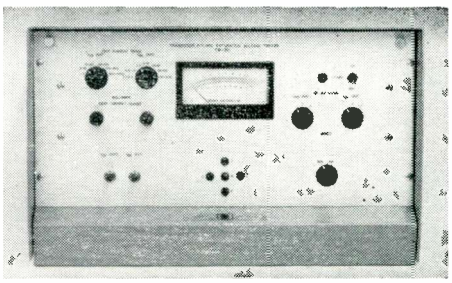
FULL RANGE OF SEMICONDUCTOR MANUAL TESTERS



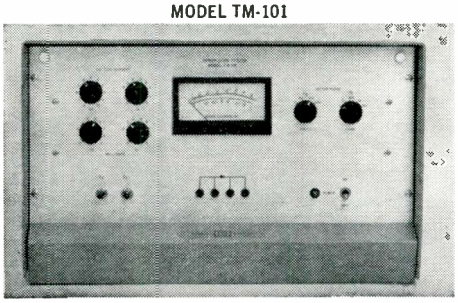
TRANSISTOR DC PARAMETER TESTER
MODEL TM-101



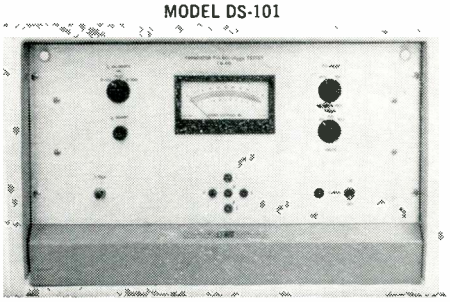
DIODE POLY-PARAMETER TESTER
MODEL DS-101



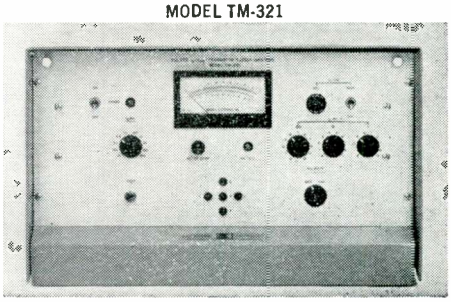
TRANSISTOR PULSED SATURATION VOLTAGE TESTER
MODEL TM-321



ZENER DIODE TESTER
MODEL ZM-101



TRANSISTOR PULSED LV_{CER} TESTER
MODEL TM-401



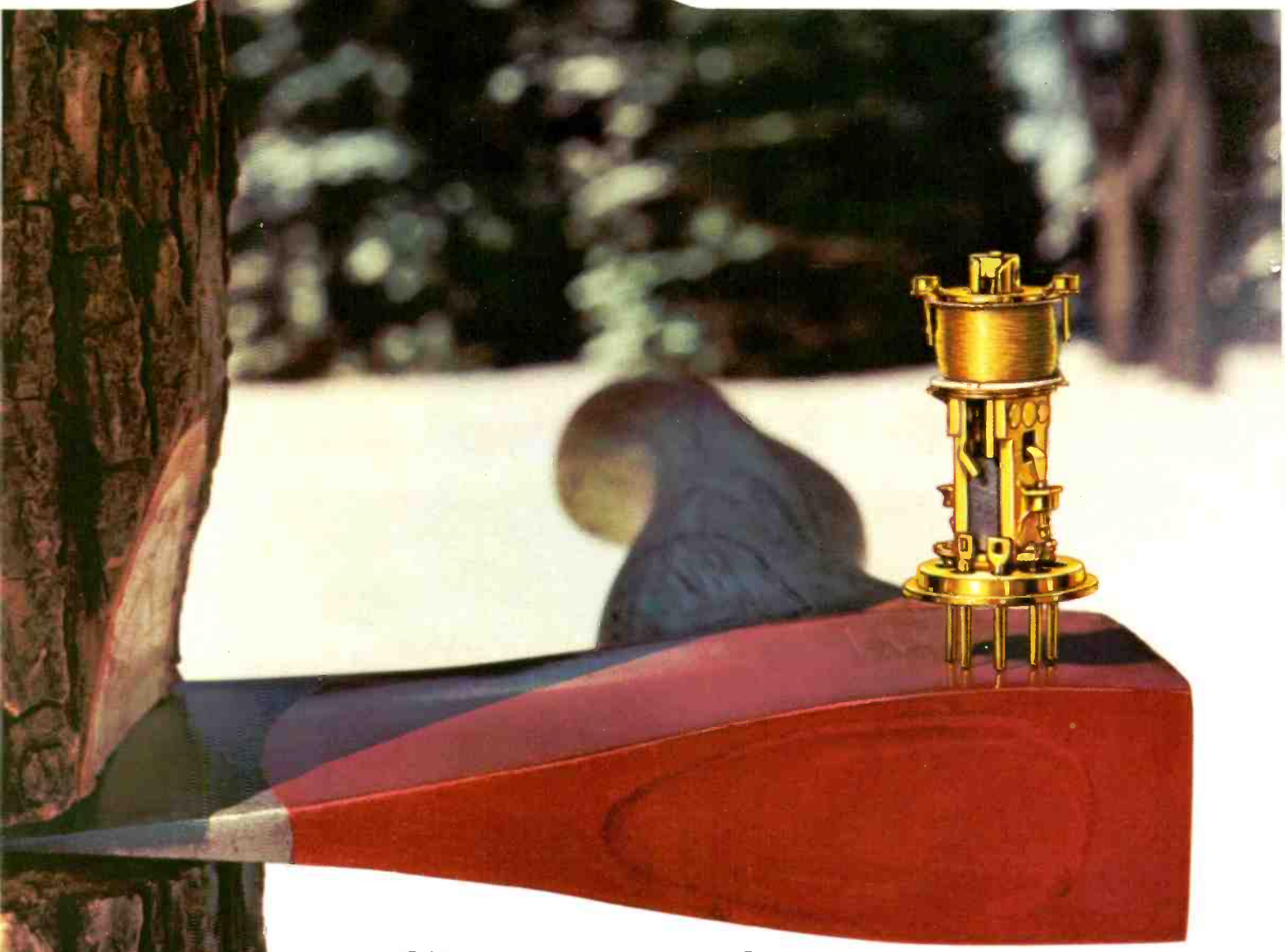
PULSED I_B (h_{FE}) TRANSISTOR TESTER
MODEL TM-221

For critical production operations, Indamer makes automatic testers—to your specifications—capable of processing up to 3600 units an hour. Custom made *life systems* also available.

IE INDAMER ELECTRONICS

SEMICONDUCTOR TESTING EQUIPMENT
1038 WEST EVELYN • SUNNYVALE, CALIF.
TELEPHONE CH 5-3291

The Oak Approach



Choppers?

The trick is to give them real guts!

Ruggedness figures decisively in the Oak approach to all product design — in choppers, high-speed relays, rotary solenoids, rotary and pushbutton switches — *all* Oak-made components. This guiding engineering philosophy gives these precision parts the guts to take it where ordinary components simply won't stand up.

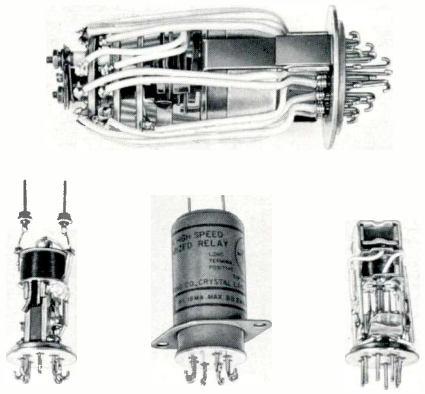
Take Oak choppers for missile applications. These new electromechanical units shrug-off forces of as many as 30 Gs . . . severe vibration, shock, temperature, humidity and altitude extremes. —You'll appreciate that's a lot from any electromechanical chopper! Thus these high-shock units are proving a *natural* for air-borne computers and other portable equipment. At the same time Oak design has *doubled* chopper life — stress-relieving the vital parts, and using contact materials such as platinum-ruthenium.

Oak choppers serve *all breeds of d-c amplifiers*, including transistorized and magnetic types. Plain enough why thousands are now handling low-level d-c signals in military and commercial systems.

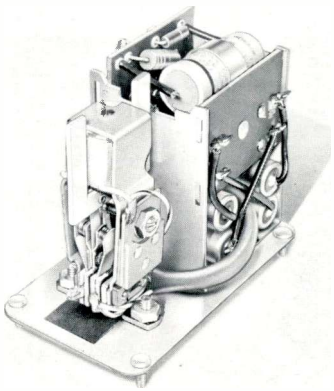
Give your circuits the advantages of *ruggedized precision parts* through the Oak Approach to component design. Our Applications Engineers offer to analyze your specific chopper and other switching functions, to assure the right all-around components for your circuits. Write, wire or telephone us direct for complete details.

Where creativity pays practical dividends

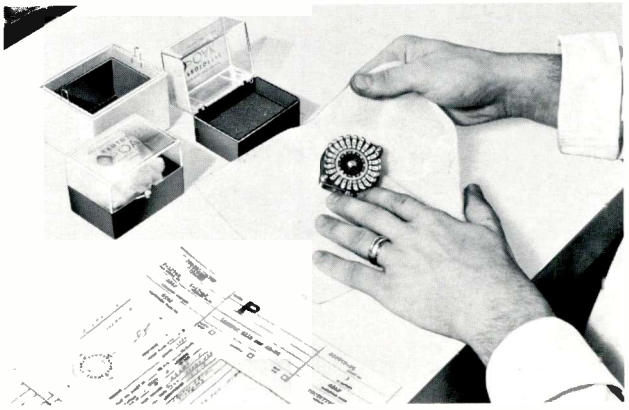
OAK ideas help cut component costs... Chopper, switch, rotary solenoid, high-speed relay — whatever Oak product you name, making it *right* doesn't necessarily mean designing the most expensive item to do the job, under all conditions, for a hundred years. But it *always* means creating the *lowest-cost component that can handle the job and provide proper use-life*. So, send your performance and application data along whenever you order. Even though you have been dealing with us for years, you'll enable us to do a still better job for you. And no part is too insignificant, even the simplest slide or lever switch will be given careful, thorough attention.



OAK assemblies can simplify production... free-up your manufacturing facilities—Given circuit data and opportunity, Oak also builds complete subassemblies — like the U. S. Signal Corps Supply Agency inverter device shown here — and often can provide savings by unifying switches and related circuitry into cost-saving "package" plug-ins. Sometimes this even eliminates the need for expensive components such as relays. Oak-built units all are life-and environment-tested. Products subject to MIL SPECS are checked for performance under vibration, shock, salt spray, humidity, high altitude and temperature extremes. You'll find Oak engineers eager to assist with problems; we urge you to take full advantage of their unique capabilities.



OAK schedules help you speed your work — Fast service is routinely part of the bargain! Need a prototype switch? Order it from Oak: generally it's completed in 3 days! And compare our new, faster production cycle — now insured by expanded plant capacity. To simplify ordering Oak switches, layout sheets are available at no cost for diagraming your request. Contact your Oak representative, or call Oak directly — for specific information, details of products, or special prototype service, anytime that you feel we can lend a hand.

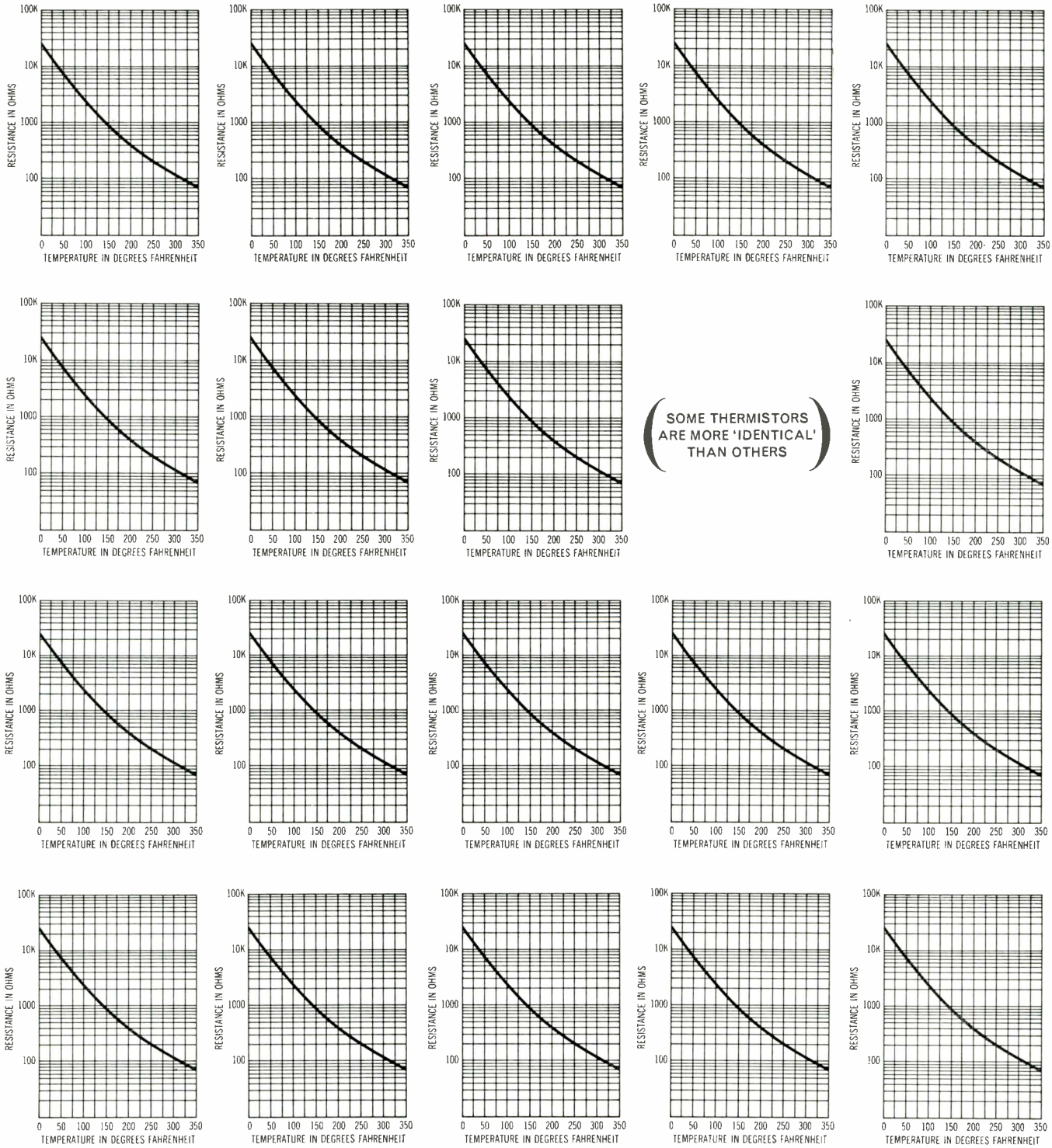


OAK MANUFACTURING CO.

CRYSTAL LAKE, ILLINOIS • Telephone: Area Code 815; 459-5000; TWX: CRYS LK 2350-U;
Plants in Crystal Lake, Illinois • Elkhorn, Wisconsin

Subsidiaries: OAK ELECTRONICS CORPORATION, Culver City, Calif. DELTA-f, INC., Geneva, Ill. McCOY ELECTRONICS CO., Mt. Holly Springs, Pa.

ROTARY AND PUSHBUTTON SWITCHES • TELEVISION TUNERS • VIBRATORS • APPLIANCE AND VENDING CONTROLS • ROTARY SOLENOIDS • CHOPPERS • CONTROL ASSEMBLIES



Only Fenwal Electronics offers curve-matched thermistors — designed for complete interchangeability

Only Fenwal Electronics offers a line of thermistors which can be supplied with identical resistance temperature curves. Thus, for the first time, you have complete thermistor interchangeability. You can achieve accurate, multi-point temperature indication or control through a single system without calibrating each individual sensor. We offer the most complete line of thermistors anywhere — we can match your requirements exactly. We offer complete thermistor custom-engineering service, backed by 20 years of solid experience. *Who else offers as much?*

For up-to-the-minute information on how to put thermistors to work in high precision circuitry — for temperature control and measurement, liquid level measurement, time delay, remote control, or any of a literally infinite number of critical applications, you should have Fenwal's new Catalog EMC-4 in your file. Why not write today?

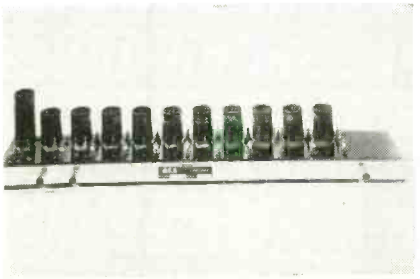
Fenwal Electronics

63 Fountain Street, Framingham, Mass.

New Products

LOGARITHMIC IF AMPLIFIER

For use in panoramic receivers and countermeasures systems.



This logarithmic amplifier, Model IF2309, has a log characteristic accurate to ±1db for a 60db signal range and ±2db for 80db range. The amplifier will find uses in instrumentation for antenna ranges, and in radar systems. Center frequency is 30MC and available bandwidths are 4 and 7MC. LEL, Inc., 75 Akron St., Copiague, N. Y.

Circle 338 on Inquiry Card

TV STORAGE TUBE SYSTEM

Stores and instantly reads-out for repeated display a single TV frame.

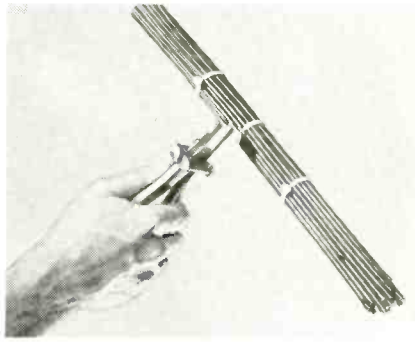
Model 206 ELECTROSTORE, recording storage tube system operates at standard EIA TV scanning rates. Resolution of 1000 lines across the dia. and grey scale fidelity of 5 to 6 shades are achieved by the Raytheon QK685 electrostatic storage tube in the Model 206. Readout is non-destructive, and the stored picture may be continuously displayed on a TV monitor for 10 min. or more. Dimensions are 77 x 22 x 24 in. Weight: 520 lbs. Image Instruments, Inc., 2300 Washington St., Newton 62, Mass. Circle 339 on Inquiry Card

Circle 117 on Inquiry Card

New Products

PERMANENT CABLE TIES

Designed for simple, sure cable tying in high production operations.

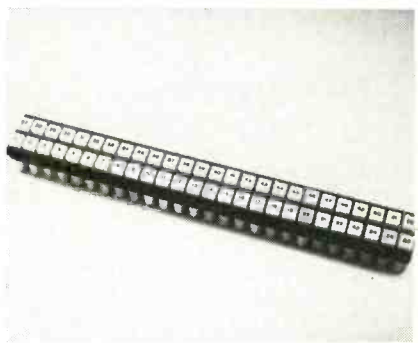


Line of permanent cable ties called STA-STRAP combines self-locking Nylon cable ties and clamps with a tensioning tool that automatically cuts off excess strap at a pre-set tension. The STA-STRAP is installed by threading the tip through the eye. The Panduit Tool is squeezed to accomplish final controlled tie tension and flush cut-off by excess strap. No twisting, pushing or pulling is required. Panduit Corp., Dept. ES-2, 17301 Ridgeland Ave., Tinley Park, Ill.

Circle 336 on Inquiry Card

PUSHBUTTON ASSEMBLIES

Available up to 6PST or 3PDT in combinations of NO and NC contacts.



Six basic types offered are: Independent; Momentary Interlocking; Independent Locking and Interlocking; Locking and Interlocking; Locking with Master Release; and Locking and Interlocking with Master Release. Unit shown contains 52 switches mechanically locked and interlocked so that when one button is depressed it remains depressed and releases any other switch previously depressed; no 2 pushbuttons can be depressed simultaneously. Pendar, Inc., 14744 Arminta St., Van Nuys, Calif.

Circle 337 on Inquiry Card

Circle 118 on Inquiry Card

Astounding Performance

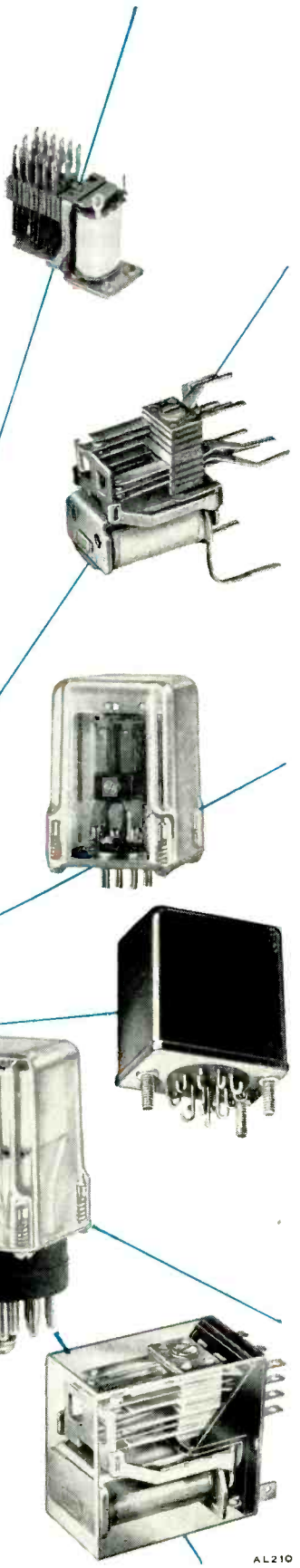
Allied's Line of

Military and Commercial

"Cradle" Relays

Life in the hundreds of millions

Small size and weight • Low level up to 5 amperes • Sensitivity from 50 milliwatts • Up to 6-pole double-throw • Sealed, open or dust cover • Plug-in, printed circuit or solder type terminals • Stocked throughout the country • Amazingly low cost • *Write for our complete new 4-page Cradle Relay Bulletin.*



ALLIED CONTROL

ALLIED CONTROL COMPANY, INC.
2 East End Avenue, New York 21, N. Y.

Circle 119 on Inquiry Card

One of these specialized meters is designed for your measuring job

Each of these Hewlett-Packard instruments has its own special usefulness for you. But all of them offer the extra values you expect in an hp instrument: Realistic specs which every instrument meets, now and next year. Conservatively designed circuitry that will perform for years, without being overworked. Careful amplifier design featuring high feedback that assures constant performance as tubes age. Cleanliness and ruggedness in design and assembly — packaging that makes routine maintenance simple.

In short, you get hp quality and accuracy and the best test instrument value in America today. Now, to the specs below. Choose the instrument designed for your present job and call your hp rep for a demonstration.

COMPLETE COVERAGE, UNIQUE VALUE, TRUSTED hp ACCURACY AND DEPENDABILITY

Instrument	Primary Uses and Features	Frequency Range	Voltage or Current Range	Input Impedance	Price
 hp 403A	Solid state ac voltmeter, battery-operated, portable. Fast, accurate, hum-free ac measurements.	1 cps to 1 MC	0.001 to 300 v 12 ranges	2 megohms 40 pf shunt, low ranges; 20 pf, mid ranges; 15 pf, high ranges	$275.00
 hp 400D	Wide range ac voltmeter. High sensitivity, 2% accuracy.	10 cps to 4 MC	0.001 to 300 v 12 ranges	10 megohms 15 pf shunt, high ranges; 25 pf, low ranges	$250.00

Instrument	Primary Uses and Features	Frequency Range	Voltage or Current Range	Input Impedance	Price
 hp 412A*	Precision VTVM. 1% accuracy; measures voltage, current, resistance; no zero set needed; 1 ohm to 100 megohm center scale for resistance meas., 60 db dc amplifier.	dc	1 mv to 1,000 v 1 μa to 1 amp	10 to 200 megohms, depending on range	$400.00
 hp 413A*	DC null meter, dc voltmeter, 60 db dc amplifier. 2% accuracy, floating input, 1 mv end scale sensitivity.	dc	1 mv to 1,000 v 13 ranges	10 to 200 megohms, depending on range	$350.00

 400H*	Similar to 400D, 1% accuracy on extra-large 5" mirror-scale meter.	10 cps to 4 MC	0.001 to 300 v 12 ranges	10 megohms 15 pf shunt, high ranges; 25 pf, low ranges	$325.00
 400L	Logarithmic 400D. Accuracy ±2% constant percentage of reading. For log voltages, linear db measurements.	10 cps to 4 MC	0.001 to 300 v 12 ranges	10 megohms 15 pf shunt, high ranges; 25 pf, low ranges	$325.00
 410B	VTVM for audio, rf, VHF measurements; dc voltages, resistances. Minimizes circuit loading, low drift, one zero set all ranges.	dc; ac, 20 cps to 700 MC	dc, 1.0 to 1.000 v, 7 ranges; ac, 1.0 to 300 v, 6 ranges	dc, 122 megohms; ac, 10 megohms/ 1.5 pf shunt	$245.00

* LAB STANDARD ACCURACY IN COMMERCIAL VOLTMETERS!

New individual calibration of meter scales gives you today's highest available accuracy in commercial voltmeters. With a servo system, each voltmeter scale is calibrated to the exact characteristics of its individual meter movement. No preprinted approximate scales are used. Scale tracking error is eliminated. What the voltage actually is —you read!

Individually calibrated meter scales are now furnished—at no increase in cost—on these instruments: 400H Vacuum Tube Voltmeter, 412A DC Voltmeter-Ohmmeter-Ammeter, 413A DC Null Meter, 425A DC Microvolt-Ammeter.

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

 405	Automatic digital VM. "Touch and read", direct dc voltage measurements, digital readout. Automatic range, polarity; readout available for printer, system.	dc	0.001 v to 1,000 v (accuracy ±0.2% of reading ±1 count)	11 megohms	$850.00
 425A*	Microvolt-ammeter reads μv, μμa; 100 db amplifier; measures dc voltages, current as in medical, biological, physical, chemical work.	dc	10 μv to 1 v 11 ranges; 10 μμa to 3 ma, 18 ranges	1 megohm ±3% (v) 1 megohm to 0.33 ohms (current)	$500.00
 428A	Clip-on dc milliammeter, eliminates direct connection, no circuit loading. Measures dc in presence of ac.	dc	3 ma to 1 amp 6 ranges		$500.00
 428B	Similar to 428A, wider range, recorder output for dc to 400 cps.	dc on meter, dc to 400 cps on recorder	1 ma to 10 amps 9 ranges		$550.00

HEWLETT PACKARD COMPANY

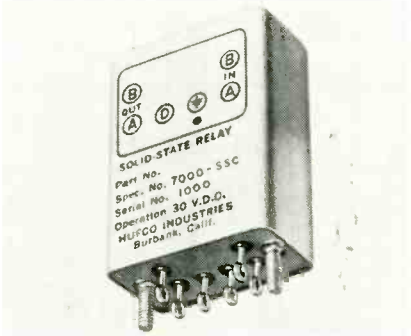
1501 Page Mill Road, Palo Alto, California. Area Code 415, DA 6-7000. Sales and service representatives in all principal United States areas; **Europe,** Hewlett-Packard S.A., Rue du Vieux Billard No. 1, Geneva; **Canada,** Hewlett-Packard (Canada) Ltd., 8270 Mayrand Street, Montreal.

Circle 120 on Inquiry Card

New Products

SOLID STATE RELAY

This ac latching relay measures 11/16 x 1 9/32 x 1.875 in.



A SPST relay, with a contact rating of 1a, it operates on an input voltage of 10 to 30vdc. Contact voltage freq. range: from 300CPS to 30KC. Pickup time is 1msec. for relay latching, and dropout time is 2msec. after removal of contact voltage. Unit withstands temperature from −55°C to +100°C, with special models to +125°C. Weight is less than 2 oz. Multipole ac or dc types are also available. Hufco Industries, 2815 W. Olive Ave., Burbank, Calif.

Circle 340 on Inquiry Card

MINIATURE CONNECTORS

The MM22 Series is for tight fits; available with 5 to 44 contacts.

This connector line features: Diallyl Phthalate molding; 1-piece 3-48 thread screwlock; bow washers to eliminate axial float; square shoulder in molding for fixed screwlock; strengthened "C" clip groove; and controlled float in socket contact. The mounting pad surrounds the entire guide hole. Both male and female contacts are of phosphor bronze. The MM22 Series meets applicable Mil specs. Lionel Electronic Laboratories, Inc., 1226 Flushing Ave., Brooklyn 37, N. Y.

Circle 341 on Inquiry Card

MORE POWER TRANSISTORS FROM BENDIX

This newly expanded line of Bendix® Power Transistors is especially valuable for use in DC-DC converter and DC-AC inverter circuits and for switching up to 400 watts as drivers for relays, relay replacements, solenoids, magnetic clutchers and other high current applications. Characteristics of typical types are listed in the table below. Included in the expanded line are power transistors which offer unusually flat beta curves for less amplifier distortion, increased current gain (up to 200 at 3 Adc), and increased power ratings. Each power transistor is 'Dynamically Tested,' an exclusive Bendix quality control process that tests each unit to assure uniformity and maximum reliability. For data on the complete line of Bendix Power Transistors and Power Rectifiers, write to Holmdel, N. J.

DYNAMICALLY TESTED!!!!!

Type Number	MAXIMUM RATINGS V_{CES} Vdc	I_C Adc	P_C W	CURRENT GAIN h_{FE} @	I_C Adc
2N297A*	50	5	35	40-100	0.5
2N456A-8A	40-80	7	50	30-90	5
2N637-8,A,B	40-80	5	90	20-60	3
2N1011*	80	5	35	30-75	3
2N1136,A,B	40-80	5	90	50-100	3
2N1137,A,B	40-80	5	90	75-150	3
2N1138,A,B	40-80	5	90	100-200	3
2N1359-2N1365	40-100	3	90	35-150	1
2N1529-38,A	30-90	5	90	20-70	3
2N1539-43,A	30-90	5	90	50-100	3
2N1544-48,A	30-90	5	90	75-150	3

*Also available per MIL-S-19500/36A & MIL-T-19500/67

Bendix Semiconductor Division

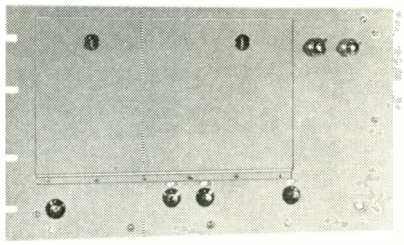
THE Bendix CORPORATION

Main Office: South St., Holmdel, N.J.—Ph: SH 7-5400 • **New England Office:** 114 Waltham, Lexington, Mass.—Ph: VO 2-7650 • **Detroit Office:** 12950 W. 8 Mile Rd., Detroit 37, Mich.—Ph: JO 6-1420 • **Midwest Office:** 1915 N. Harlem Ave., Chicago, Ill.—Ph: 637-6929 • **West Coast Office:** 117 E. Providencia Ave., Burbank, Calif.—Ph: VI 9-3961 • **Canadian Affiliate:** Computing Devices of Canada, Ltd., P.O. Box 508, Ottawa 4, Ont. • **Export Office:** Bendix International, 205 E. 42nd Street, New York 17, N.Y. **Stocking Distributors:** Contact nearest sales office for name of local distributor.

New Products

C-BAND SIGNAL GENERATORS

Features plug-in crystals to change frequency.



The Model 100R Signal Generator is designed for use as a receiver local oscillator or as a fixed freq. marker for laboratory use. The freq. accuracy (±0.0005%) and stability (±0.0001%) of the output signal is established by a crystal-controlled oscillator with a proportional temp.-controlled oven. Power out is 10mw min. into a 50Ω load. Total required power in is 75w. Weight: 18 lbs. Dimensions: 19 x 10½ x 3½ in. Frequency Engineering Laboratories, P. O. Box 504, Asbury Park, N. J.

Circle 342 on Inquiry Card

LOW NOISE AMPLIFIER

Model VS-68B provides 50megs, 50pf input impedance.

It is a fully transistorized, self-contained, battery-operated amplifier. Noise, with 50meg input, open or shorted, is less than 3μv with a bandpass of 10KC. Unit has other input impedances of 10 and 100kΩ for use with lower source resistances. Amplifier has 80db gain with 10db steps. Max. output is lv RMS on any gain setting. Freq. response is 2CPS to 180KC. Millivac Instruments, Inc., P.O. Box 997, 1100 Altamont Ave., Schenectady, N. Y.

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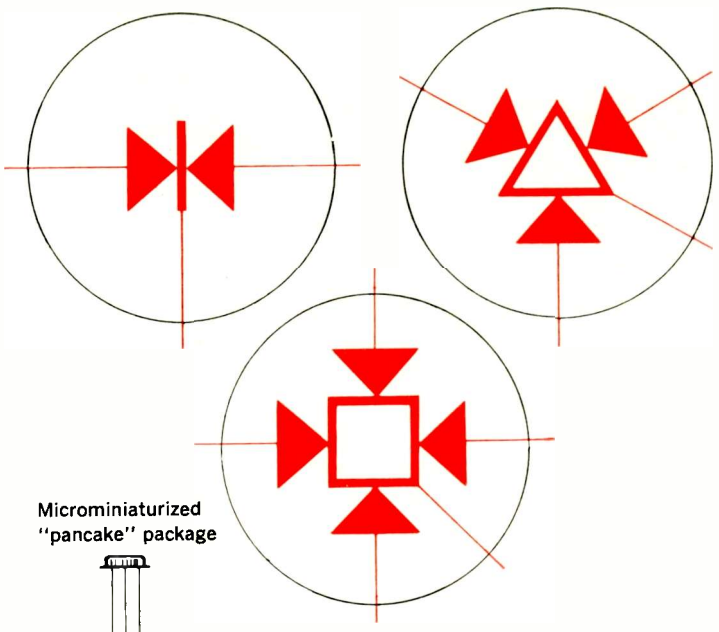
NOW!

epitaxial Silicon-Planar Multi-Diodes

available in 2, 3 and 4 junction types!

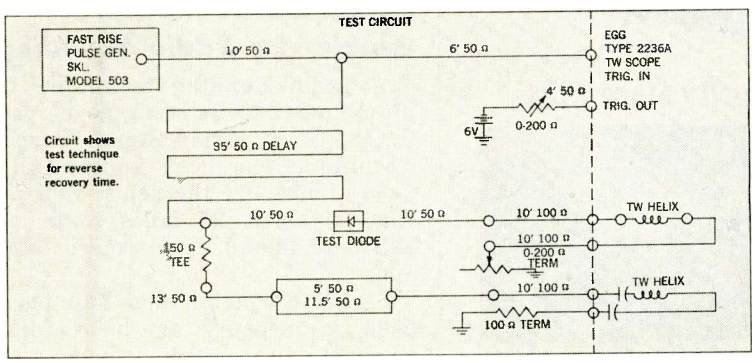


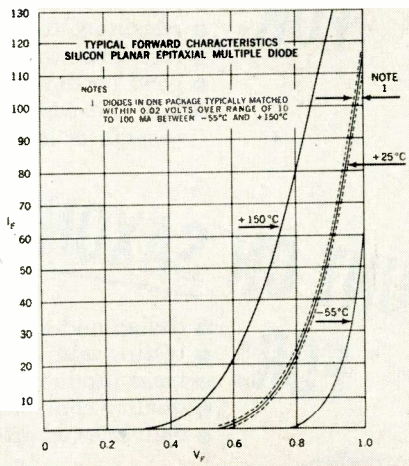
Microminiaturized "pancake" package

• process assures inherently matched characteristics • epitaxial technique provides high forward current • passivated & hermetically sealed for low leakage—high reliability • up to 4 junctions in JEDEC-approved microminiature "pancake" package • conform to MIL requirements for environment • fast switching capability—2 nsec recovery time (typ.) • multi-diode concept improves volumetric efficiency, enables economies in circuit assembly

Sylvania—leading pioneer in diode design and manufacture—continues to set the pace with the new SYLVANIA MULTI-DIODES. Only Sylvania offers multiple junction diodes that combine all the benefits and advantages of Silicon materials, Planar construction and Epitaxial process. Result: extraordinarily tight control of electrical characteristics from junction to junction within each unit—and within each type! For example, the diodes in any one Sylvania package are typically matched within 0.02 volts despite widely varying temperatures over the range of −55°C to +150°C.

Your Sylvania Sales Representative or your Sylvania Franchised Semiconductor Distributor can give you details on price and delivery. For tech data, write Semiconductor Division, Sylvania Electric Products Inc., Woburn, Mass.





2-JUNCTION TYPES	M0001	M0003	M0005	
3-JUNCTION TYPES	M0002	M0004	M0006	
4-JUNCTION TYPES	M0010	M0011	M0012	
ABSOLUTE MAXIMUM RATINGS				
Peak Inverse Voltage, PIV	40 V	75 V	100 V	
Forward D.C. Current, I_F	225 mA	200 mA	175 mA	
Average Rectified Current, I_o	75 mA	75 mA	75 mA	
Surge Current, I_{surge} (1.0 μ sec)	500 mA	500 mA	500 mA	
Power Dissipation, P_T	300 mW	300 mW	300 mW	
Operating Temperature, T_{OPR}	−65°C to +175°C (all types)			
ELECTRICAL CHARACTERISTICS				
Forward Current, I_F V_F −1.0 V	100 mA	75 mA	50 mA	min.
Reverse Current, I_R V_R = 40 V	50 mμA	—	—	max.
V_R = 50 V	—	50 mμA	50 mμA	max.
Reverse Current, I_R V_R = 40 V, T = +150°C	50 μA	—	—	max.
V_R = 50 V, T = +150°C	—	50μA	50 μA	max.
Capacitance, C_s V_R = 0, f = 1.0 mc	4.5 pf	3.5 pf	2.5 pf	max.
V_R = 6 V, f = 1.0 mc	2.0 pf	1.5 pf	1.25 pf	typ.
Reverse Recovery Time, t_{rr} (see test circuit)	3.0 nsec (max.) all types			

All cathodes common to case

SYLVANIA

SUBSIDIARY OF GENERAL TELEPHONE & ELECTRONICS

400v Transistors

Transistors with high voltage capabilities permit operation directly from 110 and 220 vac line sources and where high voltage surges are experienced. In addition, because they are silicon, they are capable of high temperature operation.

These transistors, manufactured by Delco Radio, have V_{CEO}, V_{CBO}, and V_{CES} of 400 volts. They are characterized by saturation resistaces typically of 0.15 ohms, Beta of 15 at 5 amp and I_{CBO} rating of 10 ma at 400 V_{CB}, 125° C. Units have operated up to 800 volts.

They are well suited for use where combinations of temperature and voltage transients or spikes are present, and in military environments for 24 vdc voltage switching and regulator circuits.

RCA Awarded Missile Test Equipment Contract

Computer-controlled test equipment capable of automatically checking and monitoring electronic assemblies of existing or future missile systems will be supplied to the U. S. Army under terms of a $1,587,151 contract awarded recently to RCA.

The DEE (Digital Evaluation Equipment), representing a new concept in ordnance missile test equipment, will be supplied by RCA's Aerospace Communications and Controls Div., Defense Electronic Products, Camden, N. J. The contract stems from six years of study, research, development and prototype construction.

Signal Corps Measures Glacier by Radio Sounding

A radio-sounding technique to plumb polar ice is being developed by the U. S. Army Signal Corps. Technique has been successfully used to measure the depth of Brae Glacier, about 20 miles south of Ellsmere Island, in northern Canada.

Signal Corps method had been used to measure depth of relatively stable ice caps. It had never been employed on glaciers. Because of glaciers greater movement, scientists had thought radio signals could be deflected from them and might thereby upset readings. However, no serious disruptions were observed during the measurements on Brae Glacier.

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M-R-I

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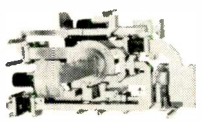
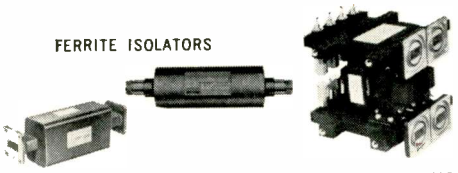
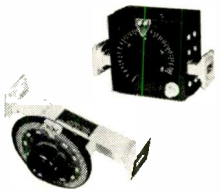


MONOPULSE RF SUBSYSTEMS



FERRITE ISOLATORS

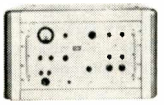
MICROWAVE SUBSYSTEMS



VARIABLE PRECISION ATTENUATORS

FERRITE DUPLEXERS AND ISO-DUPLEXERS

VARIABLE DIRECTIONAL COUPLERS



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International Electronic Sources

Up-to-the-minute abstracts of articles appearing in the leading foreign electronic engineering manuals

REGULARLY REVIEWED

AUSTRALIA

AWA Tech. Rev. AWA Technical Review
Proc. AIRE. Proceedings of the Institution of Radio Engineers

CANADA

Can. Elec. Eng. Canadian Electronics Engineering
El. & Comm. Electronics and Communications

ENGLAND

ATE J. ATE Journal
BBC Mono. BBC Engineering Monographs
Brit. C.&E. British Communications & Electronics
El Tech. Electronic Technology
GEC J. General Electric Co. Journal
J. BIRE. Journal of the British Institution of Radio Engineers
Proc. BIEE. Proceedings of Institution of Electrical Engineers
Tech. Comm. Technical Communications

FRANCE

Bull. Fr. El Bulletin de la Societe Francaise des Electriciens
Cab. & Trans. Cables & Transmission
Comp. Rend. Comptes Rendus Hebdomadaires des Seances
Onde. L'Onde Electrique
El. et Auto. Electronique et Automatisme
Rev. Tech. Revue Technique
Telonde. Telonde
Toute R. Toute la Radio
Vide. Le Vide

GERMANY

AEG Prog. AEG Progress
Arc. El Uber. Archiv der Elektrischen Uber tragung
El Rund. Electronische Rundschau
Freq. Frequenz
Hochfreq. Hochfrequenz-technik und Electro-akustik
Nach. Z. Nachrichtentechnische Zeitschrift
Rt. Regelungstechnik
Rundfunk. Rundfunktechnische Mitteilungen
Vak. Tech. Vakuum-Technik

POLAND

Prace ITR. Prace Instytutu Tele-l Radiotechnicznego
Roz. Elek. Rozprawy Electrotechnizne

USSR

Avto. i Tel. Avtomatika i Telemakhanika
Radio. Radio
Radiotek. Radioteknika 1 Elektranika
Rad i Elek. Radioteknika i Elecktranika
Iz. Acad. Bulletin of Academy of Sciences, USSR.

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CIRCUITS

Magnetic Amplifier Performance with Back-Voltage Load, M. A. Bojarchenkov and M. S. Rozenblat. "Avto. i Tel." Vol. 23, #1. 14 pp. Performance of self-saturating magnetic amplifiers with a load which develops a back-voltage are analyzed for the gating half-cycles. Various conditions which may arise are revealed and expressions for the load current are given. (U.S.S.R.)

Characteristics of Flywheel Synchronizing Circuits in Television Receivers, D. Maurice. "Elec. Eng." Feb. 1962. 5 pp. Behavior of a typical line flywheel circuit when various steady state and transient timing errors are present in the applied synchronizing signal is studied theoretically. Performance of six actual receivers presented with similar stimuli is investigated. (England.)

A Buffer Stage for Piezo-Electric Strain Gauges, D. A. Smith and M. A. Lewis. "Elec. Eng." Feb. 1962. 4 pp. A buffer stage suitable for use with piezo-electric strain gauges is described. An improved circuit is also shown which has an input resistance high enough to be used with strain gauges, at frequencies down to 1 CPS. (England.)

Capacity Feedback Differentiating Amplifier, L. Ya. Ilnitzky and L. Ya. Nagorny. "Avto. i Tel." Vol. 23, #1. 7 pp. A capacity feedback differentiating amplifier is analyzed on the basis of the generalized method of nodal voltage. Conditions of the accurate calculation of a derivative and stability of the differentiator are described in the general form. Analysis is illustrated by a capacity feedback two-stage differentiating amplifier. (U.S.S.R.)

Simplified Method of Synthesis of Circuits with Stepping Switches, V. D. Urin. "Avto. i Tel." Vol. 23, #1. 5 pp. Simplification of G. Ioanin's method (1) is suggested which is based on existence of some ways of starting the stepping switch. (U.S.S.R.)

To Problem of Functional Construction of Digital Control Machines, T. Ya. Hodorov. "Avto. i Tel." Vol. 23, #1. 7 pp. Three functional circuits of digital control machines are considered. Their peculiarities, advantages and drawbacks are discussed. (U.S.S.R.)

Analysis of Performance and Calculation of Magnetic Time Delay Element with Short-Closed Winding, V. S. Matorina and O. A. Sedykh. "Avto. i Tel." Vol. 23, #1. 13 pp. Performance of the circuit of the magnetic time-delay element with the short-closed winding is analyzed. (U.S.S.R.)

A New RC, Coupled Monostable Flip-Flop, J. Rywak. "El. & Comm." Jan. 1962. 6 pp. New monostable flip-flop features fast waveforms and is unaffected by large changes in dc line voltage. (Canada.)

Wide-Band Monocrystal Oscillator. A. M. Fyodoroff and V. S. Kotoff. "Radiotek" 16, No. 12, 1961. 9 pp. Design principles of a wide-band video-pulse generator are described. (U.S.S.R.)

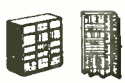
COMMUNICATIONS

Varactor Diodes Provide Non-Linear Reactance for Parametic Amplifiers, D. Walsh. "Can. Elec. Eng." Feb. 1962. 4 pp. Diffused silicon mesa diodes have been developed for use in negative-resistance parametic amplifiers for UHF receivers. (Canada.)

A Remote Control Equipment for HF Transmitters, E. Baranowski. "Nach. Z." Feb. 1962. 5 pp. A remote control equipment for HF transmitters is described. Requirements during the practical service and the particular conditions of HF communication services are taken into consideration in the design. (Germany.)

COMPONENTS

The Application of Component Parts in Military Electronic Equipment, A. P. Harris. "Can. Elec. Eng." Mar. 1962. 6 pp. Electronic equipment in modern military vehicles is exposed to a wide range of environmental stresses. The effect of these stresses on component parts is examined, and guidance is given on determination of stress levels, choice of parts, testing and application in reliable equipment. (Canada.)



COMPUTERS

Ferrite Cores as Logical Elements, "El Tech" Dec. 1961, 7 pp. Properties of ferrite cores are explained, and some of the ways in which they can be arranged to provide logical functions are then described. Operation of a typical core logical circuit is then analyzed, and the implications of the analysis in design are discussed. (England.)

Programming of Problems for Digital-Differential Analyzer, I. M. Goldenberg, Yu. B. Okunev, "Avto. i Tel." Nov. 1961, 6 pp. Technique of programming of problems to solve by digital differential analyzers operating in binary code and using the binary systems of increment representation is described. (U.S.S.R.)

Ring Counter for Binary to Decimal Conversion. "El. et Auto." Jan. 1962. 4 pp. Design procedure of a transwitch ring counter for binary to decimal conversion is investigated. (France.)

(Continued on page 186)

Your Ideal Circuit Complements for Ultra-High-Speed Switching

TI 2N964 GERMANIUM PNP EPITAXIALS

TI 2N797 GERMANIUM NPN MESAS

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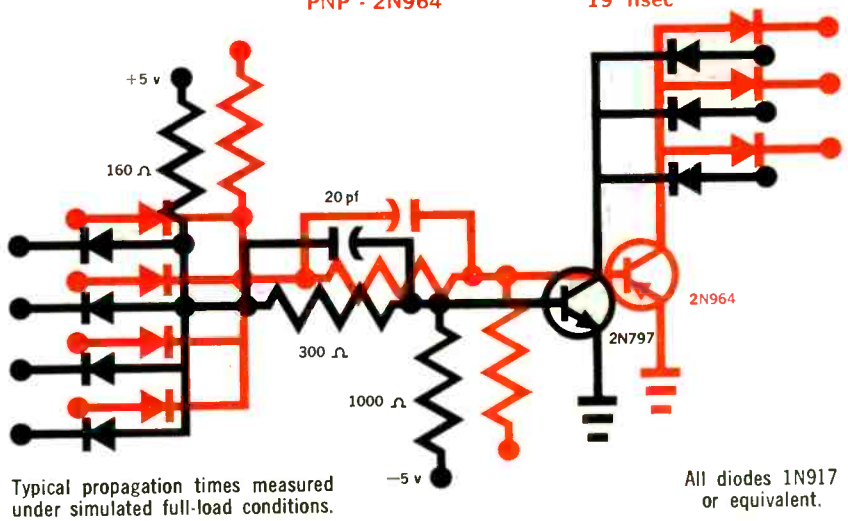
Typical Performance (7 Stages):

CIRCUIT	PROPAGATION TIME PER STAGE
NPN - 2N797	22 nsec
PNP - 2N964	19 nsec



Typical propagation times measured under simulated full-load conditions.

All diodes 1N917 or equivalent.

Increase your switching circuit design flexibility with TI's 2N964 and 2N797 **complementary** transistors. The 2N964 PNP germanium epitaxial series satisfies all your ultra-high-speed switching requirements in the 3 ma to 100 ma range. Provides high power dissipation and rugged mesa construction combined with the epitaxial features of high-gain bandwidth, short storage time and low saturation voltage. ■ Form the ideal circuit complement to the 2N964 series with TI's new NPN 2N797 germanium mesa transistor. The 2N797 also features ultra-high switching speed, low saturation voltage and high-gain bandwidth. This transistor is well suited for complementary use with all high-speed PNP epitaxials. ■ Call today for immediate delivery. The 2N964 series (including 2N960, 1,2,4,5,6) and the 2N797 transistors are available in quantity from your nearest TI Sales Office or Authorized TI Distributor.

TO-18

Check These Specifications Against Your Present and Future Circuit Requirements

PARAMETER	TRANSISTOR	TEST CONDITIONS	RATING
$V_{CE(sat)}$	2N797 2N964	I_B = 0.5 ma, I_C = 10 ma I_B = −1 ma, I_C = −10 ma	0.14 v max 0.18 v max
$\lvert h_{fe} \rvert$	2N797 2N964	V_{CE} = 5 v, I_C = 30 ma, f = 100 mc V_{CB} = −1.0 v, I_E = −20 ma, f = 100 mc	6.0 min 3.0 min
C_{ob}	2N797 2N964	V_{CB} = 5 v, I_E = 0, f = 1 mc V_{CB} = −10 v, I_E = 0, f = 1 mc	4.0 pf max 4.0 pf max
t_{on}	2N797 2N964	I_{B1} = 1 ma, I_{B2} = −0.25 ma, I_C = 10 ma I_{B1} = −1 ma, I_{B2} = 0.25 ma, I_C = −10 ma	40 nsec max 30 nsec max
t_{off}	2N797 2N964	I_{B1} = 1 ma, I_{B2} = −0.25 ma, I_C = 10 ma I_{B1} = −1 ma, I_{B2} = 0.25 ma, I_C = −10 ma	80 nsec max 60 nsec max
V_{BE}	2N797 2N964	I_B = 0.5 ma, I_C = 10 ma I_B = −1 ma, I_C = −10 ma	0.30 v min 0.44 v max 0.30 v min 0.50 v max
h_{FE}	2N797 2N964	V_{CE} = 0.25 v, I_C = 10 ma V_{CE} = −0.3 v, I_C = −10 ma	40 min 40 min
BV_{CBO}	2N797 2N964	I_C = 100 μa, I_E = 0 I_C = −100 μa, I_E = 0	20 v min 15 v min

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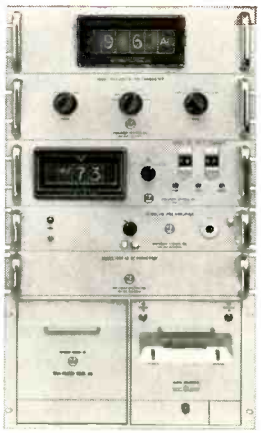
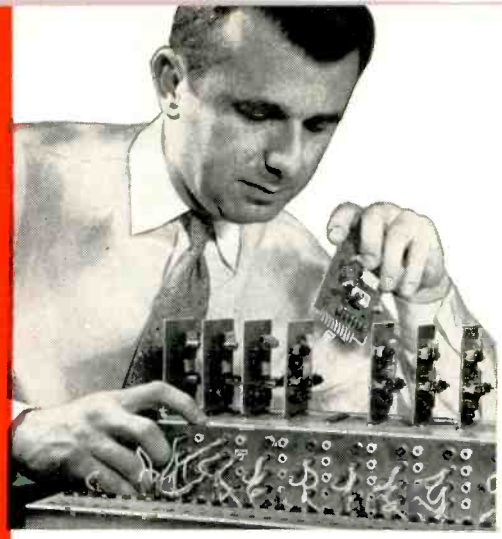


For Instrumentation

In these digital voltmeters, designed to satisfy critical standards for missile work, Non-Linear Systems, Inc., uses about 1,000 A-B hot molded resistors in each instrument.

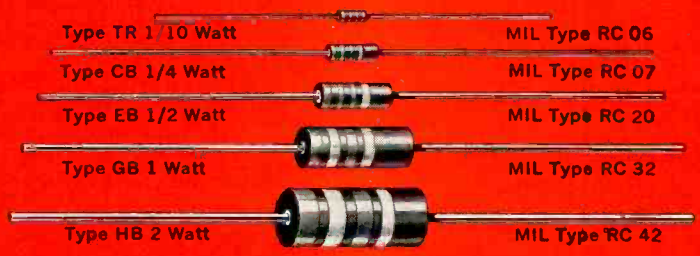


For Research

In experiments at Bell Telephone Laboratories, A-B hot molded resistors are used in artificial electronic nerve cells, designed to study information processing in nervous systems.

No Question—

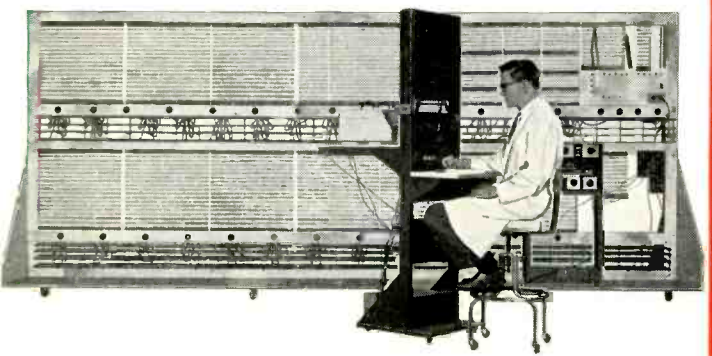
Allen-Bradley are a "Must" for



Shown Actual Size

For Ground Exploration

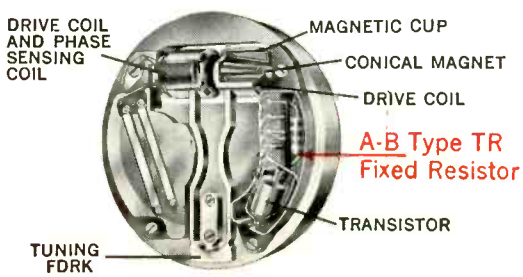
At Schlumberger's Research Center, hundreds of thousands of A-B hot molded resistors are assembled into interchangeable grids. These grids are used in a variety of networks to simulate ground formation characteristics.

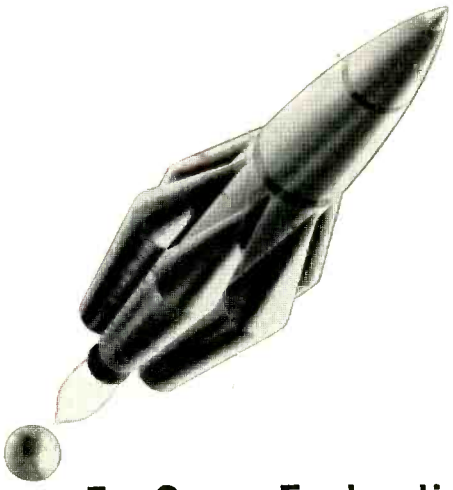


For Product Improvement

To miniaturize the circuitry in their new electronic timepiece, without sacrificing reliability, Accutron designers chose the smallest of A-B standard hot molded resistors—which are exactly as reliable as the higher rated resistors.

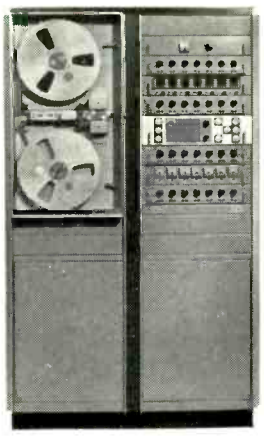
DRAWING OF ACCUTRON SHOWS BASIC MECHANISM





For Space Exploration

Allen-Bradley hot molded resistors have proved their complete reliability in the environmental extremes of shock and vibration so common in missile work.



For Data Recording

For meeting the critical requirements of the highly sophisticated circuits in their advanced recorder/reproducer. Ampex engineers could take no chances—they used Allen-Bradley hot molded resistors.

A-B QUALITY

Hot Molded Resistors Critical Applications

Allen-Bradley hot molded resistors—for more than 30 years—have proved their complete reliability and superior performance in all types of circuits

All over the world you'll find Allen-Bradley fixed resistors bringing reliability and superior performance to all types of critical circuits. The exclusive hot molding process—developed and perfected by A-B—assures such consistent uniformity from resistor to resistor that performance can be accurately predicted over long periods of time. Where Allen-Bradley hot molded resistors are used, "catastrophic resistor failure" is unknown. With their conservative ratings and stable characteristics, Allen-Bradley hot molded resistors will assure resistor dependability in *your* equipment—and they cost no more than ordinary resistors.

For complete details please write for Publication 6024—it also includes information about other A-B *quality* electronic components.

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In Canada: Allen-Bradley Canada Ltd., Galt, Ontario

ALLEN-BRADLEY

Quality Electronic Components

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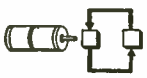
International **ELECTRONIC SOURCES**

Envelope Feedback in an Audio-Frequency Amplitude Modulator, W. D. Humpage. "Elec. Eng." Feb. 1962. 3 pp. Simultaneous solution of electrical network problems and transient problems associated with the source and load elements of these networks, may be obtained by the use of a dc electronic analog computer coupled to a model network. (England.)

A Shaft Speed Transducer, D. Robb. "Elec. Eng." Feb. 1962. 5 pp. A shaft speed transducer which generates a digital output suitable for direct operation of a counter is described. (England.)



CONTROLS

Concerning a Critical Case of Absolute Stability, V. M. Popov. "Avto. i Tel." Vol. 23, #1. 22 pp. A new method is used to investigate a problem of stability of the trivial solution of the differential equation system describing behavior of a certain automatic control system with one non-linearity. (U.S.S.R.)

Cathode Ray Tube Light Spot Follows Strip-chart Curves Automatically, Edgar R. R. Funke. "Can. Elec. Eng." Feb. 1962. 3 pp. Electro-optical strip-chart curve-follower is basically a position control servo whose input is the position of a curve, and output is a voltage related to this position. (Canada.)

Industrial Applications of Radioactive Isotopes, F. Juster. "El. et Auto." Jan. 1962. 4 pp. Radioisotopes have found numerous industrial applications in the fields of measurement and control. Paper describes two representative designs. (France.)

GENERAL

On Dynamics of Photo-Electric Amplifiers, A. N. Tkachenko. "Avto. i Tel." Dec. 1961. 9 pp. Problems of the dynamics of dc photo-electric amplifiers with a negative feedback are considered. Stability conditions are determined. The methods of stabilizing circuits with a rigid feedback and those with a flexible feedback are compared. (U.S.S.R.)

Method of Solution of Multi-Loop Pulse System Equations, I. M. Burshtein. "Avto. i Tel." Dec. 1961. 5 pp. A method for finding Laplace transformations and descrete ones (Z-transformations) in a pulse system obtaining an arbitrary structure and periodic program of pulse element closing is suggested. (U.S.S.R.)

Automatic Exchange Grading Schedules According to Standards or Adopted Patterns, J. Bohm. "Nach. Z." Jan. 1962. 3 pp. Individual design of grading schedules is unnecessary when a final decision is made on the number of grading field points which should be coordinated to one outlet for the various search steps. (Germany).

Circuit Impedance Effects in a Non-Degenerate Parametric Amplifier, D. G. Vice. "El. & Comm." Jan. 1962. 6 pp. Article uses energy relationships to investigate properties of parametric amplifiers operating in various modes. Bandwidth and tuning considerations are outlined. (Canada.)

The Transient Response of Linear Passive Networks to Phase-Modulated Signals, J. M. Ivison. "Elec. Eng." Feb. 1962. 5 pp. Response of some passive networks, stimulated by a sinusoidal signal phase-modulated by a step input, is examined. Analytical solutions are obtained for the response and the results are verified experimentally and with an analog computer. (England.)

A Design Analysis of the Operational Amplifier, V. Maloepszy. "El. & Comm." Jan. 1962. 8 pp. A design analysis, which established parameter values for the Operational Amplifier as a function of required computation accuracy is presented. (Canada.)

The General Radio Service—New in Canada, A. E. Maine. "El. & Comm." Feb. 1962. 8 pp. Following comments and predictions are based upon numerous discussions with Canadian manufacturers and distributors and with government departments. Main finding is that the new service promises good business prospects for the Canadian electronics industry. (Canada.)

Comparative Analysis of Frequency Characteristics of MDM-Type DC Amplifier for Two Modes of its Operation, V. I. Anisimov. "Avto. i Tel." Vol. 23, #1. 8 pp. Frequency characteristics of the MDM-type dc amplifier are considered and their dependence on parameters of so-called ac way, e.g. the system modulator —low frequency amplifier—demodulator is determined. (U.S.S.R.)

Three Approaches to Micro-Electronics, William F. Long. "El. & Comm." Jan. 1962. 5 pp. At present, no single micro-electronics approach will meet the full requirements of the equipment designers. Philco has created three new structure types to give widespread application. (Canada.)

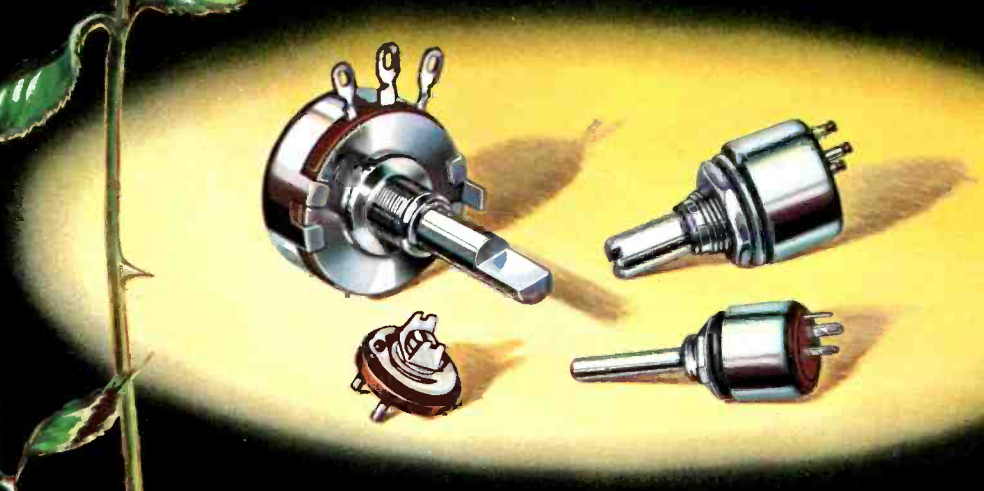
(*Continued on page* 189)

Centralab®

introduces

four styles of

HOT MOLDED CARBON POTENTIOMETERS

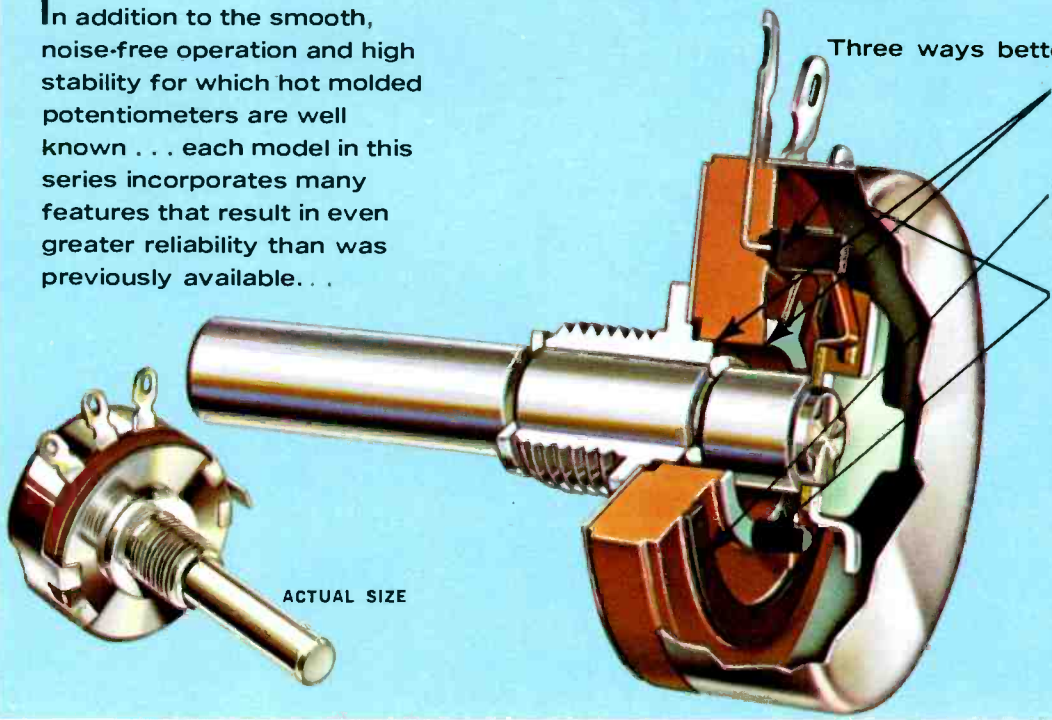


For smooth, noise-free operation and high stability . . . The widest selection anywhere . . . Designed to meet **MIL-R-94** environmental and test requirements

Centralab . . . producer of carbon potentiometers for over 35 years

CENTRALAB'S MODEL A (RV4 Style)

In addition to the smooth, noise-free operation and high stability for which hot molded potentiometers are well known . . . each model in this series incorporates many features that result in even greater reliability than was previously available. . .



Three ways better than other hot molded units

1. Greatly increased high voltage capability, due to the wide clearance between the bushing and the collector track.
2. Greater freedom from contamination of dirt, carbon particles and sealing compounds, due to the elevated resistance track construction.
3. Exceptionally long noise free operation that actually improves with use, provided by the carbon composition material of which both the collector and pick-off brushes are constructed.

SPECIFICATIONS:

RATING: 2 watts at 70° C.

SIZE: 1-3/32″ diameter, 37/64″ deep from mounting surface.

CONSTRUCTION: Completely enclosed. All metallic parts are non-magnetic and corrosion resistant. Available in tandem, triple or dual concentric construction.

ROTATION: 312° ±3°.

TORQUE: 1.0 to 6.0 ounce inches

RESISTANCES: Linear taper, 50 ohms to 5 MEG. Log taper, 100 ohms to 2.5 MEG.

MODEL N

This intermediate size potentiometer has never before been offered. Rated at ¾ watt, the Model "N" can replace 2 watt units in many military and commercial applications where size is important.

A flush resistance track is protected against contamination by the raised rim of the insulating base. Although small in size, the model "N" also has carbon composition pick up and collector brushes for long, noise-free operation.

The one-piece metal case and bushing is spun over the molded insulating base to provide a near-perfect seal. Triple shaft seals and water-tight panel seals can be supplied.

SPECIFICATIONS:

RATING: 3/4 watt at 70° C.

SIZE: 23/32″ diameter, 1/2″ deep from mounting surface.

CONSTRUCTION: Completely enclosed. All metallic parts are non-magnetic and corrosion resistant.

ROTATION: 300° ±3°

TORQUE: 5.0 ounce inches average.

RESISTANCES: Linear taper, 50 ohms to 5 MEG. Log taper, 100 ohms to 2.5 MEG.

MODEL P (RV6 Style)

Although much smaller than the Model "N", the Model "P" is rated at ½ watt and is similar in external construction.

The resistance track is hot molded, flush type. An outstanding feature of the Model "P" is the single carbon brush that serves both collector and pick-off purposes. The one-piece aluminum case is spun over the insulating base to provide a near-perfect seal.

This unit meets all applicable military requirements.

SPECIFICATIONS:

RATING: 1/2 watt at 70° C.

SIZE: 1/2″ diameter, 15/32″ deep from mounting surface.

CONSTRUCTION: Completely enclosed.

ROTATION: 290° ±3°.

TORQUE: 1.5 ounce inches.

RESISTANCES: Linear taper, 100 ohms to 5 MEG. Log taper, 500 ohms to 2.5 MEG.

MODEL T

This unique trimmer resistor, or locking-type trimmer potentiometer, is the only hot molded, single turn unit available on today's market. Rated at ⅓ watt, it has been designed primarily for printed-circuit board applications.

The Model "T" has a positive screw actuated lock and is extremely resistant to shock, vibration and acceleration.

These units can be encapsulated in a rigid resin without damage.

SPECIFICATIONS:

RATING: 1/3 watt at 70° C.

SIZE: 19/32″ diameter, 11/32″ deep from mounting surface.

CONSTRUCTION: Open (however, rugged construction permits potting of all types).

ROTATION: 300° ±3°.

TORQUE: Locking type.

RESISTANCES: Linear taper, 100 ohms to 5 MEG.

IMMEDIATE DELIVERY FROM STOCK

A full range of values of all four types of Centralab hot molded carbon potentiometers are available in quantity, from stock, through Centralab Industrial Distributors.

Centralab

THE ELECTRONICS DIVISION OF GLOBE-UNION INC.
900 E. KEEFE AVENUE • MILWAUKEE 1, WISCONSIN
In Canada: Centralab Canada Ltd., P.O. Box 400, Ajax, Ontario

CIRCLE 103 ON READER-SERVICE CARD

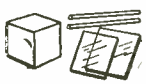
Sources

(*Continued from page* 186)

Random Signal Passing Through Time Discriminator and Integral Amplifier, F. M. Kilin. "Avto. i Tel." Vol. 23, #1. 9 pp. Recurrent correlation for the function ϕ (n) obtained in (1) is used for the investigation of statistic dynamics of a sampled-data system and for the determination of correlation functions and spectral densities of the system output signals. (U.S.S.R.)

Investigation of Automatic Optimization Gradient System with Random Noises at Object Input and Output, TS. TS. Paulauskas. "Avto. i Tel." Vol. 23, #1. 11 pp. An m-size gradient system of the automatic optimization with random noises at the object input and output when a descrete element optimizator is used, is considered. (U.S.S.R.)

Photoelectric Relay Design, F. Bobot. "El. et Auto." Jan. 1962. 2 pp. Design of sensitive photoelectric relays is greatly facilitated by the use of photovoltaic cells. (France.)

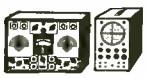


MATERIALS

High Stability Material for Mid- and Low-Power Pulse Transformers, J. Kruszewska. "Prace ITR." Vol 5, #4. 5 pp. Results of investigations to obtain a stable Mn-Zn ferrite with initial permeability of μ_0=1000 Gs/Oe are described. (Poland)

Ferrites at Microwaves, R. McLean and F. M. Aitken. "El. Tech." Jan. 1962. 8 pp. Basic properties of ferrites have been outlined and the various devices classified according to the properties on which they are based. (England).

Flux Counters with Ferrite Cores Possessing Rectangular Hysteresis Loops, W. Hilberg. "Nach. Z." Feb. 1962. 7 pp. Design of aperiodic flux counters is based on a step by step change of the magnetization of cores consisting of a material with a rectangular hysteresis loop. Report deals with the properties of such cores, controlled in different ways, and with the properties of blocking oscillators containing such cores. (Germany.)



MEASURE & TESTING

Linear Sawtooth Sweep Generator has Constant Amplitude, Recovery Time, J. M. Beddoes. "Can. Elec. Eng." Feb. 1962. 3 pp. A linear sawtooth sweep generator is described which maintains a constant output amplitude over a wide range of repetition frequencies, together with a constant, rapid recovery time. (Canada.)

Calculation of Direct Voltage Precision-Stabilizers According to Known Monotonous Transient Characteristics, V. M. Pustylnikov. "Avto. i Tel." Vol. 23, #1. 10 pp. General conditions of monotony for transient processes in stabilizers with uneven change of the load current are considered. Calculation technique is suggested for precision stabilizers with transient characteristics close to monotonous ones. (U.S.S.R.)

I. R. Camera Measures "Unavailable" Temperatures. "El. & Comm." Feb. 1962. 3 pp. New scanning IR camera system provides "thermal photographs" of electrical and electronic equipment. Both qualitative and quantitative results are provided. System is fast and accurate. (Canada.)

(*Continued on page* 190)

Sources

A Standard Signal Generator for TV Transmission, R. Kuntze. "Nach. Z." Feb. 1962. 3 pp. Performance and the circuit design of a standard signal generator are described. (Germany.)

Consideration on Suitable Measurements and Tolerancing of the Transient Response of TV Equipment, H. Springer. "Nach. Z." Feb. 1962. 6 pp. Two methods for measurements of the transient response of TV equipment are compared with one another. (Germany.)

Detection and Analysis of Cases, R. Morris, et al. "El. et Auto." Jan. 1962. 5 pp. A method and instrument have been developed for detecting minute concentrations of gases and vapors in air or process streams. (France.)

Improving the Response of a Recording Galvanometer, I. A. Boyd and W. R. Eadie. "Elec. Eng." Feb. 1962. 4 pp. Article describes the conversion of a moving-coil pen-recording galvanometer to operate on the resulting potentiometer principle, thereby eliminating pen-to-paper friction and extending the frequency response. (England.)

The Rate and Duration of Deep-Scatter Fadings on Tropospheric Scatter Links, J. Groskopf and L. Fehlhaber. "Nach. Z." Feb. 1962. 8 pp. Results of some investigations relating to the rate and duration of deep scatter fadings in tropospheric scatter propagation are reported and methods for the calculation of these values are quoted. (Germany.)

RADAR, NAVIGATION

On Some Problems Concerning the Determination of Inverse Covariance-Matrix Coefficients of Radar Signals in Clutter, J. Kulikowski. "Roz. Elek." Vol. 7, #3. 18 pp. Some practical methods of determining the coefficients of a hermitian quadrapticform are considered. The coefficients are necessary for giving an exact expression for a multi-dimensional normal probability density-function of a radar signal. They also make possible obtaining of an optimal transfer-function of a predetection pulse-filter for a coherent receiver. (Poland.)

SEMICONDUCTORS

Transistorized Triode Phantastron with Regulated Delay. V. F. Volynetz. "Radiotek." 16, No. 11, 1961. 7 pp. This article presents an analysis of a phantastron circuit, characterized by increased linearity and a short regeneration time. A transistorized version of this circuit is compared with the original vacuum-tube triode circuit. (U.S.S.R.)

Choice of Collector Load Resistance for Minimum Harmonic Distortion, Y. Azar. "Elec. Eng." Feb. 1962. 3 pp. Experience has shown that harmonic distortion in transistors can be minimized by the correct choice of load impedance. Article describes a graphical method for calculating the optimum load. (England.)

Transistors and the Domestic Broadcast Receiver, J. R. Goldthorp. "Proc. AIRE." Dec. 1961. 12 pp. Development of a "cordless mantel" domestic broadcast receiver from a minimum practical specification translated from the requirements of the transmission system and the end user is indicated. (Australia.)

Sources

Charge Control Method Analysis Switching Times of Junction Transistors, J. M. Stewart. "Can. Elec. Eng." Feb. 1962. 6 pp. Equations are derived for transistor saturation time and results quoted for delay, rise and fall times. (Canada.)

Small Signal DC Amplification. "El. et Auto." Jan. 1962. 2 pp. Amplification of small dc signals by transistors is limited by the drift of characteristics with temperature. Use of paired silicium transistors in a suitable balanced circuit provides an interesting solution to this problem. (France.)

Transistorized Electronic Clock, R. Le Chevallier and R. Soyer. "El. et Auto." Jan. 1962. 7 pp. The excellent stability of the 50 CPS frequency of the power line can be put to good use as time reference in the design of precise electronic clocks. Paper describes such a design. (France.)

TELEVISION

An Evaluation of the Various Influences Affecting the Gradation of Television Pictures, Von Herbert Grosskopf. "Rundfunk." Dec. 1961, 8 pp. Author shows, by means of overall characteristics when using image-iconoscope and image-orthicon cameras, that while room lighting reduces the contrast of the television picture, with suitable front light on the screen, the overall characteristic and thus the picture gradation are both improved. (Germany.)

Progress in the Construction of German Television Studio Apparatus, Von Frithjof Rudert, "Rundfunk" Dec. 1961, 8 pp. The paper reports on a new series of stationary equipment for studio use, that has been developed in close collaboration between the ARD Workin Committee and the manufacturers. (Germany.)

Visual Thresholds and the Visibility of Random Noise in TV, Z. L. Budrikis. "Proc. AIRE." Dec. 1961. 9 pp. A quantitative theory for calculating thresholds in black-and-white vision is given. For this purpose a linear model is postulated with input to which are normal visual patterns and the output from it is an energy level distribution in terms of which visual thresholds can be taken as a fixed constant. (Australia.)

Television Bandwidth and the Kell Factor, N. W. Lewis. "El. Tech." Feb. 1962. 4 pp. Attention is drawn to the confusion that may arise in using the term "Kell factor" with the popular meaning involving a video bandwidth, and to the inadequacy of any single definition of bandwidth for describing a practical system. (England.)

Turret Tuners with Printed Coils, P. T. Rudge. "Proc. AIRE." Dec. 1961. 4 pp. The turret tuner has been designed in which the normal individually replaceable "biscuits" carrying the various coils required for the selection of a particular channel are discarded in favor of wafers with printed coils. (Australia.)

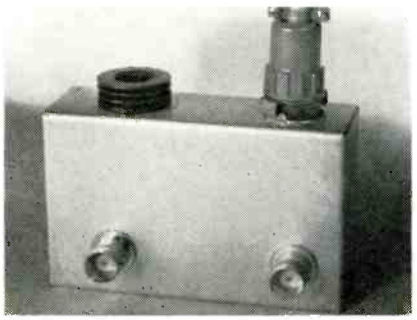
TUBES

The Present Generation of Travelling Wave Tubes, C. H. Dix. "Elec. Eng." Feb. 1962. 5 pp. Tubes currently available offer many possibilities in addition to their uses as amplifiers and some of these are mentioned in this article. (England.)

New Products

WIDE BAND AMPLIFIER

Solid state amplifier, Model 3029, has a 10v p-p output.

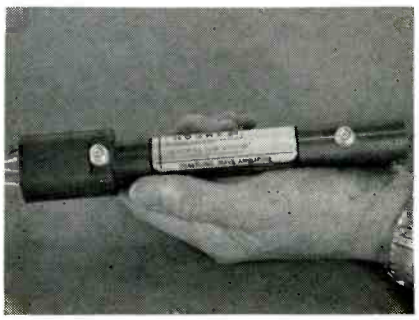


Freq. response is from 20CPS to 50MC flat to ±0.5db, down 3db at 60MC. Gain is 22db nominal. Impedance is 75Ω in and out with BNC connectors. The compact aluminum chassis measures 3¼ x 2 x 1 in. and weighs 8 oz. A separate power supply is required to supply 280ma at 30vdc. Other models covering other freq. ranges and having power supplies are available. Community Engineering Corp., 234 East College Ave., State College, Pa.

Circle 348 on Inquiry Card

TRAVELING-WAVE TUBES

They are lightweight, efficient, CW tubes for space applications.

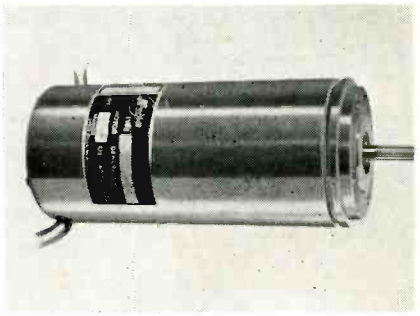


Of almost identical and rugged design, both tubes are of metal-ceramic construction, are PPM focused and feature a 7¾ x 1⅜ in. O.D. package complete with heat sink. The 314H has a power output of 2-3w at 25-27% efficiency and 27-33db gain over 1.5-3.0GC. The 349H has a power output of 10-15w at 25-30% efficiency and 25-30 db gain over 2.0-4.0GC. Hughes Aircraft Co., Microwave Tube Div., 11105 S. La Cienega Blvd., Los Angeles 45, Calif.

Circle 349 on Inquiry Card

SIZE 18 MOTOR GENERATOR

Linearity of this unit at 3600RPM is 0.2%.

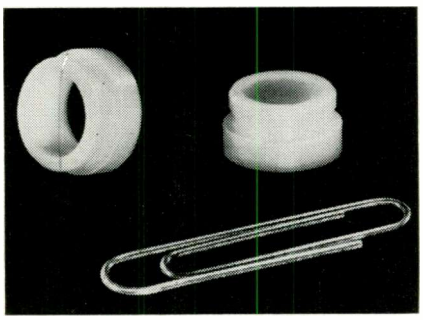


The V896-26B high performance servo motor generator is temperature stabilized by magnetic amplifier control to assure consistent accuracy despite temperature variations. Typical mechanical data includes: 4500RPM minimum no load speed; 2.35 in. oz. minimum stall torque; 35gm cm² rotor moment of inertia; and 4730 radians/sec. theoretical acceleration. The V896-26B weighs 27 ounces. Kearfott Div. General Precision, 1150 McBride Ave., Little Falls, N. J.

Circle 350 on Inquiry Card

TRANSISTOR HOLDER

This grommet-type transistor holder eliminates sockets.

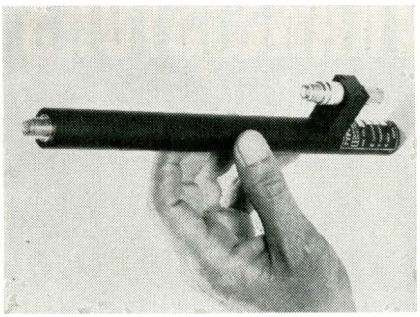


It provides mechanical mounting of the transistor without the need of a socket on metal chassis. The Sealectro B-1470 (Teflon) Transistor Bushing is pressed into a prepared hole 0.4 in. in dia. The Bushing is hollow, with a lead hole of 0.330 in. in dia. for connection of transistor leads. The receptacle for the transistor body is 0.300 in. in dia., and is chamfered for easy inserting. Height above chassis is 0.120 in. Sealectro Corp., 139 Hoyt St., Mamaroneck, N. Y.

Circle 351 on Inquiry Card

TRAVELING-WAVE TUBE

This rugged tube gives 1w CW power from 4 to 8GC.

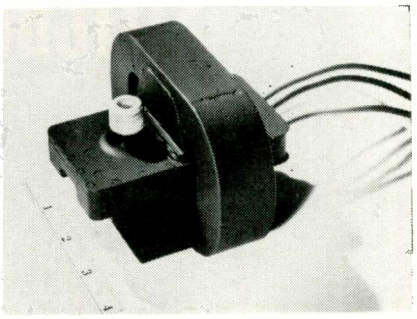


The L-3711 is a metal-ceramic TWT featuring 36db min. small signal gain and high linear saturation characteristics. It is conduction-cooled, measures 12½ in. long and ⅞ in. in dia. and weighs 21 oz. It operates with temp. compensated periodic focusing and also features high linear power. Helix design and fabrication techniques have raised the saturation gain to within 3db of small signal gain. Litton Industries, Electron Tube Div., San Carlos, Calif.

Circle 352 on Inquiry Card

MAGNETRON

This S-band unit has a min. noise figure of —60db below the carrier.



Designated the ZM-6050, it covers the 2.2 to 3.85GC freq. range and has a CW power output of 2w. Used as a local oscillator or a signal generator for rapid sweep applications such as radar and electronic countermeasures. The tube's low noise figure is the integrated noise in a band from 100KC to 100MC on both sides of the carrier freq. It weighs 3.5 lbs. and can be installed in any position. General Electric Co., Power Tube Dept., Schenectady, N. Y.

Circle 353 on Inquiry Card

NEW SILICON TRANSISTORS FROM DELCO RADIO

ACTUAL SIZE

Silicon power transistors in a TO-37 package

Delco's unique new family of silicon NPN power transistors combines the benefits of miniaturization (TO-37) and light weight with the ability to withstand continuous junction temperatures of up to 175°C while operating at these absolute maximum ratings: collector diode voltage Vcb 100 volts; emitter diode voltage Vebo, 4 volts; collector current, 1 amp.; base current, .2 amp. This entire 2N2340 family is particularly useful where moderate power handling capabilities are required in a miniature package. The units have just two mounting holes and may be mounted with leads up, down or sideways on either side of the heat sink. Available in either single or matched units, they're characterized by low saturation voltage and high switching speeds. The transistors in this family are especially well suited for military or industrial applications in regulated power supplies, square wave oscillators, servo amplifiers and core driver circuitry. For complete engineering data, or applications assistance, write or call our nearest Sales Office or your nearest Delco Radio Semiconductor Distributor.

Number	IC Max.	Vcbo	Vceo	Sat. V @ IC Max.	Gain Min.—Max. @ IC	fae @ 250 ma IC (typical)
2N2340	1A	50V	40V	4V @ .75A	10— 40 @ .75A	900 kc
2N2341	1A	50V	40V	4V @ .75A	40—100 @ .75A	550 kc
2N2342	1A	100V	60V	3V @ .75A	10— 40 @ .75A	900 kc
2N2343	1A	100V	40V	2.5V @ .75A	40—100 @ .75A	550 kc

Thermal resistance of 8°C/watt max. Typical Alpha cutoff of 15 Mc

Rise Time of .2μ seconds—.75A, IB = 40 ma (Vce = 12V), Fall Time of .5μ seconds (IC = 0 Veb = 2v Reb = 37Ω)

Union, New Jersey
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Division of General Motors

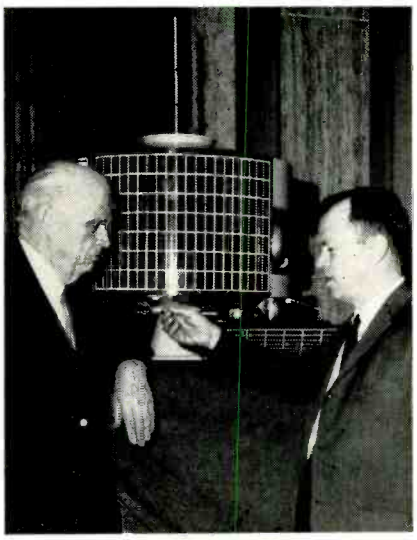
DELCO RADIO
DEPENDABILITY
RELIABILITY

Tele-Tech's
ELECTRONIC OPERATIONS

The System Engineering Section of ELECTRONIC INDUSTRIES • MAY 1962

SYSTEMS—WISE . . .

SENATOR SHOWN SYNCOM SATELLITE, SCHEDULED FOR SHOOT IN LATE '62



Sen. Robert D. Kerr (left), Chairman, Senate Committee on Aeronautical and Space Sciences, examines model of Syncom, an experimental communications satellite. Dr. A. E. Packett (right), Vice President of Hughes Aircraft Co., Culver City, Calif., holds one of 4 telemetery whip-antennas. In a 22,300 mile near synchronous orbit, Syncom will relay telephone and telegraph signals over near Hemispheric distances. Hughes developed, and will control Syncom in orbit, under a contract with NASA.

▸ The National Science Foundation has awarded $149,000 to Sidney University, Australia. The money will aid in construction and operation of a Mills Cross radio telescope, at Canberra, Australia. The telescopes two arms (at right angles, running North-South and East-West) will be about a mile long and 40 ft. wide. The antenna will be on level ground and have mechanical tilting and electronic phasing for partial steering ability.

▸ The FCC has authorized the Pacific Northwest Bell Telephone Co. to demonstrate, on a for-hire but developmental basis, the Bell System's "BELLBOY" 1-way signaling system. The radio paging system operates on the 150MC band. It is being used at the Seattle World's Fair. This is the first large-scale testing, and if successful, may lead to petition for amendment of Part 21 of the FCC rules to allow regular operation in the Domestic Public Land Mobile Services.

▸ The airlines are starting to do something about speeding up requests for tickets between the different lines. The U. S. scheduled airline industry has begun a study to develop a "common-use" electronic computer system for interline passenger reservations. Requests from throughout the country would be fed into a central computer and the answer as to times, flights, etc. would be sent back immediately.

▸ RCA's Aerospace Communications and Controls Div., Camden, N. J., under a $1,587,151 contract, will supply the Army with automatic missile check-out equipment. The computer-controlled systems, designed primarily for the Mauler Missile system, have adaptive capabilities for use with other present and future missiles.

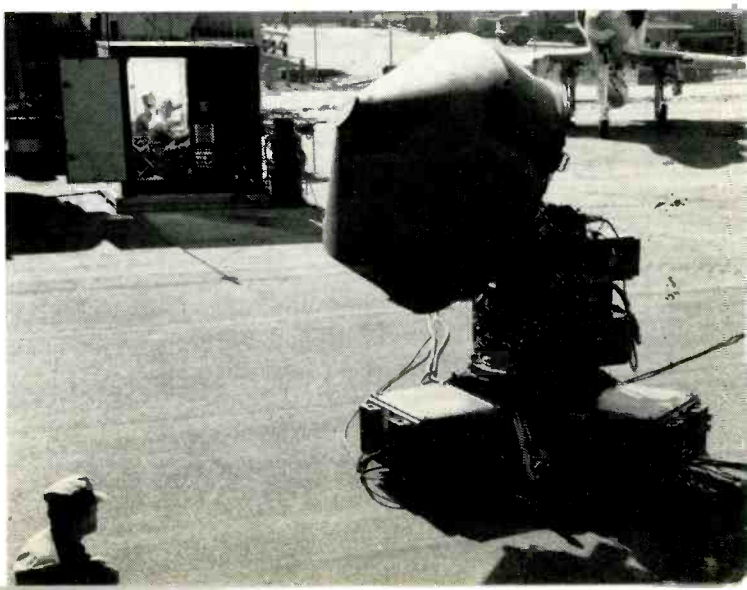
▸ NASA's Goddard Space Flight Center has awarded an R&D contract of over $3 million to Motorola, Inc's. Military Electronics Div. at Scottsdale, Ariz. The contract is for the Goddard Range and Range Rate Tracking System. For use in future deep and near-space satellite tracking, the system will be portable and be moved to accommodate any satellite orbit. It can measure a spacecraft's position to within a few feet and velocity to within fractions of a foot/second.

▸ The U. S. Army is using what might be termed the "library of tomorrow". From over 200 video-taped lessons available, any student at the Army Ordnance Guided Missile School at Huntsville, Ala., can dial a desired tape and view it in an individual booth. The tapes are also used in class-room work. Viewing screens range from regular size in the booths to giants of 12 by 20 ft. in the classroom. Program time ranges from 5 minutes to 2 hours, and cover astronaut launchings to keeping dust out of missile parts.

▸ The FCC has approved the purchase of a UNIVAC III computer, to be used at its offices in Washington, D. C. With the new computer, the processing of applications in AM, FM, and TV broadcasting, and the various safety and special radio uses will be speeded up. Among the principle features will be the automatic plotting of service and interference contours and the quick retrieval of information on all existing and pending communications facilities. Cost of computer and equipment is about $1 million.

PORTABLE CLOSE AIR SUPPORT RADAR SYSTEM FOR "VERTICAL ENVELOPMENT"

Marine technicians check-out Radar Course Directing Central, AN/TPQ-10, at Point Mugu, Calif. Radar and Control Central, (background) direct attack aircraft to targets in all-weather, day or night, operations. The system is helicopter-lifted in two compact units. It was designed and developed by General Electric's, Heavy Military Electronics Dept., Syracuse, N. Y.



By A. W. LANGILL, JR.
Development Engineer
Solid Rocket Plant
Aerojet-General Corp.
Sacramento, California

A Control System "How to . . . ."

Measuring Step Function

Although the s-plane and Laplace transforms are powerful tools in circuit design, their use, especially obtaining the inverse, can sometimes be tedious and time consuming. Here is a ruler and protractor method of getting this transform directly from the s-plane pole-zero array.

IN feedback control design, s-plane methods offer a powerful, well defined, graphical procedure. Once parameters have been determined, however, it is often necessary to insure that the final design does, indeed, meet all time domain specifications. Design, analysis, and evaluation may have to be repeated many times before obtaining a completely satisfactory transient response.

Translating a closed loop pole-zero array into meaningful time domain data (rise time, settling time, overshoot, etc.) requires an inverse Laplace transform which can be both tedious and time consuming when attacked by classical, partial fraction expansion methods. Here's a graphical method of getting an inverse Laplace transform directly from the s-plane pole-zero array. It is applicable to systems containing real, imaginary and complex first order poles when excited with a step input forcing function.

Mathematical Preliminaries

Graphical inverse Laplace transform calculations are based upon the three relationships presented in Eqs. (1), (2) and (3).

$$L^{-1}\left[\frac{A}{s+a}\right] = Ae^{-at},\ a = \tau + j\omega \qquad (1)$$

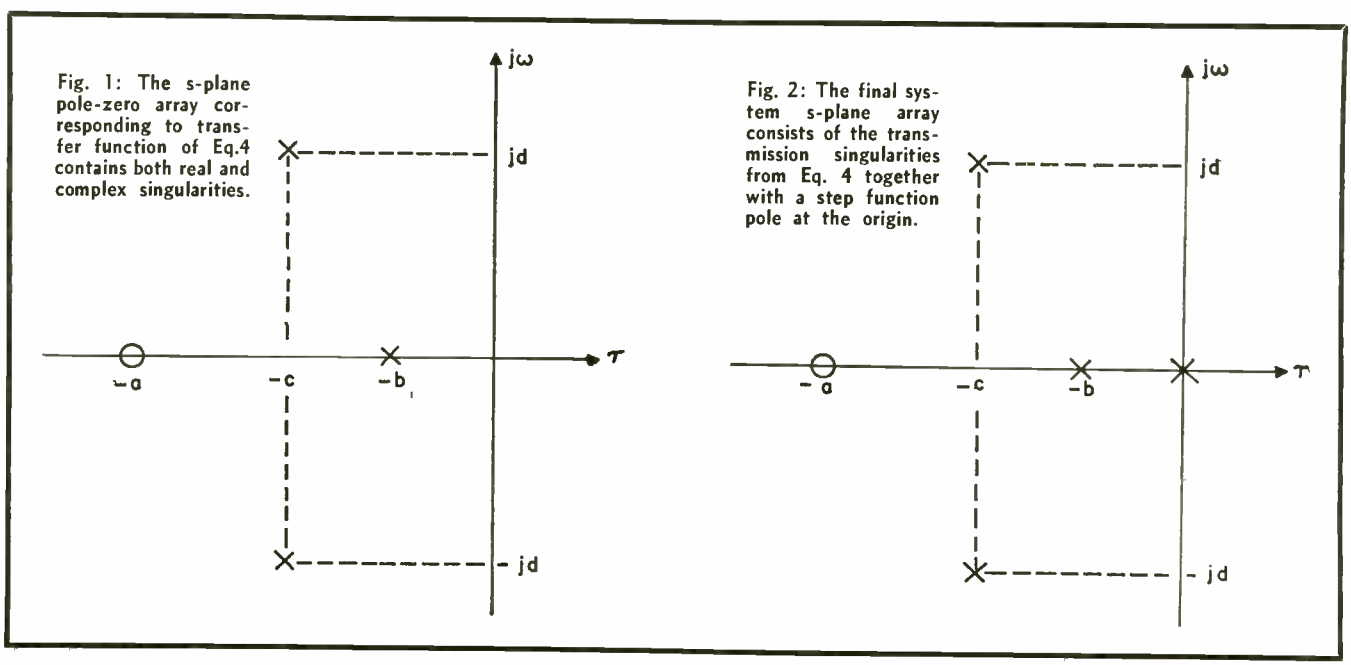


Fig. 1: The s-plane pole-zero array corresponding to transfer function of Eq.4 contains both real and complex singularities.

Fig. 2: The final system s-plane array consists of the transmission singularities from Eq. 4 together with a step function pole at the origin.

Response

$$Ae^{j\theta} + Ae^{-j\theta} = 2\,Re\,Ae^{j\theta}$$
$$= 2\,Re\,Ae^{-j\theta} \qquad (2)$$

where A is the absolute value and θ the phase angle of the complex number

$$Re\,Ae^{j\theta} = A\cos\theta$$
$$Re\,Ae^{-j\theta} = A\cos\theta \qquad (3)$$

The first equation states that the inverse Laplace transform of a pole located at $-a$ (where a is complex) is a decaying exponential time function with a time constant of $1/a$. The second shows the sum of a complex number and its complex conjugate equals twice the real part of either quantity. Eq. (3) defines the real part of a complex number by polar coordinates.

Inverse Laplace Transform

Let's study an arbitrary closed loop control system. Its transfer function is described in Eq. (4); the s-plane pole-zero array in Fig. 1.

$$\frac{C}{R}(s) = \frac{s+a}{(s+b)\left[(s+c)^2+d^2\right]} \qquad (4)$$

For a unit step function input, i.e., $R(s) = 1/s$, Eq. (4) becomes:

$$C(s) = \frac{s+a}{s\,(s+b)\left[(s+c)^2+d^2\right]} \qquad (5)$$

The pole-zero array for Eq. (5) is plotted in Fig. 2. In applying conventional inverse Laplace transform methods to Eq. (5), the following steps would be followed.

Step 1. Eq. (5) is expanded into partial fractions through arbitrary coefficients, Eq. (6).

$$\frac{s+a}{s\,(s+b)\left[(s+c)^2+d^2\right]} = \frac{A}{s} + \frac{B}{s+b} + \frac{Cs+D}{(s+c)^2+d^2} \qquad (6)$$

Step 2. To determine the first coefficient A, Eq. (6) is multiplied by s, and the resulting expression evaluated for $s = 0$, i.e.,

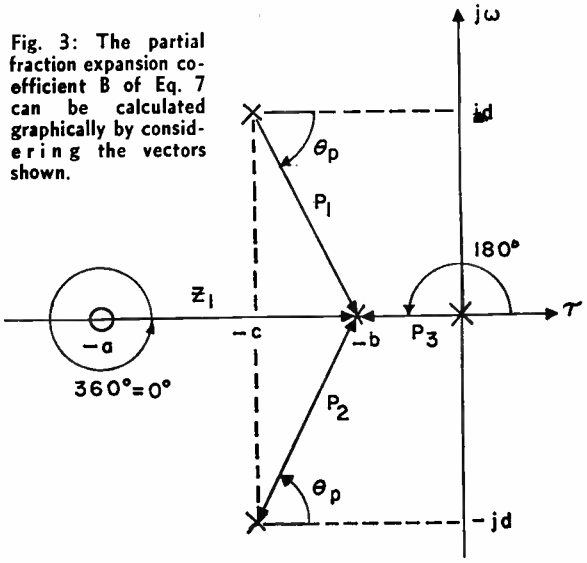


Fig. 3: The partial fraction expansion coefficient B of Eq. 7 can be calculated graphically by considering the vectors shown.

$$A = sC(s)\big|_{s=0}$$

and similarly,

$$B = (s+b)C(s)\big|_{s=-b}$$

Step 3. To calculate C and D, Eq. (6) is multiplied by the quadratic $(s+c)^2 + d^2$. Then substitute $s = -c + jd$ and define C and D by equating real and imaginary parts of the resulting expressions. With all coefficients now determined, obtain the inverse transform by referring to standard transform tables.

This method becomes involved for complex systems, and may readily lead to algebraic or arithmetic error. A graphical approach can dispose of these problems.

Graphical Inverse Transform

A slightly different partial fraction expansion is used for graphical inverse Laplace transforms. Each quadratic is reduced into first order complex poles so that the resulting partial fraction expansion appears as in Eq. (7).

$$\frac{s+a}{s\,(s+b)\left[(s+c)^2+d^2\right]} = \frac{A}{s} + \frac{B}{s+b} + \frac{C}{s+c-jd} + \frac{D}{s+c+jd} \qquad (7)$$

Once the arbitary coefficients A, B, C and D have been computed, the inverse transform can be written directly—without referring to tables—since each factor is in the form of Eq. (1). In computing B by classical means, we multiply $C(s)$ by $s+b$ and evaluate $(s+b)\,C(s)$ for $s = -b$ as described previously. This is equivalent, geometrically, to constructing vectors from each s-plane singularity to the pole associated with B, i.e., $1/(s+b)$, measuring the length and subtended angle of each vector, and evaluating B according to the following generalized expression:

$$B = \frac{Z_1 e^{j\theta_{z1}}\; Z_2 e^{j\theta_{z2}} \ldots Z_n e^{j\theta_{zn}}}{P_1 e^{j\theta_{p1}}\; P_2 e^{j\theta_{p2}} \ldots P_n e^{j\theta_{pn}}} \qquad (8)$$

Measuring Response *(Concluded)*

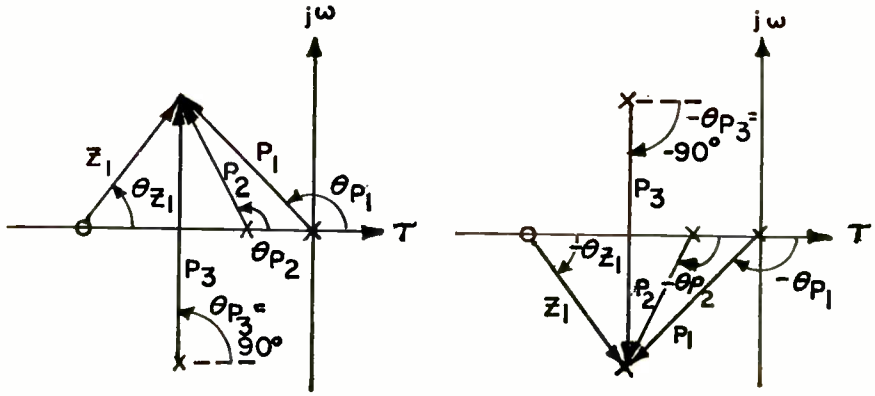


Fig. 4: Coefficients corresponding to complex conjugate poles are also complex conjugates.

$$= \frac{Z_1 Z_2 \ldots Z_n e^{j(\theta_{z1} + \theta_{z2} + \ldots + \theta_{zn})}}{P_1 P_2 \ldots P_n e^{j(\theta_{p1} + \theta_{p2} + \ldots \theta_{pn})}}$$

where $Z_1 Z_2 \ldots Z_n$ = products of vector lengths from system zeroes to pole in question,

$P_1 P_2 \ldots P_n$ = products of vector lengths from system poles to pole in question,

$\theta_{z1} + \theta_{z2} + \ldots + \theta_{zn}$ = sum of angles subtended by all zero vectors,

$\theta_{p1} + \theta_{p2} + \ldots + \theta_{pn}$ = sum of angles subtended by all pole vectors

Returning to the final s-plane pole-zero array, Fig. 2, B is now computed as follows:

$$B = \frac{Z_1 e^{j\theta^\circ}}{(P_1 e^{-j\theta_P})(P_2 e^{j\theta_P})(P_3 e^{j180^\circ})}$$

$$= \frac{Z_1}{P_1 P_2 P_3} e^{-j180^\circ}$$

$$= -\frac{Z_1}{P_1 P_2 P_3}$$

To generalize, the coefficient corresponding to any real axis pole will be a real quantity (either positive or negative), since each complex pole or zero exists as one half of a complex conjugate pair.

C and D are determined in an identical manner. For complex poles, however, the coefficients are also complex in nature, representing a conjugate pair, Fig. 4,

$$C = \frac{Z_1 e^{j\theta_{Z1}}}{P_1 P_2 P_3 e^{j(\theta_{P1} + \theta_{P2} + \theta_{P3})}}$$

$$= \frac{Z_1}{P_1 P_2 P_3} e^{j\phi}$$

$$D = \frac{Z_1 e^{-j\theta_{Z1}}}{P_1 P_2 P_3 e^{-j(\theta_{P1} + \theta_{P2} + \theta_{P3})}}$$

$$= \frac{Z_1}{P_1 P_2 P_3} e^{-j\phi}$$

$$\phi = \theta_{Z1} - \theta_{P1} - \theta_{P2} - \theta_{P3}$$

Assuming that A, B, C and D have been determined numerically as A_1, B_1, $\Delta e^{j\phi}$ and $\Delta e^{-j\phi}$, the inverse Laplace transform of Eq. (7) appears as

$$c(t) = A_1 - B_1 e^{-bt} + \Delta e^{j\phi} e^{-(c - jd)t} + \Delta e^{-j\phi} e^{-(c + jd)t} \quad (9)$$

Rearranging the above,

$$c(t) = A_1 + B_1 e^{-bt} + \Delta e^{-ct} e^{j(dt + \phi)} + \Delta e^{-ct} e^{-j(dt + \phi)} \quad (10)$$

Since the quantities $e^{j(dt+\phi)}$ and $e^{-j(dt+\phi)}$ form a complex conjugate pair, Eqs. (2) and (3) can be applied to yield the final result described by Eq. (11).

$$c(t) = A_1 + B_1 e^{-bt} + 2\Delta e^{-ct} \cos(dt + \phi) \quad (11)$$

Thus, it is not necessary to measure both coefficients associated with any set of complex conjugate poles. Only one of the coefficients need be calculated; the total corresponding time domain expression is then evaluated as twice the real part of the resulting single pole inverse transform.

★ ★ ★

CUES for Broadcasters

Emergency Power Line Switch-Over

PHILIP ROSS, Tech. Supr.
WBNX, New York 36, N. Y.

A loss of power to vital broadcast equipment such as studio consoles, turn-tables, tape machines, clocks, etc., is often caused by the failure of a single primary fuse. These cartridge fuses are usually located in unknown areas of basements. Many of these blow-outs are caused by voltage surges at the feed, rather than overloads or shorts by the user. Since one side of the line is so effected, it knocks out only half of the branch circuits fanning out of the Circuit Breaker Cabinet, which is conveniently located. See Fig. 1.

By using a suitable heavy duty industrial relay and enclosure, available at electronic suppliers for under $10, essential circuits can be automatically switched over to the "live leg" while an unhurried search is made for the blown fuse.

The modification, as shown in Fig. 2, can be made in two hours. Wiring should be in conformity with local electrical codes.

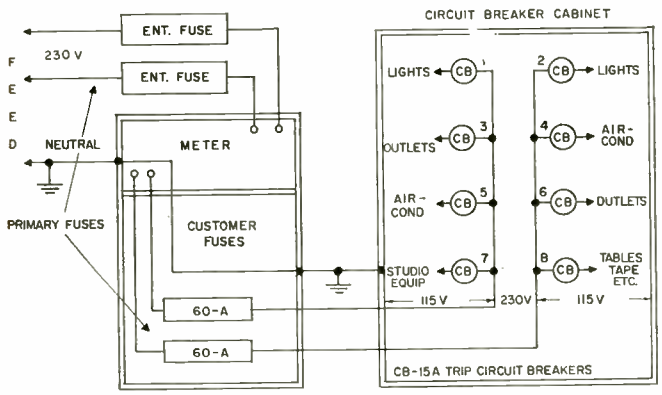


Fig. 1: Typical three-wire 230/115 volt power distribution.

First, add 2 similiar 15 or 20 ampere circuit breakers. Most panels have extra knock-outs for such additions. Turn Off breakers 7, 8, 9, & 10. Mount relay and enclosure, which is quite small, 3 x 4 in., in any suitable spot. Fasten directly to the circuit breaker cabinet by means of a short piece of ½ in. conduit.

Identify and remove wires from the load side of breakers #7 & #8. Connect new leads from #7 to lower relay contact and #8 to upper relay contact. Now connect leads from breakers #10 to upper contact and #9 to lower contact of the opposite contacts. Also connect a short lead from the relay coil to this

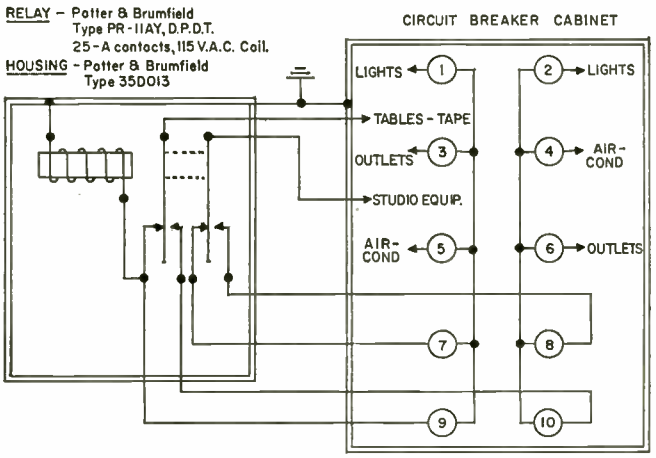
$$$ for Your Ideas

Readers are invited to contribute their own suggestions which should be short and include photographs or rough sketches. Typewritten, double spaced text is requested. Our usual rate will be paid for material used.

CUES for Broadcasters

lower contact. Connect a lead to the movable contact and splice to the identified lead which was removed from breaker #7. A lead should then be attached to the other movable contact and spliced to the identified lead removed from breaker #8. Finally, connect a lead to the other relay coil terminal and fasten to the grounding buss (white wires) in the circuit breaker cabinet.

Fig. 2: Modified power panel shown in the "normal" position.



Throw On breakers 7, 8, 9 & 10. The relay should energize. To check out the system, throw breaker #9 to Off. Only a momentary interruption of power will take place as the relay is de-energized and the controlled loads move over to the other "live leg."

Power Coupling

The multiple-beam klystron (MBK) offers a new means of generating up to 100 times more microwave power than a single-beam klystron. The device, developed by General Electric's Power Tube Dept., uses several electron beams paralleled in one vacuum envelope. Effect of Multiple-beam interaction is to multiply power in proportion to the number of beams used. Project engineer John S. Hickey holds model of the multiple-beam interaction section, heart of the new device.

Precision Radiography by Scanning

IN 1943, a beam slit scanning mechanism was developed for the non-destructive evaluation of the proximity fuse component after encapsulation. Absolute correlation between the image and the fuse was required; scanning, the only practical solution.

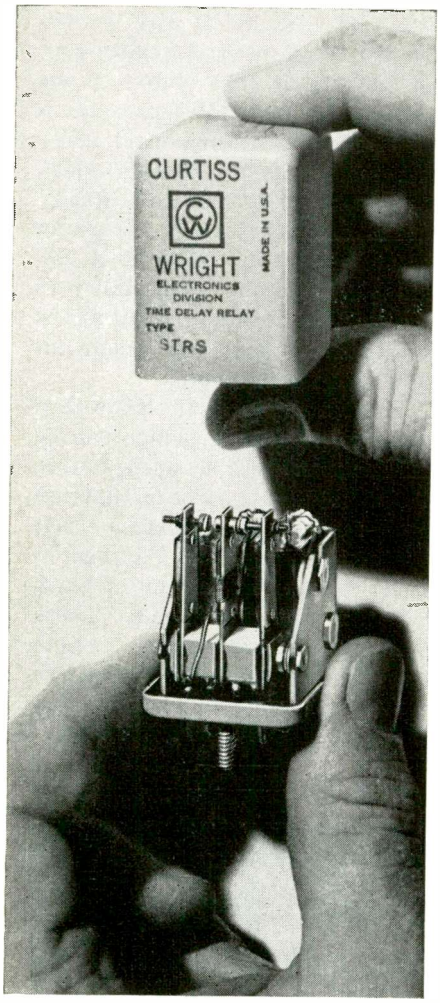
Today we face the same problem in evaluating the dependability of electro-mechanical and mechanical assemblies, small precision castings, welded assemblies. The divergent, heterogenous beams of the radiation emitted by the X-ray tube preclude the possibility of obtaining distortion free images in the usual manner. For example, if we visualize a storage battery set up for X-ray inspection, we get the perspective by placing the eye at the same point as the X-ray source. We see thru the spaces between the plates that are directly under the center of your vision, but superimposition takes place as the plates become remote from the center point. Now by using the scanning method of inspection, a slit is interposed between the eye and the battery and as the battery is moved past the slit each interspace is visualized. Place a film beneath the battery, substitute the X-ray beam for the eye and the image will delineate each and every segment of the battery.

While elimination of the projection distortion is the prime function of the scanning method, it performs two equally important tasks in improving the recorded image. One by absorbing all extraneous radiation from the tube housing and reducing the secondary radiation from the test object to an absolute minimum. Secondly, the resolution in the recorded image is revealed in clear, crisp delineation in extremely fine detail in the radiograph.

Since the scanning method uses only a small portion of the primary radiation, its safety factory is higher than that of any other X-ray inspection unit and it may be constructed as an integral quality control instrument. The ability of the scanning system to reproduce a true image recording, part after part, makes its application ideal. There is no doubt that this precise method of X-ray image recording adds considerably to product dependability and its adaptability to existing X-ray units as an auxiliary tool, tends to keep equipment investment to a minimum.

There are at present laboratory models in production which can be used for spot check scanning, using an 8 x 10 in. film. For production line X-ray testing a conveyor belt system machine would be used to permit continuous feeding of parts thru the scanning beam. These units, under the trade name SCAN-X, are made by the ALL-RAY Precision Laboratories Co., 221 Gorsuch Street, Folsom, Pa.

Thermal Time Delay Relays



Instant Reset

Voltage Compensated

Vibration Resistant

Precision-built Curtiss-Wright thermal time delay relays reset instantly when de-energized — provide the same delay period for each succeeding cycle. Compensated for wide voltage variations. Available in either 28V DC or 115V AC, 60 or 400 cps. Chatter-free operation, under severe shock and vibration conditions. Small sized, hermetically sealed, temperature compensated for precise, reliable operation and long life. Preset time delays from 10 to 180 seconds with SPST, SPDT or DPDT snap action contacts.

Write for latest complete components catalog #516

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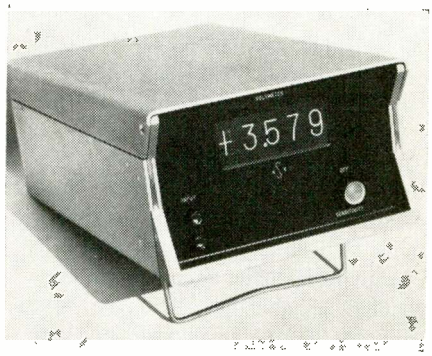
Circle 140 on Inquiry Card

New Products

DIGITAL VOLTMETERS

Feature all plug-in circuits and printed circuit board assemblies.

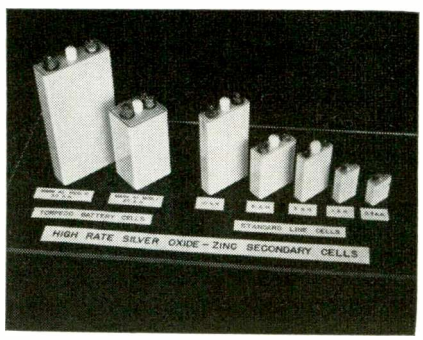


The ASX digital voltmeter measures 5¼ x 8½ x 14 3/16 in. This size allows for internal mounting of such optional equipment as ac/dc converter, battery pack for isolated dc operation, ratiometer, ohmmeter, automatic range and polarity, and printer drive. The voltmeter is in 3 basic models. These consist of completely solid state, reed relay and stepper switch units. Accuracy of each instrument is 0.01% of full scale ±1 digit. American Space Exploration Inc., 3910 S. Kalamath, Englewood, Colo.

Circle 356 on Inquiry Card

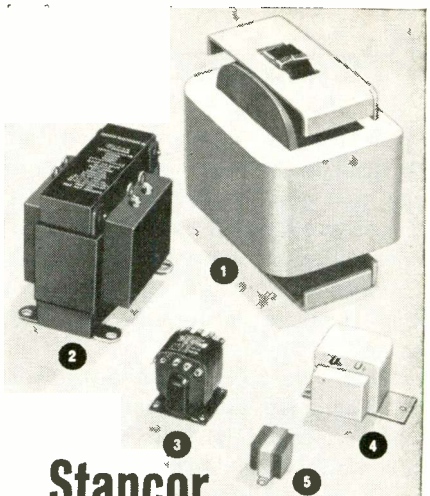
SILVER-ZINC BATTERIES

Designed for use where small size and light weight is important.



These cells are originally designed to meet the requirements of rigid military specs. through environmental testing. Their size, weight and ability to withstand shock and vibration make them particularly suitable for use in missiles. These cells, either primary or secondary, can be designed to meet varying requirements of performance, weight, and terminal size for specific uses. NICAD Battery Div., Gould-National Batteries, Inc., E-1200 1st National Bank Bldg., St. Paul 1, Minn.

Circle 357 on Inquiry Card



Stancor transformer encapsulations meet mil specs

for flammability, humidity, temperature

Stancor Electronics offers the industry's widest range of encapsulation techniques and materials—many developed in our own encapsulation laboratory and available only from Stancor.

Substantial reduction in size and weight without sacrifice of reliability or environmental characteristics can be achieved through the use of Stancor designed and encapsulated transformers.

For help with your transformer design problems, write for the address of our nearest engineering sales office.

1. Filter Reactor with epoxy molded coil meets MIL-T-27A, Grade 5, Class R.
2. Epoxy molded dual filter reactor, flame retardant material—meets MIL-T-27A, Grade 5, Class R.
3. Epoxy dipped filament transformer, 105°C operating temperatures.
4. Silicone rubber encapsulated power transformer, 200°C operating temperature.
5. MIL-T-27A Filter Reactor with "Scotch Cast" impregnated coil. Entire unit epoxy molded.

RIQAP

Since 1955, Stancor Electronics, Inc., has been operating continuously under RIQAP, the U. S. Army Signal Corps' Reduced Inspection Quality Assurance Plan. When you specify Stancor transformers, delivery time is reduced and incoming inspection is at a minimum. You are assured of the highest quality units for military application.

Factory and product approval has been received from leading military prime contractors.

For Immediate Delivery—Stancor makes available the most extensive line of stock transformers in the industry—through Stancor Industrial Distributors. For a detailed listing of these units, write for Catalog CS-101.

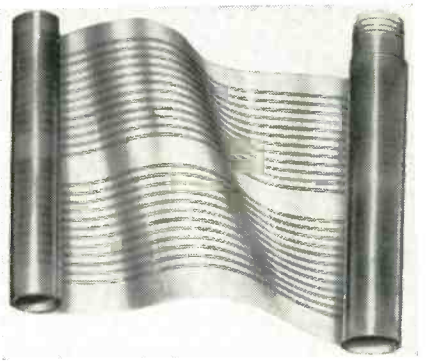
STANCOR
ELECTRONICS, INC.
3516 W. Addison Street • Chicago 18, Illinois

Circle 141 on Inquiry Card

New Products

FLAT CABLE

For use in severe environments where space and weight saving is a must.

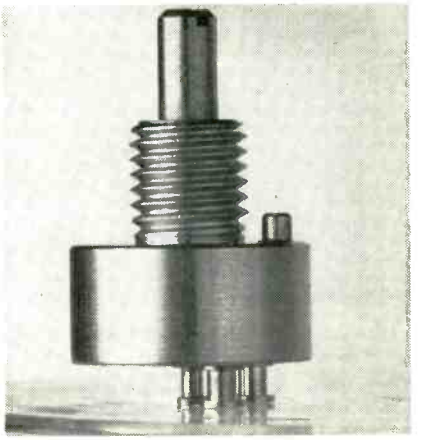


The conductors are encapsulated in Mylar. The material, a new variation of Methode's Plyo-Duct, is available in continuous lengths and contains up to 24 pairs or 48 conductors of 0.002 in. round copper wire. This wire, in a film 0.004 in. thick, has spacing tolerances of 0.002 in. Plyo-Duct has high dielectric strength under severe environmental conditions, with very good flex-life and min. weight characteristics. Methode Electronics, Inc., 7447 W. Wilson Ave., Chicago 31, Ill.

Circle 354 on Inquiry Card

MINIATURE POTENTIOMETER

This wire-wound, precision unit will operate from —55° to 150°C.



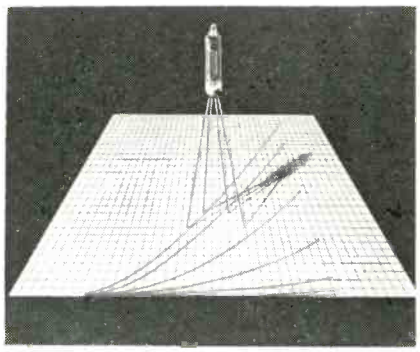
The JP/2 is a panel mount potentiometer, smaller in overall volume than standard ½ in. miniature pots and considerably lower in cost. It is designed to meet standard military environmental specs. The JP/2 can be interchanged with most ½ in. pots. It is available in a resistance range from 10Ω to 20KΩ. Waters Manufacturing, Inc., Wayland, Mass.

Circle 355 on Inquiry Card

New Products

VACUUM INDICATOR TRIODE

This subminiature high-vacuum triode has a fluorescent anode.

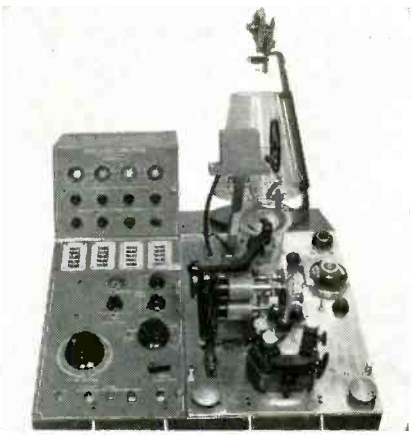


The Type 6977 Indicator Triode is designed for transistor circuits, where its high input impedance will not load the transistors and its small drive requirements are suited to transistor circuit voltages. It can be used to replace neon lamps in electronic computers and data processing systems. The 6977 can be operated from ac or dc supplies and draws 0.03a of heater current at 1.0v. Plate voltage is 50v, and series grid resistance is 100KΩ. Tung-Sol Electric Inc., 1 Summer Ave., Newark 4, N. J.

Circle 346 on Inquiry Card

COIL WINDING MACHINE

T-100C toroidal winding unit has winding speeds to 2000 turns/min.



It can produce toroids ranging in size from 1/32 in. I.D. to 5 in. O.D. with wire in sizes from 50 to 16 AWG. Features: a finely adjustable variable speed control; and controlled acceleration and deceleration. The predetermined turns counting system uses an r-f probe pickup which requires no adjustments. Up to 7 preset counts of 4 digits are available—one for shuttle loading, 6 for winding and tap pulling. Set-up time is reduced with new quick change interchangeable heads. Boesch Mfg. Div., Waltham Precision Instrument Co., Inc., Danbury, Conn.

Circle 347 on Inquiry Card

WASHINGTON News Letter

QUICK EXPANSION OF TV—A proposal for "quick expansion" of UHF television broadcasting by licensing the nation's 458 VHF stations to telecast simultaneously on UHF channels has been submitted by the Electronic Industries Association to the Senate and House Commerce Committees, which handle communications-radio matters. Simultaneous VHF-UHF telecasting would foster the "orderly growth" of UHF television, EIA stated. By this program, EIA stressed, many new set buyers who do not have UHF stations in their areas would be given a reason for paying the approximately $30.00 difference between all-channel and VHF set prices, and once the public has a reason for purchasing all-channel receivers, TV set manufacturers will quickly produce them and promote their sale.

FIRST TIME—The new Director of Telecommunications Management, Dr. Irvin Stewart, in his first statement on his responsibilities over frequency management since his appointment, told the Senate Commerce Committee that "for what I believe is the first time, one individual acting under the President is to be responsible for seeing the telecommunications resource is effectively used from the standpoint of national policies," particularly by government agencies. He told the Senate Committee that he understands "if anyone wishes to upset one of my decisions, he must go to the President." The Interdepartment Radio Advisory Committee, which has set spectrum needs for the government, should be continued "indefinitely" as long as the Director of Telecommunications "finds it useful," he stated.

ORDERLY MANAGEMENT—Stewart outlined to the Senate Committee his concept of the post's responsibilities as put forth in President Kennedy's executive order. He said basically it is "designed primarily for the orderly management of frequencies on the government side." Dr. Stewart stated that the authority spelled out in the executive order to grant, amend, modify or revoke frequency assignments for government use can be more easily achieved in "a spirit of cooperation than of competition." He stressed there will be no infringement on FCC authority and that he anticipates very close cooperation with the commission.

CCIR RECOMMENDATIONS—The recommendation that sharing of frequencies by satellites with ground operations probably would work best without serious interference with point-to-point microwave systems was agreed on by the study group on satellite communications of the CCIR (International Radio Consultative Committee). The CCIR group of 150 delegates from 25 nations adopted a proposed limitation on the power to be used by satellites and point-to-point microwave systems to make this feasible. The recommendations and reports of the study group are to be submitted at the plenary CCIR conference held in New Delhi, India, in January, 1963. The New Delhi meeting will compile a report for the International Telecommunications Union Space Communications Conference to be held in the Fall of 1963 in Geneva.

National Press Building
Washington 4

ROLAND C. DAVIES

FOREIGN INVESTMENTS HERE—The $6.9 billion total of foreign business investments here in 1960 was more than double the 1950 total of $3.4 billion, but foreign business earnings here increased only 15% in the same period, a U. S. Dept. of Commerce Survey reveals.

Earnings of the foreign-controlled enterprises ranged between $300 million and $350 million per year until 1959, then jumped to $400 million in both 1959 and 1960.

Of the $6.9 billion total, $2.6 billion was invested in manufacturing companies. Of this, nearly $1.0 billion was in food products and beverage companies. Other large investments were in chemicals and related products ($0.5 billion), machinery ($0.4 billion) and pulp and paper products.

United Kingdom investments here totaled more than $2.2 billion. Canadian investments ranked next with $1.9 billion, followed by The Netherlands ($0.9 billion) and Switzerland ($0.7 billion).

The total of U. S. investments abroad in 1960 was $32.7 billion, the survey says.

SPENDING FOR SPACE—The accelerating national space program has helped boost federal research and development spending to a record $12.3 billion called for in fiscal 1963.

The NASA budget alone calls for expenditures of $863.6 million. The largest item is for advanced manned flight projects beyond Project Mercury, which has a $13.2 billion budget. The advanced projects include Project Apollo, the three-man lunar spacecraft, and Project Gemini, the interim two-man capsule designed primarily to explore orbital rendezvous techniques.

Still other research and development projects include an improved multi-purpose space booster system using both solid and storable liquid propellants, atomic aerospace reactors and the Mach 3 bomber, with a planned speed in excess of 2,000 miles an hour.

ENGINEERS, EE
and MATHEMATICIANS:

Reliability begins with an idea... and never really ends

'The days of more-or-less *passive* reliability work are ancient history at General Electric's Defense Systems Department.

When potentially globe-spanning systems such as AWCS-412-L[1] and MISTRAM[2] are at stake, you just don't start cranking in reliability somewhere along the development line. Reliability is not only "in on the act" virtually from the first glimmerings of a new concept... it operates as a full, active partner throughout the life of the program—and beyond, as the system moves into the field.

If you've never been exposed to reliability work of DSD's scope and complexity, you are quite possibly missing out on an opportunity to cast off the frustrations of narrowly limited responsibilities and truly accelerate your professional growth.

Our Reliability Group has the responsibility for the concept, proposal and implementation of Reliability programs for the entire Defense Systems Department. The implemented programs are in accordance with such specifications for Aero-Space Systems as MIL-R-27542. The general functional areas of activity are as follows:

Systems Reliability Analysis

—encompasses the establishment of systems reliability goals if not specified by the customer's requirements. When the customer's requirements define a specific reliability, the allocation of this requirement to the subsystems and lower levels of assembly must be performed. In the performance of this allocation, previous history of similar equipments, state-of-the-art improvement and functional configuration of the system must be prepared. From the detailed functional configuration, the development of mathematical reliability models evolves. The utilization of the developed functional and mathematical models predictions of the system reliability may be made.

Evaluation of configuration changes are performed using the established models and with proper costs associated the cost trade studies would be completed.

Design Review

—involves performance of detailed analysis of electrical and mechanical characteristics of each assembly and component to assure optimum reliability. The design reviews require close coordination between design engineering and the reliability engineer.

Evaluation of circuit and equipment designs is conducted to obtain sufficient knowledge of performance of various designs. This evaluation becomes a documented report which encourages the design engineer to utilize the more reliable circuit and/or equipment design.

Component Parts

—includes evaluation of components for utilization by the design engineer, and reliability design review activity. The evaluation takes the form of application notes for the utilization in future designs, with emphasis on derating concepts and establishment of the mode of failure.

Data Analysis

Establishment of data collection, analysis and processing systems. The established data system must be utilized for data from in-plant, field and subcontractors. The analysis of the data takes the form of statistical and analytical reports.

Failure Analysis

An intricate part of the reliability function is to perform or cause to have performed those analyses of failures as are required by applicable specification or customer request.

Liaison and Coordination

This is an effort associated with all previously defined functional areas and includes communication with customers, vendors, design engineers, manufacturing, repair depots and all other functions to assure the achievement of customer reliability requirements.

Qualifying Experience

In most cases, a BSEE with some experience in circuit design review, experimental verification of reliability performance, circuit analysis or failure analysis. In many instances, a BS in Mathematics with some solid reliability experience in another field.

For more information about the opportunities immediately available in the Reliability Group, or to apply, forward your resume in full confidence. You will receive a prompt and personal reply. Address:
Mr. P. W. Christos, Div. 24-ME.

DSD DEFENSE SYSTEMS DEPARTMENT
A Department of the Defense Electronics Division

GENERAL ELECTRIC

NORTHERN LIGHTS OFFICE BUILDING, SYRACUSE, NEW YORK

❶ AWCS-412-L is an air weapons control system of virtually global potential. It will consist of a closely coordinated network of data acquisition stations, data processing and display centers, and weapon bases... providing the tools for effective and flexible air space management, continent-wide or in single point defense.

❷ MISTRAM is a revolutionary precision trajectory measurement system with important ramifications in space. Basic system concept involves a geometric arrangement of 5 ground radio receiving stations. Missile position, trajectory and velocities are continuously calculated from phase differences in a beacon signal received from the missile. Radar only orients the radio receiving antennas in the general direction of the missile.

Circle Number 800
Professional Profile, page 208

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

Machine "Dues" to Ease Impact on Workers

U. S. Industries, Inc., has announced that its automation machines will pay "dues" to be used to develop ways to ease automation's impact on displaced workers.

The dues will be calculated upon the sales or lease price for each automated USI machine. These payments will continue monthly for one year from the date of sale or lease. It is estimated that dues will range in annual amounts from $25 to $1,000 per machine.

Dues will be paid to a labor-management foundation now being created, which will be charged with the responsibility of administering the funds thus collected for the benefit of employees affected by automation advances. The foundation is being established under the joint sponsorship of USI and the International Association of Machinists.

NSF Establishes New Planning Office

Establishment of a Science Resources Planning Office in the National Science Foundation has been announced by Dr. Alan T. Waterman, NSF Director. The office will serve as a focus for studies of the nation's future needs and resources for research and education in science.

Dr. Richard H. Bolt has been named to head the SRPO and to occupy a new Foundation position, Associate Director (Planning). Dr. Bolt has served as NSF's Associate Director (Research) since January, 1960.

The SRPO, in studying science resources, will use information developed in cooperation with educational institutions, with industry, and with government agencies.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient resume form, page 208.

Educator Cites Value of Education To American National Security

A Chicago scientist and educator blamed America's complacent attitude toward progress in education, and not inferior standards, for the nation's struggle with Russia for technical and scientific supremacy.

Speaking before the City Club of Chicago, Dr. Martin A. Elliot, academic Vice President of the Illinois Institute of Technology, cited the importance of scientific and technical education to American national security.

He cautioned that our national security will be jeopardized unless we overcome the technical setbacks inflicted by the complacency of the past. We must produce the new science and technology necessary to give us the edge over our potential adversaries, he said.

In this age of accelerating technological progress, the battle for the balance of world power is being fought, not on the battlefield as in the past, but rather in the R&D laboratories of the U. S. and the Soviet Union, he went on.

It is our collective obligation to see, by all means at our disposal, that increasing numbers of young people choose careers in science and technology; to fail in this obligation is to court disaster! Elliot exclaimed.

We must realize that brains are our greatest resource, and that educated brains will perpetuate freedom for all mankind, he concluded.

AWARD WINNERS

Model of circuit analyzer used in production line for Accutron electronic watches is checked by Max Hetzel (l) and William O. Bennett. These two men were recently presented gold medals as recipients of the American Watchmakers Inst. Research Award for 1962. Hetzel, Bulova Watch Co. chief physicist, started developing the "tickless" timepiece 9 years ago. Bennett is Bulova's vice pres. of research and engineering.

Missile School Seeks Teachers

Fifty experienced civilian instructors who can meet qualifications in electronics are being sought by the Army Ordnance Guided Missile School at Redstone Arsenal, Huntsville, Ala. The 50 positions must be filled between now and August. The Civil Service positions are graded from GS-7 to 11 and pay from $5,355 to $7,560 annually.

Technical teaching experience is emphasized in the job requirements.

Openings for Engineers

U. S. Dept. of the Interior has openings for creative electrical/electronic engineers to conduct R&D program on automation in data accumulation, reduction and processing in geology—geophysics, water resources investigations, geodesy, photogrammetry and allied fields.

This includes development of new techniques and equipment for sensing, transmitting, logging, processing and storing of mass data. Contact Placement Officer, U. S. Geological Survey, Washington 25, D. C.

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

By EDMUND L. STODDARD
Senior Technical Editor
Surface Radar & Navigation
Raytheon Company
Wayland, Mass.

Keeping the Engineer at Work ...On What He Does Best!

The supply of engineers is critical.
The best engineering talent is being diverted to other duties.
Here's one solution to this disturbing problem.

A "GOOD deal of concern is being expressed over the changing role of the engineer. The best engineers . . . no longer have time for engineering. They are either drafting proposals, or they are saddled with administrative duties."* It might also be well to add, they are writing reports. "How to keep our best engineers at work on what they do best . . ."* is a problem which always faces engineers and management.

These tasks can be removed from the engineer by using the technical communicator: a man well versed as a writer but not necessarily an engineer. This man can talk to the engineer in his own language and put on paper what the engineer wants to say in his reports and proposals. Sometimes the engineer may rough out his thoughts but he is relieved of the task of the final polishing. He has final control of the finished words, and yet is free to do the work his job calls for—engineering. This is only one part of what a technical communicator can do for engineers. It is the task of the communicator to provide answers to questions such as, "Has anyone else come up with a circuit like this, and if so, where can I find it?" The technical communicator maintains an information retrieval system which will enable him to answer rapidly, and accurately, such questions.

Most managers would say, "This is a very fine approach to solving a problem, but where can we find a technical communicator?" The technical communicator is not any one individual but a combination of talents available through a technical publications department. He is the technical writer. He is the technical illustrator. He is the information retrieval specialist. The talents of all these specialized personnel should be put to work in much the same manner as the engineer is put to work in the field in which he is a specialist—engineering. If the engineer needs something written, he should communicate his thoughts to the technical writer and let the technical writer worry about whether or not it is phrased in the best possible manner to reach the objective that the engineer wants to reach. Similarly, for illustrations to go with articles, reports, etc., the engineer should use the services of the technical illustrator.

How to communicate better is, and always has been, the prime concern of the technical communicator. This man is available in almost every company in the country today. The problem is, why isn't he being used by the engineers?

Information retrieval is relatively new to the field of technical communications. However, much engineering effort today is redundant because "scientists are not communicating with each other as well as they should."* In a well organized retrieval system, information that the engineer wants is available because all documents, drawings, proposals, etc., necessary for completion of the engineering task have been indexed to a sufficient depth. No matter how the question is put by the engineer, if the work has been performed in the past, the information retrieval system can provide the location of the data desired.

The technical communicator is not intended to do the engineer out of any of his primary tasks. He is

* *Electronic Industries*, February 1962, page 5.

Engineer at Work *(Continued)*

present to aid the engineer in providing the large amount of documentation necessary for American industry to advance as rapidly as our technological age demands. The technical communicator becomes part of a team effort when used in this manner.

Precisely how a publications department should be organized to include all of these talents depends on the individual company concerned. Many articles have appeared presenting various ways of organizing publications departments. Almost any one of these types of organization would be satisfactory. The most important thing to remember is that the technical communicators are the experts in communicating and can aid the engineer in this area.

Packaged Circuits

(Continued from page 111)

because, laboratory-type bridges and comparators would require many pieces of equipment, and use 5 to 6 operators.

With the evident need for automatic or semi-automatic testing, equipments used by other makers were studied.

Most of that equipment used comparison standards and sequential switching. The major disadvantages were: range limitations, operating rates, excessive initial cost, and excessive operating costs.

The unit finally developed and used is based on the following principles:

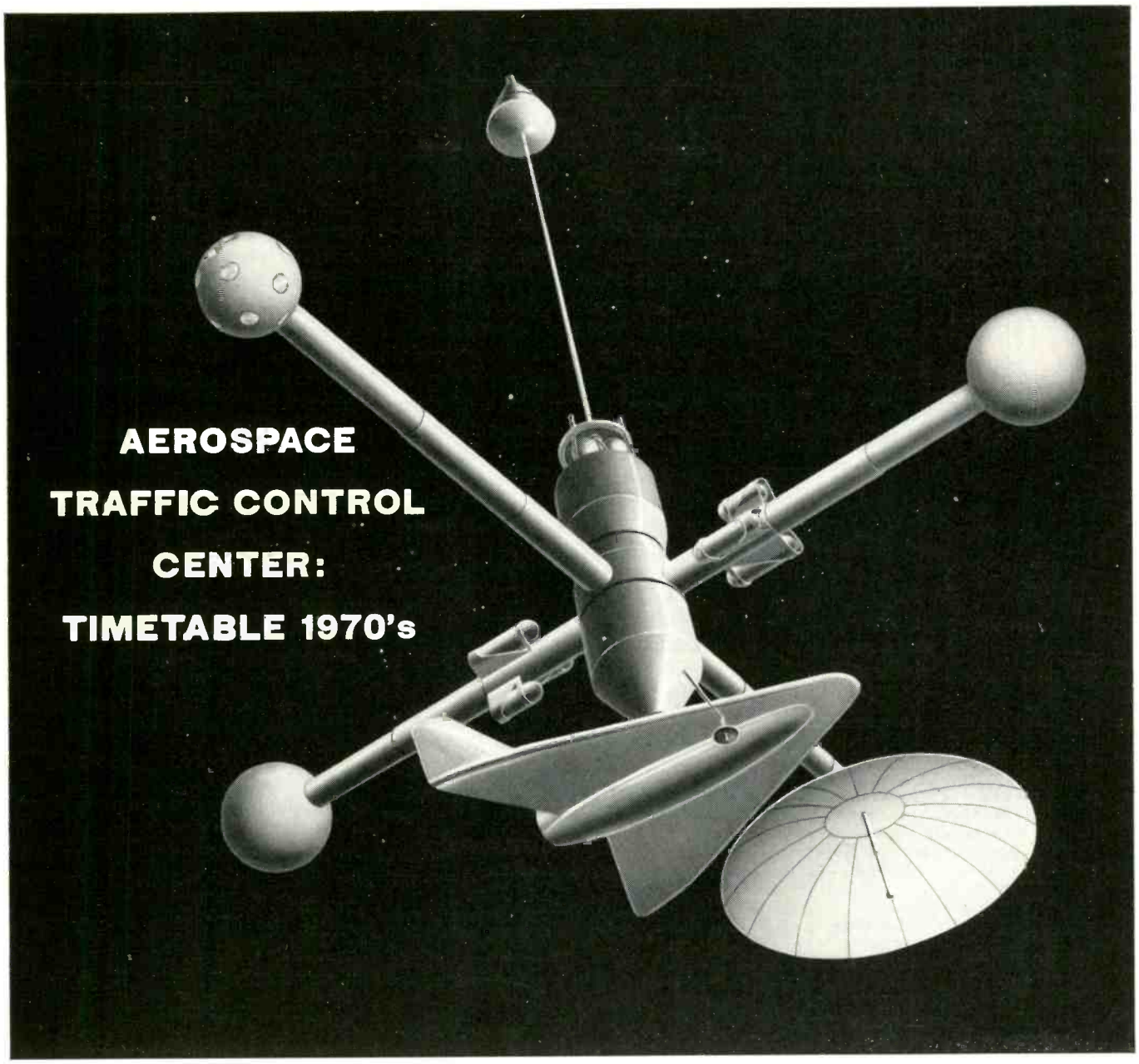
Bridge circuits and voltage divider networks are capable of checking the entire range of values. These circuits feed signals to automatic accept-reject mechanisms which reject unless signalled to accept. This provides foil-safe protection.

The dc bridges have available voltages to check resistors at test voltages prescribed by MIL-R-11. The ac test circuits have available a variable frequency voltage to permit singling out individual components in networks, in addition to checking individual capacitors.

To overcome the slow test rate, an indexing table is used which permits simultaneous testing of all components, and automatic unloading of rejects and good parts. Units are placed in loosely fitting receptacles which automatically position a unit as it is indexed to a test station. The device to be checked at a preselected station becomes part of a bridge or voltage divider network, where it is checked to tolerance. If the part is rejected, it is ejected at this point; if not, it indexes to the next test station.

The cost of building and maintaining standards is eliminated by comparing high limits with pre-set resistor an capacitor decades (a permanent part of the installation); low limits are compared with reference voltages established by pre-set controls.

This approach permits checking components for high and low tolerance simultaneously, and channelling the signal to a common accept-reject mechanism.



A typical example of advanced design by Lockheed-California Spacecraft

Will command centers based in space be an outstanding development in the ten-year span from 1967 to 1977?

The answer at Lockheed-California Company's Spacecraft Organization is—Yes. Proof: the Spacecraft design pictured here. It reflects the maturity developed in our thinking about manned space systems.

The station—aeroscope traffic control center of the 1970's—will be assembled in orbit in a series of pieces brought together by rendezvous techniques. Included: Command center; living quarters; maintenance station; radar and infra-red sensing devices; nuclear power supply; communication links with the earth and other space vehicles. As now planned, 12 people will man the vehicle. Their tour of duty will be measured in weeks.

For four years Lockheed-California Spacecraft has concentrated on the needs of man in space. Activities embrace all fields pertaining to development of complex spacecraft as well as supporting technologies. An operation of such magnitude opens many doors of opportunity.

Scientists and Engineers of outstanding talent and training are needed to develop new Spacecraft, Aircraft, ASW concepts in: Human Factors; Physics (theoretical, plasma, high-energy, solid state, infrared, optics, nuclear); Thermodynamics; Servosystems; Reliability; Guidance and Control; Dynamics; Electronic Systems; Aerospace Ground Equipment; Bioastronautics; Systems Integration and Trade-Off; Space Mechanics; Sub-Systems Synthesis and Analysis; Nuclear, Electric and Liquid Rocket Propulsion; Electronics Research; Hydrodynamics. Send résumé to: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 1405, 2421 N. Hollywood Way, Burbank, California. An equal opportunity employer.

LOCKHEED *CALIFORNIA COMPANY*

A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

Systems and Circuits

SPEED RADAR WARNING devices have been banned in Connecticut and Washington, D. C. New York State is taking steps to ban the warning device also. The device alerts drivers that they are being clocked by a radar speed trap. It is set on the dash or clipped to the sun visor of a vehicle and emits a buzzing noise as a warning. Probably the next civilian countermeasures device may be radiation absorbent material on the front of motor vehicles to prevent a signal return.

NO COMMUNICATIONS WAIVERS for the joint use of fire communications on police frequencies will be granted. The deadline for divorcing fire communications from police systems is October 31, 1963. The FCC says that fire communications must move to their own band or operate with local government radio service.

ULTRASONIC WELDER specifically for electronic applications has been developed by the Sonobond Corp. The welder can perform most of the semiconductor and micro-circuitry bonding applications to which ultrasonic welding should be applied.

LONG-LIVED TWT with a claimed mean-time-before-failure life of 58,000 hours has been developed by RCA's Electron Tube division. Designated A-1245, the tube will be used in NASA's relay communications satellite. It operates from 4050 to 4250 MC.

FIRM RFI PROVISIONS are expected to be written into contract specifications within the next few years. This statement was made by James M. Bridges, Defense Research and Engineering, Pentagon during the RFI panel discussion at the IRE Show. Mr. Bridges said that MIL-STD-446A is a measurement technique, not a standard. Proper measurement standards are needed before strict requirements can be made.

PLASTIC WAVEGUIDES are being offered on a limited basis by the Joclin Manufacturing Co. of Wallingford, Conn. The reinforced plastic is copper plated. In full production the cost will be less than metal guides because of the lower cost of molding plastic shapes. They will also be lighter.

A HIGH-SPEED COMPUTER which wil permit many parallel modes of operation is being built at the Univ. of Illinois.

Dr. James E. Robinson, head of the project, estimates that the memory cycle of the computer will be between 1.8 and 2.1 μs. The computer is a floating point machine, with an add and subtract time of about 2 μs., multiply time of about 8 μs. and divide time 16 μs.

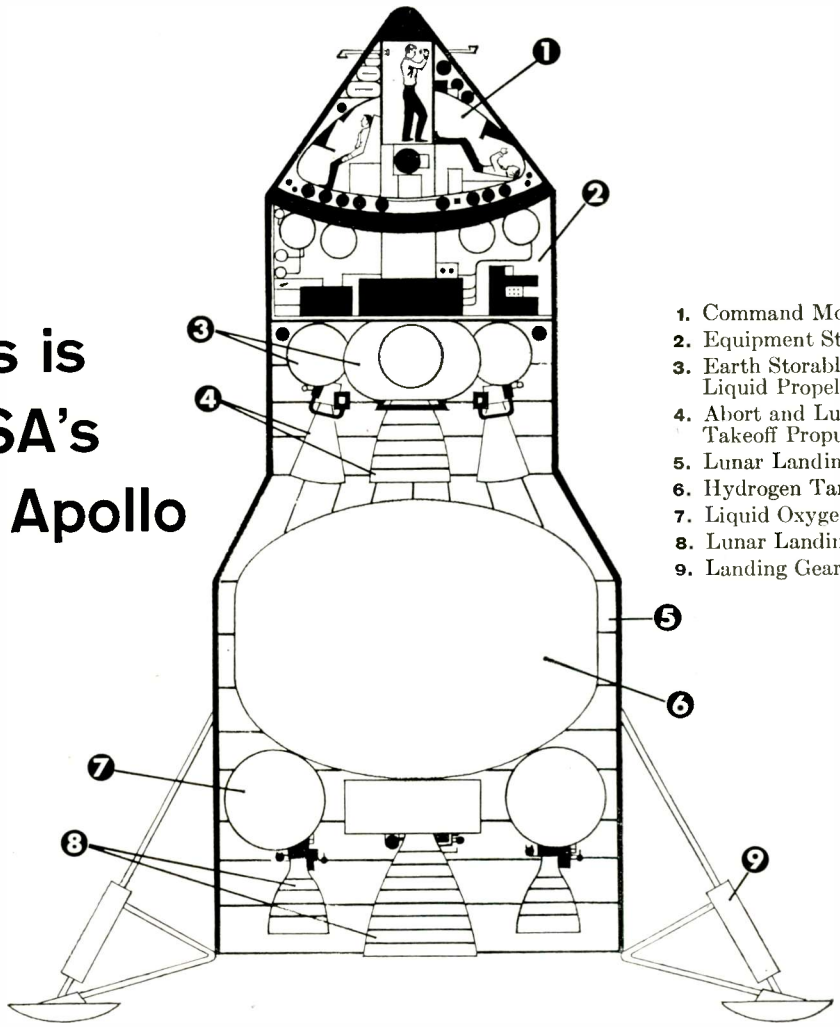
Parallelism is achieved by arithmetic coded in a "base four" way, even though the machine is essentially a binary system; by a separate carry storage system, and by a "look ahead" or "advanced control" feature.

The advanced control feature will allow the computer to do "bookkeeping" as well as some calculating. For example, while making one calculation, it can "look ahead" and take certain data from its memory and prepare it for the next calculating step. Word length of the asynchronous computer is 52 bits.

THE TIROS SERIES of weather satellites have entered their third year of operation. Since the first one was launched in April, 1960, a total of four satellites have been boosted into orbit. Number IV is still transmitting. All told, over 100,000 cloud cover photographs plus much infrared data has been sent back to Earth. Tiros V is scheduled for launch this Spring. By late this year, when NIMBUS (an advanced version weather satellite) is scheduled to orbit, a total of seven Tiros satellites will have been launched.

(*Continued on page* 215)

This is NASA's Project Apollo



1. Command Module
2. Equipment Storage
3. Earth Storable Liquid Propellants
4. Abort and Lunar Takeoff Propulsion
5. Lunar Landing Module
6. Hydrogen Tank
7. Liquid Oxygen Tank
8. Lunar Landing Propulsion
9. Landing Gear

The men of NASA are readying for a journey that will surely be one of the most significant achievements of this century—Project Apollo, the landing of men on the moon and their safe return to earth. It will happen before this decade is over.

The project will proceed in three stages. Before the culminating voyages to the moon, three-man Apollo spacecraft will first orbit the earth for as long as two weeks. Next, spacecraft will head out toward the moon, circle it and return to earth.

The end product of Project Apollo and NASA's other space programs is not just placing a man on the moon, but the release of a flood of knowledge and benefits for mankind through research and development. We will chart the last unexplored sea on the map—the great void of space; we will improve weather forecasting (where even a 10 per cent gain in accuracy would save the nation billions of dollars every year); we have already taken the first steps in establishing a global system of communications satellites; and we may expect new products and new techniques that will stimulate the entire industrial spectrum.

Still, the advances in scientific knowledge hold the exciting promise of much greater returns, far beyond what earthbound man can possibly envision.

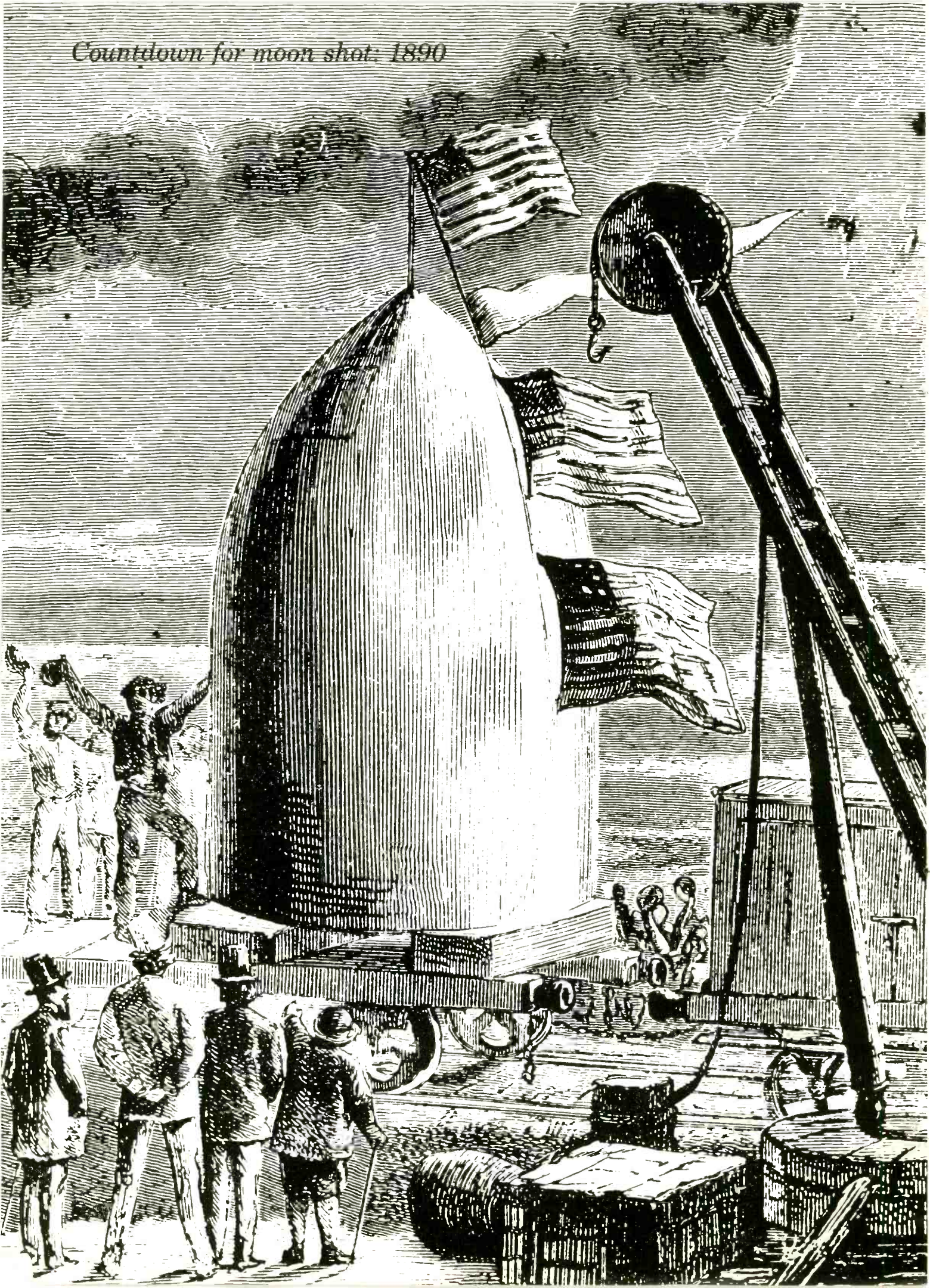
SEND JUST ONE RESUME TO NASA

. . . it will be reproduced and distributed to all appropriate NASA facilities for consideration. You can be sure to play an important role in America's space achievements when you join NASA. Outstanding career opportunities are available in these locales: Washington, D. C. area; Mountain View and Edwards, Calif.; Hampton and Wallops Island, Va.; Cleveland, Ohio; Huntsville, Ala.; Cape Canaveral, Fla.; and Houston, Texas.

Write to: Director, Professional Staffing, Dept. 106, NASA Headquarters, Washington 25, D. C.

AN EQUAL OPPORTUNITY EMPLOYER. POSITIONS ARE FILLED IN ACCORDANCE WITH AERO-SPACE TECHNOLOGY ANNOUNCEMENT 252-B.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION


Countdown for moon shot: 1890

Systems and Circuits

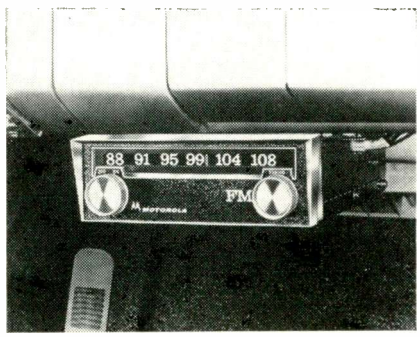
(*Continued from Page 212*)

FCC RULES, PART 21 may be in for an amendment, if Bell System's "BELLBOY" paging system is a success at the Seattle World's Fair. The FCC authorized the Pacific Northwest Bell Telephone Co. to demonstrate the system on a for-hire but developmental basis. This is the first commercial use of the new FM paging system. Up till now Bell has offered a paging service (1-way) on 35MC. Part 21 may be amended to allow 1-way paging on 150MC in the Domestic Public Land Mobile Services section of the frequency spectrum.

DISTANCE MEASURING EQUIPMENT (DME) SYSTEM, which is air-droppable, has been developed by the Martin Co., Baltimore, Md. The system can be used for tracking and locating objects in the water, whether they are on the surface, in the deep ocean, or on the ocean bottom. It can also be used in anti-submarine warfare training exercises.

System consists of an air-droppable, recoverable buoy and a carry-on shipboard electronics package. The buoy includes a salt-water actuated transducer, transmitter, receiver, and a flotation unit. The shipboard package contains a transducer, transmitter, receiver, and recorder.

FM TUNER FOR CAR



Motorola's new model operates through car's existing AM radio system. Chassis features seven tubes, two limiters with its own r-f stage, automatic gain and frequency controls. Suggested retail price is $69.95.

WHITE ROOMS? How big? How clean? RCA has what is believed to be the country's largest controlled environment facility—38,000 sq. ft.—at its Cambridge, Ohio, plant. It's presently being used for Minuteman engineering and production operations. How clean do you want it? Automatic Electric, Northlake, Ill., is not satisfied with "near surgical or operating room cleanliness." They use a clean room within a controlled clean room in the manufacture of micro-miniature relays. And still on the cleanliness degree facet, Unistrut Products Co., Chicago, Ill., will build a room based on your specific requirements—thus preventing over-design or under-design. They have labeled their questionnaire — Ultra-Clean Rooms, Clean Rooms, and Gray Rooms. Finally, it's nice to see clean room operators referring to USAF Spec. T.O. 00-25-203 when they state the characteristics of their facilities. We mentioned the tentative publication of this document over a year ago—in our December 1960 Editorial.

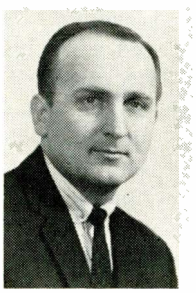
TELEVISED FLUOROSCOPY is not enough for the medical electronic teams operating in the Philadelphia area. In a recent IRE-PGBME meeting, representatives from the Temple Univ. School of Medicine and Philco's Video Products Group, Communications & Weapons Div., described and demonstrated a stereoscopic version. Will color be next? or hi-fi? More seriously, the stereo image orthicon television X-ray equipment was designed by the Philco group for the School's hospital. The system includes a dual X-ray source, a single image intensifier tube, and an optical multiplex arrangement. By this means the two image orthicon television camera tubes obtain the two views necessary to provide an instantaneous three-dimensional, X-ray image of moving objects on a stereoscopic television display.

Industry News

Dr. Gordon S. Brown, Prof. of Electrical Engineering, Massachuestts Institute of Technology, Cambridge, Mass. — appointed to the President's Committee on the National Medal of Science.

Elmer F. Burns—appointed Operations Vice President, Accuracy, Inc., Waltham, Mass.

Clemens J. Czapinski, Jr. — named Manager of Marketing Services, Sola Electric Co., Elk Grove Village, Ill.



C. J. Czapinski, Jr.

R. L. Smallman

Robert L. Smallman — named Director of Marketing, Beckman Instruments, Inc., Fullerton, Calif.

Charles C. Camillo—appointed Vice President, Engineering, FXR, the RF Products and Microwave Div. of Amphenol-Borg Electronics Corp., Danbury, Conn.

Irwin D. Stein — appointed Vice President, Power Designs Inc., Westbury, L. I., N. Y.

R. C. Chase, Vice President and General Manager, Spectrol Electronics Corp. — elected President, Precision Potentiometer Manufacturers Association, Chicago, Ill.

Emanuel Weintraub—elected President, John E. Fast Co., sub. of The Victoreen Instrument Co., Chicago, Ill.

Donald C. Havens, Jr. — appointed East Coast Sales Engineer, Logitron Corp., Garfield, N. J.

Frederick J. Seufert—named Division Manager, Sanders Associates, Inc., Nashua, N. H.

Florida Gears & Systems, Inc., Miami, Fla., announces the following appointments: **R. Walter Bond, Jr.**—promoted to President; **Harry Sweet**—appointed Vice President of Manufacturing; and **Michael Phillips** — appointed Vice President of Research and Engineering.

A. L. Frye—named Technical Director, Paper Products Div., Minnesota Mining and Mfg. Co., St. Paul, Minn.

Dr. Elmer W. Engstrom, President of the Radio Corp. of America, will be awarded the Electronic Industries Association's Medal of Honor for "distinguished service contributing to the advancement of the electronics industry."

Russ B. Walworth—appointed Vice President for Sales, Burnell & Co., Inc., Pelham, N. Y.

Jack W. Sheriff—appointed Director of Marketing, The Daven Co., Livingston, N. J.

J. W. Sheriff

R. A. Featherston

Roger A. Featherston — appointed Vice President and Sales Manager, Kelvin Sales Co., Van Nuys, Calif.

Edward L. Klein—named Executive Vice President, Mepco, Inc., Morristown, N. J.

Herbert D. Bissell — promoted to Vice President, Corporate Marketing, Minneapolis-Honeywell Regulator Co.

Lucien Feldt—appointed Sales Engineer, Rohde & Schwarz Sales Co., Inc., Passaic, N. J.

J. Thomas Scheerle—named Director of Marketing, Ordnance Operation, Avco's Electronics and Ordnance Div., Richmond, Ind.

Ben Stanley—named President and Chief Executive Officer, Teleradio Engineering Corp., New York, N. Y.

Donald T. Spaulding — appointed President, Federal Systems Div., International Business Machines Corp., Rockville, Md.

Transistor Electronics Corp., Minneapolis, Minn., announces the following appointments: **Gerald I. Williams**—appointed Vice President, Tec-Lite Div.; and **Jack F. Pauls**—Vice President Sub-Contract Div.

Donald G. Storck—appointed Director of Industrial and Military Marketing, Dynamic Instrument Corp., Syosset, N. Y.

Marvin D. Lester—named Director of Marketing, El-Tek, Inc., Hawthorne, Calif.

Industry News

Roy A. Olerud—elected President, Custom Components, Inc., Caldwell, N. J.

Hugh J. Daly — appointed Sales Manager, Electronic Laboratories Div., Dorsett Electronics, Inc., Norman, Okla.

Hughes Aircraft Co., Los Angeles, Calif., announced the following appointments: **John W. Black** — Vice President and Manager, Aeronautical Div., Aerospace Group; **Joseph Ferderber**—Vice President and Manager, El Segundo Div., Aerospace Group; **Lester M. Field**—Vice President and Assistant Group Executive, Components Group; **William L. Hoffman**—Vice President, Administration and Materiel, General Offices; **Charles B. Huestis**—Vice President and Treasurer, General Offices; and **John L. Winkel**—Regional Vice President, District Offices.

Augat Inc., Attleboro, Mass., announces the following appointments: **Ralph C. Hoy** — Vice President in Charge of Production; and **Neil F. Damon**—Vice President in Charge of Engineering.

George E. Mobus, formerly Vice President and Sales Manager, Mosley Electronics, Inc., has become an Account Executive and Manager, St. Louis Area Office of Taylor-Crook Associates, Inc., an Industrial Marketing and Advertising firm.

Robert M. Jackson—appointed Manager of Advertising and Sales Promotion, Semiconductor Div., Sylvania Electric Products Inc., Woburn, Mass.

R. M. Jackson

J. R. Jahoda

Joseph R. Jahoda—appointed Vice President, Washington Div., American Electronic Laboratories Inc., Colmar, Pa.

News of Mfrs' Representatives

Representatives Wanted

Manufacturer of low frequency oscillators, frequency standards and inverters, wishes representative in all states except the following: Southeastern Coastal states, New York, Connecticut, Northern New Jersey, California, Wisconsin, Minnesota, Iowa, Michigan, Indiana and Illinois. Box 5-1, Editor, ELECTRONIC INDUSTRIES.

Chairmen Named for ERA '62 Management Institutes

Chairman of the Education Committee of ERA, John Lightner of Lightner Associates has announced the names of the two members who will handle the planning on both the Basic and Advanced ERA Management Institutes. The Institutes are scheduled to run concurrently from **June 10th to 15th, 1962 at the University of Illinois** in Urbana. Chairman of the Basic course will be R. Edward Stemm of R. Edward Stemm, Inc., and Chairman of the Advanced program will be Gordon Gray of Hill & Gray, Inc.

J. F. McElligott with O. F. Masin, Inc. 25 yrs.

February 10, 1962, marked the 25th anniversary of J. F. McElligott's association with the O. F. Masin, Inc. organization. Mr. McElligott is President of the corporation and O. F. Masin is Chairman of the Board.

Rene A. Marcott — formerly with Industrial Reactor Laboratories, has joined QED Electronic Sales Corp., in charge of their Suffolk County, Long Island sales territory.

Penzner Sales Co., Overland Park, Kansas — named sales representative for G. B. Components, Van Nuys, Calif., to cover Missouri, Kansas, Nebraska, and Central and Western Iowa.

L. G. White Co., Silver Spring, Md. —named representative for Packard Bell Computer Corp., Los Angeles, Calif., to cover Maryland, West Virginia, Washington, D. C., Virginia, Eastern Pennsylvania, Southern New Jersey, Delaware, North and South Carolina, and Eastern Tennessee.

Electronic Manufacturers Consultants, Inc., 226 E. Vermijo, Colorado Springs, Colo., has been formed as manufacturer's representatives to cover Colorado, Utah, Arizona, New Mexico, and Wyoming. Principals of the company are Paul Hale, formerly with Columbia Broadcasting System Inc., and Earnest Clemons, of Rocket Electronics of Colorado Springs.

ELECTRONIC INDUSTRIES Advertisers—May 1962

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SPECIAL PURPOSE TUBES

OA2	.80	4-65A	10.00	25Z6WGT	1.50	725A	10.00
OA2WA	2.00	4-125A	20.00	26Z5W	1.50	726A	5.00
OA3	.85	4-250A	32.50	FG-27A	20.00	726B	5.00
OB2	.60	4-400A	30.00	28D7W	3.50	726C	8.50
OB2WA	2.00	4-1000A	85.00	FG-32	6.50	NL-760	20.00
OB3	.70	4AP10	10.00	35T	10.00	802	5.00
OC3	.50	4B31	12.50	35TG	1.50	803	3.50
OD3	.30	4C27	7.50	FP-54	100.00	804	15.00
C1A	7.50	4C35	15.00	FG-57	6.00	805	7.50
1AD4	1.50	4CX250B	30.00	RK-60/1641	1.25	807	1.35
1B24A	12.50	4D32	15.00	HY-69	3.00	807W	1.75
1B35A	3.00	4E27	10.00	BL-75	3.00	808	2.50
1B63A	10.00	4J32	100.00	TG-77	7.50	809	5.00
1C/3B22	5.00	4J34	100.00	HF-100	10.00	810	15.00
C1K	7.50	4J50	100.00	100TH	12.00	811	2.50
1P21	32.50	4J52	35.00	100TL	12.00	811A	4.00
1P22	8.00	4RR60A	50.00	FG-105	25.00	812A	4.75
1P25	10.00	4X150A	15.00	F-123A	5.00	813	12.50
1P28	15.00	4X150D	15.00	FG-172	25.00	814	3.50
1Z2	1.50	4X150G	25.00	211	2.50	815	2.50
2-01C	12.50	4X250B	25.00	212E	25.00	816	2.25
2AP1A	7.50	4X250F	30.00	FG-235	40.00	828	3.50
2B23	20.00	5BP1A	9.50	242C	10.00	828	12.50
2BP1	8.50	5C22	17.50	244A	3.50	829B	9.50
2C36	22.50	5CP1A	9.50	245A	3.50	832	2.50
2C39A	9.75	5CP7A	9.50	249B	10.00	832A	7.50
2C39B	15.00	5D21	7.50	249C	5.00	833A	37.50
2C40	7.50	5J26	50.00	250R	10.00	834	7.50
2C42	3.00	5LP1	7.50	250TH	25.00	836	2.50
2C43	7.50	5R4GY	1.10	251A	50.00	837	1.00
2C46	5.00	5R4WGA	5.00	254A	3.50	838	1.00
2C50	4.00	5R4WGB	6.00	FG-258A	75.00	842	7.50
2C51	1.50	5R4WGY	2.75	259A	3.50	845	7.50
2C52	1.50	5RP1A	9.50	262B	3.50	849	75.00
2C53	7.50	5Y3WGT	1.25	267B	5.00	851	35.00
2D21	.50	5Y3WGTB	3.00	271A	12.50	866A	1.90
2D21W	1.00	6AC7W	.50	274A	3.50	869B	50.00
2E22	2.50	6AC7WA	2.00	283A	3.00	872A	5.00
2E24	2.25	6AG5WA	1.50	287A	3.50	874	.75
2E26	2.50	6AG7Y	1.00	QK-288	250.00	884	1.25
2J42	75.00	6AK5W	1.25	HF-300	35.00	885	.85
2J51	50.00	6AK5 (WE)	.75	300B	5.00	889RA	150.00
2J55	90.00	6AL5W	.60	304TH	35.00	891R	200.00
2K22	25.00	6AN5	1.75	304TL	35.00	902-P1	3.50
2K25	8.50	6AN8WA	3.50	307A	.50	913	9.50
2K26	35.00	6AQ5W	1.00	310A	3.50	920	2.50
2K28	30.00	6AR6	.75	311A	3.50	927	1.50
2K29	25.00	6AS6	.85	313C	1.50	931A	3.50
2K30	50.00	6AS6W	1.00	323A	6.00	1000T	80.00
2K33A	200.00	6AS7G	2.50	328A	3.50	R1130B	10.00
2K34	75.00	6AU6WA	1.25	329A	4.50	1500T	150.00
2K35	200.00	6B4G	3.35	336A	2.50	1611	2.00
2K39	150.00	6BA6W	.75	337A	3.50	1614	2.75
2K41	50.00	6BE6W	1.50	347A	1.00	1616	1.00
2K42	125.00	6BH6W	2.75	348A	4.50	1620	4.00
2K43	175.00	6BL8	20.00	349A	3.50	1624	1.00
2K44	125.00	6BM6	25.00	350A	3.50	1625	.50
2K45	20.00	6BM6A	30.00	350B	2.50	1846	50.00
2K47	150.00	6C4W	2.50	352A	8.50	1855	250.00
2K48	50.00	6C4WA	1.00	354A	12.50	2050	1.25
2K50	100.00	6C21	17.50	355A	12.50	ZB-3200	100.00
2K54	10.00	6D4	1.50	371B	2.50	5528/C6L	3.50
2K55	15.00	6F4	3.50	388A	2.00	5545	20.00
2K56	50.00	C6J	10.00	393A	5.00	5550	30.00
2P21	40.00	C6J/A	15.00	394A	3.00	5552/FG235	50.00
2X2A	1.00	C6J/K	20.00	395A	2.25	5553/FG258	75.00
3A5	.75	6J4	1.50	396A/2C51	1.50	5557/FG17	5.00
3AP1	3.50	6J4WA	2.50	398A/5603	3.00	5558/FG32	6.50
3B24W	3.00	6J6W	.60	401A/5590	1.00	5559/FG57	8.00
3B24WA	5.00	6J6WA	1.00	403B/5591	3.00	5560/FG95	20.00
3B25	2.50	6K4	2.00	404A/5847	7.50	5561/FG104	40.00
3B26	2.25	6L6GAY	.75	407A	3.75	5586	150.00
3B28	3.00	6L6WGA	1.50	408A/6028	3.25	5636	2.25
3B29	5.00	6L6WGB	2.50	409A/6AS6	1.00	5642	2.00
3BP1A	5.00	6Q5G	2.50	410R	75.00	5643	3.00
3C/4B24	4.00	6SJ7WGT	1.25	416B/6280	35.00	5647	3.50
3C22	25.00	8SK7W	.75	417A/5842	9.50	5651	.75
3C23	4.00	8SK7WA	2.00	418A	9.50	5654/6AK5W	1.50
3C24/24G	7.50	8SL7WGT	1.00	420A/5755	5.00	5656	5.00
3C33	7.50	8SN7W	.50	421A/5998	7.50	5663	1.00
3C45	3.50	6SN7WGT	1.00	429A	6.50	5665/C16J	35.00
3CX100A5	17.50	6SN7WGTA	2.50	GL-434A	7.50	5670	1.00
3D21A	2.50	6SU7GTY	.85	450TH	40.00	5672	1.35
3D22	8.00	6V6GTY	1.00	450TL	40.00	5675	8.50
3DP1A	5.00	8X4W	.75	575A	15.00	5678	1.25
3E29	7.50	6X4WA	1.50	578	5.00	5686	2.25
3GP1	1.50	6X5WGT	1.00	KU-610	5.00	5687	1.50
C3J	7.50	SRL7F	100.00	NL-623	8.50	5691	5.00
C3J/A	9.50	SRL7H	100.00	631-P1	5.00	5692	2.50
3J21	35.00	7AK7	2.50	673	15.00	5693	3.50
3J31	50.00	7MP7	22.50	678	30.00	5696	.75
3JP1	5.00	10KP7	15.00	677	40.00	5720/FG33	17.50
3K21	125.00	12AT7WA	1.50	701A	5.00	5721	110.00
3K22	125.00	12AU7WA	1.50	703A	1.50	5725/6AS6W	1.50
3K23	200.00	12AX7W	1.35	707B	2.50	5726/6AL5W	.75
3K27	150.00	12AY7	1.00	NL-710	9.75	5727/2D21W	1.25
3K30	100.00	C16J	25.00	715C	15.00	5728/FG67	10.00
3KP1	9.75	FG-17	5.00	719A	12.50	5749/6BA6W	.75
3RP1	7.50	HK-24	5.00	721B	5.00	5750/6BE6W	1.50
3WP1	12.50	25T	10.00	723A/B	3.50	5751/12AX7W	1.35
						5751WA	2.00
						5763	1.75
						5777	150.00
						5778	150.00
						5783	2.25
						5787	2.50
						5796	8.00
						5800/VX-41	7.50
						5803/VX-55	5.00
						5814A	1.35
						5829	1.00
						5830/FG41	100.00
						5836	50.00
						5837	50.00
						5840	2.50
						5845	6.00
						5852	5.00
						5876	8.50
						5879	1.25
						5881/6L6WGB	2.50
						5886	4.00
						5894	18.85
						5915	1.00
						5931/5U4WG	4.00
						5933/807W	2.50
						5948/1754	100.00
						5949/1907	50.00
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						5964	.85
						5965	.85
						5676	50.00
						5992	5.00
						5993	5.00
						6002/QK221	250.00
						6005/6AQ5W	1.50
						6012	4.00
						6021A	2.00
						6027/2J42A	100.00
						6032	10.00
						6037/QK243	50.00
						6045	1.15
						6072	1.50
						6073	1.50
						6074	1.75
						6080	3.35
						6080WA	5.00
						6080WB	12.50
						6082	2.50
						6087/5Y3WGTB	3.00
						6101/6J6WA	1.50
						6115/QK351	50.00
						6130/3C45	6.50
						6136/6AU6WA	1.25
						6146	3.00
						6159	3.50
						6161	35.00
						6186/6AG5WA	1.50
						6189/12AU7WA	1.50
						6197	1.75
						6201/12AT7WA	1.85
						6202/6X4WA	1.50
						6211	.75
						6216	3.00
						6233	100.00
						6236	125.00
						6248	500.00
						6263	9.00
						6264	9.00
						6265/6BH6W	2.75
						6299	37.50
						6316/BL800A	100.00
						6322/BL25	15.00
						6336	8.75
						6336A	12.75
						6344/QK235	500.00
						6352	7.50
						6385	6.00
						6390	125.00
						6394	10.00
						6438	5.00
						6463	1.00
						6485	1.50
						6517/QK358	500.00
						6533	5.00
						6542	5.75
						6550	3.00
						6807	20.00
						6897	20.00
						7034/4X150A	15.00
						7044	1.50
						7580	35.00
						8002R	25.00
						8005	7.50
						8008	7.75
						8013A	5.00
						8014A	30.00
						8020	4.50
						8025A	7.50
						9003	2.00
						9005	3.00

ALL TUBES ARE NEW, INDIVIDUALLY CARTONED, FULLY GUARANTEED

Prices are FOB shipping point

western engineers

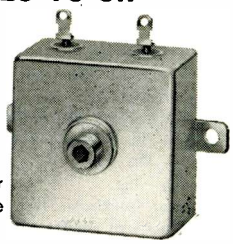
ELK GROVE, CALIFORNIA

SUPPLIERS OF ELECTRON TUBES SINCE 1932

Orders for less than $10 cannot be processed

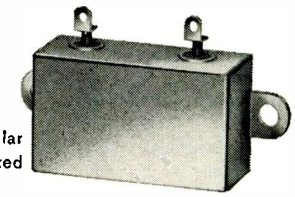
PRECISION CAPACITORS—

TOLERANCES TO 0.1%



Rectangular Adjustable

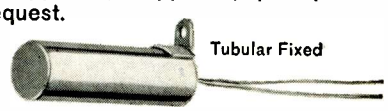
EAI precision capacitors—fixed or adjustable—are available in tolerances of ±0.1% or better and with stability closer than ±.01% over operating temperature range. These unusually high standards result from EAI's specialized manufacturing know-how which includes the ability to measure capacity to accuracies of .005% and dielectric absorption to any circuit requirements.



Rectangular Fixed

TYPICAL SPECIFICATIONS:
PS521—Polystyrene Dielectric

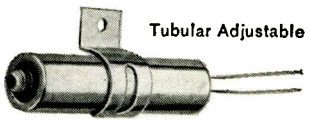
Capacitance Range: .001 mfd to 10 mfd.
Tolerance: ±5% is standard, ±2%, ±1%, and ±0.1% on request.
Stability: Better than .01%.
Dielectric Absorption: Less than .01%.
Construction: Non-inductive.
Temperature Range: -55°C. to +85°C.
Insulation Resistance: 10^{12} ohm/mfd, minimum.
Capacitance Charge: 110 ppm/°c ±10 ppm/°c; ±5 ppm/°c, upon special request.



Tubular Fixed

M521—Mylar Dielectric

Capacitance Range: .001 mfd to 10 mfd.
Tolerance: ±5% is standard, ±10%, ±1%, ±0.5% or closer on request.
Construction: Non-inductive. Sealed under inert gas.
Temperature Range: -60°C to +150°C.
Insulation Resistance: 10^{11} ohm/mfd, minimum.



Tubular Adjustable

EAI production facilities can provide capacitors of virtually any tolerance or stability in temperature ranges in excess of 200°C. Write describing your requirements. Additional data is available by writing to Components Department.

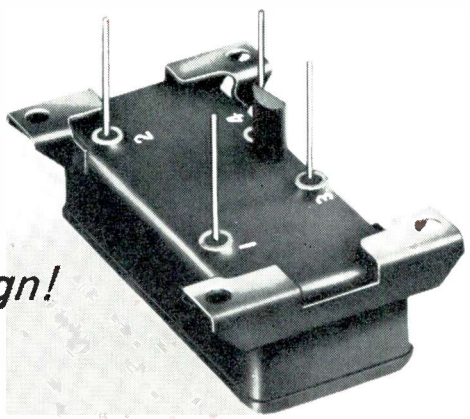
EAI

ELECTRONIC ASSOCIATES, INC.
Long Branch, New Jersey

Circle 16 on Inquiry Card

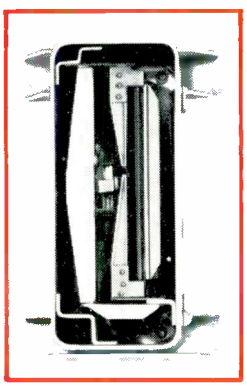
The most precise, sturdiest thermal relay ever built

. . . from the leader in thermal relay design!



Now, for missile environments and for all applications where greater precision is necessary, G-V Controls offers the revolutionary new PT Thermal Relay—the most **precise** thermal relay ever built!

And the PT's **sturdiness** is unequalled in thermal relays. It withstands missile vibration and shock far better than any other thermal relay.



SPECIFICATIONS

Time Delay: 3 to 60 seconds (Factory Set)
Setting Tolerance: ±5% (±¼ sec. min.)
Temperature Compensation: Within ±5% over —65°C. to +125°C. range (±¼ sec. min.)
Heater Voltages: 6.3 to 115 v. for delays up to 12 sec.; 6.3 to 230 v. for longer delays.
Power Input: 4 watts. Rated for continuous energization at 125°C.
Contacts: SPST, normally open or normally closed. Rated 2 amps. resistive at 115 v. AC or 28 v. DC.

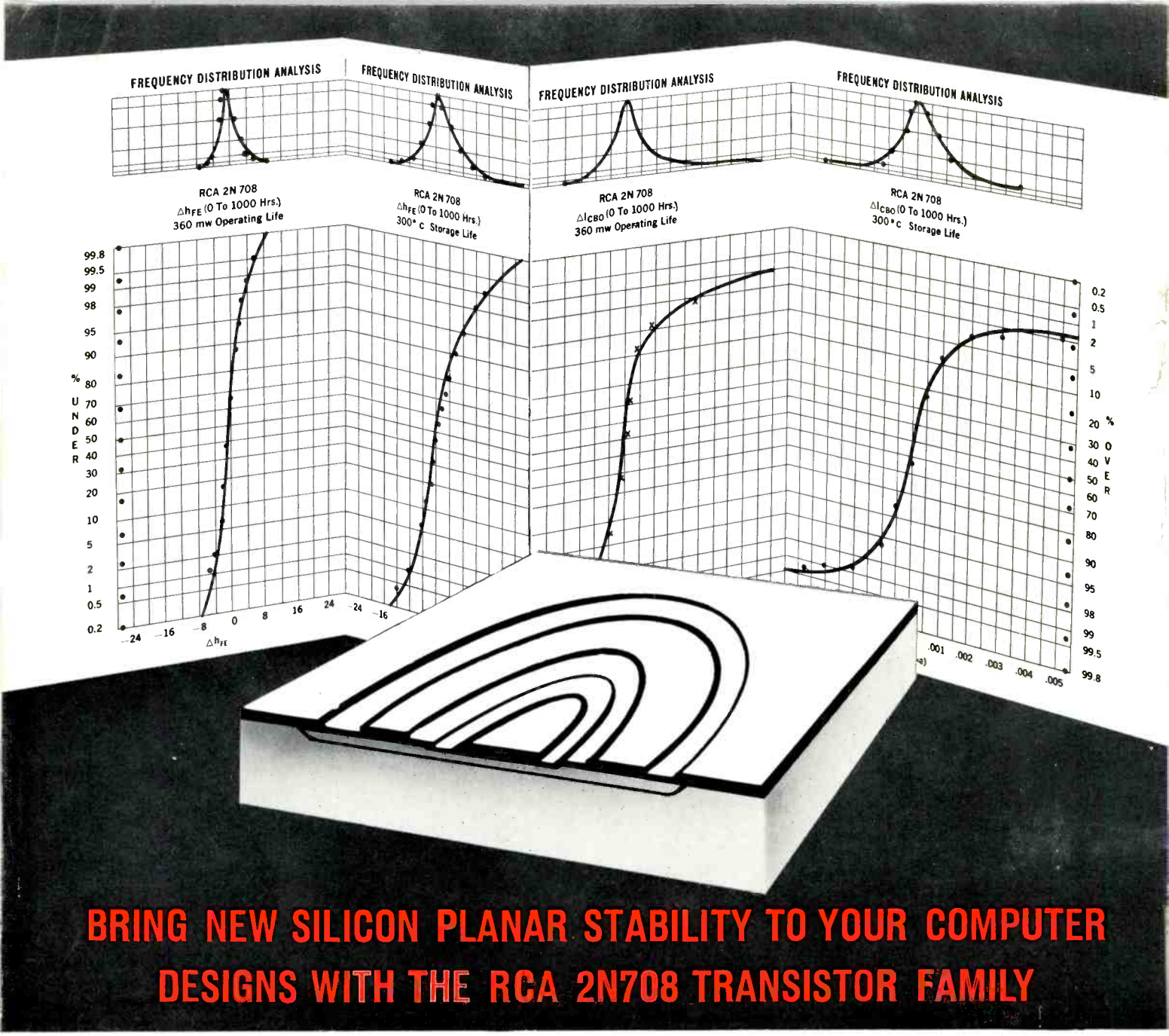
Write for Product Data Bulletin #PD-1D15

Insulation Resistance: 1,000 megohms
Dielectric Strength: 1000 v. RMS at sea level. 500 v. RMS at 70,000 ft.
Vibration: Operating or non-operating, 20 g up to 2000 cps
Shock: Operating or non-operating, 50 g for 11 milliseconds
Unidirectional Acceleration: 10 g in any direction changes delay by less than 5%, 50 g by less than 10% with proper orientation.
Weight: 2 to 2¼ ounces.

G-V CONTROLS INC.
Livingston, New Jersey

G-V®

Circle 157 on Inquiry Card



BRING NEW SILICON PLANAR STABILITY TO YOUR COMPUTER DESIGNS WITH THE RCA 2N708 TRANSISTOR FAMILY

All RCA 2N708, 2N706 and 2N706A silicon transistors—now in planar construction to assure a new degree of stability and reliability for your high-speed switching applications

Here's proof of the outstanding stability you get from RCA's 2N708 family. Check these curves which summarize the results of RCA production lot acceptance tests—a dramatic presentation of the actual production lot stability of the RCA 2N708.

In addition, here are some of the other outstanding advantages these high-speed silicon planar computer transistors will bring to your designs:

- Reduced collector cutoff current...by as much as 20 to 1 over mesa types.
- Uniform Beta over wide current range.
- Storage temperatures up to 300°C.

RCA 2N708: Proved high-reliability for very-high-speed saturated switching and high frequency amplifier applications in military and industrial equipment—designed to offer the full advantages of planar construction in low I_{CBO} and in beta stability.

RCA 2N706: Very high speed silicon planar switching transistor designed to meet MIL Specifications, field proved in a wide range of switching applications and backed by a long history of life data.

RCA 2N706A: Improved version of 2N706 for more stringent high speed applications requiring lower collector capacitance and storage time.

Call your RCA Representative today for complete reliability information on RCA 2N708 silicon planar transistors. For additional technical information write RCA Semiconductor and Materials Division. Commercial Engineering, Section E-50-NN, Somerville, N.J.

RCA HIGH-SPEED EPITAXIAL TRANSISTORS

RCA 2N1708: First silicon planar-epitaxial computer transistor in the TO-46 package for very high-speed switching applications in data-processing equipment.

RCA 2N2205: Identical electrically to the 2N1708, this very high-speed planar-epitaxial type is in the JEDEC TO-18 package.

RCA 2N2206: In the JEDEC TO-46 miniature package, this high-beta version of the 2N1708 features a minimum beta of 40 and storage time of 35 nsec. max.

Now available from RCA...2N834 and 2N914

RCA® **The Most Trusted Name in Electronics**