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electronics

engineering issue

Transistors Fix Heart Block ...p 80

Autos Enter Electronic Era

...page 73

electronics engineering issue

A McGRAW-HILL PUBLICATION • VOL. 31, NO. 47 • NOVEMBER 21, 1958

Issue at a Glance

DIGEST CONTINUED ON NEXT PAGE

DIGEST continued

electronics

Nov. 21, 1958 Vol. 31, No. 47

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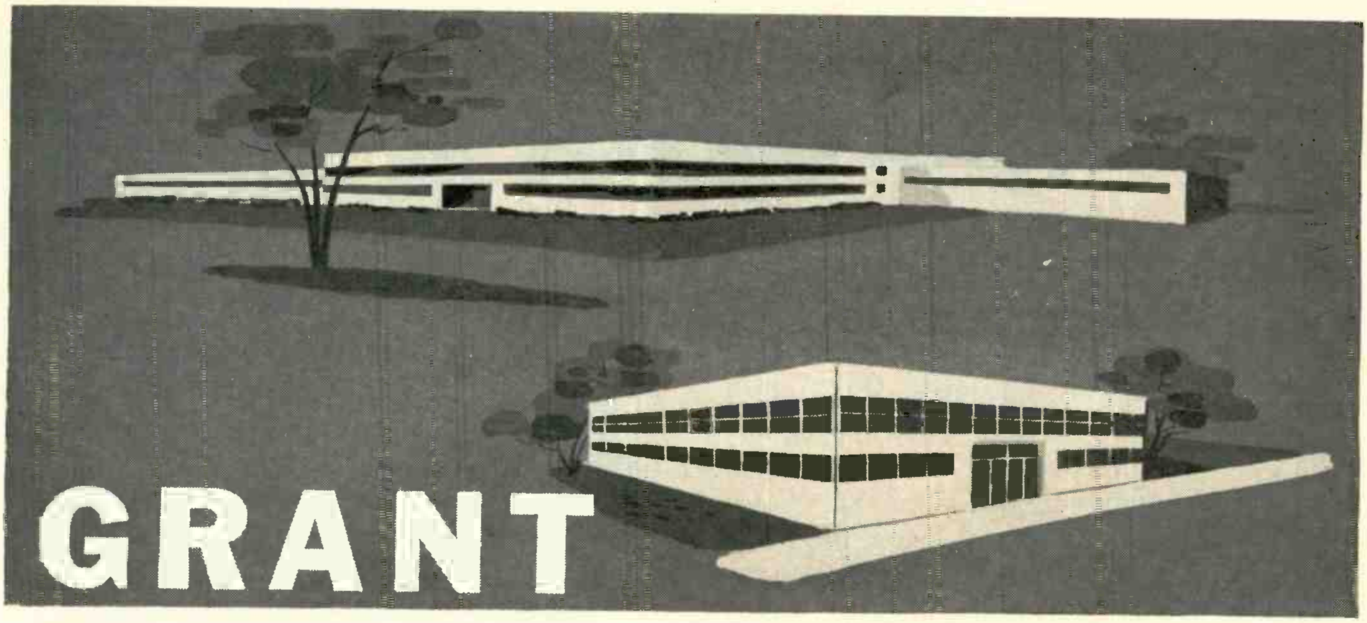

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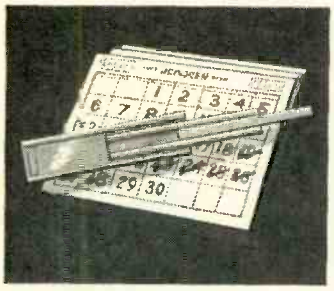

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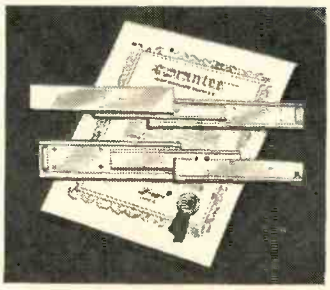

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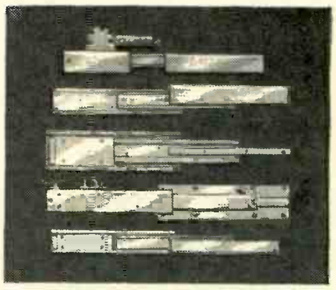

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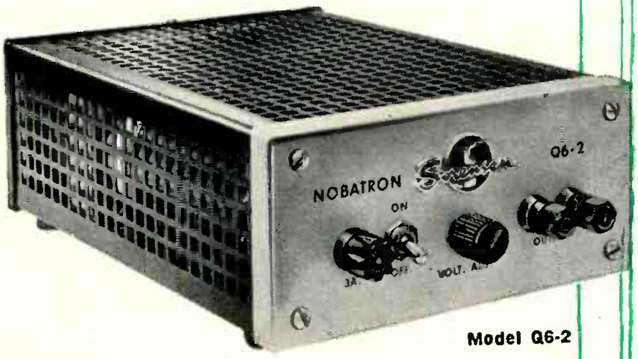

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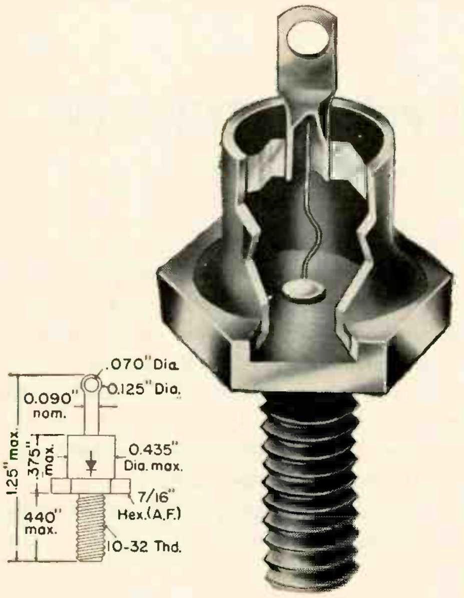
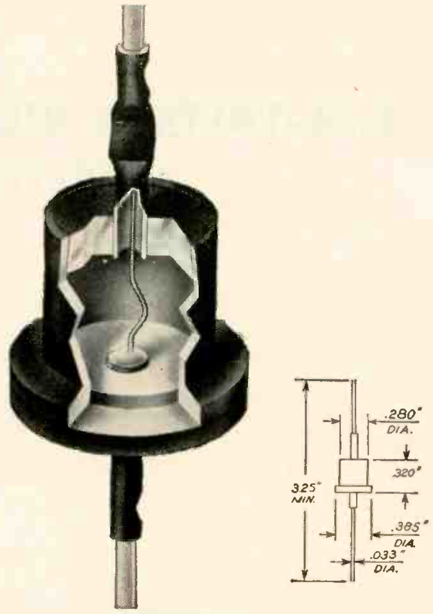


TYPE	Peak Operating Voltage −65°C to + 165°C Volts	Ave. Rectified Current 25°C Amps.	150°C Amps.	Reverse Current (Max.) at Specified PIV, 25°C µA
1N253	95*	3.0	1.0*	10
1N254	190*	1.5	0.4*	10
1N255	380*	1.5	0.4*	10
1N256	570*	0.95	0.2*	20
CK846	100	3.5	1.0	2
CK847	200	3.5	1.0	2
CK848	300	3.5	1.0	2
CK849	400	3.5	1.0	2
CK850	500	3.5	1.0	2
CK851	600	3.5	1.0	2

1N253 through 1N256 available to MIL specifications. *to +135°C

WIRE-IN-TYPE



TYPE	Peak Operating Voltage −65°C to +165°C Volts	Ave. Rectified Current 25°C mA	150°C mA	Reverse Current (Max.) at Specified PIV, 150°C mA
1N536	50	750	250	0.40
1N537	100	750	250	0.40
1N538	200	750	250	0.30
1N539	300	750	250	0.30
1N540	400	750	250	0.30
1N1095	500	750	250	0.30
1N547†	600	750	250	0.35

1N538, 1N540, 1N547 available to MIL specifications. †Same as 1N1096

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ELECTRONICS NEWSLETTER

ARMY will start testing next spring at Laplata, Md., a "tapered aperture horn antenna" that will be 844 ft long, 506 ft wide and 253 ft high. Design, says the Army Signal Corps, is a radical break with conventional curtain antennas. It was developed by Developmental Engineering Corp. for the Army's strategic long-range communications circuits, with particular emphasis on anti-jamming characteristics.

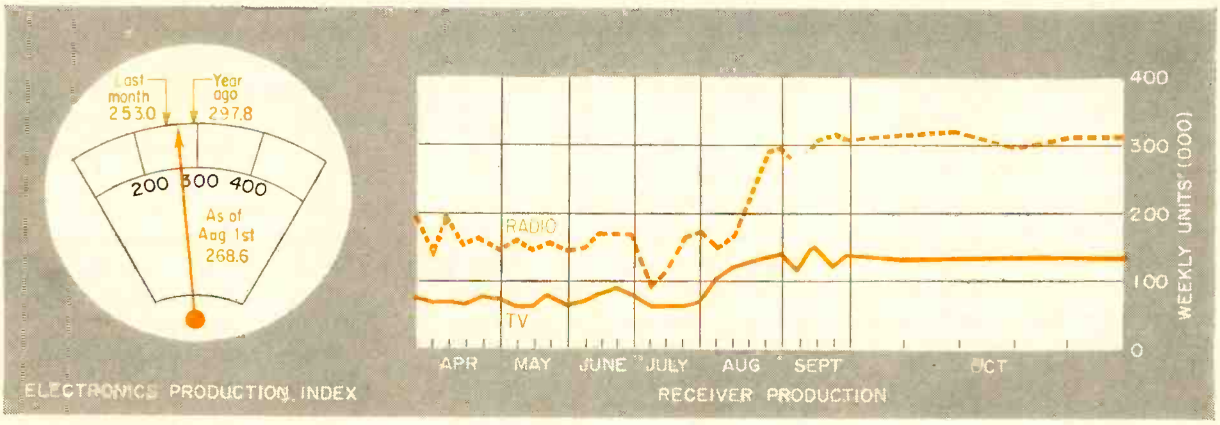
DATA HANDLING systems on order by savings banks will be transistorized by 1960, Teleregister Corp. tells ELECTRONICS. Firm says three eastern banks that had ordered systems using tubes and magnetic drum memories have agreed to wait two years for the new equipment. Systems planned are on-line; they will process deposit and withdrawal transactions as they take place.

MANNED SPACE CAPSULE CONTRACT may be awarded after January 1, 1959, according to the National Aeronautics and Space Administration. NASA was host earlier this month to 38 firms for a discussion of preliminary specifications. They were invited to submit proposals for long-term development of a space capsule suitable for manned satellite flight.

SPACEBORNE magnetic tape recorder, small enough to be held in one hand but able to store three million pieces of data, has been announced. Lockheed Missile Systems division, the developer, said the device could record and store vital data when a spacecraft was out of radio contact with the earth and then, on command, unload the information in one-sixth the time it takes to record it.

GOVERNMENT demand for data processing systems is growing, with strong emphasis on information storing and retrieval units. This was reported at the recent 1958 Computer Application Symposium in Chicago sponsored by the Armour Research Foundation. At the end of last year some 120 systems were reportedly in use by the U. S. Government, involving about $30 million in annual rentals and $9 million worth of purchased equipment. As of last June, more than 150 data systems were in the approved or advanced planning stages.

TWELVE COMPUTER CENTERS are being established for university scientists on a regional basis by the National Science Foundation. Fiscal '59 budget of NSF includes $1.5 million for university computing facilities, and the agency expects the program to run two additional years. First center will be set up at the University of North Carolina with a $500,000 grant for purchase of a Univac 1105.



FIGURES OF THE WEEK

RECEIVER PRODUCTION

(Source: EIA)	Oct. 31, '58	Oct. 24, '58	Nov. 1, '57
Television sets, total	121,465	121,267	152,306
Radio sets, total	306,977	310,148	399,196
Auto sets	56,071	75,073	131,327

STOCK PRICE AVERAGES

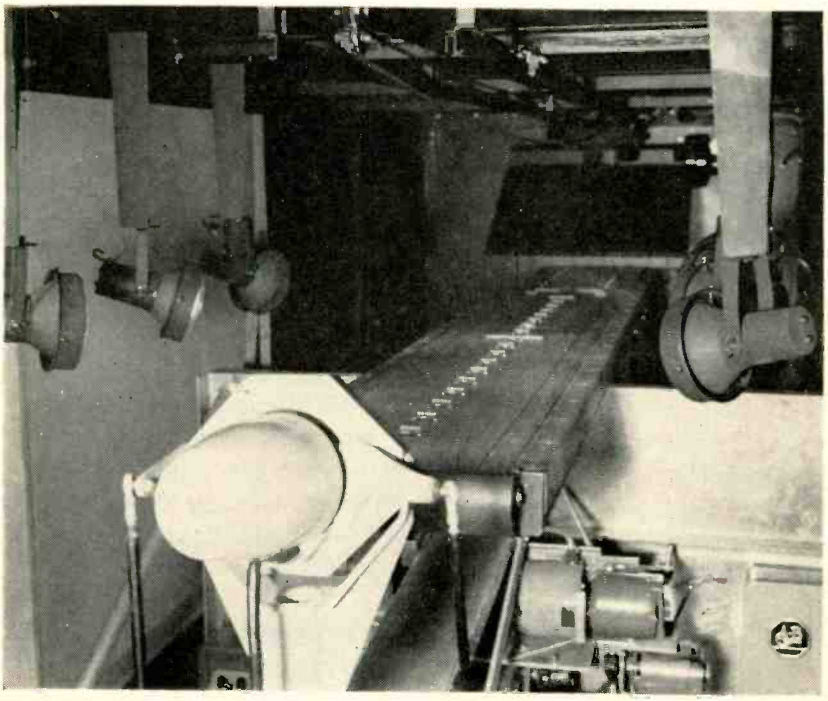
(Source: Standard & Poor's)	Nov. 5, '58	Oct. 29, '58	Nov. 6, '57
Radio-tv & electronics	66.41	62.99	41.79
Radio broadcasters	77.48	73.39	50.79

FIGURES OF THE YEAR

Totals for first nine months

	1958	1957	Percent Change
Receiving tube sales	291,718,000	341,663,000	—14.6
Transistor sales	30,387,277	18,842,300	+61.3
Cathode-ray tube sales	5,844,665	7,308,552	—20.0
Television set production	3,572,189	4,589,164	—22.2
Radio set production	8,178,821	10,764,454	—24.0
TV set sales	3,468,090	4,452,041	—22.1
Radio set sales (excl. auto)	4,903,676	5,840,372	—16.0

MORE FIGURES NEXT PAGE



Tv camera picks up model of airport runway lighting, projects to pilot in trainer

Tv Aids Airport Simulation

COMBINATION of flight-trainer techniques and industrial television is helping Airways Modernization Board check out proposed systems for runway and approach lighting.

Approach, landing and takeoff simulator, built for AMB by Doman Helicopter, was unveiled late last month at National Aviation facilities Experimental Center in Atlantic City, N. J.

Simulator, dubbed Dalto, is made up of three major subsystems. Curtiss-Wright P3A part-task trainer (which "flies" like a B-25) is one end of the system. The other is a 57-ft-3-in. moving belt on which various runway lighting configurations are set up. Connecting the two is a television system provided by General Precision Laboratories.

Runway lights are simulated by raised fluorescent dots which are illuminated by ultraviolet light. Strobe beacons are simulated by a row of small neon bulbs which are flashed by a set of commutating contacts under the belt.

Belt movement is controlled by the trainer, simulating craft's ground speed. The camera (foreground in the picture) is also slaved to the trainer through three synchro channels, providing azimuth, roll and pitch. Curtiss-Wright developed the conversion kit that slaves the camera and belt to the trainer.

A translucent filter (background in the picture) simulates conditions of fog, haze and other weather. Forward visibility can be varied from 300 to 2,600 ft. Aircraft altitude of 0 to 300 ft can be simulated; if the craft is higher, the pilot sees no picture at all.

The picture as seen by the camera is projected onto a 10-by-10-ft screen in front of the trainer, where the pilot sees it through his windscreen. The 57 ft of belt provide 17,000 ft of airspace—3,000 ft of approach, 10,500 ft of runway, and the rest black. First use will be to check out five different lighting configurations now under consideration. Actual pilot "touchdowns" and pilot opinion will both be considered in evaluating the patterns.

The Dalto system, excluding the trainer and conversion kit, sells for "under $50,000." The conversion kit costs in the neighborhood of $7,500.

Soviet Discloses Lunar Probe Gear

SOVIET LUNAR probe instrumentation was recently disclosed by a Danish Communist newspaper which quoted Moscow Planetarium scientist Vitaliy Bronshten.

Bronshten told the paper that Soviet scientists were working energetically on a moon rocket which they expect to fire soon, that the rocket would be similar in size to the Sputnik II rocket, weighing about a half ton, and that two rocket variations were being readied.

He said one was intended to land on the moon, the other to orbit the moon and return to earth.

The Russian was quoted as enumerating these instruments:

- Gear for determining the moon's mass and conductivity of heat and electricity.
- Apparatus for investigating the moon's surface and discovering

(Continued on p 12)

TRANSISTOR AND TUBE SALES, MONTHLY

(Source: EIA)	Sept., '58	Aug., '58	Sept., '57
Transistors, units	5,076,443	4,226,616	3,231,000
Transistors, value	$10,811,412	$9,975,935	$6,993,000
Receiving tubes, units	40,061,000	30,456,000	44,382,000
Receiving tubes, value	$33,951,000	$25,442,000	$35,545,000
Picture tubes, units	891,803	713,458	1,071,662
Picture tubes, value	$17,704,289	$14,190,878	$20,819,036

EMPLOYMENT AND EARNINGS

(Source: Bur. Labor Statistics)	Aug. '58	July, '58	Aug. '57
Prod. workers, comm. equip.	354,900	340,600	409,800
Av. wkly. earnings, comm.	$82.39	$80.75	$77.81
Av. wkly. earnings, radio	$81.40	$80.39	$75.81
Av. wkly. hours, comm.	39.8	39.2	39.9
Av. wkly. hours, radio	39.9	39.6	39.9

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Electrical Overload Protection . . . Magnetic circuit breaker, front panel mounted. Unit cannot be injured by short circuit or overload.

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Size . . . . 3½" H x 19" W x 14⅜" D.

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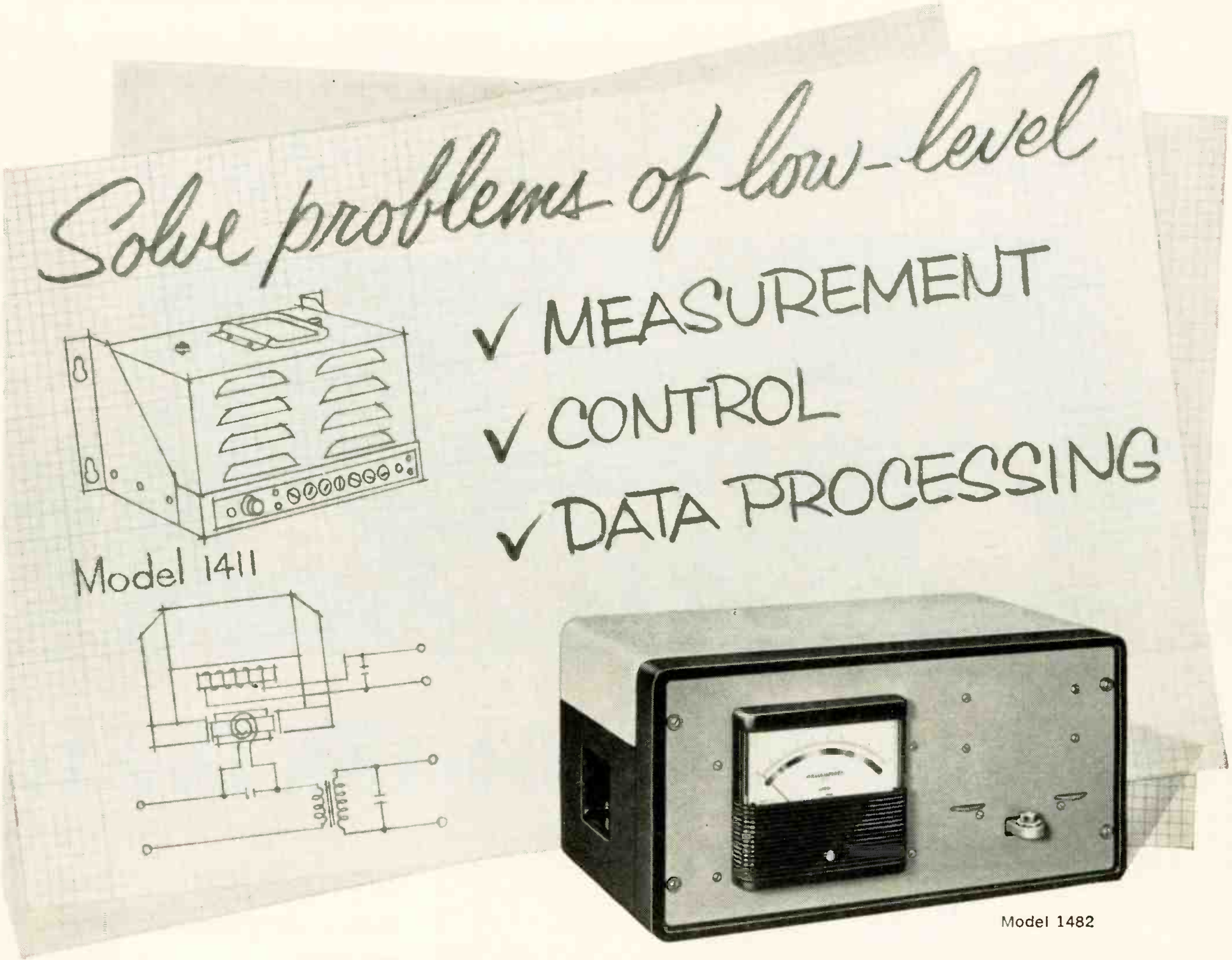

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Paper spews out at 6 ft a minute as . . .

Army Installs Speedy Printer

ELECTROSTATIC printing techniques go to work for U. S. Army Signal Corps in an electronic teletypewriter demonstrated last month by the Army and developer Burroughs Corp.

The high-speed unit, dubbed Beta by Burroughs, can operate at 3,000 words a minute. Signal Corps will run it at only 750 wpm.

Beta combines keyboard sending and electrostatic recording, uses the Baudot start-stop code. Each character is electrostatically formed by a 5-by-7 matrix of wires. Paper passes between the line of 72 matrices and a grounding plate (or "anvil"), receives the 72 sets of charges making up a single line of type, then steps to an inking station. Powdered ink is picked up by the charged areas, then bonded to the paper by a heated roller.

Each character is set up in all 72 matrices at once; a coincident positioning pulse supplied to the anvil selects the head or heads which print. The charges for a whole line are deposited in considerably less time than it takes to step the paper from one line to the next (at 3,000 wpm, the machine prints 3 to 4 lines a second).

Theoretical top speed for the de-

WASHINGTON OUTLOOK

NATIONAL AERONAUTICS AND SPACE Administration, only two months old but already the center of a lusty controversy over its proposal to absorb the Army's space scientists, this week finds itself with disenchantment on another front.

The Aircraft Industries Association charges that there are "restrictive provisions on patent rights" in the new space agency law. The Association wants Congress to put NASA patent policy in line with what it regards as the Defense Department's more liberal provisions.

Space Act of 1958 setting up NASA provides that any invention which evolves from performance of work under NASA contracts—with minor exceptions—is the Government's exclusive property. On the other hand, Pentagon rules generally allow contractors to retain title to an invention, with the military services holding licensing rights.

Just last month the Pentagon liberalized its procurement regulations to provide contractors even greater protection for trade secrets—that is, "proprietary rights" to processing methods, treatment and chemical composition of materials, plant layout and tooling and other manufacturing secrets.

Pentagon concern over this problem was stressed again last week at a special Washington conference called to spur R&D effort in the critical field of molecular electronics. Maj. Gen. M. C. Demler, Air Force director of R&D, said that proposals from industry might involve proprietary ideas. He emphasized that the armed services were aware of responsibilities in protecting industry rights.

NASA is now drafting a set of procurement regulations to govern its industrial contract work. For the most part, NASA's new rules will follow policies set forth in the long-established Armed Services Procurement Regulations, including such matters as contract negotiations and administration, and allowable costs and profits.

- **Long-simmering controversy** over the Renegotiation Act, under which so-called "excessive" profits are retrieved from defense contractors, is now moving from the courts back to Congress.

In the rush to adjourn last August, Congress renewed the law for six months to June 1959 without hearing all of industry's proposals to revise the act. However, the lawmakers did make plans for a major study of the law next year before voting on its extension again.

Professional staffers on the Joint Congressional Committee on Internal Revenue will begin informal talks next month with industry spokesmen. Open hearings will probably start a month or so later.

Sweeping Democratic gains in the new Congress have discouraged the hopes of some defense contractors for major modifications of the law—including exemptions for incentive-type contracts, the right to appeal beyond the Tax Court, and a more definitive yardstick for determining so-called excessive profits.

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KIN TEL manufactures an exceptionally complete line of digital instruments. These "digital building blocks" permit measurement of AC, ohms, ratios, and automatic scanning of multiple inputs. Preamplifiers increase digital voltmeter sensitivity to 1 microvolt DC and 10 microvolts AC. Buffers permit driving typewriters, tape punches and printers. Complete digital systems for data logging, missile checkout and production testing are also available. The reliability and accuracy of these precision instruments are assured by KIN TEL's experience in designing and manufacturing more than 10,000 "standard cell accuracy" DC instruments. Sales and service are available nationwide. KIN TEL Engineering Representatives in all major cities.

Four ranges: 0.000 to 1.599; 00.00 to 15.99; 000.0 to 159.9; 0000. to 1000 volts (manual ranging and polarity)... No moving parts... Digital in-line readout... 70 millisecond conversion time... Adjustable display time... Input completely floating and isolated... 0.1% of full scale accuracy ... Direct voltage conversion circuit... Wide range of models.

KIN TEL's Model 801A all-electronic digital voltmeter measures DC from 0.001 to 1000 volts with 0.1% of full scale accuracy... and in less than 1/10 second, presents the measured voltage clearly on an in-line digital readout that even unskilled personnel can read with ease. *Direct* voltage measurement by successive approximation provides accuracy and sensitivity previously obtainable only in delicate, complex and expensive instruments. Extremely stable operation – continuous calibration against an internal reference. (Input impedance of the Model 801A is 20,000 ohms per volt. The Model 802A, priced at $1190, has an input impedance of 10 megohms on all ranges. In other models, the binary coded decimal and decimal outputs are externally available to permit driving printers and tape punches.)

KIN TEL
A DIVISION OF
COHU
ELECTRONICS, INC.

Write today for descriptive literature or demonstration. 5725 Kearny Villa Road, San Diego 11, California vice (if the electrostatic technique were used without external limitations of paper feed) is in the neighborhood of 500,000 wpm, the Army says. Unit can also be used as an adjunct to computers.

Character spacing is 10 to the inch, and line spacing is 5 to the vertical inch. The unit requires 1.2 kilowatts, most of which is consumed by paper-transport mechanism and heater in bonding roller.

New Plastics Uses Coming

CHICAGO—Two years of progress in plastics materials, products and machinery were rounded up for the Society of the Plastics Industry's biennial National Plastic Exposition, which closed here today.

In the more than 300 new products shown at the exposition or discussed in conference sessions, there seemed to be something for everybody.

For electronics, Minnesota Mining & Manufacturing is completing work on a two-part foaming encapsulating epoxy designed to protect electronic gear from shock. Its density is seven lbs per cu ft.

There is also considerable activity in one-part resins for temperatures ranging from −100 C to 150 C. One resin will be extrusion-wrapped around coils, like thick tape, and then cured in place.

Dow Corning said it is working on room-temperature vulcanizing silicone rubbers for encapsulating. It's also developing solventless silicone resins with various fillers for high temperature purposes.

Plastics machinery firms came up with some new automatic transfer molding machines, vacuum molding machines for encapsulating and forming cases from sheet extruders.

Cadillac Plastics & Chemical showed a new gun for spraying-up reinforced plastics of chopped glass fiber and resin simultaneously.

Several electronics firms were represented among the exhibitors. These included manufacturers of radioisotope thickness gages, laboratory and production test and control devices, vacuum metalizers, dielectric heating and sealing machines and a few component firms.

MILITARY ELECTRONICS

• **A terminal guidance system** for Nike-Zeus anti-ICBM missile is being developed by Sylvania.

• **Army has completed** its Redstone missile test program with a successful 250-mi shot across the Atlantic test range. Over the past two years, 34 out of 37 launchings have been satisfactory.

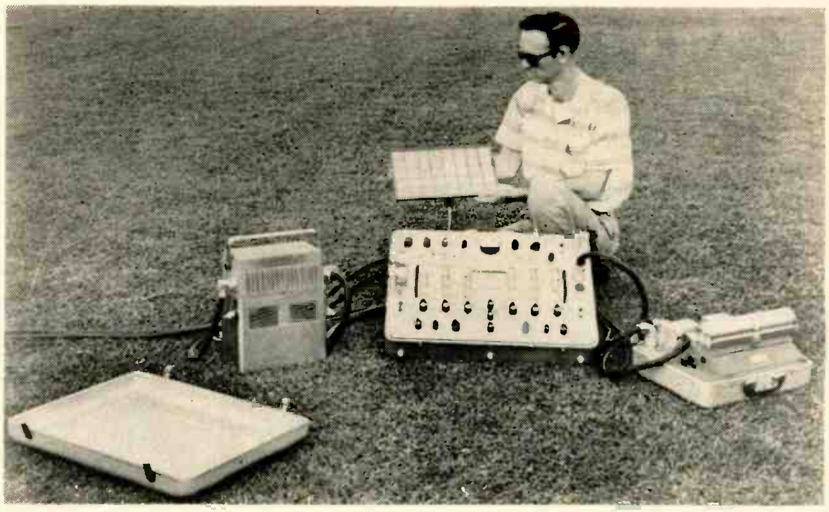
Army plans to shoot a rocket directly toward the moon and create a man-made, 30-lb planet that will orbit the sun if it misses the moon, Wernher von Braun revealed. First attempt may be made in the first week in December. Chances of success are one in two.

• **Airborne** compass systems can now be calibrated electronically by "rotating the earth's magnetic field" around a parked aircraft. This new system may eliminate the old, costly and often inaccurate method of moving the plane in 15-degree stages around a concrete compass rose.

Developed by Sperry under the sponsorship of USAF's Wright Air Development Center, the electronic system provides calibration accurate within one-tenth degree.

Equipment needed includes an electrical console, a tripod and a simple transit modified to include a special magnetic sensing device. The total weight comes to 90 pounds.

Sperry sees a big market in the system in both military and commercial aircraft.



Geophysicist uses solar converter to power . . .

New Seismic Amplifier

ALL-TRANSISTOR SEISMIC amplifier system announced recently will make it easier for geophysical crews to get about while searching for oil and ore in remote regions of the world.

The system, made by Texas Instruments, weighs about 100 pounds. The 24-channel seismograph is packed in a 57-pound case and the power supply and battery case weighs 45 pounds.

A lightweight, 12-volt aircraft battery is sufficient since the seismograph draws only 6 amps during most of its operating cycle. When TI introduced the system at the Society of Exploration Geophysicists' convention in San Antonio last month, sunlight provided the power.

An 8 by 15-inch silicon solar converter charged the battery. The converter charged at 250 milliamps at 12 volts. About 10 hours exposure to the sun was sufficient.

The seismograph is stable over a temperature range of −40 F to

new performance levels set by Hughes precision crystal filters

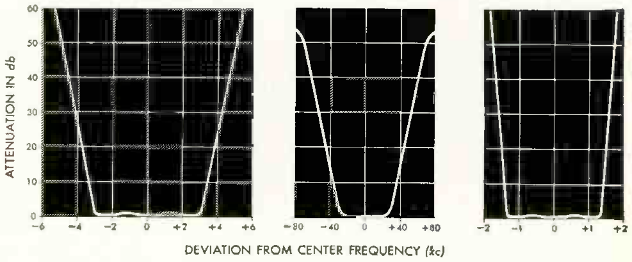
Hughes Products now offers high performance crystal filters previously available only for special military developmental contracts and Hughes-built systems. Utilizing unique design and advanced manufacturing techniques, these Hughes crystal filters provide a degree of performance previously unattainable.

With center frequencies of 30 kc to 30 mc and fractional bandwidths of 0.01% to 6%, these crystal filters have seven distinct advantages:

1. High frequency filtering
2. High selectivity
3. Low passband ripple
4. Low insertion loss
5. Small size and weight
6. Excellent temperature stability
7. Excellent shock and vibration stability

SPECIFIC PERFORMANCE CHARACTERISTICS FOR TYPICAL FILTERS

Filter No. 1 — 60/6 db Bandwidth Ratio = 1.8
Filter No. 2 — 50/6 db Bandwidth Ratio = 2.0
Filter No. 3 — 60/6 db Bandwidth Ratio = 1.37



	No. 1	No. 2	No. 3
Center Frequency	1.75 mc	10 mc	1.75 mc
6 db Bandwidth	6 kc	70 kc	2.7 kc
Maximum Insertion Loss	6 db	<2 db	6 db
Maximum Passband Ripple	± 1 db	<0.25 db	± 1 db
Stopband Attenuation	> 60 db	> 50 db	> 60 db

For further information please write HUGHES PRODUCTS, Crystal Filters, *International Airport Station, Los Angeles 45, Calif.*

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

140 F. Each channel contains 22 germanium transistors and 4 silicon diodes. In all, 591 transistors and 103 diodes are used, along with tantalum capacitors and deposited carbon precision resistors.

Development of the system was based on first-hand need. Through a subsidiary, Geophysical Service Inc., TI operates exploration crews in some 18 countries. System will be available to other prospectors.

Another transistorized system from the same firm is designed for industrial data collection and remote control of on-off devices. It consists of a receiver at a central operating point, a field selector which can read or control 100 or 1,000 locations, a common analog input for all analog output transducers, and transducers and control elements.

Stations are interrogated by dialing their code numbers. Transducer output is decoded, displayed on the receiver and may be logged. The information and the station dialed are verified before the information is displayed. Signals can be transmitted by wire or radio. Transistors are used to minimize maintenance.

FINANCIAL ROUNDUP

• **General Telephone & Electronics** will be one of the giant firms of the electronics industry if the proposed merger of Sylvania and General Telephone is approved by stockholders.

GTE is the proposed name of the combined company. But the name Sylvania will not vanish from our industry. Firm will be operated as a subsidiary of GTE. Shares will be exchanged on a one-for-one basis. Sylvania stockholders would get about one-sixth interest.

Combined firm will have sales of more than $800 million and assets in excess of $1.8 billion. Sylvania contributes sales of about $340 million, nearly $250 million in assets.

A big common interest behind the merger is the growing importance of electronic telephone communications. GT is second only to the Bell System in size; Sylvania provides electronics know-how, R&D capabilities.

Another common interest is the industrial electronics market. Much of Sylvania's receiving tube sales are to industrial users and the firm is well along in research and development of other industrial products. GT has a toehold in industrial electronics through its manufacturing subsidiary **Automatic Electric** and would like to expand further in this area. General Telephone's financial resources cement the mutual interests and activities of the two firms.

• **Telecomputing Corp.**, diversified Los Angeles electronics firm, acquires a controlling interest in **Frank R. Cook Co.** of Denver, Colo., through an exchange of stock. The Denver firm makes batteries used as a power source in many guided and ballistic missiles. Telecomputing aims to broaden its activities in the missile field.

• **Astron Corp.**, capacitor manufacturer of East Newark, N. J., purchases for cash all stock of **Minitronics Corp.** of New York City. Minitronics has been preparing to manufacture a solid tantalum capacitor. Acquisition ties in with Astron's policy of getting a bigger share of military components business through development of miniaturized and high reliability components.

• **G-L Electronics**, Camden, N. J., issues 75,000 shares of common stock through Woodcock, Hess, Moyer & Co. of Philadelphia. G-L makes magnetic components.

New Unit Guards Shopping Center

Electronic security system costing $100,000 has been activated in a $200-million shopping center in Minneapolis.

The system uses more than 1,200 photoelectric cells for light detection, ultrasensitive rise-of-heat indicators, and a two-way audio system that listens during the night and transmits music during day.

From a central control room a single guard can detect fires or intruders in any of the 800,000 sq ft area's 70 stores. He can also operate exit doors, lighting, and internal security communications in the two-level building.

Designers, G. R. Willet & Co., Chicago, point out that the low-voltage electrical system operating the "watchdog" required no special conduit installations. Further savings have been possible by using electronic heat detectors, eliminating water sprinkler systems.

A console in the central control room (photo) allows security personnel to keep the area under constant scrutiny at all times.

NEREM Spotlights Design Techniques

BOSTON—In electronics, New England is frequently a "jumping off point"—idea-wise—for devices which often go into production in other parts of the country.

Section's impact on design engineering was evident here this week in exhibits and papers at NEREM (Northeast Electronics Research and Engineering Meeting).

In second year of its graduation into circle of national shows, NEREM more than tripled size of two-day technical program with 43 papers.

Heavy emphasis this year was on computers and information theory—nearly one-third of papers were in this field; and circuit devel-

opment—eight papers.

Displays featured components, techniques rather than systems.

Papers on circuits outlined design criteria for automatic phase control systems; application of a novel null-detection method on a new impedance bridge; development of a selective calling device for tactical voice communications.

An entire session on circuits was devoted to amplifiers, with reports on an auxiliary signal method of reducing plate dissipation in audio-amplifiers; differential amplifiers; a chopper-stabilized transistor amplifier; and progress on eliminating limitations of distributed amplifiers.

Unusual feature of session on reliability and testing was paper exploring concept of reliability insurance, provided either by insurance firm or equipment producers. W. B. Bishop of AF Cambridge Research Center said preliminary study indicates risks involved in reliability insurance are calculable with sufficient accuracy to be economically acceptable. He added that techniques used to measure and predict electronic equipment reliability are similar to insurance methods for determining magnitude of risk and appropriate premiums.

Bishop's study was concerned principally with the government as an electronics user, but he said concept could be applied equally to industrial users.

Gas Pipers to Buy More Gear

THE NATURAL GAS pipeline industry "now spends millions" for electronic equipment and "will be spending several times more in five years."

This prediction comes this week from F. Vinton Long, chief of the Texas Eastern Transmission Corp.'s communications section.

The firm recently unveiled its first remotely controlled gas compressor station. Situated in Linden, N. J., the station is controlled from a facility 50 miles west, in Lambertville.

"This is one of the first uses of unattended operation techniques in natural gas service," says A. J. Shoup, TE vice president and chief engineer. He adds that his firm plans to open four more such stations next year.

The new equipment's duplex controls are designed to operate on either microwave or leased telephone lines. The electronic-electrical equipment cost $30,000 to $40,000, firm said.

About 15 companies, 10 considered large, are now in the natural gas piping industry.

Airline Installs Reserving Unit

A COAST-TO-COAST electronic seat reservation system is now in operation at Trans World Airlines.

The system links separate electronic data processing units in New York, Chicago and Los Angeles with a space inventory control unit in Kansas City. San Diego and San Francisco are tied in with the L.A. system, Milwaukee with Chicago.

The three data processors store space availability information on all TWA domestic and international flights. The system was built for TWA by Teleregister Corp., which has installed electronic reservation systems with seven airlines.

X-ray Amplifier

Industrial image amplifier enables x-ray inspection of devices with moving parts. Above, Picker X-Ray Corp. shows how its system would be used to inspect a gear. The television monitor permits remote viewing

MEETINGS AHEAD

Nov. 17-21: Space Flight Engineering Conf. and Exposition, American Rocket Society, Statler-Hilton Hotel, N. Y. C.

Nov. 19-21: Electrical Techniques in Medicine and Biology, AIEE, ISA, PGME of IRE, Nicollet Hotel, Minneapolis.

Dec. 2-4: Reliable Electrical Connections, EIA, Statler-Hilton Hotel, Dallas.

Dec. 2-4: Airlines Electronic Engineering Committee, Winter Meeting, AEEC, Hotel Statler, Washington, D. C.

Dec. 3-5: Global Communications, AIEE, PGCS of IRE, Colonial Inn-Desert Ranch, St. Petersburg, Fla.

Dec. 3-5: Eastern Joint Computer Conf., AIEE, ACM, IRE, Bellevue-Stratford Hotel, Philadelphia.

Dec. 4-5: Vehicular Communications, Annual Meeting, PGVC of IRE, Hotel Sherman, Chicago.

Dec. 9-11: Mid-America Electronics Convention, MAECON, Municipal Auditorium, Kansas City, Mo.

Jan. 12-14: Reliability and Quality Control, National Symposium, PGRQC of IRE, ASQC, EIA, Bellevue-Stratford Hotel, Philadelphia.

Jan. 21-23: Southwest Electronic Exhibit, Arizona State Fairgrounds, Phoenix, Ariz.

Feb. 1-6: American Institute of Electrical Engineers, Winter General Meeting, Statler Hotel, New York City.

Feb. 12-13: Transistor & Solid-State Circuit Conf., AIEE, PGCT of IRE, Univ. of Pennsylvania, Philadelphia.

Mar. 3-5: Western Joint Computer Conf., AIEE, ACM, IRE. Fairmont Hotel, San Francisco.

Mar. 23-26: Institute of Radio Engineers, IRE National Convention, Coliseum & Waldorf-Astoria Hotel, N. Y. C.

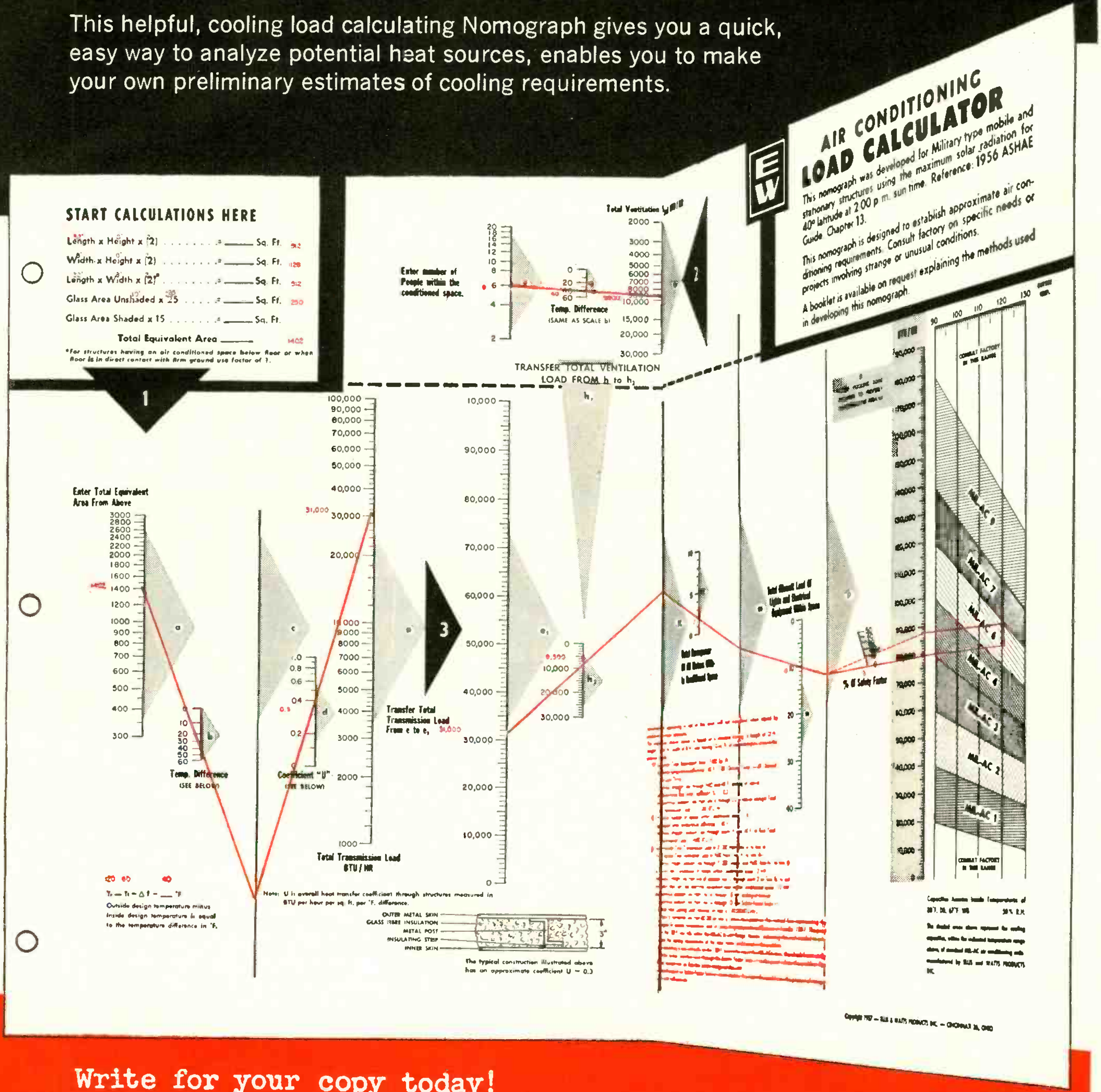
Mar. 31-Apr. 2: Millimeter Waves Symposium, Polytechnic Inst. of Brooklyn, USAF, ONR, IRE, USA Signal Research, Engineering Societies Bldg., N. Y. C.

Apr. 5-10: Nuclear Congress, sponsored by over 25 major engineering and scientific societies, Public Auditorium, Cleveland.

KW heat problems coming up?

Estimate cooling requirements for your project now!

This helpful, cooling load calculating Nomograph gives you a quick, easy way to analyze potential heat sources, enables you to make your own preliminary estimates of cooling requirements.



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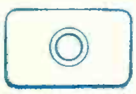
SQUARE HEAD



RECTANGULAR

This new Dot Nylon Push-in Nut offers additional design and performance advantages over our currently available plastic snap-in nuts. These advantages are:

(1) Straight legs permit easy insertion in square, punched holes and do not distort the holes even in soft aluminum or thin-gauge steel. (2) Burrs do not impede the nut or prevent proper seating. (3) Tapered screw hole causes legs to spread when screw is inserted and results in greatly increased pull-out resistance (see drawing A).

Ordinary sheet metal screws cut clean, strong threads in the molded nylon and the nut is both re-usable and highly resistant to vibration.

Used as a nut or as a spacer, Dot's Nylon Push-in Nut has wide application in all products where sheet metals or plastics are employed. They can be supplied with a moisture resistant sealer and special nuts can be designed to your specifications if volume warrants. Currently available in eleven sizes. Full information on request.

TABLE OF DIMENSIONS

For use with #8 or #10 screws, finished hole size .290/.281, application thickness .030/.060. Other sizes available soon.

HEAD SIZE	HEAD HEIGHT
7/16" DIA.	.150
1/2" DIA.	.030
1/2" DIA.	.040
1/2" DIA.	.070
1/2" DIA.	.150
1/2" DIA.	.100
3/8" SQ.	.040
3/8" SQ.	.140
13/32" SQ.	.030
13/32" SQ.	.200
3/8" x 37/64"	.060

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Actual size —
fits a 3/8" dia. hole

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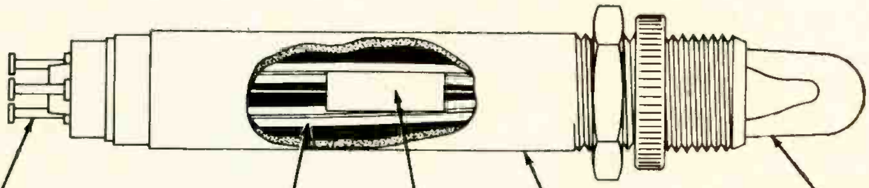

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Terminals are silver-plated, gold-flashed, cadmium-plated or electro-tin-plated. AMP-type 37 taper pins available.

QUALITY INSULATION MATERIALS
Glass nylon or Melamine MME per MIL-P-14.

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Genuine Allen-Bradley carbon composition.

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Proper lens shape in butyrate per MIL-P-10407 for clear display. Form-tip neon lamps with electrodes exposed for maximum brilliance.

You can mount almost any E-lite in a 3/8" hole. These tiny units save precious space in computer data-processing systems, aircraft and industrial control systems, instruments, test equipment, telemetering systems — wherever long life and dependable operation are essential. They'll fit your system application *exactly* because they're tailor-made for the job by system engineers. Choose from many replaceable-lamp or permanent-lamp types, with neon or incandescent lamps, with or without resistors, and in a variety of lens styles, colors and data readout capacities. 100% electrical and mechanical inspection assures you of full E-lite quality in every unit.

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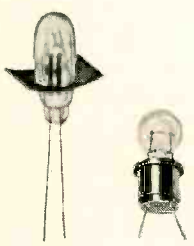
REPLACEABLE-LAMP TYPES
Single-lamp holders for neon or incandescent lamps. Variety of lens types. Up to 3 digits available on flat lenses. 1DH holder shown.

TRANSISTOR CIRCUIT NEON LIGHT
Has built-in diode-resistor network — no adapting needed. Fires on only 10 volts. Lamps are aged, selected for stability. Round or flat-face (readout) lens. Model 1AD shown.

PERMANENT-LAMP ROUND-LENS INDICATORS
With neon or incandescent lamps. Model 1AG (neon) shown.

PERMANENT-LAMP READOUT TYPES
With permanent or changeable lenses, and lenses taking up to 3 digits. Neon or incandescent lamps. Model 1EG (neon) shown.



LOW-COST INDICATORS
Neon and incandescent panel illumination, readout, etc. Round or flat lens. Lens marking available. Push-on retainer furnished. Models 1B (neon) and 1K (incandescent) shown.

DUAL LAMP HOLDER
Holds two lamps to provide double check on circuit operation. Monitors key circuitry in a variety of ways. Model 1FH.

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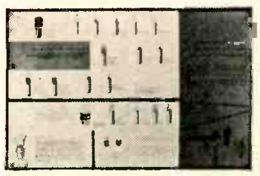

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AC SPARK PLUG ⚛ THE ELECTRONICS DIVISION OF GENERAL MOTORS

NEW!

-*hp*- 400L Logarithmic Voltmeter

High accuracy
10 cps to 4 MC
5″ true log voltage scale
Linear 12 db scale
10 db range steps
Generous scale overlap

New, convenient -*hp*- 400L is a unique instrument combining a specially designed logarithmic meter movement with the many desirable features of -*hp*- 400D and 400H voltmeters.

Model 400L's logarithmic voltage scale plus unusually long scale length provides an instrument of maximum readability and an accuracy which is a *constant percentage of the reading*. Voltage scales are more than 5″ long, with a 12 db scale spread across the full scale length. The meter is mirror backed for maximum accuracy. A range switch changes voltage sensitivity in 10 db intervals. This feature, together with the 12 db scale, provides generous overlap and is of particular convenience in work involving decibel levels.

Other features of the new 400L include exceptional long term stability, high sensitivity, high input impedance, large overload capacity, compact size and highest quality construction.

Model 400L may also be used as a stable amplifier.

makes over 350 basic test instruments for science, industry and the military

STANDARD OF INDUSTRY— 20 cps to 700 MC

-*hp*-*410B*, perhaps the most widely used of all precision voltmeters. In addition to 20 cps to 700 MC ac coverage, serves as a dc voltmeter with over 100 megohms input impedance. Also is ohmmeter for measurements 0.2 ohms to 500 megohms. For ac measurements, input capacity 1.5 $\mu\mu$f, 10 megohms input impedance, employs radical -*hp*-developed diode probe which virtually eliminates circuit loading. $245.00.

SPECIFICATIONS -*hp*- 400L

Voltage Range:	0.3 mv to 300 v, 12 ranges, 1-3-10-30 sequence.
Frequency Range:	10 cps to 4 MC
Accuracy:	± 2% of reading, or ± 1% of full scale, whichever is more accurate, 50 cps to 500 KC; ± 3% of reading, 20 cps to 1 MC; ± 5% of reading, 10 cps to 4 MC (Includes line voltage changes 103 to 127 volts.)
Long Term Stability:	G_m reduction in amplifier tubes to 75% nominal causes less than 0.5% error, 20 cps to 1 MC
Calibration:	Calibrated in RMS value of sine wave. Log voltage scale, 0.8 to 3 v and 0.3 to 1 v. Db scale − 12 to + 2 db. 10 db intervals between ranges.
Input Impedance:	10 megohms shunted by 15 $\mu\mu$f, 1 to 300 v. 25 $\mu\mu$f shunt on 0.001 to 0.3 v range.
Amplifier Usage:	Output terminals permit 400L to amplify small signals or monitor waveforms with an oscilloscope.
Power Supply:	115/230 v ± 10%, 50/1,000 cps, approx. 100 watts.
Price:	-hp- 400L (cabinet) $325.00. -hp- 400LR (rack) $330.00.

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

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IRC 2W's are designed with a one-piece nickel silver center terminal and collector ring. Resistance wire is wound by specially designed IRC machines and bonded to the core by a special coating to prevent wire shifting even under most unfavorable conditions.

LOOK AT THEIR ADAPTABILITY

You name it—the IRC 2W has it: Single control: single with SPST, DPST or SPDT switch; duals, concentric duals, with or without switch; 3-gang or 4-gang, waterproof shaft and bushing.

IRC 2W's are available with most any shaft and bushing style, including a "shaft locking" type bushing. For your further convenience there is a wide selection of standard and special locating lugs.

LOOK AT THEIR PERFORMANCE

IRC 2W Controls exceed MIL-R-19A specifications of 3% maximum and 1½% average change for 40°C load life at 1000 hours. Resistance change is less than 2% maximum after 25,000 cycles under rated load.

LOOK AT THEIR CHARACTERISTICS

2W Controls may be obtained in resistance values from 1 to 50,000 ohms, and in tolerances of 10% and 5%; lower tolerances are available on special request.

Standard taper is linear; modified logarithmic or special tapers are available.

LOOK AT THEIR APPLICABILITY

IRC 2W Controls are widely used in circuits for servo-mechanisms, test instruments, measuring instruments, automatic controls, military equipment, and many other electronic devices where high stability and low cost are necessary factors.

LOOK AT BULLETIN A-3a

for complete details of construction and specifications; derating, taper and resolution charts. Write for it today.

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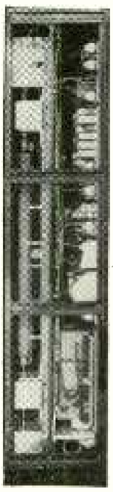
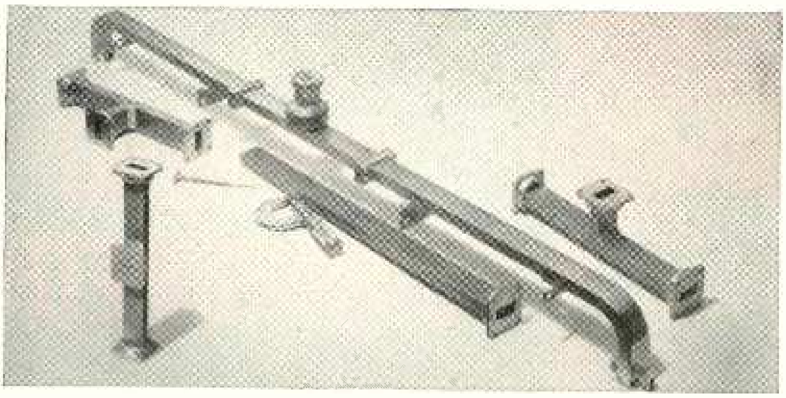
Nickelonic News

VOL. 1 — DEVELOPMENTS IN NICKEL AND NICKEL ALLOYS AND THEIR APPLICATIONS — No. 5

First commercial atomic clock...waveguides of low permeability Monel "403" hold down signal distortion





No problem fabricating these waveguides of Monel "403" low permeability alloy, reports National. The intricate tubes carry microwaves in the Atomichron atom-regulated frequency standard.

Heart of the "clock" — a cesium beam tube — Monel "403" alloy provides the tube's pole assemblies with excellent mechanical properties plus low magnetic permeability. Manufactured by National Company, Inc., 61 Sherman Street, Malden 48, Mass.

...clock generates frequencies accurate to 5 parts in 10 billion!

MALDEN, MASS.: You can now tell time accurately down to 100 millionths of a second with the Atomichron†, first commercial atom-regulated "clock."

How it works

Waveguides feed a tuned microwave signal through a stream of cesium atoms. As signal reaches the atoms' resonant frequency, it changes some atoms in internal structure. This change is sensed by a detector and signalled to a servo system, which regulates the frequency of a basic oscillator at precisely the atomic resonance value. By means of electronic multipliers and dividers, this oscillator produces standard output frequencies of 0.1, 1.0, 5, 10, and 100 megacycles — the required "clocking" action.

Designers chose Monel "403"* low permeability nickel-copper alloy for the waveguides, radio frequency sections and magnet pole assemblies, because it provides magnetic permeability so low that atomic resonance remains free from distortion. Monel "403" alloy offers excellent vacuum and mechanical properties, is readily machined and formed into intricate shapes.

Like all Inco Nickel Alloys, Monel "403" alloy is freely available.

Pertinent Literature: Write for "Basic Data-Monel '403' Low Permeability Nickel-Copper Alloy."

†T. M. of The National Company, Inc.

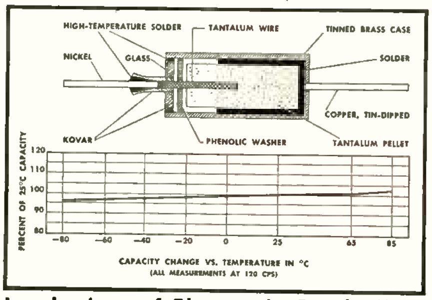
Nickel leads, welded directly to tantalum, boost capacitor ruggedness

DALLAS, TEX.: For maximum reliability, new Texas Instruments *tan-TI-cap*** capacitors depend on leads of Electronic Grade "A"* Nickel. This strong, tough nickel wire, welded soundly and easily to the tantalum stubs, helps provide the good connections needed to withstand mechanical and thermal shock.

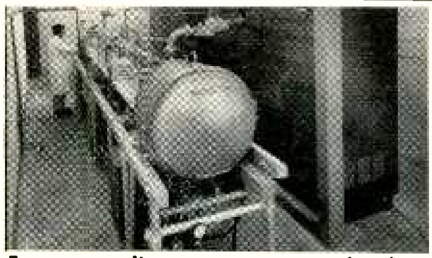
Electronic Grade "A" Nickel is highly resistant to oxidation and corrosion. What's more, it provides tight hermetic seals (note figure at right) and speeds unit installation. Another Nickel-containing alloy, Kovar***, is also used to assure tight metal-to-glass seals.

Pertinent Literature: Write for Inco Technical Bulletin T-15.

**T. M. of Texas Instruments Incorporated
***T. M. of Westinghouse Electric Corp.



Lead wires of Electronic Grade "A" Nickel strengthen this new *tan*-TI-*cap* Solid Tantalum Electrolytic Capacitor.



For outstanding vacuum properties, key parts of the Mark 1-T4 accelerator are made of Electronic Grade "A" Nickel. Built by Applied Radiation Corp., Walnut Creek, Cal.

Nickel materials keep electrons "in line" in new linear accelerator

WALNUT CREEK, CALIF.: Intense electron, neutron and X-ray beams are generated by this new ARCO linear electron accelerator. In order to operate at very high vacuums—10^{-7} to 10^{-8} mm Hg—its vacuum envelope must be degassed by baking out at 400°C. ARCO designers specify Electronic Grade "A" Nickel for the envelope because it provides the excellent vacuum properties required. This metal also resists oxidation, corrosion and retains its strength at operating temperatures well above 400°C.

Nickel plating improves seals

All metal surfaces of the envelope's metal-ceramic seals are plated with Inco Nickel. Inco Nickel is easily brazed, protects parts from oxidation. Its purity facilitates the elimination of all organic products from the vacuum envelope, permitting excellent radio-frequency operation.

Pertinent Literature: Write for "Inco Nickel Alloys for Electronic Uses."

*Registered trademark, The International Nickel Company, Inc.

INCO THE INTERNATIONAL NICKEL COMPANY, INC. • 67 Wall Street • New York 5, N. Y. **INCO**

NEW!

ruggedized . . . miniaturized peak performance . . .

Kuthe KU-73

CERAMIC HIGH POWER THYRATRON

Characteristics of KU-73 Ceramic Thyratron

epx	25.0 kv.
ib	1000 amp.
Ip (RMS)	40 amp.
Pb (epy x prr x ib) . .	20×10^9
Height	5.75 in.
Diameter	3.50 in.

HERE is a brand new hydrogen thyratron in ceramic envelope—for most severe environmental requirements in switch and network discharge applications.

The KU-73 shown here is a 25 kv/1000 amp. peak thyratron, comparable in ratings to glass type 5948/1754, more than three times its size. It is only 5¾″ high and 3½″ in diameter . . . while its glass counterpart is 15¾″ high by 5⅛″. Because it is ceramic, the KU-73 has far greater ability to stand shock and vibration. It can operate at ambient temperatures up to 125°C. Ratings can be substantially increased by air or oil cooling . . . readily accomplished because of the efficient dissipation possible with this compact, thermally efficient design.

The KU-73 incorporates an internal low temperature hydrogen reservoir for long life and highly stable performance characteristics. Jitter is less than 1 millimicrosecond.

Write today for complete data and application information.

Box K101
Kuthe Laboratories Inc.
ITT *Components Division*
730 South 13th Street
Newark 3, New Jersey

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION

CIRCLE 21 READERS SERVICE CARD

In financial aid to education...
What Should Business Do Now?

Now that the federal government is entering the field, should business firms stop giving financial aid to our colleges and universities?

This question is now being discussed by business directors throughout the country. The discussion is prompted by the near-billion-dollar program of federal aid to education passed by Congress a few months ago. For if the federal government, with its access to billions in taxes, is assuming responsibility for the financial welfare of education, should not business get out of the way and let the government take over? This is the general way the question is being asked.

The answer is a resounding NO.

What The Federal Program Does

The new federal program makes it possible for the government to spend the imposing total of $900 million for aid to education over the next four years. There are still many loose ends in the program. But already it's quite clear what such funds will — and will not — do to help relieve the financial plight of our colleges and universities.

First of all, the program is not going to solve any financial problems in education overnight. The program is just barely underway. So far no money has actually been allocated, and Congress has appropriated only $40 million — less than 5% of the total.

More important, there is very little in the total program which will result in direct aid to colleges and universities. The program does set up fellowships to train college teachers. But most of the aid will eventually be channeled through the states to primary and secondary schools. The main focus of the program is education for national defense — strengthening science, mathematics and foreign languages in elementary and secondary schools, together with grants for counseling, testing and research.

The one big item for higher education is a $295 million student loan program, which will help needy students pay tuition and other fees. But tuition rarely covers the full cost to the college of educating a student. So the net result could well be an additional financial strain on our institutions of higher learning.

For the three most pressing financial needs — faculty salaries, scholarship grants and new plant and equipment—colleges and universities must still rely heavily on help from the business community. And it would indeed be a major

misfortune if the recent actions of the government put a blight on this growing and substantial support to higher education.

In the last ten years, business has expanded its financial aid to education by more than four fold. In 1948, contributions were only $24 million. In 1957, such aid reached an estimated $125 million. Moreover, corporations have been putting a larger proportion of their total charitable gifts into education. In 1950, the percentage was only 17%. By pre-Sputnik 1956, the share had already increased to 34%, according to figures recently released by the Council for Financial Aid to Education.

Why Business Must Help

The most compelling reason for increasing business aid to higher education — at an even faster rate—is that our colleges and universities desperately need financial help. It is that simple. Private contributions to higher education must average at least $400 million over the next ten years if our colleges are to meet rising operating costs and raise faculty salaries to decent levels. Despite the growth in business contributions, we are still well below that goal.

If our colleges cannot solve their mounting financial difficulties through voluntary help from business firms, alumni and communities — then it is to be expected that federal aid ultimately will be mobilized in a big way. In principle, if not in dollars, the 85th Congress has paved the way. Indeed, a large federal scholarship program was squeezed out of this year's legislation only in the course of last-minute compromises. And Arthur S. Flemming, Secretary of Health, Education and Welfare, has urged that the next session of Congress restore the scholarship program.

About any federal rescue operation for higher education, two things are quite clear:

(1) **Such aid will come too late to prevent irreparable harm resulting from the current shortage of funds.** The need for help is urgent and immediate.

(2) **With federal taxes taking over half of all corporate income, any federal program in the end will be financed in large part by the business community.**

An Opportunity

So, viewed narrowly, it is in the selfish interest of business firms to aid our colleges and universities now, rather than wait and be forced to pay later on. By doing so, they ensure that business will have a continuing supply of well-trained graduates. They take advantage of the tax laws for charitable contributions which mean the government in effect assumes more than half the cost of business aid to education. And they win gratitude for a voluntary and generous act.

Viewed in the broad public interest, the business community has an opportunity to perform a financial rescue mission in education which could well be the key to successful survival, not only of our present system of higher education, but also of the nation itself.

As previous editorials in this series have pointed out, a very small share of the net income of business firms — about 1% — would do the job. Certainly business must not be distracted from this opportunity by the new venture of the federal government in financial aid to education.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C McGraw

PRESIDENT

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CIRCLE 25 READERS SERVICE CARD →

In
ELECTRONICS

Temco | AIRCRAFT DALLAS

means a

System of Weapons Management

Temco's capabilities in electronic research and development . . in systems management . . are making Temco a leader in the electronics field. Take Temco's work in autopilot development, for example. While converting several Army Signal Corps L-17s to radio-controlled reconnaissance drones, Temco found no suitable "commercial" autopilot. So Temco engineers developed their own . . an inexpensive, simplified unit that met all special requirements . . provided wide-range reliability and control.

Then Temco engineering came up with a low-drift d-c servo-system and a low-power d-c "pecking" amplifier . . took the basic autopilot they had developed . . miniaturized and repackaged it for use in Temco's rocket-powered transonic Teal target drone. The result: "Teal" became the first "missile" of its type to be successfully launched from a swept-wing aircraft and to operate effectively at altitudes up to 50,000 feet.

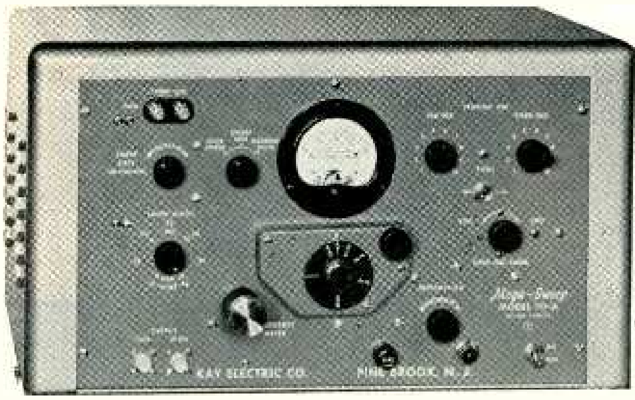
Today this know-how is directing development of "Corvus" . . the Navy's highly classified "stand-off" air-to-ground missile . . with Temco as weapon system manager. It is being used in the development and production of special flush-mounted antenna systems . . microwave devices . . advanced guidance systems . . airborne TV systems and many classified projects.

Temco's complete systems management capabilities are ready to meet your challenge.

TOMORROW'S
NEED
IS TODAY'S
CHALLENGE AT . .

TEMCO ®
AIRCRAFT CORPORATION • DALLAS, TEXAS

Flexible Laboratory Sweeping Oscillator—10 mc to 950 mc



Catalog No. 111-A

KAY
CALIBRATED
Mega-Sweep 111-A

The Kay *Mega-Sweep 111-A* is a two-band beat frequency sweeping oscillator specifically designed for improved performance in the UHF range. The *Mega-Sweep 111-A* provides wide frequency sweep widths and operates over a wide frequency range from 10 mc to 950 mc. Both sweep width and center frequency are continuously variable.

The *Mega-Sweep 111-A* employs two X-band klystrons in a waveguide mixing circuit. Suitable buffers, matching devices, and a directional coupler minimize both coupling between oscillators and load effects. A precision absorption-type frequency meter indicates the output frequency; a continuously variable microwave attenuator provides truly broadband adjustment of the output level.

A drive mechanism mounted on the front panel automatically tracks the klystron repeller electrode voltage with klystron operating frequency. One mode of klystron operating voltage is maintained with the klystron operating at or near the peak of the mode. The entire range of operating frequencies can be covered by rotating a single knob. A calibrated dial indicating center frequency ±10% is attached to the tuning mechanism; since the sweep widths are very wide, this indication is close enough for easy location of the bandpass to be displayed.

*A modified unit, **Catalog No. 112-A**, provides a frequency range of 800-1200 mc.

†With the addition of a Kay **Ultra-Former UHF** matching transformer, an output of 0.3 V rms into a balanced 300 ohm load will be delivered between 450 and 900 mc.

- **Wide Sweep Width up to 40 mc**
- **Variable Sweep Rate with Line "Lock-in"**
- **All-Electronic Sweep**
- **Negligible Leakage**
- **Constant RF Output over Sweep**
- **Zero Level Baseline**
- **Precision Wavemeter**
- **Low Harmonic Distortion**

SPECIFICATIONS

Frequency Range: Two bands; 10 mc to 500 mc and 400 mc to 950 mc.*

Sweep Width: Continuously variable, 50 kc to 40 mc.

Sweep Rate: Variable around 60 cps; locks to line frequency.

RF Output: High, approx. 0.15 V rms into nom 70 ohms.†
Low, approx. 0.07 V rms into nom 70 ohms.

Amplitude Modulation: Less than 0.1 db/mc over frequency sweep.

Output Waveform: Less than 5% harmonic distortion at full output; less than 2% at half output.

Attenuator: Uncalibrated microwave attenuator continuously variable to 26 db. Attenuation characteristic flat over output frequency range.

Frequency Measurements: Mid-point frequency of sweep may be pre-set, or frequency indicated at any point on oscilloscope display within ±5 mc by use of the precision micrometer-controlled wavemeter.

Sweep Output: Regular sawtooth; amplitude 20 V approx.

Power Supply: Input approx. 110 watts, 117 V (±10%), 50-60 cps ac. B+ electronically regulated.

Dimensions: 10½" x 18½" x 12".

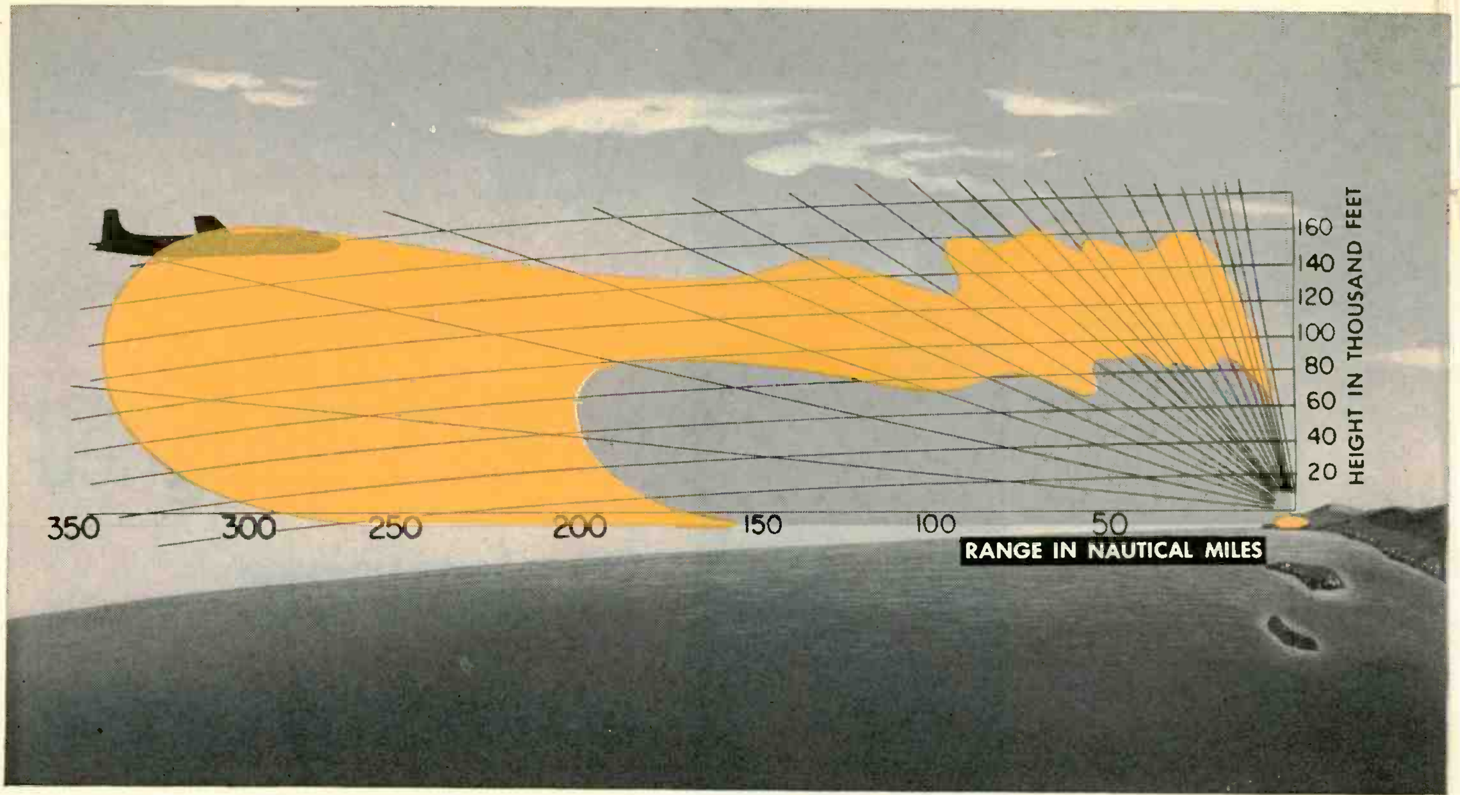
Weight: 35 lbs.

Price: $595.00, f.o.b. factory.

Write for New Kay Catalog

KAY ELECTRIC COMPANY

Dept. E-11 Maple Avenue Pine Brook, New Jersey CApital 6-4000



New Amplitron tube nearly doubles radar range. Copper tone shows increased coverage.

In radar tubes, in breaker contacts, electrically and structurally...

The COPPER METALS meet

THE CHALLENGE OF RELIABILITY

Increased maintenance costs and the increased complexity of most military and commercial products have laid greater stress on the reliability of electrical and electronic components. What the customers want, essentially, is predictable service life without maintenance. The designer faces the problems of temperature, corrosion, material and joint strength, fatigue and many others. His answer is frequently found among the copper metals — whether or not conductivity is also needed. Here are a few design problems where reliability was vital, and where copper or a copper alloy contributed to the solution:

Design Problem—Radar booster tube

Raytheon's Amplitron* is a new type of tube capable of power amplification at microwave frequencies. It boosts the output power of an existing radar installation by 8 to 14 times, and nearly doubles its range. Dependable performance is essential, whether used for military aircraft detection or commercial aircraft guidance. The design problems included extreme mechanical accuracy, durable connections, heat dissipation and vacuum retention. The solution to all of these was oxygen-free, high-conductivity copper.

The anode cavity (diagram above) depends on very tight tolerances for proper performance. Yet in some models it can be formed out of a solid blank of copper by cold forging — with a single press stroke. Copper's malleability makes this possible. The many connections can be brazed reliably because of copper's good joining properties.

With an output above 4 megawatts, heat could be a problem. Copper's thermal conductivity handles it. The good high temperature characteristics of this copper are enhanced by its freedom from oxygen traces, eliminating oxidation, scale formation and conductivity losses. The very high (50-70%) electrical efficiency of the tube depends, of course, on copper's electrical conductivity.

Vacuum retention in a tube of such complex geometry depends on two other characteristics of this grade of copper. The metal is nonporous, and its high purity eliminates the formation of gaseous products. The vacuum envelope is therefore secure, because nothing seeps in and nothing is generated within it.

Raytheon says, *"Without copper, the Amplitron would have been impossible."*

*Raytheon Trade Mark

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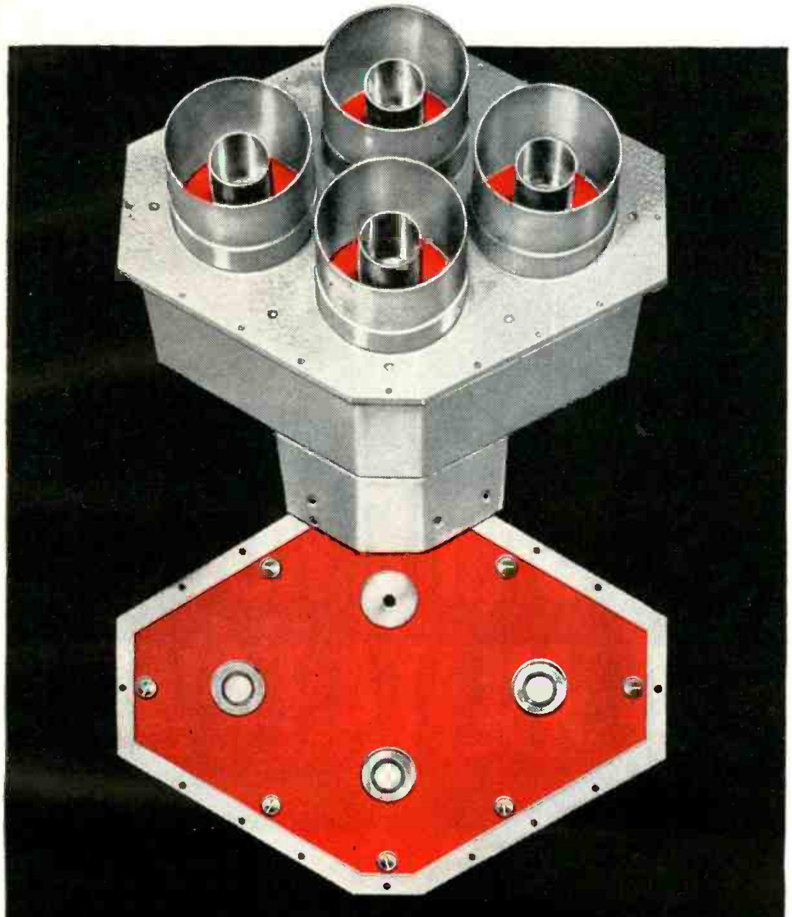
FLUOROCARBON RESINS

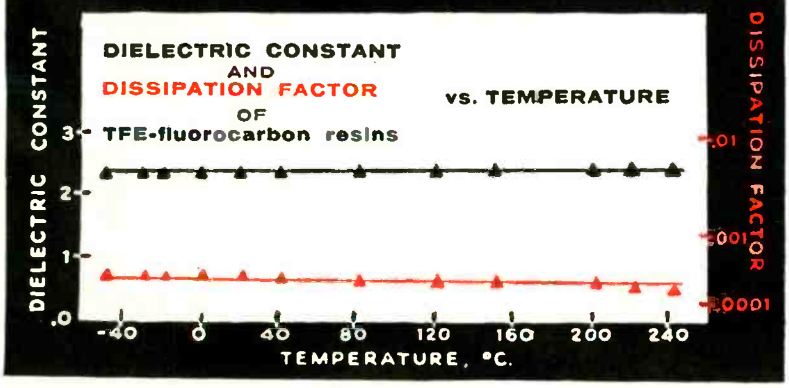
ELECTRONIC DESIGN NEWS

Design of 3⅛-inch coax switch to handle 55 KW made possible by Du Pont TEFLON®

TFE-fluorocarbon resins



TV TRANSMITTER SWITCH handles high powers with very low loss thanks to a machined layer of TFE-fluorocarbon resin. Reverse side of connector plate shows coaxial core connections through layer of TFE resin. A flat metal bar (not shown) switches power from top input connection to three outputs. Graph of properties shows why dielectric losses remain low regardless of operating temperatures. Switch is made by Thompson Products, Inc., Electronics Division, Cleveland, Ohio; and distributed by Andrew Corp., Chicago, Ill.



When increased power allocations by the FCC resulted in the need for a switch to handle greater powers and higher frequencies, engineers of Thompson Products, Inc., were faced with a major redesign problem. It looked as though the higher requirements would make their new multi-position switch for 3⅛" rigid coaxial line obsolete. Needed were models that could handle 55,000 watts of average RF power and could cover the full UHF band to 1000 megacycles. The problem was solved by changing to a TFE-fluorocarbon resin for the dielectric.

Both electrical and mechanical properties of TFE resins proved important in this design. The resin is used to make sheet dielectric for backing the grounded connector plate and a strong shaft for turning the switching bar. One of the biggest problems—impact cracking—was entirely eliminated. In addition to their unique UHF properties, TFE resins have a Class H temperature rating. 260°C. continuous rating permits increased operating temperatures in the switch. The extremely low dielectric constant of TFE resins is a natural for this microwave design. TFE resins have a minimum dissipation factor, unexcelled by any other solid. Characteristic curves for these electrical factors show that they remain flat with regard to both temperature (see graph) and frequency (60 cps to 3000 mc).

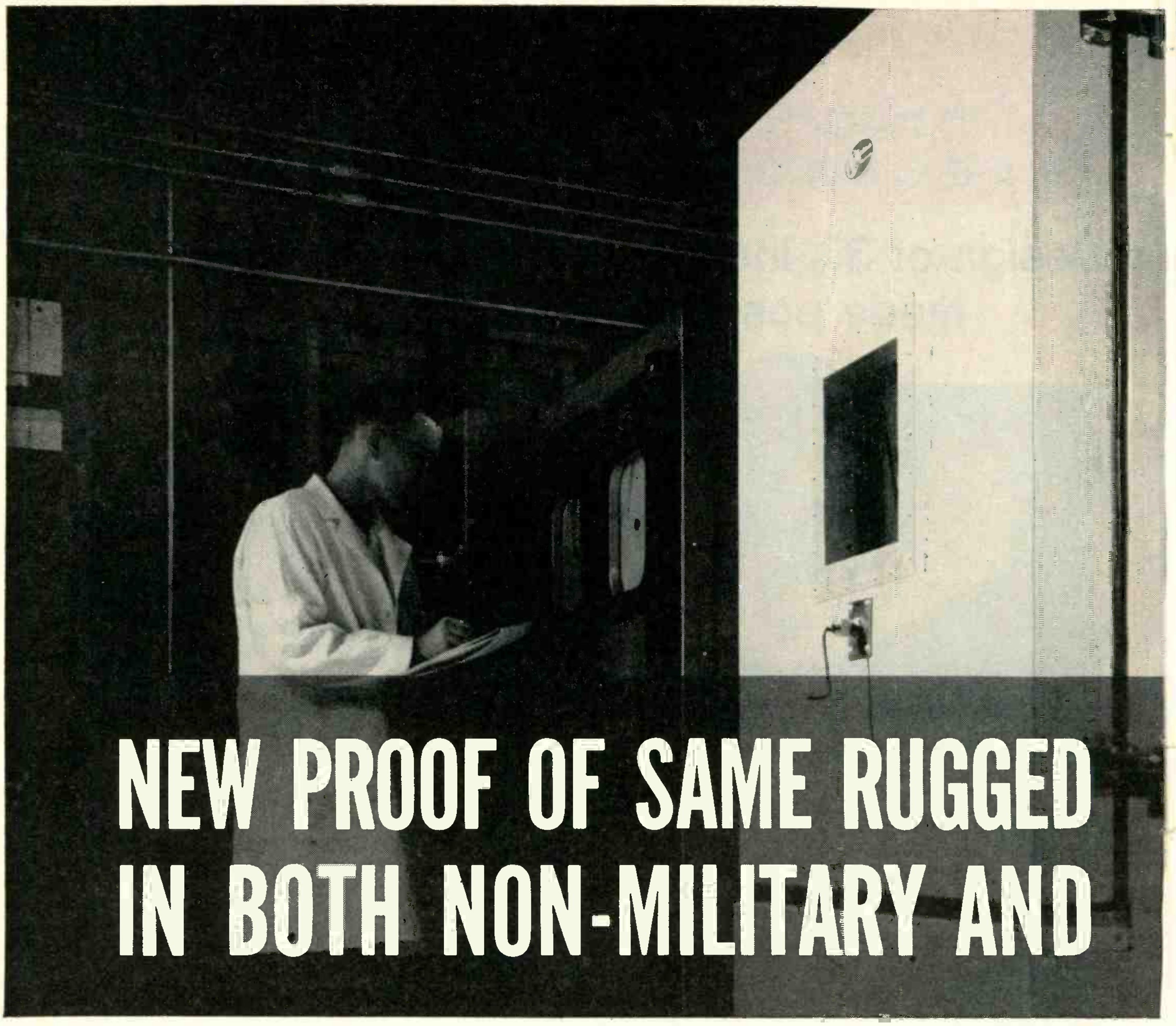
This remotely controlled, motor-operated switch is another example of the use of Du Pont TFE resins to assure **RELIABILITY** and **SAFETY** in electronic operations. We will be glad to send you information covering design data and applications of these outstanding dielectric materials.

Write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Room 1711, Du Pont Building, Wilmington 98, Delaware.

In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec.

TEFLON®
is a registered trademark . . .

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.



New environmental lab provides rigid in-plant testing of all Westinghouse electronic transformers

Westinghouse Specialty Transformer Department has established a new qualification testing laboratory in the Greenville, Pennsylvania, plant. It is fully equipped for in-plant environmental testing—humidity, altitude and temperature cycling—as well as shock and vibration testing.

Specifically designed for testing the complete line of Westinghouse MIL-T-27A electronic transformers, these facilities are also available for all other Westinghouse electronic transformers—whether for MIL-specs or non-military applications. Here is extra assurance that you get the same rugged dependability in all Westinghouse electronic transformers—regardless of use.

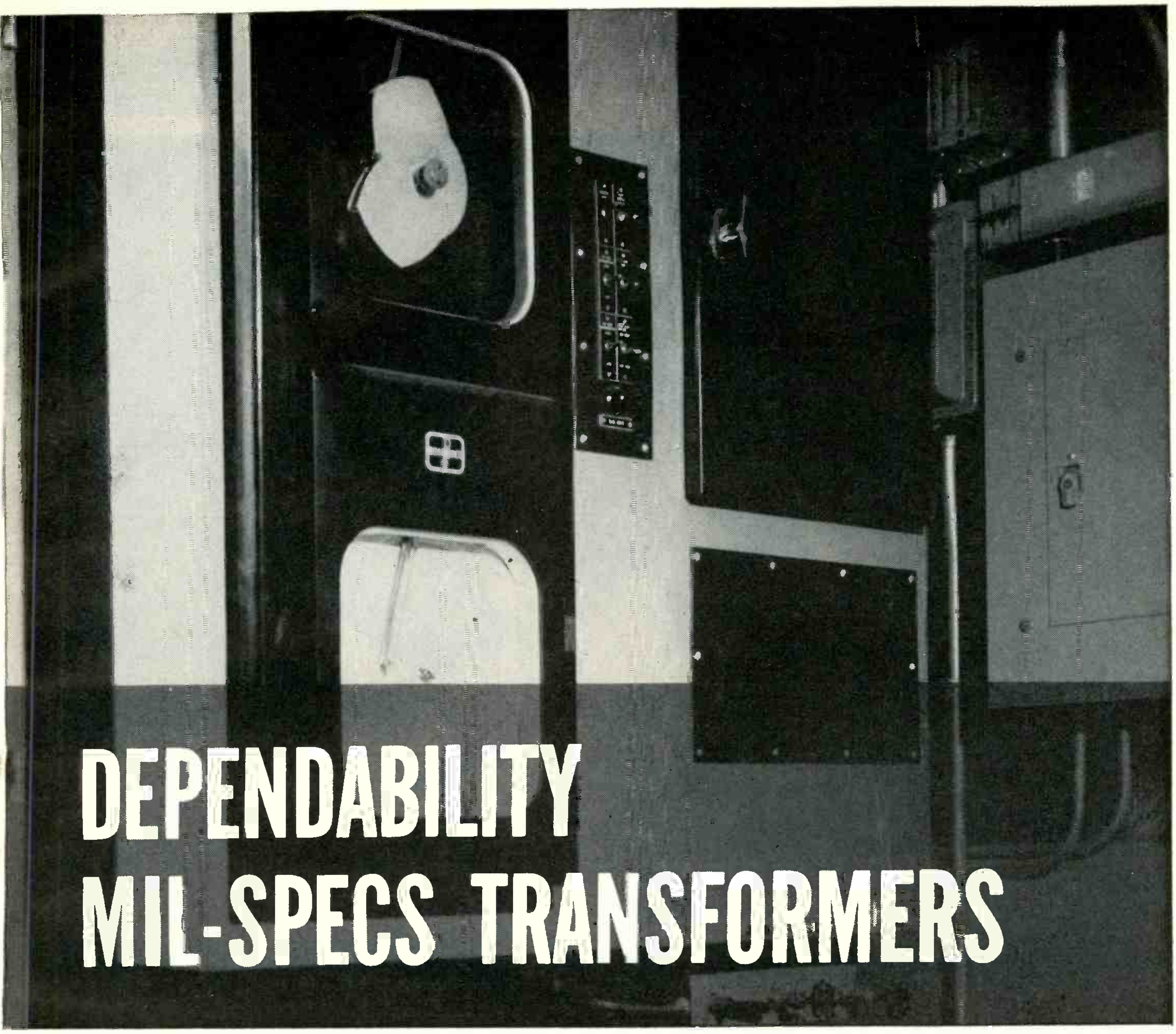
The test lab permits in-plant testing of all types of electronic transformers—hermetically sealed to open type—according to MIL-T-27A and MIL-T-9219 specifications for Grades 1 through 6. These units include the Westinghouse hermetically sealed MIL-T-27A transformers, Grades 1 and 4, and the Westmold, Westseal and molded case transformers, MIL-T-27A, Grades 2 through 6, or MIL-T-9219.

Located at the point of manufacture, this laboratory now means single responsibility by Westinghouse for design, manufacture and testing of the MIL-specs transformers—and non-military transformers—with less delays and faster delivery.

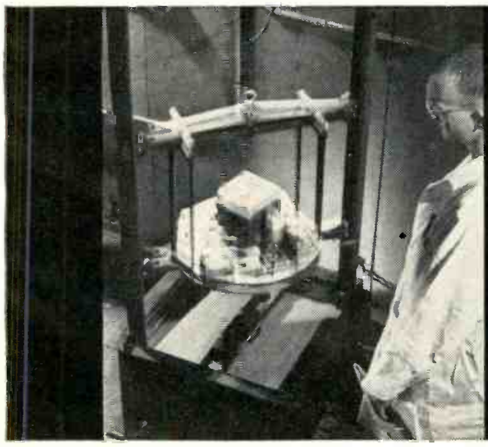
Call your Westinghouse representative for the full story of how in-plant testing in this new laboratory can aid *your* production. Ask, too, about the Westinghouse MIL-T-27A electronic transformers. J-70897

YOU CAN BE SURE... IF IT'S Westinghouse

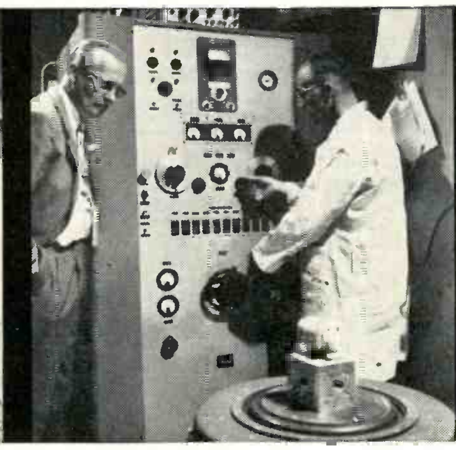
WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS



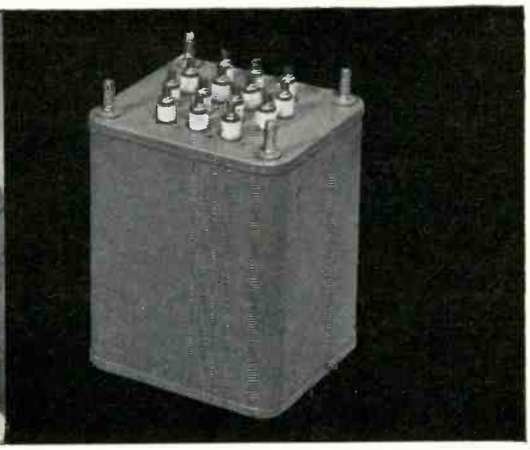
DEPENDABILITY
MIL-SPECS TRANSFORMERS



Westinghouse electronic transformers being shock-tested according to specifications of MIL-T-27A with new in-plant qualification testing equipment.



P. K. Goethe, Specialty Transformer Engineering Manager at the Greenville plant, observes shake-down run of vibration test equipment in new laboratory.



Particularly designed for power applications involving 60-400 cycles, the Westinghouse hermetically sealed MIL-T-27A transformers are available in the complete line of standard MIL-T-27A case sizes.

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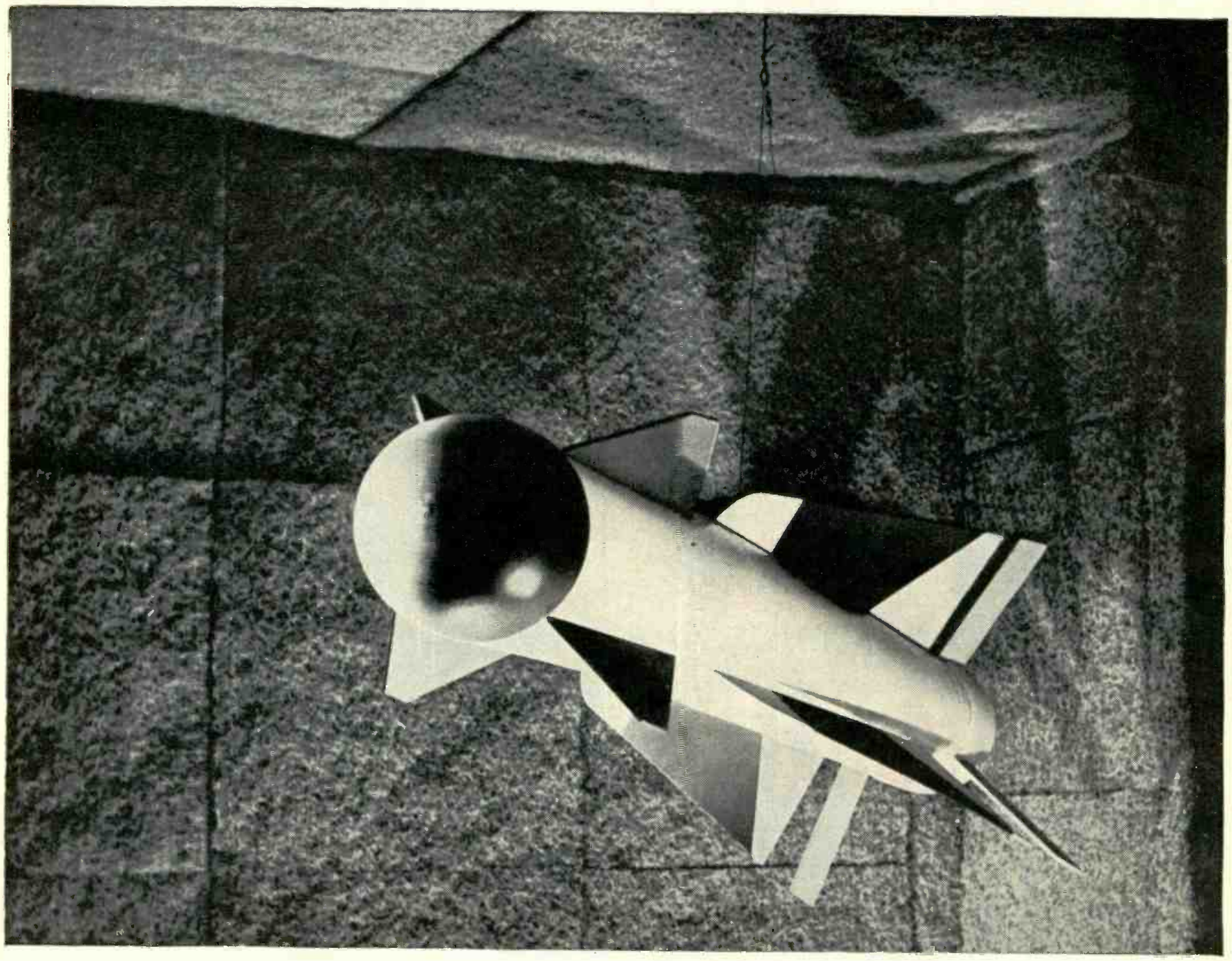
B.F.Goodrich



New low reflective absorbents makes free space tests more reliable

Ten times *lower* reflection is now available with all B. F. Goodrich Microwave Absorbents. This 0.1% material gives reliability to measurements previously unattainable for testing of guided missiles in a free space chamber.

You can now be sure, by selecting the proper B. F. Goodrich material, that you will get this 0.1% performance at any point on the microwave frequency spectrum.

In addition to this outstanding quality, the B. F. Goodrich absorbent is light-weight, fire-retardant, easy to install. It will not deteriorate in performance when walked upon and has excellent water and weather resistant properties. For darkroom use, a special white compound can be applied to the surface of the pads to increase light reflectance.

List of B. F. Goodrich Broadband Absorbents

Designation	Lowest Frequency*	Thickness	Maximum Reflection
12 CM	2500 mc	1½"-2"	2%
12 CM – 1%	2500 mc	1½"-2"	1%
12 CM – 30db	2500 mc	1½"-2"	0.1% at X-band. 2% elsewhere.
6 CM	5000 mc	1"	2%
30 CM	1000 mc	3½"-4"	2%
30 CM – 1%	1000 mc	3½"-4"	1%
60 CM	500 mc	7"-8"	2%
60 CM – 1%	500 mc	7"-8"	1%
100 CM	300 mc	10"-11"	2%
200 CM	150 mc	26"	2%
600 CM	50 mc	69"	2%
8 CM–glass fiber	3600 mc	1"-1½"	2%
4 CM–glass fiber	7500 mc	¾"	2%

Most of the above absorbents can be furnished with 0.1% maximum reflection at selected points in the frequency band.

*All perform up to 30,000 mc

When you're investing thousands, start right—specify B. F. Goodrich—the company with the longest experience and record for *consistently* high quality microwave material. For new booklet on these absorbents write The B. F. Goodrich Company, 486 Derby Place, Shelton, Connecticut.

B.F.Goodrich
microwave absorbents

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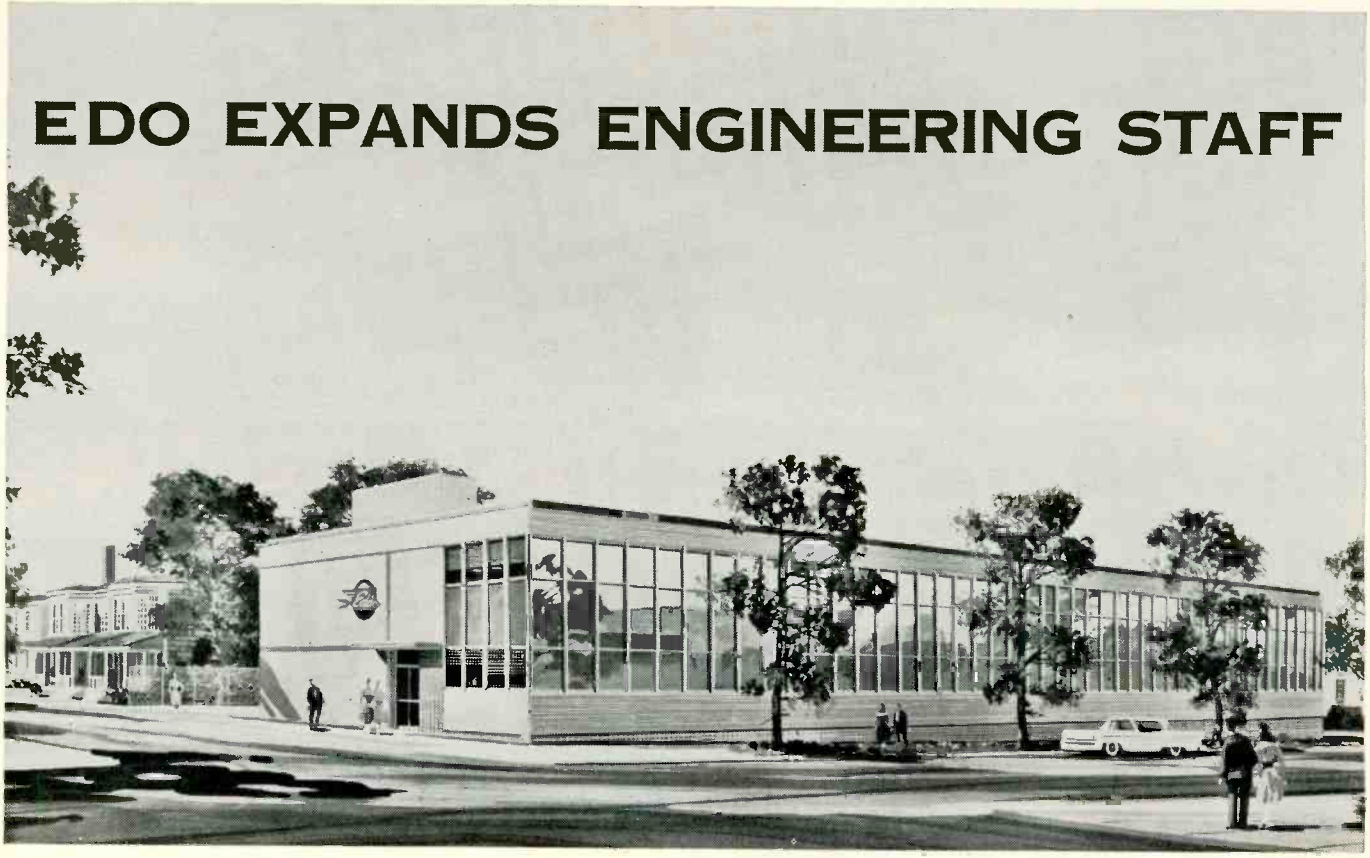
CIRCLE 37 READERS SERVICE CARD →

EDO EXPANDS ENGINEERING STAFF



New Edo Engineering and Administration Building—ultra modern, air-conditioned, on the water at College Point, L. I.

With new Half-Million-Dollar Building, L.I. Electronics and Aeronautical Firm Increases Staff To Handle $10,000,000 Backlog of Orders

Edo Corporation, Long Island manufacturer of electronic, aeronautical and mechanical equipment, moves this month into its new $500,000 Engineering and Administration Building.

Edo, specializing in the design and manufacture of underwater acoustical detection equipment, anti-submarine devices, aircraft components and related equipments, is increasing its engineering staff by one-third with the availability of new facilities. Completion of the new building releases some 18,000 square feet in the present Edo plant for an expanded manufacturing program.

As prime contractor to the U. S. Government, Edo is a major producer of sonar, radar, loran and other complex electronic systems. Edo Airborne Loran, first such equipment to be developed for commercial use since World War II, has been ordered by most of the major international airlines as basic long range navigation equipment in their jet fleets.

Edo is also the world's foremost manufacturer of aircraft floats, designer of advanced aircraft hulls and of the first amphibious helicopter conversion.

In addition to the home plant at College Point, L. I., Edo operates two wholly owned subsidiaries—Edo (Canada) Ltd., at Cornwall, Ontario, and Electro-Ceramics, Inc., Salt Lake City, Utah.

ATTENTION ENGINEERS: Edo has urgent need of engineers with experience in the electronic and aero-mechanical fields. Career opportunities are unlimited with this solid, growing firm. You're invited to phone for interview or send resume to

C. L. Fenn, Chief Engineer
Edo Corporation
College Point, L. I., N. Y.
HIckory 5-6000

EDO Corporation

College Point, Long Island, New York

Manufacturers of a Trusted Line of Marine and Airborne Electronic Equipments

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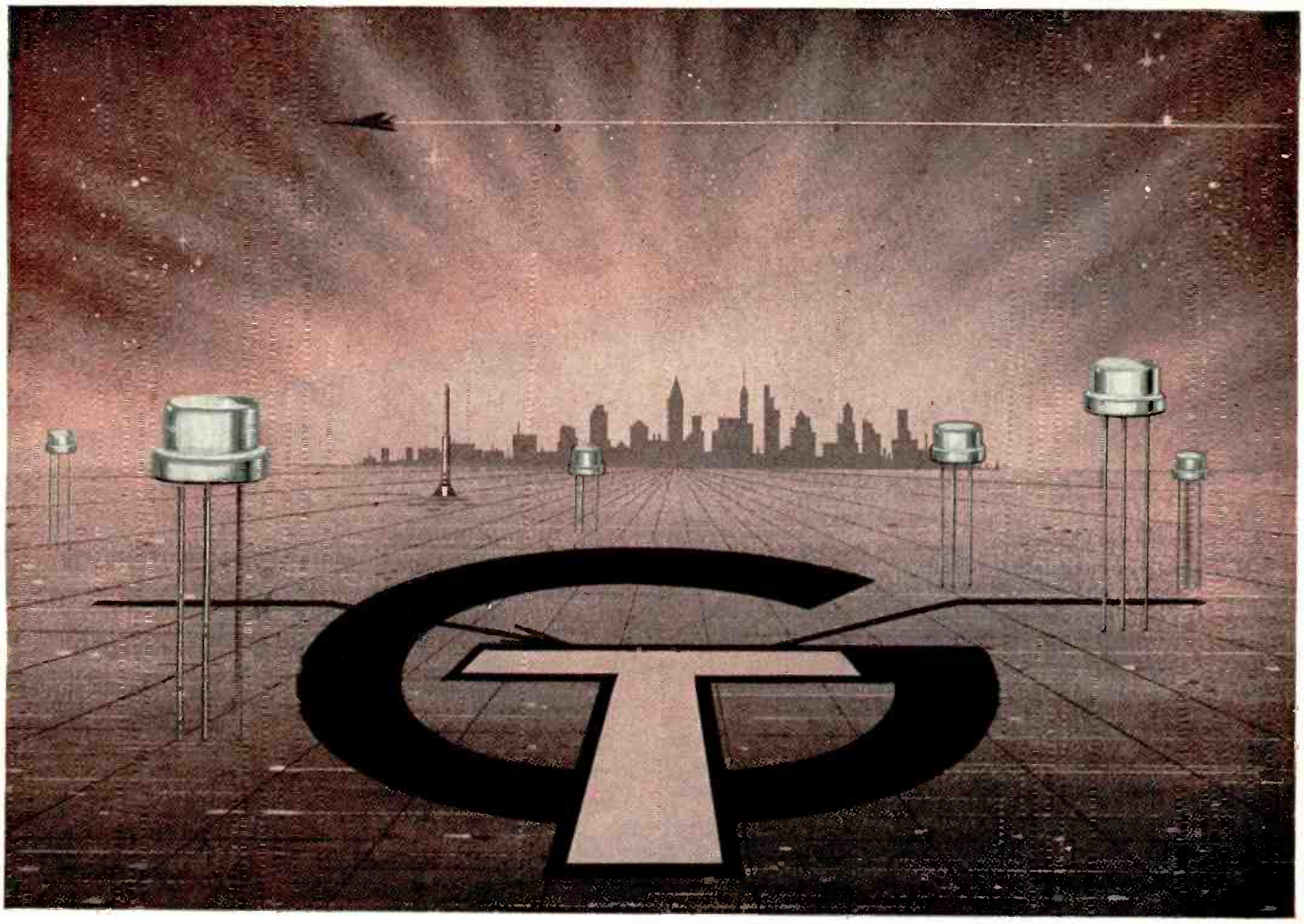


BROADEN DESIGN HORIZONS

with new pnp drift transistors

TYPICAL APPLICATIONS

- TV CIRCUITS
- FM RADIOS
- SHORT WAVE RADIOS
- HIGH FREQUENCY OSCILLATORS
- VERY HIGH SPEED SWITCHING DEVICES

SEVEN NEW DRIFT TRANSISTORS FOR HIGH SPEED SWITCHING AND HIGH FREQUENCY AMPLIFIER APPLICATIONS

General Transistor's new 2N602, 2N603, 2N604 provide the design engineer with guaranteed switching parameters such as gain-bandwidth and DC current gain, while the 2N605, 2N606, 2N607 and 2N608 provide guaranteed power gains at high frequencies.

In addition to the great speed advantages offered by the drift transistor at no sacrifice of gain, such additional features as higher voltages and lower capacity are available. Thus one can now drive higher impedance loads with no sacrifice of speed or pulse power.

The complete control of G. T.'s Drift Transistor assures longer life and maximum performance while possessing complete reliability.

Other features include: high input-circuit efficiency, excellent high-frequency operating stability, good signal-to-noise ratio, good automatic-gain-control capabilities and the rugged mechanical construction of a positive hermetically sealed JETEC 30 case.

WRITE TODAY FOR BULLETIN G-180 INCLUDING COMPLETE MECHANICAL AND ELECTRICAL SPECIFICATIONS, DIMENSIONAL DRAWINGS, GRAPHS AND ENGINEERING DATA.

ALL TRANSISTORS CAN NOW BE SUPPLIED IN FULL COMPLIANCE WITH MIL-T-19500A.

	DC Current Gain h_{FE}		Gain X Bandwidth			Power Gain K_p	
2N602	$V_{CE} = 1$ v	25-100*	$V_{CB} = 5$ v	10-30 mc	2N605	$V_{CE} = 7.5$ v	20-25 db
2N603	$I_B = 0.5$ ma		$I_C = 5$ ma	30-50	2N606	$I_C = 1$ ma	25-30 db
2N604				50-70	2N607	f = 2 mc	30-35 db
					2N608		35-40 db

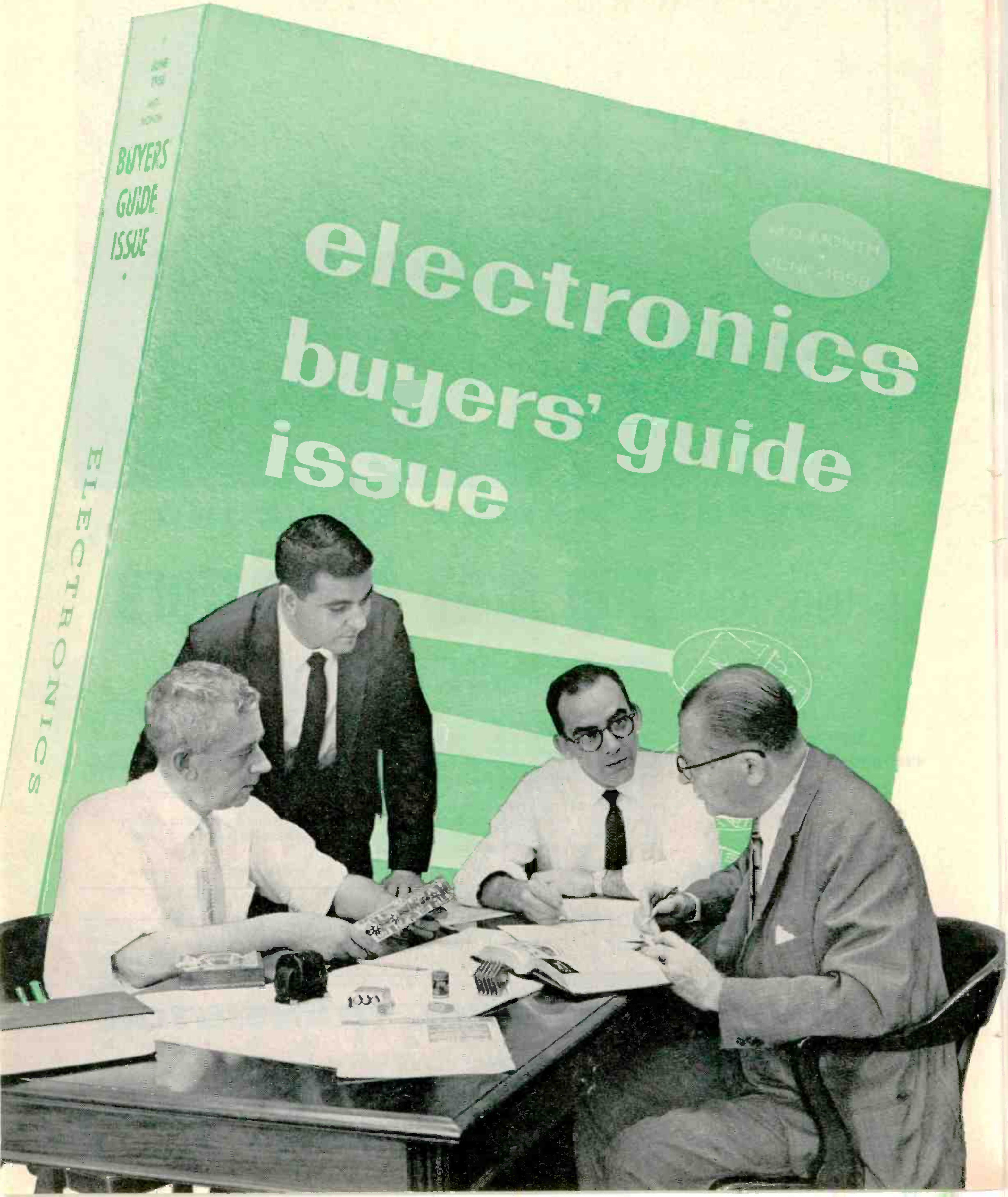
* REPRESENTS RANGE VALUE FOR COMPLETE TRANSISTOR FAMILY AND NOT FOR ONE PARTICULAR TRANSISTOR.

GENERAL TRANSISTOR CORPORATION

91-27 138TH PLACE • JAMAICA 35 • NEW YORK

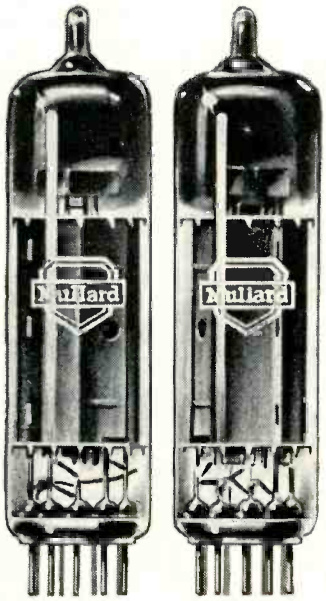
IN CANADA: DESSER E-E LTD., 441 ST. FRANCIS XAVIER, MONTREAL 1, QUEBEC
FOR IMMEDIATE DELIVERY FROM STOCK, CONTACT YOUR NEAREST AUTHORIZED TRANSISTOR DISTRIBUTOR OR GENERAL TRANSISTOR DISTRIBUTING CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK
FOR EXPORT: GENERAL TRANSISTOR INTERNATIONAL CORP., 91-27 138TH PLACE, JAMAICA 35, NEW YORK

The **electronics** BUYERS' GUIDE . .



ELECTRONICS IN BRITAIN

STEREO STEREO STEREO STEREO



EL84

12W high slope miniature pentode

This medium power, high fidelity tube is particularly suitable for stereo equipment. Its high slope of 11,300 μmhos allows two EL84s in push-pull to give over 10W output power at less than 1% distortion—all achieved for only 16V of grid to grid drive.

The EL84 may also be used for the more economical higher powered equipments. Two tubes will provide an output of up to 17W at an overall distortion of 4%.

A single EL84 will provide an output of nearly 6W. It has a maximum plate dissipation of 12W.

Typical performance details for this tube are given here—for further information and supplies write to one of the distributors listed below.

MEDIUM POWER

Distributed load conditions (screen grid taps at 43% of primary)

V_a	300	V
V_{g2}	300	V
$I_{k(o)}$	2×40	mA
I_k (max. sig.)	2×45	mA
R_k (per valve)	270	Ω
$V_{in\,(g1-g1)r.m.s.}$	16	V
R_{a-a}	8.0	kΩ
P_{out}	11	W
D_{tot}	0.7	%

HIGHER POWER

Two valves in class AB push pull

V_a	300	V
V_{g2}	300	V
R_k	130	Ω
R_{a-a}	8.0	kΩ
$I_{a(o)}$	2×36	mA
I_a (mag. sig.)	2×46	mA
$I_{g2(o)}$	2×4.0	mA
I_{g2}(max. sig.)	2×11	mA
$V_{in(g1-g1)r.m.s}$	20	V
P_{out}	17	W
D_{tot}	4.0	%

Supplies available from:

In the U.S.A.
International Electronics Corporation
Dept. E9, 81 Spring Street, N.Y.12,
New York, U.S.A.

In Canada
Rogers Electronic Tubes & Components
Dept. II, 116 Vanderhoof Avenue,
Toronto 17, Ontario, Canada.

Mullard

ELECTRONIC TUBES used throughout the world

"Mullard" is the Trade Mark of Mullard Limited and is registered in most of the principal countries of the world.

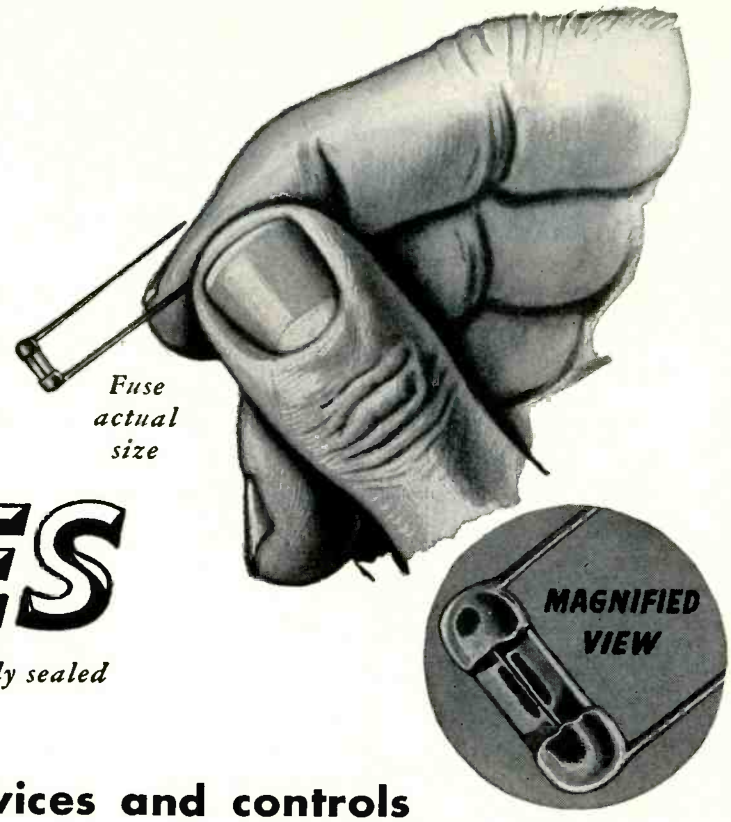
MULLARD OVERSEAS LTD, MULLARD HOUSE, TORRINGTON PLACE, LONDON, ENGLAND

MEV70

CIRCLE 46 READERS SERVICE CARD

Another outstanding development by the makers of BUSS fuses

TRON FUSES



Sub-miniatures — hermetically sealed

Designed to protect miniature devices and controls

TRON fuses make it possible to have the fuse as an integral part of miniaturized circuits, controls, electronic devices, and electrical equipment. There is no need to sacrifice space to provide built-in protection.

TRON fuses have such small physical dimensions that they can be easily incorporated into miniaturized devices or components.

The fuse element is hermetically sealed in a glass tube. Contact is made by pig-tail lead-in wires.

TRON fuses are not affected by atmospheric or surrounding conditions because the hermetic seal protects the fuse element from contact with them.

This means — TRON fuses may be potted or encapsulated, if desired, without any danger of the potting or surrounding material affecting the operation of the fuse.

Or TRON fuses can be installed anywhere in the circuit as they are self-protecting and operate without exterior flash or venting.

Likewise, TRON fuses may be teamed in one capsule or replaceable unit with such components as resistors — or anywhere that sensitive protection is desired.

TRON fuses are made in two types. GLN TRON fuses, made to carry 100% load indefinitely and to open within 10 seconds at 200% load. Available in 1/20 to 1/2 amperes.

GLX TRON fuses made to carry 100% load indefinitely and to open within 10 seconds at 150% load. Available in 2/10 to 5 amperes.

Both GLN and GLX TRON fuses will operate properly on circuits of 125 volts or less capable of delivering 50 amperes or less. The fuse body measures .140 x .300 inches. Standard pig-tails are one inch long of No. 24 copper wire.

When designing an electrical or electronic circuit — where space is of importance — consider the many advantages of TRON fuses. Send us the details of your requirements and our fuse engineers will gladly work with you.

BUSSMANN MFG. DIVISION, McGraw-Edison Co.
University at Jefferson, St. Louis 7, Mo.

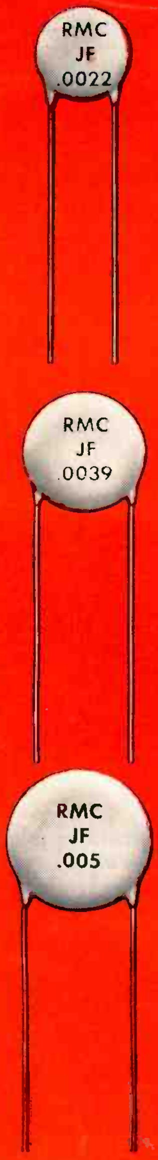
1158

BUSS fuses are made to protect — not to blow, needlessly

BUSS makes a complete line of fuses for home, farm, commercial electrical, automotive and industrial use.

FREQUENCY STABILITY

WITH RMC DISCAPS



TYPE JF DISCAPS

Type JF DISCAPS are especially designed for applications requiring a ceramic capacitor with superior frequency stability. These DISCAPS extend the available capacity range of the EIA Z5F type capacitors between +10° and +85°C and meet Y5S specifications between —30° and +85°C. Now manufactured in capacities between 150 MMF and 10,000 MMF, Type JF DISCAPS exhibit a change of only ±7.5% between +10° and +85°C.

Write today on your company letterhead for information on RMC DISCAPS.

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS COMPANY
A DIVISION OF P. R. MALLORY & CO., INC.
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

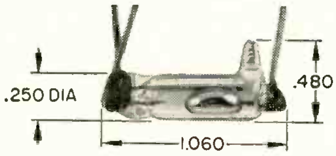
CIRCLE 49 READERS SERVICE CARD

MICRO SWITCH Precision Switches

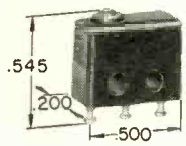
Five switches of special interest to Electronic Engineers Three of them are NEW

NEW

ultra-small super-sensitive mercury switch AS603A1



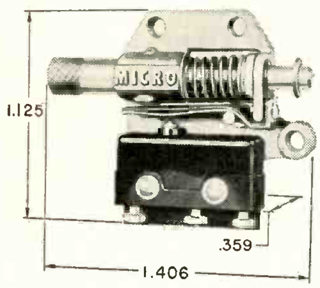
This new switch, designed for vertical gyros, stable platforms, missiles and rockets, is the most precise mercury switch available. Differential angle—.150° max. Mass shift—.085 gm. cm. SPDT. It operates reliably at temperatures as low as −65° F. Hermetically sealed contacts. Switch is unaffected by water vapor, dust, dirt, fungus and corrosive fumes. It is rated at .225 amps., 30 vac, 400 cps resistive load. Weight—3.5 grams (including leads). Ask for data sheet No. 153.



NEW

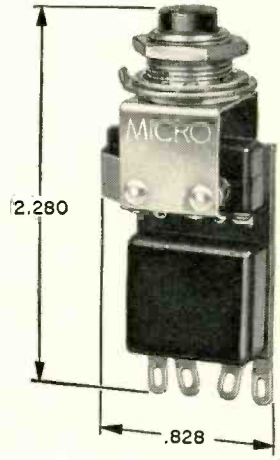
"SX" series sub-subminiature switches

These all-new switches combine extremely small size with "regular size" electrical capacity and excellent reliability. They present a new set of possibilities to the designer of compact devices. 5 amps. 250 vac, 30 vdc. Two mounting holes accept No. 2 screws. Weight—1/28 oz. Ask for data sheet No. 148.



Subminiature door interlock switch 7AC1-T

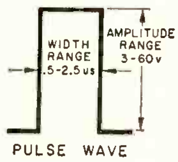
Cuts off power in equipment cabinets when service door is opened. Manually pulling the rod actuator to maintained contact position closes circuit for checking. When door is next closed, switch returns to normal . . . re-sets itself to safety position. Ask for data sheet No. 108.



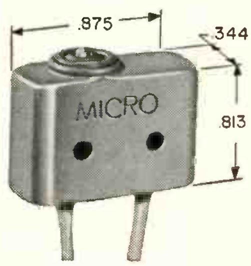
NEW

"1PB600" series "One Shot" switches

These new switch assemblies produce a one-and-only-one pulse output. Miniature package includes push-button switch and potted one-shot circuit. Eliminates need for designing special pulse input circuits for high speed electronic devices. The square wave pulse width is factory adjustable from .5 to 2.5 micro seconds, and the amplitude from 3 to 60 volts. Both width and amplitude are independent of speed of operation of switch. Ask for data sheet No. 150.



"SE" series environment-free subminiature switches



"SE" Series switches are the smallest and lightest environment-free switches available. Construction is completely sealed. Operate reliably from −65° to +350°F. Pin plunger actuation. Choice of contact arrangements. Rating 5 amps. 125 or 250 vac. 28 vdc—15 amps. inrush; 4 amps. resistive; 3 amps. inductive. Weight—.24 oz. (without leads). Ask for Catalog 77.

Engineering assistance in switch applications is available from the MICRO SWITCH *branch office near you. Consult the yellow pages of your telephone book.*

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls, Ltd., Toronto 17, Ontario

Honeywell
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MICRO SWITCH PRECISION SWITCHES

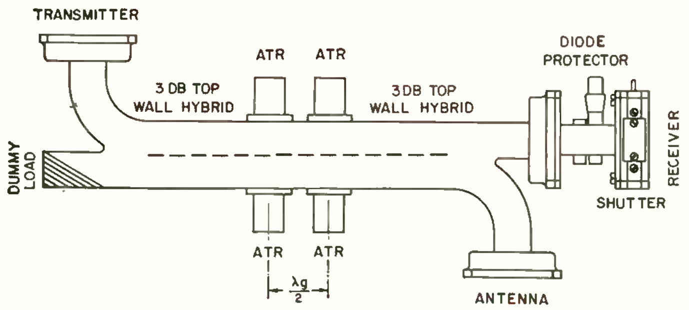
Is one of these FOUR DUPLEXER TECHNIQUES right for you...

To secure optimum performance and reliability in your duplexer system you now have a choice of five basic techniques.

Microwave Associates is in a position to give you completely unbiased recommendations because we design and manufacture all types of gas tube and ferrite devices for duplexer applications.

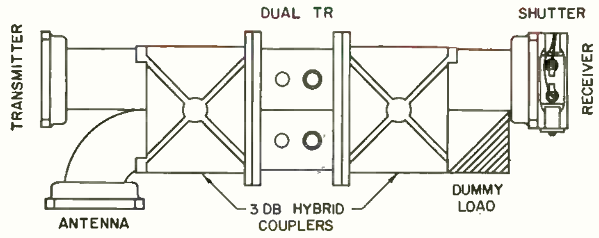
If you have a current problem in this field our application engineering service is at your disposal.

1



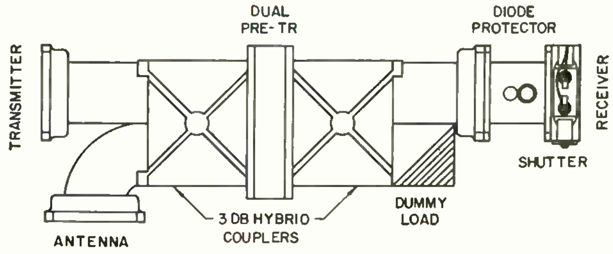
BALANCED DUPLEXER: 4 ATR's, DIODE PROTECTOR, SHUTTER

2



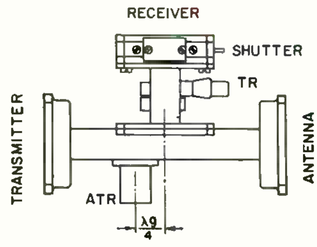
BALANCED DUPLEXER: DUAL TR, SHUTTER

3



BALANCED DUPLEXER: DUAL PRE-TR, DIODE PROTECTOR, SHUTTER

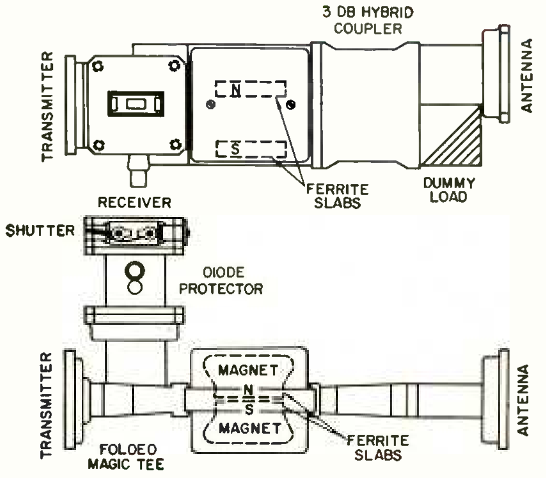
4



BRANCHED DUPLEXER: ATR, TR, SHUTTER

...OR do you need OUR NEW FERRITE DUPLEXER?

5



FERRITE DUPLEXER: DIODE PROTECTOR, SHUTTER

Write or call...

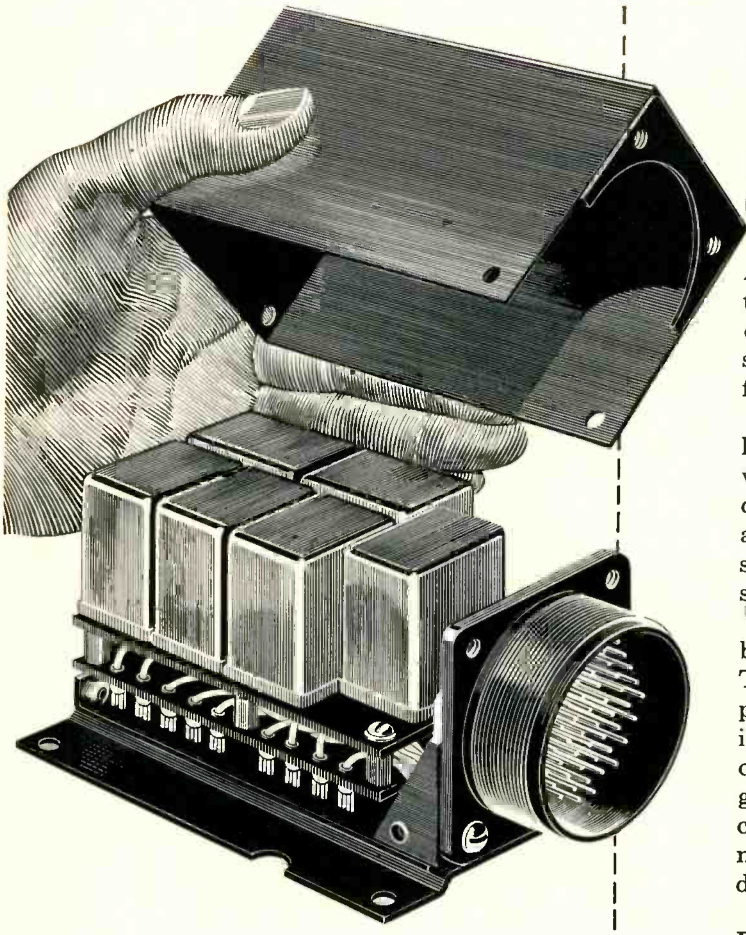
MICROWAVE ASSOCIATES, INC.

BURLINGTON, MASSACHUSETTS TELEPHONE BROWNING 2-3000

CIRCLE 53 READERS SERVICE CARD

When a jet screams down the runway fully loaded with fuel and ammo...reliability is the key to safety and "mission accomplished".

Here's where warning of system failures is vital...where Leach reliability proves itself again and again.



Look to Leach for packaged reliability!

A major airframe manufacturer relies on three types of Leach Relay assemblies in a single dimmer package to solve the problems of pilot safety, visual distraction and eye discomfort for pilots of two of its advanced jet trainers.

The assemblies switch on master caution lights, fire warning lights and other emergency warning lights...each requiring significant differences in intensity to catch the pilot's attention. Each of these assemblies has its own series of resistors and diodes; altogether they serve *27 different circuits.*

Clear lamps of fixed light intensity are used behind green, amber and red colored elements. The resistors in the Leach Relay package permit varying degrees of light intensity for instrumentation illumination. They assure control of instrument panel lighting during ground taxiing, under extreme opaque conditions at high altitudes, during night missions and in the strong brightness of daytime flights.

Most important of all, they do not fail. For dependable relays...for *packaged* reliability, look to Leach!

SEE FOR YOURSELF how Leach relays surpass all others in electrical and environmental specifications. Write today for catalog and complete information.

LEACH RELAY

A division of **LEACH CORPORATION** *5915 Avalon Blvd., Los Angeles 3*

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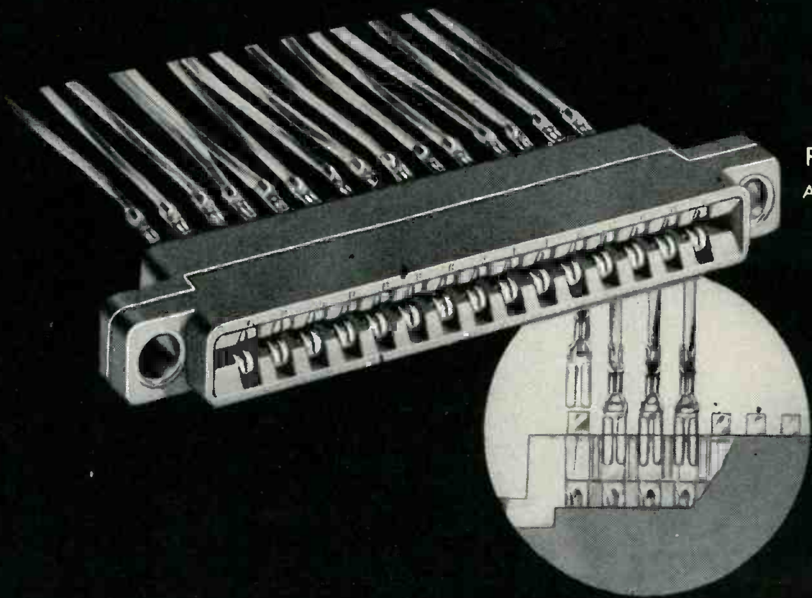
CIRCLE 55 READERS SERVICE CARD

New printed circuit connector with protective taper tab enclosure increases reliability



PCA15-78
ACTUAL SIZE

Continental Connectors

A unique molding on Continental Connector's new Series PCA15-78 printed circuit connector provides uniform spacing and insulation, and eliminates bending, twisting or shorting of contacts during assembly. For additional ease of assembly, contact terminations accommodate AMP "78" taper tab receptacles for solderless wiring. Connectors are supplied with patented and exclusive "Bellows Action" contacts in bifurcated construction. Coil spring action of "Bellows" design results in 100% contact area without loss of retention even with undersized or oversized tolerance boards.

For complete technical information and other printed circuit literature write Electronic Sales Division, DeJUR-Amsco Corporation, 45-01 Northern Boulevard, Long Island City 1, N. Y. (Exclusive Sales Agent)

Enlarged cross-section illustrates taper tab wiring and shows special molded body as an integral part of the connector. The body cavities insulate and assure uniform spacing of contacts.

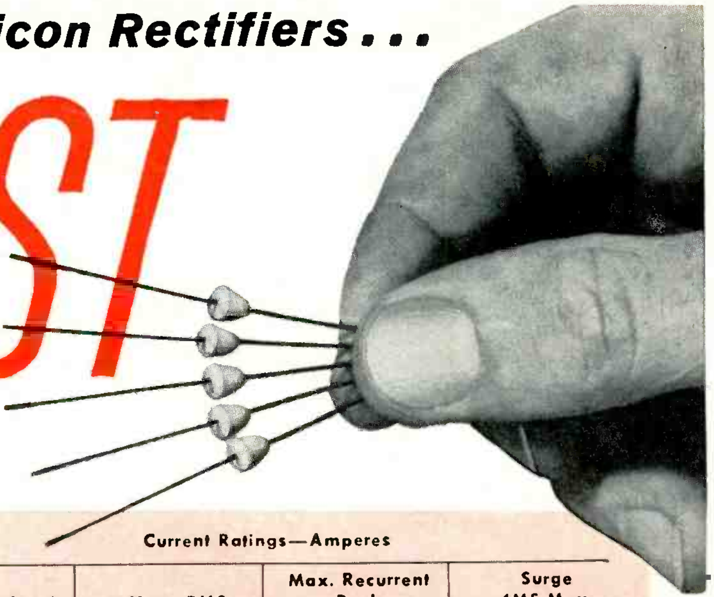
You're always sure with

DeJUR
electronic components

MANUFACTURED BY CONTINENTAL CONNECTOR CORPORATION, AMERICA'S FASTEST GROWING LINE OF PRECISION CONNECTORS

Tarzian F Series Silicon Rectifiers . . .

UTMOST



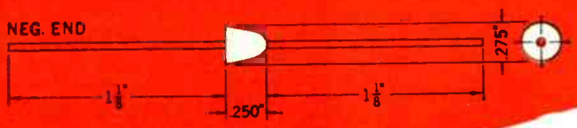
. . . in Performance

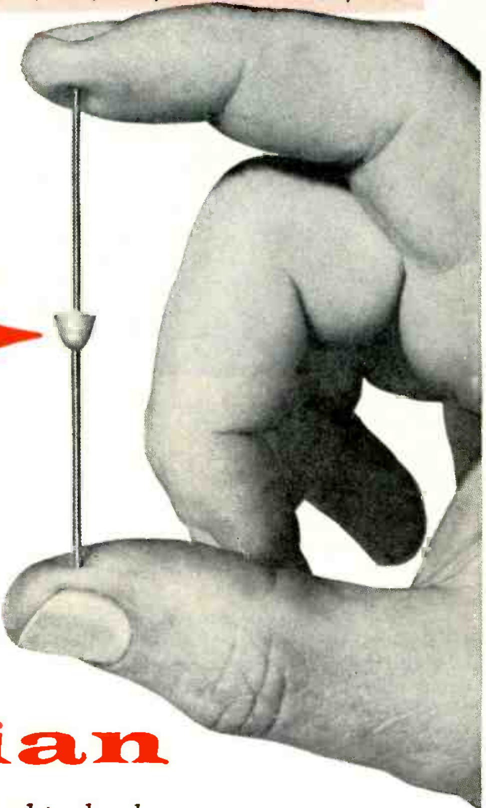
Ratings

S.T. Type	Max. Peak Inverse Volts	Max. RMS Volts	Current Ratings—Amperes: Max. D.C. Load 55°C	100°C	150°C	Max. RMS 55°C	100°C	150°C	Max. Recurrent Peak 55°C	100°C	150°C	Surge 4MS Max. 55°C	100°C	150°C
F-2	200	140	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35
F-4	400	280	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35
F-6	600	420	.75	.5	.25	1.875	1.25	.625	7.5	5.	2.5	75	75	35

. . . in Ultra Small Size

Dimensions





. . . in Low Price

Tarzian

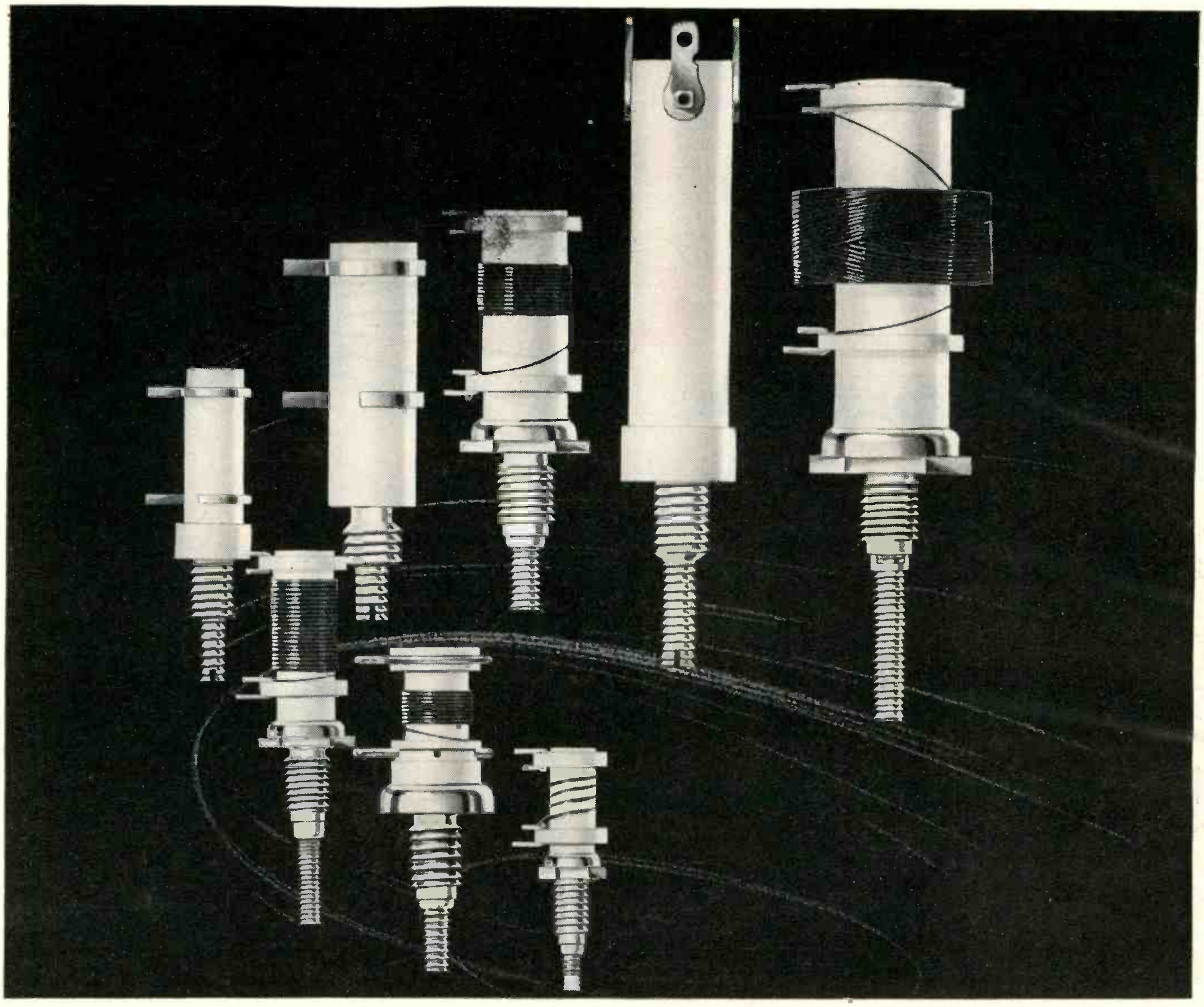
research, engineering and production know-how have combined to develop the "utmost" in a small size, very low cost silicon rectifier with giant performance. If your problem is miniaturization, or cost, or tough application, the solution is in the Tarzian F series.

Send for Design Note #31

Sarkes Tarzian, Inc., Rectifier Division

DEPT. D-5, 415 NORTH COLLEGE AVE., BLOOMINGTON, INDIANA

IN CANADA: 700 WESTON RD., TORONTO 9, TEL. ROGER 2-7535 EXPORT: AD AURIEMA, INC., NEW YORK CITY



Standard Coil Forms with screw thread mounting are LS-3, LS-4, LS-5, LS-6, LS-7, LS-8, LS-M, and LS-T. The LS-5, -6, -7, -8, and -T are available with Perma-Torq®.

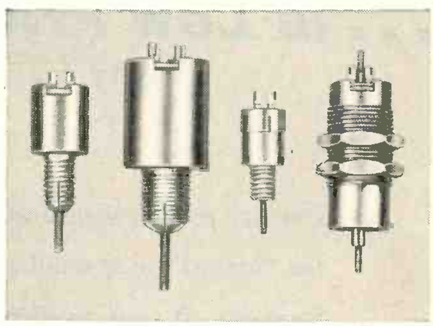
Coil up with this Form!

There's a guaranteed CAMBION® coil form for every coil winding problem! The CAMBION stock of standard coil forms provides a reliable source for any quantity you need, and CAMBION custom components carry the *same* guaranteed performance.

Standard CAMBION coil forms are compactly designed and carefully manufactured to withstand the most severe working conditions. They mount with a screw thread, are available with a variety of locking devices, including unique Perma-Torq® which allows locking of tuning cores while still tunable.

CAMBION printed circuit coil forms are ideal for use in printed and transistorized circuits. Time-saving coil leads can be soldered to circuitry when the component is mounted. Available in a wide range of sizes and materials—and you can rely on their performance.

Get guaranteed performance from every single coil by ordering CAMBION coils. Write Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Massachusetts. West Coast stocks handled by E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles 16, California. In Canada: Cambridge Thermionic of Canada Limited, Montreal, P. Q. CAMBION products now available from leading distributors throughout the U. S. and Canada.



CAMBION shielded coil forms are specially designed to give top performance in "tight spots." The LS-9 is 7/16" in diameter, 1/2" high. LS-10 is 5/8" in diameter, 1 5/16" high. LS-11 is 5/16" x 17/22". The LS-14 is double ended, 1/2" O.D., and 1 5/64" overall. All are highly shock resistant.

CAMBRIDGE THERMIONIC CORPORATION

CAMBION®

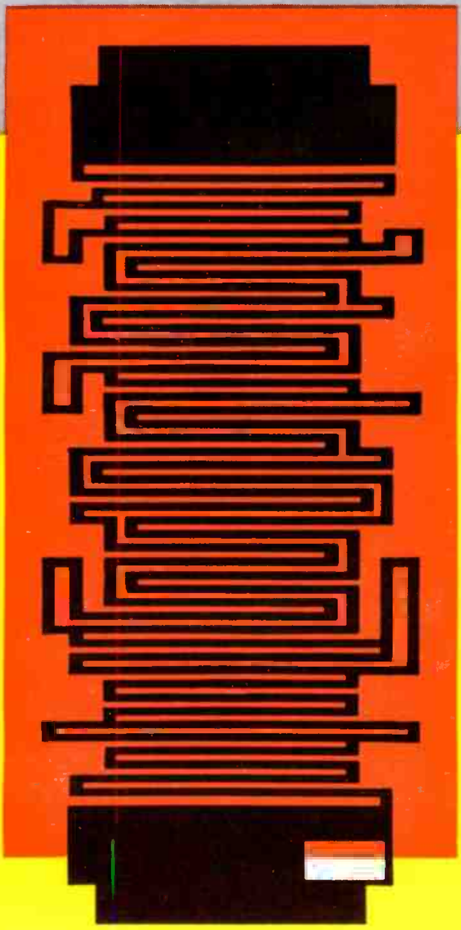
Makers of guaranteed electronic components, custom or standard

CIRCLE 58 READERS SERVICE CARD

CIRCLE 59 READERS SERVICE CARD→

ALLEN-BRADLEY PRESENTS...

NEW METAL GRID



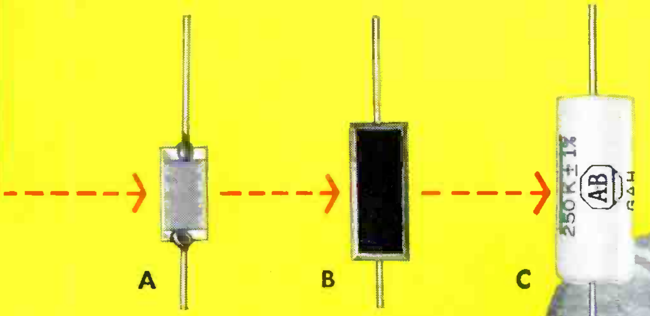
¼, ½, and 1-WATT

PRECISION RESISTORS

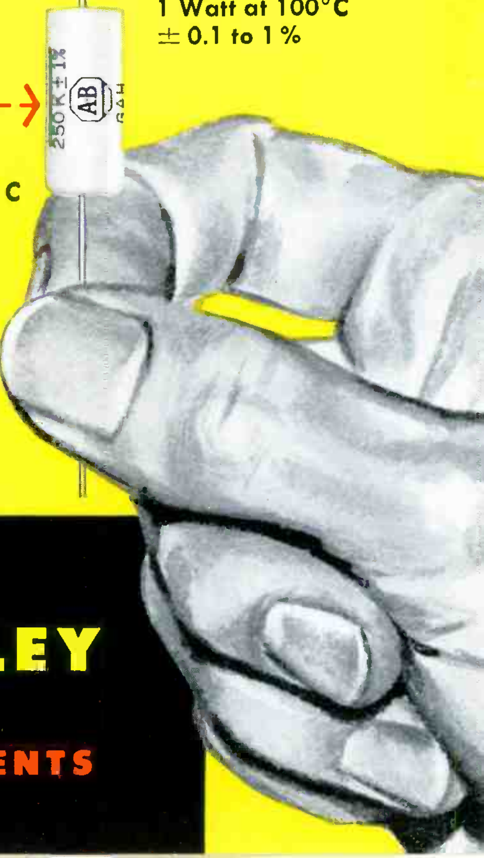
A-B QUALITY

Far exceed MIL Specs for film and wire-wound resistors

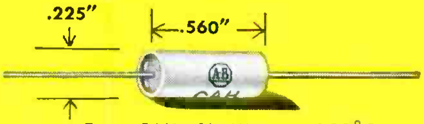
Allen-Bradley's new, truly accurate, metal grid resistors are now available in ¼, ½, and 1-watt ratings, producing test results that are a substantial improvement over the MIL Specifications for wire-wound and film type precision resistors. They combine remarkable stability, under load and on the shelf, with an exceptionally low temperature coefficient. The metal alloy grid is noninductive, providing excellent high frequency characteristics. They also have an exceptionally low noise level... comparable to that of wire-wound units. Each unit is individually calibrated and marked with nominal resistance value, tolerance (± 0.1 to 1%), and temperature coefficient. Provided with gold plated leads for flawless soldering. Considering their superior characteristics, these new resistors justly qualify under the Allen-Bradley trademark of *Quality*.



A B C

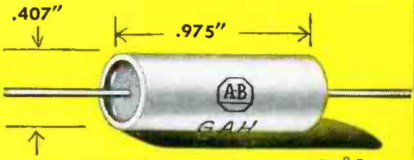


Type GAH
1 Watt at 100°C
± 0.1 to 1%



Type CAH—¼ Watt at 100°C

Type EAH—½ Watt at 100°C



Type GAH—1 Watt at 100°C

The construction of the ¼, ½, and 1-watt resistors is identical. At the upper left is an enlarged view of the metal alloy grid, mounted on glass, which forms the resistance element. (A) Actual size of 1-watt element, (B) encapsulating epoxy resin body, (C) finished unit hermetically sealed in ceramic tube.

Allen-Bradley Co.
222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY
QUALITY
ELECTRONIC COMPONENTS

6-58-E

transmissions permit instantaneous switching on the spot or by remote control.

New functionally designed control panels are clean, legible, easy to understand. All components are readily accessible for fast inspection and simple adjustment.

The most comprehensive operating manuals in the industry are included with every Brush product.

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DIVISION OF

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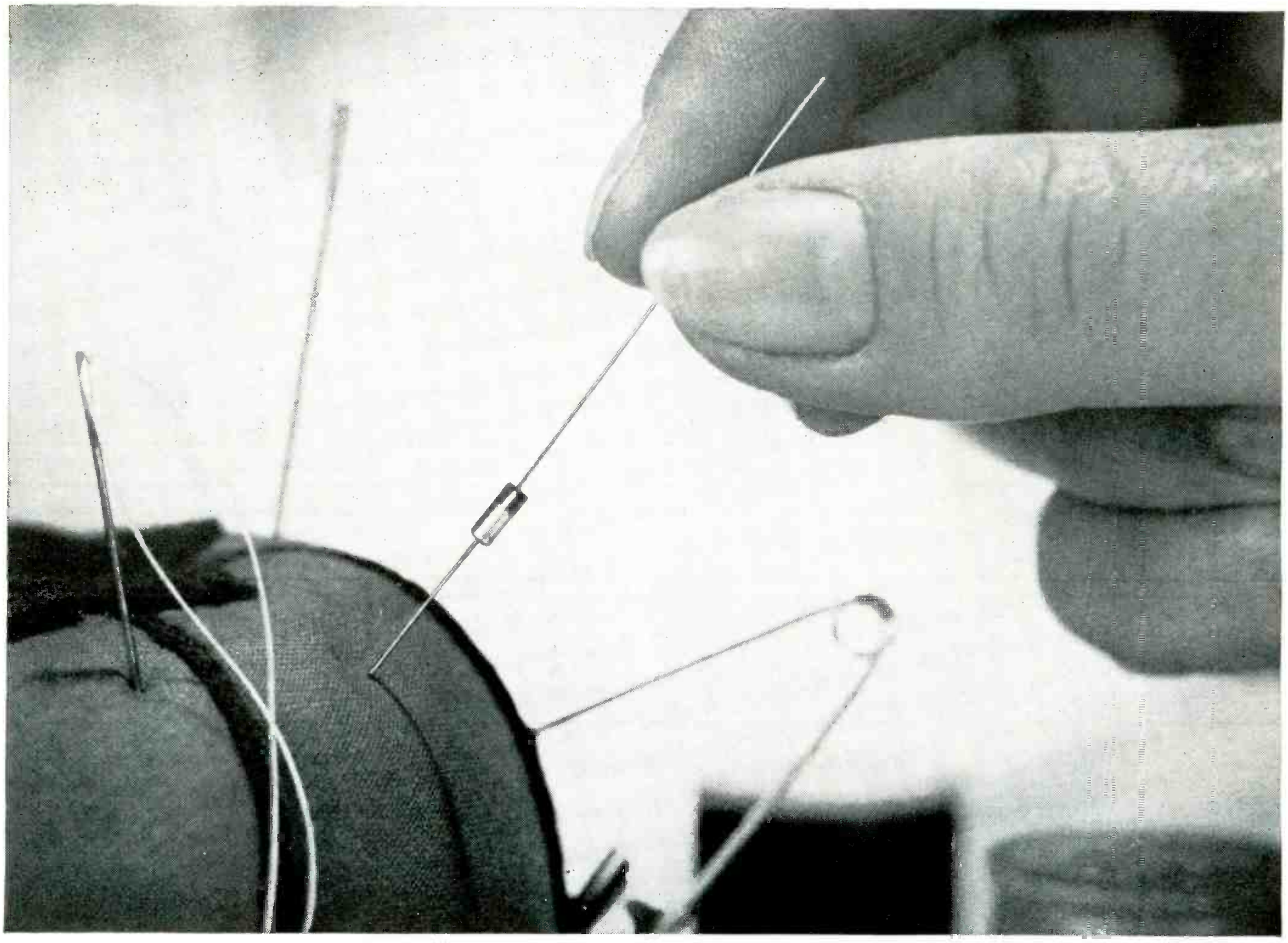
CIRCLE 63 READERS SERVICE CARD



Not a Hat Pin–But a NEW Capacitor

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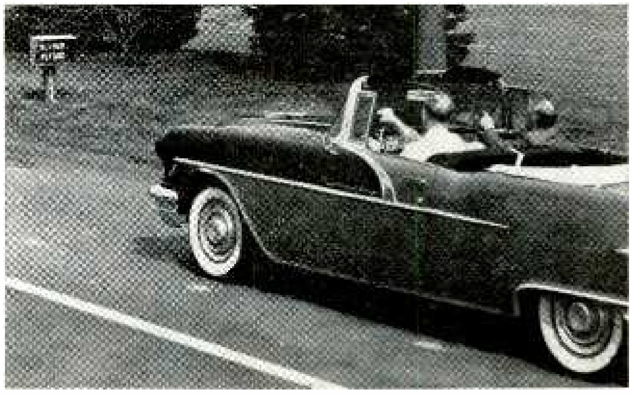
electronics
engineering issue
NOVEMBER 21, 1958

Steering, accelerating and braking operations are all done by moving single stick in GM's Unicontrol system



Illuminated sign actuated by RCA's roadside signaling system advises driver his car is exceeding speed limit

Electronics and the American Automobile

Current development programs directed towards the use of electronics to improve safety, performance, reliability and sales appeal of cars promise big, new market. Devices and systems discussed here represent results to date

By WILLIAM E. BUSHOR, Associate Editor, ELECTRONICS

THIS ARTICLE summarizes known applied and experimental electronic developments related to American passenger cars.

Control Systems

GM Research has developed an electronic system, termed Unicontrol, which takes over the functions of the conventional steering wheel and those of the brake and accelerator pedals as shown in photo.

Sidewise motion of the spring-centered control stick controls steering; fore and aft motion controls the engine throttle or the brakes. Intracardinal stick displacements permit various degrees of braking and accelerating during turns. A 20-degree rotation about the vertical axis in either direction puts car in reverse, an 80 degree turn puts car in park.

Stick motion operates two potentiometers either singly or jointly. One feeds a voltage to an electronic analog computer in the steering system, the other feeds a command signal to a servo system controlling either the throttle or the brakes.

The steering computer combines a potentiometer signal with one from a tachometer generator indicating car velocity and another from a detector indicating front wheel positions. The resulting signal is fed to an electrohydraulic valve which regulates flow of high-pressure oil to the power piston used to turn the front wheels. Front wheel angle for a given stick displacement varies inversely as the square of the speed.

Voltages applied to the brake servo regulate hydraulic pressure in the wheel cylinders. Braking torque is directly proportional to the displacement angle of the stick. A sensing element automatically detects premature wheel slowdown and maintains proper line pressure to prevent brake lockup.

A second independent but less complicated electrical steering system is available for emergency use which is also operated through the Unicontrol stick. A foot pedal is provided to switch in auxiliary steering system and to actuate an emergency braking device.

Unicontrol can be complemented with a device called Cruisecontrol which automatically maintains road speed at any preset value. Command signals from the speed selector, car speed feedback signals from the tachometer generator and signals from a throttle position indicator are fed into an analog computer. Signals required to maintain car speed are calculated and used to operate an electrohydraulic control valve in a throttle servo.

Ford is experimenting with an electronic system which will control steering. The system replaces the conventional steering wheel and transmission shift lever with tiller controls as shown in Fig. 1.

Right or left turns are made by moving the steering control in the corresponding direction. A potentiometer wiper arm connected to the stick generates a signal which is compared with a positioning signal from a slave on the Pitman arm of the steering linkage. If the position of the wheels does not correspond to the command position, an error signal equal to the difference between the potentiometer and the slave signals is generated. The error signal is then boosted by a servo amplifier and the output applied to a torque motor which operates a hydraulic valve controlling the front wheels.

Highway Guidance Systems

RCA has demonstrated the possibility of controlling highway traffic using visual roadside signaling, radio signaling and automatic guidance techniques. The roadside system, shown in photo, consists of an array of wire loops imbedded in a highway, with associated electronic equipment buried on the shoulder. The rectangular 20 by 6-foot loops consist of two turns of plastic insulated trench wire spaced at intervals from center to center slightly longer than an automobile. A plan-view block diagram of the system is given in Fig. 2A.

Each loop is excited by one volt at 300 kc. As a car passes the loop inductance changes, varying the phase relationship between the loop voltage and the excitation voltage. This difference is sensed by a phase detector which produces a d-c output proportional to the change in inductance of the loop. The weak detection signal is applied to a d-c amplifier whose output is used to actuate a relay controlling the operation of roadside or in-vehicle equipment.

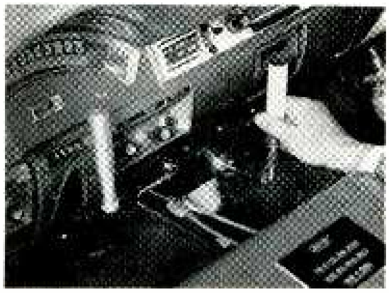


FIG. 1—Ford's control system uses two tiller sticks. Right is for steering, left controls automatic transmission

By adding selection circuits, the signals can be used to activate a series of lights along the edge of the highway. Thus, a car can have a visible tail of light following some 400 feet or more behind which warns following drivers they are approaching the preceding vehicle.

To provide drivers with information on the movement of cars ahead when visibility is poor, or to automatically brake the car under collision conditions, the roadside signal can be supplemented or replaced with radio signals. In addition to the equipment used with the roadside signaling system, the radio signaling system requires an electronic control unit and an antenna for each loop as shown in Fig. 2B.

Single Antenna Signalling

The simplest system uses antennas which extend back along the highway any desired distance. As a car passes over a loop, a roadside signaling relay is actuated. Output of the relay triggers a transistor switch in the electronic control unit, which permits a 110-kc signal to be applied to the antenna. Since the antenna is open-ended, the radiation intensity at any point is a function of the distance to the loop. If the auto is equipped with a properly tuned receiver the signals can be detected, amplified and used to operate dashboard lights, to sound a buzzer, or to control the accelerator or brakes.

Length of the radio "tail" is determined by the ON time of the transistor switch. This interval can be controlled by presetting a timing device to turn off the transistor switch after a desired time lapse. Also, the interval can be controlled by the speed of the vehicle through a circuit in the electronic control which will switch off the transistor switch of the preceeding electronic control. Thus, as a car moves from one loop to the next it will successively energize the antenna associated with the loop it is over but cut off the signal to the antenna associated with the preceeding loop.

Chain Antenna Signalling

A more complex system involves the use of an antenna chain in which each antenna is a car length long, terminated at one end to ground and at the other end through resistive coupling to the preceeding antenna. As a car passes over a loop it triggers the transistor switch in the associated electronic control, causing a maximum r-f signal to be applied to its antenna. Before reaching the preceeding antenna; however, the signal is attenuated by the coupling to 90 to 95 percent of its original strength. This process continues down the chain of antennas until the radiated signal is too small to be detected.

Another transmission scheme is to transmit a constant carrier and modulate it with a frequency whose

THE FRONT COVER—An experimental rear-view road-scanner tv system developed by Universal Broadcasting for the Buick Centurion solves the blind spot problem inherent in mirror arrangements.

The trunk-mounted camera is equipped with a wide-angle lens which gives a greater field of vision than a rear-view mirror. A true image of the road behind the car is displayed on a 4 in. by 6 in. tinted screen on the dashboard receiver unit.

The electronic control unit behind the rear seat uses special locked-in stabilizing circuits designed to hold adjustment of conventional internal tv receiver controls for a year. System power requirements compare favorably with auto radio.

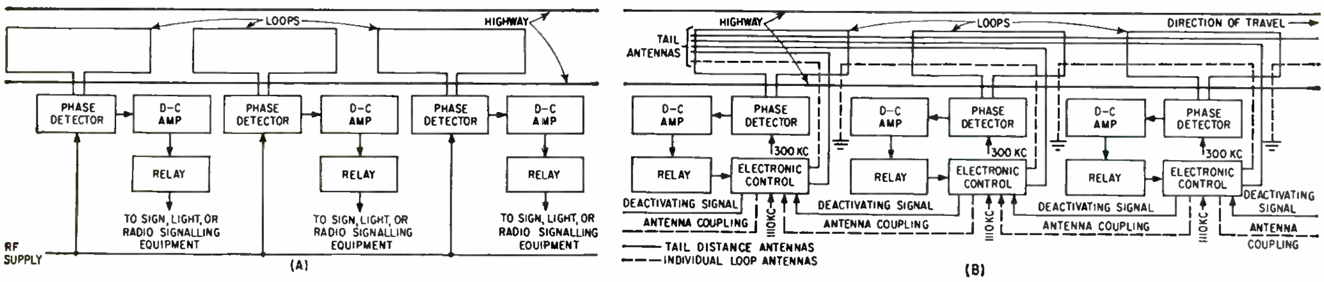


FIG. 2—Roadside signaling system layout (A) does not require aux liary equipment in cars. Radio signaling system (B) produces radio-frequency signals which operate lights or buzzers in equipped cars

amplitude is proportional to the "tail" signal transferred from loop to loop. This technique gives higher radiation intensity at the end of the "tail" and reduces sensitivity requirements of receivers.

Late last year, RCA demonstrated a form that automatic guidance could take by blind-driving an auto over a special test highway. A high-frequency current applied to a cable made of insulated trench wire imbedded in the center of the road was used as the guidance reference source. A pickup coil attached to each side of the vehicle straddled the cable and sensed the r-f radiation. By arranging the signals in voltage opposition, a differential signal was generated which registered on a meter in the dashboard; left or right deflections indicated to the driver in which direction to steer the car.

GM Research has developed an electromechanical link which eliminates driver control, as shown in Fig. 3. The guidance wire is located in a slot cut into the road surface and is excited with low-power audio frequency. Current flowing in the wire creates a circular magnetic field extending the length of the cable. Two pickup coils mounted on the front bumper are tuned to the frequency of the guidance wire excitation voltage.

In operation, the coil straddles the magnetic field around the guidance wire; therefore, the voltage across the output terminals of the pickup coils is proportional to the magnetic field strength sensed. If the car deviates laterally from the guidance wire path, voltages are induced in the coils which are different by a function of the cyclically varying magnetic fields received. Positional error is proportional to the difference in voltage magnitudes. This error signal is fed to the steering computer in the Unicontrol system and the car steered as though signals were coming from the control stick. If the signal is lost for any reason, or if the hydraulic pressure in the servo drops, a buzzer warns the driver.

In GM's experimental gas turbine car Firebird III the driver can put the car completely under electronic control by using Autoguide and Cruisecontrol together. These systems provide steering, braking and throttling control while allowing driver to retain the prerogative of overriding through an emergency foot pedal.

FIG. 3—GM Research's Autoguide system takes over steering function from driver. In demonstration auto above, driver retains control of brake and accelerator

Garage Guidance System

A guidance system developed by Polarad Electronics permits drivers to maneuver in and out of a garage without striking the sides. The car is provided with a loop antenna mounted on the front part of the roof as shown in Fig. 4A. Two loop antennas, wound to produce oppositely phased inductive fields, are mounted to the garage sides near the back and the same height above the floor.

Both garage transmitting antennas are simultaneously excited by a 60-cps source and the receiving antenna is connected to the car radio as shown in Fig. 4B. If the car moves away from the centerline between garage antennas, an audible signal is heard whose volume corresponds to the amount of lateral deviation. It is also possible to excite the garage loops with an r-f source modulated by oppositely phased a-f signals. Circuit configuration for the arrangement is shown in Fig. 4C.

Warning Systems

Bendix Research has built an experimental model of a proximity radar system which requires less power than a radio. It is capable of warning drivers that collisions are imminent with other moving vehicles or stationary objects.

Since the radar is forward-looking, the antenna is set into the front grillwork of the auto as shown in Fig. 5. An electronic control unit housing radar circuits and a computer is located directly behind the antenna. A driving condition selector and a tone generator are mounted under the dashboard.

As the equipped vehicle moves along the road, the antenna sends out a narrow-beam radiation pat-

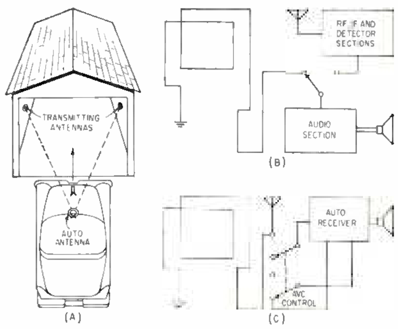


FIG. 4—Garage guidance system provides driver with audible signal if approach is skewed (A). Audio excitation requires auto's loop antenna to be connected directly to audio section of car radio (B); r-f excitation requires use of entire radio except for avc circuit (C)

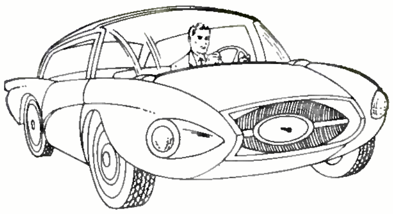


FIG. 5—Small antenna of Bendix Research's radar warning system is mounted in grillwork

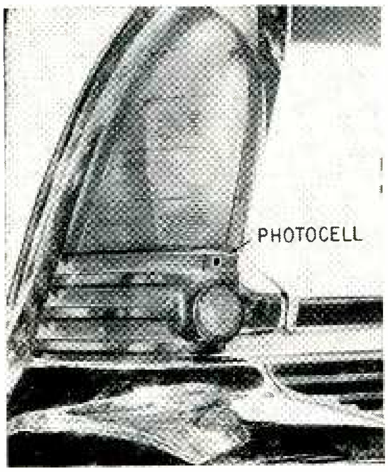


FIG. 6—Photocell for brake light warning system that warns an overtaking driver he is too close

tern. Signals reflected from vehicles or obstacles ahead are detected by the radar circuits and fed into the computer. Relative speed and distance relationships between the vehicle and reflecting surface are calculated and the result compared against a predetermined range of parameters known to be safe. If the closure rate exceeds the safe range, the computer energizes the tone generator, producing a sequence of 400-cycle bursts of sufficient loudness to alert the driver. The computer output can also automatically halt the vehicle.

Antenna Beam

Although the antenna is small, beam width is adequate for adjacent lane discrimination. The system is designed to eliminate any return from an obstacle which is beyond the safe stopping distance of the vehicle. For sharp turns into driveways and at intersections the system is disabled.

When the equipped car is approaching a stalled or slowly moving vehicle which is a great distance away, the 400-cps warning signal is of low intensity, indicating a moderate degree of collision danger. As the closure distance decreases, the warning signal becomes louder, indicating a more dangerous situation. A scheme for using lights to indicate less hazardous conditions and an incessant, imperative sound to warn of critical conditions is being studied.

Ford has demonstrated a device that flashes a warning to a following motorist when he is approaching an equipped vehicle too rapidly from behind. It consists of a photocell mounted as shown in Fig. 6 and a computer. If the forward vehicle is equipped with the system, the photocell will detect the intensity of headlight illumination from the following vehicle. The computer operates on this information, calculating distance and closing velocity. When separation distance is less than a predetermined safe following distance, the brake lights on the equipped car are flashed on to alert the following driver.

Studebaker-Packard told ELECTRONICS it is presently developing a brake warning system, but gave no details. (Another warning device, about which little is known at present, is an electronic atmosphere sampler invented by a Dane. If the driver has been drinking or is under the influence of narcotics, the device shuts off the engine; if carbon monoxide is present it shuts off the engine and blows the horn.)

Headlight Controllers

A headlight dimmer that automatically turns off the high beam and turns on the low beam whenever light strikes a photocell has been designed by Polarad Electronics. When the device fails to respond properly the headlight system is automatically returned to its original condition, allowing the headlights to be controlled in the conventional manner. The driver may dim his lights at any time and leave them dim. Also, the circuit arrangement assures that once the lights have been dimmed they will not return to the high beam as a result of a momentary reduction in the intensity of light striking the photocell. See Fig. 7A.

Guide Lamp recently transistorized the Autronic Eye circuit. The new system will hold the low beam setting even if the approaching driver dims his headlights. When light is completely removed from phototube, the headlamps are returned to high beam. However, street lights are sufficient to keep system on low beams (Fig. 7B).

Chrysler is offering an electronic headlight dimmer as optional equip-

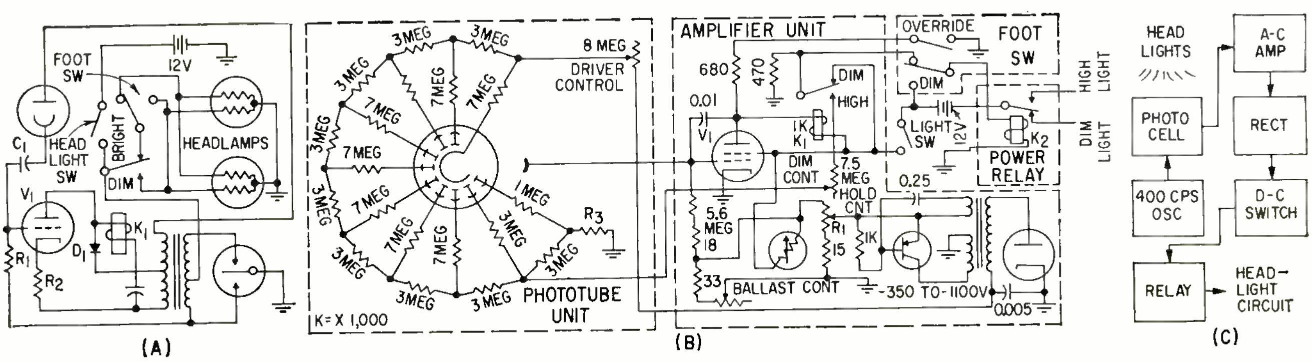


FIG. 7—Headlight dimming circuit developed by Polarad (A) is relatively insensitive to battery voltage fluctuations. Guide Lamp's new headlight dimmer (B) uses self-excited, 20-kc transistor oscillator. RCA's headlight dimmer (C) uses an a-c amplifier

FIG. 8—Demonstration model of Westinghouse's electroluminescent lighting display system

ment on all 1959 cars. Novel aspect of system is that it responds not only to white light from headlights of cars approaching in adjacent lane, but also to red light from taillights of cars in the driver's lane. The latter feature switches headlights to low beam when car ahead is close enough to be affected by glare from high beams.

Photocell output is fed to an amplifying and selection circuit housed in a box mounted under the instrument panel. Two transistors and an electron tube are used which will operate from a 12-volt car battery without a special transformer. The circuit can be adjusted to switch on low beams when approaching headlights are within a range of 900 to 1,200 feet or when tail lights of car ahead are within a range of 200 to 500 feet.

RCA's Semiconductor Division has developed a dimming system using semiconductor devices and a relay. A block diagram of the system is shown in Fig. 7C. A 2N109 transistor is used as a phase shift oscillator and provides a 400-cps signal to either a cadmium sulphide or cadmium selenimide photocell in a voltage divider circuit.

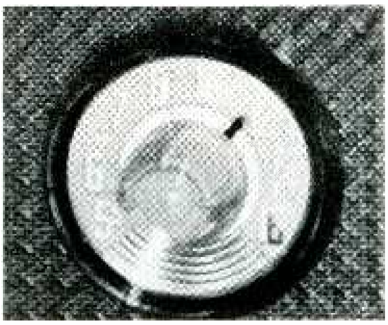


FIG. 9—Electroluminescent radio dial developed for use in American Motor's Rambler

The photocell acts as a variable coupling device whose amplitude modulates the oscillator signal. The composite waveform is then fed to a high-gain, narrow-bandwidth, a-c amplifier composed of one or two R-C coupled 2N217 transistors. The signal is then rectified by a point-contact 1N38A diode and applied to a d-c switch employing a 2N561 transistor. When the photocell is made to conduct by the presence of headlight glare, the signal level becomes high enough to actuate the d-c switch which energizes the relay, switching on low beams.

Delco Radio's electronic light control built for Firebird III automatically actuates various sections of the lighting system, depending on external ambient light intensity. Three externally mounted light-sensitive pickups control the low and high beam headlamps, the parking and tail lights, and also vary the intensity of the instrument panel lighting. The light sensitive cells are regulated to measure real daylight and are not activated by momentary light changes when shadows pass over the car.

Interior Lighting

Electroluminescent lamps will probably begin to replace conventional incandescent bulbs used in dashboard, dome and courtesy lighting by 1960.

Westinghouse's Rayescent lamp is made by coating a thin glass plate with a transparent, electrically conductive film. Over this is spread a layer of phospher imbedded plastic which is then capped with an aluminum overlay. When the two conducting layers are excited the phosphor emits light. Westinghouse has also developed a method for applying the phosphors to a plastic, nylon or steel-mesh base which allows the lamp to be bent into any desired shape.

The application of such lamps has been extended by devising an electroluminescent display system which presents glowing letters and numbers as shown in Fig. 8. The characters are selected by digital techniques and are bright enough for daylight use.

Sylvania's Panelescent lamp is made by firing a layer of solid ceramic material similar to white porcelain onto a vitreous-enameled steel electrode which has been cut to final form. Another layer of ceramic material, in which is suspended the light producing electroluminescent phosphor, is then applied over the solid ceramic coating. The two ceramic layers serve as the dielectric. A transparent conducting layer, serving as the second electrode, is then applied and over this is placed a layer of glass. Electrical connections can be made to any point on the two electrodes. Only use of electroluminescent technique in autos to date has been the Panelescent radio dial in American Motor's Rambler shown in Fig. 9.

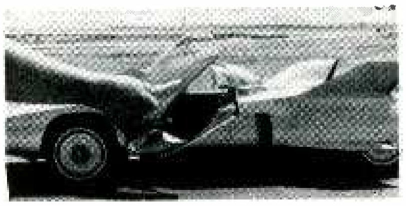


FIG. 10—Pen-shaped "ultrasonic key" opens door of GM's Firebird III from 15 feet away

Sylvania has also developed an electroluminescent display system which converts electrical or optical signals into dots of light. The image created can be held or erased at will. The device could be used to display speedometer and clock dial readings in digital form.

AC Spark Plug has developed an electroluminescent instrument panel for Firebird III. Figures used on the speedometer, tachometer, clock, preset timer, and fuel gage are silhouetted against an electroluminescent band which moves up and down.

Ultrasonic Key

GM Research has developed an ignition "key" which can also be used to open locked doors on the Firebird III as shown in Fig. 10. When vibrated within a 10 to 15 foot radius of the vehicle the key emits an ultrasonic signal which is detected by microphones concealed externally on the car's body. The

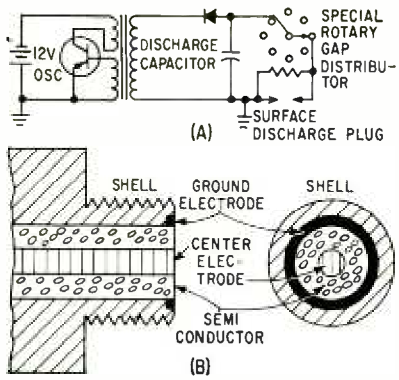


FIG. 11—Electric Auto-Lite's low-voltage, high-frequency ignition system uses transistor oscillator circuit (A) and surface-discharge spark plug (B)

signal is then fed through an amplifier to a door actuating mechanism.

Ignition Systems

Electric Auto-Lite has developed an ignition system which uses a transistorized excitation circuit and a surface-discharge spark plug. A schematic of the ignition system is shown in Fig. 11A.

The transistor oscillator generates a high-frequency, low-voltage current which is stepped up to 500 to 5,000 volts, converted to d-c, and applied across the center and ground electrodes of the surface discharge plug shown in Fig. 11B. The spark arcs from the center to the ground electrode along the surface of the plug and ionizes the semiconductor materials in its path.

High-voltage capacitor discharge systems of 20 to 25 kv have also been built and tested. ELECTRONICS hears that a Denver firm intends to develop a practical ignition system of this design using transistors.

Clevite Transistor Products is experimenting with an ignition

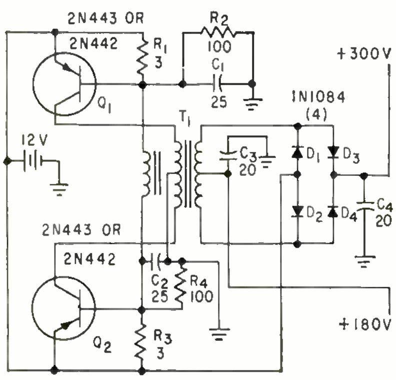


FIG. 12—Each switching transistor in Delco Radio's 120-watt d-c to d-c converter uses a 7 in. by 7 in. by 1/8 in. aluminum heat sink

system using the Harkness method of banging barium titanates to produce a discharge. Commonwealth Engineering has a new ignition system which eliminates breaker points. Sarkes Tarzian is developing a transistorized ignition system using silicon rectifiers.

Converters

A 120-volt d-c to d-c converter for 12-volt auto systems has been developed by Delco Radio. A schematic is given in Fig. 12. This company has also developed a converter for use with car tv sets which develops a square-wave voltage at a frequency of approximately 200 cps, using a pair of high-power transistors. The square wave is converted into 245 v d-c by a silicon-diode bridge rectifier.

Delco-Remy has developed a silicon diode full-wave rectifier for converting a-c from their 12-volt three-phase automobile generator into d-c required to charge the battery. Sylvania has developed a d-c to d-c converter especially for supplying voltage and frequency requirements of electroluminescent panels. Unit reportedly delivers 200 v at 250 cps.

A d-c to d-c transistor oscillator power converter is being developed by National Union Electric specifically for use with gas-discharge-tube instruments and indicators in motor vehicles. This power supply will provide a means for varying the duty cycle and thereby controlling the brillance of the display.

Fuel Controllers

Delco-Remy has developed an electronic governor for maintaining the speed of the auxiliary engine driving the 12-v a-c generator in Firebird III. The device compares the output of a tachometer generator with a reference voltage indicating speed and uses the difference voltage to control the throttle valve in the engine's carburetor.

Bendix's Electrojector system for automatically sensing engine fuel requirements as driving conditions vary was described in ELECTRONICS, (Feb. 57, p 192).

Voltage Regulators

Delco-Remy recently announced the development of a new a-c to d-c

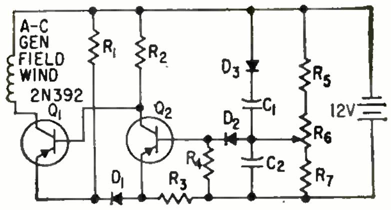


FIG. 13—Completely transistorized voltage regulator circuit developed by Delco-Remy to handle output of new a-c generator

voltage regulator designed to operate with a new 12-volt a-c generator. Power rectifier outputs have been controlled to within ±0.1 volt in an installation. A schematic is given in Fig. 13.

Electronic Horn

GM Research has developed an electronic horn which consists of a continuous-belt tape recorder, a horn-type speaker and a control switch. The recorder runs whenever the ignition switch is on but feeds the speaker only when the horn control switch is depressed. Any warning sound can be recorded on the tape and changed as desired. Power requirements compare favorably with those of an auto radio.

Rear-View Mirror Positioners

A device for automatically flipping a day-night rear-view mirror to the night position when glare from headlights of following vehicles becomes excessive is being marketed by Instrument Research. This unit was described in ELECTRONICS (July 57, p 196).

Although circuit details are not yet available, Instrument Research indicates a transistorized mirror positioner which will eliminate the need for a high-voltage B+ supply has been developed. Huppower Division of the Hupp Corporation will

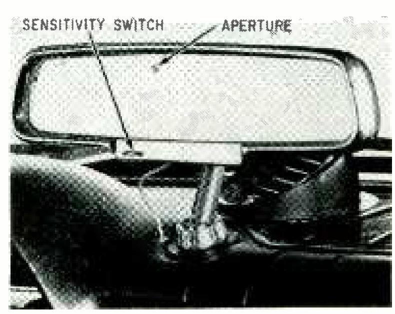


FIG. 14—Photocell in Chrysler's automatic mirror positioner is mounted behind mirror aperture

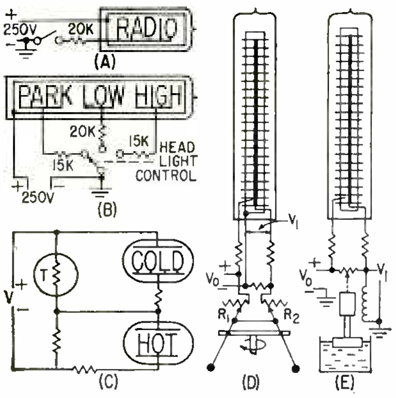


FIG. 15—**Glow discharge bulbs used for single tell-tale instrument-panel word (A) multiple tell-tale word (B), temperature indicating system (C) speedometer (D) and fuel gage (E)**

undertake production and distribution of the device.

Chrysler is offering an automatic rear-view mirror positioning device as optional equipment on 1959 cars. The electronic unit is mounted to the rear of the mirror, located above the dashboard as shown in Fig. 14. An aperture in the mirror's surface allows light to impinge on a photocell mounted behind. Current generated by the photocell is amplified by subminiature electron tubes and applied to the coil of an electromagnet. When glare from headlights of following cars is excessive, the current increases sufficiently to energize the electromagnet, pulling the mirror up to the night position.

Temperature Controls

Harrison Radiator has developed an electronic control which automatically maintains heating, air conditioning and defrosting temperatures at any desired level. Three thermistors sense the temperature of the passenger compartment and outside ambient air, and generate signals corresponding to these thermal levels. The signals are sent to an electronic control circuit which regulates the proportions of recirculating air, hot air from the radiator and incoming atmospheric air required to assure correct heating, air conditioning and defrosting temperatures.

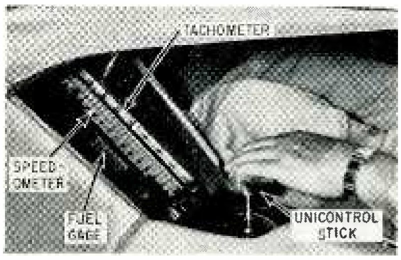


FIG. 16—**Electronically controlled instrument panel in Firebird III**

Indicators and Instruments

National Union Electric has developed gas-discharge devices consisting of a collection of variously formed metallic elements sealed within a glass bulb which is evacuated and filled with a suitable discharge gas. Simple tell-tale illuminated signals or instructions can be formed as shown in Fig. 15A. This arrangement is especially useful when a single word or group of short words are simultaneously illuminated. Multiple tell-tales can be made up as shown in Fig. 15B. Here two or more words oriented in an in-line configuration are read through the same frame opening and are illuminated one at a time.

A typical tell-tale system is shown in Fig. 15C. When temperature surrounding the thermistor is low, its resistance is high and a large voltage drop appears across it. This drop is sufficient to cause the COLD tell-tale to illuminate, however, the HOT tell-tale cannot light because the voltage drop across the resistor is too low. If the thermistor is heated, its resistance decreases appreciably extinguishing the COLD tell-tale and raising the voltage across the resistor sufficiently to light the HOT tell-tale.

Analog readout systems can also be designed in which the length of illumination in a tubular bulb is proportional to current flow. A simple speedometer can be built as shown in Fig. 15D. A fly-ball governor coupled to the transmission controls the amount of supply voltage V_0 applied the tube by positioning variable resistors R_1 and R_2. As the speed of the governor increases, the resistance across the glow discharge circuit decreases. Since excitation voltage V_1 becomes larger as the governor rotates faster, the bar is illuminated lengthwise in direct proportion to the car's speed.

If pulsating d-c is used as supply voltage V_0, a moving core in an inductance coil can be used as

FIG. 17—**Entire chassis of back-seat auto tv developed by Delco Radio can be removed and used conventionally**

a fuel-level indicator as shown in Fig. 15E. Since voltage V_1 is highest when the core is fully inserted in the coil and lowest when core is withdrawn, the bar of light will expand proportional to float level.

AC Spark Plug has developed electronic indicators for the Firebird III control panel shown in Fig. 16. Outputs from the car speed, engine speed and fuel-level transducers are converted by transistor amplifiers into electrical signals which position gage mechanisms in the instrument panel. Each gage mechanism consists of two drums about which is wrapped a tape. Half the tape is made of electroluminescent material which gives off colored light when excited by a-c. As the drums are positioned by the command signal from the amplifier, the colored band of light on the tape —red for the speedometer, orange for the tachometer and blue for the fuel gage—is moved up or down behind a transparent, calibrated scale.

A transistorized tachometer which does not require a "sender," and can be mounted under or in the dashboard has been developed by Radson Engineering. This unit was described in ELECTRONICS (Aug. 15, 1958, p. 92).

Rear Seat TV Receiver

Delco Radio has developed a portable tv receiver for Oldsmobile which has been experimentally installed in a car as shown in Fig. 17. Tube heaters are directly connected to the car battery; a small d-c to d-c converter in the trunk supplies the plate voltage. Built in relays automatically connect the heater and power supply circuits for proper operation off 117-v lines when unit is removed.

Dog with artificially induced heart block exhibited typical sluggishness until normal circulation was restored by pulse amplifier

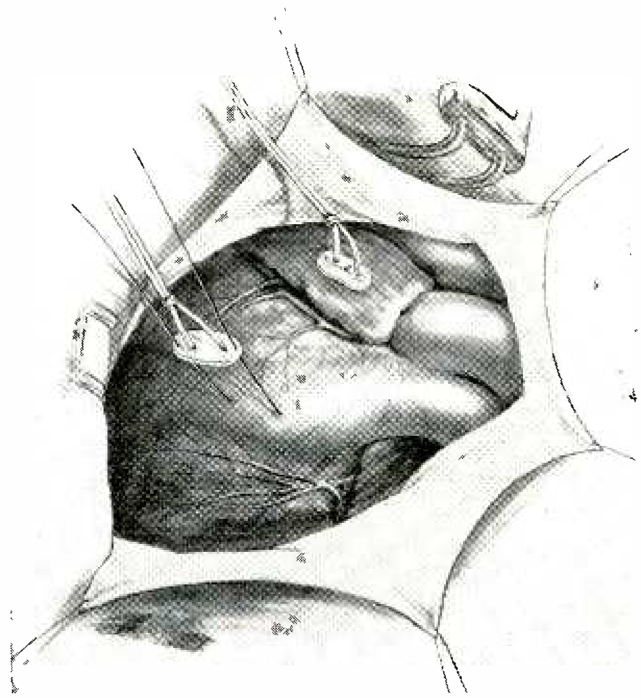


FIG. 1—Pair of electrodes supported on flat polyethylene insulator sewn to right auricle (top). Pair is being sewn to ventricle (bottom)

Two-Transistor Amplifier

SEVERANCE of the beat-rate control link between chambers of the heart results in an affliction known as heart block. The pulse amplifier and output devices described here have corrected this condition in dogs and are being used for emergency treatment of human patients.[1]

In normal hearts, the auricle produces an electrical impulse which is carried by the nervous system to the ventricle. The impulse stimulates the ventrical causing it to contract with sufficient force to pump blood throughout the circulation system. If the nervous pathway between chambers is broken, the ventricle beats at a natural rhythm which is not rapid enough to supply the body with an adaquate amount of blood.

To bypass the block and reestablish normal beat rhythm, pickup electrodes are sewn to the auricle and ventricle, the control pulse from the auricle is amplified, and the resulting output used to stimulate the ventricle to contract. Electrodes are constructed of stainless steel mesh one cm^2 in area and are attached to the outer wall of the chambers as shown in Fig. 1.

Pulse Amplifier

The pulse amplifier shown in Fig. 2 is used to provide adequate stimulating voltage to the ventricle. Input from the auricle is a 10-millivolt pulse having the waveform shown in Fig. 3. To insure continuous coordinated beating of the ventricle and auricle, the amplifier must supply an output pulse with a minimum peak voltage of 500 millivolts. This condition was met by designing the circuit to have a maximum gain of 200 when operating from a 5,000-ohm source and supplying a 1,000-ohm load. Use of a-c coupling permits acceptance of pulses with plus or minus polarity.

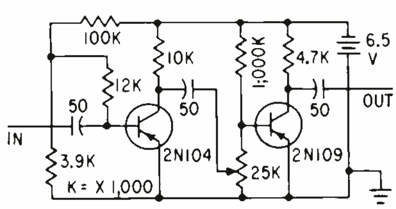


FIG. 2—Pulse amplifier circuit. Power is supplied by 6.5-v mercury cell connected to circuit by spring clips. Battery must be taken out to deenergize circuit

Body tissue between the input and output electrodes exhibits an extremely low resistance; therefore, a certain fraction of the output signal is fed back to the amplifier input. Since the output of the amplifier has the same polarity as the input, a feedback signal will add to the input signal and increase the gain. If the magnitude of the feedback exceeds the signal generated by the auricle, the amplifier becomes unstable and oscillates.

Feedback amplitude is deter-

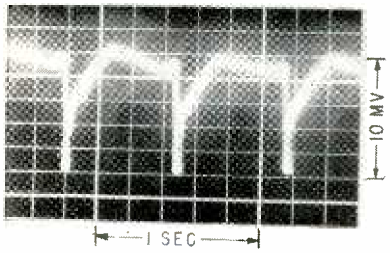


FIG. 3—Reverse polarity oscillograph of output pulses from right auricle of dog

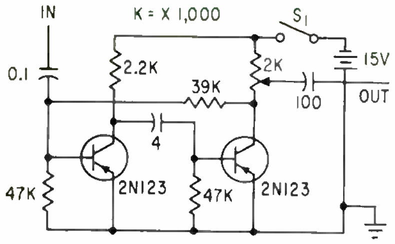
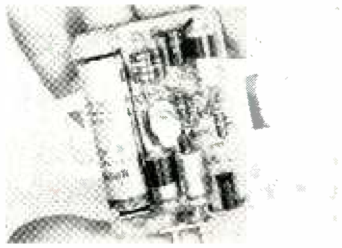


FIG. 4—Pulse output circuit. Power is supplied by miniature 15-v battery



Pulse amplifier. Gain control in center of unit can be screwdriver adjusted

Pulse amplifier reestablishes proper circulation of blood in heart-block patients by driving ventricle at beat rate dictated by auricle. Command pulses picked up by electrodes on auricle are amplified 200 times without waveform distortion. Output pulses applied to ventricle electrodes produce normal pumping rhythm. Supplementary output circuit boosts voltage to overcome scar-tissue resistance developed under ventricle electrodes

By G. H. VANDERSCHMIDT, Consulting Physicist, Belmont, Mass.

Corrects Heart Block

mined by the gain of the amplifier, input and output impedance of the amplifier, and resistance of body tissue and the electrodes. In practice the gain control is set to zero, input and output leads connected to the amplifier and the gain increased until amplification is sufficient to cause contraction of the ventricle.

Because tissue resistance is constantly changing and cannot be controlled, no advantage would be realized by including a gain compensation circuit.

Pulse Output Circuit

If the scar tissue developed under the output electrodes over a period of time introduces too much load resistance, the ventricle will not respond to the largest pulse available from the amplifier. To overcome this condition, the pulse output circuit shown in Fig. 4 is used in conjunction with the amplifier to increase the stimulating voltage. Tandem operation is arranged by connecting the output of the pulse amplifier to the input of the pulse output circuit.

When triggered by a positive pulse similar to that shown in Fig. 3, the pulse output circuit produces a constant-voltage, positive-going pulse having a maximum amplitude of 15 volts and a duration of 0.1 sec. An input of 2.5 mv or more applied by the auricle to the input of the amplifier is sufficient to trigger the pulse output circuit. The pulse from the auricle must be positive with respect to the grounded electrode.

Noise Sources

Although shielded cables are used between the amplifier and the body surface, noise from local power lines, nearby electrical machinery and the like is introduced by way of the unshielded stainless-steel wires in the body cavity. To minimize pickup, the unshielded wires should be made as short as possible particularly in the region where they leave the body cavity and connect to the shielded cables. Since the pulse amplifier and pulse output circuit are battery operated and well shielded, the only internally produced spurious voltage present is thermal noise with amplitudes in the microvolt region.

Special Connection

Because the stainless steel leads existing at the skin surface will not solder to the wire strands in shielded cables used with the amplifier, a special method of junctioning is required. This technique consists of wrapping the stainless steel wire around a thicker copper wire, silver-soldering them together, and then soft soldering the copper wire to the copper strands in the shielded cables.

REFERENCE

(1) Electronics Gives Beat, ELECTRONICS, p 24, Mar. 1958.

Blind speeds in a moving target indicator are relocated by staggering the pulse repetition frequency. Limitations of an moving-target-indicator radar system are investigated and a staggered prf circuit described. Clutter fluctuation in staggered prf is compared with response to clutter fluctuation in a convention mti system

By S. E. PERLMAN, Senior Project Engineer, Laboratory for Electronics Inc., Boston, Massachusetts

Staggered Rep Rate Fills

MOVING TARGET indicator systems, discriminate against stationary targets so that moving targets, which are masked by land masses in a normal system, can be detected. The system has an inherent deficiency which results in zero response to certain radial target velocities. The critical radial velocities are called blind speeds. For instance, in an X-band radar with a prf of 5,500 cps, blind speeds will occur in a progression at 160, 320 knots, etc. In some radar applications, these blind speeds appear at velocities of interest. Blind speeds can be changed to other velocities by changing the basic prf of the radar. Here, however, the limitation of second-time targets enters the picture. A technique that relocates the blind speeds is a staggered prf of alternate periods T_1 and T_2.

System Transform

The transfer characteristic of an mti system can be derived from the equation, $e_o(t) = e_i(t) - e_i(t - T)$ where $e_o(t)$ is mti output, $e_i(t)$ is mti input, and T is repetition interval of the radar. If $e_i(t)$ has a radial Doppler envelope of $\sin 2\pi ft$ the equation becomes $e_o(t) = \sin 2\pi ft - \sin [2\pi f (t - T)]$. It can be rewritten as $e_o(t) = 2 \sin \pi fT \cos [2\pi f (t - T/2)]$.

With a time average of $e_o(t)$, the first term determines the frequency response. This is the comb filter characteristic as shown in Fig. 1. The characteristic is zero to zero frequency and all multiples of $1/T$. To change the variable f to velocity, $\sin \pi fT = \sin \pi v (2Tf_o/c)$ where v is radial velocity, f_o is transmitter frequency and c is the velocity of light. Blind velocities are then

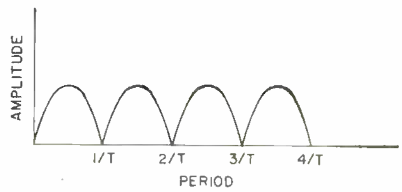


FIG. 1—Velocity response of simple mti

$$V_o = \frac{VC}{2Tf_o}$$

Staggered prf can be visualized as a combination of the output of two mti radars, each having a blind speed corresponding to its prf. The first over-all blind speed will occur when the nth null of the first radar velocity response coincides with the mth null of the second.

The rms signal response of a staggered prf system is given by the equation $v_\phi(\text{rms}) = \sqrt{\sin^2 (\omega_d T_1/2) + \sin^2 (\omega_d T_2/2)}$ where ω_d equals $2v\omega_o/c$, T_1 is the shorter repetition interval, T_2 is the longer repetition interval and ω_o is transmitted radian frequency. Letting $v_o' = 2\pi c/T_p\omega_o$ where $T_p = T_1 + T_2$, $R = T_1/T_p$, and $1 - R = T_2/T_p$ the previous equation becomes:

$$V\phi\ (\text{rms}) = \sqrt{\sin^2 \left(2\pi \frac{V}{V_o'} R\right) + \sin^2 \left[2\pi \frac{V}{V_o} (1 - R)\right]}$$

A plot of this response for two stagger ratios 2/3 and 7/8 is shown in Fig. 2. The curves are normalized with respect to $T_p/2$.

Velocity Response

The stagger ratio determines the location of the first blind speed. However, another factor must be considered. As the ratio T_1/T_2 approaches unity, not only does the first blind speed move out to a higher velocity, but variations in the response curve become greater.

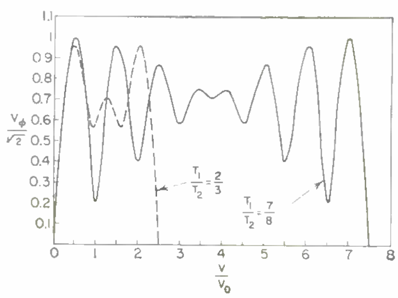


FIG. 2—Response of a staggered prf mti for stagger ratios of ⅔ and ⅞

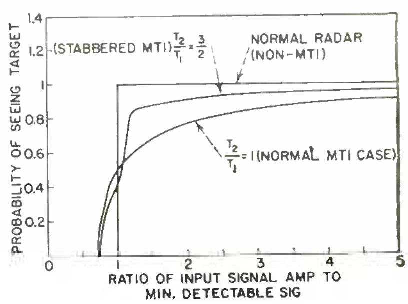
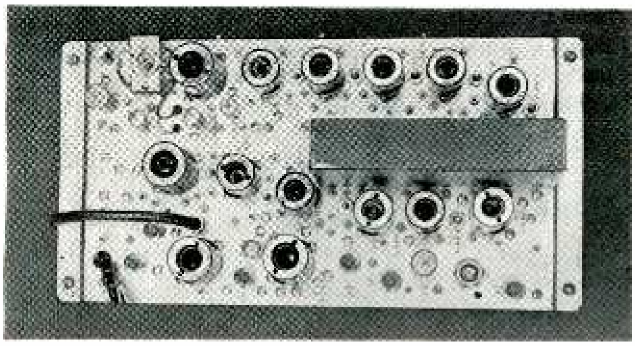
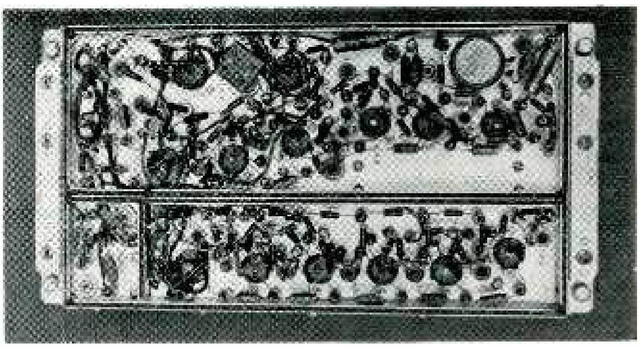


FIG. 3—Probability of seeing a target on normal radar, normal mti and staggered prf mti systems

Prf staggering switch relocates blind speeds in mti system. Short lead dress is constant with military and h-f specifications

Radar Blind Spots

A compromise between the first desired blind speed and the magnitude of the velocity response ripples that can be tolerated must be made.

Radar Transmitter

Before modifying an existing radar with the staggered prf technique any possible radar and mti degradation must be investigated. The effects of a staggered prf on functioning of the radar transmitter, mti response to clutter fluctuations, cancellation loss due to scanning modulation, mti response to targets in the clear and complexity of radar will be discussed.

In general, the range of the radar will determine how staggering is accomplished. If a loss in range time can be tolerated then a stagger ratio can be taken with the existing T as the mean of the two periods. Average power transmitted will be the same as for the mean period.

If range time is a problem then the existing repetition interval can become T_1 the smaller of the two periods. A loss in transmitted power will result.

Frequency Shifts

It is necessary that no pulse-to-pulse transmitter frequency shift exist in an mti radar. A shift produces a pulse-to-pulse change in the phase detector output, degrading cancellation. The high voltage charge in the pulse forming network must remain a constant for the firing times associated with T_1 and T_2.

Allowable pulse-to-pulse frequency shift is given by:

$$\text{Cancellation Ratio} = \frac{0.187}{\Delta f_o\, \delta}$$

where Δf_o is change in transmitter frequency and δ is pulse width. With a 0.5-μsec pulse, a frequency shift of only 3.7 kc can be tolerated for a cancellation ratio of 40 db.

Clutter Response

Clutter signals are the radar returns from land masses, trees, buildings, and similar objects. Variations in these signals resulting

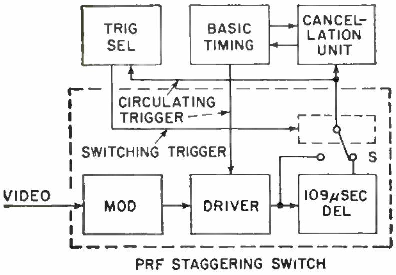


FIG. 4—Block diagram of prf staggering switch and trigger selector

from perturbations such as wind are called clutter fluctuations. The frequency or velocity spectrum of clutter fluctuations consists mainly of low velocities. Clutter fluctuations appear on the mti velocity response curve as narrow spectrums about zero velocity and all side bands of the transmitted pulse.

At first sight the staggered system appears to have a greater response to clutter fluctuation than a normal mti, since where the clutter spectrum appears for T_1 there is a gain in the response for T_2. This is not strictly true, because on one sweep the clutter response depends upon the velocity characteristic of the T_1 period while on the next sweep the clutter response depends upon the velocity characteristic of the T_2 period. These are then summed in the indicator. Therefore, the clutter fluctuation response of the staggered system should be no worse than that of a mti operating at the mean prf.

Another approach is to assume that the clutter fluctuations may have all velocities with equal probability. The rms response is

$$V_{\phi\,(rms)} = \sqrt{\frac{1}{\beta}\int_0^{\beta} (V_{\phi\,(rms)})^2\, dx},$$

where x is normalized velocity and β is clutter velocity. When β approaches infinity, $V_{\phi\,clutter}$ is equal to one. This is the same rms expected response as a simple mti.

Cancellation Loss

When a radar antenna scans past a target, the signal returns from the target are amplitude modulated by the antenna azimuth pattern. If the a-m is below the limit level in the phase detector it will degrade cancellation.

The allowable cancellation ratio (CR) is given by the equation,

$$CR = -10 \log_{10}\left[\frac{6.183\,(1 + r^2)}{(P_{BW}^2)\,(1 + r)^2}\right]$$

where P_{BW} is the number of pulses per beam width and $r = T_2/T_1 =$

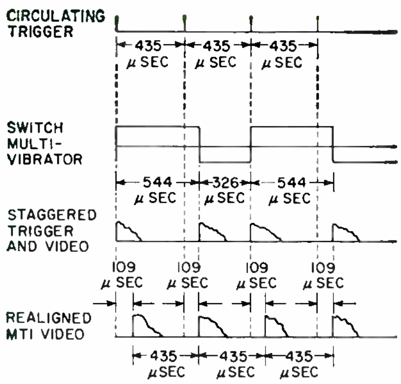


FIG. 5—Staggered prf timing diagram

(1-R)/R. The equation is based on the assumption that sin x/x one way antenna pattern is obtained, $P_{BW} > 4$, the target returns have not been limited prior to phase detection, the target is a large number of antenna aperture diameters away from the antenna, and the signal echo phase angle is that required for maximum phase detection output. If this condition is not met, the cancellation ratio will be higher.

The cancellation degradation due to scanning modulation caused by the 3/5 stagger ratio is a fraction of a db more than that of a simple mti operating at the mean prf. For example, with $P_{BW} = 20$, the allowable CR in a single period mti is 21.08 db. and the allowable CR in a staggered prf, mti for $r = 5/3$ is 20.86 db.

Targets In The Clear

One method of assessing the effect of staggered mti on targets in the clear is to determine the probability of detecting these targets. Assuming an equal probability of all velocities occurring, the probability that a target return exceeds a given first level is determined. The results are compared with a normal radar and a simple mti.

The probability distribution curve is plotted in Fig. 3 as a function of the ratio of input signal to minimum detectable signal, where the minimum detectable signal was taken as some arbitrary level A. The probability distribution for the staggered case lies between that for the simple mti and the normal systems. It is greater than the simple mti for the higher ratio values because there are fewer velocities that the staggered system is actually blind to.

For smaller input ratios the probability curve is lower than that for the simple mti. This can be explained by the fact that around optimum velocity points, $v_o/2$ in the simple mti, the simple mti has a slightly higher gain.

To modify an existing radar for staggered prf a unit similar to a cancellation unit must be added and some modification of the existing timing unit is necessary.

Radar Complexity

In a particular application it was desired to have the first blind speed at 300 knots for an X-band radar with a basic prf of 2,300 cps. Since a loss in range time could be tolerated, a stagger ratio of 3/5 was chosen with 2,300 cps as the mean prf. With this ratio, the alternate periods are 324 and 545 μsec. The blind speeds associated with each repetition period are 100 and 60 knots respectively giving the first over-all velocity null at 300 knots.

In designing the staggered triggers some means must be made for realigning the returning video so that it can be processed in a video cancellation unit. A prf staggering switch that performs both of these functions is shown in Fig. 4.

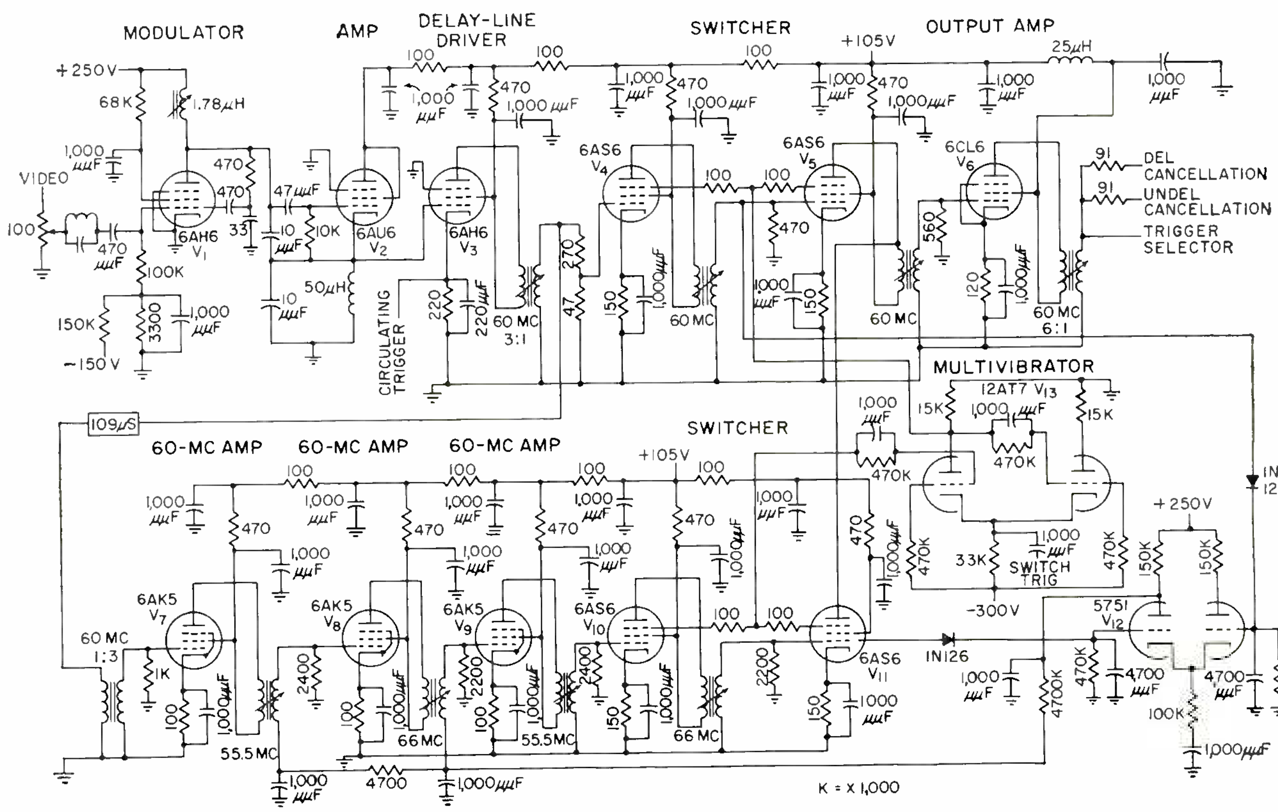


FIG. 6—The prf staggering switch realigns the returning video so that it can be processed in the video cancellation unit

The prf staggering switch consists basically of a 109-μsec delay line that is alternately switched in and out of the unit. The radar mti video, modulates the carrier at the input to the unit and, after being either delayed 109 μsec or not, depending on switch condition, is sent directly to the cancellation unit.

Referring to the block diagram of Fig. 4 and the timing diagram Fig. 5, the basic, stable 2,300-cps trigger is established by slaving the system repetition rate to the 435 μsec delay line in the canceller. A circulating trigger is derived from the basic oscillator and fed to the prf staggering switch every 435 μsec to a-m the carrier prior to being passed through the delayed or undelayed channel.

Staggering Operation

Assume that the channel is in the undelayed position. The first circulating trigger is applied through the undelayed channel and then to the trigger selection unit. The trigger selector produces an output which is used as a switching trigger for the switch tube in the prf staggering switch and also as the radar modulating trigger.

Therefore, after the first trigger is sent through the undelayed channel, the switch is moved to the delayed position. The next circulating trigger to be selected by the trigger selection unit is applied through the delayed channel. After this second circulating trigger, the switch is moved back to the undelayed position and the process is repeated. Staggered prf triggers are therefore generated with alternate repetition intervals of 326 and 544 μsec.

The function of the trigger selector unit is to detect the triggers at the output of the staggering switch and use them to generate the switching trigger and the system trigger. It must discriminate against the trigger that occurs 109 μsec after the undelayed trigger.

As mentioned previously, the radar video must be realigned prior to the actual cancellation process. Realignment is also performed by the prf staggering switch. A circulating trigger that has been delayed 109 μsec, flips the switch to the undelayed position and one that comes through undelayed flips the switch to the delayed position. Video returns from a delayed trigger therefore are undelayed, and those from an undelayed trigger are delayed. This realigns the video.

Staggering Switch Circuit

Referring to the schematic diagram of the prf staggering switch Fig. 6, the mti video frequency modulates the 60-mc carrier by a reactance tube V_1. The carrier is amplitude modulated by the circulating trigger at delay line driver V_3 and sent to both the 109-μsec line and, after being attenuated, to the undelayed channel. The delayed signal is amplified by three 60-mc amplifiers V_7, V_8 and V_9. Actual switching or channel selection is accomplished by the multivibrator V_{13}, the undelayed channel switch tubes V_4 and V_5 and the delayed channel switch tubes V_{10} and V_{11}. Twin switch tubes are required in each channel to insure that the feed through signal is greater than 50 db down. To minimize cancellation deterioration, agc is used to equalize the gains of both channels.

The second switch tubes for each channel V_5 and V_{11} have a common load which is fed to the output tube V_6. The output carrier is sent to the delayed and undelayed channels of the cancellation unit and to the trigger selector unit. In the trigger selector unit, Fig. 7, V_{14} amplifies the 60-mc amplitude-modulated carrier from the prf staggering switch. The circulating trigger is diode detected, amplified in video amplifier V_{15} and fires the blocking oscillator V_{16}.

When the prf staggering switch is switched to the delayed position, the first circulating trigger comes through 109 μsec later. This is a superfluous trigger and the selector unit must reject it. If the recovery time of the blocking oscillator is adjusted so it will not fire on the extraneous 109 μsec pulse, it will not fire reliably on the 324 μsec pulse. To eliminate the superfluous trigger the blocking oscillator was designed with a fast recovery time and the recovery waveform phase-shifted and applied to the parallel triggering tube and the previous stage V_{13}. The phase shift is adjusted so the 109-μsec trigger does not fire the blocking oscillator.

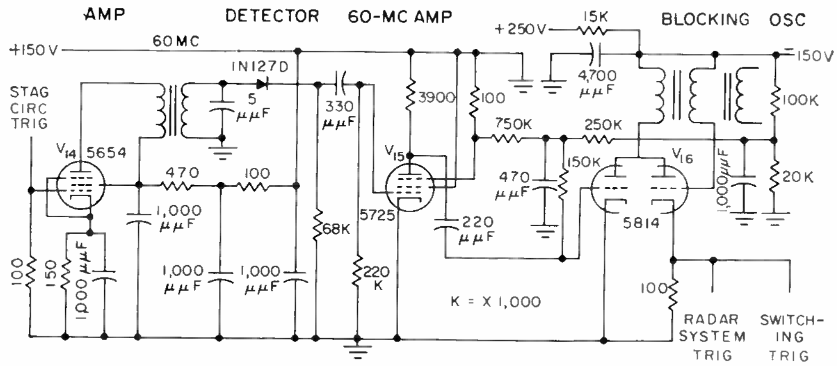


FIG. 7—Fast recovery time of blocking oscillator in trigger selector circuit eliminates unwanted trigger

Test Results

A video cancellation figure of 30 db for a 0.4 μsec pulse was obtained by keeping interchannel leakage in the prf staggering switch to -100 db. Individually shielding the delayed and undelayed channels kept the leakage down to this level.

A qualitative test of the effect of staggered prf on clutter, made by comparing the clutter response of the staggered system with a simple mti operating at the mean prf showed little difference. This was done by disabling the switch in the prf staggering switch so that only the undelayed channel was energized. The video cancellation achieved was 30 db.

The work of developing the staggered prf canceller was done on Rome Air Development Center Air Force Contract AF 30(602)-1175.

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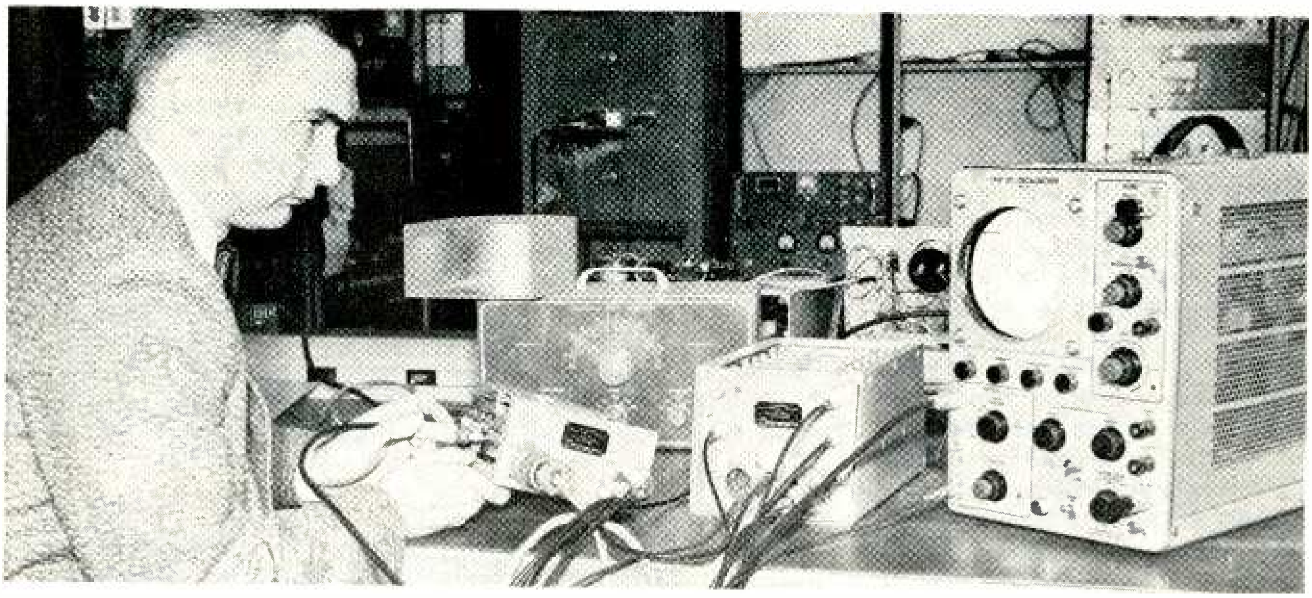

Transistorized power converter in center unit supplies drive motor of miniaturized tape recorder mechanism at left

Boosting Power

Precise control of transistor instantaneous voltage and current produces operating efficiencies that approach the ideal. Since peak power dissipation in a single transistor occurs in the middle of a transition between on and off states, transition time is kept small

By JOHN W. CALDWELL* and T. C. GORDON WAGNER**

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Efficiencies exceeding 98 percent have been obtained from two power transistors used to drive a 400-cps synchronous motor of a portable tape transport. High efficiency is obtained by carefully controlling the instantaneous voltage and current through the transistor.

Power may be lost in a transistor when it is conducting, when it is off, or during the transition between the on and off states. The thermal time constant of even a large power transistor may be around 50 μsec or less, so the instantaneous power dissipation must be carefully controlled for optimum transistor protection.

If a pair of transistors is employed to switch a purely resistive load, the peak power dissipation of one transistor will occur in the middle of each transition and will have a value one-half the total average power delivered to the load by both transistors. The dissipation averaged over the period of a single transition will be one-third the power delivered to the load. Thus if the transition time is not small compared to the thermal time constant, the power handling capabilities of a pair of transistors with a resistive load is limited to three times the transistor rating.

In most cases where the transistors see a resistive load, the average dissipation is principally a result of transition loss. If the load presented to the transistors is reactive, the losses may become much greater, but with the proper reactance and the proper drive much improvement may be realized.

Instantaneous Power Loss

The instantaneous power lost is given by the instantaneous product of the voltage across the transistor and the current through it. During the conduction period the dissipated power is small because the

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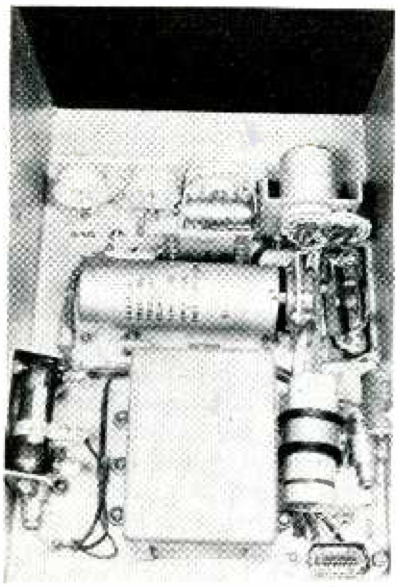
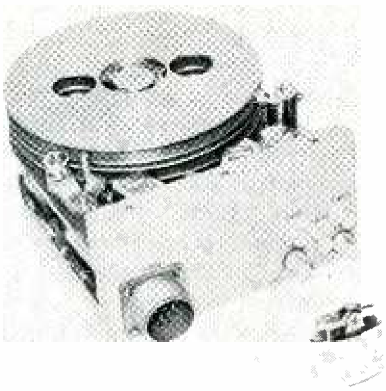
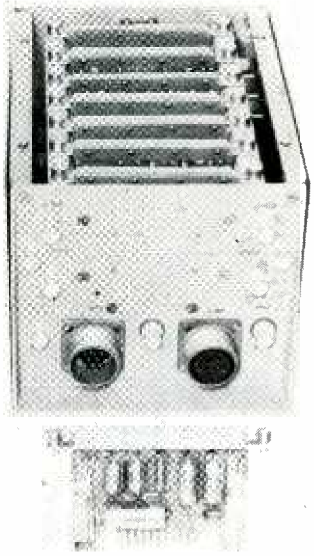


Pair of power transistors is at upper left





System comprises transport (left), and recording amplifiers and power converter (right)

Transistor Efficiency

voltage is essentially zero. In order that the instantaneous power lost during the transition be small, it is necessary that the current passing through the transistor be small.

This can be accomplished by the simple expedient of cutting the transistor current off quickly while slowing down the voltage change during the transitions. The quick cut off may be obtained from an external source, and the voltage control during transition may be achieved by the addition of a capacitor. This serves to reverse the voltage across the transformer much the same as does the timing capacitor of a vibrator supply.

Circuit Operation

A typical circuit is shown in Fig. 1. The two power transistors are operated with grounded collectors. They supply their own base power through a tertiary winding on the output transformer. Without the synchronizing pulses the circuit would be free running at a frequency below 400 cps.

Negative synchronizing pulses at 800 cps are applied to the base of Q_3 to produce positive pulses at the bases of Q_1 and Q_2, thus cutting them off quickly. The reversal of voltage across the output transformer is controlled by C_1 and the 1N93 diodes to prevent an overswing when both transistors are cut off. The 800-cps signal is derived from a precision oscillator to maintain constant motor speed.

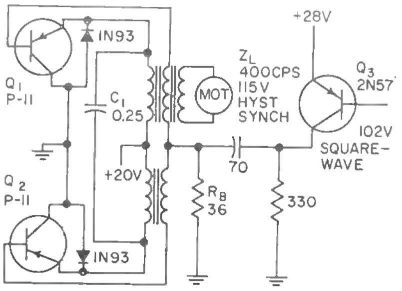


FIG. 1—Simplified schematic of transistor power converter

In the circuit analysis, neglect the reactive component of the motor load and consider the transformer losses to be included as part of the load. In Fig. 2A are shown the voltage across and the current through one of the transistors in the ideal case. It is important that the current be zero before the voltage across the transistor has any appreciable value.

The difference in the currents of the two transistors is shown in Fig. 2B. Neglecting the current flowing through the capacitor, this is the current which is effectively flowing in the transformer primary. It has two principal components, a magnetizing current which might be described as a symmetrical sawtooth, and the load current.

Magnetizing Current

To ensure proper circuit operation, the magnetizing current must be large enough to store energy in the transformer sufficient to reverse the voltage stored in it during the transitions. A large magnetizing current, however, will increase the transistor losses during the conduction period . The average conduction losses are proportional to $i_L^2 + i_M^2/3$, where i_L is the load current and i_M is the peak magnetizing current, which must be at least equal to the load current. In this type of operation, conduction losses are increased by a factor of at least 4/3.

A magnetizing current value of twice the load current is not exces-

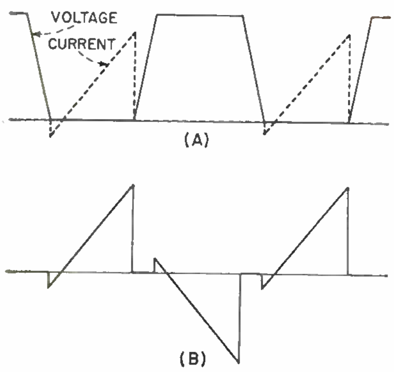


FIG. 2—Ideal waveforms (A) of current and voltage of single transistor, and difference of the currents (B) flowing, through transistors of Fig. 1

sive. At the end of a transition neither transistor is conducting, and an overswing of the transformer voltage is prevented by the conduction of one of the diodes. At the end of the synchronizing pulse one of the transistors will be put in a conducting condition. In the early portion of the cycle it is likely that the transistor will be conducting in the reverse direction. An alloyed-junction transistor may conduct in the reverse direction even in common-collector or common-emitter service.

Conduction in the reverse direction is not normally intended, but since the semiconductor is essentially symmetrical it will function as a reverse transistor. Relatively large currents can be passed by a *pnp* transistor with both emitter and base negative with respect to the collector. In this case the emitter and collector exchange roles, and a small current from base to collector will enable a large current from collector to emitter. The reverse current is clearly observable in the oscillogram of Fig. 3A, which shows the emitter current for a transistor connected in the circuit of Fig. 1.

Circuit Design

There are a few practical considerations about this circuit. The common - collector arrangement simplifies mounting problems. The base drive is supplied during conduction by the transistors themselves. A certain fraction of the power output must be supplied as base input, and the actual circuit configuration cannot affect the overall electrical performance to any great degree. The self-excitation feature of the circuit is not a necessity, but it is easier to obtain the proper base drive this way.

The circuit design is straightforward. Starting with the required power output, the motor in this case, including transformer losses, requires 24 w. With a 20-v supply, the load current referred to one-half the primary will be 1.2 amp. With a peak magnetizing current of 1.5 times the load current or 1.8 amp, the peak transistor current is 3 amp.

From the characteristics of the transistor, a peak base current of 0.4 amp and a base-to-emitter voltage of 2.5 v is required. If we allow 5.5 v reverse base-to-emitter voltage when the transistor is in the off condition, the base-to-base voltage is 8 v more than the emitter-to-emitter voltage. With a 20-v supply the latter is 40 v and the turns ratio of the emitter winding to base winding is 40/48.

Component Valves

At the end of the cycle the voltage across R_B is the difference between the voltage across half the base winding and the forward base-to-collector voltage. This is $24 - 2.5 = 21.5$ v. The current through R_B will be the sum of the 0.4-amp forward base current and 0.2 amp

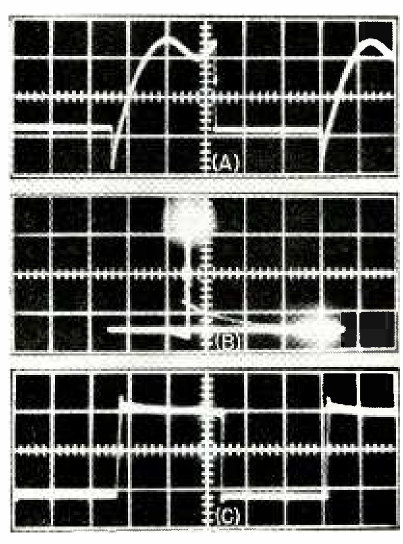


FIG. 3—Current waveform (A) of one transistor when load is not purely resistive, and transistor voltage as a function of current (B) and of time (C) for circuit of Fig. 1

to be supplied by the synchronizing pulse. Thus $R_B = 36$ ohms.

The value of the timing capacitor is not critical and may be determined experimentally. It may also be calculated by examining the transient response of the circuit when the conducting transistor is turned off. Then $C = Gt/[2 \log_e (K+1)/(K-1)]$, where G is the load conductance referred to one-half the transformer primary, t is the duration of a transition and K is the ratio of the peak magnetizing current to the load current.

In the example given $G = 0.06$ mho, $t = 62.5$ μsec and K is taken as 1.5. Substituting these values in the equation, C becomes 0.96 μf, the capacitance referred to one-half the primary. Then C_1 is 0.24 μf.

Similarly the inductance of one-half the primary is calculated from $L = T/2KG$, where T is the period each transistor conducts. In the given case T is 1,250 μsec and L then becomes 8.33 mh. The total inductance from emitter to emitter is therefore 33.3 mh.

Since it is not possible to cut off transistors instantaneously, perfectly ideal conditions cannot be achieved. Relatively large values of t/T, on the order of 5 or 10 percent, will make practical circuit conditions approach the ideal.

Ideal Operation

The degree to which the ideal may be approached is shown in Fig. 3B. If the transistor loss were zero, a plot of transistor voltage against current would be two straight lines. In Fig. 3B the current is shown on the horizontal axis and the voltage on the vertical axis. There is a time when the peak dissipation is approximately 1.5 w or about 6.5 percent of the load power, but the average dissipation is much lower. The section of reverse current is also observable. Transistor current and voltage as functions of time are shown in Fig. 3A and C with the motor as the load.

Due to the magnetizing current, conduction losses of the transistor are increased by a 7/4 factor. With a saturation resistance between 0.05 and 0.2 ohm, the conduction loss will lie between 0.25 and 1 percent of the load power for each transistor.

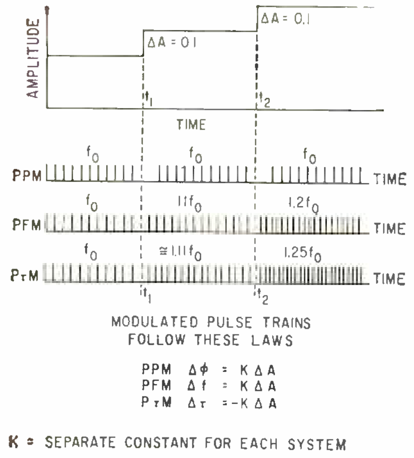


FIG. 1—Waveforms illustrate differences between the three forms of modulation

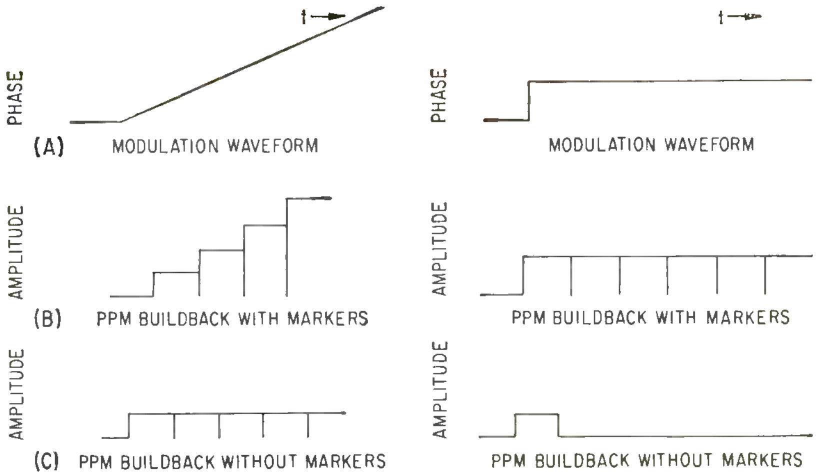


FIG. 2—Waveforms in (C) are close derivatives of (A). Left set shows ppm by linear waveform, right set by step waveform

Using Markerless Pulse Trains to Communicate

Three types of markerless pulse train modulation are compared. Circuitry for demodulating a markerless pulse train, containing low frequency audio information as a time interval variation between pulses, is described

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PULSE MODULATION for communication purposes often involves time sharing of a single transmission channel by several sets of pulse trains[1, 2, 3].

Pulses of a particular train occur within time limits set by marker pulses. These marker pulses are used in the demodulation process to direct each pulse into its proper channel and to reconstruct the original waveform[4].

Occasionally a communications problem arises which requires single-channel pulse modulation, and consequently marker pulses are theoretically not needed.

Pulse Train Types

Markerless pulse trains can be generated from three types of pulse-train modulations: pulse-frequency modulation—pfm; pulse phase or position modulation — ppm; and pulse period or interval modulation —pτm. The pulse train modulations are analogous to the corresponding continuous-wave types of modulation. In fact, a continuous-wave may be clipped, differentiated, and applied to a blocking oscillator to obtain these pulse-modulated trains. If the modulation is reduced to zero, the c-w becomes a single-frequency carrier and the pulses are emitted at a constant rate designated the average sampling frequency. This frequency must be greater than twice the highest modulation frequency to be transmitted.

For example, an audio channel has a 5-kc upper frequency limit the pulse sampling rate must be greater than 10 kc. Period modulation of c-w is unconventional but the pulse train equivalent is useful in the build-back process which will be described.

Characteristics

The type of pulse modulation is identified by the property of the pulse train which varies proportionally with the modulating signal. Equations for the modulator characteristics of the three types are

$$\text{ppm} \quad \Delta\phi = K_{mp}\,\Delta A_m \quad (1)$$
$$\text{pfm} \quad \Delta f = K_{mf}\,\Delta A_m \quad (2)$$
$$\text{p}\tau\text{m} \quad \Delta\tau = K_{m\tau}\,\Delta A_m \quad (3)$$

where $\Delta\phi$ is the change in phase, Δf the change in frequency, $\Delta\tau$ the change in period, ΔA_m the audio modulating signal amplitude and

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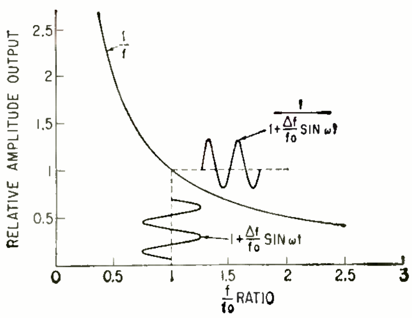

FIG. 3 Nonlinear distortion results when a pfm signal with large recurrence-frequency derivation is demodulated by a pτm demodulator

$K_m(p, f, \tau)$ the modulator gain constants.

Markerless ppm and pfm trains are formed from phase- and frequency-modulated cw's as mentioned above. A pτm train can be formed from a free-running multivibrator whose grid discharge voltage is varied by the modulating signal. The trailing edge of the rectangular waveform at the plate will jitter in pτm fashion. The free-running period of the multivibrator will be the average sampling period. A positive modulation will reduce the magnitude of the (negative) grid bias and thus reduce the discharge time, and thereby the period between successive pulses.

The modulation characteristic of this type modulator is negative. For this reason a negative sign is used with $K_{m\tau}$.

Application of the two-step modulation waveform shown in Fig. 1 illustrates the differences between the three forms of modulation. The pulse repetition frequency of both pfm and pτm changes in discrete steps. Due to the inverse relationship between frequency and period, the frequency shift is different. Step modulation in ppm causes a phase shift of the pulses but the average pulse repetition frequency remains unchanged.

The step modulated pulse trains of Fig. 1 show that the time interval between pulses is determined by the modulating signal amplitude for both pfm and pτm. Hence a separate set of marker pulses is not needed to reproduce or build back the step modulating signal. Each pulse serves as a marker for the next pulse. Th[illegible] considerations apply to pfm and pτm pulses modulated by complex waveforms.

This is not the case however for ppm. When each pulse of a phase-modulated train is used as a marker for the succeeding pulse, the demodulated output obtained by a build-back process based on pulse interval measurements is a differentiated form of the modulating signal. The waveforms shown in Fig. 2C are nearly the derivatives of Fig. 2A. Such a system exhibits high-pass filter characteristics.

Buildback of a ppm train with markers is usually accomplished by converting the marker-to-pulse intervals to a new set of duration-modulated pulses. The pdm pulses are converted to pulse-amplitude modulation and then to a replica of the original amplitude[6].

Pτm Demodulation of Pfm

Corresponding to the definition of modulation type, demodulation type is designated by that characteristic of the input pulse train which when varied produces a proportional variation in the output amplitude. A pτm demodulator follows the law

$$\Delta A_d = K_d \Delta \tau \qquad (4)$$

where: ΔA_d is the amplitude of the demodulated signal increment, $\Delta\tau$ is the change in pulse repetition period and K_d is the demodulator gain constant.

Equating Eq. 3 and 4

$$\Delta A_d = -K_{m\tau} K_d \Delta A_m \qquad (5)$$

which within the bandpass of $K_{m\tau} \times K_d$ is independent of frequency.

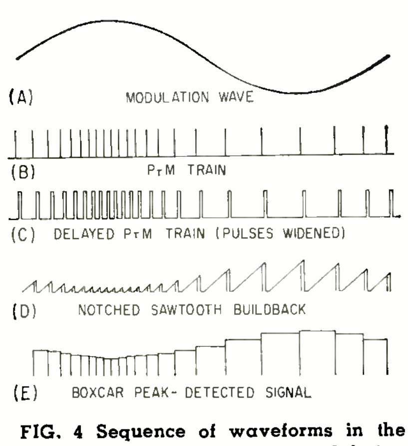

FIG. 4 Sequence of waveforms in the buildback process for pτm modulation wave (A), pulse-period modulated train (B), delayed pτm train (pulses widened) (C), notched saw-tooth build back (D) and boxcar peak-detected signal (E)

For pfm applied to a pτm demodulator with period expressed in terms of frequency and combining Eq. 2 and 4

$$\Delta A_d = -K_{mf} K_d \Delta A_m f^2 \qquad (6)$$

Where f is the average sampling frequency if ΔA_d and ΔA_m are small.

Fig. 3 shows the nonlinear distortion that results when a pfm signal with relatively large recurrence frequency deviation is demodulated by a pτm demodulator. When the percentage deviation, $\Delta f/f_o$, is small, linear demodulation of pfm occurs. Conversely, pτm applied to a pfm demodulator would be limited to small period deviations for linear operation. In both cases signal polarity is reversed.

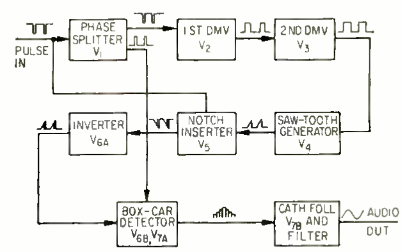

FIG. 5 Block diagram of a pulse period demodulator

Pτm Buildback Process

Fig. 4 shows the sequence of waveforms in the build-back process for pτm. A sinusoidal modulation waveform is shown in (A). The corresponding pτm pulse train is shown in (B).

The first step to be taken in building back the audio content from (B) is to generate another train of pulses (C) which are delayed with respect to (B) by some convenient time interval, for example 10 to 20 μsec, to provide time for resetting the boxcar detector. This delay is constant and involves no loss of modulation content. For convenience, the delayed pulses are widened, by forming them with a delay multivibrator so that they remain constant in both width and amplitude. The maximum width adjustment must be such that no two adjacent pulses touch when the intervals between the pulses of (B) and the interval deviation are minimum.

The varying time intervals between the pulses of (C) are then converted to linear saw-tooth waveforms of constant rate-of-rise, as shown in (D). Peak amplitudes of (D) are proportional to the intervals between pulses in (C). By peak-detecting the saw-tooth waveform (E), a stepped waveform resembling the original modulation signal is obtained.

This stepped waveform is then passed through a low-pass filter which smooths it into a replica of the original modulation waveform. The light vertical lines in waveforms (D) and (E) represent notches which are discussed later.

Increased demodulation sensitivity in the pτm buildback process can be obtained without additional amplifying stages by increasing the saw-tooth rate-of-rise. When the minimum interval deviation of the pulse train is significantly less than the average sampling period, say by 25 percent, then delaying the start of each saw-tooth a fixed amount after each sampling instant permits an increased rate-of-rise without increasing the saw-tooth generator B-supply voltage.

Pτm Demodulator

The demodulator was designed for operation at a 2,500 pps average sampling rate. It has a sensitivity, $K_d = A_d/\Delta\tau$, of 0.33 v/μsec and is capable of generating up to 40-v rms sinusoidal signals over a frequency range of 16 to 800 cps. It uses both sweep delay and sweep clipping to increase gain.

The pτm demodulator block diagram and schematic are shown in Fig. 5 and 6. An input pτm train of negative 10-μsec pulses is applied to the grid of the phase-splitter, V_1.

Negative 10-μsec pulses from the cathode of V_1 are applied to delay multivibrators V_2 and V_3. The first multivibrator generates a positive 20-μsec pulse. The second multivibrator is triggered by the trailing edge of this pulse and generates a positive 120μsec rectangular pulse. This waveform is applied to the saw-tooth generator V_4. The saw-tooth is generated during the negative portion of the waveform, when V_{4A} is cut off. Therefore, the saw-tooth starts 140 μsec after the occurrence of the 10-μsec negative pulse and ends 30 μsec after the occurrence of the next 10μsec input pulse.

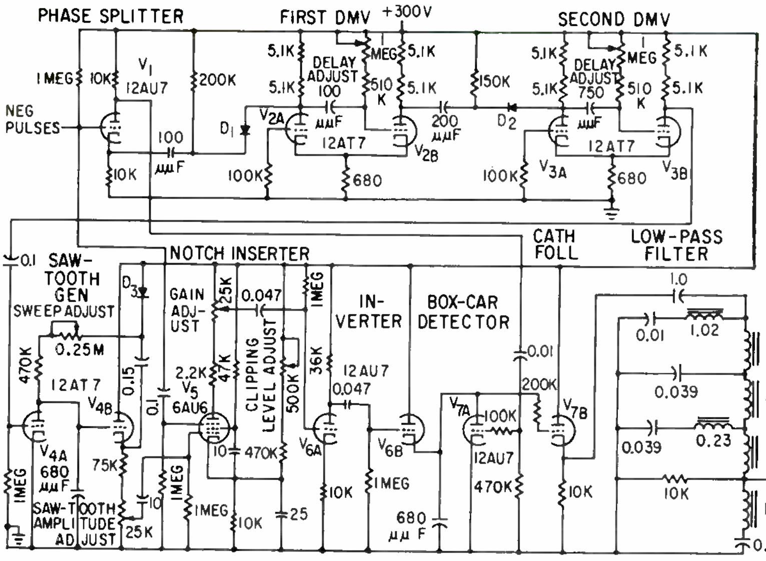

FIG. 6 **Pulse period demodulator circuit for markerless pulse trains**

Bootstrap feedback through V_{1B} linearizes the saw-tooth waveform. The output saw-tooth, taken from the saw-tooth amplitude potentiometer, is positive going. It is fed to the control grid of V_5, which interrupts or notches the saw-tooth voltage for the duration of an input pulse. The notching is accomplished by applying the negative pulse from the cathode of V_1 to the suppressor grid of V_5.

In addition, V_5 removes most of the saw-tooth waveform which is below the minimum peak amplitude that occurs for a given maximum percentage of pτm. Amplitude clipping is achieved by biasing V_5 to cut off at the unwanted level of the saw-tooth waveform appearing on the control grid.

The resultant notched saw-tooth appears inverted at the plate of V_5. The waveform is reinverted by V_{6A} to a positive-going notched saw-tooth and applied to the boxcar detector V_{6B}, V_{7A}. The detector samples the waveform at chosen intervals and maintains the sampled amplitude until the succeeding sample is taken. Output of the boxcar detector is a sequence of ascending and descending steps.

Cathode-follower V_{6B} has a cathode d-c return path only through the plate of V_{7A}. During the time the saw-tooth notch drives the grid of V_{6B} down, a positive pulse from V_1 is applied to the grid of V_{7A}. The grid of V_{7A} is normally biased off by grid rectification. Thus, when the positive pulse occurs, plate conduction takes place. Since V_{6B} is cut off during the notch interval, the capacitor in the cathode of V_{6B} discharges through V_{7A} almost to ground potential. The notch pulse and the discharging pulse occur simultaneously since both are derived from the input pulse.

The saw-tooth applied to the grid of V_{6B}, however, continues for an additional 20 μsec to recharge the cathode capacitor through V_{6B} to the peak voltage of the saw-tooth. This voltage is maintained across the capacitor until the next discharge pulse occurs. The result is a staircase waveform which closely approximates the original modulation waveform. The staircase waveform is fed to a cathode-follower which drives an m-derived low-pass filter. The filter smooths the staircase waveform and removes the high-frequency sampling pulse rates. A replica of the original modulation signal is obtained.

The circuit described was developed as part of the work done under a Signal Corps contract.

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(5) Ref. 1, chap. 4.
(6) Ref. 1, chap. 18.

Tones Find Data in

Companion digital timing generator and magnetic-tape search unit give automatic, high-speed access to selected data from multichannel magnetic-tape instrumentation systems. Tone modulated recording and signal integration recovery techniques permit reliable operation regardless of tape defects

By REUBEN WASSERMAN and PAUL HURNEY, Hycon Eastern, Inc., Cambridge, Mass.

MAGNETIC TAPE data processing systems currently in use require fast access, easily controlled search equipment for efficient operation. The searcher described here was specifically designed to take full advantage of controlled search features of high-performance tape recorders.

The searcher consists of two separate and electrically unrelated assemblies. One, the digital timing generator, operates during recording periods and generates, displays and records on a magnetic tape channel precise digital records of elapsed time. The other, the magnetic tape search unit, operates during data reduction periods and provides automatic location and controlled playback of data sequences selected on the basis of elapsed time addresses previously recorded by the timing generator.

Digital Timing Generator

Time is recorded on a single channel of the multichannel magnetic tape and the signal is made up of 24 sequential tone bursts at one of two different frequencies. One frequency corresponds to the binary digit ONE the other to ZERO (see Fig. 1A and 1B). Time is in hours, minutes, and seconds, and is recorded in binary-coded decimal form. In addition to the 24 tone bursts or bits, 6 other bits are generated as identification markers and control bits.

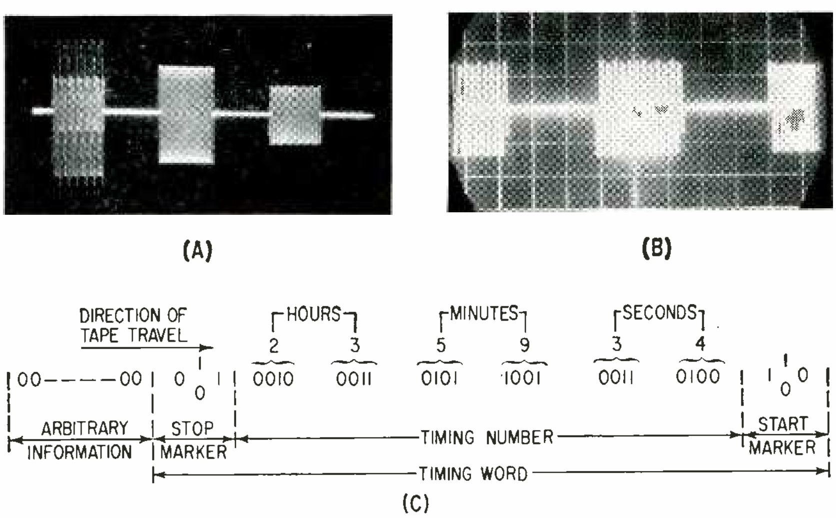


FIG. 1—Binary zero in searcher system is represented by single amplitude tone burst shown at right in (A). Center shows binary one while left shows start-stop marker. Actual tone burst of zero-zero-one chain is shown left to right in (B). Word format used by digital timing generator is shown in (C)

Format of the timing word shown in Fig. 1C consists of three parts: the start marker, composed of a ZERO, a ZERO and a ONE formed simultaneously, and a ONE; a binary-coded decimal representation of time in 24-time bit form; and the stop marker which is the mirror image of the start marker. Mirror imaging enables search in both directions.

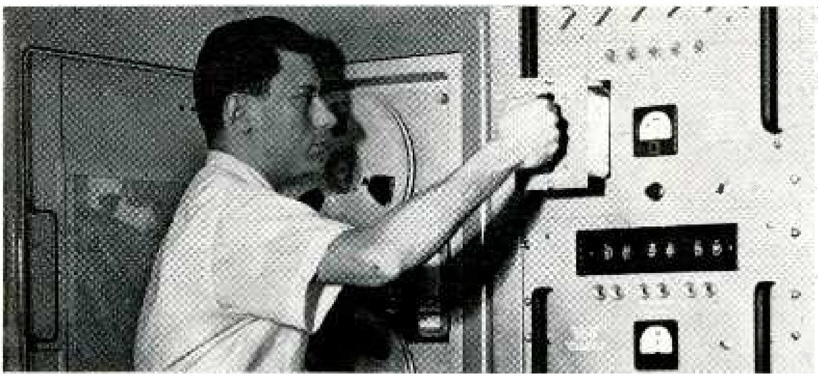
Frequency and duration of the tone bursts are direct functions of tape speed as shown in Table I. This relationship keeps the bit length on the tape constant regardless of the tape speed; therefore, the magnetic tape search unit can be operated at any desired playback speed and is independent of the recording speed used.

Time information continuously displayed on the timing generator is in synchronism with the time recorded on the magnetic tape. A horizontal array display is used consisting of six illuminated indicators capable of reading out in Arabic numerals.

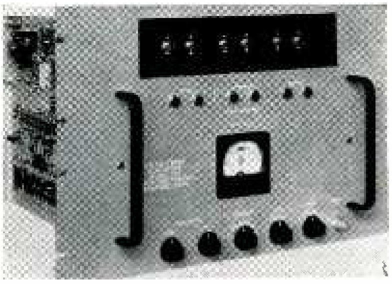
Generator Circuit

A block diagram of the digital timing generator is shown in Fig. 2. Timing indices are derived from an 800 pps square wave generated by a tuning-fork oscillator and a Schmitt trigger. The 800 pps square wave is frequency divided by complement-type flip-flops into square waves of 400, 200, 100, 50, 25 and 12½ pps. These square waves serve as digit sync pulses and are

High-Speed Tape Systems



Engineer inserts 60- and 30-ips speed playback band-pass filter into magnetic tape search unit. Digital timing generator is below search unit



Digital timing generator generates reference time base, records time in hours, minutes and seconds on magnetic tape and displays time information in Arabic numerals

used to control the rate at which the time bits are recorded on magnetic tape. A tape speed switch permits selection of the correct digit sync bit rate.

Basic Time Pulse

In addition to serving as the digit bit rate at one particular tape speed, the 100 pps from the frequency divider is reduced to 1 pps by two decade dividers. This 1 pps pulse is used to advance the digital clock one step each second and also serves as the basic time pulse for the rate at which a complete time word of 30 bits is recorded. Record or word rate is also controlled directly from the tape speed selector switch. One of the four different word rates shown in Table I can be selected depending on the tape speed used.

The digital clock consists of six multideck stepping switches connected to count in hours, minutes, and seconds, or in seconds only. Functionally, the step switches actuate the count to the visual display and transfer the count in binary-coded decimal form to a magnetic-core shift register. Time information is accepted in parallel by the shift register and is read out serially, low order-bit first.

Word rate is selected from tap-offs at various positions on the unit-seconds step switch or word-rate counter. This switch, in conjunction with the tape speed selector switch, controls the rate of the read-in driver which feeds time information to the digital clock which then transfers it to the shift register.

Information in the shift register is shifted out serially at a given digit bit rate by the read out driver.

A Schmitt trigger is used as a gate control to distinguish between the binary ONE and ZERO and to flip the ONE and ZERO gates off or on. The gates control Wien bridge oscillators used to convert the ONES and ZEROS in the time signal into frequency bursts. Since the carrier frequencies are also a function of the tape speed, the tape speed selector switch is used to insert correct R-C values corresponding to a particular tape speed.

Magnetic Tape Search Unit

The magnetic tape search unit operates during data reduction periods on time information previously recorded on tape by the digital timing generator. This unit provides for automatic search and controlled playback of data sequences selected on the basis of manually set time addresses and displays to the operator the time addresses associated with the data being searched or played back.

During automatic search and playback operations, the magnetic tape search unit controls the tape transport mechanism. Normally, the start and stop times, which represent the beginning and end of a desired data sequence, are manually set into the start and stop selector switches.

When the tape drive mechanism is started, the search unit scans the tape at high speed in the proper direction until the start time

Table I—Frequency and Duration of Tone Burst to Tape Speed Relationship

Tape Speed in Ips	Digit Rate in Bits Per Sec	Carrier Freq for ONE in Kc	Carrier Freq for ZERO in Kc	Timing Word Repetition Period in Sec	Arbitrary Digits Available Between Timing Words
120 (Search only)	800	30	20		
60	400	15	10	1	370
30	200	7.5	5	1	170
15	100	3.75	2.5	1	70
7½	50	1.87	1.25	2	70
3¾	25	0.937	0.625	5	95
1⅞	12.5	0.469	0.312	10	95

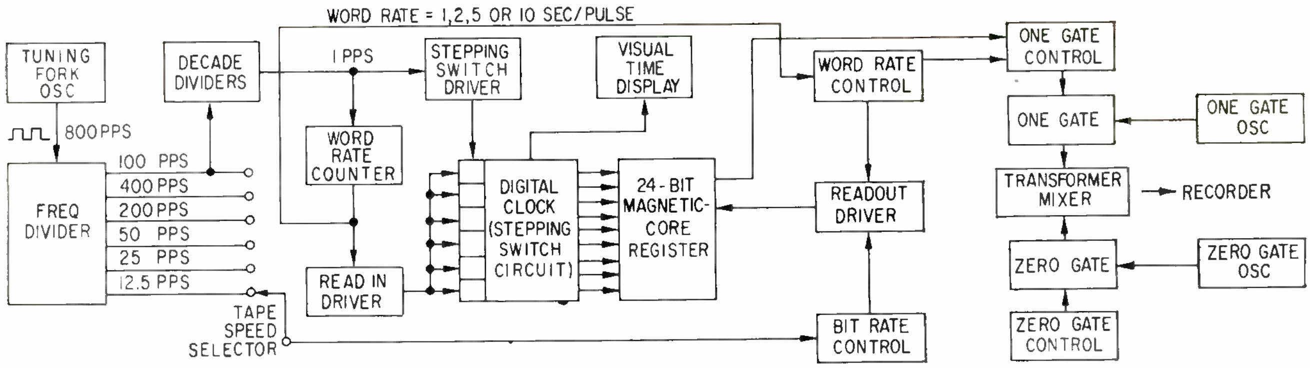


FIG. 2—Block diagram of digital timing generator. The generator is self-timed permitting search and playback decoding to be dependent only upon the time signals

is located on the tape. At this point, tape speed is automatically reduced to desired playback speed and selected data read from the tape for processing by other equipments. Upon reaching the desired stop time, the tape halts and waits for another operation instruction. Time information read from the magnetic tape is continuously displayed during search and playback.

Search Circuit

A block diagram of the magnetic tape search unit is shown in Fig. 3. Time information read from the magnetic tape consists of a serial composite of signals of one of two frequencies corresponding directly to the binary digits ONE and ZERO. These frequencies are amplified and then separated by m-derived pass-band filters into separate channels. Pass-band filters insure system reliability since they only accept information recorded by the timing generator. Separate playback pass-band filters are inserted for each given playback speed.

Each carrier signal is detected by rectification and level selection. The detector employs a signal integration technique, which results, within limits, in reliable operation even in the presence of tape defects or drop outs. Detector outputs are then shaped into square waves which trigger the ZERO or ONE decoder flip-flops. The output from the decoder flip-flops is the binary-coded decimal representation of the time address as originally produced by the digital timing generator.

Start time, set manually into the start time selector switch, is transferred in binary-coded decimal form to a magnetic-core shift register. The output of the ONE flip-flop, which is the tape time in serial form, is compared serially with the information that was manually stored in the shift register of the serial comparator.

Final Location

If the number in the output of the decoder, which represents tape time, is greater than the number stored in the shift register, a control signal is sent to the tape transport mechanism which reverses the direction of the tape motion. If, however, the decoder output is less than the number stored in the shift register, the tape continues in a forward direction until the location of the desired data sequence is indicated by equality comparison. The tape speed is then reduced to playback speed, and the filters are switched automatically from the search to the playback filter.

During playback, the stop time, previously inserted manually into the stop time selector switches, is transferred into the shift register and compared continuously with the binary-coded decimal output from the decoder flip-flop. When the output from the decoder is equal to the desired stop time, the tape transport mechanism halts and the search units wait for another pair of search addresses.

While the information from the register is being shifted out serially for comparison, the time information from the decoder is shifted into the register. When completely filled with the time information from the tape, the register transfers the information in parallel to a thyratron-relay tree converter which actuates the decimal time display. This action permits con-

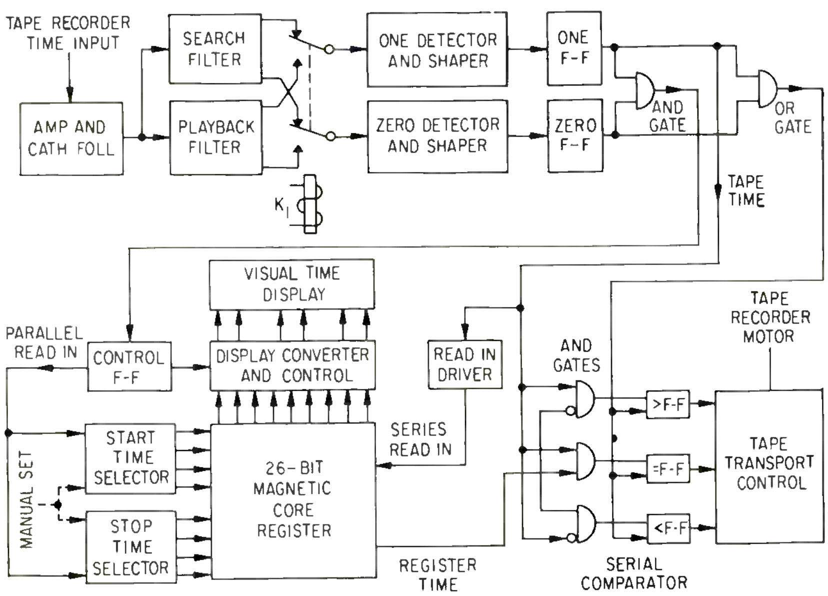


FIG. 3—Block diagram of magnetic tape search unit. Start and stop markers permit the search unit to detect the beginning and end of a series of time bits

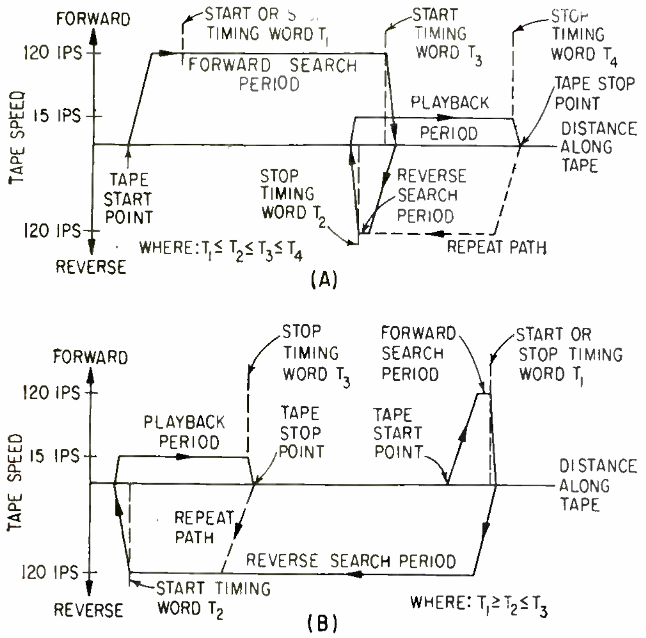


FIG. 4—With segment ahead of pickup (A), tape is read in forward direction. Cycle for segment behind pickup is as in (B)

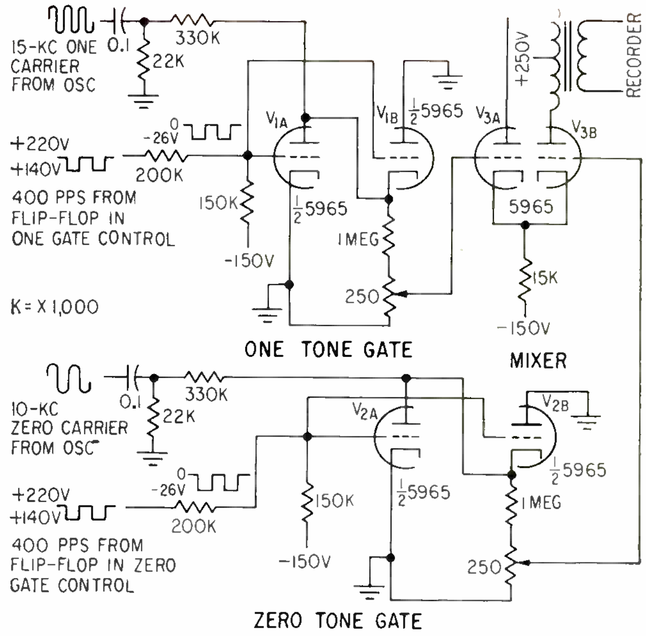


FIG. 5—Tone gate and mixer circuits. Tone bursts from dual triode V_3 are mixed by output transformer common secondary

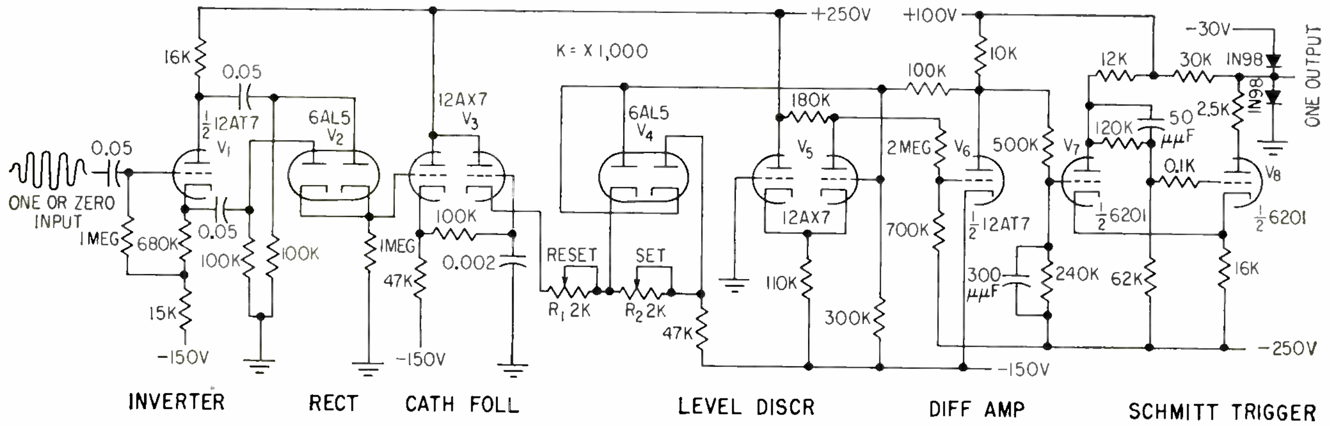


FIG. 6—Detector circuit. Difference between level setting of R_1 and R_2 establishes hysteresis or backlash in the detector

tinual display of time during search and playback.

To prevent overshooting of the tape transport when the timing word is reached, the sequence of operation shown in Fig. 4 is used.

Component Circuits

A clamped bistable multivibrator used in conjunction with multiple diode gating accomplishes all required digital functions. A type 5965 vacuum tube is used exclusively with the 1N98 germanium diode for clamping, and a 1N67A diode is used for gating.

The ONE-ZERO gates and mixer are shown in Fig. 5. Each Wien bridge oscillator produces a continuous output which is applied to gates V_1 and V_2. Each gate is a dual triode arranged symmetrically to suppress any pedestal effect. Gating voltages from either the ONE flip-flop or ZERO flip-flop are applied between grids and cathodes. During ON gating, the triodes are cut-off; during OFF gating, the triodes are conducting. Bias voltages and gate signal amplitude are adjusted by precision resistors to make the two tube currents identical; therefore, the quiscent output voltage level remains constant. Tone bursts are mixed through the dual triode V_3 and the output transformer.

Recovery of the time signal is accomplished during playback by the detector circuit shown in Fig. 6. After the two tone-modulated frequencies are amplified and separated by pass-band filters into separate channels, each signal is fed to its respective detector. Inverter amplifier V_1 couples the signal to full-wave rectifier V_2. Filter smoothing of the rectified signal is done with an R-C network which is coupled directly to d-c level discriminator V_4 and V_5 by second cathode follower V_3.

The discriminator is a precise amplitude detector whose set and reset levels are predetermined by potentiometers R_1 and R_2. Discriminator output is fed directly into a difference feedback amplifier, made up of V_6 and V_7 which is d-c coupled to V_8, Schmitt trigger that is used for shaping.

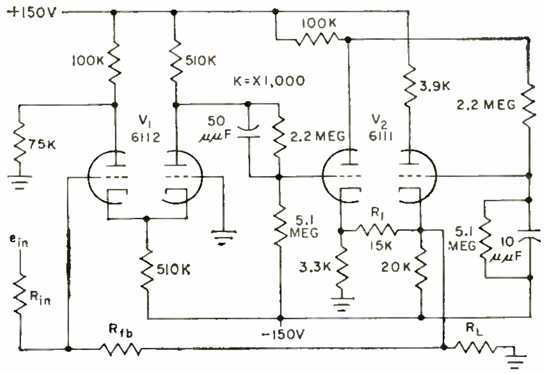
D-C Amplifiers for Control Systems

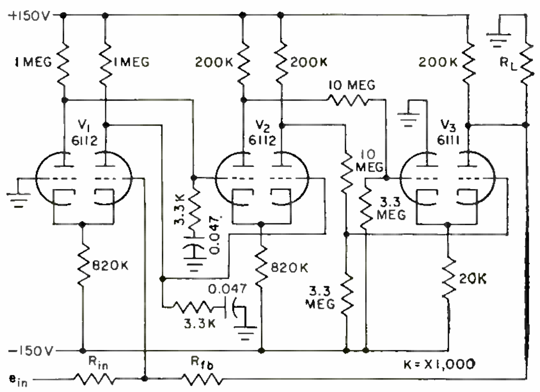
Typical direct-coupled, high-gain amplifier systems which boost gain and equalize d-c and low-frequency signals are described. Circuits and sample applications provide desired performance characteristics for control systems

By **LARRY S. KLIVANS**, Manager, Electronic Support Dept., Radioplane Co., Van Nuys, California

TWO-TUBE POWER-SUMMING AMPLIFIER—First stage in a three stage, subminiature, two-tube d-c amplifier is common cathode coupled; the second is a conventional gain stage and the third is a current limited cathode follower. Open-loop gain is greater than 2,000 and the maximum voltage swing is ± 10v into a 2,000-ohm load. The minimum closed-loop gain R_{fb}/R_{in} should be 0.1 and the maximum should be 50 for good stability. Zero drift referred to the amplifier input is less than 20mv with constant power-supply voltages.

Circuit is best suited for laboratory applications where it is necessary to drive a 2,000-ohm electrohydraulic servo-valve coil, or for straight resistance summing of several input signals. Use of positive feedback to obtain open-loop gain may require selection of R_1





BALANCED DIFFERENTIAL OPERATIONAL AMPLIFIER—Using three stages with subminiature dual triodes, this amplifier has low drift characteristics because all stages are common-cathode coupled.

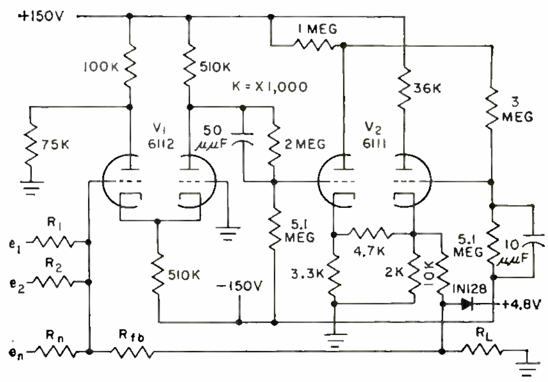
The plate and cathode power supplies of ± 150 v permit the output to operate above and below zero potential. Open-loop gain is greater than 5,000 into a 10,000-ohm load and good stability and summing accuracy is possible with closed-loop gains of 0.1 to 100. Zero drift referred to the amplifier input is less than 20 mv after temperature cycling of —40 to +185 F.

The amplifier is well suited for essentially no-load, one-megohm or higher, applications where ±50-v swing is required and space is a premium. Other applications include integrating or differentiating in airborne or ground based electronic control systems. Phase lag of 5 deg at 20 cps with closed-loop gain of 10 limits applications to low-frequency control systems

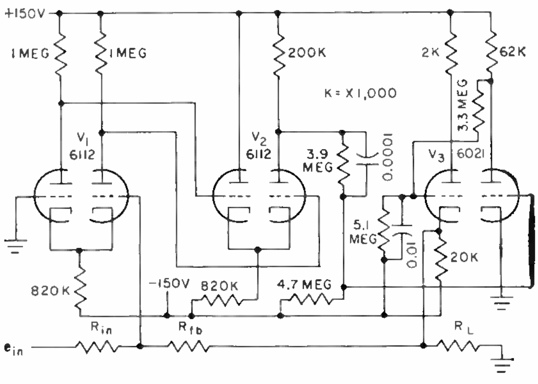
TELEMETERING CONVERSION SUMMING AMPLIFIER—Two voltage-gain stages with a cathode-follower output are used. The first stage is a differential dual-triode amplifier with the output feeding a second voltage-gain stage and a current and voltage-limited cathode follower. The follower limits the amplifier output swing between 0 and ±5 v. An open-loop gain of 2,000 is obtained with positive feedback in the last two stages.

Principal applications for the amplifier are in airborne or ground based electronic systems. In these systems it is necessary to amplify d-c or low-frequency signals, isolate transducers or other sensors, change scale factors or shift the operating mean potential of d-c signals

(continued on page 98)



D-C Amplifiers for Control Systems (continued from page 96)



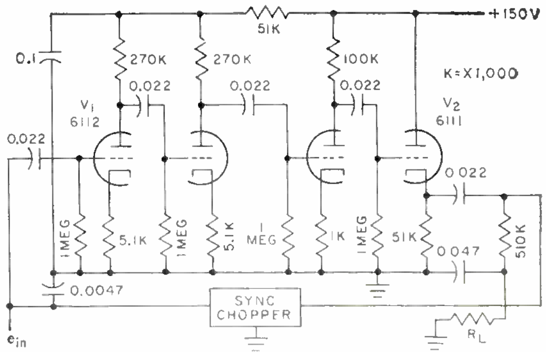
THREE-TUBE 400-CPS SUMMING & POWER AMPLIFIER—The four-stage d-c amplifier has two differential double-triode gain stages, a conventional single-triode gain stage and a cathode-follower output stage.

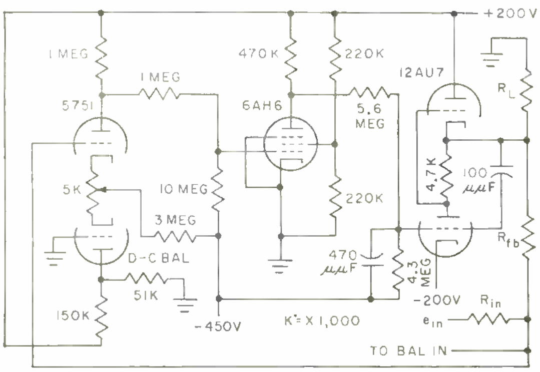
The open-loop gain is greater than 5,000, and the voltage swing is ± 10 v into a 1,500-ohm load and ± 25 v into a 5,000-ohm load. Internal equalization allows the amplifier to have less than 5 deg phase shift from d-c to 400 cps.

Amplifier is applicable to 60 or 400-cps control systems where several signals must be summed and amplified in a precise manner. It is also used for broadband equalization where the load impedance is lower than 25,000 ohms and the phase lag must be held to a minimum

MODULATED 400-CPS CARRIER D-C AMPLIFIER—This amplifier uses a 400-cps electromechanical chopper and an a-c amplifier. The chopper modulates the incoming d-c signal; the resulting a-c signal is amplified and then demodulated by the chopper. The circuit has three gain stages and a cathode-follower output stage with a d-c to d-c conversion gain of greater than 5,000.

A dpdt or synchronous chopper is required for stability. Circuit is suitable for high-gain, low-level d-c amplifier applications, such as strain gage or thermocouple signals, where amplifier drift must be minimized, regulated power supplies are not available and d-c balancing is not desirable





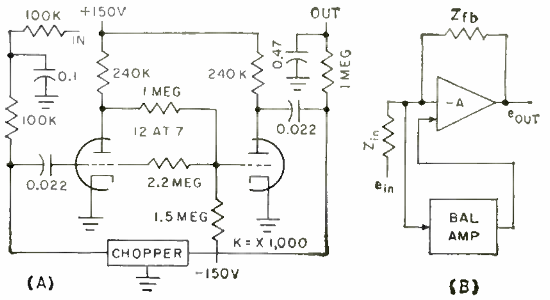
OPERATIONAL D-C AMPLIFIER FOR ANALOG COMPUTERS—Amplifier has an open-loop gain greater than 15,000. It has a differential double-triode input stage and a pentode second stage. Third stage is a dual-triode cascade amplifier acting as cathode-follower. The output swings ±100 v into a 20,000-ohm load. Usable signal frequency is d-c to 20 kc at unity closed-loop gain.

Amplifier is well suited for control systems or analog computer applications because of broad passband and large control-system response characteristics. Amplifier may be used with all passive equalization networks to obtain desired response

BALANCING D-C AMPLIFIER—A d-c amplifier (A) with a gain of 300 uses one dual triode, a two stage a-c amplifier and an electromechanical chopper. When used with an operational amplifier (B), the amplifier produces a d-c gain of 3×10^{6}.

An R-C filter with $\tau = 0.47$ must filter the output as the primary purpose of the balancing amplifier is to detect slow changes at the operational-amplifier summing point, amplify the drift voltage and supply an opposite-polarity signal to the second input grid of the operational amplifier. Action is similar to a null-seeking servo mechanism in that any low-frequency variation of the summing point voltage is always driven back to zero.

Long-term drift of the operational amplifier is reduced from 20 mv, referred to the input grid, without balancing amplifier, to less than 0.2 mv. Operational amplifier should use balancing d-c amplifier for long period integration or low drift summing with large closed-loop gain



(A) (B)

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H W Mateer

Publisher

Trap Improves Tv Picture

By **GORDON C. FIELD** Television Engineering Dept., Dominion Electrohome Industries, Ltd., Kitchener, Ontario

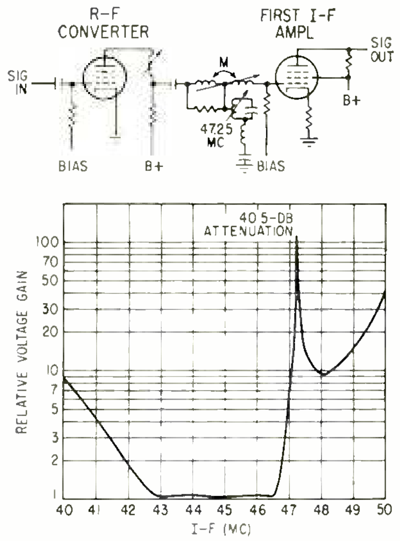

FIG. 1—Trap increases carrier slope

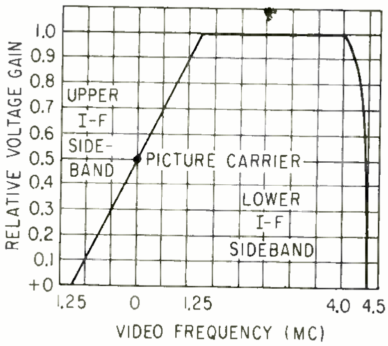

FIG. 2—Linear plot shows standard vestigal sideband signal

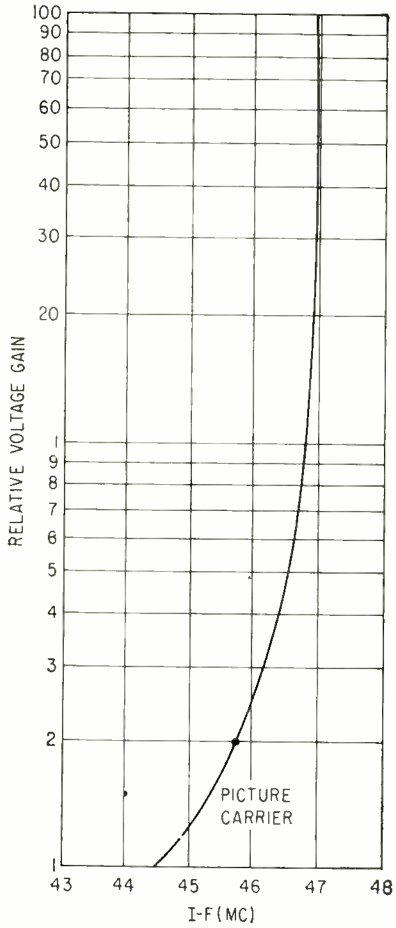

FIG. 3—Logarithmic plot of standard vestigal sideband signal

RECENTLY, high-attenuation series traps have been incorporated in monochrome tv receivers. Their purpose is to suppress adjacent-channel interference in 40-mc i-f amplifiers.

Although these traps have accomplished their purpose, they have had some undesirable effects. The use of bifilar T traps is suggested to accomplish the same function without some of the drawbacks.

The series traps now in use have reduced frequency response between 45.75 and 47 mc. This reduction causes a serious increase in slope at the picture carrier frequency of 45.75 mc, as shown in Fig. 1.

The increased slope causes poorer picture detail and accentuates preshoot and overshoot. In addition, white snowballs trailing black noise pulses have resulted.

The original idea of vestigal-sideband transmission has been kept in mind in using these traps. The sum of the upper and lower sidebands have been made equal to unity for the video frequency range from zero to 1.25 mc. However, the presence of the quadrature component in unsymmetrical sideband detection has been neglected.

To achieve bandwidth at the expense of increasing the quadrature component, it was established that the picture carrier should be at the 50-percent point on the i-f slope of the passband. (Linear and logarithmic plots of standard vestigal sideband signals are shown in Fig. 2 and 3.) This was found to result in best overall performance.

However, under this condition, maximum tolerable quadrature component exists. Therefore, it appears that further increase in the quadrature component will degrade the picture.

Basic Theory

Amplitude of the quadrature component varies directly as the difference in amplitude of the sidebands. This difference, in turn, is directly proportional to the slope at the picture carrier for the linear portion of the response. This can be seen from the expansion for the quadrature component.

$$e_q = (B_1 - B_2) \sin (2\pi ft - \theta)$$

where B_1 is amplitude of lower sideband, B_2 is amplitude of upper sideband, f is modulating frequency and θ is angle between sidebands and carrier.

Amplitude of the quadrature component is also dependent on amplitude of the picture carrier and percentage modulation. Considering the relationship between quadrature component and reproduction of a unit function, the smaller the value of θ_q, the more exact is the transient response of a unit step function.

Where cochannel sound reception fades, it becomes necessary to tune the picture carrier down the i-f response curve to increase sound sensitivity. In such cases, there will be a smaller effect on picture performance for i-f amplifiers with a minimum slope at the picture carrier. (Minimum slope is defined as 0.4 v/mc.)

Bifilar T Trap

General picture tuning will also be improved with minimum slope, because of the balance of varying amounts of the quadrature component and the extreme change of picture carrier level.

To achieve high attenuation at 47.25 mc (the adjacent lower channel sound carrier) and still retain minimum slope at the picture carrier frequency, use of bifilar T traps becomes desirable[1]. Such a trap is shown in Fig. 4.

Overall i-f response may then ap-

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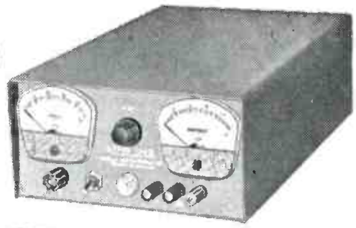
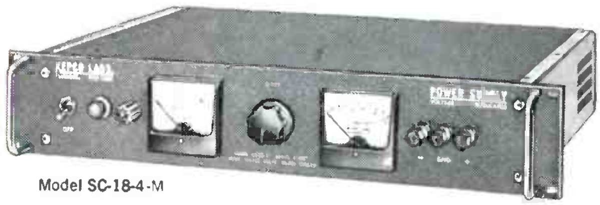


Model SC-18-2-M

*Two units mounted in Rack Adapter RA-2



Model SC-18-4-M

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MODEL	OUTPUT VOLTS DC	OUTPUT AMPERES DC	OUTPUT IMPEDANCE DC-1KC	OUTPUT IMPEDANCE 1KC-100KC	SIZE W	SIZE H	SIZE D
SC-18-0.5	0-18	0-0.5	.04	.4	8¼"	4 5/32"	13⅝"
SC-18-1	0-18	0-1	.02	.2	8¼"	4 5/32"	13⅝"
SC-18-2	0-18	0-2	.01	.1	8¼"	4 5/32"	13⅝"
SC-18-4	0-18	0-4	.005	.05	19"	3½"	13"
SC-36-0.5	0-36	0-0.5	.08	.8	8¼"	4 5/32"	13⅝"
SC-36-1	0-36	0-1	.04	.4	8¼"	4 5/32"	13⅝"
SC-36-2	0-36	0-2	.02	.2	19"	3½"	13"
SC-3672-0.5	36-72	0-0.5	.15	1.0	8¼"	4 5/32"	13⅝"
SC-3672-1	36-72	0-1	.08	.8	19"	3½"	13"

Patent Pending

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TRANSISTORIZED
SHORT CIRCUIT PROTECTED

- **REGULATION:** 0.1% for line changes 105-125 volts at any output voltage in the range minimum to maximum.

  0.1% or 0.003 volt for load changes 0 tc maximum (whichever is greater) at any output voltage in the range minimum to maximum.
- **RIPPLE:** 1 mv. RMS.
- **RECOVERY TIME:** 50 microseconds.
- **STABILITY:** (for 8 hours) 0.1% or 0.003 volt (whichever is greater).
- **AMBIENT OPERATING TEMPERATURE:** 50°C maximum. Over-temperature protection provided. Unit turns off when over-temperature occurs. Power-on-off switch on front panel resets unit.
- **TEMPERATURE COEFFICIENT:** Output voltage changes less than 0.05% per °C.
- **SHORT CIRCUIT PROTECTION:** No fuses, circuit breakers or relays! Designed to operate continuously into a short circuit. Returns instantly to operating voltage when overload is removed. Ideal for lighting lamps and charging capacitive loads.
- **OVER-CURRENT CONTROL:** Can be set from 0 to 120% of full load. Current is limited to preset value for any load including short circuit.

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- **REMOTE PROGRAMMING** at 1000 ohms per volt is provided. Remote programming allows mounting a voltage control at a remote point.
- **REMOTE ERROR SIGNAL SENSING** is provided to maintain stated regulation directly at load.
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- **POWER REQUIREMENTS:** 105-125 volts, 50-65 cycles. 400 cycle units available.
- **OUTPUT TERMINATIONS:** DC terminals are clearly marked on the front panel. All terminals are isolated from the chassis. Either positive or negative terminal of each DC output may be grounded. A terminal is provided for connecting to the chassis. The DC terminals, the remote programming terminals and the remote error signal sensing terminals are brought out at the rear of the unit.
- **CONTROLS:** Power-on-off switch, one turn voltage control, on front panel. Over-current control on rear of unit. Ten turn voltage control available on special order.
- Continuously Variable Output Voltage. No voltage switching.
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Units without meters use model numbers indicated in table. To include meters add M to the Model No. (e.g. SC-18-1-M).

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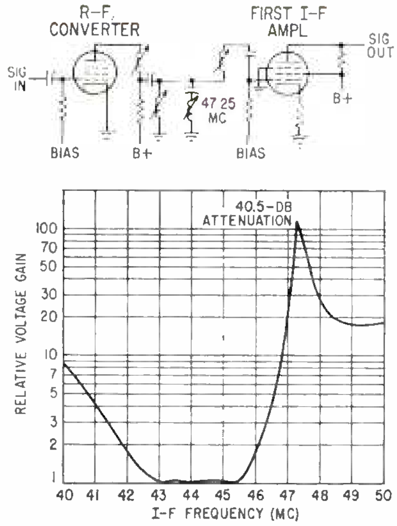


FIG. 4—Bifilar T trap at 47.25 mc results in minimum slope

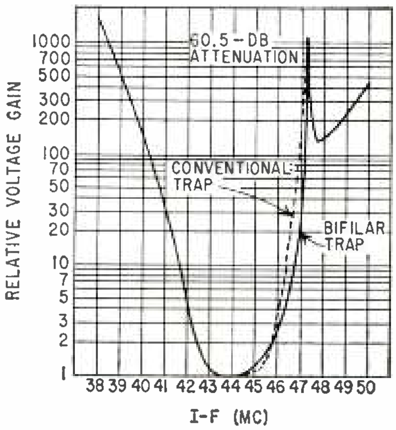


FIG. 5—Comparison shows improvement in slope with bifilar T trap

proach the vestigal-sideband requirement with minimum slope at the picture carrier frequency. Yet this arrangement maintains 60 db attenuation at 47.25 mc. It is believed that this cannot be obtained with present-day low-impedance high-Q series traps.

Slopes using the traps of Fig. 1 and 4 are shown in Fig. 5.

REFERENCE

(1) RCA Bulletins LB950, 961, 998.

Speed Indicator Tests Carrier Aircraft

ELECTRO-OPTICAL system measures aircraft horizontal velocity just prior to engagement with the arresting gear on an aircraft carrier. The system can also be used to measure horizontal velocity of catapult launchings.

The Naval Air Test Center,

Patuxent River, Md., developed the system to test the suitability of new types of aircraft for carrier use.

The speed-over-deck indicator consists of two identical detector units separated by a known distance. An optical system projects thin vertical fields of modulated light through which the aircraft passes.

A trihedral or retroflective mirror mounted on the aircraft reflects the light of each field back to its respective detector. The detectors provide start and stop commands for an electronic timer.

The time registered is used in computing aircraft velocity in traversing the distance between the two fields of light.

Trigger Stabilizes Frequency Divider

By KUN-MU CHEN

Div. of Engineering and Applied Physics, Harvard Univ., Cambridge 38, Mass.

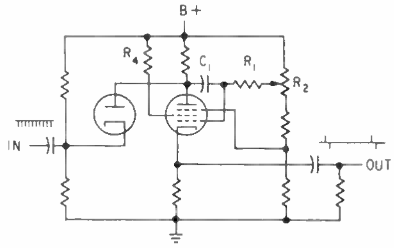


FIG. 1—Conventional phantastron frequency divider is triggered by pulse train with triggers of only one polarity

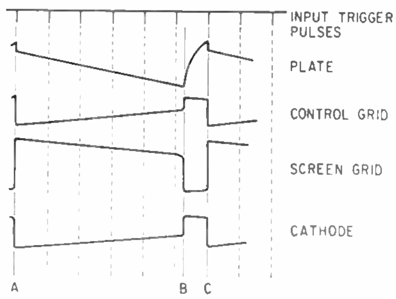
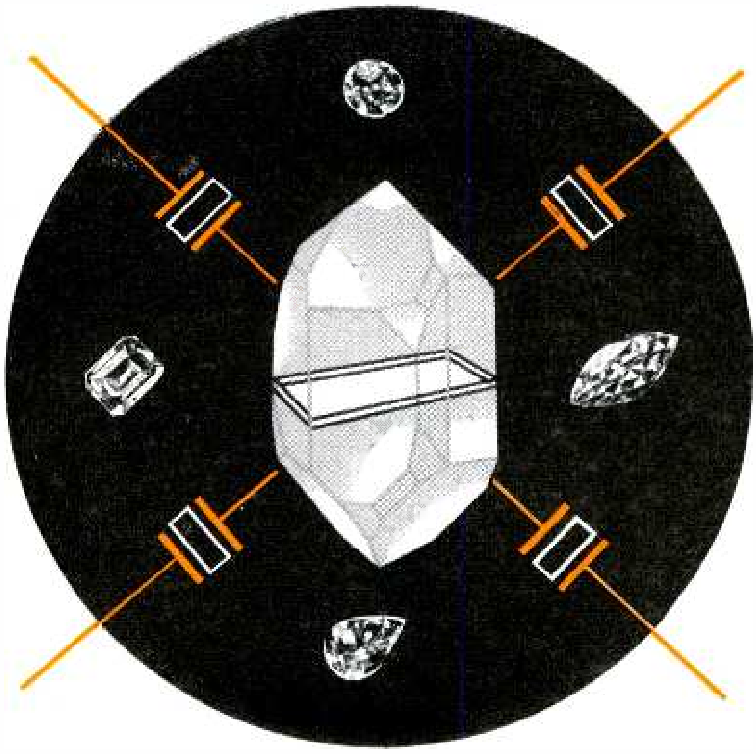
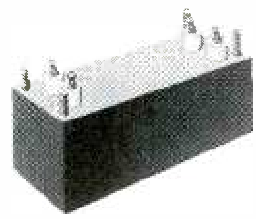


FIG. 2—Points *A* and *C* in conventional divider are fixed, but point *B* is unstable, particularly at low frequencies

PHANTASTRONS can be used as frequency dividers at frequencies of several hundred kc with adequate stability. With minor modifications, a phantastron can divide frequencies lower than several hundred cps with high stability.

The conventional phantastron frequency divider is shown in Fig. 1,





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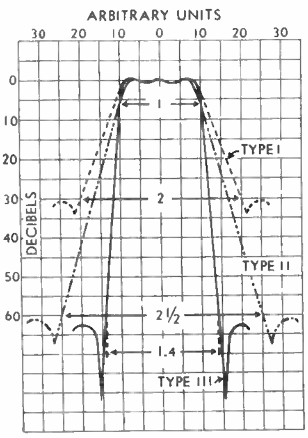
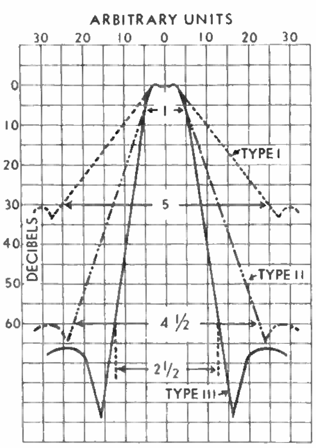


WIDE BAND CRYSTAL FILTER



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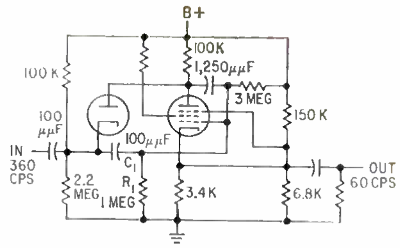


FIG. 3—Modified phantastron is triggered by train with both positive and negative pulses

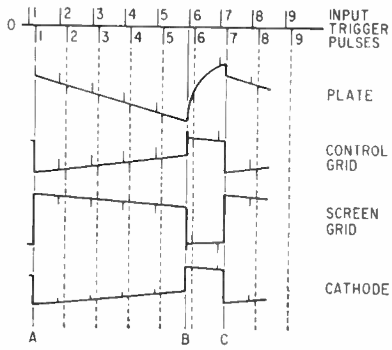


FIG. 4—With pulse train containing both positive and negative pulses, point *B* is fixed

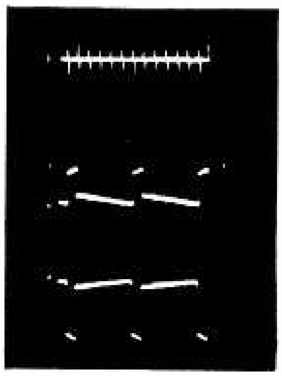


FIG. 5—Phantastron operating with 360-cps train containing pulses of both polarities develops waveforms shown in photograph

and the waveforms are shown in Fig. 2. The beginning and end of a cycle (A and C) are fixed by two negative trigger pulses.

Point B in Fig. 2, however, is not fixed. Its location is determined by circuit parameters, including C_1, R_1 and power-supply voltage. If the circuit is operating near the a-c power frequency, this frequency can also affect the location of point B.

Improved Circuit

A double-triggering method is proposed to make point B more stable. An input trigger is used that has both positive and negative pulses. In the usual frequency-divider chain, such a trigger can be gotten by differentiating the cathode or screen grid voltage from the previous stage.

In the circuit in Fig. 3, the trigger pulse train is fed to the plate through the diode and the control grid through an r-c coupling circuit (C_1 and R_1).

In Fig. 4, negative trigger pulses 1 and 7 fix points A and C, respectively. As control grid voltage nears cutoff, positive pulse 6 helps the tube to switch. This positive pulse fixes point B.

In most cases, variable resistor R_2 in Fig. 1 can be eliminated.

This circuit divides 360 cps to obtain 60 cps, and its waveforms are shown in Fig. 5.

Control Unit Uses X-Ray Tv

QUALITY CONTROL UNIT unveiled this week combines x-ray techniques with tv pickup methods to allow fluoroscopic product inspection on an assembly line basis.

The new x-ray sensitive camera tube allows direct transfer of x-ray energy to electron energy at levels suitable for display on a tv monitor. Pickup camera consists of an x-ray image pickup tube, horizontal and vertical sweep subchassis and preamplifier unit.

Control unit for the new system incorporates rectifier, regulator, video, sync and blanking subchassis. Each is easily removed for servicing.

System monitor has a horizontal resolution of 46 lines per inch (min.) at center. Vertical resolution is 37 lines per inch at center. Video high frequency response is flat to 8 mc ±1 db, less than 10 percent tilt of peak-to-peak amplitude with 60 cps square wave. Modulated signal output for use with conventional tv receivers is 0.1 v rms video-modulated r-f into 75 ohms, tunable to standard tv channels 2 to 6, double sideband radio frequency.

Increased Brightness

Brightness 10,000 times higher than a conventional fluoroscope image is claimed for the system by General Electric, developer. Further advantage is that inspection can be made from remote locations to protect operators from exposure to x-rays. This permits safe use of any x-ray intensity necessary for adequate penetration up to the limit of the associated x-ray generator. The viewing monitor provides quality control inspectors with an image size electronically variable from ½ to 3 times the size of the original object.

The x-ray tv system can be used with any ordinary x-ray generating apparatus.

Oscillators Measure Broadcast Frequency

EXTENSION of the commercial broadcast spectrum upwards toward 1,000 mc and increase of frequency assignments in the vhf and uhf regions are aggravating certain technical problems in broadcasting.

To avoid mutual interference, the FCC assigns each broadcaster a specific carrier frequency and carefully specifies accuracy. Accuracy is customarily stated as plus or minus a certain number of cycles around the specified frequency.

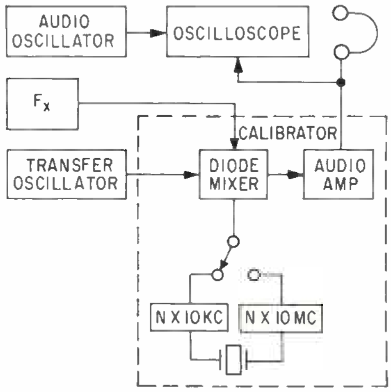


FIG. 1—Transfer oscillator output with transmitter frequency provide sum and difference frequencies that can be beat against harmonic series. Transmitter frequency can then be corrected

To achieve specified accuracy, the brodcaster must refer his frequency to a frequency or time standard whose accuracy is appreciably better. For the a-m, f-m and tv bands, periodic reference to a national frequency standard such as WWV is required, as well as continuous comparison to a frequency-deviation monitor having at least twice the accuracy of the transmitter.

A basic system for checking transmitter frequency is shown in Fig. 1. Either of two crystal-controlled harmonic series can be injected into a diode. One is spaced at 10-mc intervals extending upwards of 1,000 mc; the other at 10-kc intervals upwards of 10 mc. The unknown frequency, F_x, is injected into the same mixer diode. F_x can be set equal to any harmonic of either harmonic series by adjusting for zero beat in the phones.

Sum or Difference

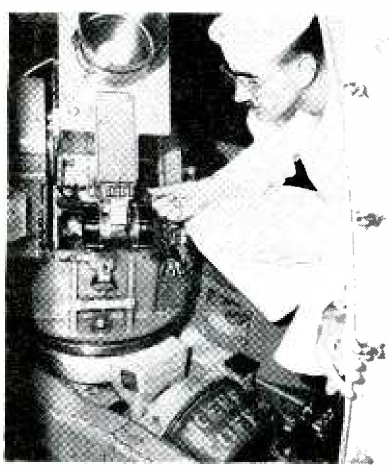
Above 10 mc, however, the only values of F_x are exact multiples of 10 mc, of which there are very few.

To apply the necessary resolution of the 10-kc harmonic series to the region above 10 mc, the frequency under measurement must be considered as the sum or difference of two frequencies. One is a multiple of 10 mc; the other a multiple of 10 kc but less than 10 mc.

For example, if 193.24 mc is modulated with either 3.24 or 6.76 mc, one of the frequencies generated will be an exact multiple of 10 mc. It will therefore be at zero beat with one of the 10-mc harmonics.

The transfer oscillator in Fig. 1 can be set accurately by means of the 10-kc harmonic series. By injecting both F_x and this accurately calibrated transfer frequency into the diode, sum and difference frequencies will be generated. Switch-

Phototube Sextant



Electronics technician adjusts camera assembly of Farrand's photoelectric sextant now being evaluated on USS Compass Island. Sensing device is image orthicon tube ing over to the 10-mc series, any beat note heard in the phones will indicate an error in F_x. The error can be corrected by adjusting F_x for zero beat.

Accuracy

Accuracy of this system is determined by accuracy of the crystal oscillator controlling the harmonic series. At the time of measurement, this oscillator must be set to zero beat with a sufficiently accurate standard such as WWV.

Initial accuracy of the transfer oscillator is not significant, since it can be set in terms of the calibrator. Short-term stability sufficient to enable the measurement to be made is necessary, however. It must be able to maintain its frequncy within a cycle or two for the few seconds it takes to switch the calibrator from 10-kc to 10-mc.

The usual difficulty of setting to precise zero beat would limit the precision of setting F_x to perhaps 50 cps. Resolution of better than one cycle can easily be achieved by offsetting the transfer oscillator frequency from its calculated value by some arbitrary amount.

Improving Resolution

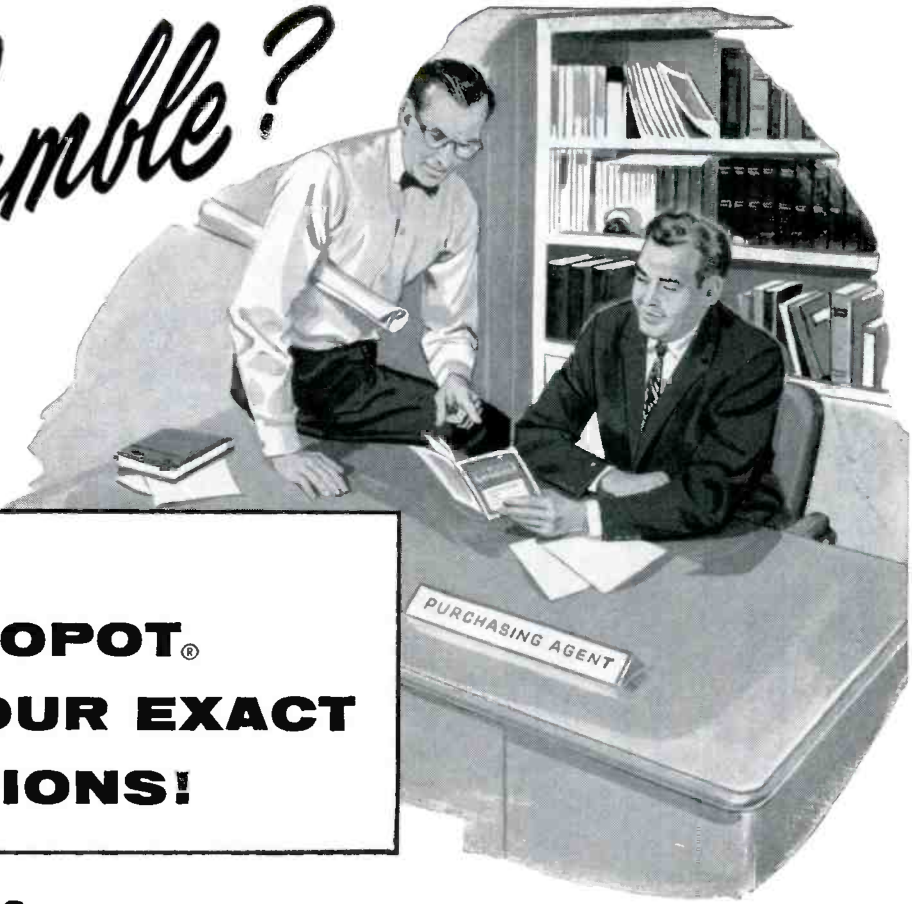
F_x is adjusted so that the beat notes against both harmonic series have the same frequency and the same sign. The particular beat frequency does not matter.

The beat signal is applied to one pair of deflection plates of an oscilloscope and an audio oscillator to the other pair. With the calibrator set to 10 kc and with the transfer oscillator detuned slightly, a recognizable Lissajous figure is obtained by adjusting either oscillator. The calibrator is switched to 10 mc and F_x adjusted for the same pattern. The audio oscillator and oscilloscope serve as memory during the switching process.

Having obtained the desired resolution, the offset frequency is changed slightly and the two beat frequencies are checked to determine that they stay matched. This checks that the direction offset is the same for both beat notes.

This material was abstracted from a Wescon conference paper by C. A. Cady and W. P. Buuck of General Radio Co.

Why Gamble?



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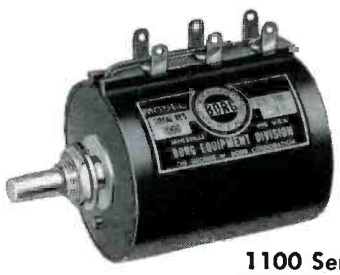

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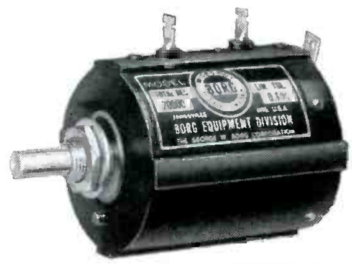

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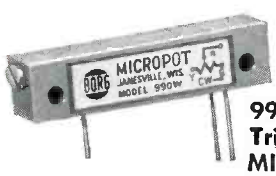

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Around-the-Mast Rotary Joint

By **HENRY S. KEEN,** Engineer, Airborne Instruments Laboratory, Div. of Cutler-Hammer, Inc., Mineola, N. Y.

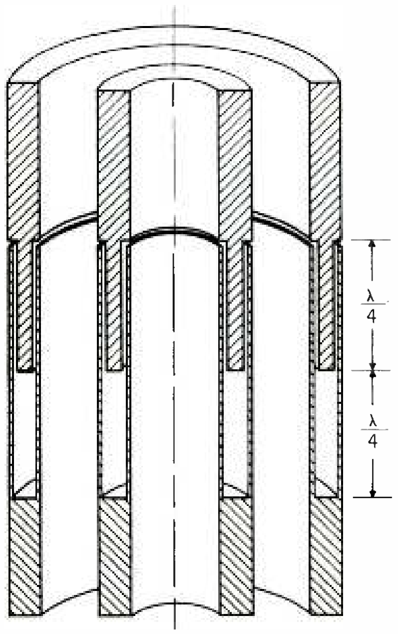

FIG. 1—Basic coaxial choke joint

MICROWAVE rotary joints are used to maintain electrical continuity between a stationary r-f generator and a continuously rotating antenna system. Many variations appear in the design of these units for radar applications. The particular one chosen depends usually on the requirements of the radar antenna system.

Until the around-the-mast type of joint was developed, available designs provided only a limited number of rotary channels. The antenna had to be designed for the rotary joint. The multiple-feed antenna offered more information through lobe comparison. But it could be used only with remotely controlled r-f switching, mounted on the rotating system or with a rotary platform on which the entire system is mounted.

Basic Rotary Joint

The basic rotary joint as shown in Fig. 1 is of the familiar coaxial form. It consists of two collinear sections operating in the TEM mode coupled by quarter-wavelength noncontacting chokes. A successful alternative design using circular waveguide operating in the TM_{01} mode is useful for high-power applications but is not adaptable to around-the-mast techniques.

The problem of multiple-channel continuity in a rotary-joint system has led to the annular design. In this system, identical units can be combined into a microwave slip-ring assembly. In order to combine rotary units in this manner, an opening must be provided through the center of the assembly. This opening must be large enough to pass as many transmission lines as there are channels. Complications arise when one of these channels must be a waveguide carrying the higher power from the transmitter. Resulting transverse dimensions will almost certainly be measured in wavelengths. Under these conditions, higher-order modes become a definite possibility with resulting variations in transmission characteristics as the joint is rotated.

The tendency to establish undesired modes must first be minimized by feeding the necessarily large-diameter basic coaxial joint at points equally spaced about its circumference. These points must be separated by less than a half-wavelength. Signals that are fed to the coaxial section in this manner must be identical in both phase and amplitude. Such signals are obtained best by a binary feed system consisting of a series of tee-junction power dividers in strip transmission line.

Binary Feed

Design of the binary feed, Fig. 2, is simple. Quarter-wavelength impedance-matching transformers are combined with the tee junctions. As a result, energy at the 50-ohm input is divided equally between eight 40-ohm output points. To insure phase equality, path lengths from the input to any of the eight output points must be identical. Impedance-matching transformers are arranged in back-to-back pairs, to increase bandwidth.

Any traces of higher-order modes that might survive the feed precautions described are further attenuated by a system of built-in mode filters located in the basic coaxial section of the joint. These filters consist of a series of slots in the outer conductor of the basic

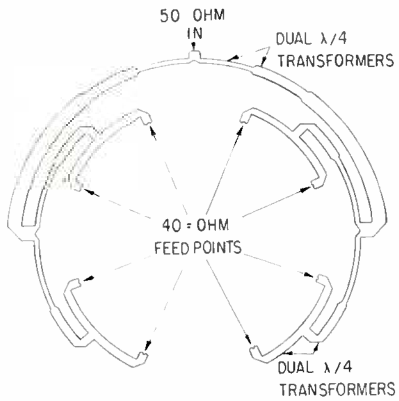

FIG. 2—Binary feed system

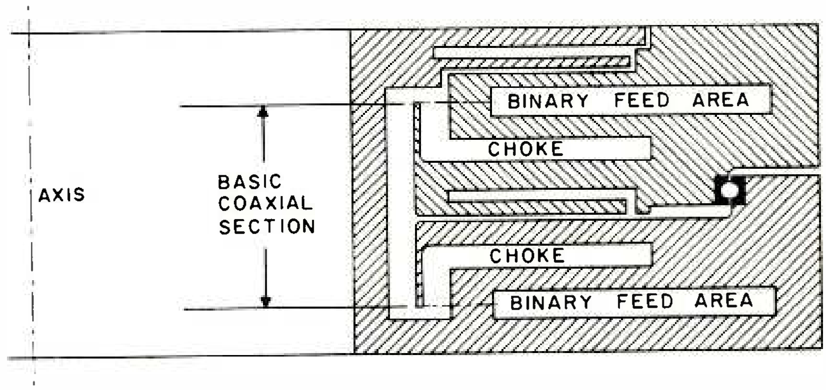

FIG. 3—Cross-sectional view of the rotary joint

(ACTUAL SIZE)

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	Ratings		Typical Performance			
	Vdc	Pc (25°C)	B (Ic-5 Adc)	Vs (Ic-5 Adc)	$f\alpha$	rbb′
2N1073	40	35 W	40	0.5 Vdc	1.5 mc	2 ohms
2N1073A	80	35 W	40	0.5 Vdc	1.5 mc	2 ohms
2N1073B	120	35 W	40	0.5 Vdc	1.5 mc	2 ohms

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Red Bank Division Bendix AVIATION CORPORATION coaxial section parallel to the axis of rotation. Circumferential currents inherent in the higher-order modes are attenuated effectively by lossy magnetic material which fills the slots.

The method of feeding the basic coaxial section by the multipoint binary feed shown in Fig. 3 is unusual. Inner conductors of the feed system connect to the outer conductor of the basic coaxial section. A quarter-wavelength choke, located at the feed points, electrically frees the outer conductor making this method of feed possible.

Although the original design was evolved for a power level compatible with receiving service, increased ground-plane spacing and elimination of dielectric from points of intense field strength will lead to a joint of transmitting possibilities.

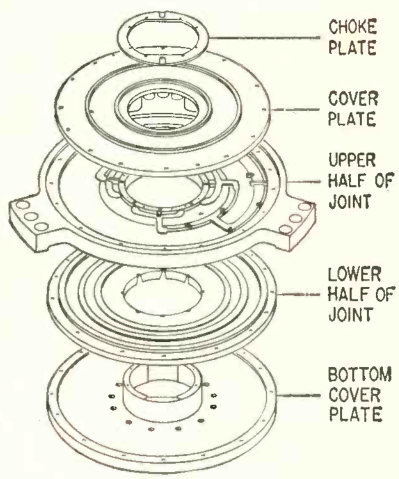
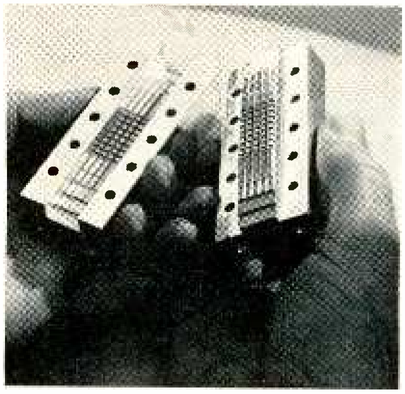


FIG. 4—Exploded view of single joint

Typical characteristics of an L-band joint give an insertion loss of less than 0.2 db, wow with rotation under 0.1 db and negligible phase shift for most applications. Bandwidth varies with the swr requirements but a value of 1.25 has been obtained over a bandwidth of 15 percent. A slight relaxation of the swr requirements can double this figure. An exploded view of a single joint is shown in Fig. 4.

Waffle-Iron Waveguide Filter

EFFECTIVE screening out of unwanted high-frequency signals is made possible by a new filter design

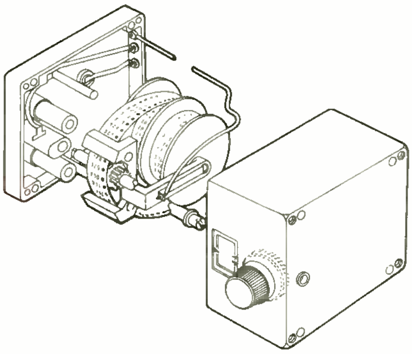


developed by Stanford Research Institute for the Hewlett-Packard Co.

The new filter has a waffle-iron grid design made up of a carefully computed pattern of slots cut across lengthwise grooves. The design passes microwaves in the 10- to 15.5-kmc band. Higher frequencies with shorter wavelengths are trapped by the grid design and reflected to the power source.

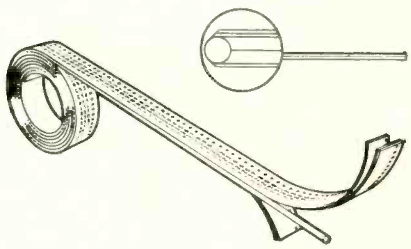
Slidewire Pot Has Digital Readout

BASIC ACTIVE ELEMENTS of a new potentiometer produced by The Howell Instrument Co., Fort Worth,



Texas, is a resistance-wire bonded within the edge of a laminated Mylar tape. The wire may be either straight or in helical form depending upon the total resistance required. It is available in lengths of 120 in. Resistance ranges obtainable are from 100 to 100,000 ohms.

Readout is direct through a window on the front of the case of the potentiometer. With the calibration stamped on the tape, any linear or nonlinear calibration can be obtained. Typical applications include direct digital reading of temperature with any type of thermocouple, square-root extraction when used with differential-pressure transducers for flow measurement and hyperbolic and logarithmic functions encountered in analysis and radiation systems.



Each Ta'Pot is calibrated automatically by a system that compares the unit under test with a master tape 60-ft long. Digital values, as specified, are printed on the tape automatically during calibration. For the 120-in tape, 1,000 calibration points are printed.

Conformity between true resistance value and specified function of the calibration is 0.05 percent. Resolution is better than 0.01 percent; total resistance tolerance, 0.25 percent and end resistance less than 0.05 ohm. Power rating is two watts at 25 C.

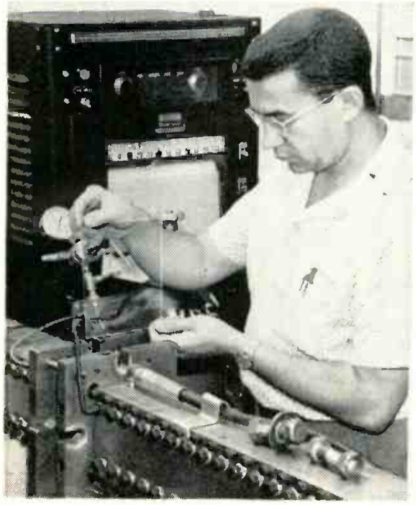
Transducer Test Program

RESEARCH, development and testing of telemetering transducers is the basis of a program being carried out at the National Bureau of Standards.

The program provides data on performance of transducers over significant ranges of such ambient conditions as temperature, temperature shock, pressure, vibration, acceleration, humidity, pressure shock and acoustic vibration. A special shock tube for testing transducers provides a pressure step-function of known value which can be applied to the transducer pressure gage under study. Response of the gage is detected by an oscilloscope and recorded photographically for further analysis.

Accelerometers

Calibration of accelerometers presents no problems at frequencies from 10 to several hundred cps. But the frequency of interest often lies below this range. One procedure for calibration at lower frequencies involves rotation of the accelerometer in the earth's gravitational field. The other makes uses of a specially designed centrifuge.



Diaphragm being inserted between compression and expansion chambers

Both methods provide a known frequency input to the accelerometer. A response curve represents the dynamic characteristics of the device.

Shock Tube

The special shock tube constructed is of flanged steel sections. It has a working cross-sectional area three in. square, a compression chamber variable in length from 3.4 to 12 ft and an expansion chamber eight ft in length. The tube is equipped with three pairs of optical glass windows. Each pair is provided with a schlieren system and multiplier phototube arranged to give a pulse at the time of passage of the shock wave. Auxiliary equipment measures initial expansion of chamber pressure accurately and determines transit time of the shock wave between schlieren stations.

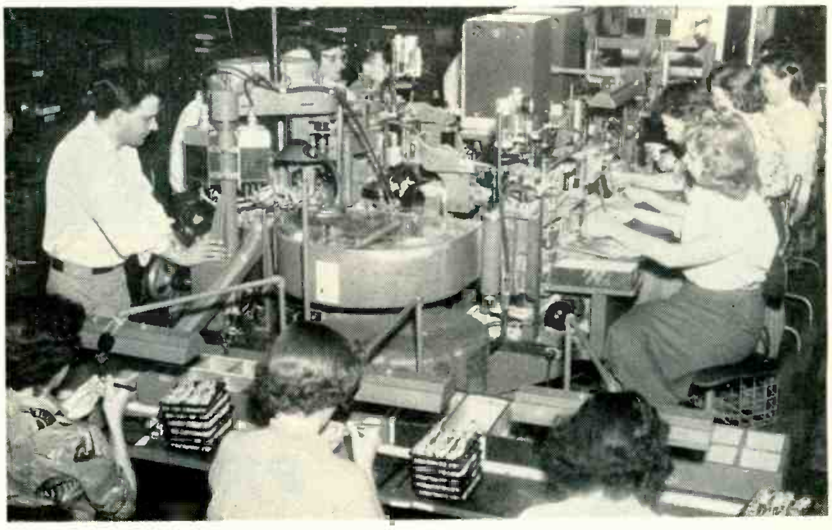
The shock tube gives pressure steps lasting four to five millisec. Expansion-chamber pressures up to 350 psi and compression-chamber pressures up to 1,000 psi can be selected. Shock step heights may be generated up to about 600 psi by using air on both sides of the diaphragm.

Turntables Feed Tube Assembler

ELECTRONIC TUBE cage assembly machine in use at Sylvania Electric Corporation's new plant in Altoona, Pa., represents an application of Detroit-type automation to a delicate operation. Its assembly rate for most common tube types is 1,800 an hour.

At each of the several stations is an inserting device, fed by a turntable which in turn is fed by an operator. The turntables are designed to simplify the operator's work.

At the first station, for example, the operator fits an unpunched mica spacer into loading forms. As the turntable revolves, the mica is punched and its thickness sensed. Then it is passed onto the machine's central conveyor, where it is gripped in position and passed along to the next station.



At top speed, this tube cage assembly machine represents a production rate of more than 100 assemblies an hour for each operator required

Cathode Loading

At the second station, an operator drops cathodes through a funnel to the apexes of conical supports carried on another turntable. The machine picks the cathodes off this turntable and inserts them in the spacers. A similar procedure is followed with the grids, plates, shield and top mica spacer. At the last station, the cathode tabs are welded in place.

Each station is provided with sensing devices so that the absence of the necessary part will either stop the line and sound an alarm, or will cause the incomplete assembly to be picked off the line and rejected. The operations of adding heater and getter, and joining cage to stem, are performed manually. Hand methods are used on tubes not assembled in large quantity.

A number of other machines were designed to step up production at the plant by about 25 percent, while keeping its work force at 900-odd. The plant is the latest outcome of a 12-year, $40 million Sylvania effort to mechanize component production.

Grid winding machines wind continually on support bars. But the method used does not require the operator to unwind grid turns to bare sections of the supports for mounting clearance.

The machine winds the number of turns specified for a particular grid, then jumps the wire over the support clearance space. The grid wire jump is burned through at each end and the excess is sucked off by air. Meanwhile, the supports are notched and the turns of wire are peened to the supports.

In the next 3 stations, the machine swages the ends of the supports into their mounting shape, hot-stretches the grids and clips them apart. At the final station, the grid is pneumatically drawn over a cold-stretching sleeve for final shaping. The grids are then dropped into miniature buckets on a conveyor and carried to an automatic traying station. One operator monitors, loads and unloads 4 to 6 of these machines.

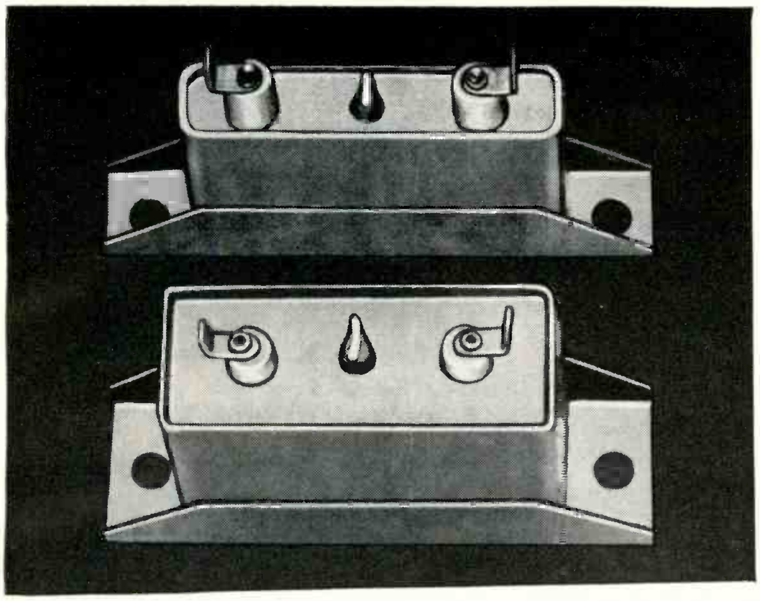
Heater Winder

One operator can also handle several of the heater spadewinders. The machine not only winds, but also cuts the heaters apart, picks them up, puts them in trays and stacks the loaded trays. It can wind over 4,000 of the simpler types of heaters an hour. As the heaters are wound, they are grasped by the jaws of heads on a turntable, which carry them through finishing operations to the unloading point. They are unloaded by an oscillating gripper arm which transfers them to trays. The trays are moved so that the arm finds an open tray slot.

Stem maker places leads in posi-

Cathode loading station. Girl drops cathode onto turntable through funnel

Heaters are wound at right, trimmed at left and trayed by arm at bottom



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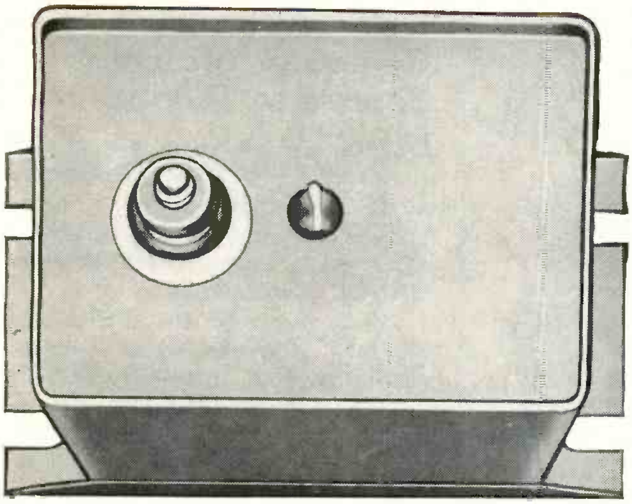
This nonpolarized capacitor is available in a variety of sizes in a capacity range of from 0.05 to 4.0 microfarads at 600 VDC. It is also available in higher voltage ratings. Performance data and operating characteristics are given in Technical Bulletin SL-61 which is supplied upon request.

*Confirmed by qualification test of 1000 hours at 100% rated voltage over ambient temperature range of —55° to +315° C.



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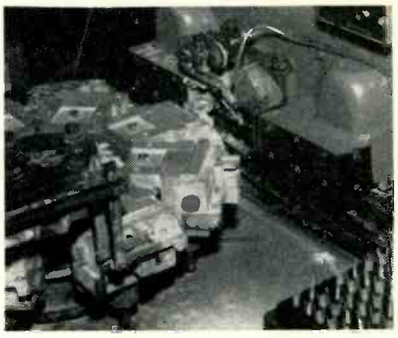
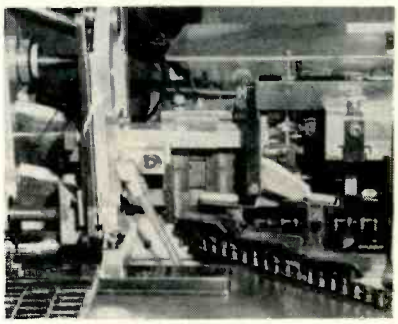


Closeup shows how unloading arm picks heaters from jaw of turntable head



Shaping and clipping section of grid winder. Grids move from left to right

tion and drops a glass collar around the leads. The collar is formed into a disk by heat and pressure so glass surrounds the leads. After annealing, a series of crimping and clinching stations automatically bend and shape the leads for connection to electrodes. There are some 3 dozen crimping heads to form leads. Each head works on only 1 wire at a time. Its rate is also 1,800 an hour and 1 operator can monitor and load 2 or more machines.

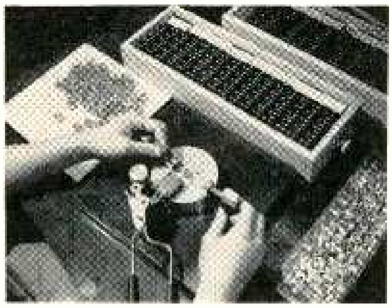
Computer Matches Reference Diodes

COMPUTER ASSISTS in coding and classifying the 3 Zener reference diodes which make up Zener reference elements produced by Hoffman Electronics Corp., Semiconductor Division, Evanston, Ill.

After assembly, the diodes are mounted in racks which connect each diode to a voltmeter. The diodes are tested in oil baths at temperatures of −55 C, 25 C and 100 C. The computer, in association with the voltmeter, records on tape the performance of each diode.

Acceptable diodes with similar performance ratings are then matched in groups of 3. The groups are placed in a drawer-like file, until assembly into elements. The elements are temperature tested at maximum tolerance of ±0.2 percent from −55 C to 100 C.

Racks of diodes are tested in oil baths



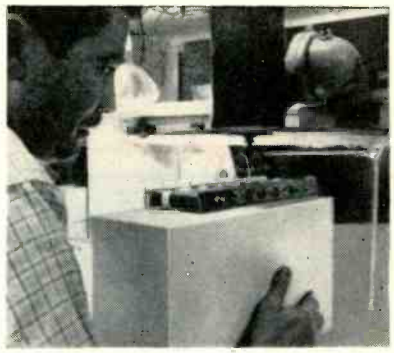
Jig bends leads of diodes into position

Elements are temperature tested

Catalyst, Hot Air Keep Epoxy Fluid

FULL DAY'S SUPPLY of epoxy compound for encapsulating resistors is kept fluid through use of a heated reservoir and anhydride curing agents. The cylindrical reservoir has a built-in fan and heater which circulates hot air around the reservoir to adjust the epoxy's viscosity for optimum flow.

The setup is in experimental use at Electronic Plastics Corp. (Eastern Precision Resistor Corp.), New



Blower on reservoir adjusts encapsulant viscosity with heat

York. A foot-controlled needle valve is presently used to dispense epoxy, leaving the operator's hands free to position the encapsulating fixture. Timing and indexing devices would automate the operation.

Casting Fixture

The fixture encases the resistors in Teflon so they may be easily released after the epoxy has cured. One side of the fixture is lined with Teflon sheet. After the encapsulating shells are positioned on the sheet, the bobbins are centered in the shells by Teflon tubing. Teflon washers go on top of the assembly. The other side of the fixture is snugged down with bolts.

Fixture holds 6 resistors in Teflon for easy parting after cure

The epoxy is poured into a slot cut in the shell. The same epoxy formulation is used for the bobbin, shell and encapsulant to assure homogeneity, preventing a spread of electrical tolerances. Rods from which the bobbins and shells are machined are cast in copper tubing.

The anydride curing agents are used to extend the pot life of the epoxy and improve its workability. Two types are used: hexahydrophthalic anhydride, a solid which melts on heating, and methyl

Nadic anhydride, a liquid produced by National Aniline division, Allied Chemical Corp., New York. Both are compatible with almost any epoxy resin.

Low viscosity and long gelation period of the encapsulant permits entrapped air to escape before the epoxy hardens. Rods less than $\frac{1}{4}$ inch diameter, however, are vacuum cast to prevent porosity.

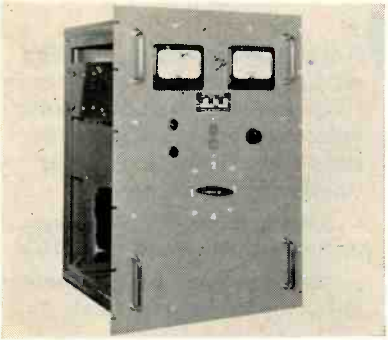
AN-Connector Wrench

SPECIALIZED WRENCHES for assembling or disassembling Cannon, Bendix Scintilla or Amphenol AN connectors have been developed by Spec Tool Co., in cooperation with Cannon Electric Co. Each of the combination type male or female wrenches will grip 12 sizes of connectors. Photo shows how the male wrench is used with a pair of pliers. In the background are a female wrench and a single-size wrench.

Gas Tests Circuit Component Shorts

FREEZONE-TYPE GAS sprayed on circuitry will locate intermittent shorts which are caused by changes in ambient temperature. The gas creates a rapid change in the physical body of the component or solder joint. In the resulting contraction and expansion, the intermittent contact will be detectable. The area of the chassis in which the short is located can be quickly determined by spraying the chassis in sections. The gas is available in pressure spray can, under the name Zero-Mist, from General Cement Mfg. Co., Rockford, Ill. The firm also has developed a spray-on silicone compound which assists in insulation and heat transfer between transistors and chassis.

NEW PRODUCTS

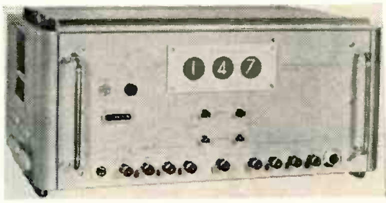


D-C Power Supply wide voltage range

PERKIN ENGINEERING CORP., 345 Kansas St., El Segundo, Calif., has developed a wide voltage range d-c power supply with magnetic amplifier regulation. Model M-1193 provides a d-c output of 5-50 v at 50 amperes from an a-c input of 110, 220 or 440 v, 60 cps, single phase. The wide output voltage range is accomplished by means of a rotary switch which provides three separate ranges which are used in conjunction with a potentiometer to supply smooth continuous voltage adjustment over each range. Regulation accuracy is ±1 percent for line variations of ±10 percent and ±1 percent for load changes of 10 percent full load to full load. For additional information request catalog E-59.

Resolver for servo testing

SOLARTRON, INC., 530-532 Cooper St., Camden 2, N. J. A new resolver enables accurate reference phase controls during test of servo components and systems. Model JX746A features a four-phase input



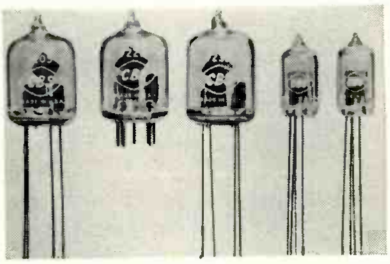
of 10 v rms per phase and a four-phase output of 10 v or 50 v rms per phase at any phase angle from 0-360 deg. Input impedance is 100,000 ohms; output impedance is less than 1 ohm per phase. Maximum output current is 7 ma rms/phase. Output phasing accuracy is ±1 deg, assuming no error in input intelligence. **Circle 300 on Reader Service Card.**

Power Amplifier miniaturized

RHEEM MFG. CO., 777 Industry Ave., Rivera, Calif. A ruggedized, miniature r-f power amplifier only 5¼ by 3½ by 3 in. increases signal power significantly in the 215 mc to 260 mc telemetering band. Model REL-10 can be used with most presently available f-m transmitters and delivers from 10 to 100 w of r-f power with 2 w of drive. The tiny high-output unit is highly reliable in adverse environments of shock, vibration, and temperature and features a self-contained cooling system. It meets the environmental requirements of missileborne instrumentation systems. **Circle 301 on Reader Service Card.**

Trigger Tubes fast-switching

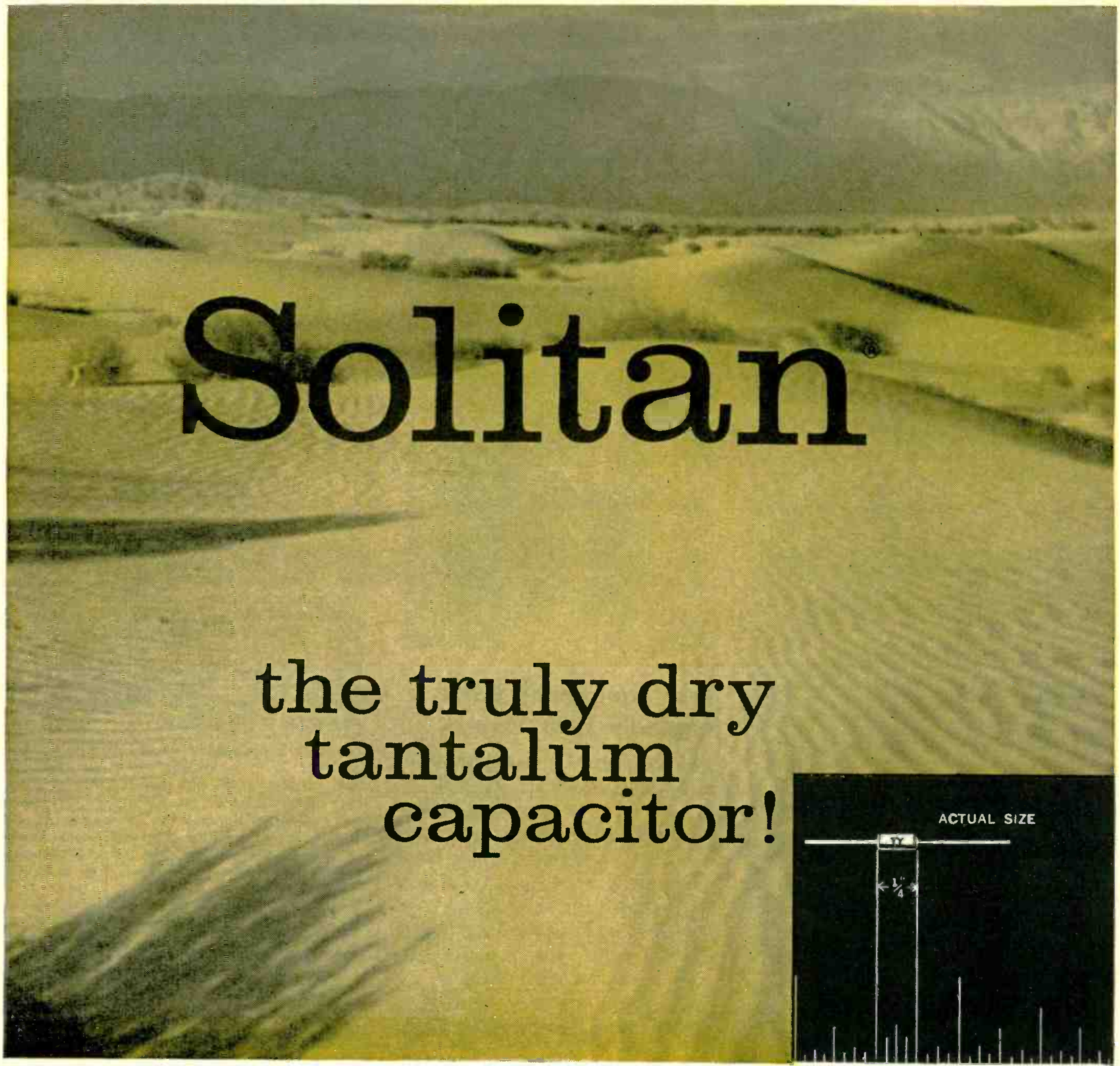
CBS-HYTRON, 100 Endicott St., Danvers, Mass. A new line of cold-cathode trigger tubes, known as Krytrons, have been designed to replace relays, thyratrons and other devices in simplified circuits for reliable military and industrial equipment. Designed to operate



under extreme conditions of heat, shock and vibration, the tubes control up to 500 amperes with input currents of less than 20 μa. Ambient temperature range is from −55 to +85 C. Anode delay times are from 1.6 to 4.0 μsec, dependent upon the type, with a maximum variation of 0.4 μsec. Minimum trigger voltage for a 2-μsec pulse is 230 v. Holdoff voltages range from 1,000 to 3,000 v. **Circle 302 on Reader Service Card.**

V-R Power Supply transistorized

KEPCO LABORATORIES, INC., 131-38 Sanford Ave., Flushing 55, N. Y. Model SC-36-1 tubeless transistorized voltage regulated power supply delivers 0 to 36 v, 0 to 1 ampere. Regulation for line or load is less than 0.1 percent or 0.003 v, whichever is greater. Ripple is less than 1 mv rms. Recovery time is less than 50 μsec. Stability for 8 hr is less than 0.1 percent or 0.003 v, whichever is greater. Operating ambient temperature is 50 C maximum. Temperature coefficient is less than 0.05 percent per deg C;



NEW SOLID-STATE ELECTROLYTE CAPACITORS BY CORNELL-DUBILIER • SOLITAN capacitors are specifically designed for transistor application in computer and military circuits. Solid electrolyte tantalum assures extreme resistance to shock and vibration, wider useful temperature characteristics, stability of capacitance in spite of aging or temperature variations, freedom from corrosion or leakage. Cornell-Dubilier has SOLITAN tantalum capacitors in production quantities. Write for 4-pg. Bulletin No. 537 to Dept. E-11, Cornell-Dubilier Electric Corp., South Plainfield, N.J.

SOLITAN

Specifications and Features

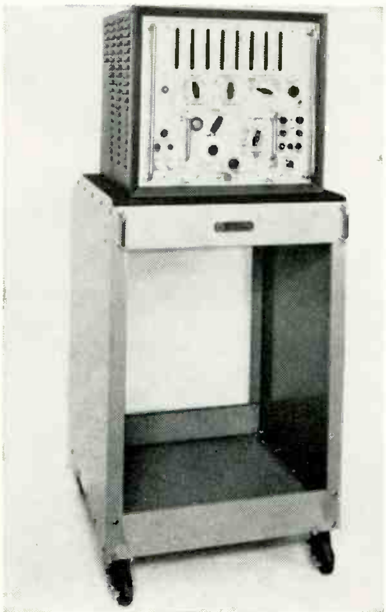
- Ratings up to 6.0 mfd. at 35 volts DC Working, or 60.0 mfd. at 6 volts
- Wider useful temperature characteristics within range of −80°C to +85°C
- Freedom from corrosion and leakage
- Extremely small size
- Remarkable stability of capacitance with time and temperature
- Metal cased, hermetically sealed

Consistently Dependable

CORNELL-DUBILIER CAPACITORS

CIRCLE 90 READERS SERVICE CARD

output impedance is less than 0.04 ohm. Circle 303 on Reader Service Card.

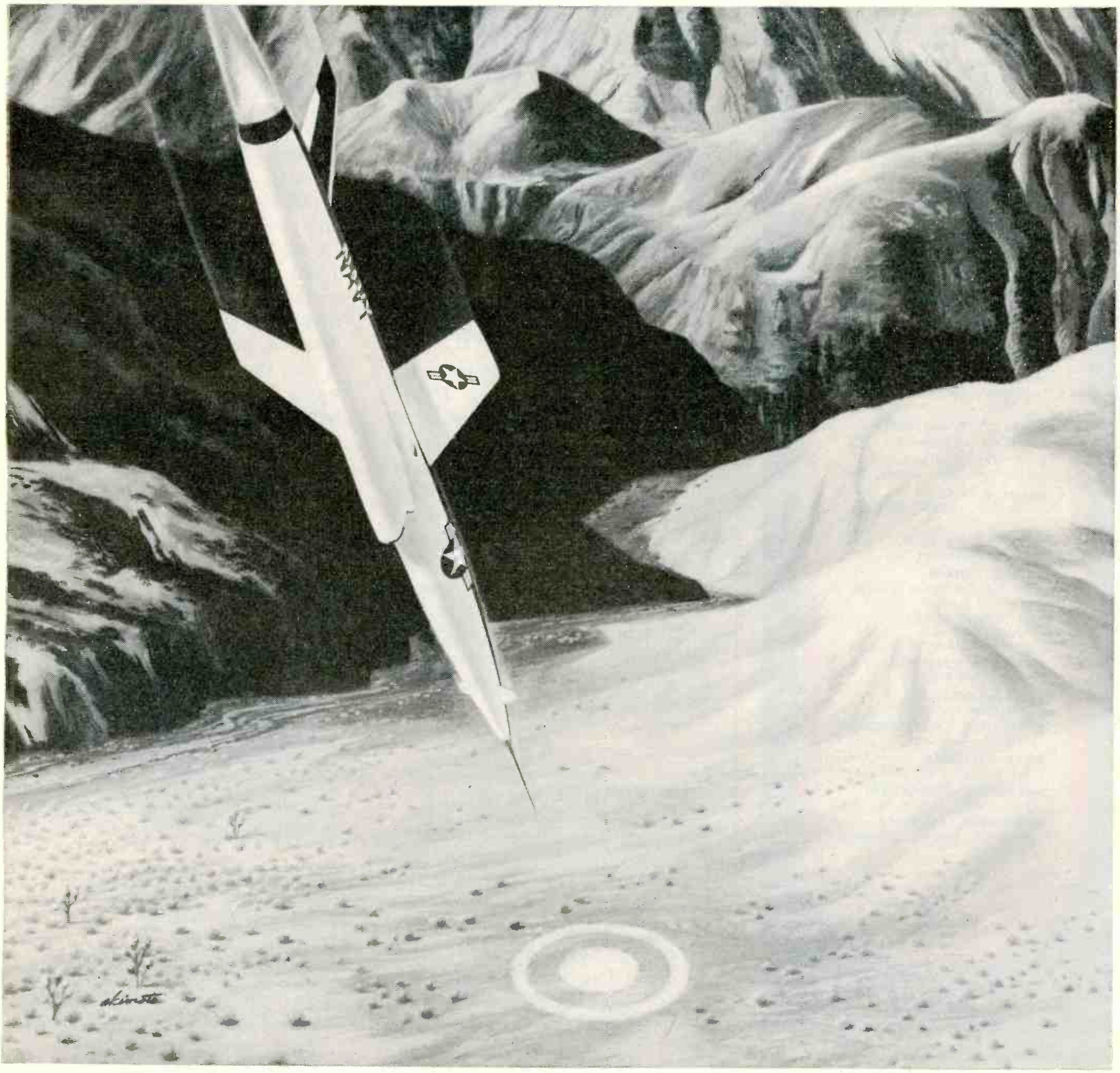


Test Equipment Cart ruggedly built

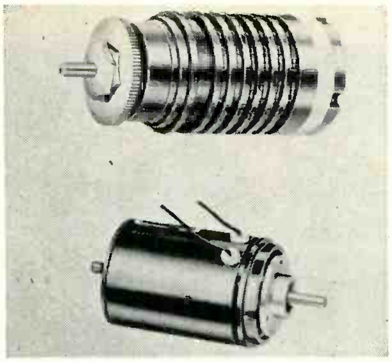
Northeastern Engineering, Inc., 25 South Bedford St., Manchester, N. H. A new test equipment cart is designed to accommodate frequency counters, scopes and similar major test units. Formed and welded from sheet metal it is strong enough to take severe usage and still protect the expensive test gear. It can be rolled about on its rubber-tired casters effortlessly. Circle 304 on Reader Service Card.

Multipliers standard frequency

General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. Accurate measurements of microwave frequencies are facilitated by use of the new type 1112 standard



frequency multipliers with a crystal-controlled frequency standard. These multipliers generate sine-wave signals of 1, 10, 100 and 1,000 mc and greatly extend the useful range of conventional frequency standards such as the type 1100-A. The instruments are characterized by low noise and by almost complete freedom from submultiple-frequency spurious signals. In addition, the phase stability of the output signals is maintained at a high value. **Circle 305 on Reader Service Card.**



Magnetic Clutches lightweight, compact

HELIPOT DIVISION of Beckman Instruments, Inc., Fullerton, Calif., has available two new models of miniature magnetic clutches for electrical control of servo system rotary mechanical functions. Both are the dry-disk, fixed-coil type of solenoid controlled clutches which use no slip rings. Inputs of 24 or 48 v may be specified. A 48-pitch, $14\frac{1}{2}$ in. pressure angle stainless steel input gear is furnished with each clutch; or special input gears may be substituted. **Circle 306 on Reader Service Card.**

Magnetrons for missile radar

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y., announces three new K_a-band (33-36 kmc) magnetrons especially ruggedized for missile applications. The new types—M4063, M4064 and M4155—plus the earlier 5789 and 6799, cover a power range from 20 to 100 kw. The tubes are used for radar equipment where very high resolution is required. As the source of the pulsed outgoing signal, they are the heart of a radar set. Typical applications are in cloud-finding, mapping, and missile guidance equipment. **Circle 307 on Reader Service Card.**

A-C/D-C Voltmeter wide range

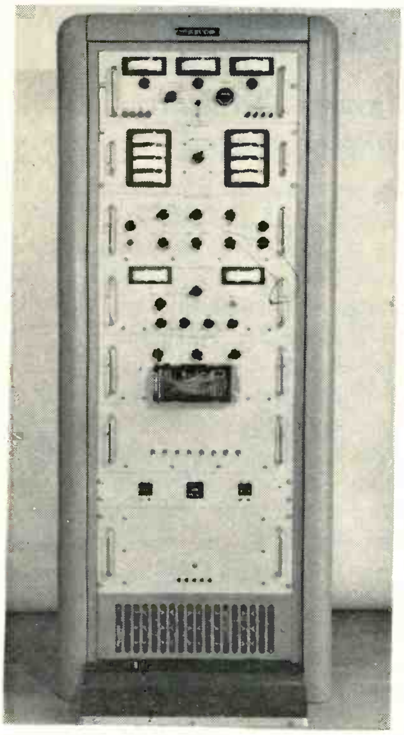
SOUTHWESTERN INDUSTRIAL ELECTRONICS CO., 2831 Post Oak Road, Houston 19, Texas. The new model R-2 a-c/d-c voltmeter measures a-c (10 cps to 1 mc) and d-c (+ or −) voltages from 1 mv to 1,000 v in 14 ranges, and resistances from 10 ohms to 10 megohms midscale in 7 ranges. It is accurate within 2 percent on all functions. A "d-c distend" feature allows the upper 10 percent or 1 percent of any d-c range to be expanded to cover the full meter movement. This is particularly useful in such applications as measuring the regulation of power supplies. **Circle 308 on Reader Service Card.**

Mv Meter Indicator analog-to-digital

B&H INSTRUMENT CO., INC., 3479 W. Vickery Blvd., Ft. Worth 7, Texas, announces a new digital indicating millivolt meter with laboratory accuracy. Contained in a case 3 in. by 5 in. by 5 3/8 in. deep, this miniature instrument has a guaranteed accuracy of 0.1 percent with infinite resolution slidewire. It weighs less than 3 lb. It is a continuous null-balance, servo-driven, slidewire potentiometer with transistorized amplifier and Zener referenced power supply. **Circle 309 on Reader Service Card.**

Marker System single package

TELONIC INDUSTRIES, INC., Beech Grove, Ind. Model SSX-2 sweep and signal generator covers the entire low r-f and common i-f frequencies. It simplifies testing of amplifiers and other l-f devices by combining functions of sweep generator, signal generator, pulsed c-w, and marker generator into one compact, precision instrument. **Circle 310 on Reader Service Card.**



Ground Station pam/pwm

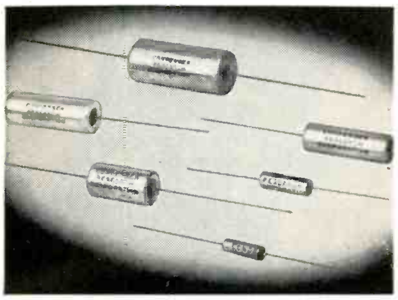
APPLIED SCIENCE CORP. OF PRINCETON, P. O. Box 44, Princeton, N. J. New telemetry decommutation equipment that can handle sampling rates from 24 to 3,600 pps in both pulse amplitude (pam) and pulse width (pwm) coding is now in production. The new equipment is a more compact and flexible version of the M-series decommutation and display equipment which has been used in missile and aircraft development programs. Besides the dual pam/pwm capacity and the wide sampling rate capability, the equipment also features: long term system accuracy of better than ± 0.5 percent, including any system nonlinearity and drifts; an undecommutated but thoroughly corrected output for convenience in digitizing. **Circle 311 on Reader Service Card.**

Image Orthicon highly rugged

WESTINGHOUSE ELECTRONIC TUBE DIVISION, P. O. Box 284, Elmira, N. Y. The WL-7198 image orthicon tube operates throughout the range of vibration specified in MIL-E-5272A, Paragraph 4.7, Procedure I, which demands 10 g's acceleration up to 500 cps. At 5 g's acceleration (50 to 500 cps), the tube shows horizontal resolution of at least 350 lines with 3 X 10^{-2} foot-candles illumination on the photocathode. Thirty g's shock does not impair subsequent tube performance. The WL-7198 is also a very sensitive tube. At least 250 lines horizontal resolution may be obtained with only 0.0003 foot-candles illumination on the photocathode of the tube. **Circle 312 on Reader Service Card.**

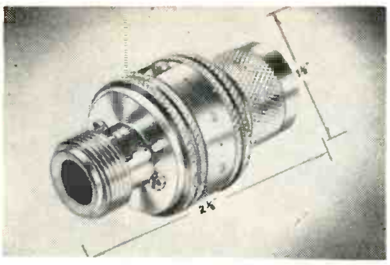
Diffusion Pump high capacity

NRC EQUIPMENT CORP., 160 Charlemont St., Newton Highlands 61, Mass. Model H-32-P, a 32-in. vacuum oil diffusion pump has a top speed above 50,000 cfm (24,000 liters per sec) at an inlet pressure of 1×10^{-4} mm Hg (atmospheric pressure = 760 mm Hg) and speeds above 30,000 cfm at pressures between 3.5×10^{-4} and 6×10^{-6} mm Hg. Untrapped blank-off is less than 1×10^{-6} mm Hg and tolerable forepressure greater than 0.2 mm Hg. Price is $3,575. **Circle 313 on Reader Service Card.**



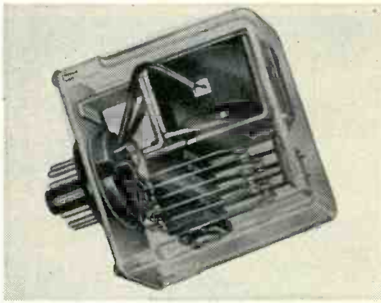
Capacitors
tubular-type

Condenser Research Corp., 715 S. Oesting St., Seymour, Ind. New tubular-type capacitors are engineered for coupling, by-pass, and filter applications in computers, servomechanisms, airborne electronics equipment, and guided missiles. They are available in Mylar and Polystyrene in standard capacities from 0.001 to 1.0 μf; in Teflon from 0.001 to 0.47, and in metalized Mylar from 0.005 to 10.0. **Circle 314 on Reader Service Card.**



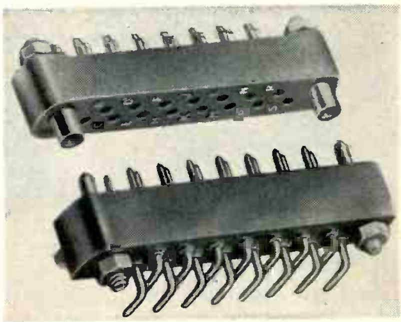
Double-Stub Tuner
radial design

Don-Lan Electronics, Inc., 1101 Olympic Blvd., Santa Monica, Calif. A new subminiature double-stub tuner for transmission lines and other r-f equipment provides a variable susceptance over the 1,000 to 10,300 mc frequency range. Because of the unit's radial design a 2.7 in. by 0.50 center to center adjustment is afforded by the two stubs. Once the radial adjustment has been set, an external lock-screw can be tightened and the tuner used in permanent installation. Unit is priced at $78.50 each with standard type N connectors. **Circle 315 on Reader Service Card.**



Relays
compact units

STRUTHERS-DUNN, INC., Pitman, N. J. Frame 19 relays feature small size and low operating power. This, coupled with their reasonable price, aids materially in reducing size, weight and cost of many control panel assemblies. They are designed for long, trouble-free performance on the order of 20 million operations. The relays are mechanically protected by sturdy plastic covers and are designed with plug-in construction for easy servicing. **Circle 316 on Reader Service Card.**

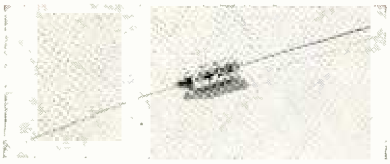


P-C Connectors
reliable devices

ARMEL ELECTRONICS, INC., 840 Fifth Ave., Brooklyn 32, N. Y. Reliability and versatility are mated in the new DEP series printed circuit connectors. Compatible with the 0.100 by 0.100 grid system, automatic assembly and dip-soldering processes, either the plug or receptacle or both may be board mounted. The precision machine contacts gold plated over silver plate with a MIL approved insulation are positively polarized by layout and guide pins. An illustrated brochure gives pertinent information on the size and variations of connectors available. **Circle 317 on Reader Service Card.**

Decade Counters ten electrical outputs

Burroughs Corp., P.O. Box 1226, Plainfield, N. J., announces new 110-kc decade counters with 10 electrical outputs. Types DC-106-A and DC-106-B have been designed for military and commercial applications. Units are of modular printed circuit construction, with a shielded beam switching tube for maximum reliability. The ten outputs will: (1) operate both local and remote Nixie indicators; (2) provide direct operation of decimal printing devices or matrices; (3) function as pre-set counters by the addition of gating circuitry. Power requirements are 15 ma of current at 300 v. Price ranges from $75 to $100 depending on type and quantity. **Circle 318 on Reader Service Card.**

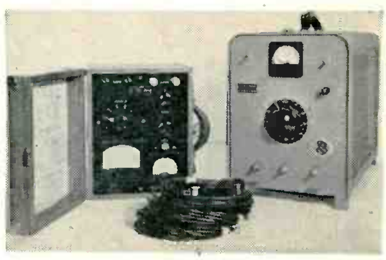


Tantalum Capacitors extended ratings

P. R. Mallory & Co., Inc., Indianapolis 6, Ind. The TAP2 series tantalum capacitors provide a broad range of ratings in subminiature size appreciably smaller than previously available. Only 0.226 in. in diameter and 0.625 in. long, they come in ratings covering the range from 140 μf, 6 v d-c to 11 μf, 90 v d-c. They are rated for ambient temperatures from −55 to +85 C, and will meet the 2,000 cycle, 20 g vibration requirements of specification MIL-C-3965 B. **Circle 319 on Reader Service Card.**

Phase Shifter
400-cycle unit

KNOPP INC., 1307 66th St., Oakland 8, Calif. Type Q-4 phase shifter provides any phase shift from 90 deg leading to 90 deg lagging in the testing of electronic equipment and their control circuits, watthour meters, rotating standards, wattmeters, power-factor indicators, induction relays, and instrument transformers. It is rated at 1,000 va, continuous duty; input, 120/240 v; output, 120 or 240 v, three phase. **Circle 320 on Reader Service Card.**

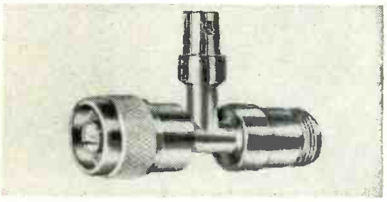


Ohmmeter
low resistance

J. W. DICE CO., Englewood, N. J. Resistance values as low as 1 microhm can be measured within 2 percent accuracy with a new test set. The portable test set consists of a model 151-S Microhm Meter plus a transistor type model SM rectifier for supplying both a 10 ampere d-c and a 100 ampere d-c current source. In addition, the Microhm Meter has its own self-contained 10-ampere battery power supply which permits using the instrument in locations where power lines are not available or are de-energized. **Circle 321 on Reader Service Card.**

Snap-Acting Switches sealed, subminiature

UNIMAX SWITCH DIVISION, The W. L. Maxson Corp., Ives Road, Wallingford, Conn., has available a line of sealed subminiature snap-acting switches developed for use in applications where very small size, reliability, safety in explosive atmosphere, and sealing against moisture and dirt are essential. **Circle 322 on Reader Service Card.**



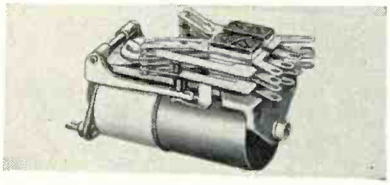
Helix Monitor Tees used with twt's

T. E. M., INC., 71 Okner Parkway, Livingston, N. J., announces a new line of helix monitor tees. They are employed to monitor helix interception current in traveling wave tubes or to apply modulation to a twt. The monitor tees are available to cover octave frequency ranges from 250 to 12,000 mc. A d-c blocking capacitance may be supplied in the r-f output arm. They are supplied with type N, TNC, or BNC connectors. **Circle 323 on Reader Service Card.**

Precision Resistors metal film type

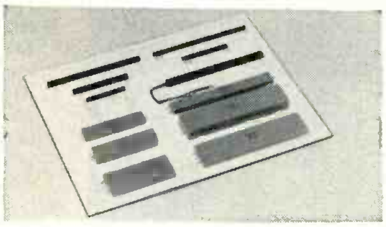
OHMITE MFG. Co., 3695 Howard St., Skokie, Ill. Series 77 metal film resistors are now smaller yet offer higher maximum resistance than the previous models. Resistance range is now 25 ohms to 400 K ohms. Standard tolerance is ±1 percent but tolerances as low as 0.1 percent can be furnished. A lower standard temperature coefficient of resistance is now provided—0 ±25 ppm/deg C (0 ±0.0025 percent/

deg C) over the very wide temperature range of −55 C to +190 C (25 C reference ambient). The resistors may be used at full ¼ w rating in an ambient temperature of 150 C, ½ w at 105 C or derated to 0 at 190 C. **Circle 324 on Reader Service Card.**



Time Delay Relay
telephone type

MAGNECRAFT ELECTRIC CO., 3350 B W. Grand Ave., Chicago 51, Ill. Increased time delay, combined with great coil power and service life are claimed to be featured in a new heavy-duty telephone-type relay, the class 66S. Great coil space for a relay of this size makes practical the use of long slugs for operate delay up to 0.15 sec and release delay up to 0.25 sec. **Circle 325 on Reader Service Card.**

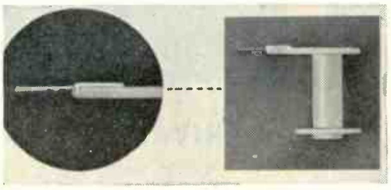


Delay Lines
three new types

TECHNITROL ENGINEERING CO., 1952 E. Allegheny Ave., Philadelphia, 34, Pa., has developed three new distributed parameter electrical delay lines having delay periods ranging from 0.05 to 1.0 μsec per 6-in. length. Types 25E, 25F, and 25G delay lines are available in a variety of standard case styles including hermetically-sealed metal cans and epoxy encapsulated sticks permitting either plug-in or pig-tail mounting. They are available in a special design that will withstand severe environmental conditions, meeting the requirements of all military specifications. Standard tolerance on delay time is ±5 percent and several windings may be cascaded to produce longer delay periods. Circle 326 on Reader Service Card.

Power Supplies variable frequency

Empire Devices Products Corp., Amsterdam, N. Y., has available two new variable frequency power supplies, the VP-410 and VP-1000. The units have excellent regulation (vary less than 2 percent from no load to full load), and low harmonic distortion (less than 1 percent up to 2,000 cps, less than 3 percent up to 6,000 cps). Other features include fast recovery under fluctuation of line voltage and applied load and arrangements for external drive so that these instruments may be used as power amplifiers where phasing with the external source is necessary. Circle 327 on Reader Service Card.

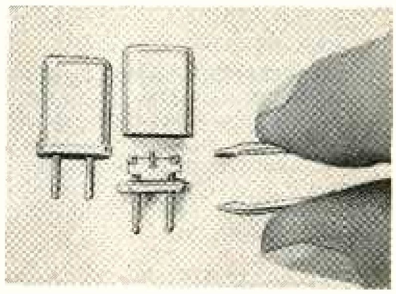


Soldering Terminals for Nylon bobbins

American Molded Products Co., 2727 W. Chicago Ave., Chicago 22, Ill., has developed an innovation in soldering terminals for its stock Nylon bobbin line. The Insu-Lug terminal has the advantage of being imbedded in the Nylon. This provides positive insulation and eliminates all exposed edges which could catch the wire during coil winding. The new process results in a sturdy bobbin with lugs that will resist over a 15 lb pull. **Circle 328 on Reader Service Card.**

Infrasonic Amplifier low-noise unit

THE GEOTECHNICAL CORP., 3712 Haggar Drive, Dallas 9, Texas. Small fractions of a microvolt may now be detected and amplified by the recently developed galvanometer-phototube amplifier, model 4300. A voltage gain of ¼ million and a noise level of less than 0.025 μv rms referred to input are typical of performance when, for example, a Geotech 5-cps mirror galvanometer is employed. Other features are: a drift of less than 0.1 μv referred to input over an 8-hr period; a dynamic range of at least 70 db, noise level to clipping level; and a linearity of ±2 percent noise level to 75 percent clipping level, based on best straight line. **Circle 329 on Reader Service Card.**



Tiny Crystal in military case

SHEROLD CRYSTALS, INC., 1512 McGee Trafficway, Kansas City, Mo.

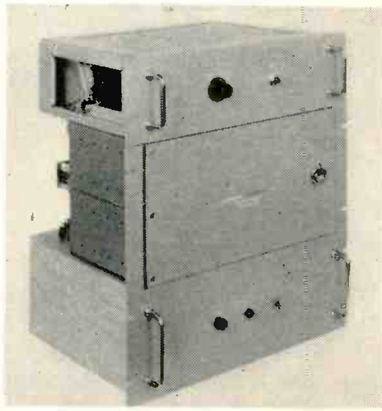
A new subminiature crystal is packaged in the military case. HC18/u, with the crystal wafer suspended between the two terminals. The crystals are operative from 300 kc to 125 mc and their use in frequency control and filter applications results in simplification of manufacture and great reduction in size when many crystals are involved in a single unit. **Circle 330 on Reader Service Card.**

Actuator Packages solenoid controlled

WALDORF FLUID SYSTEMS DIV., Waldorf Instrument Co., Huntington Station, N. Y., announces a new line of solenoid controlled actuator packages which are presently being used in the missile field. An outstanding feature of these packages, other than their light weight and compactness, is their extremely low leakage—even with Helium. Units can be obtained for pressure ranges to 3,000 psi, and for continuous duty temperatures to + 500 F. **Circle 331 on Reader Service Card.**

Tape Recorder stereo playback

TELECTROSONIC CORP., 35-18 37th St., L. I. C., N. Y. Model 300 professional tape recorder features complete stereo facilities for the playback of either stereo tape or disk. It offers a 3-speed, pushbutton, multi-speaker, recorder/reproducer, with a 4-track head, for the price of $189.95. Pushbutton controls allow for stop, record, rewind, wind, play and pause to provide for ease of operation and complete flexibility. Unit has two complete built-in preamplifier and amplifier systems, and features a separate 8-w pushpull amplifier for each channel so that no additional electronic equipment is required for stereo. **Circle 332 on Reader Service Card.**



Core Buffer Memory high reliability

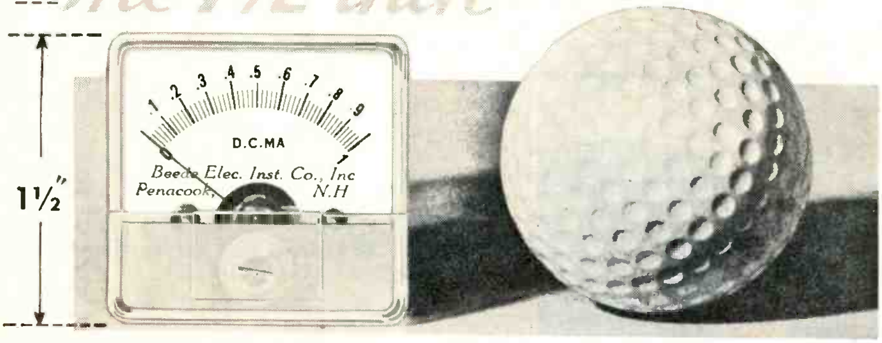
TELEMETER MAGNETICS, INC., 2245 Pontius Ave., Los Angeles 64, Calif. Type 1092-BQ8A buffer stores up to 1,092 characters of eight bits each and operates at a 100-kc rate. Characters are loaded and unloaded sequentially with all bits of each character being handled simultaneously. Solid state elements—ferrite cores, transistors, and diodes—are used throughout. **Circle 333 on Reader Service Card.**

Relay frequency sensing

G-V CONTROLS INC., 28 Hollywood Plaza, East Orange, N. J. Auto-

BEEDE ELECTRICAL INSTRUMENTS

The 1½ inch Model 5



SMALLER THAN A GOLF BALL

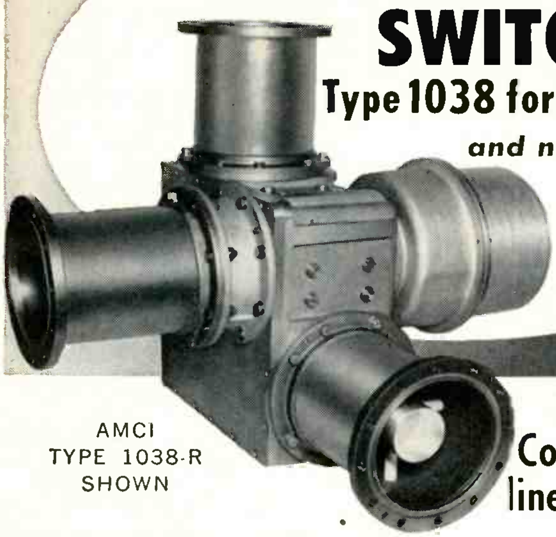
The Model 5 has our new Magcentric design that is self-shielded and has a total weight of less than 2 ounces. This new addition to our instrument line provides more complete fulfillment of our customers' requirements and is an excellent solution for difficult panel problems.

BEEDE ELECTRICAL INSTRUMENT CO., INC.
PENACOOK, N. H.
BD

CIRCLE 209 READERS SERVICE CARD

NEW NEW

AMCI COAXIAL SWITCHES



Type 1038 for use in 6⅛" lines
and now **Type 1136 for use in 3⅛" lines**

AMCI
TYPE 1038-R
SHOWN

For use in Rigid Coaxial Transmission lines at VHF and UHF

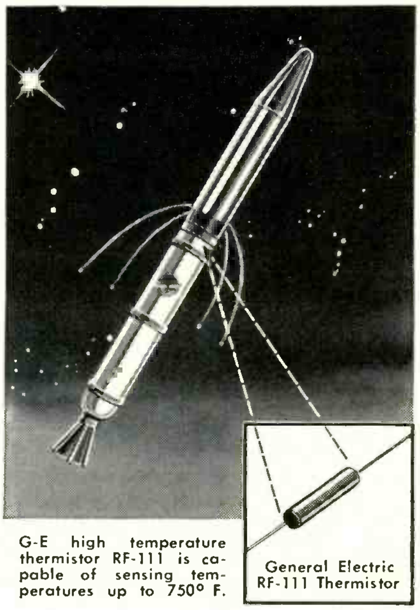
- VSWR is under 1.05 over rated frequency range: 0-450 mc for the Type 1038 6⅛" Coaxial Switch; 0-500 mc for the Type 1136 3⅛" Coaxial Switch.
- CW rating is approximately that of the mating transmission lines.
- Switches are available in either motor-driven or manually operated models.

Write for complete information on AMCI Instrument Loads

ANTENNA SYSTEMS — COMPONENTS — AIR NAVIGATION AIDS — INSTRUMENTS
AMCI **ALFORD** *Manufacturing Company* 299 ATLANTIC AVE., BOSTON, MASS.

CIRCLE 210 READERS SERVICE CARD

GE THERMISTOR



G-E high temperature thermistor RF-111 is capable of sensing temperatures up to 750° F.

General Electric RF-111 Thermistor

DETECTS EXPLORER I'S SKIN TEMPERATURE IN OUTER SPACE

One of the critical pieces of information relayed from space by Explorer I was the external skin temperature of the satellite as it orbited from sun to shadow around the earth. This exacting job of sensing temperature variations was assigned to a standard General Electric RF-111 high temperature thermistor.

Thermistors are thermal-sensitive semi-conductors with large *negative* temperature coefficients of resistance. In some types of G-E thermistors, it is possible to double the resistance with a temperature change of as little as 20° C.

In addition to temperature measurement, control, and compensation, G-E thermistors can suppress initial current surges which damage filaments or trip relays. They also are used in time delay, sequence switching, and voltage regulating devices.

General Electric thermistors can be supplied with resistance values from 1 to 10,000,000 ohms and temperature coefficients of resistance from −1% to −5% at 25°C. For more technical information—or the assistance of a G-E engineer – write: *Magnetic Materials Section, General Electric Company, 7806 N. Neff Road, Edmore, Michigan.*

Progress Is Our Most Important Product
GENERAL ELECTRIC

CIRCLE 211 READERS SERVICE CARD

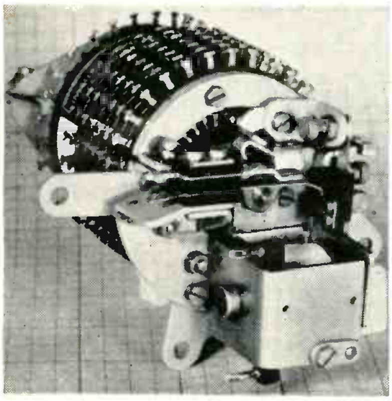
matic protection of electronic equipment against damage due to low supply frequencies is provided by a new frequency sensing relay. Unit consists of a high-pass filter feeding a thermal sensing relay. Model BS-5003 is designed for use on 115 v, 400 cps systems, and has a nominal cut-off frequency of 370 cps. Operating point is held within a tolerance of ±10 cps over the ambient temperature range of –65 C to +85 C and over an applied voltage range of 115 v ±5v. **Circle 334 on Reader Service Card.**

Connectors snap-in contacts

THE DEUTSCH CO., 7000 Avalon Blvd., Los Angeles 3, Calif., has introduced a new DS series of miniature electrical connectors with snap-in contacts. They are equipped with silicone inserts for high-temperature operation. Units withstand extremes from – 100 F to temperatures in excess of 300 F. Crimp-type terminations are used to eliminate soldering and greatly reduce installation time. Connectors feature an exclusive ball-lock coupling ring and are available in a wide range of shell sizes. They meet or exceed requirements of MIL-C-5115. **Circle 335 on Reader Service Card.**

Test Set portable unit

AVTRON MFG. INC., 10409 Meech Ave., Cleveland 5, Ohio. Line voltage and line frequency can be measured and indicated, and voltage modulation and frequency modulation of the output of an electrical generating system can be measured to 0.5 percent or better accuracy with the model T-75A test set. It is available to test systems with a range of operating voltage from 24 v to 600 v, and operating frequency from 300 cps to 4,000 cps. Circle 336 on Reader Service Card.



Stepping Switch
high-speed device

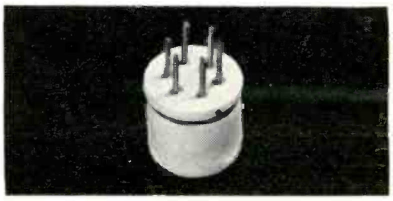
IMTRA CORP., 11 University Road, Cambridge 38, Mass. A high-speed stepping switch called the Miniature Uniselector is designed for use in automatic switching and timing-control circuits. It will operate at speeds up to 80 steps per sec on impulse drive (80 percent make, 20 percent break) from a power supply of 24, 50 or 110 v d-c. Up to 12 banks can be fitted, each having 30 individual contacts mounted in a complete circle. When only seven or less banks are required, a sequence switch can be fitted. Circle 337 on Reader Service Card.

Termination
for resistance wire

REON RESISTOR CORP., 117 Stanley Ave., Yonkers, N. Y., has developed a new method of terminating the resistance wire of precision wire wound resistors that is claimed to be far superior to the old methods. Using a pure silver base, a casting is made around the termination that bonds to both the wire and the terminal, making one solid mass. Since no extreme heat or pressure is used, the diameter of the wire is not deformed; thus the strength is at least twice that of a weld, and has an extremely low contact resistance. It will not in any way loosen the contact when dipped into a solder pot for any length of time. Circle 338 on Reader Service Card.

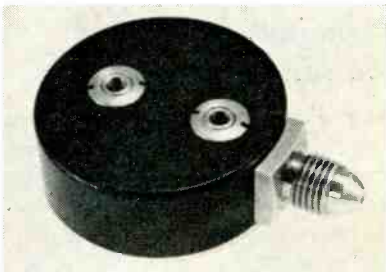
Delay Line adjustable

DELTIME INC., 608 Fayette Ave., Mamaroneck, N. Y. Type 140 delay line is designed for studies and applications calling for longer time delays. It is based on the magnetostrictive principle and provides for continuously-adjustable pickups in the 130 μsec range, juxtapositioned to 20 μsec and pulse widths of from 0.25 μsec to d-c. Circle 339 on Reader Service Card.



Headers high temperature

MITRONICS INC., 1290 Central Ave., Hillside, N. J., introduces a new line of high temperature headers made of metallized alumina. These headers will function at temperatures above 1,000 C. Illustrated is the header assembled to alumina cup, which is completely hermetic. Circle 340 on Reader Service Card.



Pressure Transducer low-cost unit

RAHM INSTRUMENTS, Division of American Machine and Metals, Inc., 65 Rushmore St., Westbury,

N. Y. A new low-cost T series pressure transducer has a 50-percent over-pressure feature with less than 1 percent zero shift and embodies rugged construction and high performance with small size (1.63 in. diameter). Unit is designed to meet aircraft and missile high vibration and shock applications and will handle corrosive media in the ranges 0-100 psig to 0-5,000 psig. **Circle 341 on Reader Service Card.**

Thyratron Controller packaged circuit

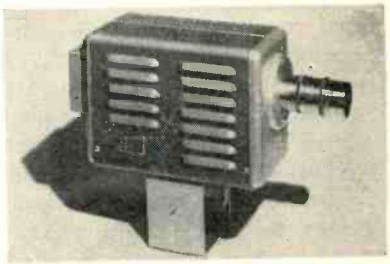
HANSON-GORRILL-BRIAN, INC., 85 Hazel St., Glen Cove, N. Y. Newly packaged thyratron grid circuit eliminates costly circuit development when using thyratrons for industrial controllers. The Thyra-Pulse will smoothly control thyratrons of all types and sizes. Control input can be a variable resistance or variable a-c or d-c voltage or current. The unit can be used in half-wave, full-wave and three phase circuits. Mounting feet and screw-type barrier terminal strips are suitable for industrial front-of-panel wiring. Internal d-c with superimposed a-c bias eliminates line transient misfiring. **Circle 342 on Reader Service Card.**

Digital Recorder for traffic counting

FISCHER & PORTER CO., 911 Jacksonville Road, Hatboro, Pa., announces a new digital recorder for traffic counting. Traffic flow during any preselected time interval may be readily measured. Operated by electrical impulses from a conventional road treadle, the recorder produces a permanent record on punched paper tape. The tape recorder is easily interpreted visually or is suitable for use with automatic data processing machines. Circle 343 on Reader Service Card.

LVDT rugged unit

SCHAEVITZ ENGINEERING, Route 130 and Schaevitz Blvd., Pennsauken, N. J., has developed a new linear variable differential transformer for heavy industrial use. It consists of a shielded lvdt potted in an anodized aluminum case with four mounting holes in integral flanges. Space is provided in the case for housing additional components such as temperature-compensating networks, phase-shifting networks and the like. Input and output connections are screw-type terminals. Circle 344 on Reader Service Card.

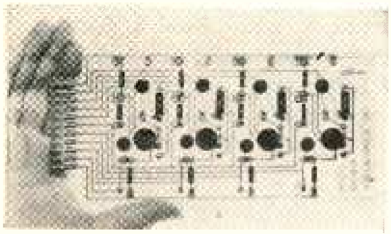


TV Camera automatic unit

DAGE TELEVISION DIVISION, Thompson Products, Inc., Michigan City, Ind. Weighing only 10 lb, and measuring 6¾ in. high by 5⅛ in. wide by 11 3/16 in. long, this new model 63A television camera is completely self-contained and completely automatic. Designed for industrial, military and educational applications, it automatically adjusts lens stops, and beam, target and electrical focus circuits to optimum values. Circle 345 on Reader Service Card.

Silicone Lubricant for plastic molding

PARA PRODUCTS, 5200 River Road, Washington 16, D. C., has developed Paralese, a new silicone spray mold release and lubricant. Formulated with a very high Silicone-to-Freon ratio, it is said to give more Silicone per shot affording quality coverage and elimination of sticky and marked molds. Particularly applicable in the plastics field, it is also being employed in the shell molding, die casting, electronics, rubber and epoxy fields. Circle 346 on Reader Service Card.



Power Pulser transistorized

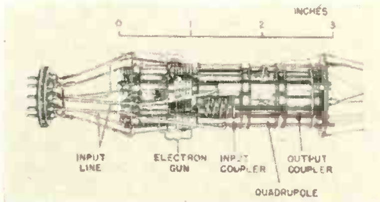
AIRTRONICS, INC., 5522 Dorsey Lane, Bethesda, Md. The DK402 Mod I power pulser is a fully transistorized, high current magnetic memory matrix driver with current pulses up to 400 ma. The printed circuit card contains four separate two-transistor blocking oscillator pulsers. The pulser "on" time is determined by the controlled rate of flux-switching in a square loop magnetic core. Each of the four pulsers is capable of switching 400 ma for a maximum period of 10 μsec at a 20-kc repetition rate at 25 C ambient temperature. Circle 347 on Reader Service Card.

D-C Voltmeter transistorized

CONSOLIDATED ELECTRODYNAMICS CORP., 300 North Sierra Madre Villa, Pasadena, Calif. Model 30A

CIRCLE 217 READERS SERVICE CARD

d-c electronic voltmeter requires no warmup time. It features eight ranges, ± 50 mv to 150 v with accuracy ± 3 percent of full-scale. The battery operated portable unit weighs 10 lb complete. Circle 348 on Reader Service Card.



Parametric Amplifier for uhf receivers

Zenith Radio Corp., 6001 W. Dickens, Chicago 39, Ill., has developed a fast wave parametric amplifier for use in uhf and microwave receivers. Tube is based on new concepts that involve the removal of noise from a fast wave on a stream of electrons which carries the signal, and the parametric amplification of that wave. Typical performance data: a noise figure about 1 db; and a gain up to 30 db. Circle 349 on Reader Service Card.

Transformers very small units

Palo Alto Engineering Co., 620 Page Mill Road, Palo Alto, Calif., offers a new line of miniature transformers engineered to customer specifications. Designed for both commercial and military application, the new transformers are particularly useful in transistorized missile circuits. Size is so small that 20 units occupy only 1 cu in.; weight is 175 units per lb. The manufacturer offers uncased, encapsulated or molded plug-in design. Circle 350 on Reader Service Card.

Literature of

MATERIALS

Picture Tube Phosphor. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y. A new technical bulletin, "Sylvania CR-405 Phosphor," describes a blend of silver-activated zinc and zinc cadmium sulfides designed especially for use in aluminized tv picture tubes. **Circle 375 on Reader Service Card.**

COMPONENTS

Transformers. Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y. A 4-page brochure lists such types of transformers as transistor power supply, driver, output, low level chopper input, and d-c/d-c converter transformers. **Circle 376 on Reader Service Card.**

Motor Shields. Magnetic Shield Division Perfection Mica Co., 1322 No. Elston Ave., Chicago 22, Ill., has issued data sheet 139 illustrating and describing the new 3-layer Co-Netic Netic small motor shield. **Circle 377 on Reader Service Card.**

Microwave Catalog. Amerac, Inc., Dunham Road, Beverly, Mass. A recent short form catalog contains an illustrated description and technical specifications of a line of microwave cavities and accessory microwave products. **Circle 378 on Reader Service Card.**

Transient Filters. ERA Electric Corp., 67 East Centre St., Nutley, N. J. Catalog No. 302 covers the Slim-Tran transient filters which are intended for all types of transistor switching applications. **Circle 379 on Reader Service Card.**

Relays and Switches. Automatic Electric Co., Northlake, Ill. A 100-page catalog covers the company's full line of telephone type relays and rotary stepping switches for industrial control applications. More than 200 photos, drawings, mounting diagrams, circuits and charts are included. **Circle 380 on Reader Service Card.**

the Week

Industrial Tubes. Tung-Sol Electric Inc., 95 Eighth Ave., Newark 4, N. J., has published a new 30-page "flip-style" chart showing electrical and physical characteristics for the most important electron tubes having industrial, special purpose and military applications. **Circle 381 on Reader Service Card.**

EQUIPMENT

Instruments. Electronics Division, Van Norman Industries, Inc., 186 Granite St., Manchester, N. H., has published a catalog of its Transitron line of electronic instruments. Signal and sweep generators, a video translator, a frequency standard and an insulation tester are included. **Circle 382 on Reader Service Card.**

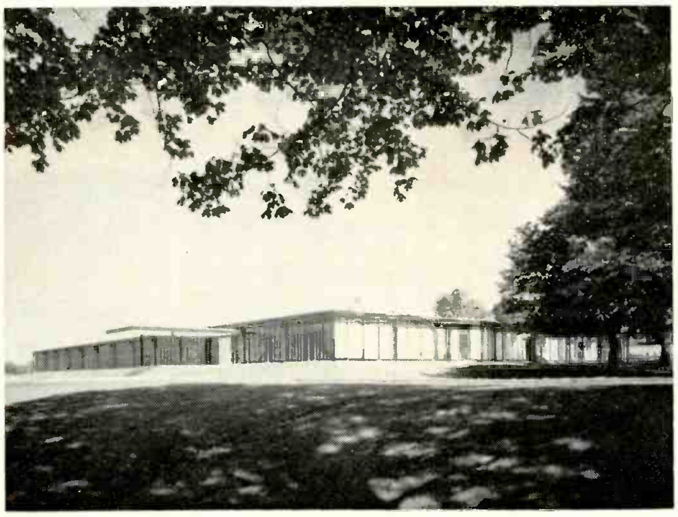
Gyro Test Equipment. Sterling Precision Corp., 17 Matinecock Ave., Port Washington, N. Y. An 8-page folder illustrates and describes the company's electronic gyro test equipment modular components. **Circle 383 on Reader Service Card.**

Digital Indicating Instruments. Performance Measurements Co., 15301 W. McNichols, Detroit 35, Michigan. Principles and applications of servo null-balance digital indicating instruments are discussed in bulletin No. 1758. **Circle 384 on Reader Service Card.**

CCTV. General Electric Co., Schenectady 5, N. Y. Bulletin GEA-6833, six pages, describes in text, tables and pictures the uses and advantages of GE closed-circuit tv for use in military applications. **Circle 385 on Reader Service Card.**

FACILITIES

Radio Frequency Interference. Technical Wire Products, Inc., 48 Brown Ave., Springfield, N. J., has available a design data file on Tecknit radio frequency interference gasketing. A complete free-design engineering service is discussed. **Circle 386 on Reader Service Card.**



CBS Labs Opens R&D Center

A MILLION-DOLLAR Research Center was recently dedicated by CBS Laboratories on a 23-acre site in Stamford, Conn. The glass-enclosed aluminum and steel structure's facilities include the most up-to-date scientific equipment and environment for research and development in many fields. These include audio-video systems, audio and acoustics, magnetics, solid-state physics, physical chemistry, optics, vacuum tubes, data processing systems and electronics for communications and other uses.

The Research Center serves as both administrative and scientific headquarters for CBS Laboratories, which had previously been located in the CBS Building at 485 Madison Ave., New York City.

Construction of the new facilities was described by Frank Stanton, president of Columbia Broadcasting System, Inc., as an important step "to provide broader research and development services for industry and government". He said that the program of the Laboratories was expanding in three areas: improved audio and video techniques, electronics projects under government contract for military and other purposes, and more comprehensive applied research for industry.

Librascope Gets New Department

ACQUISITION of Precision Technology, Inc., Livermore, Calif., was recently announced by Librascope, Inc., Glendale, Calif.

In making the announcement, Librascope's president, Lewis W. Imm, said Precision Technology, Inc., has been incorporated into Librascope's Engineering Division, establishing a new engineering department.

The Precision Technology Department will expand Librascope's research and technical capabilities in special nuclear weapons instrumentation, proximity scorers, exploding bridgewire ordnance components and systems, arm-safe switches, and high-speed image converter cameras for special purpose photography.

Lippert Joins Victoreen

APPOINTMENT of George R. Lippert as director of technical services of The Victoreen Instrument Co. has been announced.

Lippert comes to Victoreen from I-L-S Instrument Corp., where he recently served as vice president, and previously for six years as chief engineer. He will spearhead Victoreen's expanding program in large nuclear monitoring systems, telemetering and computing, and world-wide measurement of radioactive fallout.

He will also handle liaison between Victoreen and government agencies, as well as industrial users of electronic and nuclear equipment.

Name Director At CEC Div.

EVERETT J. LONG was recently promoted from assistant director for operations to director of the Transducer Division, Consolidated Electrodynamics Corp., Monrovia, Calif.

Joining CEC in 1952, he was manager of the Special Products Division before becoming production manager of the Transducer Division in 1956.

In his new post, Long will direct all activities of the division which designs and manufactures sensing devices used in dynamic and static remember your...

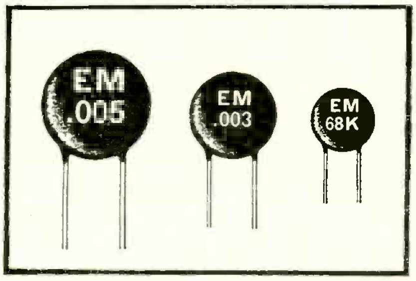
P's and Q's

call on El-Menco for capacitors

... with proved Performance and Quality!

CERAMIC DISC CAPACITORS

with TEST-PROVED RELIABILITY!



In the field of capacitors, the name of El-Menco stands head and shoulders above all others. Its ceramic disc capacitors dominate in quality . . . in performance . . . in creative engineering . . . are unmatched for high Q value, high insulation resistance, high dielectric strength.

Write for Bulletin on Ceramic Discs

WRITE TO EL-MENCO for latest bulletin and samples on Ceramic Disc Capacitors . . . the Mighty Midgets with EXTRA Ruggedness and Stamina.

Superior Features of El-Menco Ceramic Disc Capacitors . . .

- Working V.D.C. 500 . . . available also in 1,000 working volts and 2,000 test volts D.C. per E.I.A. specs. RS-165.
- Wax impregnated with low-loss phenolic coating.
- Flat design assures reduced self-inductance.
- Insulation resistance far exceeds the 10,000 megohm minimum requirements.
- Available with straight leads 1¼" minimum. Or manufactured with crimped leads for printed circuit applications.

MIGHTY MIDGETS BY EL-MENCO INCLUDE:

El-Menco TC — Temperature Compensating — for resonant circuit application.
El-Menco TS — Temperature Stable — designed for applications where a minimum capacitance change with temperature is required.
El-Menco SS — Semi-Stable — general purpose with stability.
El-Menco GP — General Purpose — for bypassing, coupling or filtering applications . . . space saving, provide high capacity in relation to size.

EL-MENCO CERAMIC DISC CAPACITORS MEET OR EXCEED E.I.A. SPECS. RS-198.

LOOK TO THE LEADER . . . LOOK TO EL-MENCO . . . for capacitors to serve all your needs. Investigate, too, El Menco Dur-Mica Capacitors, the longest-living capacitors ever made.

El-Menco Capacitors

THE ELECTRO MOTIVE MFG. CO., INC.
WILLIMANTIC CONNECTICUT
Manufacturers of El-Menco Capacitors

• molded mica • dipped mica • mica trimmer • dipped paper
• tubular paper • ceramic • silvered mica films • ceramic discs

Arco Electronics, Inc., 64 White St., New York 13, N. Y.
Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada

testing systems and is active in the area of telemetry and in the development of basic missile-control devices.

WacLine Elects New Director

JOHN J. VELESKY has been elected a director and vice president of WacLine, Inc., Dayton, Ohio. He is also chief engineer for the company.

Prior to becoming associated with WacLine in 1953, Velesky was chief engineer of Frampton Electric Co. of Dayton. He was formerly associated with RCA in Bloomington, Ind., and with Wright Air Development Center at Wright-Patterson AFB.

WacLine manufactures electrical indicating meters, tachometer generators, electric adjustable speed drives, and microwave components.

Gabriel Division Expands

MOVEMENT of the Bohanan Mfg. Division of The Gabriel Co., Los Angeles, into a new plant in Compton, Calif., was recently announced by John H. Briggs, president of Gabriel.

Expansion into the new facilities, located on a 13-acre site and totaling more than 52,000 sq ft, is necessitated by the increasing backlog of orders from the aircraft and missile industries which has risen to a current $2,700,000 from approximately $1,000,000 in February of this year.

Johnson Joins Photocircuits

NEW MANAGER of customer engineering in the sales department of Photocircuits Corp., Glen Cove, N. Y., is George F. Johnson. In this capacity he will serve as liaison between the company's production, engineering and research departments, and customers with specific problems in these areas.

Johnson was manager of the plated circuit engineering department of Motorola, Inc., for the past eight years, following engineering assignments with Westinghouse, Majestic and Zenith.

Eimac Promotes D. H. Preist

ELECTRON-POWER tube manufacturer, Eitel-McCullough, Inc., San Carlos, Calif., recently named Donald H. Preist associate director of research. In this post he is responsible for the overall guidance of the technical phases of the company's research and development program.

Preist joined Eimac in 1946 as research engineer after an association with the British Government Service in radar development. In

1952 he was named klystron project coordinator at Eimac and later served as chief research engineer concerned with the development of high power tubes and circuits.

Elect Rempt To High Post

AT THEIR annual meeting at the U. of California in Santa Barbara, Calif., the Institute of Navigation elected Henry Rempt president.

The Institute was founded in 1945 to establish a common meeting ground for those professionally concerned with the science and art of navigation. In addition to celestial, magnetic, and electronic navigation for surface and air, it is active in the fields of polar navigation, space navigation, aerodesy, cartography, meteorology, and oceanography.

Rempt presently directs the Electronics and Armament Systems Division for the Lockheed Aircraft Corp. at Burbank, Calif.

Lycoming's Kerr Heads Avco RAD

NEW PRESIDENT of Avco Research and Advanced Development Division, Wilmington, Mass., is James R. Kerr, who continues as president of Lycoming Division also and a vice president of Avco Corp.

As head of Avco RAD, Kerr succeeds Dr. Lloyd P. Smith, who moves to Avco headquarters in New York as vice president in charge of corporation's research planning.

Kerr, former Air Force officer and Air Materiel Command executive, joined Avco in 1954 as director of West Coast divison and assistant general manager of Avco RAD.

News of Reps

FIBERGLASS-EPOXY tubing lines of Lamtex Industries, Inc., Westbury, N. Y., will be handled in northern California by **Jack Kaufman.**

V. T. Rupp Co., Los Angeles engineering rep firm, is named by G. M. Giannini and Co., Inc., to handle its line of potentiometers, Rotosteppers and pressure switches, in southern California, New Mexico, and Arizona.

James L. Highsmith and Co. of Charlotte, N. C., is appointed by Navigation Computer Corp., Philadelphia, Pa., to handle its digital data handling products in North and South Carolina, and in Virginia except Fairfax County.

Computer Engineering Associates, Inc. appoints **Michael S. Coldwell, Inc.** as reps for Maine, Vermont, New Hampshire, Massachusetts, Rhode Island and Connecticut.

Digitronics Corp., Albertson, L. I., N. Y., will be represented in southern New Jersey and the state of Pennsylvania by **Lew Slubin & Co.** of Philadelphia for the sale of lumped constant delay lines and electromechanical clutches and brakes.

WacLine, Inc., Dayton, Ohio, manufacturer of electrical panel meters, tachometer generators and microwave components, announces four new rep agreements.

R. Edward Stemm of Chicago, Ill., will handle the products in Indiana, Illinois, Iowa, Minnesota and Wisconsin. **Standard Products, Inc.,** of Wichita, Kan., handles the account in Kansas and Missouri. **ElectroRep** of Detroit, Mich., covers Michigan, Ohio, Kentucky and western Pennsylvania. The **Jack Miller Co.** of Forest Hills, N. Y., will serve in northern New Jersey.

NEW BOOKS

Feedback Theory And Its Applications

BY P. H. HAMMOND

The Macmillan Co., New York, 1958, 348 p. $7.00.

IMPORTANCE of feedback in many areas of engineering is well known; worthy of particular note, however, are two branches of electrical engineering where feedback plays an especially important role—feedback amplifiers and control systems. The subject matter of this book concerns itself with those electronic devices and control systems which in some form incorporate feedback. The treatment extends to a discussion of well-tried linear as well as nonlinear methods of analysis and design.

Basic Mathematics—The first two chapters are devoted to a review of the solution of linear differential equations (using the Laplace transform method) and the basic feedback principles with particular attention directed to response time, gain stability and distortion influences. This is followed by a discussion of the Routh criterion and its limitations, whereupon the Nyquist criterion is introduced as a more useful gage of stability.

Twenty pages are devoted to a brief but interesting treatment of the frequency response of system and loop transfer functions as well as stabilization networks.

The foregoing material constitutes the common core of the book; the remainder is then devoted to a study of the devices and systems in which these principles are applied. Thus, in the area of feedback amplifiers a fairly thorough examination is made of the cathode follower, the difference amplifier and the high gain d-c amplifier used as a computing amplifier. Careful attention is given to such items as gain, output and input impedance, loading effects and methods of stabilization.

Servomechanisms—Almost the entire second half of the book is devoted to linear as well as nonlinear servomechanisms with one brief chapter dealing with simulation of nonlinear control systems using the electronic analog computer.

One of the strong points of the book is the rather complete and well illustrated treatment of nonlinear servomechanisms. Both the phase plane and the describing function method of analysis are covered.

Although the phase plane method is restricted to the second-order system, the techniques are applied to a system which has output rate feedback as well as primary position feedback. The analysis is carried out in dimensionless form, thus making the results applicable in general. Phase-plane diagrams are included for such nonlinearities as saturation, backlash and coulomb friction.

In the chapter dealing with the describing function method of analysis, a table lists the describing function of eight different kinds of symmetrical, amplitude nonlinearities including characteristics with changing slopes.

Also appearing in the book is a thorough treatment of the on-off servo which includes a discussion of methods for reducing or eliminating steady-state oscillations by dead-zone front-lash stabilization as well as rate feedback.

Nonlinear Servos—Analysis of nonlinear servos is a major topic of the book. It is surprising that the author has not directly reflected this in the title. As a matter of fact it is not at all apparent why the author has chosen the topics he has, while omitting others, which could just as easily have been included. For example, since half the book is concerned with servomechanisms, it is unfortunate that no mention is made of the simple but powerful root locus method.

By statement of the author (who resides in England) the book is intended for post-graduate engineering and physics students who want an introduction to the subject. However, most of the material with the possible exception of that dealing with nonlinear servos is to be found in undergraduate curricula in the U.S.A. One of the weaker points of the book concerns the treatment of linear-servo analysis. Here an expansion of the introductory material as well as a few more illustrations on linear stabilization techniques could have been used to advantage.

The book is written in a style which makes for easy reading and it is well illustrated throughout. It indeed fills a need for those persons who want a background in feedback theory as well as methods of analyzing nonlinear servomechanisms and feedback amplifiers.—VINCENT DELTORO, *The City College, New York 31, N. Y.*

THUMBNAIL REVIEWS

Broadcasting Stations of the World. Superintendent of Documents, Government Printing Office, Washington 25, D. C., 4 vol., approximately 896 p, $5 (paper). All known radio broadcasting and television stations except those in the standard broadcast band in the U. S. are listed in this Foreign Broadcast Information Service publication. Part 1 ($1.50) lists stations by country and city; Part 2 ($1.50) gives location of transmitters by frequency; Part 3 ($1.25) is in two sections—station call letters and station name or slogan; Part 4 ($0.75) lists tv and f-m stations according to location and frequency. Part 4 also includes data necessary to distinguish audio, video, polarization and other technical factors.

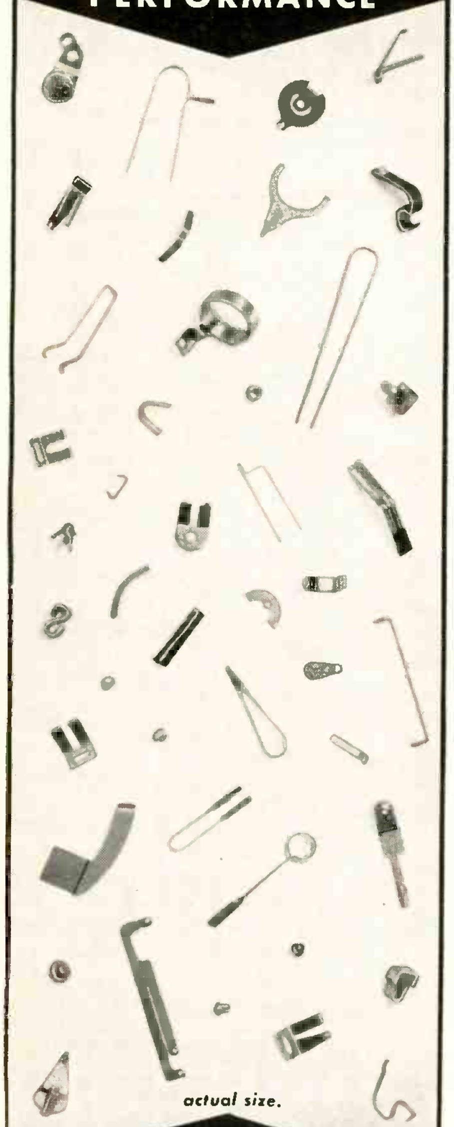
Motion and Time Study. By R. M. Barnes, John Wiley & Sons, Inc., New York, 1958, 665 p, $9.25. This fourth edition has five new chapters dealing with motion study, mechanization, automation, mechanized time study, electronic data processing, motion-time data systems, work sampling, multifactor wage incentive plans and evaluating and controlling factors other than labor.

Management for Engineers. By R. C. Heimer, McGraw-Hill Book Co., Inc., New York, 1958, 453 p, $6.75. This book trys to interpret management to engineers and the engineers' position to management. It takes a practical look at the impact of costs, standards, materials, methods, taxes, insurance and power, equipment, labor and ethics upon engineering considerations in the day-to-day workings of a business firm.

Production Planning and Inventory Control. By J. F. Magee, McGraw-Hill Book Co., Inc., New York, 1958, 332 p, $7.50. Graphs and numerical examples are used extensively in this publication to introduce operating executives and planning and control system engineers to the concepts and methods of production planning and inventory control.

Automation and Management. By J. R. Bright, Division of Research, Harvard

MINIATURE PRECIOUS METAL CONTACTS For MAXIMUM PERFORMANCE



actual size.

Slip Rings • Micro Brushes
Springs • Rivets
for
Potentiometers • Synchros
Relays • Switches

INDUSTRIAL DIVISION

GENERAL FINDINGS AND SUPPLY COMPANY

Sales Offices: New York
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Precision custom fabrications of all precious metal contact alloys. Miniature contacts using wire as fine as .005", sheet as thin as .00075", and tubing as small as .030" diameter. Precision base metal fabrications also available.

Prompt quotations to your print and specifications.

CIRCLE 239 READERS SERVICE CARD

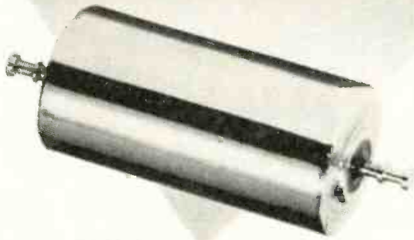
New *LOW LOSS* Solid Ultrasonic Delay Lines by BLILEY

This new series of solid ultrasonic delay lines, in range 2 to 50 microseconds, employs special barium titanate transducers to reduce loss level. Loss levels, into 100 ohm terminations, range from 6 to 10 db compared to 35 db for conventional types.

TYPICAL CHARACTERISTICS OF A 2 USEC. BLILEY LOW LOSS LINE

- Delay time: 2 usec.
- Type: double ended absorber
- Center frequency: 30 mc.
- Termination: 500 ohms.
- Capacity: 385 mmf.
- Insertion loss to first reflected pulse: 5 db.
- Third time signal down 30 db.
- Delay time variation from −20 to +60°C.: ± .01 usec.

Request Bulletin #513 for details.



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Business School, Boston 63, Mass., 1958, 269 p, $10.00. After providing the background of the nature of production line mechanization, this book briefly describes the automation programs of 13 plants. The impact of automation on maintenance, the skill requirements of the work force in the high automated plant, the sales effort and management itself are considered.

Applied Statistics for Engineers. By Wm. Volk, McGraw-Hill Publishing Co., Inc., New York, 1958, 250 p, $9.50. Covering statistical techniques, rather than theory, this book is intended for the practicing engineer and as a text. It deals with the treatment of engineering data for correlation, presentation and analysis of experimental factors. A review of probability theory and frequency distribution is included along with detailed discussions of curvilinear correlation, analysis of the variance and interpretation of the analysis of the variance.

Conductance Curve Design Manual. By K. A. Pullen, Jr., John F. Rider Pub. Inc., New York, 1958, 128 p, $4.25. An original technique for designing circuitry using conductance curves of 70 most representative vacuum tubes. With these graphs, designs using small-signal parameters can be used to predict large-signal performance.

Electron Tube Materials. American Society for Testing Materials, Philaphia, Pa., 1958, 242 p, $3.50. This first edition contains 41 standards relating to cathode materials, insulators, wire, metallic and nonmetallic seals and miscellaneous materials.

Program for an Electronic Digital Computer. By M. V. Wilkes, D. J. Wheeler and Stanley Gill, Addison-Wesley Publishing Company, Inc., Reading, Mass., 1957, 238 p, $7.50 (second edition). Written for those who program for, initiate operation of, or assess applications of electronic digital computers, this book covers elements of program design, subroutine development, input-output techniques, program error diagnosis and automatic programming in general, while library subroutines and complete programs for EDSAC are given in detail.

Table for the Solution of Cubic Equations. By H. E. Salzer, C. H. Richards and I. Arsham, McGraw-Hill Pub. Co., Inc., New York, 1958, 176 p, $7.50. For engineers, physicists and applied mathematicians, this table supersedes other tables in number of decimal places, range, interval, required labor for finding all three roots and convenience in use.

COMMENT

Micromiles and Megafeet

I have noticed a tendency lately, even in your esteemed publication, to employ hyperfine units when seeking to create the impression of sensitivity (relays operate on 750 milliwatts), high-frequency capability (transistors switch in 500 millimicroseconds) and the like. Translating up and down scales by a factor of 1,000 each time, I discover that these figures mean $\frac{3}{4}$ watt and $\frac{1}{2}$ microsecond respectively.

Frankly, after an elapsed time of 38,100 seconds between leaving the house at an unearthly hour of the morning and returning in time for supper, allowing for traveling 413,012 inches each way to and from work, this irritates me.

Honestly, now, does it really make sense to specify a simple quantity like $\frac{3}{4}$ of one unit or $\frac{1}{2}$ of another (especially when these may be finer gradations than the facts warrant) in terms of many hundreds of a unit a thousand times smaller? Granted that engineers use milliwatts in much of their work, and certainly understand millimicroseconds whether they commonly use them or not, what is gained by this parading of tiny units when you need a basketful of them to say the same thing that could have been said with simple fractions (and sometimes whole numbers) of the larger unit?

Once in a while there's an excuse, as in tables of transistor characteristics, where collector current is expressed in milliamperes because this is a common and appropriate unit for most of them, even though occasional types may rate 3,000 or 5,000 milliamperes. Let's see if we can inhibit this trend before the national debt hits 30,000,000,000,000 cents, which probably isn't far off.

WILLIAM C. SCHUMACHER
GLENDALE, N. Y.

Probably about 30,000 microcenturies, by our calculations.

Magnet Power Supply

In your Oct. 17 issue (p 31) you ran a new product announcement on our magnet supply, model M25. Please note that you made a typographical error in the output specification. You give the current as 100 amperes, whereas it should be 10 amperes.

At the same time, an oversight on our part had the price at $395; it should be $495.

MARTIN SEROY
MANSON LABORATORIES
STAMFORD, CONN.

The College Market

Your Oct. 3 issue indicated (in "College Market Grows," p 16) that "a device that can focus four ultrasound beams from four separate irradiators inside the human brain on a target no larger than the diameter of a lead pencil" was built at the State University of Iowa. Unfortunately this statement is incorrect.

The equipment referred to was designed and built at the Biophysical Research Laboratory of the University of Illinois.

For the past ten years the Biophysical Research Laboratory, under the direction of William J. Fry, has been conducting a research program on the effects of high-intensity focused ultrasound on the central nervous system. This program includes basic biological and physiological studies on animals as well as an intensive instrumentation program. As a result of this work, a technique was developed here for applying high-intensity ultrasound to humans with certain dysfunctions of the central nervous system.

Dr. Russell Myers, head of the department of neurosurgery of the State University of Iowa hospitals, and professor Fry of this Laboratory, then entered into a cooperative program for application of this technique to selected patients. A special so-called portable ultrasonic irradiator was designed and built here at the University of Illinois and transported to Iowa. Several staff members from both this Laboratory and the SUI department of neurosurgery are directly concerned in applying this instrument to human neurosonic surgery.

ELIZABETH KELLY
UNIVERSITY OF ILLINOIS
URBANA, ILL.

ENGINEERS–OPPORTUNITIES

SYSTEMS ENGINEER to develop complex devices in fields of servomechanisms, radar, or computers, and integrate these elements in weapons systems. Must have three to five years' experience in such activity and two years' experience in over-all systems analysis. Assignment involves design and analysis of closed-loop systems, consisting of inertial and radar equipment, display materials, and digital or analog computers.

Qualifications: B.S. or Advanced Degree in E.E. or A.E.

RADAR ENGINEER to analyze ultimate limits of present techniques and develop new concepts of providing topographical sensors for advanced airborne and space systems; to design airborne radar pulse, microwave and deflection circuitry; to analyze Doppler radar systems in order to determine theoretical accuracy and performance limitations.

Qualifications: B.S. or Advanced Degree in E.E. and 3 to 5 years' experience in radar systems development, including display equipment and circuits, control consoles, and Doppler or search radar design.

CIRCUIT ENGINEER to undertake advanced circuit design based on transistor-diode logic for digital systems; to review new circuits for application in digital control systems; to define basic techniques for improving performance characteristics; to participate in advanced analytical studies associated with application of transistor circuitry to pulse and digital systems.

Qualifications: B.S. or Advanced Degree in E.E. and 2 years' experience with pulse circuitry, transistor circuit design, or digital techniques.

COMPUTER ENGINEER to undertake logical design of airborne digital computer equipment, transistorizing computer circuitry for size and weight reduction. Assignment entails: Mechanization of computer circuitry and packaging; interpreting problems for solution with the IBM 704.

Qualifications: B.S. or Advanced Degree in Engineering or Physics and 3 to 5 years' experience in design of digital or analog computer equipment. Experience also desirable in transistor technology, computer logic, programming, instrumentation, computer system evaluation, or servo-mechanism design.

ADVANTAGES OF IBM

A recognized leader in the electronic systems field... products used for both military and commercial work... advancement on merit... company-paid relocation expenses... liberal company benefits... salary commensurate with ability and experience.

Immediate openings at Owego, N. Y.

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Mr. P. E. Strohm, Dept. 554Y
Military Products Division
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ELECTRONIC ENGINEER

(Senior)

QUALITY CONTROL

- Develop test equipment, methods and procedures for determining conformance of complex electronic equipment with Company and Air Force specifications.
- Contact various electronic manufacturers to determine and purchase equipment as required to test and simulate flight operations of radar, navigation, fire control and similar electronic systems.
- Also develop procedures for use of electronic test equipment. Conduct investigatory work and recommend corrective action and changes. EE degree required.

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in confidence to

INSTRUMENTS FOR INDUSTRY, INC.
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HAVE SENSORS...WILL TRAVEL

Flying at 50,000 feet, probing the heavens up to 150,000 feet, Bendix personnel during the years immediately ahead will be finding out more about the world's weather than man has ever known. A new project, to be undertaken by Bendix Systems Division for the U. S. government, will employ jet aircraft, flying distances up to 4,500 miles at Mach 0.95 to measure cloud formations and look inside storms with radar sweeps extending 150 miles from the plane.

Using rocketsondes, dropsondes, computers and new aircraft sensors the system will collect and analyze atmospheric phenomena on a global scale from the earth's surface well into the stratosphere. Officially designated the AN/AMQ-15 Air Weather Reconnaissance Program, the new project will be carried out in cooperation with Boeing Aircraft Company and six other Bendix divisions, under the Bendix Systems Division's general supervision.

The new program offers an outstanding opportunity for qualified scientific and management personnel in the fields of physics, chemistry and meteorology with upper atmosphere and air sampling background.

For complete details, write Technical Personnel Department B1121, Bendix Systems Division, 3300 Plymouth, Ann Arbor, Michigan.

Bendix Systems Division

Ann Arbor, Michigan

Bendix AVIATION CORPORATION

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SALARIES TO $20,000.00 PER YEAR

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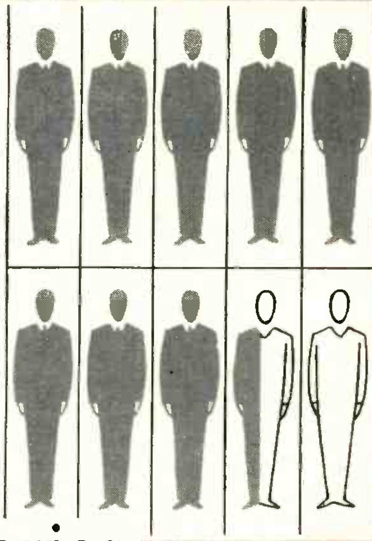
More than **8 OUT OF 10 ENGINEERS** say "yes" to an invitation to join Norden Laboratories



The ratio of 8.3 acceptances for every 10 engineers invited to join Norden Laboratories' professional staff is unusually high, especially in the opportunity-rich electronics industry. We went right to the source and checked new members of our engineering groups, who revealed these factors impelling their decision in favor of Norden:

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- *Small R & D Groups Fostering Individual Accomplishment*
- *Close Contact With Management*
- *Flexibility of Assignments*
- *30-Year Company History of Achievement in Precision Electronics*

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Enjoy the pleasure of working in a new laboratory in a company whose products are known as the highest quality in the industry.

Write or call collect: Personnel Manager

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We are now interviewing electrical engineers with practical experience in TV circuitry or radio tube production.

If you have such experience and would like to discuss your future plans and ambitions with us, please call in person or write to D. Bellat, **Personnel Director c/o Tung-Sol Electric Inc., 200 Bloomfield Avenue, Bloomfield, New Jersey. Pilgrim 8-8700.**

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Leland—2 K.W.—17.4 amps. 115 Volts—400 Cy.—1 PH. —Ball Bearing Construction.

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BRAND NEW
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Also, Same Generator Mounted on Base with—
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*See advertisement in the 1958-1959 *ELECTRONICS BUYERS' GUIDE* for complete line of products or services.

CIRCLE 252 READERS SERVICE CARD

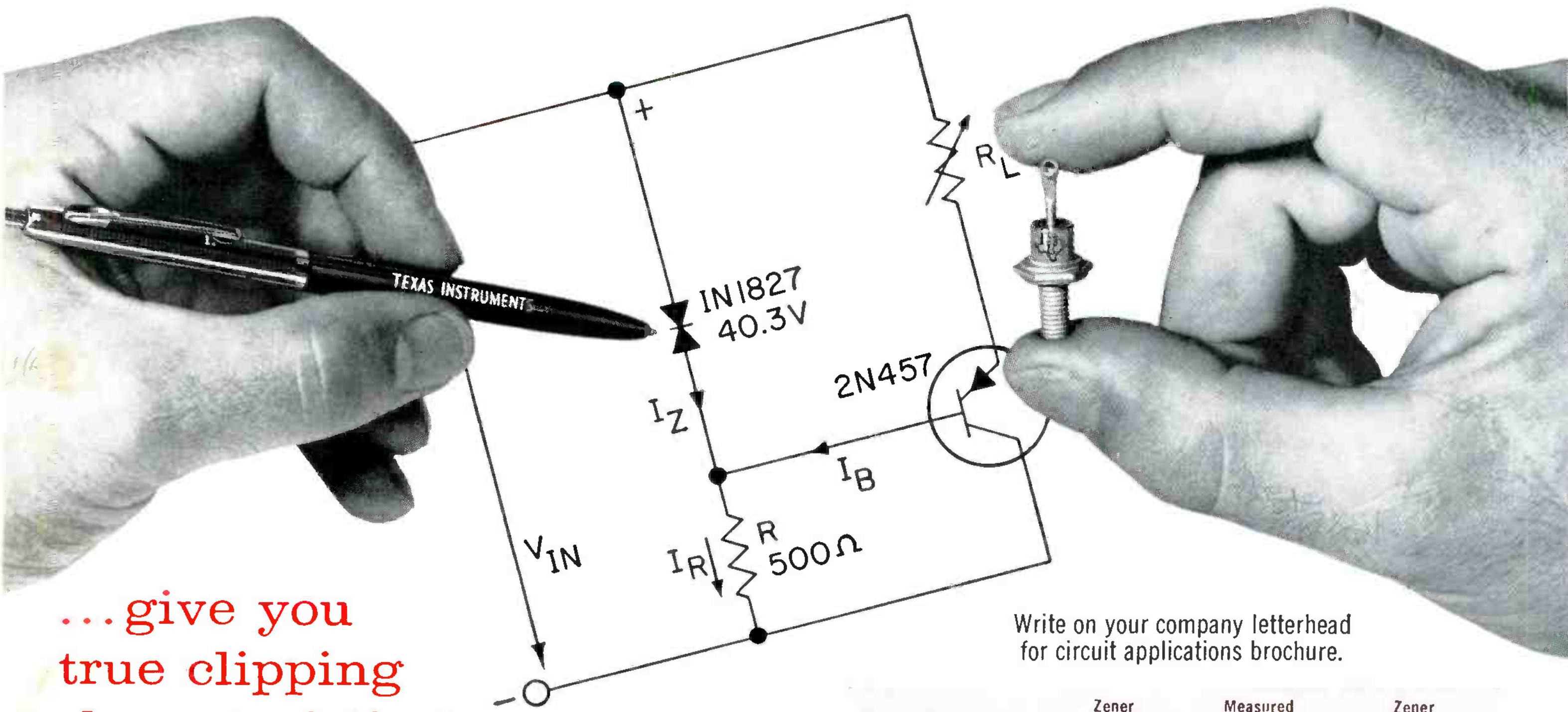
CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

*See advertisement in the 1958-1959 **ELECTRONICS** BUYERS' GUIDE for complete line of products or services.

NEW 10W VOLTAGE REGULATORS FROM TEXAS INSTRUMENTS



...give you true clipping characteristics!

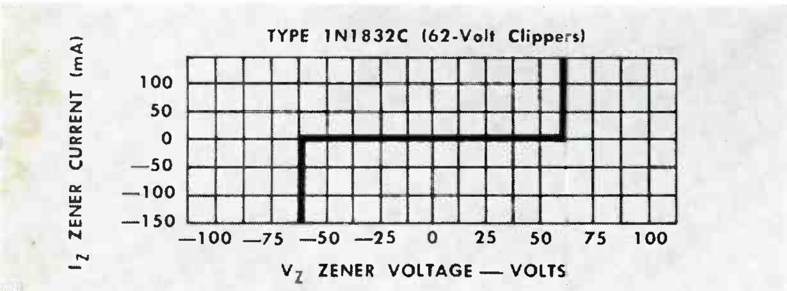
Write on your company letterhead for circuit applications brochure.

You get true clipping action with TI 1N1816-series double anode voltage regulators. A full line of regulators with dissipation ratings to 10 watts is available in 5 or 10% tolerances over a 13 to 91-volt range.

These stud-mounted silicon voltage regulators give you guaranteed zener impedance, –65 to 150°C operation, and are designed to meet or exceed strict military (MIL-T-19500A) requirements.

This new 1N1816-series provides greater design flexibility for your shunt regulator, surge protection, operating bias, and arc suppression applications. Select from 105 types . . . 16 voltage ratings . . . 5 or 10% tolerances . . . cathode-to-stud or anode-to-stud polarity.

Type	Zener Voltage V_Z Volts	Measured at I_Z I_Z mA	Zener Impedance at I_Z Z_Z (max) ohms
1N1816	13	500	2
1N1817	15	500	2
1N1818	16	500	3
1N1819	18	500	3
1N1820	20	250	3
1N1821	22	250	3
1N1822	24	250	3
1N1823	27	250	3
1N1824	30	250	4
1N1825	33	150	4
1N1826	36	150	5
1N1827	39	150	5
1N1828	43	150	6
1N1829	47	150	7
1N1830	51	150	8
1N1831	56	150	9
1N1832	62	50	12
1N1833	68	50	14
1N1834	75	50	20
1N1835	82	50	22
1N1836	91	50	35



1N1816C — 1N1836C CLIPPER

Types IN1816C — IN1836C are specifically designed to clip, and exhibit true double anode characteristics. Each zener is held within 10% tolerance of the specified voltage. See "Typical Clipper Characteristics" curve at left.

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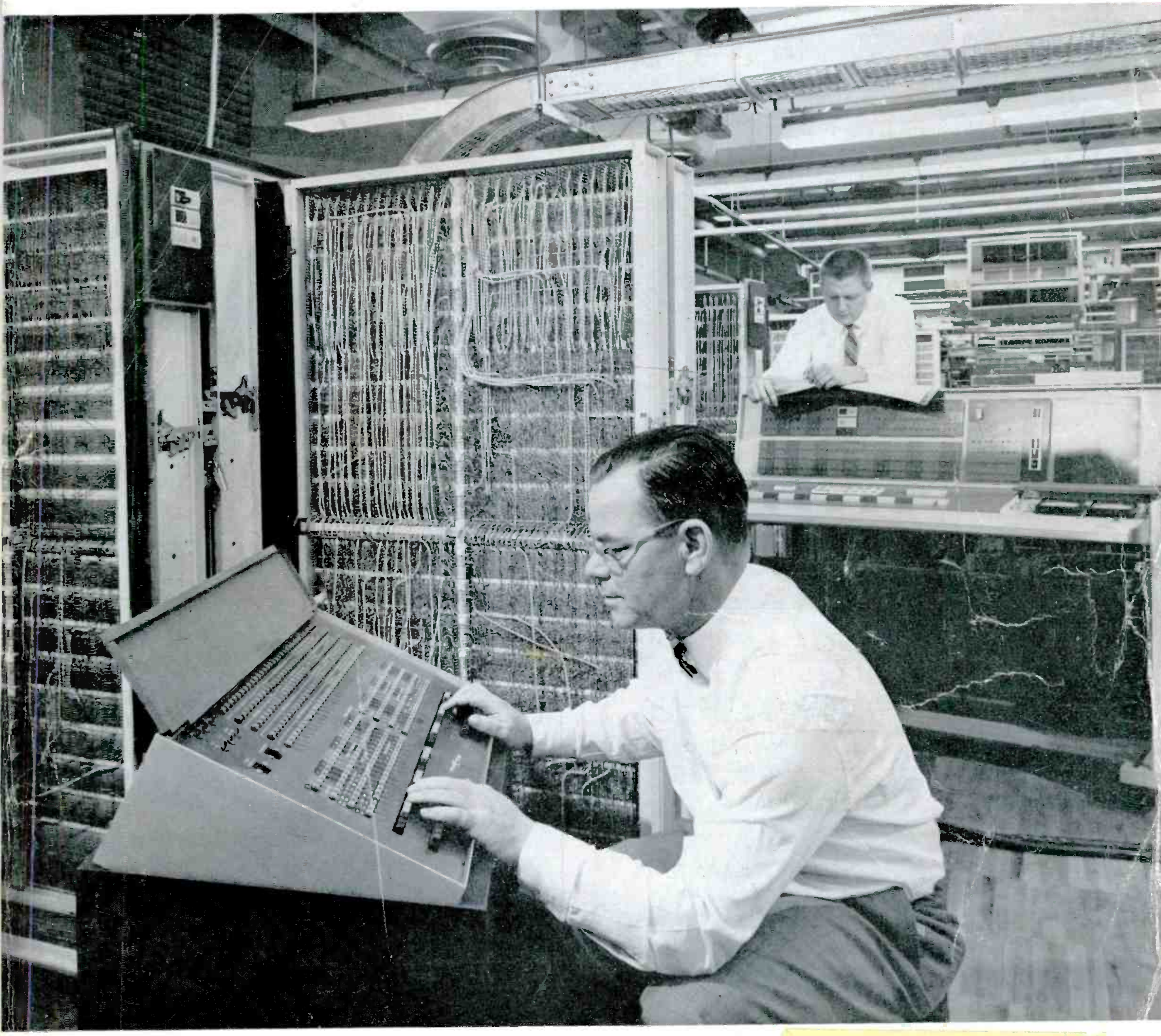
May 12, 1961

electronics

Three-dimensional core-storage memory for computers (below) stores one million bits, needs special design techniques, p 68

Using a microwave radiometer to detect small icebergs, p 72

A McGraw-Hill Publication 75 Cents



PARTS SHOW SPECIAL

New Distribution Patterns and Techniques

May 12, 1961

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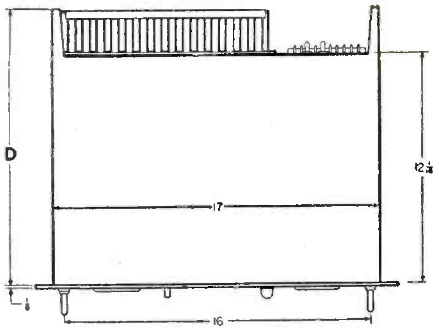
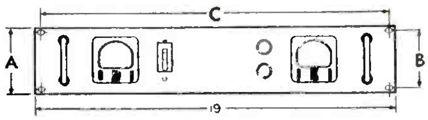


Top View of All Models

Front View



	MODEL †		
	LA 50-03A LA 20-05A LA 8-08A	LA 100-03A LA 40-05A LA 15-08A	LA 200-03A LA 80-05A LA 30-08A
A	3½"	7"	10½"
B	3"	*4"	*7½"
C	18 5/16"	18¼"	18¼"
D	14⅜"	14⅜"	16½"

* These models notched per RETMA Standards
† Includes metered models with suffix "M"

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DC OUTPUT (Regulated for line and load)

Model	Voltage Range (1)	Current Range	Minimum Voltage (1)	Voltage Steps (1)	Price(2)
LA 50-03A	0- 34 VDC	0- 5 AMP	0	2, 4, 8, 16, and 0- 4 volt vernier	$ 395
LA100-03A	0- 34 VDC	0-10 AMP	0	2, 4, 8, 16, and 0- 4 volt vernier	510
LA200-03A	0- 34 VDC	0-20 AMP	0	2, 4, 8, 16, and 0- 4 volt vernier	795
LA 20-05A	20-105 VDC	0- 2 AMP	20	5, 10, 20, 40, and 0-10 volt vernier	350
LA 40-05A	20-105 VDC	0- 4 AMP	20	5, 10, 20, 40, and 0-10 volt vernier	495
LA 80-05A	20-105 VDC	0- 8 AMP	20	5, 10, 20, 40, and 0-10 volt vernier	780
LA 8-08A	75-330 VDC	0- 0.8 AMP	75	15, 30, 60, 120, and 0-30 volt vernier	395
LA 15-08A	75-330 VDC	0- 1.5 AMP	75	15, 30, 60, 120, and 0-30 volt vernier	560
LA 30-08A	75-330 VDC	0- 3 AMP	75	15, 30, 60, 120, and 0-30 volt vernier	860

(1) The DC output voltage for each model is completely covered by four selector switches plus vernier control. The DC output voltage is the summation of the minimum voltage plus the voltage steps and the continuously variable DC vernier.

(2) Prices are for unmetered models. For metered models add the suffix "M" and add $30.00 to the price.

Regulation (line) ...... Less than 0.05 per cent or 8 millivolts (whichever is greater). For input variations from 100-130 VAC.

Regulation (load) ..... Less than 0.10 per cent or 15 millivolts (whichever is greater). For load variations from 0 to full load.

Transient Response ..... Output voltage is constant within regulation specifications for step function:

(line) .... line voltage change from 100-130 VAC or 130-100 VAC.

(load) ...... load change from 0 to full load or full load to 0 within 50 microseconds after application.

Internal Impedance .... LA 50-03A less than .008 ohms
LA100-03A less than .004 ohms
LA200-03A less than .002 ohms
LA 20-05A less than .06 ohms
LA 40-05A less than .03 ohms
LA 80-05A less than .015 ohms
LA 8-08A less than .5 ohms
LA 15-08A less than .25 ohms
LA 30-08A less than .15 ohms

Ripple and Noise ...... Less than 1 millivolt rms with either terminal grounded.

Polarity .... Either positive or negative terminal may be grounded.

Temperature Coefficient .... Less than 0.025 %/°C

AC INPUT .... 100-130 VAC, 60 ± 0.3 cycle[3]
LA 50-03A ....360 watts[4]
LA100-03A ....680 watts[4]
LA200-03A ...1225 watts[4]
LA 20-05A ....390 watts[4]
LA 40-05A ....710 watts[4]
LA 80-05A ...1350 watts[4]
LA 8-08A ....415 watts[4]
LA 15-08A ....760 watts[4]
LA 30-08A ...1450 watts[4]

[3]*This frequency band amply covers standard commercial power lines in the United States and Canada.*
[4]*With output loaded to full rating and input at 130 VAC.*

AMBIENT TEMPERATURE AND DUTY CYCLE Continuous duty at full load up to 50°C (122°F) ambient.

OVERLOAD PROTECTION:

Electrical .... Magnetic circuit breaker front panel mounted. Special transistor circuitry provides independent protection against transistor complement overload. Fuses provide internal failure protection. Unit cannot be injured by short circuit or overload.

Thermal .... Thermostat, manual reset, rear of chassis. Thermal overload indicator light front panel.

METERS .... Voltmeter and ammeter on metered models.

CONTROLS:

DC Output Controls ... Voltage selector switches and adjustable vernier-control rear of chassis.

Power .... Magnetic circuit breaker, front panel.

Remote DC Vernier .... Provision for remote operation of DC vernier.

Remote Sensing .... Provision is made for remote sensing to minimize effect of power output leads on DC regulation, output impedance and transient response.

PHYSICAL DATA:

Mounting .... Standard 19" Rack Mounting

Size

LA 50-03A, LA20-05A, LA 8-08A 3½" H x 19" W x 14⅜"D
LA100-03A, LA40-05A, LA15-08A 7" H x 19" W x 14⅜"D
LA200-03A, LA80-05A, LA30-08A 10½" H x 19" W x 16½"D

Weight

LA 50-03A, LA20-05A, LA 8-08A 55 lb Net 85 lb Ship. Wt.
LA100-03A, LA40-05A, LA15-08A 100 lb Net 130 lb Ship. Wt.
LA200-03A, LA80-05A, LA30-08A 140 lb Net 170 lb Ship. Wt.

Panel Finish .... Black ripple enamel (standard). Special finishes available to customers' specifications at moderate surcharge. Quotation upon request.

electronics
May 12, 1961 Volume 34 Number 19

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CROSSTALK

"ELECTRONICS IN EUROPE" is the title of Chief Editor MacDonald's upcoming Special Report (June 9) and this photo is the current condition of his desk—give or take another mail call.

It's enough to make a traveling man take up painting.

Instead, he plans to give readers a full-stroke picture of what goes on overseas. Realistically. Bright colors, somber grays, important in-betweens . . . the whole panorama. Meanwhile, in this issue (p 26), three prominent European friends sketch in a bit of the future.

PARTS SHOW

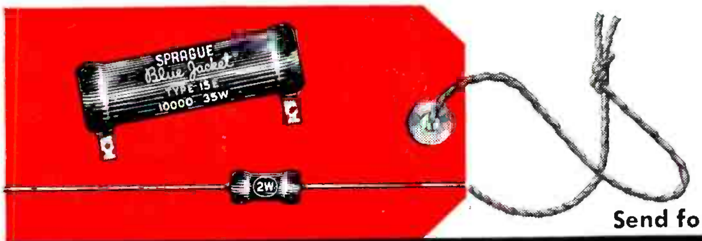
CHANGING marketing patterns and techniques are bringing major expansion to the 24-year-old Electronic Parts Distributors Show to be held in Chicago week after next. Trend of big exclusively franchised distributors taking over from factory-to-factory selling is told on p 28.

Products to be introduced at the show will include stereo f-m broadcast adapters, tuners and receivers; antennas with tubes built in, nuvistor-equipped preamps and a transmitter-receiver with acoustically isolated earphones and mouthpiece for use in high-noise level areas. See p 30.

Mergers and acquisitions are among trends which now point to fewer and bigger parts distributors doing a doubled volume by 1965. These indicators are reflected in the marketing story on p 22. Necessity for thinking and planning big to share and survive in booming industrial electronic parts business is wrapped up on p 132 by one of the top men behind the parts show.

Coming In Our May 19 Issue

METEORFAX. Transmission of facsimile messages up to distances of 1,000 miles over meteor-burst paths appears feasible with the meteorfax technique described in our next issue. According to B. F. Gedaminski and W. G. Griffin, Jr. of Air Force Cambridge Research Laboratories in Bedford, Mass., high-speed transmission of data in this system eliminates the need for storage devices such as magnetic tape. The authors report tests where picture rates in excess of 300,000 bits a second were achieved.



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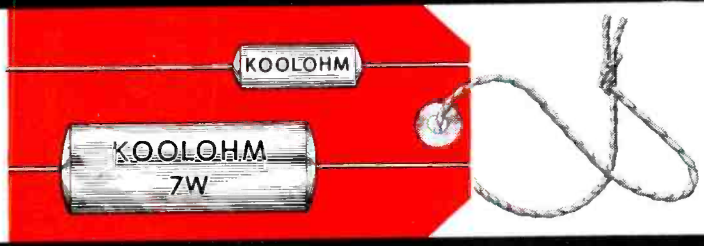

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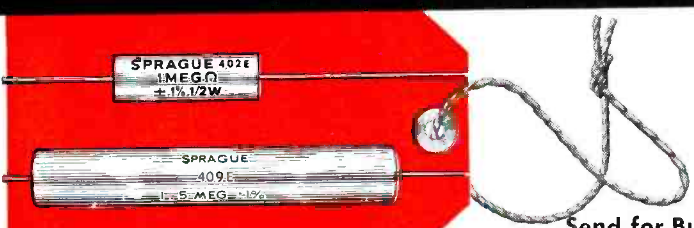

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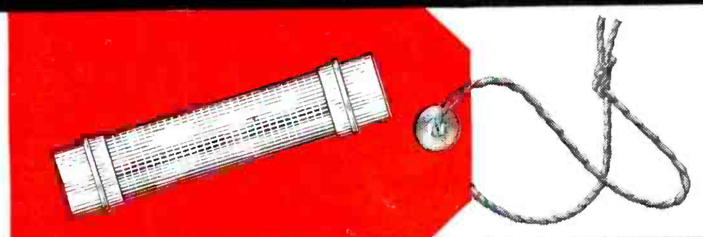

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COMMENT

Gallium Arsenide

We have been intrigued by the letter from C. G. Masters and J. E. Rathmell (Comment, p 6, Mar. 17) concerning the deterioration of gallium arsenide tunnel diodes. In the editorial comment which follows, you mention that "the gradual deterioration of gallium arsenide devices has been known for about ten months . . . "

As users of GaAs devices, we would like to know whether you could give us more specific information on the deterioration, or refer us to published material on the subject. In particular, do you know whether the same type of deterioration occurs in GaAs variable-capacitance diodes?

BRIAN J. ROBINSON
NETHERLANDS FOUNDATION FOR RADIOASTRONOMY
DWINGELOO, THE NETHERLANDS

Gallium arsenide diodes have come under critical scrutiny at several recent conferences, including the International Solid-State Circuits Conference held in Philadelphia late in February. Reports of deterioriation after prolonged service were mentioned; also reported was deterioration during periods of disuse. Manufacturers report, however, that 2,000-hour life tests at 100 C with a reverse bias of 5 v have yielded no change in characteristics. Researchers acknowledge that behavior of GaAs diodes under forward-bias conditions is not completely understood; apparently several independent mechanisms affect deterioration in tunneling characteristics. For example, in zinc-doped GaAs, the peak current decreases with age, while in cadmium-doped materials, the valley current goes up. Work is still being done to eliminate the gaps in knowledge.

Japan's Missiles

In the Apr. 7 edition, the section Electronics Newsletter (p 12), you had an item entitled "Japan Will Produce Own Air-Air Missile." The closing statement was to the effect that Japan had bought 40,000 U. S. Sidewinder missiles. Inasmuch as this was public information, would you be kind enough to inform me as to the source of this particular information? As a manufacturer of Sidewinder components, I am very much interested in your statement that 40,000 have been bought by Japan . . .

GEORGE B. MARCHEV
GORDOS CORP.
BLOOMFIELD, N. J.

To be precise, we said Japan's air defense forces "had borrowed the U. S. Sidewinder missile, of which Japan has so far bought about 40,000." The source of this information was Japan's Self-Defense Agency, one of whose spokesmen told McGraw-Hill World News on March 20 that up to the end of fiscal 1960 Japan had bought 40,000 missiles of the Sidewinder type. Not all these were necessarily produced in the U. S.

International News

As a relatively recent subscriber to ELECTRONICS, and in fact a relatively recent resident of the U. S., I have been consistently pleased by the depth and breadth of your magazine's coverage of international news in the electronics technology. One is accustomed to chauvinism in industrial journals; I have yet to detect any substantial note of chauvinism in your stories.

With the world growing smaller daily, and especially with the Free World becoming more interdependent all the time, this broad view is particularly valuable today . . .

A. E. LANDER
WASHINGTON, D. C.

We regard electronics as an international industry and do our best to serve as an international journal. By the way, watch for "Electronics in Europe," coming June 9.

Transistor Socket

In New Products for Mar. 10 (p 242), the item about Augat Bros.' narrow transistor socket should have specified that the socket fits the Clevite Spacesaver power transistor . . .

EBEN S. CHURCH
HORTON, CHURCH & GOFF
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We omitted the identifying designation Clevite. *Sorry.*

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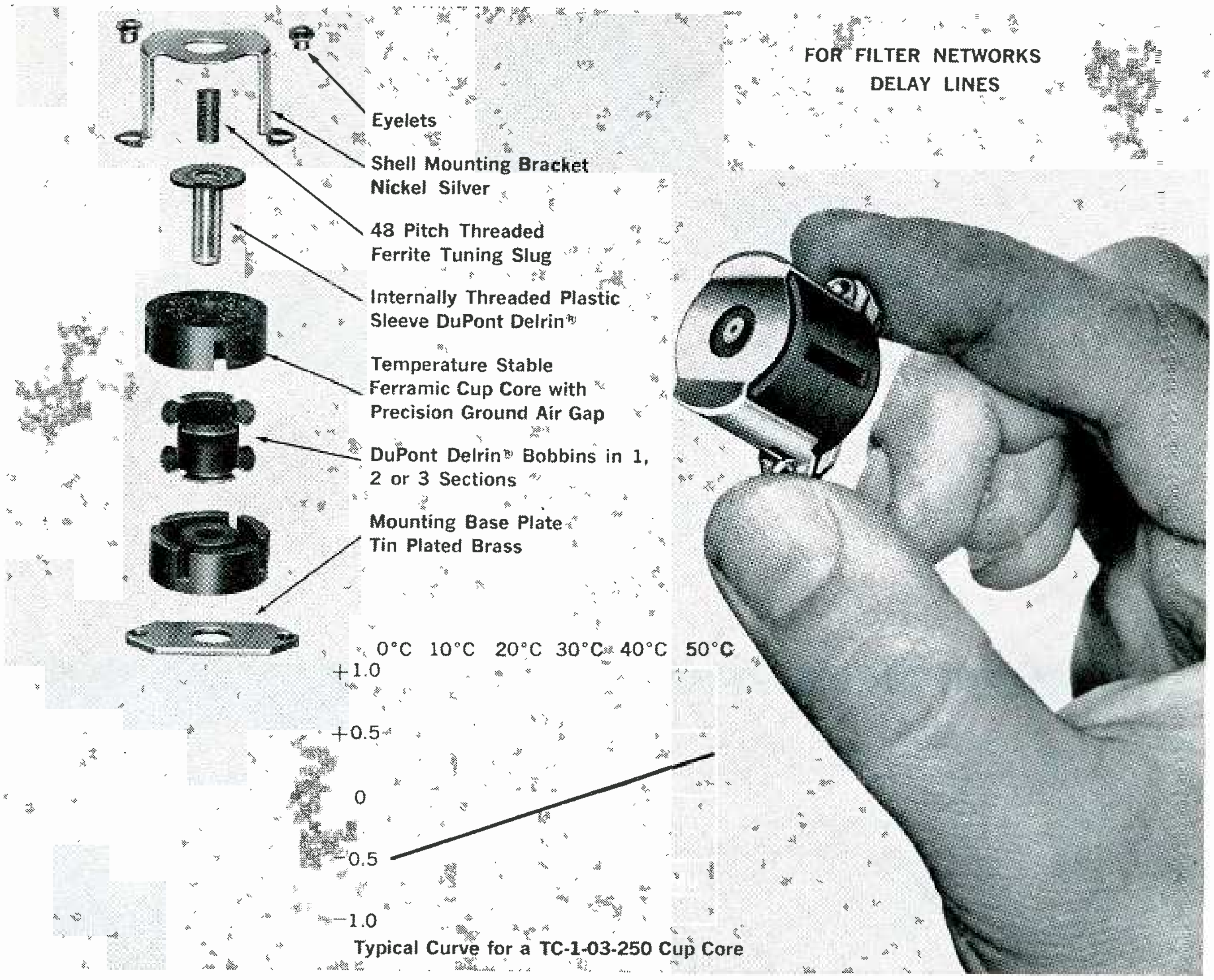

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ELECTRONICS NEWSLETTER

Beacon Speeded Astronaut Recovery

WHEN ASTRONAUT Alan B. Shepard rode his Mercury capsule 115 miles up and 320 miles downrange last Friday, the carrier *Lake Champlain* was standing by near the planned impact point to pick him up. Aiding the carrier helicopters to locate the capsule was a beacon device called Sarah (search and rescue and homing), developed by Simmonds Precision Products.

Sarah system consists of a miniature transmitter in the spacecraft and homing devices aboard the searching ships and aircraft. Transmitter was activated as the craft came down to about 10,000 ft; pulse signals were presented on crt indicators in the craft. Use of the homing device—similar to one carried by the Soviet Union's *Vostok* on its single orbit—permitted the *Champlain* pilots to pick Shepard up and get him safely aboard within half an hour after reentry.

Companies Suggest Joint Effort For Satellite Communications

TWO MAJOR electronics companies last week recommended that satellite communications systems be developed and exploited by joint private enterprise. General Electric went so far as to set up a new company, dubbed Communications Satellites Inc. General Telephone & Electronics recommended to the Federal Communications Commission that the nation's communications companies be authorized to form a single jointly-owned commercial space communications company.

The Bell System has already expressed its willingness to launch experimental communications satellites by Christmas if the National Aeronautics & Space Administration will give immediate approval of the plan.

Both GE and GT&E made their announcements in answer to an FCC request for industry comments on various regulatory and administrative problems relating to the space communications business. GT&E stressed that satellite communications requires "effective utilization of all this country's scientific, engineering and management resources in the communications common-carrier field." GE added that the flexibility and vitality of private enterprise would be reasserted if the system can be accomplished through the cooperative efforts of U. S. industry. GE sees Communications Satellites Inc. as a focal point for cooperative participation by private enterprise in a worldwide commercial satellite system under government regulation.

Former ONR Chief Takes Industry Job

RETIRING Chief of Naval Research Rawson Bennett last week joined Sangamo Electric as a senior vice president and director of engineering. Bennett, who retired from the Navy on Feb. 1, spent much of his service career in electronics. During World War II he headed the electronic design division of BuShips, also served as the principal liaison officer to the Office of Scientific Research & Development. In 1939, he designed a sonar team trainer for antisubmarine and allied work. A 1927 graduate of the Naval Academy, he also holds an M.S. in electrical engineering from the University of California.

Sangamo is a major supplier of sonar equipment and other electronic gear to the Navy.

Semiconductor Conductivity Observed to Oscillate

INVESTIGATIONS at MIT's Lincoln Laboratory are currently attempting to explain—and possibly show the way to exploit—an oscillatory phenomenon observed in germanium, silicon and indium antimonide. Effect manifests itself as an oscillating variation in the conductivity of a semiconductor sample which contains excess minority carriers and is subjected to nearly parallel d-c electric and magnetic fields.

Experimental apparatus has been built at the Lincoln Lab to measure infrared absorption of the free carriers as a function of time during the oscillations.

1960 Instrument Shipments Totaled $120 Million

BUSINESS & DEFENSE SERVICES Administration announced last week that shipments of electrical measuring instruments by U. S. manufacturers in 1960 amounted to about 3.8 million units valued at about $120 million. Military orders accounted for about a sixth of the volume and about a third of the value.

Unfilled orders at the end of the fourth quarter represented a little over 900,000 units valued at $31 million; BDSA estimates this as a production backlog of about three months.

Classification includes instruments for indicating and recording electrical quantities, including instrument relays; iron-vane, dynamometer, rectifier and thermocouple types; watthour, power-factor and phase-angle meters; self-balancing instruments, and oscillographic recorders of both galvanometer and oscilloscope types.

Miniature UHF Transmitter Withstands Space Environment

HIGH-POWER transmitter to operate in the uhf band for missile and space communications has been developed by Space Electronics, Glendale, Calif. The transmitter is housed in a cylinder 13 in. long and 4½ in. in diameter. Company rates the unit as having an output power of 1 to 2 Kw at a frequency of 200 to 400 Mc, says it can operate continuously at temperatures up to 500 F.

Heat generated in the transmitter's environment is conducted away from sensitive electronic elements to a heat-dissipating medium where it is disposed of by ablation or evaporation. Transmitter structure is highly conductive thermally. Special ceramic dielectrics having high thermal conductivity and low r-f loss are used in the cavities. Concentric cavity-nesting technique gives the unit its necessary mechanical strength while reducing the overall dimensions. Transmitter is virtually solid, and ceramic components are under purely compressive stress.

Radio-frequencies circuits are broadbanded for operation over a 10-Mc frequency range around a center frequency selected by replaceable oscillator crystals.

Soviets Track Satellites With Seventy Stations

VICE CHAIRMAN of the Soviet Academy's astronomical council, A. Masevitch, reported recently that there were 70 satellite tracking stations in the Soviet Union alone, and many in other countries. Masevitch made the statement as part of a report recently on progress thus far in setting up a Soviet tracking network.

The academician said that up until January the USSR's computing center had received data from over 90,000 observations including 37,000 made in 35 foreign countries. He added that Hungarian scientists have developed a simple but efficient computer to process tracking data; three of the computers have been presented as gifts to the astronomical council.

Air Force Develops Blood-Pressure Monitor

AIR FORCE has developed a device which automatically monitors diastolic and systolic blood pressures and provides an electrical signal that can be automatically recorded or telemetered. The portable instrument uses transistor logic to perform its program functions, weighs 35 lb exclusive of recorder or telemeter. Range of operation is between 100 and 200 mm of mercury; measurement can be repeated at intervals varying from one to 15 minutes.

Wright Air Development Division, which developed the automatic monitor, also announced the successful design of a chronic brain polarographic implant unit capable of detecting small changes in availability of cerebral oxygen. The unit is surgically implanted in the skull of an experimental animal; report states that reproducible data can be obtained within 5 days of postsurgical recovery.

USAF Steps Up Experiments In Atmospheric Ducting

PROPAGATION EXPERIMENTS using ducts in the atmosphere over the ocean are being stepped up by Air Force's Cambridge Research Labs. The ducting phenomenon was first observed a couple of years ago, is caused by temperature inversion layers at about 5,000 ft altitude and centered at about 30 deg north and south latitude.

Recent experiment beamed a 425-Mc radar signal eastward from a station on Trinidad. The signal was coupled into the duct, produced strong returns from the Canary Islands, the coast of Africa, and the Atlas Mountains in northern Africa; the mountains are some 3,900 miles from Trinidad.

Electronic Ignition Fires At One Kilocycle

BRITISH automobile subsystems supplier Joseph Lucas Ltd. recently introduced an electronic ignition system capable of producing sparks at the rate of 1,000 per second, equivalent to an 8-cylinder engine speed of 15,000 rpm. A transistor is used in the Lucas development to release current to a high-voltage transformer. Outputs up to 20 Kv can be produced. Ignition system is presently intended for racing-car engines.

Navy Contracts Favor Sub Defense

RECENT CONTRACTS awarded by the Navy show the continuing emphasis on antisubmarine defense.

Control Data Corp. last week announced the receipt of an order for eight digital geoballistic computers to go into the Polaris' Mk 84 fire-control system; value of the production contract is in excess of $4 million. CDC built the functional prototype of the geoballistic computer under a previous prime development contract from BuWeaps for $5 million. Computer receives position data from ship's inertial navigation system (SINS), calculates trajectories to assigned targets until the missiles are fired, at which time the missile's guidance system takes over.

Another contract, for long-range basic research in undersea noise, was awarded to Electro Nuclear Systems Corp. of Minneapolis. Contract is from Office of Naval Research for an undisclosed amount.

Encoding Keyboard Uses Optical Techniques

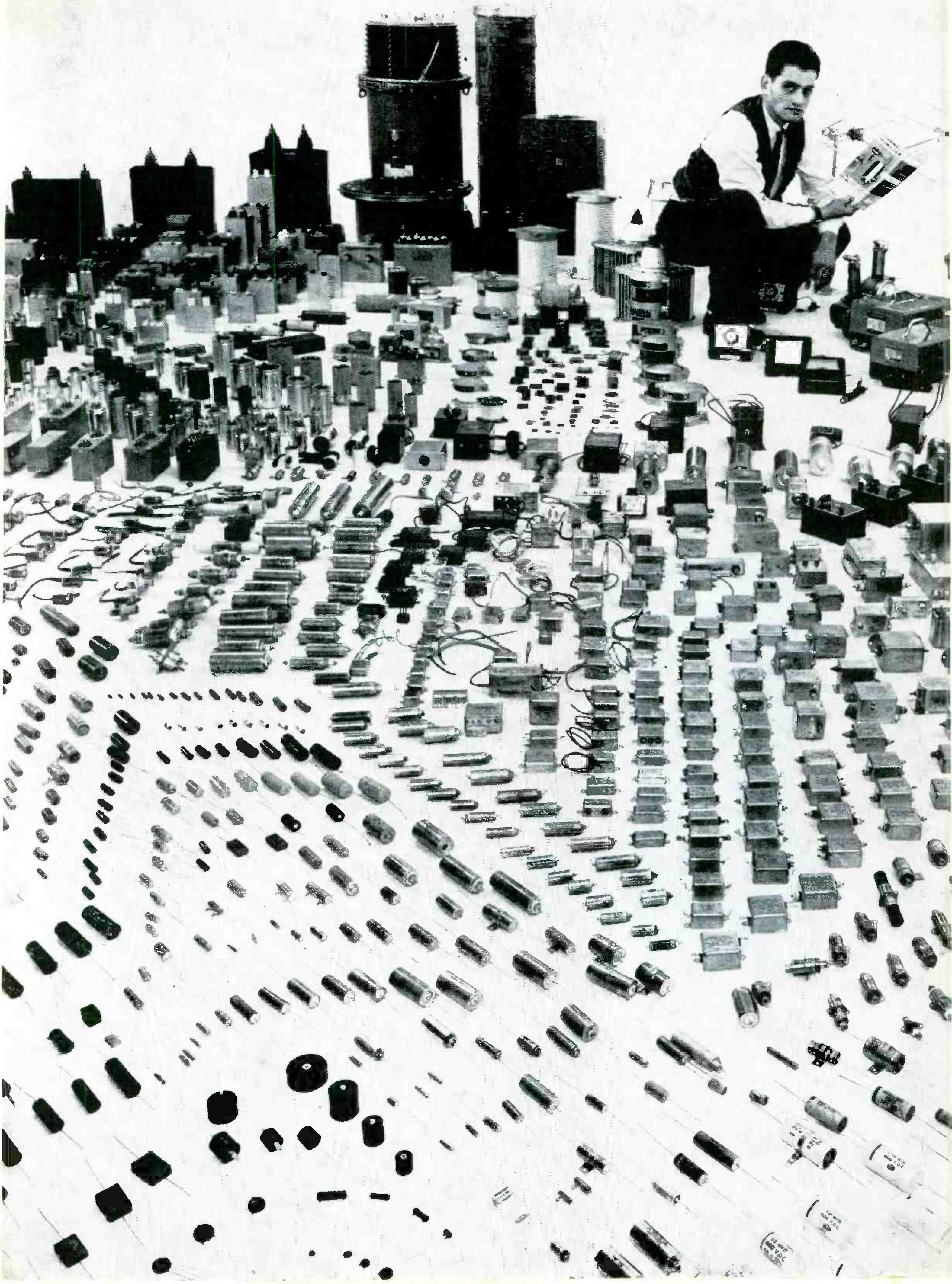
PHOTOELECTRIC binary-encoding keyboard for use with data-processing peripheral gear was announced last week by Invac Corp., Natick, Mass. The keyboard can put out standard or special 5, 6, 7 or 8-bit binary codes.

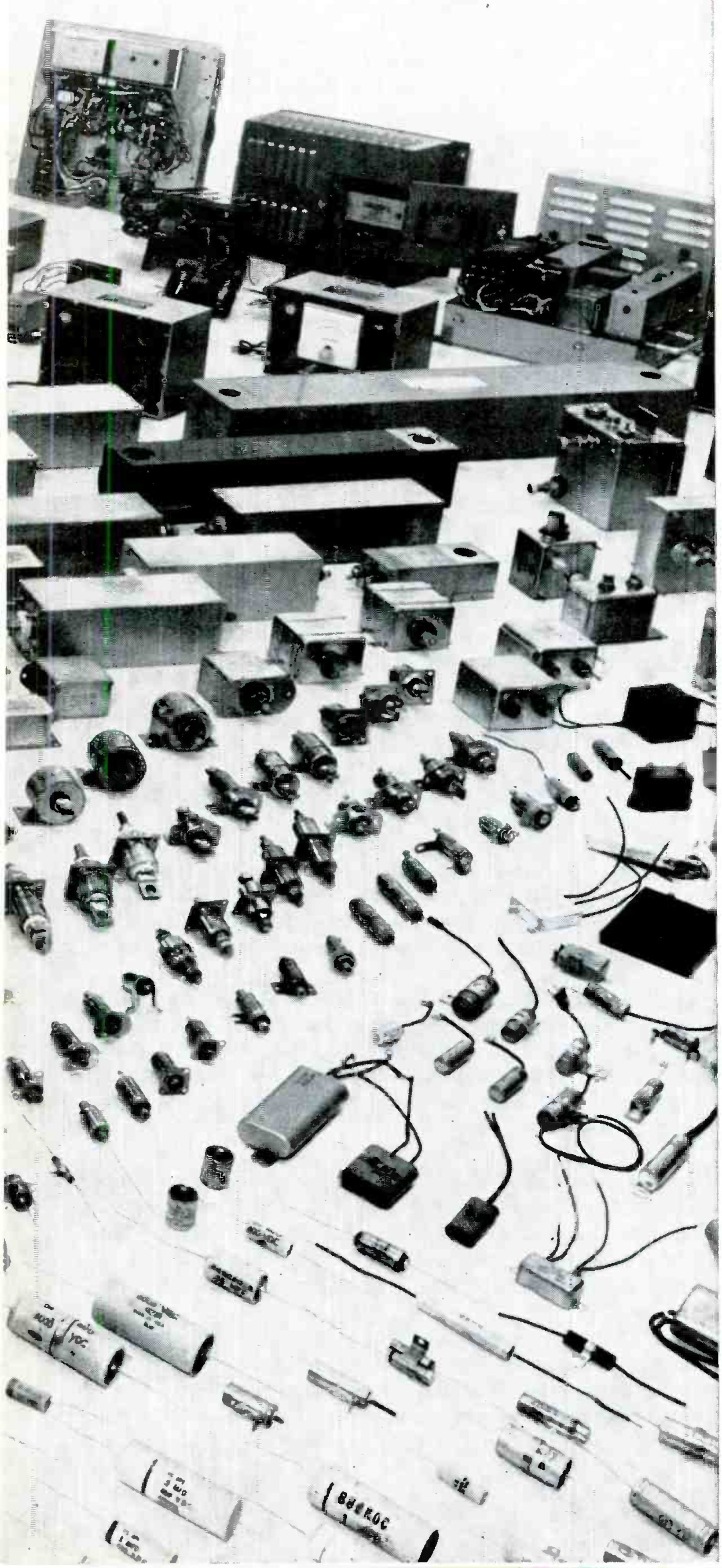
When a key is pushed, a binary-coded shutter modulates a bank of light-data channels; the coded signal bears on a bank of photoconductors which produces the required electrical signals. Amplifiers are optional. Standard 44-key alphanumeric keyboard can be used for dual logic (upper case can mean something different from lower case). Keyboard with amplifiers sells for $550.

FCC Reorganization Seeks Work Speedup

REORGANIZATION of the Federal Communications Commission proposed by the Kennedy administration is designed to speed the FCC's work and reduce the lag in handling cases.

The speedup would be accomplished by permitting the agency to hear cases before panels of commissioners, individual commissioners, hearing examiners, or other employees. The Commission would have the right, with some exceptions, to declare FCC actions final, court recourse for losers.





WASHINGTON OUTLOOK

MORE CENTRAL CONTROL over weapons research and development is being tried in the Pentagon. By overhauling the Defense Dept.'s massive budget-making procedures, Secretary McNamara hopes to have a stronger hand in deciding what weapons and what service will be charged with strategic and tactical roles and missions.

Short-term, between now and Oct. 1, the policy is aimed at deciding what weapons are best. Thus, the Air Force Minuteman, now in development stage, will be pitted against the Navy's Polaris, already in production, to see which one will be relied upon as a mobile, solid-fueled ballistic missile.

Or, the Army's Pershing missile will be pitted against the Air Force's advanced fighter-bomber, and then a decision made as to which should get that tactical chore.

There will be sharper competition among weapons systems, and an early showdown in the three services as to which will win a role for either limited or deterrent missions.

Long-term, what McNamara and his comptroller, Charles J. Hitch, are attempting to arrive at is a consistent and steady spending figure for years to come, and to award money to the Army, Navy and Air Force on a basis of what function each has, rather than on an eenie-meenie-miney-mo system.

These officials claim the savings on "marginal" projects will be so substantial that more funds should be available for higher-priority arms and equipment.

The impact, for industry, will be more in terms of stability. Once an R&D or production project is approved with a specific schedule, it will now be less likely that major changes will be made in the future, barring unforeseen technological developments.

Incidentally, the outlook is for a continuing rise in defense spending in the years ahead. In fiscal 1962, which starts July 1, spending is estimated at $43.8-billion, up $1.3-billion over the current rate.

THE ADMINISTRATION'S tax credit plan to stimulate investment in new plant and equipment is getting more knocks from congressmen and business groups than praise.

After reviewing all of Kennedy's programs to speed recovery and the country's long-term economic growth, the Democrats on the Joint Economic Committee of Congress are doubtful about the tax credit idea. They say the tax credit (which would reduce business taxes by $1.7-billion a year geared to spending on new plant and equipment), might provide "relatively little stimulus in investment unless consumer demand is stimulated." Their thought: a tax cut for individuals might do more good.

Secretary of the Treasury Dillon gave some details on the tax credit plan: companies would be permitted to carry forward unused tax credits for 5 years (to help out companies whose spending fluctuates); but to prevent bunching of expenditures to get the maximum tax credit, below-depreciation spending in a given year would be charged against the depreciation base in future years.

ANOTHER EFFORT is being made in Congress to help self-employed professional men set up their own retirement program. The legislation, sponsored by Rep. Eugene Keogh (D.-N.Y.), would give an income tax deduction to a taxpayer who set up a retirement program acceptable to the Internal Revenue Service. There would be a limit of $2,500 a year deduction.

But it will take presidential backing before it gets through Congress. Many professional organizations are supporting the measure, but the White House is inclined to put the legislation over until next year when the administration intends to try an overhaul of the personal income tax laws.

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Use of a photoelectric chopper instead of a mechanical vibrator, insuring low noise and drift. Protection against 1,000 volt momentary overloads. Probe minimizing thermocouple and triboelectric effects. Heavy ac filtering.

Above are but a few of the reasons why the hp 425A does the work of complex equipment arrays faster, more simply and with 10 times previous accuracy.

In addition to extremely small voltages and currents, Model 425A measures resistances from milliohms to 10 megmegohms, in conjunction with an external constant current.

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SPECIFICATIONS

MICROVOLT-AMPLIFIER

Voltages: Pos. and neg. 10 μv to 1 v end scale. 11 ranges, 1-3-10 sequence.

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PRICE: hp 425A, $500.00 (cabinet); hp 425AR, $505.00 (rack mount).

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These small, transistorized receivers are available today for the U, L, S, C, X and P bands, with similar models soon to be available in these ranges: 18-26.5 KMC, 26.5-40 KMC. Battery-operated cabinet models also available on special order for portable field use.

Receivers for all frequency bands are identical except for tuning cavity and dial. The DRO-4A display unit designed for use with the receiver can be used with all models, is packaged separately for maximum flexibility. Only one interconnecting video cable is required.

SPECIFICATIONS

Frequency Ranges:	Model RCU-1: 400 MC-1 KMC Model RCL-1: 1-2 KMC Model RCS-1A: 2-4 KMC Model RCJ-1: 4-8 KMC Model RCX-1: 8-12.4 KMC Model RCP-1: 12.4-18 KMC
Sensitivity:	-40 dbm minimum
Selectivity:	1% at 3 db (maximum)
Video Bandwidth:	4 MC
Dial Accuracy:	1%
Weight:	Receiver, 15 lbs.; display, 30 lbs.
Size:	Receiver, 3½" x 15" x 19"; display, 7" x 15" x 19"
Sync sweep speed:	10, 100, 10,000 μsec
Price:	$900.00 (add $150 for model RCX-1 or Model RCP-1) DRO-4A Display Unit, $900.00

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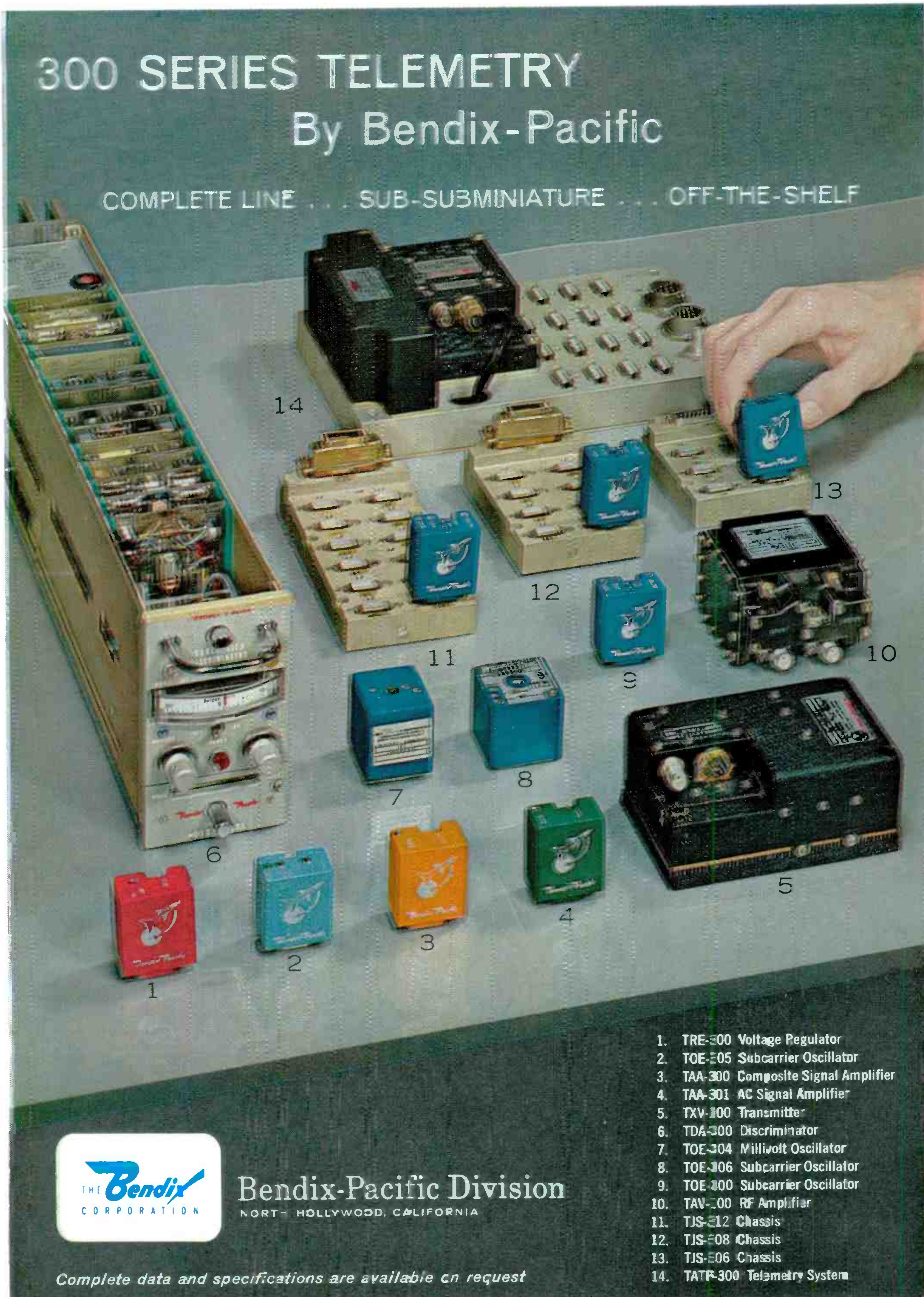
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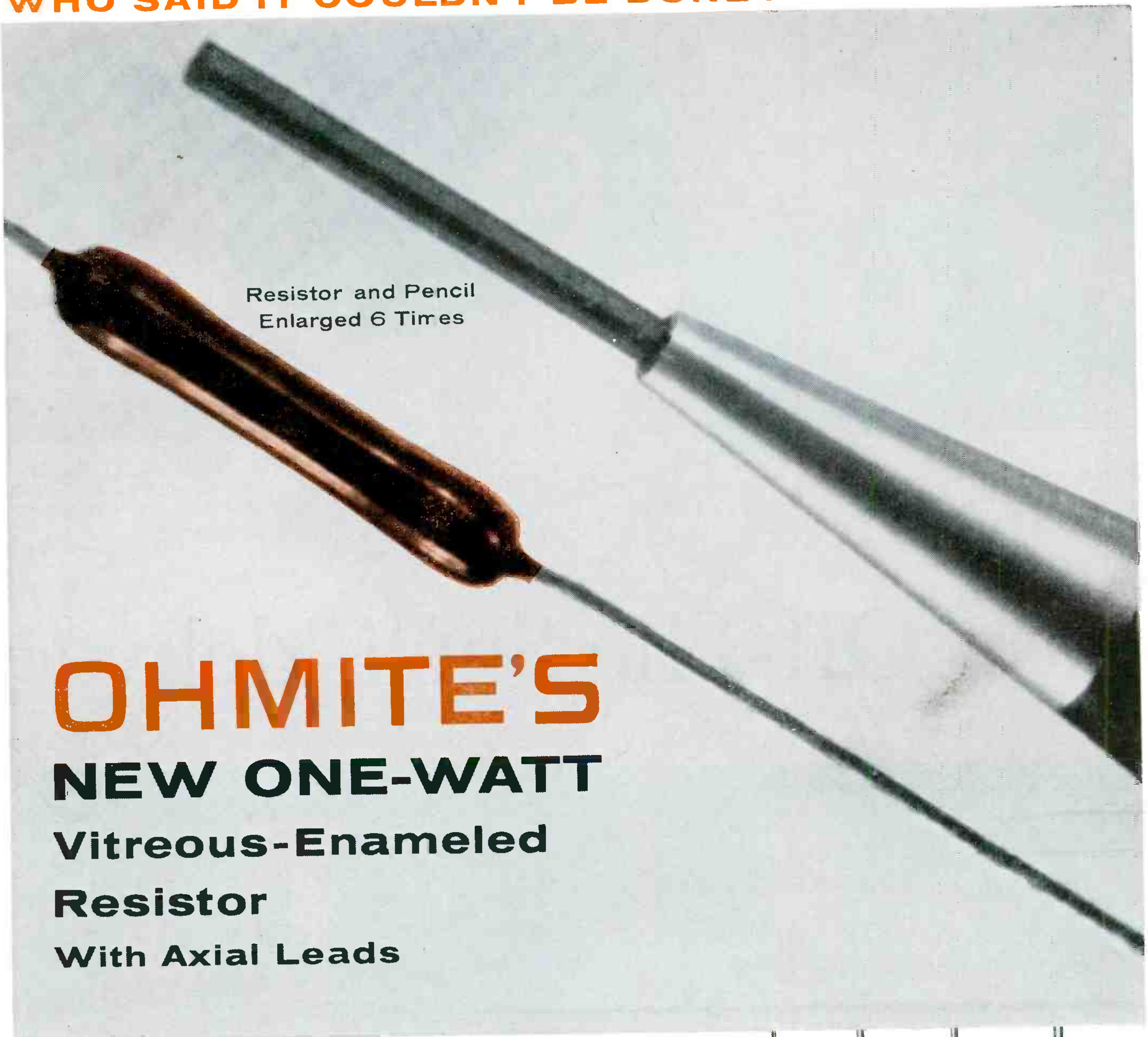
WHO SAID IT COULDN'T BE DONE?



Lots of people thought this tiny "1-watter" was impossible. But here it is. And for the first time in this power rating, circuit designers can get all the advantages of a wire-wound, vitreous-enameled resistor with axial leads—high temperature operation, up to 350°C; ±5% tolerance; low temperature coefficient; low "noise" level; stability; and strong, welded construction.

Construction is the same as Ohmite's 3, 5, and 10-watt sizes—including ceramic core, uniform winding, tough Ohmite vitreous enamel coating, and traditional Ohmite reliability.

Resistance values range from 1 to 6000 ohms. But you can find out all about this *exclusive* Ohmite development by writing for *Bulletin 147F. Do it now!*

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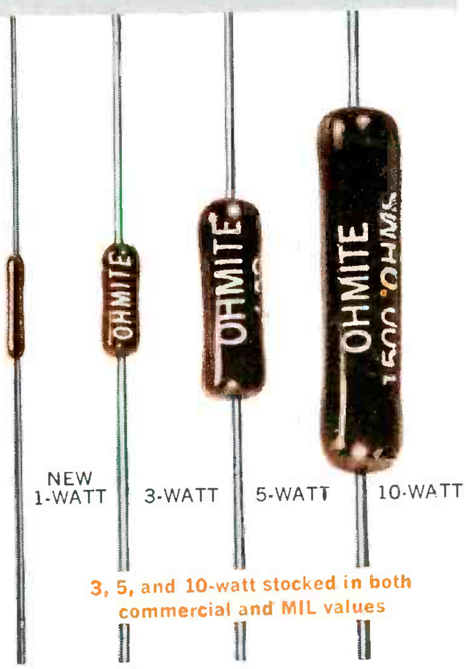

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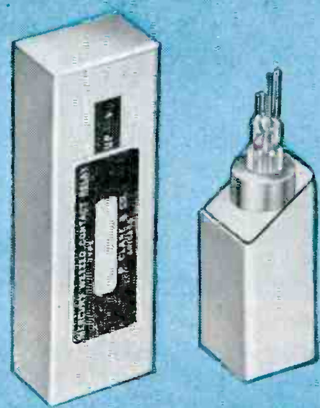

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...mercury-wetted contact relay modules for mounting on your own printed circuit board

Type HGM relay module (left) with cut-away (right) showing mercury-wetted switch capsule and coil potted in steel enclosure.

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A compact telephone type relay of unequaled long life and superior performance.

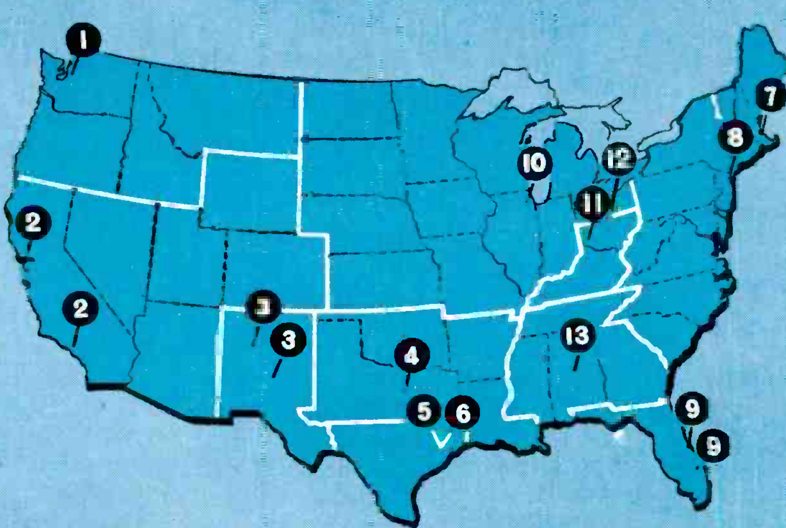
A highly reliable switching device for single or multiple circuit control . . . wide mounting versatility.

Single or multiple switch capsules potted in steel container. Gives billions of operations with no maintenance.

A crystal can relay with unusual flexibility and a variety of mounting styles.

# of top-quality Clare relays

From these distributors



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Relays and related control components

CIRCLE 21 ON READER SERVICE CARD

Distributors' Volume to Double by '65

CHICAGO—Fiercely-competitive electronic parts distributing business has yet to persuade its participants to reveal figures necessary for assembly of detailed statistics, charts and graphs. Best estimates set $1.2 billion as distributors' total share of $3 billion worth of parts sold during 1959.

Distributors' business was $1.55 billion during 1960 and total sold by them is expected to reach at least $2.3 billion by 1965, according to management of the Parts Show here week after next.

Industry has come a long way from 1937 beginnings of Chicago show when 20 to 30 distributors were earning a few thousand dollars a year handling parts for hams and experimenters.

Receiving tube renewal volume alone has grown from 27 million units, year the show started, to 171 million in 1959, accounting for nearly half of $369 million total receiving tube volume in the most recent year for which industry figures are available. Distributor transistor volume jumped from $130,000 in 1954 to more than $24 million in 1959.

Many of today's nearly 3,000 distributors earn several million dollars annually, with additional volume expected to follow widespread move into industrial electronic parts.

Newest trend has manufacturers setting up from 25 to 250 new, bigger and better financed distributor organizations. Capable of assuming heavier inventory and sales responsibilities, these outlets offer standard components in industrial quantities at factory prices for immediate delivery, plus special pricing structures for quantities as high as 5,000 units. Geographically closer to users, they can provide faster prepaid delivery than air shipments from the factory itself.

Exclusive franchises are a growing trend among electronics manufacturers who arrange to stock distributors and then follow up with training and equipment to help their people sell.

Fantastically snowballing variety and volume of parts in recent years is leading many manufacturers to conduct sales training programs to help distributor staffs follow-through with customers preconditioned by advertising.

Recent boost in industrial electronic parts distribution results from increasing number of applications for variety of new components and equipments.

New industrial applications for electronic equipment will continue to increase. So will types of products and number of customers—but not necessarily the number of distributors.

Here's what executives in the electronic parts distribution business see ahead:

Mergers and acquisitions will result in emergence of large, well managed, well staffed and well financed industrial distributors.

Big industrial distributors of future won't have space to duplicate several complex lines in depth, so they'll be selective. Staffs will be better trained in specialized product knowledge, so they'll have to be better paid, another factor which will call for stronger financial backing of distributors for the future.

British Manufacturers Cut Television Prices

LONDON—British television receiver retailers are experiencing a slump in buying, according to English sources. The slump was emphasized recently by price reductions of about 25 percent for 17- and 21-inch sets.

General Electric Co., Ltd. cut its 21-inch models from $255.78 to $209.74; 17-inch sets from $185.22 to $144.06. The company's 17-inch portable, $173.46, was dropped to $161.70.

Because of credit restrictions and heavy purchase taxes, stock has been piling up in shops and factories, and British observers report widespread distress selling for several months. Trade circles feel

PARTS SHOW

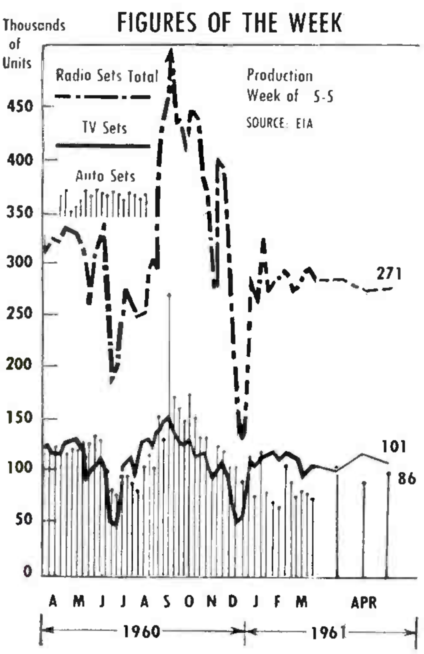
price cutting is partly aimed at clearing the way for 19- and 23-inch sets.

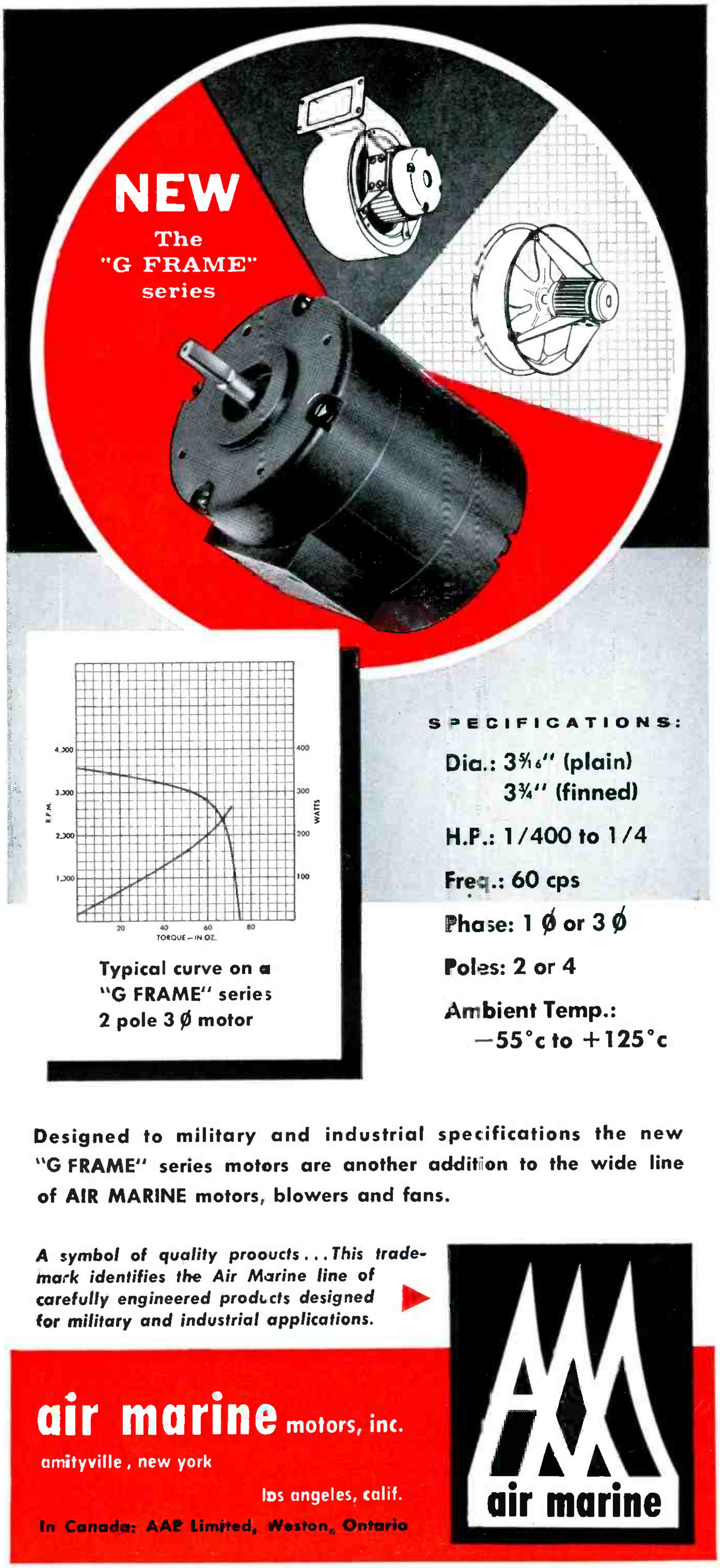
Although factory inventories have dropped slightly from the one million unit level of last year, manufacturers are prepared for the possibility of production cuts later this year.

Transistor Sales Rise One Million Units

TRANSISTOR SALES in February gained by more than one million units and $2.7 million over totals for January this year, according to Electronic Industries Association.

February sales for units sold at factories were 13,270,428 valued at $25,699,625. The month before, 12,183,931 units worth $22,955,167 were sold. During the first two months of this year, total transistor sales were 25,454,359 compared with 19,134,292 sold during the same period in 1960. Revenue from sales during 1961's January-February period was $48,654,792 as against $49,546,150 during the two-month period last year.





CIRCLE 23 ON READER SERVICE CARD

EASTWOOD

EUROPEANS

JACOBAEUS

de FERRANTI

Three significant statements to ELECTRONICS' *editor MacDonald, now back in New York and hard at work writing a special report about "Electronics in Europe" for our June 9th issue:*

By E. EASTWOOD
Marconi's Wireless Telegraph Company, Ltd.
Great Baddow, England

THE AIRSPACE above the British Isles is one and indivisible. All aircraft, whether military or civil, wish to have the freedom of this airspace in order to operate at maximum efficiency, but this freedom can only be achieved if the principle of control is accepted by all users.

It has been Air Traffic Control philosophy hitherto that any aircraft may use the airspace and is free to choose whether it will cooperate with the A. T. C. system. This attitude is clearly impossible in the era of high air traffic density into which we have now entered.

The modern jet airliner has overridden the boundary that has been assumed to exist between civil and military traffic, so that the only real distinction that can now be drawn is between the needs of a generalized military and civil traffic control system on the one hand and the requirement for the active phase of air defense on the other.

In order to exercise control it is necessary that ground controllers have complete knowledge of the content of the airspace. This essential information cannot be derived from procedural sources alone but must be obtained from a radar system capable of surveying the whole airspace at all altitudes, unaffected by precipitation echoes and ground returns. Such a system would demand judicious deployment of a number of radars operating at different frequencies, the information from this network being transmitted to a central station where the positional data on aircraft could be correlated with the supplementary procedural information being fed into the system from the traffic side.

Such a library of processed information, which could be the content of an electronic store, would be available to all users of the airspace, i.e. those responsible for civil flights, those responsible for the movements of military aircraft and, finally, to the defense authorities who would be responsible at all times for deciding whether the airspace contained aircraft of unknown origin whose presence constituted a threat to the safety of the country.

According to this view it is inevitable that ground radar shall cease to be regarded as a mere navigational aid for use in the terminal area only; it is necessary that it be seen for what it is—the only possible monitor over the complete airspace.

By CHRISTIAN JACOBAEUS
L. M. Ericsson Telephone Co.
Stockholm, Sweden

THE PRINCIPAL product of the electronics industry is brain work. The articles it produces are being increasingly perfected in their functions while being constantly reduced in size.

Hardware in the sense of product volume and product weight is being eliminated as far as possible. The capital equipment of the electronics industry is often on quite a modest scale, counted per employee, especially as only in exceptional cases are production series of any considerable length. A very large part of the cost of advanced products lies in research and development.

This trend has been accentuated in recent years, not only directly through developments in technique, but also indirectly through the shortage of engineers, which has forced up the levels of salaries. How, then, should one get to grips with the problem?

LOOK INTO THE FUTURE

Manufacturers can to some extent train selected members of their staffs, but the main contribution to the engineer cadres must come from educational institutes. What manufacturers can do is to rationalize their engineering work.

There are many possibilities in this respect, most of which are well known to those in charge of engineering organizations. I shall here deal with only one of them, which might be called "the advanced use of computers".

In the telecommunications industry we now use computers almost as a matter of routine for a multitude of problems. The best known use perhaps is for filter computation.

Another application is for switch and circuit provision in telephone plants.

Two methods are available for this purpose, a direct computing method based on mathematical expressions, and a simulating method based on simulation of the interplay between the different parts of a plant.

For electronic exchanges it has been possible to study in advance the function of the logic circuits by running a corresponding program in a computer. Likewise it has been possible to simulate alternative structures of transmission systems. All the data involved in these procedures are of an analytical character.

We hope that in future we shall be able to solve problems involving the essential elements of synthesis.

In other words, we hope to be able to inject primary data, and possibly a general principle for the solution, after which the computer would deliver an optimal solution in the desired respect. This would presumably have to be done by means of a learning process. The computer would initially present solutions to problems, and the solutions would be criticized by the technicians.

The computer can then be informed of the criticism and adjust its actions accordingly. The solution must be presented in a form which permits the simple derivation of production documents, for example in the form of a tape which can be used for the direct control of a wiring machine.

For a large number of logic circuits with relays or solid state components this should be possible without too great a development effort. Solutions would probably be attainable for other circuits as well, such as oscillators and amplifiers.

Development on these lines requires intimate cooperation between the engineers and the mathematicians.

Computer technique can be of valuable assistance, too, and in the long run indispensable, in an entirely different field, the field of patents. At present no patents office in the world can be expected to make a reliable examination of inventions in electronics. This is because it has obviously not been possible to arrange and cross-reference the vast amount of new material that exists.

If a computer could be acquired for storage of references to earlier patents, publications, constructions, etc., an efficient examination of patents would be possible. If done on an international basis, a mass of duplicated work by highly qualified patents engineers could be avoided.

By BASIL Z. de FERRANTI
Ferranti, Ltd.
London, England

A FUNDAMENTAL LAW is emerging in the computing field, namely that the power of usefulness of a computer increases as the cube of its cost.

Thus the future of computing may well be with large central machines using small satellite computers on the customer's premises and high speed data links for communication. However a "communications barrier" is now evident.

If a breakthrough can be achieved here comparable to the breakthrough in power distribution, due to the use of high voltage alternating current the whole shape of the computer business will be radically altered.

Can Radar Tell Difference Between Hail and Rain?

UNIVERSITY OF ARIZONA scientists are now completing basic studies needed for developing better radar techniques to differentiate between rain and hail storms.

The work is being done by Benjamin M. Herman and Louis J. Batten of the university's department of meteorology and climatology. Discoveries so far indicate that, contrary to general belief, hailstones may reflect many times more energy than equivalent-size raindrops provided the radar wavelength is larger than the particle size—if the wavelength is smaller the reverse is true. Also, use of two or more different wavelengths of radar to produce variations in reflectivity makes it possible to determine both presence—and size—of hail.

Microwave Network To Control Pipeline

TRANSISTORIZED microwave control system now being constructed in Texas will handle Magnolia Pipeline Company's 540-mile oil transmission network.

The control system will be operative by January 1962 and manage the flow of 235,000 barrels a day.

Nearing completion are 12 microwave relay towers and stations along a 335-mile segment of the pipeline. The system was built by Dresser Electronics, Inc.

New Distribution Patterns to Dominate Parts Show

Servicing the industrial market is seen as a big challenge to the parts distributor and an opportunity for vastly increased business. Back-to-school sessions scheduled outside of show hours will bring distributors up to date on technology and business

PARTS SHOW

By CLETUS M. WILEY, Midwestern Editor

One of the exhibit halls at last year's Parts Show.

CHICAGO—Widespread distributor penetration of the industrial electronics market during the past few months will bring a major expansion to the 24-year-old Electronic Parts Distributors Show here week after next (May 22-24). A new industrial conference section will take over an additional half of the seventh floor of the Conrad Hilton Hotel where the show will have its headquarters.

Rarely thought of as a new products show—leaving most components to be introduced through OEM channels—the Parts Show pulls a switch this year, documenting its "What's New" theme with brand new stereo f-m broadcast adapters, tuners and receiving compenents, nuvistor-equipped preamplifiers, radio controls for a wide range of industrial applications, a sound-isolated two-way portable radio network, a self-powered, self-contained public-address system and even a so-called sidearm screwdriver.

More than 300 exhibitors bought out all available space even earlier than last year in two basement halls of the Hilton Hotel, plus fifth and sixth floor display areas. Half of latter space has been allocated to audio and hi-fi manufacturers. Total of 12,500 manufacturers and distributor reps are expected to attend this month's show.

Special seventh floor addition will bring together distributors and manufacturers who have recently been setting up new distributor networks to serve industrial customers faster and better than the manufacturer can himself.

Trend away from factory-to-factory selling and toward giving industrial electronics distributor a more important role is rapidly spreading and seen as the pattern of the future.

Distributors handled only two to three percent of the industrial electronics market 15 years ago, according to Sam Poncher, head of his own Newark Electronics company and president of the Electronic Industry Show Corporation which runs the show.

"Industrial electronics market is now expanding at a far greater pace than any other segment of this growth industry," Poncher says. Changes accelerated during the past year are expected to boost growth 20 to 25 percent a year, increase electronic parts business 10 times in next 10 years and eventually bring over over 75 to 90 percent of the industrial parts market to distributors, he believes.

Back-to-school movement is the "most significant technical and business trend in the electronics parts business today," says Kenneth C. Prince, general manager of the show which is also sponsored by the Association of Electronic Parts and Equipment Manufacturers, Inc., Electronic Industries Association, Producers of Associated Components for Electronics, Western Electronics Manufacturers Association and National Electronic Distributors Association.

"We're all going back to school to fill in the gaps in the knowledge we need to keep up with this fast-moving technology," Prince said in outlining management and sales seminars scheduled at nonconflicting hours to bracket both ends of 9:00 a.m. to 6:00 p.m. exhibition periods all three days of the show.

"Manufacturers and distributors are both increasingly aware of the need for updating their product and business administration knowledge," he says.

Scene will be repeated week after next

Distributor workshop seminars, billed as one of the most ambitious self education attempts ever made by an industry, will be new in timing, format and subject matter. Nonconflicting schedule has been designed to permit managerial personnel to attend both workshops.

Management seminar will cover inventory management, personnel management, profit management, effective communications and product information.

Sales seminar will include sessions on catalog sheets, brochures and uses, selling specific products, account development and opening new accounts.

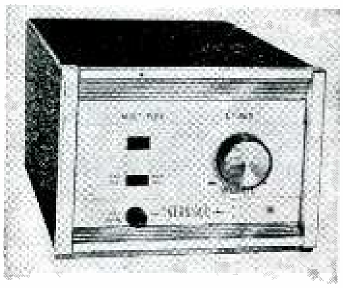
Common problem areas will be analyzed by professional staff and informally discussed by small, noncompetitive groups at tables, summarized and then reinforced with take-home materials.

Wider use of standardized parts to save inventory, space and backup is seen as a third major and growing trend within the parts industry.

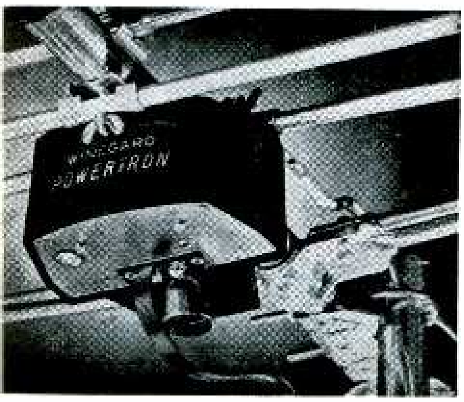
Broad range of parts to be shown offers sufficient versatility for most designs without added expense of short component runs for special designs, distributors say.

Soundproof two-way radio by Globe Electronics gets workout from air-hammer operator

PARTS SHOW



Three-tube f-m stereo adapters by Sherwood Electronic Labs



Tv antenna by Winegard has built-in frame-grid amplifier

STEREO F-M Among NEW PRODUCTS

Other new items at Parts Show include soundproof helmet transmitter-receiver, tv antenna with built-in preamplifier, barium-ferrite loudspeaker that fits in wall

CHICAGO—Timely items in the new products section of the Electronic Parts Distributors Show week after next will be stereo broadcast receivers and adapters of type being introduced by Sherwood Electronic Labs of Chicago.

Starting with three-tube plug-in adapter, line includes a self-powered unit at $59.50, combination adapter and f-m tuners for stereo-phono combinations and an 18-tube, 30-watt dual receiver, priced at $299.50—all offered for delivery before the June 1 date set for beginning f-m stereo broadcasts.

A soundproof earphone-mouthpiece combination containing a seven-transistor two-way radio for use chiefly in high-noise level operation, such as around jet planes, oil fields, foundries and auto race-tracks, will be introduced by Globe Electronics division of Textron, Council Bluffs, Iowa.

Glycerine-filled rubber pads cover the ears. Right earpiece contains receiver circuit; the left, rechargeable batteries. Mouthpiece houses transmitter and audio control.

Globe will also introduce an accessory device to provide selective calling on citizen band and commercial two-way radios. The calling device activates the radio unit only when individual using unit is being called.

Television antennas with a built-in electronic tube will be introduced by Winegard Company, Burlington, Iowa. Each of three models has amplifier with 6DJ8 frame-grid tube mounted directly on antenna boom and coupled to driven elements to amplify signals before any line loss occurs. Voltage gains range from 5 to 9. The antenna may be used to amplify signals to a single tv set or to as many as 10 antenna plug-in outlets.

Low-noise, high-gain nuvistors will be featured in new series of preamplifiers covering amateur bands from 3½ Mc to 220 Mc being introduced by American Electronics, Mineola, L. I. The company will also introduce a compact transmitter for 6 through 80-meter phone and c-w service: it's capable of handling 90 watts.

A radio-control system adaptable for opening and closing gates, controlling traffic lights, fork-lift trucks or operating cemetery chimes will be introduced by Perma-Power, Chicago. Company is also planning to unveil a transistor garage-door operator.

Sidearm screwdriver that converts a conventional screwdriver into a high-torque tool will be introduced by Vaco Products, Chicago. The handle flops over at right angles to the blade.

Public-address speakers using barium-ferrite ceramic magnets to permit highly efficient shallow loudspeakers that may be mounted between wall studs of a house will be introduced by Quam-Nicholas Company, Chicago.

More than 300 exhibitors will show new products ranging from such basic components as cables, transformers, switches, relays, transistors; through microphones, headsets, testers and loudspeaker baffles to citizens band gear, transceivers, hi-fi systems and transistor tv cameras.

Stripfilm picture and optically recorded sound track message (inset) are projected and reproduced in synchronism by Kalart Co. still projector

Still Projector Syncs Optical Sound Track

OPTICALLY RECORDED sound messages are scanned and reproduced in synchronism with the projection of an accompanying picture in a 35-mm stripfilm projector that has been developed by Kalart Co., Plainville, Conn.

Variable density recorded sound messages and pictures are arranged alternately on standard 35-mm motion picture film. As each image is projected on a screen, the related sound message is scanned by a photocell system, and reproduced by the built-in amplifier and speaker.

Each frame is advanced automatically once the operator has threaded the machine, centered and focused the first image and set the sound volume level.

The machine handles the new sound-on-filmstrip programs, as well as standard silent filmstrips and slides.

Picture frame and related sound frame size are each 24 × 36mm. While the picture is in position for projection by the five inch, f3.5 lens, the adjoining sound frame is in curved contact with a scanning head cylinder that contains a rotating scanner using four light beams. The multiple beams are produced optically from a single 60 cycle heated exciter lamp.

The four beams serially illuminate a 90 degree segment of the scanning head which contact the complete sound recording area. The beams move vertically as they rotate, passing from one horizontal sound track line to the next. A gas filled photocell picks up the modulated light, and provides input to the amplifier.

A 120 cycle filter in the amplifier eliminates hum caused by a-c heating of the lamp, which causes peaks of light at half cycles of maximum current. Power output is 3 watts maximum, total harmonic distortion 5 percent, frequency response 80 cps to 8 Kc.

As the end of each sound track is reached, a mechanical sensor encounters a notch cut in the film strip's edge, placed to allow a short delay, then advance to the next frame. A maximum message time of 18 seconds can be recorded.

Controls are provided to hold a frame for discussion, repeat of a picture, rapid advance and reverse.

The company will process sound from magnetic tape or disc, along with picture negatives, to produce combined programs.

New System Stores, Sends Space Images

DALLAS—Space vehicles will be able to obtain and transmit back to earth clear, detailed photographic images of the moon and the planets, as well as smaller objects in space, even in extremely dim light, by means of a system called ISTAR (Image Storage Translation and Reproduction).

The new concept was announced today by the Astronautics division of Chance Vought Corp., which has received an initial contract for more than $250,000 from the Navy for further reserach and development.

Vought Astronautics already has constructed an ISTAR test system and demonstrated potential capabilities of the new technique, which is neither a television system nor a facsimile one. Company officials said the contract from the Bureau of Naval Weapons is for development of a very advanced unit to evaluate the equipment's future role in space.

The system is highly resistant to damage from outer space radiation; it is compact, lightweight and requires very little power to operate.

Working with Chance Vought in development of the system were Haloid Xerox, Inc., Rochester, N. Y., and General Electrodynamics Corp., Garland, Texas.

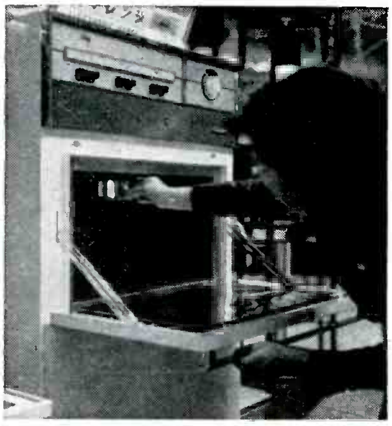
Navy Awards Contract For Air-to-Air Missile

SPARROW III air-to-air guided missile contract for about $7.8 million has been announced by Navy's Bureau of Naval Weapons. The contract, which went to Raytheon, will cover production of the missile and associated gear.

Designated Sparrow III-B, the new all-weather missile will be used by Navy's F4H-1 Phantom II supersonic jet interceptors. The fast and long-range fighter will soon form part of the deployed operational forces. The missile can be used by F3H-2 Demon fighters now using older versions of the Sparrow.

Raytheon will make the missiles at plants in Lowell, Mass. and Bristol, Tenn. Final checkout will be made at Oxnard and Point Mugu, Calif.

Data processing computer, first from Matsushita Electric's plant built in Yokohama last year



Hayakawa Electric's 2,500-Mc electronic range reportedly carries a $2,800 price tag

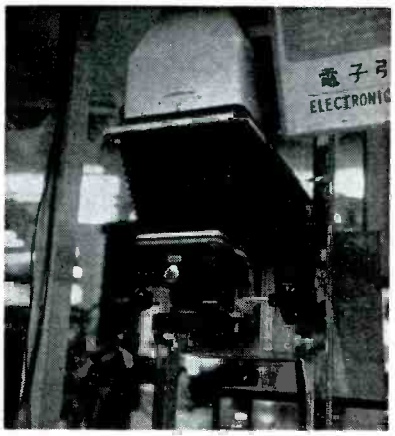
Tokyo Fair Features Electronic Items

TOKYO (McGraw-Hill World News)—The Fourth International Trade Fair, which ended Sunday, featured numerous new electronic products. Among them were applications of thermal converters and photo-electronics.

Sanyo Electric came out with a refrigerator, thermal pack, thermos can, and panel cooling system, with 16, 12, eight, and 88 thermo-modules respectively. Each module consists of 10 pairs of thermal converters.

Sanyo started developing a thermal converter in 1956 and now claims it is producing its thermal converter (bismuth and tellurium) at 25 percent of the cost of other manufacturers, or about $2.80 per converter. With completion of its thermal converter plant in July, Sanyo plans to produce monthly one million thermal converters.

Specifications for its panel cooling system are d-c input 2.2 Kw, 25 a, maximum cooling capacity −20 C, and water circulation 0.2 cubic meter/per hour.



Electronic enlarger (Hayakawa Electric) expands 35-mm film to 67 cm × 80 cm pictures

Pilots, Forecasters To Test New System

ONE-YEAR TEST of direct pilot-to-weather-forecaster communications systems has been agreed to by Federal Communications Commission and Federal Aviation Agency. U. S. Weather Bureau also will participate. The service will operate at 122.6 Mc.

Tests will be conducted in the Washington, D. C., and Kansas City areas.

FCC statement on the tests says the objective will be to determine degree of need and best ways of making such direct information transmissions to greatest number of users.

Forecasters will use the direct transmission system to answer questions as they come in from pilots and give explanations on hazardous weather conditions along the line of flight. Plans are to stress the form in which information is transmitted for accurate translation in the aircraft. Research will also be done to determine interference hazards to adjacent channels.

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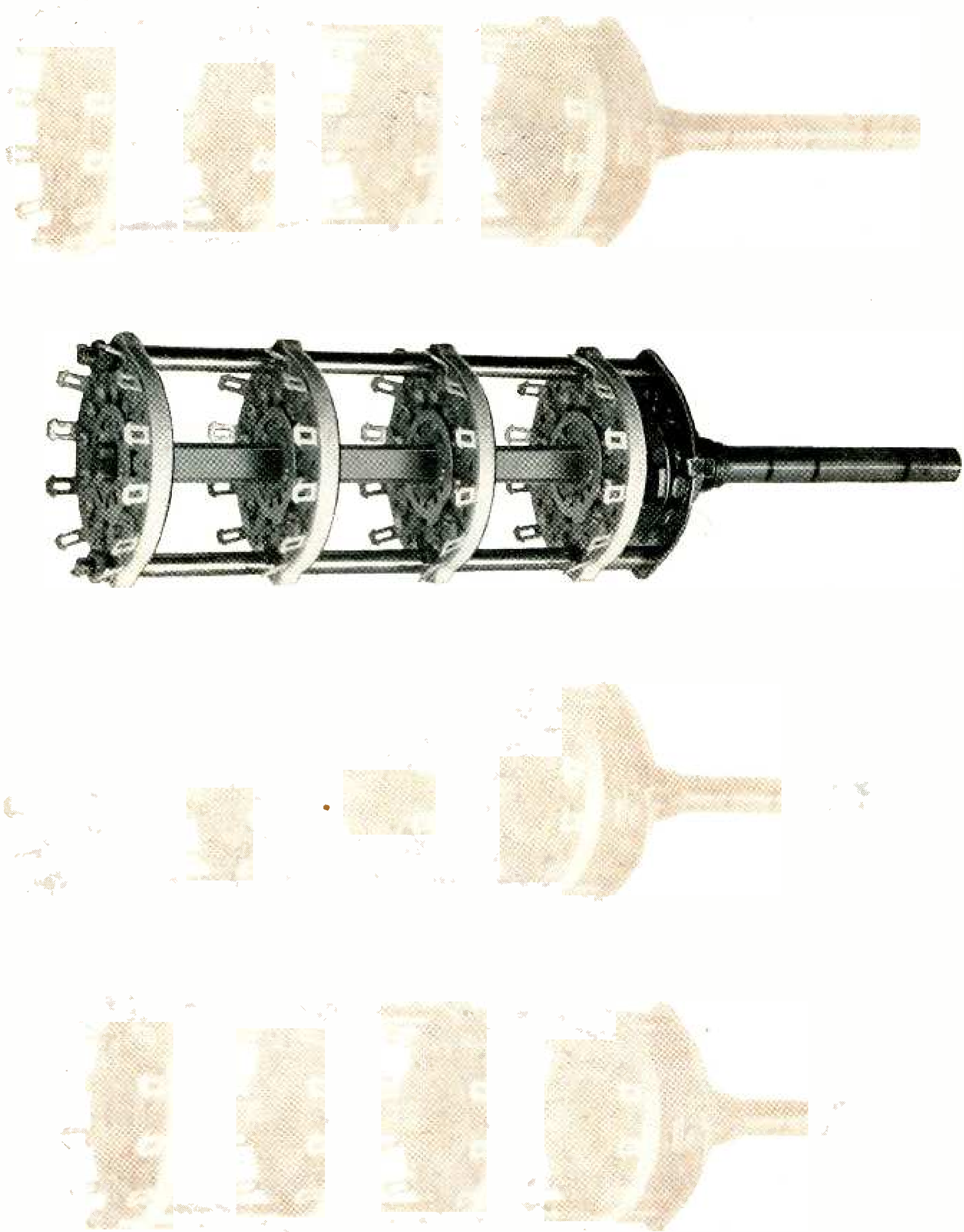

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Oak has pioneered the development of the double-wiping spring clip that assures positive, high-pressure contact under normal conditions throughout the life of a switch. Oak researchers have developed special new alloys for contacts that retain their tension under high temperature operation. Our development engineers are constantly striving to find better ways to handle all your switching needs.

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Oak craftsmanship begins with careful, exacting quality control from raw materials to finished product. Oak tool engineers design new or adapt existing fabricating and assembly equipment to meet ever-changing production needs. Their special know-how enables Oak to produce parts to more critical tolerances without a corresponding increase in cost.

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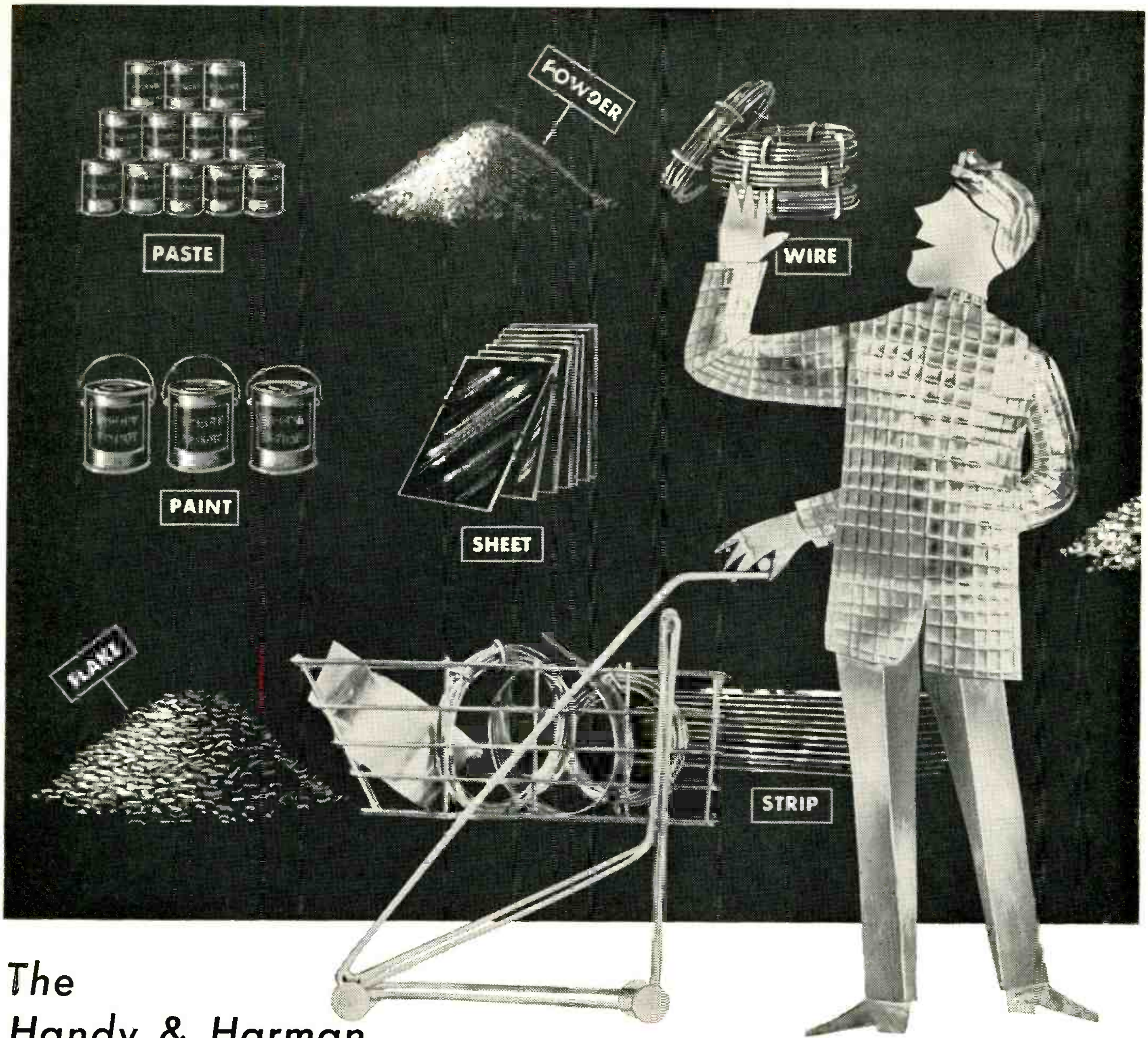

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May 15-17: Microwave Theory & Tech., National Sym., PGMTT of IRE; Sheraton Park Hotel, Wash. D. C.

May 17: Reliability & Quality Control, Product Engineering, Joint PGRQC and PE of IRE; Willkie Memorial, N. Y. C.

May 22-24: Communications Symposium, (GLOBECOM V) PGCS of IRE, AIEE; Sherman Hotel, Chicago.

May 22-24: National Telemetering Conf., PGSET of IRE, AIEE, IAS, ARS, ISA; Sheraton Towers Hotel, Chicago.

May 22-25: Electronic Parts Distributors Show, Electronic Industry Show Corp.; Conrad Hilton Hotel, Chicago.

May 23-25: Large Capacity Memory Techniques for Computing Systems, Office of Naval Research; Dept. of Interior Auditorium, Wash., D. C.

May 31-June 2: Frequency Control Symposium, U. S. A. Signal R & D Lab.; Shelbourne Hotel, Atlantic City, N. J.

May 31-June 2: Radar Symposium, Univ. of Michigan Inst. of Science & Technology; Ann Arbor, Mich.

June 5-8: Instrument-Automation Conf. & Exhibit, ISA; Royal York Hotel, Toronto, Ontario, Canada.

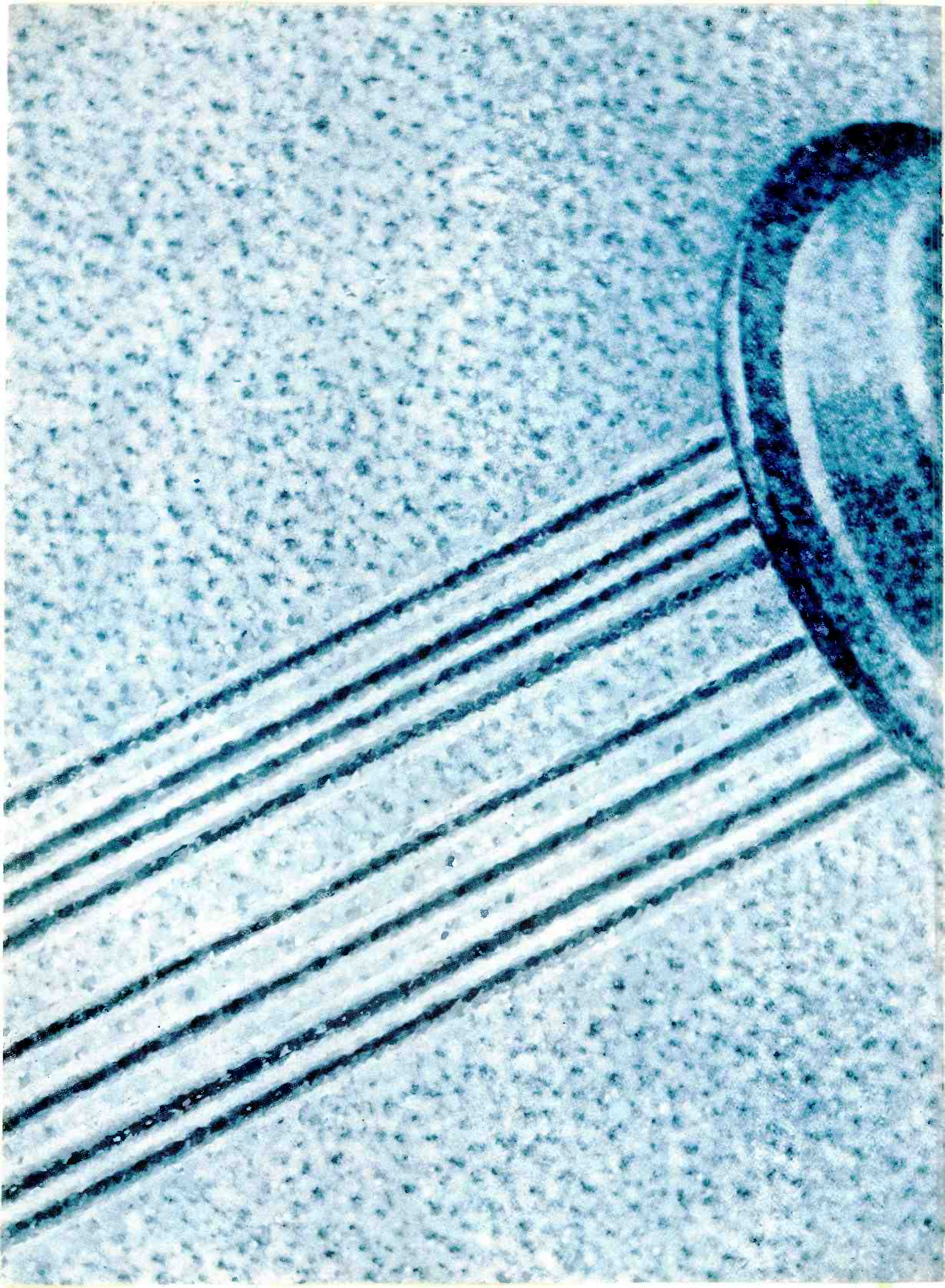
June 8-9: National Electrical Manufacturers Assoc., NEMA; Biltmore Hotel, Los Angeles.

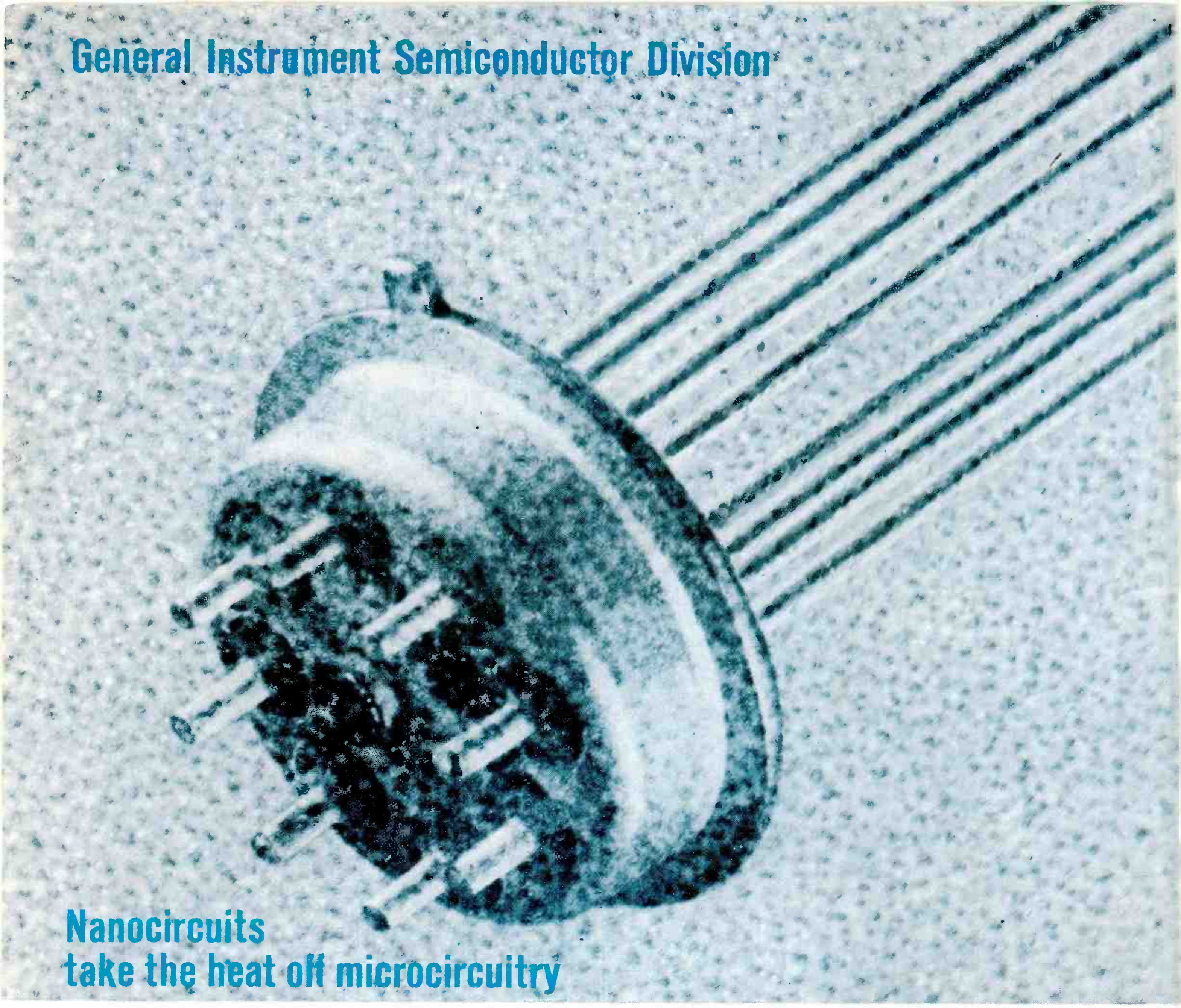
Aug. 22-25: WESCON, L. A. & S. F. Sections of IRE, WCEMA; Cow Palace, San Francisco.

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

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

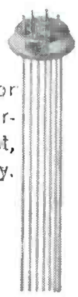
Nov. 14-16: Northeast Research & Engineering Meeting, NEREM; Commonwealth Armory and Somerset Hotel, Boston.





Nanocircuits bring several important advantages to computer logic design, not the least of which is size reduction. This one packs six diodes (it could have been a diode-transistor combination) into a standard TO-5 case. ■ Equally important in the General Instrument concept: only the active components (surface-passivated for stability) are fused to the common substrate. The diodes are not exposed to the heat of such loss-generating components as resistors and capacitors whose demands differ from those of the active elements. ■ Not only is component reliability increased but, since the semiconductors are pre-selected from a 100%-tested standard product line, the designer can evaluate circuit reliability rather than that of individual components. This technique reduces the number of assembly and testing operations, so cost is lower, too. ■ General Instrument also allows the logic designer the flexibility of transferring new or existing circuits, breadboarded with conventional components, directly into nanocircuits. Let us show you how.

Get complete details on nanocircuits and other semiconductor devices from one of our sales offices or the franchised distributor nearest you. Or write today for Bulletin NC-10 to General Instrument, Semiconductor Division, 65 Gouverneur Street, Newark, New Jersey.



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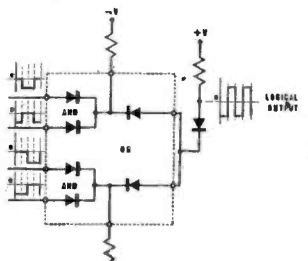
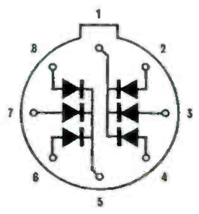
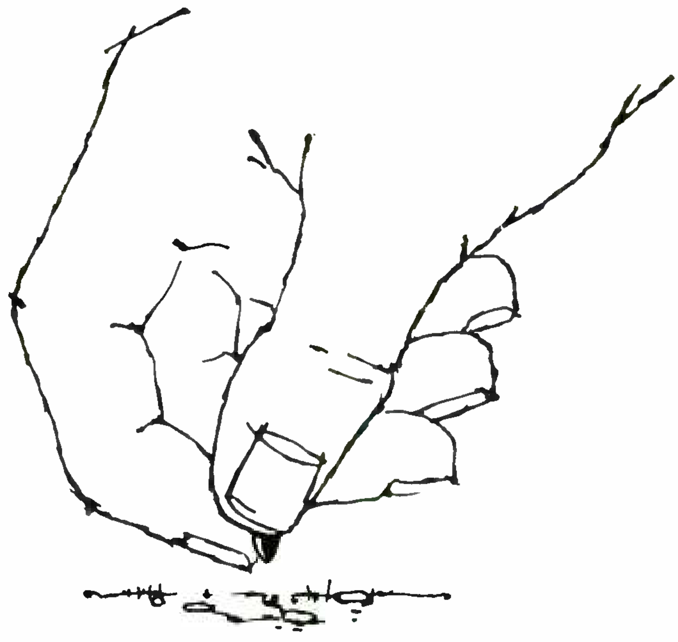


AND/OR Coincidence Gating Circuit



Pins 1 & 5 are 'n' commons. Pins 2, 3 & 4 are one set of 'p' leads; 6, 7 & 8 the other.



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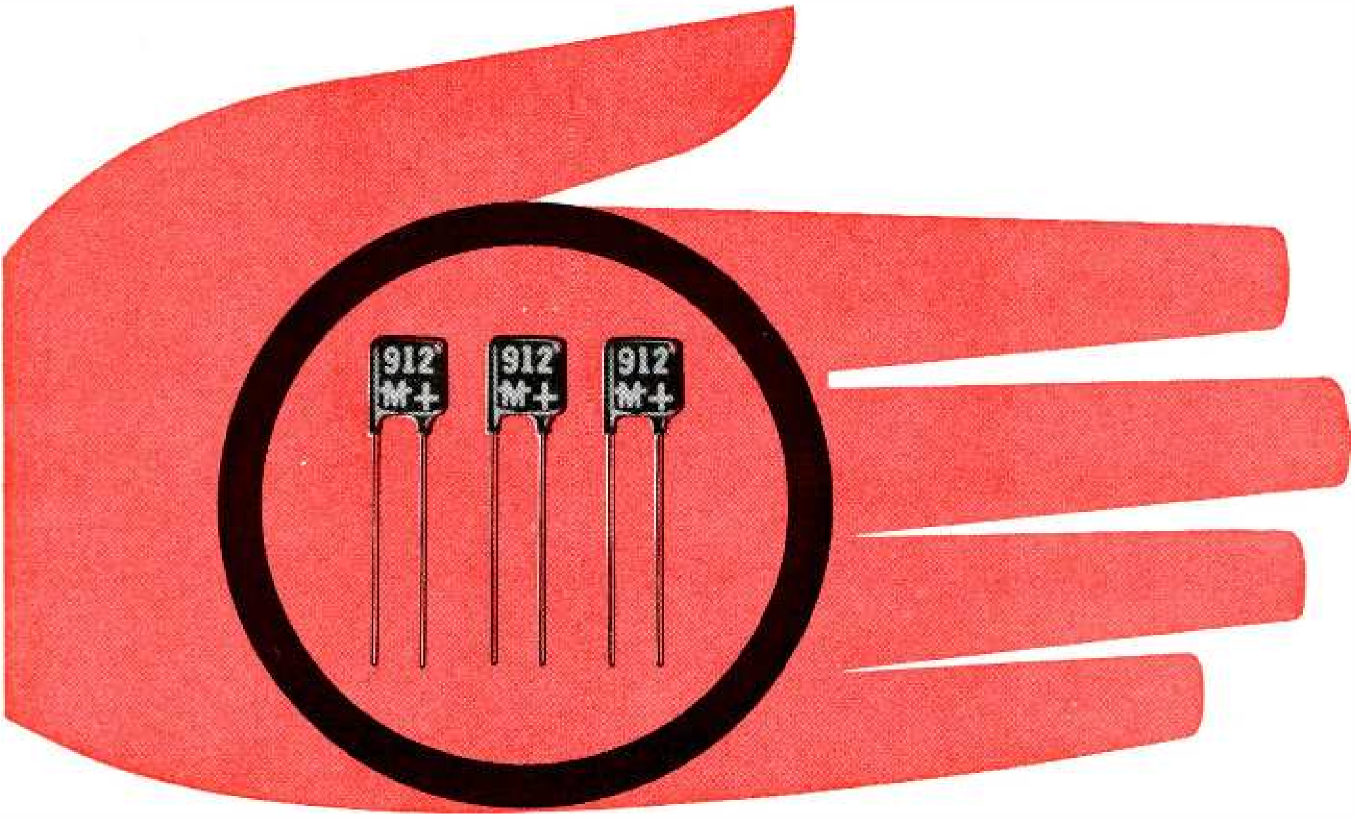

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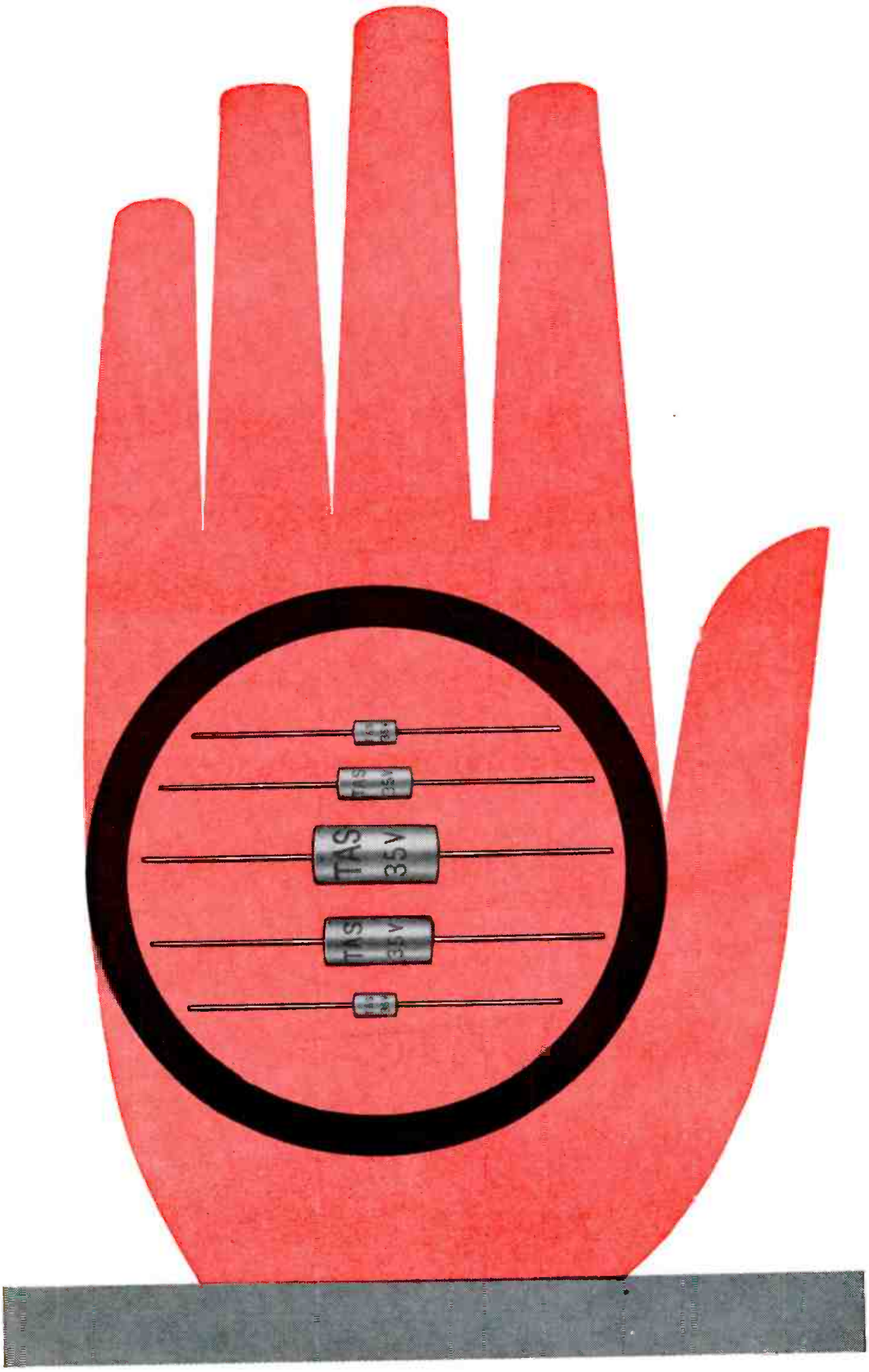

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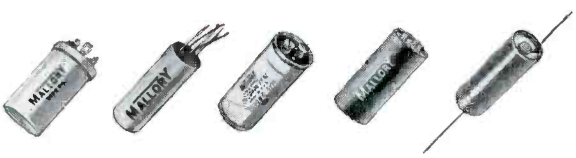

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Each month the editors of *electronics* are selecting a significant article and offering it in reprint form —FREE—to readers.

The May free reprint is an article from the May 5th issue. It is a two page article by Fred W. Kear—Digital Control Uses Unijunction Transistors.

The bistable characteristic of the unijunction transistor makes it a useful control device for digital circuits, replacing many components used in conventional transistor switching circuits, reducing packaging size and lessening maintenance problems. This article discusses the use of unijunction transistors in readout and control circuits.

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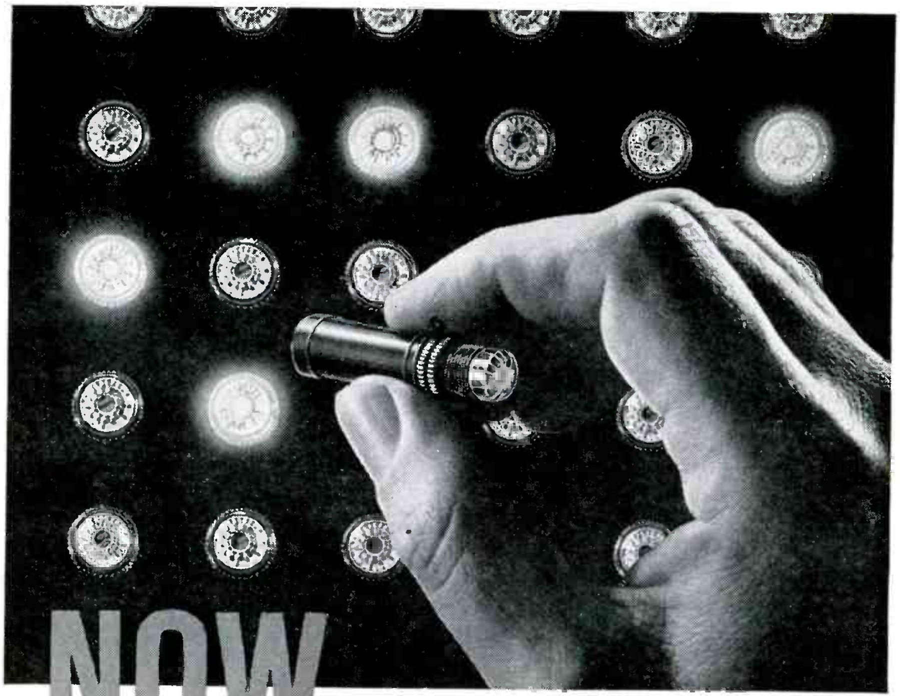

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POSITIVE LOGIC			Turn ON	Turn OFF			Turn ON	Turn OFF
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Standby power	−100V at 2mA, 6V at 0.1 mA				−12V at 20mA 6V at 0.1 mA		1.25 Vac at 250 mA	70 Vdc at 1.5 mA
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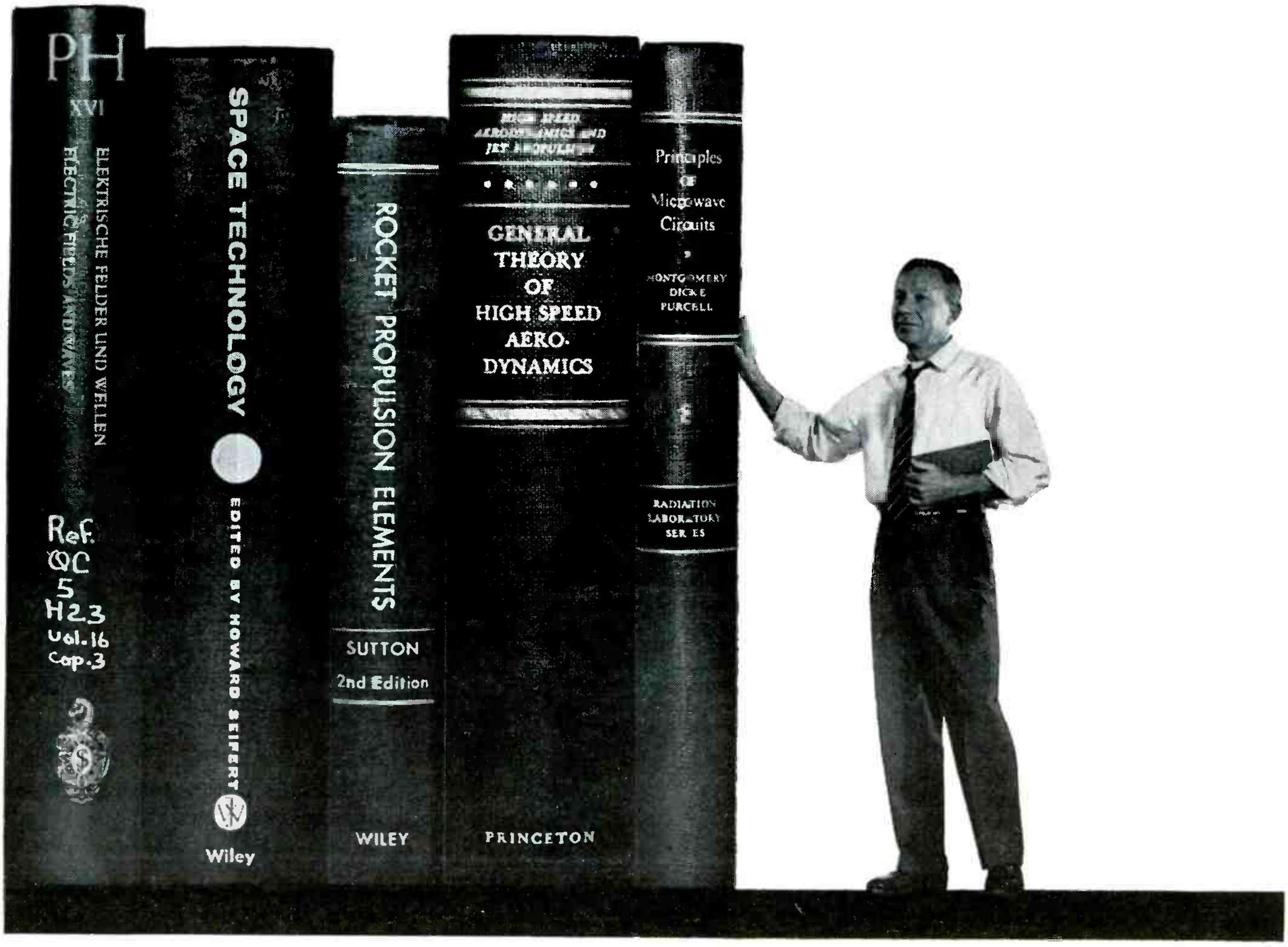

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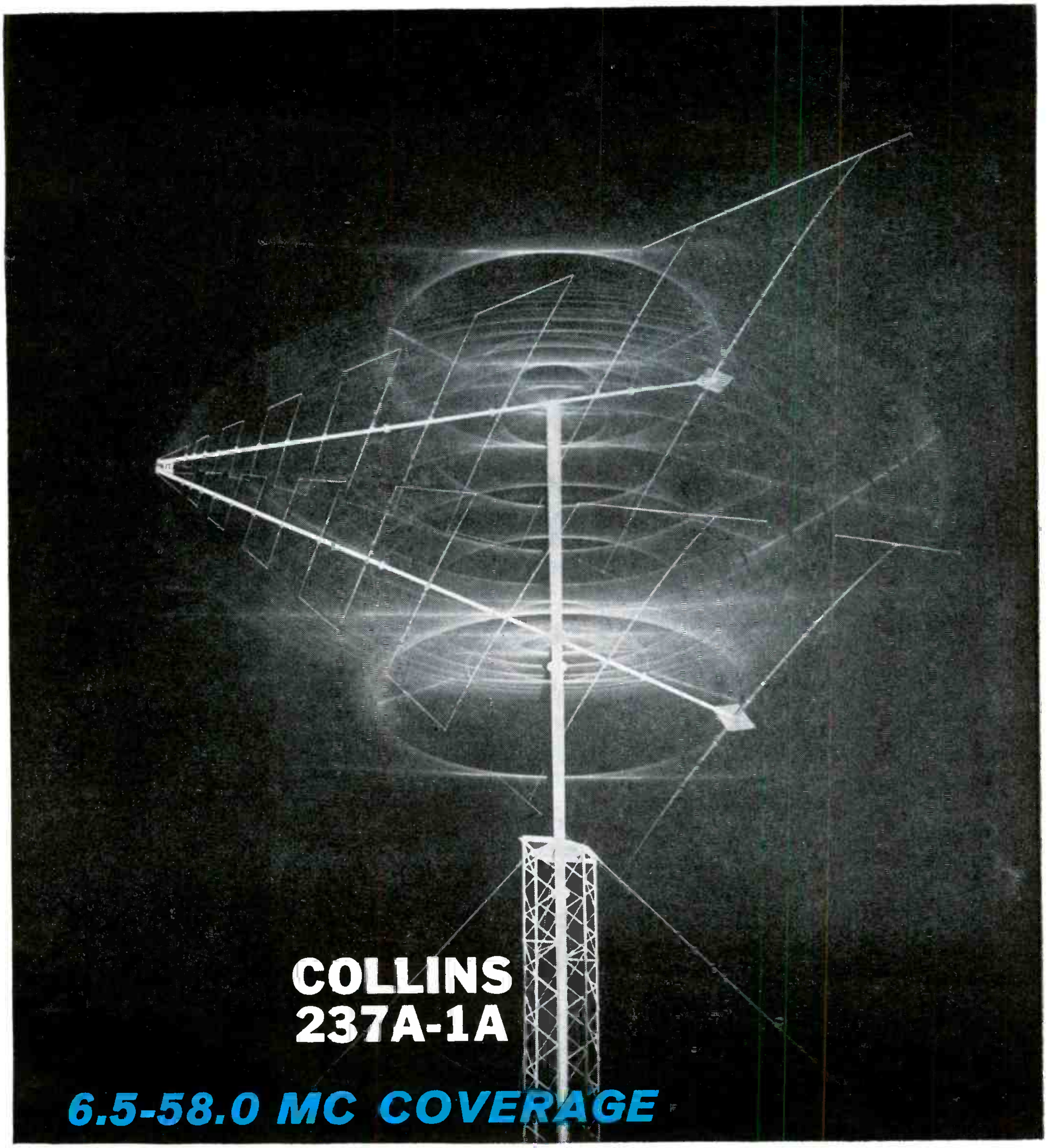

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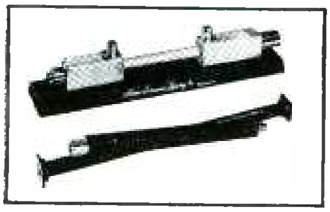

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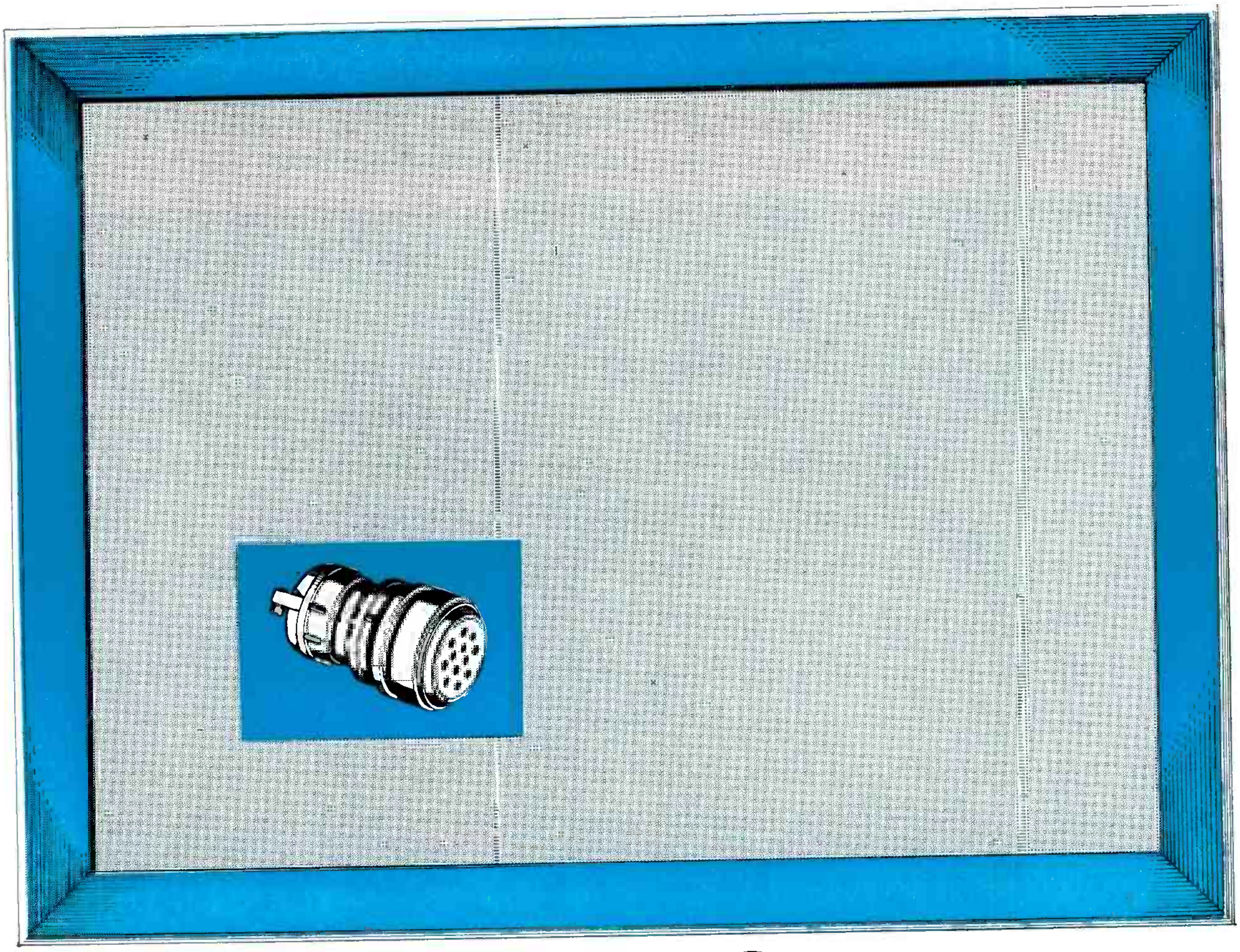

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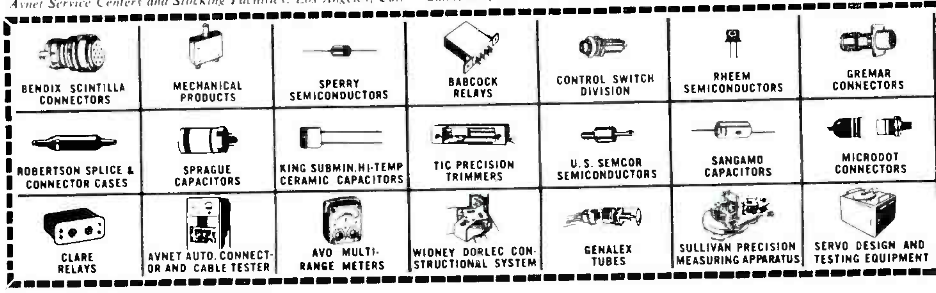

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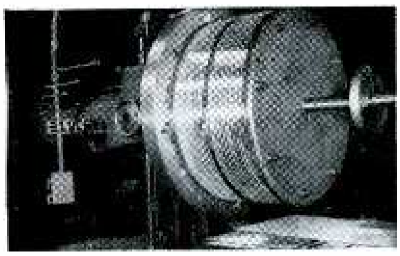

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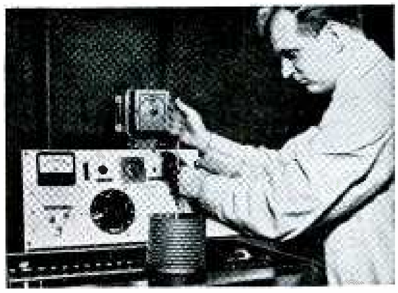

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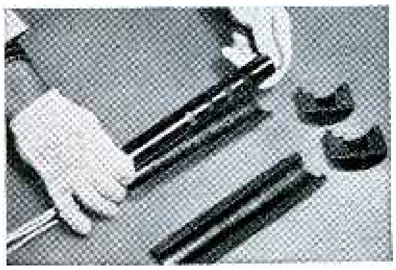

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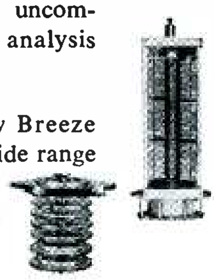

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Examples of Westinghouse display storage tube design capabilities

	WL-7268	WX-4363	WX-4187/ WL-7952	WX-4611/ WL-7682	WX-4511	WX-4418/ WL-7174	WX-4581/ WL-7748	WX-4584	WX-4614/ WL-7033
Maximum diameter-in.	5¼"	5¼"	5¼"	5¼"	5¼"	4½"	5 9/16"	5¼"	5¾"
Maximum length-in.	16"	16"	15"	15"	15"	10"	13⅝"	15"	11½"
Min. useful screen-in.	4"	4"	4"	4"	4"	3"	3.8"	4"	4"
No. of write guns	2	2	1	1	1	1	1	1	1
Type of focus	ES	ES	ES	ES	ES	Mag.	ES	ES	ES
Type of deflection	ES	ES	ES	ES	ES	Mag.	ES	ES	Mag.
Storage time min.-sec.	5	30	60	30	60	30	20	6	60
Writing speed min.-in./sec.	4×10^4	4×10^4	4×10^5	4×10^5	4×10^5	2×10^5	3×10^5	1.2×10^6	1×10^5
Erase uniformity-volts	1	2	2	2	2		1	2	
Erase time max.-millisec.	50	50	50	50	50	5		10	50
Viewing screen-KV	10	10	5	5	10	15		5	9
Brightness min.-ft.-L	2,500	2,000	200	200	2,500	10,000	1000	200	2,000
Resolution min.-Lines/in.	50	65	50	50	50	35	50	50	65

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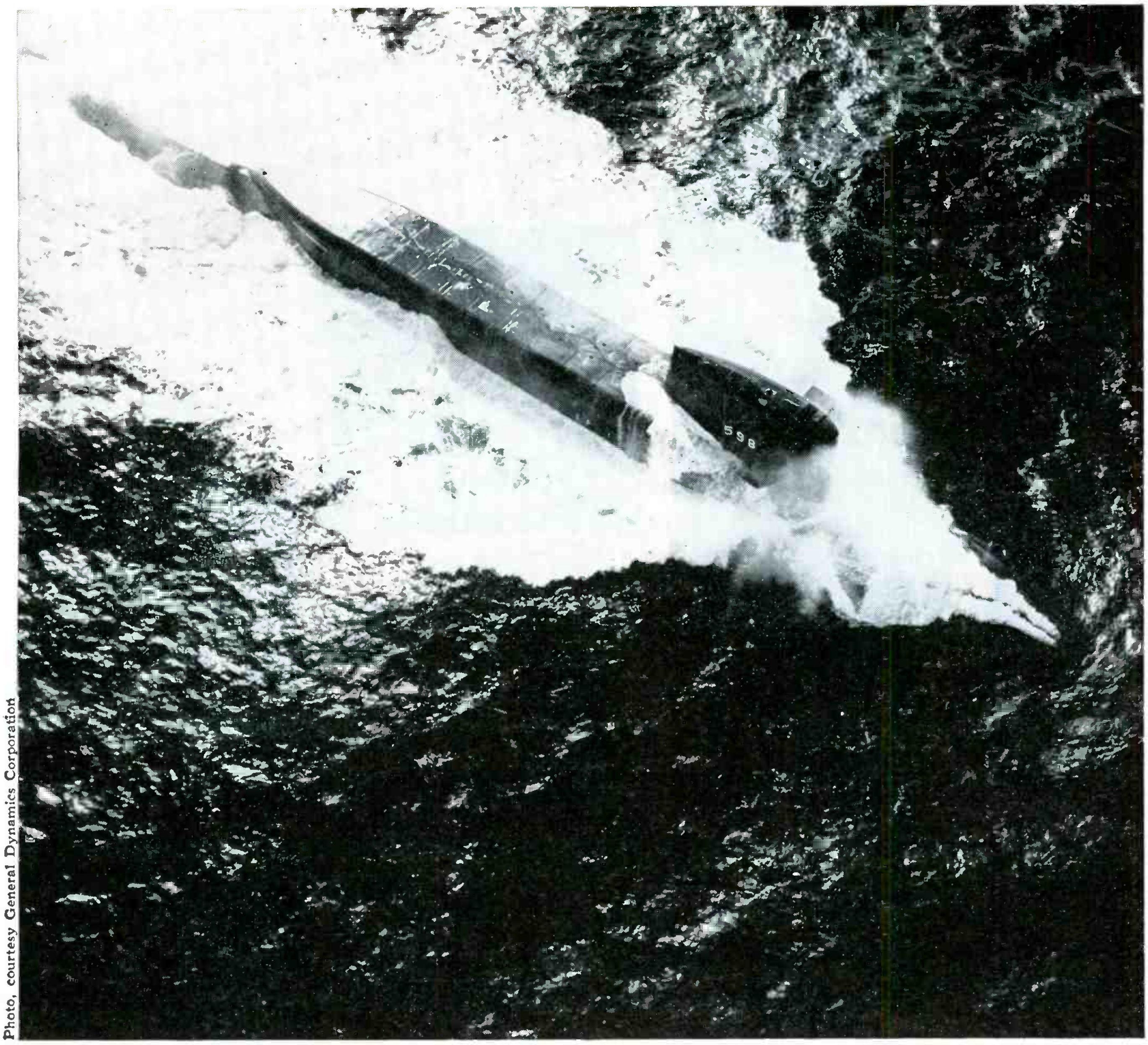

Photo, courtesy General Dynamics Corporation

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**President John F. Kennedy's State of the Union message, January 30, 1961*

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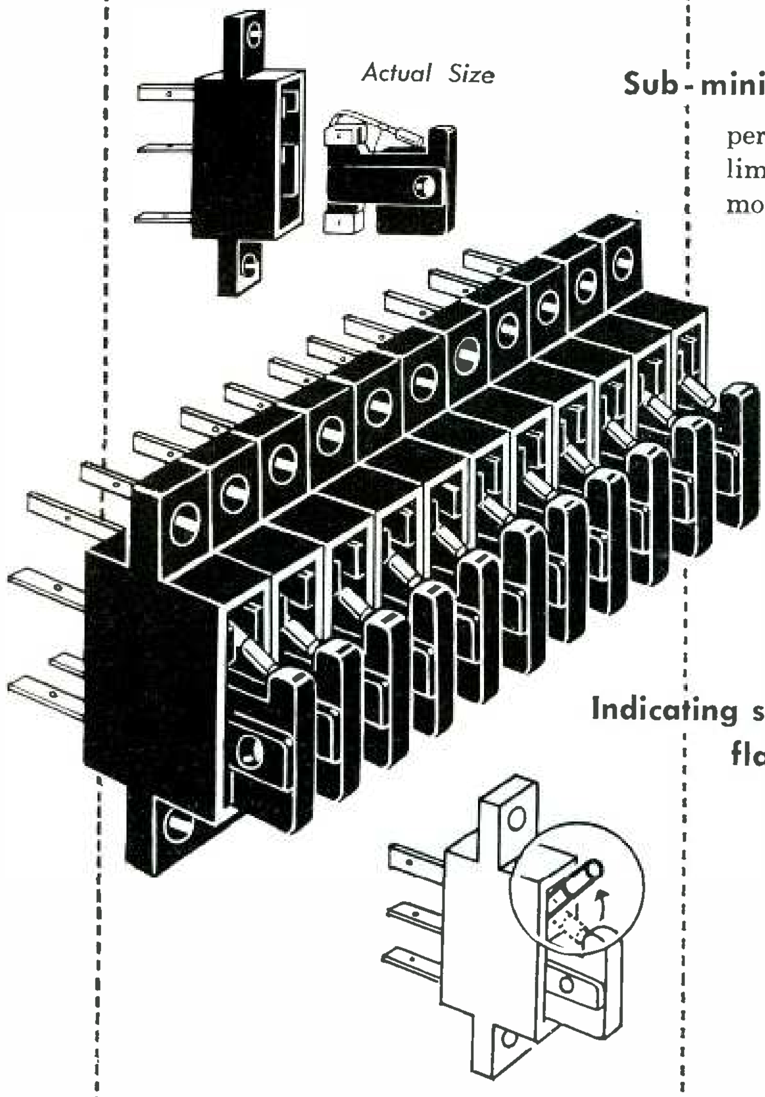

Sub-miniature design

permits multiple mounting of fuses in limited space. Fuseholders can be mounted on ¼ inch horizontal centers.

Fuse and holder combination readily adaptable for use in equipment operating at 300 volts or less, such as: communication equipment, business machines, computors, control equipment or other multiple circuit apparatus where space is at a premium.

Indicating spring flashes color-coded flag when fuse opens

to give quick, positive identification of faulty circuit.

Indicator spring also makes contact with an alarm circuit so, it can be used to flash a light—or sound audible signal on fuse panel or at a remote location.

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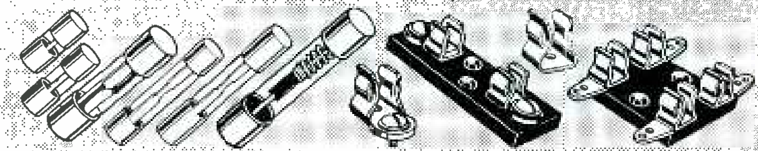

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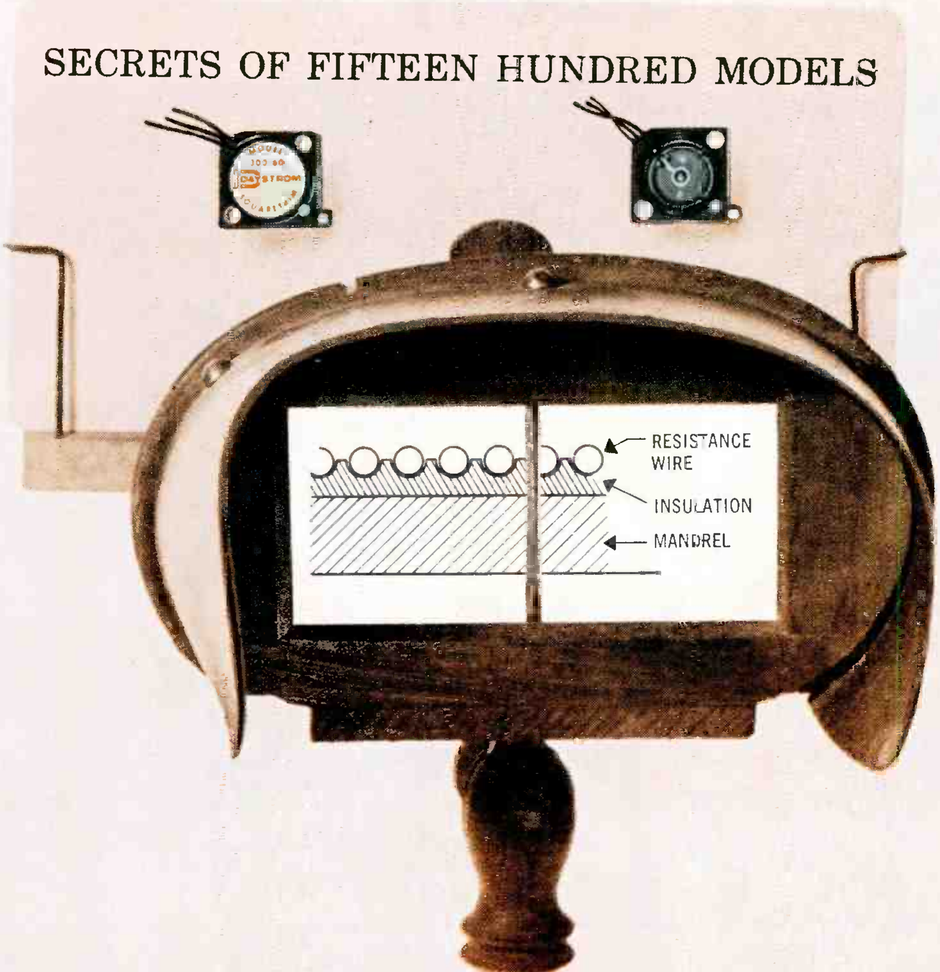

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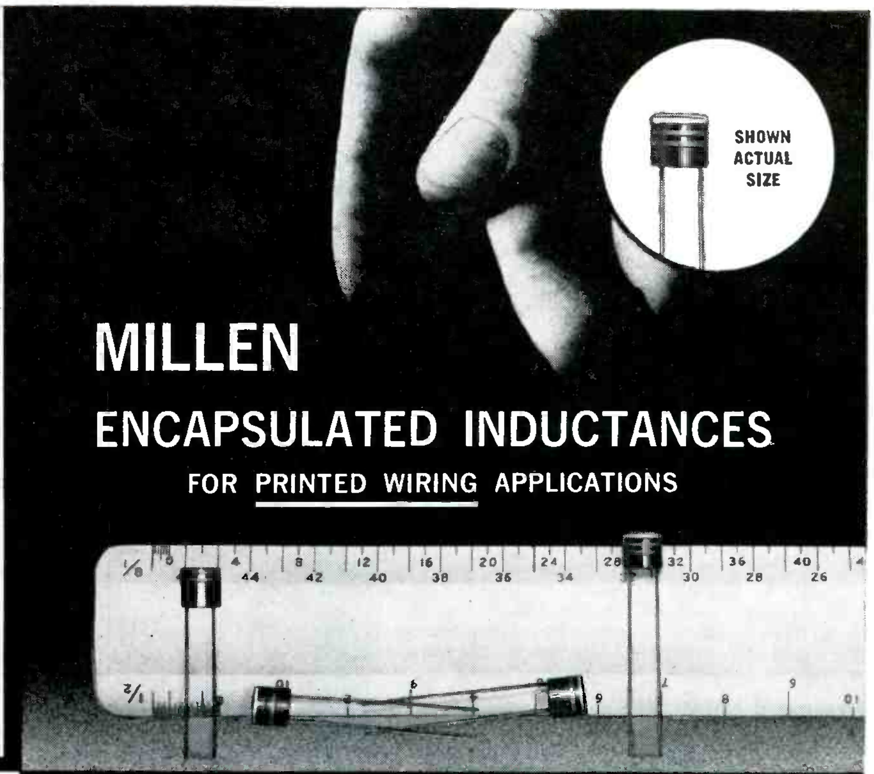

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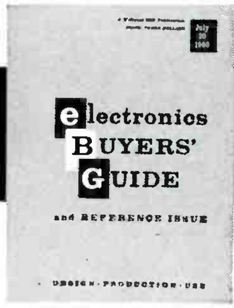

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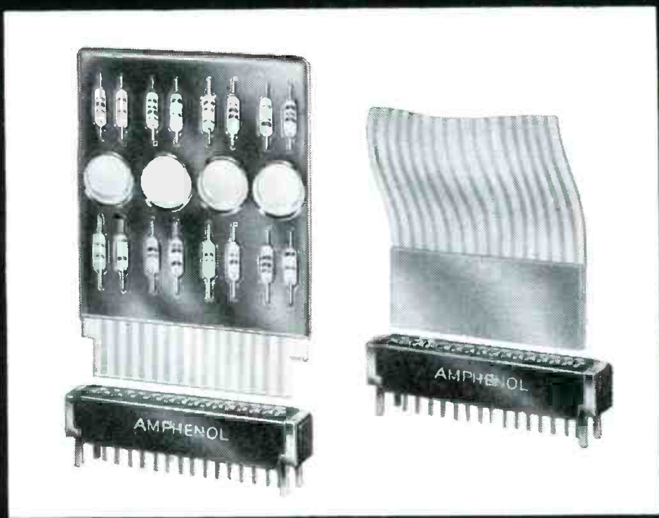
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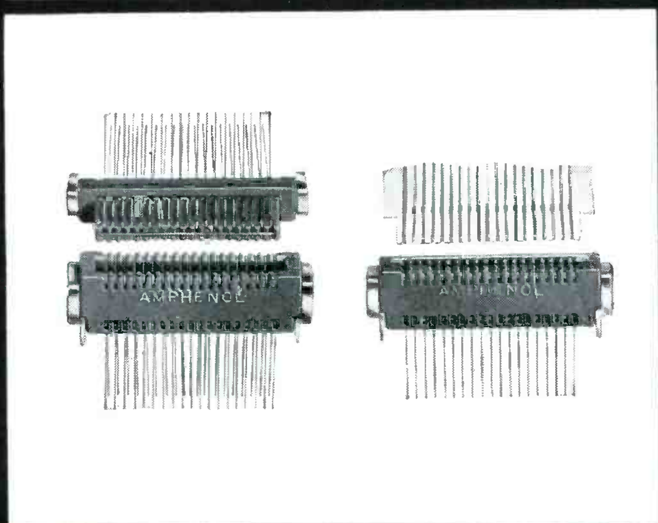


electronics
May 12, 1961

Glow-Tube Programmer Controls Neutron Spectrometer Experiments

Multielement glow tubes are used as switches to control sequence of operation. Tubes can be cascaded to provide more than ten individual functions

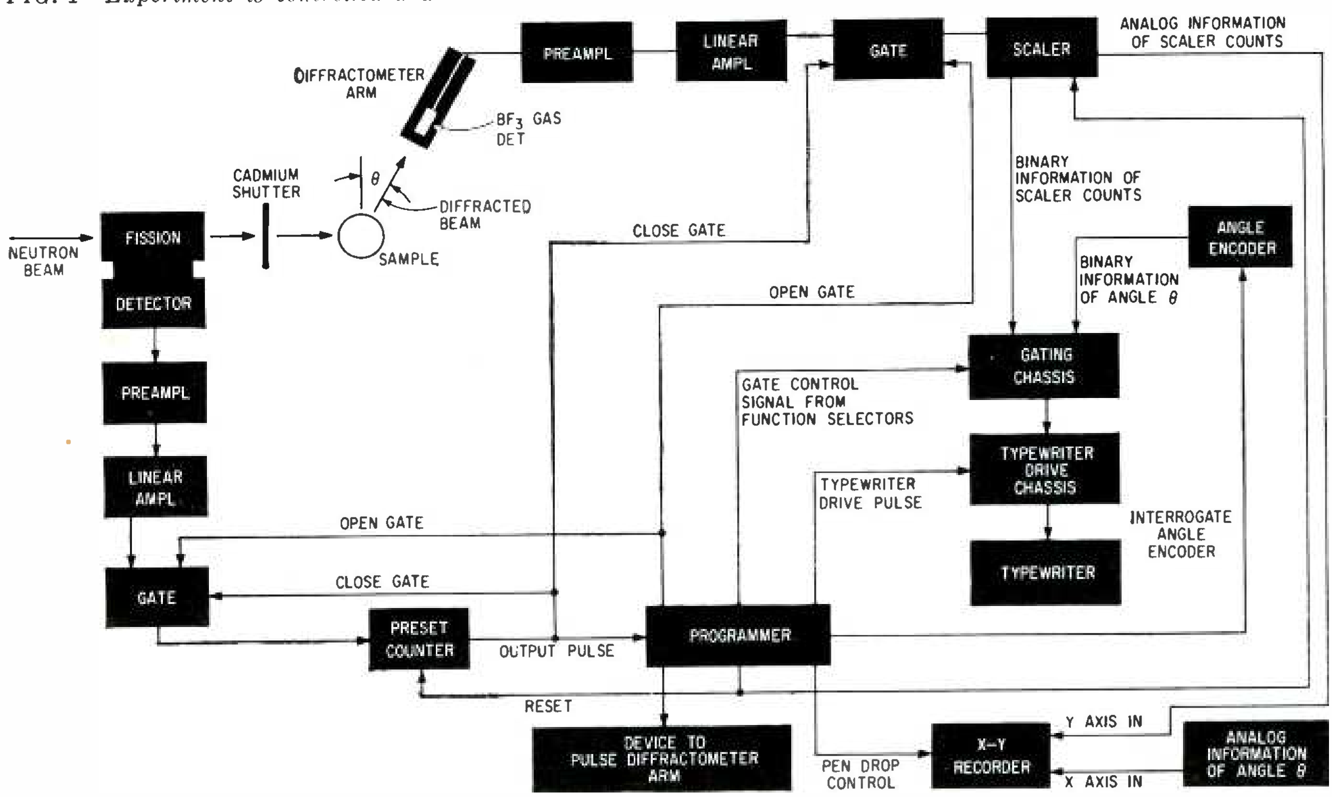
By EDWARD W. JOHANSON,
Argonne National Laboratory
Argonne, Illinois

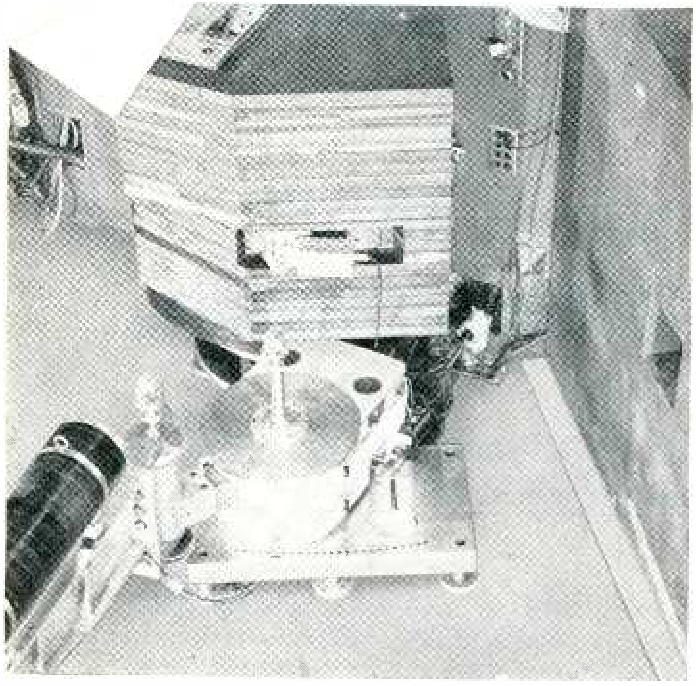
COUNT DATA can be recorded automatically and mechanical motions controlled automatically in neutron diffraction experiments by using glow-transfer tubes as switches or control devices.

In the experiments (see Fig. 1), the neutron beam emerges from the reactor, passes through a fission detector, strikes the sample and is diffracted. The diffractometer arm that determines the angle θ is moved through the diffracted beam pattern, and the BF_3 gas-type detector tube mounted on the diffractometer arm detects the diffracted beam. The counts from the BF_3 detector enter a scaler for later print-out. The electronic information of the angle θ of the diffractometer arm enters an angle-encoder for later print-out. Output of the fission detector is fed through an amplifier to a pulse counter. The counter is preset to determine the length of time of data accumulation and initiates data recording. This method of preset counting eliminates counting errors due to the reactor level fluctuations because the counting time is based on the number of neutrons passing through the fission detector.

The programmer outlined in Fig. 2 is turned on by the output pulse of preset counter. A 60-cycle square wave, generated from the line frequency, drives the first glow-trans-

FIG. 1—Experiment is controlled and accumulated data are recorded automatically by glow-tube programmer





General view of neutron diffractometer shows reactor side wall

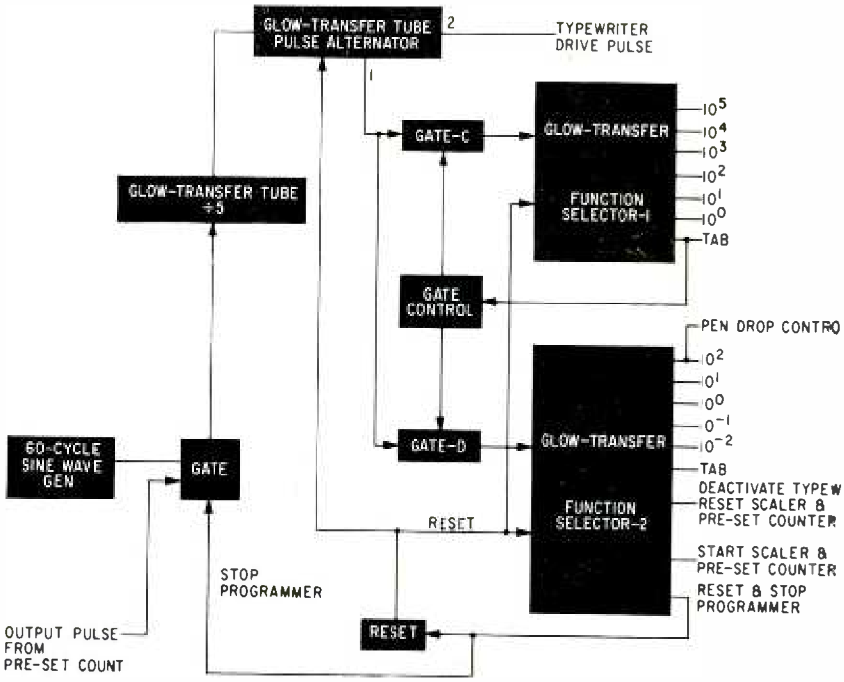


FIG. 2—Block diagram of programmer, in which function selector 1 controls readout of scaler count, selector 2 controls angle readout

fer tube. Output of this tube is one pulse for every 5 input pulses. After this division by 5, the pulses are transmitted to the pulse-alternator glow-tube. Alternate output cathodes of this glow-tube are connected to form two groups of five cathodes each. Output of this tube, then, as it is being driven, alternately comes from output cathode group 1 and output cathode group 2. Hence, the designation pulse-alternator or alternator.

Pulses from group 1 pass through either gate *C* or gate *D* to drive the function selectors. The pulses from group 2 operate the relays that provide the power to the key solenoids of the electric typewriter.

At the start of the programming cycle gate *C* is open, gate *D* is closed and all glow-tubes and flip-flops are reset. After the programmer is activated the first pulse from the alternator moves the beam of function selector 1 to cathode 1 (Fig. 3). This cathode is now drawing current and provides current to the typewriter gate control transistors Q_1 and Q_2. Transistors Q_1 and Q_2 both saturate, energizing the four HGS-1048 mercury relays. Contacts of these relays switch the binary information in the 10^5 decade to the typewriter drive circuit.

In this circuit the binary infor-

WHAT A NEUTRON DIFFRACTOMETER IS AND DOES

Thermal neutrons emanating from the reactor have a wavelength of approximately 1 A which is of the same order as the interatomic distances in matter. Consequently, a solid or crystal serves as a three-dimensional diffraction grating for thermal neutrons. When a well-collimated monochromatic neutron beam is incident upon crystalline sample, each atom serves as a diffraction or scattering point, and the interferences of these diffracted beams give a neutron diffraction pattern.

If the sample is a single crystal, the observed pattern is a three-dimensional array of diffraction spots. If the sample is a powder composed of small randomly-oriented crystallites, the resulting diffraction pattern is a series of cones originating from the sample. In direct analogy with x-ray diffraction procedures, it is possible to determine the unit cell dimensions and geometry from the angular positions of the diffraction spots and from the intensities of the spots to determine the positions of the atoms within the unit cell.

Neutrons and x-ray diffraction have many common features; however, their differences make them supplemental tools to each other in crystal structure determinations. X-rays are scattered by the electrons of an atom, and, hence, the scattering power of atoms increases with atomic number. The x-ray diffraction contribution from electron-poor light elements, such as hydrogen and carbon, may be completely obscured by the scattering from electron-rich heavy atoms, such as thorium and uranium. Scattering of neutrons is by the atomic nuclei, and scattering from light atoms is of the same order as from heavy atoms and, in fact, can be greater.

Consequently, neutron diffraction has proved valuable in locating the positions of light atoms in crystal structures. This same difference is also useful in the studies of ordering in alloys of elements of nearly the same atomic number. The neutron has a magnetic moment and hence is scattered by the magnetic moments of atoms in magnetic materials. It is possible by applied magnetic fields or thermal means to separate the magnetic from the nuclear scattering and obtain the orientations of the magnetic moments or magnetic structure of the material.

In essence, a sample acts as a diffraction grating and scatters the incident neutrons so that there are peaks of high intensities at various angles, and the data recorded is the intensity of the scattering and the angle at which it occurs.

Nowhere is this closeness more apparent than at Lockheed. Here, with each passing day, new technological advances help bring nearer the exploration of Mars, the Moon and Venus.

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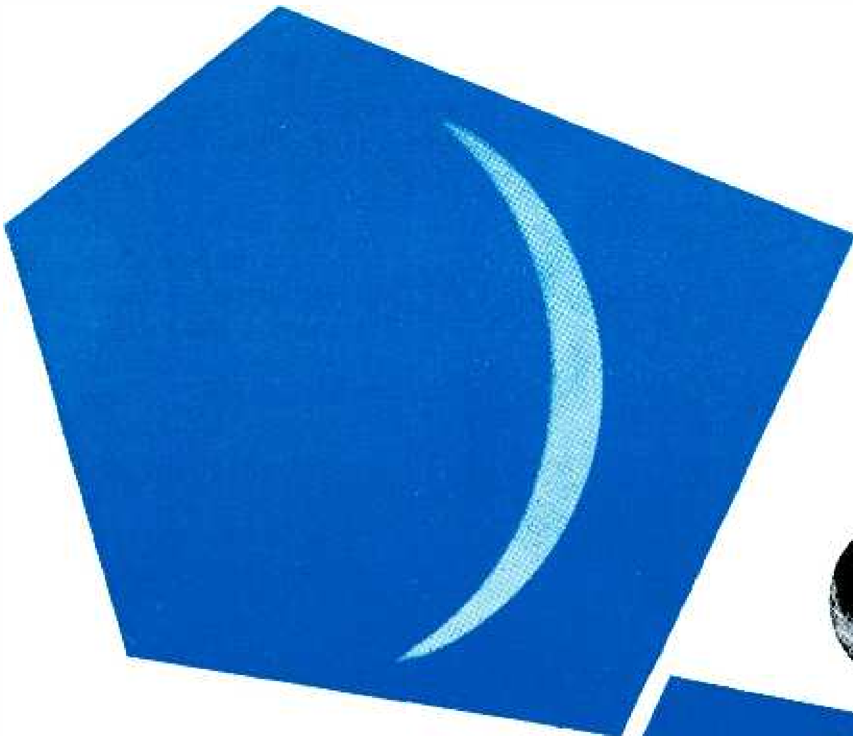

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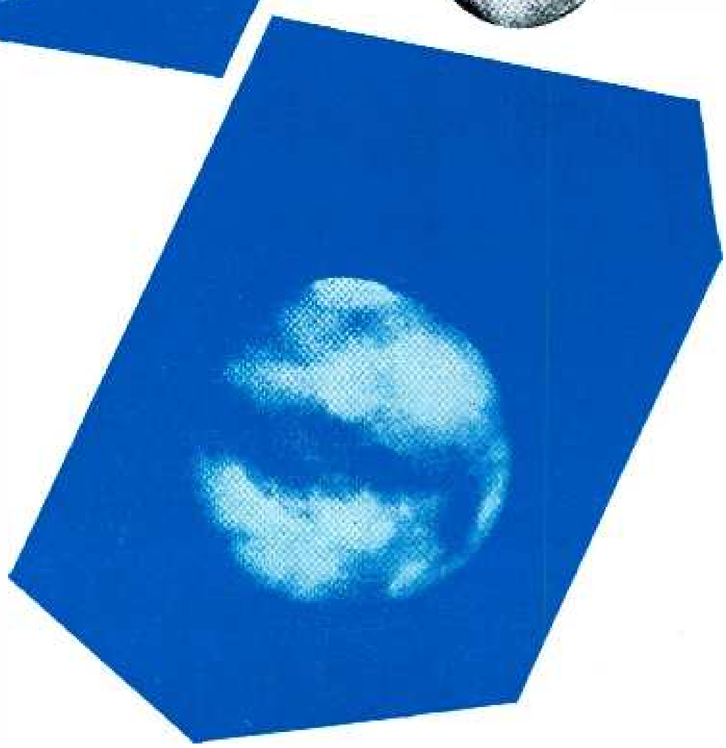

Reading clockwise: Venus, Moon, Mars. Approximate distance from Venus to Earth, 25,000,000 miles; from Moon, 240,000 miles; from Mars, 50,000,000 miles.

Photos courtesy of Mount Wilson and Palomar Observatories.

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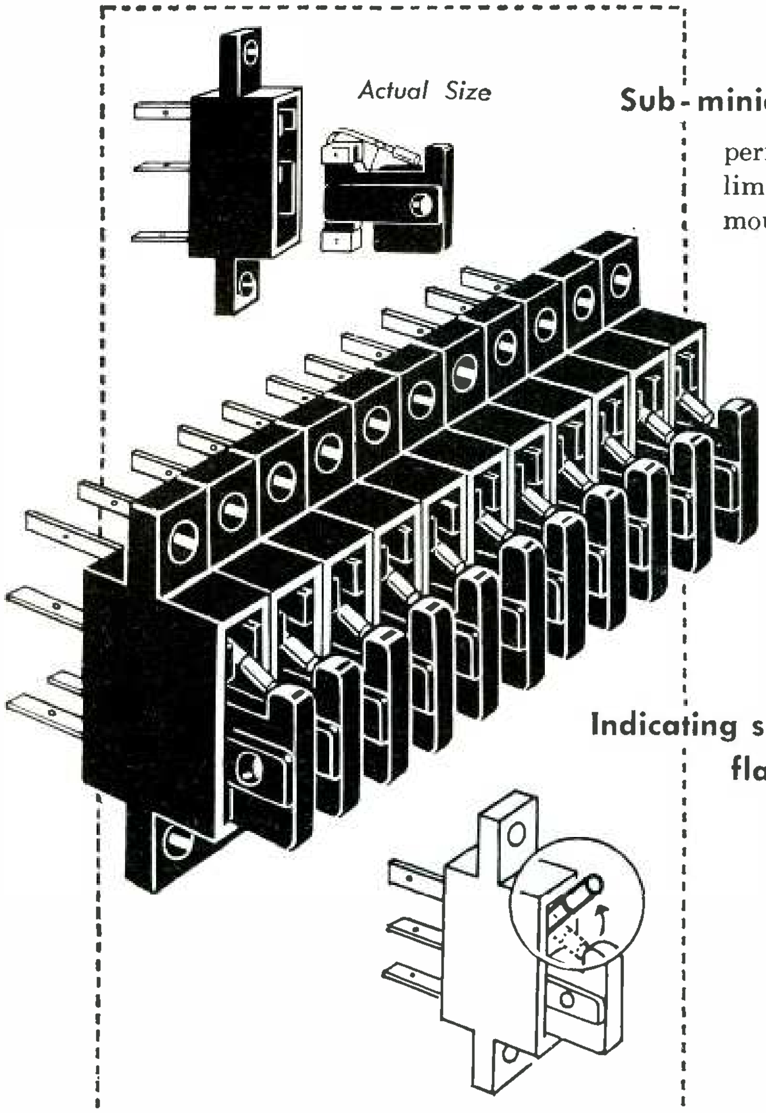
GMT Fuse & HLT Fuseholder



Sub-miniature design

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Fuse and holder combination readily adaptable for use in equipment operating at 300 volts or less, such as: communication equipment, business machines, computors, control equipment or other multiple circuit apparatus where space is at a premium.

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Ask for bulletin GMCS on BUSS GMT fuses and HLT holders.

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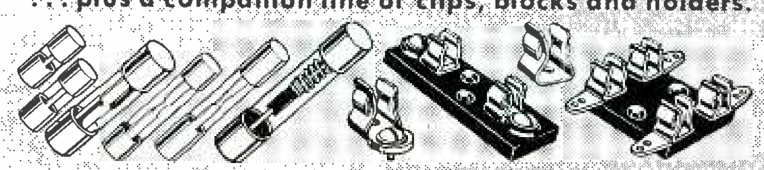
you'll find the type and size fuse to fit your every need . . . plus a companion line of clips, blocks and holders.



FUSETRON — TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION — BUSS — McGRAW-EDISON

BUSSMANN MFG. DIVISION, McGraw-Edison Co., UNIVERSITY AT JEFFERSON, ST. LOUIS 7, MO.

mation is converted to decimal form and selects the proper number solenoid on the output writer. Now the second pulse out of the alternator applies power to the selected solenoid, and the number is printed.

The numbers on the cathodes of the function selector tubes indicate the decade in the scaler or angle encoder being set up for printing. When the beam has progressed as far as the tab operation in function selector 1, a pulse is generated which activates the flip-flop in the function selector gate control. The flip-flop voltage levels control the gates and thus stop the pulses to function selector 1 and allow the pulses to drive function selector 2 by opening gate *D*.

This same cathode current of selector 1 also activates a relay, whose contacts when closed cause the angle θ encoder to be interrogated and the angular information to be stored in a relay memory for printout. Function selector 2 now prints out the angle number stored in the memory in the same fashion as the scaler from selector 1 was printed out.

When function selector 2 has completed the tab step at cathode 6, the current of cathode 7 deactivates the typewriter. This is done by discontinuing the pulses from output cathode group 2 of the alternator. At this step of the programming, the scaler and preset counter are reset to zero. The beam of function selector 2 now is moved to cathode 8 which causes the scaler and preset counter to start counting. The final step of selector 2 resets and stops the programmer.

At times during the activation of either function selector 1 or 2, additional relays are energized to perform single functions. These include activation of the drive for the diffractometer arm, activation of the recorder pen-drop mechanism, and providing a pulse that is used to open or close the cadmium shutter in front of the gas counter for background recording.

This glow-tube programmer was prepared for S. Sidhu, M. Mueller and L. Heaton of Argonne National Laboratory. The author thanks G. T. Weiss, R. B. Hoger and J. H. Erickson for their help. The work reported here was performed under the auspices of the U. S. Atomic Energy Commission.

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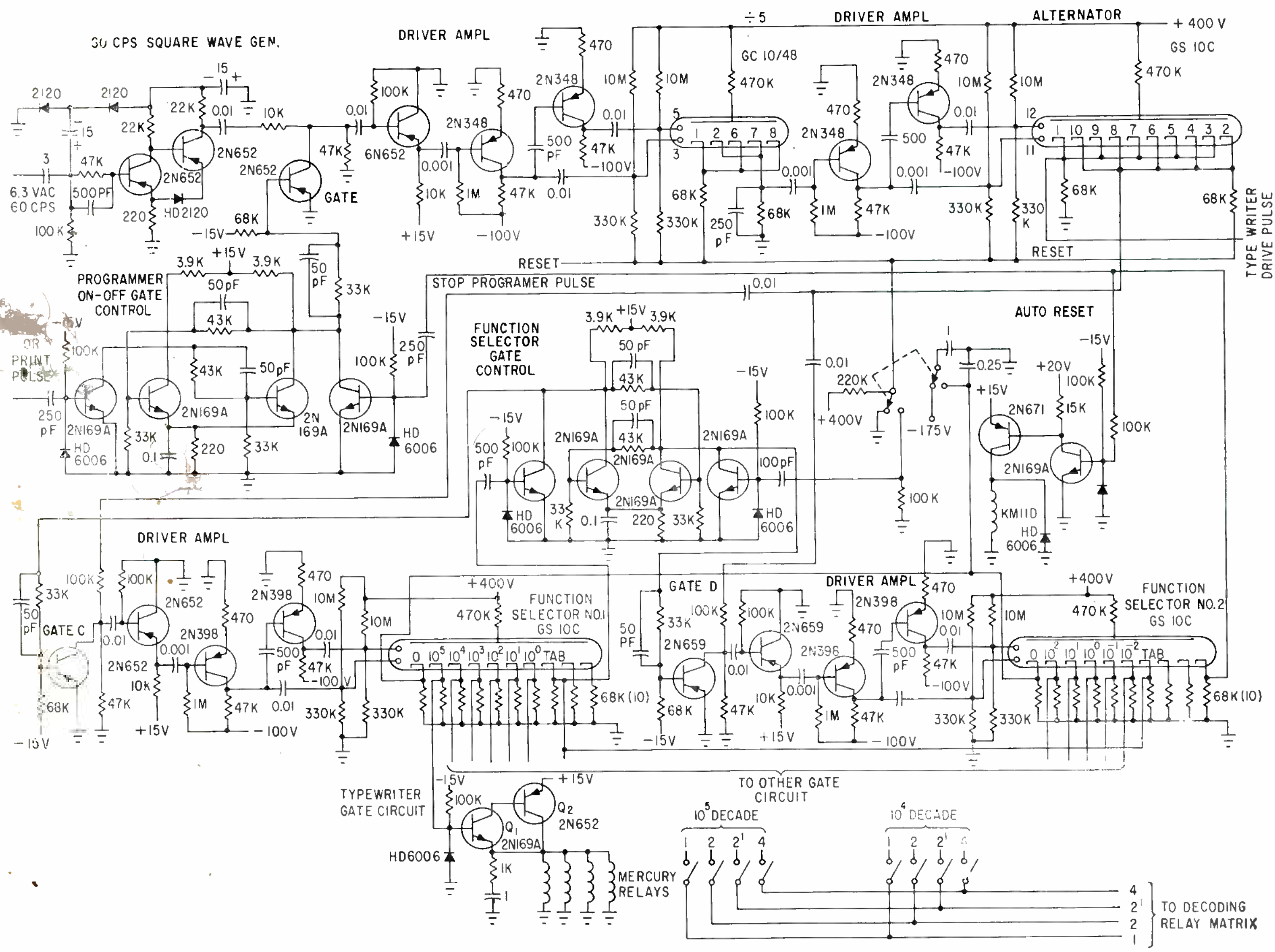

FIG. 3—Schematic of programmer shows two function selectors cascaded in series so that each cathode does only one job

Three-Dimensional Core Memory

Storage unit handles 16,384 words, each of 72 bits length, by a three-dimensional process of word selection and read. The memory cycle time for selecting any word at random from the system is 2.18 microseconds

MAGNETIC CORE STORAGE is established in the data processing industry and is an efficient and reliable technique for the high-speed main memories in digital computers. Millions of magnetic cores are used in computer memories without failures due to core deterioration; in addition, advances in technology have consistently lowered core switching time, resulting in the high-speed magnetic memories presently used. The economics of memory construction has improved, along with increased speed, due to improvements in the techniques of addressing and selecting storage locations within the memory.

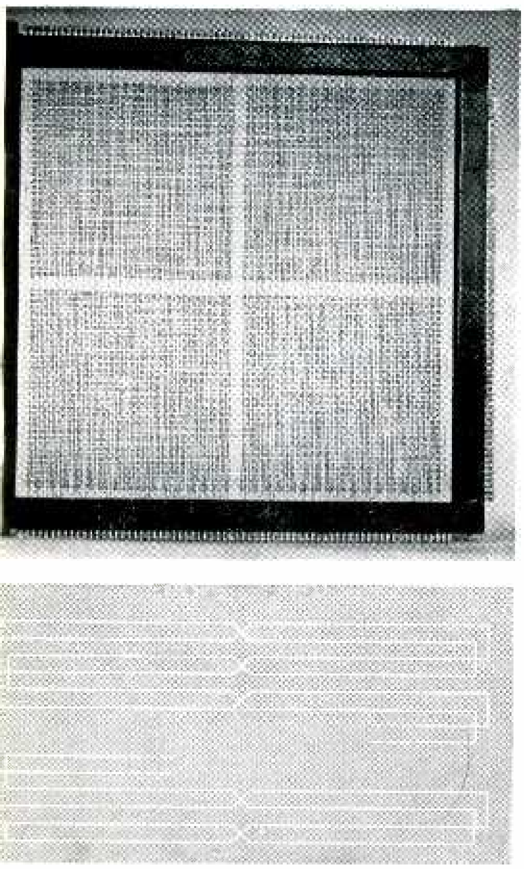

FIG. 1—Plane of core memory elements, top, with arrangement of sense windings for minimum noise

The number of lines that are activated to select and store information at any given address in a memory determines the dimensions of memory selection, with most core-memory systems today having either two or three dimensions of selection. Two-dimensional memory is often called word-organized, word-oriented, linear access, or just 2-D memory. Two-dimensional units are used in small, fast memories, but the cost of logical selection usually tends to make such two dimensional memories uneconomical for large-capacity storage. In large-scale memories, three dimensional or 3-D selection becomes less costly than 2-D.

In the three-dimensional memory of 16,384 words, each word is addressed by selecting one of 128 X lines and one of 128 Y lines. Information is stored in 3-D, and also 2-D, by a digit or bit, or Z line, that permits a 1 or a 0 state to be set in each core of the selected word. In a two-dimensional memory of the same size, a single line must be selected to address a word; that is, one of 16,384 word lines is selected. The cost difference between 3-D and 2-D is between selection for only 256 lines in 3-D and selection for 16,384 lines in 2-D.

The IBM 7302 core storage unit has 16,384 words addressed by three-dimensional selection. Each word has 72 bits of information for a total storage unit capacity of 1,179,648 bits. A magnetic core for each of these bits is set to one of its two possible remanant states to store either a 1 or a 0 in binary. The cores are ferrite material and are switched by the coincidence-of-address selection currents. The memory cycle time is 2.18 microseconds. There are no programming restrictions, so that any random address may be selected repetitively at full cycle time.

The memory is a solid-state system. Graded-base transistors are used as logic and sensing elements and as core drivers. The ferrite cores are conventional torroids 30 × 50 ×12 mils in size.

Cores for the memory were selected on the basis of switching time and drive current. For a 2.18 μsec cycle time, maximum core switching time was set at 0.4 μsec, and nominal half-select current at 0.6 amp or less with 0.1 μsec rise (T_r) time.[1,2]

Actual core parameters are: full-select current of 1.17 amp nominal with T_r at 0.1 μsec, and delta noise at 1.0 mv per pair. Under marginal drive conditions switching time is 0.43 μsec maximum with minimum 1 at 110 mv and maximum 0 at 33 mv.

Figure 1A shows a complete plane of cores. The over-all plane is approximately 10 inches square with a center-to-center core spacing of 0.0625 inch. Each of the 72 planes has one bit for each word in the memory, or a total of 16,384 cores; these are wired into a 128 × 128 matrix.

The Z lines include four sense windings and four inhibit windings; each of these link a rectangular core-matrix 32 × 128. The sense and inhibit matrices are interlocked and perpendicular to each other. This configuration allows only 1,024 cores to share a given pair of windings, and reduces the proportion of core noise in the total sense segment noise caused by pulsing an inhibit segment.

The shape of the sense segment is rectangular for optimum use

Accommodates One Million Bits

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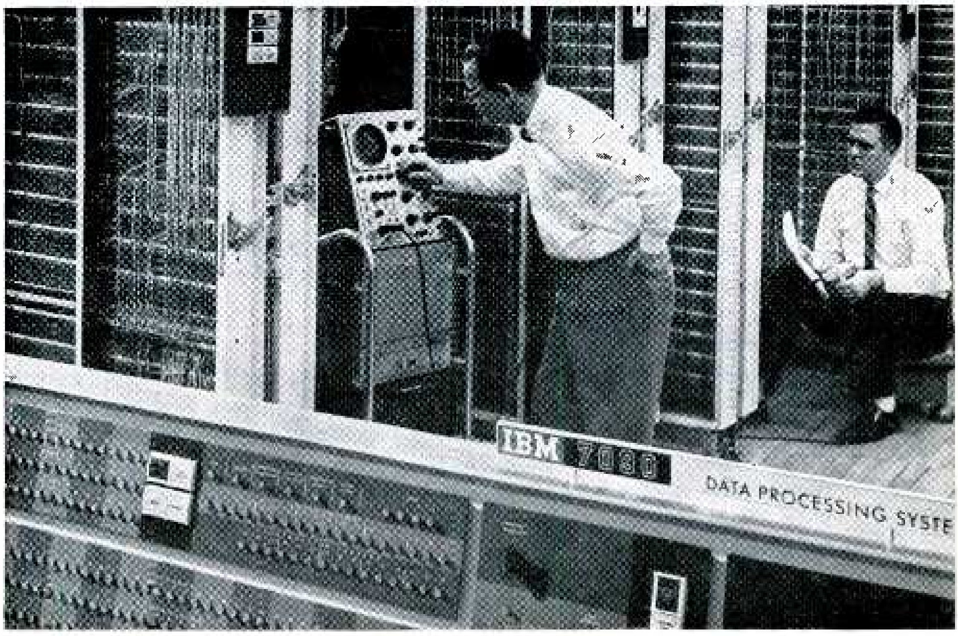
with staggered read. Compared with a conventional square segment, this shape reduces by 50 per cent core half-select noise at strobe time.

All but the sense windings are conventional. The sense configuration, Fig. 1B, has the following advantages over diagonal winding: shorter physical and electrical length decreases signal attenuation and delay. Smaller time delays between cancelling components improve noise cancellation. Transmission characteristics of the X lines become approximately equal to the characteristics of the Y line. This last advantage occurs because the sense line is parallel to the X line just as the inhibit line is parallel to the Y line; this provides uniform distributed capacitance from both X and Y to array ground. The same wire orientation is maintained in every core: the sense and X lines are separated by the inhibit and Y lines to reduce capacitance and assure its uniform distribution. Originally this arrangement caused electrostatic coupling between the adjacent inhibit and Y lines; that is, when a large number of inhibit drivers were turned on, capacitively coupled noise spikes were propagated on the Y lines. This problem was solved by careful pulse timing.

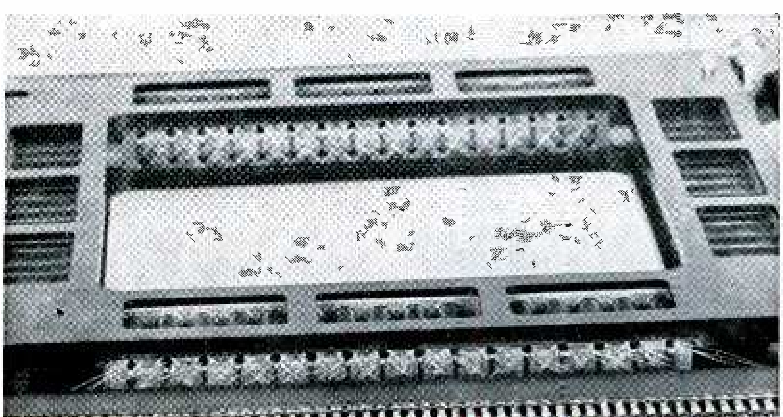


Engineers check out a newly installed 7090 digital computer. This machine uses transistor logic and core storage

The 72 planes of the complete array are connected by word selection lines. The 16,384 words of the basic memory have 72 bits each. With the IBM 7090, however, the array operates with 32,768 words of 36 bits. In this modified system, two words are read out simultaneously.

In the initial design of word selection, electromagnetic and electrostatic coupling between selection lines was a serious problem. Close spacing between adjacent lines, rapid change rate of drive current, and relatively long lines led to noise spikes on unselected lines during drive-pulse rise and fall; these spikes were greater than 35 per cent of the drive current.

FIG. 2—Part of the load sharing matrix switch



The problem of this cross-talk was solved through two measures. First, the external array jumpers for the X and Y lines were connected so that any two would be adjacent in only a few planes. In other words, any two selection lines, each comprised of 72 connected X or Y lines, would at worst be immediately adjacent over only a small part of their total length. In this way, the worst possible coupling occurred only between alternate lines that ran parallel through most of the array.

Second, alternate planes in the array were turned over; this arrangement separated the planes in a pair by only about 0.06 inch, but separated the pairs by 0.75 inch.

The combination of both corrective measures reduced cross-talk between lines to less than 10 per cent of the drive current. In the final machine, this reduced percentage was more than enough to eliminate cross-talk problems.

Cooling was another important consideration in designing the basic array. Excessive heat can cause undesirable changes in core properties. Because one address may be selected continuously, core temperature stabilization was required. To achieve good heat transfer and uniform temperature distribution in spite of a power dissipation of about 42 mw in each core switched, the array was immersed in liquid.

All windings in the array resemble lossless transmission lines and terminate in pure resistances equal to their characteristic impedances. The liquid environment with its increased dielectric constant decreased Z_o and increased the time delay (T_d) in all lines. This undesirable increase in T_d was a most important consideration in selecting the liquid. As a result, a commercial inhibited transformer oil with a low dielectric constant was chosen as the coolant.

The choice of a liquid environment yields several fringe advantages: the entire array, together with load-sharing switch assemblies and terminating resistors, is immersed in a tank of oil more compact than a blower system would have been. Lower rated power resistors can be used, and the reduced Z_o value eases demands on the inhibit drivers.

Because the X and Y lines have the same distributed inductance and very nearly the same distributed capacitance, the properties of both lines are virtually identical. Immersed in oil, the lines have a Z_o of 100 ohms. Since the drive system produces a nominal half-select current of 0.585 amp to be driven into this impedance, read and write pulses must be 58.5 volts. With the same current, the inhibit drive requires 53 volts across the Z line impedance of 90 ohms.

A load-sharing matrix switch[8] provides read and write pulses in the X-Y drive system. The use of a direct drive system would require a peak inverse voltage of at least 125 volts because read and write currents are of opposite polarity and the X and Y drive lines must be driven bidirectionally. Existing high-speed core-driver transistors cannot reliably withstand voltages this high. Furthermore, a conventional matrix switch would be unsatisfactory because of high inductances and the excessive currents needed to provide the voltage step-up. A load-sharing switch, however, provides pulses with reasonable transistor dissipation and

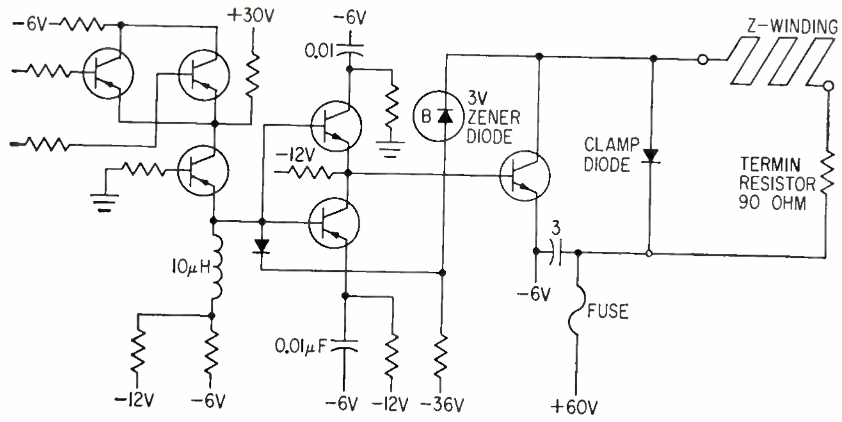


FIG. 3—Schematic of the circuit that feeds the Z selection lines; this circuit is similar to those used in the X-Y drivers

permits voltage step-up without either excessive power per drive, or high series inductance.

Figure 2 shows a 16-output load-sharing matrix switch. Each address-selection coordinate of the memory uses eight of these devices, for a total of 16 switches. Each switch has 32 single-turn input windings, 16 nine-turn output windings and a bias winding.

An address is selected from the memory address register by the decoding logic. For a given address, the logic generates two patterns, one to turn on the drivers of the Y-axis switch and one to turn on the drivers of the X-axis switch. In both switches 16 drivers turn on at read-time and a complementary 16 turn on at write-time. Drivers are in pairs, and the address determines which of the two conducts for read and which conducts for write. As a result, driver currents of opposite polarity for read and write cancel out in all but one of the 16 switch cores. At the same time, the one switch core receives the total current of 16 drivers for both read and write.

Because the switch cores are in a low remanent state at the start of each read current pulse, maximum core flux is required; this is furnished by the d-c bias winding, which provides a slight average current unbalance in each switch core.

Each X-Y driver has a nominal current of one-sixteenth of the switch core magnetizing current plus 56 per cent of the half-select current; this is about 0.36 amp. With a 9 to 1 step-up ratio, the 32 single-turn windings of the switch each require less than 8 volts. The X-Y drivers terminate in a 56-ohm resistance to 30 volts plus the total resistance of the leads and switch windings.

A medium-power graded-base transistor is used in the X-Y driver circuit. The germanium transistor, packaged in an air-cooled sink, operates about 3 volts out of saturation. A Zener diode in the feedback loop determines the operating level of the output.

The Z driver circuit has the same configuration as the X-Y circuit; this is shown in Fig. 3. The Z circuit also uses the medium power transistor. Transistor specifications include a rating of 90 volts for collector-to-emitter breakdown voltage with a grounded-emitter large-signal current gain greater than 100 at 0.66 amp.

A direct drive supplies the inhibit current to the 32 × 128 segment of the core plane. The Z winding terminates in a 90-ohm resistor plus wiring resistance to a 60-volt supply. Excessive peak voltage is prevented from reaching the driver transistor by a clamping diode.

Timing for the Z driver is staggered for two reasons. First, since the Z and Y lines are parallel, charging currents are induced on the Y windings when the Z pulse turns on and off. By phasing the Z pulse timing to groups of planes, the cumulative effect of the charging currents is reduced.

Second, the write pulse propagation time through 72 planes is 220 nanoseconds. In each plane inhibit pulse timing must overlap this write pulse. However, time-stag-

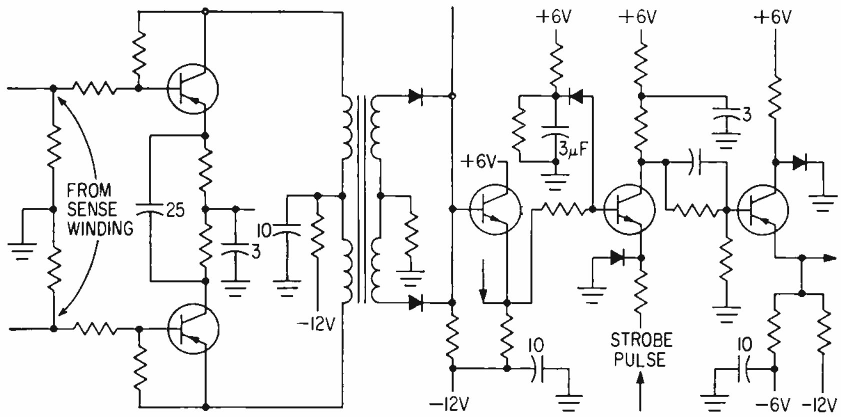


FIG. 4—Sense amplifier handles readout signals and has high gain for component frequencies in the range 300 to 800 Kc

gering the Z pulses to overlap an early write pulse in the first planes and a delayed write pulse in the last planes reduces the total memory cycle. Furthermore, the Z pulse width can be reduced, and for the next cycle, read time can start sooner into the top plane.

The delay of the Z current is about 80 nanoseconds in oil and the characteristic impedance is 90 ohms. The delay of the X and Y currents is about 200 nanoseconds with a Z_o of 100 ohms. Drive currents into the array have rise and fall times of about 100 nanoseconds.

Since the windings resemble lossless transmission lines, each must terminate in a resistance equal to its Z_o, or risk long recovery times and reflections.

The resistive load presented to the drive systems is virtually constant. Wire resistance causes some current distortion, but this is minimized by the matrix switch. As the series resistance of the line becomes effective, the current into the first plane decreases slightly. The line presents a load of 100 ohms at the beginning of the pulse; this resistance increases, however, as the wavefront propagates through the array. Therefore, the peak input current to the first plane is higher than the peak output current from the last plane. With a series resistance in each primary driver, the matrix switch allows some primary winding voltage change. This aids in matching the driver system to the array by compensating for some wire resistance.

The sense winding is segmented for three reasons. First, the common-mode Z noise on each sense amplifier for a segment is reduced to one-sixteenth the noise of a full 128 × 128 sense and Z plane.

Second, the time difference is reduced between the signals traveling in two directions from a switching core in the plane. If the time difference is too great, strobe timing must be wider, two half-amplitude signals will be sensed at different times, and cycle time increases somewhat.

Third, with the Y-axis drive intersecting only 32 cores on each segment, the winding reduces the delta noise. Part of the read-drive noise on the sense line is the noise level remaining from the first of two staggered read pulses; this pulse intersects 128 X-axis cores in each plane and runs parallel to the sense winding. The rest includes the half-select noise of the one uncanceled core of the Y-axis drive, and the delta noise caused by the current rise of the second read pulse. Because of the segmented configuration, only 15 core pairs contribute to the delta noise.

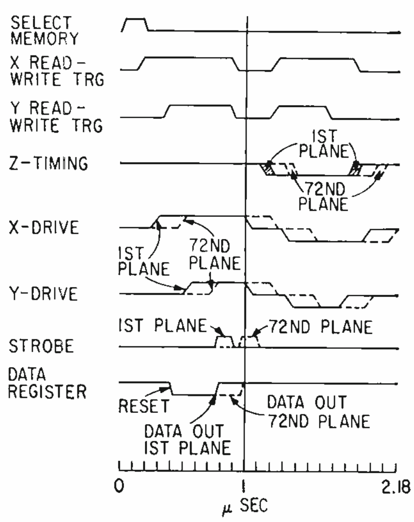


FIG. 5—Timing of control waveforms circulated in the core-storage unit

Figure 4 shows the sense amplifier circuit. Each sense segment uses four preamplifier channels. Frequency discrimination is used, and much of the relatively high frequency noise on the sense winding is blocked by the circuit cut-off frequency. In addition, the amplifier strobes and sets a clipping level for the usual amplitude and time discrimination.

Prior to strobe time, frequency discrimination of more than the bit one signal attenuates readout noise in the sense amplifier. For a band of frequencies in the 200 to 800 Kc range, the bit one has a relatively high amplitude. Because of the interstage transformer, low cut-off frequency of the preamplifier stage is about 100 Kc. High cut-off frequency is about 2 Mc.

Figure 5 shows the cycle timing for the memory. Strobe timing of the sense amplifier resembles Z timing in that both are staggered in groups of planes. As the read pulse travels through the 72-plane stack, the sense strobe timing coincides with the core peaking time for each plane.

The IBM 7302 core storage unit is six times faster than its predecessor, the IBM 738. Both storage capacity and speed in the two units is similar. However, with the increase in speed and smaller size of the 7302, the advancement of technology is significant.

The coincident current memory has proved significantly more economical than the word-oriented type. Improved ferrites, components, and design techniques are further advancing core memory technology, and there is every reason to believe in the eventual feasibility of coincident current core memories which are even larger, faster, and more economical.

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Sensitive Microwave Radiometer Detects Small Icebergs

Since icebergs and sea water do not radiate thermal microwave energy at the same rate, their differing apparent temperatures allow radiometer to detect icebergs that are invisible to radar

By T. V. SELING* and D. K. NANCE*, AC Spark Plug Div., General Motors Corp., Milwaukee, Wis.

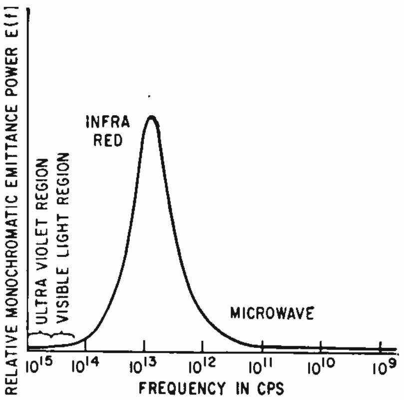

FIG. 1—Black body emittance characteristic

A NOVEL APPROACH has been tried for spotting icebergs in the North Atlantic shipping lanes. An experimental microwave radiometer has detected icebergs by using the same property that makes the icebergs difficult or impossible to detect by radar.

The U. S. Coast Guard operates the International Ice Patrol, responsible for charting the positions of icebergs and issuing warnings to ships. Coast Guard aircraft based at Argentia NAS, Newfoundland, do the patroling. In clear weather, icebergs can be spotted by eye. When the area is blanketed by fog, which is most of the time in that area, the patrol planes have to rely on radar.

Icebergs are poor radar targets because they are highly absorbent for microwaves; in radar terms, they have small backscatter cross-sections. Small icebergs, called growlers, cannot be detected at all except with carefully adjusted radars. Also, it is hard for radar to tell the difference between an iceberg and a ship.

For these reasons the Coast Guard decided to look into microwave radiometry—measurement of radiant energy in the microwave region—as an alternative to radar for locating and identifying icebergs. Initial studies were encouraging and a feasibility test was made with equipment installed in a Coast Guard patrol plane.

The concept of apparent temperature was used to predict test results. A black body, according to Planck's law, radiates energy as a function of temperature and frequency, as shown in Fig. 1, and as given by

$$E(f) = 2\pi h f^3/[c^2\,(e^{hf/kT} - 1)]$$

where $E(f)$ is spectral emittance in watts/m^2/cps, f is frequency in cps, h is Planck's constant (6.62×10^{-34} joule sec), c is the velocity of light (3×10^8 m/sec), k is Boltzman's constant (1.38×10^{-23} joule/deg K), and T is absolute temperature in degrees K.

In the microwave region the exponential term can be replaced by a series expansion, resulting in the Rayleigh-Jeans Law, which states

$$E(f) = 2\pi k T f^2/c^2$$

The Rayleigh-Jeans law can be used throughout the entire microwave spectrum and well into the infrared region without significant error.

It can be shown generally that any antenna has an average gain inversely proportional to the square of the frequency. The net combination of the square-law frequency

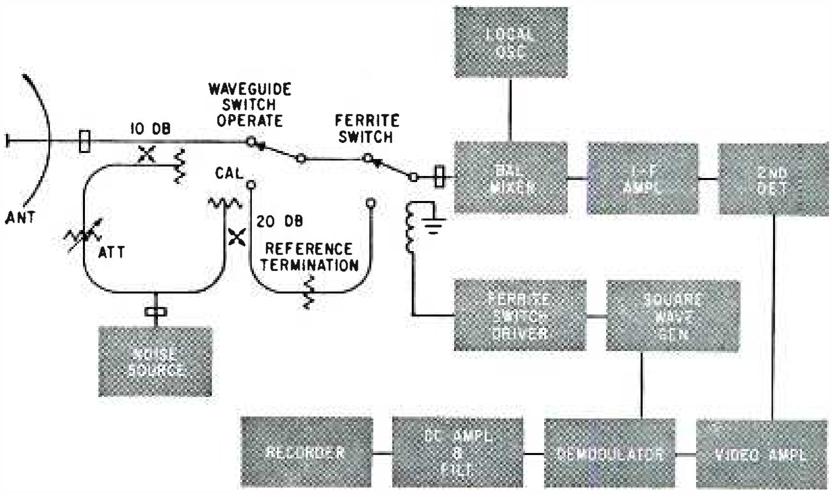

FIG. 2—Noise generator provides a reference signal corresponding to temperature of about 20 C, and also provides signal that keeps system output zero except when target is present

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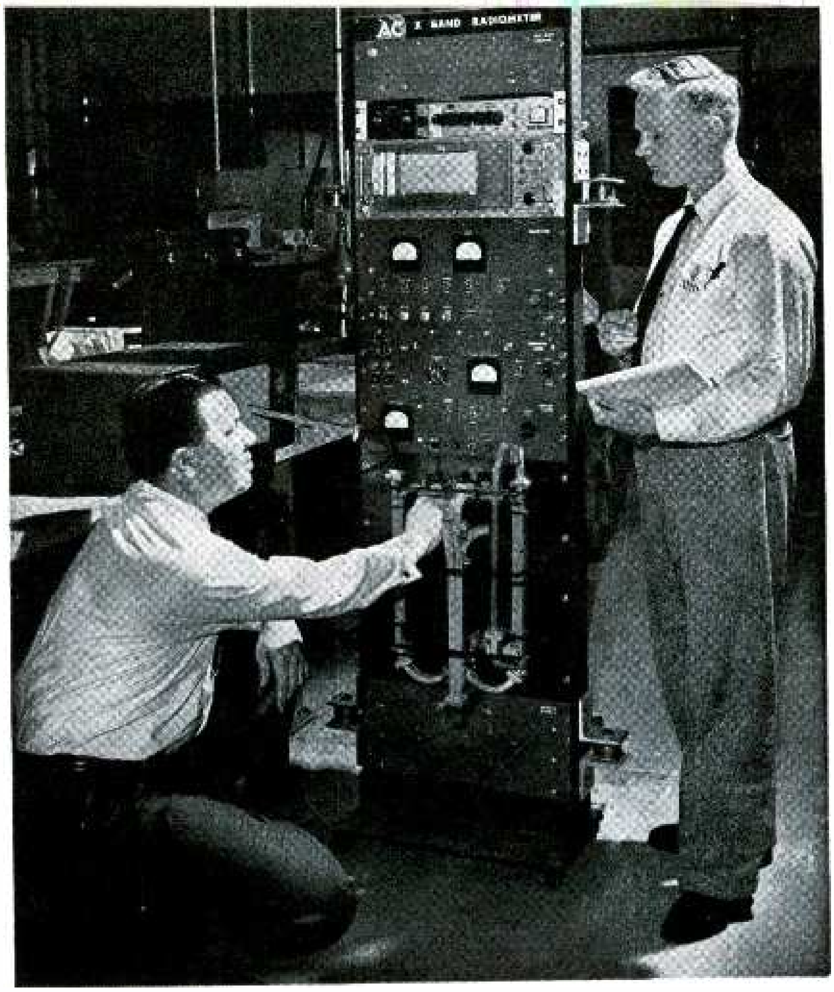

Authors are calibrating the radiometer with dummy antenna at −18 C

dependency of the thermal radiation and the inverse square law of frequency dependence of antennas makes the thermal radiation received by a microwave antenna independent of frequency. Thus, the received thermal radiation is proportional only to the temperature of the target and the bandwidth of the receiving system. That is, $P = kBT$, where P is the received thermal power in watts, B is the bandwidth of the receiver and k and T are as previously defined.

Most objects are not "black" in the microwave region but radiate with an efficiency ϵ, the emissivity. A simple thermodynamic argument shows that the emissivity of any object is equal to its absorptivity, α, and also equal to one minus its reflectivity, ρ:

$$\epsilon = \alpha = 1 - \rho$$

The *apparent temperature* of an object is the temperature that a black body ($\epsilon = 1$) would have to be at to radiate the same amount of power. The sky appears cold at microwave frequencies, about −250 C in the 3-cm band. In the same frequency range the sea, with an emissivity of 0.35 and a reflectivity of 0.65, has an apparent temperature of −150 C. But icebergs, with emissivity and absorptivity of about 0.9, have an apparent temperature of −50 C, or 100 C hotter than the sea. Thus the high absorptivity of ice makes it a good target for a radiometer but a bad one for radar.

Emissivities were computed from the dielectric constants and conductivities of ice and sea water. Icebergs proved to have somewhat smaller emissivities, probably because they were covered with a thin film of water.

A radiometer antenna will indicate an antenna temperature equal to the weighted average of the temperatures of everything in its field of view. The idea of antenna temperature can best be explained in terms of the received thermal power. The total available noise power (Johnson Noise) from a resistor terminating a transmission line is given by $P = kBT$. Therefore the antenna can be considered a termination of the receiving transmission line that is at a temperature equal to the weighted average of the temperature of everything within its field of view.

If a small iceberg fills only part of the field, the rise in antenna temperature will be less than the apparent temperature difference between the sea and the iceberg. For the feasibility test, the standard iceberg was chosen to be a growler 40 feet across. Icebergs much smaller than this are generally not considered dangerous to shipping. The system used in the feasibility test was an X-band (9,000 Mc) radiometer using a two-foot parabolic antenna with a beamwidth of four degrees. At an altitude of 1,000 feet, the change in antenna temperature was predicted to be approximately 30 C for a 40-foot growler.

The experimental system was a comparison radiometer. The system block diagram is shown in Fig. 2. Following the antenna are the microwave circuits for calibration and noise balancing. Calibration is done by switching the input between the two ends of a double-ended termination. This termination is used to insure that in the calibrate mode, the system output is zero. This corresponds to a target at ambient temperature. After the system zero is established, a test signal from an argon-tube noise source is injected into the reference termination through a 20-db precision multihole directional coupler. This provides a test signal equal to an apparent temperature of approximately 50 C. The noise source is divided by a waveguide tee so that the equivalent reduction in the temperature of the noise tube is 23 db.

In operation, the ferrite switch connects the receiver alternately to the antenna and reference termination. With the antenna pointed at the water, the antenna temperature is approximately −150 C, while the reference temperature is approximately 20 C. To minimize the effects of receiver gain variations, a small amount of noise is injected in the antenna transmission line through a directional coupler to make the apparent antenna temperature equal to the reference temperature. The system's output is always zero except when a target is present, and the variations in the receiver gain do not produce

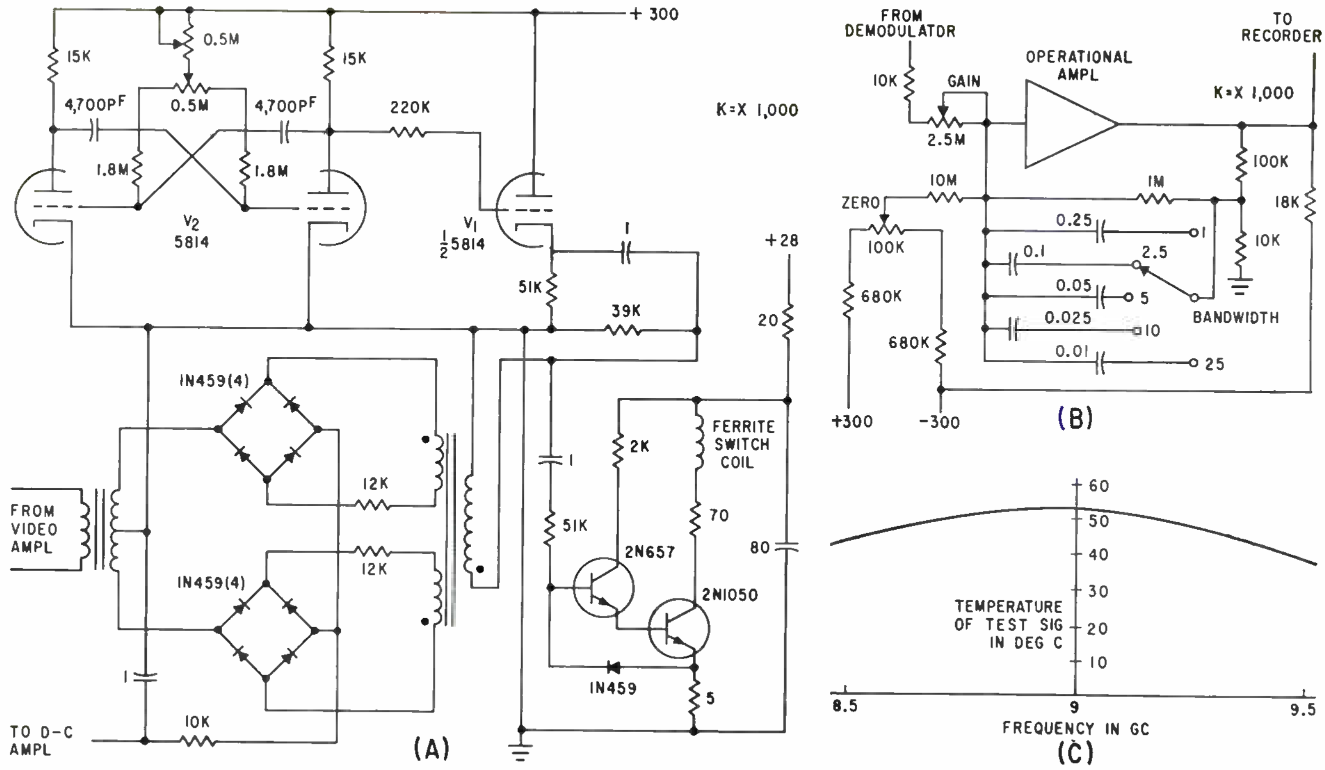

FIG. 3—Demodulator and ferrite-switch driver (A); amplifier-filter (B); frequency sensitivity of test signal (C)

false targets or increased noise.

The ferrite switch is a Faraday rotational type driven at 125 cps. The square-wave-modulated noise signal is amplified by a modified X-band radar receiver. The balanced mixer uses matched 1N23C diodes. Receiver bandwidth is 5 Mc and the noise figure is 8.5 db (double sideband). Following the second detector is the video amplifier which amplifies the detected square wave. At this point the amplitude of the square wave is proportional to the difference between reference temperature and antenna temperature. With noise balancing, this difference is zero when no target is present. The amplified square wave is detected by a phase-sensitive demodulator, which produces a d-c voltage proportional to the change in antenna temperature and the polarity of the signal: positive for warm signals, negative for cold. This d-c output is amplified and filtered with a d-c operational amplifier. The d-c amplifier is used to drive a Brush recorder.

The 125-cps timing square wave is generated by a free-running multivibrator. The multivibrator output supplies the reference voltage for the phase-sensitive demodulator and the drive signal for the ferrite switch driver. The ferrite switch driver is a two-stage transistor current amplifier used as a single-ended switch to control the coil current of the ferrite switch. A small bar magnet is used to bias the ferrite switch so that a single-ended driver can be used. The schematic of the demodulator and ferrite-switch driver is shown in Fig. 3A.

Demodulator output is amplified and filtered by a Philbrick UPA-2 operational amplifier. This stage provides a gain control, low-pass filter with variable cutoff frequency, and zero adjust for the pen recorder that is driven directly by the amplifier. The schematic of the amplifier-filter is shown in Fig. 3B. The 18,000-ohm resistor from the amplifier output to the −300 volt supply is used to shift the operating point of the amplifier stage to provide equal response to signals of both polarities. This is necessary to compensate for the loading of the pen recorder. The bandwidth of the amplifier is calibrated directly in equivalent noise bandwidth.

Output fluctuations due to receiver noise had an rms value of 4 C referred to receiver input, with output bandwidth of 2.5 cps.

Environmental tests were made on the radiometer system to ensure that humidity, cold storage, and vibration did not affect the system performance.

Final calibration of the system was made by checking the standard test signal from the argon noise tube against a cold load. A dummy antenna was placed in a temperature chamber and allowed to stabilize at −18 C.

By using the cold load and measuring temperature of the reference

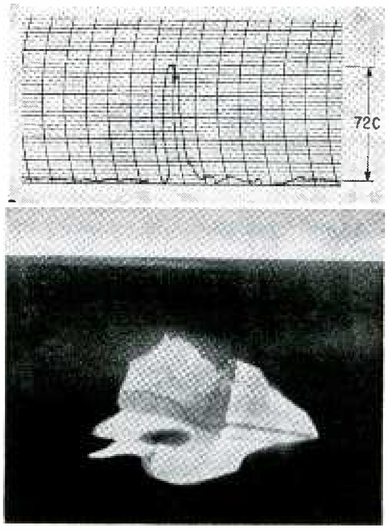

FIG. 4—Iceberg with puddle of water makes its own distinctive trace

termination, absolute calibration of the radiometer was made. A cold load was used rather than a hot load to simulate more closely the expected signals and to minimize the effect of detector nonlinearities. Figure 3C is a plot of the value of the standard test signal against frequency. Frequency sensitivity is due to variations in the waveguide components.

The radiometer was mounted on a relay rack and suspended by rubber shock mounts in a frame bolted to the aircraft. In one of the photographs the equipment is shown being calibrated by the authors. The waveguide at the left led down to the antenna, a two-foot paraboloid with Cutler feed, bolted to the airframe and pointing straight down. An aluminum box with a honeycomb plastic bottom was riveted to the skin of the aircraft as a radome.

The installation was made and checked out in flight in less than two days. The fixed antenna required only a small hole in the aircraft and no structural modification. Targets were detected by flying directly over them, with either radar guidance or by eye. A system for operational use would need a scanning antenna.

A short flight near Milwaukee showed that the equipment was operating properly. The shore of Lake Michigan made a convenient target, since the apparent temperature of the beach was about 20 C, and that of the water about −150 C.

The aircraft was flown to Argentia Naval Air Station, Newfoundland, headquarters of the International Ice Patrol. A series of flights was made over icebergs and ice fields. Icebergs of different sizes and shapes showed a striking uniformity in apparent temperature, 60 to 70 degrees C warmer than the sea. This was less than the 100 degree difference predicted from theory, probably because of a thin water film on the ice.

Figures 4 and 5 show results. The puddle visible on the iceberg of Fig. 4 shows as a dip on the radiometer recording. Figures 5A and 5B show recordings of a large iceberg. The first was made from 500 feet, just under a thick cloud layer; the other, from 2,400 feet, just above the clouds, showing that the effect of cloud cover on detectability is slight. The sharp pip of Fig. 5C is the recording of a growler about the size of an automobile, seen from 500 ft. This growler could not be seen on radar.

A series of flights was made over various types of ships. Metal ships had been expected to appear colder than the sea, since the emissivity of metal is almost zero. However, the apparent temperatures of ships ranged all the way from 50 degrees below sea temperature to 80 degrees above. Ships are made of many different materials topside, and metal ships are often largely nonmetallic when seen from straight overhead. Figure 5D shows the recording of a freighter that looked hot at one end and cold at the other. Thus, ships could be told from icebergs by scanning with a narrow beam.

The experiment showed that icebergs make good targets for a radiometer, even when they are not visible to radar, and that ships have a signature on a radiometer that they do not have with radar (both positive and negative outputs).

Besides iceberg detection, experiments with several other applications of microwave radiometry have been made in surveillance, detection and navigation.

A surveillance radiometer operating at K_a band (35,000 Mc) was built to evaluate the capabilities of high-performance rapid-scan radiometers. Figure 5D is a radiograph made with this radiometer and Fig. 5E is a photograph of the same area. Although this radiograph was made in 175 seconds, equal quality has been achieved in about 30 seconds. A great deal of detail can be seen in the radiograph: the supporting legs and central discharge pipe of the water tower; a telephone pole and its crossarm; the overhead lamp on the building at the right.

Reflections are important in interpreting microwave radiographs. Two men near the center of the picture are not detectable, since their apparent temperatures are near that of the background. Their reflections in the comparatively cold concrete walk, however, are visible.

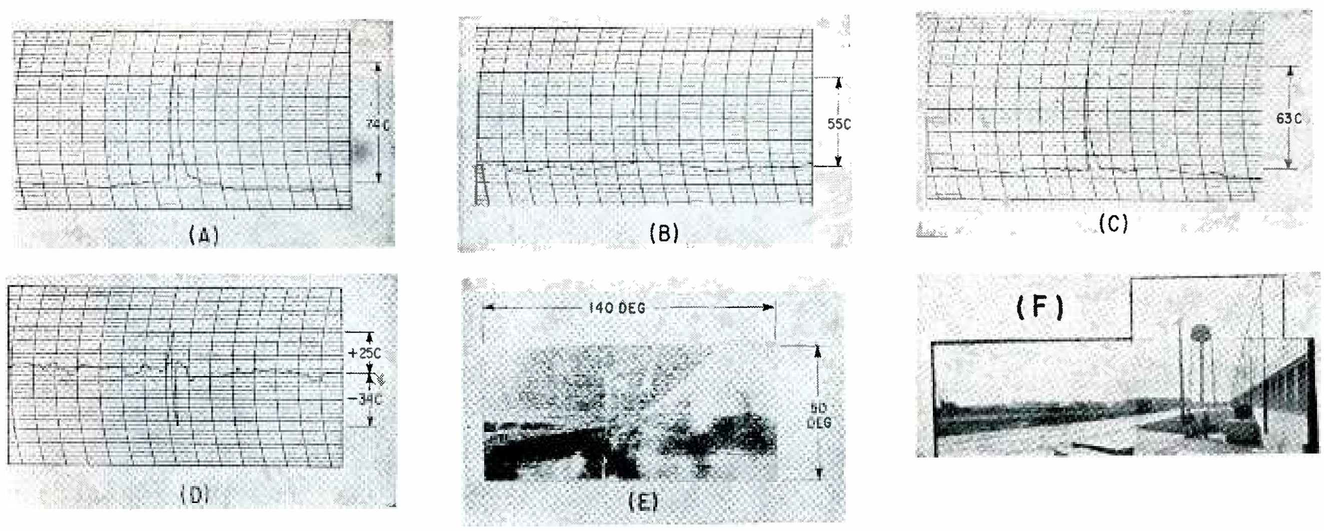

FIG. 5—Iceberg from 500 feet altitude just below a cloudbank (A), and same iceberg from 2,400 feet (B) above cloudbank: little difference is noticed. Growler signature from 500 feet (C). Positive and negative signature of a freighter (D). Radiograph (E) and photograph (F) of same scene

Monostable Pulse Generator

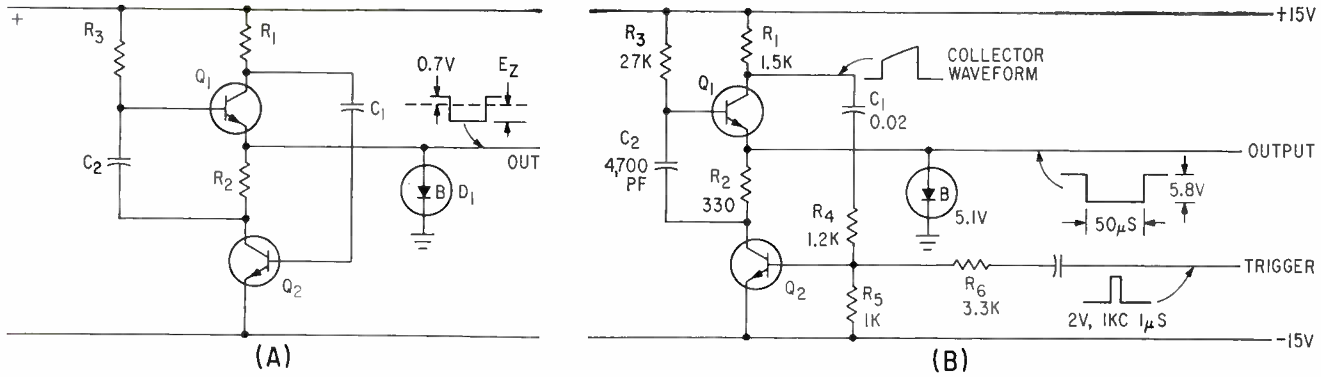

FIG. 1—Basic circuit (A) is adapted for use with positive trigger as shown by (B)

By C. M. STEWART,

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THERE IS A FREQUENT need for simple circuits that produce pulses of known length and amplitude when triggered by an external pulse. This circuit is useful in many applications.

The pulse generator circuit is shown in Fig. 1A. Initially transistor Q_1 is bottomed, drawing base current through R_3. Base current to Q_2 is blocked by C_1, therefore this transistor is cut-off and current flows from the positive supply through R_1, Q_1 and the Zener diode D_1 only. The Zener diode is connected so that the current is flowing from anode to cathode and the voltage drop across it is only 0.7 v. Voltage at the output terminal is 0.7 v above ground.

When the circuit is triggered, transistor Q_1 starts to turn off, and the voltage on its collector attempts to rise. Capacitor C_1 begins to charge through R_1 and the base-emitter junction of Q_2. The base current flowing into Q_2 turns Q_2 on and its collector voltage falls towards the negative supply. The voltage across C_2 was initially nearly zero and it cannot change instantaneously, therefore the fall in voltage on the collector of Q_2 is transmitted to the base of Q_1 speeding the turn off of this transistor. Action is regenerative with Q_1 turning off and Q_2 turning on.

Current through the Zener diode reverses as Q_2 turns on and Q_1 turns off. Voltage at the emitter of Q_1 will therefore fall towards the negative supply until it is caught below ground at the Zener voltage of the diode. The base of Q_1 will, however, be pulled down almost to the value of the negative supply by the bottoming of Q_2. Thereafter C_2 will begin to charge through R_3 towards the positive supply. Transistor Q_1 will remain off until the voltage on its base has risen above the value at which its emitter is clamped by the Zener diode. Transistor Q_1 will then turn on, reversing the flow of current into C_2 and the base of Q_2. Now, Q_2 will turn off, the action being regenerative until the original state is restored.

The pulse produced by this circuit has good rise and fall times because in each case the output voltage is charging towards one of the supplys and is caught by the Zener diode at a voltage less than the supply voltages. This is useful, particularly when the load has some capacitance. Output impedance during the length of the pulse is fixed by the dynamic impedance of the Zener diode and is of the order of 5 to 30 ohms. Output impedance

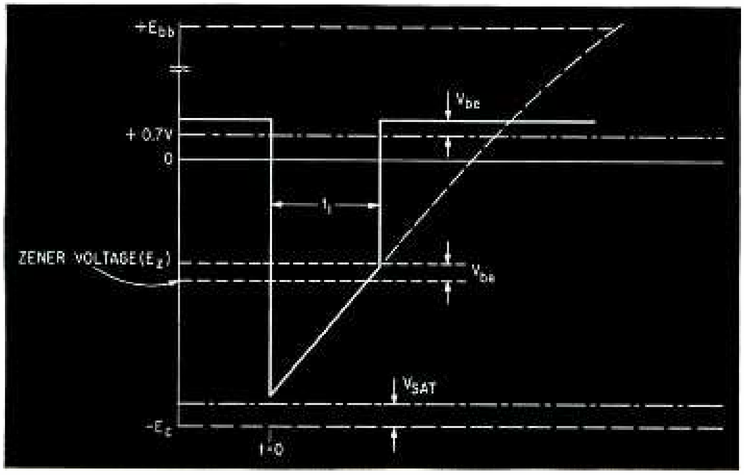

FIG. 2—Voltage waveform across C_2 is basis for determining expression for t_1

Employs Zener-Diode Clamp

during the rise time is fixed by R_2.

Figure 1B shows a circuit with some additional components. This circuit is triggered by a positive pulse and since, initially, Q_1 is bottomed, R_4 is required to prevent the pulse being decoupled to ground through C_1 and Q_1. Resistor R_5 provides a path for the current discharging capacitor C_1. Series connected resistor R_6 limits the current drawn from the triggering source. Value of this resistor depends on the trigger pulse voltage.

A diode may be necessary in series with the base of Q_1 if the maximum base-emitter voltage of the transistor is otherwise exceeded.

The circuit designer must know the length of pulse required; amplitude of pulse; and maximum current required from the pulse.

The amplitude of the pulses fixes the voltage of the Zener diode and this must be less than the voltage of the negative supply.

Maximum value of R_2 is determined by the maximum current required from the pulse. Most of the current through this resistor also flows in the load, but sufficient excess current must be allowed to flow through the Zener diode to enable it to stabilize.

Value of R_1 is fixed either by the permissible standing current of the circuit or the fall time required on the output pulse, particularly if the load has some capacitance.

Figure 2 shows the waveform on C_2. Here

$$t_1 = R_3 C_2 \log_e \frac{E_{bb} + E_c - V_{sat}}{E_{bb} + E_z - V_{be}}$$

Voltages V_{sat} and V_{be} are normally small compared with E_c and E_{bb}, hence to a close approximation

$$t_1 = R_3 C_2 \log_e \frac{E_{bb} + E_c}{E_{bb} + E_z}$$

where only the magnitude of E_c and not the sign is considered.

The maximum value of R_3 is that which provides just enough base current to Q_1 to bottom it in the initial state.

The time constant of $R_1 + R_4$ and C_1 must be long enough to hold Q_2 bottomed for a time exceeding the length of the output pulse so that this part of the circuit takes no part in the timing.

If the exact value of the external load is known, the Zener diode is not essential and the circuit can be modified as shown in Fig. 3A, but the output pulse will not be rectangular as the turn-on point of Q_1 is not so clearly defined.

If a voltage supply with a value less than that of E_c is available, diode catching can be used to eliminate the Zener diode as shown in Fig. 3B.

An extremely useful feature of this pulse generator is that it can also be triggered by a negative pulse as shown in Fig. 3C. Note that resistor R_4 is no longer required.

When R_4 is connected into the circuit, a positive pulse equal in length to the output pulse appears at the collector of Q_1 and this may be used externally provided the loading does not upset circuit operation.

This pulse generator circuit is intended for output pulses of from 2μs duration up to seconds. Leakage resistance of timing capacitor C_2 should always be much greater than resistor R_3 (Fig. 1A and 1B).

No special transistor type numbers are shown in the diagrams as a wide variety of types both *pnp* and *npn* have been used with equal success. The *pnp* types will give a circuit with positive output pulses.

Mark to space ratios of greater than 1 are easily obtainable.

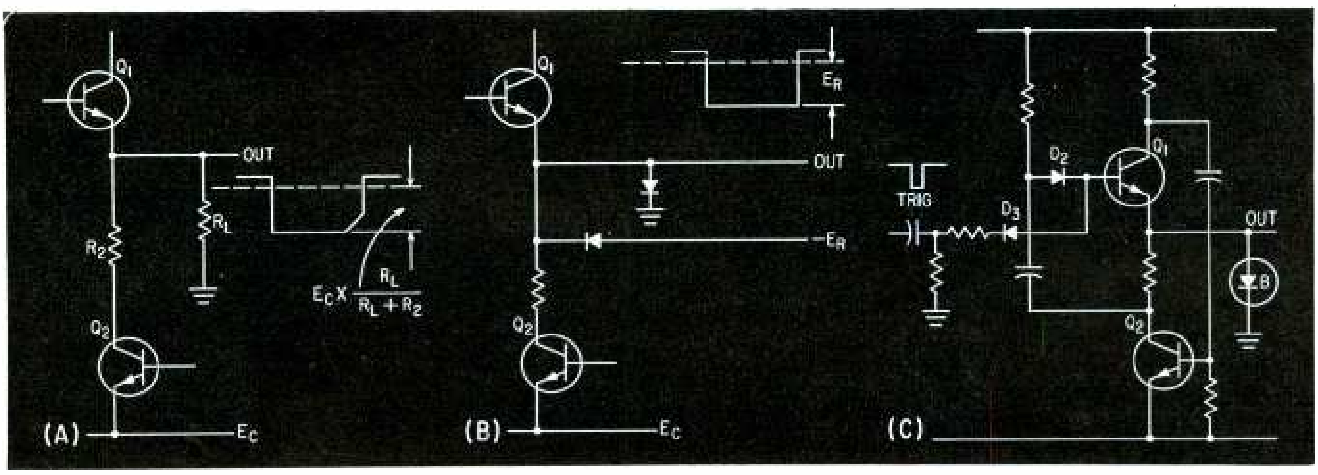

FIG. 3—Methods of eliminating the Zener diode are shown in (A) and (B). Circuit for triggering with negative pulse is given in (C)

Solid-State Parallel-Mode Scanner

Engineer checks oil temperature reading from scanner system, against direct reading from thermometer

Monitor system handles parameters that can be converted to a change of electrical resistance. A diode array checks the maximum or minimum values of input signal; by replacing the diodes with transistors, source of signal being displayed can easily be identified

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COMPLEXITY of modern instrumentation has increased the number and cost of indicators needed for showing the state of equipment within a system, and indicating whether the equipment is working properly. Scanning techniques using mechanical steppers are used for monitoring temperature, pressure, resistance and other variables on a serial or step-by-step basis; however, such systems are relatively slow in operation and are subject to mechanical wear and breakdown. This article describes a solid-state monitoring system that checks a range of variables in a parallel (rather than serial) mode and reports when any one of the measured parameters exceeds (or falls below) a predetermined limit.

The parameter to be measured may be of any physical or electrical variable that can be expressed as a change of resistance. Some of physical quantities for which transducers exist are temperature, pressure, gas density, resistance, vibration, light intensity, displacement (linear or rotation), level (conductive liquids), acceleration and strain gages (high level). Developments in transducer engineering are certain to expand this list.

An early use of one monitor to observe several different inputs consisted of an indicator and its manually operated selector switch. This led to a single indicator with memory capability (peak reading VTVM's) and a stepping switch. Recent developments include solid-state switching techniques to increase the reliability and speed of mechanical systems. However, the basic sequential nature of such systems leads to defects and in some circumstances it is possible for a failure to occur before the stepper has had time to report a fault condition.

The use of computer type OR and AND circuits for minimum and maximum selection is cited in the literature.[1] A typical circuit is shown in Fig. 1, for which the output voltage E_o will be approximately equal to the lowest of the input voltages. The output voltage E_o will actually exceed the minimum input voltage by the magnitude of the d-c drop across the diode. At low transducer outputs, the drop across the conducting diode is signicant and it becomes necessary to employ a compensating diode D_4 as shown in Fig. 1. The compensation circuit shown in Fig.

Reads System Physical Parameters

1 results in similar bias currents through both conducting and compensating diodes for the entire range of input signals when used with a servo indicator. This circuit yields an error due to discrepencies in diode characteristics. If a nonrebalancing indicator is used (a vtvm is a typical example) then it becomes difficult to maintain similar currents through the conducting and compensating diodes. This will result in an additional scale error of small magnitude.

The demands of military and industrial instrumentation almost preclude the use of germanium diodes for these circuits. A typical silicon diode will exhibit a d-c drop of 0.2 to 0.7 volt over a wide range of ambient temperature (−65 C to +100 C). In most accurate instrumentation systems this 0.5-volt variation cannot be neglected and some technique must be used to compensate for the error. In addition, analytical investigation reveals a range of about 0.1 volt in which two diodes are partially conducting. Within this region of multiple diode conduction, the output voltage is a complex function of input voltages and diode characteristics. The output voltage is, however, bounded by the two active input voltages and is always between these narrow limits.

The circuit of Fig. 1 selects the algebraic minimum of the input voltages. Thus, a polarity reversal of the transducer supply voltage gives a circuit whose output is equal to the maximum input voltage. Other configurations of supply voltage are also possible and yield circuits with similar appearance and properties.

Figure 1 circuit offers a method of achieving adequate scanning performance with an economical and reliable system. It does, however, contain some inherent features that result in performance disadvantages. Since it is a pure d-c system, it requires d-c indicators. While the output levels are fairly high, use of chopper stabilized direct-current vtvm's or d-c servos increases system cost. This system is also unable to identify the source of signal that it displays.

The system to be described retains the best features of Fig. 1, while offering improvements in performance and reductions in circuit complexity. The circuit of Fig. 2 uses an OR circuit in an a-c—d-c configuration to achieve its objective. The circuit uses a servo indicator, but similar operating characteristics may be obtained with vtvm indicators. The a-c and d-c voltages are in tandem across the transducer potentiometers. The magnitude of a-c or d-c voltage at the wiper reveals the amplitude of the physical parameter being sensed. The d-c voltage opens or closes a diode. The a-c signal voltage is thus transmitted with no loss in amplitude. Once the signals have passed through the conducting diode, it is easy to block the d-c with a coupling capacitor and measure the a-c output voltage with an a-c indicator. Under the common conditions of one diode conducting and the remaining diodes off, the d-c drop across the diode becomes unimportant. In addition, since the a-c resistance of the diode is negligible with respect to the input impedance of the amplifier (at null), the a-c drop may be neglected. Only when there are two or more inputs in close electrical proximity (within 0.10 volt d-c) does the dissimilarity between diodes have any effect. Under this condition, the output of the indicator will read somewhere between the two similar inputs. This region occupies such a narrow band that it may usually be neglected. A fur-

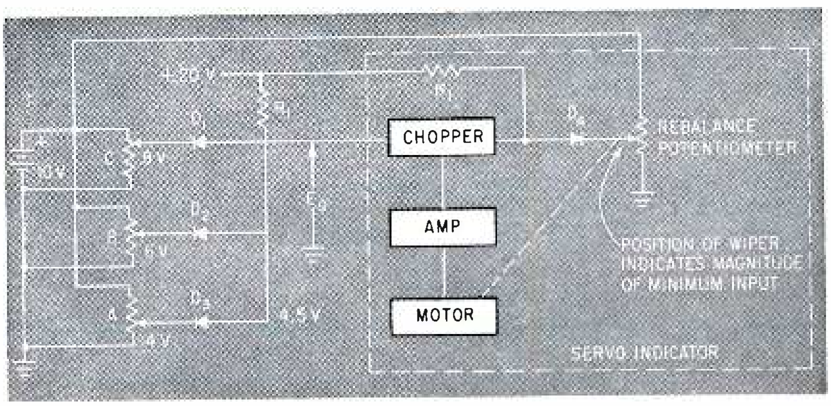

FIG. 1—In this basic three-diode monitor system, readout is obtained from the potentiometer with lowest output voltage

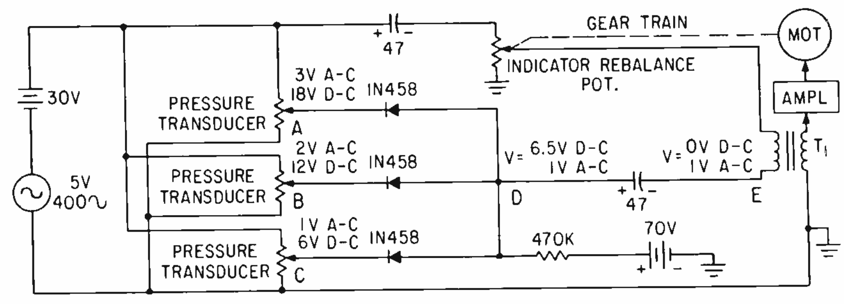

FIG. 2—Superimposing an a-c signal on the d-c control voltage overcomes variable diode conduction and permits an a-c servo to be used

ther advantage of this system is its immunity to change in diode bias current caused by variations in input or power supply levels.

Figure 1 uses potentiometer transducers (pressure vibration or acceleration). The same system may be constructed using resistive transducers (temperature and light intensity). This is done by driving each resistive transducer from a source of constant current a-c + constant current d-c. An example is shown in Fig. 3. The voltages across the resistive transducers may be operated upon as were the output voltages of the potentiometers. This method of using a constant voltage source in series with a resistor does not produce a true constant current, and the error produces a slightly nonlinear dial; however, the nonlinearity is small and is usually not obvious to the eye. The system of Fig. 2 can make a source identification scheme by substitution of transistors for diodes as shown in Fig. 4. Figure 4 is connected to transmit the highest signal and display this signal upon the common indicator. Investigation of the bias conditions with the assumed inputs reveals that the highest d-c voltage is transmitted through to the common emitter point *A*. If point *A* were to have the d-c potential associated with any input other than *B*, heavy base current would be drawn through the transistor associated with inputs *C* or *D*. This base current would draw additional current through R_1 and bring the potential of point *A* up to that of the highest input. This type of indirect reasoning can preclude any but the highest input being transmitted through to the output at point *A*. The component values may be designed to have sufficient collector current through the one conducting transistor to operate one of the source identifying devices (*E*, *F*, *G*). As before, reversal of certain bias voltages results in a system that can transmit, display and identify the lowest null.

The a-c voltage output at point *A* is the active input multiplied by the a-c gain of an emitter follower. This gain can be stabilized at 0.9985 ±0.0010, where it represents a variation in gain of 0.1 percent over a wide range of ambient temperature. The collector current of the active transistor may be designed to be in the 1 to 5-ma range. There are many ways of revealing the active transistor by visual or audible means, as Fig. 4 shows.

Transistors improve certain aspects of system performance. The selecting mode (common point of all emitters) is now fed from source impedances that are lower by the h_{fe} of the active transistor. This produces sharper transition areas and generally superior performance. The circuit selects and indicates the lowest pressure within 0.5 percent at room temperature. An additional error allowance of 0.5 percent is necessary to cover a temperature range of −55 C to +71 C. The complete system includes a manually operated selector switch that overrides the scan circuit and displays oil pressure at any particular point. This complete system (including power supplies for the transducers) was packaged in two 2 inch diameter cans of 3.5 inch length. Total system weight (exclusive of transducers) is 18 ounces. It is believed that each can length could be reduced by 0.5 to 1 inch.

Requirements for source identification increase system size and weight: it is estimated that a system with source identification and a manual selector switch could be packaged in two 2 inch diameter cans of 5 inch length.

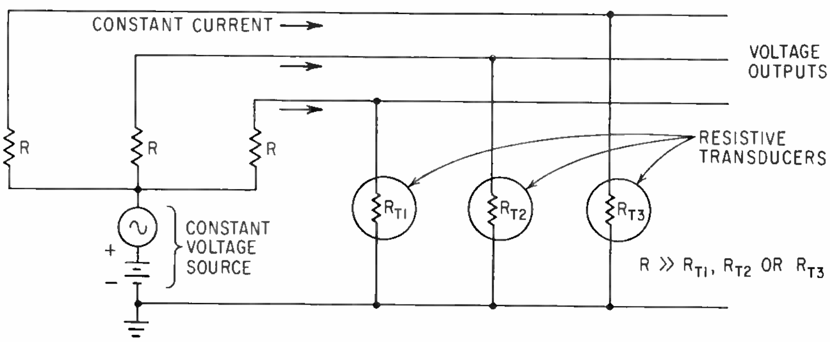

FIG. 3—When using resistive transducers, rather than potentiometer transducers, a constant current supply enables the output voltage to be directly proportional to transducer resistance

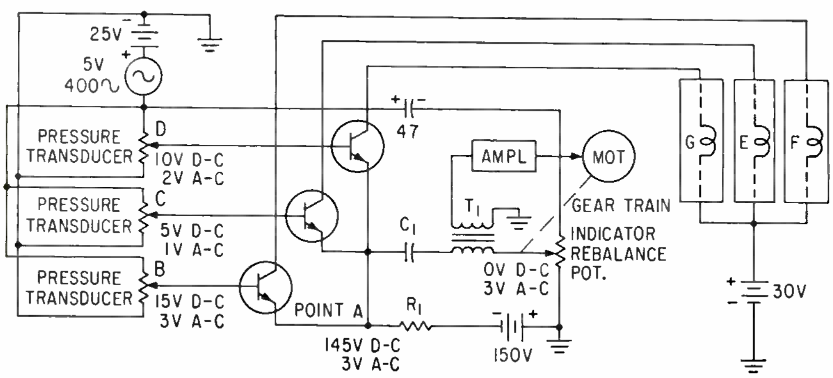

FIG. 4—Transistors in the monitor circuit, instead of diodes, operate an indicating device to show which transducer output is being displayed

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(1) Rose, Patent 2,783,453.

(2) D. M. Considine, Process Instruments and Control, Sec. 8, 34.

TRANSFORMING

Resistance-Capacitance and Resistance-Inductance Networks

These charts for canonic-one-terminal-pair R-C and R-L circuits eliminate tedious calculations in design problems involving network transformations

By H. J. BLINCHIKOFF,
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Westinghouse Electric Corp.,
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FILTERS designed with low-Q elements, preemphasis and deemphasis networks, phase and amplitude equalizers, and networks synthesized from prescribed functions all contain combinations of inductors, capacitors and resistors. Sometimes, because element values are impractical or because the quality factor (Q) of the reactance is impossible to obtain in a reasonable size, it is desirable to change the configuration of a network.

This article deals with the transformation of canonic one-terminal-pair R-C and R-L circuits. A canonic network is one that realizes a particular impedance function with the minimum number of elements. The equations transforming one network to another may be obtained in two ways. The first method is to set the impedance of one circuit equal to the impedance of the other. Equating the coefficients of the frequency terms yields simultaneous equations that must be solved for the transformation equations. The second method consists of synthesizing the impedance function into networks of Foster forms, Cauer forms or combinations of both. The charts here minimize the tediousness of making such network transformations.

Figures 1 through 14 show all possible transformations of three and four-element canonic R-C networks. Below each figure are the equations for performing the transformation. Equations for five or more elements are not given because of their infrequent use. However, they can be found by either of the two methods.

Separating the input impedance for R-C networks $Z(j\omega)$ into its real and imaginary parts, $Z(j\omega) = Re\,Z(j\omega) + Im\,Z(j\omega) = R(\omega) + jX(\omega)$, shows that the real part of an R-C impedance is a monotonically decreasing function of frequency. It has its maximum value at zero frequency and its minimum value at infinite frequency. The imaginary part of an R-C impedance is never positive from $\omega = 0$ to $\omega = \infty$: at zero frequency, it may be zero or (negatively) infinite; at infinite frequency, its value is always zero.

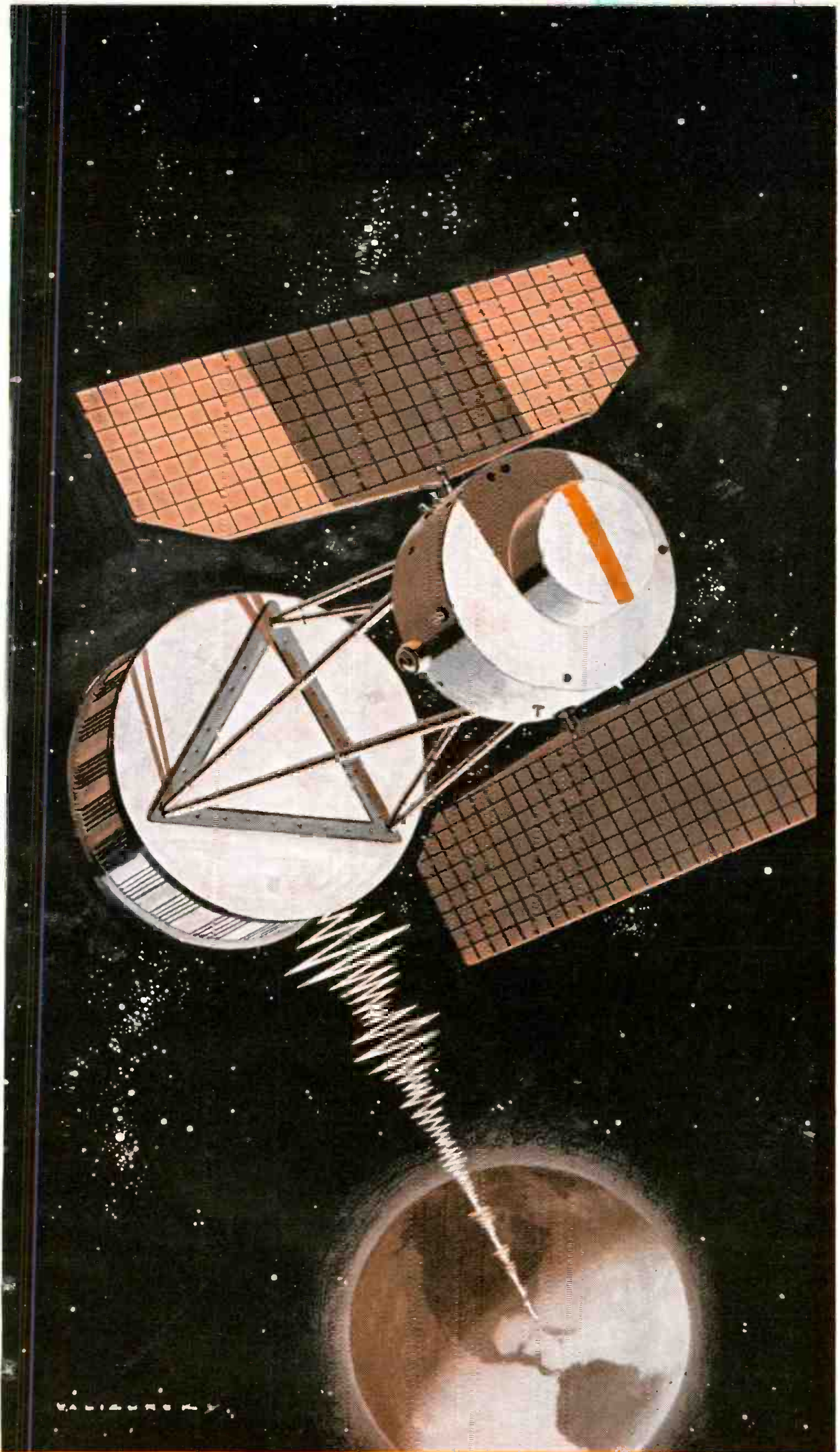
Chart I shows the s-plane pole-zero distributions of the impedance for the various networks in Fig. 1 through 14. Properties of R-C impedance function are: poles and zeros are simple and are restricted to the negative real axis of the s-plane (σ axis); poles and zeros alternate; the lowest critical frequency is a pole which may be at $s = 0$; the highest critical frequency is a zero which may be at infinity;

SYMBOL KEY

The equations describing the element values of some of the networks have been simplified in the charts by substitution of symbols for more complicated relationships. These symbols represent the following expressions.

(1) *Coefficients A, B, D, and E represent combinations of R and C. They can be determined from the applicable equations on the chart.*

(2) $W = A(A - P^2)/P(AD - PE)$
$X = (A - P^2)/(E - PD)$
$Y = (AD - PE)/(A - P^2)$
$Z = P(E - PD)/(A - P^2)$
where $P = (B + \sqrt{B^2 - 4A})/2$



Avco and . . . satellite signal selection

Space vehicles are constantly exposed to many signals as they orbit the earth. Electronic interference, false messages . . . these are but two of the problems they contend with.

To receive correct commands, a new coder-decoder has been developed by Avco's Electronics and Ordnance Division working with NASA. Built around a single-conversion concept, the Avco unit ignores stray signals, shuns radio noise and interference. Today it is operating in Explorer XI, now orbiting the earth.

Miniaturized to save weight and space, this uniquely selective radio device will pull in only proper information, feed it to the decoder, and actuate the correct on-off controls and other satellite equipment as ordered.

Communications capabilities are among the many contributions of the Electronics and Ordnance Division's experienced engineering talent and skill. For more information on this new satellite receiver-decoder, or answers to your own communications problems, write: Director of Marketing, Communications Operation, Electronics and Ordnance Division, Avco Corporation, Cincinnati 15, Ohio.

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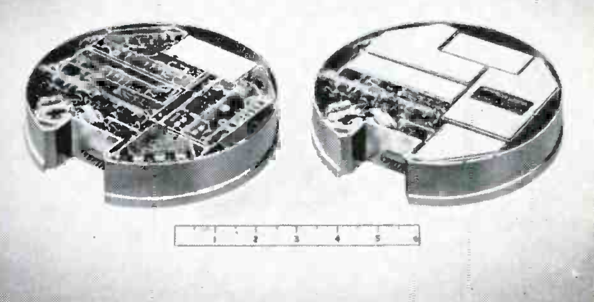
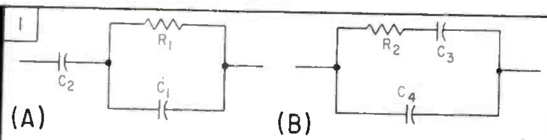
CIRCLE 83 ON READER SERVICE CARD

New Avco receiver-decoder withstands extreme vibration, shock. 6.3" in diameter, only 3.5 lbs.



1 — P-Z CHARACTERISTIC I



(A)

$R_1 = R_2\left(\frac{C_3}{C_3+C_4}\right)^2$

$C_1 = C_4\ (C_3+C_4)/C_3$

$C_2 = C_3 + C_4$

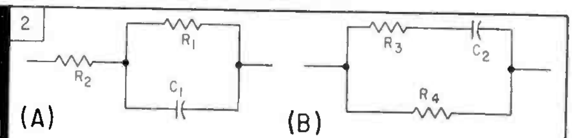
(B)

$R_2 = R_1\left(\frac{C_1+C_2}{C_2}\right)^2$

$C_3 = C_2^2/(C_1+C_2)$

$C_4 = C_1C_2/(C_1+C_2)$

2 — P-Z CHARACTERISTIC II



(A)

$R_1 = R_4^2/(R_3+R_4)$

$R_2 = R_3R_4/(R_3+R_4)$

$C_1 = C_2\left(\frac{R_3+R_4}{R_4}\right)^2$

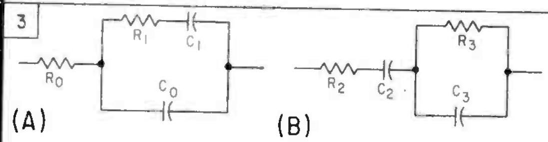
(B)

$R_3 = R_2\ (R_1+R_2)/R_1$

$R_4 = R_1 + R_2$

$C_2 = C_1\left(\frac{R_1}{R_1+R_2}\right)^2$

3 — P-Z CHARACTERISTIC III



(A)

$R_0 = R_2$

$C_0 = C_2C_3/(C_2+C_3)$

$R_1 = R_3\left(\frac{C_2+C_3}{C_2}\right)^2$

$C_1 = C_2^2/(C_2+C_3)$

(B)

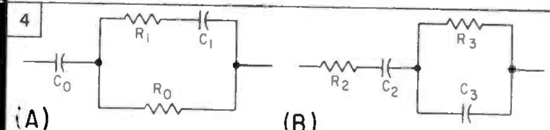
$R_2 = R_0$

$C_2 = C_1 + C_0$

$R_3 = R_1\left(\frac{C_1}{C_1+C_0}\right)^2$

$C_3 = C_0\ (C_1+C_0)/C_1$

4 — P-Z CHARACTERISTIC III



(A)

$R_0 = R_2 + R_3$

$R_1 = R_2\left(\frac{R_2+R_3}{R_3}\right)$

$C_0 = C_2$

$C_1 = C_3\left[\frac{R_3}{(R_2+R_3)}\right]^2$

(B)

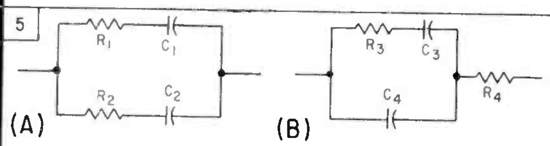
$R_2 = R_1R_0/(R_1+R_0)$

$R_3 = \frac{(R_0)^2}{R_1+R_0}$

$C_2 = C_0$

$C_3 = C_1\left(\frac{R_1+R_0}{R_0}\right)^2$

5 — P-Z CHARACTERISTIC III



(A)

$R_1 = W$ $R_2 = X$

$C_1 = Y$ $C_2 = Z$

$A = R_4R_3C_4C_3$

$B = R_4C_4 + R_3C_3 + R_4C_3$

$E = R_4C_4C_3$

$D = C_4 + C_3$

(B)

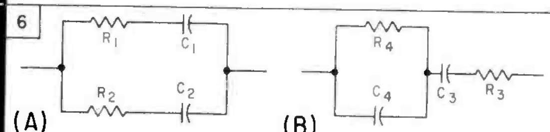
$R_4 = R_1R_2/(R_1+R_2)$

$R_3 = \frac{(R_1^2C_1+R_2^2C_2)^2}{(R_1+R_2)(R_1C_1-R_2C_2)^2}$

$C_4 = \frac{C_1C_2(R_1+R_2)^2}{R_1^2C_1+R_2^2C_2}$

$C_3 = \frac{(R_1C_1-R_2C_2)^2}{R_1^2C_1+R_2^2C_2}$

6 — P-Z CHARACTERISTIC III



(A)

$R_1 = W$ $R_2 = X$

$C_1 = Y$ $C_2 = Z$

$A = R_3R_4C_3C_4$

$B = R_3C_3 + R_4C_4 + R_4C_3$

$E = R_4C_3C_4$

$D = C_3$

(B)

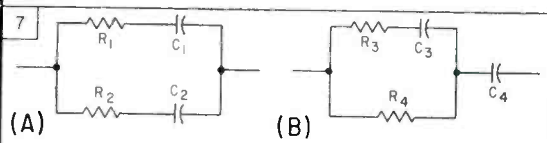
$R_4 = \frac{(R_1C_1-R_2C_2)^2}{(R_1+R_2)(C_1+C_2)^2}$

$R_3 = R_1R_2/(R_1+R_2)$

$C_4 = \frac{C_1C_2(C_1+C_2)(R_1+R_2)^2}{(R_1C_1-R_2C_2)^2}$

$C_3 = C_1 + C_2$

7 — P-Z CHARACTERISTIC III



(A)

$R_1 = W$ $R_2 = X$

$C_1 = Y$ $C_2 = Z$

$A = R_3R_4C_3C_4$

$B = R_3C_3 + R_4C_4 + R_4C_3$

$E = C_3C_4(R_3+R_4)$

$D = C_4$

(B)

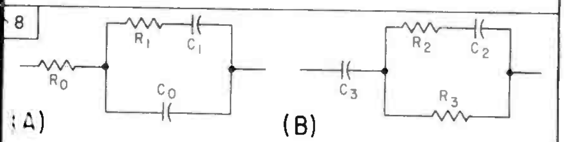
$R_3 = \frac{R_1R_2(R_1C_1^2+R_2C_2^2)}{(R_1C_1-R_2C_2)^2}$

$R_4 = \frac{(R_1C_1^2+R_2C_2^2)}{(C_1+C_2)^2}$

$C_4 = C_1 + C_2$

$C_3 = \frac{C_1C_2(C_1+C_2)(R_1C_1-R_2C_2)^2}{(R_1C_1^2+R_2C_2^2)^2}$

8 — P-Z CHARACTERISTIC III



(A)

$R_0 = R_2R_3/(R_2+R_3)$

$C_0 = \frac{C_3}{\left[1+\left(\frac{C_3}{C_2}\right)\left(\frac{R_3}{R_2+R_3}\right)\right]^2}$

$R_1 = \frac{\left[C_2(R_2+R_3)^2+R_3^2C_3\right]^2}{(R_2+R_3)R_3^2C_3^2}$

$C_1 = \frac{C_3}{\left[1+\left(\frac{C_2}{C_3}\right)\left(\frac{R_2+R_3}{R_3}\right)\right]^2}$

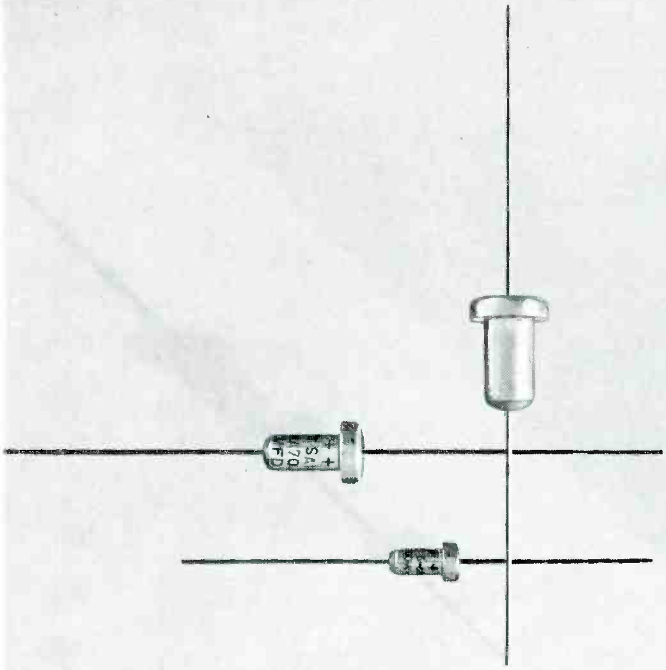
(B)

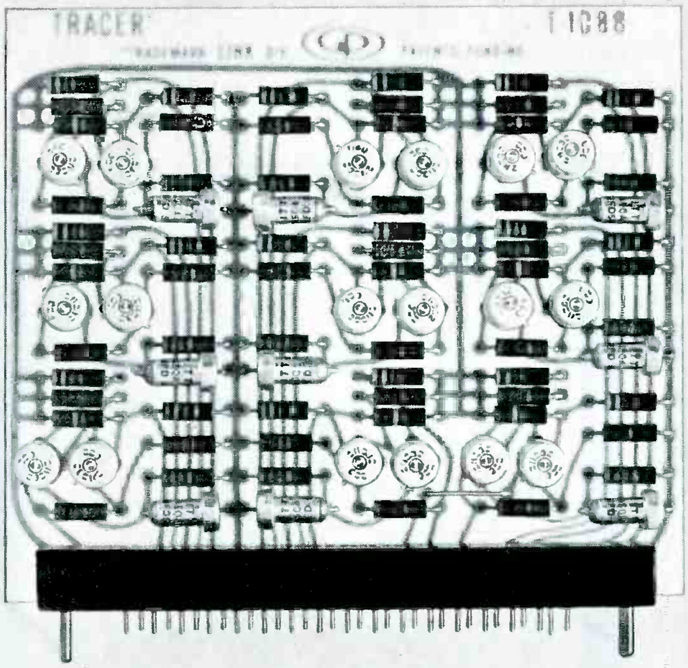
$R_2 = R_0\left(1+\frac{R_0(C_1+C_0)^2}{R_1C_1^2}\right)$

$R_3 = R_0 + R_1\left(\frac{C_1}{C_1+C_0}\right)^2$

$C_3 = C_1 + C_0$

$C_2 = \frac{R_1^2C_1^3C_0(C_1+C_0)}{\left[R_2(C_1+C_0)^2+R_1C_1^2\right]^2}$





Link Division of General Precision, Inc. specified ITT capacitors for this vital portion of its Tracer Identification and Control System, which demands utmost reliability and long life expectancy from every component.

TOTAL PROCESS CONTROL AND DISCIPLINED PRODUCTION DELIVER

HIGH-RELIABILITY WET-ANODE TANTALUM CAPACITORS FROM ITT

ITT wet-anode tantalum capacitors meet MIL-C-3965B—a fact proved by independent laboratory qualifications tests on ITT capacitors. The reliability and long life expectancy of these competitively-priced capacitors are direct results of ITT's total process control and disciplined production procedures, above and beyond testing standards more stringent than normal industry practice—and backed by ITT's world-wide facilities and experience.

ITT

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INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
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COMPLETE SPECIFICATIONS ON ITT wet- and solid-anode tantalum capacitors are available on request. Write on your letterhead, please, to the address below.

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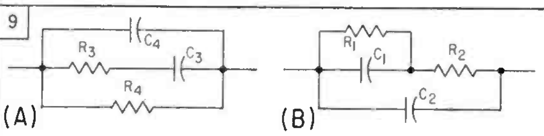
9 — P-Z CHARACTERISTIC III



(A)

$R_3 = R_2\left(1+\frac{R_2}{R_1}\right)$

$R_4 = R_1 + R_2$

$C_3 = C_1\left[R_1/(R_1+R_2)\right]^2$

$C_4 = C_2$

(B)

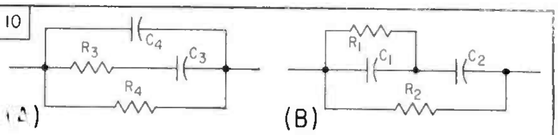
$R_1 = R_4\left(\frac{R_4}{R_3+R_4}\right)$

$R_2 = R_3 R_4/(R_3+R_4)$

$C_2 = C_4$

$C_1 = C_3\left(\frac{R_3+R_4}{R_4}\right)^2$

10 — P-Z CHARACTERISTIC III



(A)

$R_4 = R_2$

$R_3 = R_1\left(\frac{C_1+C_2}{C_2}\right)^2$

$C_3 = C_2/\left(1+\frac{C_1}{C_2}\right)$

$C_4 = C_2/\left(1+\frac{C_2}{C_1}\right)$

(B)

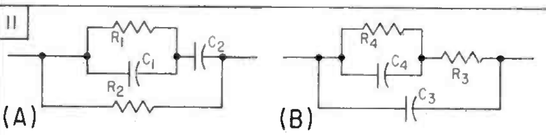
$R_1 = R_3\left(\frac{C_3}{C_3+C_4}\right)^2$

$R_2 = R_4$

$C_1 = C_4\left(1+\frac{C_4}{C_3}\right)$

$C_2 = C_3 + C_4$

11 — P-Z CHARACTERISTIC IV



(A)

$$R_1 = \frac{(R_3+R_4)R_3R_4^3C_4^2}{\left[C_3(R_3+R_4)^2+R_4^2C_4\right]^2}$$

$R_2 = R_3 + R_4$

$$C_1 = C_3\left[1+\frac{C_3}{C_4}\left(\frac{R_3+R_4}{R_4}\right)^2\right]$$

$$C_2 = C_3\left[1+\frac{C_4}{C_3}\left(\frac{R_4}{R_3+R_4}\right)^2\right]$$

(B)

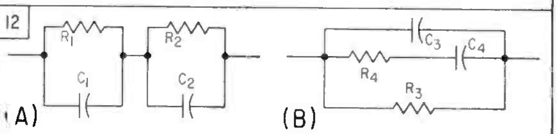
$$R_4 = \frac{R_2}{1+\frac{R_1}{R_2}\left(\frac{C_1+C_2}{C_2}\right)^2}$$

$$R_3 = \frac{R_2}{1+\frac{R_2}{R_1}\left(\frac{C_2}{C_1+C_2}\right)^2}$$

$$C_3 = \frac{C_1C_2}{C_1+C_2}$$

$$C_4 = \frac{\left[R_1(C_1+C_2)^2+R_2C_2^2\right]^2}{R_2^2C_2^2(C_1+C_2)}$$

12 — P-Z CHARACTERISTIC IV



(A)

$C_1 = W \quad C_2 = X$

$R_1 = Y \quad R_2 = Z$

$A = R_3R_4C_3C_4$

$B = C_4R_4 + C_3R_3 + R_3C_4$

$E = R_3R_4C_4$

$D = R_3$

(B)

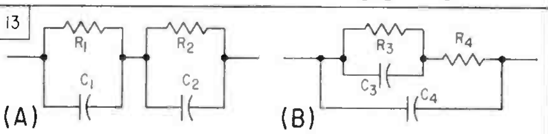
$$R_4 = \frac{R_1R_2(R_1+R_2)(C_1+C_2)^2}{(R_1C_1-R_2C_2)^2}$$

$R_3 = R_1 + R_2$

$$C_4 = \frac{(R_1C_1-R_2C_2)^2}{(C_1+C_2)(R_1+R_2)^2}$$

$C_3 = C_1C_2/(C_1+C_2)$

13 — P-Z CHARACTERISTIC III



(A)

$C_1 = W \quad C_2 = X$

$R_1 = Y \quad R_2 = Z$

$A = R_3C_3R_4C_4$

$B = R_3C_3 + R_4C_4 + R_3C_4$

$E = R_3R_4C_3$

$D = R_3 + R_4$

(B)

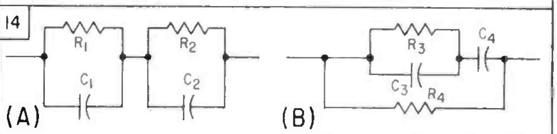
$$R_3 = \frac{(R_1C_1-R_2C_2)^2}{R_1C_1^2+R_2C_2^2}$$

$$R_4 = \frac{R_1R_2(C_1+C_2)^2}{R_1C_1^2+R_2C_2^2}$$

$$C_3 = \frac{(R_1C_1^2+R_2C_2^2)^2}{(R_1C_1-R_2C_2)^2(C_1+C_2)}$$

$C_4 = C_1C_2/(C_1+C_2)$

14 — P-Z CHARACTERISTIC IV



(A)

$C_1 = W \quad C_2 = X$

$R_1 = Y \quad R_2 = Z$

$A = R_3C_3R_4C_4$

$B = R_3C_3 + R_4C_4 + R_3C_4$

$E = R_3R_4(C_3+C_4)$

$D = R_4$

(B)

$$R_3 = \frac{R_1R_2(R_1+R_2)(R_1C_1-R_2C_2)^2}{(R_1^2C_1+R_2^2C_2)^2}$$

$R_4 = R_1 + R_2$

$$C_3 = \frac{C_1C_2(R_1^2C_1+R_2^2C_2)}{(R_1C_1-R_2C_2)^2}$$

$$C_4 = \frac{R_1^2C_1+R_2^2C_2}{(R_1+R_2)^2}$$

CHART I—RC IMPEDANCE POLE-ZERO CONFIGURATIONS IN THE S PLANE

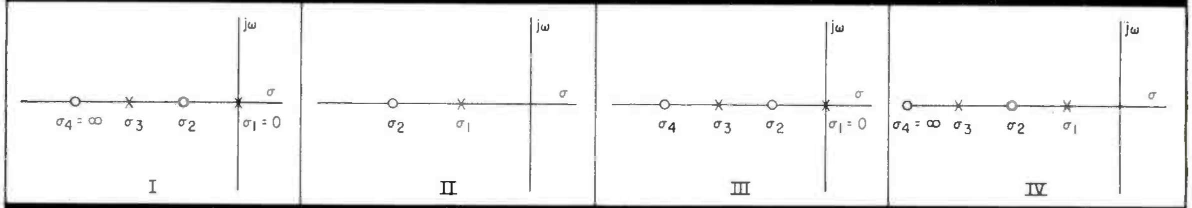
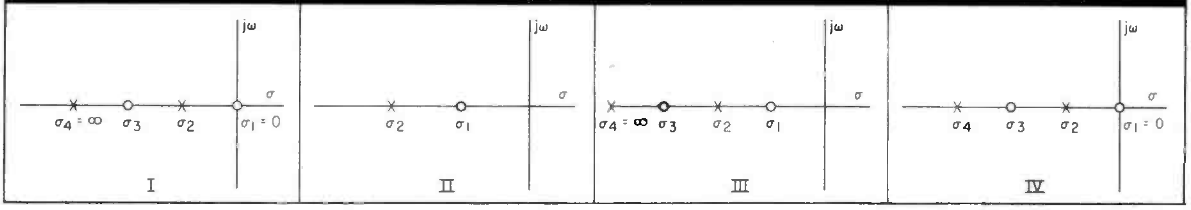


CHART II—RL IMPEDANCE POLE-ZERO CONFIGURATIONS IN THE S PLANE

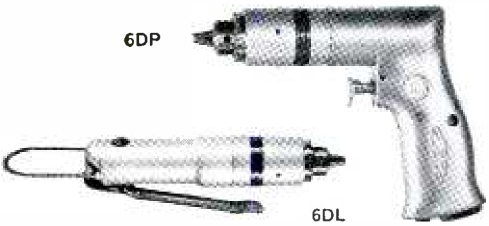


more work per tool per man hour!

CLECO

number 6 drills, nutrunners and screwdrivers

6DP



6DL

6RSP

6RSL

6RSCP

6RSCL

6RSCHP

6RSCH

Improved design features you have asked for — lighter, shorter, greater operating efficiency

What you want in air tool performance is what Cleco engineers strive to design and to produce in every Cleco product. That is why every field report by Cleco sales representatives is carefully studied by the engineering staff at Cleco.

The #6 line of drills, screwdrivers and nutrunners is the result of this tight-knit coordination between sales and engineering — an air tool *you have requested,* an air tool *that will do your job more effectively.*

The #6 drill (2,000, 3,000, 5,000 and 30,000 RPM, pistol and lever throttle) is lighter in weight, resulting in minimum operator fatigue. The handle on the pistol grip is designed for maximum comfort, and allows the operator to exert center line pressure on the bits at all times, reducing bit breakage.

The #6 rolling-impulse screwdrivers and nutrunners (1,000, 2,000, and 3,000 RPM pistol and lever throttle) are lighter and shorter, offer fast and easily adjustable torque setting and higher power. The #6 is also available with positive clutch. Also available in reversible and non-reversible models.

For greater economy, shorter running period and no waste of air, Cleco offers the #6 rolling-impulse screwdrivers and nutrunners with the auto-start feature. Auto-start eliminates throttle levers and permits the tool to run only while on the work.

Ask your Cleco representative about the complete features of the new #6 line. He will be glad to arrange a demonstration-tryout for you immediately.

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CHART III — POLES AND ZEROS OF RC NETWORKS AND RL NETWORKS

P-Z Char	Fig	RC NETWORKS $-\sigma_1$ (Pole)	RC NETWORKS $-\sigma_2$ (Zero)	RC NETWORKS $-\sigma_3$ (Pole)	RC NETWORKS $-\sigma_4$ (Zero)	RL NETWORKS $-\sigma_1$ (Zero)	RL NETWORKS $-\sigma_2$ (Pole)	RL NETWORKS $-\sigma_3$ (Zero)	RL NETWORKS $-\sigma_4$ (Pole)
I	1A	0	$\frac{1}{R_1 (C_1+C_2)}$	$\frac{1}{C_1 R_1}$	∞	0	$\frac{R_1}{L_1}$	$\frac{R_1 (L_1+L_2)}{L_1 L_2}$	∞
I	1B	0	$\frac{1}{R_2 C_3}$	$\frac{C_3+C_4}{R_2 C_3 C_4}$	∞	0	$\frac{R_2}{L_3+L_4}$	$\frac{R_2}{L_3}$	∞
II	2A	$\frac{1}{R_1 C_1}$	$\frac{R_1+R_2}{R_1 R_2 C_1}$			$\frac{R_1 R_2}{L_1 (R_1+R_2)}$	$\frac{R_1}{L_1}$		
II	2B	$\frac{1}{(R_3+R_4) C_2}$	$\frac{1}{R_3 C_2}$			$\frac{R_3}{L_2}$	$\frac{R_3+R_4}{L_2}$		
III	5A	0	$\frac{1}{R_2 C_2}$	$\frac{C_1+C_2}{(R_1+R_2) C_1 C_2}$	$\frac{1}{R_1 C_1}$	$\frac{R_1}{L_1}$	$\frac{R_1+R_2}{L_1+L_2}$	$\frac{R_2}{L_2}$	∞
III	5B	0	$\frac{1}{P}$	$\frac{C_3+C_4}{R_3 C_3 C_4}$	$\frac{P}{A}$	$\frac{A}{P}$	$\frac{R_3}{L_3+L_4}$	P	∞
III	6B	0	$\frac{1}{P}$	$\frac{1}{R_4 C_4}$	$\frac{P}{A}$	$\frac{A}{P}$	$\frac{R_4}{L_4}$	P	∞
III	7B	0	$\frac{1}{P}$	$\frac{1}{(R_3+R_4) C_3}$	$\frac{P}{A}$	$\frac{A}{P}$	$\frac{R_3+R_4}{L_3}$	P	∞
IV	12A	$\frac{1}{R_2 C_2}$	$\frac{R_1+R_2}{R_1 R_2 (C_1+C_2)}$	$\frac{1}{R_1 C_1}$	∞	0	$\frac{R_1}{L_1}$	$\frac{R_1 R_2 (L_1+L_2)}{(R_1+R_2) L_1 L_2}$	$\frac{R_2}{L_2}$
IV	12B	$\frac{1}{P}$	$\frac{1}{R_4 C_4}$	$\frac{P}{A}$	∞	0	$\frac{A}{P}$	$\frac{R_4}{L_4}$	P
IV	13B	$\frac{1}{P}$	$\frac{R_3+R_4}{C_3 R_3 R_4}$	$\frac{P}{A}$	∞	0	$\frac{A}{P}$	$\frac{R_3 R_4}{(R_3+R_4) L_3}$	P
IV	14B	$\frac{1}{P}$	$\frac{1}{R_3 (C_3+C_4)}$	$\frac{P}{A}$	∞	0	$\frac{A}{P}$	$\frac{R_3 (L_3+L_4)}{L_3 L_4}$	P

the slope $dZ/d\sigma$ is negative.

Chart III lists equations for calculating the poles and zeros associated with each network.

The close relationship between R-L and R-C circuits permits Fig. 1 through 14 to be modified for application to R-L networks: (1) In the schematics, replace all capacitors by inductors, retaining the same subscripts. (2) In the transformation equations, replace C by $1/L$.

As an example, consider Fig. 1: C_1 to C_4 are replaced by L_1 to L_4 respectively; then, replacing C by $1/L$, the equations for Fig. 1B become $L_3 = L_2(L_1 + L_2)/L_1$, $L_4 = L_1 + L_2$ and $R_2 = R_1 [(L_2 + L_1)/L_1]^2$.

Properties of the real and imaginary parts of R-L networks are identical with those of an R-C admittance. The real part of an R-L impedance is a monotonically increasing function of frequency. It has its minimum at zero frequency and its maximum at infinite frequency. The imaginary part of an R-L impedance is never negative from $\omega = 0$ to $\omega = \infty$: at zero frequency, its value is always zero; at infinite frequency, it may be zero or (positively) infinite.

Chart II illustrates the s-plane pole-zero distributions of the R-L impedances given in Fig. 1 through 14 after substitutions. Properties of R-L impedance functions are: poles and zeros are simple and are restricted to the negative real axis of the s-plane (σ axis); poles and zeros alternate; the lowest critical frequency is a zero which may be at $s = 0$; the highest critical frequency is a pole which may be at infinity; the slope $dZ/d\sigma$ is positive.

In addition to R-C networks, Chart III lists the applicable equations for calculating the poles and zeros associated with R-L networks. As an example of the pole and zero calculation of an R-L circuit, consider Fig. 1A. The pole σ_2 is found from the equation $\sigma_2 = -R_1/L_1$.

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M. E. Van Valkenburg, "Introduction to Modern Network Synthesis," Ch. 6, John Wiley & Sons, Inc., 1960.

N. Balabanian, "Network Synthesis," p 52, Prentice-Hall, Inc., 1958.

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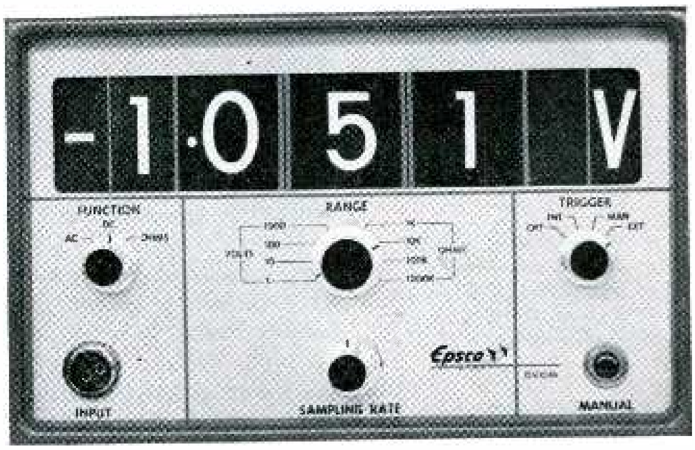
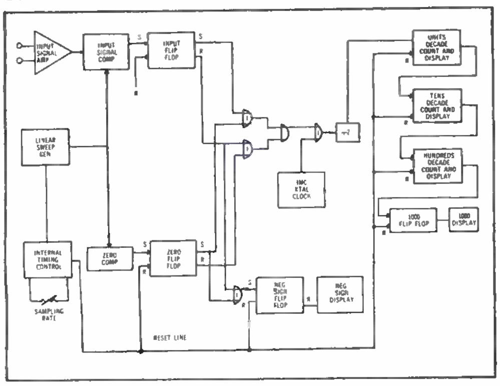


SIMPLIFIED BLOCK DIAGRAM



DVOM® DIGITAL VOLT-OHM METER

MEASURES AC, DC VOLTS & OHMS

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1) **No stepping switches, no relays**
2) **Speed: 2 millisec. per conversion (100 independent measurements per sec.)**
3) Fully transistorized, plug-in construction
4) Parallel decimal and 4221 BCD output
5) In-line, in-plane display
6) Internal and external conversion trigger
7) Requires no modification, adjustment or calibration
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KEY SPECS:

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- **Accuracy:** DC — ±0.1%, AC — ±0.25%, Ohms — ±0.25%
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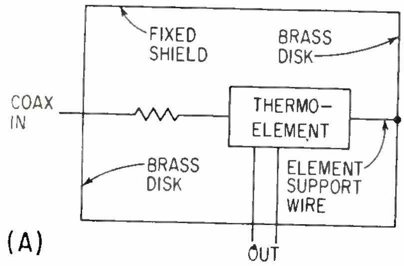
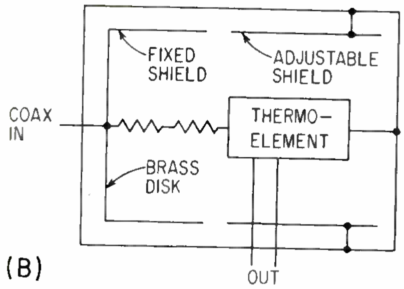
Accurate Measuring Technique for R-F Voltage





One fixed inner brass shield is satisfactory for 50-volt converter (A) while one of two cylindrical inner shields in 100- and 200-volt units (B) is axially adjustable

ACCURATE rms voltage measurements up to 30 Mc are possible using thermal voltage converters. They can also be used to determine quickly the effect of frequency on other rms instruments.

The thermal voltage converters, developed by the National Bureau of Standards, are inexpensive and simple to construct. However, they provide excellent a-c to d-c performance. Accuracy is at least 0.1 percent at frequencies up to 10 Mc and 0.2 percent at 30 Mc.

Reactance is low and computable. Frequency influence on the converters can be estimated with reasonably simple equations. Results agree well with values measured using other methods up to 40 Mc.

The converters can be used to calibrate commercial r-f thermocouple voltmeters and, with a sine-wave generator, electronic voltmeters. Because of their nearly flat response, applied frequency and its stability are not critical.

A thermoelement with low input current rating and a series impedance are used in the thermal voltage converter to develop an output emf that is dependent on input voltage. In these r-f converters, a d-c voltage is substituted for the a-c voltage to be measured.

In the transfer technique used, the same a-c voltage is applied to the converter and the similar device under test. The input is adjusted to obtain the desired indication on the device, and the converter reading is noted. A d-c input is then provided to the converter and adjusted until the same reading is obtained. The d-c input voltage can then be measured with any appropriate apparatus. Requirements of the transfer instrument are that it permit precise readings, have small frequency influence and have good short-time frequency stability.

The influence of frequency on other rms instruments can be readily determined by a-c to d-c difference tests. The same a-c and d-c input voltages are connected to the converter and to the instrument. While switching between a-c and d-c voltage inputs, the voltages are adjusted so that the same indication is obtained on the instrument under test.

The difference in converter indications is noted and, with the scale factor of the converter, is used to determine the a-c to d-c difference (frequency response) of the instrument. Because these differences are relatively stable, measurements usually need not be repeated.

A converter with a thermoelement in series with a wire-wound resistor for current limiting can be used for highly accurate voltage measurements at audio and ultrasonic frequencies. Frequency range is limited primarily by residual reactance of the resistor. Recent tests have shown that good performance can sometimes be obtained up to nearly 1 Mc.

The new converter was developed to evaluate converters using wire-wound resistors. Its cylindrical deposited-carbon resistors are mounted coaxially in a brass cylinder as shown in the figure. The resistors are in series with a uhf 5-ma thermoelement having a short straight heater in line with its supports. Residual reactances are much smaller than those of wire-wound resistors and can be computed approximately, so that frequency errors can be estimated. They can make accurate rms voltage measurements of 1 to 200 volts at frequencies from 3 cps to 30 Mc. Better resolution is obtained using a specialized potentiometer than a millivoltmeter for reading output.

The 100- and 200-volt converters contain two resistors and a 10-ma thermoelement. One of two cylindrical inner shields can be axially adjusted to minimize distributed capacitance between the resistors and the outer cylinder, which considerably extends frequency range. The 50-volt converter operates well with a single resistor and only one fixed inner shield.

The higher range voltage converters require up to 2 watts power and have marked warm-up drift although it is of short duration. A 5-ma thermoelement in series with metal-film resistors of higher resistance could reduce power requirements and drift. However, frequency range would probably be reduced for the same accuracy.

Depletion Layer Acts As Ultrasonic Transducer

EXPERIMENTAL ultrasonic transducer promises high efficiency conversion at microwave frequencies. The 830-Mc operating frequency of present units is expected to be extended to 10,000 Mc, where efficiency should be one hundred times that of other known transducers.

The new device, in the early stages of development at Bell Labs, is a piezoelectric transducer that uses a semiconductor depletion layer. Primary application of the transducer is expected to be in ultrasonic delay lines. Its high op-

erating frequency and wide bandwidth will enable the depletion layer transducer to store large amounts of information.

The depletion layer ultrasonic transducer may also be used as a tool for studying the acoustical properties of materials at higher ultrasonic frequencies. It is expected to generate high-amplitude ultrasonic waves in materials at microwave frequencies. It should also be capable of detecting very weak waves more efficiently than existing transducers.

The transducer consists of a thin metal film deposited on a plate of piezoelectric semiconductor material such as gallium arsenide. The film constitutes a nonohmic rectifying contact that causes formation of a depletion layer. Thickness of the layer can be controlled with a negative bias voltage across the interface.

When a-c voltage is applied, most of the voltage drop occurs across the layer, which behaves like a very thin piezoelectric crystal that is bonded to a solid. The electric field is very large because of the thinness of the layer (10^{-3} to 10^{-5} cm), and considerable piezolectric stress can be produced in it.

Because the layer is so thin, greatest efficiency of the transducer is at very high frequencies. Its high efficiency permits generation of ultrasonic waves from small electrical signals and detection of very weak ultrasonic waves.

Resonant frequency of the transducer is dependent on layer thickness, which can be controlled by bias voltage. Frequency control adds flexibility to the device that conventional piezoelectric transducers do not have.

Bandwidth of present models measured at 600 Mc is 5 percent, an order of magnitude greater than typical ceramic transducers operating at frequencies below 10 Mc. Even greater bandwidths can be achieved at the higher operating frequencies anticipated. Significance of larger bandwidths is that a comparable increase can be expected in the amount of information transmitted.

The use of ultrasonic delay lines at high frequencies has been limited because ultrasonic waves could not be generated or detected efficiently and because the waves are attenuated in the delay material. Higher efficiency of the depletion layer transducer makes possible delay lines having longer delay times. Combined with the larger bandwidths, longer delays will enable storage of large amounts of information.

The transducer is relatively simple to manufacture. Improvements in fabrication processes and circuit techniques should greatly extend the frequency range of the new ultrasonic transducers.

Swedes Plan Railborne Radio Telescopes

ASTRONOMICAL research, space communications and development of radio equipment are anticipated applications of four railborne radio telescopes. Two of the 12-meter diameter units will be built in the first phase of the project by the radio-astronomic research center at Rao, according to the Stockholm Dagens Nyheter. The center, which is on the west coast of Sweden, is operated by the Chalmers Institute of Technology, Gothenburg.

By mounting the radio telescopes on railroad cars, they can be operated in parallel to effectively combine their surface areas. Thus two of the telescopes will provide a surface corresponding to the size of the Harvard University telescope with a diameter of nearly 19 meters.

The telescopes can also be separated by as much as 100 meters. In this case, they would function as an interferometer. Rails for the telescopes will be laid crosswise in an east-west and north-south direction.

Total cost will be significantly reduced by building the 12-meter antennas over that of a 25-meter radio telescope originally planned. In addition, the 12-meter systems provide greater flexibility. For example, an object in space like the Russian Venus probe can be monitored by one unit without interrupting regular astronomical observations.

The use of two antennas also permits a more precise determination of the location of a space object than has been possible.

Improved Wire for Precision Wound Resistors

By EDWIN SHUTTLEWORTH,
Assist. Vice-President,
Driver-Harris Company,
Harrison, New Jersey

PRECISION WIRE-WOUND RESISTORS are used in circuits that require a precisely calibrated resistance value that must be maintained over a wide temperature range.

During World War II, precision wire-wound resistors were generally wound with Nichrome V, which has a specific resistance of 650 ohms per circular mil foot, and a tcr (temperature coefficient of resistance) of 0.01 percent per deg C. Using this alloy, a resistor calibrated to exactly 1,000 ohms at 25 C would increase in resistance one percent, or 10 ohms at 125 C.

In the late 1940's, an alloy modification of the basic 80 nickel 20 chromium alloy Nichrome V had produced a new alloy called Karma which was heat treated to control tcr and specific resistance. This alloy had a specific resistance of 800 ohms per circular foot and a tcr of 0.002 percent per deg C.

This alloy made possible resistors of the same dimensions, using the same wire diameter, with a 23-percent increase in resistance. Further, the improved tcr offered a fivefold improvement in accuracy over a wide temperature range. A resistor wound with the new alloy to 1,000 ohms would change less than 0.2 percent or 2 ohms at 125 C. For many years, this level of accuracy was more than sufficient.

Requirements for resistors in miniature satellite computers developed the need for closer control of tcr on a production basis and a new process Karma wire, now available to fill this need was recently announced.

The major advantage offered by the new process wire is a tcr of

TABLE I—TEMPERATURE STABILITY

Time at Temperature	Resistance Change in % @ 150° C.	@ 200° C.	@ 300° C.
0	0	0	0
100 Hours	−0.010	−0.02	+0.05
200 "	−0.015	−0.025	+0.070
300 "	−0.016	−0.025	+0.080
400 "	−0.016	−0.025	+0.080
500 "	−0.016	−0 025	+0.075

TABLE II—PROPERTIES OF ALLOYS USED AS FINE RESISTANCE WIRE [a]

Alloy Name	Alloy Composition, Approx., per cent	Resistivity, ohms per circular mil foot	Mean Temperature Coefficient of Resistivity, ppm per deg. Cent. based on reference temp. of 77 F (25 C)	Maximum Thermal emf versus Copper, mv per deg. Cent.	Temperature Range (for Values in Columns 1 and 5), deg. Cent.[b]	Specific Gravity	Coefficient of Thermal Expansion × 10^{-6} per deg. C 20 C to 200 C
Karma	76 Ni, 20 Cr + Fe + Al	800	0, ± 5	+0.003	−65 to +250	8.10	13.3
Nichrome V	79 Ni, 20 Cr, 1 Si	650	+ 80, ± 20	+0.006	−65 to +250	8.41	12.5
Nichrome V	79 Ni, 20 Cr, 1 Si (Stabilized, 888 Alloy)	675	+ 60, ± 20	+0.006	−65 to +250	8.41	12.5
Nichrome	58 Ni, 16 Cr, 1 Si, bal. Fe	675	+ 140, ± 30	+0.002	−65 to +250	8.25	12.8
Advance	55 Cu, 45 Ni	294	0, ± 20	−0.045	−65 to +150	8.90	14.5
Manganin	84 Cu, 12 Mn, 4 Ni	290	0, ± 15	−0.003	+15 to + 35	8.41	18.7
Midohm	77 Cu, 23 Ni	180	+ 180, ± 30	−0.037	−65 to +150	8.90	15.7
Hytemco [c]	70 Ni, 30 Fe	120	+3900, ±300	−0.04	−50 to + 20	8.46	12.0
			+4500, ±400	−0.04	+20 to +100	8.46	12.0
95 Alloy	90 Cu, 10 Ni	90	+ 450, ± 50	−0.026	−65 to +150	8.90	16.0
Lohm	94 Cu, 6 Ni	60	+ 700, ±200	−0.022	−65 to +150	8.90	16.2
30 Alloy	98 Cu, 2 Ni	30	+1400, ±300	−0.011	−65 to +150	8.91	16.1

[a] the values given either meet or surpass the specified requirements of ASTM Specification B267-60T. These listed are Driver-Harris alloys

[b] limited only by insulation

[c] temp coeff of resistivity is given for two temp ranges

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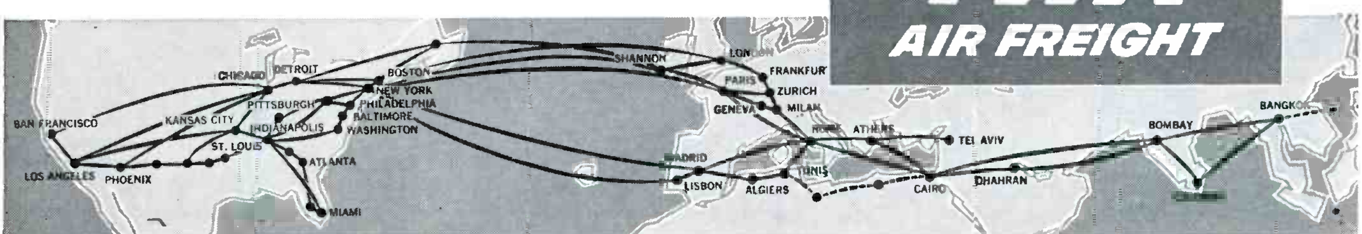
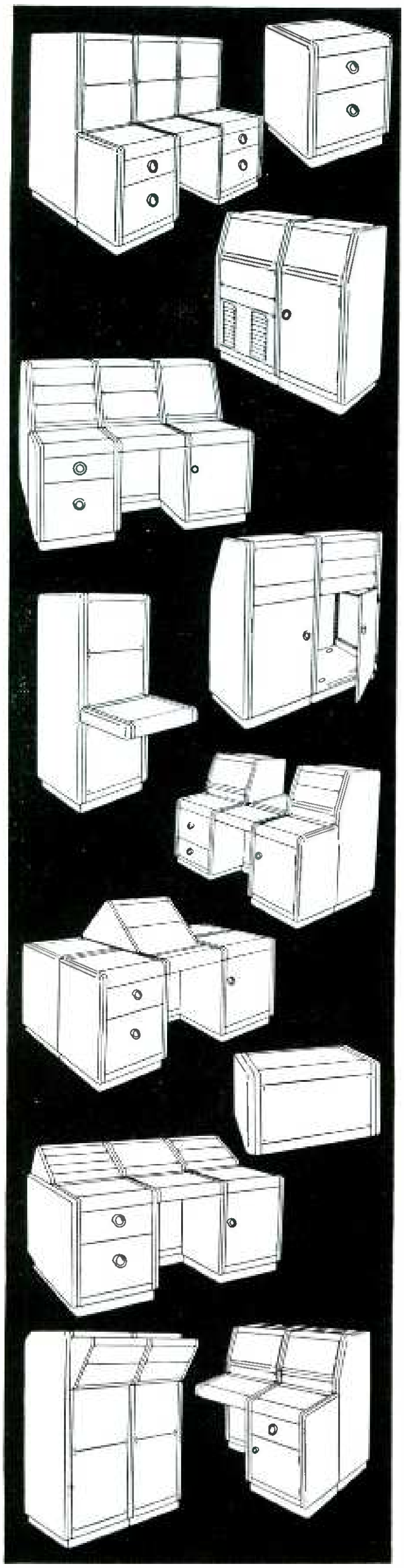


THE ONLY AIRLINE SERVING 70 KEY CITIES IN THE U. S. AND 23 WORLD CENTERS OVERSEAS



less than 0.0005 percent per deg C. Now a 1,000-ohm resistor changes less than 0.05 percent or 0.5 ohm over the temperature range from 25 C to 125 C.

The data given in Table I shows the high-temperature stability of the wire. This data shows the resistance drift of 0.0015 insulated wire wound as a single layer on a ceramic bobbin. All data was taken after an initial aging for 24 hours.

The drift rates indicate stability to at least 200 C, which is well over the maximum hot-spot temperature of present-day precision wire-wound resistors. Drift usually is so slight that processing of trial bobbins is eliminated.

Further gains in new wire come from an increase in physical property values which means fewer breaks in winding resulting in fewer rejects, more units wound per spool, and increased efficiency from winders. The average weight of wire per spool has also been increased, thus reducing downtime.

Experience with these new process techniques augurs well for the development, in the near future, of wires that have characteristics of interest to the precision potentiometer, as well as the precision resistor industry.

Table II gives names and properties of alloys used as fine resistance wires.

Induction Motor Given Two Speeds

IN THE PAST, speed changing of the squirrel-cage induction motor was possible only by winding two separate windings in one frame, and using only one winding at a time. This was wasteful and resulted in a much larger, heavier and more expensive machine.

Now, over half a century after the invention of this motor by Tesla, a British engineer[1] has devised a technique that makes it possible to obtain speed changing, in any ratio, from a single-winding induction motor.

The two-speed motor looks exactly like a standard motor. No new process is involved. But an analytical method was devised for grouping and connecting the coils. And any manufacturer who is equipped to make normal induction motors is equipped to make two-speed induction motors.

The basic designs for each speed combination have to be done by an engineer of high technical competence, and it is desirable to have such designs available for each speed combination. But thereafter, particular machines for different voltages and output powers can be designed according to a routine, as for a standard machine.

The new method of speed changing is called pole-amplitude modulation, because of the logic on which it depends. In a conventional three phase induction motor, the waveform for each phase has an approximate sinusoidal distribution around the stator assembly. If the amplitude of this waveform is modulated in space by suitable coil reconnections, the resultant waveform around the stator will have a different spatial distribution. This effect is similar to that obtained, in time, by modulating a radio carrier and considering the resultant sidebands. If, for example, the resultant waveform of one phase-winding of a pole-amplitude modulated 8-pole machine is examined, it will be found to contain waveforms corresponding to 6 and 10-pole machines, mixed.

Under certain conditions and by correct relative displacements between the three separate phase-windings, it is possible to eliminate one pole number from the resultant three-phase field and to obtain a pure three-phase field corresponding to a single speed. In the case referred to above, speeds correspond to either 6-pole or 10-pole machines.

Uniform acceleration is obtained for full speeds backwards and forward. Two-speed motors have been developed from $1\frac{1}{2}$ hp by 850 hp, but there are no limitations. So far British manufacturers have shown more interest for the larger, high-voltage machines.

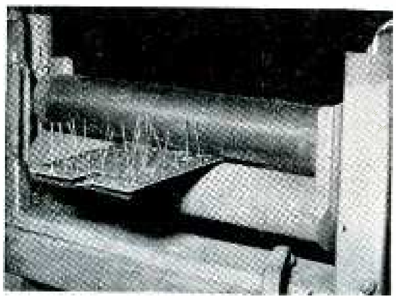
The sponsors involved in developing these motors offer licensing patent rights to American manufacturers.[2]

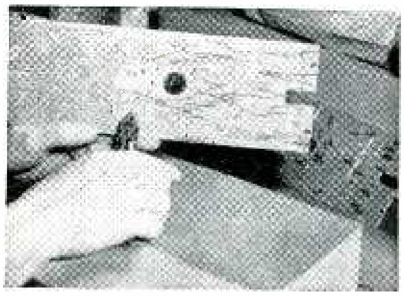
REFERENCES

(1) G. H. Rawcliffe, Head of Electrical Engineering Department, University of Bristol, Bristol, England.

(2) National Research Development Corporation of England, 1925 K Street, N. W., Wash. 6, D. C.


Boards are held in open rack while components are dropped in place


Pad is placed between components and rubber roller


Excess lead lengths are cut off. Box catches lead ends

Wringer Crimps Leads Under Circuit Boards

AN OLD-FASHIONED, hand-cranked washer wringer makes an ingenious aid to hand assembly of printed wiring boards. Used at Electronic Associates, Inc., Long Branch, N. J., to supplement mechanized equipment, it bends all the leads on a board at once. This permits batch-type board assembly, even for short runs, rather than tedious one-at-a-time lead insertion, crimping and cutting.

Jumper wires, flush-mounted axial lead components and small disk components are assembled. Bulky or delicate components, or components requiring stand-off mounting are added later. The method is used, for example, when only a few each of several kinds of resistors are required. If a large number of the same kind of resistor is required, automatic insertion and crimping machines are used.

The wringer is modified to provide a half-inch space between the rollers. The top roller is steel and the bottom roller is padded with rubber. The spacing between them can be varied to adjust pressure. Before the board is passed, components down, between the rollers, it is covered with a pad of foam rubber glued to a blank board. The pad equalizes pressure, is a further safeguard against component damage and allows the board to be turned upside-down.

As the board passes between the rollers, the components are pressed flush with the board and the leads are bent tightly to the underside.

The wringer is set up to the right of an assembly rack. The assembler takes five or six boards and puts them face up on the rack. She picks up a handful of one kind of component, puts the required number into each board, then repeats with the next component.

After crimping, an assembler on the right side of the wringer clips each lead near the bend. Occasionally, a crimp must be tightened with the clipper pliers.

Component leads and jumpers are not cut to size in advance, as the method works best with long leads. If leads are stiff, they can be bent at right angles to the body before insertion. Soft leads can be bent as they are inserted in the board.

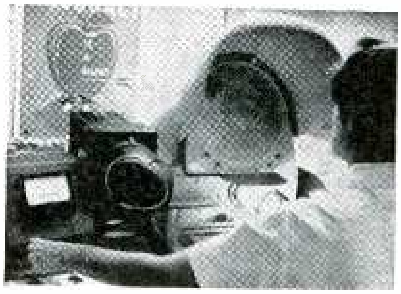
Jumper wires are generally formed in advance. They are prepared by winding a spool of wire on a bar rotated in a lathe. The resulting coil is slit into jumpers by cutting along the two sides of the bar with a milling machine.

An added bonus is that wringing breaks the oxides on the leads, improving soldering quality.

Comparator Gages Fragile Part

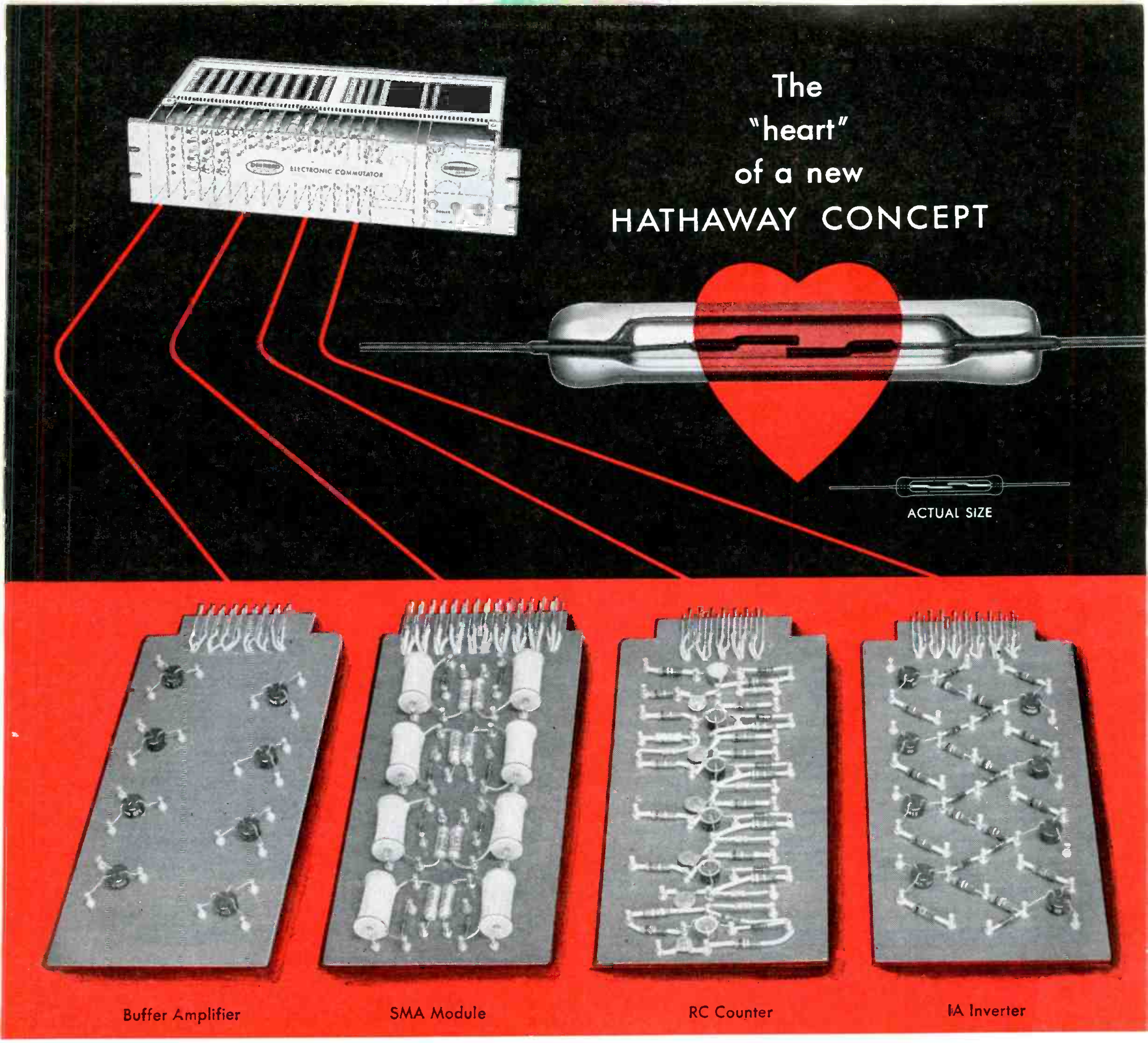
OPTICAL COMPARATORS are used by Bay State Electronics, Boston, Mass., to gage, balance and adjust photoelectrically-controlled irises for Keystone cameras.

An iris is placed in a fixture which simulates the mounting casting in the camera. Lines scribed on the fixture indicate alignment of the iris leaf and stop positions for various light levels. The iris is checked in horizontal and vertical positions, since the camera may be used in either position.


Photoelectric control is energized during gaging

With the fixture horizontal, the iris is statically balanced by adjusting small, coiled wire counterweights with tweezers. The fixture is then turned to the vertical position where the face of the iris is reflected onto the comparator screen. Current which would normally be supplied by a photoelectric cell is provided through an adjustable microampere power source. When the iris is energized, the edge

CIRCLE 99 ON READER SERVICE CARD→



DRIREED ELECTRONIC COMMUTATORS

the Newest and Best!

The NEW Hathaway DRIREED Electronic Commutator, designed to utilize Hathaway's DRIREED contact, is illustrated above in a typical rack mounted unit. Applications include telemetry, thermocouple scanning, computer inputs, strain gage scanning, transducer scanning, and PDM coding.
The unit can be packaged and tailored to fit your particular requirements.

FEATURES:

- Eliminates the transfer gain problem—closed circuit resistance less than 100 milliohms.
- No back current or channel to channel crosstalk—open circuit resistance greater than 3×10^{12} ohms.
- Output isolated from power ground and needs no "common"—isolated dual ended contacts.
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- Up to 1,000 sequential data points per second—DRIREED has resonant frequency of above 2700 cps.
- Long life, highest reliability—contact rating 10 million operations at 100 milliampere, 115 volts 60 cps, resistive load; 1 billion operations at low signal levels.

PRICE AND PERFORMANCE of this commutator make it worth considering in your application. Please address your inquiries to the address below.

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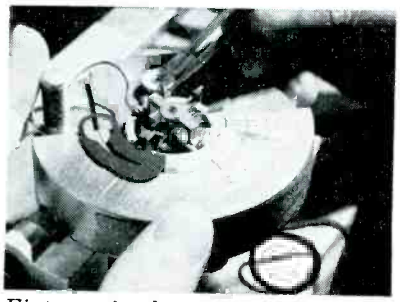
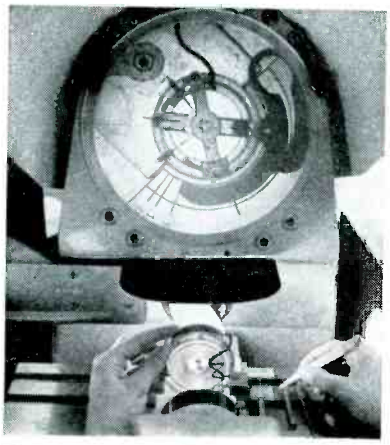


Fixture simulates mounting in camera



Magnified view of part is used to judge alignment

of the leaf must match the graduated line which represents the stop opening on the face of the fixture. The radial centerline of the leaf aperture must coincide with the scribed arc. The fixture is next revolved 90 degrees and the balance checked again while the iris is energized.

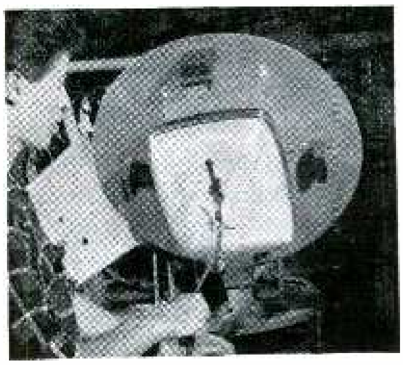
Comparator gaging during adjustment prevents mechanical distortion of the fragile iris leaf. A comparator with a large aperture lens (Jones & Lamson TC-10) is used so the entire iris visible in the fixture at five times magnification.

Conveyor Time Is Used For Tv Tube Processing

TV PICTURE TUBES spend hours on overhead conveyors passing between production steps. Some of this conveyor time is used at the Lansdale Division of Philco Corp., Lansdale, Pa., to dry the internal conductive coating and flash getters after exhaust.

The internal coating is applied by brush while the tube is rotating on a vacuum chuck. A drying riser is slipped over the neck of the tube before the tube is returned to the conveyor. As the conveyor passes over an air manifold, the risers collect the air and direct it into the neck. A sheet metal duct built around the manifold directs the air.

The gettering station is provided with two fixtures, each flashing alternate tubes. Each fixture



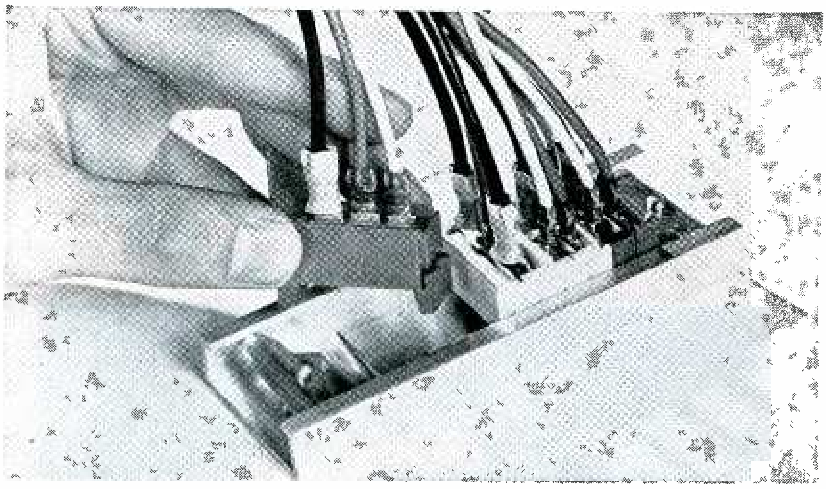
Application of conductive coating

Drying riser fits onto neck of tube

Getter flashing fixture moves with tube on conveyor

has two r-f coils, one for each basic tube size. Fixture design permits the unused coil to be shorted out and the coil in use to be raised by a lever until it surrounds the getter. The fixture moves along with conveyors. After the getter is flashed, the coil is lowered to permit the tube to pass.

New On The Market



Modular Terminal Blocks

HIGH DENSITY WIRING

BASES FOR Termi-Blok are modular 3-circuit common and 6-circuit common insulated cage assemblies, which fit into extruded aluminum track. The cages are tin-plated brass in nylon insulators. Series 3 design accommodates three circuits per inch of track; series 4 has four circuits per track inch.

Stainless steel common spring members accept tab terminals in two thicknesses. No tools are required for terminal insertion or withdrawal. Individual cages can be added by unlocking the end-locks. End locks are fixed in place with a screwdriver.

Current rating is 35 amp, or maximum wire temperature of 105 C; insulation is rated 1,500 v d-c at sea level.

Vibration according to MIL-T-7928C; corrosion resistance and humidity per MIL-T-7928C on a 3-way cage. Manufacturer is AMP Inc., Eisenhower Blvd., Harrisburg, Pa.

CIRCLE 301 ON READER SERVICE CARD

Temperature Cycler

−100 TO +500 F IN 12 MIN

TEMPERATURE chamber, model 1060F, is announced by Delta Design, Inc., 3163 Adams Ave., San Diego 16 Calif. Portable table-top model completes a cycle from −100 to +500 F in less than 12 minutes.

Control accuracy is ±½ F. Test volume is 10 × 7 × 7 in. Unit can be automatically cycled between preset temperatures with a timer. At −65 F consumption of liquid CO_2 is less than 3½ lb per hour. The unit weighs 40 pounds.

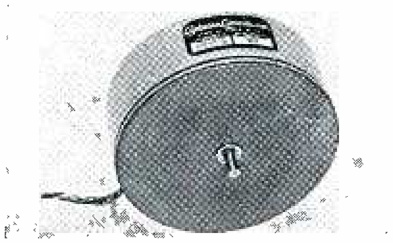
CIRCLE 302 ON READER SERVICE CARD

Shaft Encoders

TO 8,192 COUNTS

SIZE 30 and 50 models of gray code analog digital shaft encoders have high reliability, long life and high accuracy.

Type GSE 50 is 13-bit model, provides total of 8,192 counts per revolution. It has an o-d of 4.875 in. and a length of 1.750 in. excluding shafts. The device is available also with counts per revolution of 2,048 and 4,096. Size 30 models



furnish counts from 256 to 2,048.

Life tests in excess of 10,000 hours at average slew speeds of 500 rpm have shown no appreciable signs of surface damage to the disks, abnormal brush wear, or loss of the readout accuracy of ±½ digit. Units meet or exceed all applicable MIL-specs.

Manufacturer is Guidance Controls Corp., 110 Duffy Ave., Hicksville, L. I., N. Y.

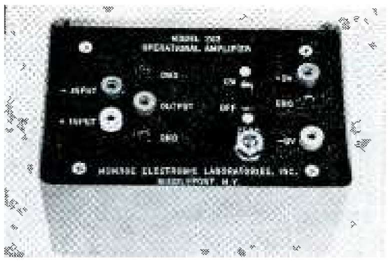
CIRCLE 303 ON READER SERVICE CARD

Operational Amplifier

BATTERY OPERATED

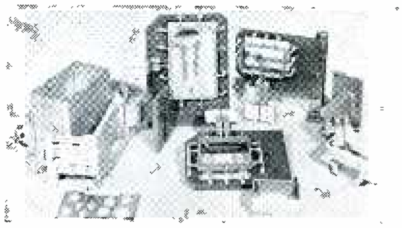
SOLID-STATE, battery-operated, operational amplifier is offered by Monroe Electronic Laboratories, Inc., 33 Vernon St., Middleport, N. Y.

Model 203 is a compact, low cost, transistor unit with open-loop gain greater than 10,000, common-mode



rejection at 60 cps greater than 10,000, unity gain bandwidth of approximately 500 Kc, and voltage drift less than one mv per day under laboratory conditions. It operates off two 9-v batteries, drawing a quiescent current of less than 2 ma, can deliver ±5 volts at 10 ma. Price is $99.50, with batteries.

CIRCLE 304 ON READER SERVICE CARD

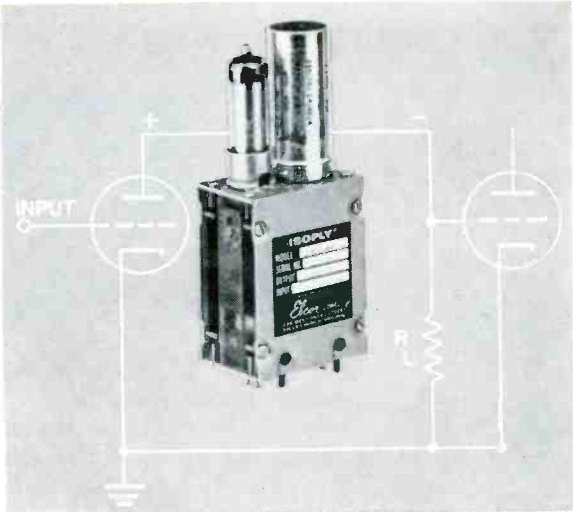


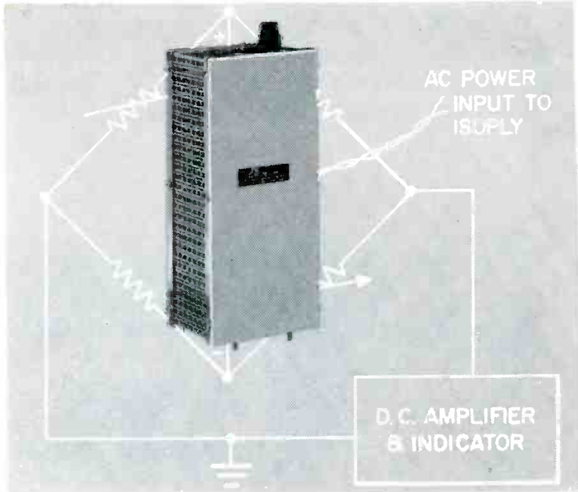
Unsoldering Equipment

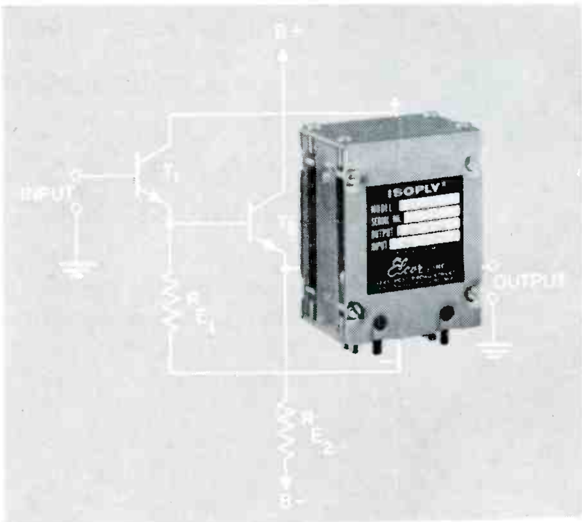
PLANT OR FIELD USE

UNSOLDERING cases containing expensive components can be accomplished with 5-Kw, 450-Kc, induction heating unit.

The instrument cases that can be unsoldered are 2 in. by 4 in., 4 in. by 6 in., 6 in. by 8 in., and cylindrical up to 4 in. o-d. All cases are





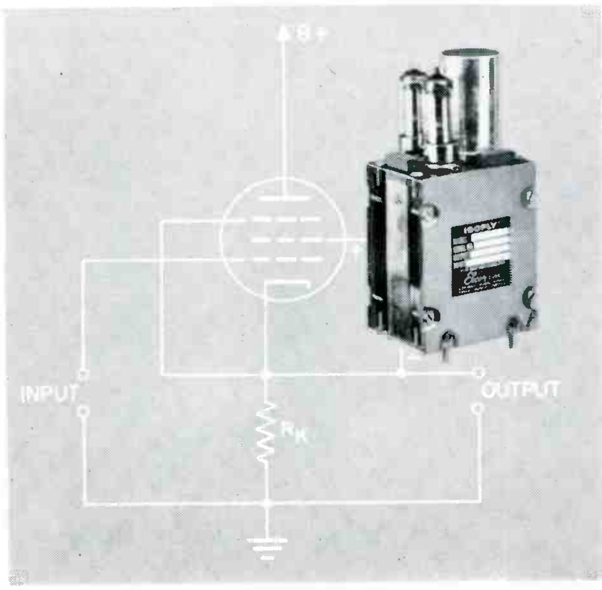


Circuit designs made simpler and more economical with new Elcor ISOPLYS®

Isoplys (isolated power supplies) can be used ungrounded. Unlike conventional power supplies, Isoplys have low shunt capacitance to ground and low noise in ungrounded applications. They are relatively insensitive to power line fluctuations and give excellent frequency response.

Many components once thought essential in conventional circuits can be eliminated. Design and assembly time can be speeded. Troublesome interaction between circuits is substantially reduced. This also helps simplify maintenance as well as solve difficult circuit problems.

Let Isoplys help simplify a circuit design you are working on now. Be prepared for design problems in the future.



Elcor

write for full information: **ELCOR Incorporated**

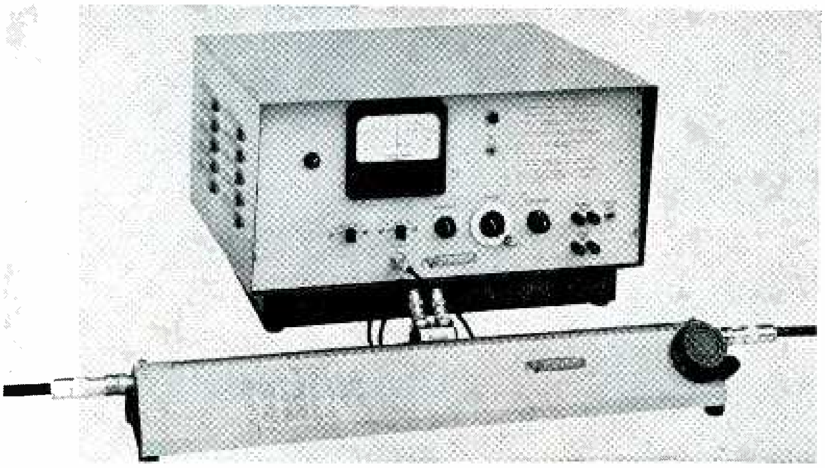
Subsidiary of Welex Electronics Corporation
Sales / R & D Laboratory / Manufacturing
1225 W. Broad Street / Falls Church, Virginia
JEfferson 2-8850

made of thin gage aluminum that is first copper-plated, then tin-plated.

Intermittent heat pulses of approximately 4 seconds on, 4 seconds off allow time for the heat to equalize. Water-cooled jackets provide cooling where required.

Cases shown in the photograph illustrate some applications. Equipment is manufactured by Induction Heating Corp., 181 Wythe Ave., Brooklyn, N. Y.

CIRCLE 305 ON READER SERVICE CARD



Microwave Phase Meter

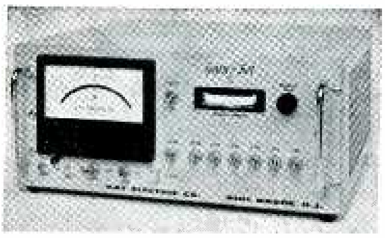
DIRECT READING: 300 MC TO 4 GC

DIRECT READING microwave phase meter checks relative phase between two signals in 300 Mc to 4 Gc range. Resolution is 0.1 degree. It uses square-law detector response in a standing-wave pattern. The standing-wave pattern is the resultant of the combination of the two signals whose relative phase is being measured.

The phase meter offers a servo output for automatic feedback phase control, can serve as an element of a phase-correcting system. The meter can be adapted for automatic swept-frequency phase measurement with recorder output.

Model 300 is priced at $2,500, 6 week delivery, from Wiltron Co., 717 Loma Verde Ave., Palo Alto, Calif.

CIRCLE 306 ON READER SERVICE CARD



Gain/Loss Measuring Set

UHF, VHF AND MICROWAVE

INSTRUMENT for measuring gain, loss, noise figure and other transmission characteristics of systems and components at uhf, vhf and microwave frequencies is announced by Kay Electric Co., 14 Maple Ave., Pine Brook N. J.

Model 625-A Gain-Set incorporates mixing, i-f amplifying, attenuating, detecting and indicating elements, as well as power supply and control circuits. The set has low noise figure and is highly stable. The signal to be measured feeds a crystal mixer having low noise figure; external mixers, can be used. Dimensions are 16 × 7 × 14 inches; weight is 25 lb. Power is 117 v a-c, 50 watts.

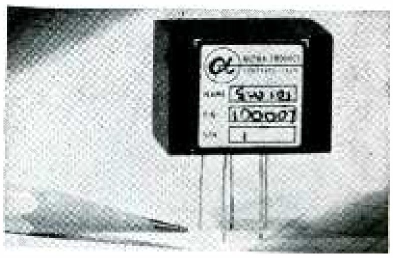
CIRCLE 307 ON READER SERVICE CARD

Low-Level Switch

5-MV RESOLUTION

SOLID STATE low-level switch handles inputs from 0 to ±1 volt with resolution of 5 mv.

Type SW 101 has switching transient of less than 4 mv, switches on command from 0 to 1,000 samples per second. Error band is less than 50 mv and load



can be varied from 1,000 to 10,000 ohms without affecting it. Device requires no external transformer and gating power is less than 2.5 mw. The closed-circuit impedance is less than 100 ohms.

Delivery is 30 days, from Alpha-Tronics Corp., 1033 Engracia, Torrance, Calif.

CIRCLE 308 ON READER SERVICE CARD

Muffin Fan

COMPACT DESIGN

LYTRON, INC., 42 Brookford St., Cambridge 40, Mass. All aluminum heat exchanger with matching fan for efficient rejection of heat from liquid cooled systems. Compact design of coil and fan combination allows multiple stacking of units to handle high heat loads in a minimum space. Lytron "Inner-Fin" construction maintains high heat transfer rates over a wide range of flow and temperature conditions.

CIRCLE 309 ON READER SERVICE CARD

Ultrasonic Solder Pots

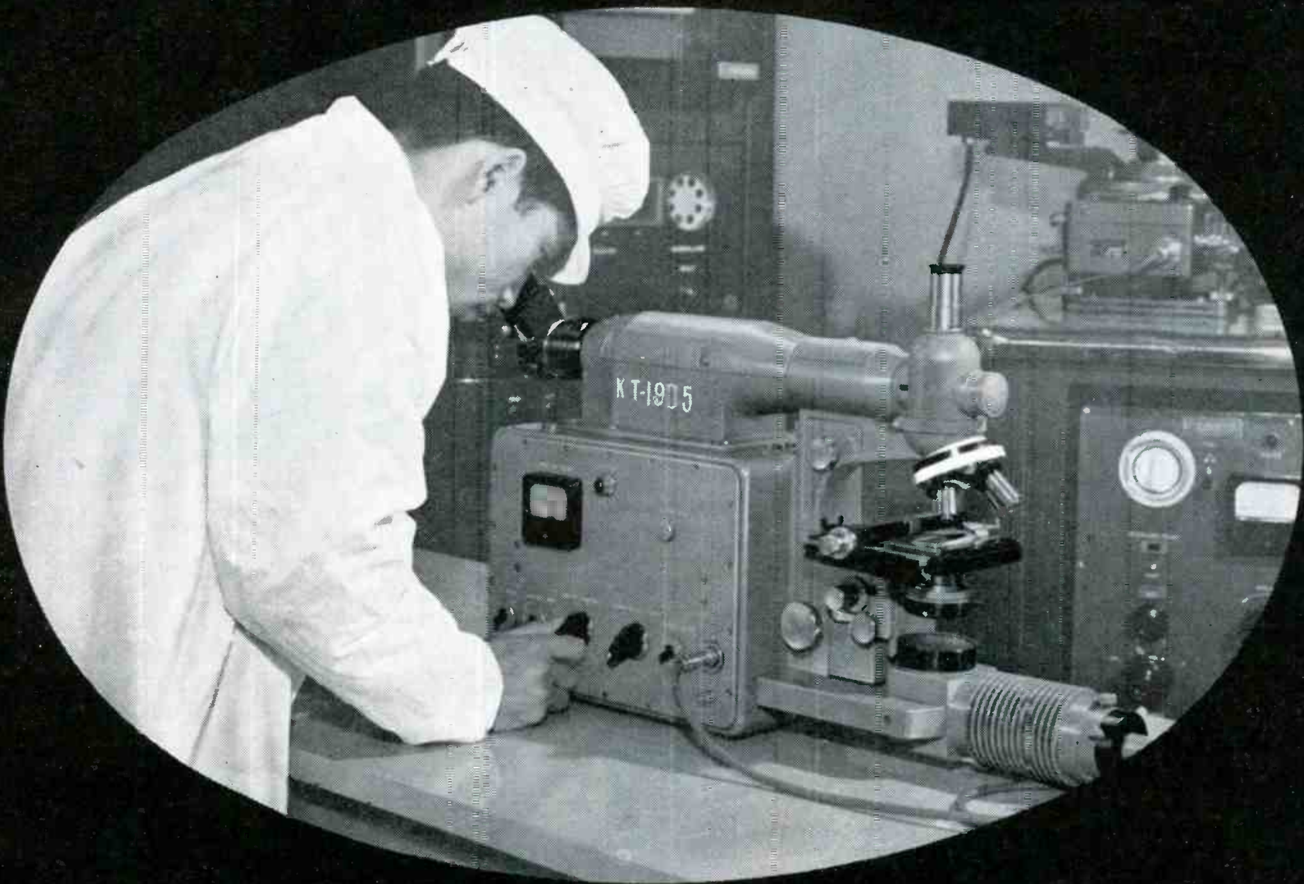
10, 50, 100 WATTS

AVAILABLE in 10, 50 and 100 watt sizes, line of ultrasonic solder pots is announced by Vibro-Ceramics Div., Gulton Industries Inc., 212 Durham Ave., Metuchen, N. J.

Ten-watt model G-10 (genera-

A new tool for the semiconductor industry . . .

NEC'S INFRARED MICROSCOPE



There has been no device for viewing stress and impurities in silicon crystals. Now NEC's development of the infrared microscope effectively fills this need.

The microscope uses an NEC image tube rated at 1.3 microns, the most sensitive commercially available. When using the 40x objective and 15x ocular lenses, IR magnification is 1,080x.

Solid state applications are inspection of silicon crystals and other intermetalic compounds for stress and impurities. Other applications are in biological and medical research.

INFRONICS at NEC

Since 1954, NEC has been concentrating on industrial applications of infrared energy and is among the leading producers of devices utilizing infrared. In addition to the microscope these include optical pyrometers, night viewers, and a pupiloscope. This year NEC will demonstrate developments in IR communications.

PERFORMANCE

Electrical

Input voltage: 100-115 v. 50 or 60 c/s
Power consumption: 70 watts

Optics

Visible image: 20x to 1,500x
IR image: Naked eye, 40x to 1,080x
Photographic film, 4.3x to 120x

Wavelengths

Visible: 0.4 μ to 0.76 μ
IR: 0.76 μ to 1.3 μ (with filter)

Dimensions (mm.)

Width length height
700 x 180 x 400
Weight: 23 kg.

NEC **Nippon Electric Company Limited**

Systems / Components

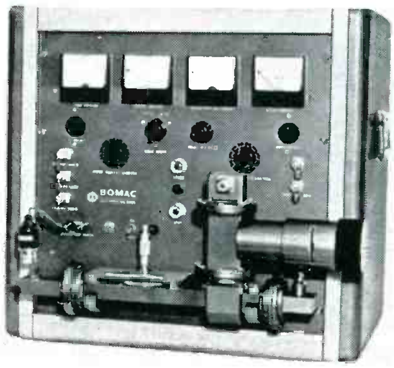
P.O. Box 1, Takanawa, Tokyo, Japan

tor) and SPT-10 (transducer and pot) has interior pot diameter of $\frac{3}{8}$ in.; 50-watt model has $\frac{1}{2}$ in. pot; 100-watt has 2 inch pot. Cavitating action cleans and solders simultaneously, without flux.

Capacities of the heating element, as distinct from the generator, range from 20 to 200 watts, depending on the model. Transducers have efficiencies of 80 percent and can operate to 650 F.

Price is $249 for the 10-watt model, including generator; availability is three weeks.

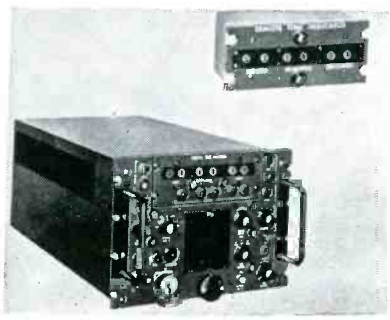
CIRCLE 310 ON READER SERVICE CARD



Magnetron Test Set
FOR C- OR X-BAND

BOMAC LABORATORIES, INC., Salem Road, Beverly, Mass. Type BLP-002K is designed for testing beacon magnetrons. The modulator, capable of producing 0.5 and 1.0 μsec pulses having a peak amplitude of 3.0 Kv at 2.0 amp, is provided with an internal trigger source, necessary control and meters, plus test jacks for pulse shape viewing test results through an oscilloscope.

CIRCLE 311 ON READER SERVICE CARD



Timing Set
FOR DATA SYSTEMS

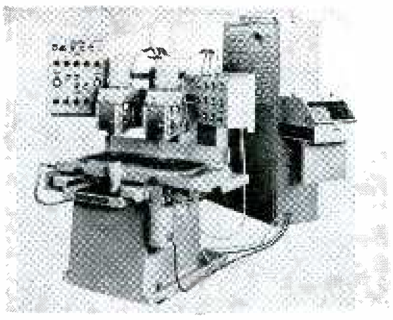
HALLICRAFTERS CO., 4401 W. 5th Ave., Chicago 24, Ill. Time correlation of simultaneous recording processes at up to 10 or more separate locations with a precision within ±1 sec per day is provided by the ETS-1 electronic timing set. Basic unit is a self-contained pulse generator, binary-decimal time encoder and 24-hr numerical clock that will control up to 10 remote time indicators while providing composite binary coded time signals and timing marker pulse trains.

CIRCLE 312 ON READER SERVICE CARD

Heat Sink

OWEN LABORATORIES, INC., 55 Beacon Place, Pasadena, Calif. Heat sink for use at the bread-board stage of solid state circuit design holds up to three semiconductors.

CIRCLE 313 ON READER SERVICE CARD



Drilling Machine
TAPE CONTROLLED

LELAND-GIFFORD CO., Worcester 1, Mass. This tape controlled drilling machine is designed to produce the complicated and precise hole patterns required in electronic p-c boards. It employs a modified GE Mark II numerical positioning control with fast tape reader that can be programmed by a Flexowriter or directly from the drilling machine using art work or a sample board. Positioning accuracy is ±0.001 in., non-accumulative, with repeatability of ±0.0005 in.

CIRCLE 314 ON READER SERVICE CARD

Linear Motion Pot
12-IN. STROKE

NEW ENGLAND INSTRUMENT CO., 39 Green St., Waltham, Mass. Linear motion pot has a wire wound element with high resolution and a standard linearity of 0.05 percent. It is available in any size from 2 to 24 in. in length.

CIRCLE 315 ON READER SERVICE CARD

Resistors

SPRAGUE ELECTRIC CO., 35 Marshall St. North Adams, Mass. For use under conditions of high humidity, epoxy-coated carbon-film resistors rate for full wattage operation at 70 C.

CIRCLE 316 ON READER SERVICE CARD

D-C Amplifier

OPERATIONAL TYPE

EMBREE ELECTRONICS CORP., 933 Farmington Ave., West Hartford 7, Conn. Model B/100/M is a high-gain plug-in type of operation d-c amplifier for analog computers, system simulation, and control applications. It is designed to provide low cost additional amplifier capacity for existing analog computer facilities. Inherent drift is low enough not to require chopper stabilization for many applications. Amplifier case is aluminum with a flat back finish and provides maximum shielding against stray pickup and hum. Output is 6 ma over a range of ± 100 v d-c.

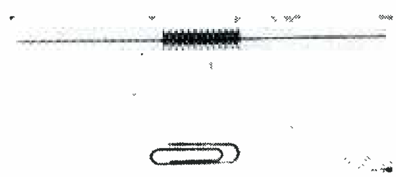
CIRCLE 317 ON READER SERVICE CARD

Modularized Filters

SOLID STATE

BAKER MFG. CO., 5660 N. River Road, Marine City, Mich. Solid state modularized filters used in conjunction with ordinary power supplies afford reduction of ripple comparable to the addition of 10-20,000 μf across the line. The E-1015-A unit, rated at 1 amp to 30 v input, affords a nominal ripple reduction ratio of 50-1.

CIRCLE 318 ON READER SERVICE CARD



Wire-Wound Resistor
HIGH FREQUENCY

REON RESISTOR CORP., 155 Saw Mill River Road, Yonkers, N. Y. High frequency wire-wound resistors can be manufactured with resistance values as high as 1 megohm. The resistors are guaranteed to an accuracy of 0.005 percent. All units in the new line exhibit a rise time of less than 0.2 μsec and a capacitance of less than 0.1 $\mu\mu$f.

CIRCLE 319 ON READER SERVICE CARD

Miniature Delay Line

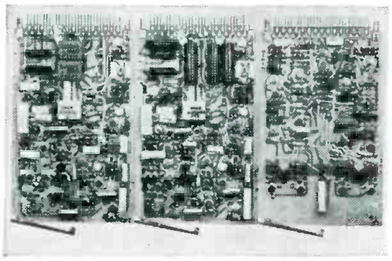
COLUMBIA TECHNICAL CORP., 61-02 31st Ave., Woodside 77, N. Y. Design for lumped-constant delay lines combines ultracompact packing with high delay-to-rise time ratios.

CIRCLE 320 ON READER SERVICE CARD

Spectrum Analyzer
TRANSISTORIZED

POLARAD ELECTRONICS CORP., 43-20 34th St., Long Island City 1, N. Y. Model SA-84T mobile, transistorized, microwave spectrum analyzer covers the frequency range from 10 Mc to 40,880 Mc. It is capable of a number of operations, including spectral measurements, detection and identification of spurious signals, countermeasures analysis, measurement of the frequency difference of two r-f signals, and testing microwave oscillators.

CIRCLE 321 ON READER SERVICE CARD



Conversion System

A-C TO D-C

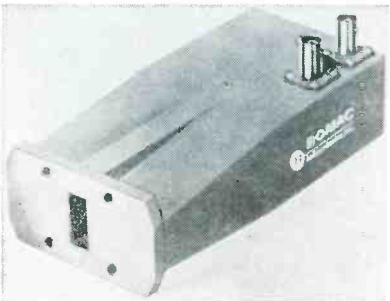
ADAGE INC., 292 Main St., Cambridge 42, Mass., announces an a-c to d-c conversion system implemented with all solid-state precision amplifiers and semiconductor switches. A single channel of a-c/d-c conversion is accomplished with three standard 5 by 8 in. p-c modules; two channels require the addition of only a single extra module. The p-c modules may be combined with any Voldicon voltage digitizer for a wide variety of a-c measurements.

CIRCLE 322 ON READER SERVICE CARD

Building Block

CONTROL EQUIPMENT CORP., 19 Kearney Rd., Needham Heights 94, Mass. Comprised of two transistor driven high-speed reed relays in one module, the block is used as a switch or gate in digital systems.

CIRCLE 323 ON READER SERVICE CARD



Noise Source

FOR MICROWAVE TESTING

BOMAC LABORATORIES, INC., Salem Road, Beverly, Mass. Compact, rugged X-band gas discharge noise source is designed to measure the noise figure of receivers. Features:

The termination, usually attached externally as an accessory, is included within the waveguide. The entire unit, exclusive of waveguide, is epoxy-resin potted to secure tube, leads, and other parts within the housing.

CIRCLE 324 ON READER SERVICE CARD

Gold Saver

TECHNIC, INC., P. O. Box 965, Providence, R. I. Cyanide or alkaline gold, which formerly was lost in the conventional plating process, is recovered by resin charges.

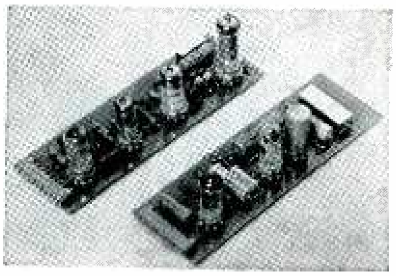
CIRCLE 325 ON READER SERVICE CARD

Surge Controller

PLUG-IN DEVICE

HOLLYWOOD TELEVISION CO., 1949 Moffett St., Hollywood, Fla. Model 20-100 Surgitron is a plug-in device for effectively controlling "turn on" surge currents in television sets, hi-fi equipments, and any other applications where greatest strain occurs when the power switch is first turned on. The device consists of a rugged wire wound surge resistance that is automatically shunted out after the initial surge current has dropped off. Price is $.30 (10,000 and up).

CIRCLE 326 ON READER SERVICE CARD



D-C Amplifier

OPERATIONAL TYPE

RAYMOND ATCHLEY DIVISION, American Brake Shoe Co., 2339 Cotner Ave., Los Angeles 64, Calif. Chopper stabilized d-c amplifier com-

 CIRCLE 112 ON READER SERVICE CARD

CIRCLE 206 ON READER SERVICE CARD

bines flexibility with performance to provide versatility and dynamic accuracy. High gain maintained over a wide band makes the unit ideal in analog computation and control system applications that demand precision at high speed. Output is ±100 v with a 10,000-ohm load and will operate at 75 ma positive output and pulses to 200 ma. Output can be short-circuited without damage. A gain of 125,000 is available from 5 to 500 cps, and the gain is 10^{8} at d-c.

CIRCLE 327 ON READER SERVICE CARD

Miniature Switches
WITH POTTED LEADS

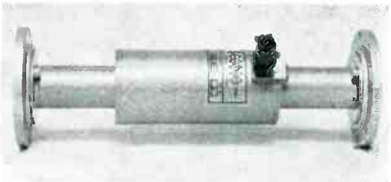
THE MILLI-SWITCH CORP., Gladwyne, Pa., announces that it can supply potted leads on its entire line of precision miniature switches. The leads, shown here on a B-PL Milli-Switch, are intended to provide a strong, positive joint with low-temperature solder. All basic switches in the line conform to MIL-S-6743.

CIRCLE 328 ON READER SERVICE CARD

Distortion Oscillator

KROHN-HITE CORP., 580 Massachusetts Ave., Cambridge 39, Mass. A 1 cps to 100 Kc oscillator features 0.01 percent amplitude stability and only 0.01 percent distortion.

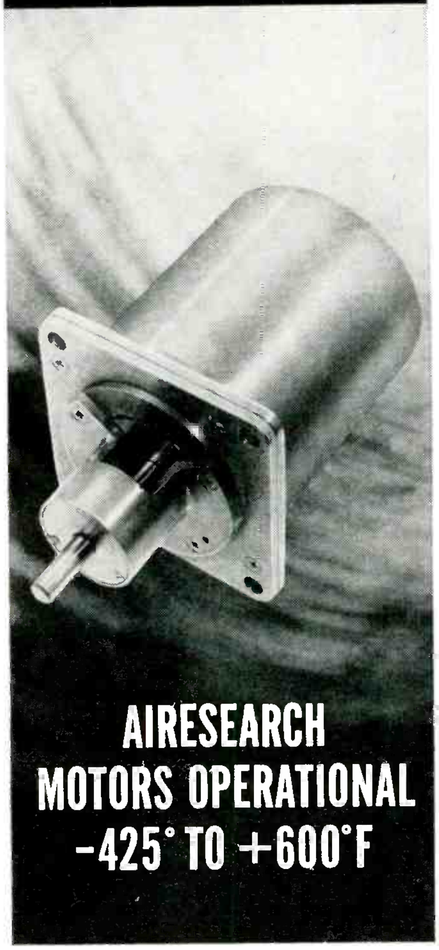
CIRCLE 329 ON READER SERVICE CARD



Amplitude Modulators
SEVEN MODELS

RANTEC CORP., Calabasas, Calif., announces a series of Faraday rota-

Electromechanical Components and Systems Capability



Specialized aircraft motors developed by AiResearch operate at temperatures from −425° to +600° F. ambient. The range of this compact, lightweight, ½ H.P. motor is −65° to +600° F.

AiResearch diversification and experience provide full capability in the development and production of electromechanical equipment and avionic controls for aircraft, ground handling, ordnance and missile systems.

A.C. and D.C. Motors, Generators and Controls • Inverters • Alternators • Linear and Rotary Actuators • Power Servos • Hoists • Electrical Pyrotechnics • Antenna Positioners • Positioning Controls • Temperature Controls • Sensors • Williamsgrip Connectors • Static Converters.

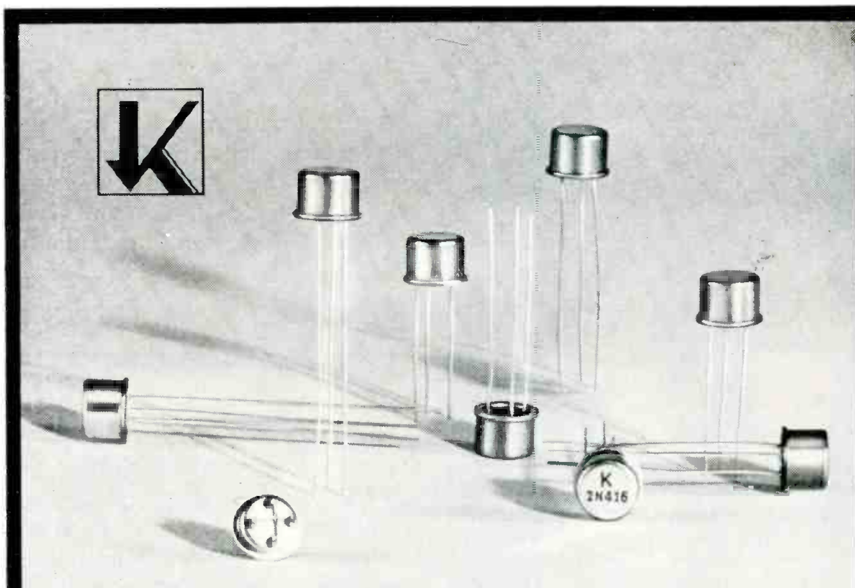
Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Manufacturing Division

Los Angeles 45, California

CIRCLE 228 ON READER SERVICE CARD



KEARFOTT TRANSISTORS PROVIDE HIGH RELIABILITY-CONSISTENT PERFORMANCE

HIGHEST POWER DISSIPATION OF ALL AVAILABLE GERMANIUM-ALLOY JUNCTION TRANSISTORS

Kearfott now offers a complete off-the-shelf series of TO-5 germanium-alloy PNP junction transistors. Their unexcelled electrical and mechanical reliability, precise electrical characteristics, and virtual insensitivity to temperature changes derive from Kearfott's intensive materials-and-methods control, plus complete, 100% functional testing. These factors add up to the consistent reliability, uniformity, extended service life, and repeatability of product performance which typify Kearfott semiconductors.

DESIGNED AND PRODUCED BY KEARFOTT SEMICONDUCTOR CORP. WEST NEWTON, MASS.

CHARACTERISTICS

Meet or exceed requirements of NAVORD OS9669B (R-212 Series) and MIL-S-19500B

All transistors tabulated below are available with maximum collector power dissipation of 200 mw.

2N123	2N404	2N520A	2N653
2N315	2N404A	2N521	2N658
2N315A	2N413	2N521A	2N659
2N316	2N414	2N522	2N660
2N316A	2N414A	2N522A	2N661
2N317	2N416	2N523	2N662
2N317A	2N425	2N523A	2N1017
2N394	2N426	2N578	2N1303
2N395	2N427	2N579	2N1305
2N396	2N428	2N580	2N1307
2N396A	2N519	2N581	2N1309
2N397	2N520	2N582	

Write for complete data

KEARFOTT DIVISION
GENERAL PRECISION, INC.

Little Falls, New Jersey

CIRCLE 115 ON READER SERVICE CARD

tion amplitude modulators. The units can also be ordered as suppressed carrier balanced modulators or as reciprocal modulators, as variable attenuators and switches. At a given frequency in the specified band, the units will produce an attenuation range of 0.5 db max to 25.0 db min. Models are available in seven different ranges from 2.6 to 18 Gc.

CIRCLE 330 ON READER SERVICE CARD

Positioning Fixture

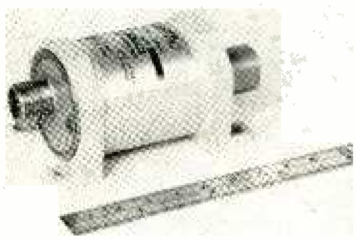
NORMAN EPSTEIN, R. D. 2, Carmel, N. Y. The Robot-Vise has from one to three arms, each terminating in a machinist's clamp that can bear a weight up to ten pounds.

CIRCLE 331 ON READER SERVICE CARD

Capacitors
EXTREMELY THIN

HOPKINS ENGINEERING CO., 12900 Foothill Blvd., San Fernando, Calif., announces a line of miniature Mylar-epoxy dipped capacitors which feature an ultra-thin shape to fit into narrow chassis spaces. Units are suited for p-c and transistor applications. A typical 0.01 μf unit measures 0.525 in. wide, and is only 0.225 in. thick. Excellent temperature stability results in a capacitance change of only 1.5 percent at 85 C.

CIRCLE 332 ON READER SERVICE CARD



Pressure Transducers
LIGHTWEIGHT

DAYSTROM-WIANCKO ENGINEERING CO., 255 N. Halstead St., Pasadena,

MICO *Precision Apparatus*

NEW HEAVY DUTY 2 & 3 DIMENSIONAL ENGRAVER

FOR
Engraving Nameplates
Fine Routing Work
Profiling Small Objects
Making Small Dies and Molds

UHF COAXIAL WAVEMETERS

2-75 Centimeter Range

Send for Illustrated Catalogs.

MICO INSTRUMENT CO.

77 Trowbridge St. Cambridge 38, Mass.

CIRCLE 224 ON READER SERVICE CARD

SECON PRECISION

POTENTIOMETER

Wire

from 37 to over 600 ohms per cmf

Secon can provide the exact precious metal potentiometer winding alloy for your requirements . . .

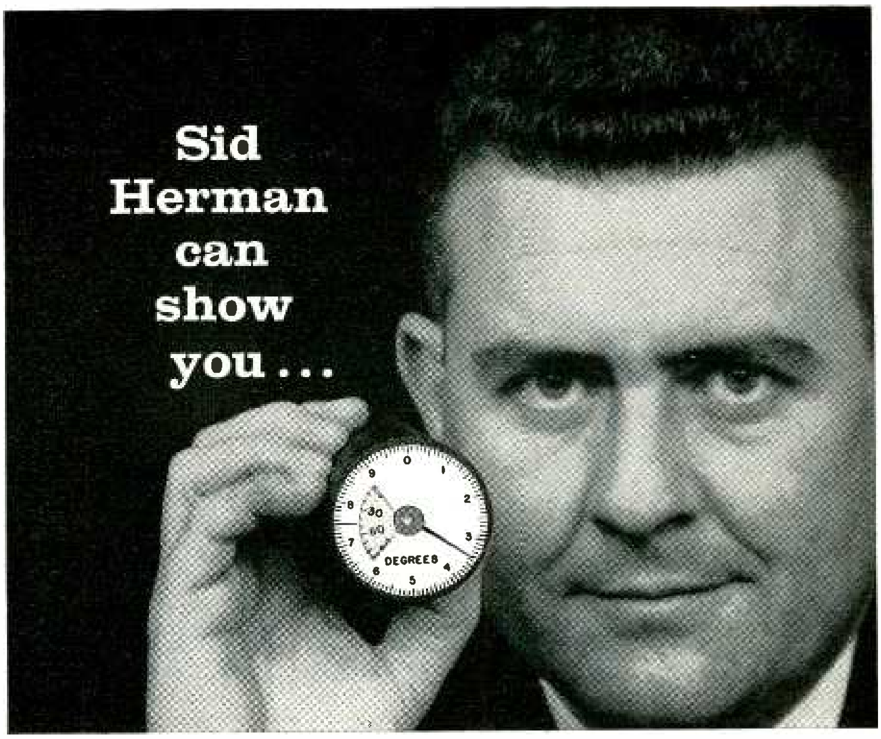
- Low temperature coefficient of resistance.
- High tensile strength.
- Low noise.
- Supplied bare or enameled.
- Long life.

For more information please write today to Secon Metals Corporation, 7 Intervale Street, White Plains, N. Y. (WHite Plains 9-4757).

SECON METALS

RELIABLE WIRE FOR THE HEART OF YOUR COMPONENT

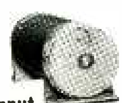
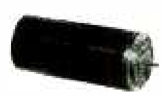
CIRCLE 226 ON READER SERVICE CARD



how North Atlantic's instrument servos fill the five major systems jobs . . . exactly.

Measurement, remote display, data conversion, control, computation . . . Name the task and it's probable that the North Atlantic man can show you how to meet it precisely from NAI's comprehensive line of 3" and 2" vacuum tube and all solid state instrument servos.

Production models are available for high- and low-level ac, dc, synchro, strain gage, thermocouple, resistance bulb and other inputs. Most can be supplied with choice of pointer, counter, torque shaft or digitizer outputs. All utilize flexible design that permits any combination of input-output features to be supplied rapidly to user requirements, for both ground and airborne applications. Some are described below.

SBI-201 Single Pointer DC Ratiometer	SBI-401 A-to D Converter	SBI-501 Shaft Position Repeater	SBI-502 Three-Digit Counter Readout	SBI-509 Dual Scale Readout
				
Input Denom. 5-50v Num. 10 mv-100v	**Input** 10 mv to 100v dc	**Input** ac, dc or synchro	**Input** ac, dc, or synchro	**Input** ac, dc, or synchro
Accuracy ±.2 to ±.5% fs	**Accuracy** ±.1% fs	**Accuracy** ±.1 to ±.5% fs	**Accuracy** ±0.5 to .1% fs	**Accuracy** .05 to .1% fs
Resolution .1 to .2%	**Resolution** from 0.05%*	**Resolution** .05 to .25%	**Resolution** .02 to .05%	**Resolution** .02 to .05%
Response .25 sec. fs	**Response** from 2 sec fs* *depending on encoder used	**Response** 7 sec. @ 15 oz-in	**Response** 15 sec. fs	**Response** 6 sec. fs

If there's a critical job for an instrument servo in your system design, it will be worth your while to talk to your North Atlantic engineering representative. For his name, call or write today. Or request Catalog SFC-1 for complete data.

NA

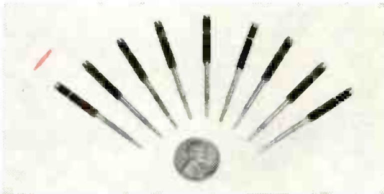
NORTH ATLANTIC *industries, inc.*

TERMINAL DRIVE, PLAINVIEW, L. I., NEW YORK • OVerbrook 1-8600

CIRCLE 117 ON READER SERVICE CARD

Calif. Small size and low power requirement of the P2-3000 series variable-reluctance d-c pressure transducers are suited to applications with critical weight limitations. Type P2-3076, for pressure ranges up to 5,000 psig, weighs 5 oz and requires only 3 ma at 28 v d-c for 0 to 5-v d-c output. Low output impedance (1,000 ohms) and mutually isolated input, output and ground circuits minimize noise problems on long lines.

CIRCLE 333 ON READER SERVICE CARD



Galvanometer

HIGH FREQUENCY

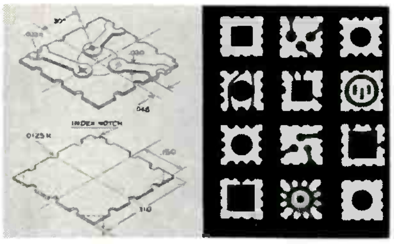
CENTURY ELECTRONICS & INSTRUMENTS INC., P. O. Box 6216, Pine Square Station, Tulsa 10, Okla., has developed a light-beam recording galvanometer having a natural frequency of 13,000 cps. The h-f unit is one of a line of galvanometers designated model 212 series. The line features high sensitivity and 2 percent linearity in most frequency ranges for deflections to 8 in. peak-to-peak.

CIRCLE 334 ON READER SERVICE CARD

Divider-Combiner

RADAR-COMBINER CORP., Pickard Dr., Syracuse 11, N. Y. Coaxial power divider-combiner divides input power equally between two mutually isolated outputs.

CIRCLE 335 ON READER SERVICE CARD



Micromodules

METALLIZED

MITRONICS, INC., 1290 Central Ave., Hillside, N. J. Micromodules with thicknesses from 0.010 in. up are

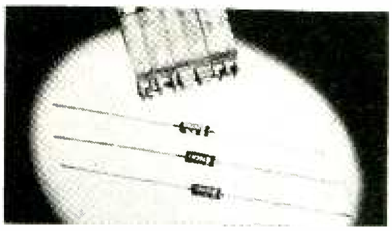
made from 96 percent alumina and metallized with molybdenum manganese and various techniques of plating which make parts suitable for soldering or brazing. They are suitable for hermetic seals. Intricate and mechanized circuitry may be applied by screening and other methods.

CIRCLE 336 ON READER SERVICE CARD

Contact Protectors

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif. Eight subminiature diode contact protectors, voltage range from 30-300 v, eliminate arcing and erosion across miniature relay contacts.

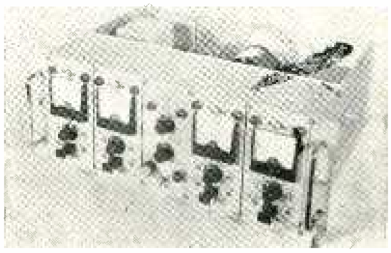
CIRCLE 337 ON READER SERVICE CARD



Silicon Diode
HIGH-SPEED

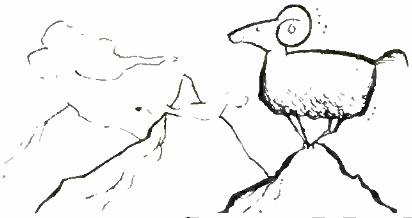
RHEEM SEMICONDUCTOR CORP., 350 Ellis St., Mountain View, Calif. High-frequency silicon diode JAN 1N251 is available per MIL-E-1/1023. It features nanosecond switching and low leakage for critical logic, detector and other h-f applications. It provides 0.15 μsec reverse switching time; 0.1 μa d-c reverse current at − 10 v; 1.0 v d-c forward voltage at I_F of 5 ma; 150 mw power dissipation and 30 v reverse voltage.

CIRCLE 338 ON READER SERVICE CARD

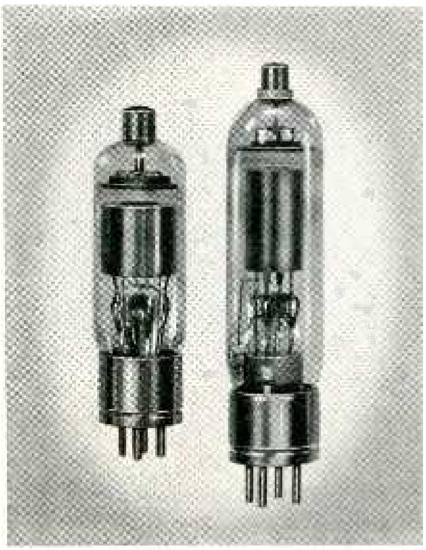


Telemetry Equipment
DIVERSITY COMBINERS

GULTON INDUSTRIES, INC., 212 Durham Ave., Metuchen, N. J., an-



ALWAYS BETTER ON THE "PEAKS"



CETRON GASEOUS RECTIFIERS

★ **Better Peak Inverse Voltage!**
★ **Better Peak Current Ratings!**

The Cetron 6013/3B and 5892/6B Xenon rectifier tubes shown here are typical of this outstanding line of full and half-wave rectifiers.

Meet Your Requirements With The Full Line Of Dependable Cetron Xenon, Mercury Vapor and Vacuum Rectifiers.

	6013/3B	5892/6B
Peak Inverse Voltage	1000	1250
Peak Current, Amps	25.0	77.0
Average Current, Amps	3.0	6.4
Filament Voltage	2.5	2.5
Filament Current	9.0	21.0

Cetron Rectifiers are capable of meeting all requirements of JAN Military specifications.

Cetron Engineers are available to assist in your tube requirements.

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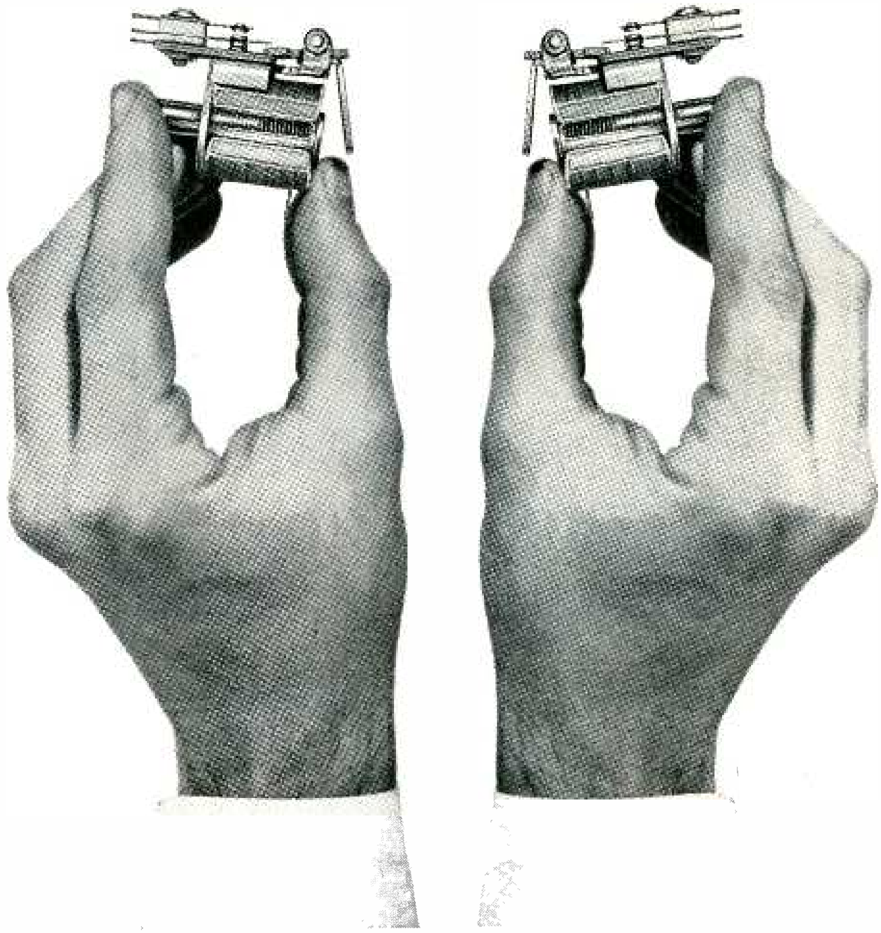
CETRON ELECTRONIC CORPORATION
715 Hamilton Street • Geneva, Illinois

CIRCLE 214 ON READER SERVICE CARD

DELAY RELAY? LOAD RELAY?

BOTH!



The Type A Silic-O-Netic Relay is a light, small time-delay relay. *It weighs a mere three ounces, gives you any delay you spec from 0.25 to 120 seconds. Keeps at it, too, for several million operations; the time-delay element cannot stick, bind, or wear.*

The Type A Silic-O-Netic Relay is a light, small load relay. *The continuous-duty coil does the trick. The Silic-O-Netic can be energized continuously, eliminating lock-in auxiliary circuits. Saves wire. Saves work. Saves space. Saves money.*

Here, then, is a time delay relay that doubles as a load-carrier. The Type A offers SPDT or DPDT switching, with contact capacity up to three amps. Consumes, at most, two watts of AC power, three watts of DC. Available for use on one of twenty standard AC and DC operating voltages, and on request, for others. Costs far less than the two relays you would need to replace it; well worth a closer look. Write for Bulletin 5003.

HEINEMANN ELECTRIC COMPANY

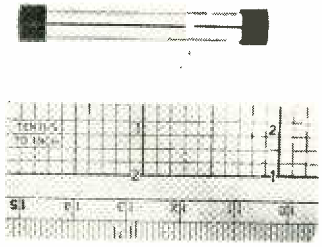
176 BRUNSWICK PIKE TRENTON 2, NEW JERSEY

SA 2377

CIRCLE 121 ON READER SERVICE CARD

nounces telemetry diversity combiners in three models. Used as accessory equipment to improve signal-to-noise ratios for telemetering systems, the combiners are designed to handle most types of signals, including pcm/f-m, pdm/f-m and f-m/f-m with bandwidths up to 5 Mc. The combiner has 2, 3 and 4 channel configurations.

CIRCLE 339 ON READER SERVICE CARD



Ampere Hour Meter
MINIATURIZED

CURTIS INSTRUMENTS, INC., 45 Kisco Ave., Mount Kisco, N. Y. Model 100 direct-reading miniature ampere hour meter operates with negligible current. The device integrates time vs current by electrolysis between mercury electrodes. Suggested uses include a battery life indicator, an elapsed time meter and a combined integrator and indicator for analog devices.

CIRCLE 340 ON READER SERVICE CARD

Capacitor

SPRAGUE ELECTRIC CO., North Adams, Mass. Tantalex Feed-Thru capacitor features effective bypassing of r-f interference on low voltage d-c power circuits.

CIRCLE 341 ON READER SERVICE CARD

Film Viewer
WIDE-SCREEN

THE GEOTECHNICAL CORP., 3401 Shiloh Road, Garland, Texas, has available a 16 mm film viewer that

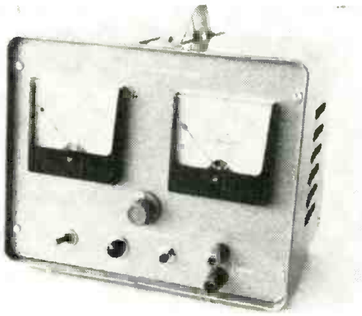
features a motorized film drive, a remote operator control, and data magnified 20 times on a large viewscreen. The operator can locate data of interest quickly by using a pushbutton to traverse the film in either direction at 120 cm/sec.

CIRCLE 342 ON READER SERVICE CARD

Pulse Generator

GENERAL APPLIED SCIENCE LABORATORIES, Merrick and Stewart Avenues, Westbury, N. Y. Pulse generator has a frequency range of 1 to 20 Mc in three overlapping ranges and a rise and fall time of less than 0.006 μsec.

CIRCLE 343 ON READER SERVICE CARD



Low Resistance Meter
TRANSISTORIZED

LYTEL CORP., 1404 San Mateo S. E., Albuquerque, N. M., announces a circuit resistance meter that measures from 0 to 200 milliohms. It features an exclusive meter safing circuit. Applications: Quality control of p-c boards by high current through hole plating and printed circuit measurements, locating high resistance solder joints in cable assemblies, and other low resistance measurements.

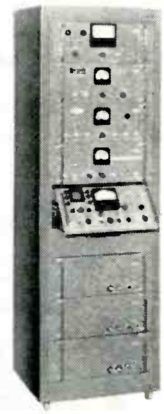
CIRCLE 344 ON READER SERVICE CARD

Voltage Divider
TRANSFORMER-TYPE

ELECTRO SCIENTIFIC INDUSTRIES, 7524 S.W. Macadam Ave., Portland 19, Ore. Model DT-72 transformer-type a-c decade voltage divider provides certified linearities starting

at ½ ppm at the larger dial settings and improving to better than 1/100 ppm at the small settings. All units are certified for use as a primary ratio standard in terms of an ESI standard traceable to the National Bureau of Standards. Units may also be certified directly by the NBS.

CIRCLE 345 ON READER SERVICE CARD



Transmitter Adapter
SINGLE-SIDEBAND

KAHN RESEARCH LABORATORIES, INC., 81 South Bergen Place, Freeport, L. I., N. Y., is producing a ssb transmitter adapter capable of operation from 1 to 50 Mc. Unit not only covers standard h-f communications bands but also makes practical high efficiency Class C ssb operation, utilizing the EER system for scatter transmission. Existing or brand new a-m transmitters may be easily adapted to produce peak envelope power of from 3 to 4 times their carrier rating for ssb operation.

CIRCLE 346 ON READER SERVICE CARD

Power Varactors
IN SUBMINIATURE CASE

MICROWAVE ASSOCIATES, INC., Burlington, Mass., has introduced a series of 55 silicon power varactors housed in a hermetically sealed, reversible cartridge for a wide variety of applications in the 1 Mc to 10,000 Mc region. Wide scale use is anticipated in h-f/vhf/uhf and microwave communications transmitters and receivers, radar transmitters, beacon transmitters, and test equipment.

CIRCLE 347 ON READER SERVICE CARD

Literature of

TAPE RECORDER Mnemotron Corp., 3 North Main St., Spring Valley, N. Y. Folder describes a two-channel analog data tape recorder/reproducer system.
CIRCLE 348 ON READER SERVICE CARD

POWER SUPPLIES Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif. The company *Journal* reports the development of two power supplies for high power semiconductor work which can limit their output currents to selectable values.
CIRCLE 349 ON READER SERVICE CARD

TRANSLATOR Adler Electronics, Inc., 1 LeFevre Lane, New Rochelle, N. Y. A vhf tv heterodyne translator, VST-1, is described in a single data sheet.
CIRCLE 350 ON READER SERVICE CARD

HYBRIDS Microwave Development Laboratories, Inc., 15 Strathmore Rd., Natick, Mass. Bulletin gives mechanical and electrical characteristics of sidewall short-slot hybrids.
CIRCLE 351 ON READER SERVICE CARD

INERTIA SWITCHES Inertia Switch Inc., 311 W. 43rd St., New York 36, N. Y. Data sheet describes typical inertia switches and lists applications.
CIRCLE 352 ON READER SERVICE CARD

THERMOCOUPLES Cryogenics, Inc., Stafford, Va., has issued a bulletin which discusses gold-cobalt/copper thermocouples.
CIRCLE 353 ON READER SERVICE CARD

METALS & JEWELS A. & M. Fell Limited, 1 Lambeth High St., London, S.E.1, England. "Transistor Engineering in Metal & Jewels" covers synthetic ruby for alloying molds, jig handling, and measuring equipment.
CIRCLE 354 ON READER SERVICE CARD

IN-CIRCUIT TESTING Molecular Electronics, Inc., a subsidiary of Precision Circuits, Inc., 87 Weyman Ave., New Rochelle, N. Y. A 12-page guide, written by the company president, discusses in-

circuit testing with particular application to diodes, rectifiers and transistors.
CIRCLE 355 ON READER SERVICE CARD

TELEMETRY RECEIVER Vitro Electronics, 919 Jesup-Blair Drive, Silver Spring, Md. Data sheet describes an f-m crystal controlled phase-lock telemetry receiver for satellite tracking.
CIRCLE 356 ON READER SERVICE CARD

TRANSFORMERS Sola Electric Co., Elk Grove Village, Ill. Bulletin lists advantages of standard sinusoidal constant voltage transformers.
CIRCLE 357 ON READER SERVICE CARD

VOLTMETER Ballantine Laboratories, Boonton, N. J., has published a brochure on voltmeter 317 which measures 300 microvolts to 300 volts at frequencies from 10 cps to 11 Mc.
CIRCLE 358 ON READER SERVICE CARD

PHASE ANGLE ANALYZER Ad-Yu Electronics Lab., 249 Terhune Ave., Passaic, N. J. Bulletin gives specifications and suggests applications for Vectorlyzer, type 202.
CIRCLE 359 ON READER SERVICE CARD

CATHODE TUBES Raytheon Co., 55 Chapel St., Newton 58, Mass. A 12-page handbook for equipment design engineers charts specifications for industrial and military cathode subminiature electron tubes.
CIRCLE 360 ON READER SERVICE CARD

CERAMICS CHART American Lava Corp., Manufacturers Rd., Chattanooga 5, Tenn. Chart No. 611 provides engineers with mechanical and electrical properties of AlSiMag ceramics.
CIRCLE 361 ON READER SERVICE CARD

LAMINATED PLASTICS Continental-Diamond Fibre Corp., Newark, Del. Twenty-page catalog covers grade selection, sizes, and property values of industrial laminated plastics in sheet, rod and tube form. Please write directly to the company for copies.

PARTS SHOW

Poncher: think and plan big

ELECTRONIC parts distributors will have to think and plan big if they want to share and survive in the booming industrial electronic parts business, says the number one man behind the Parts Show week after next in Chicago's Hilton Hotel.

Since manufacturers are merging all over the place, so should distributors, says Sam Poncher, president of Electronic Industry Show Corporation.

As president of Newark Electronics Corp., one of the biggest U. S. distributors of industrial electronic parts, Poncher has been involved in wrapping up details of a merger which promises to bring \$4½ million additional sales to his company (details were due to be announced Wednesday.)

An early and leading advocate of exclusive franchises, Sam is also one of the leaders behind the trend toward winning distributors a bigger share of the industrial electronic parts market.

"After hammering away for the past 15 years, we've finally convinced most manufacturers producing industrial items that we can really do a better job of handling inventories and small orders than they can," Poncher says.

More than half of U. S. manufacturers of industrial electronic parts will take part in this year's new seventh floor industrial conference. "We expect this section to take a whole floor by next year," Sam adds. "No doubt it will become a permanent part of future shows."

Electronic parts business has grown even faster than anticipated because new industries in transistors and computers have added their business to replacement and repair volume in the non-industrial sector, reports Poncher. He believes the industry can only continue to grow and that parts distribution business can only do even better.

Poncher got his start like most other distributors, traveling around to manufacturers, buying up their surplus and discontinued parts and worrying about the credit risks associated with an exclusively dealer-service business.

Shortly after buying his firm with his brother in 1934, Sam began astonishing broadcast stations, airlines and other industrial users by personally soliciting their business. "We had this industrial market pretty much to ourselves until the time our catalogue went national—about 1940," he says.

Year-to-year comparisons reflecting growth of Newark Electronics are hard to make because the company switched last year from a calendar year to an August 31 fiscal year. Thus 1960 figures are for eight months, instead of 12.

In the shortened period of 1960 the company showed dollar earnings of \$166,082, slightly better than \$161,092 earned during the full 12 months of 1959.

Sales for the first six months of the current fiscal year were \$6,691,521, an 18-percent rise over \$5,664,538 in first half of last year.

Profits were \$133,211, a 52-percent increase over \$87,776 reported for the first half of 1960.

Poncher expects to do even better in the second half, "especially if the economy turns up as expected. We should hit at least \$15 million in sales for the year."

A network of 16 full time sales offices, recently opened from New York to California, supplies his firm with readings of the sales and profit potentials of a region, spots local companies which might be likely targets for the mergers Poncher preaches as a necessity for survival. Economic shakeout may leave as few as 200 efficiently operated electronic parts distributors for the future, he believes.

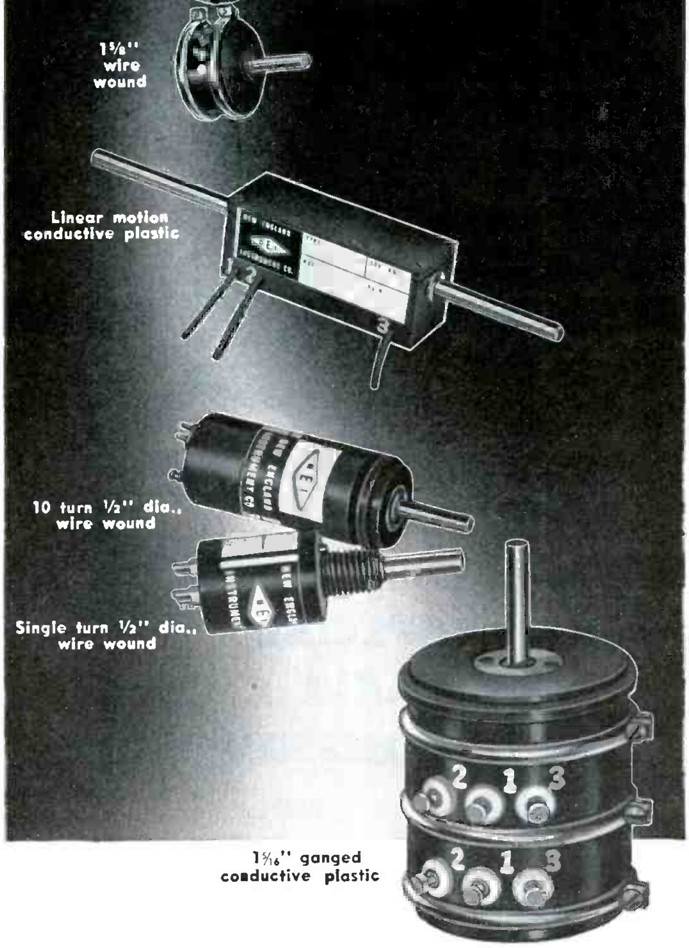
Following his own advice to think big, Sam has been sponsoring his own parts show for 14 years. Last year's edition was attended by 68 suppliers, cost him \$25,000.

Five-year target for Newark Electronics is to be five times as large as today. Although Sam says he won't be happy until his company is doing a minimum of \$50 million in annual sales, his real aim looks more like \$100 million.

Resdel Engineering Hires A. F. Boscia

ARCHIE F. BOSCIA has been named chief engineer of Resdel Engineer-

MEET THE N. E. I. POTENTIOMETER FAMILY



Their reliability assures your products performance N.E.I. precision potentiometers, both Conductive Plastic and Wire Wound, embody every desirable design and engineering feature known to potentiometer manufacture. Because we manufacture both types, our engineers can analyze your specific requirements from both sides and produce the proper solution. Remember, N.E.I. precision potentiometers are unsurpassed for reliability.

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- Infinite resolution
- Unsurpassed reliability
- Negligible noise level
- Standard resistance values 1K, 2K, 5K, 10K, and 20K, 0.5 linearity.
- Specials from 500 ohms to 1 megohm —0.1% linearity

Wire Wound
- Meet performance specs of MIL5272A, NAS710 and applicable portions of JANR-19
- Maintain excellent characteristics from —55° to 150°C
- Available from 1/2" single and 10 turn types to 3"
- Standard resistances from 1K to 100K, special designs from 25 ohm to 250K

NEI

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LESS FLOOR SPACE
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proven design—field tested

IMPROVED EFFICIENCY
compact power generation

LIFETIME WARRANTY
on new Omnimite® transducer

SYSTEM INTEGRATION
improved filter, rinse & dryer

RESTYLED CABINETS
for maximum adaptability

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Pioneer-Central Division
The Bendix Corporation
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SONIC ENERGY CLEANING

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Name

Address

City Zone State

CIRCLE 133 ON READER SERVICE CARD

ing Corp., Pasadena, Calif. Company specializes in R&D and the manufacture of vhf, uhf equipment with ultraphase stability.

Boscia was formerly associate director of R&D at Collins Radio Co., Burbank, Calif.

GE's Gifford Named JTAC Member

RICHARD P. GIFFORD, manager of engineering for the General Electric Communication Products Department, Lynchburg, Va., has been appointed a member of the Joint Technical Advisory Committee of the IRE and EIA.

The committee evaluates technical and engineering information relating to the radio art. It advises government bodies and industry and professional groups.

Gifford previously had served on a number of JTAC subcommittees on communications, including the recent Ad Hoc Subcommittee on Space Communications.

Astrosonics Forms Laboratory Division

CREATION of Astrosonic Development Laboratories, a division of Astrosonics, Inc., has been announced by John Perkins, president of the Syosset, L. I., developer and manufacturer of sonic products for industry and government.

William K. Fortman has been named director of research for the new division.

Gulton Industries Hires Group Manager

MAX LOWY has been named manager of systems integration for Gulton Industries, Inc., Metuchen, N. J. He will be responsible for coordinating and integrating the work of Gulton's eleven domestic divisions in the engineering of complete systems for the corporation.

Lowy has been associated with Data Control Systems in Danbury, Conn., Space Technology Laboratories in Los Angeles, Calif., and the Jet Propulsion Laboratory at the California Institute of Technology.

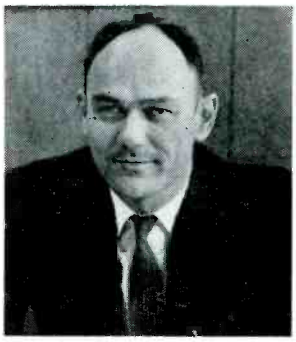
FXR Elects Ebert To Board of Directors

JOHN E. EBERT, vice president, microwave division, of FXR, Inc., has been elected to the company's board of directors. FXR, of Woodside, N. Y., manufactures microwave test instruments and associated equipment.

Wickersham Joins DIT-MCO Staff

PRICE D. WICKERSHAM has joined the staff of DIT-MCO, Inc., Kansas City, Mo., as manager of the newly formed systems engineering division, which will be responsible for the company's research and development program.

Formerly with Thompson-Ramo-Wooldridge, Inc., Wickersham has had over 18 years experience in the field of electronic research and development in the instrumentation and test equipment fields.



Appoint Pritchard Chief Engineer

THE TECHNICAL MATERIEL CORP., Mamaroneck, N. Y., manufacturer of communications equipment, announces the appointment of B. D. Pritchard as chief engineer. He comes to TMC from Montana State College where he was senior research engineer and also acted as a consulting engineer for TMC.

Powertron Ultrasonics Forms New Division

POWERTRON ULTRASONICS CORP., Garden City, L. I., N. Y. has announced formation of a wholly-owned division, Powertron New England, in West Springfield, Mass.

The new division is headed by Theodore M. Jordan, president.

REL Names Freseman To Executive Post

APPOINTMENT of William L. Freseman to a new post of assistant to the president of Radio Engineering Laboratories, Inc., communications subsidiary of Dynamics Corp. of America, is announced.

Freseman previously was vice

president of International Standard Engineering, Inc., a subsidiary of ITT Corp., and also manager of the ITT Projects Group.

Burton Announces New Building

CONSTRUCTION of a new headquarters building in Northridge, Calif., for the Burton Mfg. Co. of Santa Monica, is now under way, according to Burton president William J. Miller.

Upon completion of the $250,000 27,000-sq ft plant about July 1, it will be occupied by Burton's Instrument Division and Trans Electronics, Inc., a wholly-owned subsidiary now situated in Canoga Park.

PEOPLE IN BRIEF

Martin J. Ruthford advances at Capehart Corp. to director of military marketing. **Lawrence Nadel,** formerly with Aerojet-General Corp., joins the Western Development Labs of Philco Corp. as director of the system program office. **Robert H. Sugarman** transfers from the U.S. Army Signal Research and Development Laboratory to AEL, Inc., as head of the signal environment section. **Robert R. Owen** promoted to manager of technical liaison for Datalab, a division of Consolidated Electrodynamics Corp. **Richard E. Hillger** advances to vice president for research at Air Technology Corp. **Howard J. Rowland** leaves D. S. Kennedy & Co. to join Antenna Systems, Inc., as director of research and development. **James L. Winget,** ex-Perkin-Elmer Corp., appointed manager of the Inductosyn Dept. of Del Electronics Corp. **Theodore W. Cooper,** previously with Hughes Aircraft, chosen manager of operations division by Micro Systems, Inc. **Warren A. Christopherson** promoted to senior engineer at IBM's San Jose, Calif., engineering center. **George L. Curtis** and **Bogdan R. Stack** promoted to associate laboratory directors at ITT's Federal Labs. **George Konkol** of Sylvania Electric Products Inc. advances to general manager of microwave device operations.

electronics

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1. Review the positions in the advertisements.
2. Select those for which you qualify.
3. Notice the key numbers.
4. Circle the corresponding key number below the Qualification Form.
5. Fill out the form completely. *Please print clearly.*
6. Mail to: D. Hawksby, Classified Advertising Div., ELECTRONICS, Box 12, New York 36, N. Y. (No charge, of course).

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ERIE ELECTRONICS DIV. Erie Resistor Corp. Erie, Pa.	120*	2
ESQUIRE PERSONNEL Chicago, Illinois	140	3
HORIZONS INC. Cleveland, Ohio	120*	4
HUGHES AEROSPACE ENGINEERING DIV. Hughes Aircraft Company Culver City, California	49*	5
JET PROPULSION LABORATORY Pasadena, California	50	6
KOLLSMAN INSTRUMENT CORP. Elmhurst, New York	140	7
LOCKHEED CALIFORNIA DIV. Burkbank, California	55	8
LOCKHEED MISSILES & SPACE DIV. Sunnyvale, California	54, 55*	9
McGRAW-HILL PUBLISHING CO., INC. New York, New York	140	10
NATIONAL CASH REGISTER CO. Electronics Division Hawthorne, California	119*	11
PHILCO WESTERN DEVELOPMENT LABS. Palo Alto, California	118*	12

Continued on page 140

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electronics WEEKLY QUALIFICATION FORM FOR POSITIONS AVAILABLE

Personal Background

NAME ....

HOME ADDRESS..

CITY.......................... ZONE...... STATE............

HOME TELEPHONE..

Education

PROFESSIONAL DEGREE(S)..................................

MAJOR(S) ....

UNIVERSITY ....

DATE(S) ....

FIELDS OF EXPERIENCE (Please Check)

5121

☐ Aerospace	☐ Fire Control	☐ Radar
☐ Antennas	☐ Human Factors	☐ Radio—TV
☐ ASW	☐ Infrared	☐ Simulators
☐ Circuits	☐ Instrumentation	☐ Solid State
☐ Communications	☐ Medicine	☐ Telemetry
☐ Components	☐ Microwave	☐ Transformers
☐ Computers	☐ Navigation	☐ Other ....
☐ ECM	☐ Operations Research	☐ ....
☐ Electron Tubes	☐ Optics	☐ ....
☐ Engineering Writing	☐ Packaging	☐ ....

CATEGORY OF SPECIALIZATION

Please indicate number of months experience on proper lines.

	Technical Experience (Months)	Supervisory Experience (Months)
RESEARCH (pure, fundamental, basic)	......	......
RESEARCH (Applied)	......	......
SYSTEMS (New Concepts)	......	......
DEVELOPMENT (Model)	......	......
DESIGN (Product)	......	......
MANUFACTURING (Product)	......	......
FIELD (Service)	......	......
SALES (Proposals & Products)	......	......

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- ELECTRONIC DISPLAYS
- ADVANCED CONTROL SYSTEMS
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To arrange a confidential interview, forward a brief resume to Mr. John Whitton.

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CIRCLE 381 ON READER SERVICE CARD

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electronics

WEEKLY QUALIFICATIONS FORM FOR POSITIONS AVAILABLE

(Continued from page 138)

COMPANY	SEE PAGE	KEY #
REPUBLIC AVIATION Farmingdale, L. I., New York	122*	13
SANDERS ASSOCIATES, INC. Nashua, New Hampshire	120*	14
SIKORSKY AIRCRAFT Div. of United Aircraft Corp. Stratford, Connecticut	121*	15
P-6542	122*	16

*These advertisements appeared in the 5/5/61 issue.

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CIRCLE 383 ON READER SERVICE CARD

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES
EQUIPMENT — USED or RESALE

GET IT from GOODHEART!

0.1% SORENSEN Line Voltage Regulator

#5000S, Brand new at low surplus price! Input 95-130 V. 1 ph., with taps for 50 or 60 cy. Use for any power up to 5000 watts. Output adjustable 110-120 V and holds to ±0.1% at line frequency, or to ±0.25% if line frequency drifts 5%. Regulates against line changes of 95-130V and against load changes from 0 to 5 KVA. Maximum harmonics less than 3%! Recovery time 0.15 seconds. Input to the control section can be moved to the point where you will use the power, thus compensating for line drop. In rack cabinet 28" h, 22" wd, 15" dp. Net wt 190 lbs. Shpg wt 285 lbs FOB Utica, N. Y. In original factory pack suitable for export, including SPARE PARTS group. Sorensen catalog net price is $695.00 less spares. Our price, WITH SPARES **$349.50**

BRUSH BL-202 2-pen, ink, $295.00. BL-222, ink or electric, w/pwr sply, $325.00.

Write us, stating your specific needs in Line Voltage Regulators, Receivers, Signal Generators, Transmitters, Tuning-Fork Frequency Standards, Graphic Recorders, etc., all at low surplus prices, all certified and guaranteed unconditionally.

R. E. GOODHEART CO.
P. O. Box 1220-E Beverly Hills, Calif.

CIRCLE 460 ON READER SERVICE CARD

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OA3	.85
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1P22	7.00
1P25	8.00
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2C36	18.85
2C39	3.50
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2C39B	18.75
2C40	7.00
2C42	3.00
2C43	7.50
2C50	4.00
2C51	1.50
2C52	1.50
2D21	.50
2D21W	1.00
2E22	2.50
2E24	2.50
2E26	2.50
2E30	2.50
2J21-50	PUR
2J42	50.00
2J51	50.00
2K22	20.00
2K25	8.50
2K26	30.00
2K28	25.00
2K29	25.00
2K30	50.00
2K34	75.00
2K35	250.00
2K41	12.50
2K42	125.00
2K43	125.00
2K44	125.00
2K45	20.00
2K47	125.00
2K48	50.00
2K50	65.00
2K54	10.00
2K55	15.00
2P21	40.00
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3AP1	2.00
3B23/RK-22	2.00
3B24	.35
3B24W	3.00
3B24WA	5.00
3B25	2.50
3B26	2.50
3B28	3.00
3B29	5.00
3BP1	2.50
3C/4B24	4.00
3C22	15.00
3C23	5.00
3C24/24G	4.00
3C45	3.00
3D21A	2.00
3D22	8.00
3E22	3.00
3E29	5.00
3GP1	1.50
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C3J/A	10.00
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3J31	50.00
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3K27	150.00
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4-250A	27.50
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4B32	7.50
4C35	15.00
4D32	17.50
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6AN5	1.85
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6BM6	30.00
6BM6A	30.00
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C6J/A	15.00
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6J6W	.75
C6L	2.50
6L6GAY	.75
6L6WGA	2.00
6L6WGB	2.00
6Q5G	2.50
6SC7GTY	1.00
6SJ7WGT	1.25
6SL7WGT	.75
6SN7W	.50
6SN7WGT	.75
6SN7WGTA	2.50
6V6GTY	.75
6X4W	.75
6X5WGT	1.00
7AK7	1.50
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7MP7	17.50
10KP7	15.00
12AT7WA	1.25
12AY7	1.00
12DP7	7.50
12GP7	12.50
16F	10.00
C16J	20.00
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HK-24	2.00
25T	10.00
25Z6WGT	1.50
26Z5W	1.50
FG-27A	20.00
FG-32	6.00
FG-33	17.00
35T	5.00
35TG	1.25
FG-41	50.00
FP-54	100.00
FG-57	6.00
RK-60/1641	.85
RK-61	2.35
FG-67	3.85
HY-69	2.00
RK-73	.25
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RK-75/307A	.35
FG-81A	4.00
FG-95	15.00
FG-104	25.00
FG-105	10.00
F-123A	4.00
F-128A	25.00
HF-200	10.00
203A	2.50
211	1.00
212E	25.00
231D	.90
FG-235	40.00

242C	10.00
244A	1.25
245A	2.50
249B	10.00
249C	5.00
250R	10.00
251A	50.00
252A	4.75
254A	2.00
257A	2.50
FG-258A	75.00
259A	2.50
262B	2.50
FP-265	5.00
267B	5.00
271A	9.00
272A	2.75
274A	2.00
275A	3.00
276A	4.00
283A	2.50
287A	1.85
293A	2.50
HF-300	25.00
300B	5.00
304TH	30.00
304TL	40.00
310A	2.50
311A	2.25
313C	1.00
323A	5.00
328A	2.25
336A	2.00
337A	2.25
347A	1.00
348A	2.00
349A	1.50
350A	3.50
350B	1.00
352A	6.00
354A	7.50
355A	7.50
393A	5.00
394A	2.50
395A	2.00
396A/2C51	2.00
398A/5603	3.00
401A/5590	1.00
403A/6AK5	.65
403B/5591	3.00
404A/5847	10.00
407A	3.50
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409A/6AS6	1.00
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CK-503AX	.75
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575A	12.50
576	12.50
577	12.50
578	5.00
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673	12.50
676	25.00
677	27.50
701A	3.00
707B	.75
NL-710	8.75
714AY	10.00
715B	2.50
715C	12.50
719A	7.50
720AY-EY	20.00
721A	.35
721B	3.75
723A/B	2.85
725A	5.00
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BL-800A	50.00
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803	2.50
804	12.50
805	3.00
807	1.25
807W	1.25

807WA	5.00
808	.75
809	4.75
810	12.50
811	2.50
811A	3.50
813	10.00
814	2.50
815	1.00
816	1.85
828	8.50
829B	9.50
832	2.00
832A	6.75
833A	35.00
836	1.00
837	.80
838	1.00
842	5.00
845	7.50
850	12.50
866A	1.75
869B	50.00
872A	3.50
884	1.00
885	.65
913	8.50
918	.65
920	2.50
927	.85
931A	3.00
959	.50
1000T	90.00
CK-1006	2.00
1237	2.00
1500T	125.00
1614	2.75
1616	.50
1619	.20
1620	3.50
1624	.75
1625	.35
1846	50.00
2050	1.25
2050W	1.50
5'45	10.00
5550	30.00
5586	100.00
5641	1.75
5642	1.50
5643	3.00
5644	2.50
5647	3.50
5651	.75
5654/6AK5W	1.00
5654/6AK5W/6096	1.40
5656	2.50
5663	.75
5670	1.00
5675	8.50
5678	1.25
5686	1.85
5687	1.50
5691	5.00
5692	2.00
5693	3.50
5696	.85
5702	1.50
5703	1.00
5718	.60
5719	.60
5721	125.00
5725/6AS6W	1.00
5726/6AL5W	.60
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5750/6BE6W	1.50
5751/12AX7W	1.50
5751WA	1.60
5763	1.50
5768	35.00
5777	100.00
5778	125.00
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5787	2.00
5796	10.00
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5800/VX-41	7.50
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5802/VX-32B	2.25
5803/VX-55	2.25
5814A	1.35
5822A	55.00
5828	3.00
5829	.75
5836	50.00
5837	50.00
5839	3.00
5840	1.50

5841	2.50
5842/417A	7.50
5844	.60
5845	4.50
5852	2.25
5854	1.00
5879	1.25
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5886	3.00
5896	1.50
5902	2.50
5915	.85
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5963	1.10
5964	.75
5965	1.00
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5993	4.00
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6021A	2.00
6032	10.00
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6044	3.50
6045	1.15
6050	1.00
6072	1.50
6073	.75
6074	1.50
6080	2.75
6080WA	4.50
6080WB	10.00
6082	3.00
6087/5Y3WGTB	3.00
6098	5.00
6099	.75
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6101/6J6WA	1.00
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6147	2.50
6161	50.00
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6189/12AU7WA	1.50
6197	1.75
6198	85.00
6201/12AT7WA	1.75
6202/6X4WA	1.50
6211	.75
6216	2.50
6236	150.00
6252	15.00
6263	9.00
6264	9.00
6265/6BH6W	2.25
6282/BL-11	65.00
6293	4.50
6299	37.50
6322/BL-25	12.50
6336	9.50
6345	3.50
6350	1.75
6352	8.50
6364	150.00
6390	150.00
6438	5.00
6463	1.00
6485	1.95
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6533	5.00
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SUPPLIERS OF ELECTRON TUBES SINCE 1932

CIRCLE 462 ON READER SERVICE CARD

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electronics

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Use them in these circuit applications and you'll keep the top-level performance of your present equipment but you'll spend less to achieve it!

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