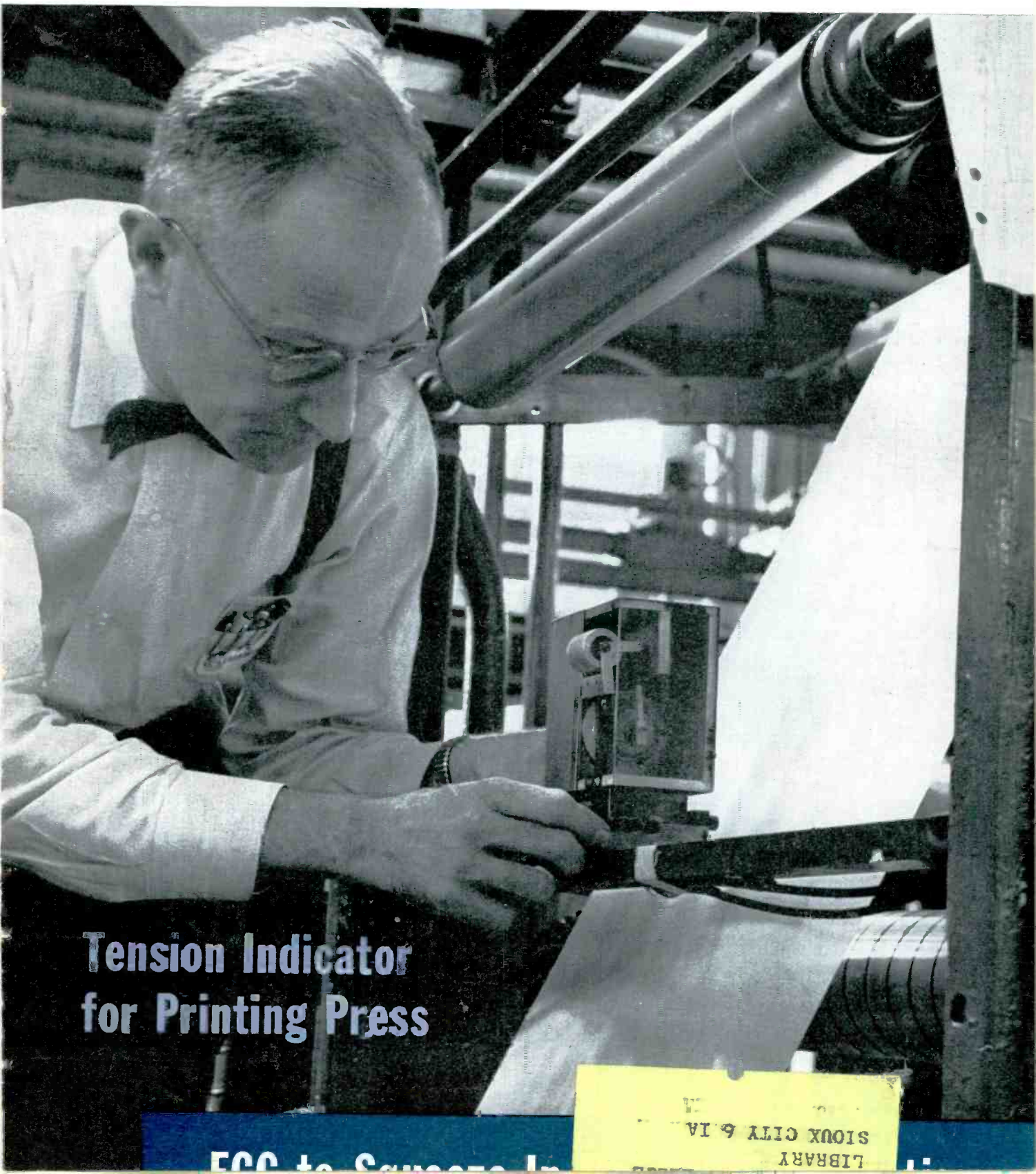
MAY 15, 1959

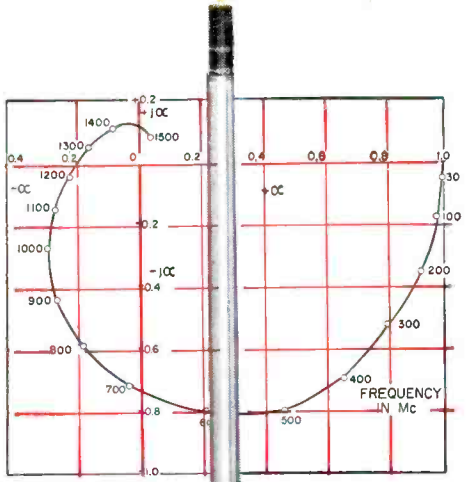
electronics

A McGRAW-HILL PUBLICATION VOL. 32, No. 20 PRICE SEVENTY-FIVE CENTS



Tension Indicator for Printing Press

AN IMPORTANT NEW VHF-UHF INSTRUMENT



Plot of Alpha versus frequency for an experimental high-frequency transistor . . . measured with the Type 1607-A.

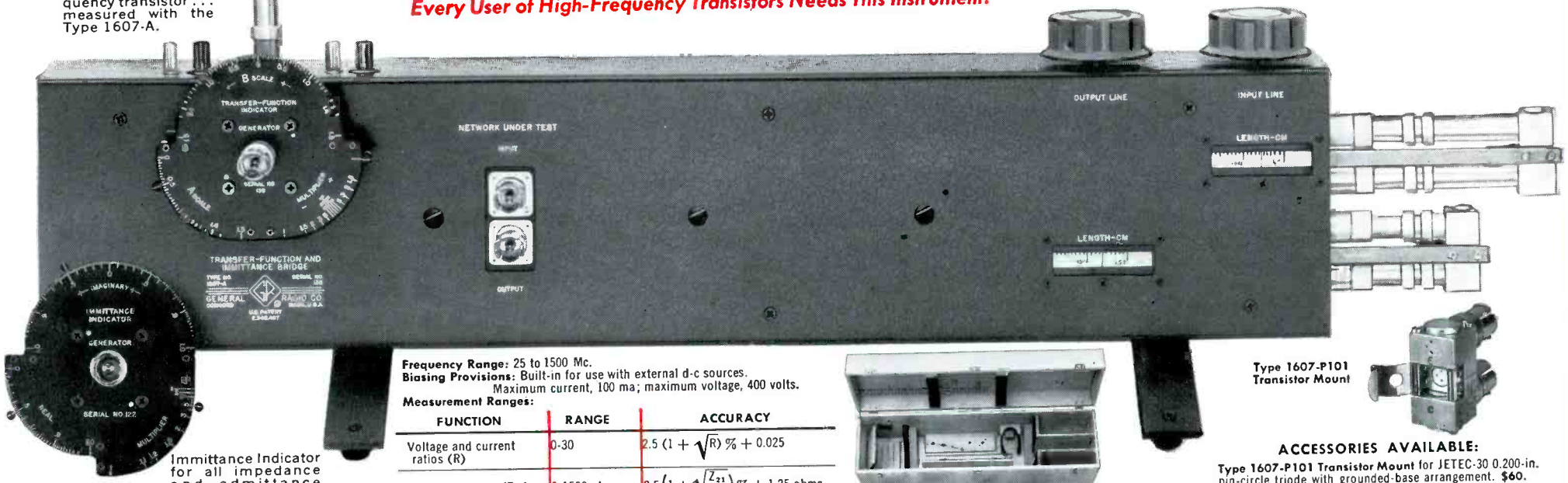
★ Measures Directly All Complex Impedance, Admittance, and Transfer-Functions of:

TRANSISTORS	VACUUM TUBES	THREE- AND FOUR-TERMINAL NETWORKS
α, β, h_f, h_r, h_i, h_o, r'_b, all short-circuit admittance and open-circuit impedance parameters.	Y_m (Y_{21}), Y_{12}, Y_{11}, Y_{22}, etc.	Z_{11}, Z_{22}, Z_{21}, Z_{12} Y_{11}, Y_{22}, Y_{21}, Y_{12} I_2/I_1, I_1/I_2, E_2/E_1, E_1/E_2

★ A Basic Tool for Measurement of: Gain and Phase Shift of Amplifiers, Transmission Circuits, and Other Active and Passive Four-Terminal Networks; Impedance, Admittance, Reflection Coefficient, and VSWR of Components, Coaxial Systems, and other Grounded or Ungrounded Elements.

★ Equally Suited for Advanced Laboratory Investigations and Rapid-Quantity Production Testing

Every User of High-Frequency Transistors Needs This Instrument.



Immittance Indicator for all impedance and admittance measurements.

Type 1607-A Transfer-Function and Immittance Bridge, $1665.

Frequency Range: 25 to 1500 Mc.
Biasing Provisions: Built-in for use with external d-c sources. Maximum current, 100 ma; maximum voltage, 400 volts.
Measurement Ranges:

FUNCTION	RANGE	ACCURACY
Voltage and current ratios (R)	0-30	$2.5\,(1+\sqrt{R})\,\% + 0.025$
Transimpedance (Z_{21})	0-1500 ohms	$2.5\left(1+\sqrt{\frac{Z_{21}}{50}}\right)\% + 1.25$ ohms
Transadmittance (Y_{21})	0-600 mmhos	$2.5\left(1+\sqrt{\frac{Y_{21}}{20}}\right)\% + 0.5$ mmho
Impedance (Z_{11})	0-1000 ohms	$2.0\left(1+\sqrt{\frac{Z_{11}}{50}}\right)\% + 1.0$ ohm
Admittance (Y_{11})	0-400 mmhos	$2.0\left(1+\sqrt{\frac{Y_{11}}{20}}\right)\% + 0.4$ mmho

ACCESSORIES SUPPLIED:

Frequency-Range Extension Unit; Two Calibrated Transfer-Function and Immittance Indicators; Terminations; Standards; 10-db Attenuator; Air Lines, Patch Cords, and other Coaxial Elements.

Type 1607-P101 Transistor Mount

ACCESSORIES AVAILABLE:

Type 1607-P101 Transistor Mount for JETEC-30 0.200-in. pin-circle triode with grounded-base arrangement. **$60.**

Type 1607-P102 Transistor Mount for JETEC-30 0.200-in. pin-circle triode with grounded-emitter arrangement. **$60.**

Type 1607-P201 Tube Mount, 7-pin miniature, grounded cathode for 6AF4, 6AF4A, 6AN4, 6T4, and other tubes with the same pin connections **$75.**

Other mounts for tetrodes, 0.100-in. pin-circle triodes, and ungrounded components are in development and will be announced soon.

Generator and Detector: G-R Unit Oscillators and Type DNT Detectors are recommended.

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electronics

MAY 15, 1959

Issue at a Glance

Business

Engineering

Departments

A McGRAW-HILL PUBLICATION
Vol. 32 No. 20

*Norman Allen is account supervisor, Mohr & Eicoff, Inc., advertising agency for Burnell & Co., Inc.

Norman Allen* takes the stand for electronics

One day last week in a discussion of engineering techniques with Norman Burnell, President of Burnell & Co., pioneer manufacturer of toroids, filters and related networks, I commented that the chain of production was no stronger than its weakest link. Mr. Burnell thought a moment and gave this highly meaningful reply. "I believe," he said, "you mean the chain of production is no stronger than its weakest *think*."

There's a lot of significance to that sentence when it comes to publications as well as people. It's one of the reasons why **electronics** has been on Burnell's advertising schedule since the company's inception—a schedule which today includes seventeen full pages.

I regard **electronics** as an indispensable medium of advertising—because it represents one of the strong 'thinks' in Burnell's production plans. Advertising in **electronics** informs industry of Burnell's product development, new designs, new circuit components, new production methods and advances in miniaturization. Moreover, **electronics'** advertising, news and feature columns have been an endless source of ideas and information. They help the Burnell engineering staff keep abreast of developments and anticipate the electronics industry's needs. In summing up, I'd say advertising in **electronics** has been of considerable help in establishing Burnell & Co. as a leader in the field of toroids, filters and related networks.

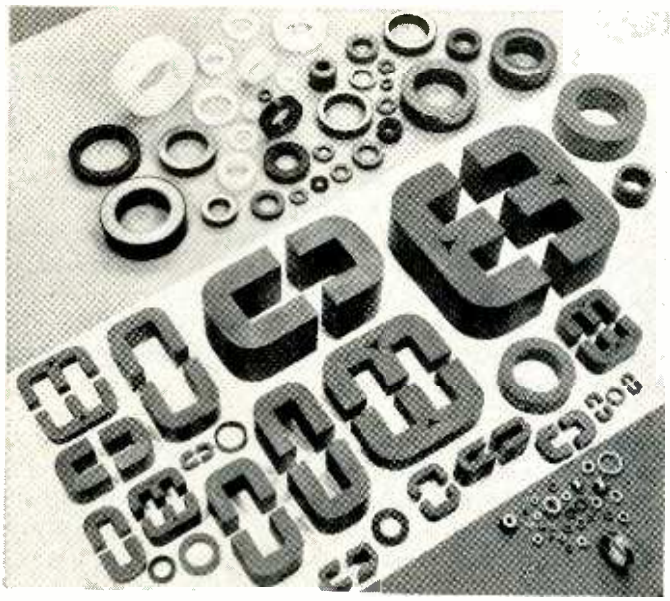
If it's about electronics, it's advertised and read in **electronics.**

electronics

Published WEEKLY plus the mid-year electronics BUYERS' GUIDE

A McGraw-Hill Publication • 330 West 42nd Street, New York 36, N. Y.

Specify "ARNOLD" for your MAGNETIC CORE requirements



Top to bottom: Tape wound cores, Silectron C, E and O cores, and bobbin cores.

Top to bottom: Mo-Permalloy powder cores, iron powder cores, and Sendust cores.

SILECTRON C-CORES, E-CORES and TOROIDS Arnold C and E cores are made from precision-rolled Silectron strip in 1, 2, 4 and 12 mil thicknesses.

They are supplied in a wide variety of shapes, and in sizes from a fraction of an ounce to several hundred pounds. In addition to standard transformer applications, they may also be supplied for special applications such as saturable reactors, instrument transformers and pulse transformers.

Over 1,000 stock cores are listed in the Arnold Silectron catalog. A wide selection of preferred sizes are carried in stock for immediate shipment. For complete data on C and E cores and Silectron toroids, *write for Bulletin SC-107A.*

TAPE WOUND CORES of High Permeability Materials Arnold tape wound cores are available made of Deltamax, 4-79 Mo-Permalloy, Supermalloy, Mumetal, 4750 Electrical Metal, Silectron, or the new rectangular-loop material, Supermendur. All except Supermendur cores are available in standard tape thicknesses of ½, 1, 2, 4 or 12-mils.

Toroidal cores are made in 30 standard sizes with protective nylon or aluminum cases. Special sizes of toroidal cores are produced to individual requirements. *Write for Bulletin TC-101A. (TC-113A for Supermendur Cores.)*

BOBBIN CORES Arnold bobbin cores are available in a wide range of sizes, tape thicknesses, widths and number of wraps to suit the ultimate use of the core in electronic computer assemblies. Magnetic materials usually employed are Deltamax and Square Permalloy in standard thicknesses of 1, ½, ¼ and ⅛ mil. Bobbins are supplied in ceramic or stainless steel. *Write for Bulletin TC-108A.*

MO-PERMALLOY POWDER CORES Available in a wide range of sizes, from .260" OD to 5.218" OD. They are given various types of enamel and varnish finishes, some of which permit winding with heavy Formex insulated wire without supplementary insulation over the core.

These powder cores are supplied in four standard permeabilities: 125, 60, 26 and 14 Mu. They provide constant permeability over a wide range of flux density, and in many cases may be furnished stabilized to provide essentially constant permeability over a specific temperature range. Large warehouse stocks of preferred sizes are carried for immediate shipment. *Write for Bulletin PC-104B.*

IRON POWDER CORES A wide selection of cores is available, from simple cylinders to special cores of complicated design. The line includes all standard types of threaded cores, cup, sleeve, slug and cylindrical insert cores: for use in antenna and RF coils, oscillator coils, IF coils, perm tuning, FM coils, television coils, noise filter coils, induction heating and bombarder coils, and other low frequency applications. Preferred sizes are carried in warehouse stock for quick shipment. A standard series of iron powder toroids is also manufactured, conforming to the standard sizes proposed by the Metal Powder Industries. *Write for Bulletin PC-109.*

SENDUST POWDER CORES Available in a wide selection of sizes, ranging from .800" OD to 3.346" OD, and in permeabilities of 10, 13, 25, 30, 50 and 80, although not all sizes are available in all permeabilities. They possess magnetic properties generally superior to iron powder cores, but inferior to Mo-Permalloy powder cores in the audio and carrier frequency range. *Write for Bulletin SDC-110.*

SPECIAL MATERIALS

2V PERMENDUR . . . a ferromagnetic alloy of cobalt, vanadium and iron that possesses high flux density saturation properties. Its magnetostrictive properties are useful in many transducer applications. *Write for Bulletin EM-23.*

VIBRALLOY . . . a ferromagnetic alloy of nickel, molybdenum and iron whose temperature coefficient of elastic modulus is controllable over a wide range. It has high ferromagnetic permeability, and a rather high coefficient of magnetostriction. Used in applications where a zero or controlled thermo-elastic coefficient is desired.

BARIUM TITANATE . . . A piezoelectric ceramic widely used in accelerometers, phono pickups, microphones, ultrasonic grinding and cleaning devices and underwater signaling devices. For more information, *write for Bulletin CM-116.*

WSW 7807

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electronics

May 15, 1959 Vol. 32, No. 20

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SHOPTALK . . . . editorial

MORE VHF TV. From Washington this week comes additional evidence that even the Federal Communications Commission may be despairing of ultrahigh-frequency television becoming a generally popular and profitable medium in the near future.

An exclusive story by McGraw-Hill's bureau in the nation's capital tells how the FCC hopes to squeeze vhf television stations together geographically. Also up the Commission's sleeve is a long-range plan to make some 25 to 50 vhf channels available rather than the present 12. The story appears on p 30.

The two dozen reporters and news analysts in our Washington bureau make up another plus for ELECTRONICS. Every week, they ferret out from Capitol Hill, the Pentagon, Supreme Court and dozens of other government rule makers and customers the top of the news as it affects the electronics industry. Our Washington office also contributes frequent business news feature articles and keeps tabs on the huge military electronics market.

SHADES OF AGINCOURT. We ran into something really new in weapons the other day reading Keith Sternerson's article on Transistor Circuits for Power-Line Carrier which appears on p 70, this issue. It's a solenoid-operated crossbow used to cause deliberate short circuits in high-voltage power lines. The crossbow is fired at a metal ring suspended from the line. A trailing fuse wire fastened to the arrow causes a momentary short circuit that checks out an electronic fault-locating system.

A solenoid-operated crossbow. Next, a servo-controlled ballista.

COMMUNITY COOPERATION. From the town pump of the nineteenth century to the volunteer fire department in today's suburbia, folks in America are always anxious to get together on a mutually helpful project.

Latest sign of this in the electronics industry is the private computer service bureau. It is a way that small companies can get the help of equipment that they are too small to buy or rent.

Until recently, most such service bureaus were maintained by manufacturers who used them largely to show what their equipment could do for prospective purchasers. Within the past three years, however, some groups have been able to purchase equipment, solve problems on a cash-and-carry basis, and make money.

Private service bureaus have some obstacles to overcome. Associate Editor Emma's findings after talks with manufacturers, users and the men who turn the knobs appear on p 39.

Coming In Our May 22 Issue . . .

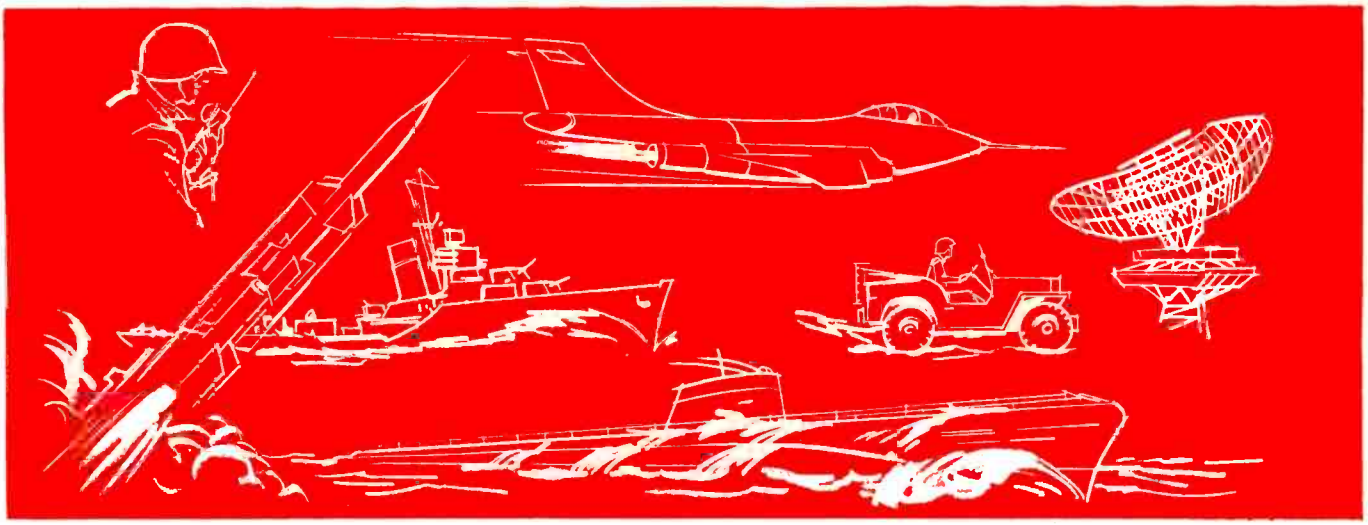
EUROPEAN DEVELOPMENTS. Much activity in European electronics firms is centered around transistorized radio receivers.

Next week, ELECTRONICS brings you a roundup of the latest developments in European receiver design, written by R. Shah of the Swiss Electrotechnical Institute in Zurich. You'll find his survey an interesting and informative report on the European approach to the many problems involved in design and broadcast, short-wave and vhf receivers using transistors.

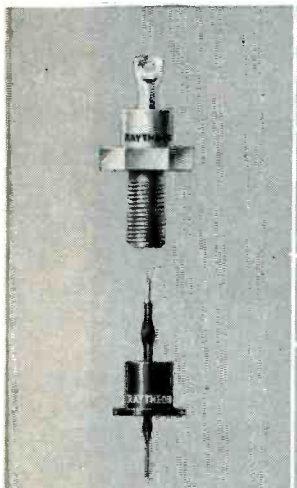
F-M MULTIPLEX. When station KSL-FM of Salt Lake City decided to add two subcarriers to their broadcast carrier for multiplexed service, the problem of piping the two channels to their transmitter atop 9,500-ft Coon's Peak sixteen miles away seemed insurmountable.

Dwight Harkins of Harkins Radio, in Phoenix, Arizona, describes how the studio-transmitter link was modified to solve the problem.

FOR MILITARY SERVICE



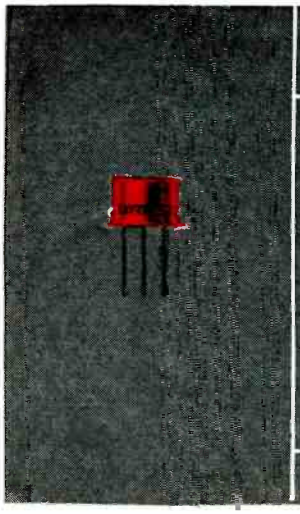
RAYTHEON SILICON Diffused Junction RECTIFIERS



Stud Type	Specification MIL-E-1/	Peak Operating Voltage −65°C to +135°C volts	Ave. Rectified Current 135°C Amps	Reverse Current (Max.) at 25°C μA at volts
JAN **1N253**	1024A	95	1.0	10 at 75
JAN **1N254**	989B	190	0.4	10 at 150
JAN **1N255**	990B	380	0.4	10 at 350
JAN **1N256**	991B	570	0.2	20 at 500

Wire in Type	Specification MIL-E-1/	Peak Operating Voltage −65°C to +165°C volts	Ave. Rectified Current 25°C mA	Ave. Rectified Current 150°C mA	Reverse Current (Max.) at 25°C μA at volts
JAN **1N538**	1084A	200	750	250	10 at 200
JAN **1N540**	1085A	400	750	250	10 at 400
JAN **1N547**	1083A	600	750	250	10 at 600

RAYTHEON PNP GERMANIUM TRANSISTORS



Type	Service	Specification MIL-T-19500/	V_{CE} max. volts	h_{fe}‡ ave.	f_{hfb} min. MC
USAF **2N404**	Computer	20 (JSAF)	−24*	30	12.0
U. S. Army **2N425**	Computer	41A (Sig. C.)	−30*	30	2.5
U. S. Army **2N426**	Computer	42A (Sig. C.)	−25*	40	3.0
U. S. Army **2N427**	Computer	43A (Sig. C.)	−20*	55	5.0
U. S. Army **2N428**	Computer	44A (Sig. C.)	−15*	80	10.0
U. S. Army **2N416**	R.F., G.P.	56A (Sig. C.)	−12	60	5.0
U. S. Army **2N417**	R.F., G.P.	57A (Sig. C.)	−12	80	15.0
U. S. Army **2N464**	Audio, G.P.	49B (Sig. C.)	−40	22	0.4
U. S. Army **2N465**	Audio, G.P.	50A (Sig. C.)	−40	45	0.5
U. S. Army **2N466**	Audio, G.P.	51A (Sig. C.)	−35	90	0.5
U. S. Army **2N467**	Audio, G.P.	52B (Sig. C.)	−35	180	0.6

*Min. Punch Through Voltage †I_B = 1mA, V_{CE} = 0.25V ‡I_E = 1mA, V_{CB} = 6V, f = 1000 cps.

All types available now in production quantities. Write for Data Sheets.

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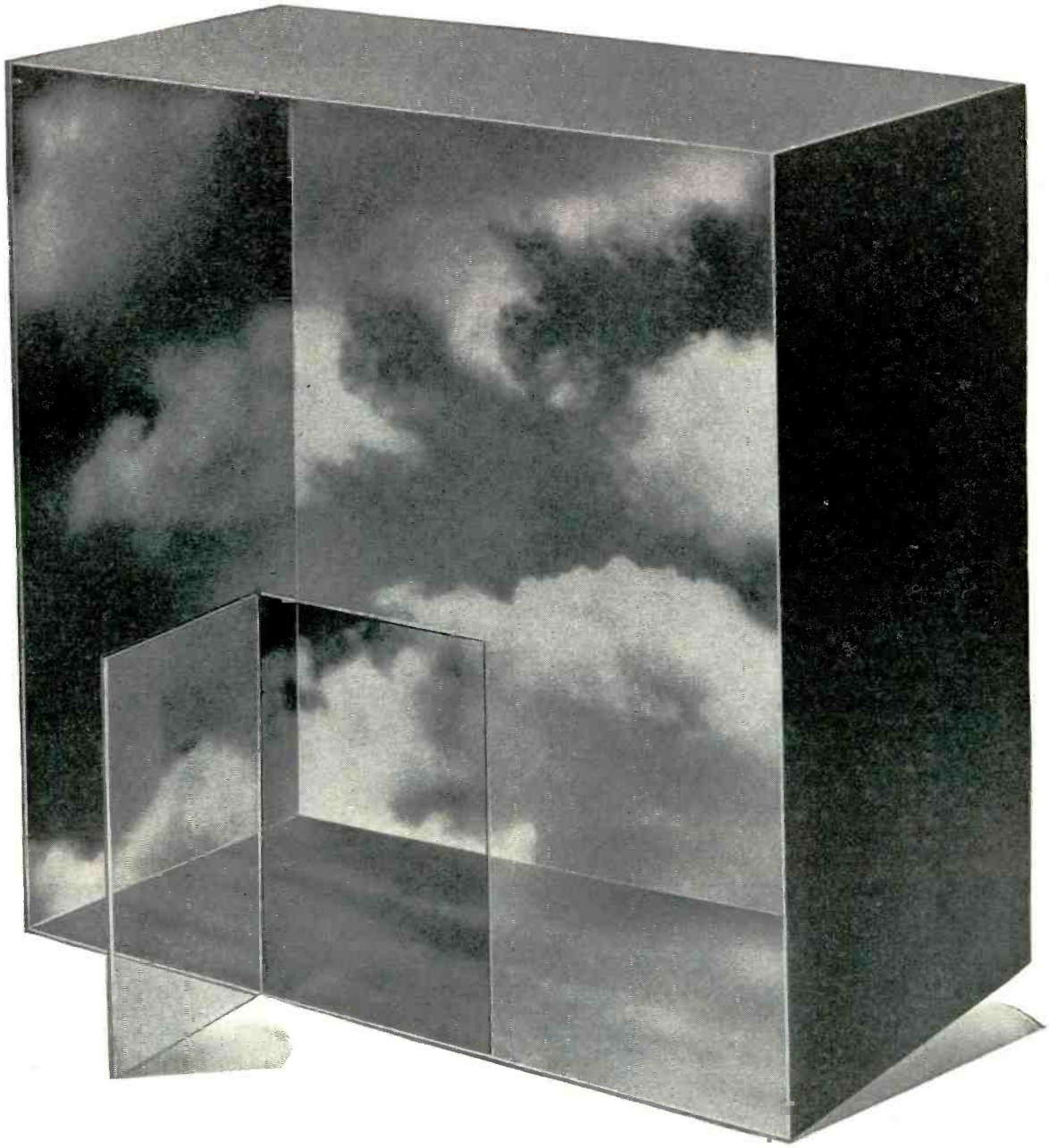

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AC-DC/DC Laboratory Standardizing Test Console. Accuracy — .05% of actual reading. Ranges — .5V. to 1111.5V. and 1 ma. (2 ma. on AC) to 11.115 amps. in decades of .1V. and 1 ma. Resolution — ±.01%. Frequency — DC to 25 kc. (minimum). General Description — The console combines an AC-DC thermal transfer standard and a DC calibrator with a .005% stable reference source, a high sensitivity galvanometer, and self contained power controls. Instrument certifications may be made directly in percentage error as well as in actual values.

Model LTC

Hand-drawn mirrored scales.
Temperature compensation.
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Shock-mounted sapphire jewels.
Diamond pivoted, of course!

Model LTD

DC Calibrator. Accuracy — .05% of actual reading. Ranges — .1V. to 1111 V. and 1 ma. to 11.11 amps. in decades of .1V. and .1 ma. Resolution — ±.01%. Combines a .005% stable reference source with two "differential" indicating instruments. A rapid calibrator that certifies instruments directly in percentage errors as well as in actual values.

Model RFVC

Radio Frequency "Self-Checking" Voltmeter Calibrator. Designed specifically for the accurate certification of VTVM's from DC to 10 megacycles. Accuracy — 3% of full scale. Frequency Influence — .2%. Type — AC/DC true RMS responding, thermocouple instrument. Ranges — .01 .1 1/3 V. Resolution — 100 and 150 divisions. 6.3" scale length. Checks its own accuracy against an internal standard source.

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Color-Correlated Controls.

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Simplified Display Control.

Internal Triggering for Sweep Delay.

Single-Knob Calibrator Control.

Improved One-Shot Sweep Operation in Types 535A and 545A.

HIGHER PERFORMANCE

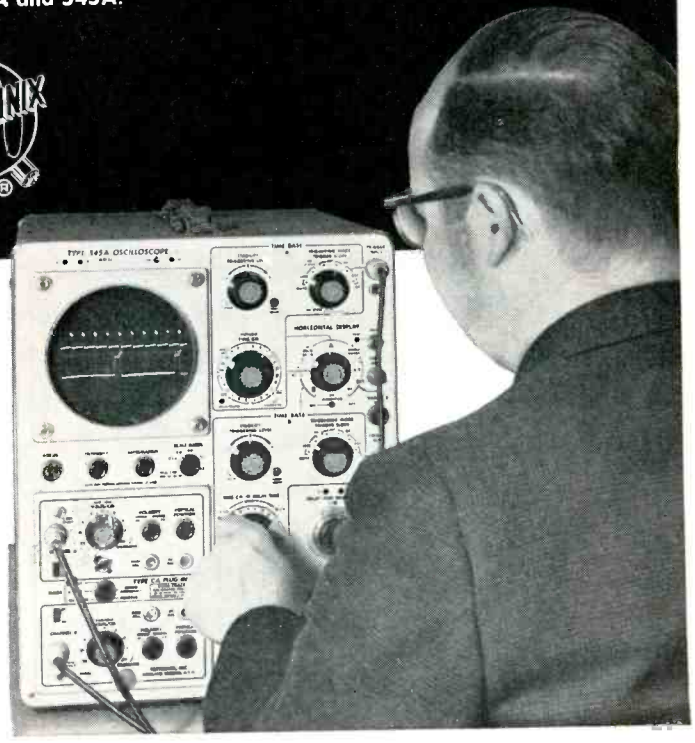
New DC-to-15 MC Vertical Amplifiers in Types 531A and 535A.

New Wider Sweep-Delay Range in Types 535A and 545A.

GREATER RELIABILITY

New Frame-Grid Twin Triodes Replace Older Types.

Silicon Rectifiers Replace Selenium in Power Supplies.



Type 545A Fast-Rise Oscilloscope with Sweep Delay

VERTICAL SPECIFICATIONS

DC-to-30 MC passband, 12-mμsec risetime, 50-mv/cm deflection factor with Type K Plug-In Preamplifier.

Many other plug-in units available for specialized applications.

Signal delay permits observation of leading edge of waveform that triggers the sweep.

HORIZONTAL SPECIFICATIONS

Two Time-Base Generators—

Time Base A—0.1 μsec/cm to 5 sec/cm in 24 calibrated steps.

Continuously adjustable from 0.1 μsec/cm to 12 sec/cm.

5x magnifier increases calibrated range to 0.02 μsec/cm.

Single sweep provision for one-shot applications.

Time Base B—Also functions as a sweep delay generator. 2 μsec/cm to 1 sec/cm in 18 calibrated steps.

Sweep Delay—Two modes of operation

Triggered—Delayed sweep started by signal under observation. Steady display, even of signals with inherent jitter.

Conventional—Delayed sweep started by delayed trigger. Time jitter less than one part in 20,000.

Range of Delay—1 μsec to 10 sec in 18 calibrated ranges, each range divisible into 1000 parts by 10-turn control with incremental accuracy of 0.2%.

OTHER CHARACTERISTICS

10-KV Accelerating Potential

Amplitude Calibrator—0.2 mv to 100 v.

Electronically-Regulated Power Supplies

Price—Type 545A, without plug-in units..... **$1550**

Type 541A Fast-Rise Oscillascape

Same as Type 545A, except that it does not have Time-Base B or provision for sweep delay or single sweeps.

Price—Type 541A, without plug-in units..... **$1200**

Type 535A Wide-Band Oscilloscope with Sweep Delay

Same specifications as Type 545A, except for main vertical amplifier. DC-to-15 MC passband, 23-mμsec risetime, 50-mv/cm deflection factor with Type K Plug-In Preamplifier.

Price—Type 535A, without plug-in units..... **$1400**

Type 531A Wide-Band Oscilloscape

Same as Type 535A except that it does not have Time-Base B or provision for sweep delay or single sweeps.

Price—Type 531A, without plug-in units..... **$995**

Rack-Mounting Models Also Available

Prices f.o.b. factory

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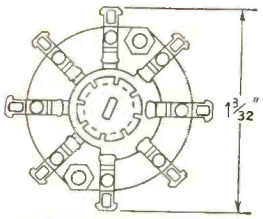
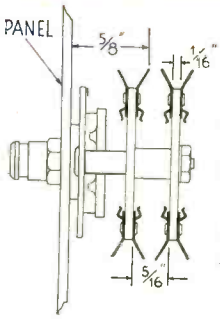
8, 10, 12 pos. miniature switch



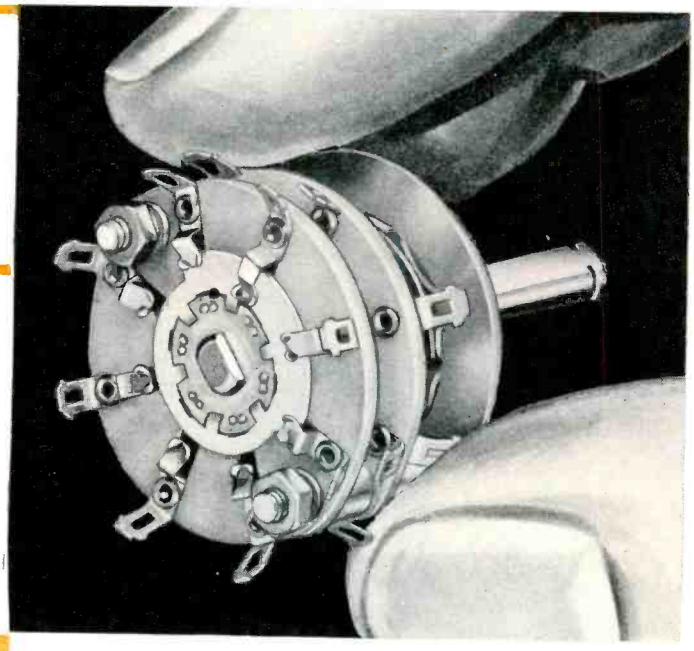
FITS IN 1-3/32" CIRCLE



MINIMUM DEPTH BEHIND PANEL—
ONLY 5/8" FOR A
SINGLE-SECTION SWITCH

SWITCH SECTION IS ONLY 1/16" THICK

MINIMUM SPACE BETWEEN SECTIONS—
5/16" WITH CLIPS ON FRONT AND BACK



OAK
SERIES "A"
LOW-CURRENT ROTARY SWITCH

- UP TO 18 CONTACTS PER SECTION
- 1/4" SHAFT, STANDARD
- LOW CAPACITANCE
- SAME HIGH QUALITY AND RELIABILITY AS LARGER OAK SWITCHES

Here's new help in the battle of miniaturization. This tiny switch can pare critical space and weight from your designs. The large number of contacts it provides enables you to handle complex circuits, too. The clips on the Series "A" are a miniature version of the famous Oak double-wiping design—long accepted as the standard of the industry for reliability and long life. Oak engineers will be glad to furnish complete information, and work with you in developing the exact variation you need.

Write on Company Letterhead for
a Copy of the Oak Switch Catalog

SPECIFICATIONS

Index—Double ball bearing, hill and valley type with stainless steel spring. Fixed and adjustable stops, and locating key available.

Shafts and Bushings—1/4" shaft with 3/8-32 bushing is standard; 5/32" shaft with 3/8-32 bushing and 1/8" shaft with 1/4-32 bushing can be supplied also. Water seal bushings optional.

Sections—8, 10, or 12-position, stacked in any number up to a total depth of three inches. The 12-position section provides up to 18 insulated contacts—12 on front, 6 on back. *No insulating blocks are needed on back.*

Poles	8-Position (45° throw)	10-Position (36° throw)	12-Position (30° throw)
1 pole	2 to 8	2 to 10	2 to 12
2 poles	2 to 4	2 to 5	2 to 6
3 poles	2 to 3	2 to 4	2 to 5
4 poles	2	2 to 3	2 to 3
5 poles	. . .	2	2
6 poles	. . .	. . .	2

Clips—Solid spring-silver alloy or silver-plated spring brass, fastened by solid rivets.

Insulation—Stator is silicone fiber glass, meeting specification MIL-P-997 type GSG; rotor is KEL-F®, known for its excellent mechanical and electrical properties.

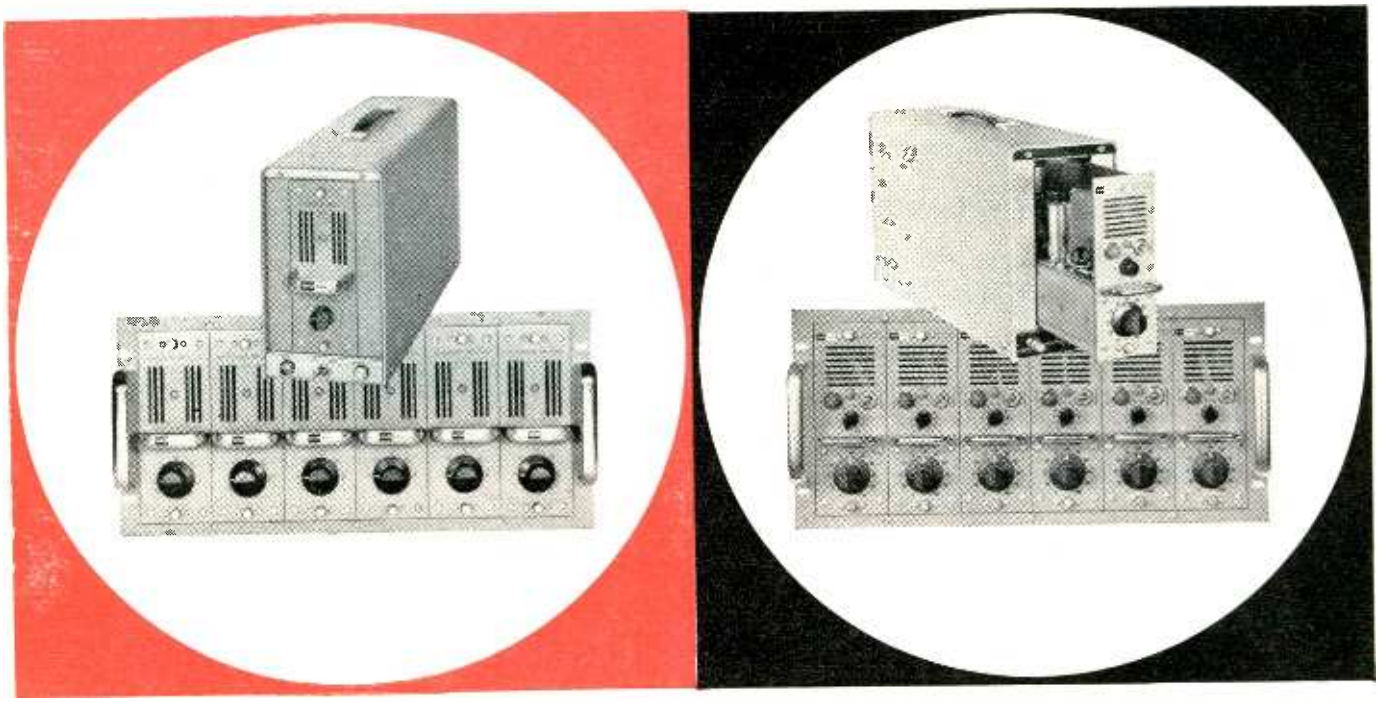
Finish—Commercial or 50 and 200-hour salt spray.

OAK MFG. CO.

1260 Clybourn Avenue, Dept. G, Chicago 10, Illinois
Phone: MOhawk 4-2222

SWITCHES • ROTARY SOLENOIDS • CHOPPERS • SPECIAL ASSEMBLIES • VIBRATORS • TUNERS

AMPLIFY MICROVOLTS WITH STABILITY... measure strain, temperature, other phenomena, to 0.1% with a KIN TEL DC amplifier



NEW...TRUE DIFFERENTIAL DC AMPLIFIERS ELIMINATE GROUND LOOP PROBLEMS...RESCUE MICROVOLT SIGNALS FROM VOLTS OF NOISE

180 db DC, 130 db 60 cycle common mode rejection with balanced or unbalanced input ■ Input completely isolated from output ■ Input and output differential and floating ■ 5 microvolt stability for thousands of hours ■ 0.05% linearity, 0.1% gain stability ■ Gain of 10 to 1000 in five steps ■ >5 megohms input, <2 ohms output impedance ■ 10 volt at 10 ma output ■ 100 cycle bandwidth ■ Integral power supply

Ideal for thermocouple amplification, the Model 114A differential DC amplifier eliminates ground loops; allows the use of a common transducer power supply; drives grounded, ungrounded or balanced loads; permits longer cable runs; and can be used inverting or non-inverting. The 114A can be mounted in either single amplifier cabinets or six amplifier 19″ rack adapter modules. Prices: 114A – $875, six amplifier module – $295; single amplifier cabinet – $125.

WIDEBAND, SINGLE ENDED DC AMPLIFIERS AMPLIFY DATA SIGNALS FROM DC TO 40 KC WITH 2 MICROVOLT STABILITY

±2 microvolt stability ■ <5 microvolt noise ■ 40 kc bandwidth ■ 100 KΩ input, <1 ohm output impedance ■ Gain of 20 to 1000 in ten steps with continuous 1 to 2 times variation of each step ■ ±45 V, ±40 ma output ■ 1.0% gain accuracy ■ 0.1% gain stability and linearity ■ Integral power supply

Millions of cumulative hours of operation have proved KIN TEL Model 111 series DC amplifiers to be the basic component for all data transmission, allowing simple, reliable measurement of strain, temperature and other phenomena. DC instrumentation systems – with their inherently greater accuracy, simplicity, and reliability than AC or carrier systems – are made entirely practical by the excellent dynamic performance, stability, and accuracy of KIN TEL DC amplifiers. Price: 111BF–$625, six amplifier module–$295, single amplifier cabinet – $125.

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Phone: BRowning 7-6700
Representatives in all major cities

KIN TEL
A DIVISION OF
COHU
ELECTRONICS, INC.

ELECTRONICS NEWSLETTER

GERMANIUM TRANSISTOR that can function as an amplifier and power source in the 1,000-2,000 mc range is reported in the laboratory development stage by Philco. The bipolar, microalloy diffused base transistor (MADT) achieves a maximum oscillation frequency of 3,000 mc. New unit provides power gain of about 4 db at 2,000 mc; at 1,000 mc gain is 9.8 db and output power is 10 mw. The transistor is about one year away from production. The firm says it may be important for the 200-300 mc range, where it could be used in tv sets and in military receivers; in the first stage of a military receiver, noise could be reduced to 4 db, says firm. For 1,000-2,000 mc use, a new coaxial type transistor package has been designed, with holder matched for direct insertion into a 50-ohm coaxial network. This, says Philco, may be a step towards integration of transistors in distributed transmission line networks, similar to microwave mixer diodes. In the new transistor, area of the electrodes is one-third that of presently available MADT's. However, says Clarence G. Thornton, director of semiconductor development at Philco's Lansdale Tube division, the electrodes of the new MADT are still about four times larger than its nearest performance rival. This means, he explained, that it is feasible for scientists now to shoot for 5,000-10,000 mc ranges by further reducing the MADT's electrode area.

TRANSISTORIZATION OF SAGE defense system gets underway this month with the award of a $33,175,558 contract to IBM from Rome Air Materiel Area. First developmental contract is for three solid-state support computers (AN/FSQ-7A); one model is understood to have been built already. New computer will be 75 percent smaller than the one it will replace. No further details of the computer are available. Procurement was negotiated with the one bidder solicited. It is believed that other solid-state updating of Sage equipment will follow.

Talos, Navy's surface-to-air missile, gets production boost with award of $28.3-million BuOrd contract to Bendix Aviation. Other contracts, amounting to about $12.9 million, are for Talos engineering and prototype procurement.

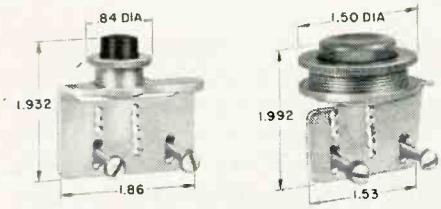
BRITAIN'S Decca Navigator Co., still smarting from the outcome of last February's ICAO meeting in Montreal which voted VOR-DME (Vortac) as the international short-range air navigation system, has issued a blast against American actions and called the meeting a "farce." Tacit approval of the statement by the UK government was implied. Firm charged that the ICAO decision which rejected the Decca system, was not based on technical grounds. Statement accused the U. S. of packing the meeting, of half-truths and misrepresentation. (ELECTRONICS is preparing a fresh rundown on the argument for an upcoming issue.) Meanwhile, an ICAO panel which will report in June on its study of ground facilities and services throughout the world, has issued a preliminary statement calling for "increased expenditures over those now planned by the nations of the world." Panel says more money will be needed to provide air navigation services and facilities for the safe and economic operation of jet aircraft.

TRITIUM, the only radioactive isotope of hydrogen, which has important electronic uses, is now available from the Atomic Energy Commission's Oak Ridge National Laboratory at $2 per curie. Tritium beta radiation causes less deterioration of phosphors than the higher energy radiation from other radioisotopes, says AEC, thus providing luminous material of long life and constant light output. Color range of tritium-activiated phosphors has been extended to cover the entire visible spectrum and parts of the ultraviolet and infrared. Applications include radar and specialized tubes.

Flight data tape recorder which can be automatically ejected in a crash for later playback has been announced by British firm Royston Instruments. Device weighs 40 lb, records up to 360 measurements in five seconds on tape that lasts for about 160 hours. Cost: about $7,000.

FACSIMILE will be used by the Japanese newspaper Asahi, starting next month, to transmit a daily edition from Tokyo to Sapporo, Hokkaido, 706 mi to the north, where it will be produced by offset printing. British Muirhead Co. supplied six transmitting and eight receiving machines, and two receiving control machines. System has 12 channels, transmits a page in 27 minutes.

CABINET-LEVEL Department of Science and Engineering is being actively backed by Engineers Joint Council, which says it represents more than a third of the nation's engineers. EJC president Enoch R. Needles recently told a subcommittee of the Senate Committee on Government Operations that creation of such a department would serve the interests of the nation. However, he said that "science and engineering, directly pertinent to the missions of certain departments, must continue to be carried out within these departments." He deplored the word "technology" as a substitute for "engineering," said the former did not fully describe the dimensions of engineering.



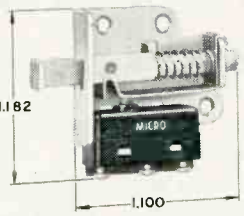
12MA1 Actuator 12MA5 Actuator

Pushbutton actuators are versatile, low cost

These actuators accept three families of basic pin plunger switches permitting their use in a wide range of applications. Two button sizes—½" and 1"—and choice of red, green or black buttons give panel distinctiveness. Switch and actuator mounting hole arrangement permits use in panels from .060" to .312" thick, and simplifies button travel adjustment. Data Sheet 155.

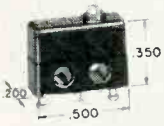
New subminiature "TM" toggle switch uses minimum panel space

The 2TM1-T offers considerable reductions in space and weight in manual control of compact equipment. Weight—4½ grams. Only ½" square at the base. Dependable operation from −65° to +200°F. Low circuit resistance. Rating: 7 amps. resistive, 28 vdc. DPDT. Data Sheet 158.



New subminiature safety door interlock

The 17AC1-T cuts off power in equipment cabinets when a 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 . . . resets itself to safety position. Dependable in temperatures from −65° to +250° F. SPDT. Data Sheet 159.



ACTUAL SIZE

Sub-subminiature series switches

These remarkable switches combine smallest available size with "regular size" electrical capacity, operate dependably in temperatures from −65° to +250°F. Weight—1/28 oz. Qualifies as Military Standard Part Number MS24547-1. Rating: 5 amps., 230 vac; 7 amps. resistive, 28 vdc. Data Sheet 148.

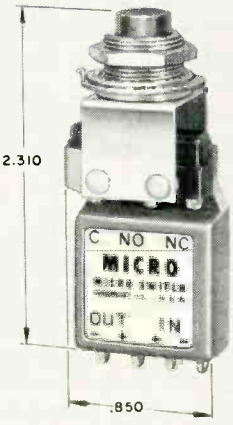
LEAF ACTUATOR

ROLLER LEAF ACTUATOR

Auxiliary actuators add to the versatility of application. Two are shown. Others are pivoted lever and pivoted roller lever. All are stainless steel.

"One-Shot" switches simplify circuit development

Time-consuming custom development of circuits is made unnecessary by "1PB600" Series "One-Shot" pushbutton switches. These switches produce one square wave pulse per operation. Pulse widths from 0.1 to 10.0 microseconds. Applications include computer and radar consoles, electronic test equipment, setting and resetting flip-flops, and reflected pulse systems. Data Sheet 150.



Selections from a line large enough to solve almost any switching problem

MICRO SWITCH makes many hundreds of switches and switch devices especially useful to the electronic designer. Here are a few of them, in a considerable range of sizes, electrical capacities, and functions. MICRO SWITCH development engineers are constantly widening the choice with new switches and devices to meet new requirements. The designer can go ahead with a switching arrangement he has in mind with confidence that MICRO SWITCH can supply his need.

Engineering assistance in switch applications is available without obligation from MICRO SWITCH branch offices. Consult the Yellow Pages.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
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Honeywell
MICRO SWITCH Precision Switches

CIRCLE 12 READERS SERVICE CARD

CIRCLE 13 READERS SERVICE CARD→

crystal growing with Trancoa silicon . . .

single, single all the way

POLYCRYSTALLINE SILICON SPECIFICATIONS

Grade	Resistivity P-Type	Resistivity N-Type	Max. Resistivity Ratio for 10% & 60% Points	Max. Boron Content (ppb)
IA	500	250	3:1	0.5
I	100	50	3:1	0.5
II	50	20	3:1	1.0
III	25	10	3:1	2.0
IV	2.5	1.0	3:1	4.0

Consistently clean Trancoa Silicon eliminates the twins, polys, and dropped charges that can result from dirty material. This will give you a larger yield of single crystal per pound of silicon . . . saving material, saving machine time, saving labor.

We prove the cleanliness of our Silicon at Trancoa by growing test crystals with only 3/16th of an inch between crucible and crystal . . . and they are single, single all the way! You can be confident of achieving uniform results within a lot and from one lot to another by growing crystals with Trancoa Silicon.

See table for the five grades available. Complete information is contained in "Trancoa for Evaluating Silicon". Write today for a copy.

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chemical corporation
312-326 Ash Street, Reading, Massachusetts
Tel. REading 2-3900

WASHINGTON OUTLOOK

A SHORT-TERM EXTENSION of the controversial Renegotiation Act, probably for two years, is in store. Rep. Carl Vinson, (D., Ga.) powerful chairman of the House Armed Services Committee, is fighting bitterly for permanent extension.

Vinson calls the measure "the only protection the government has against excessive profits" when 92 percent of defense contracts are negotiated on a cost-plus basis.

Electronic Industries Association and defense contractors are willing to go along with an extension but want certain amendments—and may well get some of them.

EIA, for instance, wants guide lines for "excess profits" spelled out more clearly to allow real rewards for efficiency, with appeal allowed to the U.S. Court of Appeals. The Pentagon goes along with this idea. It wants an amendment progressively boosting profits when production costs are held under original estimates.

The Aircraft Industries Association made a telling point in hearings before the House Ways and Means Committee last week. AIA charged that the Renegotiation Board is not allowing rewards for efficiency, but rather sets a predetermined profit rate. In 1954, for instance, the rate of return (before Federal taxes) allowed the four biggest aircraft companies, after renegotiation, varied only from 5.64 to 6.31. Before renegotiation, the rate varied from 6.39 to 8.59. This amounts in practice to "rate-making" and "effective nullification of incentive contracts," AIA charged.

Indicative of the problem's size: defense contractors are currently appealing $82 million worth of profits the Board has ordered returned to the government. Seven aircraft companies account for $72 million of that amount.

- **Do operators** of community antenna systems and tv translators and boosters have a legal right to pick up a tv signal without the station's consent. Three Salt Lake City tv stations, representing the industry, have filed suit to settle the question. So far no "proprietary right" in the tv signal has ever been established. Practical outcome of a successful suit would be to give stations commercial control over subsidiary operations, though broadcasters claim they aren't trying to put antenna operators out of business.

- **Instrumentation** for space vehicles is lagging behind development of the vehicles themselves. Within about three years the U.S. will be able to launch a space vehicle carrying a telescope and several hundred pounds of instruments—but the necessary instruments won't be ready.

  This was the significance of remarks by Leo Goldberg, of the University of Michigan Observatory, to 500 scientists attending the recent joint symposium on problems in space in Washington.

  An example of the problems ahead: the satellite telescope must not only be stabilized in space but must be controllable from the ground to point accurately in any direction. The desired stabilization will likely be achieved by use of gas jets and rotating fly wheels, Goldberg said.

- **The federal government** is having better luck lately in attracting and keeping scientists and engineers. The reasons: "recession hangover" makes some people reluctant to take jobs in unstable industries, and the government can now offer more competitive pay. Within the past year federal employees have had a 10-percent pay hike, and premium rates have been allowed for hard-to-get categories of personnel.

Delivering now!

PRECISION

372C/D Precision Attenuator

ATTENUATORS

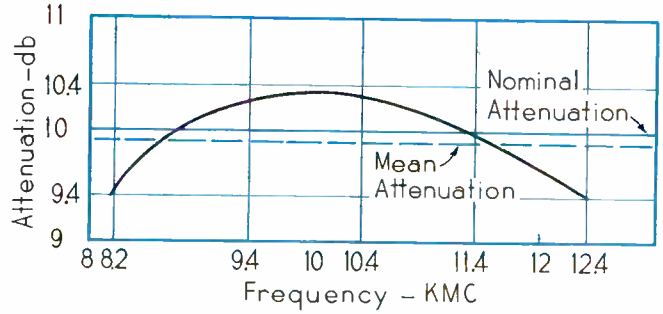
totally unaffected by aging or ambient conditions!

Aging, humidity, temperature or other ambients — none has any effect on the precise calibration of these ultra-dependable, wideband new attenuators.

Attenuation is inherently invarient because it depends neither on the position of, nor power absorbed by, resistive cards or vanes. Instead, attenuation is a function of the coupling-hole array between two permanently-joined waveguide sections — the same principle as employed in directional couplers. Attenuation accuracy thus achieved averages better than ±0.4 db from nominal, and variation full band is less than ±0.5 db from mean.

Since there are no protrusions into the waveguide, SWR's are permanent and extremely low —1.05 to 1.

372 series attenuators are offered in six waveguide sizes, with nominal attenuations of 10 or 20 db.



Typical attenuation characteristics X372C, 10 db model.

HEWLETT-PACKARD COMPANY
1003A PAGE MILL ROAD · PALO ALTO, CALIFORNIA, U.S.A.
CABLE "HEWPACK" · DAVENPORT 5-4451
Field representatives in all principal areas

SPECIFICATIONS

Model	Freq. (KMC)	Nominal Attenuation	Fits Waveguide Size (in.)	Power (watts ave.)	Price
S372C	2.6 - 3.95	10	3 x 1½	2	$375.00
S372D	2.6 - 3.95	20	3 x 1½	2	375.00
G372C	3.95 - 5.85	10	2 x 1	2	250.00
G372D	3.95 - 5.85	20	2 x 1	2	250.00
J372C	5.85 - 8.2	10	1½ x ¾	1	140.00
J372D	5.85 - 8.2	20	1½ x ¾	1	140.00
H372C	7.05 - 10.0	10	1¼ x ⅝	1	120.00
H372D	7.05 - 10.0	20	1¼ x ⅝	1	120.00
X372C	8.2 - 12.4	10	1 x ½	1	100.00
X372D	8.2 - 12.4	20	1 x ½	1	100.00
P372C	12.4 - 18.0	10	0.702 x 0.391	1	115.00
P372D	12.4 - 18.0	20	0.702 x 0.391	1	115.00

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

5488

pioneers again in better waveguide equipment

"Higher Education... Our Greatest Tool"

OSCAR G. MAYER

Chairman, Oscar Mayer & Co.

"During the last twenty years we have had dramatic evidence of what massive research can accomplish. Every thinking American today is acutely aware that our future welfare depends upon this vital activity.

"But sound higher education is the prerequisite of good research; it is vitally important that our higher education be constantly improved, beginning with our secondary schools. Higher education is the only means with which we can mine our most valuable natural resource: the creativity of the human mind in all fields, social and cultural as well as scientific.

"By supporting the college of your choice in its efforts to provide the best possible faculty and physical facilities, you are investing in the one tool with which to shape favorably the future of America."

If you want more information on the problems faced by higher education, write to: Council for Financial Aid to Education, Inc., 6 E. 45th Street, New York 17, N. Y.

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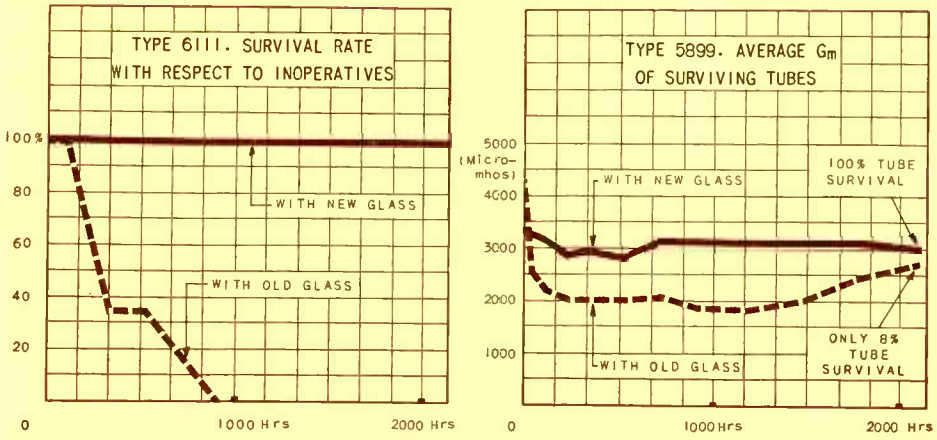
GENERAL ELECTRIC

TUBE DESIGN NEWS

FROM THE RECEIVING TUBE DEPARTMENT OF GENERAL ELECTRIC COMPANY

G-E Subminiatures with New High-Resistivity Glass Show *NO* Inoperatives after 2000-Hr Tests at 300°C!



Life tests above to military specifications except for bulb temperatures, raised to 300°C. Left: shows 2000-hour inoperative percentages for Type 6111, a subminiature known to suffer from glass electrolysis at higher-than-rated temperatures. Right: shows reduced G_m drop for new glass versus old, Type 5899. At high temperatures this tube had a tendency to slump in transconductance.

The G-E Receiving Tube Department has taken an important step forward in tube technology by applying Corning Glass Works' new high-resistivity glass to 5-Star subminiature types. Test results, as indicated at left, show a spectacular increase in tube reliability.

First with high-resistivity glass for tubes, General Electric now is building subminiatures able to withstand heats that before have shortened tube life materially. Glass electrolysis—cause of 90% of subminiature failures at high temperatures—is "stopped in its tracks."

Resistance Factor 20 Times Greater

The new glass in G-E subminiatures actually has a factor of resistance 20 times that of the old. A designer can use in two ways the improved tube performance now offered him:

1. He can design with a greater safety factor.
2. He can work with assurance to equipment specifications that call for high-temperature tube operation.

Ask any General Electric tube office on the next page for further facts!

Three Advanced Tubes Now in Production by G.E.

TYPE 6EZ8. First triple triode ever designed and manufactured! General Electric's pioneering 6EZ8 is an entertainment tube for use in FM radio tuners . . . . . makes possible a *one-tube tuner*, boon to space-cramped set designers. Saves extra tube cost, too. By itself, the new 6EZ8 will handle either of these jobs: (1) r-f amplifier, oscillator, and mixer, (2) oscillator, mixer, and AFC tube.

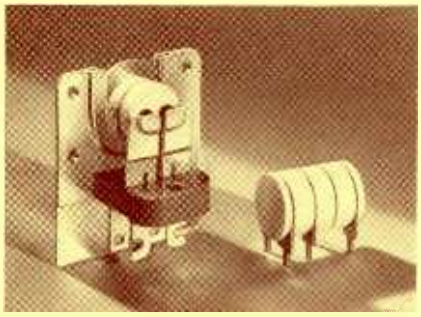
TYPE 6222. Extra-sensitive high-mu subminiature triode. A 5-Star military type, for first-stage amplification in infra-red detection circuitry. Noise level is extremely low—a maximum of 1.2 microvolts at the grid, in a test circuit of 200 cycles band width. The 6222's low noise characteristic, especially at very low frequencies, makes the tube useful in other advanced applications.

TYPE 6814. Only subminiature computer type! A 5-Star high-reliability triode intended for military use in airborne fire-control computers. Designed for binary-counter or cathode-follower applications. The 6814's extremely small size assists in optimum miniaturization of equipment.

Ready Soon: New Printboard Version of 7077 Triode

Type 7077 ceramic triode—famous as the General Electric tube which sent information to earth from Pioneer IV sun satellite for a world record distance of 407,000 miles—soon will be available for standard printboard circuitry. The new lug version has ratings which are approximately the same as those of the 7077.

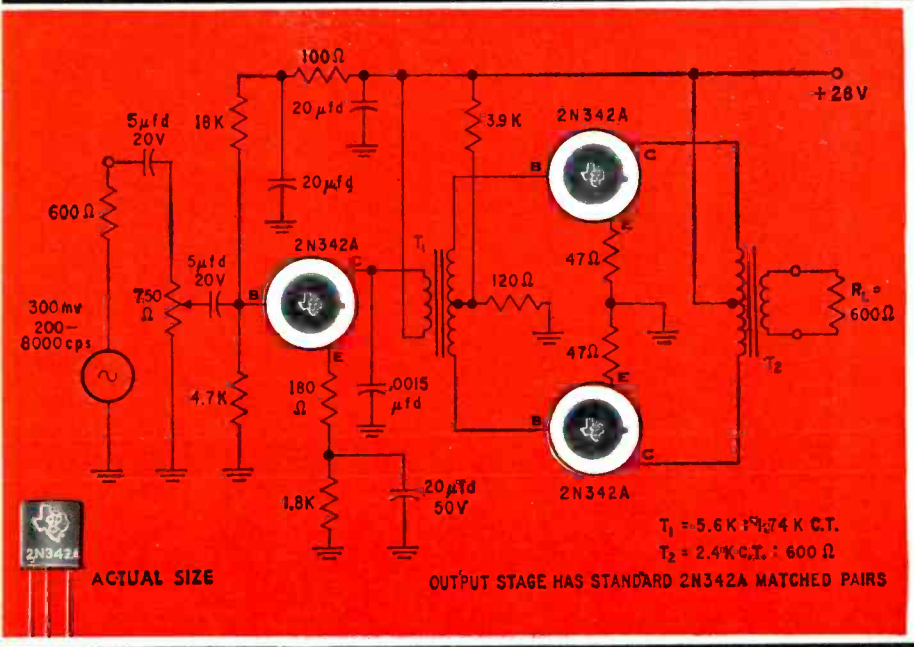
The short, solderable lugs of the new tube, cut lead inductance and capacitance to a minimum. This helps make the lug version of the 7077 ceramic triode an ideal tube for application in distributed amplifier circuits.



Side by side: socket-mounted 7077 ceramic triode and new lug version (at right) for standard printboard use. Both are shown actual size. Note smaller mounted height for printboard tube, aiding the circuit designer who is faced with rigid space limitations.

TI Silicon Transistor Application Note

TRANSISTORIZED INTERCOM EXCEEDS MIL-E-5272B SPECS



CIRCUIT SPECIFICATIONS

150-mw output from -55°C to 100°C at less than 10% harmonic distortion over frequency range

Frequency response @ 25°C stable within ±2 db of 1000 cps 100 mw reference level from 200 to 8000 cps

Frequency response @ -55°C and 100°C within ±3 db of 25°C frequency response

Less than 3-db gain variation @ -55°C and 100°C compared to 25°C measurement

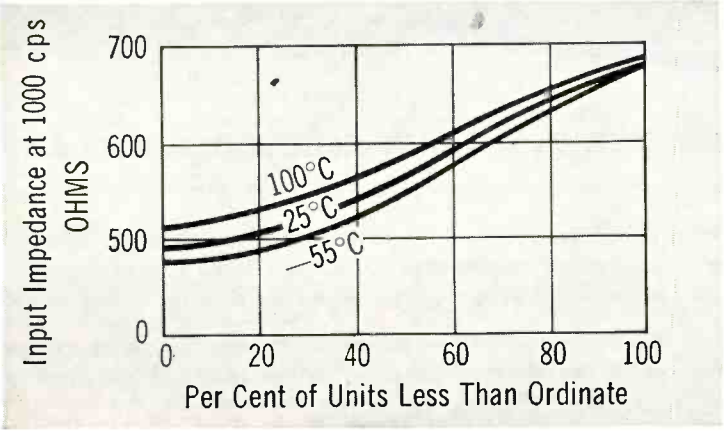
LOUD AND CLEAR AT 100°C!

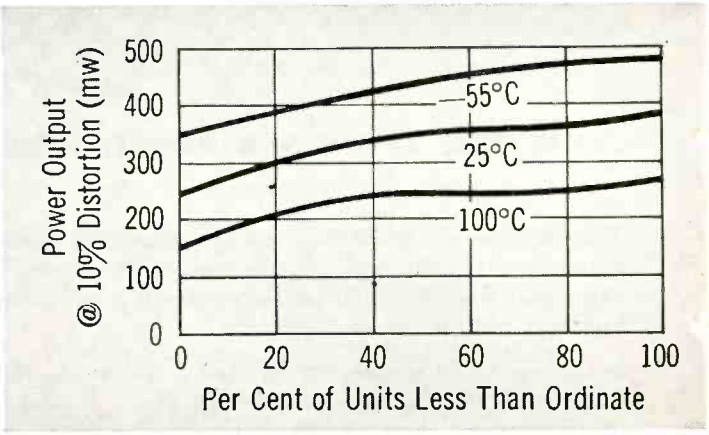
. . . with TI 2N342A silicon transistors from stock

You can satisfy the 71°C equipment requirements of MIL-E-5272B at 100°C with the intercom amplifier circuit shown above — using TI 2N342A silicon transistors with . . . guaranteed 3-to-1 linear beta characteristics . . . 85-v collector-to-emitter breakdown, giving a wide safety range with 28-v aircraft supplies . . . plus dissipation capability of 1 watt at 25°C and 200 mw at 125°C.

The newest addition to the *use-proved* TI 2N339 series introduced in 1957, this medium-power unit carries the full-year TI guarantee and is immediately available *off-the-shelf* from all TI distributors in 1-249 quantities. For production quantities, contact your nearest TI sales office.

TYPICAL INTERCOM AMPLIFIER PERFORMANCE CHARACTERISTICS USING 2N342A TRANSISTORS





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First Quarter Looks Good

FIRST-QUARTER financial reports for this year have been released by many firms. Rising volumes are indicated for most segments of our industry. Some examples are:

• **Clarostat Manufacturing Co., Inc.**, Dover, N. H., reports a 40-percent increase as compared with the first quarter of 1958. This year's first-quarter shipments totalled $2,033,000 as against 1958's $1,438,000, with a profit of $88,600 as against a loss of $117,400.

• **Burroughs Corp.**, Detroit, announces first-quarter net of $1,533,408 versus $1,100,414 in the same period of 1958. This year's revenue for the period ended March 31 was $80,922,856 compared with $67,998,240 for the same period last year. This year's provision for income tax was $450,000 higher. The firm reports incoming orders 25 percent higher than last year with expectations that the trend will continue.

• **Electronic Communications, Inc.**, St. Petersburg, Fla., reveals earnings of 68 cents a share for the first three months of this year, as compared with 57 cents a share for the three-month period ending last December. For the six months ending March 31, 1959, net earnings after taxes were $496,203 on 382,866 common shares outstanding, compared with a figure of $29,312 for the corresponding six-month period in 1958.

• **American Bosch-Arma Corp.** discloses net sales of $31,177,327 for the first three months of 1959 in contrast to $27,018,890 for the first quarter of 1958. Consolidated net income after taxes was $1,444,995, a 62-percent rise over $886,708 of last year. The firm estimates its backlog of defense production contracts at $196 million.

• **Westinghouse Air Brake** remains undaunted while announcing a decline of 21 percent from last year's first-quarter sales totalling $53,047,072. The drop amounts to $11,058,170 on a total of $41,988,902 for the first three months of 1959. As of March 31, 1959, however, backlog of orders comes to $77,700,000 compared to $1 million less a year ago. The firm also points out that this backlog had increased $13,900,000 from a low of $63,800,000 on July 31, 1958. This figure includes a rise of $6 million since the beginning of this year.

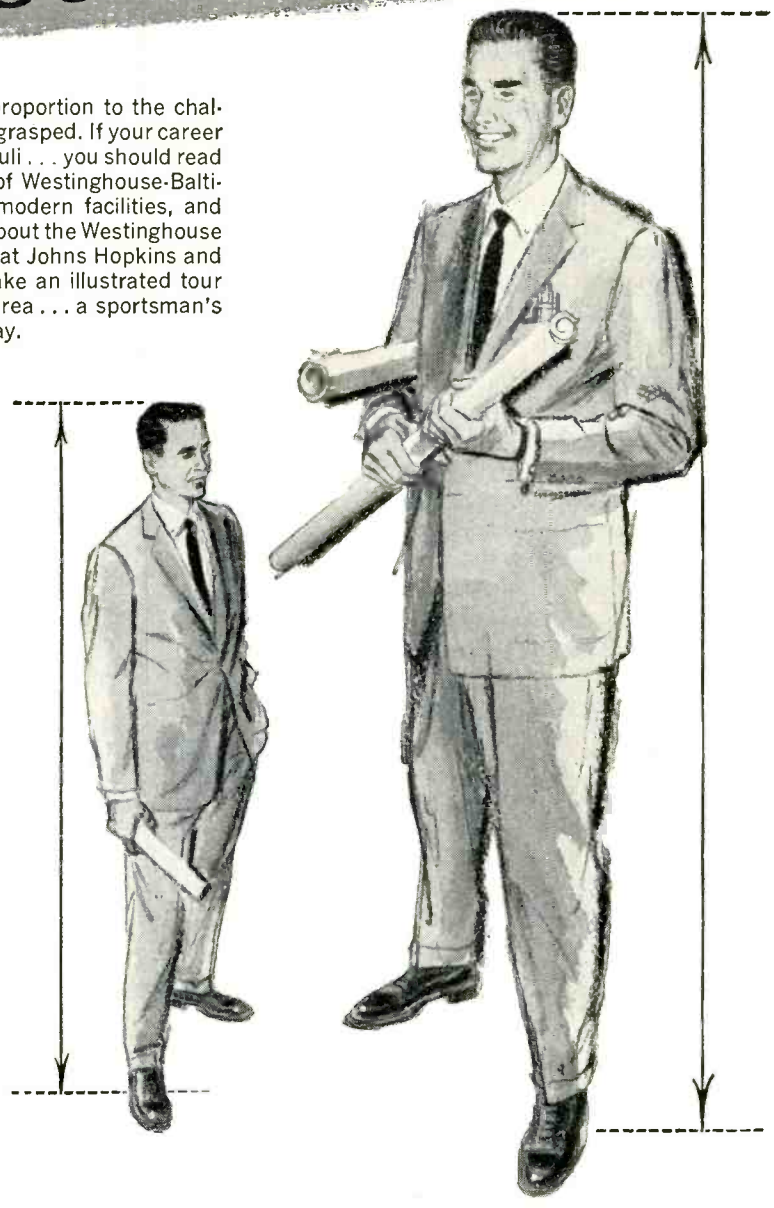
OVER THE COUNTER

1958 BIDS LOW	HIGH	COMMON STOCKS	WEEK ENDING April 24 BID	May 1 BID	ASKED
3¾	20½	Acoustica Assocs	33	34	38¼
1⅝	3	Advance Industries	3⅜	3⅛	3⅞
3⅛	6⅝	Aerovox	8¾	9¼	10⅞
5½	15	Appl'd Sci Princet	10	10¼	12⅝
1⅛	8⅞	Avien, A	8¼	9¾	11¼
6¾	24	Baird-Atomic	28¾	29¼	37¼
9¾	13⅜	Burndy	15½	15⅞	17⅛
6¾	9	Cohu Electronics	7⅞	7⅞	8½
11	22½	Collins Radio	36½	38½	43
32½	49	Cook Electric	46½	46	52½
4	7	Craig Systems	9⅝	9⅝	13⅛
17⅝	25⅜	Eastern Industries	17¾	18	20⅛
1¾	8⅜	Elco Corp	7⅝	8⅝	10¾
10½	21	Electro Instr	30	29½	32
34	49	Electronic Assocs	45½	46	56
5	11	Electronic Res'rch	17½	18	19⅝
8½	12¾	Electronic Spec Co	16	17¾	19⅛
15¼	49½	Epsco, Inc	38½	39½	47¾
5½	9⅜	Erie Resistor	9	9	11¼
10	17½	Fischer & Porter	12¾	13⅜	15⅛
5½	10½	G-L Electronics	12½	12¼	14⅜
12	27	Giannini	32	31¾	35⅞
...	...	Haydu Elec Prod	5	4¾	6⅝
30	39½	Hewlett-Packard	45	49¼	53
23¼	48	High Voltage Eng	61	63	76¼
1¾	3	Hycon Mfg	3⅜	3¼	3⅞
1⅛	5⅛	Industro Trans'tor	5¼	5½	7¼
...	...	Internat'l Rec'f'r	26¼	26¾	29⅝
...	...	Interstate Engin'g	36½	18¾	21
1½	4¾	Jerrold	6¼	6⅜	7⅛
21	30	D. S. Kennedy	28	28¼	32¾
3¾	29	Lab For El'tronics	33	33	38¾
19¼	28	Leeds & Northrup	28½	29	34⅛
2	3⅛	Leetronics	3½	3⅝	4⅜
5	18¾	Ling Electronics	25½	24¾	28¼
3¼	8¼	Magnetic Amplifiers	8	8¼	10¾
2⅞	4½	Magnetics, Inc	5⅛	5½	6⅞
4⅝	12	W. L. Maxson	14½	15⅛	16¾
10⅝	29	Microwave Assocs	46	49	54½
5¼	11¾	Midwestern Instr	12⅝	13⅛	14⅝
1⅛	7	Monogram Precis'n	11⅜	11¾	13⅞
3½	7¼	Narda Microwave	10¼	10⅜	11⅝
...	...	Narda Ultrasonics	9⅜	9¾	11¾
9¾	16	National Company	24½	24¼	26¾
14¼	56	Nuclear Chicago	33	38	41⅜
4½	7⅜	Pacific Mercury, A	13	12½	14⅛
10⅛	27½	Packard-Bell	38½	42	45⅝
4¼	9⅜	Panellit, Inc	7½	7⅝	8⅝
21	53¾	Perkin-Elmer	48	48¾	54
11⅜	19½	Radiation, A	19½	21	23
2⅛	7⅜	Reeves Soundcraft	6	7½	8¾
13	32½	Sanders Associates	29½	34	39⅜
...	...	Silicon Transistor	7¼	8½	12¼
7	12	SoundScriber	17¼	16¾	18⅝
22¾	40	Sprague Electric	45	45	50⅞
26	35	Taylor Instruments	33¾	33	36⅜
5½	15	Technical Operat'ns	20½	20½	26¼
5½	15¾	Telechrome Mfg	24½	22½	26¼
3¼	7¾	Telecomputing	11⅞	11¾	12⅞
1⅛	2¾	Tel-Instrument	2¾	2¾	3½
8¾	16¼	Topp Industries	13⅛	13⅛	16
3¾	10¾	Tracerlab	10¼	9¾	11
1⅛	3⅜	Universal Trans'tor	1¼	1⅛	1½
14¼	40	Varian Associates	60	37	41⅛

The above "bid" and "asked" prices prepared by the NATIONAL ASSOCIATION of SECURITIES DEALERS, INC., do not represent actual transactions. They are a guide to the range within which these securities could have been sold (the "BID" price) or bought (the "ASKED" price) during preceding week.

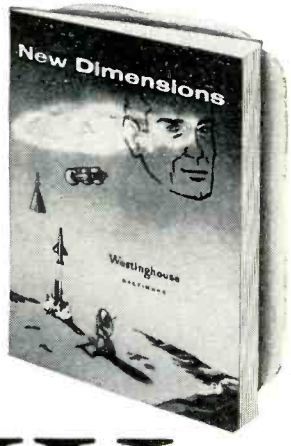
ADD A "NEW DIMENSION" TO YOUR CAREER!

A professional career grows in proportion to the challenges met and the opportunities grasped. If your career has been stunted by a lack of stimuli . . . you should read "New Dimensions". . . the story of Westinghouse-Baltimore . . . its advanced projects, modern facilities, and challenging opportunities. Read about the Westinghouse program for advanced education at Johns Hopkins and other leading universities; and take an illustrated tour of the colorful Chesapeake Bay area . . . a sportsman's paradise. Send for your copy today.



Current Career Openings Include:

Microwave Systems and Components
Radar Systems
Network Synthesis
Analogue and Digital Computer Design
Solid State Devices
Electronics Instructors
Communications Circuitry
Field Engineering
Technical Writing
Electronic Packaging
Operations Research



Write for your copy of "New Dimensions" today. For a confidential interview, send a resume of your education and experience to: Mr. A. M. Johnston, Dept. 908, Westinghouse Electric Corporation, P. O. Box 746, Baltimore 3, Maryland.

Westinghouse
BALTIMORE

EXCLUSIVE!
MOLDED* Contact Combinations on OHMITE® Relays

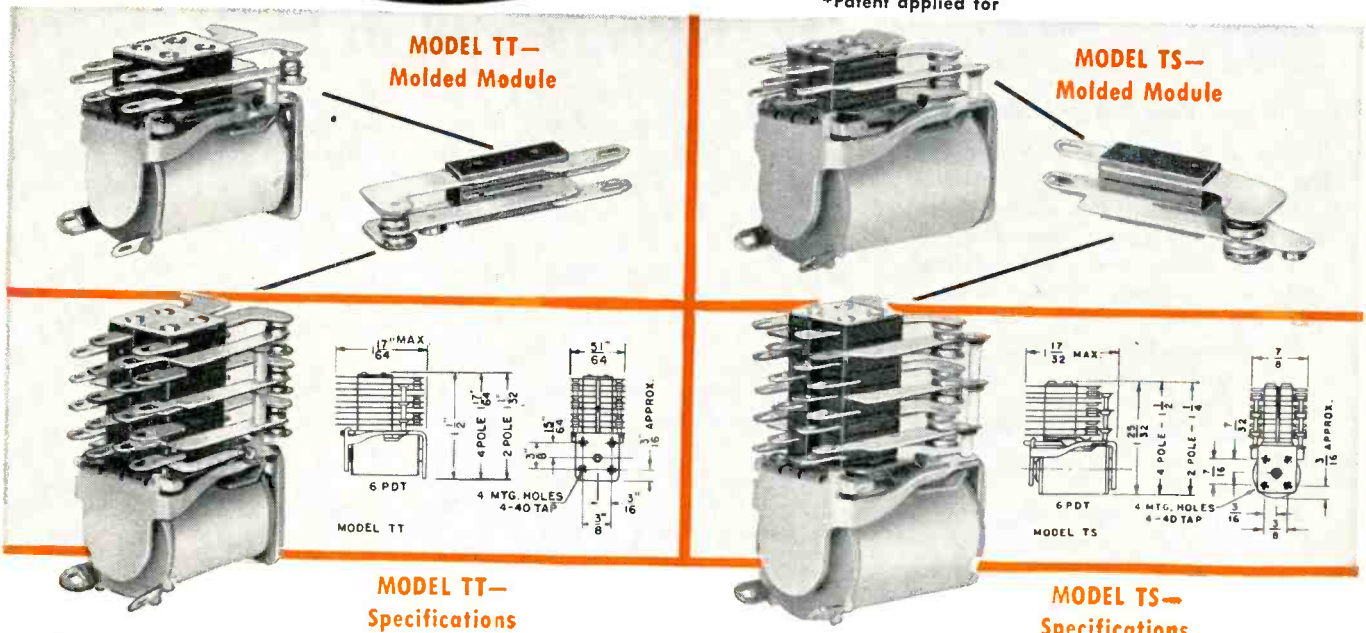
"Molded Module"* Contact Springs

Ohmite Models TT and TS Relays are designed to meet the operational requirements of MIL-R-5757C and MIL-R-6106C, respectively, and will be found ideal for aircraft or industrial uses, particularly those involving high ambient temperatures. Both relays are lightweight, yet rugged. Paramount among the design innovations is their revolutionary "Molded Module" contact spring construction. The "module" is a standard, single-pole, double-throw spring combination molded into a compact assembly. As many as six modules can be incorporated into a relay to provide a maximum six-pole, double-throw combination. With the springs rigidly held in a matrix of tough plastic, alignment of the springs is assured. More accurate alignment of all the subcombinations (modules) on the relay is possible, and adjustment of the individual contact springs is easier and more permanent. Diall Phthallate, the molding material, is capable of withstanding temperatures to 400°F.

Exceptional sensitivity for small size

A contributing factor to the remarkable sensitivity of Ohmite Models TT and TS Relays is the design of the armature retaining guard to minimize undesirable heel gap. A wide variety of hermetically sealed enclosures is available.

*Patent applied for



MODEL TT— Specifications

COIL WATTAGE: Rated nominally at .150 watt per pole at an ambient temperature of 20°C.

COIL OPERATING VOLTAGE RANGE: To 115 VDC.

CONTACT RATINGS: Up to 5 amperes at 115 volts AC or 32 volts DC noninductive, with standard contact material, palladium. Other materials can be supplied.

CONTACT COMBINATIONS: Standard combinations are DPDT, 4PDT, and 6PDT (maximum). Others can be furnished.

WEIGHT: Approximately 2 ounces for 4PDT relay.

MODEL TS— Specifications

COIL WATTAGE: Rated nominally at .250 watt per pole at an ambient temperature of 20°C.

COIL OPERATING VOLTAGE RANGE: To 115 VDC.

CONTACT RATINGS: Up to 10 amperes at 115 volts AC or 32 volts DC noninductive with standard contact material, silver-cadmium oxide. Other materials can be supplied.

CONTACT COMBINATIONS: Standard combinations are DPDT, 4PDT, and 6PDT (maximum). Others can be furnished.

WEIGHT: Approximately 3 ounces for 4PDT relay.

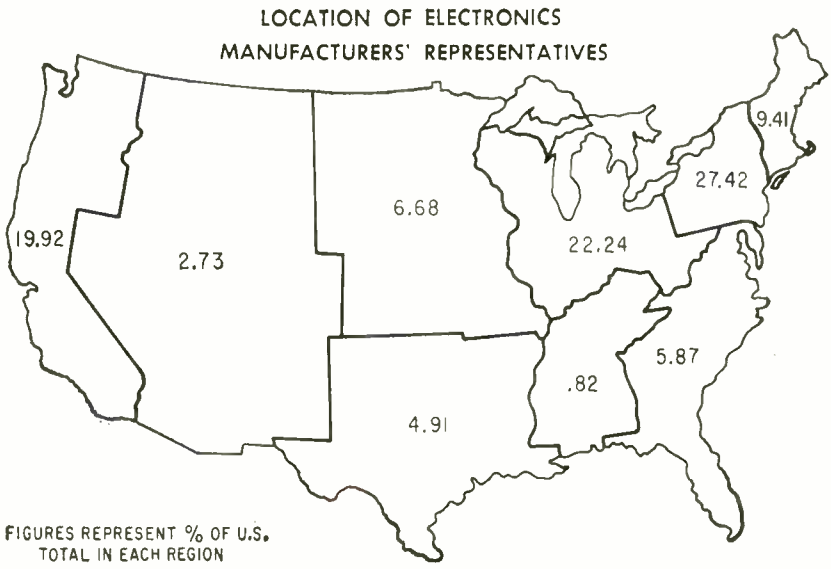
Be Right with OHMITE® Quality Components

Write for Bulletin 160

OHMITE MANUFACTURING COMPANY
3610 Howard Street, Skokie, Illinois
RHEOSTATS RESISTORS RELAYS
TAP SWITCHES TANTALUM CAPACITORS DIODES
R.F. CHOKES VARIABLE TRANSFORMERS

CIRCLE 23 READERS SERVICE CARD

MARKET RESEARCH



Most Reps Still in East

RECENT SURVEY of electronics manufacturers' representatives in the United States by ELECTRONICS shows the three major regions of rep activity are the middle Atlantic, with 27.42 percent of reps; the east north central, with 22.24 percent and the Pacific area with 19.92 percent.

Six remaining regions account for some 30 percent of reps. Breakdown shows 9.41 percent of representatives in New England area, 6.68 percent in west north central, 5.87 percent in south Atlantic, .82 percent in east south central, 4.91 percent in west south central and 2.73 percent in mountain area.

Comparison with similar survey run in 1957 reveals only slight change in geographic distribution. Percentage change for each of nine U. S. regions has varied by no more than plus or minus two percent.

Response of 733 U. S. manufacturers' representatives from a total mailing of 1,100 questionnaires represents a 66-percent return. Considerable effort was made to include all known electronics manufacturers' reps in the survey. List surveyed was built up over a number of years from field reports of salesmen, announcements from reps and published sources.

Responses by states show heaviest returns from California and New York with 122 and 111 rep replies received, respectively. Complete tabulation of state returns follows:

Ala.	1	Mich.	24
Ariz.	5	Minn.	22
Calif.	122	Mo.	22
Colo.	11	N. J.	41
Conn.	16	N. Mex.	2
D. of C.	3	N. Y.	111
Fla.	11	N. Car.	7
Ga.	10	Ohio	42
Hawaii	1	Ore.	7
Ill.	75	Penn.	49
Ind.	18	Tenn.	3
Iowa	2	Tex.	34
Kan.	3	Utah	2
Ken.	2	Va.	3
La.	2	Wash.	16
Md.	9	Wisc.	4
Mass.	53		

FIGURES OF THE WEEK

LATEST WEEKLY PRODUCTION FIGURES

(Source: EIA)	Apr. 24, 1959	Mar. 27, 1959	Change From One Year Ago
Television sets	97,485	94,378	+14.7%
Radio sets (ex. auto)	263,434	259,070	+133.2%
Auto sets	108,122	97,621	+69.5%

STOCK PRICE AVERAGES

(Standard & Poor's)	Apr. 29, 1959	Apr. 1, 1959	Change From One Year Ago
Electronics mfrs.	95.79	81.38	+85.5%
Radio & tv mfrs.	106.29	95.11	+133.2%
Broadcasters	100.30	92.61	+69.5%

Now **in stock, ready for shipment within 24 to 48 hours, General Transistor has**

PNP ALLOYED JUNCTION

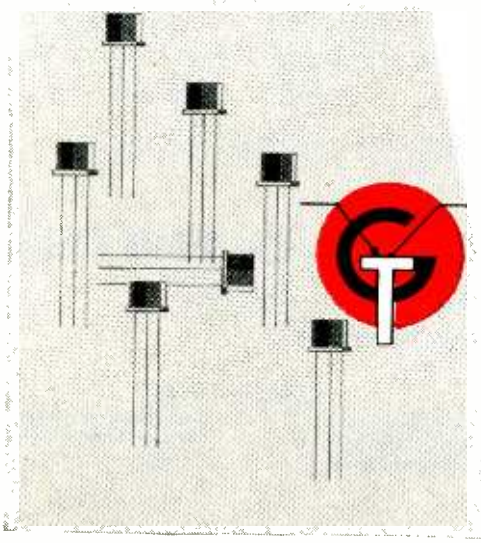
SILICON TRANSISTORS

General Transistor's years of experience in manufacturing ***Alloyed Junction Germanium Transistors*** *has resulted in continued reliability, higher quality and complete product uniformity. NOW — with this acknowledged skill and experience GT offers design engineers who demand these field proven qualities 5 new types of* ***PNP Alloyed Junction Silicon Transistors*** *of the same quality and reliability. These transistors are characterized by:*

1. **HIGH GAIN**
2. **HIGH SPEED**
3. **LOW SATURATION RESISTANCE**
4. **HIGH TEMPERATURE OPERATION**
5. **IMMEDIATE DELIVERY**

SPECIFICATION DATA

	High Speed Switch	Med. Speed Switch	High Speed Small Signal Amplifier	Med. Speed Small Signal Amplifier	High Voltage
	2N1219	**2N1220**	**2N1221**	**2N1222**	**2N1223**
V_{CBO}	30 v	30 v	30 v	30 v	40 v
V_{CEO}	25 v	25 v	25 v	25 v	40 v
V_{EBO}	20 v	20 v	10 v	10 v	10 v
I_{CO}	.1 μa max.	.1 μa max.	.1 μa max.	.1 μa max.	.1 μa max.
h_{FE}	18 min.	9 min.	——	——	——
f_{ab}	5 min.	2 min.	5 min.	2 min.	——
h_{fe}	——	——	18 min.	9 min.	6 min.



write for PNP SILICON Brochure S-100

"YEARS AHEAD IN RELIABILITY"

GENERAL TRANSISTOR

CORPORATION

91-27 138TH PLACE, JAMAICA 35, N.Y.

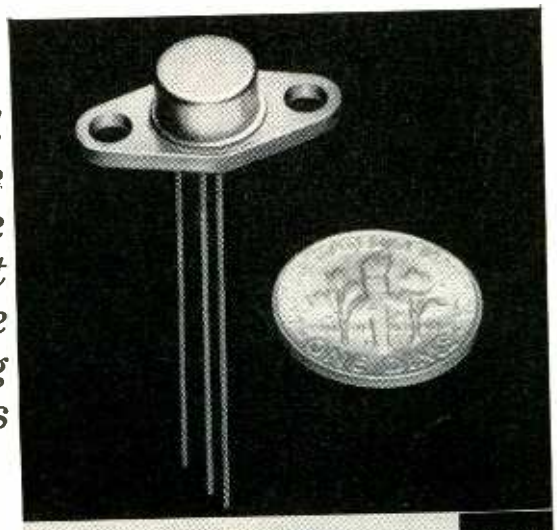
FOR IMMEDIATE DELIVERY FROM STOCK, CONTACT YOUR NEAREST AUTHORIZED GENERAL TRANSISTOR DISTRIBUTOR OR GENERAL TRANSISTOR DISTRIBUTING CORP. 91-27 138TH PLACE, JAMAICA 35, NEW YORK. FOR EXPORT: GENERAL TRANSISTOR INTERNATIONAL CORP. 91-27 138TH PLACE, JAMAICA 35, NEW YORK

NEW!

SMALL!

DELCO POWER TRANSISTOR

Designed for use where space and weight are restricting factors



MAXIMUM RATINGS	2N1172
Collector Diode Voltage	40 volts
Emitter Diode Voltage	20 volts
Collector Current	1.5 Amperes
Junction Temperature	95°C
TYPICAL CHARACTERISTICS (25°C)	
Typ. Collector Diode Current I_{co} V_{cb}=40 volts	50μ
Current Gain (V_{ec}= −2 volts, I_c=100 Ma)	70
Current Gain (V_{ec}= −2 volts, I_c=½A)	30
Saturation Resistance	0.3 ohms
Cutoff Frequency (Common Emitter)	17 kc
Thermal Resistance	12° C/Watt

The 2N1172 is a medium power transistor offering dependable operation in a new range of applications where space and weight have been a problem.

It's a mighty mite with more punch in a smaller package. The 2N1172, excellent for output use or as a driver for a very high power transistor, has already proved especially effective in DC amplifiers, voltage regulators, and as a driver for a high power stage in servo or other amplifiers.

This PNP germanium transistor is housed in a modified version of the JEDEC 30 package with a diamond shaped base for improved thermal conduction. It dissipates up to 2 watts at a mounting base temperature of 70 degrees centigrade. Available now in volume production—write today for complete engineering data.

DELCO RADIO

Division of General Motors
Kokomo, Indiana

BRANCH OFFICES

Newark, New Jersey
1180 Raymond Boulevard
Tel: Mitchell 2-6165

Santa Monica, California
726 Santa Monica Boulevard
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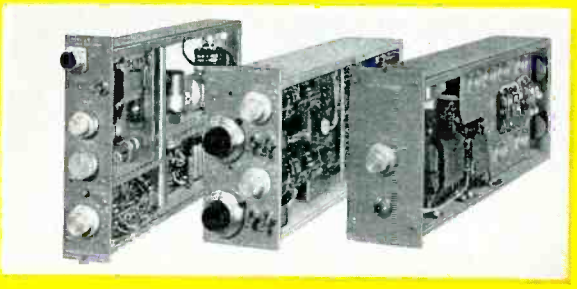
CIRCLE 26 READERS SERVICE CARD

CIRCLE 27 READERS SERVICE CARD→

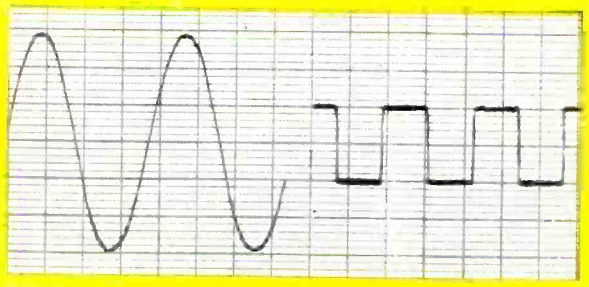
the most versatile . . . most sensitive direct writing unit available!

OFFNER ALL-TRANSISTOR R DYNOGRAPH

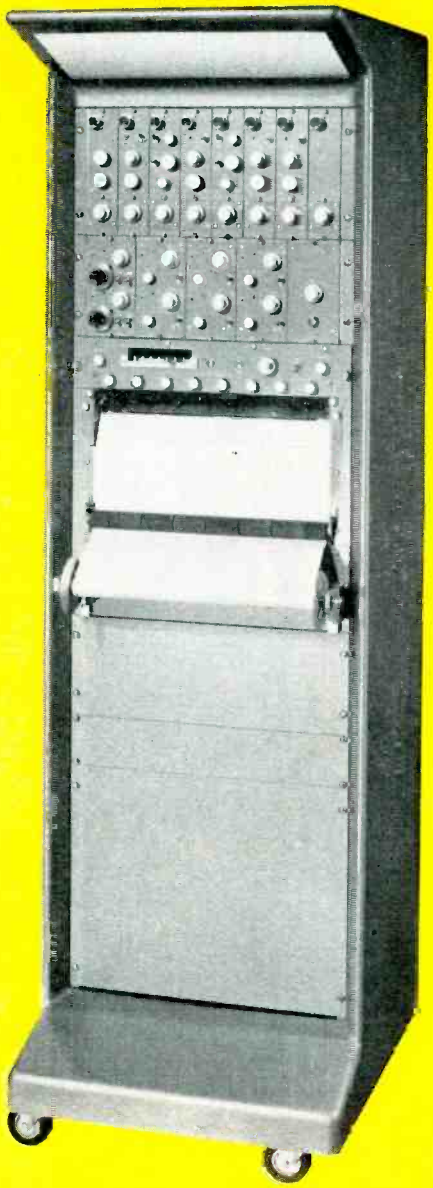


The Type 481 preamplifier, 9800 series input coupler, 482 power amplifier, and 382 power supply are all of plug-in construction. Input is available both front and rear.

The 504A paper drive gives speeds of from 1 to 250 mm/sec. Electrical speed shift 1 to 250 mm per minute available. Zero weave high precision drive, 850 ft. capacity (heat or electric) 1500 ft. (ink). Front loading, with record fully visible from front.



Full scale, unretouched charts show the extreme sensitivity of the Type R Dynograph. Left—10 microvolt RMS sine wave. Right—10 microvolt D-C square wave. Four recording media. Heat or electric rectilinear—ink or electric curvilinear. Readily convertible.



all these features...plus 8 channels in only 35″ of rack space

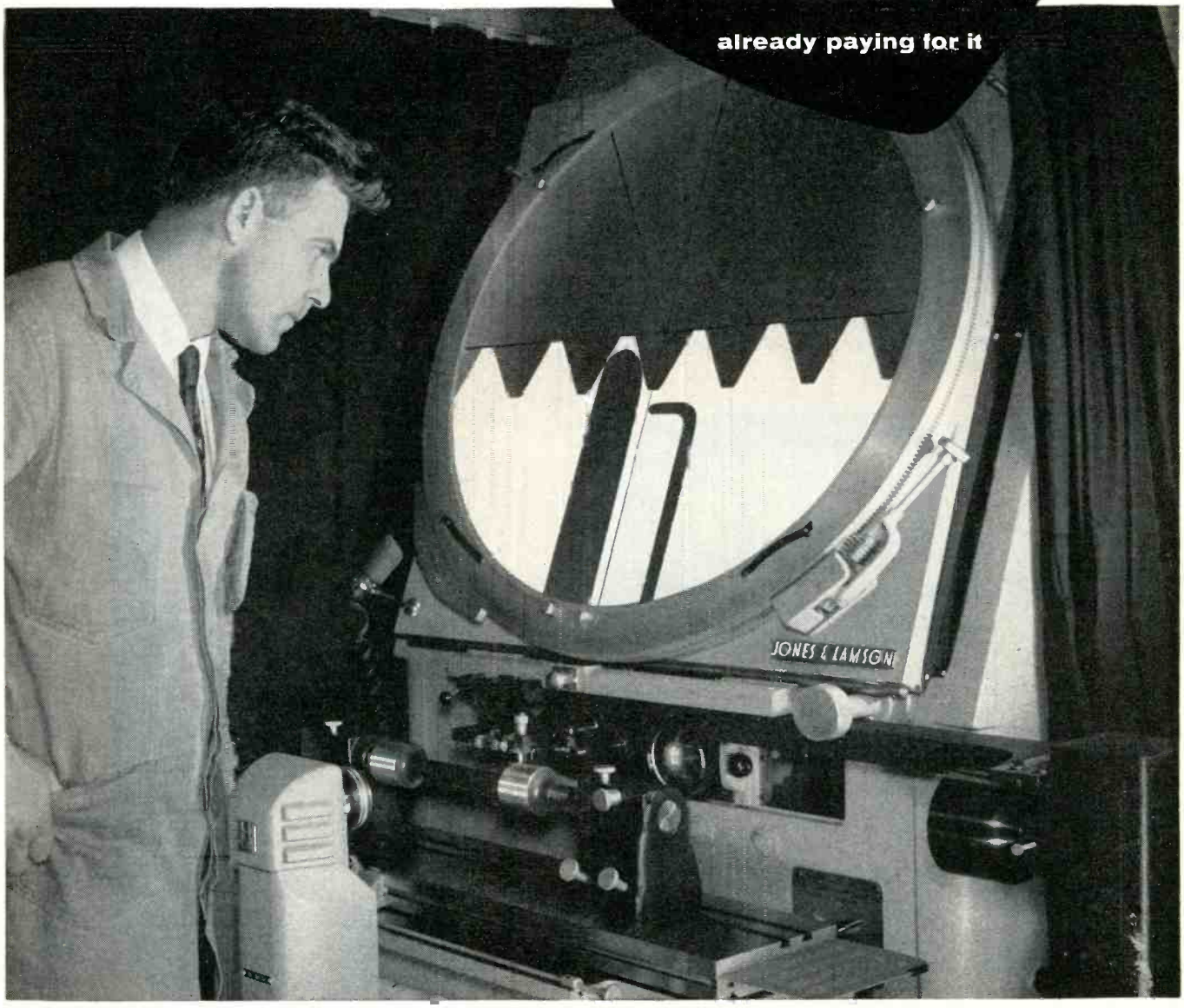
- stable d-c sensitivity of one microvolt per mm
- true differential input
- high input impedance
- response to beyond 150 cps
- reluctance, differential transformer, strain gages with a-c or d-c excitation, thermocouples, etc., used with all preamplifiers
- deflection time less than 1.5 milliseconds (2.5 ms with preamplifiers)
- fixed precision calibration
- instant warm-up
- precision source for d-c and 400 cycle excitation, self-contained
- zero suppression, twenty times full scale, both directions

Whatever your application for direct writing records, investigate the ability of the Offner Type R Dynograph to do the job *better* and more *simply*. Write on your company letterhead for details and specifications.

OFFNER ELECTRONICS INC. 3906 River Road, Schiller Park, Ill. (Suburb of Chicago)

JONES & LAMSON OPTICAL COMPARATORS

the man who needs a new machine tool is already paying for it



Determines lead and spacing errors of less than .0001"

Lead amplification on J & L Comparators combines both optical and mechanical magnification in standard gaging set-up. It produces amplification of any lead error, in threads of all standard forms and pitches.

For example, a .0001" lead error is magnified to .050" or .100" on the screen. Measurements are made direct on the machine's micrometer, with ease and repeatability.

Other demanding applications, such as the extremely precise measurement of critical spacing between the valve ports and the piston lands of hydraulic valves, are also performed with this new amplifier.

The dependability of this attachment was demonstrated in a series of tests conducted on a special application by J & L engineers. Among other things, it was proved beyond doubt that a group of Jo blocks can be measured within .000025". Furthermore, these readings were easily repeated, even by different operators.

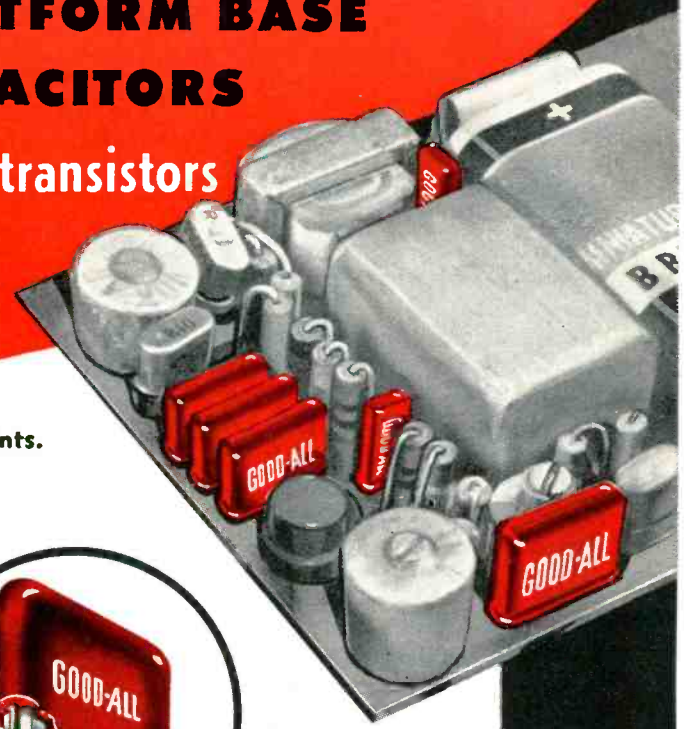
The speed, precision, flexibility and dependability of Jones & Lamson Comparators might well make a big difference in *your* operations. Write for Catalog 5700, Jones & Lamson Machine Company; 539 Clinton Street, Springfield, Vermont.

Turret Lathes • Automatic Lathes • Tape Controlled Machines • Thread & Form Grinders • Optical Comparators • Thread Tools

Good-All

New SLIM-LINE TYPE 602 PLATFORM BASE CAPACITORS

...tailored for transistors

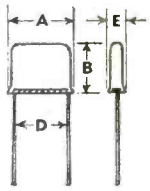


This is a special-purpose version of the popular, space saving Good-All SLIM LINE (Type 601PE) and is designed to meet **rugged vibration requirements.** The mounting platform of Epoxy-glass laminate securely seats the 602 capacitor on a printed circuit chassis. Added stability under vibration is provided by heavy gauge leads.

Tough, moisture-tight Epoxy coating

Miniature "platform" of Epoxy-glass laminate

Heavy Gauge leads precisely spaced



TYPE 602 DIMENSIONS (AVAILABLE IN 50 VOLT RATINGS ONLY)

CAP. (Mfd.)	A	B	D	E	CAP. (Mfd.)	A	B	D	E
.01	.562	.300	.440	.200	.10	.650	.525	.558	.225
.022	.562	.339	.440	.210	.15	.671	.650	.558	.260
.033	.531	.386	.440	.210	.22	.748	.717	.558	.296
.047	.531	.433	.440	.235	.33	.843	.780	.690	.312
.068	.575	.480	.440	.260					

SPECIFICATIONS

INSULATION RESISTANCE — Greater than 75,000 megohms when measured at 100 volts D.C. at 25° C for a maximum of 2 minutes.

WINDING CONSTRUCTION — Extended foil (non-inductive) MYLAR* Dielectric.

LEAD LENGTH — Standard 1" min. as shown. Available, on special order, to exact length required by application.

CAPACITY TOLERANCE — Standard tolerance is 20%.

DISSIPATION FACTOR—Less than 1% at 1,000 cycles per second at 25° C.

DIELECTRIC STRENGTH — 100 volts D.C. for 1 to 5 seconds thru a minimum current limiting resistance of 100 ohms per volt.

TEMPERATURE RANGE — May be operated at full rated voltage to 85° C. Derate to 50% when operating at 125° C.

*DuPont's trademark for polyester film.

Write for Technical Brochure on this new type.

GOOD-ALL ELECTRIC MFG. CO. • OGALLALA, NEBRASKA

In Canada, 700 Weston Road, Toronto 9, Ontario

GOOD-ALL CAPACITORS NOW AVAILABLE AT YOUR LOCAL DISTRIBUTOR

Plan to Solve Tv Shortage?

FCC's new proposal would cut down distances between tv stations and get more tv to more cities—but it may draw sharp fire from critics

LATEST PROPOSAL by Federal Communications Commission is to reduce minimum milage between tv stations from 170 to perhaps 100 miles.

Word from Washington is that this plan is likely to set off a storm of protests from broadcasters who see the proposal as detrimental to their markets. The plan would affect some 36 cities having only one or two stations.

Current distance regulations provide a separation of 170 miles between stations on the same channel, 60 miles for stations on adjacent channels. The 100-mile figure mentioned has not been confirmed, but is thought to be "most likely" in Washington circles.

Case In Point

An example of the pros and cons the plan would bring about may be seen by examining the tv situation in Dayton, O., where typical conditions prevail.

The city has only two tv channels, 7 and 2. Room for a third station could be found on channel 13 by limiting the range of the channel 13 station 100 miles away in Indianapolis. The Indiana station would most likely object to this and would contest the allocation, as would other stations in comparable situations.

Critics are calling the plan "another stopgap measure" and claiming it will only serve to further delay much-sought wholesale reallocation of the entire spectrum. Two commissioners have expressed fears the proposal will prejudge the pattern of eventual solution.

The limited-range plan is admittedly an interim measure to be set aside when ways are worked out to permanently increase the number of vhf tv channels from the present 12 to 25 or 50.

Five Alternate Systems

This increase in vhf tv space would have to be carried out over a period of about 10 years to allow gradual replacement of receivers by the viewing public, and to allow broadcasters to make technical changeovers. FCC has submitted five alternate possibilities to the Senate Commerce Committee:

1. A 50-channel system using channels 2 to 12 plus additional spectrum space.
2. A 50-channel system retaining 7 to 13, but dropping 2-6.
3. A 25-channel system retaining 7 to 13.
4. An 82-channel vhf/uhf system (presently in use).
5. A 70-channel all-uhf system.

The last two possible methods are considered least likely to succeed. Most students of the situation consider uhf dead. It has not shown itself able to compete with vhf, and broadcasters have been reluctant to use its shorter range facilities. It is likely that only some new technical improvements could cure this ailing medium.

"The ideal solution," says the Commission, "would be a 50-channel system retaining the present 12 channels." This would provide at least five stations (four commercial, one educational) in each major tv market.

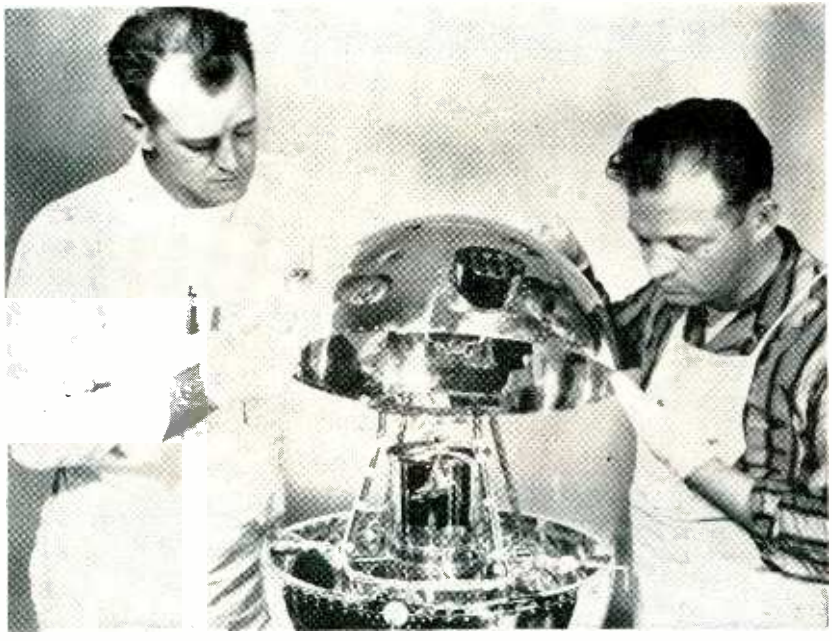
It does not appear likely, however, that government and military agencies would give up the spectrum space necessary to permit this. The military's needs are increasing rapidly as space-age electronics makes growing demands.

FCC will start negotiating with the military in the near future and hopes to have an idea in about three months on how much vhf space it can get by swapping.

A 50-channel vhf system, beginning with the present channel 7, would increase the amount of space available for other purposes. It would, however, mean reallocation of stations now on channels 2 to 6.

A 25-channel system, retaining channels 7 to 13, is considered minimal expansion by FCC, and appears to be the best hope at present. The commission recognizes that 50 channels for tv is an unrealistic share of spectrum space and admitted as

Protecting Vanguard II's Recorder



Army Signal Corps technicians lower upper half of cloud-cover satellite shell into place before Vanguard II was cast into orbit by NASA. In moon's center is 5½-in. magnetic tape recorder which put out 250,000 ft of signals

much in its report. A 25-channel band would permit five stations in most of the top 100 tv markets, but might deprive smaller cities of local tv outlets.

Two commissioners took exception to the report. R. T. Bartley opposes the interim move of mileage reduction as premature in view of pending negotiations with the military which might open up more channel space. R. E. Lee is holding out for a wholesale move to uhf.

The Commission noted too that any increase in the number of channels would render existing tv receivers obsolete. It asked for legislation which would require all sets manufactured after a certain date to be designed to receive all channels. This move is calculated to provide protection for set owners against obsolescence of their receivers in 10 years or so when the new plans go into effect.

Evolution Is Key To British Show

LONDON—EVOLUTION rather than revolution was the keynote of this year's British Radio and Electronic Component Show held here recently. Receiver-type components were the backbone of most of the 179 exhibits. Stereo equipment lagged, reflecting the present limited U. K. market.

In the stereo section was the double recording mike, provided for on some new tape decks and record players. It consists of two ribbon velocity microphones mounted vertically in line, the upper one rotating with respect to the fixed lower unit through 100 degrees to cover stereo requirements. Inbuilt phase reversing switch, used with both units in line, enables the second unit to provide high efficiency noise elimination.

As in previous years manufacturers made great play of miniaturization. Typical examples: twin-gang variable capacitors with dimensions less that 1 in. in any direction and knob-operated volume controls (primarily designed for hearing aids that measure $\frac{3}{8}$ in. in diameter and $\frac{1}{8}$ in. in depth. Power ratings are 50 mw and resistance ranges from 1,000 to 1,000,000 ohms.

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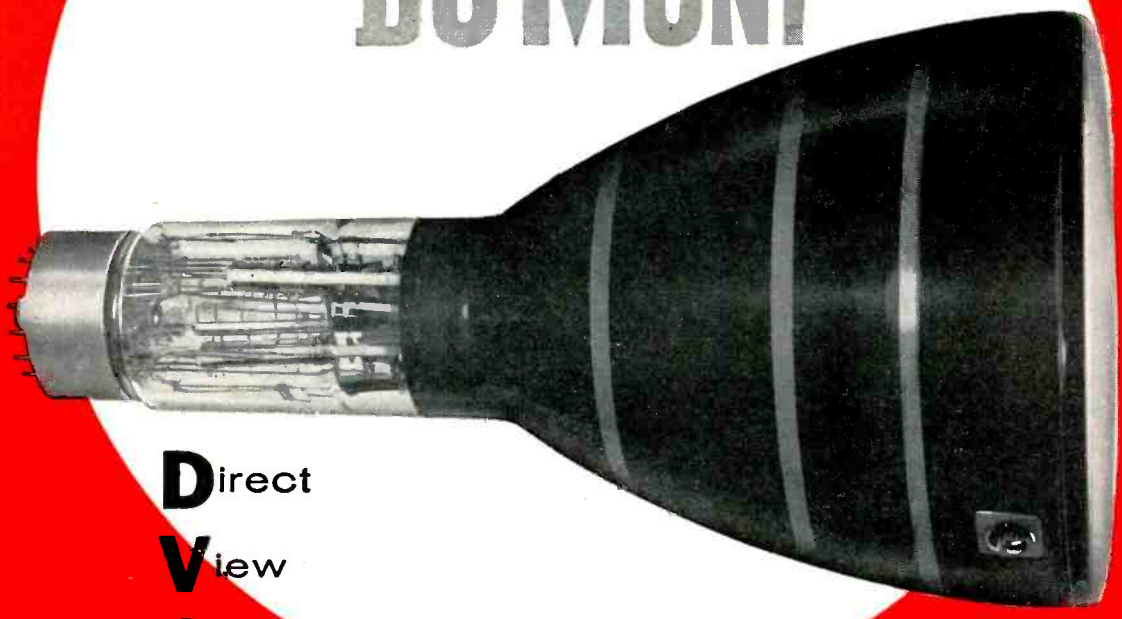

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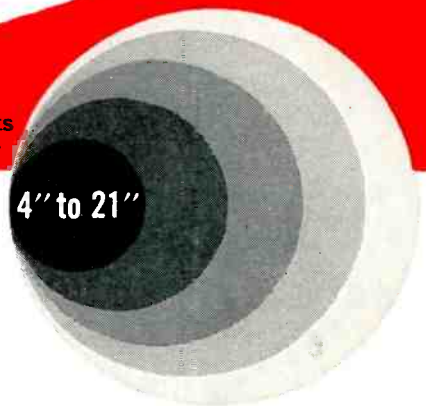

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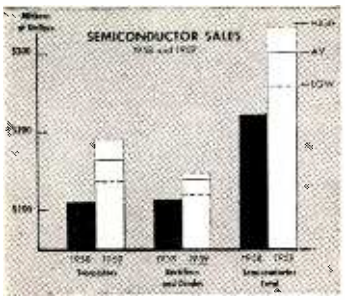

Paul Petrack takes the stand for electronics

ITT (International Telephone & Telegraph Corp.), Components Division, Clifton, New Jersey is a leading electronics manufacturer of electron tubes, fixed capacitors, silicon power diodes, selenium rectifiers, hermetic seals, miniature switches, and other component parts.

Former Chief Engineer, and present Product Manager for silicon products, Paul Petrack is a market expert for electronics components. His functions require him to determine what products will be in greatest demand (according to the industry's latest technical developments) and what products will be the most profitable to market.

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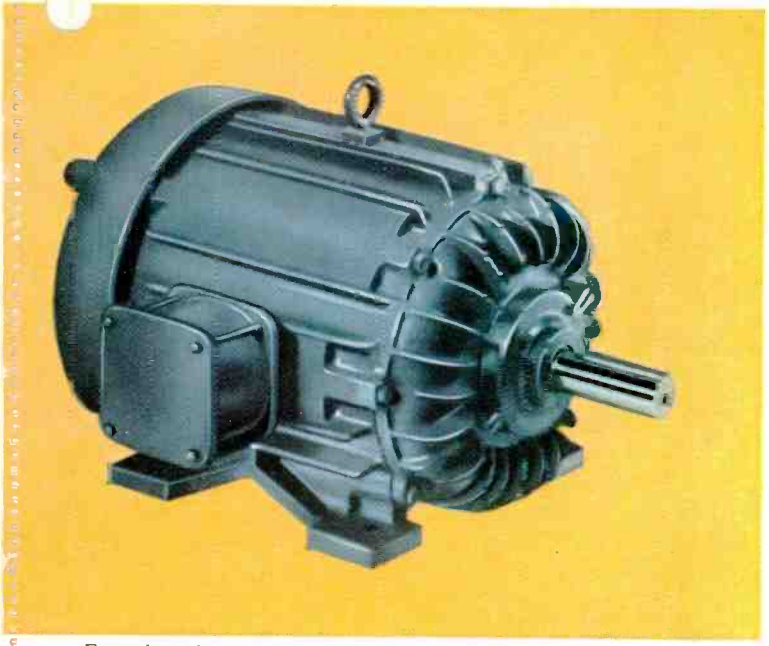

Epoxy's unique combination of dependable characteristics makes it suited to use in such equipment as totally enclosed motors, above; hermetically sealed relays, encapsulated dry-type transformers, below.

Anaconda Epoxy Magnet Wire is particularly well suited to use in oil-filled transformers. Epoxy's excellent behavior in transformer oils is but one of its many outstanding chemical characteristics.

The compatibility, chemical stability, and thermal stability, of Anaconda Epoxy have been proved by some three years of actual field experience, plus seven years of research and development, in both military and civilian applications.

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Epoxy's unique combination of dependable characteristics makes it suited to a wide variety of difficult applications. Its outstanding dielectric strength, its heat-shock, adherence, and flexibility properties make it an "all around" magnet wire for use up to 130°C in either open or closed systems.

ROUND, SQUARE AND RECTANGULAR. Anaconda Epoxy magnet wire is available in the full range of round, square and rectangular sizes. It can also be furnished in combination with glass servings.

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ASK THE MAN FROM ANACONDA® about EPOXY MAGNET WIRE

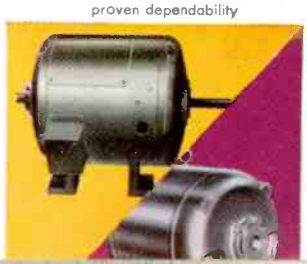
For more details on Anaconda Epoxy's unique combination of useful characteristics, please turn the page—

ANATHERM 155°C (AIEE Class F) high temperature resistance

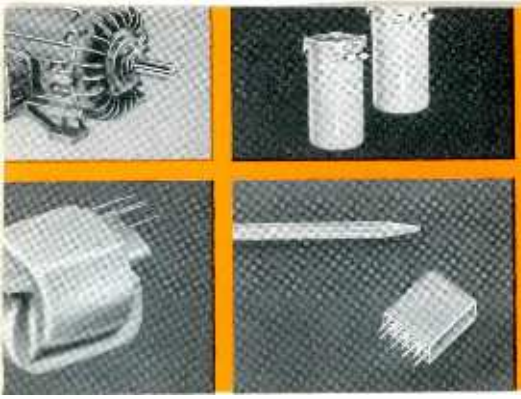
NYFORM 105°C (AIEE Class A) superior windability

VITROTEX 130°C (AIEE Class B) glass-insulated, high heat resistance

FORMVAR 105°C (AIEE Class A) proven dependability



ANALAC 105°C (AIEE Class A) solderable magnet wire



MAGNET WIRE DATA SHEET

from

Anaconda Wire & Cable Co.

IMPORTANT FACTS FOR YOUR WORK...

. . . about Anaconda Epoxy 130°C (AIEE Class B) Magnet Wire

Anaconda Epoxy film-coated magnet wire is suitable for use in 130°C (Class B) hottest spot operation. It meets MIL-W-19583 requirements. Epoxy is compatible with other insulations and performs excellently in oils. It offers unusual resistance to moisture and has a higher resistance to heat shock than other Class B wires. This unique combination of properties makes it applicable to a wide variety of difficult applications.

SUGGESTED APPLICATIONS

Oil filled transformers • Air conditioning systems where moisture is a problem • Refrigeration machines for operation with fluorinated hydrocarbon refrigerants • Totally enclosed motors, transformers, alternators • Encapsulated windings of virtually any type.

MECHANICAL PROPERTIES

Epoxy offers outstanding adherence and flexibility. It meets the exacting demands of abrasion resistance called for in high-speed winding machines.

ELECTRICAL PROPERTIES

Epoxy magnet wires exhibit high dielectric strength—a minimum of 2000 volts per mil under dry test conditions. The following are dielectric constant and dissipation factor measurements at 25°C and 50% RH:

Frequency Cycles per Second	Dissipation Factor %	Dielectric Constant
60	0.37	4.63
1,000	0.48	4.60
10,000	0.96	4.55
100,000	1.95	4.45

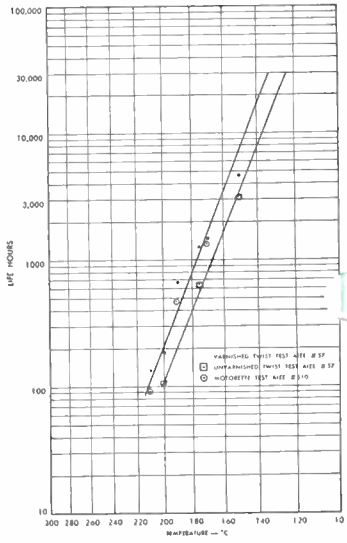
CHEMICAL PROPERTIES

Epoxy offers outstanding chemical characteristics. The Epoxy resins are characterized by their resistance to attack by compounds they may come into contact with when used in electrical apparatus. Epoxy shows exceptional resistance to 5% potassium hydroxide, 5% sulphuric acid, VM&P naphtha, ethyl alcohol, xylol, toluol. Epoxy wire has given excellent results in test programs designed to determine the effects of fluorinated hydrocarbon refrigerants. Scrape abrasion resistance is high under Freon. Freon 22 does not blister and attack the coating. Epoxy does not hydrolize in closed systems.

Epoxy is outstanding in its behavior in transformer oils. It will also withstand the action of lubricating oils at high temperature. In fact, such oils sealed in glass tubes with Epoxy wire and heated to 150°C do not damage the insulation, even when the oils have been contaminated by long use.

THERMAL PROPERTIES

Epoxy is a 130°C (Class B) magnet wire. This rating is based on AIEE test procedures. The wire is also intended for use at lower temperatures where the choice may be made to take advantage of some other characteristic. It also can be used at higher temperatures for shorter life or in some special applications. Please refer to the thermal stability chart.



Thermal stability, Epoxy round magnet wire

THERMOPLASTIC FLOW. Epoxy magnet wire meets the 200°C minimum requirement of Specification MIL-W-19583 for 130°C systems.

RETENTION OF FLEXIBILITY. Epoxy magnet wire can be heated for 168 hours at 125°C and then wound on its own diameter without cracking.

HEAT SHOCK. Epoxy magnet wire offers outstanding heat shock characteristics, as indicated by the following table (Wires are stretched or not stretched, then wound on mandrels having X times the diameter of the wire and placed in an oven at 155°C for one hour):

Prestretch %	1X	3X	5X	10X
0	Pass	Pass	Pass	Pass
10	Fail	Pass	Pass	Pass
15	Fail	Pass	Pass	Pass
20	Fail	Pass	Pass	Pass
25	Fail	Fail	Pass	Pass

MOISTURE RESISTANCE

Epoxy magnet wire can be used when sealed in electrical apparatus where water is contained in other materials. Small coils in water at room temperature for 18.000 hours (2.1 years) maintained a very high insulation resistance between the copper and water. Epoxy wires sealed in glass tubes with a small amount of water can be heated for a month at 150°C without destruction of the enamel coating.

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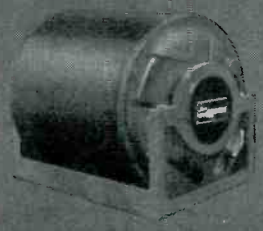

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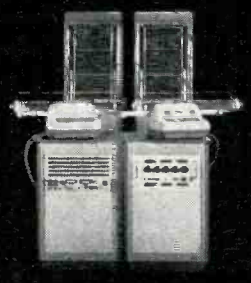

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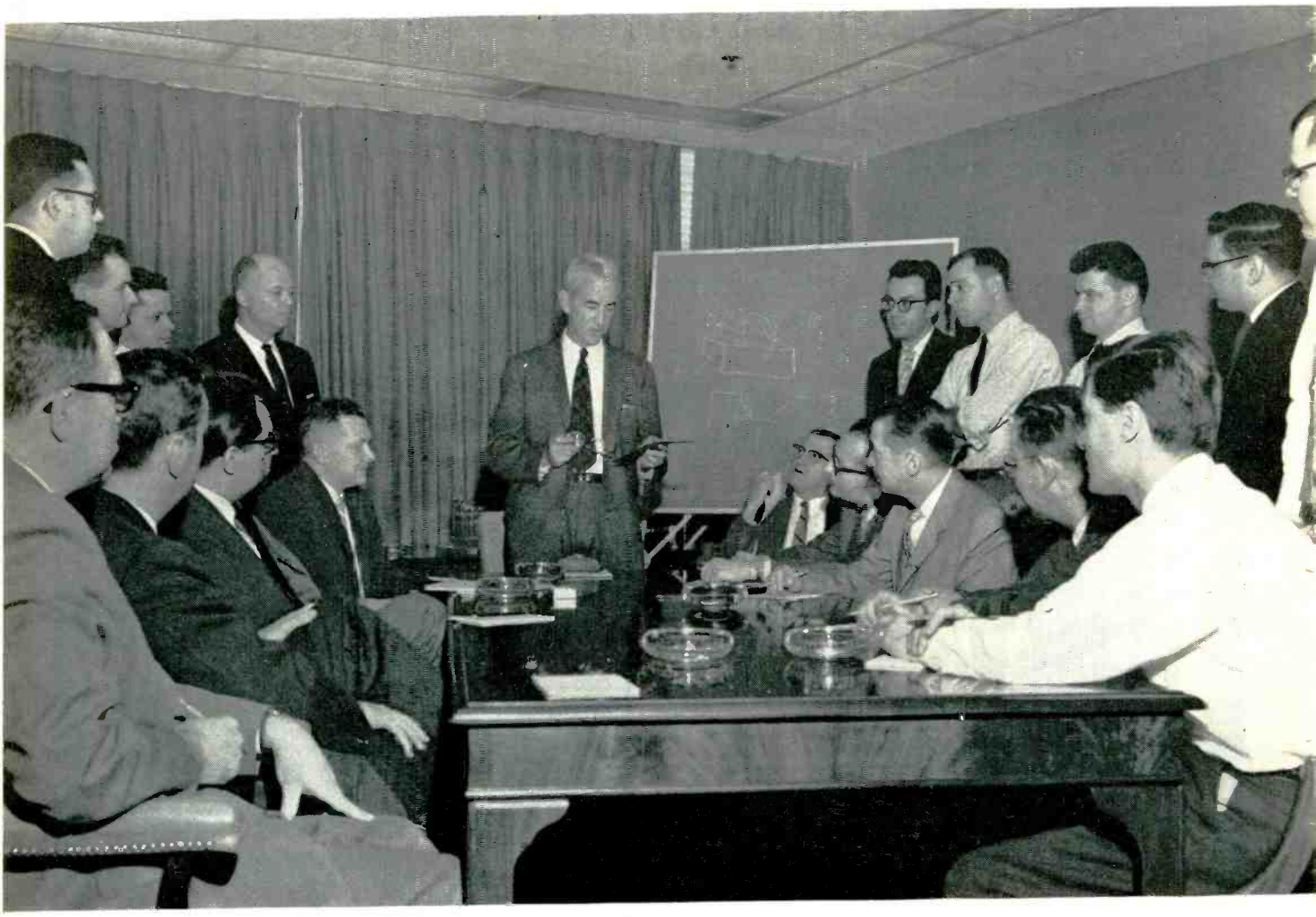

Bill MacDonald, 33 years an Editor, Feeds a Growing Boy

Electronics, like a growing boy, has a voracious appetite — an appetite for information about technical developments, new markets, business potentials . . .

electronics magazine has the job of feeding information to the industry in a balanced editorial diet so that the quality and quantity of editorial will more than meet industry requirements.

Editor W. W. MacDonald inspires respect from his 26-man editorial staff, and justly so. Mac has been, successively, an Associate Editor, Executive Editor and then Editor of *electronics*. Before joining *electronics* he had been Managing Editor of "Electrical Merchandising" and Editor of "Radio Retailing." A senior member of the Institute of Radio Engineers, he has devoted 33 years to editing McGraw-Hill publications.

Mac is responsible for *electronics* editorial. True, he has far more assistance from his highly trained, professionally mature staff than do most business publication editors. Fifteen members draw upon direct engineering experience in the electronics field. Four editors gained electronics experience in the armed services. Four others came to *electronics* with backgrounds in journalism, finance, and marketing. The balance of the staff comprise the Art Director and his assistants.

But the Editor of *electronics* is a perfectionist and never satisfied. He is constantly raising the standards by researching his readers, going into the field, sounding out his staff.

And what does Mac's editorial contribution mean?

That the reader of *electronics* is kept best informed about his industry, and is therefore most apt to progress in it. If your subscription to *electronics* is expiring, if you're not a subscriber, fill in the box on the Reader Service Card. It's easy to use. Postage is free.

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Computer Bureaus Expanding

Quick solutions to problems and pay-as-you-go charges are attracting increased numbers of customers to computer service groups

INCREASING NUMBERS of businessmen are turning to computer service bureaus to make use of the latest problem-solving equipment.

Computer service organizations fall into three general categories: the manufacturer's subsidiary, the academic and the privately owned. Of these, the greatest volume of commercial work is probably handled by manufacturer's subsidiaries.

In establishing service bureaus, the manufacturer has an ideal opportunity to show customers how computers may fit into a company operation. Subsidiary groups are not, however, mere salesrooms.

How Plan Works

Subsidiary organizations sometimes have their own sales forces, and operate independently of their parent firms. One such group is the Service Bureau Corp., a subsidiary of International Business Machines. The subsidiary has 80 branch offices throughout the U. S.

Its services are offered on an hourly basis. A customer wishing to use an IBM-704 computer pays a flat rate of $685 an hour if the operation is handled by branch office personnel. If the customer's own staff operates this equipment, the charge is $685 an hour for the first two hours and $350 for each additional hour. The service organization has a working force of 1,500 full-time employees and may, during peak periods, make use of as many as 1,000 additional. Technical personnel in data-processing centers, for the most part, are mathematically oriented and specially trained in computer work. Jobs the company performs range from high-level defense work to finding suitable names for new pharmaceutical products.

Electrodata, a division of Burroughs Corp., operates a data-processing bureau with offices on the east and west coasts. Electronic Associates Inc., maintains three computer centers in Princeton, N. J., Los Angeles, and overseas in Brussels. The centers use analog equipment which rents for $45 an hour for a 60-amplifier computer. The services of programming engineers are available for an additional $15 an hour.

Other Bureaus

Privately-owned computer service bureaus are still somewhat rare for a variety of reasons. The capital investment needed to set up a computer service is considerable and extends beyond the initial purchase or rental of equipment.

Computers of any size require special environments. Rooms must be air-conditioned, floors must be able to carry the weight of the chassis. In addition, the volume of business must be high and constant to make the operation self supporting.

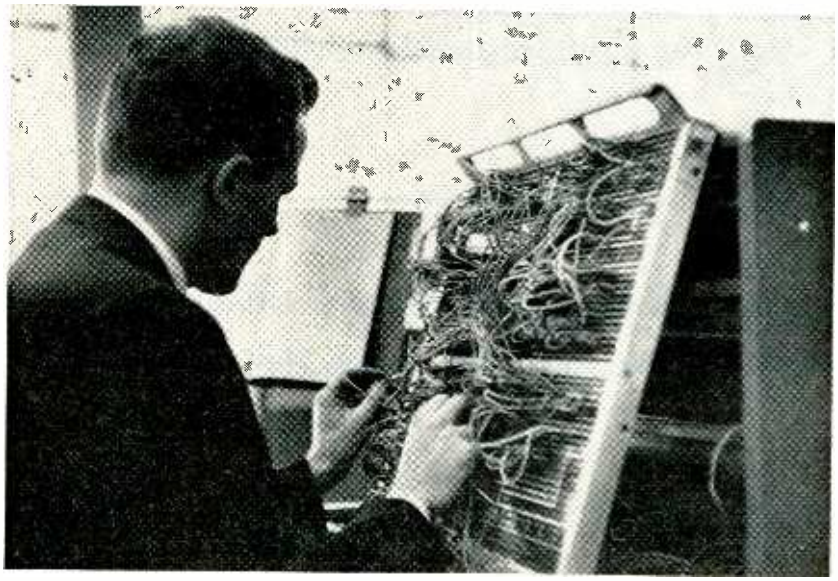
One privately-owned group estimates that during amortization a 16-hour workday for the computers represents a break-even point. Fortunately, such workdays are very often required since customers are usually in a hurry to get the results.

A further obstacle to successful private operation is the requirement of trained personnel. In many cases, small firms just getting started have difficulty attracting talented men.

The typical analog computer operator, according to Dian Laboratories, N. Y., must be a soundly experienced engineer, physicist, or aerodynamicist with a feel for mathematics. The four-year-old firm has increased its capital investment about fourfold since its establishment. In addition to purchased analog equipment, the firm has used a portion of its income to design and build its own analog computer, the Dian-120.

Most of the firm's customers supply information in mathematical form. Bureau employees then make schematics and set up the programming. Some of the work areas served include reentry problems for missiles, reactor control systems, and training devices to simulate the motion of ships and aircraft.

Academic institutions sometimes maintain service bureaus which, for the most part, function differently from the subsidiary and the privately-owned bureaus. As the head of one institutional center expresses it: "Our main job is to solve problems for our own study groups. If there is any time left over, we can use it on outside work."



A program board is readied for insertion in an IBM digital computer

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Interference Findings

Special aeronautics committee cites hazards passenger-carried electronic devices cause to airlines' communication equipment

MORE FINDINGS were revealed this week from a study of interference hazards passenger-carried electronic devices are causing to airline transport navigation and communication equipment.

Carrying out the investigation is Special Committee 88, appointed by the Radio Technical Commission for Aeronautics. It was set up last fall, after several airline pilots had reported interference with their communications, navigation and integrated flight instrument systems.

Here are some of the recommendations RTCA has made to date:

Recorders and dictaphones that comply with military standards are not considered a source of interference. The committee has requested the Federal Communications Commission to set up a program requiring that such equipment be visibly marked as meeting, or not meeting, these standards.

The committee is still studying the problem of portable a-m and f-m radio receivers and tv sets. Objective is to determine the tolerance of airborne equipment to radiation and, at the same time, the amount of radiation created by each type of passenger-carried gear.

Until such time as the matter is cleared up, RTCA recommends as a precautionary measure that portable radios not be operated in aircraft in flight.

Hearing aids have been given a clean bill of health.

Incidents

One of the first incidents reported took place on an American Airlines transport in Jan. 1957. Sudden erratic behavior of the pilot's vor needle was traced to a foreign-made portable super regenerative radio receiver, tuned in on the aeronautical band.

Two more incidents were reported by the Air Transport Association last August. One involved interference caused by a bias oscillator in a portable recorder. The other was a transistorized radio which caused oscillation of the pitch bar in the plane's integrated flight system.

National Airlines made tests using a German-made a-m, f-m radio receiver. The f-m band caused disturbance to vor navigation receivers, making them unreliable at more than 25 miles from the station. Increased interference as the portable radio was moved closer to the cabin windows indicated that the signals radiated through the window and were received by the antenna outside the plane.

ATA said, when the report came out, that "the FCC and industry standards for minimum radiation from portable devices cannot be depended on to prevent erratic operation of airline navigation, communication and flight instrument devices."

Notices Go Out

ATA further recommended that airlines require passengers to turn off personal electronic devices during flight. The memorandum expressed a dim view of letting the stewardess "check" the equipment for possible disturbance. "There

Preparing for Tests

Environmental testing centrifuge at Convair-Astronautics

Revealed

are hundreds of navigation and communication channels provided in airline electronic systems. The combination of channels in use at the time the stewardess makes the test may well change during the flight."

The following month, the Federal Aviation Agency (then CAA) issued a notice to airmen to be on the lookout for passengers operating electronic devices while the plane was in flight.

Airlines have reacted to the problem with various degrees of concern. One airline directs its stewardesses to test the set by borrowing it from the passenger and walking toward the cockpit. If the pilot notices any erratic motion of his instruments, the passenger is asked to turn the equipment off or to sit behind the wing of the plane.

Two other airlines say they have never had incidents of interference and therefore have taken no action.

Until stricter regulations come out, manufacturers see no need to alter present design of their products. One large manufacturer of portable radios says its sets are superheterodyne and well within FCC radiation limit standards.

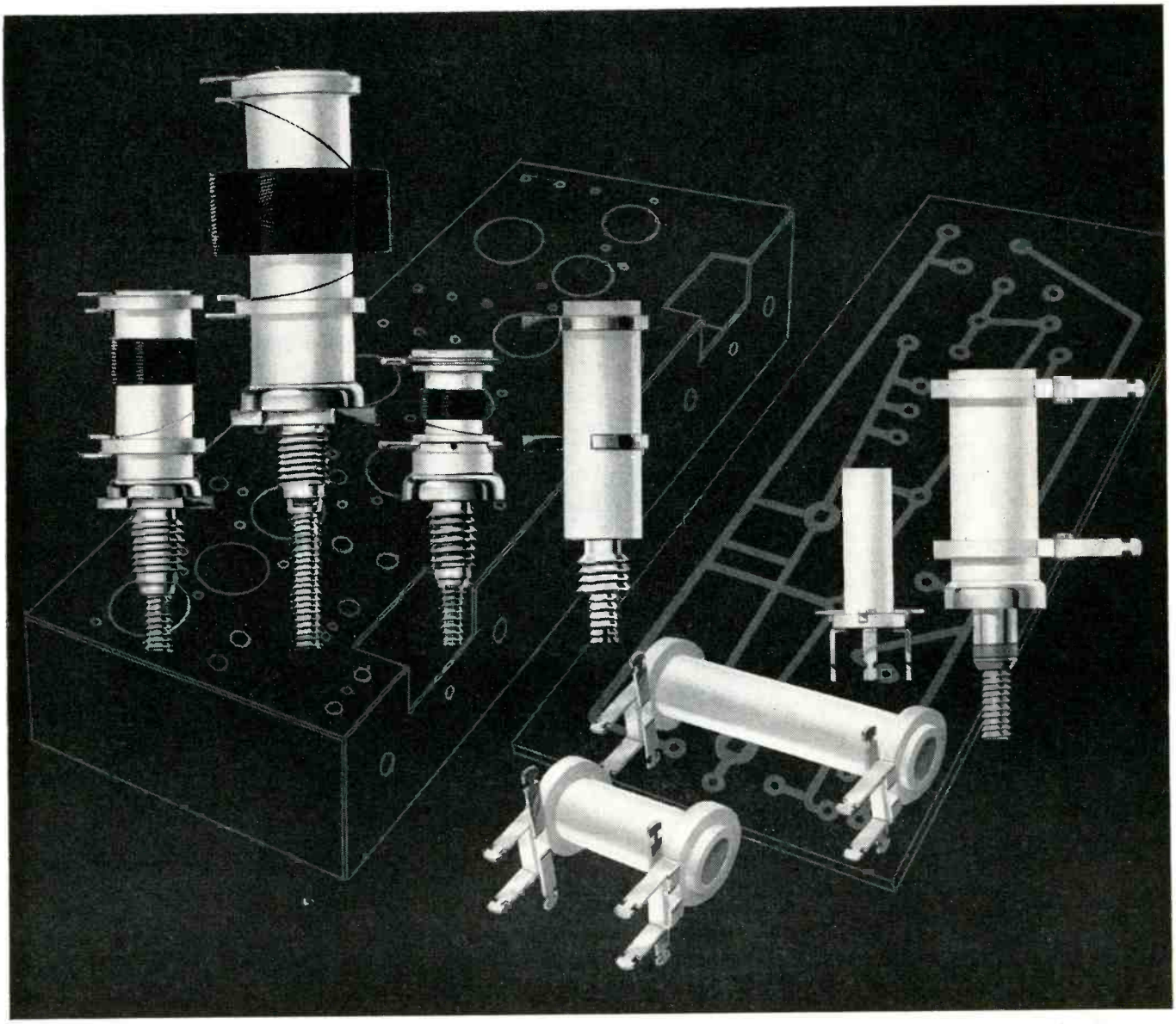
RTCA's Special Committee 88 expects to finish its tests by July.

Canada Buying 84-ft Telescope

WORK WILL BEGIN this month on erection of an 84-foot radio astronomy telescope at the new Dominion Radio Astrophysical Observatory near Penticton, British Columbia, 175 miles east of Vancouver.

A "twin" of the telescope at the Naval Research Laboratory in Riverside, Md., the polar mounted parabola was built by D. S. Kennedy & Co. of Cohasset, Mass., for the Canadian Bureau of Mines and Technical Surveys, and was transported the 3,200 miles on a 30-car freight train.

First program at the new station will be at the 21 cm, hydrogen line, frequency. Scanning type receiver for the purpose is being supplied by Ewen-Knight Corp. of Needham, Mass.



CAMBION standard coil forms cover the widest range of requirements. In addition to types for standard circuits, printed circuit types, designed to eliminate a separate soldering operation, are available in horizontal or vertical mounting styles, the latter including ceramic units with fiberglas collars.

Big variety...big advantages

To the already huge family of CAMBION® coil forms, ceramic and phenolic, new members are constantly added to meet increasing needs. Like the complete CAMBION line, they meet or better government specifications in every detail. CAMBION standard coil forms, designed for use in any type of circuit, can be custom-wound whenever required. Windings can be single layer, close wound or spaced, single or multiple pie. New coil forms are custom-designed to solve new problems.

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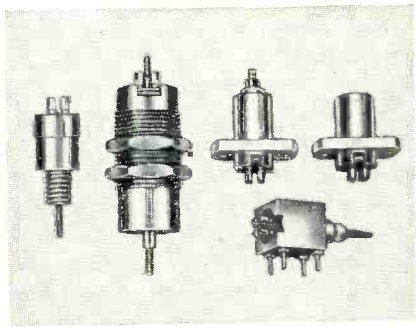

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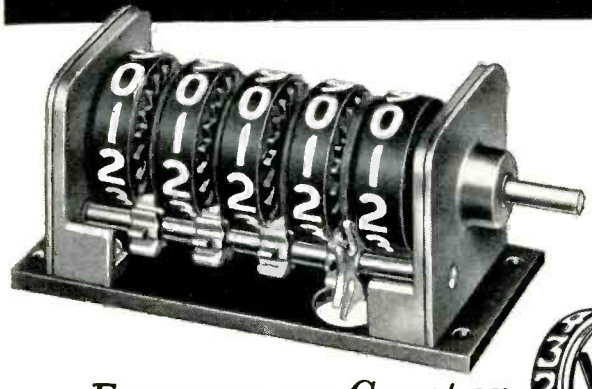

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New Roadside Radio System

Low-frequency system may permit sending information and voice safety signals to motorists

AN EXPERIMENTAL low-frequency radio system that may relay hundreds of information and voice safety signals to motorists was demonstrated recently by General Motors Research Laboratories and GM's Delco Radio division.

The system, dubbed Hycom, consists of low-frequency transmitters spaced along the highway and transistorized receivers in cars, either separate units or combined with the car radio.

How It Operates

Hycom operates whether the car radio is off or on. If the radio is on, it is muted until the voice message from the roadside transmitter is completed. If the radio is off, the transmitter can signal turn-on of the car radio's transistor output stage and put the message through the loudspeaker.

The system uses transistors and ferrite-rod antennas. Designed to operate in the 10 to 20-kc range, it is an electromagnetic induction system with a highly controlled signal that can be detected only near the transmitter antenna. Broadcast zones can be arranged so they don't overlap.

Use of transistors in the receivers makes it possible for receivers to operate continuously when the car ignition is on without heavy battery drain.

In a national emergency or a local disaster, such as a flood or tornado, motorists heading for a danger area could be warned to stop, get off the road or head for the nearest safety area.

Receiver unit could also be temporarily installed, says Delco. For example, a driver entering a turnpike might have a rental unit plugged into his car radio and return it as he left the turnpike.

Transmitters can be operated with above-ground antennas or wire loops buried in the roadside. They are modulated by a tape message repeater in a cartridge.

The system may also be applied to trains, taxiing aircraft or small boats in docking zone, says Delco. Military uses such as directing truck convoys are possible.

Explaining Army Field Computers

Models of MOBIDIC (mobile digital computer) for Army field use are described by officials of prime contractor Sylvania

MEETINGS AHEAD

May 18-20: Instrumental Methods of Analysis, ISA, Shamrock-Hilton Hotel, Houston, Tex.

May 18-20: Electronic Parts Distributors Show, EISC, Conrad-Hilton Hotel, Chicago.

May 19-21: American Institute of Electrical Engineers, Middle Eastern District Meeting, Lord Baltimore Hotel, Baltimore, Md.

May 21-27: Transistors and Assoc. Semiconductor Devices, International Convention, Institution of Electrical Engineers, Earls Court, London.

May 25-27: National Telemetering Conference, ARS, IAS, AIEE, ISA, Brown Palace & Cosmopolitan Hotel, Denver.

June 1-3: Microwave Theory and Techniques, National Symposium, PGMIT of IRE, Paine Hall, Harvard Univ., Cambridge, Mass.

June 4-5: Production Techniques, National Conference, PGPT of IRE, Villa Hotel, San Mateo, Calif.

June 7-11: Microwave Tubes, International Congress, Verband Deutscher Electrotechniker, VDE, Brienner Strasse, Munich, Germany.

June 8-11: American Rocket Society, Semi-Annual Meeting, El Cortez Hotel, San Diego, Calif.

June 15-20: Information Processing, International Conf., UNESCO, PGEC of IRE, AIEE, ACM, UNESCO House & Palais de Exhibition, Paris.

June 15-20: Electromagnetic Theory Symposium, USSI, PGAP and PGMTT of IRE, Univ. of Toronto, Ontario, Canada.

June 16-18: Circuit & Info. Theory, International Symposium, PGCT & PGTT of IRE, Univ. of Calif., Los Angeles.

June 21-26: American Society for Testing Materials, Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 24-26: Nuclear Instrumentation Symposium, ISA, Idaho Falls, Idaho.

June 24-27: Medical Electronics, International Conf., UNESCO, CIOMS, PGME of IRE, Rockefeller Inst., UNESCO House, Paris.

There's more news in ON the MARKET, PLANTS and PEOPLE and other departments beginning on p 88.

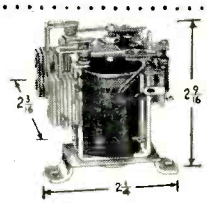
for a host of control applications

RELIABILITY coupled with low cost are two factors which place the MR series relays high on P&B's best seller list. They are being used in a multiplicity of designs . . . transmitters, street lighting equipment and small motor starters, to name but a few.

Both AC and DC models are available, with AC coils ranging up to 440 volts. All are adaptable for printed circuit mounting. The wide variety of contact arrangements include:

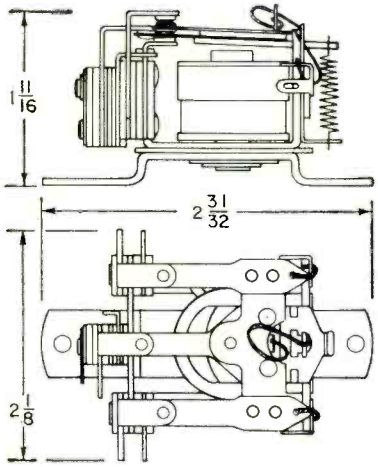
SPST-NO	SPST-NC-DB	DPST-NC	3PST-NC
SPST-NC	SPDT	DPDT	3PDT
SPST-NO-DB	DPST-NO	3PST-NO	

For more information about this medium duty, compact relay, call or write today—or get in touch with the P&B sales engineer nearest you. See our complete catalog in Sweet's Product Design File.



LM SERIES: Plate circuit relays similar to the MR. All sp and dp contact arrangements shown above are available. Coils are wound to specified resistances up to 58,000 ohms max. Sensitivity ranges from 15 mw min. (single pole) to 70 mw min. (double pole).

MR SERIES



GENERAL SPECIFICATIONS:

Breakdown: 1500 volts, 60 cycle rms between all elements.

Temperature Range:
DC —55°C. to +85°C.
AC —55°C. to +75°C.

Full-in: Approx. 75% of nominal dc voltage; 78% of nominal ac voltage.

Weight: 4 ozs.

Dimensions: 2 31/32" long x 2 3/16" wide x 2" high.

Mounting: Two 9/32" dia. holes. Can be adapted for printed circuits.

CONTACTS:

Arrangements: Up to 3pdt.

Material: 7/32" dia. silver. (Others available).

Load: 8 amps @ 115 volts, 60 cycle, resistive.

COIL:

Max. Resistance: 34,500 ohms.

Power: 1.5 watts dc; 3.25 volt-amps ac. Will withstand up to 6 watts at 25°C.

Voltages: Up to 110 volts dc; up to 440 volts 60 cycle ac.

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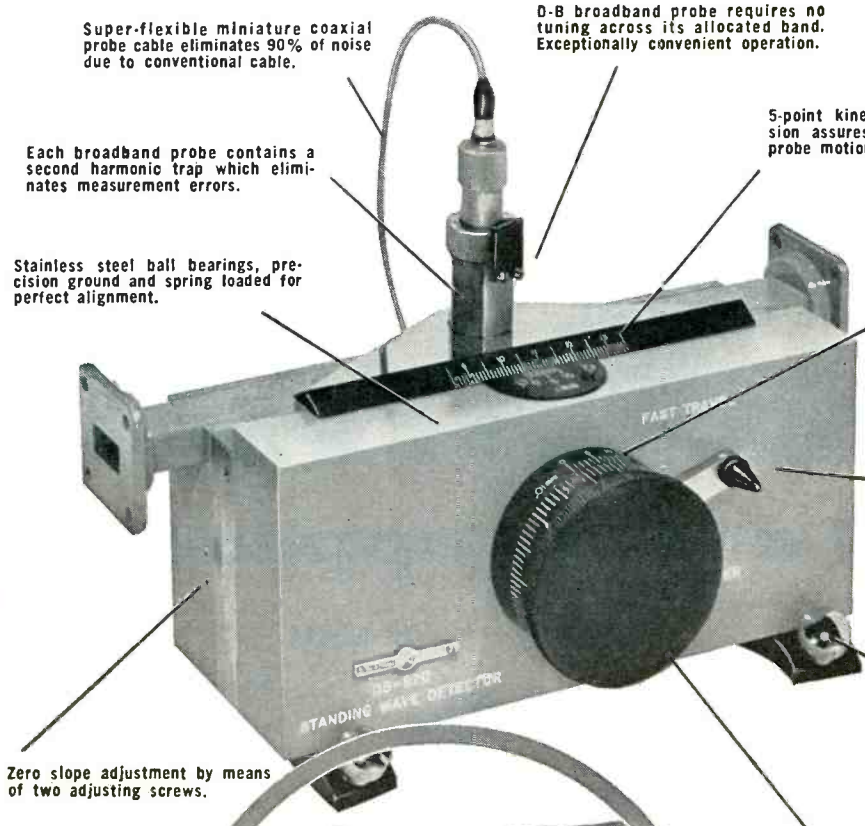

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That kind of creative engineering is a CENTRALAB specialty. As specialists in *ceramic* capacitors, CENTRALAB engineers have developed units to meet an enormous variety of difficult size and rating requirements beyond the scope of oil, mica or vacuum capacitors. The unusual designs illustrated here are typical of CENTRALAB's answers to the problems no-one else could solve. A representative group of additional specialized units are described in Bulletin #42-719. Request your free copy of this bulletin today; it will stimulate your thinking towards making full use of the design potential of ceramic capacitors.

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Precision Temperature Compensating Capacitors
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High Voltage Capacitor
12KVDCW, 2000 mmf; 30 amps at 30 mc. Unit is 6" long, 2" O.D. Extremely flexible design—can be made to a wide range of dimensions and ratings. Units that operate at 125°C. without derating can be designed.

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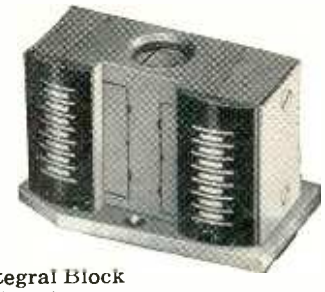

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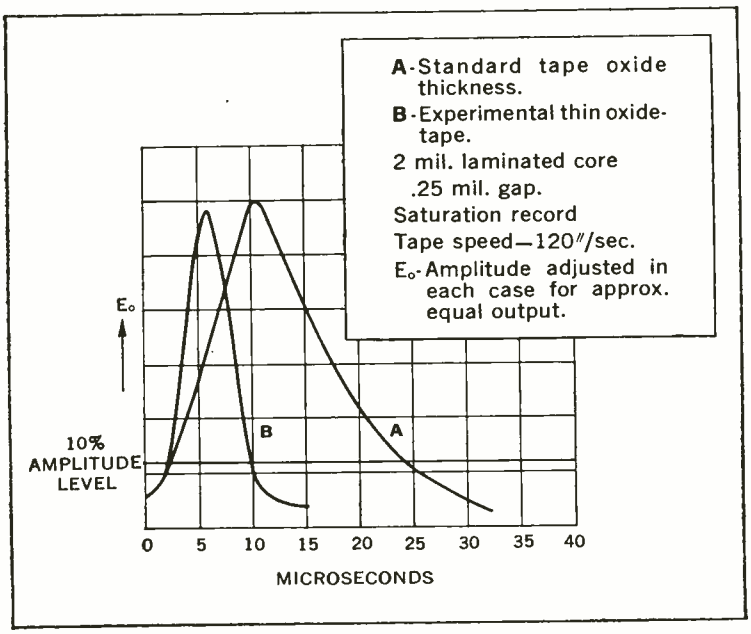

Pulse width comparison—standard and thin oxide tape.

CAPACITY— Five series of Clevite "Brush" multichannel heads give channel format variety for standard tape widths from ¼" to 2". A single block will handle up to 16 channels per inch of media width—an interlaced block up to 32 per inch. Clevite heads read pulse widths down to 1½ mils recorded to saturation on 0.3 mil coating instrumentation tape—approximately 600 pulses per inch with self-erasing saturation recording. More than 300 ppi packing is possible on 1 mil coated drums, operating 0.2 mils out of contact with a 3 mil pulse width on the drum.

ACCESS— Careful choice of material plus unique design and construction techniques enable Clevite "Brush" heads to provide uniform performance at very high processing rates. The heads themselves respond to wave lengths down to .15 mils (1.5 MC at 240 IPS) but standard instrumentation tapes and transports usually reduce the practical repetition rate of saturated recording to approximately 30 KC and 15 KC for RTZ and NRTZ respectively.

RELIABILITY — Clevite "Brush" tape and drum heads hold track width and location to ± 0.001-inch tolerance. Azimuth, contact angle and gap perpendicularity are true ± 0 deg., 5 min. and can be held even closer when required. "Gap-mounted" head (see photo) has lapped bracket and cartridge surfaces for fast replacement without critical adjustment. Redundant and interlaced (see photo) designs provide immediate checking of recorded data and higher output per channel respectively. All multichannel heads available in epoxy or full metal face (to reduce oxide pickup) at no extra charge.

* Patent Pending

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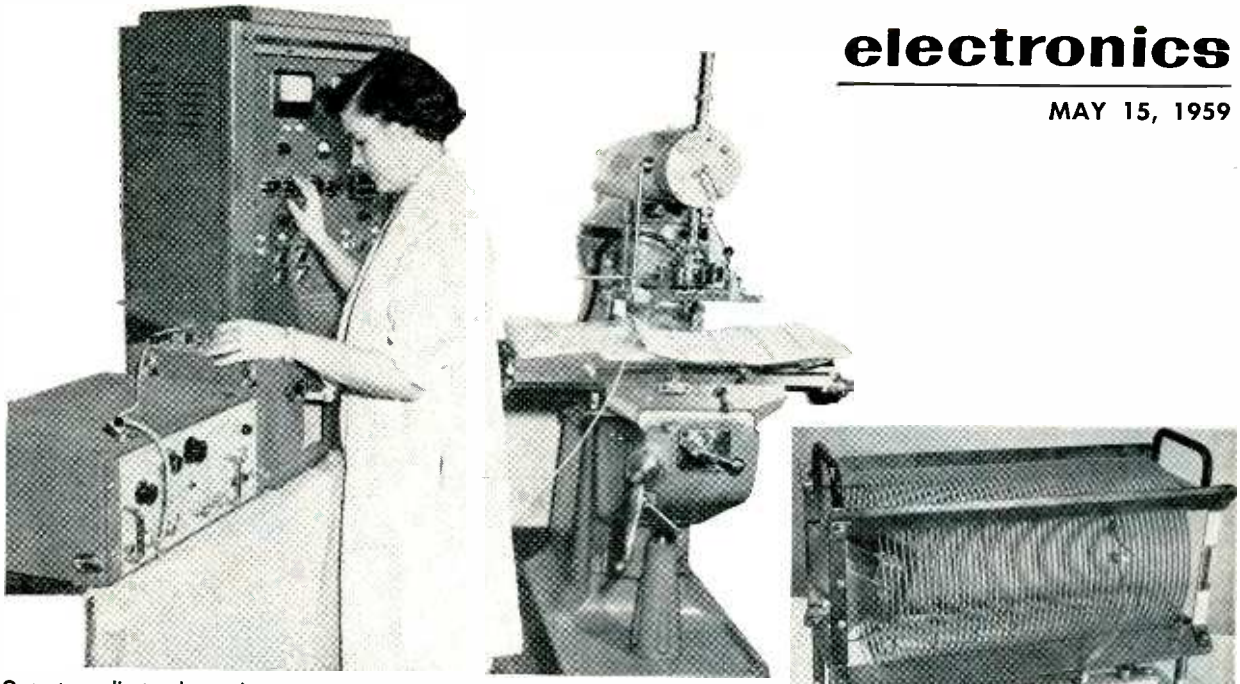

Operator adjusts ultrasonic generator. Transducer is mounted on modified milling machine (right) to give rigid support and to provide accurate positioning. Calibration of focal size and ultrasound intensity is done with precision thermocouple probe. Inset shows typical plug-in coil for low-frequency operation

Instrumentation for Ultrasonic Neurosurgery

Instrument focuses high-intensity ultrasound at precisely located regions of the brain. Radio-frequency power developed by tuned-plate triode oscillator is applied to quartz crystal driving acoustic lens

By **B. J. COSMAN,** Radionics, Inc., Burlington, Mass.
and **T. F. HUETER*,** Massachusetts General Hospital, Boston, Mass.

APPLICATION of focused high-intensity ultrasound to research problems in neurophysiology and neurology is relatively new. Recent investigations at Massachusetts General Hospital[1] and at the University of Illinois[2] have shown that precisely controlled bursts of high intensity ultrasound focused at specific points in the brain have a unique potential for both experimental and clinical neurosurgery. Using this technique it is possible to produce changes ranging from circumscribed destruction of deep-seated ganglia in the brain to subtle alterations of central nervous system function.

DESIGN CONSIDERATIONS — Ultrasonic neurosurgery involves the production of sound intensities on the order of 1,000 w/cm² at accurately positioned points in the brain, focused in such a manner that minimal or zero effect results in surrounding tissue. Instrumentation includes an r-f power oscillator, a piezoelectric transducer and an acoustic focusing device.

Small focal areas are more easily achieved with increasing frequency, but attenuation of ultrasound increases with frequency.[3] A generator with a range of frequencies from 900 kc to 5 mc and capable of delivering up to 100 acoustic watts to the loading medium (the brain) will, after attenuation in the tissues, produce focal conditions with the desired sound intensity and area of effect.

To minimize tissue heating, sonic radiation is usually delivered in pulses. The search for optimal dosage administration techniques has made it mandatory that the pulses be square so that meaningful correlation of data is possible on the effect of vari-

* Now with Raytheon Manufacturing Co., Wayland, Mass.

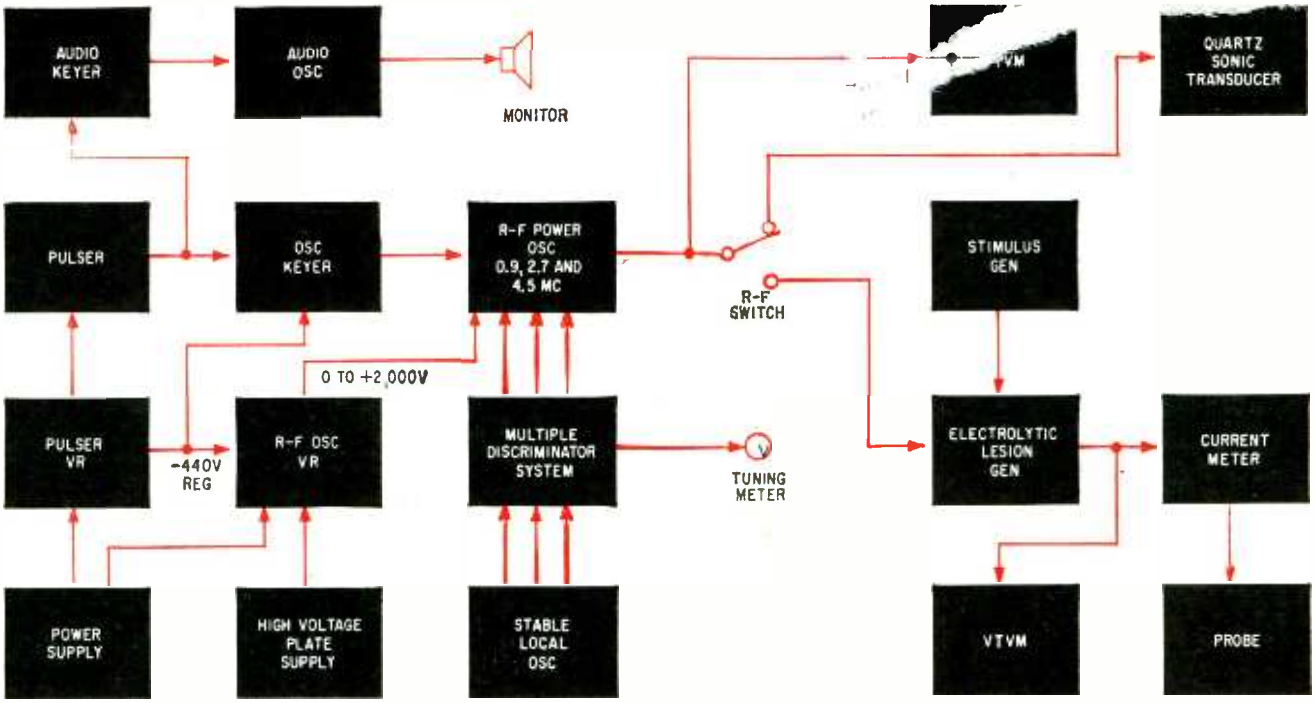

FIG. 1—Precision ultrasound generator. High voltage plate supply is closely regulated to produce flat-topped pulses of prescribed amplitude

ation of pulse height, duration, number or duty cycle, or any combination of these variables.

The ultrasound generator must produce radiation at power levels within 1 db of any prescribed level between 0.05 and 100 acoustic watts without correction of amplitude after radiation has begun. Since this characteristic is of utmost importance, the choice of r-f generator and transducer is made solely on the basis of calibration stability.

SYSTEM OPERATION—Basic functions of a precision ultrasound generator suited to the continuously varying requirements of laboratory and clinical neurological research are shown in Fig. 1. The r-f power oscillator provides sufficient output to drive the transducer at odd harmonically related frequencies in the 900-kc to 5-mc optimum range.

Precision pulse sequence modulation of the r-f source with wide variation in pulse lengths, repetition rate, height and preset number of pulses is required. To provide this modulation, a fast-recovery phantastron pulser with precise step variation of pulse length and prf over a wide range is used to control an oscillator keyer. The keyer normally supplies cutoff bias to the r-f power oscillator until the pulser signal removes the bias. Simultaneous aural monitoring of r-f conditions is provided by keying on a simple audio oscillator.

Since the effects of ultrasound are nonlinear in neurosurgery, it is necessary to generate flat-topped r-f pulses of preset magnitude. Plate voltage is applied to the oscillator while it is biased off and is preset to a value corresponding to known acoustic output conditions when the oscillator is pulsed on.

A regulated plate supply is required to maintain the preset value of d-c plate voltage when the oscillator plate current is keyed on. Regulation is required over a range from +40 to +2,000 v at currents up to 200 ma. A low-voltage regulator supplies power to the pulser circuit, bias to the oscillator keyer and reference voltage to the plate supply voltage regulator.

A vtvm is provided for calibration and tuning. When tuning, a dip occurs as the oscillator frequency is varied through the resonant frequency of the quartz crystal load. To indicate whether the oscillation is below or above the load resonance, a multiple heterodyne discriminator system preset for each frequency can be used.

Local oscillator signals are obtained from stable local oscillators which can be zeroed in on the transducer crystal frequencies. A tuning meter indicates whether the r-f oscillator is tuned high or low with respect to the crystal. Quartz crystal controlled oscillators are not satisfactory because the sonic transducer crystal resonant frequency changes slightly depending on the characteristics of the acoustic load on the transducer.

TRANSDUCER—A quartz plate transducer must be used because of its low loss and high piezoelectric stability even when subjected to driving voltages necessary to produce outputs approaching 100 acoustic watts. As shown in Fig. 2, the transducer is essentially an air-backed quartz crystal plate mounted in a water-tight rhodium-plated brass housing. The exposed surface of the quartz is silvered and maintained at ground potential while

Table I—Tank Circuit Conditions

Freq in kc	E_{rf} in v	I_c in amp	I_t in amp	Tank kva
900	3,160	2.4	2.9	9.2
2,700	3,160	7	8.7	27.5
4,500	3,160	11.7	14.5	45.9

coupled by [illegible] special high-voltage electrode [illegible] axial dri[illegible]ng cable.

Design of the backin[illegible]trode permits it to excite the largest possible are[illegible] the crystal without arc-over to the housing from the high r-f driving voltage. The electrode is spring-loaded to maintain contact with the crystal.

Waterproofing is necessary since certain experiments call for total immersion of the sound head. To prevent the heavy coaxial drive cable from interfering with positioning of the sound head and yet keep it well away from the acoustic loading medium which is sterile, the cable connecting gland is oriented at a 60-deg angle with respect to the transducer axis.

To achieve the desired focused sound intensities, the quartz plate is coupled to a polystyrene acoustic lens. Since an X-cut quartz plate for 900-kc fundamental resonance is about 3.2 mm thick, it can withstand the strains of mechanical clamping in the water-tight housing and coupling to the lens system.

ACOUSTIC LENS—Focusing can be achieved under certain conditions of refraction of ultrasound waves in passing through media of differing sound velocity. Best results were obtained by using a planoconcave lens made of polystyrene whose concave surface is machined perfectly spherical.

For small lens apertures, the radius, r, of the concave face is given by $r = f\ (n - 1)/n$, where n is the index of refraction and f is the focal length. Interposition of the lens decreases the acoustic loading on the quartz plate by a factor of about two because acoustic impedance of the plate differs from that of the coupling liquid.

CABLING CONSIDERATIONS—Major problems in r-f generator design arise out of the physical requirement that the transducer must be placed at the end of a flexible cable and that the transducer housing must be as small as possible. Matching networks located at the crystals were ruled out for both physical and electrical reasons.

A crystal can be operated at odd harmonics of its fundamental thickness resonant frequency, and be-

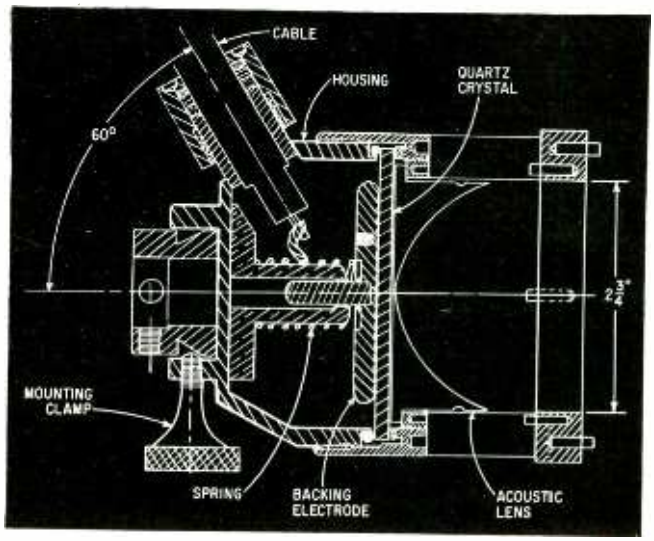

FIG. 2—Sectional view of ultrasonic transducer

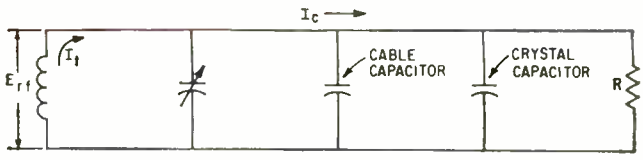

FIG. 3—Equivalent tank circuit for crystal-cable combination

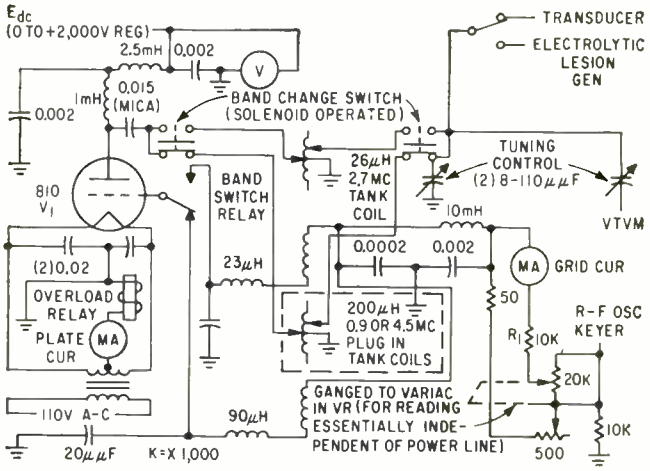

FIG. 4—Power oscillator uses tuned-plate with tickler feedback

cause it appears essentially as a capacitive impedance at these frequencies, can be driven by a nonresonant cable. The cable-crystal combination thus becomes part of the output tank of the r-f generator and appears electrically as shown in Fig. 3. Because the cable capacity usually is many times the crystal capacity, cable input current is primarily determined by cable length. Optimum Z_o for the cable is about 75 ohms since higher impedance cables lose center conductor current-carrying capacity much faster than their capacitance per foot decreases.

With five feet of RG-15/U, the total tuning capacitance is found to be 32 $\mu\mu$f (crystal) plus 100 $\mu\mu$f (cable) plus 28 $\mu\mu$f (tuning) or 160 $\mu\mu$f on all bands. For 100 acoustic watts output, E_{r-f} equals 3,160 v rms or 4,450 v peak. The condition in the tank circuit for various frequencies is shown in Table I.

Since there is a heavy circulating tank kva, the circuit components bear little resemblance to the conventional 100-watt tank. Coils are extra heavy duty commercial inductors and band switches are double-solenoid operated antenna-changeover types capable of withstanding both high r-f voltage and high r-f contact current. Means must be provided for presetting the controls which affect power output so that any arbitrarily chosen power level can be established over a 2,000:1 range. Thus, it is necessary to preset with a meter some quantity which has a specific and stable correlation to E_{r-f}.

POWER OSCILLATOR—In the final phase of equipment development, oscillator-amplifier systems were not considered because they became too complex for multiple frequency operation in a hospital or clinic. Also, oscillator-amplifier systems cannot be readily arranged to deliver a closely prescribed r-f voltage which must be preset and yet vary over a wide range. Use of a triode power oscillator permits E_{r-f} to be a

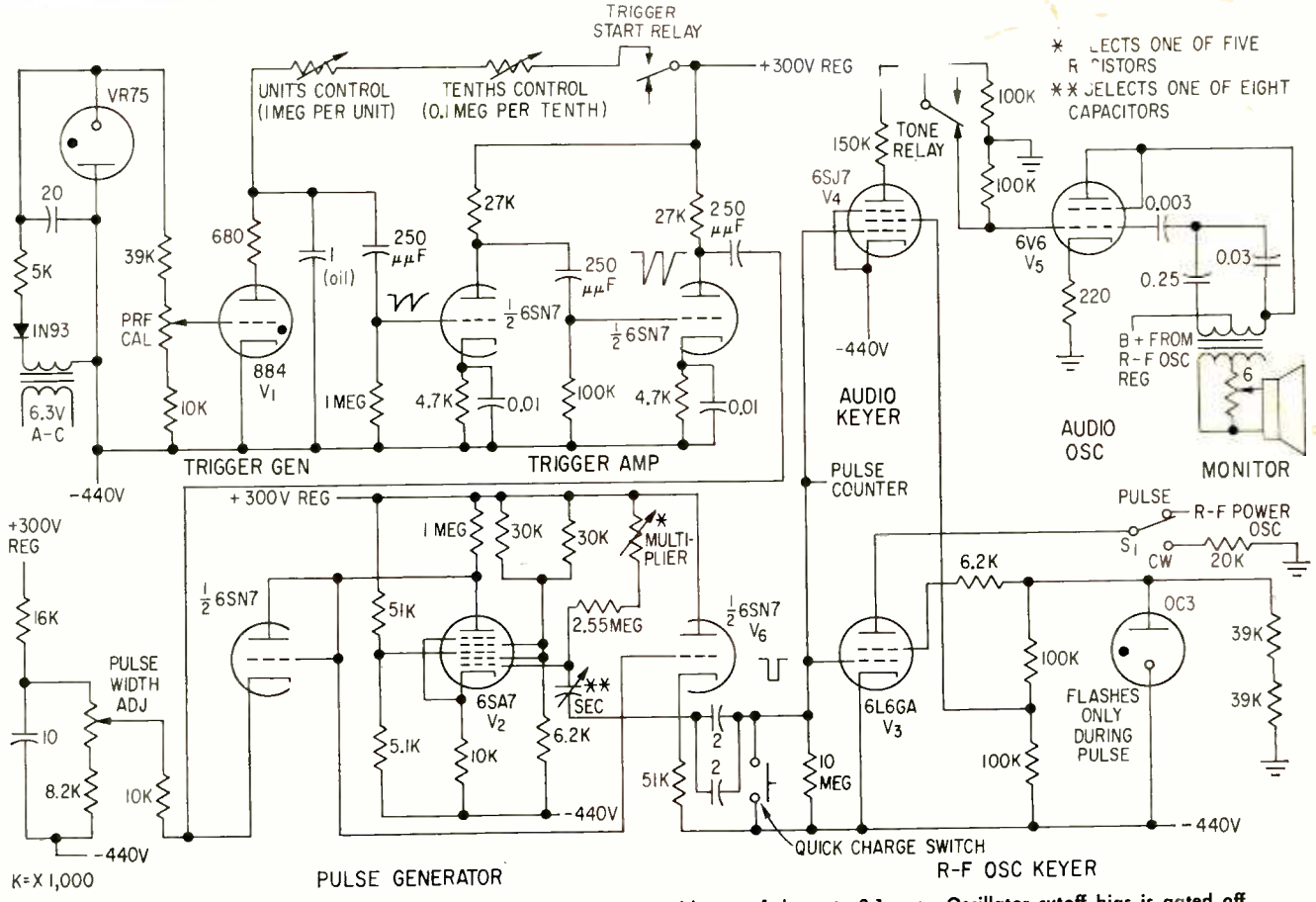

FIG. 5—Oscillator keying circuits generate keying pulses up to 2 sec wide at prf down to 0.1 pps. Oscillator cutoff bias is gated off during pulse operation and switched off during c-w operation

direct function of the plate supply voltage when all other conditions are fixed.

A schematic diagram of the tuned-plate triode oscillator used is shown in Fig. 4. The circuit oscillates at any setting of the tuning control and E_{r-f} takes a sharp dip as the frequency is varied through the resonant frequency of the load. This characteristic is displayed more clearly on the vtvm than is the corresponding increase in cathode current.

When a power oscillator is used to drive a sharply resonant load, care must be taken to prevent frequency pulling away from the load resonant frequency. To derive maximum power output for a given plate voltage, it is necessary to increase the feedback factor by driving the grid harder. A point is soon reached at which the oscillator is pulled off the resonant frequency of the load and oscillates violently in the unloaded frequency region just above the resonance of the crystal.

Excitation of the tank circuit is through a tap on the coil, thereby allowing reasonable supply voltage to be used. The oscillator has cut-off bias except when the bias is gated off by the pulser or switched off for c-w operation. Under key-down conditions, the oscillator is self-biased by grid leak resistor R_1.

Plate voltage E_{d-c} can be preset to a value which corresponds to a predetermined value of E_{r-f}. Once the bias is keyed off, plate current flow will lower E_{d-c} unless the supply is well regulated and the voltage decay transient appears on the r-f pulse envelope. An electronic plate supply regulator is used which delivers 0 to 2,000 volts at 200 ma with line and load regulations of a small fraction of one percent.

OSCILLATOR KEYING CIRCUITS—The oscillator keying circuits are shown in Fig. 5. When switch S_1 is in PULSE position, keyer tube V_3, operating at zero bias against a −440-v cathode voltage, draws heavy plate current through grid resistor R_1 in the r-f power oscillator (Fig. 4). This action causes a bias of 380 v to be developed on the r-f oscillator grid. A negative gate from the pulse generator V_6 keys off tube V_3 allowing the 810 r-f oscillator to oscillate until the plate current of tube V_3 is restored.

Pulse-repetition rate generator V_1 is a relaxation oscillator with a trigger period variable in 0.1-sec steps from 0.1 to 10.9 sec. Fast recovery phantastron pulse generator V_2 allows precision pulsing at any duty cycle up to 90 percent and a range of pulse lengths from 0.005 to 2 sec in accurate switch steps.

Audio oscillator V_5 is keyed on simultaneously with the r-f oscillator by audio keyer V_4. This circuit provides audio monitoring of r-f output conditions.

A preset pulse counter for totaling 1 to 99,999 pulses is shown in Fig. 6. The mechanical counter is actuated by thyratron V_5 which is keyed on by the 50-millisec counter pulser driven by the leading edge of the keying pulse to tube V_3 (Fig. 5).

CONTROL—Control functions are pushbutton actuated through a set of sequence-interlocking relays. Stop-start controls turn on plate voltage and radiation. Radiation can be remotely controlled and

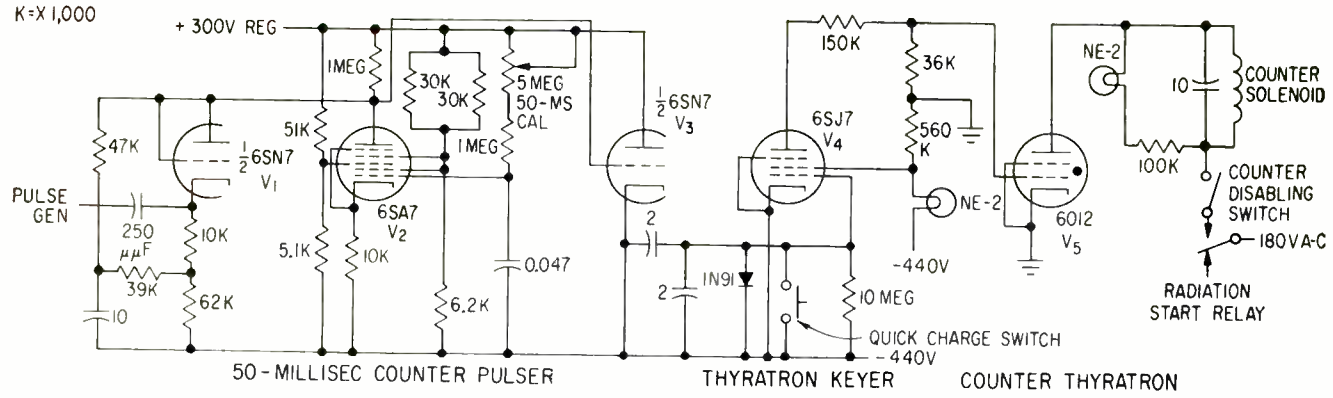

FIG. 6—Preset pulse counter automatically controls ultrasonic radiation

cut off automatically by the preset counter (Fig. 6). Band switches (Fig. 4) are large r-f contactors whose solenoid actuators are relay and pushbutton controlled. The plate voltage control is motor-operated with adjustable travel limits and indicators.

The oscillator tuning control (Fig. 4) is a variable vacuum capacitor chosen because it easily withstands high tank voltage and allows micrometer adjustment of tuning necessary for peaking on the sharply resonant crystal load. Earlier models had motor-driven tuning controls, but experience shows that dial control with a revolution counter for logging position is more satisfactory. Output voltage is measured on the four-range vtvm shown in Fig. 7.

FORMING A LESION—High sound intensities produced in the focal region of the sonic transducer causes circumscribed destruction of nervous tissue, thus creating a lesion at that point. Another method of forming lesions is to apply very high intensity r-f fields at the site. The r-f switch (Fig. 1) is used to switch the oscillator output from the quartz sonic transducer to the electrolytic lesion generator consisting of a set of special platinum wire electrode probes which the neurosurgeon inserts into the brain. When the electronic stimulus generator is turned on, the desired location of the electrodes is determined by watching the effects of the stimuli.[1] The r-f oscillator is then switched in and the vtvm and current meter give readings determined by the normal impedance of the surrounding brain medium.

Once a lesion has formed, bubbles surround the electrode and the medium impedance effectively increases. This phenomenon causes the vtvm reading to increase and the current meter reading to decrease thereby indicating to the surgeon that a lesion has been formed at the site.

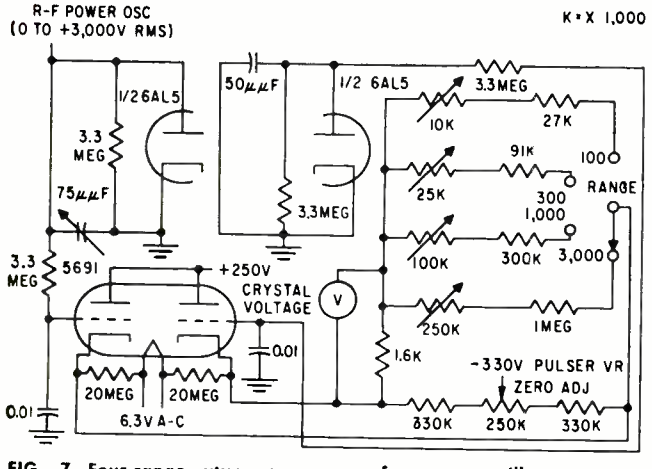

FIG. 7—Four-range vtvm measures r-f power oscillator output

APPLICATIONS—Advantages of the focused high-intensity ultrasound method over other therapeutic techniques are that it permits alteration of deep-seated brain structure without inflicting any trauma on intervening regions of the brain, and precise localization of the desired effect to small predetermined sites. A great deal of work with experimental animals has been done to determine suitable irradiation and calibration procedures and positioning techniques, and to evaluate results of histological, neurological and electrophysiological methods. Adaption of the method to some clinical uses in human patients is also in progress.

Medical applications presently considered are: irradiation of the globus pallidus or ansa lenticularis to relieve the tremor in Parkinson's disease; irradiation of deep-seated brain nuclei for relief of intractable pain; treatment of neuroma resulting from amputations or other traumatic causes; performing lobotomies in selected cases,[5] and subtle alteration of central nervous system functions.

It has been shown by animal experiments that carefully selected dosages of ultrasound focused to specific deep-seated nuclei of the brain are capable of reversal suppression of central nervous system functions without demonstrable alteration of the cellular structure. These findings are of great importance with respect to localization of the anatomical sites of certain central nervous system responses without causing permanent damage.

Problems of stereotaxic lesion placement in ultrasonic dosimetry and electrophysiological control are substantial, but practical solutions have been worked out by research teams.[1, 2]

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Automatic Controls

Automatic hue and chroma control circuits improve stability of hue, saturation, noise and pull-in characteristics of received color tv signals. Low-frequency diode gate corrects subcarrier oscillator phase from synchronous demodulator signals

By **ZBIGNIEW WIENCEK,** Senior Research Engineer, Warwick Manufacturing Corp., Chicago, Ill.

FAITHFUL REPRODUCTION of color in a color television receiver requires accurate reinstating of brightness, hue and saturation.

The brightness signal carries the information necessary for a monochrome picture, hue is the basic color to be reproduced and saturation is the degree to which a hue differs from white. When the two last quantities are represented in the color subcarrier phase diagram, hue is approximated by the phase and saturation by the amplitude of the subcarrier.

Synchronization

Color synchronization is usually accomplished by an automatic phase control loop. This loop provides the receiver with a continuous reference signal that is in phase with the received color burst subcarrier.

The color synchronizing information is encoded as short bursts of color subcarrier frequency (3.579545 mc) placed on the back porch of the horizontal synchronizing signal. In a typical automatic phase control loop the color burst is gated out, amplified and applied to a phase detector where it is compared with the crystal oscillator reference frequency. The product of comparison is then applied through a filter to a reactance tube that controls the frequency and phase of the reference crystal oscillator. The filter between the reactance tube and the phase detector largely determines the stability and pull-in performance of the loop.

Experiments show that the maximum tolerable phase error (hue) is approximately ± 10 degrees. Phase comparison accomplished at high frequencies usually has errors caused by the circuit having harmonic unbalance, leakage, nonsymmetrical layout, imposition of excessively tight component tolerances and lack of neutralization.

Another source of errors occurs in the separation of chrominance signal from reference burst signal. Factors such as line-voltage variations and warming and aging of the receiver components may have different effects on the phase relationship between the two channels. Phase errors due to the last cause may be greater than the remainder of the receiving system and as a consequence, wide-range color controls are usually provided. Such controls are considered undesirable by the average viewer.

The block diagram of a color television receiver automatic hue and chroma control circuit is shown in Fig. 1.

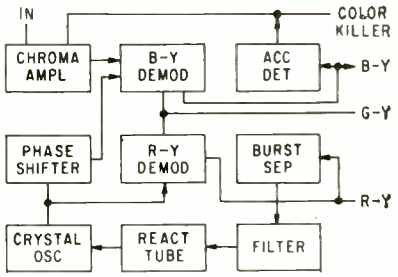


FIG. 1—Hue circuit uses *R* — *Y* signal to correct subcarrier phase and chroma circuit uses *B* — *Y* signal to establish chroma signal level

Automatic Hue Control

The output voltage of a balanced phase detector is proportional to the sine of the phase difference between the two input signals. This relationship is not unique for a balanced phase detector but also applies to the synchronous type of color demodulator usually used to recover color video information.

Synchronous demodulators therefore could be used not only to recover color information but also the color reference burst. This is possible not only because of the same functional relation for the detection of the color and burst signals but also because of the time separation between them. One signal rides on the horizontal sync back porch and the other occurs between the horizontal sync pulses.

A number of color television sets use the color difference technique for color signal reproduction. In this system, the $(R - Y)$ signal is applied to the red control grid of the cathode-ray tube, the $(B - Y)$ signal is applied to the blue control grid, and the $(G - Y)$ signal is applied to the green control grid while the Y signal is applied to the cathodes.

Analysis of a color phase diagram shows that the demodulated burst amplitude is zero along the $(R - Y)$ demodulation axis. Positive or negative values of the decoded burst are

for Color Television

obtained for the particular phase angle difference between the burst and the reinstated subcarrier.

Greater stability in color synchronization could be obtained if errors in color could be detected at the picture tube grid. The use of the $(R - Y)$ signal grid as the take-off point for the automatic hue control circuit represents one solution.

Burst Separation

The method of separating the burst from the demodulated color signal is shown in Fig. 2. Automatic hue control detector V_2 receives the $(R - Y)$ chroma signal from the demodulator and a gate signal from the horizontal flyback transformer. The R-C network in each switch leg is used to provide the proper operating point for the diodes. When the horizontal sweep is triggered by the horizontal sync pulse, the diode gate is opened to pass the demodulated burst signal.

Due to the common path of the chroma and burst signals up to the separation point, any phase error between them will be at a minimum. The output of the diode gate consists of the d-c plate voltage of the $(R - Y)$ demodulator with a voltage due to the demodulated burst superimposed on it. Positive or negative values of the decoded burst are dependent on the phase angle between the burst and the reinstated subcarrier. If the phase angle is zero, as would be the case when the $(R - Y)$ axis has the proper relationship with the burst, then the gated signal is zero. If the phase angle is other than zero, as would be the case when the $(R - Y)$ axis is wrongly positioned, the gated signal will be either positive or negative depending upon the direction of angular difference at an amplitude depending upon the amount of angular difference.

Reactance tube V_3 has cathode bias applied to balance out the $(R - Y)$ plate-voltage component. The signal that controls the reactance tube is the decoded color burst. This signal is passed through a filter to the reactance tube whose phase stability and pull-in characteristics depend upon filter design.

The low operating frequency of the diode gate with respect to the high frequency of a conventional phase detector reduces the possibility of phase error.

Automatic Chroma Control

This circuit minimizes chroma errors due to variations in signal strength of the received color signal. A maximum signal amplitude error of ±2.5 db can be tolerated.

When the automatic hue control system synchronizes the subcarrier oscillator on the basis of the $(R - Y)$ axis it automatically maintains the burst amplitude at the $(B - Y)$ axis at a constant level. The amplitude of the burst along the $(B - Y)$ axis is independent of color phase and is a function of chrome amplitude only. This amplitude determines the gain of the chroma channels to provide a constant level chroma signal to the picture tube.

Synchronous detection is accomplished at demodulator V_{1B} and the burst signal is passed to acc (automatic chroma control) detector V_4. Application of flyback transformer pulses to the acc detector gates the demodulated burst signal into integrator R_1 C_1. Gating eliminates the noise and integration averages the signal level thus providing a noise-immune acc signal.

The integrated d-c voltage at the junction of R_1 and C_1 controls the gain of the chrominance amplifiers to maintain constant color video information at the crt grids.

When a monochrome signal is being received, the d-c voltage output of the integrator, which could be used as a reference voltage for the color killer circuit, is zero.

Obtained accuracy of color phase (hue) and amplitude (chroma) is within the maximum tolerable error for the majority of observers.

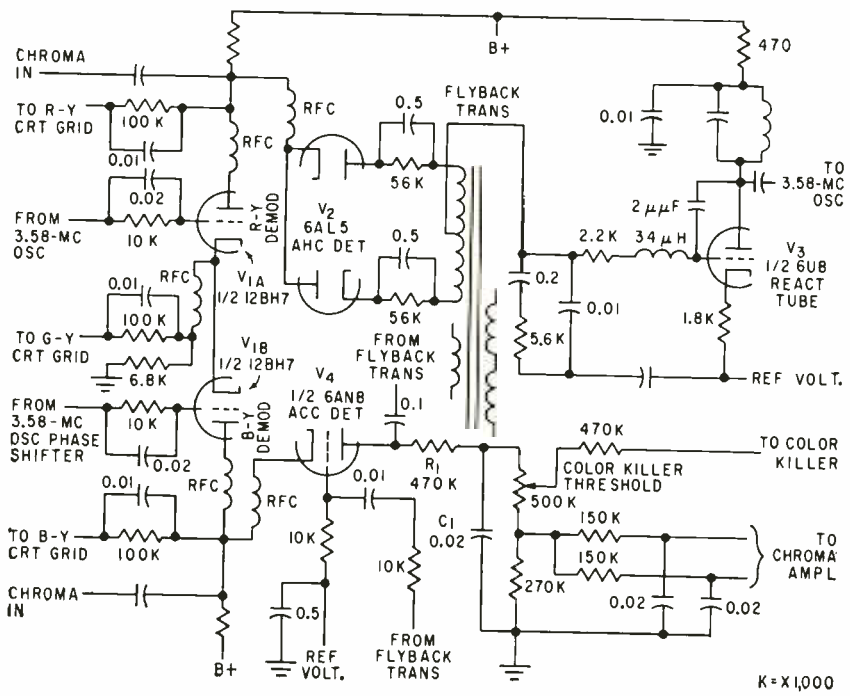


FIG. 2—Low-frequency diode gate V_2 controls phase of subcarrier oscillator and establishes signal level for chroma control circuit

Removing the Jitter

Thyratron switch generates r-f pulses used to measure ultrasonic velocity in metal test sample. Pulse jitter of less than a milliμsec improves the measurement accuracy of time interval between echo pulses

By **ROBERT L. FORGACS,** Scientific Laboratory, Ford Motor Co., Dearborn, Michigan

THYRATRONS ARE efficient switching devices but have not often been used in applications requiring low pulse jitter. The thyratron switching circuit to be described overcomes jitter and delivers relatively high-power bursts of r-f with a pulse-to-pulse time jitter of 0.2 milliμsec and a total drift of 0.3 to 0.5 milliμsec over a one-minute interval.

System

The thyratron switching circuit has been used in a system that measures ultrasonic velocity in solids[1]. A rate generator shown in Fig. 1, repetitively triggers the transmitter which contains the thyratron switch. Pulse rate is either 100 or 1,000 pps. Normally the rate is 100 pps. Pulses of sine-wave oscillations drive a quartz transducer which is mechanically coupled to the test sample. When the ultrasonic echo returns from the opposite face of the sample, the echo drives the transducer, which generates an electrical echo pulse.

The echo pulses from the transducer are amplified and displayed on the oscilloscope. A calibrated sweep, or time markers from the rate generator, indicate the time between echoes. Since the ultrasonic velocity is equal to two times the depth of the test sample divided by the indicated time, jitter must be kept low to measure velocity accurately.

Thyratron-Switch Transmitter

Pulses from the rate generator go to the grid of V_1, a secondary-emission tube (Fig. 2) used in a regenerative-driver circuit[2]. A fast pulse transformer T_1 inverts the plate pulse and doubles its amplitude. Thyratron V_2 fires, discharging storage-capacitor C_1 into the tank circuit composed of L_1, C_2 and R_1. After discharge, capacitor C_1 is effectively isolated from the tank by the thyratron. Except for the first half cycle the tank circuit produces a damped sinusoidal wavetrain that drives the transducer.

Switching Details

To minimize jitter, a thyratron-trigger pulse with a short rise time and a much larger amplitude than required to trigger a 2D21 thyratron is used. Tube V_1 produces a 200-v trigger with 0.06 μsec rise time. This amplitude is roughly 50

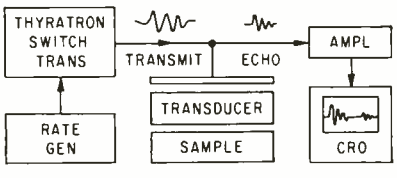


FIG. 1—Ultrasonic velocity-measuring system displays time interval between echo pulses on scope

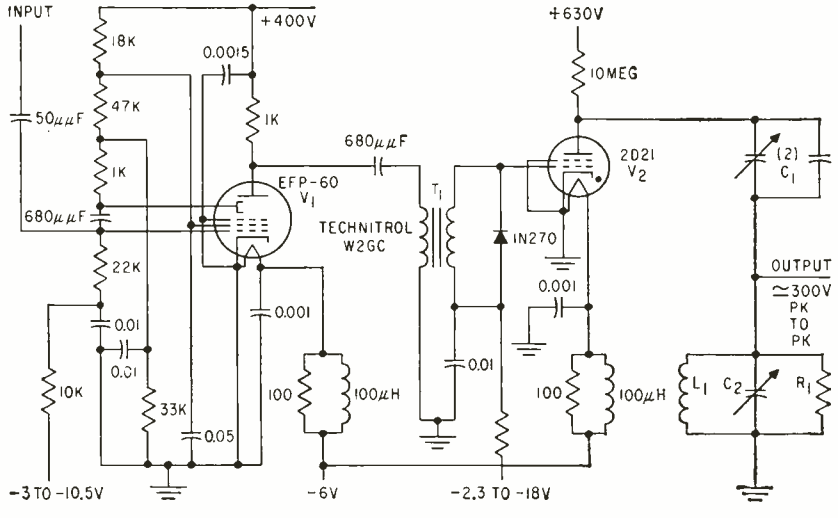
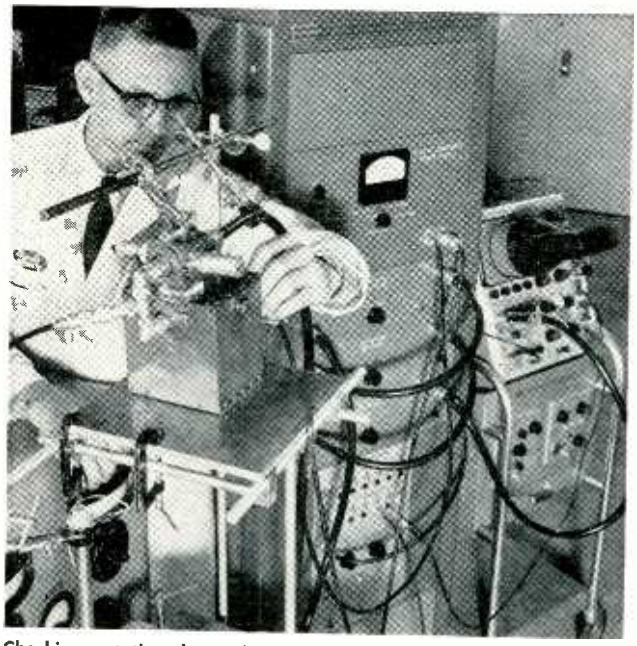
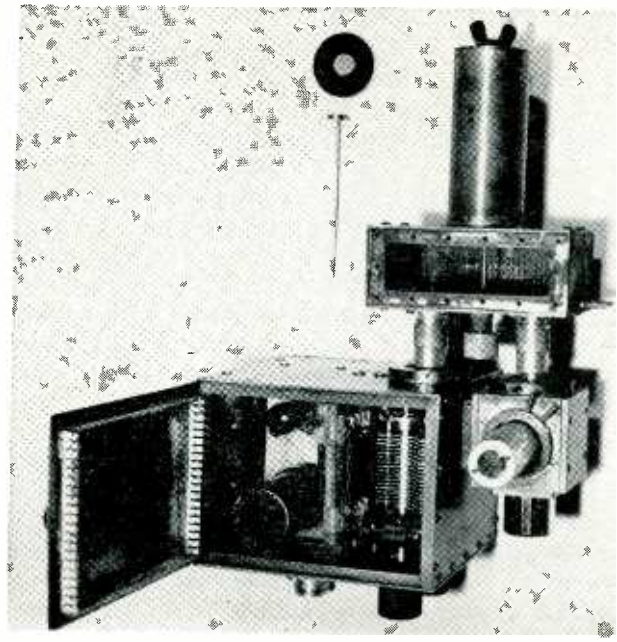


FIG. 2—Thyratron-switch transmitter receives trigger pulse from rate generator and produces pulse of r-f oscillations which decay from a peak-to-peak maximum of 300 v

From Thyratron Pulses





Checking out the ultrasonic measuring system (left). Closeup: transmitter at left, receiver preamplifier, right, and test-sample housing above

times the minimum-amplitude thyratron trigger pulse, a ratio that would be impractical for small hydrogen thyratrons with minimum trigger requirements of the order of 175 v. The rise rate of the trigger pulse is roughly 2 v/milliμsec as it passes through the minimum firing level.

Other steps are to use d-c on the filaments of V_1 and V_2, and to regulate and heavily filter the plate and bias supplies.

Results and Conclusions

Tests conducted with three different 2D21 thyratrons indicated a pulse-to-pulse time jitter of only 0.2 milliμsec. Total drift over a one-minute interval is 0.3 to 0.5 milliμsec depending on the tube. Measurements include jitter inherent in the oscilloscope and tubes V_1 and V_2. In comparison, 10 milliμsec is a typical jitter value that is normally obtained with the 2D21. It has been stated that a jitter of down to two milliμsec can be achieved, though with difficulty[3].

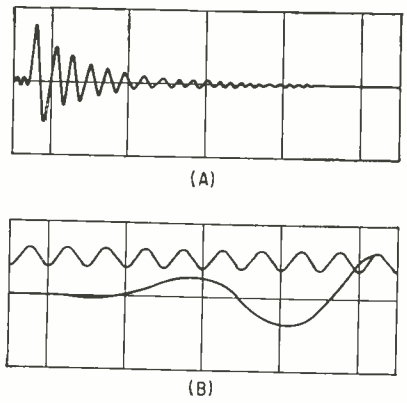


FIG. 3—Jitter is not visible in either (A) transmitted pulse shown on scale of 0.2 μsec/major div, or (B) leading portion of echo pulse compared with 50-mc calibration signal

Figure 3A shows a typical transmitted pulse and Fig. 3B compares the leading edge of a 10-mc echo pulse to a 50-mc timing wave. Despite the oscilloscope sweep speed of 20 milliμsec/cm, jitter is not visible.

If jitter requirements are not too stringent, the d-c filament supply might be dispensed with. In addition, it might be feasible to alter the circuit of tube V_1 to obtain the positive trigger pulse from the dynode, thus eliminating the pulse transformer.

In conclusion, it appears that in all but the most critical timing applications, the use of a thyratron should not be ruled out on the basis of excessive jitter, providing adequate precautions are taken.

The plate circuitry of thyratron tube V_2 is almost identical to that used in a commercial ultrasonic unit made by Sperry.

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Micromodule Components

Program to bring about 10-fold reduction in military electronic equipment size is at midpoint with production of prototype circuits

By **GEORGE SIDERIS,** Associate Editor

SIGNAL CORPS micromodule production program is at the half-way point of its initial 2 years. Most component designs and production methods have been successfully worked out by RCA and its subcontractors. Prototype modules and equipment are being assembled for engineering evaluation.

Plans are to construct a number of final microelements and micromodules during the coming year. Subsequently, modules may be phased into military equipment as circuit board plugins, or in complete assemblies. Advanced microminiature circuit techniques will be incorporated as they become available.

The program's objective is a 10-fold reduction in military electronic equipment size (ELECTRONICS, p 18, June 27, 1958). Prototype modules have component densities up to 350,000 parts a cubic foot. The initial goal is 600,000, representing an equipment density of about 250,000 parts a cubic foot.

Table I summarizes reliability requirements specified by Army Signal Research and Development Lab in SCL-6243. Table II gives general requirements for resistors and capacitors being made at present. Performance data on prototype modules is detailed in Table III.

Some of the designs used in making microelements are shown in Fig. 1. A variety of other designs can also be used. Data on other components will be reported next week. Subcontractors were previously reported (ELECTRONICS, p 38, April 24).

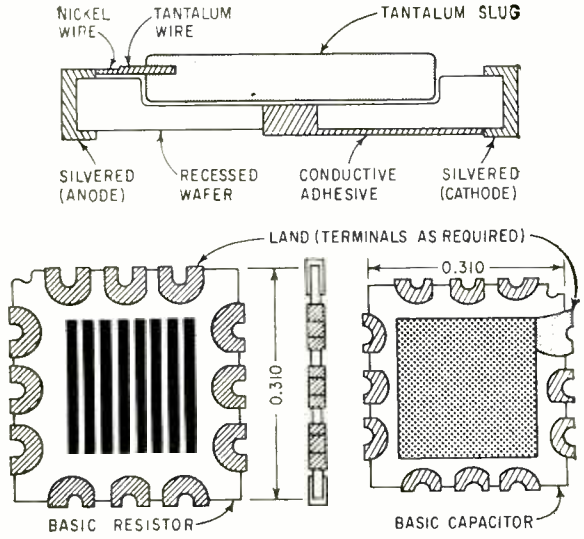


FIG. 1—Three capacitor and resistor designs. Wafer for tantalum capacitor is thicker than 10-mil wafers normally used

Table I—Requirements of Missile, Projectile, Satellite, Vehicular and Portable Ground Equipments

Environmental Tests — MIL-STD — 202A	
Thermal Shock	Method 107: Test condition A
Vibration	Method 201A: 10–55-cps, ground and portable Method 204C: 10–2,000-cps, others
Shock	Method 202A: 15,000-g, 4-millisec rise, 8-millisec duration, satellite and projectile; 50-g, 10-millisec rise, others
Salt Spray	Method 101A: Test condition A
Moisture	Method 106A: 10 cycles
Altitude	Method 105A: 10,000 ft, ground; 150,000 ft, others
Other Requirements	
Operating Temp	−55 C to 85 C, present; 125 C and 200 C, future capabilities
Spin	20,000 rpm, 1 inch radius, projectile and satellite
Storage	−65 C to 71 C storage temp; 30,000 hr storage at 71 C, all
Life of 50-part Module	Mean time between failures: 8,000 hr, missile and projectile; 15,000 hr, others. 100,000 hr, future ground and satellite

Table III—Digital and Radio Modules Being

Digital Modules	Nominal Input Signal: Amplitude (v)	Pulse Rate (kc)	½ ampl Width (μsec)
Binary Divider	5	192	0.5
Bin Div Gate (a)	5	192	0.5
(b)	5.5	96	5.2
Pulse Generator	6.5	0.75	0.5
Sawtooth Gen	5.6	8	5.2
Time Modulator	Input is output of sawtooth generator		
(c)	1.42 RMS		—
Oscillator	—	—	—
Clipper	Input is output of oscillator		
Pulse Shaper	Input is output of clipper		
Output Amplifier	Input is output of pulse shaper		

Radio Modules	Resonant Freq (mc)	Nominal Impedance: Input (ohm)	Load (ohm)
R-F Amplifier	49.4	100	200
Mixer	4.3	200	1,500
I-F Amplifier	4.3	1,500	1,500
Limiter	4.3	1,500	1,000
Discriminator	4.3	1,000	(e)
A-F Amplifier	—	22,000	1,000
Crystal Osc	45.1	—	200
Electric Tuner	30–53	100	100

(a) Emitter (b) Divider input to base of transistor 22 kilohm, output 0.2 v minimum (f) 100 ke peak

for Military Application

Table II—General Characteristics of Capacitors and Resistors Being Made Under Micromodule Program*

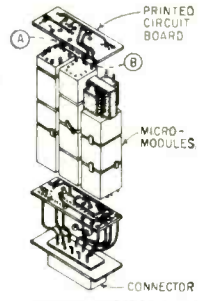
Capacitor	Material	Values	Voltage	Tolerances and Other Specifications
General Purpose	Ceramic thin films	0.01 to 0.3 μf	50+100%	Character istic: −55 C to 85 C change from 25 C capacitance: Table X, MIL-C-11015A; Steps A to D: +30, −50 ±15%; Steps E to G: +30, −80 ±15%; Power Factor Initial: 0.03; Power Factor After Life: 0.05; Insulation Resistance After Life (megohm): 3,000
General Purpose	Ceramic 10 mils	0.0001 to 0.01 μf	100+100	W, Y: +30, −50 ±15%; +30, −80 ±15%; 0.015; 0.015; 10,000
Precision and Temp Comp	Ceramic thin films	50 to 2,000 μμf	50 max	Nominal Temperature Coefficients (ppm/°C): NPO, N030, 150, 220, 330, 470, 750, 1400, 2100, 3330, 4200, 4700, 5600; Temperature Coef. Tolerances (ppm/°C): ±15, ±30, ±60, ±120, ±250; Capacitance Tolerance: ±1[a] ±5, ±10%; Capacitance Drift: 0.2% or 0.05 μμf[b]
	Ceramic 10 mils	0 to 1,000 μμf	100 max	
High Capacitance	Tantalum	0.1 to 15 μf	5 to 35	μ-coulomb Rating: 150 max; D-C Leakage @ 25 C: 0.04 μa/μf-v; @ 85 C: 0.2[c] μa/μf-v; Capacitance Change: ±15% (−55C to 85C); 25 C Cap Tolerance: ±20%; Power Factor: 5%[d]
Reactance Diode		7–80 μμf	1–11, 1–15[e]	Q ≧ 200 at 50 mc; This and variable metal film type in development
Resistors	Material	Resistance	Tolerances	Max Power; Max Voltage; Max Temp Coefficient
Fixed, Film	Metal alloy	10 ohms to 1 megohm	±1, ±5, ±10%	½w @ 70 C[f] 0w @ 150 C[g]; 100 vd-c line a-c; 0.02%/°C; Thermistor types of 10–10,000 ohms, utility types of 50–100,000 ohms and precision types are also planned

* Applicable capacitor specs are: general purpose, MIL-C-11015A; precision and temperature compensating, MIL-C-20B; tantalytic, SCL-6402A (a) But not less than 0.1 μμf (b) Whichever is greater (c) But not more than 2 μa (d) At 25 C and 120 cps (e) Voltage swing (f) Per wafer Wafers may be combined for higher values (g) Linearly derated, Characteristic A MIL-R-10509B

Produced for AN/TCC-26 Time Division Multiplex Equipment and AN/PRC-36 Radio Set

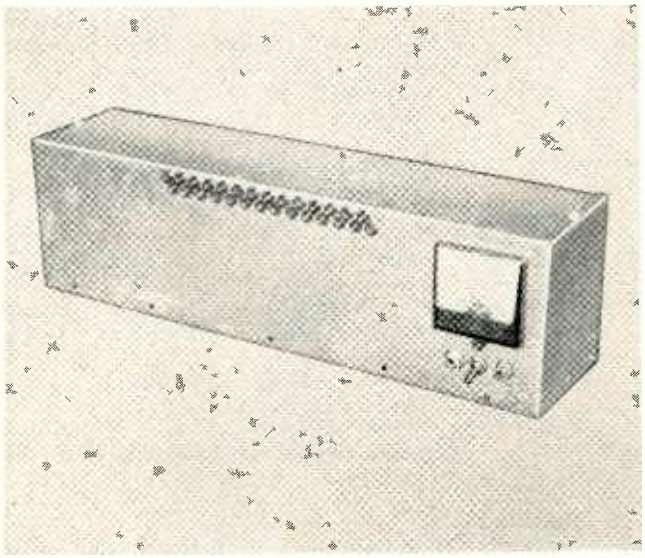
Nominal Output Signal: Rise Time (μsec)	Wave Form	Amplitude (v)	Pulse Rate (kc)	½ ampl Width (μsec)	Rise Time (μsec)	Wave Form	Nom Delay (μsec)	Nominal Supply: Voltage (v)	Load (ma)	Output Lower d-c Level (v)
0.1	pulse	5.5	96	5.2	0.1	square	0.1	12, 6, 18	2, 24, 41	−0.4
0.1	pulse	4.8	96	0.5	0.1	pulse	0.05	−6, 12	5, 1.7	−0.4
0.1	square									
0.3	pulse	8.5	0.75	1.5	0.3	pulse	0.1	−20, 4.5, −2.5, −10.5	1.5, 1, 10, 10	−10.5
0.1	pulse	11.5	8	5.2 ramp	2.2v/μs	sawt'th	0.1	12, 6, −50	0.3, 5, 5	−12
		1.6	8	2.6±0.3		pulse(d)	0.05	12, 6, −6, −18	0.5, 3, 3, 0.3	−0.7
—	sine									
—	—	11 (ptp)	192	—	—	sine	—	12, 6	2, 2	0
		5.8	192	2.3	0.1	square	0.1	12, 6, −6	6, 1, 4	−0.5
		8	192	0.35		pluse	0.1	−6, −18	14, 8	−16
		6.5	192	0.5	0.1	pulse	0.05	6, −6, 12	0.8, 4.8, 1.8	−0.8

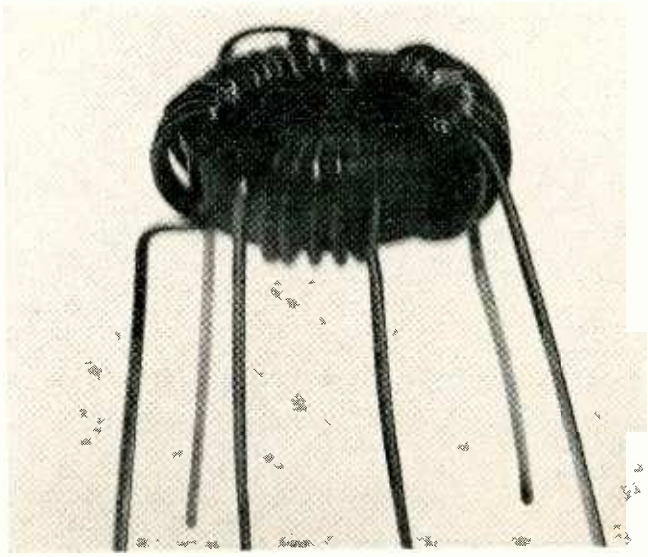
Nom Gain (db)	Bandwidth 6db pts	Nom Supply (v)	I_c (ma)	Additional Data on Radio Modules
8	2 mc	−3.75, 1.25	1.3	Minimums: 40-db image response, 60-db i-f
−2	180 kc	−3.75, 1.25	0.6	rejection for r-f subassembly (r-f. oscillator, mixer)
25	180 kc	−3.75	0.9	60-kc bandwidth at 6-db points for 5 I-F in tandem
—	—	−3.75, 1.25	1.2	<3-db output change for inputs over 3 mv
—	(f)	—	—	Audio output is ¼ v across 20,000 ohm
43	—	−3.75, 1.25	2.4, 0.37	Resp flat within 3db 400–4,000cps; audio output 1 mw
—	—	−3.75, 1.25	1.0	Output is 0.1 v with 200 ohm load
12.5	(g)	13	—	In development, will use variable capacitance diode



(c) Audio input (d) Trapezoidal pulse. All other pulses are rectangular (e) AFC: load 11 kilohm, output ±1 v; audio: load separation (g) 2 mc at 3 db, 20 mc at 10 db

Pulse Sorting With





Pulse sorter is part of a battery-powered decommutator, left. Sorter uses triple-winding cores as shown at the right

When a pulse train is applied to the input of this solid-state pulse sorter, the sorter reproduces the width of each pulse at an output terminal that corresponds to the pulse's position in the train. Simple, reliable circuits handle rates greater than 1,000 pulses/sec

By **JOHN H. PORTER,** President, Portronics, Inc., Tarzana, Calif.

PULSE TRAINS sometimes convey information by presenting pulses of varying width. The pulse sorter to be described receives a train of pulses and presents each pulse at an output terminal which corresponds to the pulse's place in the train. After presenting the last pulse of the train, the sorter to be described readies itself for another pulse train or closes its input.

Figure 1 shows what happens when a pulse train preceded by a start pulse is applied to the sorter. The widths of the pulses that ap-

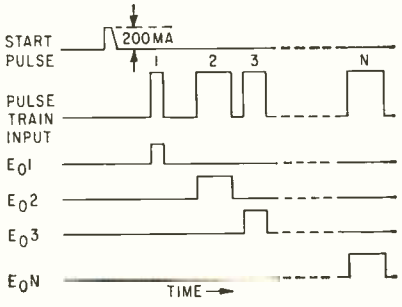


FIG. 1—Width of each pulse sent into sorter is reproduced at outputs E.

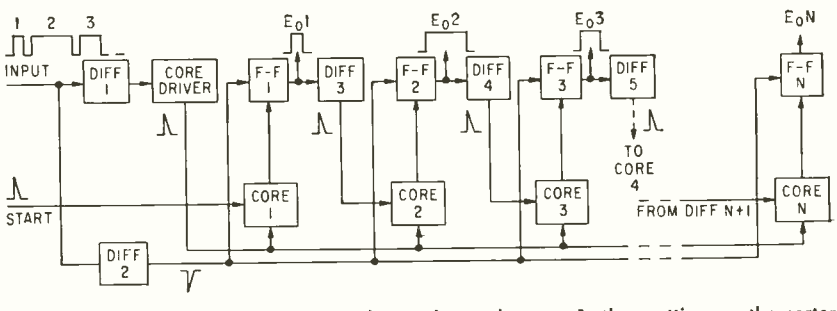


FIG. 2—Last output, E_0N, of sorter can be used to pulse core 1, thus setting up the sorter for next pulse train. Differentiators 3, 4 and 5 set up cores for pulse from core-driver

Transistors and Ferrites

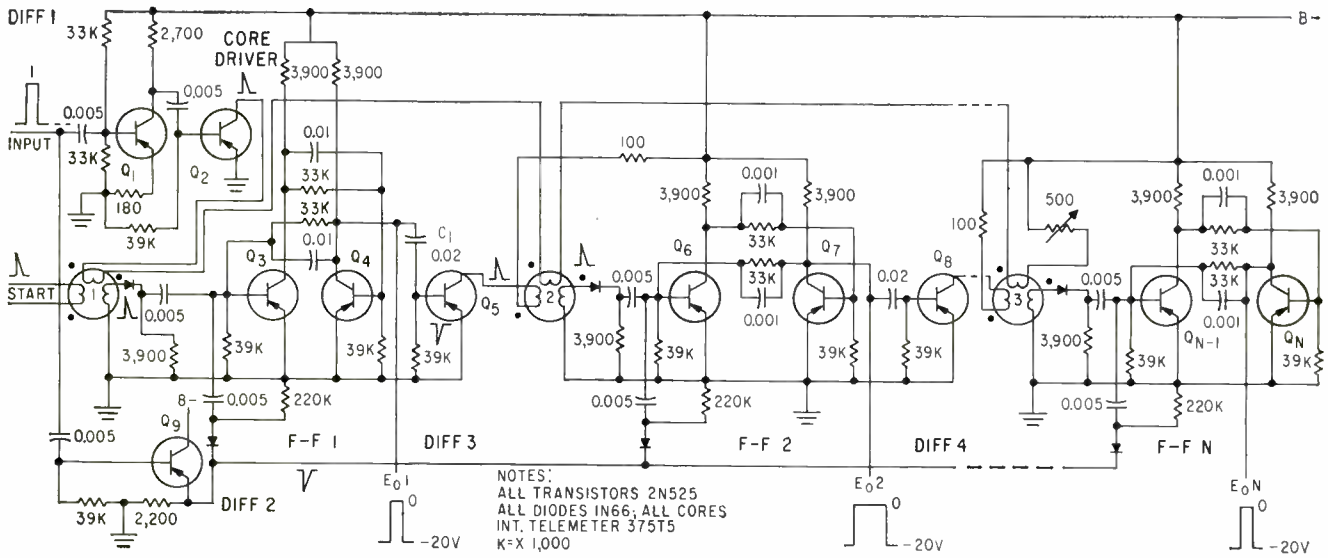


FIG. 3—Three transistors and one ferrite core are used for each sorted pulse. Widths of outputs equal widths of corresponding input pulses

pear at outputs E_o1, E_o2, E_o3 . . . E_oN are equal to the widths of corresponding input pulses.

System Operation

A start pulse sets up the sorter (Fig. 2) to receive the pulse train. The start pulse switches off ferrite core No. 1, which turns off transistor flip-flop No. 1. The leading edge of the first input pulse is differentiated by differentiator 1, which pulses the core-driver. The core driver output switches on core No. 1, which delivers a positive pulse to flip-flop 1. Flip-flop 1, which sorts the first pulse of the train, goes on.

The trailing edge of the first input pulse is differentiated by differentiator 2 which applies a negative pulse to flip-flop 1. Flip-flop 1 goes off, thus duplicating the first pulse of the train.

When flip-flop 1 went on, it pulsed differentiator 3, setting it up for a negative pulse when flip-flop 1 goes off. Differentiator 3 goes on momentarily and pulses core 2. This pulse readies core 2 for the next input pulse of the train, in the same way as the start pulse set up core 1 for the first input pulse.

Flip-flop 2 and succeeding flip-flops duplicate succeeding input pulses at their outputs the same way as flip-flop 1.

Circuit Details

Transistor Q_1 and Q_2 (Fig. 3) drive the cores with 200-ma pulses. The cores require 2 amp-turns for switching. To gain a margin of safety, each core is wound with 12 turns. The core produces about 0.5 volt for each turn of output winding, and each flip-flop transistor, such as Q_3, triggers with 2-v pulses. For a margin of safety, the core output winding has 5 turns. Since the reset windings also require 2 amp-turns, they too have 12 turns.

The flip-flop output stages produce 200-ma reset pulses. As a 2N525 transistor has a nominal β of 40 at this current, the output stage requires 5 ma from its flip-flop. This requirement accounts for the large capacitance of C_1.

All transistors that drive cores, such as Q_2 and Q_5, are biased so that between pulses only the collector cutoff current, about 5μa, flows. Thus the drivers appear as impedances of at least 1 megohm.

The flip-flops are turned off and on by positive and negative triggers, respectively. Positive trigger amplitudes are low. Negative triggers turn on the flip-flops when the triggers rise above a well-defined threshold. These negative triggers are supplied by Q_n. Each flip-flop delivers a positive-going output pulse; as many as 88 flip-flops have been used in the pulse sorter.

Cores are scramble wound with No. 28 or 30 Formvex wire. The windings are in the same direction, and concentrated in three areas of the core. These ferrite cores will not function reliably above 60 C. Tape-wound cores could be used to get around this limitation.

Compared to the transistor-core sorter that has been described, an all flip-flop sorter would require four transistors for each input pulse. When a large number of pulses is sorted, the transistor-core sorter is considerably more economical, and is more reliable, than such an all-transistor sorter.

The author gratefully acknowledges the encouragement of N. Cushman.

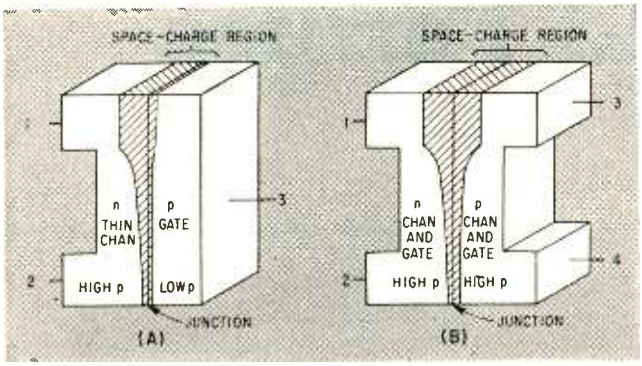


FIG. 1—Field-effect transistor (A) and new field-effect tetrode (B)

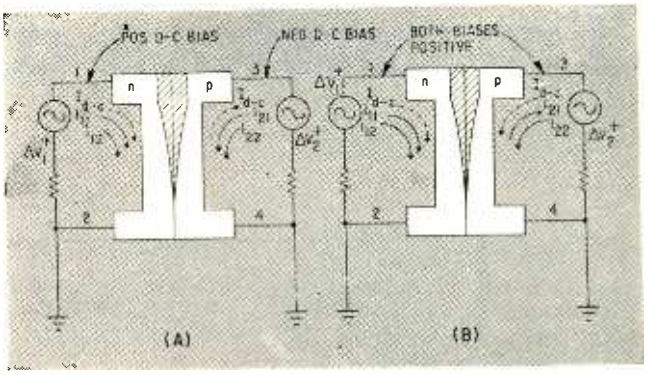


FIG. 2—Field-effect tetrode as transformer (A) and gyrator (B)

Theory and Use of

PRINCIPLES of field effect are embodied in a new structure having unusual circuit characteristics. This device is known as the field-effect tetrode.

Basic concept of the unit can be explained by reference to Fig. 1. In Fig. 1A, a field-effect transistor (triode) is shown. Resistance of the *n*-type channel between terminals 1 and 2 is modified by a potential difference applied across the junction. In this case, the potential difference is the reverse bias applied between terminal 3, the gate, and either of terminals 1 or 2. Resistance of the channel increases with gate voltage because of penetration of the space-charge region. This action reduces the effective current-carrying cross-section. Theory of the field-effect transistor was developed by Shockley in 1952.[1]

It is characteristic of the field-effect transistor that all parts of the gate *p*-type region in Fig. 1A are essentially at the same potential. This is true since there is only one contact to this region and no current flows except for the leakage across the reverse-biased junction.

Tetrode Concept

Field-effect tetrode structure is shown in Fig. 1B. Here, both the *n*- and *p*-regions are used as channels and, at the same time, each region serves as a gate for the other. Voltages may be applied to all four terminals. These voltages may be mutually independent subject only to the restriction that reverse biases obtain. Effective resistance of the *n*- and *p*-channels depends only on the potential differences appearing across the two ends of the junction. It is independent of the voltage drop along the channel. Functionally, the device has no analog either in electron tubes or in previous transistors.

Specific Applications

The field-effect tetrode is inherently a gain device in the same sense as the field-effect transistor. Additional circuit flexibility it offers over three-terminal transistors has yet to be explored fully. But apart from its possible virtues as an amplifier, the tetrode holds promise for a number of other and unique kinds of circuit applications.

Tetrode with leads applied is bonded to a header

Figure 2 is helpful in understanding how the tetrode can exhibit transformer, isolator or gyrator characteristics when the magnitude and direction of the d-c biases are changed. The gyrator is defined as a nonreciprocal four-terminal network in which the phase shift differs by 180 deg in the two directions of transmission.

Consider first Fig. 2A. The d-c biases are shown with such polarities that the bias current flows in opposite directions in the *n*- and *p*-channels. Width of the depletion layer is determined by the voltage difference across the junction (in this case, the sum of the biases). Suppose, now, an increment of voltage ΔV_1 is superimposed at terminal 1. The corresponding incremental current i_{11} will flow into the network at the terminal. At the same time, the voltage difference across the junction will be increased; the depletion layer in both channels will widen and their resistances will increase.

Since there has been no change in the voltage at terminal 3 and the resistance of the *p*-channel is higher, the bias current flowing out at the terminal will diminish. This is equivalent to adding an incremental current i_{21} flowing into the channel as indicated in Fig. 2A.

Now consider transmission in the opposite direction. An incremental voltage ΔV_2 is applied at terminal 3. The resulting increment of current i_{22} in the *p*-channel will flow inward. But in this case, the total voltage across the junction is de-

New kind of field-effect device provides in a single unit characteristics previously unobtainable or else achievable only with extensive circuitry. Tetrode should be manufacturable on a commercial basis ultimately by application of presently understood techniques

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Field-Effect Tetrodes

creased; the depletion layers become thinner and the resistance of both channels are decreased. Bias current flowing into the n-channel increases or, in other words, an incremental current i_{12} is flowing into the channel again.

With biases poled in this manner, the tetrode is a symmetrical network with the characteristics of a transformer. Impedance ratio depends on width and resistivity of the channels and on the magnitudes of the bias voltages.

If either of the bias voltages is zero, the device behaves as an isolator. For example, if the bias at terminal 3 is zero, a voltage applied at terminal 1 has no effect in the p-channel because there is no current to modulate. There is no transmission from left to right. But if a voltage signal is introduced at terminal 3, the bias current in the n-channel will be affected and a corresponding output signal will exist.

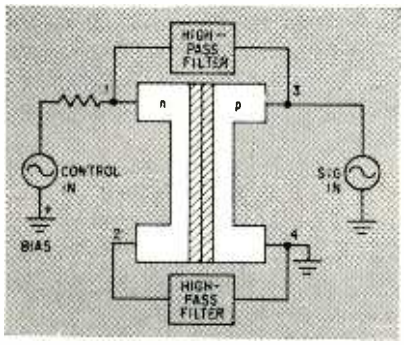


FIG. 3—Circuit for large-signal nondistorting modulator

Transmission can take place from right to left.

If the biases are poled so that the d-c flows in the directions illustrated in Fig. 2B, there is a gyrator configuration. In this case, the n-channel bias must be greater than that at the p-channel so that the condition of reverse bias across the junction will be maintained. If a voltage ΔV_1 is applied to the n-side, voltage across the junction will be increased, the depletion layer will be widened and current flow into the p-channel will be reduced. All of this action is similar to that in the transformer case. But now, since current flow in the p-channel is inward, a decrease in magnitude corresponds to an incremental current i_{21} flowing outward. Application of voltage ΔV_2 at terminal 3 decreases the voltage across the junction, narrows the depletion layer and the output current i_{21} flows inward as it did before. By examining the currents it is found that the device is nonsymmetrical, having 180-deg difference in phase in the two directions of transmission.

All of these applications are frequency-limited by junction capacitance. In the transformer configuration, the comparison with conventional transformers is weakened also by the fact that the field-effect device does not afford d-c isolation. But for certain low-frequency uses, it may have a decided size advantage.

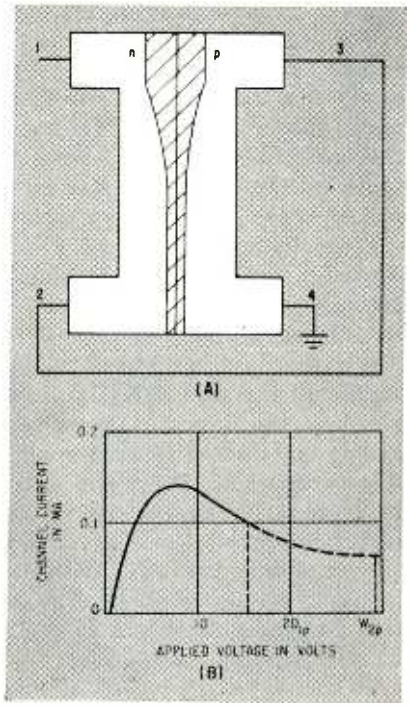


FIG. 4—Field-effect tetrode as a short-circuit-stable negative resistance; two-terminal connection (A) and characteristic curve (B)

Gyrators have considerable circuit interest. Except for microwave ferrite devices and for the Hall-effect gyrator, both of which require considerable magnetic fields, there is probably no other nonmechanical device that will perform this function except the field-effect tetrode. It is particularly attractive for impedance inversion and other gyrator functions because it has inherent gain which can be used to

compensate for losses in associated components. For example, it should be possible to terminate the tetrode's output in a low-Q capacitor and adjust the biases so that the input looks like a high-Q inductor.

Nondistorting Modulator

As a distortionless modulator or large-signal electronically controlled resistor, the field-effect tetrode may have important applications. Figure 3 illustrates how this function can be achieved. The controlling voltage which is assumed to be lower in frequency than the controlled signal is applied at terminals 1 and 2 through the large resistor. This voltage appears across the junction throughout its length and determines the width of the depletion layer and, in turn, the resistances of both channels.

The signal is applied across terminals 3 and 4. Because of the high-pass filters, this current divides between the two channels. The signal voltage does not appear across the junction and, therefore, has no effect on the depletion layer. Because of this factor, the signal voltage can be magnitudes higher than the control voltage and will still not be distorted by self-modulation. Since there is no signal voltage across the junction, this circuit does not see the junction capacitance and is not limited in frequency by this capacitance. Since the tetrode is a majority carrier device and minority transit times are not involved, none of the usual limitations to signal frequency apply. The control frequency, however, is limited by the junction capacitance.

If the signal frequency of interest is high compared to the rate of variation of the modulating or control voltage, the high-pass filters may simply be capacitors of a suitable value. If the control frequency lies within or near the signal band, more sophisticated filters are required.

Negative-Resistance Factors

In addition to four-terminal applications of the tetrode discussed, there is one two-terminal configuration of interest. This is an application in which a direct connection is made between terminals 2 and 3 as shown in Fig. 4A. If the channels are of suitable thickness and resistivity the current-voltage characteristic will be as shown in Fig. 4B with a negative slope over part of its range. In this region it behaves as a short-circuit-stable a-c negative resistance.

This negative-resistance characteristic and the preceding four-terminal characteristics discussed have been analyzed only for the pre-pinch-off condition. This condition is one where the voltage drop across the junction is low enough so that the depletion layer does not extend completely across the channel. For higher voltages, with one or both channels pinched off, the analysis is less straightforward and little progress has been made on it so far.

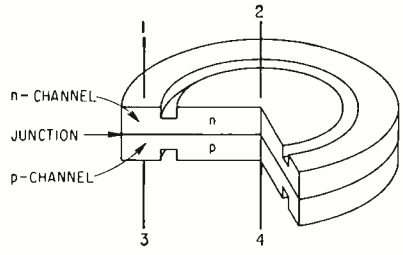


FIG. 5—Circular geometry of the tetrode

As far as the negative-resistance configuration is concerned, measurements on laboratory models show that the negative-resistance characteristic obtains with voltages that bring the device well into the pinch-off region. The broken portion of the curve in Fig. 4B corresponds to the tetrode's characteristic above pinch-off.

Structure

Development of the field-effect tetrode as a device is still in the early laboratory stage. Construction of working models has been achieved by the method to be described. It is acknowledged, however, that there would be formidable problems in reducing this method to practical commercial use.

The most serious problem is the achievement of opposing channels thin enough so that the effects of depletion-layer penetration will be significant at reasonable voltages. Typically, the channels are less than a thousandth of an inch thick.

A circular configuration has been used for laboratory models which is reminiscent of that used for the field-effect current limiter.[2, 3] This configuration is shown in Fig. 5. The starting material is a 12-mil slice of boron-doped silicon having a resistivity of about 100 ohm-cm. Phosphorus is diffused to a depth of about three mils. The slice is then lapped on one side, reducing its thickness to six mils, and a light boron diffusion is applied on the lapped side to diminish contact resistance in the finished device. Both sides of the slice are goldplated.

The slice is cut into circular wafers about 100 mils in diameter. The two circular channels are cut with an ultrasonic cutter. The channels must be registered well so that they are opposing throughout their peripheries. At this stage, each channel is about one-mil thick. Next, gold leads are applied by thermocompression bonding. Central leads are 15-mils thick and peripheral ones are three-mils thick.

Using the leads and header for mechanical support, the wafer is etched carefully. After each etch, both sides are measured as a current limiter. That is, the channel current in first one and then the other channel is observed as a function of voltage. When the pinch-off phenomenon is observed in either channel at a suitable voltage, 15 to 30 volts, that side is coated with wax so that in further etchings only the other side will be affected. It is helpful, sometimes, to dilute the etchant with water as the desired thickness is approached to slow down the etching process. After the desired thickness has been achieved in both channels, the unit can be baked out and sealed.

The described approach to tetrode geometry is difficult and uncertain. But with this technique, models have been made which verify predicted characteristics. It is certain that future ingenuity will find better ways of accomplishing the same thing.

References

(1) W. Shockley, A Unipolar Field-Effect Transistor, *Proc. IRE*, 40, p 1365, Nov. 1952.

(2) R. M. Warner, Jr., A New Semiconductor Device, *1958 IRE National Convention Record*, Part 3.

(3) R. M. Warner, Jr., W. H. Jackson, E. I. Doucette and H. A. Stone, Jr., A Semiconductor Current Limiter, *Proc. IRE*, 47, Jan. 1959.

System Cooling Methods

Ten techniques are given for cooling electronic systems; the characteristics of these methods are summarized, along with advantages and disadvantages

By **MELVIN MARK,** Consulting Engineer, Cambridge, Mass.

Table I—Techniques For Cooling Electronic Systems

System Cooling Technique	Characteristics	Advantages	Disadvantages
1. Free convection and radiation to ambient	Open equipment, components exposed to ambient	Simple, inexpensive, no leakage problems	Heat density must be low
2. Conduction, radiation & free convection to the package skin, free convection and radiation to ambient; louvering possible	Heat-dissipating components mounted as close to skin as possible, their heat path to skin not being through low-temperature parts	Simplest system for equipment that must be enclosed	Heat density must be low
3. Conduction, forced convection in liquid or gas to the package skin, free convection and radiation to ambient	Internal blowers required; components cooled either by internal fluid circulated over them, or through heat exchanger on which they are mounted, fluid in turn transferring heat to package skin	Relatively simple, can handle higher heat densities than 1 or 2 above	Additional weight of blowers and ducting. Leakage must be minimized if high altitude operation is required or fluid is other than air
4. Conduction, forced convection or both, to air as coolant, internally circulated and exhausted	Inlet and outlet ducting for air required, air circulated through ducts or baffles by components	Relatively high heat densities can be handled efficiently	Source of cooling air must be available; leakage should not be great
5. Conduction, forced convection, or both, to liquid as coolant, internally circulated and exhausted	Similar to 4, with liquid replacing air	Can handle high heat densities efficiently	Source of cooling liquid and power must be available; leakage must be prevented completely
6. Liquid evaporation to skin, free convection and radiation to ambient	Suitable coolant enclosed in case, wetting surface of components, condensing at package skin	No blowers or external coolant required. Heat transfer to skin is efficient	Additional weight of coolant; leakproof and moderately pressure-tight container required
7. Liquid evaporation to circulated secondary coolant, air or liquid	Evaporation component surface, as in 6, condensation at heat exchanger, transferring heat to secondary coolant flowing within heat exchanger	Can handle high heat densities	Weight, pressure and leakage requirements; secondary coolant must be available
8. Direct expendable evaporation	Evaporation at component surface, vapor discharged overboard	Physically simple, no heat sink other than evaporating liquid required; can handle high heat densities	Limited operational time dependent on amount of coolant at hand; weight, pressure, leakage & dielectric considerations
9. Indirect expendable evaporation	Heat transferred by convection, conduction and/or evaporation to a container of evaporating liquid, vapor discharged overboard	No heat sink other than evaporating liquid required; high heat densities can be handled; need not worry about dielectric strength of expendable liquid	Same as 8, except for dielectric consideration
10. Forced convection with local boiling and condensing	Small coolant channels in intimate thermal contact with surface to be cooled	Can handle high heat densities	Coolant source and power must be available; weight, pressure, leakage and dielectric considerations

Transistor Circuits for

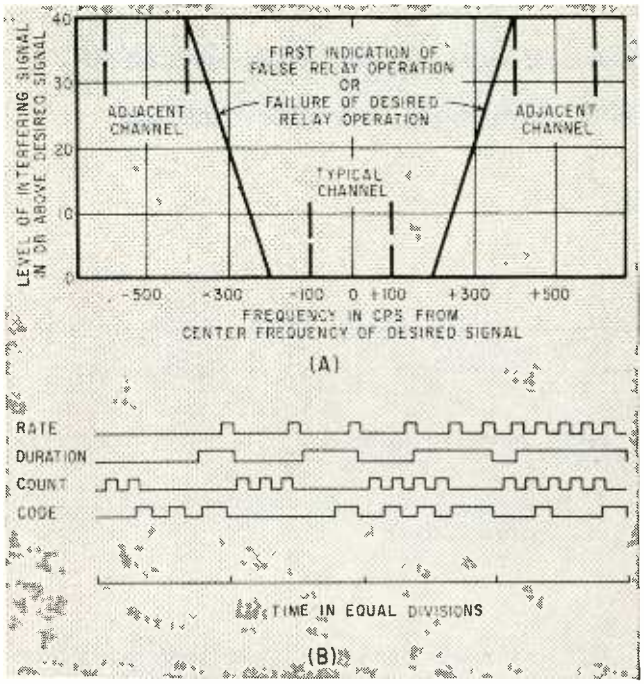
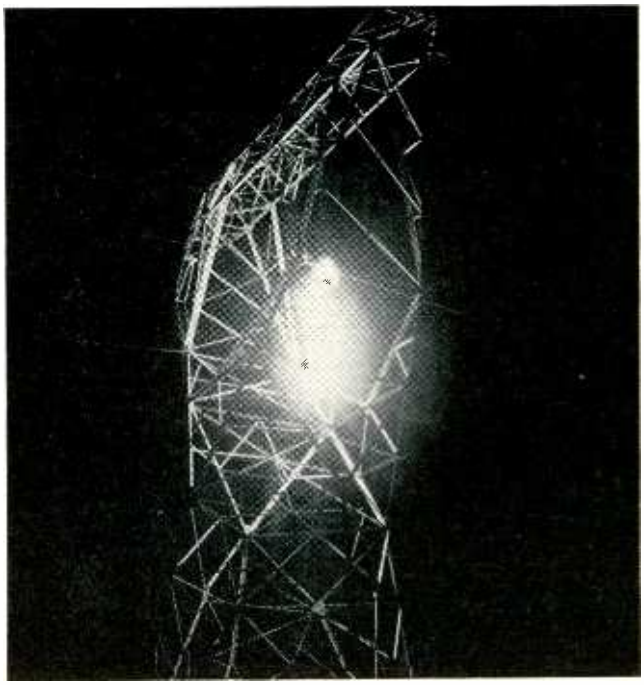


FIG. 1—Narrow channel width and adequate channel separation (A) result in negligible interchannel interference. Impulse coding schemes (B) are used for transmitting information on power lines



Arcing fault initiated on 345-kv single-phase line at Bonneville Power Administration installation tests operation of frequency-shift power-line carrier used in transfer trip relaying system

COMMUNICATION over power distribution lines, known as power-line carrier, has been widely used by power utilities for many years. Since the available spectrum is completely occupied, many existing communications requirements cannot be met. To alleviate this situation, a transistorized system capable of performing more functions than previously possible, but using less bandwidth and having greater reliability, was developed.

System Design

The 30- to 200-kc carrier spectrum is divided by the system into 200-cps channels spaced 500 cps apart. Thus, up to 20 channels are obtained over any 10-kc portion of the spectrum.

One transmitter and one receiver are required for each channel. Each transmitter-receiver set amounts to an independent system since it is used for transmission of one type of signal for one specific purpose.

As shown in Fig. 1A, more than 40 db of signal difference must be present before a transmitter at one station can interfere with a receiver on an adjacent channel 500 cps away.

Telemetering, teleprinting, telegraph, load control (lower-neutral-raise and frequency type), remote control (off-neutral-on), supervisory control, remote signaling and indication, and transfer trip relaying functions can be performed. Signals are either pulses formed in code patterns by keying contact closures as shown in Fig. 1B or low-frequency sine waves.

Transmitter

A block diagram of the transmitter is given in Fig. 2.

When keying contact closures or low-frequency sine-wave signals are applied to the transmitter, the diode modulators shift the output frequency of the modulated oscillator. The unmodulated oscillator operates independently at 2 mc plus the carrier frequency. Outputs of the oscillators are combined in the mixer to produce a difference frequency equal to the desired carrier.

A transistor r-f amplifier following the mixer provides approximately 20-db gain and introduces some harmonic rejection. A single-tuned collector load is tapped to present proper impedance to the collector while giving a reasonable L/C ratio. A potentiometer across the tuned circuit reduces output consistent with type of operation.

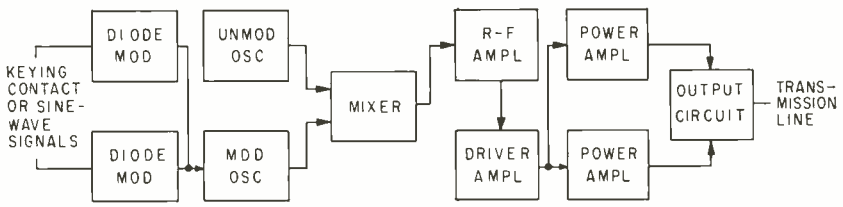


FIG. 2—Transmitter accepts impulse signals up to 60 pps and sine-wave signals up to 100 cps. Nominal output is 1 w adjustable down 50 db

Power-Line Carrier

Carrier-current transmitter and receiver uses 200-cps channel bandwidth and 500-cps channel spacing to fit more channels into power-line carrier spectrum. Keyed inputs shift carrier frequency over 200-cps range while sinusoidal inputs produce ±100-cps f-m deviations

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After further amplification by a transistor driver amplifier, the f-m carrier is fed to two power amplifiers. A series-tuned, L-C, high-Q output circuit provides harmonic attenuation and minimizes loading effects on other transmitters coupled to the transmission line.

Modulator

A schematic diagram of the modulator is given in Fig. 3.

Two transistors, serving as conducting diodes, switch additional capacitance in series with the modulated oscillator crystal. The diodes are connected to give one of three stable oscillator frequencies: 100 cps above center frequency when both diodes are cut off, center frequency when one diode conducts to saturation and the other is cut off, or 100 cps below center frequency when both diodes are conducting.

Three-position switch S_1 permits selection of two- or three-position frequency shift keying, or sinusoidal modulation. Three-position frequency shift keying utilizes all three stable states of the diodes.

Two-position frequency shift keying effectively leaves one diode in the modulator circuit. Since this diode is normally cut off, the oscillator output is 100 cps above center frequency. However, closure of the external circuit causes the diode to conduct, thereby shifting the oscillator to a frequency 100 cps below center frequency.

Four- to 100-cps sinusoidal modulation generated by a source of up to 50,000-ohms impedance can be used in place of dry-contact closure. A 15-v rms input signal provides a nominal 100-cps f-m deviation. This type of modulation is used to accommodate low-frequency telemetering equipment.

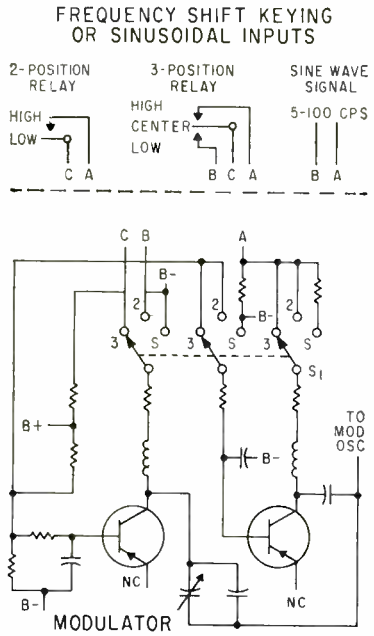

FIG. 3—Modulator uses transistors with unconnected emitter rather than diodes because of crystal oscillator loading effects

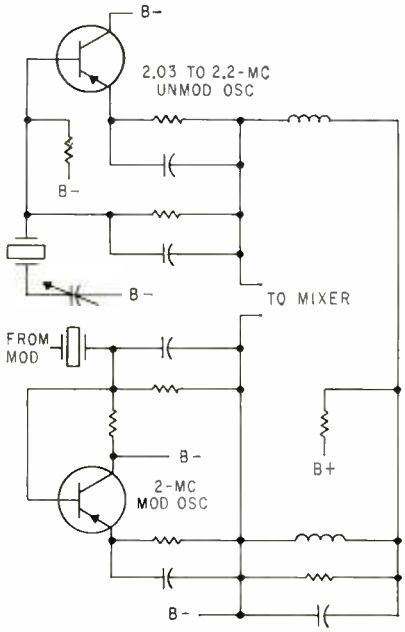

FIG. 4—Oscillators maintain uniform modulation level independent of carrier frequency

Oscillators

The two crystal-controlled oscillators used to generate the transmitter carrier are shown in Fig. 4.

Output of the modulated oscillator deviates 100 cps about an approximate 2-mc center frequency. Output frequency of the unmodulated oscillator is exactly equal to the approximate 2-mc modulated oscillator center frequency plus the lator center frequency plus the desired channel center frequency in a 30- to 200-kc range.

To gain the advantage of interchangeability, the crystals are cut for arbitrary 32-$\mu\mu$f shunt capacitance. However, the transistor oscillators do not present this capacitance to the crystal—in fact, the modulated oscillator varies the capacitance to dynamically change the frequency. Thus, a variable capacitor is used to trim the unmodulated oscillator to the desired channel center frequency after the modulated oscillator has been adjusted for the proper ±100-cps deviation.

Mixer

Outputs of the modulated and unmodulated oscillators are fed to the mixer circuit shown in Fig. 5. Since the modulated oscillator is being deviated at the rate of the modulation frequency or at the repe-

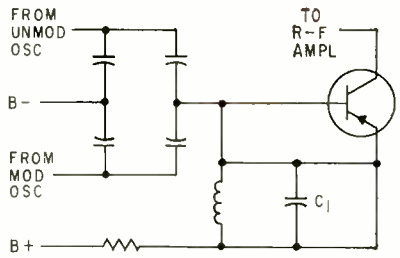

FIG. 5—Mixer combines outputs of modulated and unmodulated oscillators to obtain difference frequency in range of 30 to 200 kc

tition rate of a pair of external contacts, the mixer output is frequency modulated.

A transistor operating in a common-emitter configuration with the outputs of each oscillator coupled to the base through separate capacitors performs the mixing function. The input circuit is broadly tuned to 2 mc and the output circuit is sharply tuned to the output frequency. Both the collector circuit and tank capacitor C_1 are tapped across portions of the tank circuit inductance; C_1 connects to the coil at either of two points: across the entire coil for a 30- to 90-kc range or at a tap on the coil for a 90- to 200-kc range.

Power Amplifiers

Two power transistors connected in a common-base, class-B push-pull circuit are used as power amplifiers to provide an output with low harmonic distortion. The power transistors used are not normally capable of 30- to 200-kc operation; however, this limitation is overcome by the common-base connection and through a reduction to approximately 40 ma of the usual design emitter current of 500 ma.

Receiver

A block diagram of the receiver is given in Fig. 6.

A continuously variable input attenuator permits adjustment of receiver sensitivity. Input impedance of the overall receiver varies from 240 to 1,000 ohms depending on the setting of the attenuator; thus, five receivers may be paralleled on one circuit to present a total impedance of about 50 ohms. With the attenuators set for only 10-db attenuation, loading is reduced to 1,000 ohms per receiver or 200 ohms for five receivers in parallel.

The r-f filter following the attenuator contains six tunable coils. This unit provides selectivity before the carrier is amplified, thereby giving a high signal-to-noise ratio and minimum desensitization and intermodulation.

Incoming r-f and signals from the crystal-controlled local oscillator are fed into the mixer to obtain an intermediate frequency of 10 kc. Output of the mixer is fed to a six-coil, i-f filter with a high degree of selectivity to conserve the available spectrum.

The i-f filter feeds an i-f amplifier consisting of three high-gain stages. These stages and the following limiter stage are coupled by tunable coils. Output of the limiter is fed to power discriminators which detect the modulating signal and contribute a power gain by using two transistors in place of conventional diodes. Audio output of the limiter varies less than 1 db at constant modulation for all received signals above 400 μv.

Power Discriminator

A schematic diagram of the power discriminator is given in Fig. 7. The two transistors operate as self-biasing class-C amplifiers with rectification taking place in the base-collector junction. When a high-voltage pulse elevates the voltage in the base, a d-c pulse passes from the collector circuit into one of the two relay coils of the polar relay. A shunting capacitor tends to integrate these pulses and keep a constant current through the relay coil as long as the high voltage is present. Discriminator bandwidth is 200 cps at all r-f frequencies.

Any of three plug-in units can be connected to the discriminator output depending on the type of information transmitted. These units are an open-close relay for two-element information, a spdt center-neutral relay for three-element information, and an output transformer for sine-wave information.

With one transistor conducting, the typical voltage across the collector relay coil is 9 v and the voltage across the other transistor relay coil is 0.9 v. Since there is a current unbalance, the differential relay closes. With the other transistor conducting, reverse voltage conditions exist, and the differential relay closes in the opposite direction.

At center frequency, the voltage across each coil is approximately 7 v causing the load relay contact to remain at the center or neutral position.

Performance

Receiver selectivity is closely allied to power-line noise and transmitter-to-receiver path attenuation. Maximum path attenuations vary from 60 to 90 db in practical circuits. A figure of 400 μv was established as maximum practical sensitivity because it is reasonably below minimum noise levels expected at the 200-cycle bandwidth. A transmitter should not be spaced 500 cps away from a receiver at the same location when the difference in transmitted and received signal levels is greater than the difference produced by receiver selectivity characteristics.

Speed of operation and channel bandwidth are related in that a narrower bandwidth limits speed of operation. Nominal channel response time is 16 millisec measured from the closure of external contacts operating the transmitter to closure of the external contacts in the receiver.

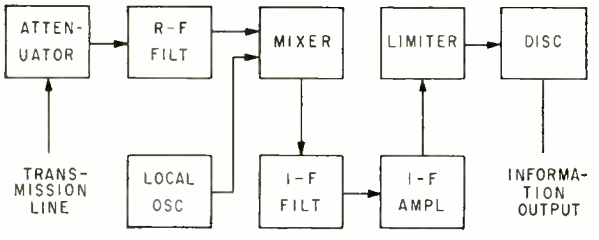

FIG. 6—Superheterodyne receiver uses f-m techniques to give constant output regardless of wide variations in power-line attenuation

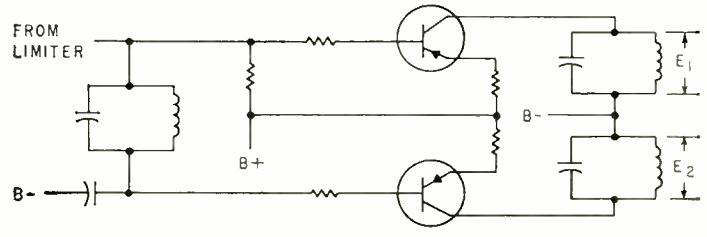

FIG. 7—Power discriminator uses medium-power transistors to supply power gain required for operation of receiver output relay.

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Servo Preamplifiers Using Direct-Coupled Transistors

Two-stage silicon transistor amplifier has adequate d-c stability under conditions of interchanging transistors having a beta range of nearly three to one. Stability over —55 to 125 C range is achieved

By A. N. DESAUTELS*

Senior Development Engineer, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.

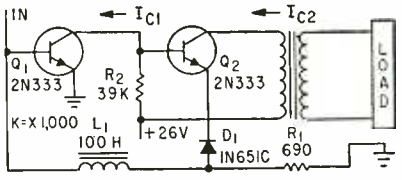

FIG. 1—Direct-coupled amplifier uses Zener diode to provide constant voltage

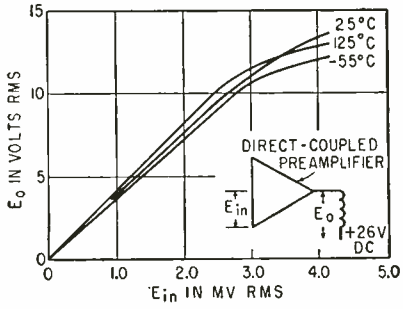

FIG. 2—Adequate gain stability is provided over wide temperature range

VARIATION in characteristics of transistors of the same type has led circuit designers to give only limited consideration to direct coupling when designing preamplifiers for servo applications.

A circuit which emphasizes the desirable characteristics of small size, simplicity and economy associated with direct coupling while still achieving excellent a-c stability is shown in Fig. 1. The circuit uses d-c feedback to achieve d-c stability.

Although it uses no capacitors and has fewer components than conventional stabilized transistor preamplifiers, this preamplifier is d-c stable with interchanging of transistors of the same type. Adequate d-c stability is achieved when interchanging transistors having a beta range of nearly three to one. The preamplifier gives stable gain from —55 C to over +125 C by using silicon transistors.

Zener Diode

The Zener diode, D_1, uses reverse diode characteristics to provide a constant emitter voltage to Q_2. This diode also determines the d-c collector voltage for Q_1. The d-c drop across R_2 establishes the base bias voltage for Q_2.

When interchanging transistors with slightly different d-c characteristics or when collector currents increase with higher temperature, the circuit automatically stabilizes itself. If I_{c1} increases with temperature, the voltage drop across R_2 will rise and cause the base voltage of Q_2 to decrease with respect to ground. Since the Zener diode keeps the emitter voltage of Q_2 constant, a decrease in the base voltage of Q_2 will tend to decrease the collector current I_{c2}. Thus, the drop across R_1 will decrease, tending to reduce the base bias current of Q_1 which reduces I_{c1}. The same theory holds for an increase in I_{c2}.

This d-c stability is obtained by a d-c feedback loop around the two stages. The feedback path is provided by L_1 which has low d-c resistance and high a-c impedance, resulting in tight d-c coupling with practically no a-c feedback.

Performance

Since stabilization is accomplished with negligible a-c degeneration, a-c performance compares favorably with that of conventional transformer or R-C coupled preamplifiers. The gain at various temperatures for the amplifier of Fig. 1, loaded with 20,000 ohms, is shown in Fig. 2. Stability of performance over the temperature range is indicated. Table I shows that there is less than ten-percent variation in d-c collector currents from room temperature to the temperature extremes.

The circuit of Fig. 1 can be adapted to any type junction transistor triode by proper biasing. Typical performance figures which can be obtained by adapting Fig. 1 are: a voltage gain of 20,000, a current gain of 500, a power gain of 70 db and an input impedance of 2,500 ohms.

Table I
Variation of I_c

Temp	25 C	125 C	—55 C
I_{c1} (ma)	0.63	0.75	0.57
I_{c2} (ma)	1.50	1.68	1.38

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Synchros Show Paper Tension

TENSIONMETER using servo principles has been operated experimentally for several years on a printing press. The unit was developed by Springdale Laboratories division of Time, Inc., for measuring tension in a moving web of paper.

Measurement is accomplished by depressing a small roller into the web. Magnitude of normal force on the roller depends on geometry of the web in the deflected state. The device shown in Fig. 1 provides a measure of this force, which may be displayed on a meter or strip chart recorder.

To prevent introduction of wrinkles or excessive local tension in the web, the measuring device must provide adequate output with relatively small angular deflection of the web. In applications involving 40-lb magazine paper, deflection angles of less than 20 minutes are normally used to produce full scale output of 5 lb/in.

When connected as shown, the synchro operates at an output null and is essentially linear over the normal operating range. Output of the germanium diode rectifiers at low levels, however, is nonlinear. These nonlinearities can be compensated by calibration of the associated meter.

If a linear output current versus roller deflection is desired, the alternate circuit (shown dotted) may be used to buck a portion of the output current. This requires that the synchro be zeroed at a point above electrical null, as indicated by a zero reading of output current.

Adjustment and calibration of the tension head is normally carried out by removing the web and using the zero adjustment to produce zero meter indication. A section of web is attached to one of the adjacent rolls, passed under the tension head and over the next roll. The web is then clamped across its full width and a load (spring scale or weights) is applied that corresponds to the desired full-scale deflection.

THE FRONT COVER. Simple, inexpensive electronic instrument developed at Springdale Laboratories of Time, Inc., provides continuous indication of tension on paper in high-speed magazine printing press

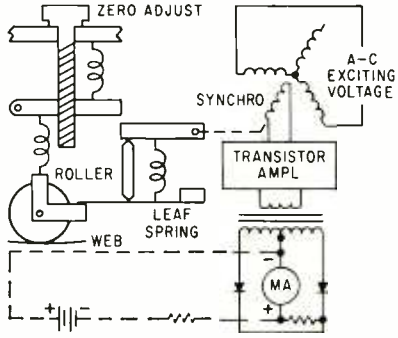


FIG. 1—Synchro with transistor amplifier provides indication of tension on paper in operating printing press

The tension head is moved into the web until the meter reads full scale and is then clamped rigidly in place. Web loading is varied to produce intermediate calibration points.

An improved web tension head under development at this laboratory includes an integral transistor amplifier.

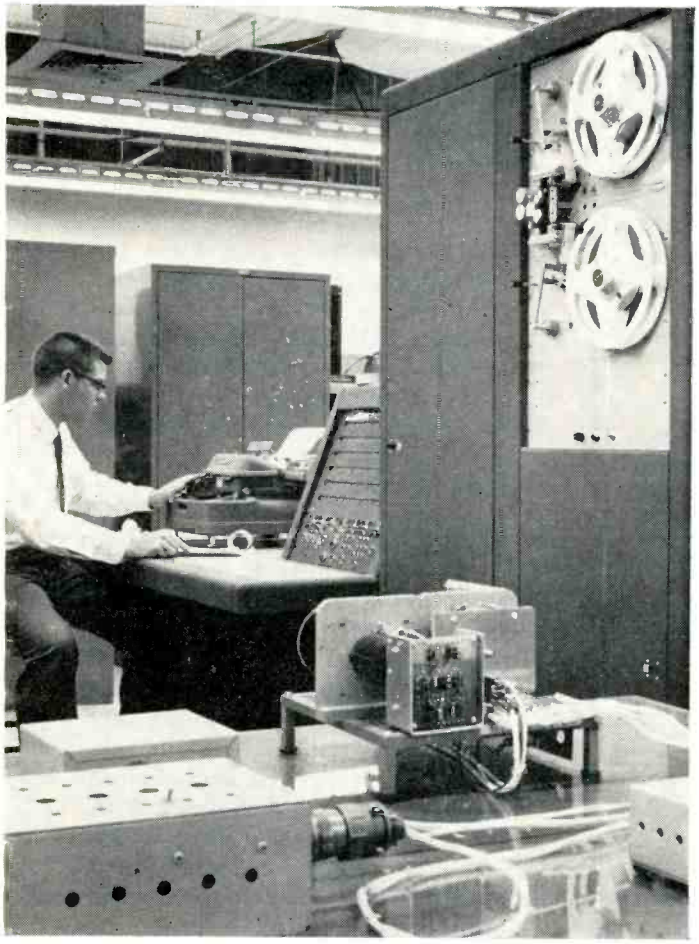
Quality Test of Ear Defenders

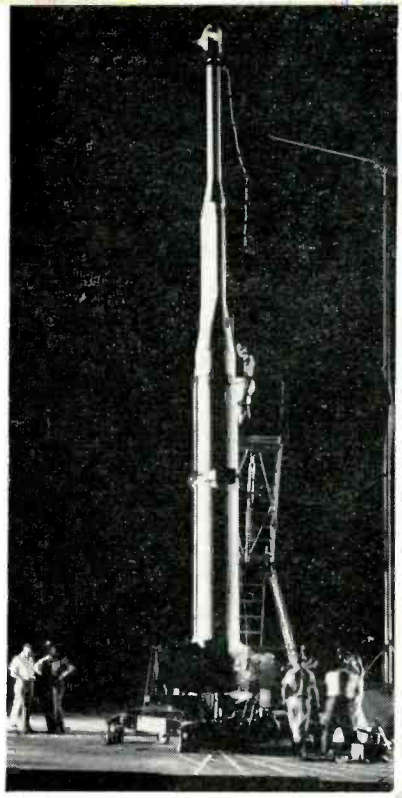
Ear defenders are evaluated at Stromberg-Carlson division of General Dynamics. Under study is the subject's ability to recognize information transmitted to the receivers in various types of ear defenders while working where noise is 122 db. About 100 speakers in single array are used to provide sound for test for U.S. Army Signal Equipment Support Agency. Work is being carried out under subcontract with Lehigh Engineering Associates

Vibration Analyzer Gives Strobe Effect

TIME-SAVING vibration analyzer developed by the National Bureau of Standards can be used for determining vibration characteristics of bodies such as aircraft and missile structures.

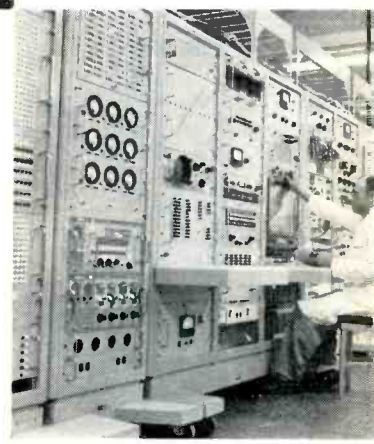
The instrument uses the principle of a stroboscope, enabling an oper-





(left) Lockheed X-17. Lockheed-designed checkout computers are already proving their effectiveness in service.

(below) Another Lockheed-designed automatic missile check-out system for quick determination of flight readiness.



(left) Automatic Checkout and Readiness Equipment (ACRE) – a Lockheed product – automatically performs pre-program missile checkouts and runs diagnostic routines to localize trouble.

COMPUTER DEVELOPMENT

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

Lockheed's capability in the design and development of computers is contributing to the advancement of the state of the art. Research in the area includes the development of self-organizing, or adaptive computing systems; the design of new kinds of pattern recognition devices; the development of automatic library systems for the storage and retrieval of information; and the development of high speed input-output devices for digital equipment.

The ACRE system developed by Lockheed combines outstanding performance at the lowest cost in the industry, and has broad applications to a number of other missile and space projects.

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ator to quickly explore vibration patterns in a complex structure. Early in an analysis, an operator can determine whether his vibration pickups have been properly located.

The analyzer was developed for calibrating vibration pickup, where vibrations other than longitudinal were unwanted. By using several small pickups, it was possible to eliminate transverse or flexural vibrations.

Resonant Frequencies

A stroboscope is convenient for determining resonant frequencies of bodies vibrating at low frequencies. However, when higher frequencies are examined, duration of the light pulses becomes too short for visual inspection for resonant points. Also, the vibrating body must be observed with a stroboscope. For small, even microscopic, movements or parts, this examination becomes difficult. When the movement is submicroscopic, some other method must be used. Here the analyzer is a useful tool.

With a stroboscope, periodic changes of position of a given body are displayed in apparent slow motion or are stopped at some desired phase of the vibration cycle. With the analyzer, the same effect is produced by processing signals from pickups so as to display the pattern of motion on an oscilloscope.

Rods Lighten Antenna

Radar antenna uses light-weight sandwich structure and is supported by prestressed truss rods like bicycle wheel spokes. Twenty-story high antenna designed by Narmco Mfg. Co. is said to provide greater accuracy, increasing radar range

Electrical signals from the pickup are sent to a mixer that adds a reference signal slightly lower in frequency. Difference signals are separated by a low-pass filter or square-law detector. Displayed on an oscilloscope, the vibration pattern can be readily seen for a given phase. As vibration frequency is changed, the reference signal changes a corresponding amount, so that the difference signal remains at the same frequency.

To make a bar-type trace on the oscilloscope instead of a sine wave, a transistor was used as an emitter follower and d-c rectifier. An output transistor was used to invert the negative signals.

By varying vibration frequency and positions of the pickups, a complete analysis can be made of the vibration characteristics.

Display Devices

Flashing lights may be used for the display, and when properly positioned in space, can give a three-dimensional representation of vibration. A recorder can be connected to the output channels. When a recorder of limited dynamic response is used, difference frequency can be chosen to suit the recorder.

A voltmeter can read absolute value of motion. The signal from a given pickup is fed to the voltmeter from a T-connector at the input to its mixer channel. The vibration analyzer is more useful for exploring than for measuring.

The analyzer is most useful in helping visualize varied motion patterns of a complex structure or in determining interactions among varied motions. Usefulness depends to some extent on ingenuity of the user. For example, motion to be studied need not be controlled. The signal from one pickup can be used as a reference, and applied to each mixer channel by way of the phase shifter.

This device should simplify gathering data from any periodic process in which amplitude and phase relations of changes are important. Characteristics of the pickups are the only limits to vibration amplitudes that can be studied; and by changing the oscillator, frequencies of any range can be analyzed.

Thermionic Integrated-Micromodules

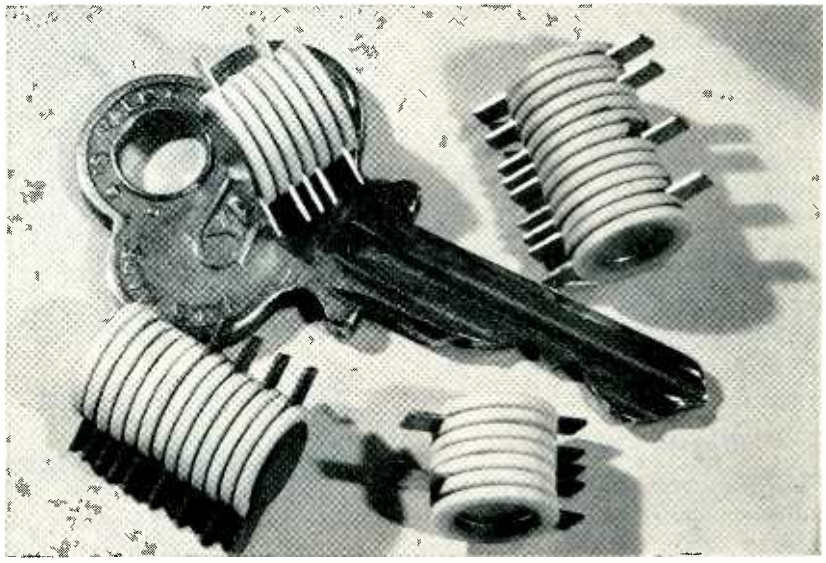
By J. E. BEGGS and W. GRATTIDGE, Research Laboratory, General Electric Co., Schenectady, N. Y.
PHILIP J. MOLENDA, General Engineering Laboratory, General Electric Co., Schenectady, N. Y.
and A. P. HAASE and A. F. DICKERSON, General Electric Co., Owensboro, Ky.

IN THE DESIGN approach to be described, extremely high component densities are provided with standardized component packaging as in the Signal Corps micromodular concept. But in the system under discussion, tiny heaterless electron tubes are used instead of transistors; auxiliary cooling is eliminated and heat losses generated within the equipment serve to increase over-all efficiency of operation and contribute to extended life and reliability of the equipment.

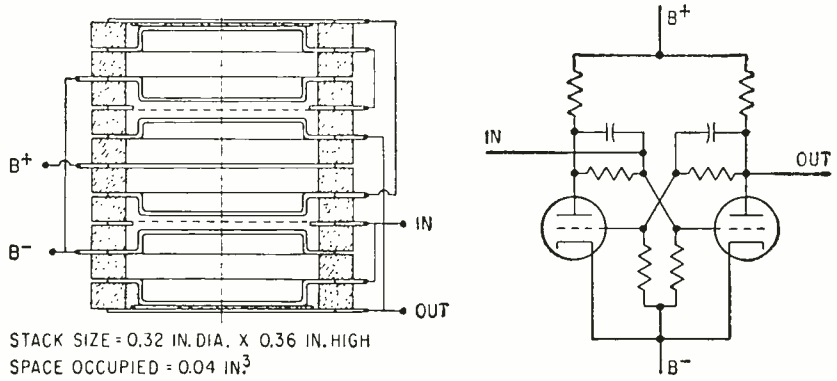
Small-sized heaterless tubes have been made of titanium and ceramic materials as shown in Fig. 1 by stacking, exhausting and sealing the parts in vacuum at about 1,000 C. Diameter of the tubes was determined by the cathode current required and operating temperature desired. It was assumed that 2 ma of plate current would be sufficient for many operational functions although higher or lower values could be chosen. For a 2-ma plate-current requirement, total available saturated emission from the cathode of the tube should be about 10 ma.

To achieve a reasonable degree of miniaturization, it was decided to operate at 580 C with a cathode area of 0.2 cm^2—about 0.2 in. diam and over-all tube size of about 0.32 in. diam. Spacing insulators were made 0.030-in. thick, limiting high-frequency performance to 6,000 mc.

Electrical characteristics of oven triodes can be different from those obtained with conventional triodes. The tubes can be constructed so that the zero bias curve is the middle one of the plate-current-plate voltage characteristic. The zero bias curve can be in a position so as to essentially cut off the plate current. Therefore, for essentially all modes of operation, the input circuit may be applied directly between grid and cathode without requiring use of an external bias battery or a cathode bias resistor and capacitor. This new built-in bias feature, found only in tubes with clean electrodes, gives increased flexibility to the circuit designer and also can lead to use of fewer circuit components.



Cathode follower (upper left); plate clamped, flip-flop stage, grid-driven, grounded cathode, bistable multivibrator (upper right); triple in-and gate (lower left) and a second cathode follower (lower right). These correspond to building blocks shown in Fig. 3



Cross-sectional view of stacked circuit showing electrical connections and schematic circuit diagram for a bistable multivibrator

Heaterless diodes and triodes have retained uniform characteristics over several thousand hours of operation on life test at various oven temperatures from 350 to 600 C.

Resistors are made as shown in Fig. 2. The film can be positioned in a band around the inside surface of the ceramic insulator. Electrical connections are made to the terminals from diametrically opposite points of the band. Resistors of this type have been made with resistance values as low as one ohm and as high as one-half megohm and operate stably to 700 C.

Tiny capacitors have been made by using the same titanium and ceramic parts for the vacuum enclosure as are used in the tubes and resistors. Synthetic mica sheets, capable of withstanding the 1,000 C exhaust and sealing procedure, are used for the dielectric material. A capacitance of about 20 $\mu\mu f$ is obtained by using a single piece of

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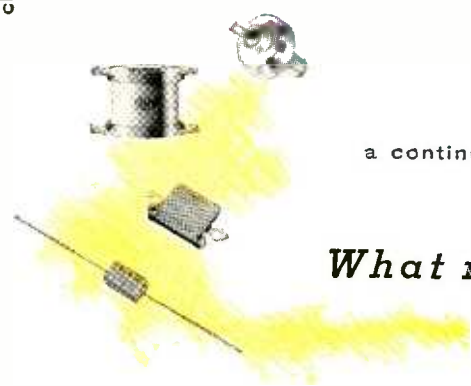

What makes mica the unique dielectric?

Mica is as old as the earth itself. Ancient Hindu writings show that mica was thought to be the remains of lightning flashes from which sparks had emanated and had become preserved in the earth. It was therefore regarded as being endowed with extraordinary properties, and was used in medical ritual. The replacement of such charming stories with modern technical knowledge has, however, not altered the fact that mica is endowed with extraordinary properties.

Mica is found in pegmatite rock, formed in the early stages of the cooling of the earth's mass. Crystals of mica were formed under high heat and pressure, and in the presence of moisture vapor and magnetic fields. The physical and chemical changes during this period served to impart a unique stability in physical, chemical and electrical properties. The chemical structure of mica is represented as $H_2KAl_3(SiO_4)_3$ which is Muscovite; India Ruby is one of the grades of exceptional quality and is used in most mica capacitors. Other types of mica, to name a few, are Phologopite, Lepidolite and Biotite, of which only Phologopite is of limited interest in experimental capacitors for very high temperature operation.

Mica is found in varying degrees of purity, some with less mineral or vegetable constituent, or stain, and some with more nearly perfect physical integrity — that is, free from cracks or air inclusions. As a result, raw mica must undergo careful physical examination and be graded according to quality and size. Sangamo has had over 35 years experience in the selection and processing of mica, together with a knowledge of mica capacitor production. Capacitor grades of mica film are generally obtained from the Bihar, Bengal, or Madras provinces of India. Mica for other purposes may be found in Canada, Brazil, Argentina, Madagascar, Africa, Russia, New Hampshire, South Carolina and South Dakota. This list is by no means complete. An idea of the magnitude of the task of selecting suitable mica can be obtained from the fact that only an estimated ten per cent of all the world's mica deposits are suitable for use in mica capacitors.

The earliest mica capacitor was probably made by Matteuci, a contemporary of Faraday's, about 1845. However, capacitors did not become commercially interesting until the advent of radio in the early years of this century, as a result of the growth of electrical technology. Both the electrical and electronics industries have depended significantly upon mica. Mica insulation between commutator segments in rotating machinery and the mica spacers in vacuum tubes are still vital to these industries.

In capacitors, the choice of dielectric material is as important as the method of construction. Mica, because of its sheet form, lends itself to stacked construction, resulting in a lower inductance assembly than can be obtained in wound capacitors. Mica capacitors are therefore suitable for very high frequency operation.

The mechanical or dimensional stability of mica allows blanking or die-cutting of dielectric plates to a desired size with only a very few thousandths of an inch variation. Precise assemblies may therefore be obtained and result in a greater ability to achieve accurate miniaturization. Electrodes may be permanently bonded to the mica dielectric plates by screening on conducting silver paste. This process has been refined to a high degree of accuracy, and results in superior electrical stability when compared to laying foil between mica plates to form the electrodes. Silvered mica capacitors exhibit exceptional stability in extremes of temperature.

The Q and dielectric constant (therefore, the capacitance) of mica change very little over wide ranges of frequency and temperature. Such small changes are due to the fact that the molecular structure of mica is essentially non-polar — that is, the molecules of mica do not have an unbalanced electrical charge. Thus they are not free to swing freely as magnets do (mica is practically non-magnetic) when in the presence of an electric field. Such fields are present when the capacitor is charged. Movement of the molecules would result in heating by the friction of their motion. Poor dielectrics exhibit considerable heating, as is shown by the heat developed in wood and glue in the process of laminating plywood in dielectric heating devices.

Heating effects may become very pronounced when high frequency alternating voltages are applied. The rapid changes in the direction of current flow cause polar molecules to literally vibrate about their rest position. The low heating of mica under such conditions is evidenced by the fact that certain types for transmitting applications will carry apparent currents to 50 amperes, at a few megacycles, resulting in only few degrees temperature rise.

Minimum dielectric heating is very essential since it has been shown that the life expectancy of a capacitor is reduced by a factor of approximately one-half for each ten degree centigrade rise in temperature.

All mica capacitors do not possess the ultimate characteristics of natural mica, since designs and manufacturing procedures differ according to original intent and application. However, the characteristics shown in the table could be realized under ideal conditions.

Characteristic	Approximate or Ideal Value
Dielectric Constant	7 (resulting in a moderate degree of miniaturization)
Q	3000 or greater
Power Factor	0.05% or less
Self Resonant Frequency	Up to 500 megacycles
Insulation Resistance	100,000 megohms or greater
Operating Temperatures	Up to 230°C. (85°C standard for commercial types)
Temperature Coefficient of Capacitance	0 to +70 parts per million per degree centigrade
Capacitance Drift or Capacitance Retrace	0.05% or less

At Sangamo all mica capacitors are designed and manufactured to exceed the physical and electrical requirements of applicable military specifications. The wide variety of Sangamo mica capacitor types allow flexibility of design and superior products for the most critical applications to meet individual specification requirements. Engineering catalog and bulletin giving full information on types and characteristics are available upon request for your examination.

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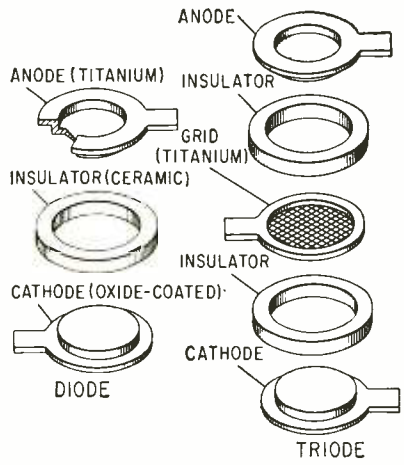


FIG. 1—Exploded views of microminiature titanium-ceramic diode and triode

mica between the end plates. No changes in the characteristics have been observed for units that have been operated for several hundred hours at 580 C.

There is every indication that a complete line of microminiature components can be developed for coordinated use with the present vacuum-encapsulated ones. Developmental models of various other high-temperature components such as inductors and transformers have been tested at temperatures up to 500 C and show promise of being stable and reliable.

Various microminiature tubes and components can be stacked to form tiny circuit TIMM's. Few external connections are required, as many of the connections are inherent in the stack. Since the cathode derives its operating temperature from the environment in which the stack operates, no cathode heaters, or connections to them, are required. Cathode bias resistors and capacitors are unnecessary because of the built-in bias feature of the triodes. The fact that the components are small; that they can be arranged compactly in stacked circuits and interconnected with short

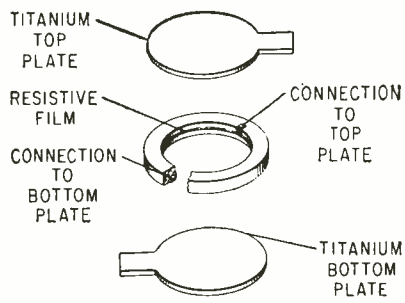


FIG. 2—Exploded view of microminiature titanium ceramic resistor

jumpers should lead to good high-frequency performance.

The microminiature stacked high-temperature circuits can be assembled in one operation with a consequent saving of parts. Resistor and capacitor elements can be combined in parallel in a single R-C unit.

Small size of the stacked circuit permits a large number of such building blocks to be assembled in a small space. Figure 3 shows six typical building blocks. Two of them are input "and" gate stacks; two are "logical" flip-flop stacks and two are dual unit cathode-follower stacks. There are 44 components in all—10 diodes, 14 triodes, 14 resistors and 6 capacitors. Placed end-on-end, they make a stack 0.32-in. thick by 0.50-in. wide by 2.6-in. long. By trimming the connection lugs so they can be contained in a 0.32-in. square cross-section, the volume occupied by the 44 components is 0.32 by 0.32 by 2.6 in. or 0.27 in^3. This is a circuit density of 250,000 components per ft^3.

If frequency requirements are such as to allow thinner ceramic wafers, circuit densities of 1,000,000 components per ft^3 are possible.

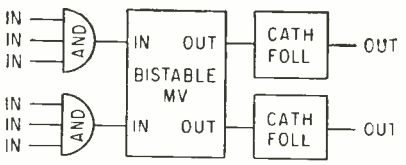


FIG. 3—Stock diagram of six typical building blocks

Practical circuits can be constructed from the microminiature components described. The circuits are smaller, lighter and generally require fewer components than their conventional encapsulated semiconductor counterparts. They seem to offer fewer temperature problems, higher reliability, longer life, greater ruggedness, resistance to nuclear radiation and higher operating speeds.

In systems applications, compactness of the new circuits should lead to improved electrical performance, greater efficiency through useful application of circuit power dissipation. The system also tends toward reducing both weight and volume in systems where elevated temperature ambients are encountered

Making Test Fixtures More Versatile

SEMIAUTOMATIC GO-NO-GO in-circuit testing of parameters of complex components provides standardized test results, avoids operator errors and saves time. It is practical in high variety production when the test equipment is sufficiently versatile.

A method employed by Magnetic Amplifiers, Inc., New York, N. Y., permits a large variety of tests without excessive expenditures for equipment and calibration. Versatility is obtained by building-block test fixtures, combined as required with auxiliary fixtures and instruments.

Standard Chassis

Standard test chassis are made for each type of family of amplifier and major components, such as toroids. The chassis provide an in-use circuit or the remainder of the unit's circuitry and the wiring required to effect a series of tests. The chassis generally do not include a power supply or test instruments.

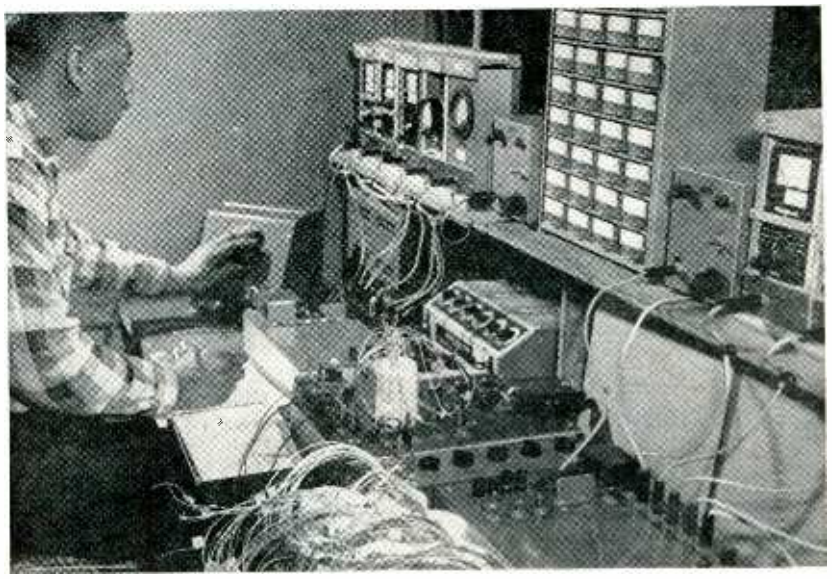
A typical chassis will have jack positions and polarity pilot lights along the top, for connection to instruments. A female connector is on the right side. The connector allows a variety of auxiliary test fixtures to be hooked into the basic chassis. In addition some chassis have speed clips so components can be tested on the chassis.

On the left side are on-off or stepping switches and connectors for power supplies. The switches allow the chassis to be used for a variety of tests on one unit or related groups of units.

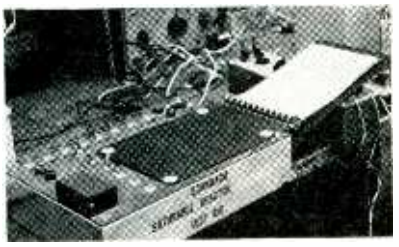
Test chassis are filed in racks when not in use

A procedure sheet is fastened in the center of the chassis. Or, if the chassis is used for a family of units, the sheets are bound in a loose-leaf book fastened to the chassis. The sheets specify instruments to be requisitioned, their location in the housing boxes, connections to be made and switch positions for each test. Ranges observed on the meters are checked off or logged, as required, on the quality control forms accompanying each unit.

For preliminary tests of components, lead wires are placed in color coded speed clips. A toroid may be tested on a chassis with a ring of clips. A completed unit may be connected to an auxiliary fixture by gang plugs connected in turn to the female connector of a chassis. These auxiliary fixtures generally use a lever arrangement for quick connect and disconnect of the unit.



Final inspection of toroid. Procedure sheet specifies instruments and connections required to perform variety of tests

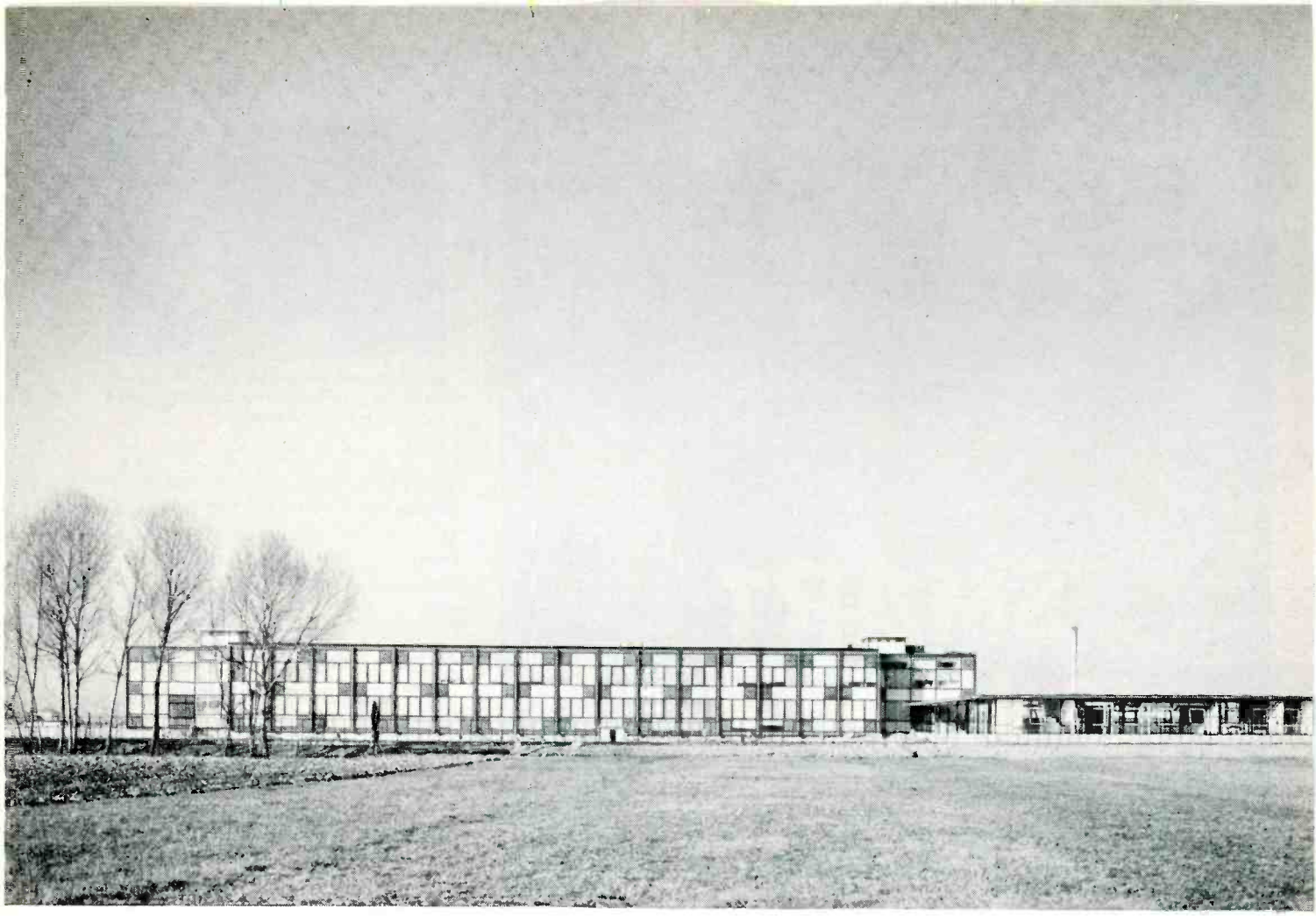


Test procedures for different types of units are bound in loose-leaf book

Small meters are packaged in wooden boxes with an adapter plate on the connectors. Microphone jacks connect box to chassis to assure correct polarity. The meters and the meter housing boxes are coded in conformance with the procedure sheets. Blocks of wood in the hinged housing tops keep the meters in place. Meters are provided from a central source where they are periodically calibrated.

Final test rigs may be more complex and may have meters built into the test chassis. One setup, for example, simulates a missile's hy-

Meter is placed in housing. Adapter plate and microphone jack prevent wrong polarity



Transistor Engineer Wanted, To Head Laboratory, Italy

olivetti

Olivetti (Italy) has established a subsidiary in Milan for the production of silicon and germanium transistors and diodes.
It is now looking for the right person to head the existing development laboratory.
These are the requirements: (1) At least 5 years experience in transistor development
(2) Degree of Master of Science in Physics
(3) Willingness to move to Italy and learn Italian.
It would be desirable if you were familiar with present applications and future potentialities of transistors and diodes, in order to contribute actively to the general policy of the new firm.
Salary will be commensurate with experience and ability. Transportation and moving expenses will be paid.
Written replies will be sent to all applicants.
Chosen candidates will be invited for a personal interview in New York City, expenses paid.
Please write, enclosing detailed resume, to Project

T. D. L., Olivetti, Ivrea, Italy.

Inspection of completed unit. Meters are built into test chassis and auxiliary fixture connects units to chassis

draulic system so a servo can be tested over its operating range. Although the instrumentation is more complex, the same principles are followed.

Fiber Drums Cut Cost of Preservation Packs

FIBER DRUMS can be used as preservation packs for hermetically-sealed aircraft and missile electronics equipment. Since the equipment itself is already sealed against corrosion, 100 percent vapor proofing is required only for exposed electrical and mechanical connectors.

The moisture resistant fiber drum shown houses a Model 7002C displacement gyroscope made at Lear Corp., Grand Rapids, Mich., division. Connectors are vapor-proofed with metal or plastic caps and rubber gaskets. Dunnage around the gyroscope is preformed hair latex.

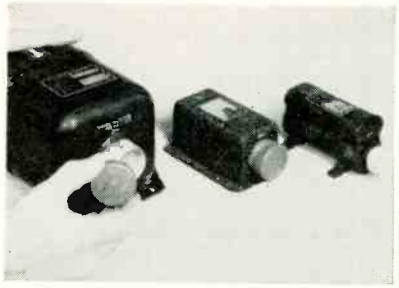
Lear instituted the packaging method recently after independent study by packaging engineers of the firm and Air Materiel Command's Middletown Area Depot. AMC has given tentative approval to the

Gyroscope packed in 14 by 20-inch fiber drum which weighs 6.25 pounds

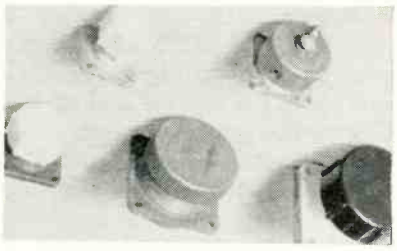
method pending preparation of formal specifications.

Lear has found that the use of fiber drums for hermetically sealed units yields substantial savings in drum and shipment cost and weight. Calibrated drop tests show a 7 percent reduction in shock transmission, compared to steel. If bruised, the fiber does not take a permanent set.

The drums conform to federal specification PPP-D-732A. The drum shown is manufactured by the Fiber Drum Division, Continental Can Co. Metal vapor caps are purchased from the Cannon Co. and conform to Mil-Spec 25043-22 and 25043-24. Plastic caps, purchased from S. S. White Dental Co., do not as yet have military specifications.



Metal caps cover connectors of gyroscope and power adapter. Plastic cap is on rate sensor (right)



A variety of metal and plastic caps attached to connectors

Preservation packs are those suited to long storage or overseas shipment. Previously a vapor-proof container, such as a steel drum, was required for both hermetically sealed and non-hermetically sealed military units. Lear has been using drums for commercial shipments of non-hermetically sealed units when the units are intended for immediate use. If the commercial shipment is remarked for a preservation pack, the unit and its dunnage are transferred to a vapor-proof drum.

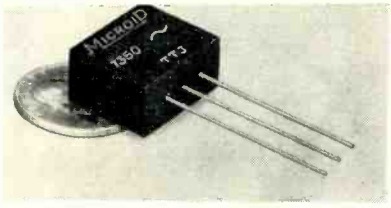
ON THE MARKET

Power Transistors
germanium type

TEXAS INSTRUMENTS INC., P. O. Box 312, Dallas, Texas, announces a new line of 10 to 25-ampere germanium *pnp* alloy power transistors which are uniquely integrated to permit selection of specialized devices for specific jobs. Featuring high collector currents and voltages, plus a new low R_{cs} of 0.05 ohm maximum at maximum rated collector current, the units provide a dissipation of 80 w at 25 C. **Circle 200 on Reader Service Card.**

Band Pass Filter
miniaturized

BURNELL & CO., INC., 10 Pelham Parkway, Pelham, N. Y. Type TTJ Microid band pass filter is designed for performance on 7,350 cps and



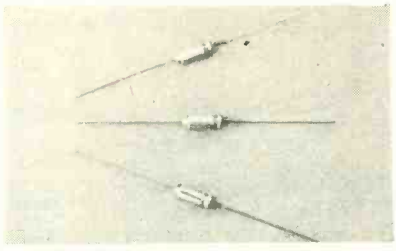
up to 100 kc. Physical size is $\frac{1}{2}$ in. by $\frac{13}{32}$ in. by $\frac{1}{8}$ in. with a weight of 0.3 oz. Band width is 15 percent at 3 db and +60 percent —40 percent at 40 db. Units are completely encapsulated. **Circle 201 on Reader Service Card.**

Rectifier Control
extremely compact

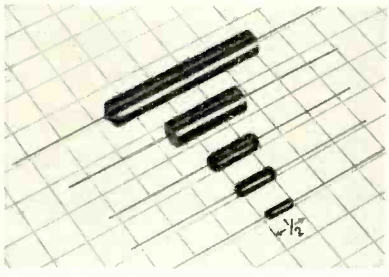
VEC TROL ENGINEERING, INC., P.O. Box 1089, Stamford, Conn., has released its Silicontrol—a 400 cycle phase-shift peaking control for linear, sensitive, wide range, fail-safe, gate control of the GE silicon controlled rectifier. It ideally provides sharp pulses of constant amplitude and 180 deg variable phase angle to control the rectifier output proportionately from zero to maximum with but a 1 to 2 mw d-c signal. Its four control windings are isolated from the rectifier power circuits, and loss of the control signal turns off the rectifier. **Circle 202 on Reader Service Card.**

Capacitors
tantalum slug

OHMITE MFG. CO., 3601 Howard St., Skokie, Ill., announces a new physical type in tantalum slug capacitors—the straight-cylindrical as contrasted to the hat-shaped variety. The new series offers savings



in space and improved ease of mounting. They utilize a slug of sintered tantalum metal for the anode. Stability of the units is greater than other types of electrolytics, and their leakage current and equivalent series resistance is lower than wire or foil tantalum capacitors. **Circle 203 on Reader Service Card.**

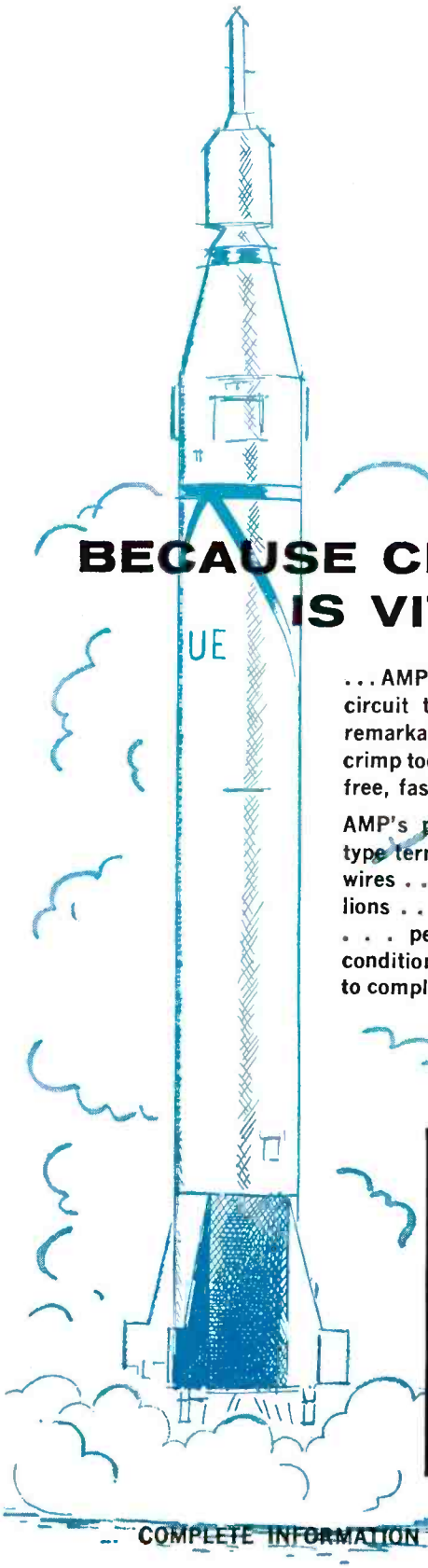


Resistors
metal film

DALE PRODUCTS, INC., Box 136, Columbus, Neb. New MF type molded metal film resistors combine advantages of advanced high vacuum evaporated metal film techniques with Dalohm molding process to provide the best characteristics of wire wound resistors, yet retain miniature size. Resistance range is from 100 ohms to 4 megohms, depending on size. Temperature coefficient is ± 50 ppm or ± 100 ppm. Operating temperature range is —55 to 150 C. **Circle 204 on Reader Service Card.**

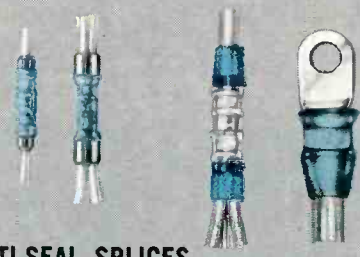
Limiter Amplifier
transistorized

OTARION LISTENER CORP., Scarborough Park, Ossining, N. Y. The EPD-100 limiter amplifier accepts input signal variation of 12 db, but limits the output signal to less than 2 db. It is designed for operation in the audio range of 50 cps to 15,000 cps, at temperatures from —55 C to +85 C, and for power supply variation of ±5 percent. Limiting is accomplished with less than 5 percent distortion, using only four



STRATO-THERM
TERMINALS AND SPLICES

- up to 1200°F. operating temperature
- solid, stranded or combination conductors
- shock and corrosion resistant
- wire size range 22-10 AWG
- serrated inner barrel for maximum tensile strength



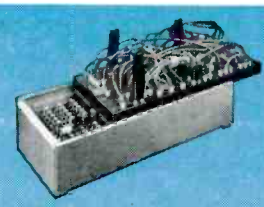
CERTI-SEAL SPLICES
AMPLI-NYL TERMINALS AND SPLICES

- combined wire size range 22-2/0 AWG
- exceed millivolt-drop specifications
- finest nylon pre-insulation
- shock and corrosion resistant
- color coded by wire size

BECAUSE CIRCUIT RELIABILITY IS VITAL . . .

. . . AMP's product is more than fine circuit terminals . . . more than remarkably precise compression-crimp tooling . . . more than an error free, fast method of attachment.

AMP's product is finished crimp-type terminations on your circuitry wires . . . by the hundreds or millions . . . of the highest reliability . . . performing under gruelling conditions . . . from basic terminals to complete patchcord systems.

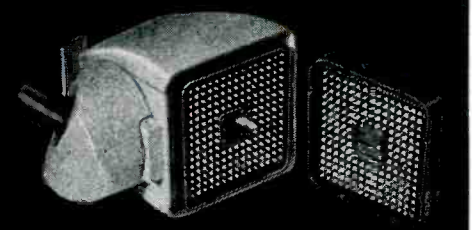


PATCHCORD PROGRAMMING UNITS
(Airborne "240" shown)

- universal or shielded systems
- patented wiping action pre-cleans pins and contact springs
- nylon sleeve insulates and firmly seats patchcord pin in board
- contacts have rear board accommodation for taper pins to provide reliable solderless lead terminations

200 CONTACT CABLE CONNECTORS

- extremely reliable disconnect for ground electronic and instrumentation application
- connector can be electrically disengaged without mechanical separation
- five indexed positions to permit strain-free cable exit
- identical inserts and contacts in both halves
- polarized to prevent improper coupling—has numbered cavities to assure proper circuit identification



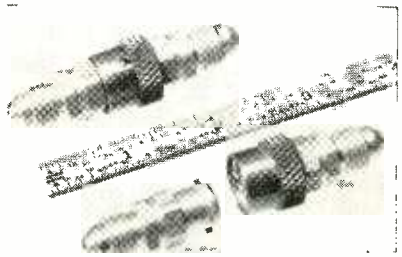
COMPLETE INFORMATION ON THESE FOUR PRODUCT LINES IS AVAILABLE ON REQUEST.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

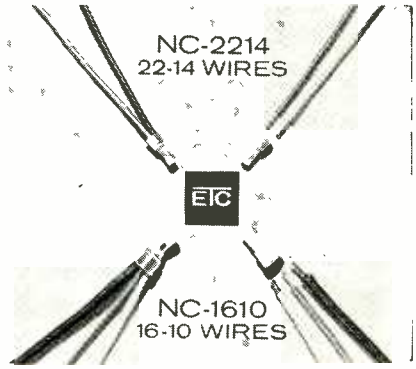
A-MP products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Japan

transistors and one diode. Unit accepts minimum inputs of 2-50 mv, peak to peak, with an input impedance of 600-4,000 ohms, and provides an output of 0.5 v, peak to peak, ±1 db across a 3,000 ohm load. **Circle 205 on Reader Service Card.**



Coupling self-sealing

AEROQUIP CORP., Jackson, Mich. The 1010 series coupling is only 2½ in. long and weighs slightly over ½ oz. Connection is by a simple bayonet-type lock and each half is self-sealing with Viton A "O" rings. Coupling is suitable for electronic cooling systems, test stand, filling and charging connections, pressure sensing, and other general aircraft or missile applications where light weight and compactness are desired. Design exceeds requirements of MIL-C-7413 and has an operating temperature range of −65 to +375 F with operating pressures to 1,500 psi. **Circle 206 on Reader Service Card.**



Pigtail Connectors nylon-insulated

ELECTRIX TERMINALS & CONNECTORS, INC., 990 E. 76th St., Cleveland 3, Ohio, is making new nylon-insulated solderless connectors for

NEW BENDIX MS-R ENVIRONMENT RESISTING ELECTRICAL CONNECTOR

Now available and approved in complete conformance with MIL-C-5015D.

This new connector answers the demand from the aircraft industry for a shorter, lighter and more reliable environment resisting connector. This connector will inactivate practically all other MS types and the Military has assigned a new class letter R to insure incorporation of this better connector in all new designs.

An important reliability feature of the new MS-R connector is an "O" ring at the main coupling joint which provides for the best possible sealing and more positive inter-facial compression and assures complete performance compatibility among all approved MS-R connectors. Establishment of the MS-R connector as the "universal" military connector is testimony to the record of previous MS environmental resistant connectors using resilient inserts as pioneered by this Division. In the Bendix* connector, wire sealing is accomplished by an exclusive slippery rubber grommet which permits convenient wire threading and grommet travel over wire bundles.

Write for more complete information on this latest addition to the ever-growing family of Bendix electrical connectors.

*TRADEMARK

Bendix **SCINTILLA DIVISION**
SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. Canadian Affiliate: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec.

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COMMUNICATIONS & COUNTERMEASURES To direct and supervise group of physicists, engineers and technicians in projects involving weapons systems, ranging, detection, atmospheric measurements, etc. Conversant with practical and theoretical implications of defensive or offensive systems.

ULTRASONICS To direct group of physicists, engineers and technicians in research and development of sonic and ultrasonic equipment for commercial and military applications, and encompassing all aspects of ultrasonic research. Requires qualities of leadership and compatibility with highly skilled scientific minds.

SERVOS & CONTROLS Will direct and supervise group of engineers, physicists and technicians in research and development in electro-mechanical devices, servos, industrial controls and instrumentation. Excellent opportunity in applied research in this field.

Degree required in engineering or science with a minimum of 5 years related experience. These positions are with the Research Division, at Quehanna, in the picturesque area of North-Central Pennsylvania, 40 miles from State College, home of Pennsylvania State University.

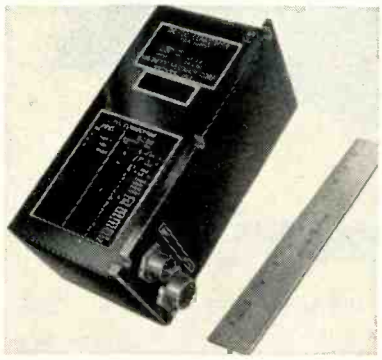
Send resume including salary requirements to: **Mr. T. W. Cozine, Manager, Executive & Technical Placement, Curtiss-Wright Corporation, Dept. RD-71, Wood-Ridge, New Jersey.**

All replies confidential

CURTISS-WRIGHT

CORPORATION • WOOD-RIDGE, N.J.

pigtail splicing of two or more wires. Formed of translucent nylon in a closed-end design, the connectors are available for immediate shipment from factory stock. They can be furnished in special coding colors on quantity orders. The pigtail units replace slower methods of individually splicing and then insulating with tape or tubing. Wires are inserted, then crimped in a single operation. The splice is permanently anchored and insulated, cannot be loosened by vibration. **Circle 207 on Reader Service Card.**



Static Converter hermetically sealed

MAGNETIC RESEARCH CORP., Hawthorne, Calif., has developed a d-c/d-c static converter for computer, portable test equipment, emergency equipment and airborne equipment applications. Output power is multiple, 150 w maximum. Size is 5.0 in. by 3.5 in. by 3.7 in. Weight is 3.5 lb. Efficiency is greater than 75 percent. Line regulation is less than ±1 percent. Unit is short-circuit proof and offers a 28 v d-c input. **Circle 208 on Reader Service Card.**

Noise Figure Tester for tube industry

LEL, INC., 380 Oak St., Copiague, L. I., N. Y., offers a noise figure test set of high accuracy featuring the GE microminiature ceramic 7077 tube as a low-noise input

Jack Carroll

Managing Editor, **electronics**
Holds Partial Staff Meeting

Resumé:

Carroll, John M., (seated in photo) Lehigh University, BS, Hofstra College, MA in Physics, member several I.R.E. committees. Naval electronics, World War II. Electronics engineering officer during Korean war. Background in engineering derives from experience with the National Bureau of Standards, Naval Research Laboratories, Liberty Aircraft, American Instrument Co. Author of technical books for McGraw-Hill Book Company.

Present Occupation:

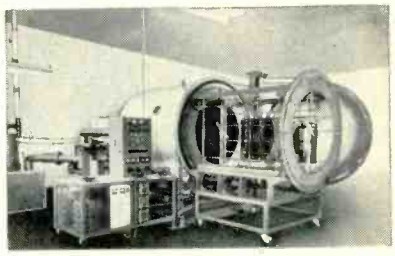
Jack Carroll is responsible for "getting-out-the-book" each week within the framework of editorial policy formed by W. W. MacDonald, Editor of **electronics**. Jack is occupied with editorial makeup, with the accuracy of editorial content, with scheduling the workload of a 26-editor staff to provide maximum coverage of technical developments and business information.

References:

Jack is a dedicated man—dedicated to the interests of the readers of **electronics** magazine. His prime goal is to help edit a publication which will be required reading for the important people in the electronics industry – a publication that will fill the needs of design-research, production, management. If you are not receiving the publication that is edited to keep you best informed, if you are not a subscriber, or if your subscription is expiring, fill in the box on the Reader Service Card. Easy to use. Postage is free.

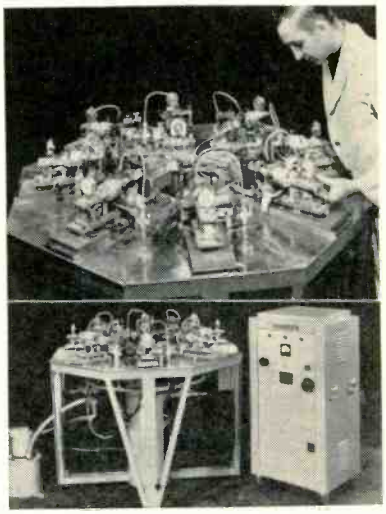
electronics
A McGraw-Hill Publication
330 West 42nd Street, New York 36, New York

stage, followed by a 200-mc amplifier of 100 db gain. An integral 3-db attenuator and an output meter, plus a separate filtered detector are included. Intended for use in testing tube performance in r-f tuners or preamplifiers at 200 mc, it is designed to JETEC 5.4 subcommittee specs as a standard test set for the tube industry. **Circle 209 on Reader Service Card.**



High Vacuum Coaters
large work chambers

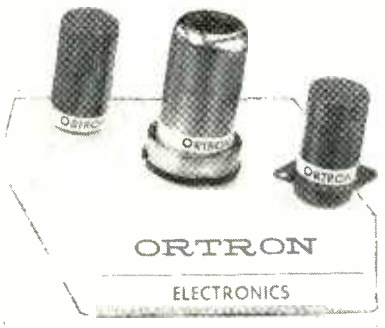
KINNEY MFG. DIVISION, The New York Air Brake Co., 3529 Washington St., Boston 30, Mass. The PH series high vacuum evaporators have work chambers large enough for high production processing of small parts or the handling of large objects—up to 6 ft in length. Work chambers provide volumes of 50, 100 and 175 cu ft. Chambers of greater volume are also available. **Circle 210 on Reader Service Card.**



Machine Tool
ultrasonic unit

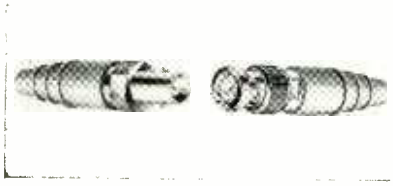
THE SHEFFIELD CORP., Dayton 1, Ohio. Strikingly different in design and operation, a new space-saving, cost-cutting ultrasonic machine tool

does the work of 8 conventional machines. It was designed to meet industry's need for a more economical and efficient method of machining hard and brittle materials such as germanium, silicon, ferrite, glass, and quartz in ever-increasing quantities. A single magnetostrictive transducer mounted in the well of the table transmits 20,000 ultrasonic machining strokes per sec to each station by means of the curved cylindrical ultrasonic transmission lines. A remote 1,000 w h-f electronic generator drives the transducer. **Circle 211 on Reader Service Card.**



Time Delay Relays
rugged, precise

ORTRON ELECTRONICS, 29 Lincoln Ave., Orange, N. J., announces the new Hi-Gee thermal time delay relay. It is made to conform to all existing MIL specs including MIL-R-5757 and MIL Standard 202. Life expectancy is 50,000 to 100,000 guaranteed operations at rated load. Vibration tests showed no structural damage to units or change in time setting. Shock test of 15 shocks of 50 g's showed same. Contact arrangement is spst either normally open or normally closed. **Circle 212 on Reader Service Card.**



R-F Connectors
less assembly time

AMPHENOL CONNECTOR DIVISION of Amphenol-Borg Electronics Corp., Chicago, Ill. A new line of BNC r-f connectors can be assembled in half the time of ordinary connectors. Called Quick-Crimp, they are partially pre-assembled before shipment into only three basic parts (plus an optional boot) as compared to as many as 10 parts in a standard BNC connector. Family consists of 19 different connectors which mate with standard BNC's if desired. Voltage rating is 500 v peak; vswr is low up to 10 kmc.

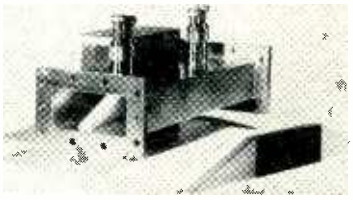
H-V Resins
high heat

ARIES LABORATORIES, INC., 45-33 Davis St., Long Island City 1, N. Y. Impregnating and encapsulating resins that withstand higher temperatures are offered under the designation Aritemp 215 and Aritemp 221. They pass the requirements for Class H insulating compounds. Transformer coils impregnated with Aritemp 221 and then encapsulated in Aritemp 215 resisted a test voltage of 8,000 v for more than 1,000 hr at temperatures up to 200 C. **Circle 213 on Reader Service Card.**

Spectrometer
automatic

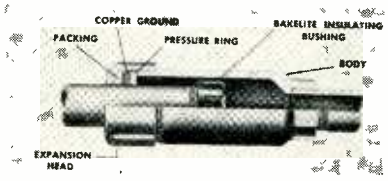
RADIATION INSTRUMENT DEVELOPMENT LABORATORY, INC., 5737 S. Halsted St., Chicago 21, Ill. Model 50-1 automatic spectrometer consists of model 33-1 single channel pulse height analyzer (modified ORNL Q-1192) containing an Argonne type A61 nonoverloading linear amplifier, a model 39-2 electronic sweep-count rate meter and h-v supply plus a Brown ElectroniK recorder. An electronic sweep circuit is used to automatically scan the spectrum between any two pre-

determined levels from 0 to 85 v, then resets and repeats cycle. **Circle 214 on Reader Service Card.**



Ferroxcube for microwave

FERROXCUBE CORP. OF AMERICA, Saugerties, N. Y. Designated as Ferroxcube 5, a new material is currently being offered in a variety of shapes and sizes for use in rotation, resonance and field displacement isolators and other unidirectional devices operating in S, X, K, Q or V bands. **Circle 215 on Reader Service Card.**

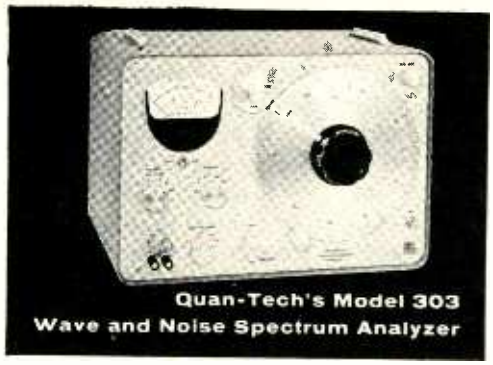


Conduit Fittings weathertight

SPRING CITY ELECTRICAL MFG. CO., Spring City, Pa., has announced a complete line of weathertight conduit expansion fittings to relieve the strain of expansion and contraction in long runs of conduit. Different types are available in ferrous and nonferrous metals, for rigid conduit or EMT, and for deflection in addition to expansion and contraction. **Circle 216 on Reader Service Card.**

Precision Pot noise-free

NEW ENGLAND INSTRUMENT CO., 320 Main St., Woonsocket, R. I. Each section of the new model 158 4-w, multisection, wirewound pot passes a rigid test for noise at −55 C, thereby assuring noise-free operation over the temperature range −55 C to +105 C. Under certain combinations of service conditions, life up to 5 million revolutions can be expected. Available in resistances



Quan-Tech's completely transistorized Model 303 is designed especially for applications in the fields of ultrasonics and noise spectrum analysis. A switch enables you to select any of four constant bandwidths. The two broadest positions are flat topped, vastly increasing the simplicity and accuracy of noise measurements, and facilitating tuning at high frequencies.

NEW !

...for measuring harmonics and noise from 30 cycles to 100 kc

FREQUENCY RANGE: 30 cycles to 100 kc., ±300 cycle vernier.

VOLTAGE RANGE: 100 microvolts to 300 volts full scale.

BANDWIDTH: −3 db at 10 and 30 cycles round top; 100 cycles and 1 kc. flat top.

MONITOR OUTPUT: Meter output and a voltage proportional to dial setting provide graphic display on oscilloscopes and X-Y recorders.

DIMENSIONS: 10½" H, 14" W, 11¼" D overall.
Wt. 28 lbs.

Write for complete information

Quan-Tech LABORATORIES

QUAN-TECH LABORATORIES • Morristown, New Jersey

CIRCLE 161 READERS SERVICE CARD

Thomas Emma, BA, Columbia, is a U.S. Naval Reserve officer who was formerly a technical writer with IT&T. Tom prepares "Financial Roundup"—a regular weekly business feature. In the coming months Tom will be concerned with radio communications, but he will be specifically involved with spectrum useage problems. To keep abreast of finance in electronics, turn to Tom's weekly coverage of latest developments. To subscribe or renew your subscription, fill in box on Reader Service Card. Easy to use. Postage free.

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The Stokes 4-inch Ring-Jet Diffusion Pump combines high pumping speed with very high forepressure tolerance. Maximum pumping speed is 655 cfm at 1 micron. Larger 6-, 10-, and 16-inch units are available for pumping requirements up to 12,000 cfm.

STOKES makes a complete line of vacuum components . . . advance-designed and engineered to help make your vacuum systems more productive. Each unit reflects Stokes' unparalleled experience, pioneering leadership and wealth of vacuum technology.

The product list includes: Diffusion Pumps, Vapor Booster Pumps, Mechanical Pumps, Vacuum Gages and Valves.

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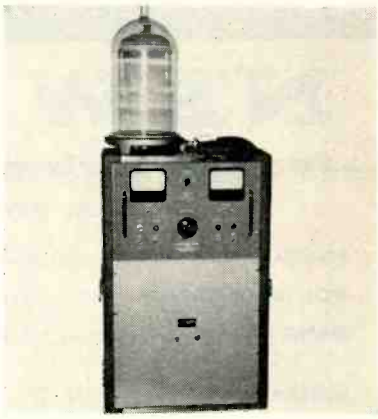
Vacuum Equipment Division
F. J. STOKES CORP.
5564 Tabor Rd., Phila. 20, Pa.

STOKES

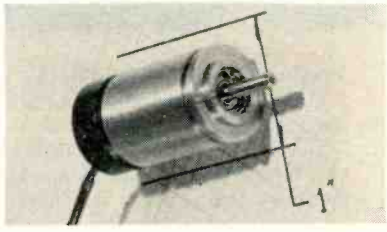
CIRCLE 163 READERS SERVICE CARD

up to 150,000 ohms, the standard model 158 has an independent linearity of ±0.25 percent, resistance tolerance of ±5 percent, and resolution of 0.05 percent. Insulation resistance is 100,000 megohms. **Circle 217 on Reader Service Card.**



Dielectric Tester
portable unit

PESCHEL ELECTRONICS, INC., Towners, Patterson, N. Y. Dielectric testing in vacuum, or atmospheres other than air, is simplified by the availability of a packaged unit, model H20 DC-XVP, which combines in one unit a dielectric test set and a two-stage vacuum pump with bell jar assembly. High altitude ceramic terminals, bushings, connectors and insulating material in general can now be conveniently tested by placing them within the bell jar of this test set. **Circle 218 on Reader Service Card.**



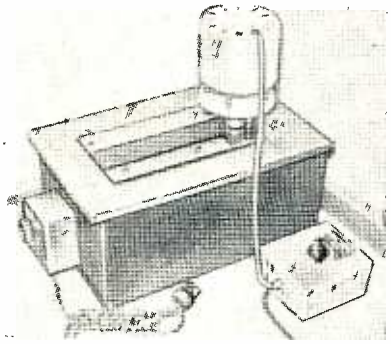
Resolvers
winding-compensated

AMERICAN ELECTRONICS, INC., 1025 W. Seventh St., Los Angeles 17, Calif. Winding-compensated resolvers are now available in the miniature size 8 configuration. They weigh only 1.2 oz and have a frame diameter of 0.750 in., with maximum frame length of 1.241 in. Units are designed for the 26-v,

400-cps input signals that are characteristic of aircraft and missile instrumentation systems. An important feature is that the slip ring and wiper assembly is designed to withstand shock loads up to 45 g at 2,000 cps. **Circle 219 on Reader Service Card.**

Drift Transistors
pnp alloy type

RADIO CORP. OF AMERICA, Somerville, N. J. Three new drift transistors—RCA-2N643, 2N644 and 2N-645—of the *pnp* alloy type, are intended for use in high-speed nonsaturating switching circuits of computers such as inverters, flip-flops and logic gates where high gain-bandwidth product and pulse repetition rates up to 10 mc are primary design requirements. They feature a minimum gain-bandwidth product of 20, 40, and 60 mc, respectively. **Circle 220 on Reader Service Card.**



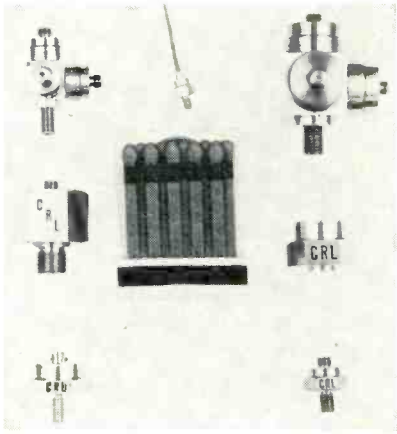
Soldering Device
for p-c use

WELLESLEY ENGINEERS, 15 State St., Wellesley, Mass. A new concept in printed circuit soldering is made available at very low cost, for installation in existing soldering pots. A continuously recirculating wave of solder gives linear contact soldering with less distortion, less delamination; eliminates icicles, and eliminates "cold" joints. It cuts rejects and rework. **Circle 221 on Reader Service Card.**

Anhydride
for epoxy curing

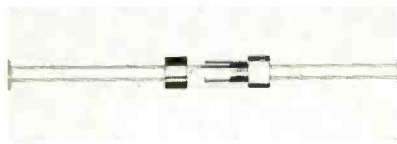
HEYDEN NEWPORT CHEMICAL CORP., 342 Madison Ave., New York 17,

N. Y., announces Beta-S, a new liquid dicarboxylic anhydride. As a curing agent it is suitable for systems used in impregnating, potting, casting, laminating, tooling and coatings. The low density offered by Beta-S cured epoxies is expected to promote material economy in potting and casting. For aircraft and missile application, the cured resin's low density can save weight for increased payloads. **Circle 222 on Reader Service Card.**



Accelerometers for high temperature

COLUMBIA RESEARCH LABORATORIES, McDade Blvd. and Bullens Lane, Woodlyn, Pa., has introduced a line of crystal accelerometers which operate in an ambient temperature range between −65 F and 540 F without cooling or correction. They utilize a newly developed piezoelectric crystal in a true compression type seismic system to provide an accuracy of ± 5 percent over broad acceleration and frequency ranges. Line consists of 16 accelerometers ranging from heavy duty to subminiature models with sensitivities from 30 mv/g to 1 mv/g. **Circle 223 on Reader Service Card.**



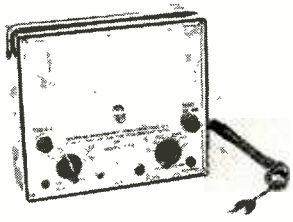
Switch current-sensitive

THERMOCAL, INC., 1627 Colorado St., Santa Monica, Calif., announces the Pyristor, a single shot, current-

sensitive switch designed for circuitry testing purposes, bypassing squibs, protective devices against surge currents, and applicable in current-operated triggering devices. They are hermetically sealed and available in normally open and normally closed single-pole types. **Circle 224 on Reader Service Card.**

Heat Radiator for transistors

THE BIRTCHER CORP., 4371 Valley Blvd., Los Angeles 32, Calif. Model 3AL-672 transistor heat radiator offers an inexpensive method of cooling diamond shape transistors as much as 30 C under typical operating conditions. Providing 12 sq in of radiating surface, it is ideal for use with transistors when they are used above ground potential and heat cannot escape into the chassis. The device attaches with the transistor to the chassis and does not interfere with operation or servicing. **Circle 225 on Reader Service Card.**



VTVOM multifunction

ELECTRONIC MEASUREMENTS CORP., 625 Broadway, New York 12, N. Y. Model 107A directly measures peak to peak voltages in 6 ranges from 0.2 v to 2,800 v. For a-c rms voltages it is capable of measuring in 6 ranges from 0.1 v to 1,000 v. Capacitance can be measured in 6 ranges from 50 $\mu\mu$f to 5,000 μf. Resistance from 0.2 ohm to 1,000 megohms can be measured in 6 ranges. Unit can also measure inductance from 1.4 henrys to 140,000 henrys in 4 ranges. **Circle 226 on Reader Service Card.**

Literature of

MATERIALS

Plastics. Emerson & Cuming, Inc., 869 Washington St., Canton, Mass. Physical and electrical properties, interesting features, major uses and general remarks on a wide variety of plastics for electronics are given in a colorful wall chart. **Circle 250 on Reader Service Card.**

COMPONENTS

Counting Units. Landis & Gyr, Inc., 45 W. 45th St., New York 36, N. Y. A new bulletin illustrates and describes Sodeco single-decade counting units and shows their varied applications. **Circle 251 on Reader Service Card.**

Crystal Case Relay. Wheelock Signals, Inc., Long Branch, N. J. Technical data on a new microminiature crystal case relay are given in bulletin 160-1. **Circle 252 on Reader Service Card.**

Single-Turn Pot. Helipot Division of Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif. Data sheet 1543 details the 1⅞ in. all-metal single-turn series 5400 precision potentiometer. **Circle 253 on Reader Service Card.**

Transformers. Sterling Transformer Corp., 297 North 7th St., Brooklyn 11, N. Y. A new catalog of contour molded Clipper series transformers for 400 cycle operation is now available. **Circle 254 on Reader Service Card.**

EQUIPMENT

F-M Transmitters and Amplifiers. Industrial Transmitters and Antennas, Upper Darby, Pa. A line of f-m transmitters and amplifiers are covered in a recent 4-page folder. **Circle 255 on Reader Service Card.**

Portable Tape Recorders. Amplifier Corp. of America, 398

the Week

Broadway, New York 13, N. Y. A 6-page brochure covers the Trans-Magnemites — professional, transistorized, battery-operated spring-motor tape recorders.—**Circle 256 on Reader Service Card.**

Insertion Loss Test Set. Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md. A new edition of Application Notes No. 4 describes a dual channel system for measurement of insertion loss up to 20 db with an accuracy of 0.02 db per 10 db at any frequencies for which power sources and bolometers are available. **Circle 257 on Reader Service Card.**

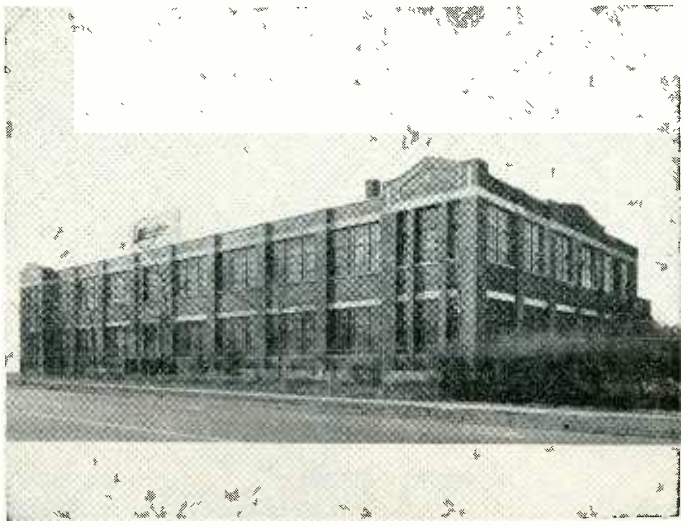
Microwave Equipment. Sperry Microwave Electronics Co., Division of Sperry Rand Corp., Clearwater, Fla. Publication No. SJ-60-004 contains illustrations and technical data on a wide variety of Microline equipment. **Circle 258 on Reader Service Card.**

Multiplex. H. H. Scott Inc., 111 Powdermill Road, Maynard, Mass. A four-page folder contains a message that will help answer questions about multiplex and multiplex adaptors. **Circle 259 on Reader Service Card.**

FACILITIES

Countermeasures. Instruments for Industry, Inc., 101 New South Road, Hicksville, L. I., N. Y., announces a brochure on its history and extensive background in the design and manufacture of automatic wideband countermeasures, special equipment and complete systems. Included are illustrations of its engineering facilities. **Circle 260 on Reader Service Card.**

Automatic Systems. Atronic Products Inc., Bala-Cynwyd, Pa. A recent brochure discusses the company's services which include system engineering, advanced technique development, and packaged components for the automatic control of industrial processes. **Circle 261 on Reader Service Card.**



Kearfott Opens 8th Facility

KEARFOTT CO., INC., recently expanded its engineering division into newly-leased quarters in Clifton, N. J. The aircraft instrument concern will now occupy four facilities in Clifton, in addition to four other buildings in Little Falls and Paterson, N. J. The plant, a two-story structure, contains approximately 33,000 sq ft.

Robert N. Brown, Kearfott vice-president and director of engineering, explains the expansion was made to relieve pressure on the company's existing engineering plant in Clifton. In the past few months, he says, the company has won many new development contracts covering equipment for some of the nation's leading aircraft and guided missile programs.

The new facility will house an electromechanical pilot plant, a drafting section and other supporting departments.

Located in New Jersey since 1951, Kearfott has grown from 244 employees to more than 4,500 people engaged in the development, manufacture and sale of precision systems and components for airborne and missile navigation and control. Among the programs in which the company is active are the Navy's Polaris missile, the Air Force's Atlas ICBM, and many other military and commercial developments. Kearfott reports its equipment is used in nearly all U. S. military manned aircraft and in more than 20 missiles of all types.

DCA Subsidiary Names New V-P

AS PART of its new program of decentralizing executive authority, Dynamics Corp. of America has named Jack F. Lepre to the newly-created post of vice president in charge of industrial relations and special projects for its wholly-owned subsidiary, Reeves Instrument Corp.

Lepre will have full charge of labor relations at the DCA subsidiary's 2,500-employee plant at Roosevelt Field, L. I., N. Y. He will also undertake special assignments from Raymond F Kelley, president and board chairman of both DCA and Reeves Instrument, and from J. Bryan Straley, executive vice president of Reeves.

Briggs Adds to Staff and Lab

AN INCREASE in scope of business activity has led to appointment of several persons to the professional staff and to the occupancy of an additional 5,000 sq ft of laboratory space, announces Thomas H. Briggs, president of Briggs Associates, Inc., Norristown, Pa.

To the newly established position of manager of accounting is appointed Leonard A. Colavita, formerly assistant controller of Artloom Industries, Inc.

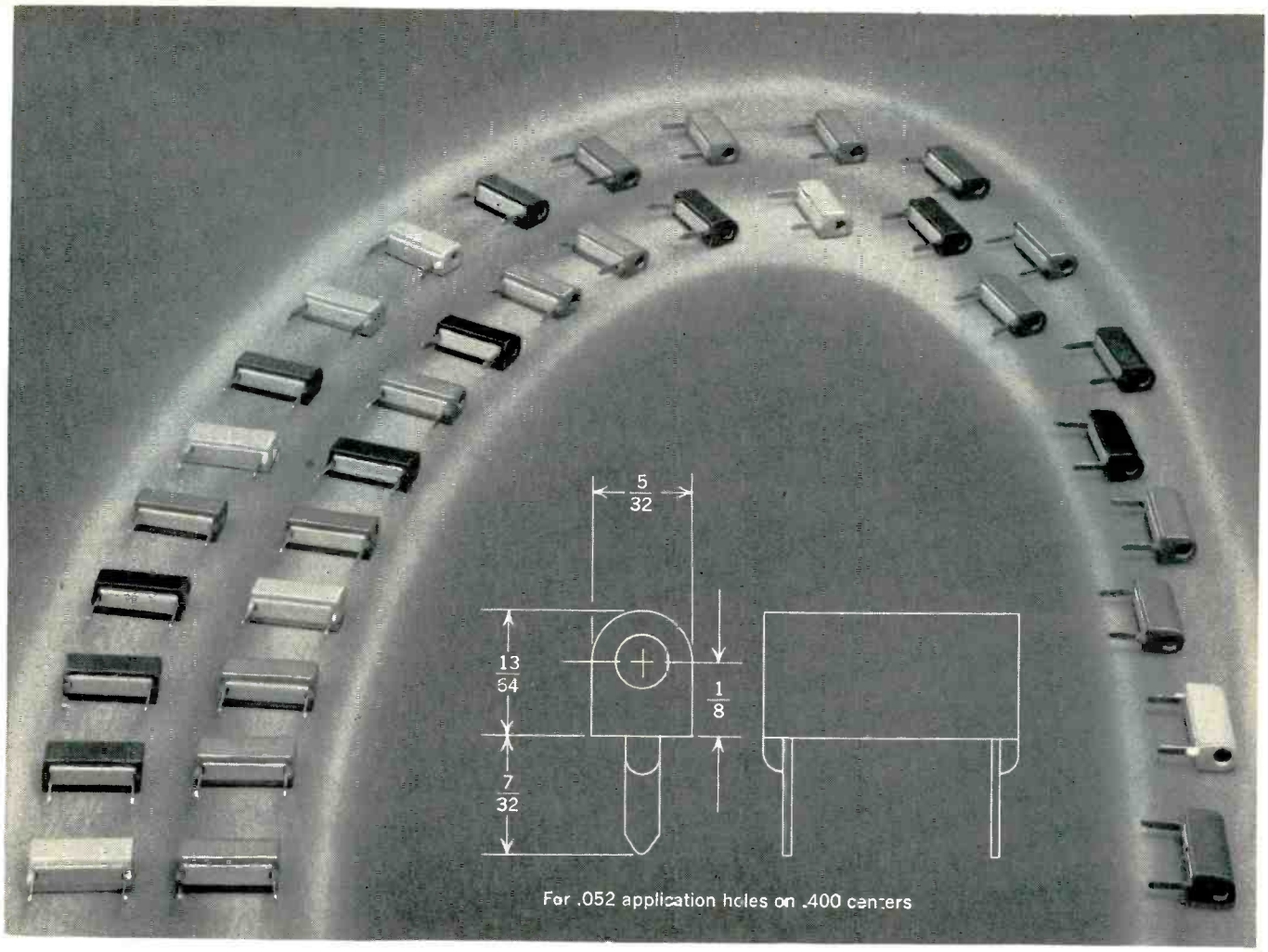
An engineering sales position has been created with appointment of K. Kennard Gross, field engineer, formerly chief engineer of Keystone Transformer Co.

Appointed to a further newly established position of technical editor is Anne Seel Bikle, formerly technical writer at Burroughs Corp.

Additions to the engineering staff include J. W. Moller, electrical engineer and Frank L. Egenstafer, test equipment engineer formerly associated with Revner Industries and RCA, respectively.

Vacuum Expert Heads Army R&D

RICHARD S. MORSE, 47, specialist in high vacuum technology, takes over June 1 as director of research and



New
Test Jacks for Printed Circuits

Designed for permanent assembly to printed circuit boards, these new test jacks by Ucinite are easily accessible to standard .080 test probes and eliminate the need for individual adaptor boards.

Simple, economical construction ensures reliability and reasonable cost. Gold-over-silver-plated beryllium copper contacts provide dependable, low-resistance connections. Nylon bodies are available in eleven standard code colors specified as follows: Part number (119437) plus letter suffix . . . A-Opaque White, B-Red, C-Black, D-Brown, E-Green, F-Orange, G-Blue, H-Yellow, J-Gray, K-Violet, L-White translucent.

With an experienced staff of design engineers plus complete facilities for volume production of metal and plastic parts and assemblies, Ucinite is capable of supplying practically any requirement for fasteners, connectors, switches and other small metal and metal-and-plastics assemblies. Call your nearest Ucinite or United-Carr representative for full information or write directly to us.

ELECTRICAL DOT ASSEMBLIES

Manufactured by

The UCINITE COMPANY

Division of United-Carr Fastener Corporation, Newtonville, Mass.

development for the Army.

Morse organized National Research Corp., Cambridge, Mass., and served as its president since 1940.

A graduate of MIT, he did advanced work in physics at the University of Munich, Germany. From 1935 to 1940, he was engaged in sound and color reproduction work at Eastman Kodak Co.

Last year, Morse was named chairman of the Army Scientific Advisory Panel, and in this capacity served as a member of the DOD Defense Science Board.

In the Army R&D post, Morse succeeds William H. Martin.

New president of National Research is chemist Hugh S. Ferguson.

BREI Expands

BABCOCK RADIO ENGINEERING, INC., has increased its facilities in Costa Mesa, Calif., with the addition of a 25,000 sq ft production building. In less than two years the company has quadrupled its employees and doubled its plant area.

Babock is engaged in the design and manufacture of guidance control equipment for missile target aircraft, transmitters, coding and decoding systems and a variety of test equipment used throughout the electronics and missile industries.

Engineer Group Starts New Firm

FOUNDING of new company, Metco Inc. (Microwave Electronic Tube Co.) in Salem, Mass., is announced by 11 engineers who resigned their posts at Bomac Laboratories Inc. in nearby Beverly, a subsidiary of Varian Associates.

Heading the new corporation are Richard J. Broderick, former treasurer of Bomac and now president-treasurer of Metco; and Harold Heins, who was Bomac vice president for engineering and becomes executive vice president of Metco.

Firm will concentrate on microwave R&D and manufacture of microwave tubes and devices. With 14 employees, Metco scheduled start

of production two weeks after firm was founded. Broderick said it is expected employment will reach about 100 within a year.

Both Broderick and Heins are founding directors. Broderick said selection of other board members would be announced in the near future, simultaneously with disclosure of the financial backing for the new firm.

Metco has taken over a former CBS-Hytron plant in Salem, which had been vacant since 1957.

News of Reps

The A. P. M. Sales Corp., Yonkers, N. Y., appoints five new sales reps to handle its line of high-pressure seals and fasteners. Reps and the areas they cover are:

Koehler & Pasmore—Michigan; **Jack Geartner Co.** — Florida; **Wayne Goldie Co.**—lower California; **Morris Steel & Alum. Co.**—New Mexico; **J. Tyler Griffin**—eastern Pennsylvania and southern New Jersey.

Technical Representation of Glenside, Pa., adds **William S. Kendrick** to its staff of technical sales engineers. Firm serves as mid-Atlantic sales rep for Atlantic Transformer Corp., International Telephone & Telegraph Corp., Stackpole Carbon Co., Times Wire & Cable Co., and Victory Engineering Corp.

Howell Sales, Inc. of Denver, Colo., and Seattle, Wash., has been named by Inso Electronic Products, Inc., Union, N. J., as its western sales rep. Inso, which produces insulated wire, is a wholly-owned subsidiary of Adam Consolidated Industries, Inc.

Kurman Electric Co., Brooklyn, N. Y., appoints the **D. R. Bittan Co.** of Valley Stream, N. Y., as rep for the metropolitan New York and New Jersey area.

M. W. Riedel & Co., electronic manufacturers' rep firm, is appointed sales rep for the line of magnetic components produced by Magnetic Circuit Elements, Inc., in the states of California and Arizona.

COMMENT

Single-Channel Stereo

What is presently acclaimed to be stereophonic sound is in reality binaural. The third factor in stereo reproduction is the depth factor which is effected through accoustical triangulation.

This can be achieved by the placement of three microphones in an L configuration and providing recovery through a complementary speaker arrangement. The dead spots common to binaural systems are not present in this type of resolution. The sound source is resolved both laterally and in depth.

Present stereo systems operate through a two-channel carrier. True stereo with three channels would employ a separate channel for each microphone and speaker. It is possible to arrive at this effect with a single-channel system.

The distance from a sound source to three microphones in an L formation controls a time difference, or phase variation, among them. Since the inverse-square law also holds, the energies arriving at the microphones exhibit both phase and amplitude differences. The difference in phase between the sound arising at the third (most distant) microphone and the summation energy from all three is the depth factor contributed by third microphone.

Stereo reproduction attempts to pinpoint a precise level of acoustical energy commensurate with the initiating energy source. This can only be achieved by acoustical triangulation.

If the three microphones are designed so that each will trigger a separately identifiable sync pulse at 0 and 180 degrees, and cut off at some later time after reversing at 90 and 270 degrees, and if a receiver's speaker system were designed so that each complementary speaker would cut off and on in sync with the companion microphone, we would then have a single-channel stereo system comparable to a three-channel system.

Analysis discloses that the speaker system will perform as desired, since any such piston-actuated system is subject to rise time and any given speaker can respond only with the energy it has been permitted to accumulate by virtue

of the time lag accorded its operation cycle. Control of the system is effected within the broadcast studio.

What remains to be done is to incorporate a simple and compatible sync generator and the necessary piston controls.

It would appear that realism will ultimately demand a stereo-4 system (at least 4 microphones and speakers, and four channels at the transmitting and receiving ends), in order to recreate precisely the acoustical geometry in the studio.

A compatible stereo-4 system would require standardization of a microphone modulation standard. This would establish two frequencies, A and B; the four separate modulation frequencies for the four studio microphones then would be A, B, A + B and A − B. The output from the microphones is mixed and added to a frequency C, which is that frequency which, added to A − B, gives the station carrier.

Standard network mike placement would ensure universal orientation even when the listener switches over to stereo-3 or -2.

The stereo-4 receiver offers many design opportunities. Using a conventional front end, the receiver could extract the A + B, then separate them and treat them individually. To avoid introducing phase variables, the separately extracted A and B components would be used to operate the loudspeaker switching system on the same go-no go basis described above. The audio would be routinely handled, fed to all speakers through 1 amplifier.

With each loudspeaker under the precise and exclusive control of the carrier and modulation of its complementary microphone, then stereo-4 cast without phase distortion would become a reality.

ROBERT E. PROUTY
OLNEY, MD.

Add Wildlife Hazards (Correction Department)

With reference to Industrial Hazards, Wildlife Division (Comment, p 89, Apr. 17): any Old Wife will tell you that it is toads and not frogs that cause warts.

JIM CURRY
TASKER INSTRUMENTS
HOLLYWOOD, CALIF.

It's a pardonable oversight; we don't have a single Old Wife on our staff to advise us on these matters.

ENGINEERS

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...TO LIVE IN

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SYLVANIA ELECTRIC PRODUCTS INC.

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Engineering Employment Manager, Dept. 11E-3

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Electronic Research And Development Project Engineers

Excellent opportunities are available in the monitoring of engineering work performed by contractors and laboratories in the development of electromechanical devices simulating, for training purposes, the operational characteristics of weapons and weapon systems. Those with degrees in electronic engineering, in combination with at least three years of professional electronics experience, are preferred.

These positions will be filled in accordance with applicable Federal civil service procedures. Salaries range from $7510 to $8810 per year. Appointees will receive full civil service benefits in Federal tenure, retirement, vacation and sick leave, and life insurance. Travel and moving expenses will be paid.

Other engineers with degrees in electronics are also invited to apply for positions with starting salaries of $6285.

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NTDC

U.S. Naval Training Device Center

Department of the Navy
Sands Point, Port Washington
Long Island, New York

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(Classified Advertising)

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The publisher cannot accept advertising in the Searchlight Section, which lists the names of the manufacturers of resistors, capacitors, rheostats, and potentiometers or other names designed to describe such products.

RADIO RESEARCH INSTRUMENT CO.
550 FIFTH AVE. NEW YORK JUDSON 6-4691

F-28/APN-19 FILTER CAVITY

Jan. spec: Tuneable 2700-2900mc. 1.5db max. loss at ctr, freq. over band. New, $37.50 each.

SCR 584—SKYSWEEP ANTENNA PEDESTAL

Full azimuth and elevation sweeps, 360 degree azimuth, 205 degree elevation. Accuracy ± one mill or better in angle, 6 ft. dish, fully desc MIT, Radiation Lab series Vol. I pg 284 and 209, Vol. 26, pg 233. For full tracking response. Includes pedestal drives, selsyns, etc. Excellent used condition. First time these pedestals have been available for purchase. Control consoles also in stock.

COMPLETE RADAR SYSTEMS

SCR-584 30 ft. trailer Skysweep antenna system PPI indicator + RHI 10 cm. High power for airway control missile-satellite tracking, radio astronomy R & D. As new. Complete.

SCR 784 Complete 10 cm. Sky Sweep System.

AN/APS-10 Complete airborne Radar Mfg. by G.E. 3cm. using 2J42 Magnetron for Navigation, Mapping, Weather, Collision Avoidance. Like New.

AN/MPN-1A (GCA) Ground Control Approach Radar, 30 ft. trailer with 3cm precision and 10cm Search Radars as used by CAA. Full desc. Vol. 11 MIT Rad Lab Series Sec. 8.13.

WEATHER RADAR 275 kw. 10 cm. Compact wt. 488 lbs. rotating yoke PPI 4, 20, 80 mile ranges, ideal for weather forecasting. Lab. Brand new. FCC approved $950.

WANTED

ALLEN-BRADLEY

RESISTORS and POTENTIOMETERS

LEGRI S. COMPANY
391 Riverdale Ave.
YONKERS 5, NEW YORK

Antique

Polished Brass Telephone Lamp! Mouthpiece and receiver bakelite. Less shade and bulb—$14.00.

All shipments FOB Simpson, Pa.

TELEPHONE ENGINEERING CO.
Dept. E-69 Simpson, Pa.

TYPES AB; CD; EF—J—JJ—JJJ—JJJJ and G's

POTENTIOMETERS

From stock in all values.

LEGRI S COMPANY
391 Riverdale Ave. Yonkers 5, N. Y.
Phone YO 9-6000

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Searchlight Equipment Locating Service
c/o ELECTRONICS, P. O. Box 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

Searchlight Equipment Locating Service
c/o ELECTRONICS, P. O. Box 12, N. Y. 36, N. Y.

Please help us locate the following equipment components.

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NAME ..... TITLE.....

COMPANY .....STREET .....CITY 5/15/59

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● See advertisement in the June, 1959 Mid-Month ELECTRONICS BUYERS' GUIDE for complete line of products or services.

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CLASSIFIED ADVERTISING
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BOMAC BEACON MAGNETRONS

Pioneer space probe shown being launched by a Jupiter C missile. Bomac beacon magnetrons are an integral part of these programs.

MINIATURIZED · WITHSTAND HIGH SHOCK · LIGHTWEIGHT

For the highest possible reliability under the most severe environmental conditions, Bomac's complete line of beacon magnetrons have proved they can take it. They have successfully withstood accelerations of 20,000 g's, have survived centrifuge tests where the applied acceleration was in the order of 20,000 g's, and have operated satisfactorily when subjected to vibrations at a 30-g level from 50 to 2000 cps.

Tube	Ef Volts	If Amps	Peak Anode Voltage	Peak Anode Current Amps	Peak Power Watts	Frequency Mcs	Output Mates To	Weight	Band
BL-212	5.0	0.5	1200 V	0.8	100	5400–5900	50Ω SM Jack	8 oz.	C
BL-223	5.0	0.7	1900 V	1.1	400	5400–5900	50Ω TNC Plug	10 oz.	C
BL-226	5.0	0.5	1300 V	0.9	100	9100–9500	50Ω TNC Plug	8 oz.	X
BL-227	5.0	0.5	1300 V	0.9	100	8700–9100	50Ω TNC Plug	8 oz.	X
BL-228	5.0	0.5	1300 V	0.9	100	8300–8700	50Ω TNC Plug	8 oz.	X
BL-230	5.0	0.7	2800 V	1.9	1000	5400–5900	50Ω TNC Plug	10 oz.	C
BL-231	5.0	0.5	1450 V	1.0	200	5400–5900	50Ω SM Jack	8 oz.	C
BL-233	5.0	0.7	2800 V	1.5	1000	9375	UG 40/U	11 oz.	X
BL-242	5.0	0.7	1900 V	1.1	400	5400–5900	TNC or 50Ω N Plug	10 oz.	C
BL-243	5.0	0.5	1450 V	1.0	200	5400–5900	50Ω SM Jack	8 oz.	C
BL-245	5.0	0.7	2800 V	1.9	900	5400–5900	50Ω TNC Plug	10 oz.	C
BL-247	5.0	0.5	1200 V	0.8	100	9100–9500	50Ω TNC Plug	8 oz.	X
BL-250	5.0	0.5	1350 V	1.0	150	5400–5900	50Ω TNC Plug	8 oz.	C
BL-M003	5.0	0.5	1300 V	0.9	100	9100–9500	50Ω TNC Plug	7 oz.	X
BL-M004	5.0	0.5	1200 V	0.9	150	8900–9100	50Ω TNC Plug	8 oz.	X
BL-M007	5.0	0.5	1300 V	0.9	100	9100–9500	50Ω TNC Plug	8 oz.	X
BL-M008	5.0	0.7	2200 V	1.1	400	5400–5900	50Ω TNC Plug	10 oz.	C

Leaders in the design, development and manufacture of TR, ATR, Pre-TR tubes; shutters; reference cavities; crystal protectors; silicon diodes; magnetrons; klystrons; duplexers; pressurizing windows; noise source tubes; high frequency triode oscillators; surge protectors.

Write today for full information –

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Salem Road, Beverly, Massachusetts

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Los Angeles 22, Calif.
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