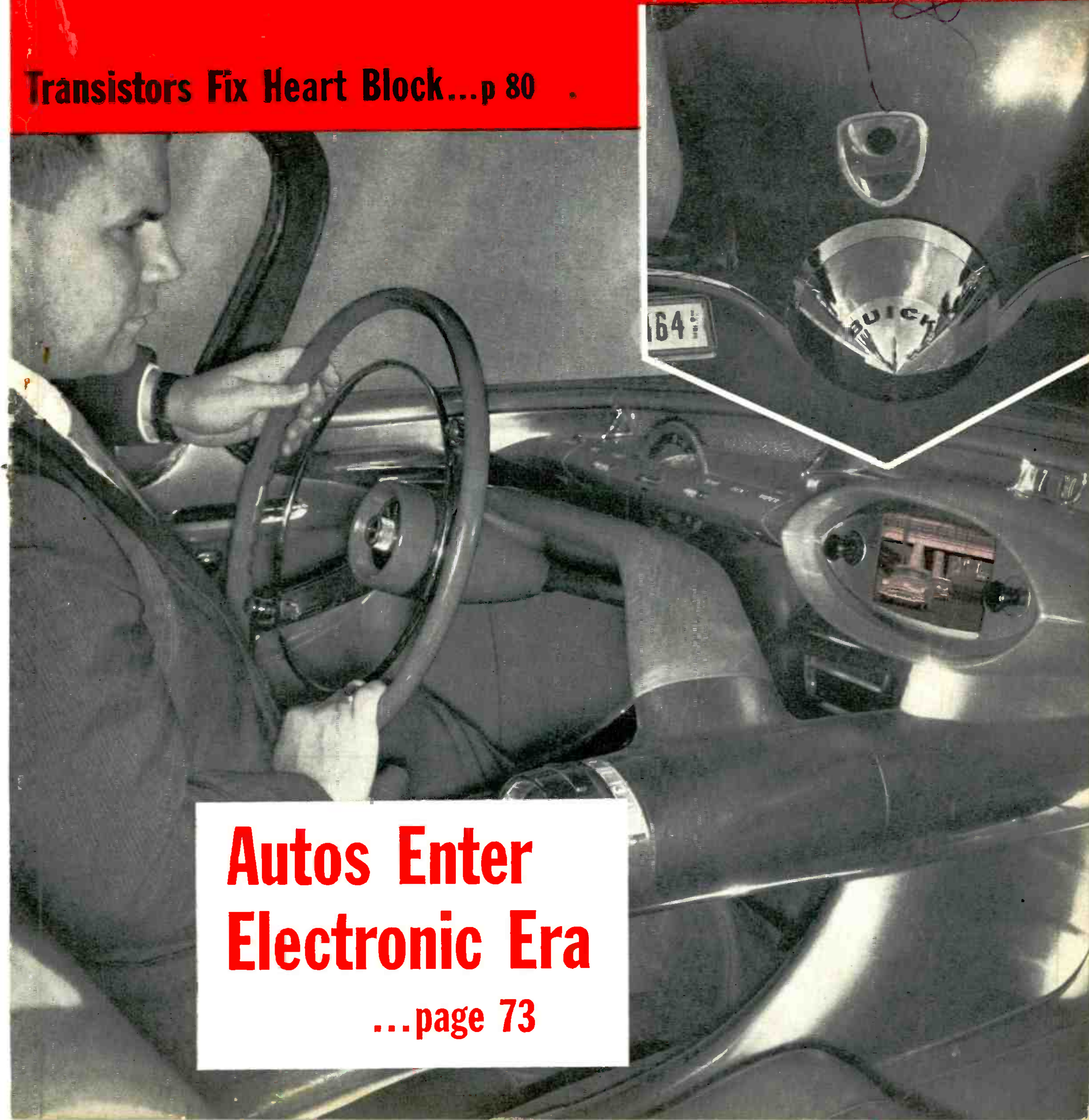
A McGRAW-HILL PUBLICATION • PRICE ONE DOLLAR

NOVEMBER 21, 1958

electronics

engineering issue

Transistors Fix Heart Block...p 80



Autos Enter Electronic Era

...page 73

signal generators

10 to 21,000 MC!

EASIER TO USE • MORE ACCURATE • MORE STABLE

11 TO CHOOSE FROM

With *-hp-* signal generators, frequencies are directly set and read on one dial. Output voltage is directly set and read. No calibration charts are required. Most *-hp-* generators offer internal pulse, FM or square wave modulation; some include external pulsing and FM'ing. New *-hp-* 626A (10 to 15.5 KMC) and 628A (15 to 21 KMC) offer 10 mw output, SWR 1.2.

-hp- signal generators outsell other signal sources by approximately 2:1. Engineers report the reasons are simpler operation, versatility, trouble-free performance, and exceptional value.

Instrument	Frequency Range	Characteristics	Price
-hp- 608C	10 to 480 MC	Output 0.1 µv to 1 v into 50 ohm load. CW, pulse or AM mod. Direct calibration.	$ 950.00
-hp- 608D	10 to 420 MC	Output 0.1 µv to 0.5 v into 50 ohm load. CW, pulse or AM mod. Direct calibration and crystal calibrator check	1,050.00
-hp- 612A	450 to 1,230 MC	Output 0.1 µv to 0.5 v into 50 ohm load. Pulse, CW or amplitude modulation to 5 MC Direct calibration.	1,200.00
-hp- 614A	800 to 2,100 MC	Output 0.1 µv to 0.223 v into 50 ohm load. Pulse, CW or FM modulation. Direct calibration.	1,950.00
-hp- 616A	1,800 to 4,000 MC	Output 0.1 µv to 0.223 v into 50 ohm load. Pulse, CW or FM modulation. Direct calibration.	1,950.00
-hp- 618B	3,800 to 7,600 MC	Output 0.1 µv to 0.223 v into 50 ohm load. Pulse, CW, FM or square wave modulation. Direct calibration.	2,250.00
-hp- 620A	7,000 to 11,000 MC	Output 0.1 µv to 0.223 v into 50 ohm load. Pulse, CW, FM or square wave modulation. Direct calibration.	2,250.00
-hp- 623B	5,925 to 6,575 MC; 6,575 to 7,175 MC; 7,175 to 7,725 MC	Output 70 µv to 0.223 v into 50 ohm load. FM or square wave modulation. Separate power meter and wave meter section.	1,900.00
-hp- 624C	8,500 to 10,000 MC	Output 3.0 µv to 0.223 v into 50 ohm load. Pulse, FM or square wave modulation. Separate power meter and wave meter section.	2,265.00
-hp- 626A	10,000 to 15,500 MC	Output 1 µµwatt to 10 mw. Internal or external pulse, FM, or square wave modulation. Direct calibration.	3,250.00
-hp- 628A	15,000 to 21,000 MC	Output 1 µµwatt to 10 mw. Internal or external pulse, FM, or square wave modulation. Direct calibration.	3,250.00

Your -hp- field engineer has complete data on all -hp- generators. Or, write direct.

HEWLETT-PACKARD COMPANY
4055A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U. S. A.
CABLE "HEWPACK" • DAVENPORT 5-4451
FIELD ENGINEERS IN ALL PRINCIPAL AREAS

complete coverage, outstanding value

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

Published weekly, with alternating engineering and business issues and with a BUYERS' GUIDE issue in mid-June, by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948) Founder.

Executive, Editorial, Circulation and Advertising Offices: McGraw-Hill Building, 330 W. 42 St., New York 36, N. Y. Longacre 4-3000. Publication Office: 99-129 North Broadway, Albany 1, N. Y.

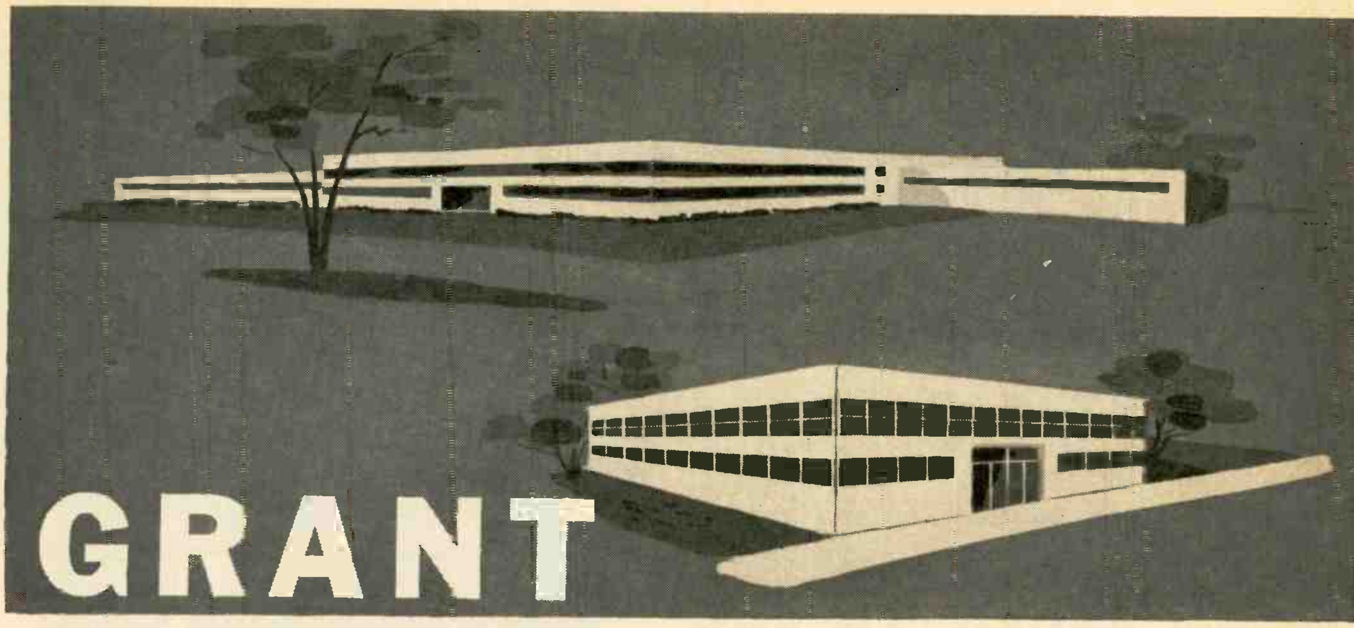
See panel below for directions regarding subscriptions or change of address. Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice President; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary; Nelson L. Bond, President, Publications Division; Shelton Fisher, Senior Vice President; Ralph B. Smith, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator.

Single copies $1.00 for Engineering Issue and 50¢ for Business Issue in United States and possessions, and Canada; $2.00 and $1.00 for all other foreign countries. Buyers' Guide $3.00. Subscription rates—United States and possessions, $6.00 a year; $9.00 for two years; $12.00 for three years. Canada, $10.00 a year; $16.00 for two years; $20.00 for three years. All other countries, $20.00 a year; $30.00 for two years; $40.00 for three years. Second class postage paid at Albany, N. Y. Printed in U.S.A. Copyright 1958 by McGraw-Hill Publishing Co., Inc.—All Rights Reserved. Title registered in U. S. Patent Office. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11; 68 Post Street, San Francisco 4; McGraw-Hill House, London E. C. 4; 15 Landgrat-Wilhelm, Frankfurt/Main; National Press Bldg., Washington 4, D. C.; Six Penn Center Plaza, Philadelphia 3; 1111 Henry W. Oliver Bldg., Pittsburgh 22; 55 Public Square, Cleveland 33; 856 Penobscot Bldg., Detroit 26; 3615 Olive St., St. Louis 8; 350 Park Square Bldg., Boston 16; 1321 Rhodes-Haverty Bldg., Atlanta 3; 1125 West Sixth St., Los Angeles 17; 1740 Broadway, Denver 2. ELECTRONICS is indexed regularly in The Engineering Index.

Subscriptions: Address correspondence to: Fulfillment Manager, Electronics, 330 W. 42nd St., New York 36, N. Y. Allow one month for changes of address, stating old as well as new address. Subscriptions are solicited only from persons engaged in theory, research, design, production, management, maintenance and use of electronics and industrial control components, parts and products. Position and company connection must be indicated on subscription orders.

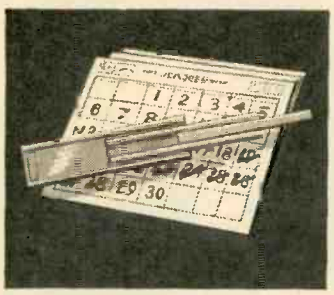
Postmaster: please send form 3579 to Electronics, 330 W. 42nd St., New York 36, N. Y.

Member ABP and ABC



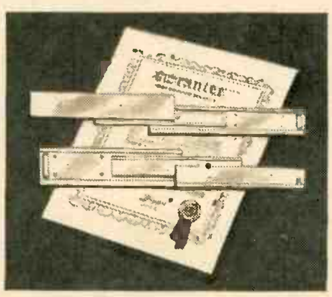
a multi-plant organization, with the most up-to-date equipment and the greatest experience…produces the nation's widest range of Industrial Slides priced right every time.

7-10 days from request to delivery of prototypes. 2-3 weeks for production.

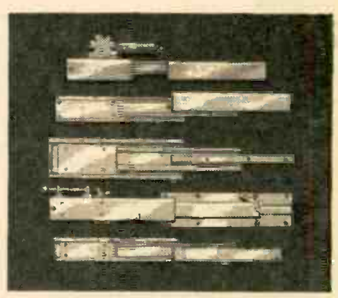


FAST DELIVERY:
Prototypes — 7 to 10 days, Production — 2-3 weeks.

RESEARCH & DEVELOPMENT
Constantly designing, testing, improving.



UNCONDITIONAL GUARANTEE
All Grant Slides guaranteed against defects in workmanship and materials.



TREMENDOUS VARIETY OF SLIDES
Standard and Special Types . . . priced right every time, too.

The nation's first and leading manufacturer of slides.

GRANT INDUSTRIAL SLIDES

Write for your copy of Grant's Industrial Slide Reference Catalogue.

GRANT PULLEY & HARDWARE CORP., 23 HIGH STREET, WEST NYACK, N. Y. 944 LONG BEACH AVENUE, LOS ANGELES 21, CALIF.

new Transistorized Power Supplies

Model Q28-1

Nine models available in 6, 12 or 28V nominal outputs, 2:1 adj, range, output power levels approx. 15, 30 and 50 watts.

Ripple: .01% maximum

Response time: 50 microseconds

Regulation: ± ¼% for line and load change combined

Meters: Optional on 50 watt units

Prices: From $165 to $240 depending on model and rack or cabinet mount

LOW-VOLTAGE HIGH-CURRENT DC POWER SUPPLIES

with the PERFORMANCE of ALL-TRANSISTOR CIRCUITRY

DC sources of utmost reliability, minimum ripple, and very fast response in lighter, smaller packages. And these new, compact power packs are fitted with the Zener diode reference circuit that assures the ± 0.25% regulation accuracy and high stability. The 2 to 1 output voltage range gives these supplies an application range that is unsurpassed. The all semi-conductor design provides the excellent ripple and response properties that rule out line and load transients. An exclusive protective circuit prevents short-circuit damage to the transistors. 15 and 30 watt units come in single or dual rack mount, or in cabinets. 50 watt units have provision for remote sensing. 100 and 200 watt units will be available shortly (90 days).

Full information on this important advance in low voltage, high current technology is now in print. Ask your Sorensen representative for full data, or let us mail it to you directly.

Model Q6-2

Sorensen

CONTROLLED POWER FOR RESEARCH AND INDUSTRY

SORENSEN & COMPANY, Inc. Richards Avenue, South Norwalk, Connecticut

In Europe, contact Sorensen-Ardag, Eichstrasse 29, Zurich, Switzerland, for all products including 50 cycle, 220 volt equipment

 CIRCLE 3 READERS SERVICE CARD

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.

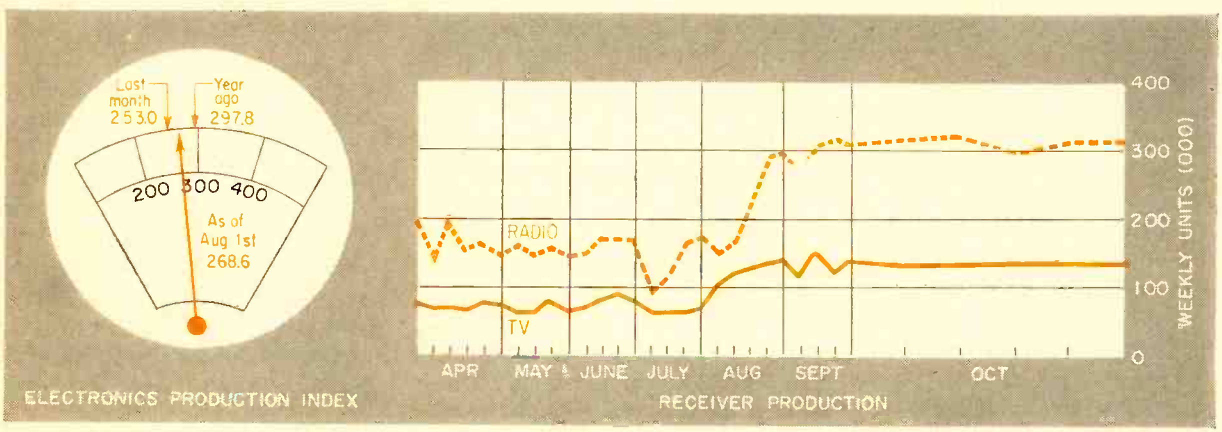
DATA HANDLING systems on order by savings banks will be transistorized by 1960, Teleregister Corp. tells ELECTRONICS. Firm says three eastern banks that had ordered systems using tubes and magnetic drum memories have agreed to wait two years for the new equipment. Systems planned are on-line; they will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

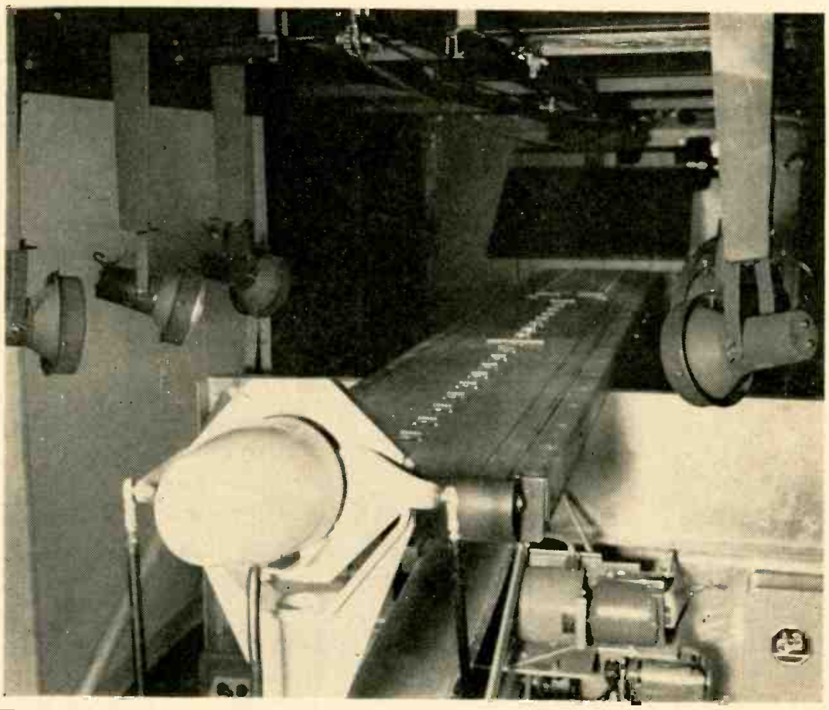
(Source: Standard & Poor's)	Nov. 5, '58	Oct. 29, '58	Nov. 6, '57
Radio-tv & electronics	66.41	62.99	41.79
Radio broadcasters	77.48	73.39	50.79

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

LAMBDA'S ALL-TRANSISTOR LINE

Delivered now • Guaranteed for five years

FOUR NEW POWER SUPPLIES

1-AMP and 2-AMP · CONVECTION COOLED

No internal blowers • No moving parts

0-32 VDC

0-1 AMP 0-2 AMP

Model LT 1095	**$285**
Model LT 1095M (metered)	**$315**
Model LT 2095	**$365**
Model LT 2095M (metered)	**$395**

- **Ambient 50° C at full rating.**
- **High efficiency radiator heat sinks.**
- Silicon rectifier.
- 50-400 cycles input.
- Special, high-purity foil, long-life electrolytics.
- **Compact. Only 3½" panel height.**
- **Short-circuit proof.**
- Protected by magnetic circuit breakers.
- Hermetically-sealed transformer. Designed to MIL-T27A.
- **All transistor. No tubes.**
- **Fast transient response.**
- Excess ambient thermal protection.
- Excellent regulation. Low output impedance. Low ripple.
- Remote sensing and DC vernier.

CONDENSED DATA

Voltage Bands . . . 0-8, 8-16, 16-24, 24-32 VDC

Line Regulation . . . Better than 0.15 per cent or 20 millivolts (whichever is greater). For input variations from 105-125 VAC.

Load Regulation . . . Better than 0.15 per cent or 20 millivolts (whichever is greater). For load variations from 0 to full load.

AC Input . . . . 105-125 VAC, 50-400 CPS

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

Thermal Overload Protection . . . Thermostat, manual reset, rear of chassis. Thermal overload indicator light, front panel.

Size . . . . 3½" H x 19" W x 14⅜" D.

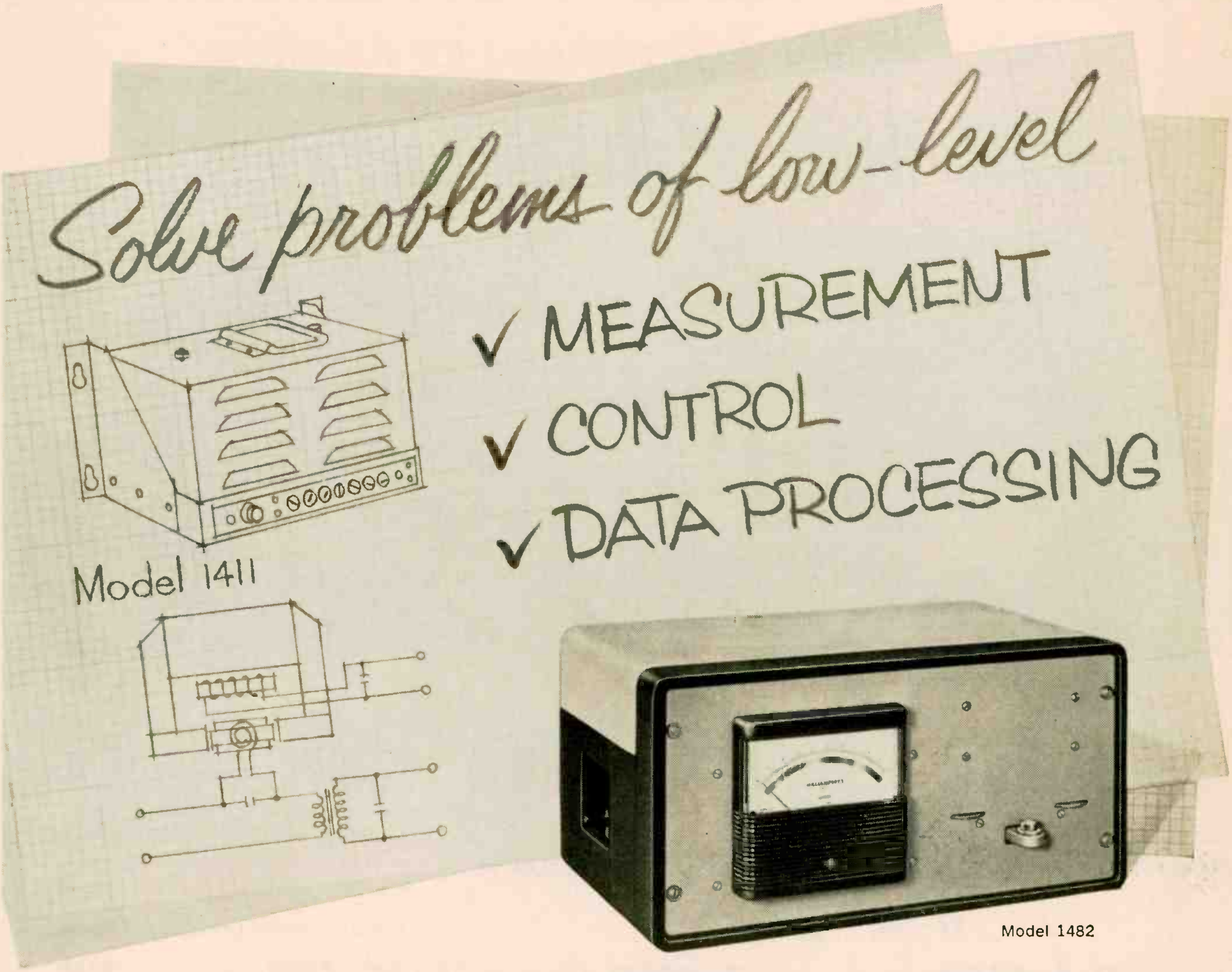
Send for complete LAMBDA L-T data.

LAMBDA Electronics Corp.

11-11 131 STREET • COLLEGE POINT 56, NEW YORK

INDEPENDENCE 1-8500 Cable Address: Lambdatron, New York

CIRCLE 5 READERS SERVICE CARD



USE WESTON INDUCTRONIC®

components and systems

The Weston Inductronic System of D-C amplification is a precise method of low-level measurement and regulation. It is designed for industrial and laboratory processes requiring high standards of service . . . stability . . . sensitivity . . . speed of resolution. Coupled with appropriate transducers, Inductronic units can achieve many unusual applications which would otherwise be impractical. Review and comment by Weston engineers on any special requirements are offered without obligation.

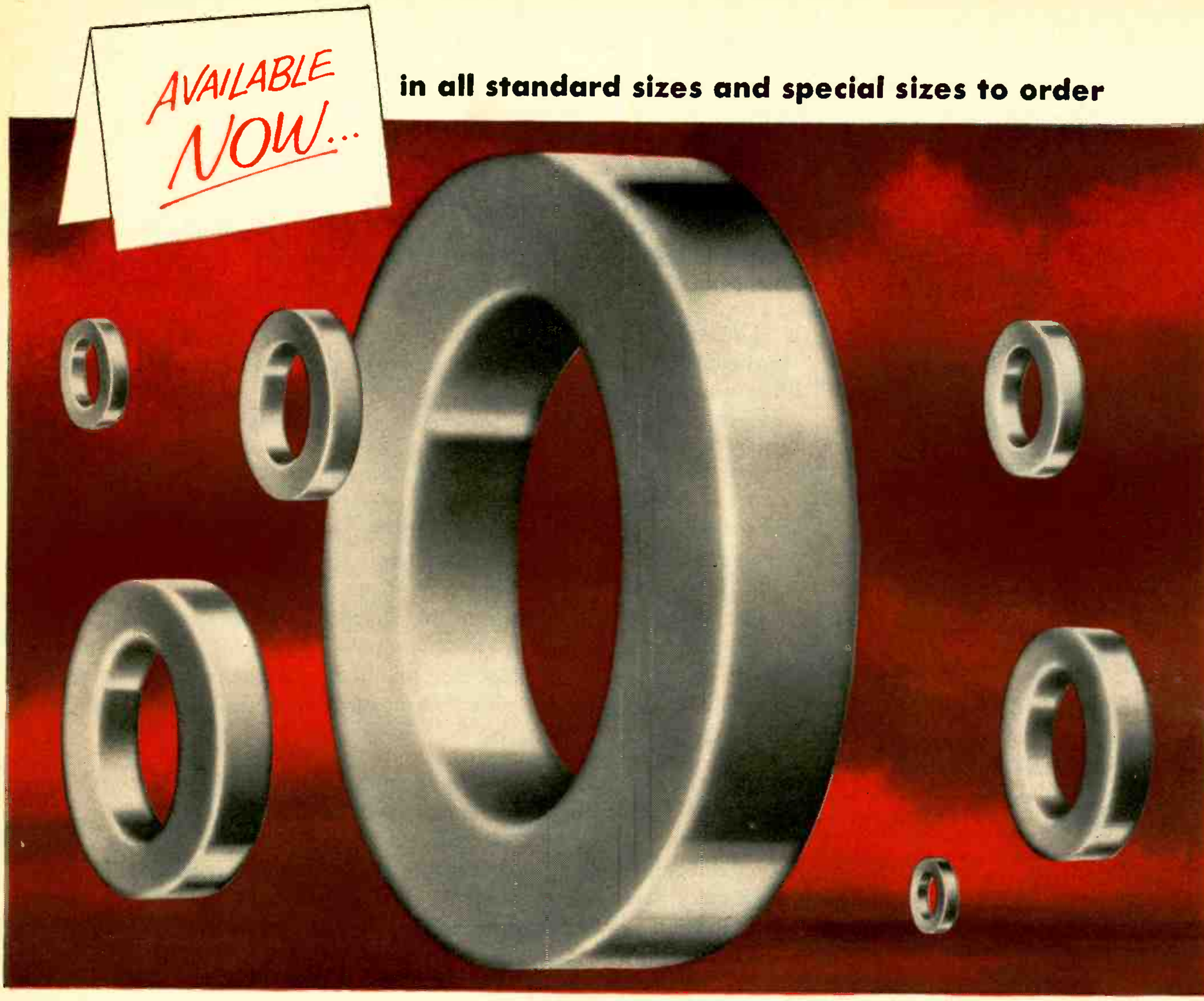
INDUCTRONIC D-C AMPLIFIER (MODEL 1411) is the basic component of Weston Inductronic Systems . . . the electronic equivalent of a potentiometric system. Plug-in Standards are available for ranges from 2 microamps to 1 milliamp, or 10 microvolts to 1 millivolt. Accuracies run as high as 0.1%. Output is bi-directional. Either side may be grounded. On most ranges, response time is 20 milliseconds or less. Model 1411 is not sensitive to line voltage variations, input frequency disturbance, or tube characteristics—due to its unique method of full feedback null-balance.

INDUCTRONIC PRODUCT RESOLVER (MODEL 1482) is a precise A-C to D-C transfer standard. It provides an output proportional to the product of two independently varying A-C or D-C voltages. Even at low power factor, rate accuracy falls within 0.2%. An electrodynamometer instrument mechanism is used as the translational device operating into a full feedback amplifier (similar to Model 1411). Its field coils are rated in single ranges from 50 milliamps to 5 amps. Voltage ranges are 20 ohms per volt. The response time of the entire system is approximately 20 milliseconds.

Write for Weston *Catalog B-36*, containing detailed information on these and other Inductronic systems and components. Address: Weston Instruments, Division of Daystrom, Inc., Newark 12, N. J. *In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 10, Ont. Export: Daystrom Int'l., 100 Empire St., Newark 12, N. J.*

WESTON

A DAYSTROM UNIT *Instruments*



in all standard sizes and special sizes to order

The **New ARNOLD** *6T* **Aluminum-Cased Tape Cores**

give you 4 BIG ADVANTAGES... *at no added cost!*

(1) **NEW COMPACTNESS in Aluminum-Cased Cores** permits you to design for greater miniaturization, yet retain the distortion-free strength of an aluminum case that resists winding stresses. Overall dimensions are smaller than older types of aluminum cases and comparable in size with plastic-cased cores.

(2) **HERMETICALLY SEALED, with Built-in Protection against shock and vibration,** Arnold 6T Cores provide the most complete protection against deterioration of magnetic properties available on the market. Strain-sensitive core materials are completely surrounded by an inert shock absorbent, hermetically sealed within the cases. Trouble-free performance is virtually assured, even over long standby periods. 6T Core design further guarantees that you can vacuum-impregnate your coils.

(3) **1000-VOLT BREAKDOWN *GUARANTEED!***
The Arnold 6T Core employs a strong, inert covering with hard gloss finish which carries a 1000-volt breakdown guarantee. Suitable radii and the elimination of sharp corners insure against cutting the winding wire's insulation. Its hard non-cold-flowing finish protects the covering against cuts. Both features guarantee against shorted wiring.

(4) **MEETS MILITARY "SPECS" for Operating Temperatures and Temperature Rise.**
The Arnold 6T Core fully meets the requirements of military specifications Mil-T-5383 or Mil-T-7210, wherever applicable. These specifications call for case construction to withstand ambient temperatures to 170° C, and a 25° C temperature rise.

Arnold 6T Tape Cores are available in all standard sizes, and special sizes may be made to order... all guaranteed for size, hermetic seal, dielectric strength and temperature of operation.

● We'll welcome your orders for prompt delivery of pilot or production quantities.

WSW 7319

THE ARNOLD ENGINEERING COMPANY

Main Office & Plant: Marengo, Illinois

Repath Pacific Division Plant: 641 East 61st Street, Los Angeles, Calif.

District Sales Offices:

Boston: 49 Waltham St., Lexington *Los Angeles:* 3450 Wilshire Blvd.
New York: 350 Fifth Ave. *Washington, D.C.:* 1001-15th St., N.W.

possible landing places for man-carrying space vehicles.

- Instruments for determining whether the moon has a magnetic field similar to that of the earth and the sun.
- Tv apparatus for viewing the far side of the moon.

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.


+ 8·4 5 4

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

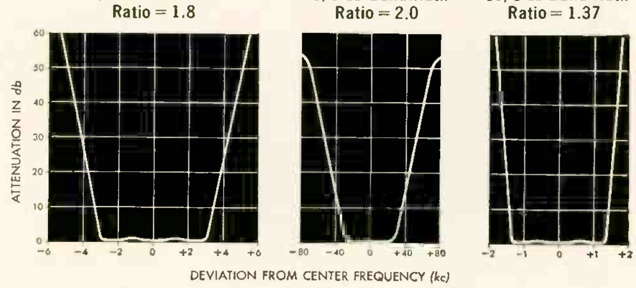
Hughes Products now offers high performance crystal filters previously available only for special military developmental contracts and Hughes-built systems. Utilizing unique design and advanced manufacturing techniques, these Hughes crystal filters provide a degree of performance previously unattainable.

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-

CIRCLE 10 READERS SERVICE CARD

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.

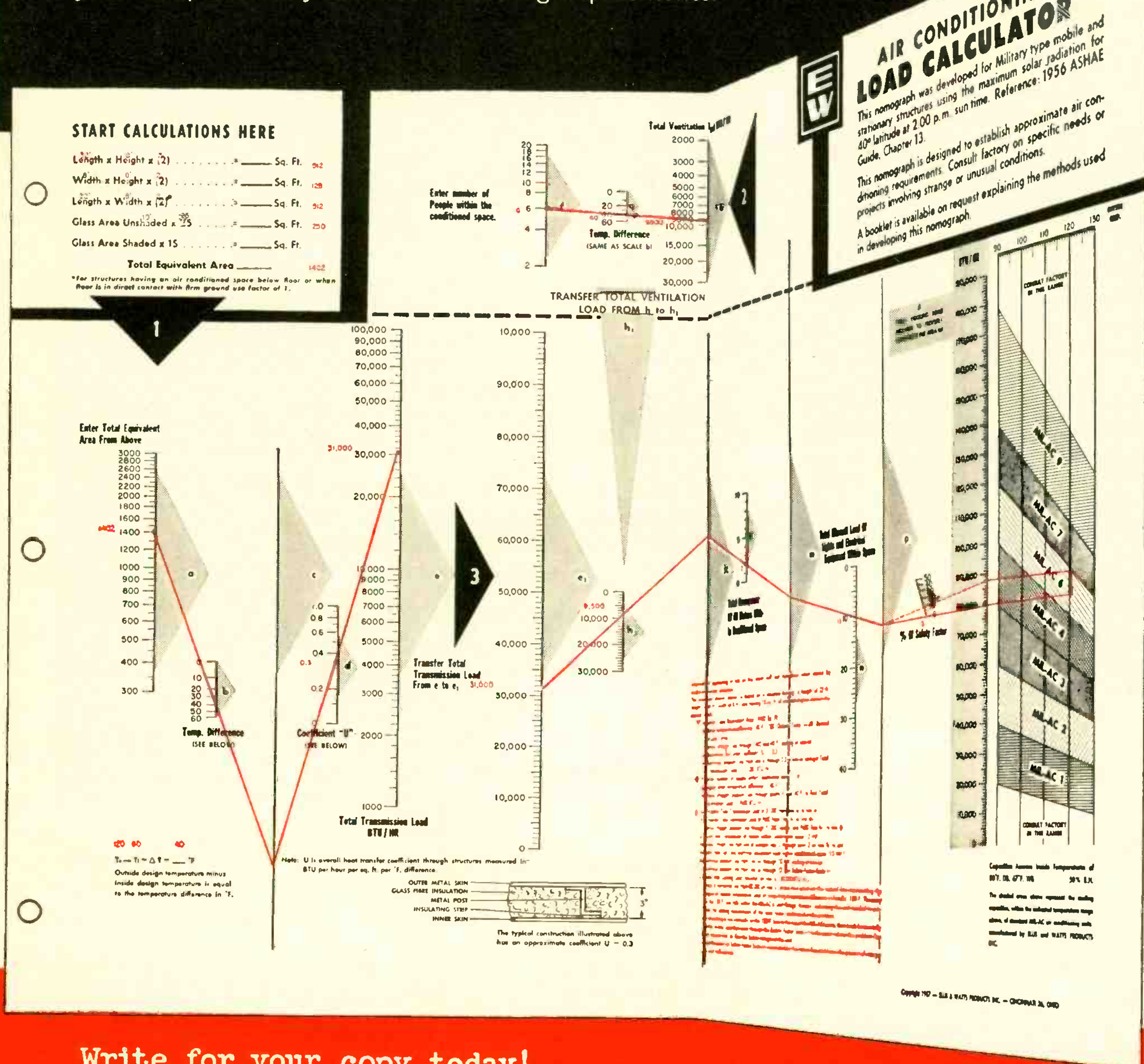
Mar. 31-Apr. 2: Millimeter Waves Symposium, Polytechnic Inst. of Brooklyn, USAF, ONR, IRE, USA Signal Research, Engineering Societies Bldg., N. Y. C.

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.



Write for your copy today!

Ellis and Watts Products, Inc.

P.O. Box 33 E, Cincinnati 36, Ohio

Designers and builders of specialized air conditioning equipment: MIL-AC Units, refrigerated liquid coolers, computer cooling equipment, dewpoint control equipment, electronic console coolers, air to liquid coolers and large capacity dehumidifiers.

CIRCLE 11 READERS SERVICE CARD

New amplifier battles "noise"

Four-stage junction diode amplifier was developed at Bell Telephone Laboratories by Rudolf Engelbrecht for military applications. Operates on the "varactor" principle, utilizing the variable capacitance of diodes. With 400-mc. signal, the gain is 10 db. over the 100-mc. band.

The tremendous possibilities of semiconductor science are again illustrated by a recent development from Bell Telephone Laboratories. The development began with research which Bell Laboratories scientists were conducting for the U. S. Army Signal Corps. The objective was to reduce the "noise" in UHF and microwave receivers and thus increase their ability to pick up weak signals.

The scientists attacked the problem by conducting a thorough study of the capabilities of semiconductor junction diodes. These studies led to the conclusion that junction diodes could be made to amplify efficiently at UHF and microwave frequencies. This was something that had never been done before. The theory indicated that such an amplifier would be exceptionally free of noise.

At Bell Laboratories, development engineers proved the point by developing a new kind of amplifier in which the active elements are junction diodes. As predicted, it is extremely low in noise and efficiently amplifies over a wide band of frequencies.

The new amplifier is now being developed for U. S. Army Ordnance radar equipment. But it has numerous other possibilities. In radio astronomy, for example, it could be used to detect weaker signals from outer space. In telephony, it offers a way to increase the distance between relay stations in line-of-sight or over-the-horizon communications.

BELL TELEPHONE LABORATORIES

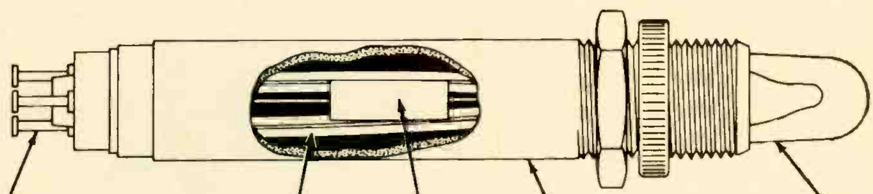
WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

BE SURE...BUY E-LITES

engineered especially for computers, control systems, military applications

Actual size —
fits a 3/8" dia. hole

THE ORIGINAL MINIATURE INDICATOR LIGHT



MULTIPLE TERMINALS— NO "HOT" CASES
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.

BUILT-IN RESISTORS OPTIONAL
Genuine Allen-Bradley carbon composition.

STRONG, LIGHTWEIGHT ALUMINUM CASES
Black or silver anodized to MIL-A-8625 (ASG).

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

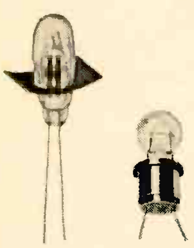
You can mount almost any E-lite in a 3/8" hole. These tiny units save precious space in computer data-processing systems, aircraft and industrial control systems, instruments, test equipment, telemetering systems — wherever long life and dependable operation are essential. They'll fit your system application *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.

TWO-WEEK DELIVERY ON 1560 STANDARD VARIATIONS
Special Prices On Volume Orders

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.



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.

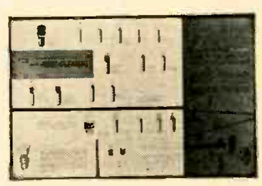
DUAL LAMP HOLDER
Holds two lamps to provide double check on circuit operation. Monitors key circuitry in a variety of ways. Model 1FH.

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

MORE THAN 1500 SATISFIED USERS:

IBM Burroughs General Electric Electro-Data Bendix Hughes Brush Instruments Magnavox Ampex . . . and others!

Write for 6-page bulletin with photos, descriptions, dimension drawings for the complete line. Sales representatives in principal cities. Submit your special problem for our engineered solution.



Eldema
CORPORATION

1805 Belcroft Avenue, El Monte, Calif.
A subsidiary of Genisco, Incorporated

There's a "one-best voltmeter" for every job... and you'll find it here!

Makeshift measurement—where you *stretch* a faithful but outmoded instrument to or beyond its limitations—this takes time. Save engineering time by choosing and ordering now the "one-best" *-hp-* voltmeters fitting your measurement need. *-hp-* offers a complete array of precision, dependable voltmeters, each specifically suited to a given type of voltage measuring job. Check the brief data here, then ask your *-hp-* representative for demonstration—*on your bench and on your problems!*

WIDE RANGE—10 cps to 4 MC

-hp- **400D**, probably the best *-hp-* voltmeter ever built. Covers all frequencies 10 cps to 4 MC. Extremely sensitive, accurate within ±2% to 1 MC, measures 0.1 mv to 300 v. Direct reading in dbm. 10 megohm input impedance insures negligible loading on circuits under test. New amplifier circuit with 56 db feedback insures maximum stability and freedom from change due to external conditions. $225.00.

MULTI-PURPOSE to 600 KC—$200

-hp- **400AB**, unique value, broad utility and long-term dependability in a low cost laboratory instrument. Covers 10 cps to 600 KC, measures from 0.3 mv to 300 v in 11 ranges. High stability, high sensitivity, accuracy ± 2% full scale from 20 cps to 100 KC. 10 megohm input impedance; 25$\mu\mu$f shunt. Meter reads direct in volts and dbm. $200.00.

EXTREME ACCURACY of 1%

-hp- **400H**, designed for users who need highest accuracy within ± 1% to 500 KC, ± 2% to 1 MC and ± 5% full range. Covers frequency range 10 cps to 4 MC. Has 5" meter with mirror scale, measures voltages 0.1 mv to 300 v. High 10 megohm resistance minimizes circuit disturbances; amplifier with 56 db feedback insures lasting stability. Direct reading in db or volts. Extremely high quality throughout. $325.00.

-hp- also offers a broad variety of voltmeter accessories including voltage dividers, connectors, shunts and multipliers to extend the useful range of your equipment. Details on request from your -hp- representatives or direct; or see page 46 of current -hp- catalog.

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

HEWLETT-PACKARD COMPANY
4650A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U. S. A.
Cable "HEWPACK" • DAvenport 5-4451
FIELD ENGINEERS IN ALL PRINCIPAL AREAS

CIRCLE 17 READERS SERVICE CARD

For your Magnetic Shielding Problems ...

MUMETAL is the answer!

Write for your copy

"MAGNETIC MATERIALS"

This 32-page book contains valuable data on all Allegheny Ludlum magnetic materials, silicon steels and special electrical alloys. Illustrated in full color, includes essential information on properties, characteristics, applications, etc. Your copy gladly sent free on request.

ADDRESS DEPT. E-11

Mumetal shields will give instant relief to interference caused by extraneous magnetic fields. This material can cure many troubles—solve many a problem for you.

Use it where high permeability is required at low flux densities, such as in input and microphone transformers, hearing aid diaphragms, instruments, wire and tape recorders, etc. For properly heat treating Mumetal, we can also offer commercial hydrogen annealing facilities.

A fund of technical data on shields and other applications for Allegheny Ludlum Mumetal is available—let us help with your problems.

In addition to Mumetal and other high-permeability alloys, we offer a range of magnetic and electrical alloys and steels that is unmatched in its completeness. Our services also include the most modern facilities for lamination fabrication and heat treatment. • Let us supply your requirements. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

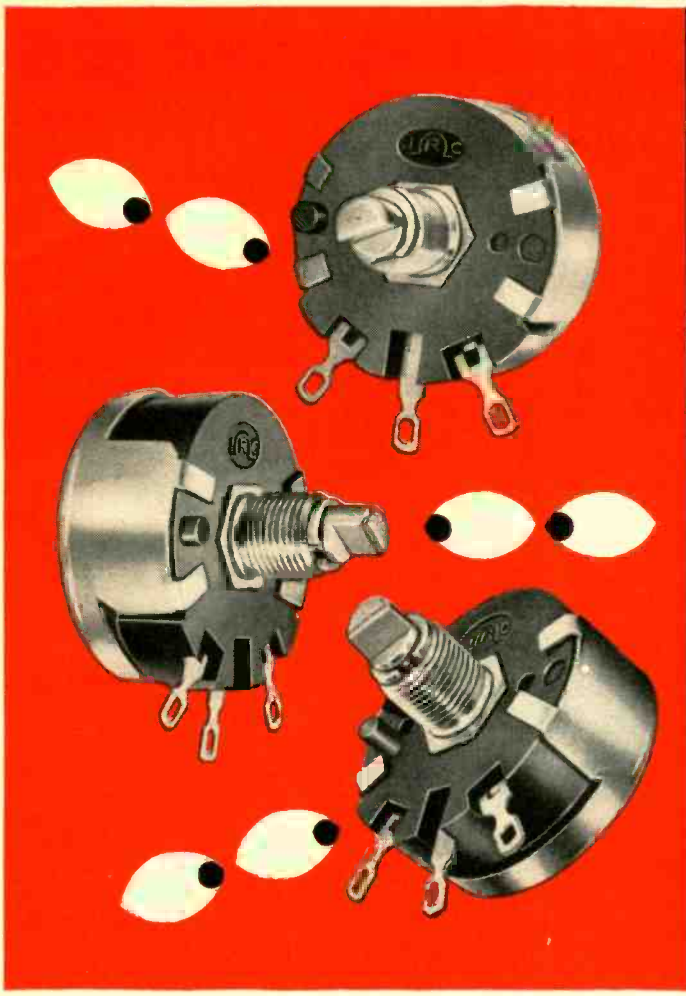
STEELMAKERS to the Electrical Industry

Allegheny Ludlum

AL ® STEELS FOR THE ELECTRONIC AGE

Warehouse stocks of AL Stainless Steels carried by all Ryerson plants

WSW 6094



Any way you look at them IRC Type 2W 2 WATT RHEOSTAT POTENTIOMETERS are your best buy

LOOK AT THEIR DESIGN

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.

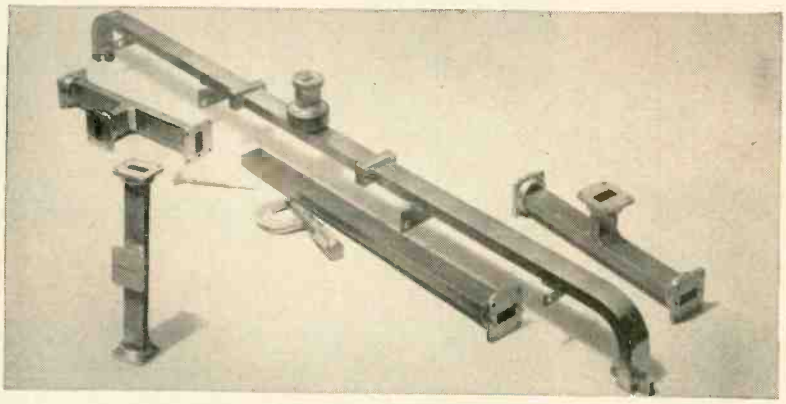
IRC ®

INTERNATIONAL RESISTANCE COMPANY • Dept. 377, 401 N. Broad St., Phila. 8, Pa. *In Canada:* International Resistance Co., Ltd., Toronto Licensee

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.

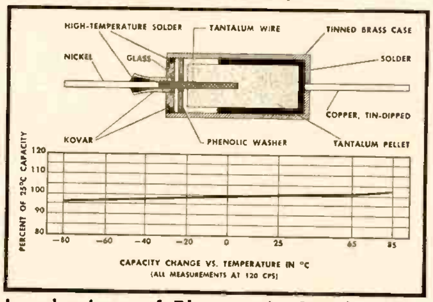
Nickel leads, welded directly to tantalum, boost capacitor ruggedness

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

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 x 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.

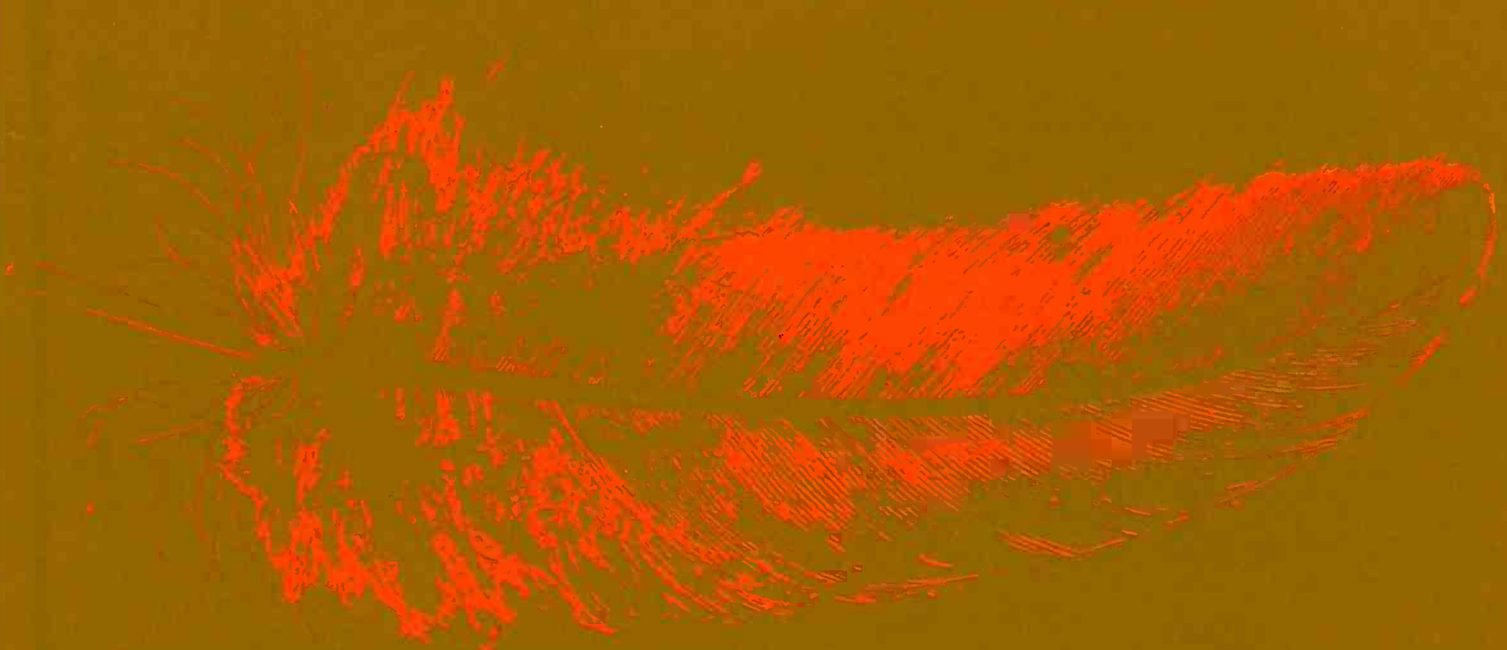
This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

35% LIGHTER!



NEW!
all electronic
A-D converters
and
digital voltmeters

for medium and high speed applications

2
new series of advanced instruments

The 7000 Series

for *high-speed* conversions. Up to 1000/second • 1 megohm input impedance • Automatic polarity • 3- and 4-digit models • Sensitivity and resolution 0.01% • Transistorized logic circuits • Transistorized direct-reading indicators.

The 8000 Series

for *medium-speed* conversions • Maximum balance time 100 milliseconds • 1000 megohms input impedance at balance • Automatic ranging • Automatic polarity • 4-digits • Sensitivity and resolution 0.01% • Totally transistorized.

Both the 7000 and 8000 Series develop voltage state BCD outputs for data recorder entry. Standard code is 2, 4, 2, 1; other codes available on special order.

Write today for complete engineering specifications

Electro Instruments, Inc.

3540 Aero Court
San Diego 11, California

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

- 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

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.

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.

*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.

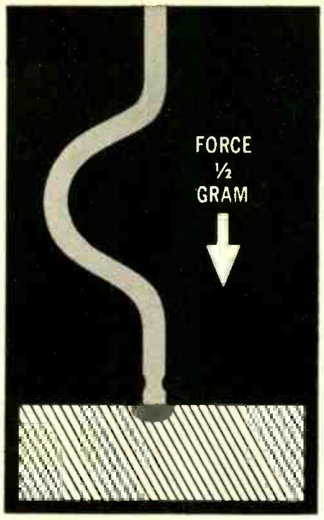
Write for New Kay Catalog

KAY ELECTRIC COMPANY

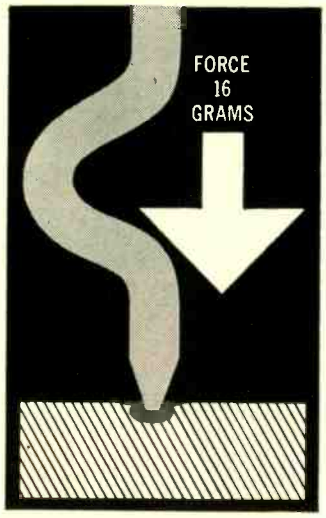
Dept. E-11 Maple Avenue Pine Brook, New Jersey CApital 6-4000

Now... COMPUTER DIODES designed to eliminate opens and shorts

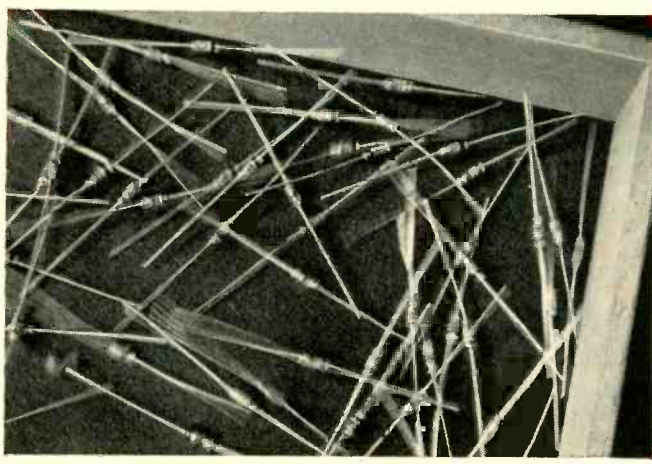
Other bonded diodes
A 0.002-inch whisker of precious metal is micro-fed under a force of less than 0.5 gram into light contact with the germanium. Shock or temperature variation can break this contact.



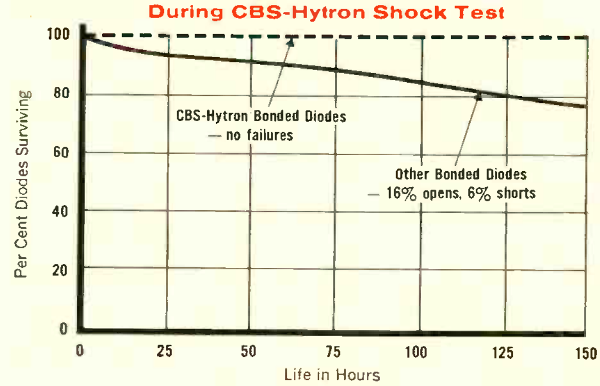
CBS-Hytron bonded diodes
A heavier 0.005-inch whisker of rigid tungsten wire with a sharp point is pressed against the germanium under a force of 16 grams. This results in a contact pressure of about 400,000 pounds per square inch. Positive contact is assured during manufacture and use.



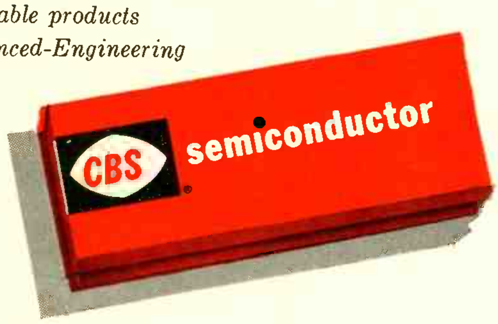
Computer diodes must be reliable . . . with a small fraction of 1% failures. Opens and shorts usually account for the majority. CBS-Hytron bonded junction diodes are designed to eliminate such catastrophic failures. See illustrations.



SURVIVAL CURVES—OPENS AND SHORTS
During CBS-Hytron Shock Test



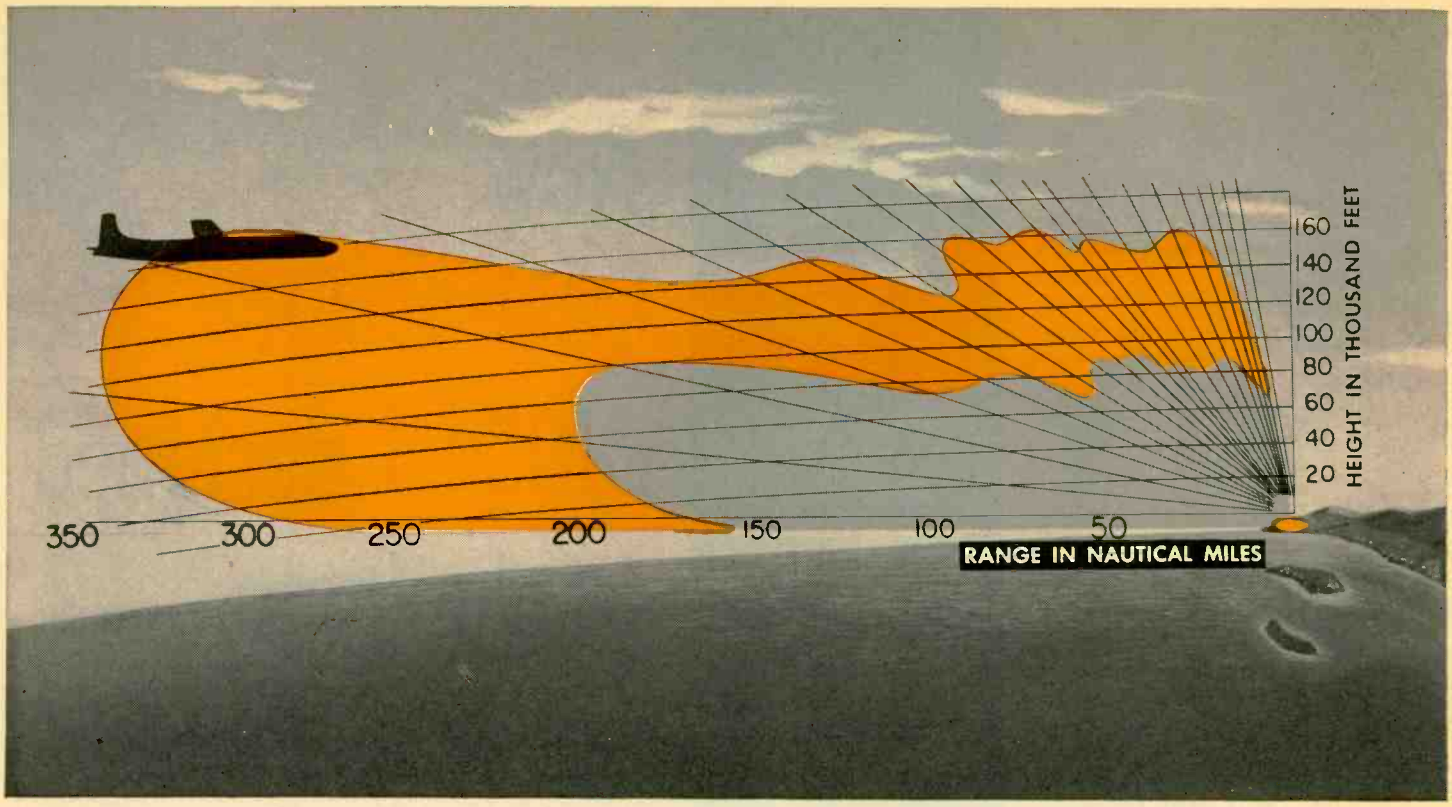
More reliable products through Advanced-Engineering



Comparative Shock Test CBS-Hytron bonded computer diodes are designed to withstand shock and vibration during printed-circuit assembly and during life. See illustration of CBS-Hytron shock test . . . more severe than military shock and vibration tests. Note the distribution curves comparing diodes subjected to this "paper jogger" test.

The inherent ruggedness of the CBS-Hytron line of bonded-junction computer diodes can free you from catastrophic failures. Let us supply you with engineering samples designed for your applications. Ask for Bulletin E-314. Call or write today.

CBS-HYTRON, Semiconductor Operations, A Division of Columbia Broadcasting System, Inc.
Sales Offices: **Lowell, Mass.,** 900 Chelmsford St., GLenview 4-0446 • **Newark, N. J.,** 32 Green St., MArket 3-5832
Melrose Park, Ill., 1990 N. Mannheim Rd., EStebrook 9-2100 • **Los Angeles, Calif.,** 2120 S. Garfield Ave., RAymond 3-9081



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.

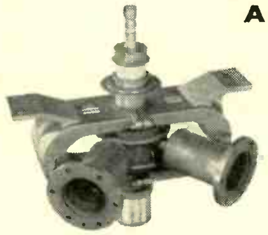
With an output above 4 megawatts, heat could be a problem. Copper's thermal conductivity handles it. The good high temperature characteristics of this copper are enhanced by its freedom from oxygen traces, eliminating oxidation, scale formation and conductivity losses. The very high (50-70%) electrical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

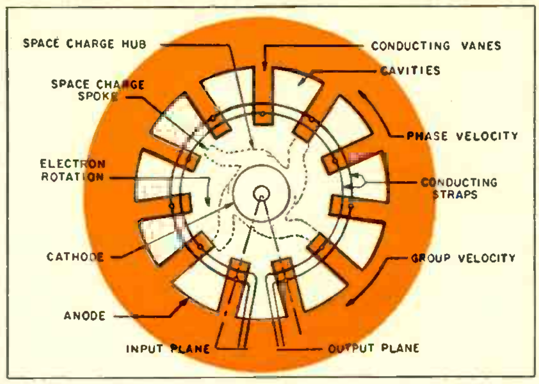
Raytheon says, *"Without copper, the Amplitron would have been impossible."*

*Raytheon Trade Mark

Schematic diagram of Amplitron tube ➾

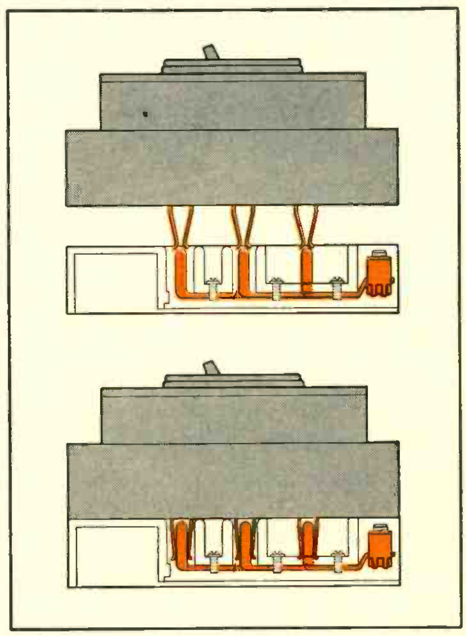


Reliable performance depends on conductivity, vacuum retention and accurate fabrication. Copper makes it possible. Complete Amplitron unit shown at left.



Design Problem—Plug-in breaker connections

Federal Pacific Electric Company's "STABreaker" circuit breakers plug right into the panelboard to permit changing units and ratings without bolting and unbolting. Dependable performance of the connectors is essential to circuit continuity and to avoid heating and false tripping. The design problems included high fatigue strength, spring qualities, easy cold working, reliable welded connections and, of course, electrical conductivity. The solution to the problem was found in Phosphor Bronze 5%. The result was an excellent electrical connection and a dependable one.



"**STABreaker**" plugs into panelboard. Enduring spring qualities of Phosphor Bronze 5% assure a reliable contact.

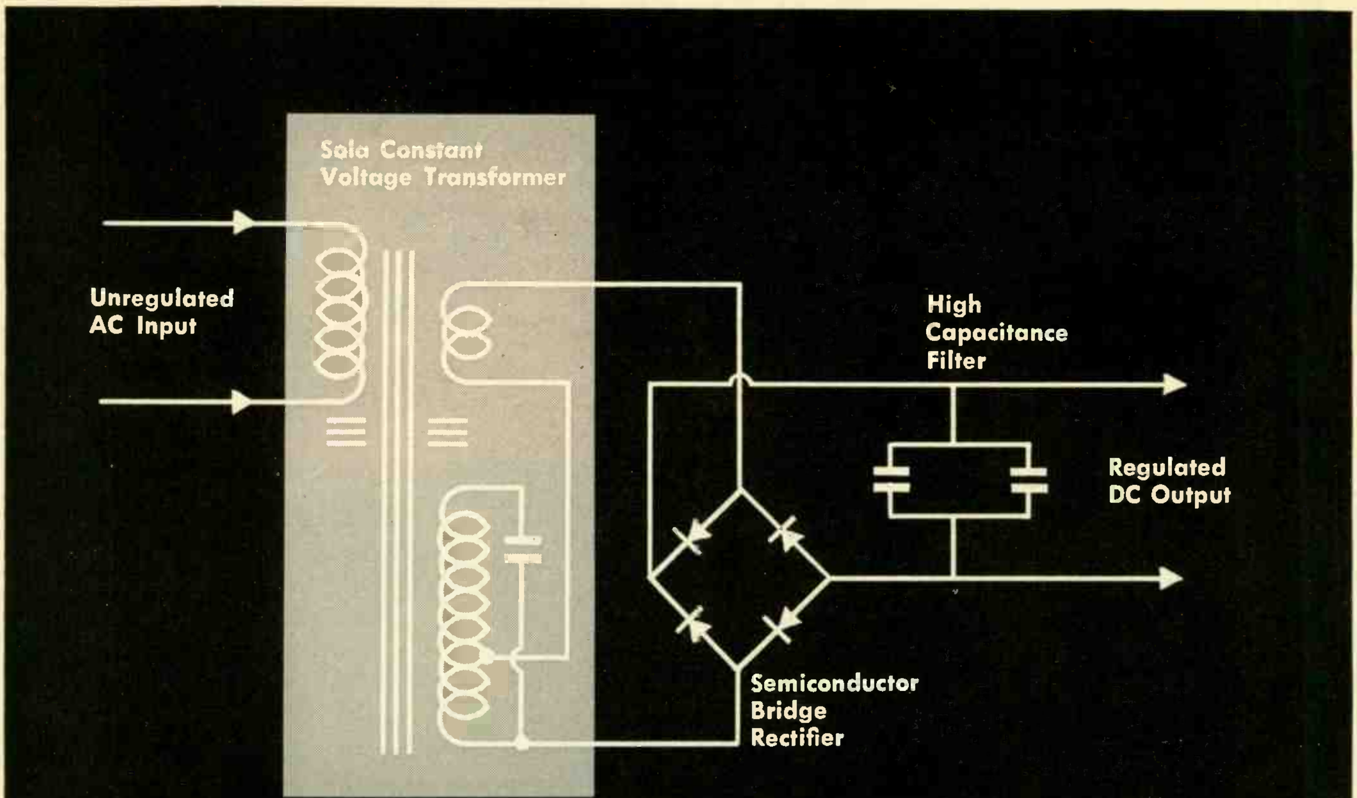
Design Problem—Yours

Whenever reliability determines design, the copper metals should be investigated. They have many properties besides conductivity that can help enhance the maintenance-free service life of your product. The Copper & Brass Research Association, 420 Lexington Ave., New York 17, N. Y., will be happy to cooperate in your investigation.

THERE'S A NEW FRONTIER IN . . .

COPPER · BRASS · BRONZE

CIRCLE 31 READERS SERVICE CARD



Basic schematic diagram of Sola Constant Voltage DC Power Supply illustrates its design simplicity. Electrically and mechanically, these dc supplies are extremely reliable due to this basic simplicity.

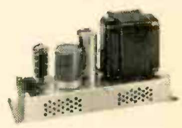
SIMPLE, regulated DC power supply

Emerson said, "To be simple is to be great," and that perfectly describes the Sola Constant Voltage DC Power Supply. If you want to keep your apparatus as simple as you can (especially if it's basically complicated) this dc supply will do it.

You needn't worry about manual adjustments or maintenance in the field. There are no moving or expendable parts . . . no tubes. The entire supply is a unique combination of three components: 1) A special Sola Constant Voltage Transformer, 2) a semiconductor rectifier, and 3) a high-capacitance filter. It's that simple. It's extremely dependable.

Regulation is ±1% against line voltage variations up to ±10%. Ripple is within 1% rms. Outputs are in the "ampere range." It's particularly well-suited for use on apparatus with pulse, intermittent, or variable loads. Efficiency is high.

The Sola Constant Voltage DC Power Supply is simple, compact, very reliable, and moderately priced.



Fixed output — six ratings available from stock

Adjustable output — six ratings from stock

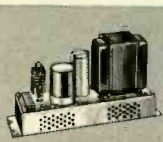
Custom-designed units produced to your specs

Write for Bulletin 7K-DC-235

Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill., BIshop 2-1414 • Offices in principal cities • In Canada, Sola Electric (Canada) Ltd., 24 Canmotor Ave., Toronto 18, Ont.

SOLA

CONSTANT VOLTAGE TRANSFORMERS



REGULATED DC POWER SUPPLIES

MERCURY LAMP TRANSFORMERS

FLUORESCENT LAMP BALLASTS

A DIVISION OF BASIC PRODUCTS CORPORATION

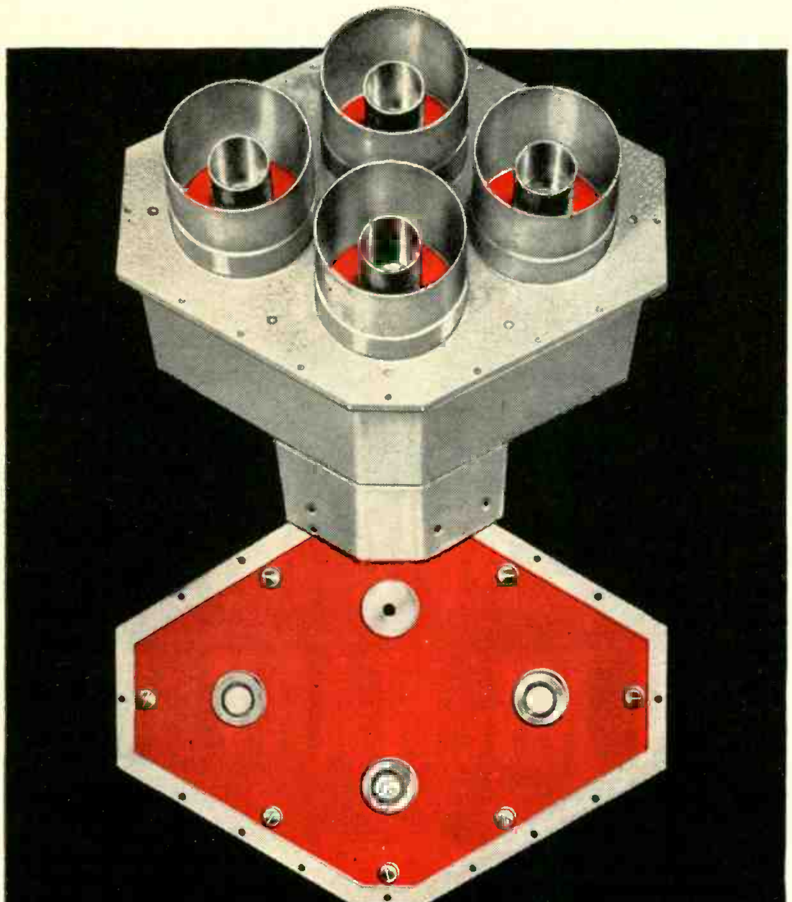
DU PONT
REG. U. S. PAT OFF
Better Things for Better Living
. . . through Chemistry

TEFLON®
FLUOROCARBON RESINS

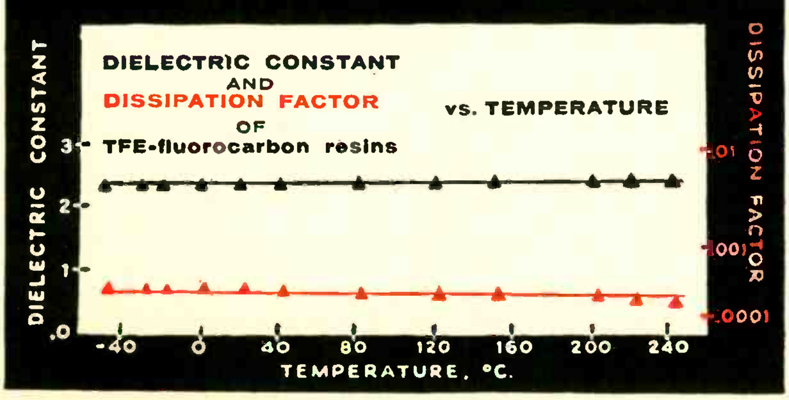
ELECTRONIC DESIGN NEWS

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.

CIRCLE 33 READERS SERVICE CARD

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.

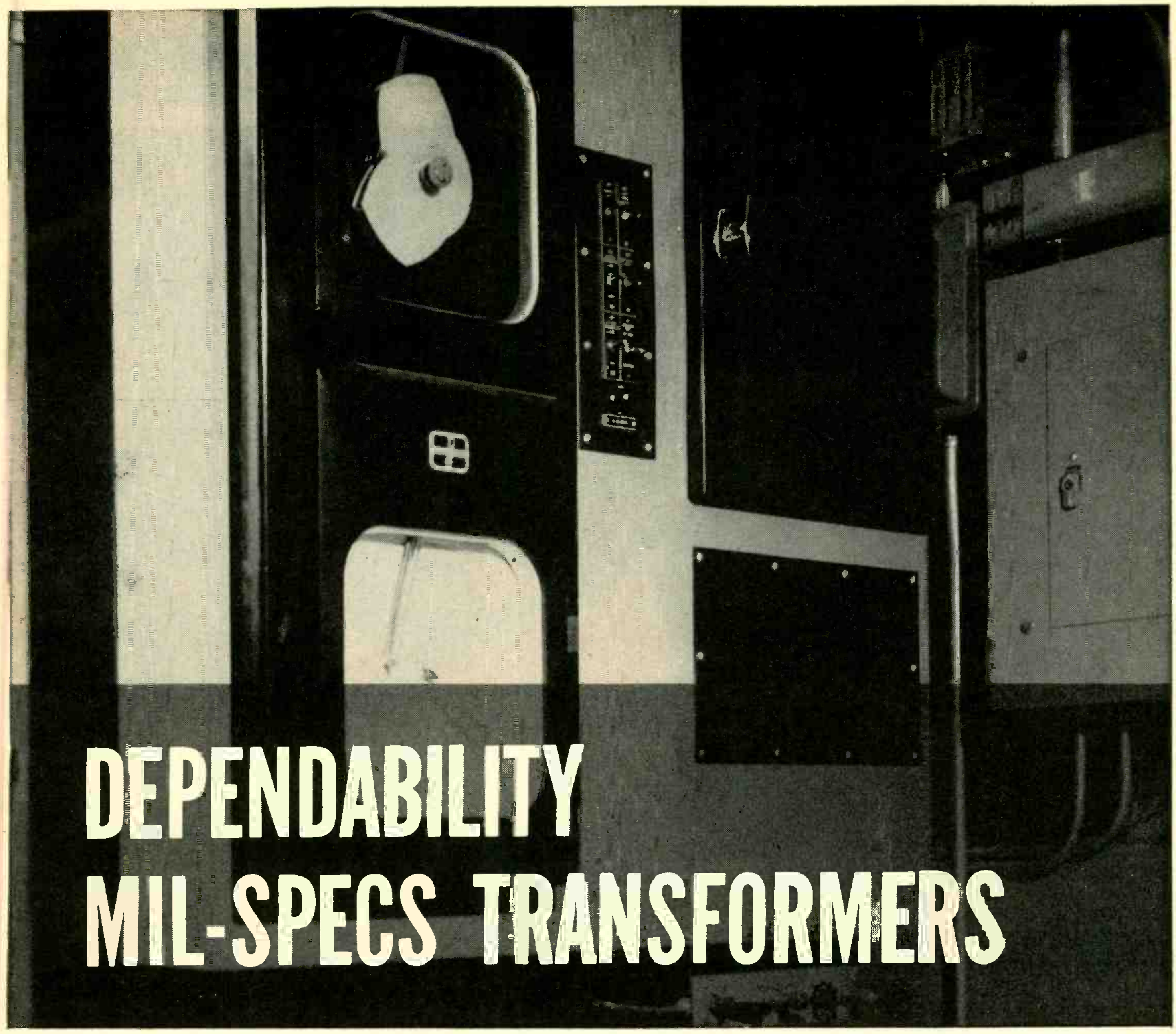
The test lab permits in-plant testing of all types of electronic transformers—hermetically sealed to open type—according to MIL-T-27A and MIL-T-9219 specifications for Grades 1 through 6. These units include the Westinghouse hermetically sealed MIL-T-27A transformers, Grades 1 and 4, and the Westmold,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

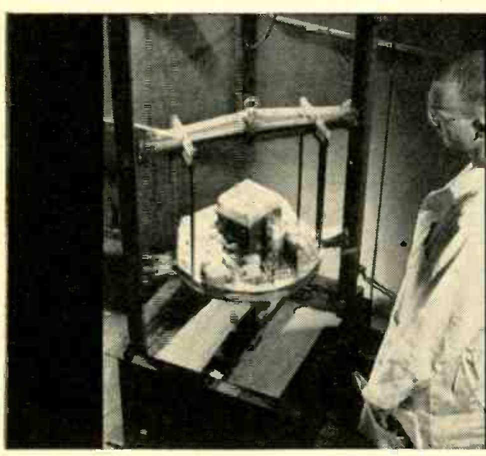
Located at the point of manufacture, this laboratory now means single responsibility by Westinghouse for design, manufacture and testing of the MIL-specs transformers—and non-military transformers—with less delays and faster delivery.

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

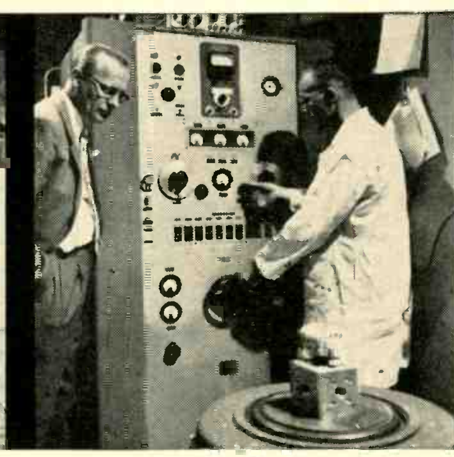
YOU CAN BE SURE...IF IT'S Westinghouse

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

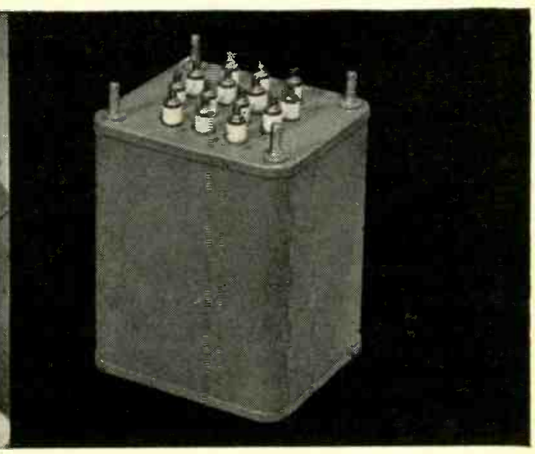




Westinghouse electronic transformers being shock-tested according to specifications of MIL-T-27A with new in-plant qualification testing equipment.

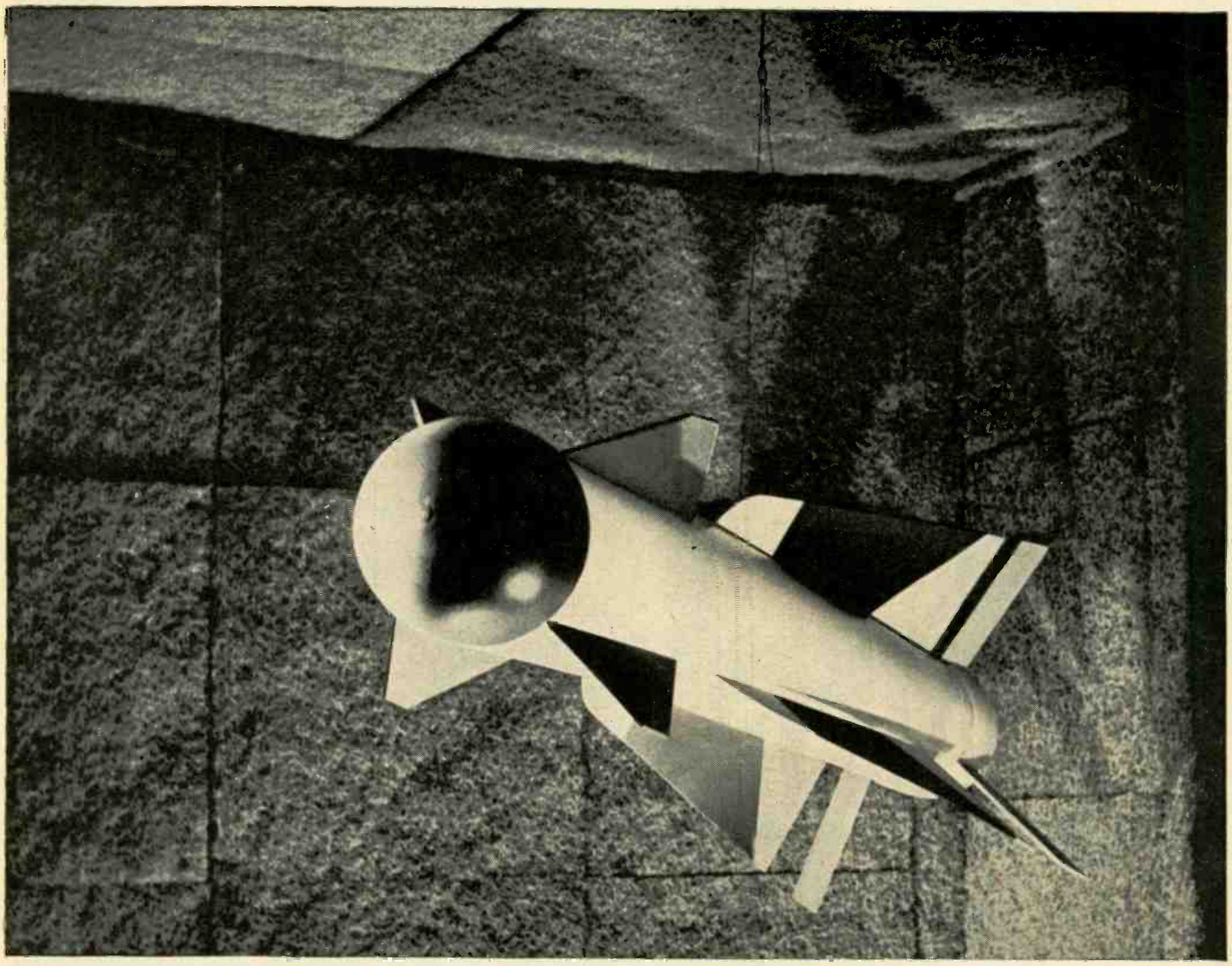


P. K. Goethe, Specialty Transformer Engineering Manager at the Greenville plant, observes shake-down run of vibration test equipment in new laboratory.



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.

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.

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.

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%

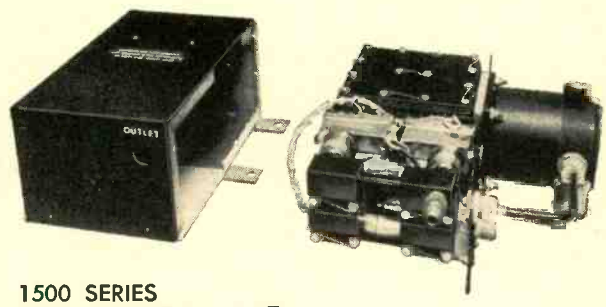
Most of the above absorbents can be furnished with 0.1% maximum reflection at selected points in the frequency band.

*All perform up to 30,000 mc

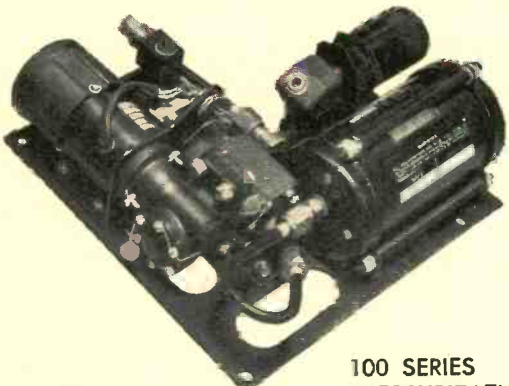
B.F.Goodrich
microwave absorbents

CIRCLE 36 READERS SERVICE CARD

CIRCLE 37 READERS SERVICE CARD →



1500 SERIES PRESSURIZATION UNIT



100 SERIES PRESSURIZATION UNIT

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

CIRCLE 38 READERS SERVICE CARD

CIRCLE 39 READERS SERVICE CARD →

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

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

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.

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 2N603 2N604	$V_{CE} = 1$ v $I_B = 0.5$ ma	25-100*	$V_{CB} = 5$ v $I_C = 5$ ma	10-30 mc 30-50 50-70	2N605 2N606 2N607 2N608	$V_{CE} = 7.5$ v $I_C = 1$ ma $f = 2$ mc	20-25 db 25-30 db 30-35 db 35-40 db

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

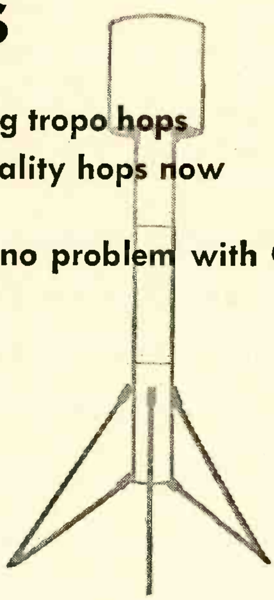
GENERAL TRANSISTOR
C O R P O R A T I O N

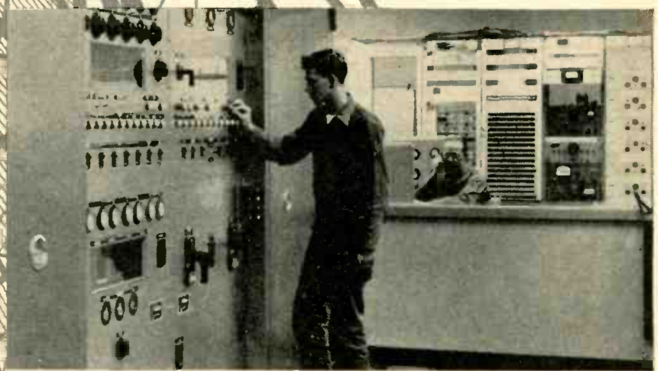
91-27 138TH PLACE • JAMAICA 35 • NEW YORK

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

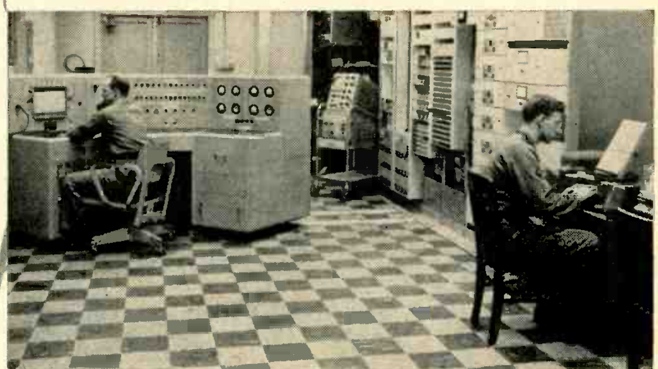
FIRST LONG DISTANCE TROPO SCATTER SYSTEM PROVES

- **SSB best for long tropo hops**
- **Longer high-quality hops now feasible**
- **High power is no problem with G-E amplifier**





Klystron power amplifier of new design, featuring higher efficiency, reliability and lower operating cost. The entire system was designed by MIT Lincoln Laboratory in conjunction with Air Force Air Research and Development Command.



Control room showing control console and teletype machines. The system has been designed for ease of maintenance and operation to cope with extreme weather conditions.

Operation of the world's first *long* distance single sideband tropospheric scatter system proves the practicality of SSB for over-the-horizon hops of several hundred miles. Spanning 640 miles between sites near Boston and Winston-Salem, multi-channel voice and teletype communications are maintained with high reliability.

With this system General Electric demonstrates the inherent advantages of SSB for long distance transmission: the ability to get more wide-band signal over long one-hop distances with less power, at less cost.

When considering long-distance communications, remember General Electric's many years of experience in the design and manufacture of high power amplifiers, a key limiting factor in tropo scatter system design. And G-E engineers possess the practical system "know-how" so essential in the design and installation of long-range communication systems. Call these engineers to study your requirements. Military - Industrial Sales Technical Products Department, General Electric Company, Electronics Park, Syracuse, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC

NOW-

RAPID ACCURATE TESTING OF

SILICON
GERMANIUM
SELENIUM

RECTIFIERS and DIODES

MODEL S-101

MODEL S-102

WITH THE NEW Cedco METALLIC RECTIFIER ANALYZERS

FEATURING

5 STANDARD CIRCUIT TESTS

1. Visual dynamic voltage-current characteristic.
2. Dynamic reverse-current leakage.
3. Dynamic forward-voltage drop.
4. Static reverse-current leakage.
5. Static forward-voltage drop.

NOW . . . for the first time, production and laboratory users of power rectifiers and signal diodes may perform *five* standard circuit tests with *one* precision instrument . . . the CEDCO Metallic Rectifier Analyzer.

Versatile, accurate and rapid, the new CEDCO Analyzer exceeds the highest standards of engineering quality. Three Weston meters, accurate within 1%, AC Voltmeter (0 to 1500 V.), DC Voltmeter (0 to 1000 V.) and DC Milliammeter (0 to 10 AMP.) assure dependable performance.

Model S-101—Self-contained featuring complete set of plug-in adapters, accepting wide range of sizes.

Model S-102—Ideal for laboratory use. Adjustable test fixture for remote testing permits shelf mounting away from the working area.

Illustrated brochure, Bulletin R-250, is available upon request.

Eastern Regional Sales Office:
Wilson Building
Camden, New Jersey

Cedco ELECTRONICS
ERIE, PENNSYLVANIA

DESIGNERS AND MANUFACTURERS OF PRECISION ELECTRONIC TEST EQUIPMENT

CIRCLE 45 READERS SERVICE CARD

WHAT THE "SYSTEMS CONCEPT" MEANS AT HUGHES

Activity at the Hughes Research & Development Laboratories is spread over a wide range of sciences. However diverse this activity—whether interest centers on components, sub-systems, or systems themselves—the final systems use is always a common denominator. As a result of this view, Hughes has evolved as the West's leader in advanced electronics.

COMMUNICATIONS SYSTEMS

Projects underway include the development of systems capable of deflecting their signals from meteors, artificial satellites, and even the moon. Still another area is the development of systems which transmit intelligence through media impervious to radio frequencies.

AIRBORNE SYSTEMS

Made up of advanced radars, computers, automatic flight control, communication and navigation equipment, these Hughes systems are designed to meet the ever-increasing operational and flight demands of supersonic flight.

GUIDED MISSILE SYSTEMS

A combination of most of the advanced technologies in a number of fields, the Hughes guided missile development and study programs include Ballistic Missiles, Air-to-Air Missiles, AICBM, and Surface-to-Air Missiles.

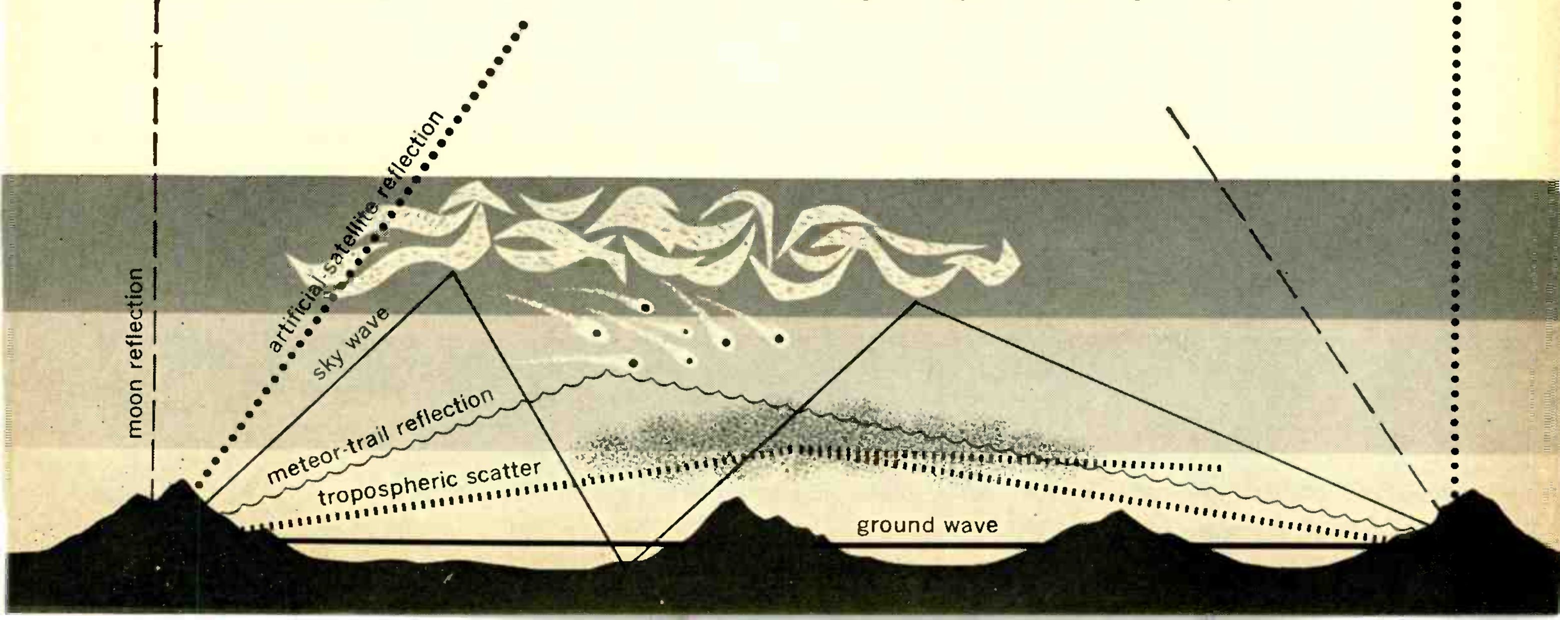
Diversification and expansion by the Hughes Research & Development Laboratories into unexplored new areas have created more engineering openings than ever before existed! Engineers or Physicists, with degrees from accredited universities may investigate by writing directly to:

Dr. Allen Puckett, Associate Director,
Systems Development Laboratories

the West's leader in advanced electronics

HUGHES

Hughes Aircraft Co., Culver City 25, Calif.



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.

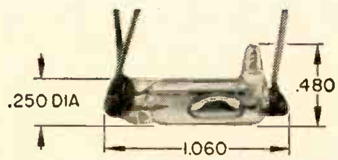
 CIRCLE 49 READERS SERVICE CARD

MICRO SWITCH Precision Switches

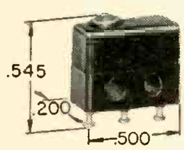
Five switches of special interest to Electronic Engineers Three of them are NEW

NEW

ultra-small super-sensitive mercury switch AS603A1



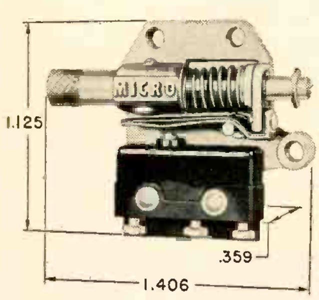
This new switch, designed for vertical gyros, stable platforms, missiles and rockets, is the most precise mercury switch available. Differential angle—.150° max. Mass shift—.085 gm. cm. SPDT. It operates reliably at temperatures as low as −65° F. Hermetically sealed contacts. Switch is unaffected by 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.



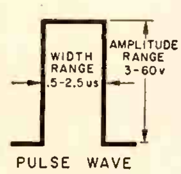
Subminiature door interlock switch 7AC1-T

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.

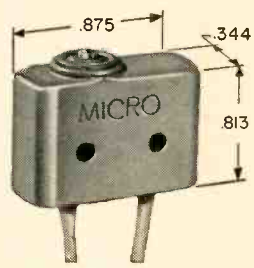
NEW

"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
HONEYWELL
MICRO SWITCH PRECISION SWITCHES

high reliability . . . extreme compactness . . .

IN THE

NEW SANBORN

850

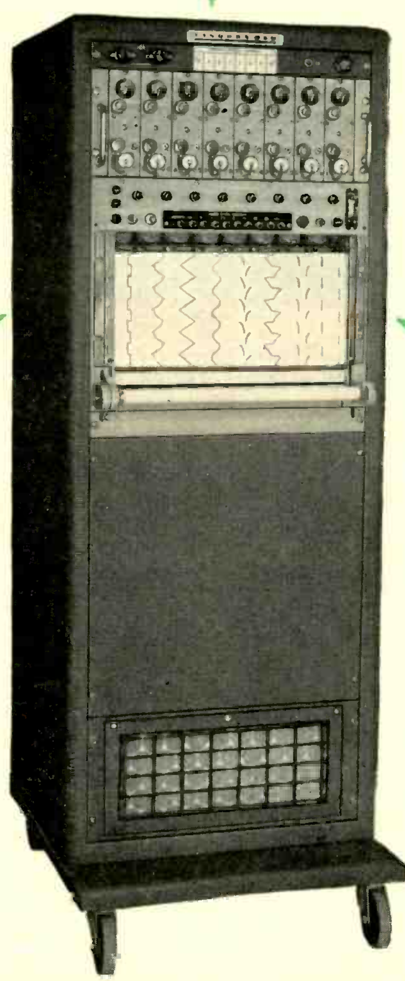
6- & 8-CHANNEL DIRECT WRITING SYSTEM

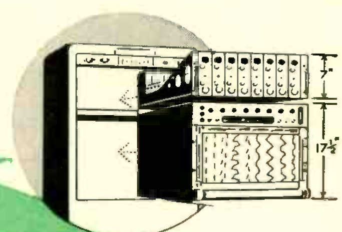
If you want a practical direct writing system for straightforward recording in the range from DC to 100 cps — such as computer readout, telemetry recording — look what the new Sanborn "850" offers in compactness, reliability and operating convenience. A complete 8-preamplifier module with power supply, plus an 8-channel flush-front recorder package containing power amplifiers and power supply at rear, occupy only 24½" of "850" panel space.

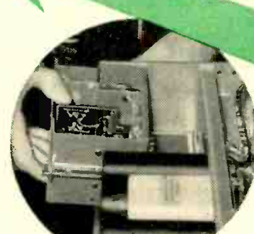
PERFORMANCE characteristics of an "850" include flat frequency response 0–70 cps, down 3 db at 100 cps (10 div. peak-to-peak amplitude) . . . thermal drift eliminated by current feedback power amplifiers . . . limiting at input to prevent amplifier saturation or cut off, so that damping is never lost . . . drift less than 0.2 div. for 20° to 40° C. changes, line voltage changes from 103 to 127 volts . . . gain stability better than 1% with 20° C. and 20 volt changes . . . linearity 0.2 div. over 50 divisions . . . clear, permanent, inkless recordings in true rectangular coordinates.

IN RELIABILITY, "850" features include fully transistorized power amplifiers and power supply . . . rugged galvanometers with low impedance, high current, enclosed coil assemblies and velocity feedback damping . . . JAN components wherever practical, such as MIL-T-27 hermetically sealed power transformers, MIL-approved electrolytics in power supplies, etc. . . . forced filtered air cooling for stable operation.

And in operating **CONVENIENCE,** an "850" system provides such advantages as nine electrically controlled chart speeds, selected by pushbuttons . . . a choice of interchangeable Preamplifiers (DC Coupling and Phase Sensitive Demodulator presently available, with others in development) . . . remote control of chart drive, speeds, timer and marker . . . monitoring connection points . . . a Recorder that loads from front and has built-in paper take-up and paper footage indicator.







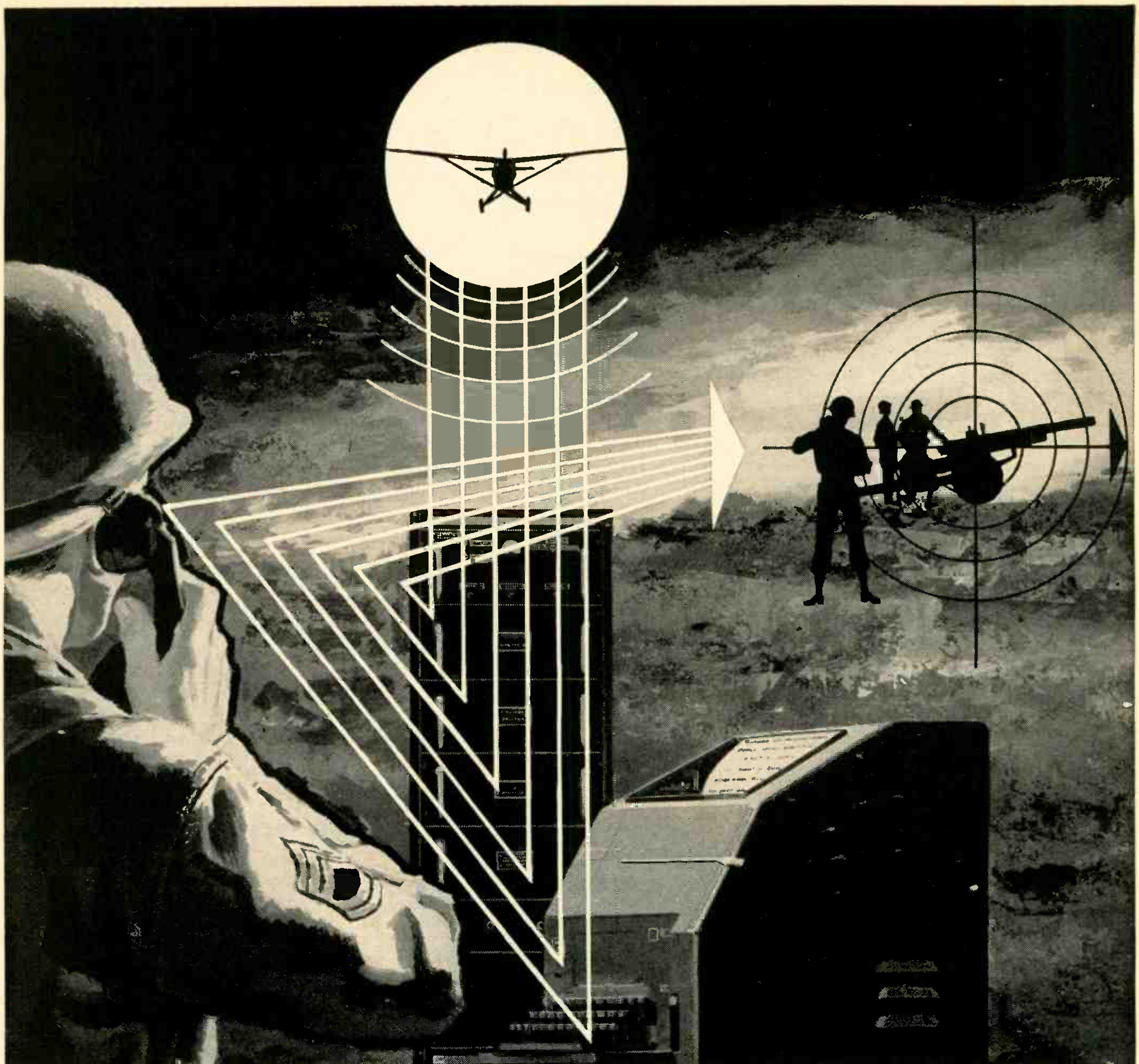
SANBORN COMPANY

175 Wyman Street, Waltham 54, Mass.

Ask your local Sanborn Industrial Sales-Engineering Representative for complete facts — or write the Industrial Division in Waltham.

(All data subject to change without notice)

CIRCLE 51 READERS SERVICE CARD



Why LABIL is a powerful link in the communications chain

Speed and reliability make LABIL, Stromberg-Carlson's new data link, ideal for automatic transmission of flight information from light aircraft to ground receiving and control locations.

Into the link the pilot or observer can enter 13 types of data regarding flight and target. When the ground control group wants the information, a lamp on the panel of the airborne equipment lights. The pilot or observer presses the transmit key, and the entire stored message is automatically transmitted over his *existing voice communications equipment.*

Greatly increased reliability is achieved by transmitting each character *twice.*

At the receiving end the message is checked for errors due to noise interference. The error detector examines the two transmissions for complete agreement, then prints the message out on a teletypewriter. Speed of transmission is limited only by the bandwidth of the communications equipment and printout device.

The standard format and digital nature of each transmission make LABIL easily adaptable to large-scale operational control systems in which automatic data handling is a requirement.

Complete technical data on Stromberg-Carlson's Light Aircraft Binary Information Link is available on request.

"There is nothing finer than a Stromberg-Carlson"

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION
1464 N. GOODMAN ST. • ROCHESTER 3, N.Y.
Electronic and communication products for home, industry and defense

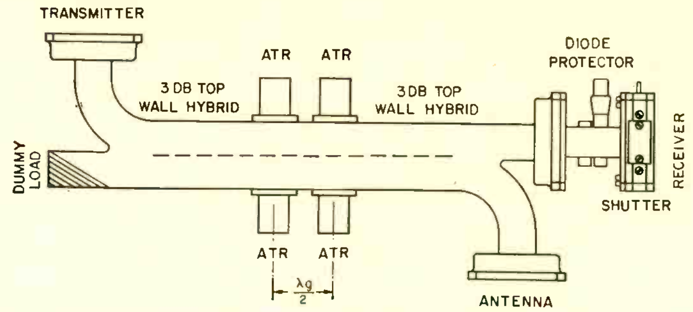
Is one of these FOUR DUPLEXER TECHNIQUES right for you . . .

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.

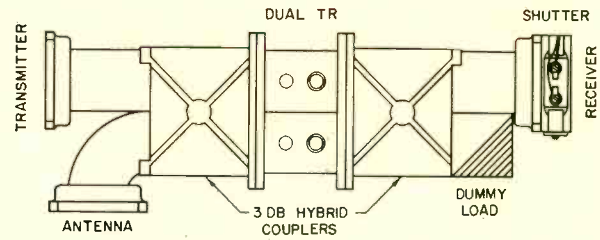
If you have a current problem in this field our application engineering service is at your disposal.

1



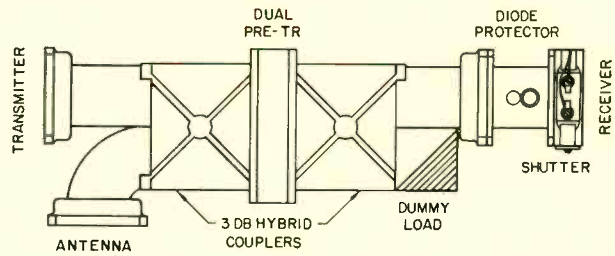
BALANCED DUPLEXER: 4 ATR's, DIODE PROTECTOR, SHUTTER

2



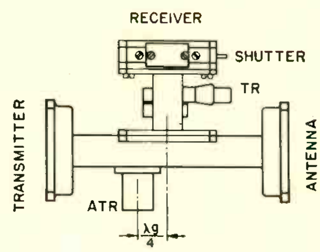
BALANCED DUPLEXER: DUAL TR, SHUTTER

3



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

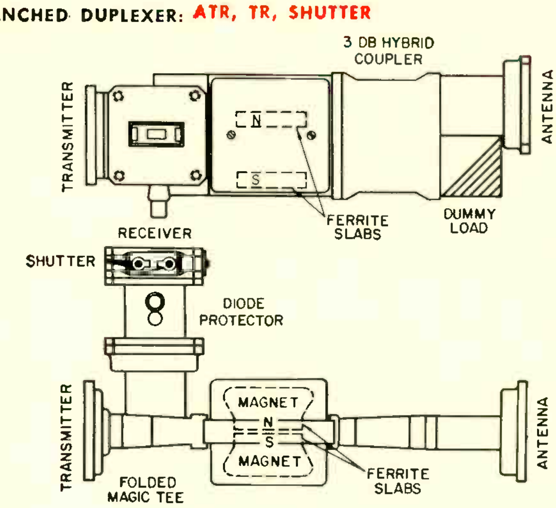
4



BRANCHED DUPLEXER: ATR, TR, SHUTTER

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

5



FERRITE DUPLEXER: DIODE PROTECTOR, SHUTTER

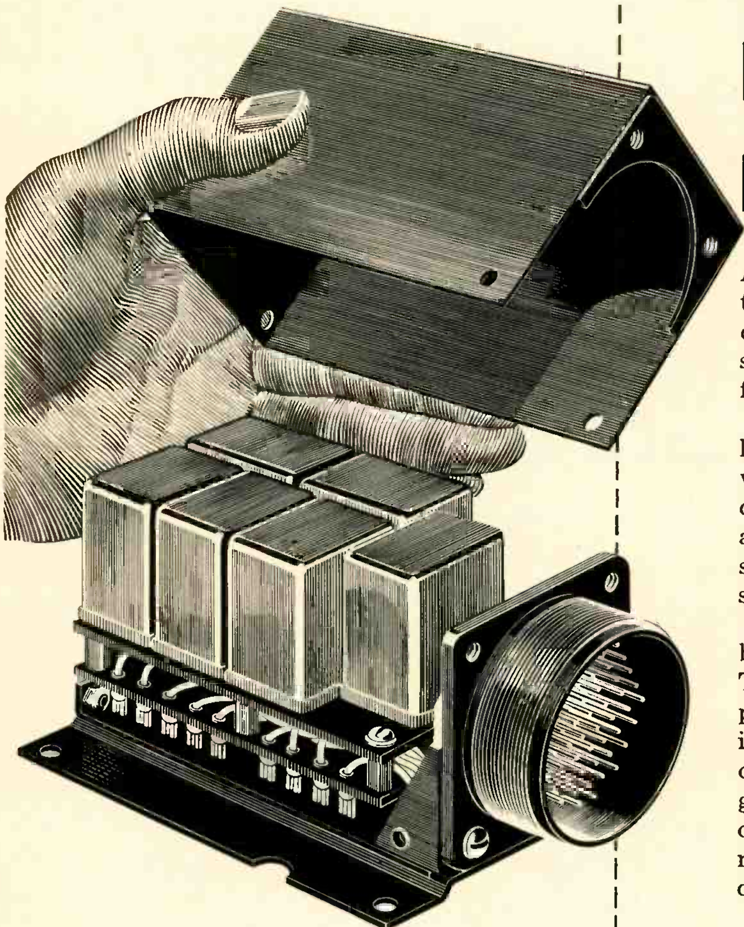
Write or call . . .

MICROWAVE ASSOCIATES, INC.

BURLINGTON, MASSACHUSETTS TELEPHONE BROWNING 2-3000

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

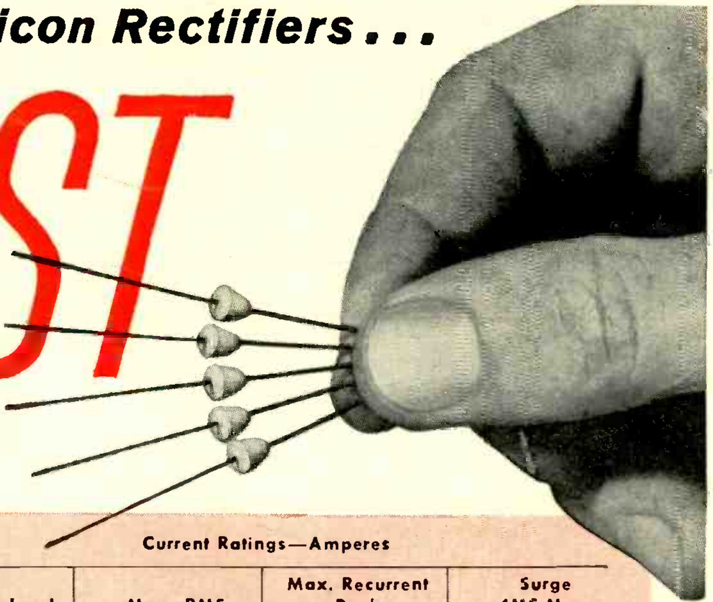
A division of **LEACH CORPORATION** *5915 Avalon Blvd., Los Angeles 3*

District Offices and Representatives in Principal Cities of U. S. and Canada

EXPORT: LEACH CORPORATION, INTERNATIONAL DIVISION

Tarzian *F Series Silicon Rectifiers . . .*

UTMOST



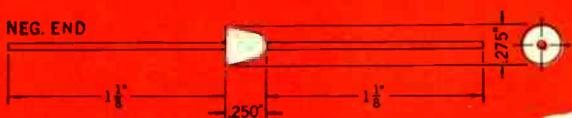
. . . in Performance

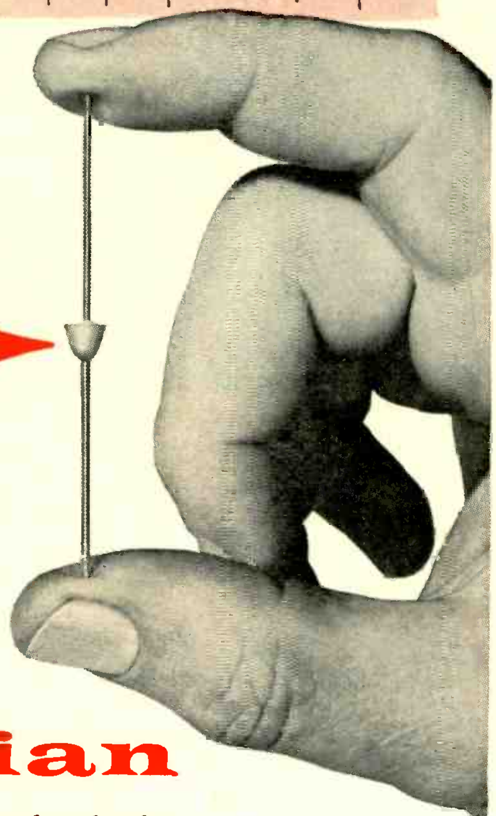
Ratings

S.T. Type	Max. Peak Inverse Volts	Max. RMS Volts	Current Ratings—Amperes											
			Max. D.C. Load			Max. RMS			Max. Recurrent Peak			Surge 4MS Max.		
			55°C	100°C	150°C	55°C	100°C	150°C	55°C	100°C	150°C	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

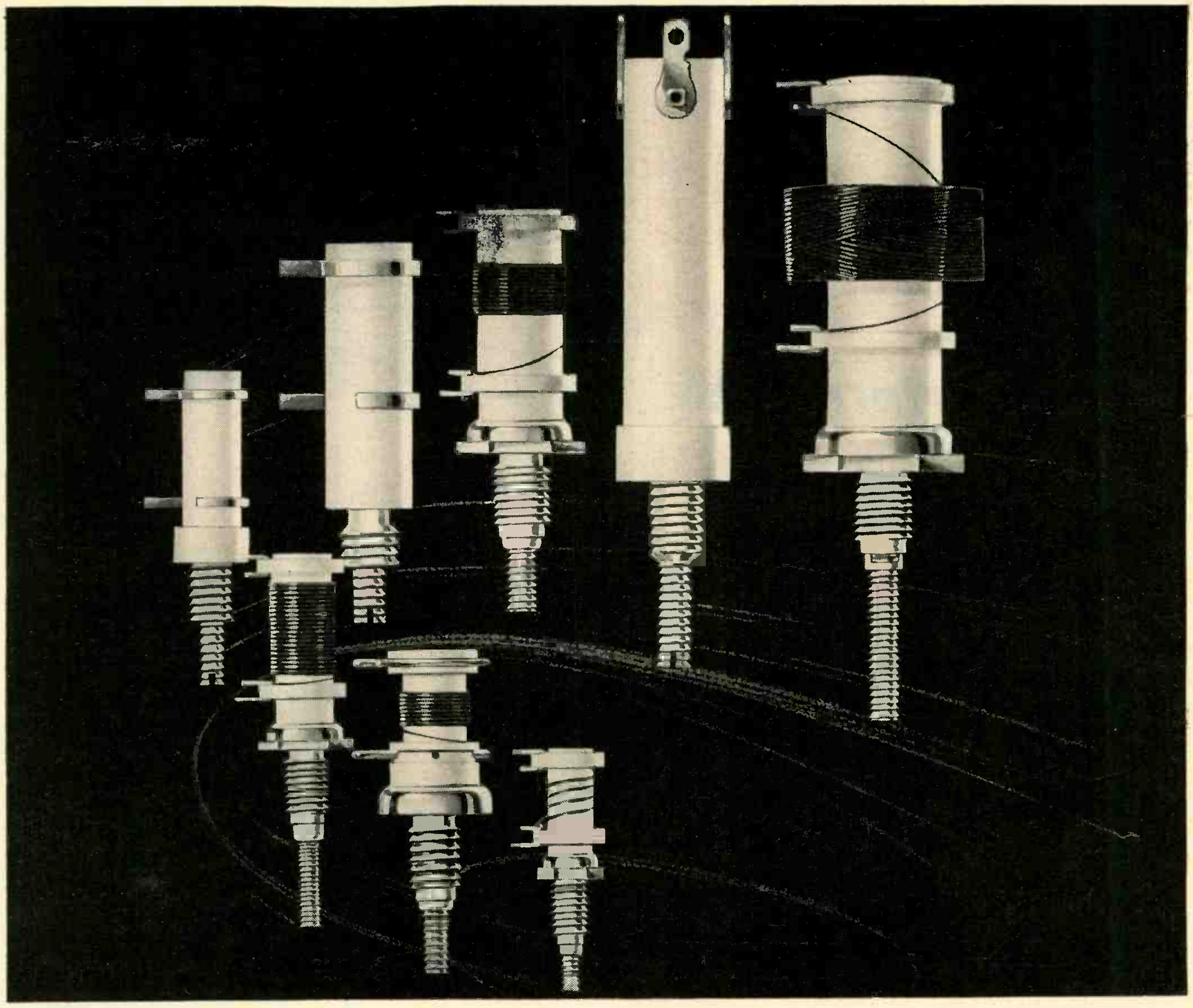
research, engineering and production know-how have combined to develop the "utmost" in a small size, very low cost silicon rectifier with giant performance. If your problem is miniaturization, or cost, or tough application, the solution is in the Tarzian F series.

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®.

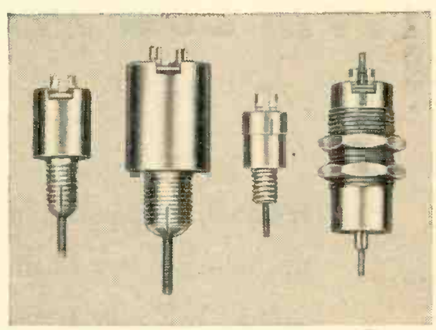
Coil up with this Form!

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®

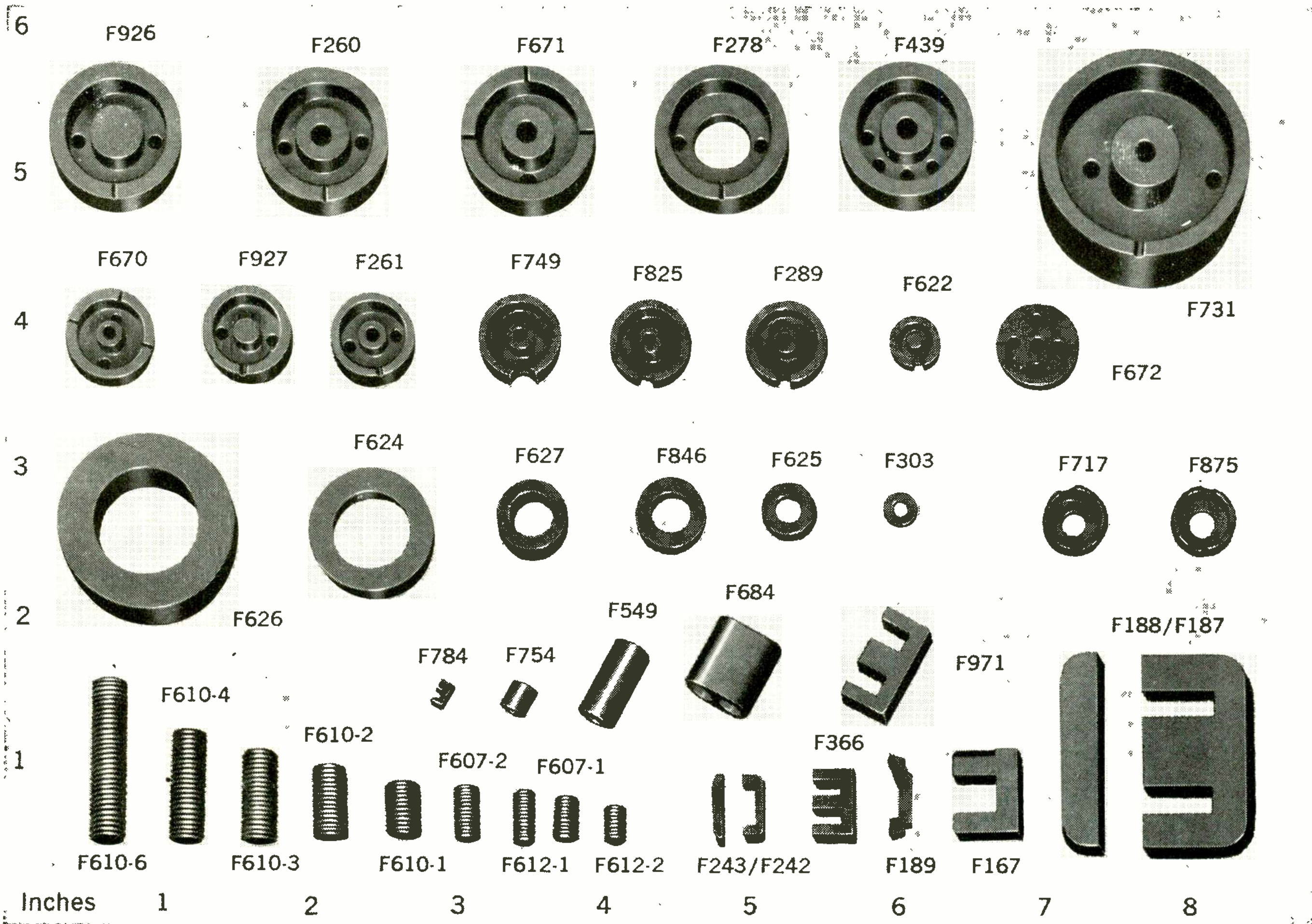
Makers of guaranteed electronic components, custom or standard

CIRCLE 58 READERS SERVICE CARD

CIRCLE 59 READERS SERVICE CARD→

Now, Immediate Delivery from Stock on

GENERAL CERAMICS SPECIAL PURPOSE FERRITE CORES



Rush service for designers – use this handy materials selector chart

Ferrite Cores available in various materials for development and design engineers to cover specific frequency bands of operation from 1 KC to 50 megacycles. General Ceramics provides extra-fast service on sample quantities for development and will make prompt delivery on production parts in reasonable quantities. Call, wire or write General Ceramics Corporation, Keasbey, New Jersey. Please direct inquiries to Dept. E.

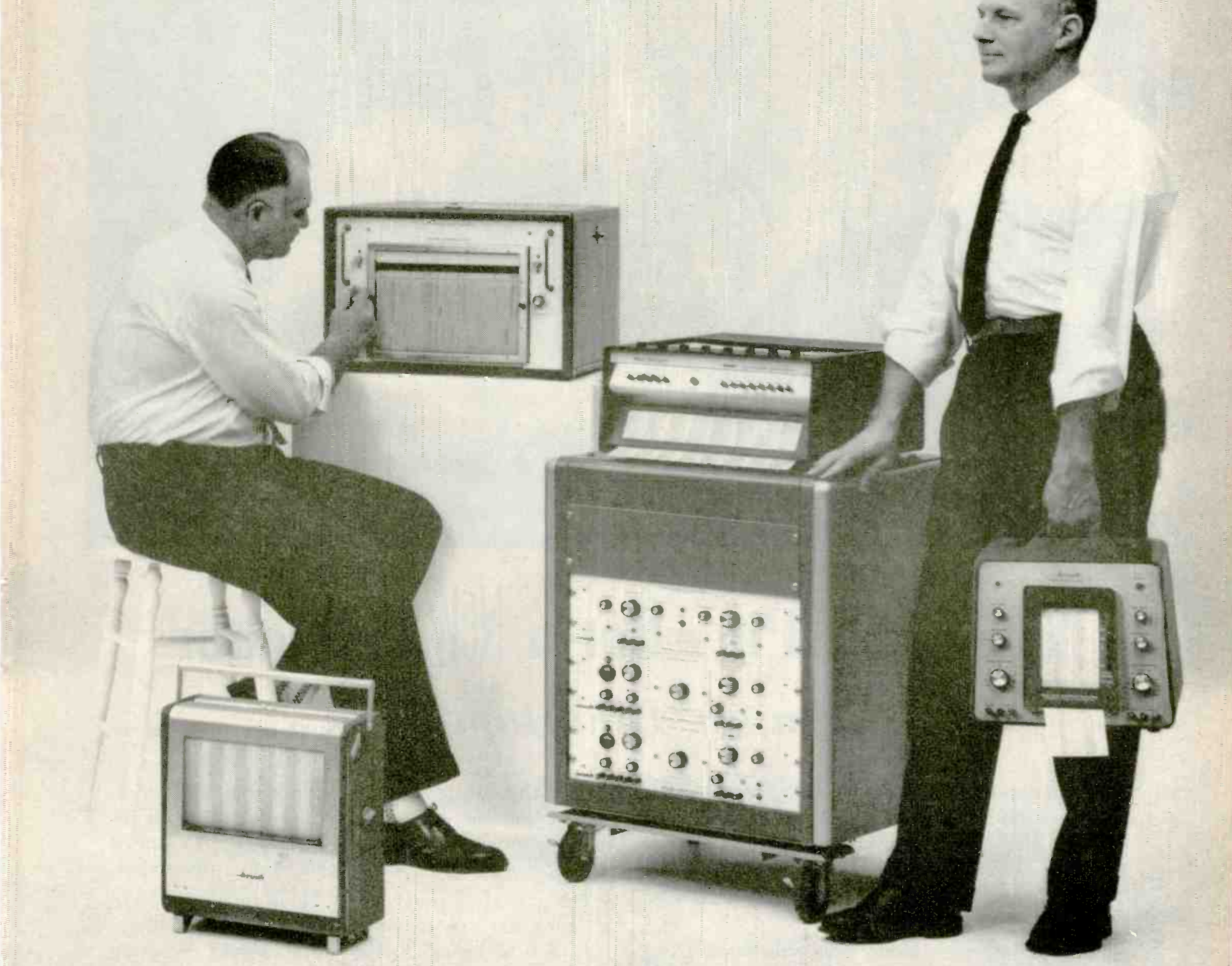
APPLICATION	DESIRED PROPERTIES	FREQUENCY	FERRAMIC BODY	SHAPES
Filter Inductors	High μQ, magnetic stability, sometimes adjustable	up to 200 kcs 200 kcs-10 mcs 10 mcs-80 mcs	"O-3", "T-1" "Q-1" "Q-2"	Cup cores, toroids, C-cores, E-cores, slugs
IF Transformers	Moderate Q, high μ, magnetic stability, adjustable	465 mcs 40 mcs other	"Q-1" "Q-2" Materials for filter inductors apply	Cup cores, threaded cores, toroids
Antennae Cores	Moderate Q, high μ, magnetic stability	.5-10 mcs 10.50 mcs	"Q-1" "Q-2"	Rods, flat strips
Wide Band Transformers	High μ, moderately low loss	1 kc-400 kcs 1 kc-1 mc 200 kcs-30 mcs 10 mcs-100 mcs	"O-3", "T-1" "H" "Q-1" "Q-2"	Cup cores, toroids, C-cores, E-cores
Adjustable Inductors	High μ, moderately low loss	Same as Wide Band Transformers	Same as Wide Band Transformers	Rods, threaded cores, tunable cup cores
Tuners	High μ, moderate to high Q, magnetic stability, as much as 10 to 1 adjustability with mechanical or biasing methods	Up to 100 mcs	For high Q selective circuits, materials under filter inductors apply. For others, materials under wide band transformers apply	Threaded cores or rods for mechanical tuning. Toroids, C-cores, E-cores for biasing methods
Pulse Transformers	High μ, low loss, high saturation	Pulse	Materials under wide band transformers apply	Cup cores, toroids, C-cores, E-cores
Recording Heads	High μ, low loss, high saturation, resistance to wear	Audio, pulse	"H" "O-3", "T-1"	

GENERAL CERAMICS

Industrial Ceramics for Industrial Progress... Since 1906

FREEDOM OF CHOICE

trace presentation . . . configuration



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

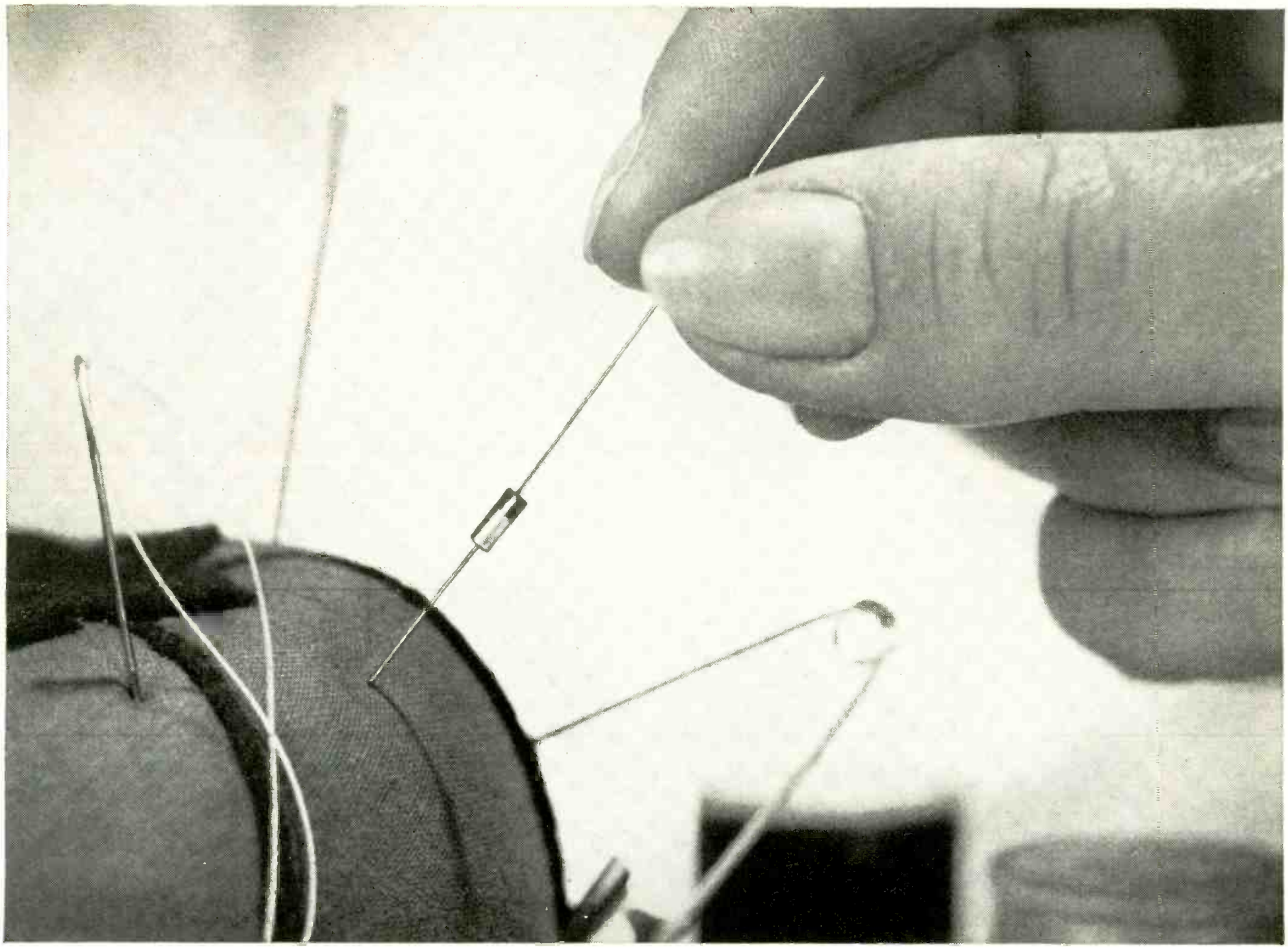
New functionally designed control panels are clean, legible, easy to understand. All components are readily accessible for fast inspection and simple adjustment.

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

Factory branches, service and warehousing at Arlington, Va., Boston, Cleveland, Los Angeles, San Francisco and Seattle; engineering representatives in all key locations.

brush INSTRUMENTS
DIVISION OF
3405 PERKINS AVENUE CLEVITE CORPORATION CLEVELAND 14, OHIO

CIRCLE 63 READERS SERVICE CARD



Not a Hat Pin–But a NEW Capacitor

...Tiniest Tantalum Ever

Here's a capacitor that sets a new standard for tiny size and big performance. It's the new Mallory HAT tantalum. Only .070" in diameter and .200" long (over insulating sleeve), it's the latest member of the Mallory family of micro-miniature components.

The HAT gets superior characteristics from sintered pellet anode construction, pioneered by Mallory in the first and only tantalum capacitors rated at 200° C for military use. For the first time, this construction makes possible, in a micro-size capacitor, exceptionally low leakage (1 micro-ampere max.) and low power factor . . . at a price competitive with wire anode miniature types.

The new HAT line is available in ratings of 16 to 1 mfd. at 1 to 16 volts, suitable for new ultra-miniature hearing aids, instruments, radiation detectors and other new types of tiny portable electronic equipment. Write today for complete data.

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Tuning Devices • Vibrators
Electrochemical—Capacitors • Mercury and Zinc-Carbon Batteries
Metallurgical—Contacts • Special Metals • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.

Expect more... get more from

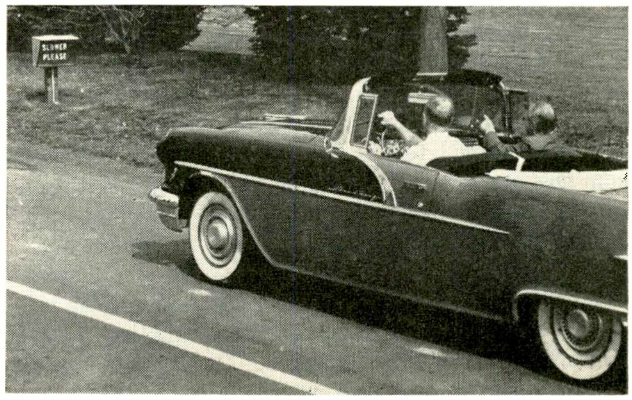
P. R. MALLORY & CO. Inc.
MALLORY

P. R. MALLORY & CO. Inc., INDIANAPOLIS 6, INDIANA

CIRCLE 64 READERS SERVICE CARD

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.

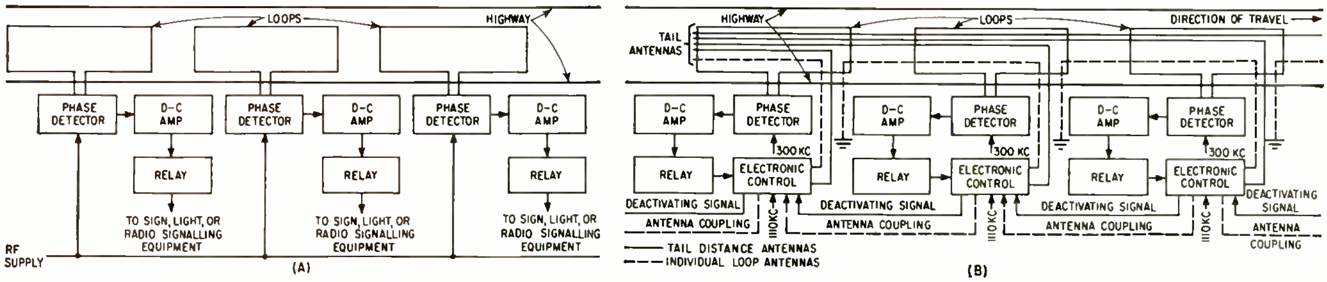


FIG. 2—Roadside signaling system layout (A) does not require aux liary equipment in cars. Radio signaling system (B) produces radio-frequency signals which operate lights or buzzers in equipped cars

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-

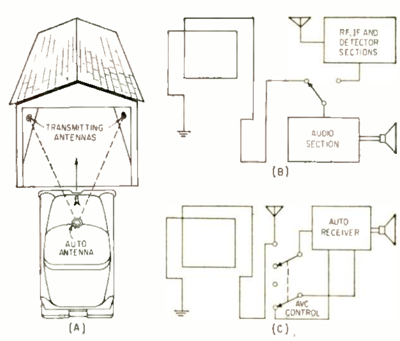


FIG. 4—Garage guidance system provides driver with audible signal if approach is skewed (A). Audio excitation requires auto's loop antenna to be connected directly to audio section of car radio (B); r-f excitation requires use of entire radio except for avc circuit (C)

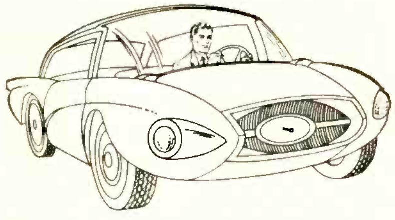


FIG. 5—Small antenna of Bendix Research's radar warning system is mounted in grillwork

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-

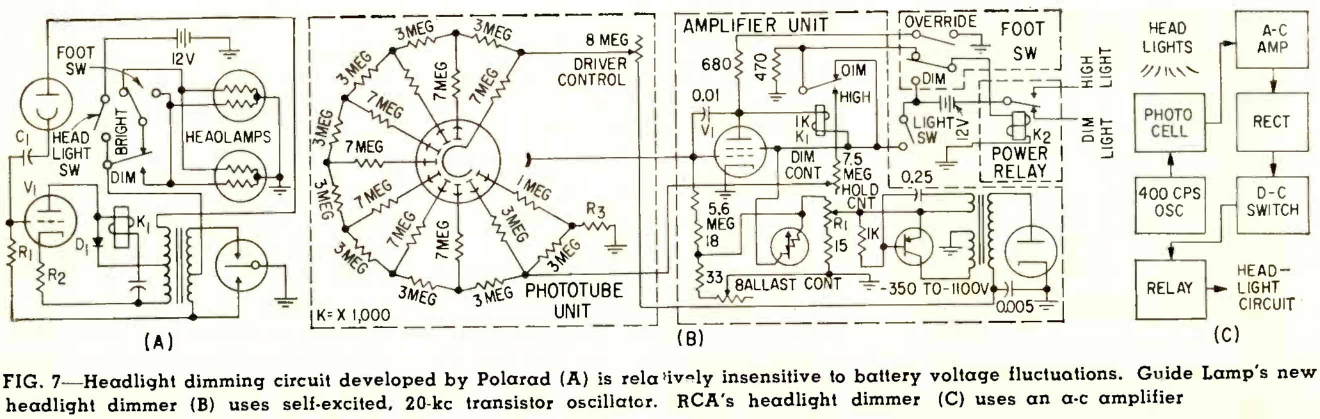


FIG. 7—Headlight dimming circuit developed by Polarad (A) is relatively insensitive to battery voltage fluctuations. Guide Lamp's new headlight dimmer (B) uses self-excited, 20-kc transistor oscillator. RCA's headlight dimmer (C) uses an a-c amplifier

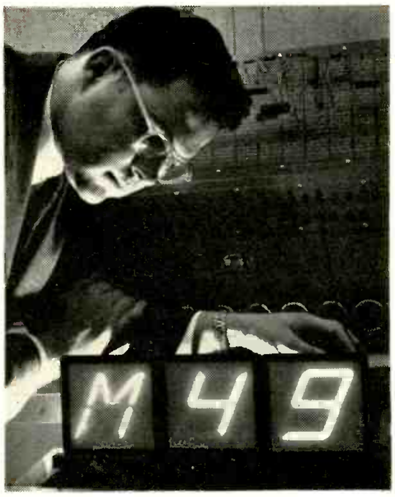


FIG. 8—Demonstration model of Westinghouse's electroluminescent lighting display system

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

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

shift oscillator and provides a 400-cps signal to either a cadmium sulphide or cadmium selenimide photocell in a voltage divider circuit.

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

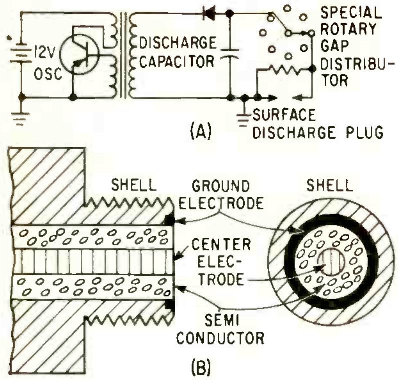


FIG. 11—Electric Auto-Lite's low-voltage, high-frequency ignition system uses transistor oscillator circuit (A) and surface-discharge spark plug (B)

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

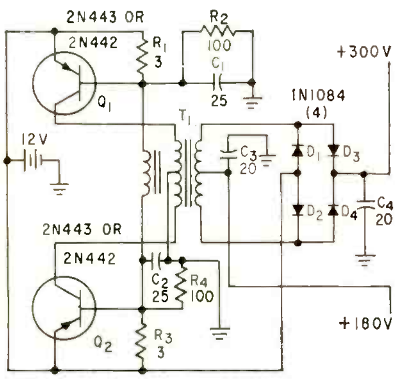


FIG. 12—Each switching transistor in Delco Radio's 120-watt d-c to d-c converter uses a 7 in. by 7 in. by ⅛ in. aluminum heat sink

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

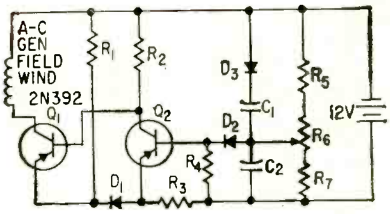


FIG. 13—Completely transistorized voltage regulator circuit developed by Delco-Remy to handle output of new a-c generator

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

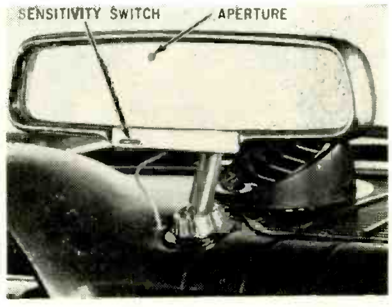


FIG. 14—Photocell in Chrysler's automatic mirror positioner is mounted behind mirror aperture

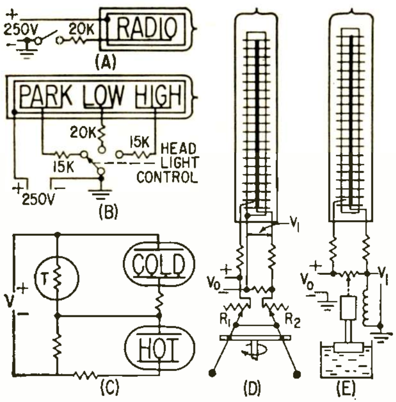


FIG. 15—Glow discharge bulbs used for single tell-tale instrument-panel word (A) multiple tell-tale word (B), temperature indicating system (C) speedometer (D) and fuel gage (E)

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.

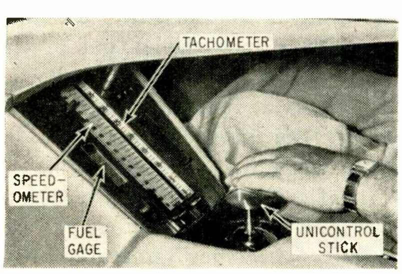


FIG. 16—Electronically controlled instrument panel in Firebird III

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 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.

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

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

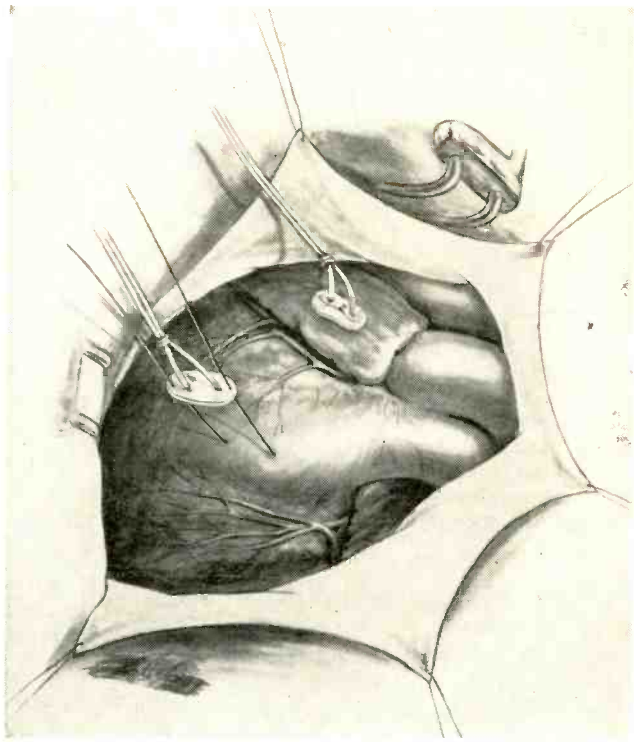


FIG. 1—Pair of electrodes supported on flat polyethylene insulator sewn to right auricle (top). Pair is being sewn to ventricle (bottom)

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.

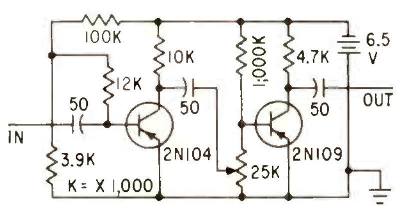


FIG. 2—Pulse amplifier circuit. Power is supplied by 6.5-v mercury cell connected to circuit by spring clips. Battery must be taken out to deenergize circuit

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-

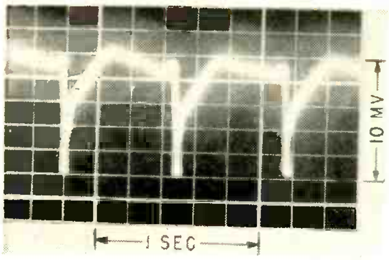


FIG. 3—Reverse polarity oscillograph of output pulses from right auricle of dog

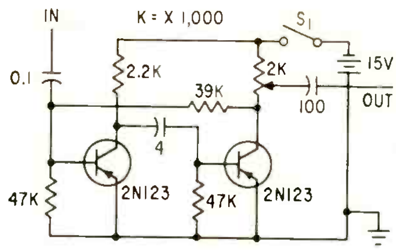


FIG. 4—Pulse output circuit. Power is supplied by miniature 15-v battery

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

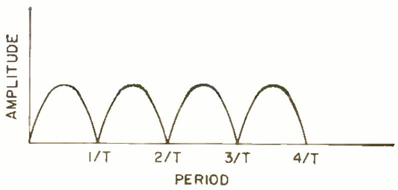


FIG. 1—Velocity response of simple mti

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

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

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.

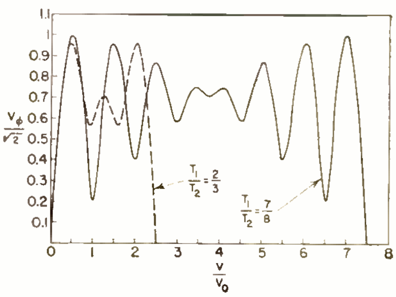


FIG. 2—Response of a staggered prf mti for stagger ratios of ⅔ and ⅞

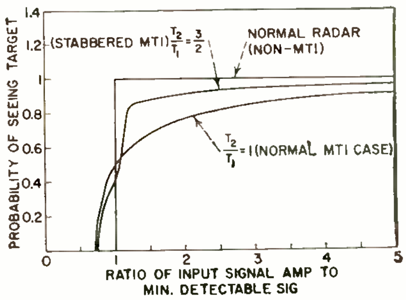
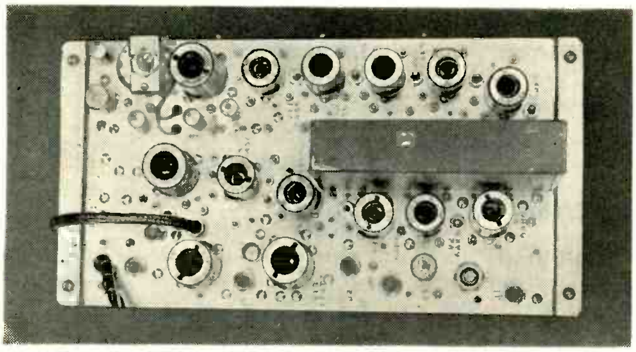
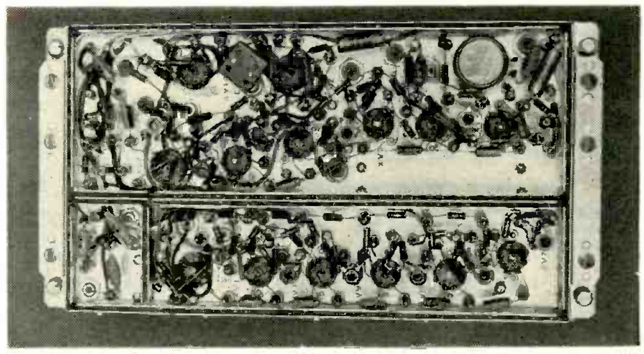


FIG. 3—Probability of seeing a target on normal radar, normal mti and staggered prf mti systems





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

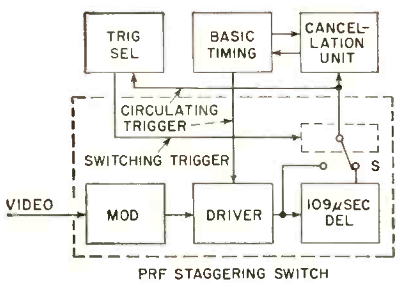


FIG. 4—Block diagram of prf staggering switch and trigger selector

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 $r = T_2/T_1 =$

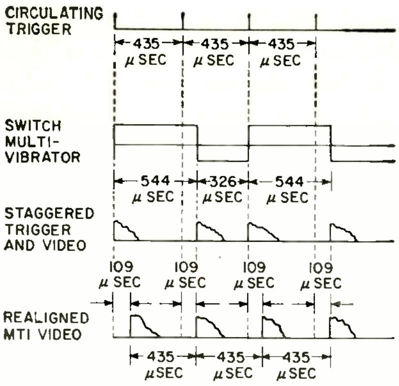


FIG. 5—Staggered prf timing diagram

(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.

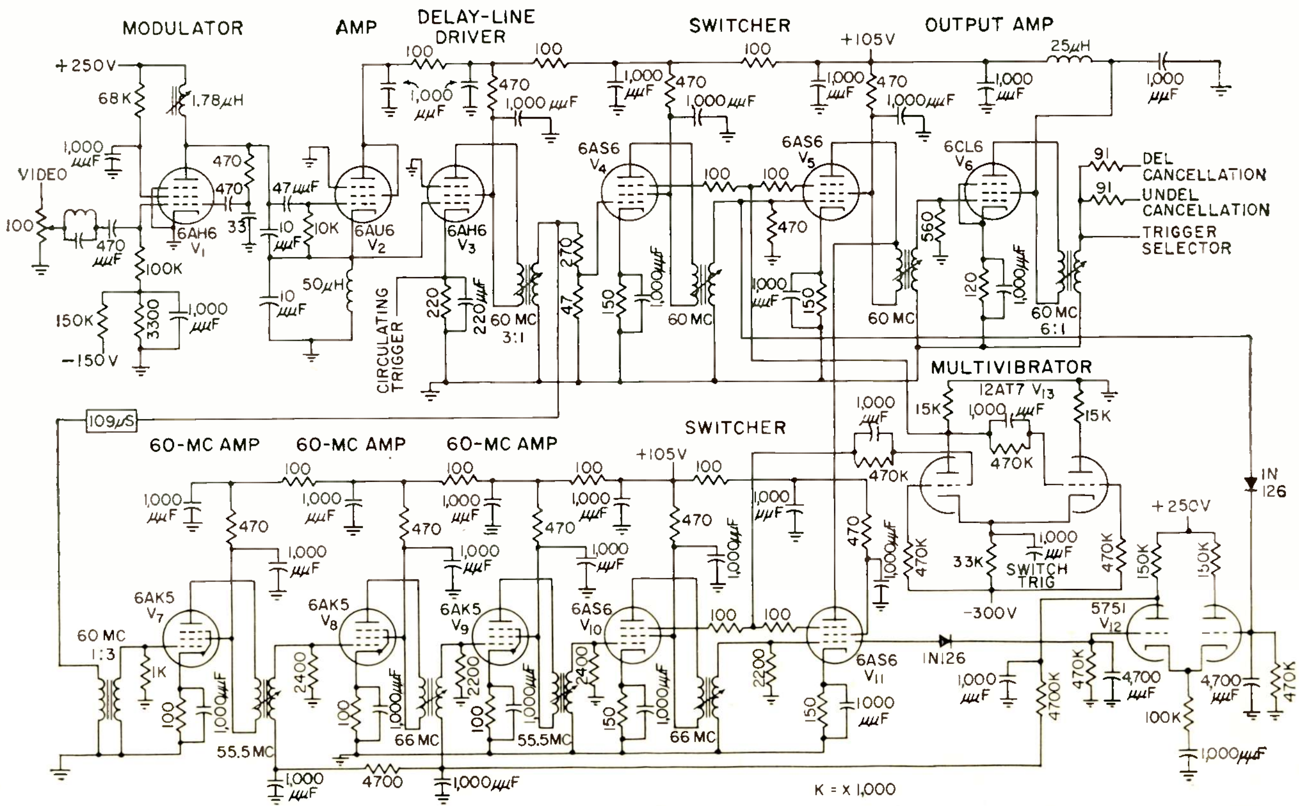


FIG. 6—The prf staggering switch realigns the returning video so that it can be processed in the video cancellation unit

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 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

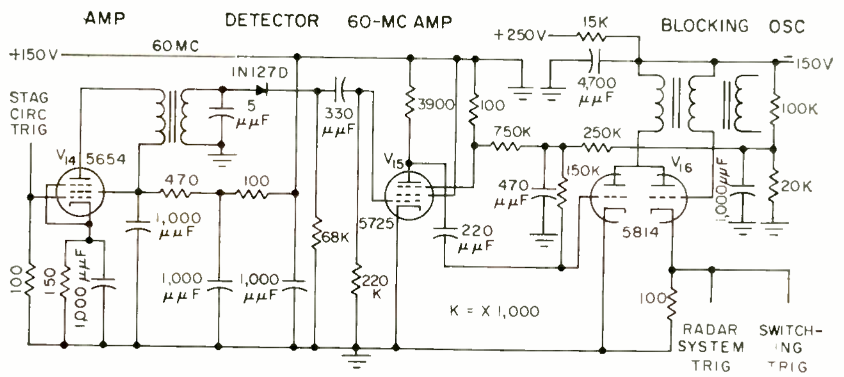


FIG. 7—Fast recovery time of blocking oscillator in trigger selector circuit eliminates unwanted trigger

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 stage V_{13}. The phase shift is adjusted so the 109-μsec trigger does not fire the blocking oscillator.

Test Results

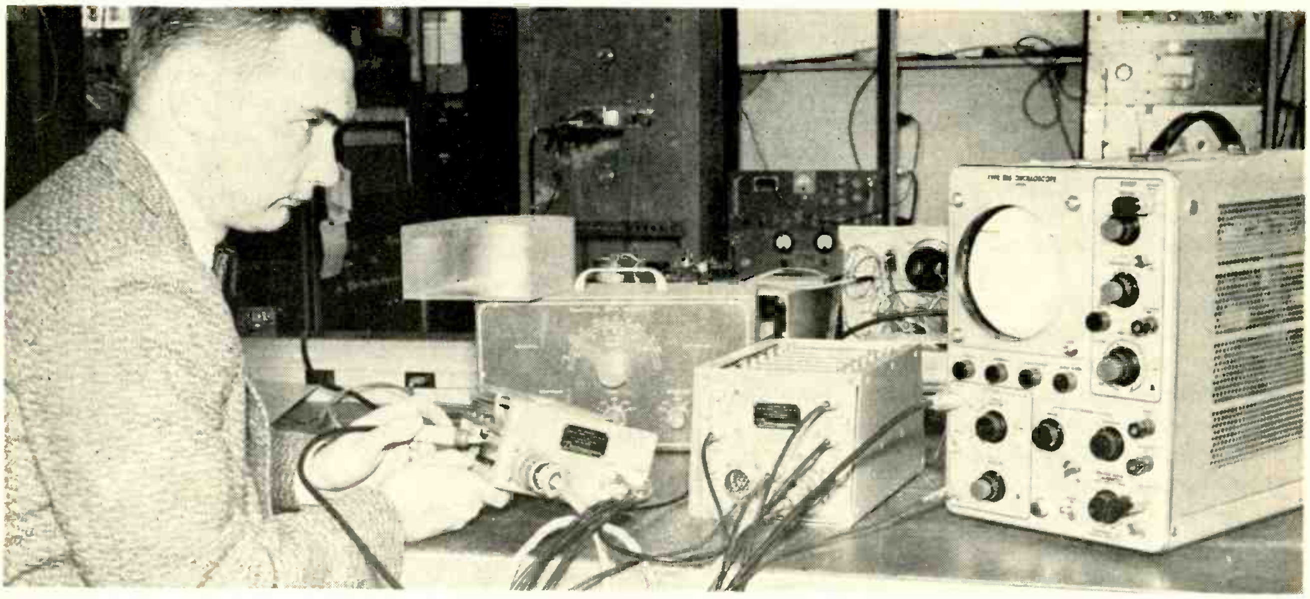
A video cancellation figure of 30 db for a 0.4 μsec pulse was obtained by keeping interchannel leakage in the prf staggering switch to -100 db. Individually shielding the delayed and undelayed channels kept the leakage down to this level.

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.

REFERENCES

(1) Final Engineering Report on the MTI Measurement Problem, LFE 1950.
(2) LFE Interval Reports #476 and #518, E. H. King.



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**

Minneapolis Honeywell Regulator Co., Davies Laboratories Division, Beltsville, Maryland

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.

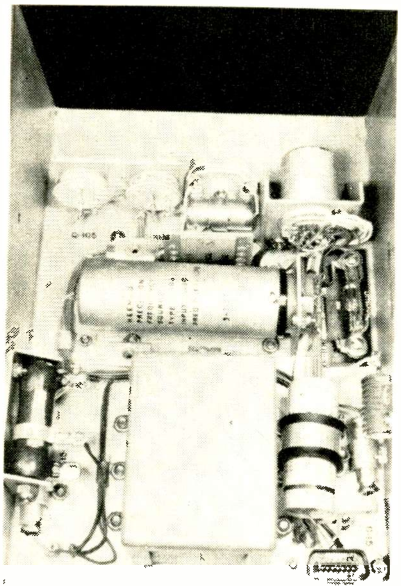
In most cases where the transistors see a resistive load, the average dissipation is principally a result of transition loss. If the load presented to the transistors is reactive, the losses may become much greater, but with the proper reactance and the proper drive much improvement may be realized.

Instantaneous Power Loss

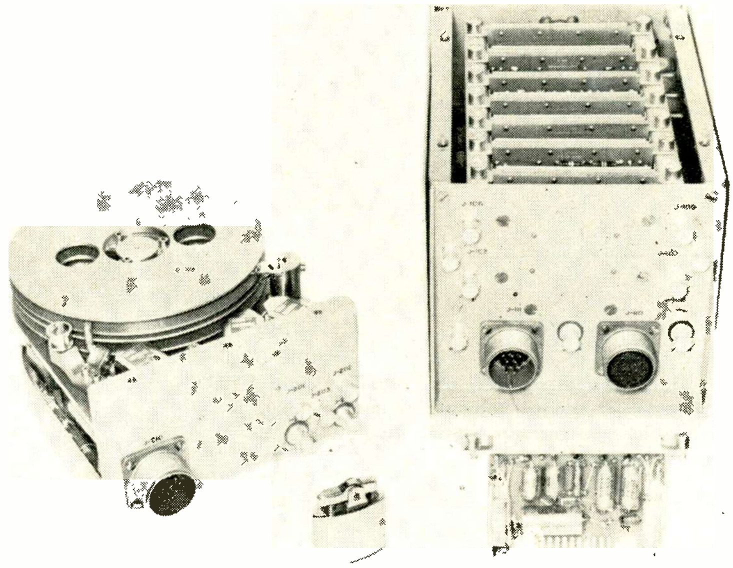
The instantaneous power lost is given by the instantaneous product of the voltage across the transistor and the current through it. During the conduction period the dissipated power is small because the

* Now at Diamond Ordnance Fuze Labs.

** Also at The University of Maryland



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.

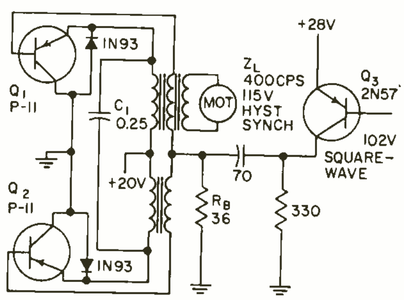


FIG. 1—Simplified schematic of transistor power converter

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-

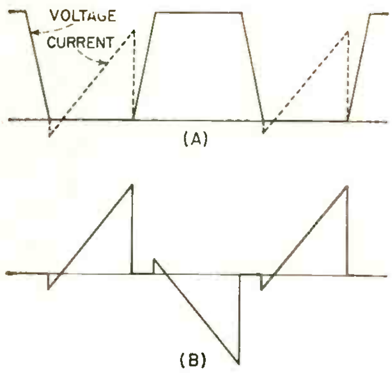


FIG. 2—Ideal waveforms (A) of current and voltage of single transistor, and difference of the currents (B) flowing through transistors of Fig. 1

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

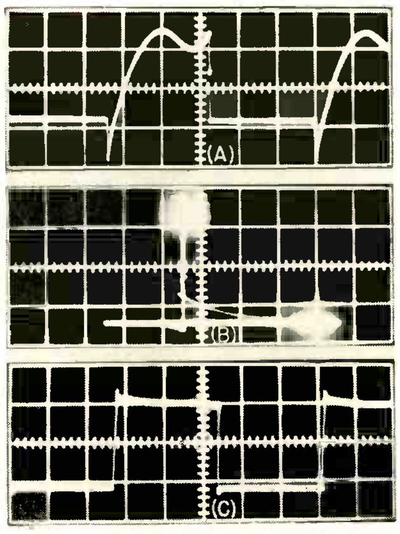


FIG. 3—Current waveform (A) of one transistor when load is not purely resistive, and transistor voltage as a function of current (B) and of time (C) for circuit of Fig. 1

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.

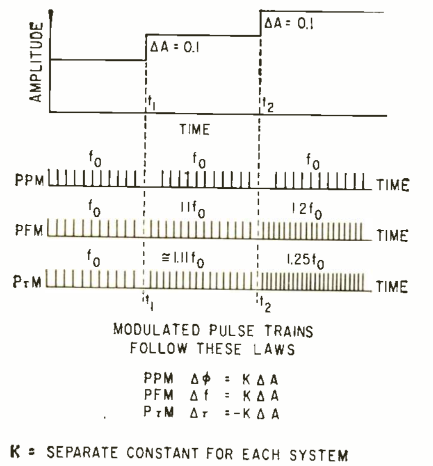


FIG. 1—Waveforms illustrate differences between the three forms of modulation

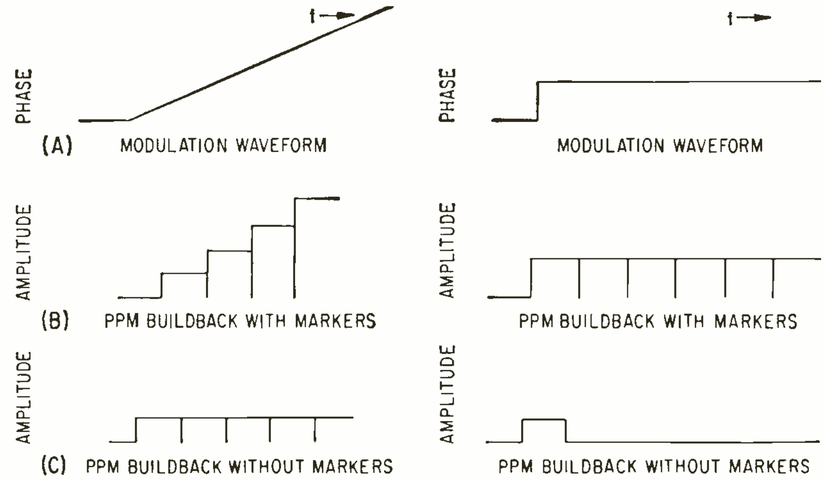


FIG. 2—Waveforms in (C) are close derivatives of (A). Left set shows ppm by linear waveform, right set by step waveform

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

By M. DAVIDSON,* H. JOSEPH and N. ZUCKER,
Avion Division, ACF Industries, Inc., Alexandria, Virginia

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

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

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

* Now with The Johns Hopkins Univ., Silver Spring, Md.

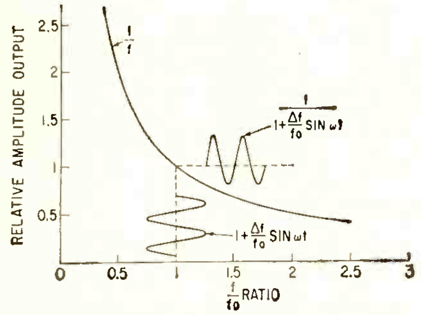


FIG. 3 Nonlinear distortion results when a pfm signal with large recurrence-frequency derivation is demodulated by a pτm demodulator

$K_m(p, f, \tau)$ 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. The same 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.

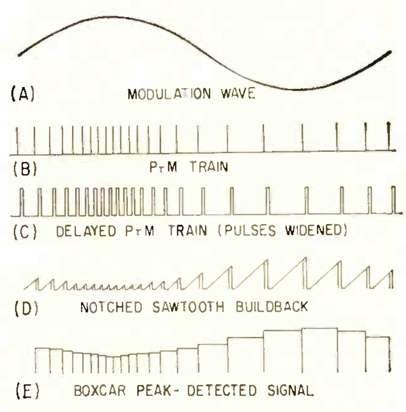


FIG. 4 Sequence of waveforms in the buildback process for pτm modulation wave (A), pulse-period modulated train (B), delayed pτm train (pulses widened) (C), notched saw-tooth build back (D) and boxcar peak-detected signal (E)

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.

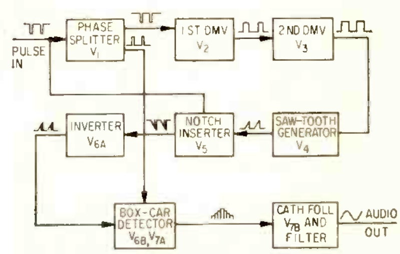


FIG. 5 Block diagram of a pulse period demodulator

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.

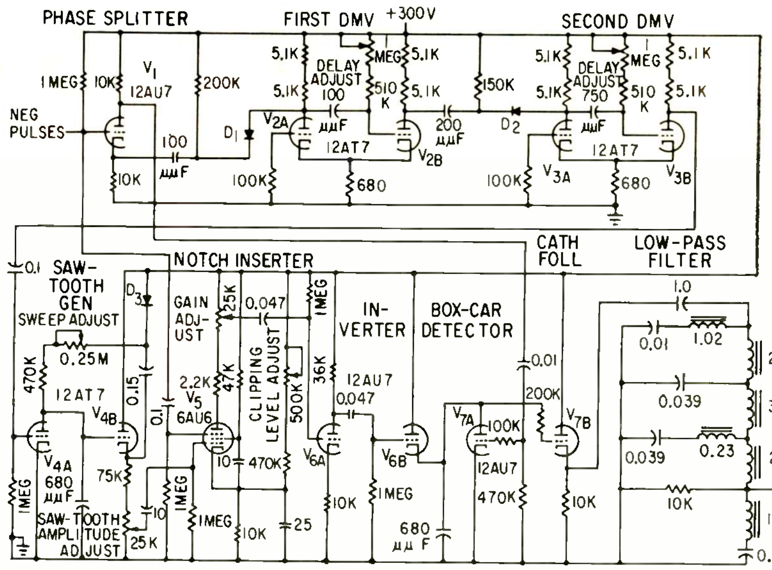


FIG. 6 Pulse period demodulator circuit for markerless pulse trains

Bootstrap feedback through V_{4B} 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.

REFERENCES

(1) H. S. Black, "Modulation Theory", 1953, Van Nostrand.
(2) M. Nichols and L. Rauch, "Radio Telemetry", 1956, John Wiley & Sons.
(3) E. L. Marton, Advances in Electronics, Vol. IV, "Multichannel Radio Telemetering", p. 301 ff, Academic Press.
(4) A. T. Starr, "Radio and Radar Technique", p. 30 1953, Pitman & Sons.
(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.

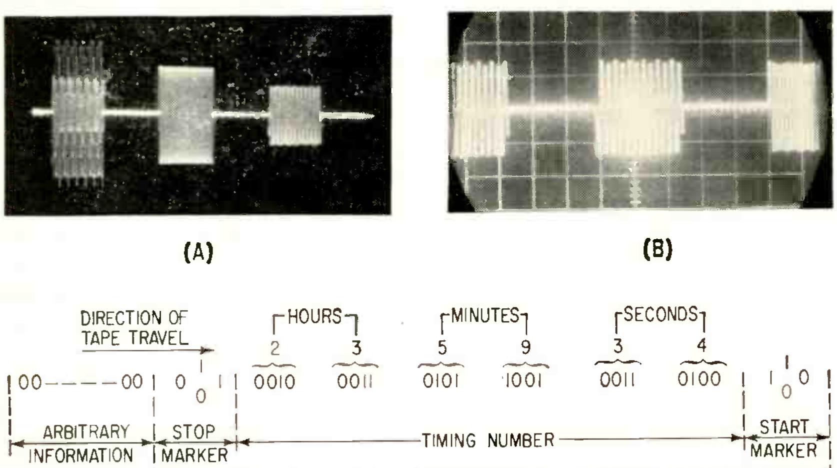


FIG. 1—Binary zero in searcher system is represented by single amplitude tone burst shown at right in (A). Center shows binary one while left shows start-stop marker. Actual tone burst of zero-zero-one chain is shown left to right in (B). Word format used by digital timing generator is shown in (C)

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.

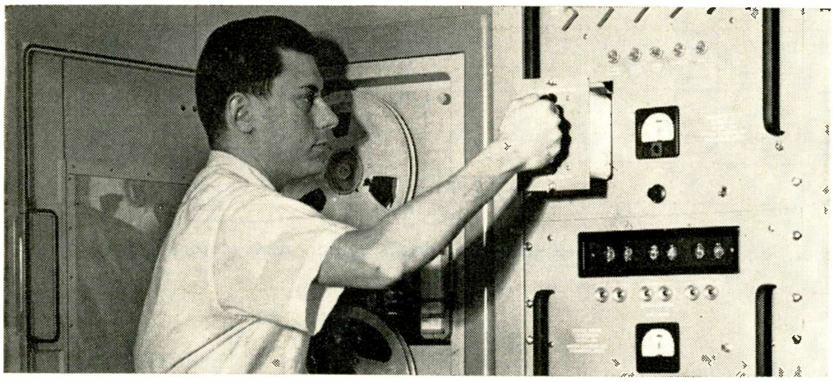
Frequency and duration of the tone bursts are direct functions of tape speed as shown in Table I. This relationship keeps the bit length on the tape constant regardless of the tape speed; therefore, the magnetic tape search unit can be operated at any desired playback speed and is independent of the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

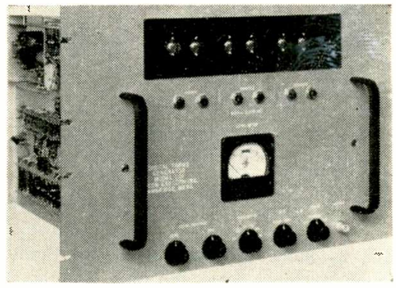
Generator Circuit

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 tapoffs 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

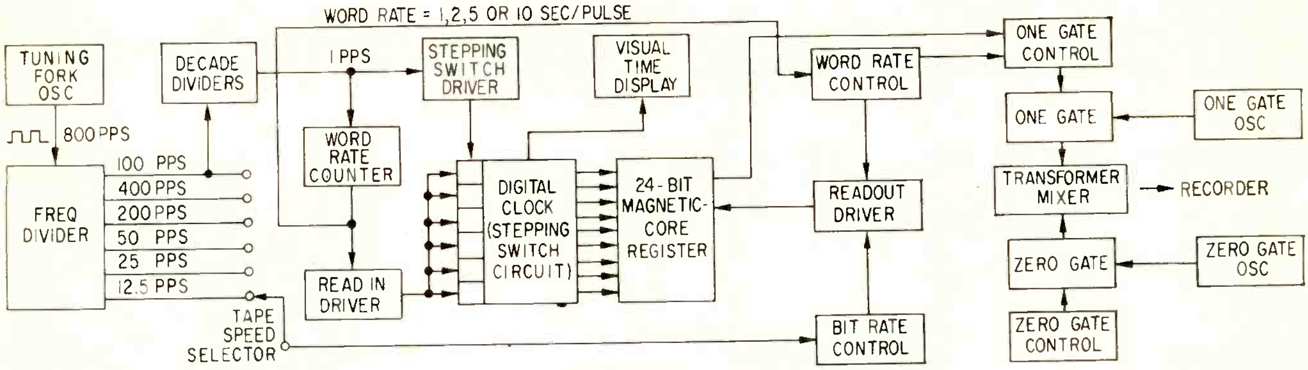


FIG. 2—Block diagram of digital timing generator. The generator is self-timed permitting search and playback decoding to be dependent only upon the time signals

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-

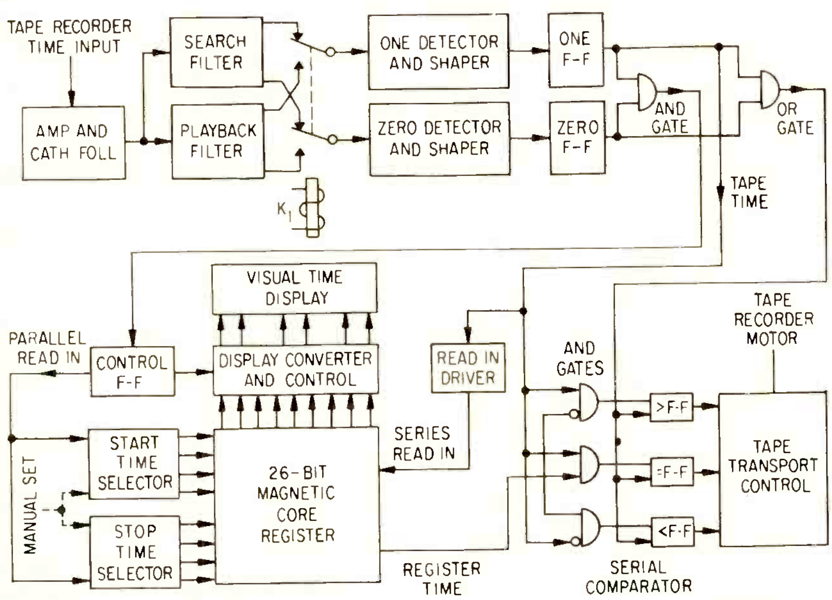


FIG. 3—Block diagram of magnetic tape search unit. Start and stop markers permit the search unit to detect the beginning and end of a series of time bits

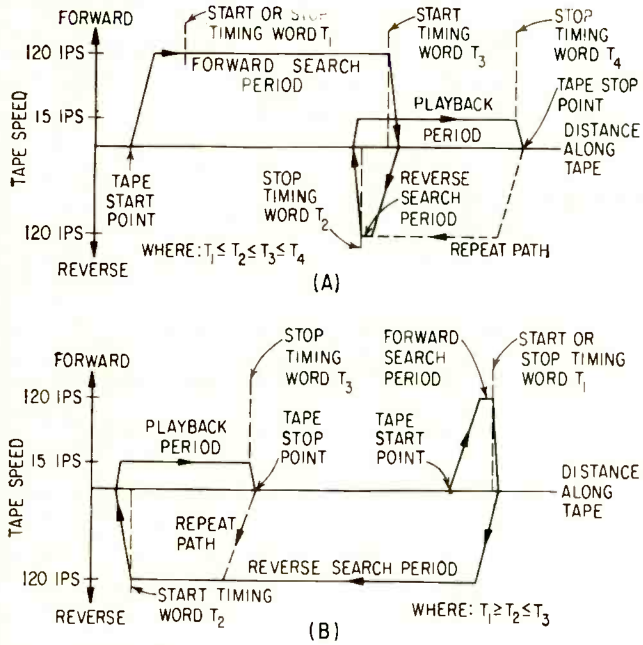


FIG. 4—With segment ahead of pickup (A), tape is read in forward direction. Cycle for segment behind pickup is as in (B)

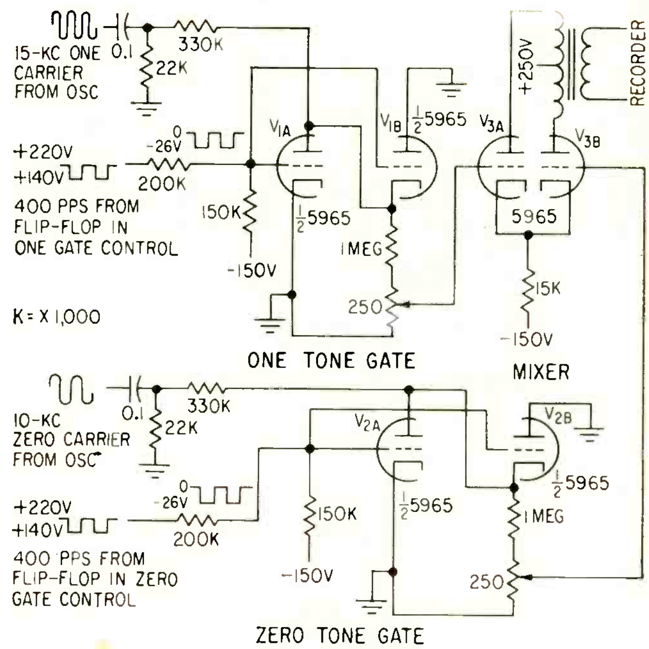


FIG. 5—Tone gate and mixer circuits. Tone bursts from dual triode V_3 are mixed by output transformer common secondary

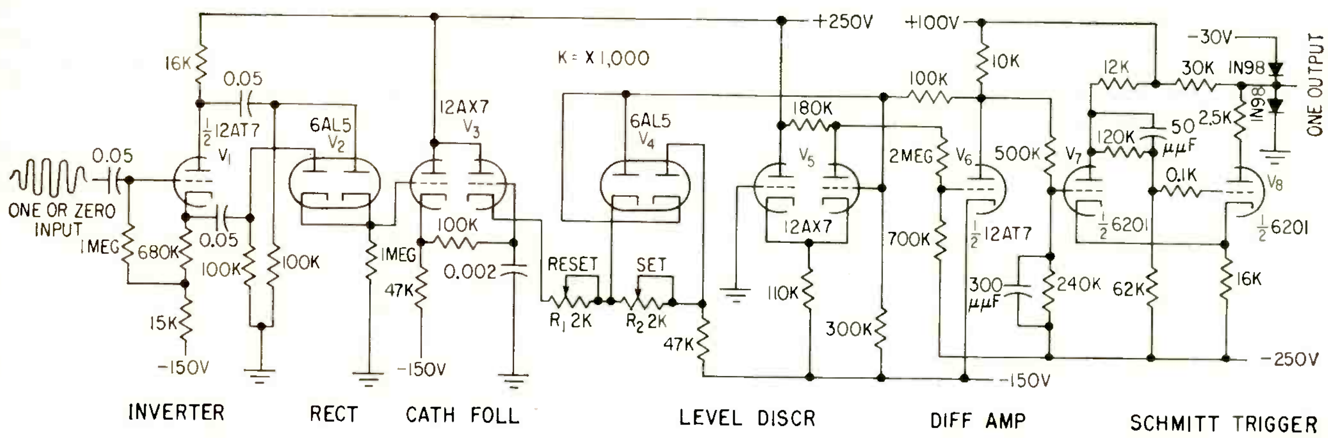


FIG. 6—Detector circuit. Difference between level setting of R_1 and R_2 establishes hysteresis or backlash in the detector

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.

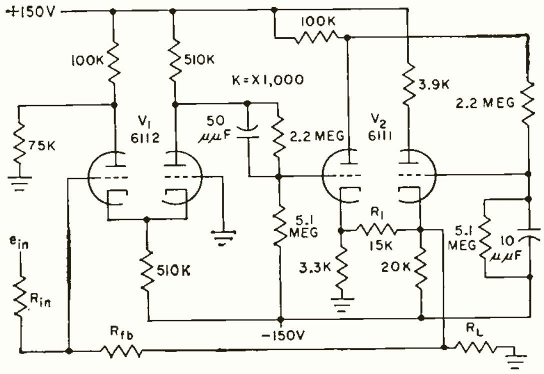
D-C Amplifiers for Control Systems

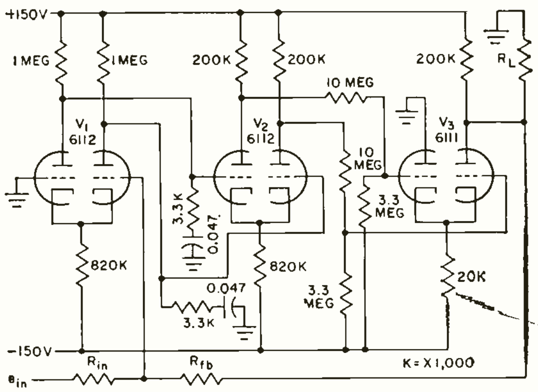
Typical direct-coupled, high-gain amplifier systems which boost gain and equalize d-c and low-frequency signals are described. Circuits and sample applications provide desired performance characteristics for control systems

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.

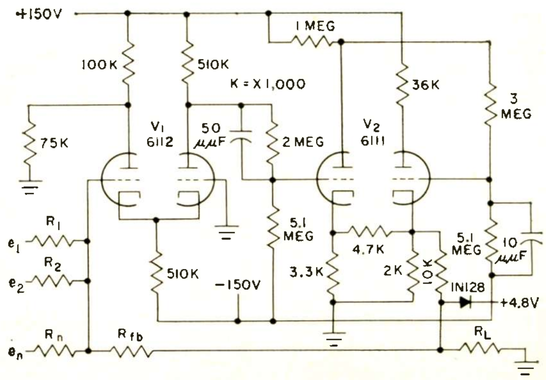
The plate and cathode power supplies of ± 150 v permit the output to operate above and below zero potential. Open-loop gain is greater than 5,000 into a 10,000-ohm load and good stability and summing accuracy is possible with closed-loop gains of 0.1 to 100. Zero drift referred to the amplifier input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

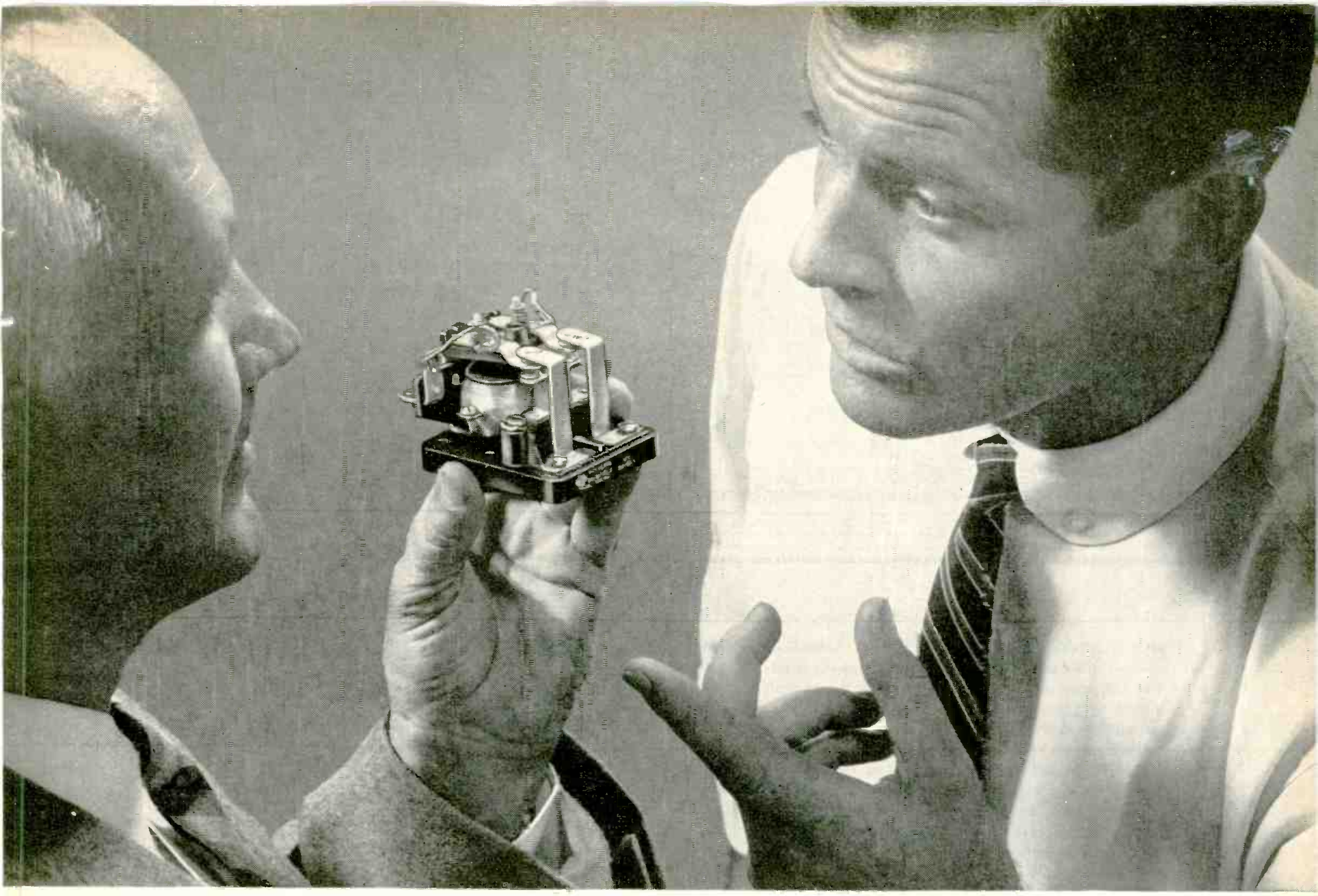
The amplifier is well suited for essentially no-load, one-megohm or higher, applications where ±50-v swing is required and space is a premium. Other applications include integrating or differentiating in airborne or ground based electronic control systems. Phase lag of 5 deg at 20 cps with closed-loop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





HERE'S WHY P&B's PR POWER RELAY IS PREFERRED

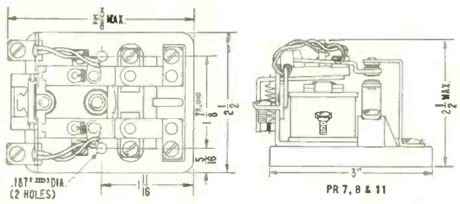
for high current/voltage switching

HEAVY DUTY construction means long-term dependability when switching up to 20 amperes (double break contacts). Here is a ruggedly built relay, packed with high quality features, yet economically priced.

The PR's full floating movable contact carrier, for example, provides excellent contact pressure and ample wipe for self-cleaning contact action. The coil is centrifugally impregnated with top-grade varnish to eliminate moisture traps.

Contact arrangements up to DPDT are available. The PR has been adapted for printed circuitry and heavy duty plug-in applications.

All standard AC actuated PR relays may carry the UL and Canadian Standards Association seals of approval. Write or call for complete information.



GENERAL SPECIFICATIONS:
Breakdown Voltage: 1500 volts rms min. between all elements and ground.
Ambient Temperature: DC: —55° to +85°C. AC: —55° to +55°C.
Terminals: Heavy duty screw type. Standard printed circuit pins or plug-in on request.
Enclosures: PR dust cover.

CONTACTS:
Arrangements: Up to 2 Form C (DPDT).
Material: 5/16" dia. silver or silver cadmium oxide. (Others available)
Load: Single break: 15 amps; Double break: 20 amps at 115 volts 60 cycle AC resistive.

AUXILIARY CONTACTS:
Arrangements: 1 Form A, B or C.
Material: 3/16" diameter silver
Rating: 5 amps at 115 volts 60 cycle AC resistive.

COILS:
Resistance: 64,000 ohms maximum.
Power: 1.8 watts DC; 9.8 volt-amps AC.
Duty: Continuous AC or DC (DC coils will withstand 10 watts at 25°C).
Insulation: Centrifugally impregnated with high quality varnish.
Mountings: 2 holes .187" diameter 1⅞" o.c.

PR Relays Approved By Underwriters' Laboratories and Canadian Standards Association

Type	Contact Arrangement*	Type	Contact Arrangement*
PR1AY	SPST-NO	PR5AY	SPDT
PR2AY	SPST-NC	PR7AY	DPST-NO
PR3AY	SPDT-NO-DM	PR8AY	DPST-NC
PR4AY	SPDT-NC-DB	PR11AY	DPDT

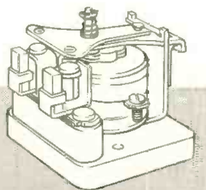
These relays are available in any of the following operating voltages: 6, 12, 24, 48, 115, 208, 230, or 440 volts 50/60 cycles AC.

The contacts are rated at: 13 amps, 115 volts AC. 6.5 amps, 230 volts AC. 1 hp for 115 or 230 volt AC motors.

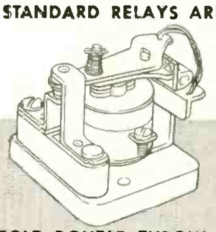
Any relays deviating electrically or physically from these standard models will not carry U/L or CSA approval.

*Read: NO normally open, NC normally closed, DB double break, DM double make.

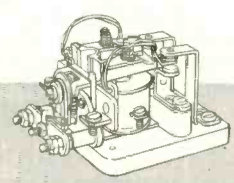
P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR



PR RELAY WITH MAGNETIC BLOW-OUTS
Models PR3 and PR7 can be supplied with alnico magnets to suppress arcs on DC loads over 1200 watts.



SINGLE POLE DOUBLE THROW VERSION
PR 5 (SPDT) has all the heavy-duty features of other models in this series.

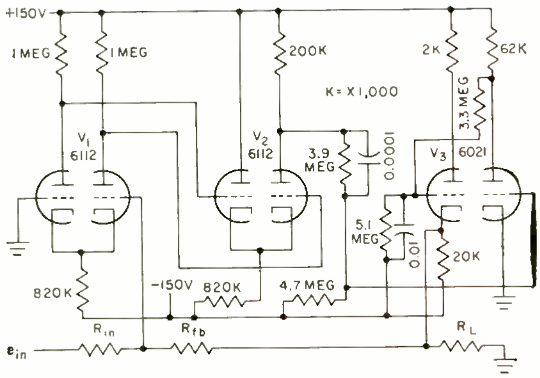


PR WITH AUXILIARY CONTACTS
All PR models can be equipped with auxilliary contacts in 1 Form A, B, or C arrangements.

POTTER & BRUMFIELD INC.

PRINCETON, INDIANA • SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

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.

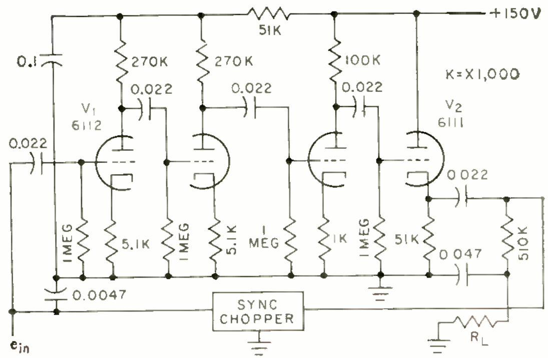
The open-loop gain is greater than 5,000, and the voltage swing is ± 10 v into a 1,500-ohm load and ± 25 v into a 5,000-ohm load. Internal equalization allows the amplifier to have less than 5 deg phase shift from d-c to 400 cps.

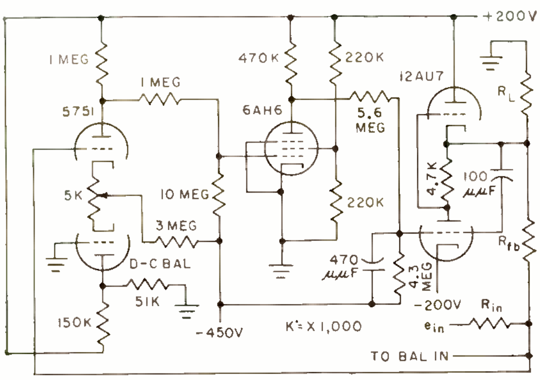
Amplifier is applicable to 60 or 400-cps control systems where several signals must be summed and amplified in a precise manner. It is also used for broadband equalization where the load impedance is lower than 25,000 ohms and the phase lag must be held to a minimum

---

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.

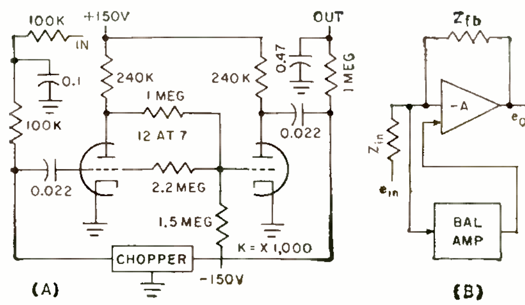
Amplifier is well suited for control systems or analog computer applications because of broad passband and large control-system response characteristics. Amplifier may be used with all passive equalization networks to obtain desired response

---

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



ONE BEST BET in 1959

Beginning in January, ELECTRONICS will have the same editorial format each week.

Technical articles that have distinguished the magazines since 1930 as the leading publication in its field will be increased in number and will be joined by business articles we now know have wide appeal and usefulness.

We learned in 1957 that there was a need for this additional material; we learned in 1958 that it was needed weekly. So our planned standardization of issues should better serve readers in research, design, production and management. And we hope it will make ELECTRONICS compulsory reading for many others.

Subscribers gained 400 additional editorial pages in 1957, more than 550 in 1958. They will benefit again in the year just ahead, both in quantity and in quality, as we further broaden our scope and coverage without taking our eye off the engineering ball.

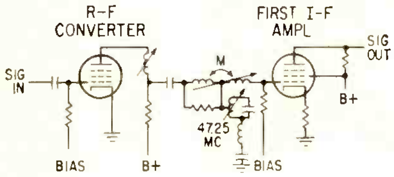
Thus ELECTRONICS keeps pace with its growth industry. If it's about electronics, read it in ELECTRONICS—repackaged as a straight weekly.

H W Mateer

Publisher

Trap Improves Tv Picture

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



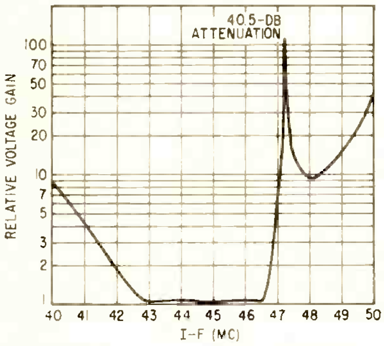


FIG. 1—Trap increases carrier slope

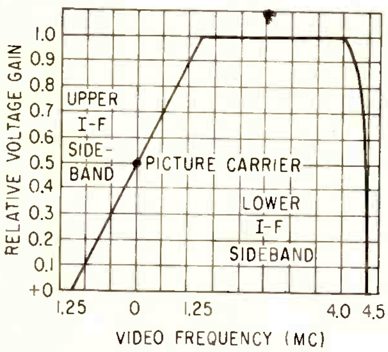


FIG. 2—Linear plot shows standard vestigal sideband signal

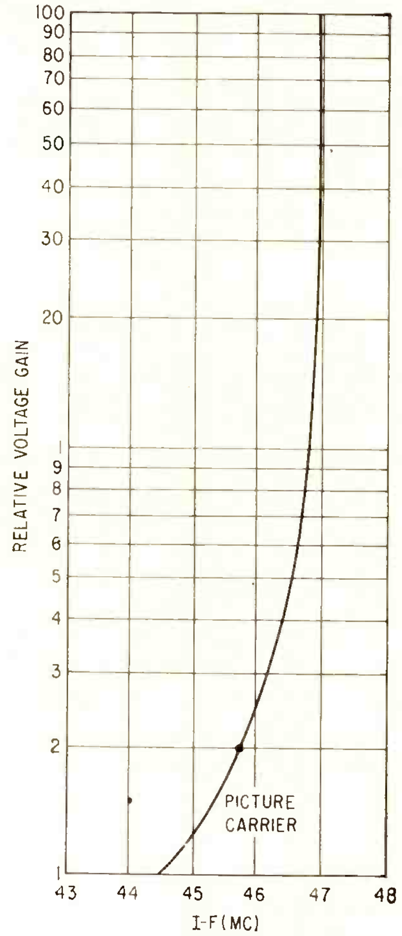


FIG. 3—Logarithmic plot of standard vestigal sideband signal

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

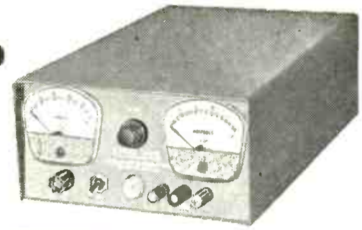
General picture tuning will also be improved with minimum slope, because of the balance of varying amounts of the quadrature component and the extreme change of picture carrier level.

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.

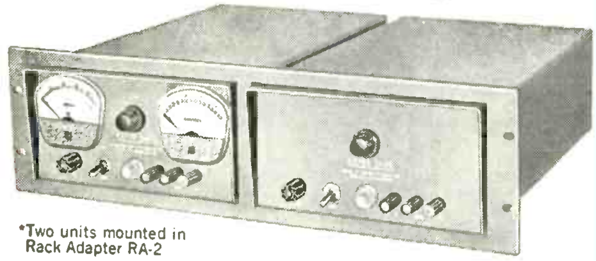
Overall i-f response may then ap-

VRPS Kepco for the most complete line of POWER SUPPLIES

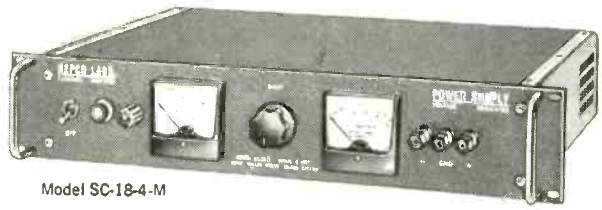
REGULATION and STABILITY 0.1%



Model SC-18-2-M



*Two units mounted in Rack Adapter RA-2



Model SC-18-4-M

VOLTAGE REGULATED POWER SUPPLIES

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

(TUBELESS) 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 to 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.

KEPCO LABORATORIES, INC.
131-38 SANFORD AVENUE • FLUSHING 55, N.Y.
INDEPENDENCE 1-7000

- **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.
- **CONSTANT CURRENT OPERATION:** These units can be set up for constant current operation without internal modification.
- **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.
- Suitable for square wave pulsed loading.
- Either positive or negative can be grounded.
- Units can be series connected.
- High efficiency
- Low heat dissipation.
- Compact, light weight
- For bench or rack use.
- Color: Gray hammertone. (Special finishes available).

ORDERING INFORMATION:

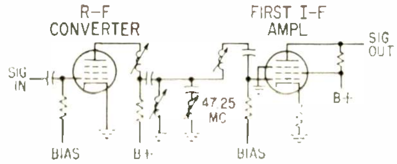
Units without meters use model numbers indicated in table. To include meters add M to the Model No. (e.g. SC-18-1-M).

*Rack adapter for mounting any two 8¼" x 4 5/32" units is available. Model No. RA2 is 5¼" high 19" wide.

*Rack adapter for mounting any one 8¼" x 4 5/32" unit is available. Model No. RA3 is 5¼" high 19" wide.

AN 0.01% SERIES IS AVAILABLE IN 13 NEW MODELS

KEPCO OFFERS MORE THAN 120 STANDARD VOLTAGE REGULATED POWER SUPPLIES COVERING A WIDE RANGE OF MAGNETIC, TUBE AND TRANSISTOR TYPES. MOST MODELS AVAILABLE FROM STOCK. SEND FOR BROCHURE B-587



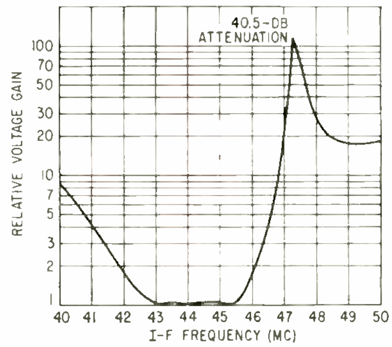


FIG. 4—Bifilar T trap at 47.25 mc results in minimum slope

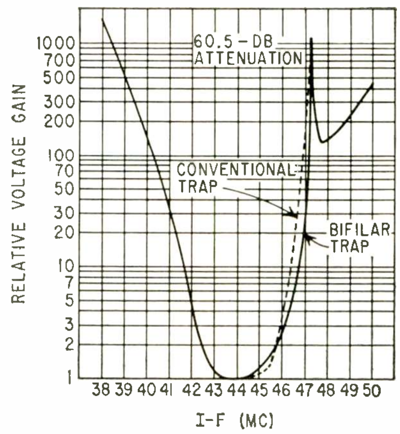


FIG. 5—Comparison shows improvement in slope with bifilar T trap

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,

...supplying the following major airplane subsystems: Autopilot, Air Induction, Armament Control, Navigation, Surface Controls, Cockpit Indicator and Pneumatic Static Pressure Correction.

The AiResearch centralized air data computing system integrates pneumatic, electronic, electrical and mechanical components on one of the Navy's fastest jets. It senses, measures, and automatically corrects all air parameters affecting flight. It supplies air data information to the pilot and all major airplane subsystems.

This centralized combination of transducers, computers and indicators is the most complete air data computing system ever devised. It enables aircraft to operate at maximum efficiency continuously.

Eliminating duplication of components, the AiResearch centralized air data computing system cuts down space and weight requirements over decentralized systems by many times. Its principal functions: angle of attack, true static pressure (electrical and pneumatic), true air speed, true Mach, altitude, rate of climb, total temperature, dynamic pressure and altitude and Mach error.

AiResearch has been the leader in the development of centralized computing systems. The F4H-1 installation is the first, single package air data computer possessing completely interchangeable, modular construction.

Your inquiries are invited.

ENGINEERING REPRESENTATIVES: AIRSUPPLY AND AERO ENGINEERING, OFFICES IN MAJOR CITIES

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

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.

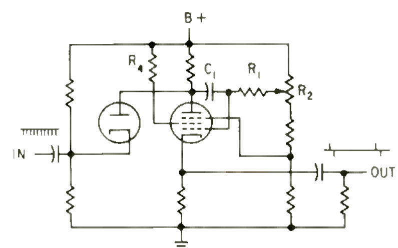


FIG. 1—Conventional phantastron frequency divider is triggered by pulse train with triggers of only one polarity

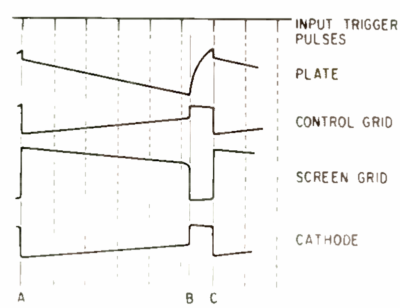
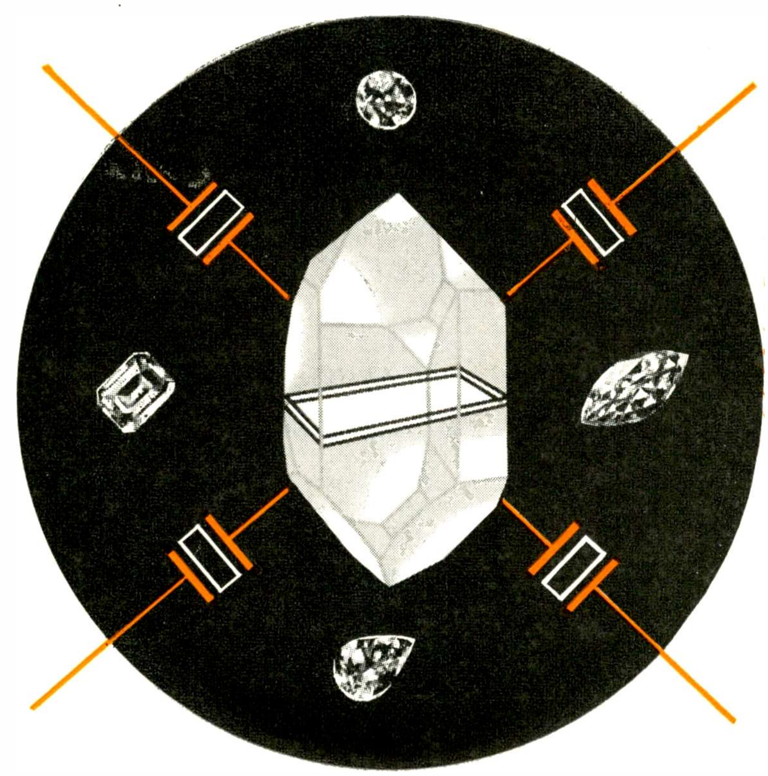
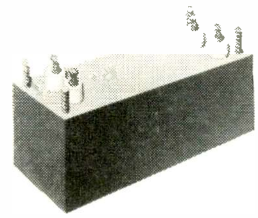


FIG. 2—Points *A* and *C* in conventional divider are fixed, but point *B* is unstable, particularly at low frequencies

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,





HOW TO SIMPLIFY CIRCUIT DESIGN WITH BURNELL CRYSTAL FILTERS

Through advanced crystal filter production techniques and circuitry by Burnell & Co.,it is now possible to overcome numerous design problems formerly believed insoluble with even the best individual toroidal components.

FREQUENCY RANGE EXTENDED

Depending on band width and frequency, filters may be composed entirely of crystals or in complex networks, combine quartz crystal elements with stabilized toroidal coils to produce the desired band width and shape factor. Frequency has been extended from low range up to 20 megacycles.

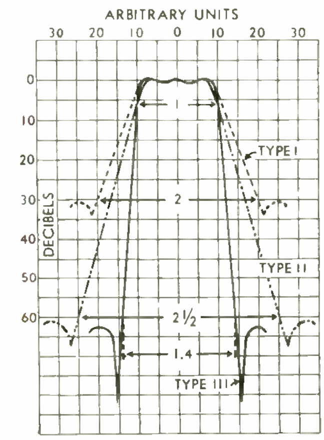
TRANSISTOR TO PENTODE OPERATION

Economy is achieved with standardized complex designs of lattice networks and their three terminal network derivatives. Packaging encompasses a wide range in standard, miniature and sub-miniature sizes with considerable latitude in permissive impedance range from transistor usage to pentode operation.

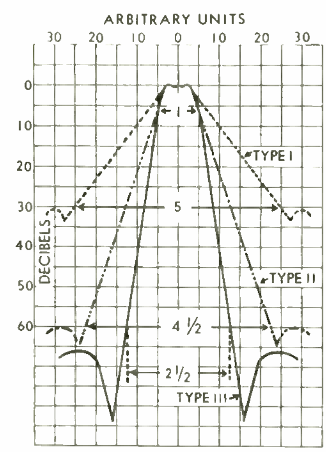
STANDARD DESIGN OR CUSTOM ENGINEERED

Whether you need crystal filters of standard design or custom units engineered to specifications of center frequency, band width, selectivity and impedance level, the facilities of Burnell & Co. are at your disposal. Write for new Burnell Crystal Filter Bulletin XT-455.

TYPICAL RESPONSE CURVES INDICATING THE VARIOUS SHAPE FACTORS AVAILABLE IN STANDARDIZED BURNELL CRYSTAL FILTERS



WIDE BAND CRYSTAL FILTER



NARROW BAND CRYSTAL FILTER

Burnell & Co., Inc.

PIONEERS IN TOROIDS, FILTERS AND RELATED NETWORKS

Dept. E-11

EASTERN DIVISION
10 PELHAM PARKWAY
PELHAM, N. Y.
PELHAM 8-5000
TWX PELHAM 3633

PACIFIC DIVISION
720 MISSION STREET
SOUTH PASADENA, CALIFORNIA
RYAN 1-2841
TWX PASACAL 7578

CIRCLE 73 READERS SERVICE CARD

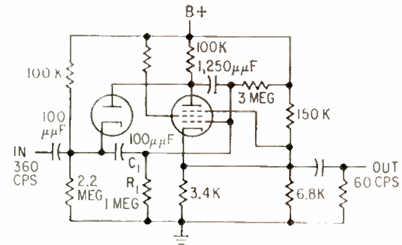


FIG. 3—Modified phantastron is triggered by train with both positive and negative pulses

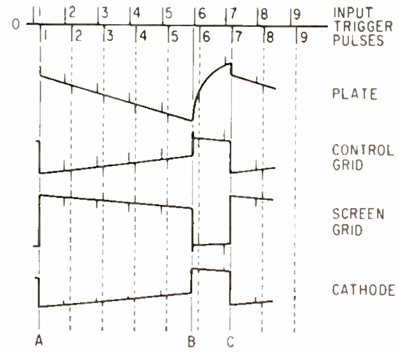


FIG. 4—With pulse train containing both positive and negative pulses, point *B* is fixed

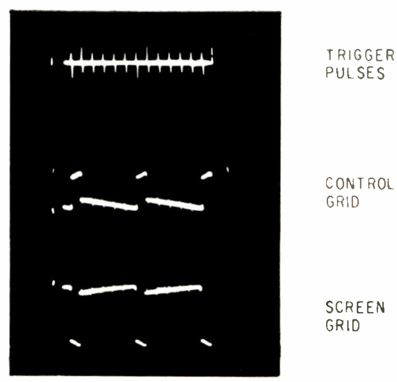


FIG. 5—Phantastron operating with 360-cps train containing pulses of both polarities develops waveforms shown in photograph

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.

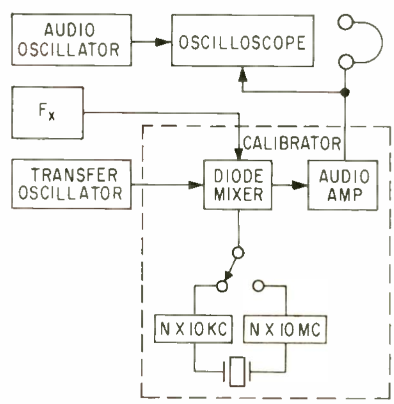


FIG. 1—Transfer oscillator output with transmitter frequency provide sum and difference frequencies that can be beat against harmonic series. Transmitter frequency can then be corrected

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

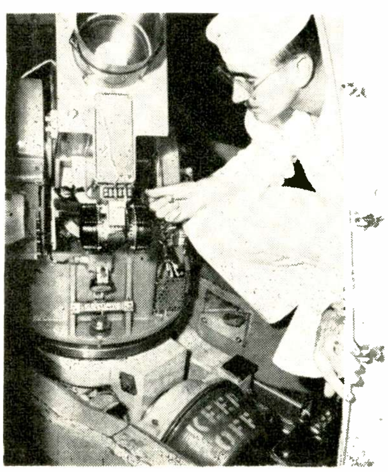
Above 10 mc, however, the only values of F_x are exact multiples of 10 mc, of which there are very few.

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.

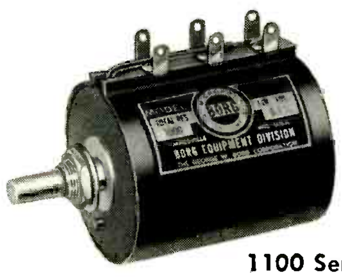
This material was abstracted from a Wescon conference paper by C. A. Cady and W. P. Buuck of General Radio Co.

Why Gamble?

THERE'S A BORG MICROPOT® TO MEET YOUR EXACT SPECIFICATIONS!

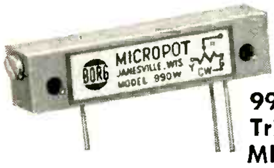
BORG MICROPOTS...
the Ultimate in Multi-Turn Precision Potentiometers

Borg offers a complete line of high-precision, linear potentiometers called MICROPOTS. Precision is Borg's business . . . that's why MICROPOTS offer so many exclusive advantages. Superior design and production methods make Borg MICROPOTS available in any quantity. Write today for the name of your nearest Borg Jobber or "Tech-Rep."



1100 Series MICROPOTS

A precision MICROPOT that offers your products a price advantage in today's competitive markets. Lug or lead type terminals. Accurate . . . dependable . . . long lived.

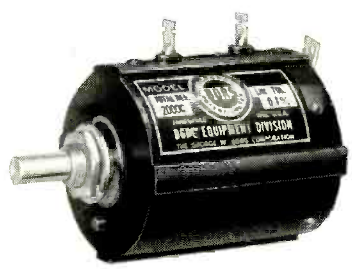


990 Series Trimming MICROPOTS

Small in size, lightweight, rugged and dependable. Three types of terminals . . . printed circuit, solder lugs or insulated wire leads.

900 Series MICROPOTS

Standard ten-turn and three-turn models to fit most special design needs. Extremely accurate and dependable under adverse environmental conditions including severe vibration and shock.



205 Series MICROPOTS

A quality MICROPOT. Designed for both military and commercial applications. Proven in many different mobile and stationary types of electronic circuitry.

WRITE FOR COMPLETE ENGINEERING DATA • CATALOG BED-A90

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

ELECTRONIC-MECHANICAL BORG EQUIPMENT

Built by Borg

MOTORS
MICROPOTS
MICRODIALS

Around-the-Mast Rotary Joint

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

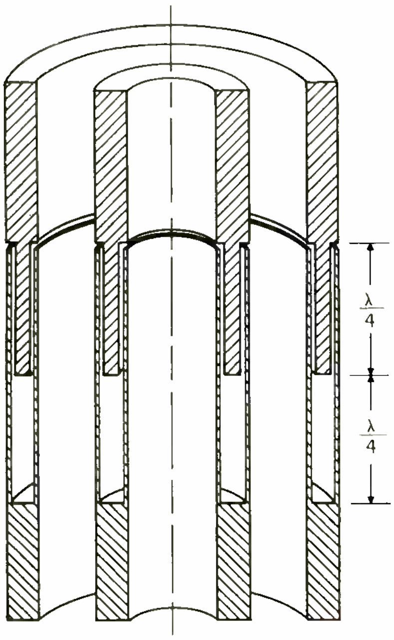


FIG. 1—Basic coaxial choke joint

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

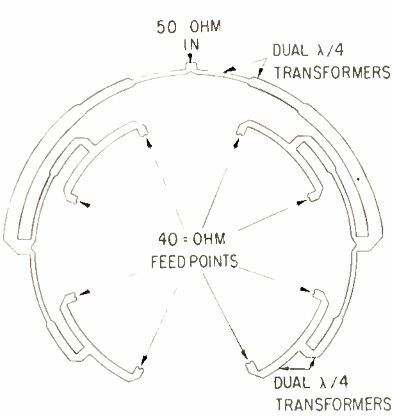


FIG. 2—Binary feed system

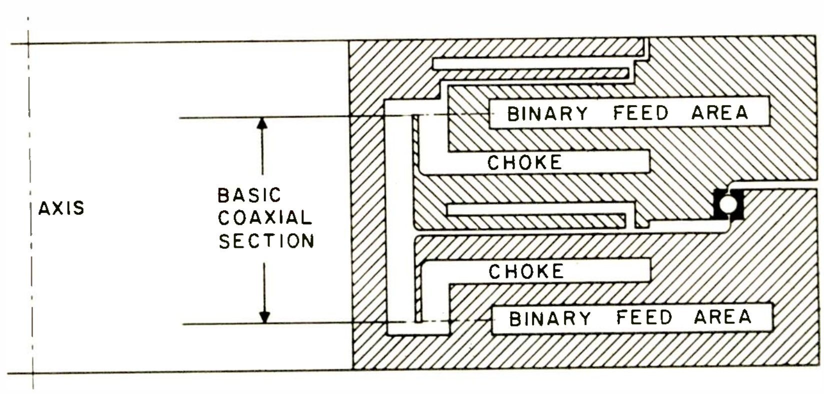
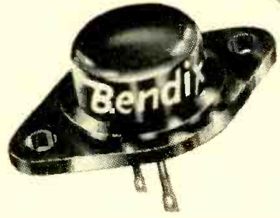


FIG. 3—Cross-sectional view of the rotary joint

D A P



(ACTUAL SIZE)

DIFFUSED ALLOY POWER TRANSISTORS

Features

Faster Switching Times 0.5-5 μ Sec
Switching Currents up to 10 amperes
Flatter Frequency Response 40 Kc
Higher Breakdown Voltage up to 120 Volts
Current Gain of 40 at 5 amperes
Standard Power Transistor Package
Lower Base Resistance, 2 ohms
Lower Saturation Resistance, 0.1 ohm

Uses

TV Horizontal Output
Hi-Fi Amplifiers
Core Drivers
High Current Switching
Power Converters
Ultrasonic Generators
Modulators

Because no other transistor offers this combination of features and uses, you will want to try out the DAP transistor in your circuits. Get full details now on new Bendix diffused alloy power transistors by writing SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY.

	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

West Coast Office: 117 E. Providencia Ave., Burbank, Calif.
Canadian Distributor:
Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ontario
Export Sales and Service:
Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

Red Bank Division Bendix AVIATION CORPORATION

CIRCLE 80 READERS SERVICE CARD

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.

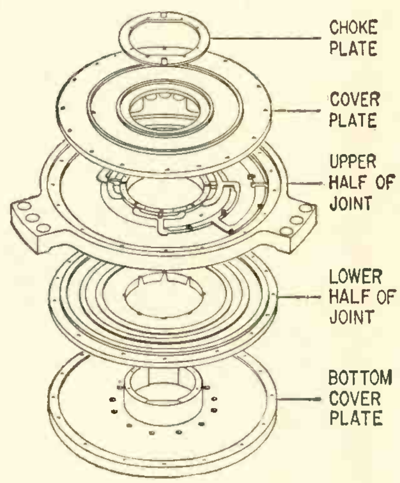
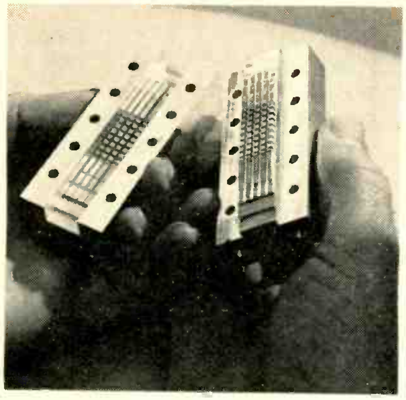


FIG. 4—Exploded view of single joint

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

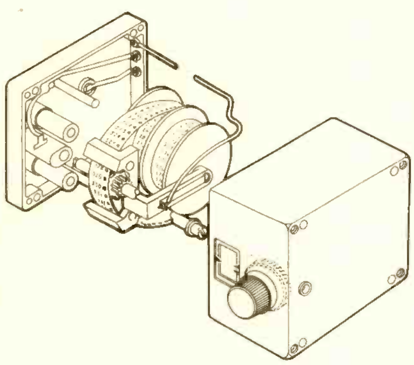


developed by Stanford Research Institute for the Hewlett-Packard Co.

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.

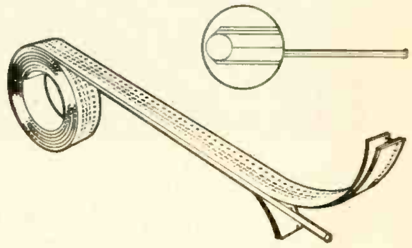
Slidewire Pot Has Digital Readout

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.

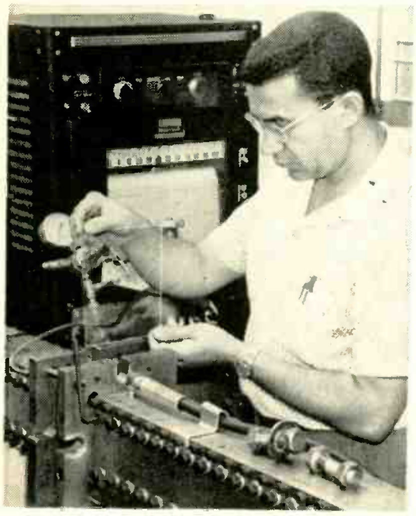
Transducer Test Program

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

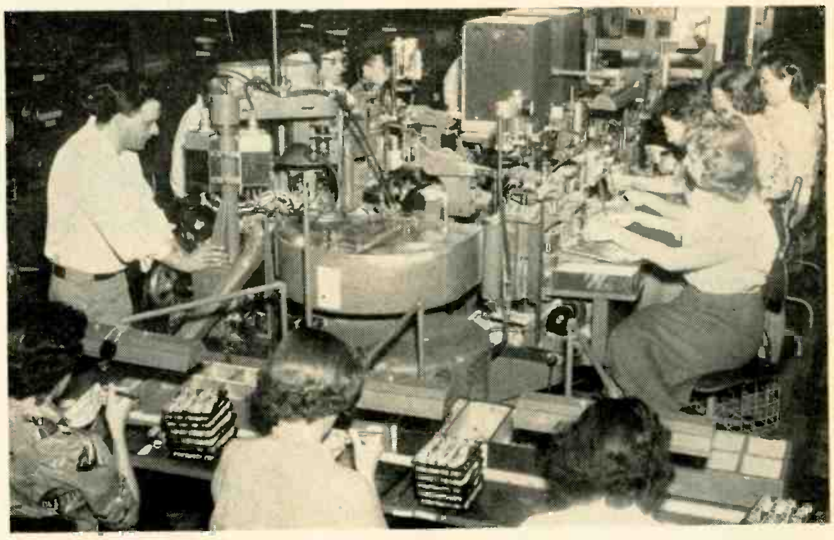
Both methods provide a known frequency input to the accelerometer. A response curve represents the dynamic characteristics of the device.

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



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

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.

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.

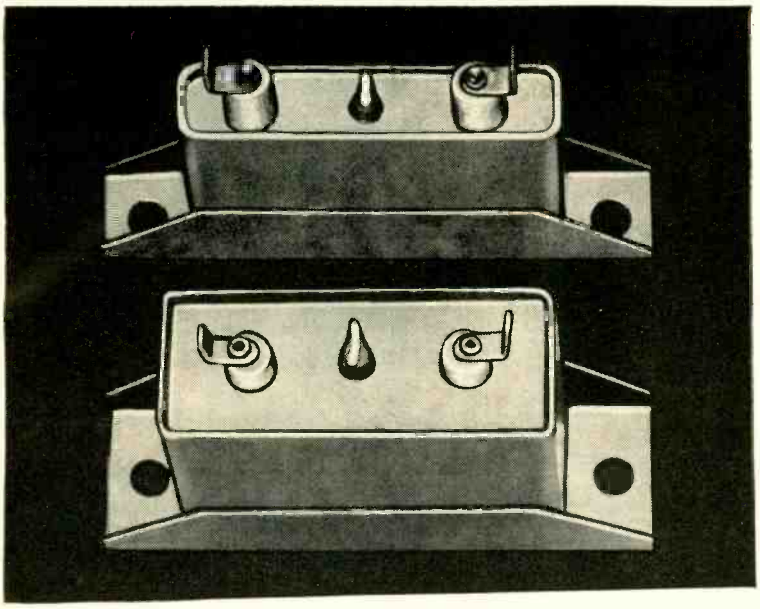
Heater Winder

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



HIGH TEMPERATURE CAPACITORS BY BENDIX

Now Available
in Production Quantity

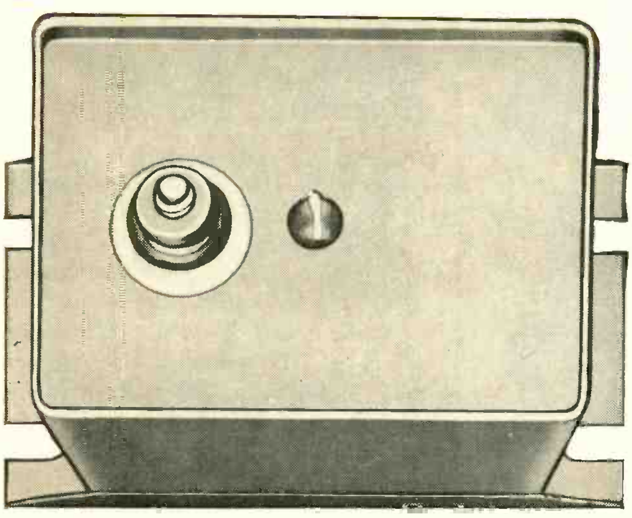
E-315

Scintilla Division of Bendix developed and has in production the *E*-315 family of *E*-nvironmental resistant capacitors to aid in satisfying the fast growing requirement for high temperature components in the high speed aircraft and missile fields.

The *E*-315 capacitor offers proven stability of operation over the temperature range of —55° to +315° Centigrade* with no voltage derating and low capacitance variation. Of rugged hermetically sealed construction and nonstrategic materials, this capacitor is built for high altitude and severe environmental operation.

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.



DESIGN FEATURES

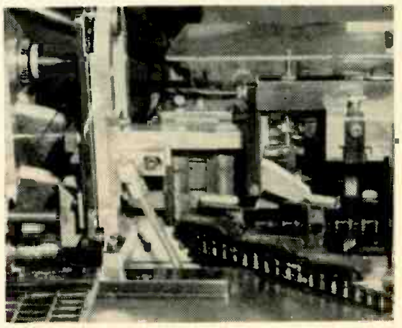
Temperature Range . . . —55° to +315°C. Capacitance . . . 0.05 to 4.0 uf at 600 VDC. Voltage Range . . . 600 V to 3000 V per section. No Voltage Derating, Low Capacitance and Power Factor Variation, Environmental Resistant, Hermetically Sealed, Rugged Construction, Nonstrategic Materials, Minimum Size and Weight, High Altitude Operation.

Scintilla Division
Sidney, New York

Bendix
AVIATION CORPORATION

CIRCLE 85 READERS SERVICE CARD

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 ¼ inch diameter, however, are vacuum cast to prevent porosity.

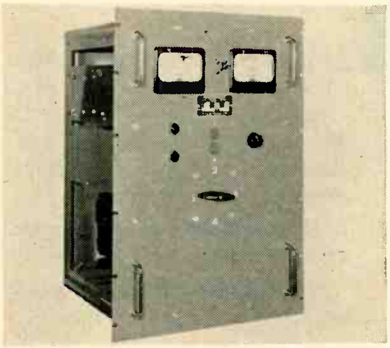
AN-Connector Wrench

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

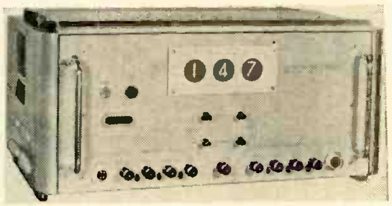


D-C Power Supply
wide voltage range

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



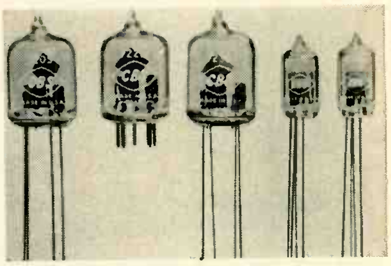
of 10 v rms per phase and a four-phase output of 10 v or 50 v rms per phase at any phase angle from 0-360 deg. Input impedance is 100,000 ohms; output impedance is less than 1 ohm per phase. Maximum output current is 7 ma rms/phase. Output phasing accuracy is ±1 deg, assuming no error in input intelligence.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

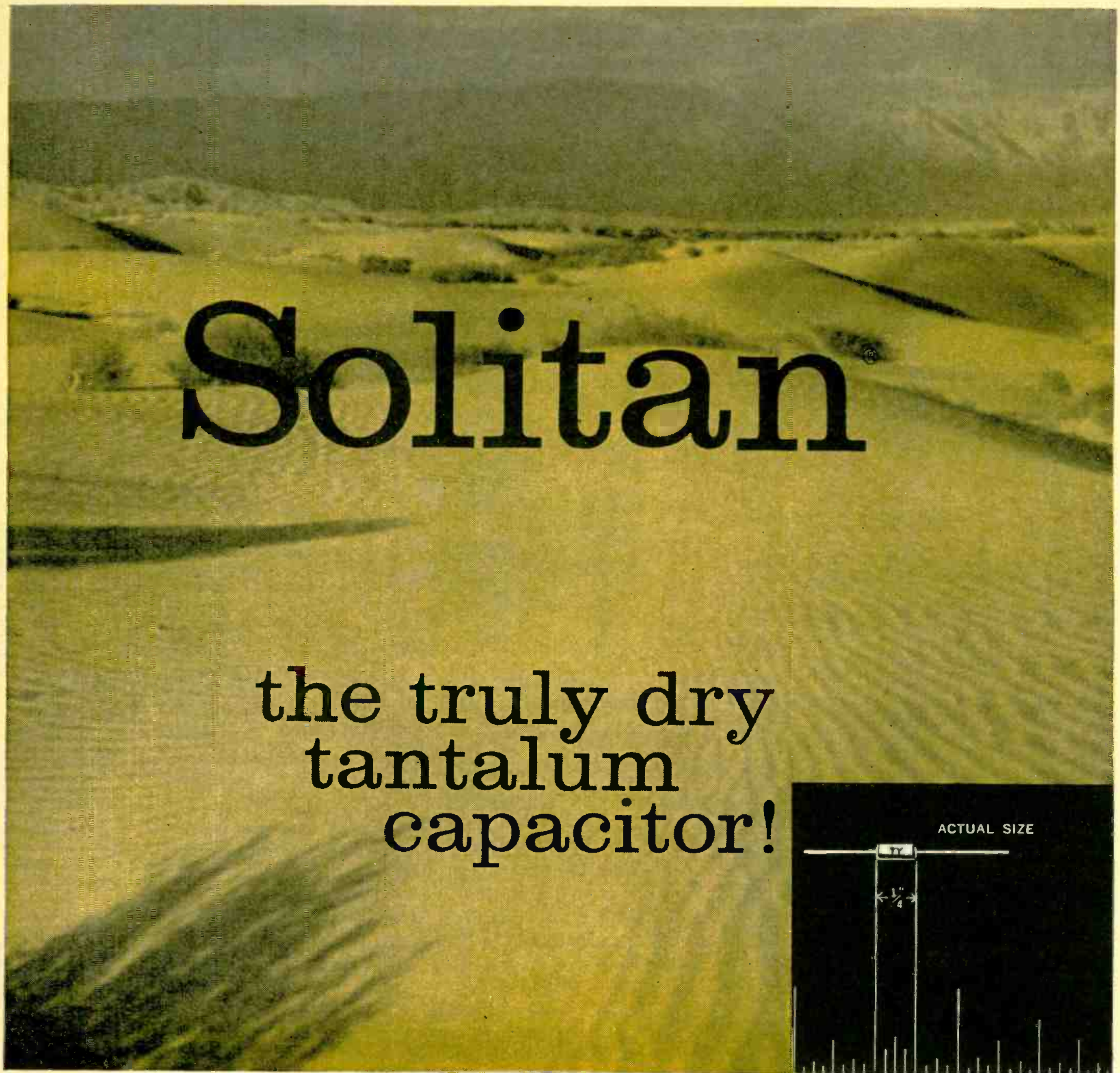
CBS-Hytron, 100 Endicott St., Danvers, Mass. A new line of cold-cathode trigger tubes, known as Krytrons, have been designed to replace relays, thyratrons and other devices in simplified circuits for reliable military and industrial equipment. Designed to operate



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

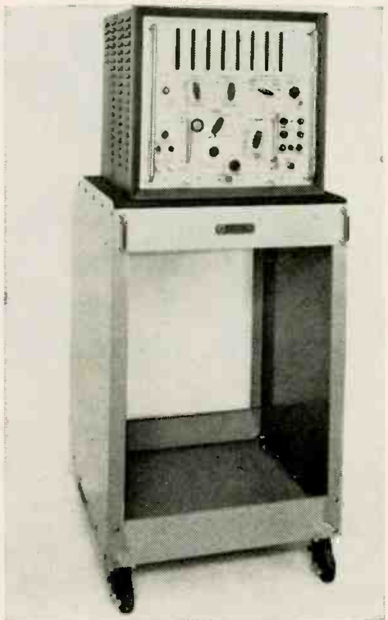
Consistently Dependable

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

Vought Vocabulary

ac′cu·ra·cy: *guided all the way, this long-range missile pinpoints distant, hard-to-hit targets*

This nuclear-armed "bird" is the supersonic missile with which the U.S. can retaliate against the toughest of enemy targets – distant, hard-to-hit military fortifications.

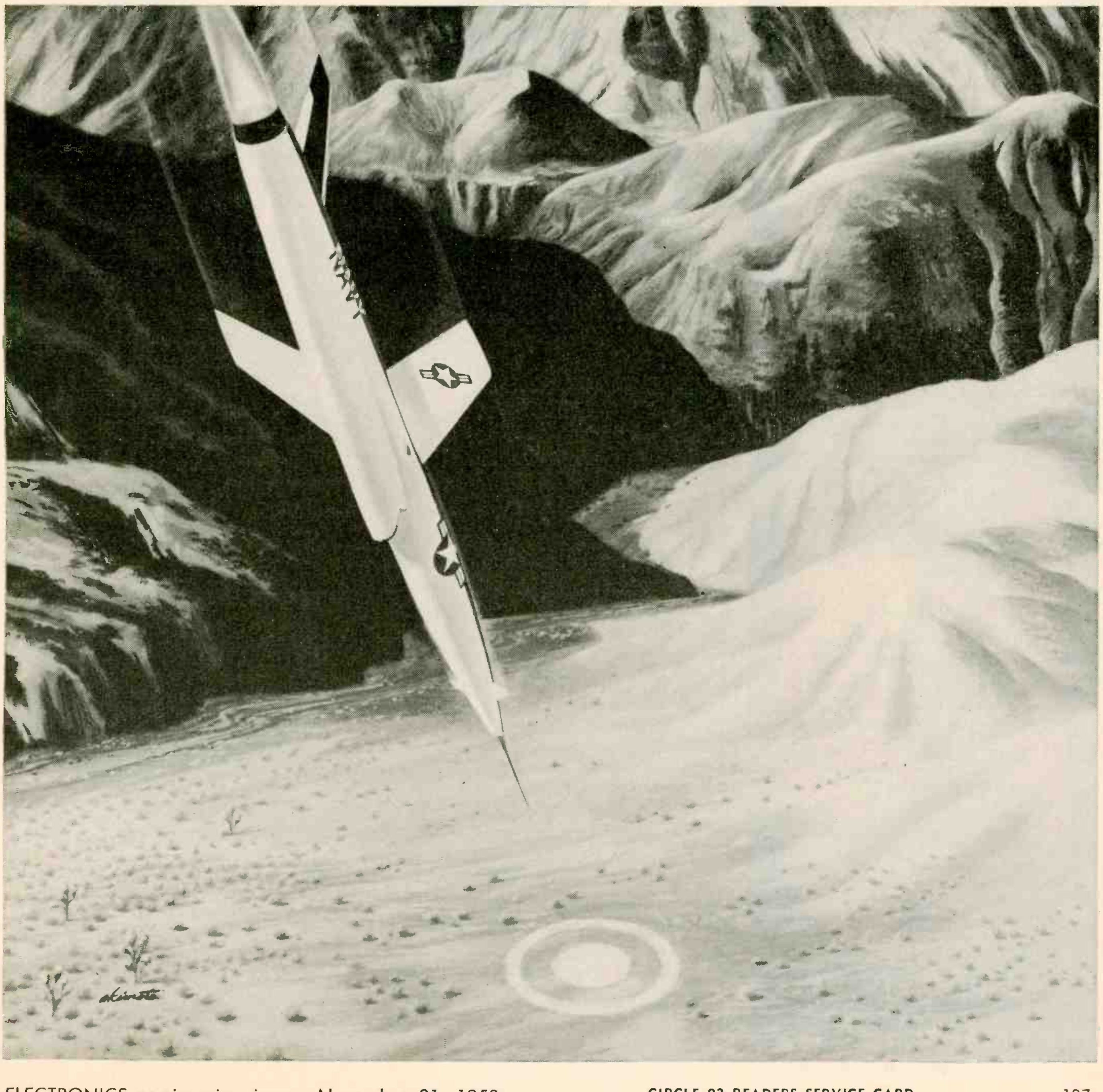
Chance Vought's *Regulus II* provides the extra margin of accuracy that enables the Navy to zero in on such "small" – and deadly – strongholds as H-bomb storehouses, submarine pens, ballistic missile bases.

The instant *Regulus II* launches, its advanced guidance system takes control . . . constantly compensating, correcting . . . keeping this Mach 2 missile on target to the instant of impact.

In production now, *Regulus II* provides double deterrence: the power to help forestall nuclear war – pinpoint accuracy to deter localized trouble.

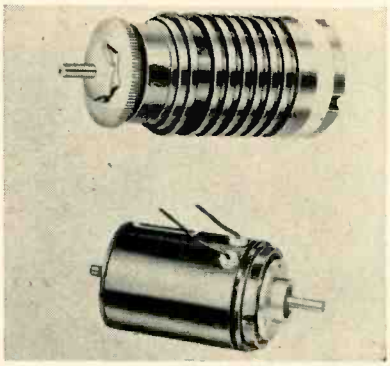
Scientists and engineers: pioneer with Vought in new missile, manned aircraft, and electronics programs. For details on select openings write to: C. A. Besio, Supervisor, Engineering Personnel, Dept. R-12.

CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS



CIRCLE 93 READERS SERVICE CARD

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 sub-multiple-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, 14½ 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

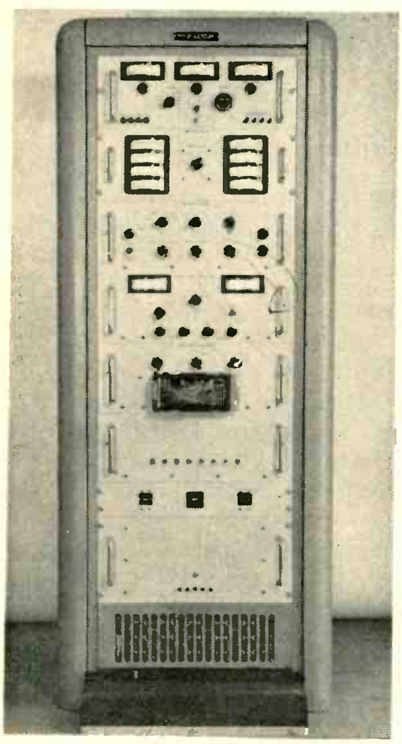
SOUTHWESTERN INDUSTRIAL ELECTRONICS CO., 2831 Post Oak Road, Houston 19, Texas. The new model R-2 a-c/d-c voltmeter measures a-c (10 cps to 1mc) and d-c (+ or −) voltages from 1 mv to 1,000 v in 14 ranges, and resistances from 10 ohms to 10 megohms midscale in 7 ranges. It is accurate within 2 percent 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

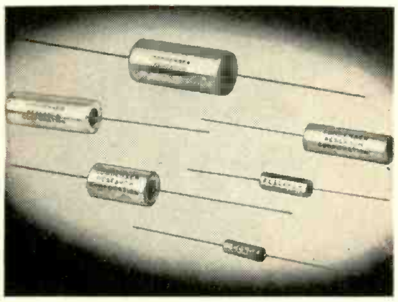
APPLIED SCIENCE CORP. OF PRINCETON, P. O. Box 44, Princeton, N. J. New telemetry decommutation equipment that can handle sampling rates from 24 to 3,600 pps in both pulse amplitude (pam) and pulse width (pwm) coding is now in production. The new equipment is a more compact and flexible version of the 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.**

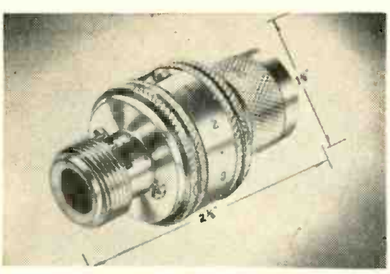
Diffusion Pump high capacity

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.**



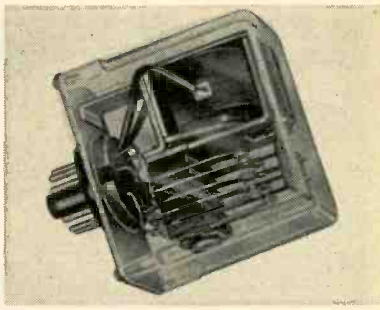
Capacitors tubular-type

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.**



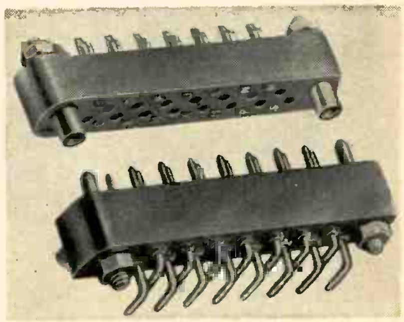
Double-Stub Tuner radial design

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.**

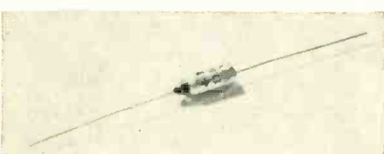


P-C Connectors reliable devices

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.**

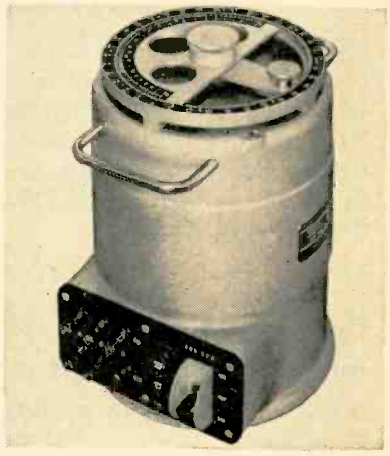


Tantalum Capacitors extended ratings

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

 CIRCLE 99 READERS SERVICE CARD

of specification MIL-C-3965 B. **Circle 319 on Reader Service Card.**



Phase Shifter
400-cycle unit

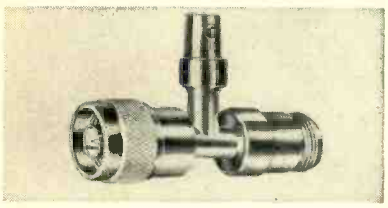
KNOPP INC., 1307 66th St., Oakland 8, Calif. Type Q-4 phase shifter provides any phase shift from 90 deg leading to 90 deg lagging in the testing of electronic equipment and their control circuits, watthour meters, rotating standards, wattmeters, power-factor indicators, induction relays, and instrument 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.**



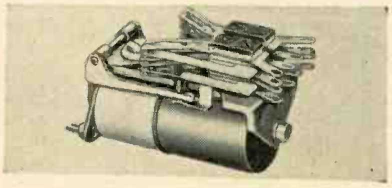
Helix Monitor Tees used with twt's

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

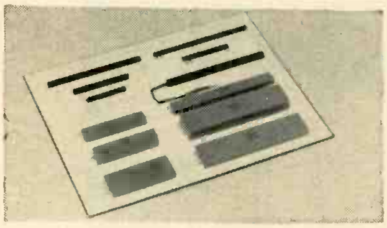
OHMITE MFG. CO., 3695 Howard St., Skokie, Ill. Series 77 metal film resistors are now smaller yet offer higher maximum resistance than the previous models. Resistance range is now 25 ohms to 400 K ohms. Standard tolerance is ±1 percent but tolerances as low as 0.1 percent can be furnished. A lower standard 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.



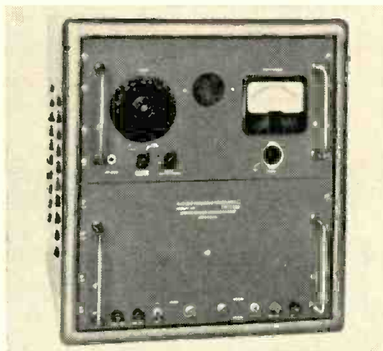
Time Delay Relay telephone type

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.



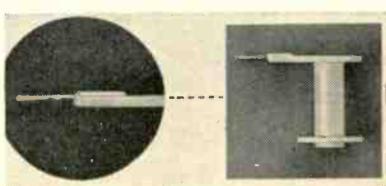
Delay Lines three new types

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.

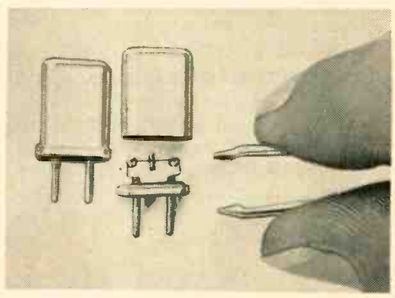


Soldering Terminals for Nylon bobbins

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.

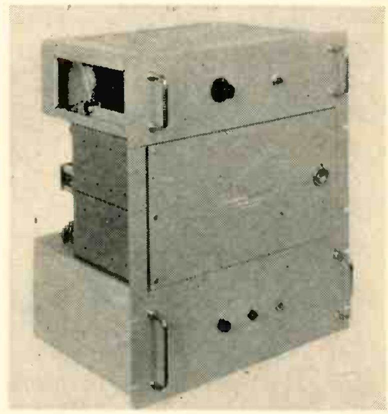
A new subminiature crystal is packaged in the military case, HC18/u, with the crystal wafer suspended between the two terminals. The crystals are operative from 300 kc to 125 mc and their use in frequency control and filter applications results in simplification of manufacture and great reduction in 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, push-button, 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.**



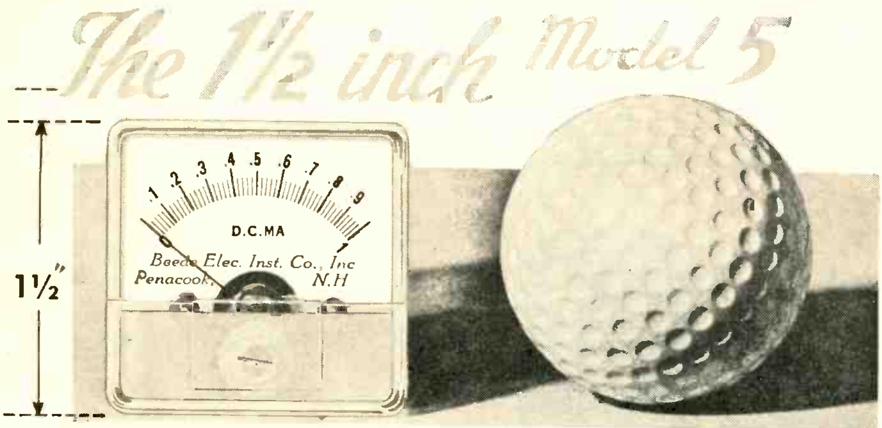
Core Buffer Memory high reliability

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



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

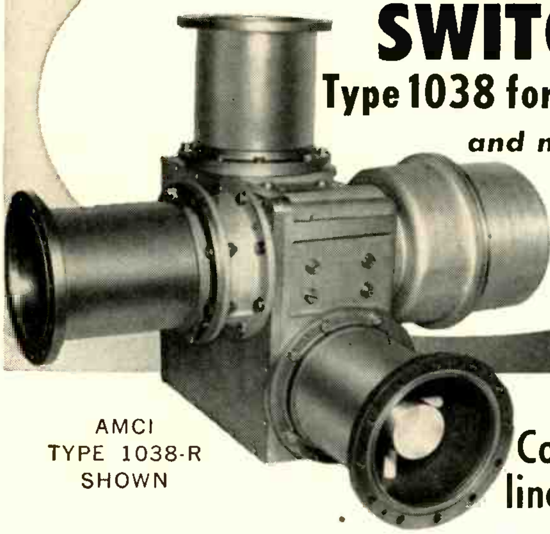
CIRCLE 209 READERS SERVICE CARD

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

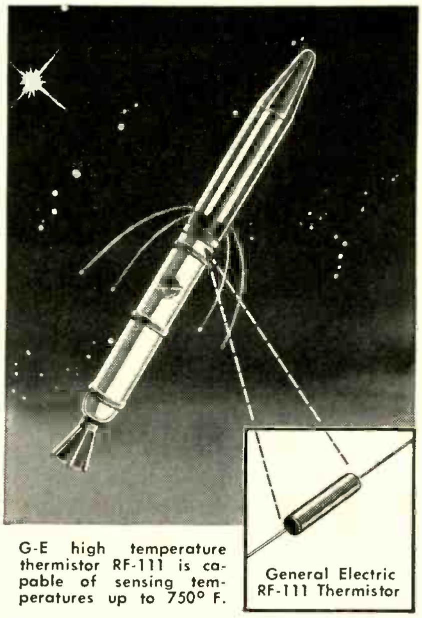
- VSWR is under 1.05 over rated frequency range: 0-450 mc for the Type 1038 6⅛" Coaxial Switch; 0-500 mc for the Type 1136 3⅛" Coaxial Switch.
- CW rating is approximately that of the mating transmission lines.
- Switches are available in either motor-driven or manually operated models.

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

THERMISTOR



G-E high temperature thermistor RF-111 is capable of sensing temperatures up to 750° F.

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

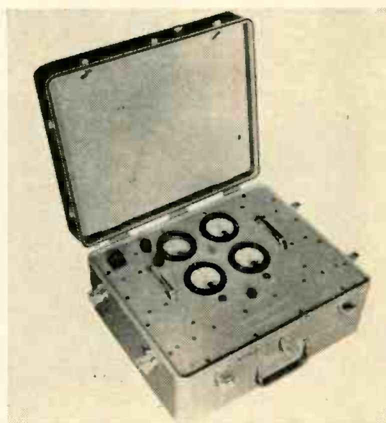
GENERAL ELECTRIC

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.**

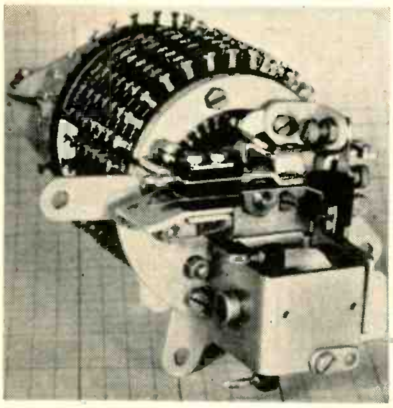
Connectors snap-in contacts

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

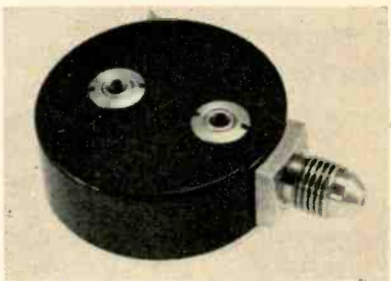
REON RESISTOR CORP., 117 Stanley Ave., Yonkers, N. Y., has developed a new method of terminating the resistance wire of precision wire wound resistors that is claimed to be far superior to the old methods. Using a pure silver base, a casting is made around the termination that bonds to both the wire 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

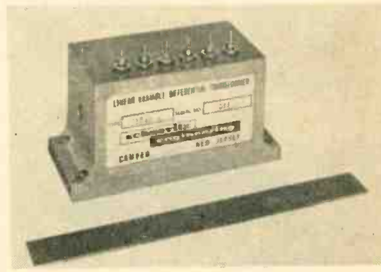
HANSON-GORRILL-BRIAN, INC., 85 Hazel St., Glen Cove, N. Y. Newly packaged thyratron grid circuit eliminates costly circuit development when using thyratrons for industrial controllers. The Thyra-Pulse will smoothly control thyratrons of all types and sizes. Control input can be a variable resistance 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. Oper-

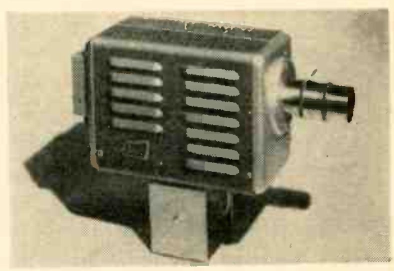
CIRCLE 215 READERS SERVICE CARD

ated 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.

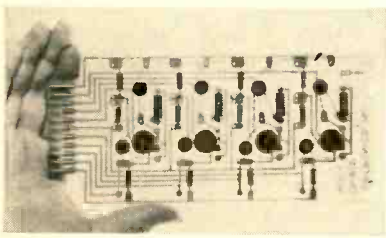


TV Camera automatic unit

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.

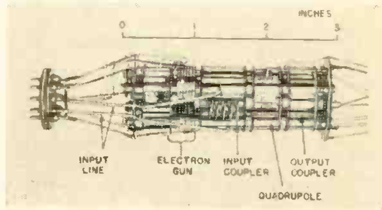


Power Pulser transistorized

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 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.

QUALITY is not an accident

It cannot be copied.

It is not attained over night.

Quality is built into E-A Recorders by specialists—workmen whose livelihood depends upon quality and who have spent their lives making just this one product.

For over 50 years, E-A has made the best for those who want only the best in recorders.

Product Representatives in Most Principal Cities

Ask for Catalog 657

The ESTERLINE-ANGUS Company, Inc.

Pioneers in the Manufacture of Graphic Instruments

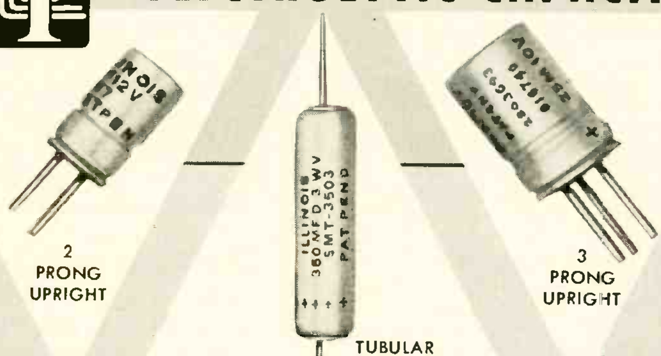
Dept E. , P. O. Box 596, INDIANAPOLIS 6, INDIANA

CIRCLE 220 READERS SERVICE CARD

ILLINOIS SUB-MINIATURE

ELECTROLYTIC CAPACITORS

Time Tested Quality



2 PRONG UPRIGHT

TUBULAR

3 PRONG UPRIGHT

Here is a complete line of sub-miniature electrolytics which are especially desirable for low voltage D.C. circuits.

Advantages include: patented construction; hermetically-sealed; immersion proof; excellent life characteristics; low leakage currents; shock and vibration-resistant; plus many others.

Available in tubular and upright types, as illustrated, ILLINOIS SUB-MINIATURE CONDENSERS are ideal for applications requiring minimum size and weight.

Write for new, illustrated SMT catalog.

ILLINOIS CONDENSER COMPANY

Telephone: EVerglade 4-1300

1616 N. Throop Street Chicago 22, Illinois

CIRCLE 221 READERS SERVICE CARD

WIDE SPECTRUM

CRYSTAL CONTROLLED FREQ. CALIBRATOR

50 mcs to 11,000 mcs

an accurate, secondary frequency standard for CALIBRATING AND TESTING

MICROWAVE RECEIVERS*

*The Model 121 can also be used as a quick means of determining sensitivity of receivers in the field.

RADAR SYSTEMS

NAVIGATIONAL BEACONS & AIDS

SIGNAL GENERATORS

RF PRE-SELECTORS AND FILTERS

FORMS THE BASIS OF A MICROWAVE, CRYSTAL CONTROLLED LOCAL OSCILLATOR.

WIDE FREQUENCY RANGE:
Covers entire spectrum from 50 mc to 11,000 mc without the use of tuning controls.

EASE OF OPERATION:
A flick of the switch delivers the full spectrum. A switch provides a choice of 50 mc or 100 mc spacing. The amplitudes of the marker signals are adjusted by an output level control.

ACCURATE:
(±) 0.005% at any frequency, unaffected by temperature or input power variations.

COMPACT; RUGGED; LIGHT WEIGHT:
Built to the same specifications as its Military equivalent of Test Set AN/USM-45.

WANTED: Sales Reps. — Key areas open. Contact E. Wendolkowski, Pres.

CONTROL ELECTRONICS CO., INC.

10 Stepar Place

Huntington Station, New York

CIRCLE 222 READERS 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.

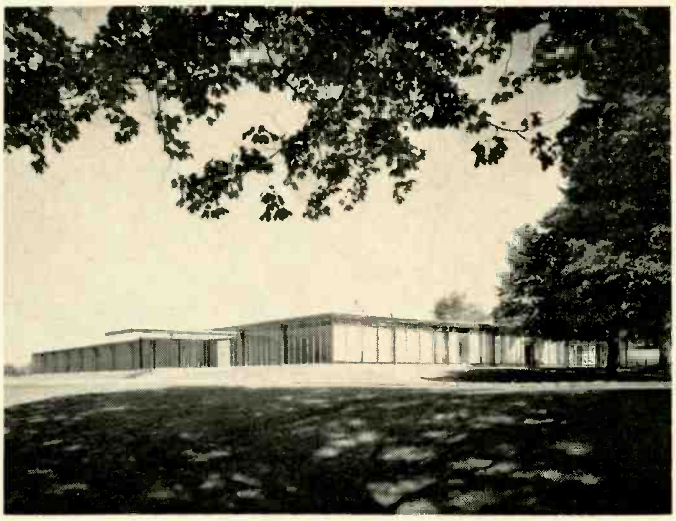
Gyro Test Equipment. Sterling Precision Corp., 17 Matinecock Ave., Port Washington, N. Y. An 8-page folder illustrates and describes the company's electronic gyro test equipment modular components. Circle 383 on Reader Service Card.

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 Teck-nit 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.

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.

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.

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.

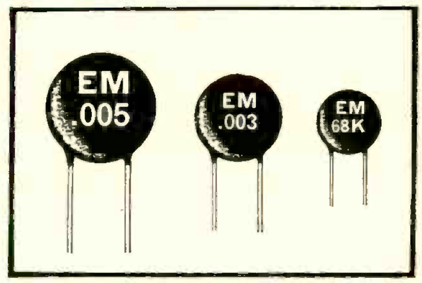
In his new post, Long will direct all activities of the division which designs and manufactures sensing devices used in dynamic and static remember your...

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 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.

Write for Bulletin on Ceramic Discs

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.

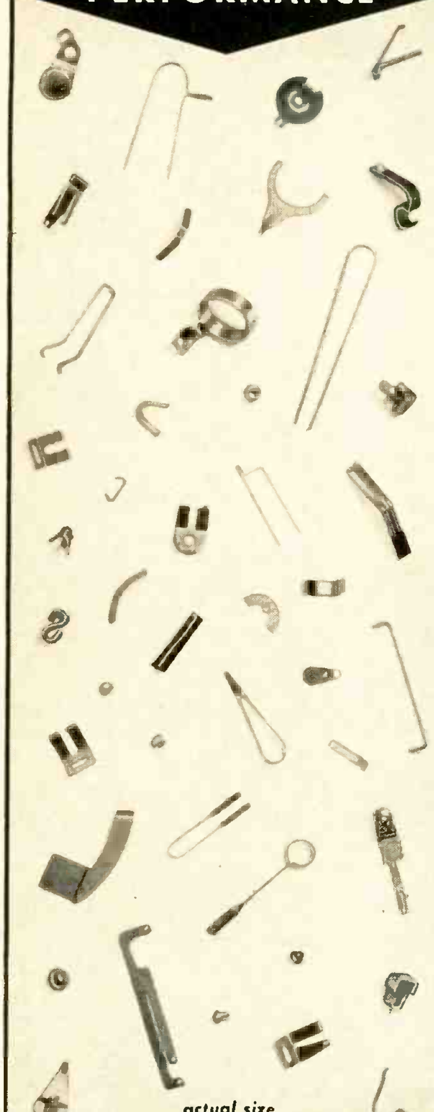
Motion and Time Study. By R. M. Barnes, John Wiley & Sons, Inc., New York, 1958, 665 p, $9.25. This fourth edition has five new chapters dealing with motion study, mechanization, automation, mechanized time study, electronic data processing, motion-time data systems, work sampling, multifactor wage incentive 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

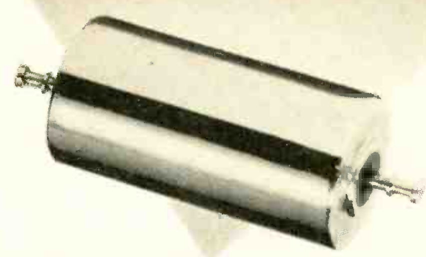
Sales Offices: New York
Chicago • Los Angeles • Attleboro

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.

Bliley

BLILEY ELECTRIC COMPANY
UNION STATION BUILDING • ERIE, PENNSYLVANIA

CIRCLE 241 READERS SERVICE CARD

RIBBONS · STRIPS

—of—

★ PURE TUNGSTEN ★ THORIATED TUNGSTEN
★ MOLYBDENUM ★ SPECIAL ALLOYS

and OTHER METALS
IN

ULTRA THIN SIZES

to

TOLERANCES CLOSER THAN COMMERCIAL STANDARDS
by

OUR SPECIAL ROLLING TECHNIQUE

Note: for highly engineered applications—strips of TUNGSTEN and some other metals can be supplied

ROLLED DOWN TO .0003 THICKNESS

- Finish: Roll Finish—Black or Cleaned
- Ribbons may be supplied in Mg. weights if required

For HIGHLY ENGINEERED APPLICATIONS

DEVELOPED AND MANUFACTURED BY

H.CROSS CO.

15 BEEKMAN ST., N. Y. 38, N. Y.
TELEPHONE WOrth 2-2044
COrtlandt 7-0470

CIRCLE 242 READERS SERVICE CARD

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 ¾ watt and ½ 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 ¾ of one unit or ½ 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.

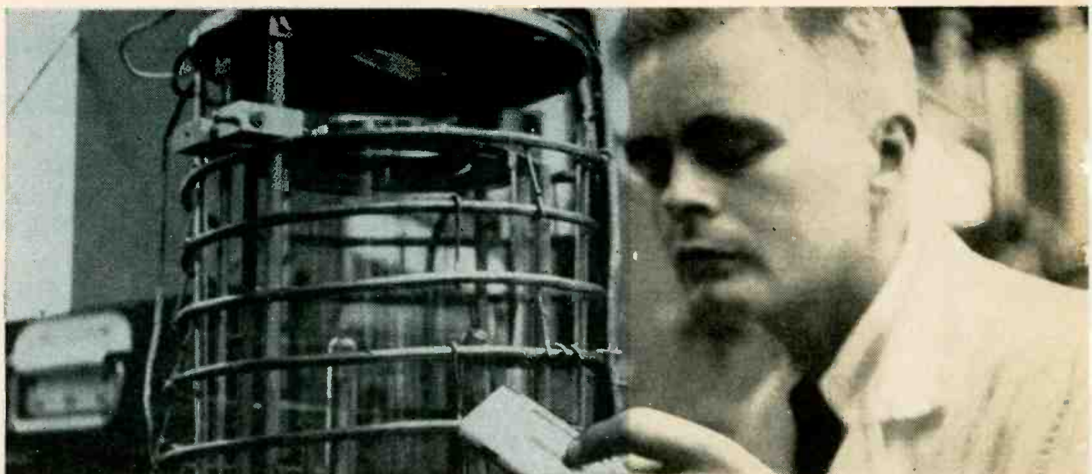
ELIZABETH KELLY
UNIVERSITY OF ILLINOIS
URBANA, ILL.

IBM KINGSTON

. . . probing electronic frontiers
for tomorrow's break-throughs

Research into uses of magnetic thin-film components in advanced electronic equipment is typical of the many exciting creative opportunities now available at IBM Kingston. IBM research teams are also investigating other problems, such as: The use of magnetic materials in liquid-helium memory systems . . . and the evolution of new fabrication methods based on vacuum deposition techniques. This is a fine opportunity to satisfy unfulfilled ambitions to do really original work among creative, constantly inquiring minds.

IBM, a recognized leader in the electronic computer field, offers a stable balance of military and commercial work. You will find ground-floor opportunities for professional achievement at IBM Kingston. Liberal company benefits set standards for industry today, and salaries are commensurate with your abilities and experience. Kingston, N. Y., is a pleasant Hudson River valley community. It combines country living with easy proximity to New York and other metropolitan areas.



ASSIGNMENTS
open in these development areas:

- **Cryogenics**
- **Digital Computer Design and Programming**
- **Guidance and Detection System Analysis**
- **Magnetic Devices**
- **Optical Systems for Data Presentation**
- **Solid-State Physics**

There are other openings in related fields to broaden your skills and knowledge.

QUALIFICATIONS: B.S., M.S., or Ph.D. Degrees in Electrical Engineering, Physics, Mathematics or related disciplines. Industrial experience is desirable.

Write, outlining qualifications and experience, to:

Mr. D. H. Hammers, Dept. 554Y
IBM Corporation
Military Products Division
Kingston, N. Y.

IBM MILITARY PRODUCTS

Plants and laboratories: Endicott, Kingston, Owego, Poughkeepsie, Yorktown, N. Y.; Lexington, Ky.; Rochester, Minn.; San Jose, Calif.; Burlington, Vt.

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.

WRITE, outlining qualifications and experience, to:

Mr. P. E. Strohm, Dept. 554Y
Military Products Division
IBM Corporation, Owego, N. Y.

IBM® MILITARY PRODUCTS DIVISION

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.

Salary commensurate with ability.

In addition to other advantages Republic offers a comprehensive benefit program among the finest in industry.

Send Resume in Confidence to
Mr. W. Walsh
Employment Office

REPUBLIC AVIATION

Farmingdale, Long Island, N. Y.

ELECTRONIC ENGINEERS

Research & Development

Move ahead with a young, rapidly expanding organization in Hicksville, LI, N. Y.

PROJECT ENGINEERS
SENIOR ENGINEERS
ENGINEERS

B.S. in E.E. or Physics

We need at once for lifetime careers—additional trained personnel, at all levels, experienced in circuitry and equipment design or applicable exp to work on UHF & VHF systems, wide band knowledge desirable; for challenging assignments on electronic countermeasure systems for military application and electronic instruments for civilian use.

Salaries commensurate with ability. Excellent benefits including Profit Sharing Retirement Trust Plan.

INSTRUMENTS ifi FOR INDUSTRY

Call for interview
J. V. Hicks
OVerbrook 1-7100
or send resume in confidence to

INSTRUMENTS FOR INDUSTRY, INC.

101 New South Rd. Hicksville, LI, N. Y.

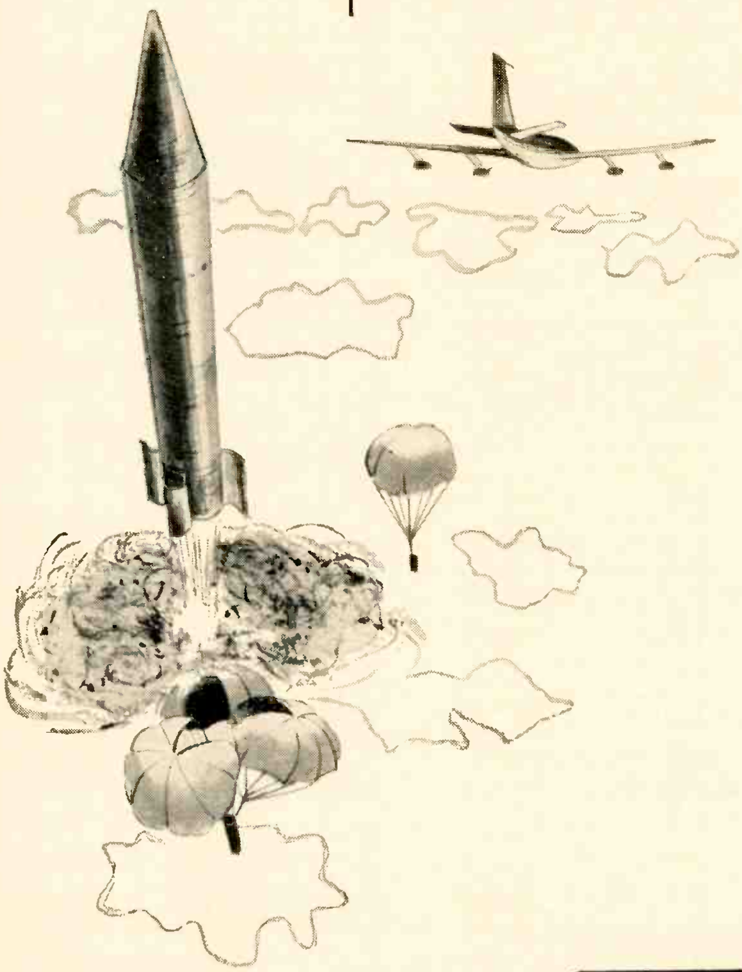
HAVE SENSORS . . . WILL TRAVEL

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

FOR ADDITIONAL INFORMATION

About Classified Advertising

Contact

The McGraw-Hill Office Nearest You

ATLANTA, 3
1301 Rhodes-Haverty Bldg.
JAckson 3-6951
M. H. MILLER

BOSTON, 16
350 Park Square
HUbbard 2-7160
D. J. CASSIDY

CHICAGO, 11
520 No. Michigan Ave.
MOhawk 4-5800
W. J. HIGGENS
D. C. JACKMAN

CLEVELAND, 13
1164 Illuminating Bldg.
SUperior 1-7000
W. B. SULLIVAN
F. X. ROBERTS

DALLAS, 1
1712 Commerce St.,
Vaughn Bldg.
RIverside 7-5117
GORDON JONES
F. E. HOLLAND

DETROIT, 26
856 Penobscot Bldg.
WOodward 2-1793
D. M. WATSON

LOS ANGELES, 17
1125 W. 6 St.
HUntley 2-5450
R. L. YOCOM

NEW YORK, 63
500 Fifth Ave.
OXford 5-5959
D. T. COSTER
R. P. LAWLESS

PHILADELPHIA, 3
Six Penn Center Plaza
LOcust 8-4330
T. W. McCLURE
H. W. BOZARTH

ST. LOUIS, 8
3615 Olive St.
JEfferson 5-4867

SAN FRANCISCO, 4
68 Post St.
DOuglas 2-4600
R. C. ALCORN

ELECTRONIC ENGINEERS

Heath Company, a Division of Daystrom, Inc., has challenging opportunities in a progressive engineering program. Immediate openings for Project Engineers to design and develop new products in Amateur Radio and Marine equipment lines. B.S.E.E. in Electronics or the equivalent in practical experience. Knowledge of SSB and transistors desirable. Should have amateur license. Send complete resume to D. J. McNamara, Personnel Manager.

HEATH COMPANY

Benton Harbor, Michigan

DISENCHANTED ENGINEERS

If your present employer has failed to utilize your full potential, why not permit us to explore the parameters for your personal qualifications with the many dynamic young companies in aviation, electronics, missiles and rockets. We now have in excess of 4,000 openings in the $8,000 to $40,000 bracket, all of which are fee paid. Why wait? Send resume in duplicate at once to:—

FIDELITY PERSONNEL

1218 Chestnut Street, Philadelphia 7, Pa.

YOUR BEST TALENTS

Are they used in your present position? Is your salary right? Do you have proper recognition?—If not, our services can help you to relocate in a choice position. S.E.E. (a non-profit organization) serves growth companies throughout the nation. We help them to find able professional men who really want to get ahead.

Send resume for appraisal & full information.

SCIENTISTS, ENGINEERS & EXECUTIVES, INC.

1026 Seventeenth Street, N. W., Washington 6, D. C.

SPACE TECHNOLOGY

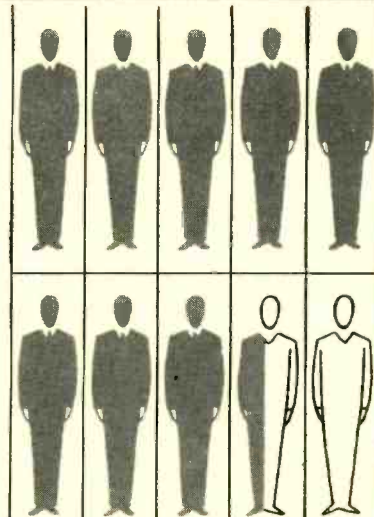
SALARIES TO $20,000.00 PER YEAR

EE-S or Physicists to work in the following areas—Gaseous Phenomena, Plasmas, Re entry Plasmas, Theological Dynamics. Materials → Pyograthite. Niobates, etc. Space systems—passive and active sattelite communications. Our company clients will assume all employment expense.

MONARCH PERSONNEL

28 East Jackson Blvd., Chicago 4, Illinois

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:

- *Pioneering Nature of the Work in Diversified Electronic Areas*
- *Small R & D Groups Fostering Individual Accomplishment*
- *Close Contact With Management*
- *Flexibility of Assignments*
- *30-Year Company History of Achievement in Precision Electronics*

If this partial description of the professional environment at Norden Laboratories appeals to you, look into these immediate openings on a variety of advanced projects at both White Plains, New York and Stamford, Connecticut locations:

TELEVISION & PASSIVE DETECTION • TV Display Circuitry • TV Camera Circuit Design • TV Transistor Circuitry
Also openings for recent EE grads

RADAR & COMMUNICATIONS *Design & Development openings in the following areas:* Antennas • Microwave Systems • Microwave Components • Receivers • Transmitter Modulators • Displays • Pulse Circuitry (VT & Transistors) • AMTI • Data Transmission • ECM

DIGITAL • Digital (Senior) Design: Logical, Circuit, Magnetic Storage

QUALITY ASSURANCE • Reliability Analysis • Standards • Environmental Test

ENGINEERING DESIGN • Electronic Packaging

STABILIZATION & NAVIGATION • Stabilization Servos • Amplifiers & Electronics

FUTURE PROGRAMS • PROPOSAL ENGINEER (SENIOR) — Diversified systems experience (TV, Radar, Electronics) Excellent advancement opportunity • SENIOR ENGINEER — Cost development for R&D proposals. Require broad technical experience in electromechanical & electronic systems

PROJECT ENGINEERING • SENIOR ENGINEERS — engineering program management. Handle project from customer contact through technical & component phase of program

SYSTEMS ENGINEERING • Synthesis, Analysis & Integration of Electronics & Electromechanical Systems. Require broad experience analytical work & systems component integration

- *Descriptive Brochure Available Upon Request*

After-hour interviews arranged at your convenience.

Send resume in confidence to: **TECHNICAL EMPLOYMENT MANAGER**

NORDEN LABORATORIES

NORDEN DIVISION — UNITED AIRCRAFT CORP.

121 Westmoreland Avenue • White Plains, New York

White Plains, New York | Stamford, Connecticut

HIGH LEVEL TECHNICAL EXECUTIVE

An expanding industrial organization with annual sales of electronic, electrical and precision mechanical devices exceeding $50,000,000 seeks to strengthen its central management group by addition of a resourceful Electric Engineer or Physicist combining high technical competence with broad industrial experience. Working at the top level of the Company, this man will play a key role in the continuing expansion of the Company's activities in the consumer, industrial and scientific fields.

His ability and personality must command the respect of highly qualified directors of present and future operating divisions.

He must have the vision and critical judgment to contribute forcefully to expansion plans involving either acquisitions or new products arising from a research and development program of long tradition and exceptional depth.

Some traveling in this country will be required in addition to European visits for evaluation of know-how available to our Company.

Our organization knows of this advertisement

Please reply, in confidence, to

Box 339B, 300 West 43 St., New York 36, N. Y.

PHYSICISTS — CHEMISTS

We are offering important opportunities as project leaders in applied research in semiconductors and electron tubes. If you have had several years experience in either of these fields and know you are ready to tackle a responsible position with people who place as much emphasis on initiative as ability, write or call D. Bellat, Personal Director, for appointment.

TUNG-SOL ELECTRIC INC.

200 Bloomfield Ave., *Pilgrim 8-8700* Bloomfield, N. J.

New McGRAW-HILL *Books*

NONLINEAR CONTROL SYSTEMS

Just Published—Gives practical guidance and theory essential to analysis, testing, and design of modern control systems. Treats such subjects as describing function (effective gain), determining response, systems excited by random input signals, application of switching circuits, etc. By **R. L. Cosgriff**, The Ohio State U. **328 pp., 205 charts, tables and illus., $9.00.**

APPLIED MATHEMATICS for ENGINEERS and PHYSICISTS

2nd Edition Just Published—Provides you with the principal mathematical techniques needed to analyze mathematical problems that arise in practice and to understand important current technical papers. Carefully revised to include essential, up-to-date material. 2nd Ed. By **L. A. Pipes**, U. of California, L. A. **723 pp., illus., $8.75.**

TABLE for the SOLUTION of CUBIC EQUATIONS

Just Published—Supersedes all other such tables in number of decimal places, range, interval, required labor in finding all three roots, and convenience in use. With this book you can obtain all three roots of any equation using nothing more complicated than a desk calculator. By **H. E. Salzer** and **C. H. Richards**, Convair Astronautics; and **I. Arsham**, Diamond Ordnance Fuze Laboratories. **176 pp., $7.50.**

ELECTRONIC SEMICONDUCTORS

Just Published—A useful introduction to semiconductor physics as related to rectifier and transistor problems. Precisely defined basic concepts lead to the physics of crystal amplifiers, imperfection equilibria, and boundary layers in semiconductors. By **E. Spenke**. Translated by **D. Jenny, H. Kroemer, E. G. Ramberg,** and **A. H. Sommer**, RCA Labs, Princeton, N. J. **430 pp., 163 illus., $11.00.**

An Introduction to the Theory of RANDOM SIGNALS and NOISE

Just Published—Takes up step by step the theory of probability and statistics essential to random signals and noises. Discusses applications in such areas as shot noise generated in thermionic vacuum tubes, space-charge-limited tubes, noise in amplifiers, radar, etc. By **W. B. Davenport, Jr.** and **W. L. Root**, both of M.I.T. **393 pp., 69 charts, graphs, and tables, $10.00.**

10 DAYS' FREE EXAMINATION

McGraw-Hill Book Co., Dept. L-11-21
327 W. 41st St., New York 36, N. Y.

Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep, plus few cents for delivery costs, and return unwanted book(s) postpaid. (We pay delivery costs if you remit with this coupon—same return privilege.)

- ☐ Cosgriff—Nonlinear Control Systems, $9.00
- ☐ Pipes—App. Math. for Eng. & Phys., $8.75
- ☐ Salzer, Richards & Arsham—Table for the Solution of Cubic Equations, $7.50
- ☐ Spenke—Electronic Semiconductors, $11.00
- ☐ Davenport & Root—Random Signals & Noise, $10.00

(PRINT)
Name ....

Address ....

City .... Zone .... State..........

Company ....

Position ....

For price and terms outside U.S. write McGraw-Hill Int'l., N.Y.C. L-11-21

Foreign Employment
ELECTRONICS TECHNICIAN

Minimum 5 years practical experience maintaining and installing standard commercial communications equipment. Emphasis on V.H.F. fixed and mobile radio transmitters and receivers, both broad band and narrow band. Some experience desirable with carrier equipment, HF mobile equipment, HF fixed stations transmitters and receivers, and television equipment. For work in Saudia Arabia.

Salary to $830. per month, according to ability. Liberal benefits provided.

Write outlining personal history and work experience. Please include telephone number.

Recruiting Supervisor, Box 297

ARABIAN AMERICAN
OIL COMPANY

505 PARK AVENUE
NEW YORK 22, NEW YORK

ELECTRONIC ENGINEER

Manufacturer of automatic controls located in northwest suburb of Chicago is seeking a young man age 30 to 40, with college degree in Electronics or Electrical Engineering plus 6 to 8 years experience in design and development in the electronic field, with special emphasis on control systems or servomechanisms.

Exceptional opportunity for one desiring responsibility for an electronic development program now in its infant stage.

This is an AAA-1 company with modern facilities and complete employee benefits.

Give full information concerning education, experience, personal data and salary.

P-9274, ELECTRONICS
520 N. Michigan Ave.
Chicago 11, Ill.

RATES . . . .
"Employment Opportunities"

Displayed—The advertising inch is $28.67 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

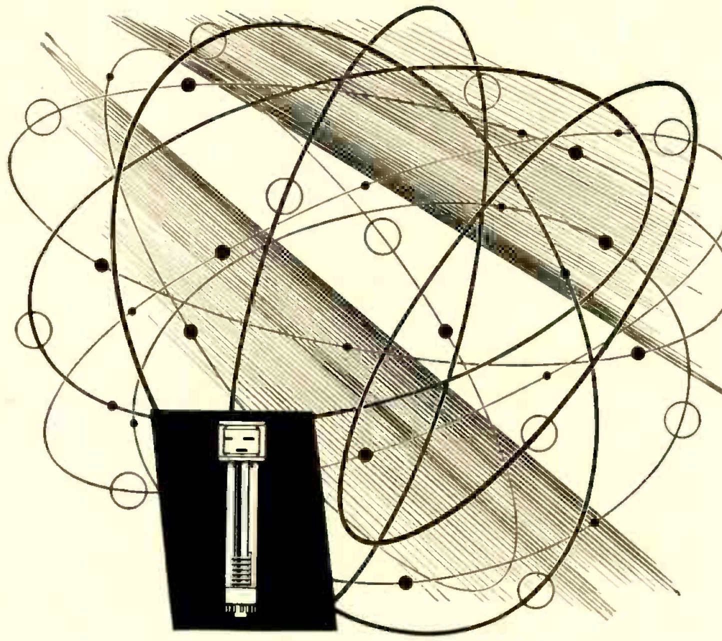
An advertising inch is measured 7/8" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

Undisplayed—$2.40 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions. Not subject to Agency Commission.

Send NEW ADS to ELECTRONICS, Class. Adv. Div., P. O. Box 12, New York 36, N. Y.



RCA PHOTOELECTRONICS

beams a whole new light on your engineering future

As RCA photosensitive devices work new and ever more amazing wonders with light . . . further dark corners in science and technology loom ahead awaiting exploration by RCA engineers. *Yours* could be one of the many engrossing careers to be built in RCA tube design, development and application.

Electrical Engineers—For Design, Development, and Application of electron tubes. Special emphasis on tube fabrication processes and circuitry. B.S., M.S. or Ph.D. degree.

Physicists—Specialists in fields of solid-state (high-temperature phenomena, photosensitive materials, glass technology), instrumental analysis, radioactive tracing techniques and electron optics. B.S., M.S. or Ph.D. degree.

Lancaster . . . Ideal Career Location—You'll find in growth-minded Lancaster all of a college town's unique cultural advantages. Philadelphia is only two hours away. There's a real satisfaction in the professional atmosphere of RCA's modern Lancaster plant . . . plus planned advancement, liberal benefits, tuition refunds for advanced study. RCA pays interview and relocation expenses.

To arrange confidential interview, contact: Mr. E. F. Stevens, Manager, Employment, Radio Corporation of America, New Holland Pike, Lancaster, Penna., Attention Dept. **G-12L.** Or phone: EXpress 3-3661.

EQUAL JOB For All Qualified Applicants OPPORTUNITY

Tomorrow is here today at RCA

RADIO CORPORATION of AMERICA
ELECTRON TUBE DIVISION PLANT
LANCASTER, PA.

CAREER OPPORTUNITIES

ARC

Navigation Systems

Communication Systems

Servos

Transistors

Transmitters

Receivers

Antennas

With a company making premium grade electronic equipment for aircraft for over 30 years. Located in the beautiful lake region of Northern New Jersey, less than 35 miles from New York City.

- **Transistor Circuit Engineer**
- **Tacan Engineers**
- **Receiver Engineers**
- **Transmitter Engineers (VHF & UHF Frequencies)**
- **Navigation Equipment Engineers**
- **Antenna Design Engineer**
- **Technical Writers**

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

AIRCRAFT RADIO CORPORATION

Boonton, N. J. DE 4-1800—Ext. 238

ENGINEERS

If several years of practical experience have given you the youthful maturity that requires more than just a job, it may be to your advantage to investigate the career opportunities with our company.

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.**

SEARCHLIGHT SECTION

400 CYCLE GENERATOR-1 PHASE POWER

For Your Test Bench

Leland—2 K.W.—17.4 amps. 115 Volts—400 Cy.—1 PH. —Ball Bearing Construction.

Spark Gap Modulator — by Raytheon — Type CRP — 10249. Welded steel mounting base. 43" L. x 18" W.

Also, Same Generator Mounted on Base with—

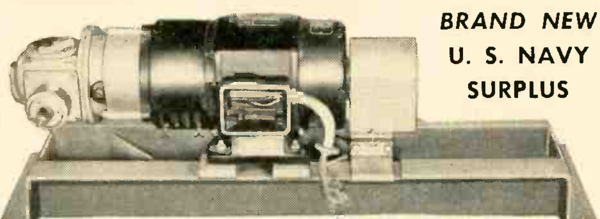
3 H.P. Motor 60 Cy. 1 Ph. . $295.
3 H.P. Motor 60 Cy. 3 Ph. . $289.
3 H.P. Motor 110 V.D.C. . . $275.

F.O.B. Chicago

Free! Big New Catalog. Write

BRAND NEW

U. S. NAVY SURPLUS



SHIP WT. 400 LBS. NOW ONLY 189^{50} F.O.B. CHGO.

GROBAN SUPPLY CO.

1139-S. Wabash Ave., Chicago 5, Ill.

SEARCHLIGHT SECTION
(Classified Advertising)

EMPLOYMENT • BUSINESS
EQUIPMENT — USED OR RESALE

OPPORTUNITIES

—RATES—

DISPLAYED

Individual Spaces with border rules for prominent display of advertisements.

The advertising rate is $24.75 per inch for all advertising other than Employment.

Employment Opportunities—$28.67 per inch, subject to Agency Commission.

An advertising inch is measured ⅞" vertically on one column. 3 columns—30 inches—to a page.

UNDISPLAYED

$2.40 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.

Positions Wanted take one-half of above rate.

Box Numbers in care of our New York, Chicago & San Francisco offices count as one additional line.

Discount of 10% if full payment is made in advance for 4 consecutive insertions.

TELETYPE EQUIPMENT

Model 14 send-receive Typing Reperforators, Model 15 & 19 Printers, Transmitter Distributors, Keyboards Model 15, Rectifiers RA 11, 30, 87. Tables Model 14, 19 and portable No. 36, Maintenance Kits ME 86 and numerous others.

SUPLEX LAMPS LTD.

239 High Holborn
London W. C. 1, England

lab grade TEST EQUIPMENT for sale

standard brands—military surplus
(new or professionally reconditioned)
experienced problem solvers and budget-cutters

ENGINEERING ASSOCIATES

434 Patterson Road. Dayton 19, Ohio

Money saving prices on tubes. TV, Radio, Transmitting, and Industrial Types. New, 1st quality, guaranteed. Top name brands only. Government surplus and commercial test, lab, and communications equipment in stock. Sell us your excess tubes and equipment. Unused, clean tubes of all types wanted. Send specific details in first letter. Write for "Green Sheet" catalog 25¢.

BARRY ELECTRONICS CORP.

512 Broadway WA 5-7000 New York 12, N. Y.

THERMO-ELECTRONICS

Successor to Thermo-Electricity

Change heat to electricity DIRECTLY—no acids, liquids, moving parts or sunlight! Build a THERMO-ELECTRONIC battery. Mail quarter today for information and sample thermo-electronic alloy.

HERMON E. COTTER

15766-X Blackstone Detroit 23, Mich.

R/388's, R/390's, 51J's

COMMUNICATIONS RECEIVERS
PURCHASED, SOLD, AND SERVICED

GIZMOS & SUCH

STILL RIVER, MASSACHUSETTS

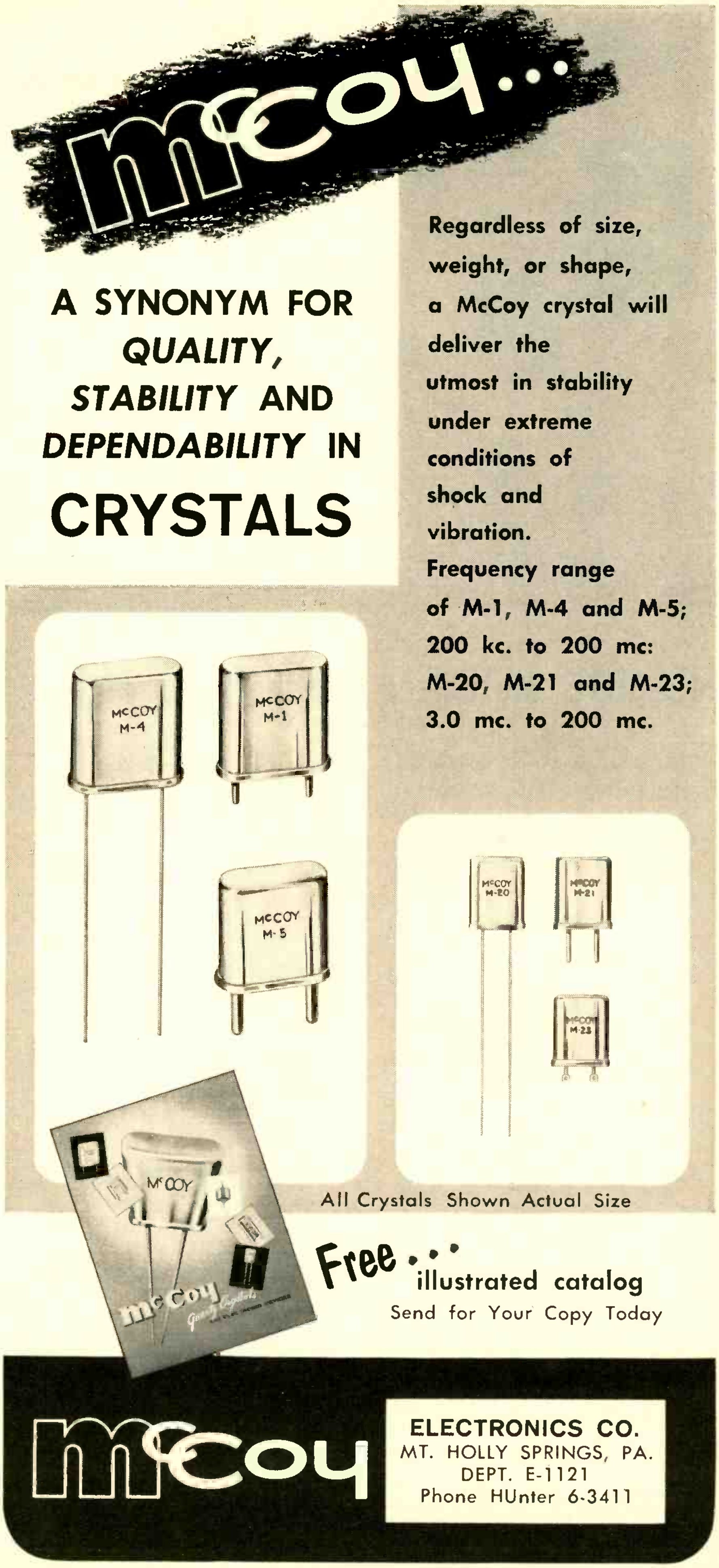
SPECIAL SERVICE

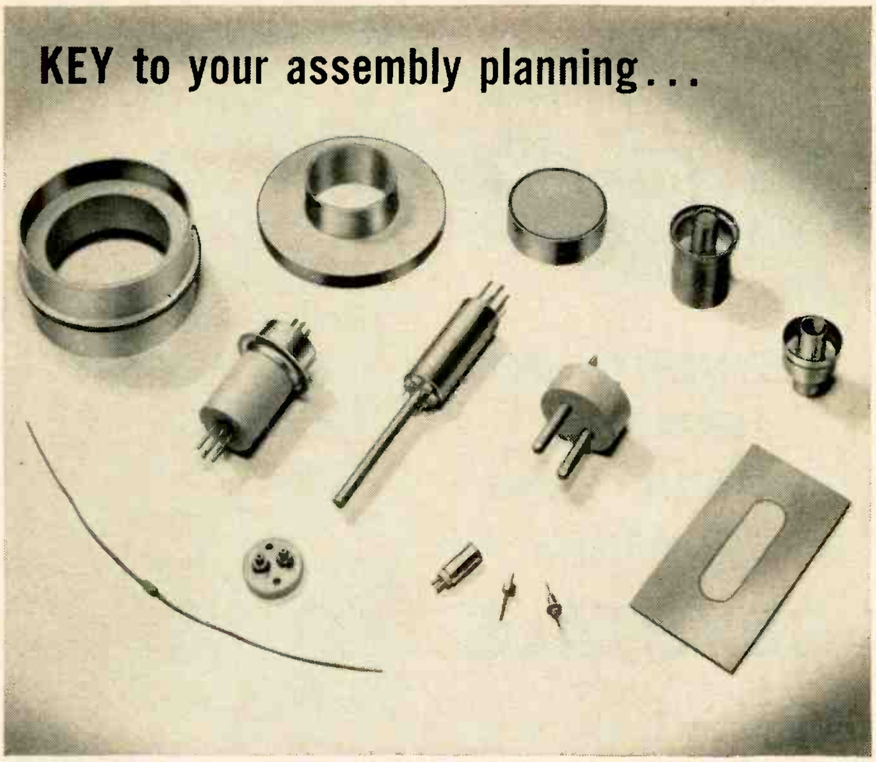
Engineers, Designers, Inventors. Be listed in "Who's Who In Design And Invention". Cyclopedia Co., Box 656, Poughkeepsie, N. Y.

INDEX TO ADVERTISERS

*See advertisement in the 1958-1959 *ELECTRONICS* BUYERS' GUIDE for complete line of products or services.

*See advertisement in the 1958-1959 *ELECTRONICS* BUYERS' GUIDE for complete line of products or services.





MOLCOTE® Metallized Coating for Ceramics

Now is a good time to get acquainted with MOLCOTE in your assembly planning. A metallized coating firmly bonded to ceramic, MOLCOTE presents a surface to which a metal part or other metallized ceramic parts may be soldered or brazed easily, quickly . . . effectively.

MOLCOTE is ideal for a wide variety of assembly applications. For example, it

. . . can be used effectively with copper brazing.

. . . can be immersed in a wide variety of molten brazing alloys for extended periods of time.

. . . permits excellent dimensional control.

. . . offers high bond strength.

MOLCOTE surfaces are supplied ready for use for soldering and brazing applications in any temperature range up to 2000° F. MOLCOTE bonds are exceptionally strong with a tensile strength exceeding 10,000 psi.

Frenchtown Engineering Bulletin 1155 contains complete details and data on MOLCOTE Metallized Coating for Ceramics. We'd be pleased to send you a copy for use in your assembly planning. A good time to write for it is *NOW*.

frenchtown PORCELAIN COMPANY

FRENCHTOWN, NEW JERSEY

■

CLASSIFIED ADVERTISING

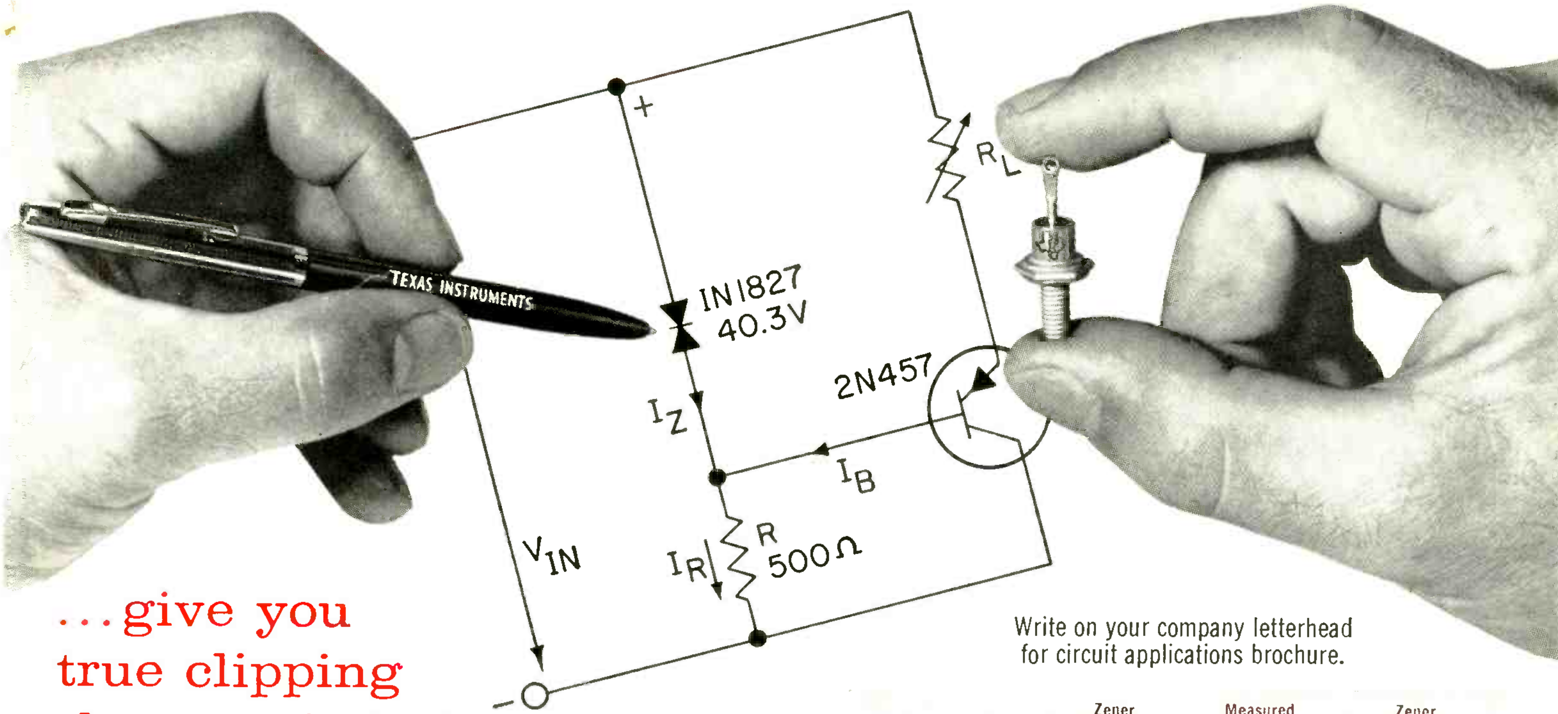
F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

*See advertisement in the 1958-1959 *ELECTRONICS* BUYERS' GUIDE for complete line of products or services.

This index is published as a service. Every care is taken to make it accurate, but ELECTRONICS assumes no responsibilities for errors or omissions.

NEW 10W VOLTAGE REGULATORS FROM TEXAS INSTRUMENTS



...give you true clipping characteristics!

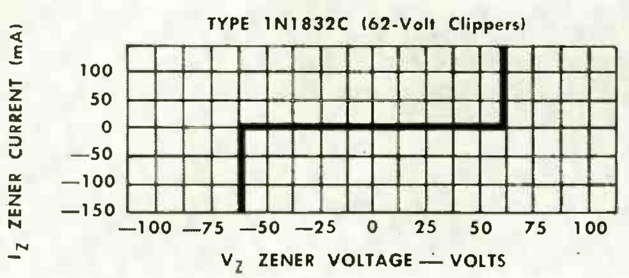
Write on your company letterhead for circuit applications brochure.

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.

WORLD'S LARGEST SEMICONDUCTOR PLANT

TEXAS INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
POST OFFICE BOX 312 · 13500 N. CENTRAL EXPRESSWAY
DALLAS, TEXAS

Announcing new

RCA SILICON RECTIFIERS

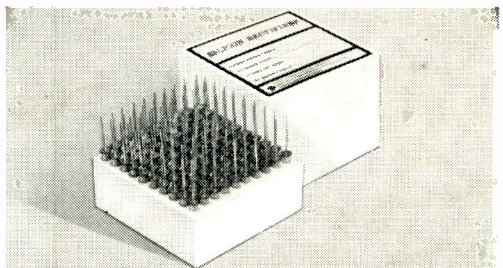
RCA is now in mass production of silicon rectifiers of the diffused-junction type for use in electronic applications. The two types now available are the initial units of a broad line intended for power supplies of entertainment, industrial, and military equipment.

These RCA Silicon Rectifiers Offer You:

- Low Cost—specifically priced for entertainment applications.
- Electrical Uniformity—precision controlled diffusion process forms superior junctions.
- Welded Hermetic Seal—each unit individually pressure-tested to provide complete protection against moisture and contamination.
- Rugged Construction—industrial-type "top-hat" design with axial leads for soldering-in applications; may also be mounted in standard fuse clip.

TYPE	MAXIMUM RATINGS			* CHARACTERISTICS		APPLICATION
	Peak *Inverse Volts	RMS Supply Volts	DC Forward Ma	Max. Reverse Current at Indicated Peak Inverse Volts	Max. Instantaneous Forward Voltage at Indicated Instantaneous Forward Current	
1N1763	400	140	500	100 μa at 400 volts	3 volts at 15 amperes	Black-and-white TV, radios, phonographs and other electronic equipment operating direct from power line
1N1764	500	175	500	100 μa at 500 volts	3 volts at 15 amperes	Color TV, radios, phonographs and other electronic equipment operating from the power line through a step-up transformer

*At ambient temperature of 25°C



New RCA "100 Production Pack" saves time and motion. Package is specially designed for quick, convenient, operator handling. Saves inventory-control time; simplifies the "count".

For sales information, contact your RCA Field Representative at any of these offices:

EAST: 744 Broad Street, Newark, N. J., HUmboldt 5-3900

NORTHEAST: 64 "A" Street, Needham Heights 94, Mass., HIllcrest 4-7200

EAST CENTRAL: 714 New Center Bldg., Detroit 2, Mich., TRinity 5-5600

GOV'T: 224 N. Wilkinson St., Dayton, Ohio, BAldwin 6-2366; 1625 "K" St., N. W., Washington, D. C., District 7-1260

WEST: 6355 E. Washington Blvd., Los Angeles 22, Calif., RAymond 3-8361

CENTRAL: Suite 1154, Merchandise Mart Plaza, Chicago 54, Ill., WHitehall 4-2900

RCA Silicon Rectifiers are also available at your local authorized RCA Distributor!

New Designer's Data-Sheets Ready Now! Write RCA Commercial Engineering, Section L-19-NN-3, Somerville, New Jersey.

RADIO CORPORATION OF AMERICA
Semiconductor and Materials Division
Somerville, New Jersey