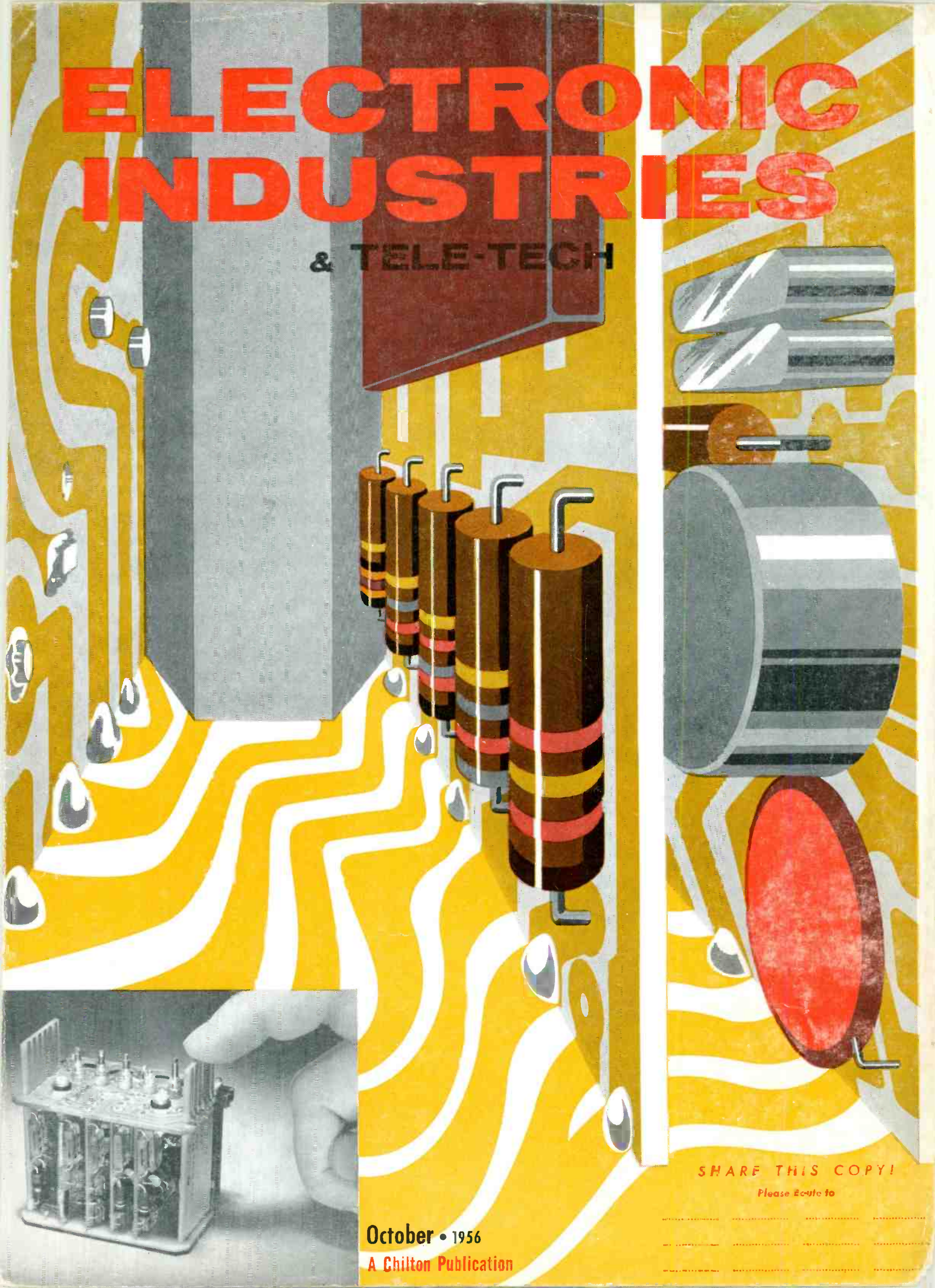
ELECTRONIC INDUSTRIES

& TELE-TECH



October • 1956

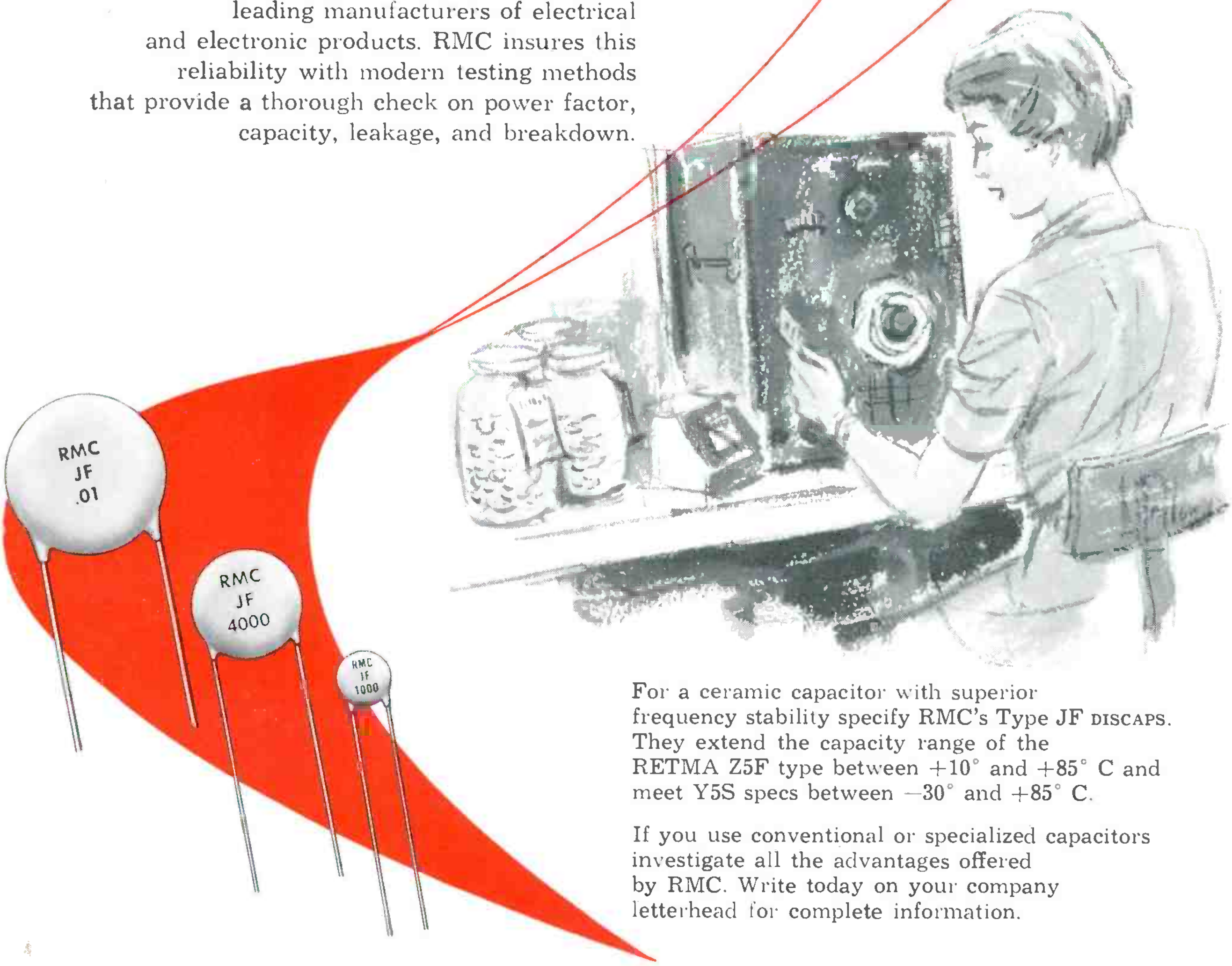
A Chilton Publication

MODERN

testing methods insure reliability

RMC DISCAPS

The proved reliability of RMC DISCAPS is a primary reason why their use is specified by leading manufacturers of electrical and electronic products. RMC insures this reliability with modern testing methods that provide a thorough check on power factor, capacity, leakage, and breakdown.



For a ceramic capacitor with superior frequency stability specify RMC's Type JF DISCAPS. They extend the capacity range of the RETMA Z5F type between +10° and +85° C and meet Y5S specs between —30° and +85° C.

If you use conventional or specialized capacitors investigate all the advantages offered by RMC. Write today on your company letterhead for complete information.

DISCAP
CERAMIC
CAPACITORS

RMC

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GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
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Address all mail to
Chestnut & 56th Sts., Phila. 39, Pa.
SHerwood 8-2000

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ELECTRONIC INDUSTRIES & Tele-Tech, Oct., 1956, Vol. 15, No. 10. A monthly publication of the Chilton Co. Executive, Editorial & Advertising offices at Chestnut & 56th Sts., Phila., Pa. Accepted as controlled circulation publication at Phila., Pa. Additional acceptance at N. Y., N. Y. 75¢ a copy. Subscription rates U. S. and U. S. Possessions: 1 yr. $5.00; 2 yrs. $8.00; 3 yrs. $10.00. Canada 1 yr. $7.00; 2 yrs. $11.00; 3 yrs. $14.00. All other countries 1 yr. $10.00; 2 yrs. $16.00.

ELECTRONIC INDUSTRIES
& TELE-TECH

Vol. 15, No. 10 **October, 1956**

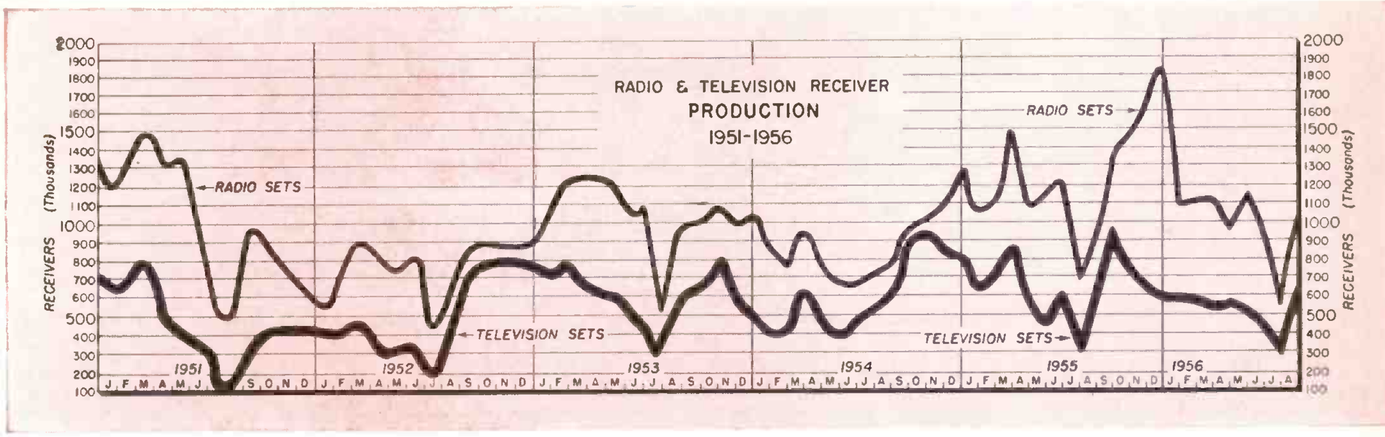
FRONT COVER: This artistic rendition, heralding our fourth annual round-up of printed circuit feature articles and latest developments, might be termed "an electron's view of printed circuits." Actually, this presentation is a close-up of a military printed circuit package as manufactured by Sanders Associates Inc., Nashua, New Hampshire. The complete unit measuring 2¼ x 1⅝ x 2½" contains 4 subminiature tubes, 15 resistors, 21 capacitors, 5 slug tuned i-f coils, 3 chokes, 2 coaxial r-f connectors and 2 six contact plugs. It meets MIL 5422 vibration specs and operates up to 125° C.

MONTHLY NEWS ROUND-UP

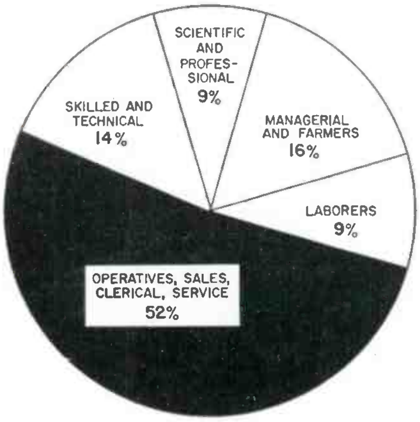
NEW ELECTRONIC EQUIPMENT

DEPARTMENTS

TOTALS



THE NATION'S WORK FORCE



From "The Skilled Work Force of the United States."—U. S. Dept. of Labor.

GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in May 1956.

Amplifiers	210,294
Batteries, Dry	224,789
Cable Sets	151,609
Chargers, Battery	564,448
Connectors	29,252
Crystal Units	28,656
Echo Boxes	149,370
Filters, R. F.	25,170
Generators, Electrical	10,411,423
Generators, Signal	310,426
Kits, Avianic Modification	4,929,246
Kits, Modification	772,596
Kits, Radar Modification	71,365
Meters	63,817
Power Supplies	76,605
Radar Components & Spares	55,000
Radio Receivers	2,396,969
Radio Transmitters	778,286
Rectifiers, Metallic	245,953
Relays	55,853
Resistors	63,500
Simulators	800,000
Sonar Equip.	121,133
Switches	72,746
Syncros	155.293
Teletype	65.762
Television Equip.	72,299
Transformers	156,432
Tubes, Electron	1,579,156
Tubes, Klystron	175.344
Wire & Cable	1,205,889

ELECTRONIC TEST EQUIPMENT SALES

Year	Factory price of products shipped	Estimated retail value	Estimated purchases by radio & tv servicemen
1947	$ 54,805,000	$ 78,000,000	
1951	87,032,000	124,000,000	
1952	139,202,000	199,000,000	
1953	152,565,000	218,000,000	
1954	158,000,000 (est.)	226,000,000	
1955	174,000,000 "	248,000,000	
1956	190,000,000 "	271,000,000	$37,000,000
1957	207,000,000 "	295,000,000	38,000,000
1958	222,000,000 "	317,000,000	40,000,000
1959	239,000,000 "	341,000,000	43,000,000
1960	254,000,000 "	362,000,000	44,000,000

From a report by Jerome D. Braverman of Industrial Marketing Assoc., 635 South Kenmore Ave., Los Angeles 5, Calif.

Distribution of Numbers of Producers of Electronics Test Instruments by Employment Size Groups

	Group A[1]	Group B[2]	Group C[3]	Totals
Over 500 Employees*	3			3 (1%)
150 to 500 Employees*	8	3		11 (4%)
50 to 150 Employees*	16	12	9	37 (14%)
15 to 50 Employees*	26	43	20	89 (34%)
Under 15 Employees*	28	43	51	122 (47%)
Totals	81	101	80	262 (100%)

Distribution of Annual Dollar Volume of Electronics Test Instrument Producers by Employment Size Groups (000,000 added)

	Group A[1]	Group B[2]	Group C[3]	Totals
Over 500 Employees*	$31 (20%)			$31 (20%)
150 to 500 Employees*	$30 (19%)	$11 (7%)		$41 (26%)
50 to 150 Employees*	$17 (11%)	$12 (7%)	$14 (9%)	$43 (27%)
15 to 50 Employees*	$ 9 (6%)	$14 (9%)	$ 7 (4%)	$30 (19%)
Under 15 Employees*	$ 3 (2%)	$ 4 (3%)	$ 5 (3%)	$12 (8%)
Totals	$90 (58%)	$41 (26%)	$26 (16%)	$157 (100%)

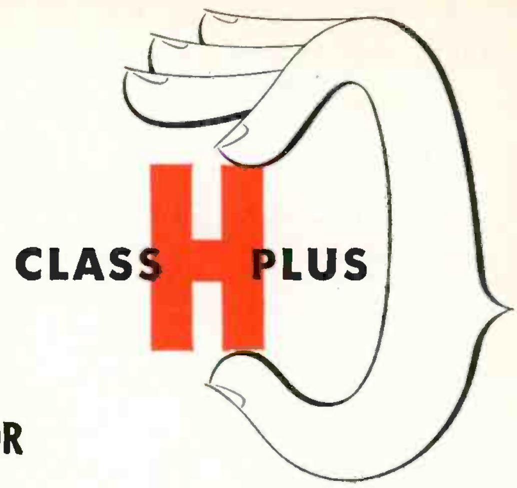
* *Engaged in Electronics Test Instrument Production.*

[1] *Group A. General-purpose Electronics Test Instrument production comprises more than half of the firm's total activity.*

[2] *Group B. General-purpose Electronics Test Instrument production comprises less than half of the firm's total activity; however, other products are closely related in terms of manufacturing facilities and production experience.*

[3] *Group C. General-purpose Electronics Test Instrument production comprises less than half of the firm's total activity; other products are of a different nature in terms of manufacturing facilities and production experience.*

From "The General-Purpose Electronics Test Instrument Industry"—U. S. Dept. of Commerce.



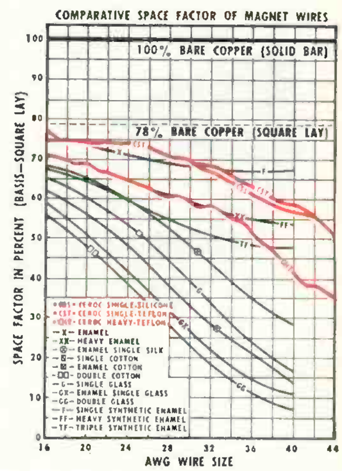
THERE IS ONLY ONE MAGNET WIRE WITH AN EXTREMELY HIGH SPACE FACTOR CAPABLE OF SUCCESSFUL, CONTINUOUS OPERATION AT

250°C

CEROC is an extremely thin and flexible *ceramic* insulation deposited on copper wire. *This ceramic base insulation is unaffected by extremely high temperatures.* Thus, in combination with Silicone or Teflon overlays, Ceroc insulations permit much higher continuous operating temperatures than are possible with ordinary insulations.

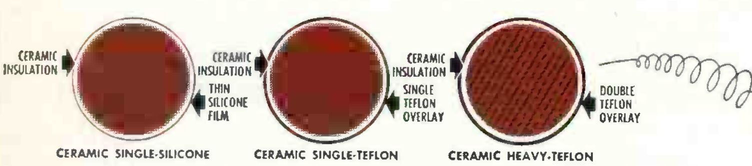
There are three standard Ceroc Wires: Ceramic Single-Teflon and Ceramic Heavy-Teflon for operation at 250°C. feature unique characteristics of flexibility, dielectric strength and resistance to moisture. They have been used successfully to 300°C in short time military applications. Ceramic Single-Silicone, for 200°C application, pairs the ceramic with a Silicone reinforcement to facilitate winding.

All three Ceroc Wires have far superior cross-over characteristics to all-plastic insulated wire—all provide an extraordinarily high space factor that facilitates miniaturization with high-reliability standards. ★ ★ ★ ★

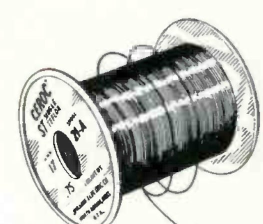


IT IS SPRAGUE'S . . . Ceroc®

CERAMIC INSULATED MAGNET WIRE



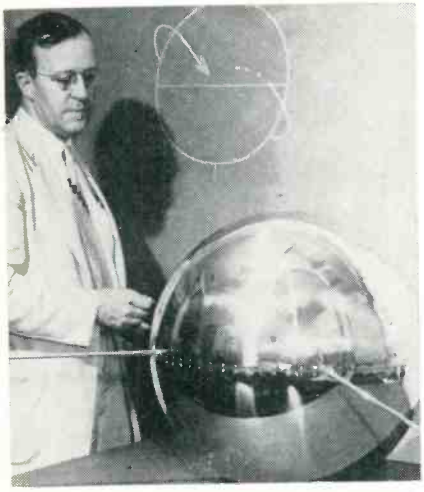
ENLARGED CROSS-SECTIONS OF CEROC® COPPER MAGNET WIRE



FOR COMPLETE ENGINEERING DATA ON CEROC WIRES, WRITE FOR BULLETIN 400A.

SPRAGUE ELECTRIC COMPANY • 233 MARSHALL ST. • NORTH ADAMS, MASS.

As We Go To Press...



Dr. John P. Hagen, Director of Project VANGUARD, shown with first full-scale model of the scientific earth satellite.

First Earth Satellite Model Is Displayed

Closely resembling the real satellite, the first full-scale model of the scientific earth satellite has been publicly shown. So light a small child could easily lift it, the model is complete with antennae and was fabricated to meet requirements for scientific experiments to be performed during the International Geophysical Year (July 1, 1957, to Dec. 31, 1958).

Model measures 20 in. in diameter and is made of mirror-bright metal. Actual satellite will be launched sometime during the IGY as part of America's scientific program, and will be instrumented to relay scientific information.

Dr. John P. Hagen is Director of Project VANGUARD, which has been undertaken by the Dept. of Defense in cooperation with the request of the U. S. National Committee for the IGY, established by the National Academy of Sciences, and with the National Science Foundation, sponsor of U. S. participation in the IGY. The Naval Research Lab, Washington, built the model and is responsible for the technical program and launching of the satellite.

Talk-See Telephone Uses Regular Wires, Features Playing-Card Sized Screen

People can now see each other while they're talking on the telephone—or, "Picture-Phone"—which has been developed by AT&T's Bell Labs in Murray Hill, N. J.

Technicians said it is the first system of its kind to use a pair of ordinary telephone wires, and that it has been in operation on an experimental basis between New York and Los Angeles. Only one other line, consisting of a pair of wires like the regular telephone line, would have to be installed on the user's premises to carry the picture.

A new picture is displayed every two seconds on the 'phone, whereas TV sends 30 pictures a second. The 'phone picture sends a smaller and less detailed image; head, shoulders and facial expression are readily apparent.

To get a picture, it may be dialed like an ordinary telephone call, provided the switch on the picture equipment is on at both ends of the line. If the switches are off, the call will be completed without pictures. A caller checks his position in front of the camera's lens by looking into a visual guide.

Devised by Winston E. Kock, Floyd K. Becker, R. L. Miller and others at Bell Labs, the Picture-Phone is considered commercially feasible because of the ease of equipment installation.

To be made more compact than the present experimental apparatus, the talk-see telephone is a box-like unit 8x15x20 in., with a camera lens above the small picture tube. The telephone remains as a separate integral unit.

Now in three separate units, an advanced model of the Picture-Phone is in one unit.

More News on page 9

Air Force Asst. Secy. To Speak at Aero Meet

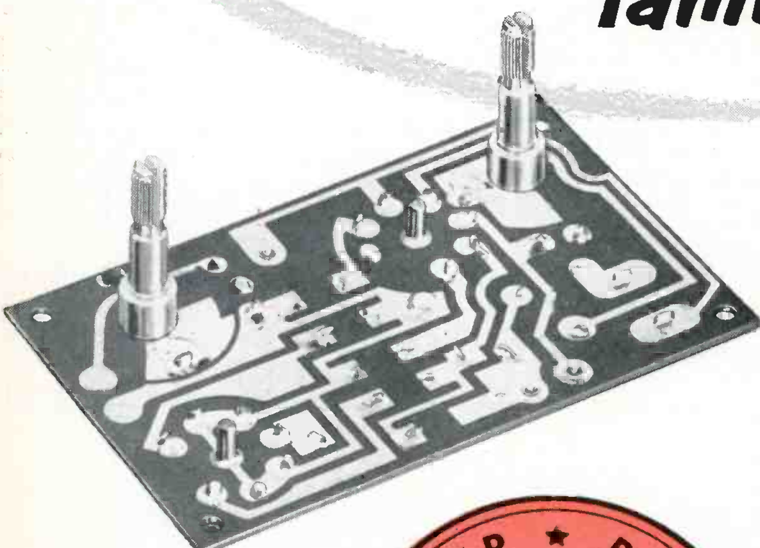
Principal speaker at the 3rd Annual Banquet of the East Coast Conference on Aeronautical and Navigational Electronics on Oct. 29 in Baltimore will be Richard E. Horner, Acting Asst. Secretary of the Air Force (Research and Development). An Air Force veteran of World War II, Mr. Horner is expected to discuss policy matters and certain relationships between the Air Force and the electronics industry.

WHIRLY BIRD in action shows helicopter as self-contained flying TV station for possible use during major naval operations. Airborne TV was developed for Navy by Philco Corp., Philadelphia.

Taylor Fibre Co.

says...

"Using Revere Rolled Copper we are able to produce superior copper-clad laminates!"



At the top of the page opposite is a section of an etched printed circuit enlarged 10 times. These particular lines are of .008 thickness, spaced .012 apart. They show the kind of printed circuits obtainable by combining Revere Rolled Printed Circuit Copper and Taylor laminates. Note the fine line etching, the close spacing and the sharp definition of the edges . . . the smoother surface (freer from pits, pinholes and imperfections) . . . the more uniform thickness with no sacrifice of conductivity. Results—consistently satisfactory etching at better production rates.

Laminators and users alike also have found that Revere Rolled Copper produces no peaks or valleys, that its smooth, hard surface of uniform density permits resist to clean off easily for there are no pores to hold resist and cause trouble when soldering.

They have noted, too, that Revere Rolled Copper is free from oxidation as it comes from the mill and is without lead inclusions. And because of its clean surface, fluxes wet readily, while in the automatic soldering operation it makes possible a uniform solder coat every time free of skips or bald spots.

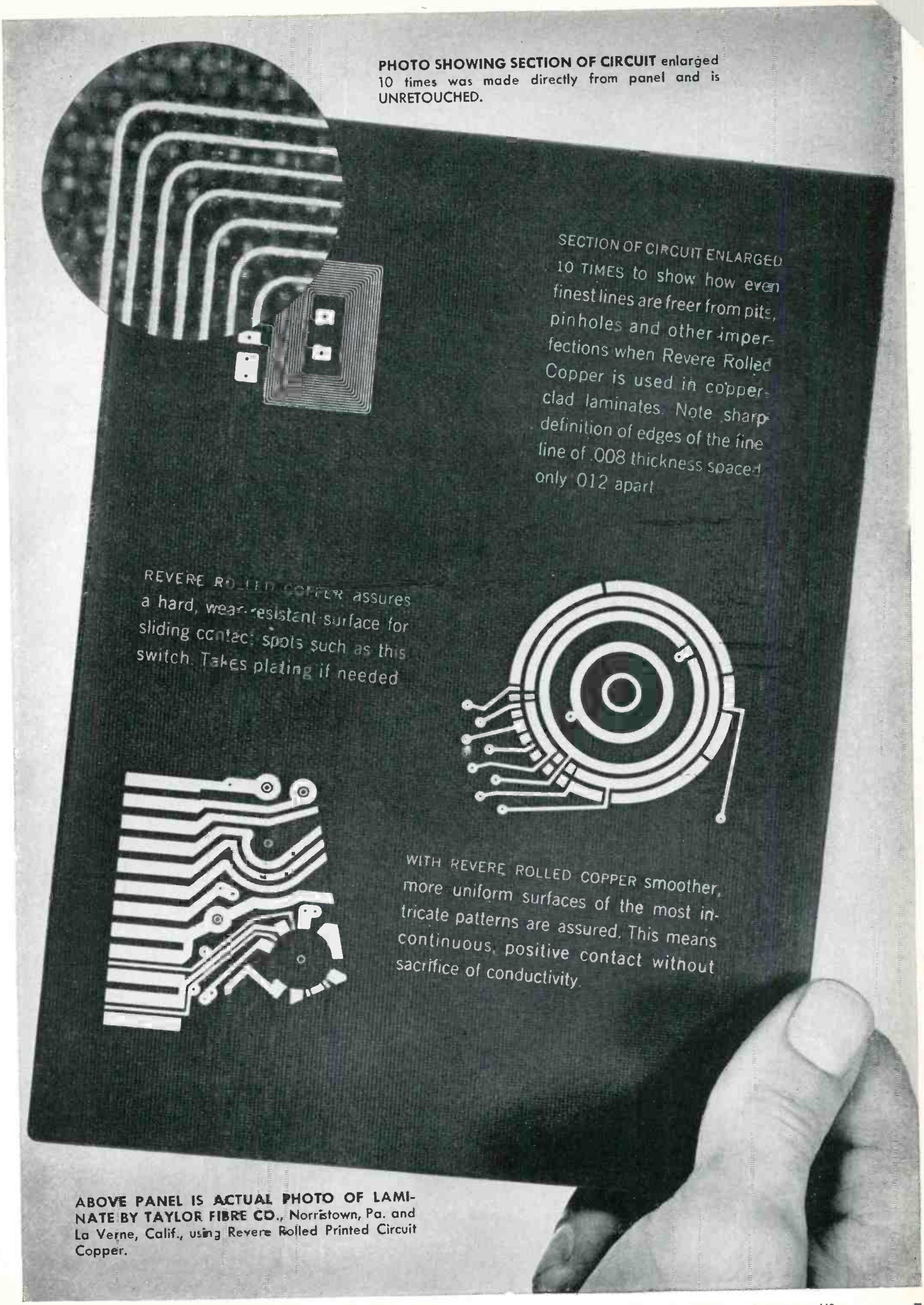
Those are the very reasons why you should insist that Revere Rolled Copper be used when ordering blanks from your laminator. It is available in unlimited quantities in standard coils of 350 lbs. in widths up to 38" and in .0015 and .0027 gauges, weighing approximately 1 oz. and 2 oz. per square foot. Revere Rolled Copper exceeds requirements of standard specifications and meets ASTM B5 specification for purity with 99.9% minimum.

REVERE
COPPER AND BRASS INCORPORATED
Founded by Paul Revere in 1801
230 Park Avenue, New York 17, N.Y.

Mills: Baltimore, Md.; Brooklyn, N. Y.; Chicago, Clinton and Joliet, Ill., Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Newport, Ark.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere.

COPPER ★ BRASS ★ ALUMINUM
1801
REVERE

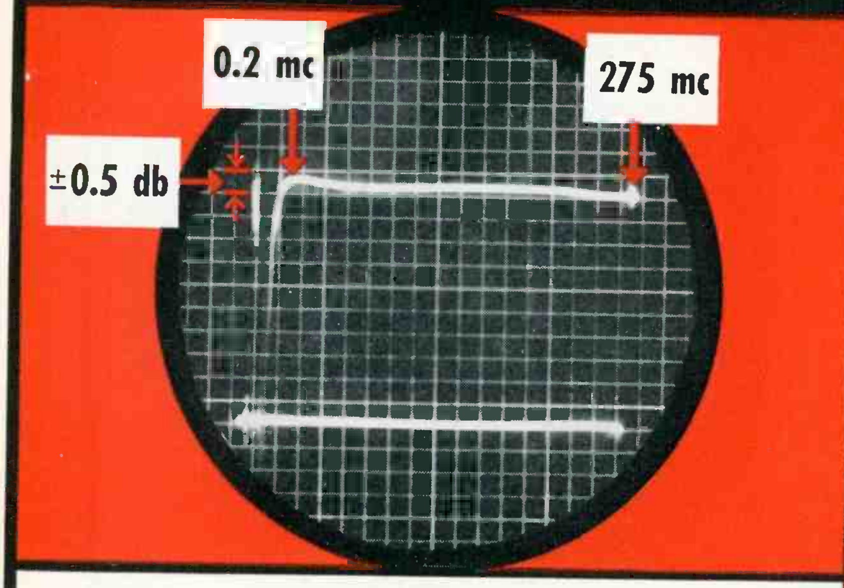
PHOTO SHOWING SECTION OF CIRCUIT enlarged 10 times was made directly from panel and is UNRETOUCHED.



ABOVE PANEL IS ACTUAL PHOTO OF LAMINATE BY TAYLOR FIBRE CO., Norristown, Pa. and La Verne, Calif., using Revere Rolled Printed Circuit Copper.

For product information, use inquiry card on page 113.

SWEEP Wide Bands In One SWOOP



with
JERROLD'S
NEW
W-I-D-E BAND
SWEEP GENERATORS

MODEL 900

For laboratory or production tests where unusual versatility, high stability and extreme constancy of output are essential in accurate sweep frequency measurements.

Supplies a sweep signal at any frequency from 0.2 mc to approximately 1000 mc with sweep widths as high as 300 mc or as low as 0.1 mc.

SPECIFICATIONS:

	VHF Range	UHF Range
Center Frequency:	Continuously Var. 0.2 mc to 275 mc.	Continuously Var. 275 mc to 1000 mc.
Sweep Width:	Continuously Var. 0.1 mc to 275 mc.	Continuously Var. 0.1 mc min. to max. of 100 mc at 275 mc cent; 300 mc at 1000 mc cent.
Source Impedance:	*75 ohms—VSWR less than 1.2	
Output Voltage:	0.3 V rms	0.3 V rms
Max. Output Voltage Variation at Max, Sweep	±0.5 db	±3.0 db
Frequency Modulation:	60 Cycle Sinusoidal	

*(50 ohm Model available on special order)

Model 900

- Internal Detector
- Internal Oscilloscope Preamplifier
- Internal Filter
- Internal Marker Amplifier
- Output AGC controlled

price $1120.00 f.o.b. plant

Models 95 and 220

price $375.00 f.o.b. plant

MODEL 220

A rugged portable unit that supplies a sweep signal at any frequency from 50 mc to 225 mc with sweep widths as high as 175 mc and as low as 2.0 mc. Output voltage is 0.7 volts rms (into 75 ohms) with a variation at maximum sweep widths of ±0.5 db.

MODEL 95

Same mechanical features as 220. Frequency range from 22 mc to approximately 110 mc. A high voltage output of 1.5 volts rms is maintained across this band to within ±0.5 db.

Ideal for laboratory or field use

SPECIFICATIONS OF MODELS 220 and 95:

Frequency Range: Model 95—22 mc to 95 mc; Model 220—54 mc to 220 mc — Continuously Variable

Sweep Range: Continuously var. from a min. of 2.0 mc to max. Sweep deviation approx. 5 to 1 range.

RF Output Response: (75 ohms load) Model 95—1.5 Volts flat across a 70 mc—AGC controlled; Model 220—0.7 Volts flat across a 165 mc—AGC controlled

Horizontal Sweep Output: Sine voltage of 60 cps. Complete phasing over a range of 360 degrees is provided. Internal blanking provided.

This model available on special order covering any frequency range from a minimum of 1.0 mc to a maximum of 220 mc with maximum sweep deviation of approximately 5 to 1.

For detailed information write to

JERROLD ELECTRONICS CORPORATION
2300 CHESTNUT STREET • PHILADELPHIA 3, PENNSYLVANIA

As We Go To Press

Signal Corps Sets Up Data Processing Net

Formal operation of a giant electronic computer as the basis of the Army Signal Corps' computer-communications system for signal supply management has begun at the Army's Signal Supply Agency in Philadelphia.

Designed by IBM, the computer is a key element of the electronic data processing network that handles requisitions, stock control, and other data pertaining to signal supplies for the entire U. S. Army. The network provides high-speed control of global logistical operations of signal supplies to and from the focal point in Philadelphia.

Operating computer's master control console

The computer can make 30,000 logical logistical decisions per second, and can make 8,400 additions, or 1,200 multiplications, per second. Every minute it can process 8,000 tabulating cards.

More than 150,000 items of signal communication equipment and supplies can be accounted for and controlled daily; such supplies are stored in U. S. and overseas depots in 40 different categories.

Information made available to the computer is memorized and stored on reels on magnetic tape, 10½ in. in diameter. Stored data are continuously available, and can be reproduced at electronic speeds, says the Signal Supply Agency, which added that the computer will be in continuous operation at its Philadelphia headquarters.

More News on page 12

ELECTRONIC SHORTS

A fast computer, the Univac Scientific 1103A, is being used on developmental work of inter-continental ballistic missiles by **Lockheed's Missile Systems Div.**, Van Nuys, Calif. For highly complex problems and rapid solutions, the computer is said to be the first of its kind.

Sylvania Electric Products, Inc., recently opened a new electronics plant at Hillsboro, N. H., to expand manufacturing in the transistor and diode field.

Dr. James Hillier, Chief Engineer of Commercial Electronic Products, RCA, Camden, addressed the 1st European Regional Conference on Electron Microscopy at the Karolinska Inst., Stockholm.

George and Zolton Haydu have formed **Haydu Electronic Products, Inc.**, 1426 W. Front St., Plainfield, N. J., having purchased certain assets and equipment from Haydu Bros. of N. J., subsidiary of Burroughs Corp.

Glenn L. Martin Co., Baltimore, received Air Force contract in excess of $4,000,000 for modification of TM-61 Martin Matadors, a guided missile for operational use.

"Big Maggie," a magnetron designed and developed by **Westinghouse's Electronic Tube Div.**, Elmira, N. Y., is at the heart of the longest-range radar to be installed on shipboard. The powerful radar set is on the Cruiser "Northampton," a Navy command vessel for directing firepower of a task force.

Use of an Electronic Dew Point hygrometer will help control telltale "condensation trails" of jet airplanes, a factor of military importance. This miniature electronic instrument, developed by **Burton Mfg. Co.**, Santa Monica, is being produced for the Air Force and is expected to make significant advances in the study of high altitude meteorology.

American Management Assn., New York, is sponsoring conferences on administration of research and development: Oct. 18-19, Hotel Statler, New York; and March 25-27, 1957, Palmer House, Chicago.

Radio Receptor Co., Inc., Brooklyn, has developed a miniature, lightweight radar beacon designed to enable ground crews to track a guided missile in flight. Device, called Radar Beacon, AN/DPN-43, weighs 2½ lbs. and is the size of a jelly jar.

Twenty-one **educational TV stations** are on the air in 18 states across the country, and three more expect to start this year: WHYY-TV, Philadelphia; WETV, Atlanta; and WIPR-TV, San Juan, Puerto Rico.

Westinghouse is introducing a line of 14-in. portable TV receivers in solid and two-tone colors this Fall.

RETMA, Washington, has announced these committee chairmanship appointments: Paul V. Galvin, to RETMA Organization and to Annual Awards; Robert S. Alexander, TV Committee; and W. R. G. Baker, President of RETMA, to head the Special Committee on Frequency Allocations.

British retail sales of radio and TV receivers decreased during the first half of this year as against 1955: TV sets were off 14%, and radio sales dropped 19%

The Saudi Arabian Government has sanctioned the import of TV sets by Saudis There are already a large number owned by Americans in the country.

Canadian production and sales of TV receivers are declining slightly in 1956. Sales dropped from 196,000 to 166,000 in the first four months of 1956. Nearly 40% of Canadian homes were equipped with TV sets in 1955.

Bell Telephone, Arma Div. of American Bosch Arma Corp., Ramo-Wooldridge, and **Fairchild** are among the firms participating in the Air Force Ballistics Missile Program, which includes Atlas, Titan and Thor.

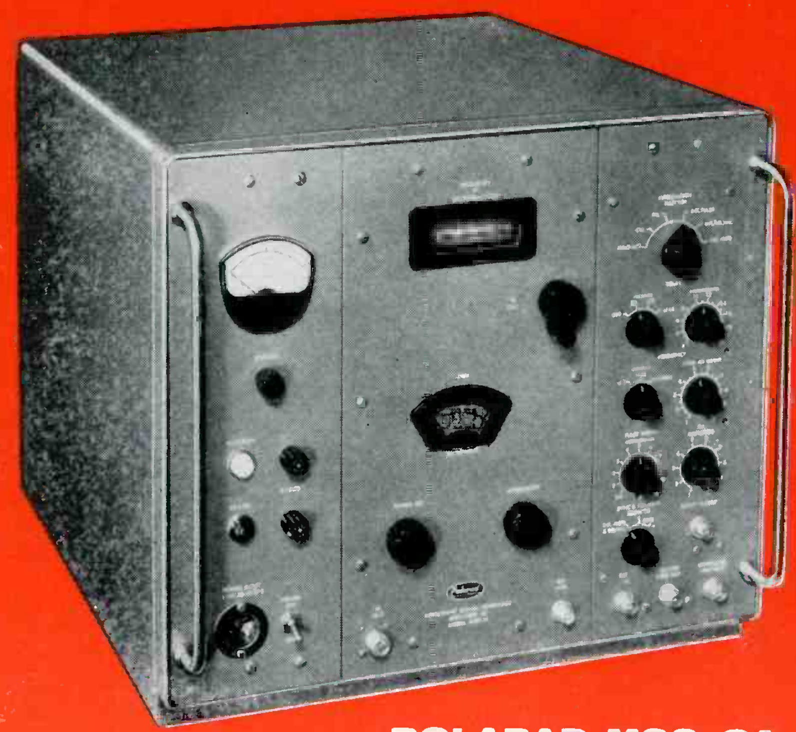
National Science Foundation, Washington, announced first of a series of grants in support of computation centers and research in numerical analysis. Grants totaling $135,000 have gone to: Calif. Inst. of Tech.; M. I. T.; Oregon State; Univ. of Washington; and Univ. of Wisconsin.

ACF Industries, Inc., New York, has established a Missiles Group to coordinate activities of several divisions in the field.

Dr. Floyd A. Firestone, inventor and consulting physicist, will receive the Edward Longstreth Medal of The Franklin Institute, Philadelphia, on Oct. 17, at Annual Medal Day ceremonies for his invention and development of the ultrasonic reflectoscope.

RETMA, Washington, has formed a Computing and Data Processing Systems Section as part of its Technical Products Div.

NEW ULTRA-BROADBAND MICROWAVE SIGNAL GENERATOR



POLARAD MSG-34

Replaces 2 or more present-day signal generators normally required to cover C and X bands (4,200-11,000mc)

The new Polarad MSG-34 outperforms all existing signal generators both in frequency coverage and ease of operation. In all respects, it is the most efficient and economical instrument to generate frequencies between 4,200 and 11,000 mc at high power level.

By means of a unique design utilizing Polarad's exclusive UNI-DIAL control, Ultra-Broadband Frequency Coverage has been achieved in one completely integrated unit. Reflector voltages are automatically tracked while tuning continuously. Frequency is read **direct** from an expanded linear dial, eliminating the need for mode charts or slide rule interpolations.

Because of its operational simplicity and ultra broadband coverage, the MSG-34 will save valuable engineering and production-line man-hours.

AVAILABLE ON EQUIPMENT LEASE PLAN

POLARAD PROVEN RELIABILITY **ELECTRONICS CORPORATION**
43-20 34th STREET, LONG ISLAND CITY 1, N. Y.

For product information, use inquiry card on page 113.

As We Go To Press

(Continued from page 9)

Stratton, Heising To be Honored by IRE

Dr. Julius A. Stratton, Chancellor of M. I. T., will receive the Institute of Radio Engineers' 1957 Medal of Honor, and Dr. Raymond A. Heising, radio pioneer and consulting engineer, will receive the IRE Founders' Award, on March 20 at the 1957 IRE Convention in the Waldorf-Astoria Hotel, New York, during the Annual IRE Banquet.

Dr. Heising

Dr. Stratton

Radiation Survey Made For U. S. Air Force

Future design and construction of atomic-powered rockets and space satellites may be determined by a study of radiation damage to electronic components being undertaken by Admiral Corp., Chicago, for the U. S. Air Force. (See "Effects of Radiation on Electronic Components," ELECTRONIC INDUSTRIES, Sept., 1956, p. 57.)

All types of electronic components are being bombarded and tested with neutrons as part of the project, which is being carried out at the Government's Argonne Labs, Lemont, Ill., and at an Atomic Energy Commission installation at Arco, Idaho. After being "cooked" in the reactors, the radioactive isotopes are transported in lead shields to a special nucleonics lab near Admiral's Chicago headquarters.

The project calls for testing electronic components before being subjected to radiation, as well as afterward, in order to determine the extent and nature of radiation damage. Recommendations will be made to the AF following tests.

Coming Events

A listing of meetings, conferences, shows, etc., occurring during the period October, 1956 into 1957, that are of special interest to electronic engineers

Oct. 1-3: 12th Annual Conference of the NEC; at the Hotel Sherman, Chicago.

Oct. 1-3: Canadian IRE Convention and Exposition; in the Automotive Bldg., Canadian Natl. Exhibtn. Park, Toronto.

Oct. 8-9: Second National Symposium on Aeronautical Communications, sponsored by the IRE Prof. Gp. on Communications Systems; at the Hotel Utica, Utica, N. Y.

Oct. 9-10: Conference on Computer Applications, sponsored by Armour Research Foundation of Illinois Institute of Technology, Chicago.

Oct. 10-12: 3rd Natl. Symposium on Vacuum Technology; at Hotel Sheraton, Chicago.

Oct. 11-12: Fall Meeting of the URSI, at the University of California, Berkeley.

Oct. 11-12: NARTB Regional Conferences, Region 2; Shoreham Hotel, Washington. **Oct. 15-16**: Region 1; Somerset Hotel, Boston. **Oct. 18-19**: Region 4; Sheraton-Lincoln Hotel, Indianapolis. **Oct. 25-26**: Region 3; Dinkler-Tutwiler Hotel, Birmingham. **Oct. 22-23**: Fall Meeting of RTCA Assembly; at the Marott Hotel, Indianapolis.

Oct. 15-17: Radio Fall Meeting, sponsored jointly by the IRE and RETMA, at the Hotel Syracuse, Syracuse, N. Y.

Oct. 16-18: Conference on Magnetism and Magnetic Materials, sponsored by the Magnetics Subcommittee of the Basic Science Committee of AIEE, at the Hotel Statler, Boston.

Oct. 25-26: 2nd Annual Tech. Mtg. of IRE Prof. Gp. on Electron Devices; at Shoreham Hotel, Washington.

Oct. 25-26: Annual Display of Aircraft Electrical Equipment, by the Aircraft Electrical Society, at Pan-Pacific Auditorium, Los Angeles.

Oct. 25-26: Fall Assembly Meeting, of the Radio Technical Commission for Marine Services, at the Park Sheraton Hotel, New York.

Oct. 29-30: Third Annual East Coast Conference on Aeronautical and Navigational Electronics, sponsored jointly by the Baltimore Section of IRE and the IRE Prof. Gp. on Aeronautical and Navigational Electronics; at the Fifth Regiment Armory, Baltimore.

Nov. 2-3: Sixth Annual Tool Engineering Conference, sponsored by IIT and Northwestern and Illinois Universities in cooperation with Illinois chapters of the American Society of Tool Engineers; on the Illinois Tech campus, Chicago.

Nov. 7-9: Conf. on Elec. Tech. in Medicine & Biology, sponsored by the PGME, AIEE and the ISA; at the Gov. Clinton Hotel, New York.

Nov. 8-9: Ann. Tech. Conf., Kansas City, Kans., IRE Section; at Town House Hotel, Kansas City, Kans.

Nov. 14-16: Symp. on Applications on Optical Principles to Microwaves, sponsored by the PGAP and Geo. Wash. Univ.; at Geo. Wash. Univ., Washington.

Nov. 15-16: New England Radio Engineering Meeting, sponsored by Region 1, IRE, at Boston.

Nov. 26-30: International Automation Exposition, at the Trade Show Bldg., 500 Eighth Ave., New York.

Nov. 29-30: PGVC Annual Mtg., sponsored by the PGVC; at the Fort Shelby Hotel, Detroit.

Dec. 5-7: 2nd IRE Instrumentation Conf. & Exhibit, PGI, Atlanta Section; at the Biltmore Hotel, Atlanta.

Dec. 10-12: Eastern Joint Computer Conference, sponsored by the PGEC, AIEE and the ACM; at the Hotel New Yorker, New York.

Jan. 14-15, 1957: Symp. on Reliability & Quality Control in Elec., sponsored by the PGRQC, ASQC and RETMA; at the Statler Hotel, Washington.

Jan. 23-25, 1957: Very-Low Frequency Symposium, sponsored by Denver-Boulder chapter of PGAP and the Boulder Lab., Nat'l Bureau of Standards; at the NBS Boulder Labs., Boulder.

Jan. 30, 1957: Electronics in Aviation Day, sponsored by the PGANE, IAS and RTCA; at New York.

Feb. 1957: Conf. on Transistor Circuits, sponsored by PGCT, Phila. Sec, and the AIEE, at Philadelphia.

Feb. 26-28: Western Joint Computer Conf., sponsored by PGEC, AIEE and the ACM; at Los Angeles.

March 18-21: IRE National Convention, sponsored by all P.G.'s; at the Waldorf-Astoria Hotel, New York.

Abbreviations:

ASTM: American Society for Testing Materials
AIEE: American Institute of Electrical Engineers
IRE: Institute of Radio Engineers
ISA: Instrument Society of America
RETMA: Radio-Electronics-TV Manufacturers

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For product information, use inquiry card on page 113.

TELE-TIPS

RADAR CHAFF. Roosters in and about Elmira, N. Y., are finding their harems being depleted by a new airborne invader — not the chicken hawk! The AF has been dropping radar jamming chaff—shiny, metallic and unfortunately, poisonous, particles — that the chicks have adopted as a change in menu.

INFALLIBLE ELECTRONIC "BRAINS" will be a thing of the past, if the British Physical Society research robot, Eucrates I, is exploited by future-fearing concerns. This robot can forget, go into panic, sulk, go haywire, and learn from experience—and therefore, is affectionately referred to as being "neurotic."

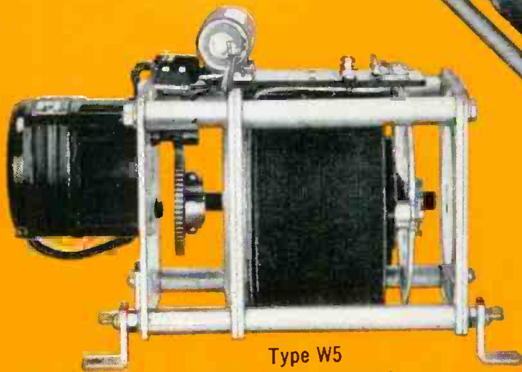
ULTRASONICS FOR HICCUPS. Two Brazilian doctors have reported using ultrasonic sound waves to stop hiccups. Other extensive medical uses include slicing brain tissues with better control than a surgeon's knife.

AUTOMATION FARMING, the agrarian dream, is likely to be here long before any other industry achieves full automation, according to a study of mechanized agriculture's needs. The average farm worker already has at his command more than 5 times the inanimate horsepower available to the average industrial worker.

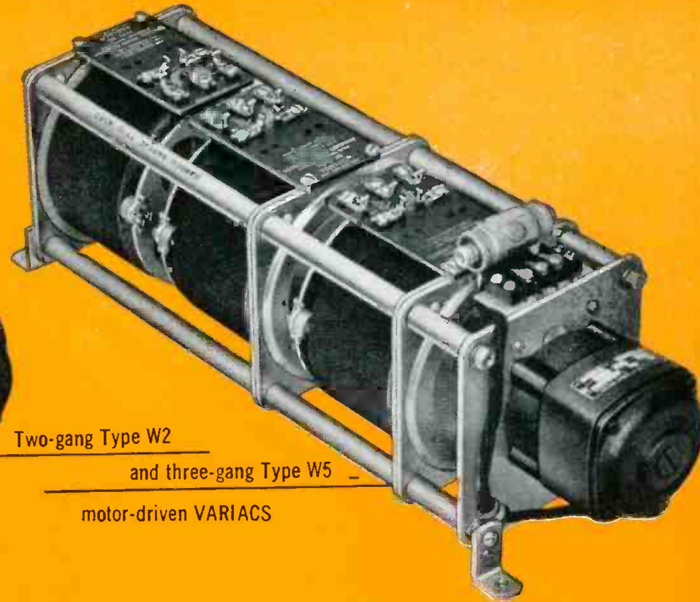
WEAPONS SYSTEMS. A top Navy official has disclosed that training personnel to maintain and operate complex new, weapons systems is probably the Navy's most serious problem. And the weapons of tomorrow will make the problem even more acute.

USED TV. In St. Louis, used TV sets are sold wholesale at $1 an inch. Fifty dealers have jumped into the second-hand TV set market in the past year-and-a-half.

(Continued on page 16)



Type W5
Motor Driven VARIAC

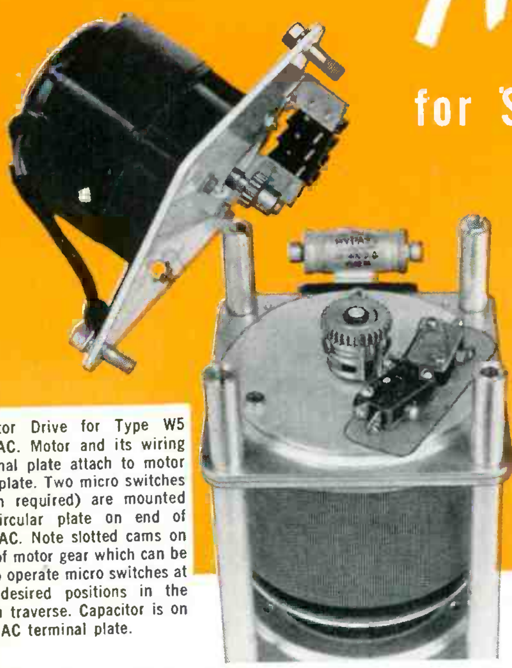


Two-gang Type W2
and three-gang Type W5
motor-driven VARIACS

Announcing *NEW* Motor-driven Variacs®

for Servos and Remote Positioning

A Number of Motor-Gear Combinations



Motor Drive for Type W5 VARIAC. Motor and its wiring terminal plate attach to motor base plate. Two micro switches (when required) are mounted on circular plate on end of VARIAC. Note slotted cams on hub of motor gear which can be set to operate micro switches at any desired positions in the brush traverse. Capacitor is on VARIAC terminal plate.

Unique and very simple design makes possible quick and economical assembly from stock parts, sub-assemblies and motors.

Standard, fully-enclosed, two-phase, gear-reduction induction motors are used. The motor is mounted on a plate which is attached to the base end of the VARIAC by means of four corner posts.

Gear coupling between the motor and the VARIAC is used to

- ★ Simplify alignment between shafts
- ★ Eliminate phase shifts which are likely with flexible couplings
- ★ Provide several drive speeds from each motor by using different gear ratios

Standard speeds of 2-4-8-16-32 or 64 seconds for 320° traverse

For Servo Applications — motor has low moment of inertia and high angular acceleration. Internal gear reducer provides output shaft speed of about 1 rps.

For Remote Positioning — same servo motor assembly with different shaft speed is used. Low moment of inertia makes possible fast stopping without overshoot. Ordinarily, dynamic braking is unnecessary, although it can be provided easily if desired.

In high and medium speed models, simple mechanical stops operate on the main drive gear with no stalling torques transmitted to the VARIAC. Both motor and gear trains will withstand stalling indefinitely and will take thousands of full-impact stops without damage.

At the slower speeds, limit micro switches are required. These micro switches also are available for applications requiring electrical limit means for stopping at predetermined VARIAC positions, or for operating auxiliary circuits when a given VARIAC voltage is reached.

Motor-driven assemblies for single or ganged models are available in uncased and completely enclosed units. Stocks of the basic ball-bearing VARIACS and all parts of the motor-drive assembly are maintained so that prompt deliveries can be made.

The incremental prices for motor drives fitted to standard ball-bearing VARIACS, varies between $75.00 and $81.00, depending upon the quantity.

Write for the NEW Variac Bulletin for Complete Data

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TELE-TIPS

(*Continued from page 14*)

CELESTIAL AIR. Forty-eight quarts of air from the borderlines of outer space have been captured by Army Signal Corps scientists 75 miles up. These only existing samples of pure air from very high altitudes of the upper atmosphere are expected to help scientists unravel basic mysteries in rocketry and geophysics.

PROFIT-EARNING TIME in the normal working day of the typical manufacturing company is only about 19 minutes. And only about half of the 19 minutes result in dividends for the owners. The rest of the profit minutes are used for reinvestment in the business.

"RELIABILITY" is so much discussed these days that it sometimes seems as though even the best designs are just not good enough. Which makes this piece of news doubly welcome: Setchell-Carlson, midwest TV manufacturer, locked up one of their receivers in a glass enclosed vault, plugged in an automatic recording time clock, and turned the set on. Four thousand nine-hundred hours later the set was still showing a sharp, clear picture and clean sound. And absolutely no service or replacement parts had been required.

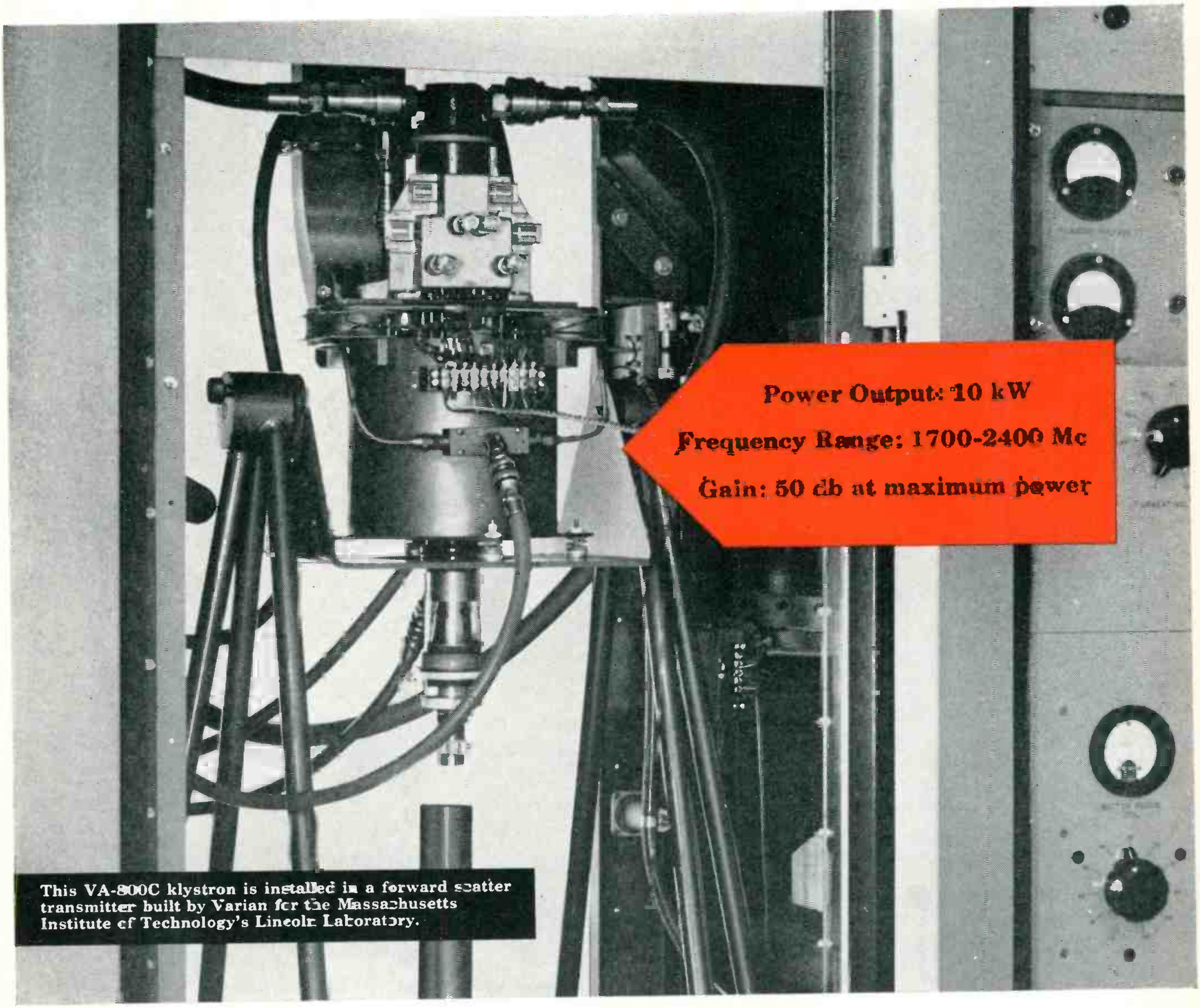
NEW STORAGE TUBE developed at GE will store up to nearly a million bits of information. Part of the tube is a thin sheet of glass in which small holes have been etched and then filled with metal. Holes are spaced 5 to the inch and each square inch has 250,000 individual storage cells. Each cell will recognize at least 10 different levels of intensity from the writing gun.

PHONETIC TYPEWRITER, based on an electronic computer which memorizes words and transmits the proper impulses to the typewriter keys is being developed at RCA Labs. The machine has a vocabulary of 10 words that are used in different combinations.

SYSTEM DESIGNERS

now specify VA-800 series klystrons for

FORWARD SCATTER COMMUNICATION



This VA-800C klystron is installed in a forward scatter transmitter built by Varian for the Massachusetts Institute of Technology's Lincoln Laboratory.

First with 10 kW power in the important 2000 Mc range is the Varian VA-800 Klystron series. Two tubes cover the range 1700—2400 Mc, the VA-800C for higher frequencies . . . the VA-800A for lower frequencies. These klystrons offer reliability backed by a 1000-hour warranty, simplified design that permits easy installation without demounting any components and superior performance that extends microwave propagation far beyond previous limits.

VARIAN KLYSTRONS HELP SOLVE SYSTEM DESIGN PROBLEMS in long range microwave communication, cw radar and illuminator service. Why not write today for complete specifications and technical data on the VA-800 series and other Varian high-power klystrons? Contact your nearest Varian representative or address Applications Engineering Department **F1**

Career Opportunities at Varian are well worth the consideration of engineers and scientists . . . a letter to our Personnel Director will bring full details.

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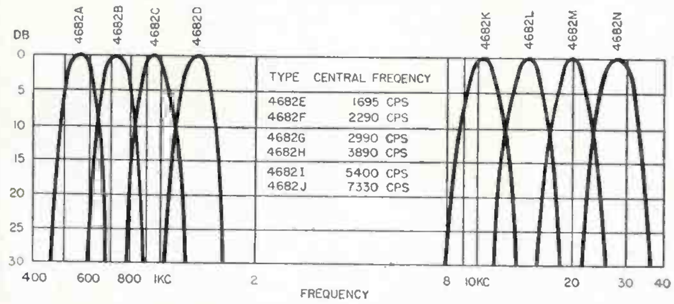
For product information, use inquiry card on page 113

OUR MILLIONTH FILTER SHIPPED THIS YEAR...

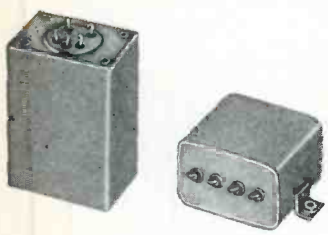
FILTERS
FOR EVERY APPLICATION

TELEMETERING FILTERS

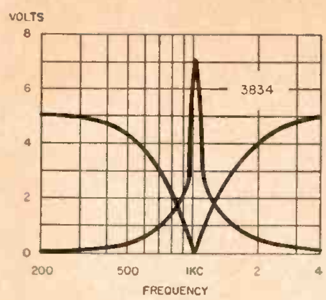
UTC manufactures a wide variety of band pass filters for multi-channel telemetering. Illustrated are a group of filters supplied for 400 cycle to 40 KC service. Miniaturized units have been made for many applications. For example a group of 4 cubic inch units which provide 50 channels between 4 KC and 100 KC.

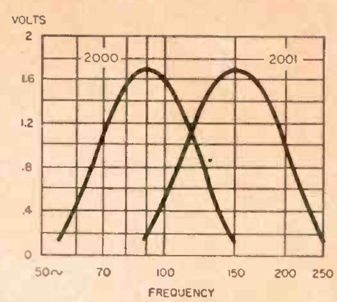


Dimensions:
(4682A) 1½ x 2 x 4"



Dimensions:
(3834) 1¼ x 1¾ x 2-3/16".
(2000, 1) 1¼ x 1¾ x 1⅝".





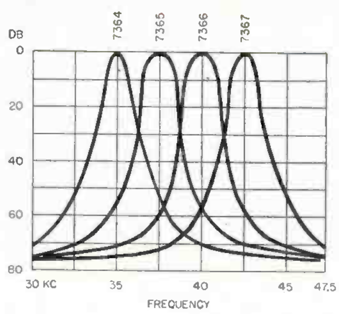
AIRCRAFT FILTERS

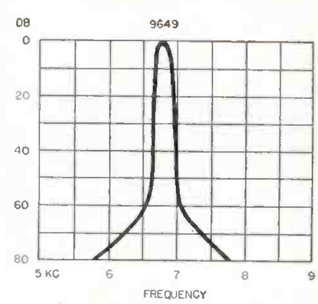
UTC has produced the bulk of filters used in aircraft equipment for over a decade. The curve at the left is that of a miniaturized (1020 cycles) range filter providing high attenuation between voice and range frequencies.

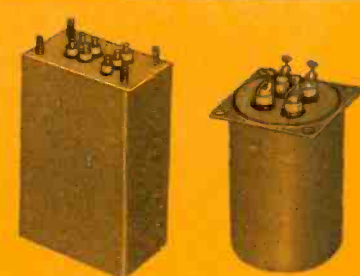
Curves at the right are that of our miniaturized 90 and 150 cycle filters for glide path systems.

CARRIER FILTERS

A wide variety of carrier filters are available for specific applications. This type of tone channel filter can be supplied in a varied range of band widths and attenuations. The curves shown are typical units.



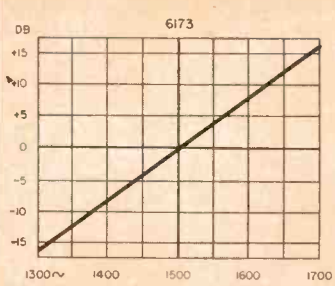


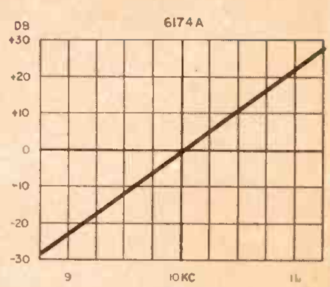


Dimensions:
(7364 series) 1⅝ x 1⅝ x 2¼".
(9649) 1½ x 2 x 4".

DISCRIMINATORS

These high Q discriminators provide exceptional amplification and linearity. Typical characteristics available are illustrated by the low and higher frequency curves shown.





Dimensions:
(6173) 1-1/16 x 1⅜ x 3".
(6174A) 1 x 1¼ x 2¼".

For full data on stock UTC transformers, reactors, filters, and high Q coils, write for Catalog A.

UNITED TRANSFORMER CO.

150 Varick Street, New York 13, N. Y. EXPORT DIVISION: 13 E. 40th St., New York 16, N. Y. CABLES: "ARLAB"

INDUSTRY NEWS

Michael Kory has been named President of Emerson-New York, Metropolitan area distributors. **Hal Dietz** becomes Vice President-Sales at Emerson Radio & Phonograph Corp., Jersy City.

George A. Svitek has been appointed to the new position of National Service Manager for General Electric's Communication Equipment Section, Syracuse, N. Y.

William G. Tuscany will head sales of the newly-created Semi-Conductor Section, and **Earl Clemick** will handle sales of Packaged Electronic Circuits, at Centralab, a Div. of Globe-Union, Inc., Milwaukee.

Henri G. Busignies has been made President of Federal Telecommunications Labs, research unit of International Telephone & Telegraph Corp., New York; **Charles D. Hilles, Jr.**, has been appointed Executive Vice President of IT&T; and **Henry H. Scudder** has been advanced to Executive Vice President of IT&T's International Standard Electric Corp., the firm's overseas management unit for manufacturing and research. **Col. Sosthenes Behn**, who recently resigned as Chairman of IT&T, has been elected Honorary Chairman.


G. C. Isham


H. G. Busignies

George C. Isham has been named General Merchandising Manager of the Electronic Products Sales Dept., Sylvania Electric Products, Inc., New York.

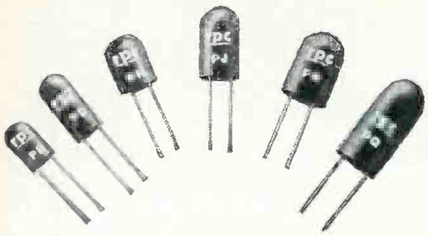
Neil E. Firestone has been named Manager, Mfg. Operations Svce., and **Armand V. Feigenbaum** is now Manager, Quality Control Svce., a new component in Mfg. Services, at General Electric Co., Schenectady.

Ralph E. Bates is Manager, Instruments and Merchandising Sales for associated company operations of RCA International, New York.

Charles F. Rork has become Asst. Sales Manager, International Div., Tung-Sol Electric, Inc., Newark, N. J.

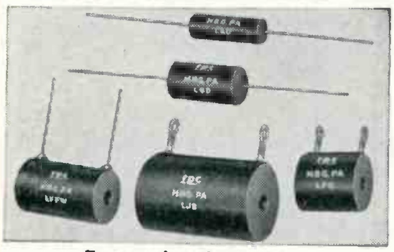
(*Continued on Page* 28)

For product information, use inquiry card on page 113.



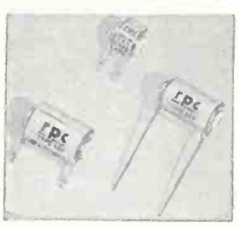
NEW **Printed Circuit Precision Resistors**

To meet the requirements for printed circuitry, RPC has developed Type P Encapsulated Wire Wound Precision Resistors. Miniature, single ended units designed for easy rapid mounting on printed circuit panels with no support other than the wire leads. Many newly developed techniques are employed in the manufacture of Type P Resistors. These units can be operated in ambient temperatures up to 125°C. and will withstand all applicable tests of MIL-R-93A, Amdt. 3. Available in 6 sizes, rated from 1/10 watt to .4 watt. ¼" diameter by 5/16" long to ⅜" diameter by ¾" long. Resistance values to 3 megohms. Tolerances from 1% to 0.05%.



Encapsulated Precision Wire Wound Resistors

RPC Type L Encapsulated Resistors will withstand temperature and humidity cycling, salt water immersion and extremes of altitude, humidity, corrosion and shock without electrical or mechanical deterioration. Type L resistors are available in many sizes and styles ranging from sub-miniature to standard with lug terminals, axial or radial wire leads. Available for operation at 105° C. or 125° C. ambient temperatures. These resistors will meet all applicable requirements of MIL-R-93A, Amdt. 3. Type L can be furnished with all resistance alloys and resistance tolerances from 1% to .02%.



Wire Wound Precision Resistors

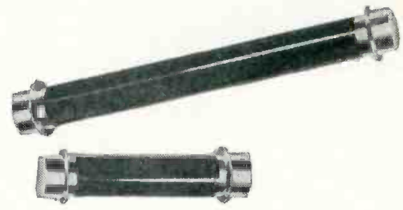
Type A Precision Resistors are widely used for all general requirements. They are available in a wide variety of sizes, styles and terminal types. They can be furnished with all resistance alloys in tolerances from 1% to .02%. Type A will meet the requirements of MIL-R-93A, Amdt. 2, Characteristic B. Special winding techniques, impregnation and thermal aging result in resistors of exceptional stability. Matched resistors, networks and special assemblies can be supplied.

HIGH QUALITY RESISTORS FOR ELECTRONICS

RPC is a widely recognized supplier of high quality resistors to industry, Government Agencies and the Armed Forces. Advanced production methods, modern equipment and scientific skill enables RPC to manufacture resistors of *highest quality* in *large quantities* at *reasonable cost.* Modern manufacturing plant is completely air conditioned and equipped with electronic dust precipitators to insure highest production accuracy. RPC resistors are specified for use in instruments, electronic computers, radiation equipment, aircraft equipment and scientific instruments.

Test equipment and standards for checking and calibrating are equalled by only a few of this country's outstanding laboratories. Our ability to produce resistors of highest quality coupled with prompt delivery have established RPC as a leading manufacturer of resistors. Small or large orders are promptly filled.

Representatives in principal cities. For full information send for latest catalog.

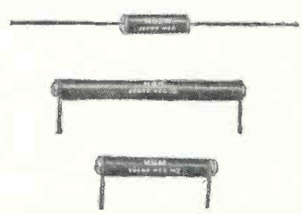


Wire Wound Precision Meter Multiplier Resistors

Type MFA and MFB High Voltage Wire Wound Resistors are Hermetically Sealed in glazed steatite tubes with ferrule ends for maximum protection against all adverse environmental conditions. Fully meet all requirements of JAN-R-29. Special multi-section winding insures greatest safety factor due to low voltage gradient between sections. Standard resistors up to 6 megohms, 6 KV, 0.5% tolerance. Higher resistance and closer tolerances available. MFA 9-25/32 inches long x 1 1/32 inches diameter. MFB 5 5/32 inches long x 1 1/32 inches diameter.

High Voltage Resistors

Type B Resistors are stable compact units for use up to 40 KV. These resistors are used for VT voltmeter multipliers, high resistance voltage dividers, bleeders, high resistance standards and in radiation equipment. They can be furnished in resistance to 100,000 megohms. Available as tapped resistors and matched pairs. Sizes range from a 1 watt resistor 1 inch long x 3/16 inch diameter rated at 3500 volts, to a 10 watt resistor 6½ inches long x 9/16 inch diameter rated at 40 KV. Low temperature and voltage coefficients. Standard resistance tolerance 15%. Tolerances of 10%, 5% and 3% available. Tolerance of 2% available in matched pairs.



High Megohm Resistors

Type H Resistors are used in electrometer circuits, radiation equipment and as high resistance standards. Resistance available to 100 million megohms. (10^{14} ohms). For utmost stability under adverse conditions Type HSD and HSK Hermetically Sealed are recommended. Eight sizes from ⅞ inch to 3 inches long are available. Voltage rating to 15,000 volts. Low temperature and voltage coefficients. Standard resistance tolerance 10%. Tolerance of 5% and 3% available. Also matched pairs 2% tolerance.

RESISTANCE PRODUCTS CO. 914 S. 13th Street HARRISBURG, PA.

Sylvania Tubes and designed for

Full line of tubes and semiconductors is carefully designed and produced to exhibit reliability characteristics essential in good computer design.

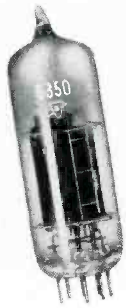
In the computer field, as perhaps in no other, the importance of Sylvania's integrated production of tube and semiconductors from raw material to finished product assumes important proportions.

A prime example is the development of special cathode alloys to reduce cathode interface problems. Another is the controlled processing of germanium to achieve properties which contribute to diodes and transistors with faster transient response.

These and many other factors in the design and production of tubes and semiconductors make Sylvania a supplier of major importance to computer manufacturers.

TYPE 6888—

A gated pentode built to rugged computer specifications. Features sharp cut-off, controlled to close tolerances. Designed to minimize flicker shorts and interelectrode leakage for greater reliability.



TYPE 6350—

A high perveance twin triode designed for heavy duty computer applications. Capable of delivering peak cathode currents of 300 ma and total dissipation up to 7 watts. Features separate cathode construction.

OTHER COMPUTER TYPES:

7AK7	sharp cut-off pentode	**5844**	low mu dual triode
5915A	sharp cut-off pentode	**5963**	low mu dual triode
6145	sharp cut-off pentode	**5965**	low mu dual triode
6814	sharp cut-off pentode	**6211**	low mu dual triode
		5964	low mu dual triode

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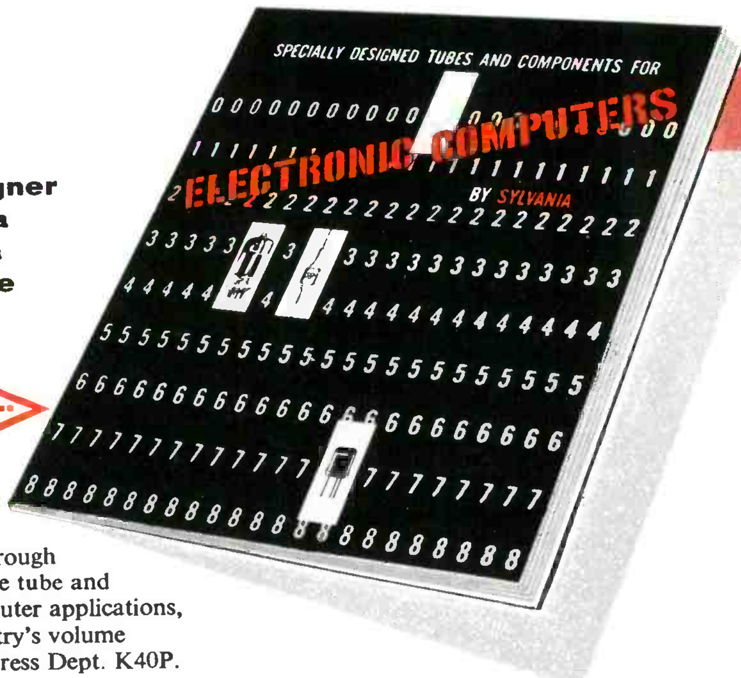
Shell Tower Building, Montreal

LIGHTING • RADIO • TELEVISION • ELECTRONICS • ATOMIC ENERGY

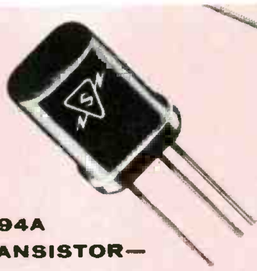
For product information, use inquiry card on page 113.

Semiconductors computers



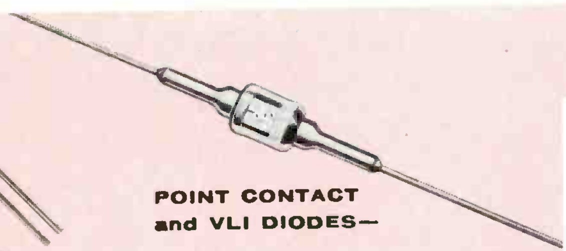
What every computer designer should know about Sylvania components is detailed in a new 64-page book available upon request—

Here, in one book, is the complete story of Sylvania's service to the computer manufacturer: Sylvania's philosophy of reliability; thorough testing procedures; ability to develop the tube and transistor parameters required for computer applications, and Sylvania's ability to meet the industry's volume requirements. Write for your copy. Address Dept. K40P.



2N94A TRANSISTOR—

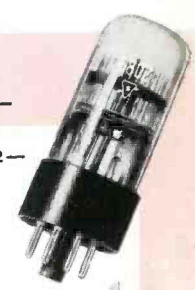
A high speed NPN switching transistor designed for reliable operation in computers. The type 2N94A combines excellent transient response with high gain at high peak current levels.



POINT CONTACT and VLI DIODES—

Very Low Impedance Diodes offer high forward conductance with fast recovery time and stable drift-free performance. A complete line is offered to meet a range of current and voltage requirements. Point contact diodes for extremely fast transient response featuring high back resistance at elevated temperatures.

COUNTER TUBES—



TYPE 6802—

A multiple output, cold cathode bidirectional decade counter providing visible and electrical outputs.

TYPE 6879—

A miniaturized version in a T5½ bulb, this tube features the advantages of the 6802 which includes reliable long-life operation.

For product information, use inquiry card on page 113.

Finland, Korea Get Started in TV

One of the few countries in Europe without officially-sponsored TV operations, Finland plans this fall to begin regular telecasts, and Korea recently had its first TV broadcast.

The Finnish Radio Co. expects to provide six program hours per week from a transmitter in Helsinki. In the first development period, through 1960, four TV transmitters and a relay station are expected to be put into operation. Further expansion is planned after 1960, to a total of 15 transmitters.

The Korean telecast, over Station HLKZ-TV, was received on only about 45 TV sets, mostly in public places. Regular broadcasting was scheduled to start during the past summer.

TV Picture Tubes Now Produced in Venezuela

Manufacture of television picture tubes has been started recently by a firm in Caracas, Venezuela, reports the Pan American Union, which said that the organization was established to produce electronic devices.

Known as Electronica Venezolana, the firm plans to make picture tubes from imported parts. Capacity is 100 tubes a day. There are an estimated 80,000 TV sets in use now in Venezuela.

Radar Camera Fixes Ship Crash Blame

Responsibility for collisions at sea may be fixed in the future by the use of a maritime radar camera, the "Mirar," which automatically takes pictures of a ship's radar scope at specified intervals, such as one a minute.

Developed by engineers of Fairchild Camera and Instrument Corp., Syosset, N. Y., the camera would help boards of inquiry in such collisions as that between the *Andrea Doria* and the *Stockholm*. Film would indicate whether radar sets were operating properly; the relative positions of ships prior to impact; and speed of vessels could be accurately fixed.

For product information, use inquiry card on page 113.

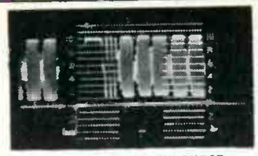
THEY'RE CHECKING VIDEO EVERYWHERE

WITH THE FAMOUS **TELECHROME** INCORPORATED

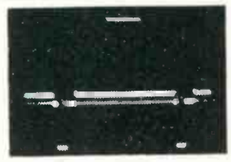
Model 1003-B

PORTABLE VIDEO TRANSMISSION TEST SIGNAL GENERATOR

★ Completely self contained ★ Portable ★ Multi-frequency burst ★ Stairstep ★ Modulated stairstep ★ White window ★ Composite sync ★ Regulated power supply.

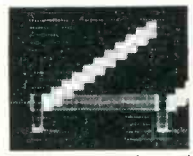


MULTI-FREQUENCY BURST AMPLITUDE vs FREQUENCY. Check wide band coaxial cables, microwave links, individual units and complete TV systems for frequency response characteristics without point to point checking or sweep generator.



WHITE WINDOW

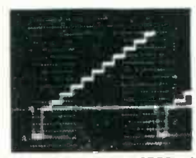
LOW & HIGH FREQUENCY CHARACTERISTICS. Determine ringing, smears, steps, low frequency tilt, phase shift, mismatched terminations, etc. in TV signals or systems.



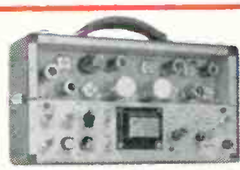
STAIRSTEP SIGNAL modulated by crystal controlled 3.579 mc for differential amplitude and differential phase measurement. Checks amplitude linearity, differential amplitude linearity and differential phase of any unit or system.
Model 1003-C includes variable duty cycle stairstep (10-90% average picture level).

Model 608-A HI-LO CROSS FILTER for Signal analysis.

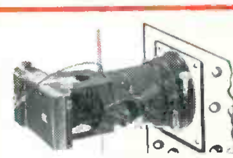
MODULATED STAIRSTEP signal thru high pass filter. Checks differential amplitude.



MODULATED STAIRSTEP signal thru low pass filter. Checks linearity.



1004-A VIDEO TRANSMISSION TEST SIGNAL RECEIVER for precise differential phase and gain measurements. Companion for use with 1003-B.



1521-A OSCILLOSCOPE CAMERA—Polaroid type for instantaneous 1 to 1 ratio photo-recording from any 5" oscilloscope.

DELIVERY 30 DAYS

Literature on the above and more than 100 additional instruments for monochrome and color TV by TELECHROME are available on request.

TELECHROME INCORPORATED

The Nation's Leading Supplier of Color TV Equipment
88 Merrick Road Amityville, N. Y.
AMityville 4-4446

For product information, use inquiry card on page 113.

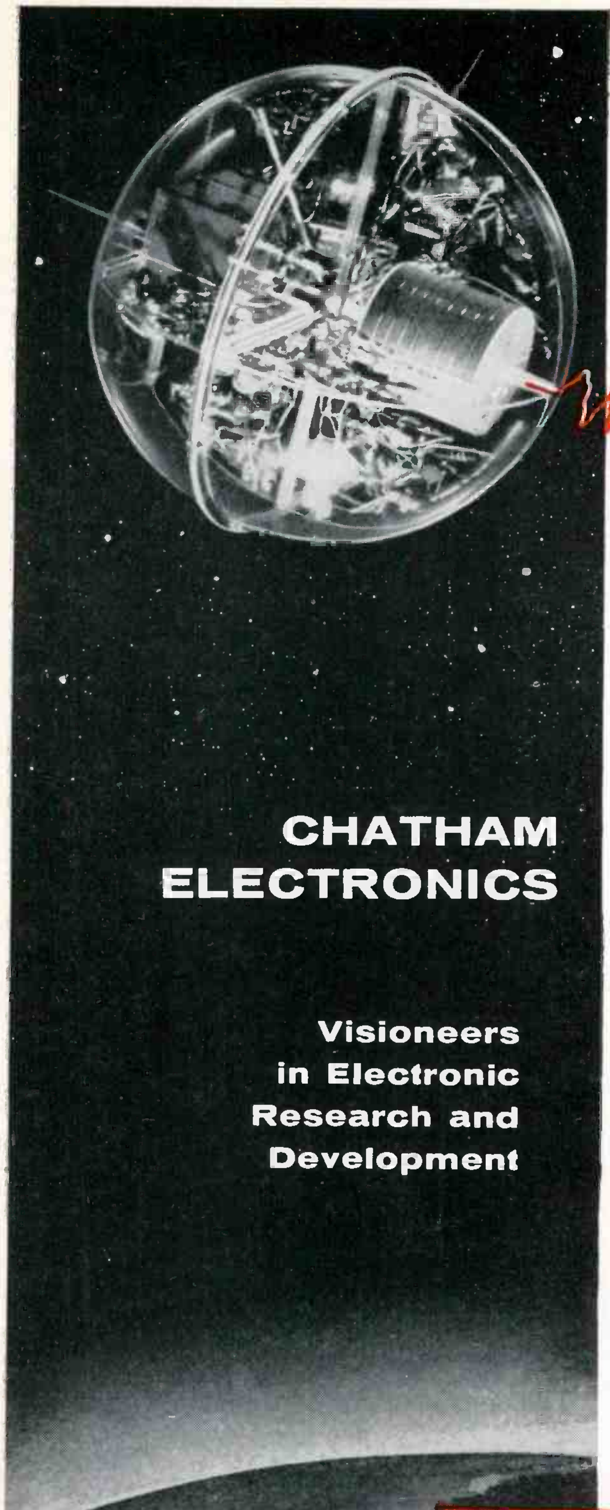


Photo courtesy of
Popular Mechanics Publishing Co.

"Echo from Eternity!"

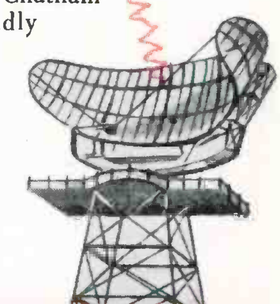
–AT WORK

...*CREATING* electronic equipment and components that anticipate and exceed the varied and rigorous requirements of industry, science and the Armed Forces

...*TRANSLATING* these designs into manufactured products of outstanding dependability

...*ANTICIPATING* problems to meet the challenge of the future. These are the functions, and the accomplishments...the every day work of Chatham Electronics—where progress is soundly based on the theory that vision is the foremost factor in research.

Why not consult Chatham on your requirements today? Work on your special problem may be under way as a routine research assignment at Chatham, now!



CHATHAM RECTIFIER withstands 900 G shock, operates at altitudes up to 60,000 feet

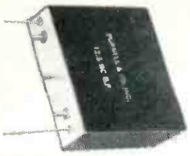
CHATHAM'S LIGHTWEIGHT AIRCRAFT CONVERTER —solves space and weight problems

CHATHAM BATTERY-LESS RADIAC DETECTOR CHARGER —an extremely compact design

Chatham Electronics
DIVISION OF GERA CORPORATION
Livingston, New Jersey—Branch Offices in Principal Cities

DESIGNERS-MANUFACTURERS OF ELECTRONIC TUBES, SELENIUM RECTIFIERS, AIRCRAFT CONVERSION EQUIPMENT, RADIOLOGICAL INSTRUMENTATION, CUSTOM COMPONENTS

 For product information, use inquiry card on page 113.



SUBMINIATURE FILTERS

- for I.F. amplifiers, printed circuit use
- temperature compensated to .15% from —55°C to +85°C
- for operations above 1 mc
- dimensions: 13/16" x 2-1/2" x 2" high

ENCAPSULATED TOROIDS

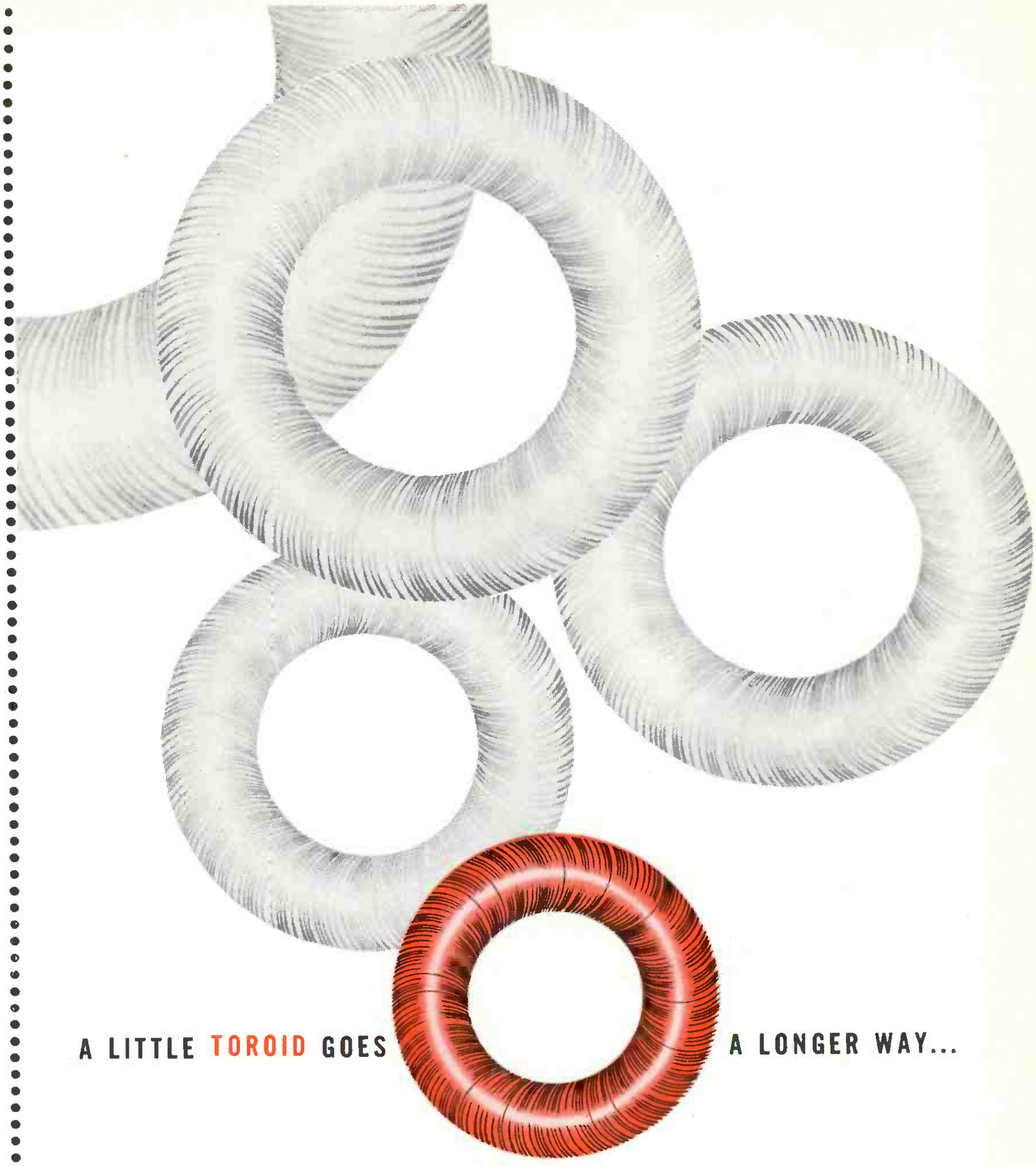
- hermetically sealed
- high Q
- center-mounting permits stacking
- complete range of sizes and types
- dimensions: 21/32" x 3/8"

TOM THUMB TELEMETERING FILTERS

- miniaturized for guided missiles
- high temperature stability
- designed to withstand shock and vibration
- hermetically sealed —wt. 1.5 oz.
- dimensions: 45/64" x 45/64" x 2" high

SUBMINIATURE ADJUSTOROIDS

- precise continuous adjustment of inductance over a 10% range
- no external control current needed
- hermetically sealed
- low cost—wt..83 oz.
- dimensions: 45/64" x 45/64" x 3/4" high



A LITTLE TOROID GOES A LONGER WAY...

As the toroid shrinks — it expands.

The smaller and more accurate Burnell succeeds in making toroids the wider the applications they continue to find . . . In subminiature filters for aircraft and guided missiles. In communications filters for receivers. In side-band filters for carriers. In filters for telemetering systems. And in an array of other new and remarkably specialized equipment.

Burnell files contain thousands of special designs in subminiature components. If the one you need is not already among them—we will make it for you. Consult us on any network problem. Write today to:—

Burnell & Co., Inc.

first in toroids, filters and related networks

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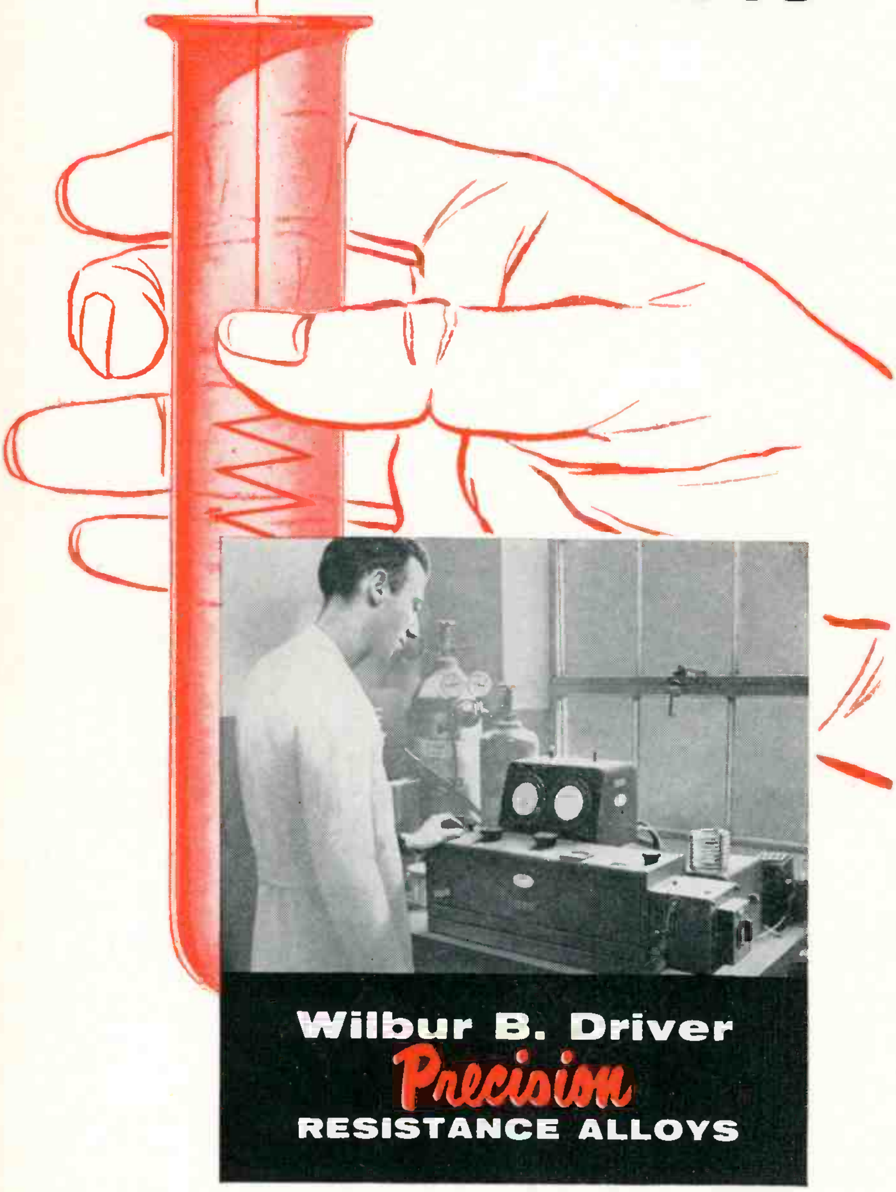
PACIFIC DIVISION: 720 MISSION STREET, SOUTH PASADENA, CALIFORNIA TELETYPE: PASADENA 7578

For product information, use inquiry card on page 113.



INDUSTRY NEWS

(*Continued from Page* 19)

H. H. Kieckhefer has been appointed Sales Manager, Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill.

Paul W. Knaplund and **J. Hunter White, Jr.**, have been appointed assistants to the Director, Applied Science Div., IBM Corp., New York.

O. B. Wilson has been appointed a Vice President of Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Philadelphia. He continues as General Sales Manager for the Brown Div.

Paul H. Dillow has been promoted to General Sales Mgr. of Stahlin Bros. Fibre Works, Inc., Belding, Mich., makers of a light-weight phenolic duct used on control panels.

Joseph L. Dooling has been made Director, Contracts Div., Hoffman Laboratories, Inc., Los Angeles, subsidiary of Hoffman Electronics Corp.

George W. Mousel is now Asst. Manager, Sales Dept., of Perkin Engineering Corp., El Segundo, Calif.

Jules Cardon has been named to head the new Industrial Sales Dept. of Servo Corp. of America, New Hyde Park, N. Y., and **Dr. Wayne W. Akey** has been appointed Personnel Manager by Servo.

Joseph M. Walsh, of the Grand Rapids Div., was elected Asst. Secretary of Lear, and **Forrest D. Beamer** was elected Asst. Secretary and Asst. Treasurer.

Morris D. Dettman was named Manager of the newly-created Merchandising Dept. of Datamatic Corp., Newton Highlands, Mass., which is jointly owned by Minneapolis-Honeywell and Raytheon.

Leon F. Herbert has been appointed Manager of the Patent Dept., Eitel-McCullough, Inc., San Bruno, Calif.

Paul Travers, Director of Engineering, Mack Electronics, a Div. of Mack Trucks, Inc., Plainfield, N. J., has been appointed a member of the Missile Guidance and Control Committee of the American Ordnance Assn.

Robert Sackman has been elected Vice President of Ampex Corp., Redwood City, Calif. He continues as Manager of Ampex' Instrumentation Div.

Edward L. Montgomery has been appointed Secretary of Ford Motor Company's new subsidiary, Aeronutronic Systems, Inc., Glendale, Calif.

Precision Instruments...

backed by the

RCA reputation

for engineering

excellence

VHF Signal Generator Type LG-22
(5 mc to 230 mc)

$395.00*

VHF Signal Generator

Now . . . For The First Time . . . Precision Features in a Low Priced VHF Signal Generator . . . Ideal For Production Use!

This attractively priced RCA Signal Generator has laboratory precision features that make it highly desirable for production use. Excellent frequency accuracy and stability. Individually calibrated. Negligible RF leakage. Wave-guide below cut-off type attenuator normally found in more expensive instruments.

Valuable in designing and evaluating receivers, amplifiers, and other apparatus that operate at frequencies between 5 and 230 mc. Particularly useful in measuring sensitivity and gain and for driving impedance bridges. Other signal generators available to meet your equipment and price requirements.

RCA Instruments of Laboratory Precision

PULSE GENERATOR ★ RF POWER METERS ★ NULL VOLTMETERS ★ IMPEDANCE BRIDGES ★ SIGNAL GENERATORS ★ VACUUM TUBE VOLTMETER ★ MULTIMETER ★ CRYSTAL MODULATOR AND OTHERS.

**Price in U.S.A., subject to change without notice.*

USE COUPON BELOW FOR COMPLETE INFORMATION

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CAMDEN, N. J.

In Canada: RCA VICTOR Company Limited, Montréal

Radio Corporation of America
Precision Electronic Instruments
Dept. K-119, Building 15-1, Camden, N. J.

☐ Please send me complete information on the following instruments:

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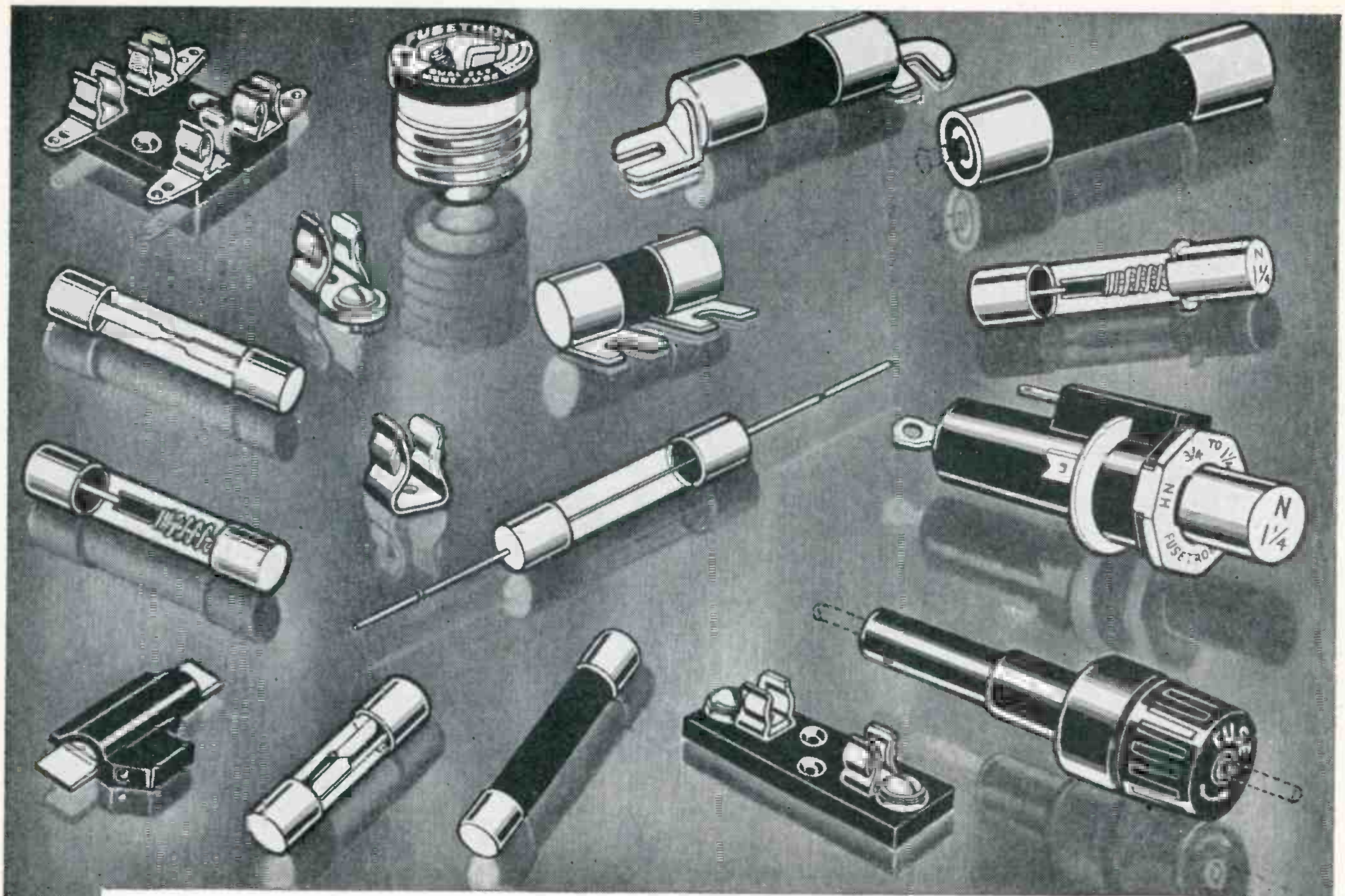
☐ Send name of nearest representative

NAME __________ TITLE __________

COMPANY __________

ADDRESS __________

CITY __________ ZONE ______ STATE ______



the "LITTLE FELLOWS" are doing a big job better...

Type ML-2G
All-glass 7-pin miniature. Extensively used in 27.255 Civilian band equipment.

ML-300 Series
For color television. All-glass; the only crystal for color use permanently sealed in vacuum. 7-pin base ideal for printed circuits.

Type ML-18
Metal version of ML-1G. Available with wire leads or fixed pins.

Type ML-1G
Especially adapted to limited-space assemblies. All-glass, hermetic seal. 2 wire leads; no socket necessary. No grounding problems.

FAST SERVICE on many regular stock types, available from inventory or on short order.

All pictured here actual size

Midland MINIATURES

for every crystal application

"We want the same performance, or better, but from a **smaller** unit." That has been the constant demand of the electronics industry for all equipment in the trend toward miniaturization.

Midland answered by making frequency control crystals both smaller **and better.** Today there's a Midland miniature for every crystal need . . . doing the same kind of dependable job that made Midland's conventional-size units first choice in two-way communications throughout the world.

Your Midland miniature is a masterpiece of accuracy, stability and uniformity . . . assured by Midland's Critical Quality Control through every step of processing from raw quartz to sealed unit. You can depend on it!

Whatever your crystal need — conventional or highly specialized — when it has to be exactly right, contact

Midland MANUFACTURING COMPANY, INC.

3155 Fiberglas Road • Kansas City, Kansas

WORLD'S LARGEST PRODUCER OF QUARTZ CRYSTALS
. . . every one produced to the industry's highest standards.

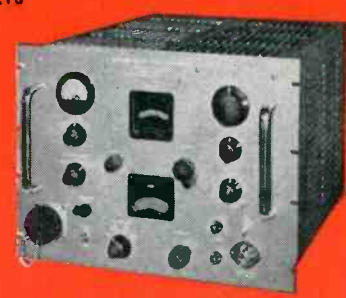
For product information, use inquiry card on page 113.

MICROWAVE
SIGNAL GENERATORS
AND SIGNAL SOURCES

EHF

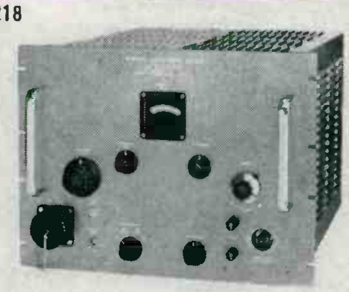
for extremely high frequencies 12,400 to 50,000 mc

SG-1218



POLARAD MICROWAVE SIGNAL GENERATORS
12.4 TO 39.7 KMC

SS-1218



POLARAD MICROWAVE SIGNAL SOURCES
12.4 TO 50.0 KMC

Rugged, compact, completely integrated units. Designed to save engineering manhours in the laboratory and on the production line. Operate simply with direct-reading continuously variable dials. No calibration charts.

Frequency is measured by direct-reading reaction-type wavemeters that assure extreme accuracy. VSWR is exceptional—Signal Generators 1.7 to 1; Signal Sources 1.7 to 1 when attenuated. Calibration accuracy is given special attention.

Consult Polarad on all your EHF problems.

	SIGNAL GENERATORS		SIGNAL SOURCES	
Frequency Range	Model Number	Output Power	Model Number	Power Output (Average)
12.4 to 17.5 KMC	SG 1218*	−10 DBM	SS 1218	15 mw
18.0 to 22.0 KMC	SG 1822	−10 DBM	SS 1822	10 mw
22.0 to 25.0 KMC	SG 2225	−10 DBM	SS 2225	10 mw
24.7 to 27.5 KMC	SG 2427	−10 DBM	SS 2427	10 mw
27.27 to 30.0 KMC	SG 2730	−10 DBM	SS 2730	10 mw
29.7 to 33.52 KMC	SG 3033	−10 DBM	SS 3033	10 mw
33.52 to 36.25 KMC	SG 3336	−10 DBM	SS 3336	9 mw
35.1 to 39.7 KMC	SG 3540	−10 DBM	SS 3540	5 mw
37.1 to 42.6 KMC			SS 3742	Approx. 3 mw
41.7 to 50.0 KMC			SS 4150	Approx. 3 mw

*External Source Power Measurement
Range +10 to +30 DBM
Accuracy with Correction: ±2 DB

Modulation:
1. Internal
   1000 CPS Square Wave
2. External
   a. Pulse
      Pulse Width: 0.5 to 10 Microseconds
      PRF: 50 to 10,000 PPS
      Pulse Amplitude: 10 volts Pk to Pk Min.
      Polarity: Positive
   b. Sawtooth or Sinusoidal
      Frequency: 50 to 10,000 CPS
      Amplitude: 15 Volts RMS Min.

SPECIAL FEATURES OF EHF SIGNAL GENERATORS

- Unique power measurement system employs waveguide components of unusual design — allows continuous and front panel monitoring.
- Attenuation is independent of power set and frequency.
- 1000 cycles cps square wave modulation and external fm or pulse modulation provided over entire frequency range.

AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

For complete information write to your nearest Polarad representative or directly to the factory.

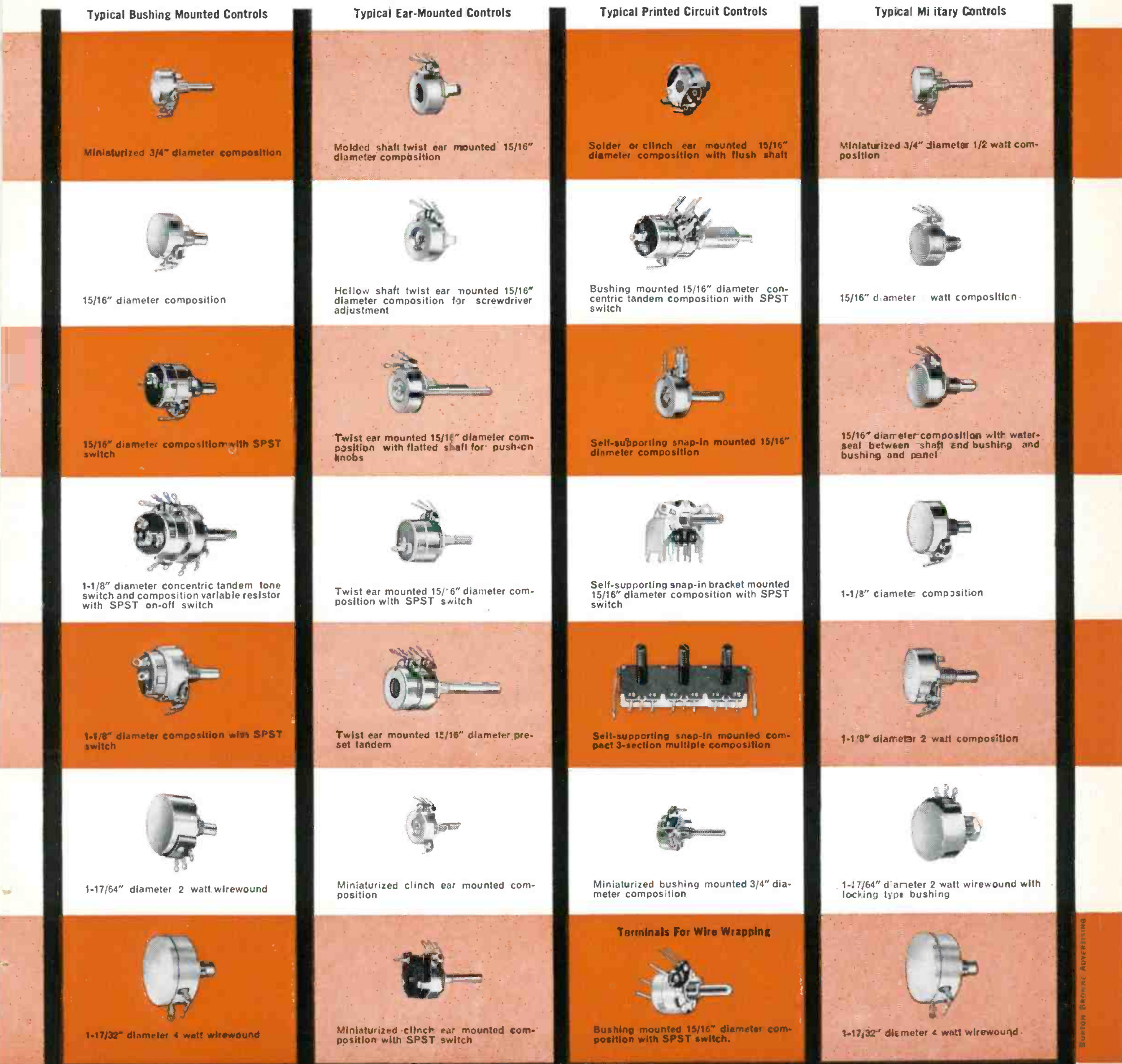
POLARAD PROVEN RELIABILITY **ELECTRONICS CORPORATION**
43-20 34th STREET, LONG ISLAND CITY 1, N. Y.

A complete line of Microwave Signal Generators available in a range of 950 to 11,500 MC and Signal Sources available in a range of 650 to 10,750 MC.

REPRESENTATIVES: Albuquerque, Atlanta, Baltimore, Boston, Buffalo, Chicago, Cleveland, Dayton, Denver, Fort Worth, Kansas City, Los Angeles, New York, Philadelphia, Portland, St. Louis, San Francisco, Schenectady, Syracuse, Washington, D. C., Winston-Salem, Canada; Arnprior, Ontario. Resident Representatives in Principal Foreign Cities

MILLIONS OF VARIABLE RESISTORS
for every commercial and military need

- A world-wide reputation . . . for economical uniform high quality assembly . . . on a precision mass production basis . . . by 1500 skilled, trained-on-the-job specialists . . . to your exact individual specification.
- 315,000 sq. ft. of plant area devoted to variable resistors.
- Exceptionally good delivery cycle . . . on both commercial and military orders.
- Write for complete 62 page catalog today.



Variable resistors shown 1/3 actual size

A CTS control can be tailored to your specific requirement. Let CTS SPECIALISTS help solve your current control problems. Write or phone today.

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SOUTHWESTERN U.S.A.
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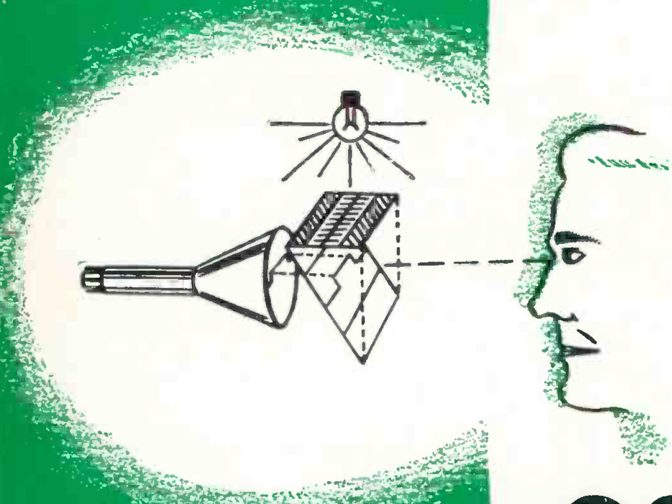
ELKHART • INDIANA

The Exclusive Specialists in Precision Mass Production of Variable Resistors • Founded 1896

Lavoie

Are you interested in quantitative or qualitative measurements?



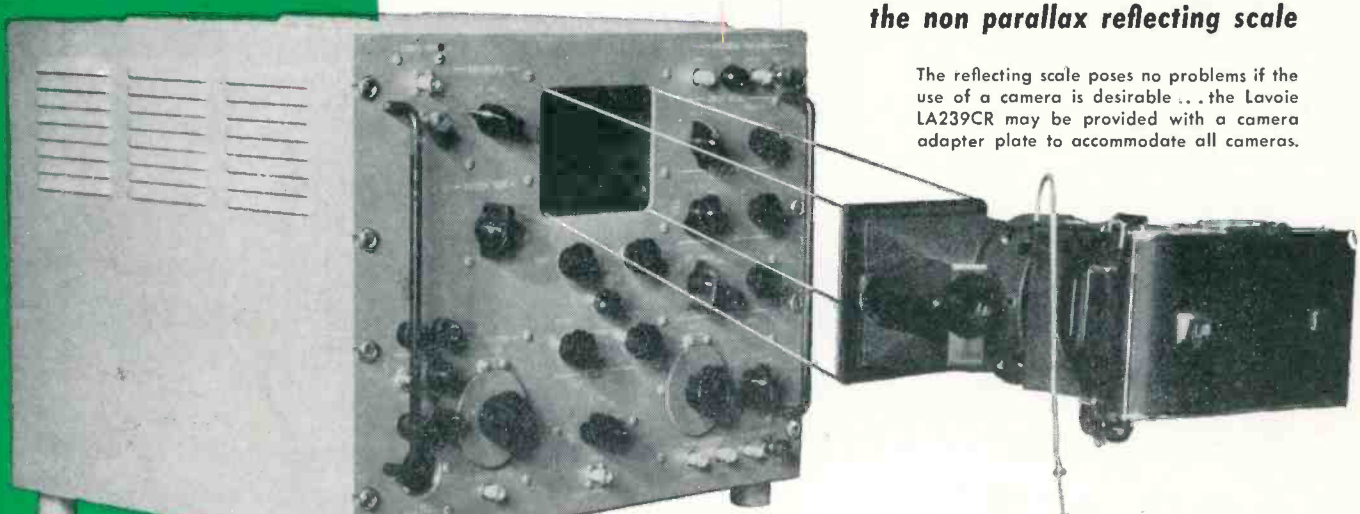
Voltage calibration and sweep calibrations are held to 2½% accuracy in the Lavoie LA-239CR Oscilloscope. To minimize observation errors and make maximum use of this accuracy, non-parallax viewing is employed. High accuracy of measurement is achieved by employing separate calibration circuits within the oscilloscope to calibrate the voltage sensitivity and sweep speed. This approach provides the maximum accuracy when highly stable circuits for sweep and vertical amplifier, such as those employed in the LA-239CR, are used. Change in horizontal and vertical deflection sensitivity due to aging, tube changes and environmental effects are immediately corrected through the self-checking feature.

The Lavoie 239CR (AN/USMC-50A)

OSCILLOSCOPE

is the ONLY commercial scope with the non parallax reflecting scale

The reflecting scale poses no problems if the use of a camera is desirable . . . the Lavoie LA239CR may be provided with a camera adapter plate to accommodate all cameras.



The same instrument is also available in the conventionable flush-face model 239CF.

- wide band — 10 cps — 15 mc
- extended sweep frequencies
- high stability
- militarized construction
- non-parallax screen
- time and voltage calibration
- higher signal sensitivity
- regulated power supply

See for Yourself

The Lavoie nationwide group of engineer-representatives can arrange a practical demonstration of this outstanding Oscilloscope AT YOUR PLANT — on short notice — to suit your convenience. Write for illustrated brochure with complete specifications—and the name of the Lavoie representative nearest you.

Supporting Equipment for Military Systems

The Lavoie 239CR Oscilloscope is the official general purpose instrument for the military services (AN/USM50A). Available with dust cover or for standard rack mount. Extremely rugged and easy to use under the most exacting field or laboratory conditions.

Lavoie Laboratories, Inc.

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ADVANCED ELECTRONICS · *Research* · *Development* · *Manufacture*

Electronic Industries News Briefs

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

EAST

PHILCO CORP., Philadelphia, has launched another campaign to smash the multi-million dollar racket in sales of worn-out and discarded TV and radio receiving tubes. A number of tube racketeers have thus been forced out of business. Philco distributors throughout the U. S. will give all radio and TV technicians and servicemen a credit of 5¢ for each old tube turned in.

STEWART-WARNER ELECTRONICS, the Electronics Div. of Stewart-Warner Corp., Chicago, has entered the facsimile transmission and reception equipment field with the purchase of the entire facsimile business of Allen D. Cardwell Electronics Productions Corp., Plainville, Conn. Development and production of fax apparatus for both commercial and military applications is planned.

AIRCRAFT - MARINE PRODUCTS, INC., Harrisburg, Pa., has moved executive, administrative, sales and advertising, and product management divisions to a new building on Eisenhower Blvd., near the Harrisburg East Interchange of the Pennsylvania Turnpike. Engineering and product development departments are in the former general office building at 2100 Paxton St., Harrisburg; new branch offices are in Maplewood, N. J., and Cincinnati.

SUPERIOR TUBE CO., Norristown, Pa., is beginning production of aperture masks, a basic component of picture tubes for commercial TV receiving sets. A new department has been set up for this product; known also as "shadow masks," they will be produced under license from Buckbee Mears Co., St. Paul.

BURROUGHS CORP., Detroit, has formed the new Electronic Tube Div., in Plainfield, N. J., and named Saul Kuchinsky as General Manager. The Division will occupy the Plainfield plant of Haydu Bros., formerly a Burroughs subsidiary, and be responsible for manufacture and sale of special vacuum tubes.

ORRADIO INDUSTRIES, INC., Opelika, Ala., received a large order from Columbia Broadcasting System TV Div. for its new "Videotape," a magnetic tape for recording both picture and sound simultaneously on the same tape strip. For use in both TV and movies, product was developed jointly by ORRadio and Ampex Corp.

STACKPOLE CARBON CO., St. Mary's, Pa., recently observed its 50th anniversary in business.

SYLVANIA ELECTRIC PRODUCTS, INC., which has its Parts Div. in Warren, Pa., has purchased the Titusville, Pa., plant of Ruel H. Smith Enterprises, which assembles electronic components for TV and radio.

MINNEAPOLIS - HONEYWELL announced that a $4,000,000 aeronautical plant with 207,500 sq. ft. of floor space will be erected by mid-1957 near Pinellas Co. Airport at St. Petersburg, Fla., to develop and produce advanced aerial navigational equipment known as inertial guidance systems. Honeywell has also bought the 250,000 sq. ft. plant of Hathaway Bakeries, Inc., Boston, for its Transistor Div.

TELE-DYNAMICS, INC., Philadelphia (formerly, Raymond Rosen Engrg. Prods., Inc.) named Brig. Gen. William L. Bayer, USA, Ret., Executive Vice President and General Manager.

JERROLD ELECTRONICS CORP., Philadelphia, showed an increase of sales and revenues of more than 33 1/3% in the first 1956 fiscal quarter; income topped $1,000,000.

UNITRONICS CORP. has received stockholder approval as the new corporate name of Olympic Radio & Television, Inc., Long Island City, N. Y.

GULTON INDUSTRIES, INC., Metuchen, N. J., is the new name of the firm resulting from the merger of Thermistor Corp. of America and Vibro-Ceramics Corp. with Gulton Mfg. Corp.

RADIO CONDENSER CO., Camden, N. J., reorganizing certain operations, is discontinuing TV tuner manufacturing, revamping Eastern and Western divs., and entering new markets. Tuner research and development will, however, be continued, and military work will now be concentrated in the East. Firm has entered the magnetic clutch and audio frequency filters fields.

MID-WEST

CONTINENTAL CARBON, Cleveland, has acquired Wirt Co., Philadelphia, manufacturer of such products as wire wound potentiometers, rheostats, various types of resistors, and a line of slide switches. Wirt was founded in 1910.

RADIO CORP. OF AMERICA, Camden, N. J., has delivered a high-power UHF TV transmitting pylon antenna to WTVH, Peoria, Ill., that will enable the station to more than double its effective radiated power; antenna provides a gain of nearly 50 and increases radiated power from 214,000 to 500,000 watts.

UNIVERSITY OF MICHIGAN has begun installation of an RCA compatible color TV system for use in teaching surgical and clinical procedures to undergraduate and post-graduate students at its hospital in Ann Arbor. Scheduled for completion early in 1957, installation will be operated by the Medical School and the University's TV studios.

JENSEN MFG. CO., Chicago, expects soon to complete installation of additional facilities to double production capacity of its Guttenberg, Ia., loudspeaker plant.

BENDIX AVIATION CORP., Cincinnati Div., plans to occupy a new plant in Hyde Park, a Cincinnati suburb, for manufacture of dosimeters, and nuclear and ultrasonic instruments.

TEXAS INSTRUMENTS, INC., Dallas, which recently acquired Wm. I. Mann Co., a Monrovia, Calif., optics firm, has received more than $7,000,000 in new contracts, primarily for its Apparatus and Semiconductor-Components Divs. Principal customers: Air Force, Navy Dept., and Army Signal Corps.

ELGIN NATIONAL WATCH CO., Elgin, Ill., will help produce a completely integrated air data computer for jet aircraft under contract with the Eclipse Pioneer Div., Bendix Aviation Corp., Teterboro, N. J. Volume production of the units will be handled at Elgin's Lincoln, Neb., plant.

ILLINOIS INST. OF TECHNOLOGY, Chicago, has received a $750-per-year scholarship bearing the name of Ross D. Siragusa, President of Admiral Corp., Chicago. Funds to support the award for an extended period were raised by Admiral distributors as a 50th birthday tribute to Mr. Siragusa.

CBS-HYTRON, Danvers, Mass., has opened a modern 57,000 sq. ft. Chicago warehouse, located on Mannheim Rd., in Melrose Park, the firm's 10th such U. S. facility.

LEAR, INC., Grand Rapids Div., has received a $4,000,000 order from the Air Force for pictorial vertical gyro indicator systems for aircraft to meet a combined Air Force-Navy requirement.

AC SPARK PLUG DIV., GENERAL MOTORS CORP., Flint, Mich., is developing guidance systems for the Air Force's Ballistic Missile Program. Systems are being developed for manufacture at AC plants in Milwaukee and Flint.

WEST

AUTOMATION ELECTRONICS, INC., electronic equipment manufacturers, has been formed with offices at 231 W. Olive St., Burbank, Calif., and headed by Frank G. Jameson. Thomas L. McKnight is Executive Vice President of firm, which has received an Air Force contract for technical order modification kits.

SARGENT-RAYMENT COMPANY'S name has been purchased by L. W. Rayment, general manager and former owner. Engineering and administrative offices have been moved to: 4926 E. 12th St., Oakland 1, Calif.

EL DORADO ELECTRONICS CO., 1401 Middle Harbor Rd., Oakland 20, Calif., is the new corporate name of the Sargent-Rayment Co., Oakland. W. K. Rosenberry is President, and J. J. Shapiro has been named Chief Engineer for firm, which will carry on research, development, and manufacturing of nucleonic and industrial electronic devices for both commercial and military markets.

PACIFIC MERCURY TV MFG. CORP., Sepulveda, Calif., has increased plant size to 150,000 sq. ft. and entered the electronic organ field with the Nationally-distributed Thomas Organ.

ENGINEERED ELECTRONICS CO., Santa Ana, Calif., is the new name of EECO Production Co., a wholly-owned subsidiary of Electronic Engineering Co. of Calif., Los Angeles.

RAYTHEON MFG. CO., Waltham, Mass., bought a 15-acre site near Santa Barbara, Calif., for a new engineering lab to be used in design and development of airborne electronics and infra-red equipment.

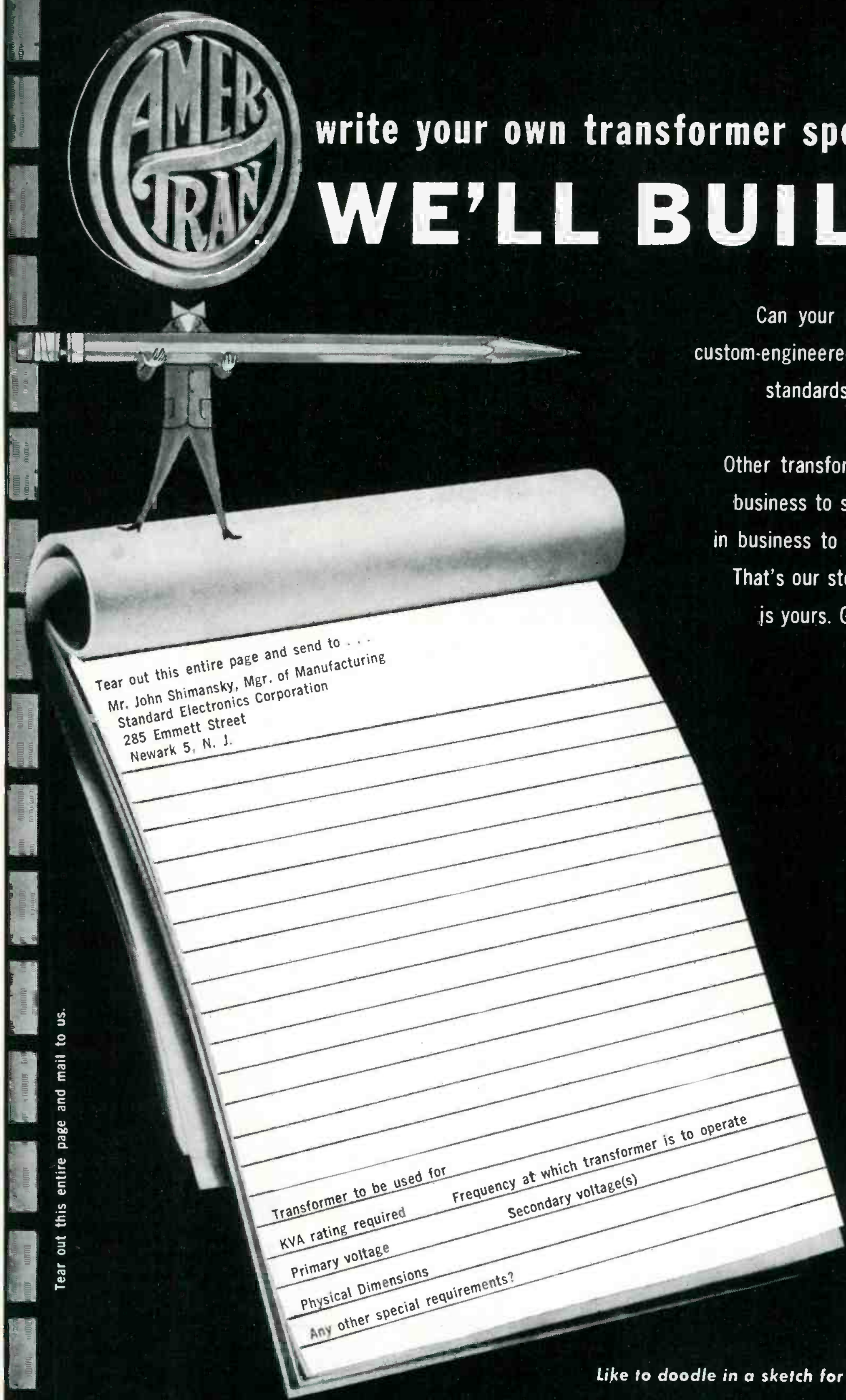
DAYSTROM SYSTEMS DIV., Daystrom, Inc., Elizabeth, N. J., has been formed and will be located at LaJolla, Calif. Chalmer E. Jones will be General Manager of Division, which will design, build, test and install complete systems for automation applications.

FOREIGN

REMINGTON RAND, Div. of Sperry Rand Corp., New York, shipped a 20-ton UNIVAC electronic computing system by air from New York to Frankfurt. Said to be the first such installation on the Continent, the 20 tons of major UNIVAC units were flown in two Seaboard & Western Airlines planes to Battelle Institute, Frankfurt, for a large-scale computer service center.

HUPP INTERNATIONAL has been formed as a Division of Hupp Corp., Cleveland, with Hupp Vice President Donald S. Smith as President. He will administer all corporate activities outside the U. S., with headquarters in Cleveland.

MOTOROLA, INC., Chicago, has licensed Addison Industries, Ltd., Toronto, to manufacture radio and TV products, and for Addison, Ltd., to distribute them throughout Canada. (Addison continues to make and sell Norge appliances.)



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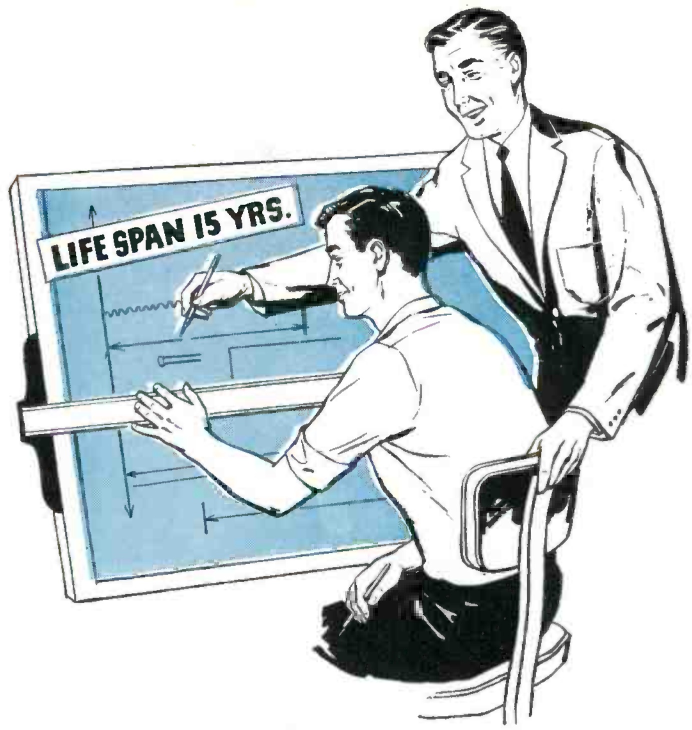

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A recent series of the toughest trials has proved El-Menco DM15, DM20 and DM30 Dur-Mica Capacitors outlast all others. Accelerated conditions of 1 ½ times rated voltage at ambient temperature of 125° centigrade found El-Menco capacitors still going strong after 10,000 hours. Similar conditions obtaining under normal usage would equal a lifetime of over 15 years!

Tougher phenolic casing means *longer life, greater stability,* over wide temperature range.

Meet all humidity, temperature, and electrical requirements of both civilian and MIL-C-5 specs.

Parallel leads simplify use in television, electronic brains, miniature printed circuits, computors, guided missiles, and other civilian and military applications.

DM15

Actual Size

DM20

El-Menco Dur-Mica DM15, DM20, and DM30 Capacitors Assure:

1. LONGER LIFE
2. POTENT POWER
3. SMALLER SIZE
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Tell us your specific needs. Write for FREE samples and catalog on your firm's letterhead.

Take Your Own Word For It. Test El-Menco Dur-Mica Capacitors Yourself.

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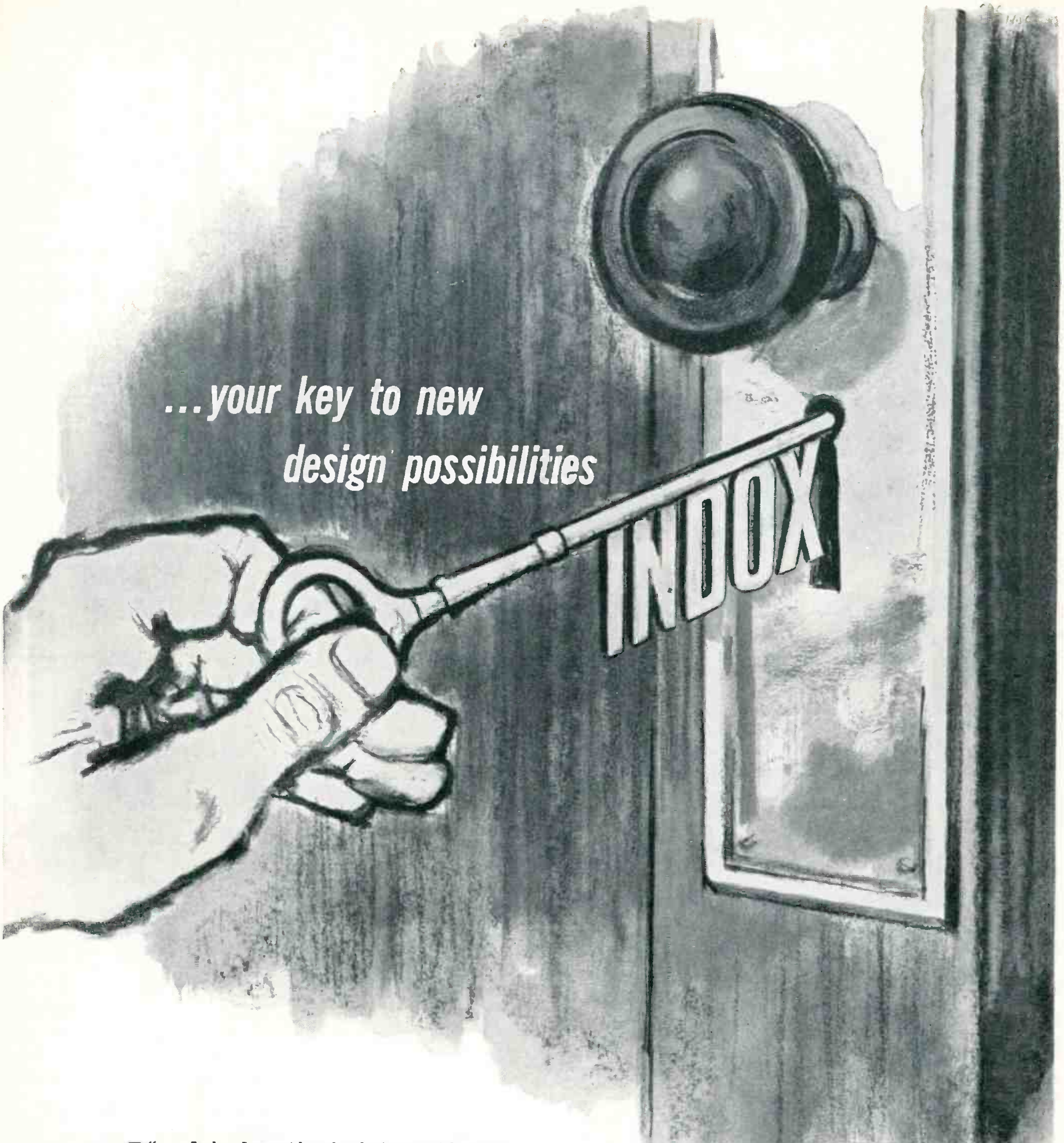
• tubular paper • ceramic

Arco Electronics, Inc., 64 White Street, New York, N. Y.
Exclusive supplier to jobbers and distributors in United States and Canada.

For product information, use inquiry card on page 113.



- *"... Indox I provides the designer with space conservation in a new direction ..."*
- *"... Indox I shows exceptional promise for use in traveling wave tubes ..."*
- *"... The high coercive force of Indox I permits both, or all, of the poles to be located on one surface of the magnet, so pole pieces can be eliminated ..."*
- *"... Indox I magnets can be placed behind decorative coverings without an excessive loss in holding force—a significant design feature when equipment styling is important ..."*
- *"... The high-temperature coefficient of Indox I opens a completely new field for permanent magnets ..."*

from "Applied Magnetics"

CERAMIC MAGNETS

If you use permanent magnets, you should investigate the advantages of Indox I . . . the most significant permanent magnet development since the introduction of Alnico!

Indox I opens new and wider horizons of design possibilities. The applications listed below are only some of the more promising.

Smaller size . . . a longer effective life . . . lighter weight . . . savings in cost . . . improved performance . . . are just a few of the benefits already reported by users of this ceramic magnet.

Indox I is *not* a substitute for the magnetically stronger magnets such as Alnico. Instead, it extends the field of application for magnets . . . permitting design changes not always possible with Alnico.

Investigate the advantages Indox I may hold for *your* product. Our design and application engineers will be glad to help. And, because we make *all* types of permanent magnet materials, you can be sure our recommendations will be for that magnet material which will do the best job in your product. For prompt recommendations, without cost or obligation, call or write to Valparaiso today!

These special properties of Indox I:

1. No critical materials
2. High coercive force
3. Magnetization before assembly
4. High resistivity
5. Low specific gravity
6. Cost advantage
7. High potential energy
8. Low incremental permeability

. . . offer significant advantages in these applications:

ELECTRONIC
•TV focuser (1, 2, 5, 6)
Traveling wave tube (2, 3, 5)
•Loud-speakers (1, 2)

HOLDING (1, 3, 6, 7)
•Cabinet latches
•Can openers
•Holding assemblies (flashlights, fishing poles)
Door closers (refrigerators)
Conveyors (automation)
•Toys and novelties

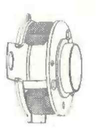
POLARIZING (2, 4, 8)
Sonar
Magnetostriction
cleaning
homogenizing
ultrasonics

ELECTRO-MECHANICAL
•Synchronous drives (1, 2, 6, 7)
Motors
d-c fields (2, 6)
a-c rotors (1, 3, 6, 7)

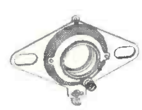
MISCELLANEOUS
•Arc blowout (2, 4)
•Temperature control

Note: The numbers following each application, or group of applications, identify those properties of Indox I that make it particularly well-suited to that product.
•Indox I magnets are currently being produced for these applications.

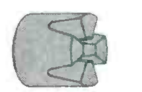
ALNICO
Conventional-type television focuser used three Alnico magnets . . . as shown to right.



INDOX I
Shaded area shows ring type magnet . . . with simpler mounting. There are savings in space and weight.



ALNICO
Note depth of conventionally designed magnet drive unit.



INDOX I
Note *shorter* length of drive unit made of Indox I . . . which also is lighter.

Here's "Applied Magnetics" (Vol. 4, No. 3) which gives you detailed information on the design and application of Indox I Ceramic Permanent Magnets. Use this coupon to ask for your copy:

The Indiana Steel Products Company
Dept. N-10
Valparaiso, Indiana

World's Largest Manufacturer of Permanent Magnets

Please send "Applied Magnetics" (Vol. 4, No. 3).

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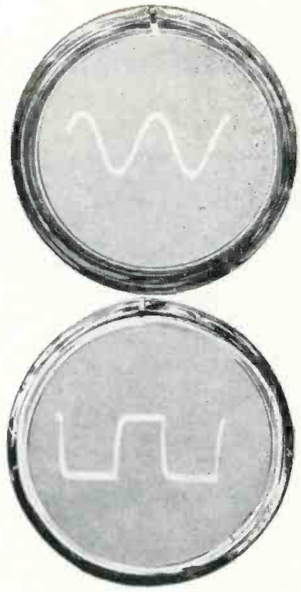
HUGHES PRODUCTS

presents 3 unusual new

STORAGE TUBES

MEMOTRON



Photos show single transient pulses, 20 microseconds wide with a one microsecond rise time, showing writing capabilities of one million inches per second. These photos were taken in full daylight without a hood.

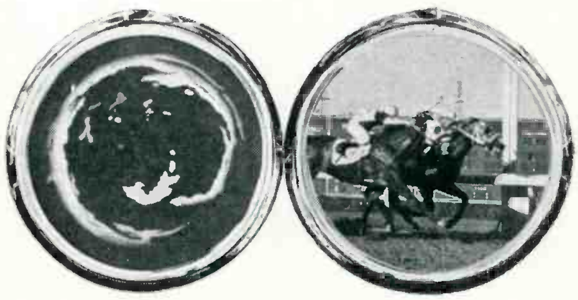
The MEMOTRON, a direct-display cathode ray storage tube, retains traces and transients until intentionally erased. Analysis and comparison are possible without photography because MEMOTRON visually displays successive transient writings. All displays occur at uniform brightness, regardless of writing speeds, so are easily photographed for file records. Applications: viewing transients in shock testing, read-out of solutions from analog computers, curve plotting at high and low speeds, electrocardiography, vectorcardiography and heart sounds.

General Specifications:

RESOLUTION . . . 50 to 60 written lines per inch.
WRITING SPEED . . . 0 to at least 100,000 inches/second.
BRIGHTNESS . . . 50 foot-lamberts.
USABLE SCREEN DIAMETER . . . 4 inches.
DIMENSIONS . . .
Over-all length: $18\frac{1}{2}$ inches $\pm\frac{1}{2}$ inch.
Bulb diameter: $5\frac{5}{8}$ inches maximum.
Neck diameter: $2\frac{1}{4}$ inches $\pm\frac{3}{32}$ inch.

TONOTRON

The TONOTRON, another exclusive Hughes direct-display cathode ray storage tube with a 5-inch screen, presents a complete spectrum of grey shades. The high light output makes a hood unnecessary, even when viewing in full daylight. TONOTRON'S length of persistence and rate of decay are controllable. Superior presentation of the grey scale assures "high fidelity" picture reproduction. Applications: radar, Narrow Band Television, instrumentation, etc.



Photos: Left, weather radar with brilliant halftone picture on TONOTRON. Right, TONOTRON freezes action picture until intentionally erased.

TYPOTRON

The TYPOTRON is the first commercially available storage tube for displaying printed data rapidly. A choice of 63 characters is available for the presentation of data in words, numbers or symbols. As a high-speed digital read-out device, the TYPOTRON writes characters ⅛ inch in size at speeds of at least 25,000 characters per second. The written information remains visible indefinitely without fading or blooming, until intentionally erased. This feature makes TYPOTRON an ideal read-out device in many digital computer applications.

Photo: Presentation of all available characters.

HUGHES PRODUCTS

A DIVISION OF THE HUGHES AIRCRAFT COMPANY

ELECTRON TUBES

Our applications engineers invite your inquiries regarding specific uses of these tubes. For further information and descriptive literature please write to:

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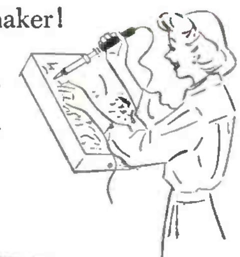
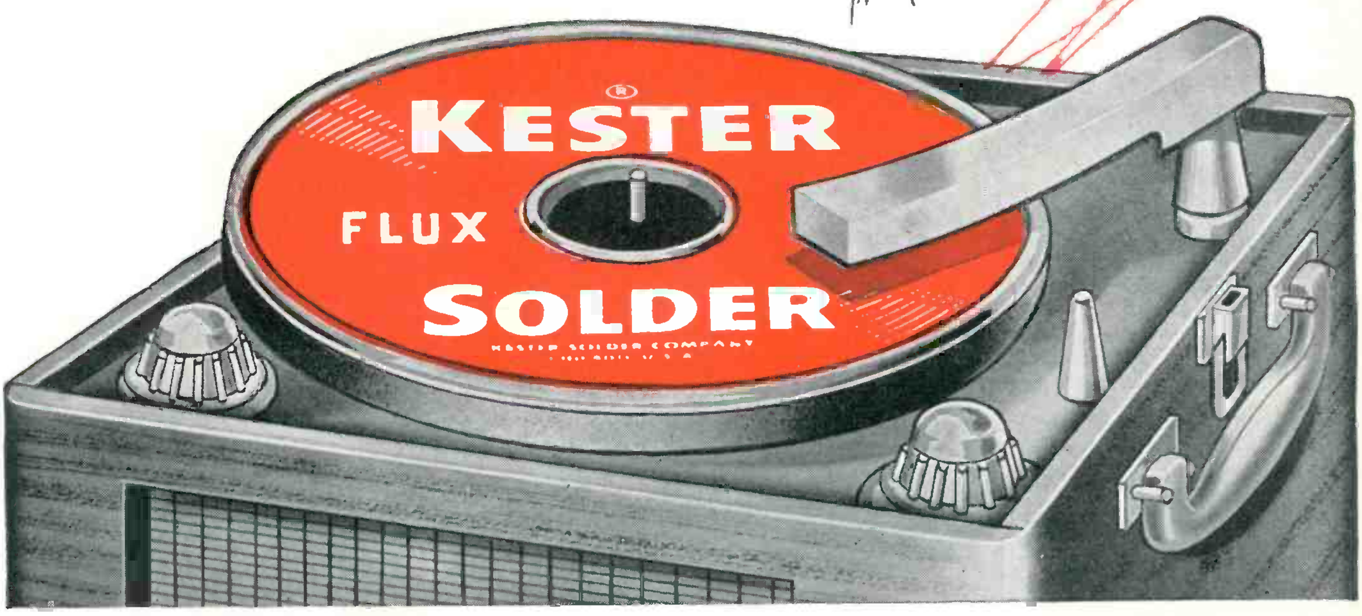
WRITE TODAY for Kester's NEW 78-Page Informative Textbook, "SOLDER . . . Its Fundamentals and Usage."





KESTER SOLDER

COMPANY 4210 Wrightwood Avenue, Chicago 39, Illinois; Newark 5, N. J.; Brantford, Canada

For product information, use inquiry card on page 113.

PERSONAL

Maj. Gen. Raymond C. Maude, former Commander, Air Force Cambridge Research Center, has been named assistant to **Dr. Thomas T. Goldsmith, Jr.,** Vice President-Government and Research, Allen B. Du Mont Labs, Clifton, N. J. General Maude will assist in directing the supply of electronic equipment to the armed services.

Allan R. Ogilvie has been elected Vice President of Hancock Electronics Corp., Redwood City, Calif.

Dr. A. Gurewitsch

A. R. Ogilvie

Dr. A. M. Gurewitsch, a physicist at General Electric's Research Lab in Schenectady, has been appointed a European scientific representative of the Lab. He will headquarter at GE's new research office in Zurich, Switzerland.

Hjalmer Lundquist, formerly Chief Design and Tool Engineer with National Vulcanized Fibre Co., Wilmington, Del., is now an engineering consultant for the firm, following his recent retirement.

Charles J. Falk is now Manager-Engineering, Distribution Assemblies Dept. General Electric Co., Plainville, Conn.

Dr. Samuel B. Batdorf has joined Lockheed's Missile Systems Div., Research Branch, Van Nuys, Calif., as Asst. Director and head of the Electronics Div. His doctorate is in theoretical physics.

Dr. Sidney L. Simon is now Director of Applied Research in the Research and Advanced Development Div., Avco Mfg. Corp., Stratford, Conn.

Edward G. Hall has been promoted to Chief Applications Engineer at Lenkurt Electric Co., San Carlos, Calif.; he had formerly been sales engineering mgr. and general sales mgr. **Carl W. Roe** has been made General Commercial Relations Manager by Lenkurt.

Philias H. Girouard, formerly Chief Engineer, U. S. Navy Bureau of Ordnance, has been named Asst. Director of Engineering at Consolidated Electrodynamics Corp., Pasadena, Calif.

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Excellence in Electronics

RAYTHEON

RAYTHEON MANUFACTURING COMPANY

Microwave and Power Tube Operations, Section PL-43

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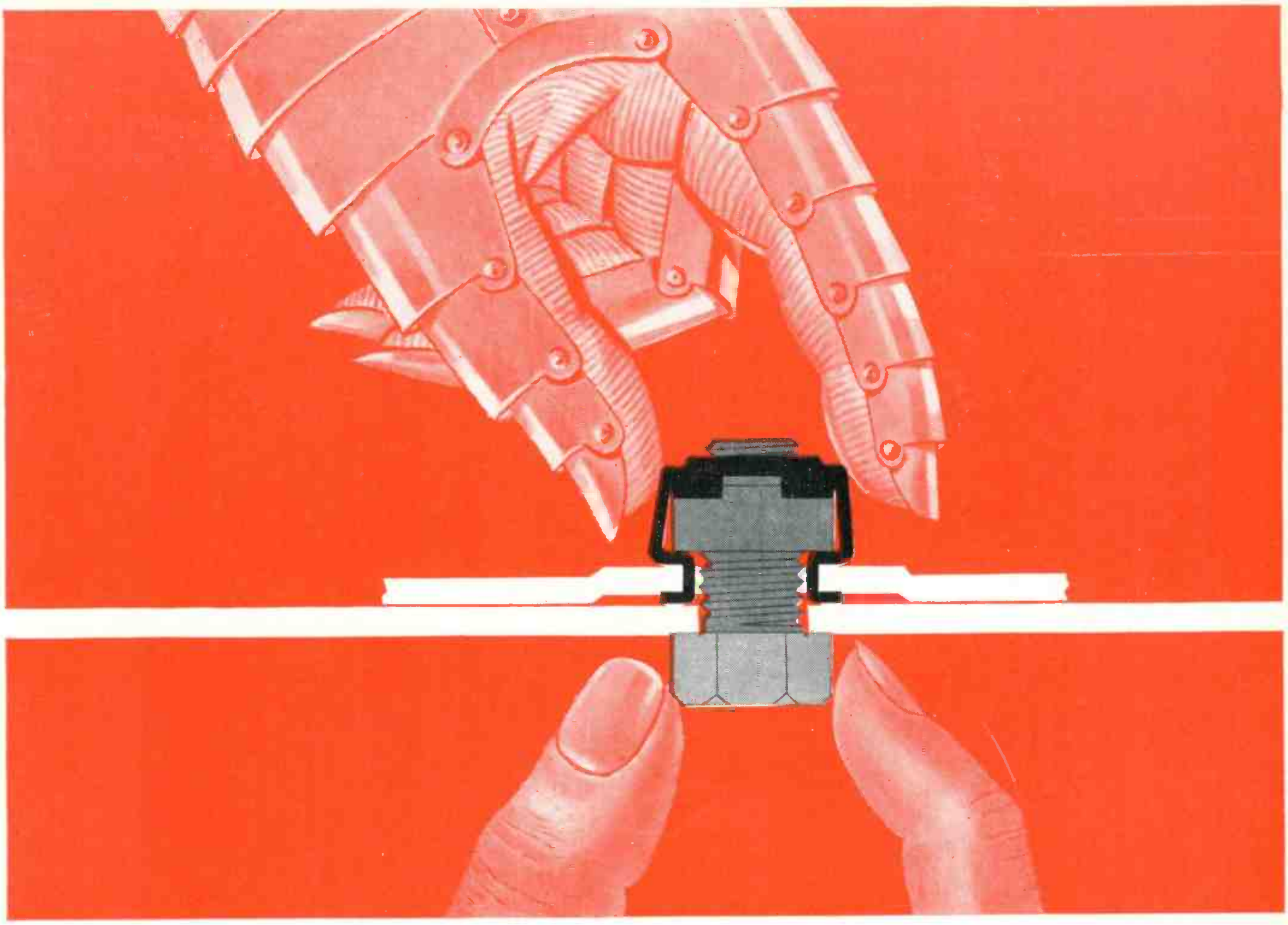
Raytheon makes: Magnetrons and Klystrons, Backward Wave Oscillators, Traveling Wave Tubes, Storage Tubes, Power Tubes, Receiving Tubes, Transistors



FINGERS OF STEEL
that hold where you can't reach

If you can't reach the back of a panel to hold a nut, let the spring steel fingers of a Tinnerman SPEED GRIP® Nut Retainer hold it for you. No welding or staking, no special skills or equipment required. It's the most efficient way to attach a square nut to a panel in blind location.

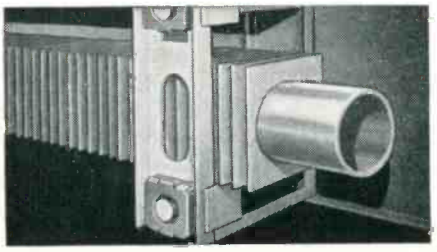
The SPEED GRIP combines a square nut retained in a spring steel cage. The SPEED GRIP snaps easily into the panel. Expensive rigid position methods are eliminated. Nut floats free in the cage to offset minor hole misalignments, but cannot turn as bolt is tightened.

SPEED GRIPS can be put on anywhere along your assembly line . . . no side trips to special stations, no line deviations of any kind. Rust-proofed, they can be applied after painting, ending costly masking or retapping of paint-clogged threads.

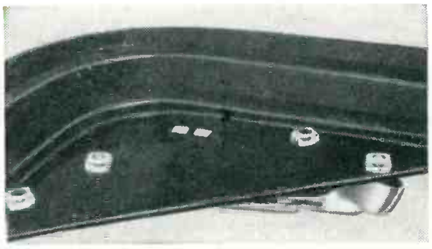
Consult your Tinnerman representative soon and write for Bulletin No. 335. **Tinnerman Products, Inc., Box 6688, Department 12, Cleveland 1, Ohio.**

TINNERMAN *Speed Nuts*

FASTEST THING IN FASTENINGS®



SPEED GRIPS eliminate several punched and tapped holes, cut assembly costs 78%, simplify installation of heater.



SPEED GRIPS applied *after* painting simplify blind-location assembly of auto seat handle, avoid paint-clogging of threads.

SPEED GRIPS cut costs 75% by replacing tapped holes and weld-type nuts as mounting fasteners on car radio.

For product information, use inquiry card on page 113.

ELECTRONIC INDUSTRIES

& TELE-TECH

M. CLEMENTS, Publisher ★ O. H. CALDWELL, Editorial Consultant ★ B. F. OSBAHR, Editor

Tubes and Components at 500°C

All of us have become aware of the terms "sonic" and "thermal" barriers as being applied to supersonic aircraft guided missiles, and earth satellites. We know too, that the high velocities experienced by these devices in the earth's atmosphere can create so much heat as to make conventionally designed electronic equipment completely inoperable. The forced location of electronic equipment near high-heat producing jet propulsion units also gives rise to many thermal operation problems.

In the past we have tried to make components withstand greater heat ranges and we have even looked to refrigeration as the possible vehicle with which to overcome heat dissipation problems. It is because of this that the recent press meeting sponsored by General Electric is so significant. At this meeting, the General Electric Research Laboratory revealed for the first time the work that they had done to develop components and circuitry that would operate at 500°C (932°F) or better for extended periods. They showed heaterless titanium and ceramic constructed vacuum diodes and triode tubes that would operate as high as 800°C; a transformer using a grain-oriented steel core and new glass insulation material on copper windings that operates successfully for 500 hours at 520°C; ceramic metal-film resistors operating at 600°C; mica capacitors operating at 800°C; printed ceramic circuits with platinum supports and silver conductors which operate at 700°C. Also shown was a complete multivibrator circuit with heaterless tubes operating at 700°C; an r-f detector and audio amplifier capable of operating at 800°C and a servo motor for 500°C operation.

GE scientists pointed out that many interesting by-products had developed as they pursued this "if you can't lick 'em . . . join 'em" type research. The heaterless diodes, for example, find excellent application now as oven and range thermostats because they can be placed directly in the flame or in the heater. Obviating the need of vacuum tube heaters reduces equipment power requirements as much as 85%. Heaterless tubes minimize hum problems and they offer a much lower noise factor than regular tube types. In fact, a three times noise factor improvement in UHF-TV head-ends is reported. The titanium and ceramic parts are so small that no hand assembly is possible. Such tubes, however, can be built in different configurations such as rectangular, round, triangular or square to take advantage of miniaturization, special space considerations, etc.

The work that has been done here in overcoming thermal barrier problems is truly remarkable and represents an important step forward for the electronic industries. Additional detailed engineering data on these various developments will be published in subsequent issues. (See photo on page 50 in this issue.)

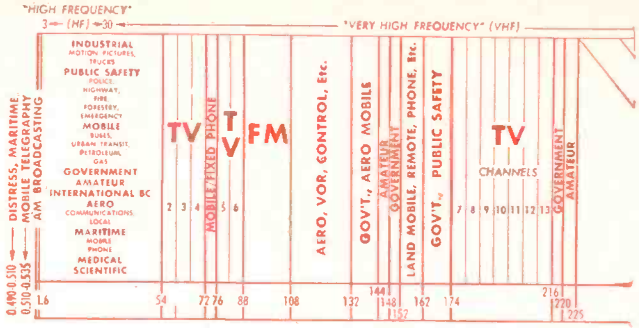
Electronic Pin Balls—For the Home?

In recent years the lowly pin-ball machine has risen greatly in stature. Today the steady nationwide flow of nickels and dimes attests to the appeal that these devices have. The design of modern pin-ball machines show considerable engineering experience and ingeniousness. The more popular games today challenge the skill of the player in contrast to those earlier units where the course of the shining balls was left to chance. Today we have electronic shooting galleries, electronically scored bowling games, and games based on popular outdoor sports where player-actuated intermediate controls inject the element of skill.

Interestingly enough, our survey finds that there are relatively few manufacturers of these extremely popular devices. It raises the question as to why some of our more dynamic electronic manufacturers with imaginative research staffs shouldn't enter this growing field with some real 1957 models. Besides production for public use, let's not overlook the possibility of an electronic pin-ball machine for every home.

RADARSCOPE

Revealing important developments and trends throughout the spectrum for radio, TV and electronic research, manufacturing and operation

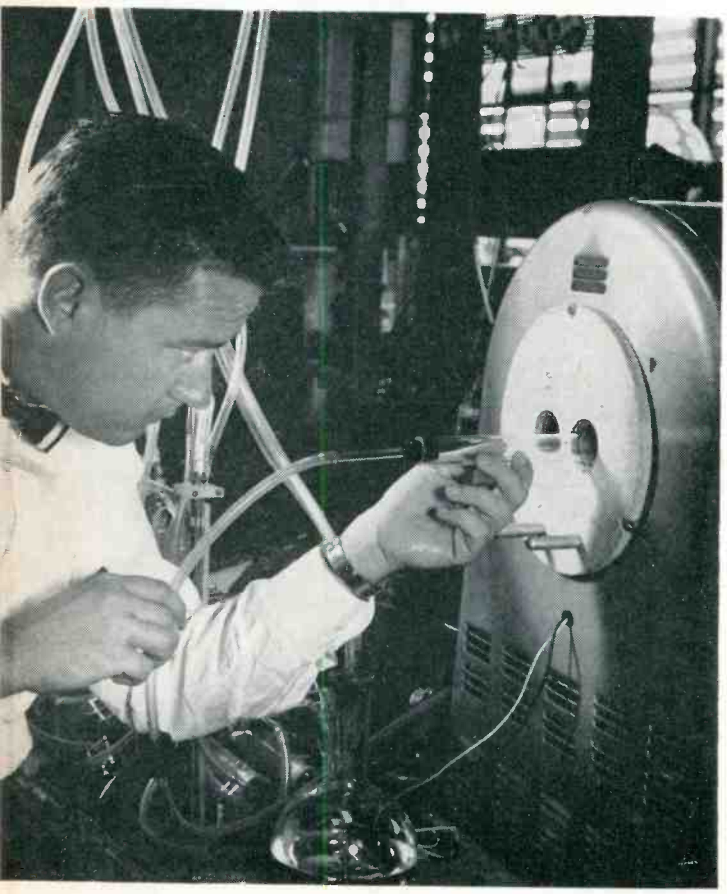


MUCH NEEDED SHOT-IN-THE-ARM for color TV sales may come from the banks. They are reportedly agreeing to finance color set purchases on the basis of payments over 36 months as against the usual 24 months, with 10% down payment.

NEW COLOR RADAR has been developed by a Philadelphia firm, which reportedly minimizes the effects of sea-clutter.

NEXT YEAR'S TV receivers will feature 110° picture tube, according to Dr. W. R. G. Baker. The new tubes will shorten the depth of sets by four or five inches.

NEW TRANSISTOR TECHNIQUE



Germanium blanks for Philco's new surface-barrier diffused (SBDT) transistors are shown being prepared by engineer R. A. Williams. New process in which particles of metal are diffused into germanium surface results in transistors operating up to 500 MC.

HEAVY RECRUITMENT CAMPAIGNS are being waged in Europe by a number of top U. S. manufacturers to attract engineers. For desirable personnel, the companies apparently handle all arrangements connected with immigration, and promise, in addition, especially high pay.

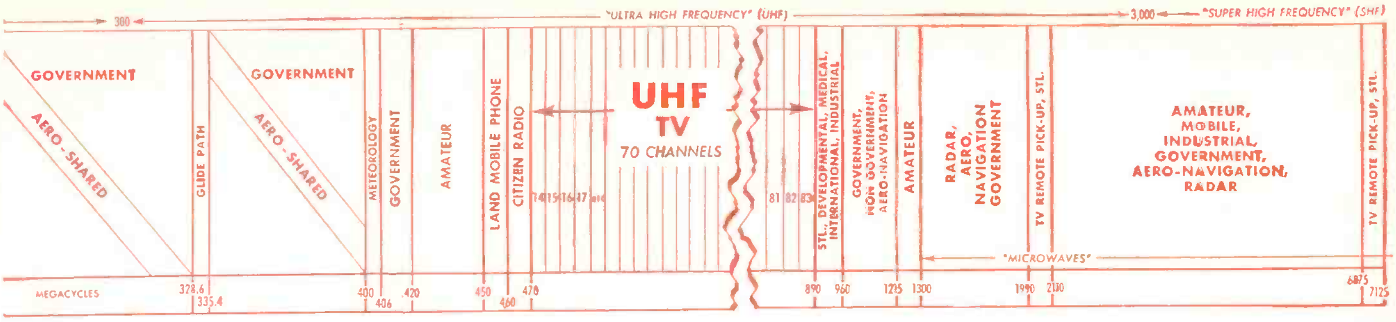
LOOK FOR electronic ranges to become big business. In the wake of Raytheon's success with their commercial model, four top appliance manufacturers are now planning home type units, priced in the $1,000 to $1,200 range.

RADIO-CONTROLLED TRAFFIC LIGHTS will be installed in New York City early next year. In the same connection, GE is suggesting that radio units installed in traffic lights be used for public address systems for the purpose of avoiding panic in the streets during extreme national emergencies.

IN THE FUTURE federally supported basic scientific research of an unclassified nature will be made more widely available to scientists everywhere under a new program announced by the National Science Foundation. With support from the Office of Scientific Information of the Foundation, the Library of Congress and the Office of Technical Services of the Dept. of Commerce will jointly undertake wider dissemination of significant information in some 20,000 unclassified technical reports on basic research issued annually by organizations engaged in Government-sponsored scientific Research.

NEW FOIL MAGNET, latest product of the new foil manufacturing technique has been developed at the Univ. of Colorado. An electro magnet, it is said to be cheaper and lighter than similar types and to operate at higher average temperatures.

ELECTRONIC MAIL SORTING may be the next step in the electronic processing. The Canadian Post Office department is now installing a unit at their Ottawa office, which sorts post office mail into any one of the 10,000 pigeon holes at a speed of 10 letters per second. The sorter—working on a computer principle, reads coded symbols printed on mail and triggers mechanical units which do the actual sorting. Four coded symbols are printed on the envelopes by comparatively unskilled operators. From that point automatic processing takes over.



DARK HORSE of the industry is marine telephones. The number of units has increased eight times over in the past 10 years—from 3,282 in 1945 to 27,343 in 1955. New streamlined models feature automatic noise limiting, and "Squelching" of background noises. Market here has vast potential in view of the sky rocketing sales of small pleasure craft. The only obstacle to date is price, and this should be overcome as production is stepped up.

AIR NAVIGATION

COMPROMISE DECISION which established Vortac —combination of VOR/DME and the military's TACAN—as the official air navigation system for the United States will cost $56 million dollars for the first year of change over, and reduce to $10 million dollars a year for several years thereafter. Any decision they would have made obsolete either the civilian VOR/DME or TACAN would have involved tremendous expenditures on either side. The only dissent was voiced by the Aircraft Owners and Pilots Association (AOPA), organization of sport and business plane owners, who termed the decision a major victory for the military. They pointed out that during the past two years of dispute over the value of the two systems, the military was spending tremendous sums of money on TACAN installations, so much that when the time came for the Air Coordinating Committee to make a decision, they were necessarily heavily influenced by the amount of money that had already been spent on existing installations.

ENGINEERING MANPOWER

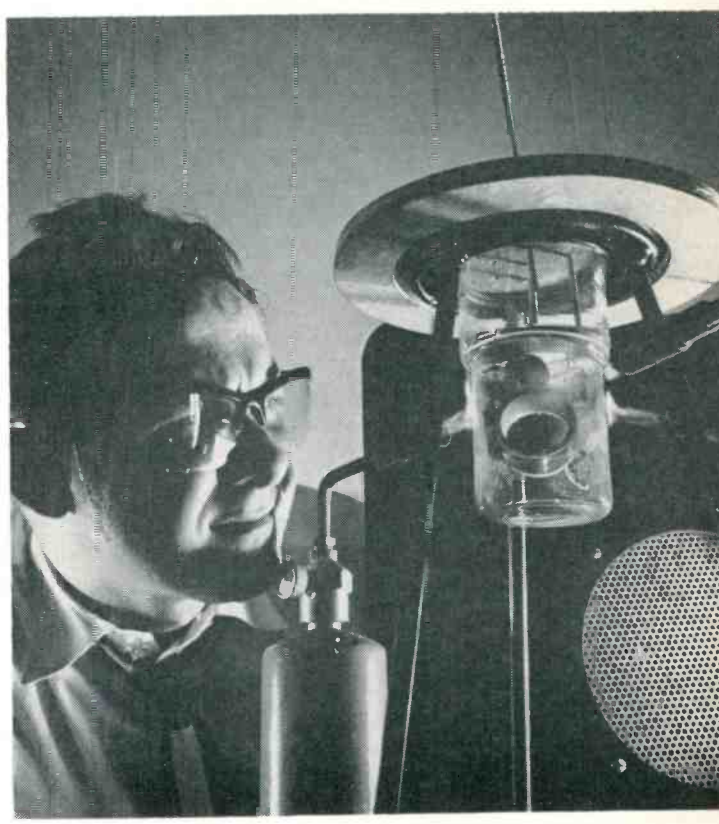
NO LONGER AN EXPERIMENT but an established trend is the industry's search for a solution to the engineering shortage through upgrading skilled technicians to handle second rank engineering jobs. Four top manufacturers are now waging heavy advertising campaigns to woo technicians to fill engineering positions.

ON THE PLUS SIDE for the experienced and well-trained engineer will be relief from the boredom of the menial engineering tasks that must be done. The lament so commonly heard in engineering circles that too little of the engineer's valuable training is being applied should be less commonly heard, and with this upgrading of engineers' duties should come a general improvement in the quality of electronic engineering.

ON THE MINUS SIDE is the fact that the line between technicians and engineers, quite sharply defined at present, will, of necessity, become more and more vague. And these overlapping functions could sooner or later be reflected in generally lower engineering pay scales.

While the threats to the professional status of engineers brought on by the influx of technicians can hardly be minimized, the movement does fill a very serious gap in the electronic chain-of-command. It has long been apparent that a particularly serious side of the engineering shortage was the lack of strong second rank junior engineers to handle the more routine engineering tasks. With the new trend, there is an added incentive for the more talented technicians to step into this new role.

"RED HOT" CIRCUITS



General Electric research engineer, C. B. Mayer applies blow torch to GE's new high temperature components to illustrate their ability to operate under high ambient conditions. Among units designed for 500°C. operation are heater-less tubes, ceramic diodes

Flexural Mode

Slender quartz bars, cut in the YZ flexural mode, give stable frequency control down to 100 cps. New techniques for producing cultured quartz crystals with the necessary length and axis orientation are described

By DR. R. BECHMANN and DR. D. HALE

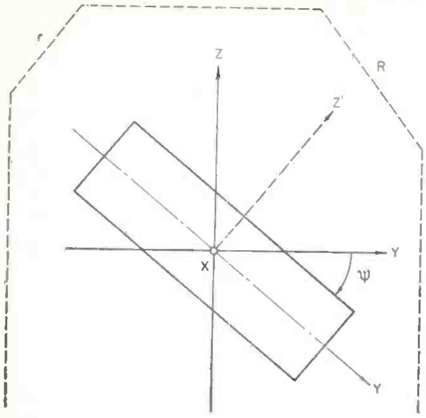


Fig. 1: Quartz bar orientation for YZ flexural mode

Dr. R. Bechmann

Dr. D. Hale

THE frequency range of 100 cps to 30 kc can be covered with quartz bar resonators excited in a flexural mode. These frequencies require quartz crystals having a large dimension in the Y-direction. Natural crystals large enough to meet this requirement are somewhat scarce, but recent developments in the growth of synthetic quartz crystals have made possible a new synthetic Y-bar type[1] which is an excellent starting material for the production of flexural mode resonators.

Generally the YZ flexural mode of a +5°X bar and the NT cut are used for audio frequency generation and selection. However, there is another kind of flexural mode, the YX flexural mode of an X bar, giving a very small temperature coefficient of frequency.[2] This mode is used extensively in Europe but is practically unknown in this country. The properties of this mode and the arrangement of electrodes for optimum excitation are discussed.

DR. R. BECHMANN, Frequency Control Branch, Signal Corps Engineering Labs, Fort Monmouth, N. J. and DR. D. HALE, Crystal Growth Section, Clevite Research Center, Cleveland, Ohio.

Flexural Excitation

To excite the flexural mode of a bar piezoelectrically, two electrically opposite pairs of electrodes are necessary, producing two opposite stresses parallel to the axis of the bar. The actual piezoelectric coefficient d'_{12} for exciting a quartz bar with its length in the YZ-plane is given by

$$d'_{12} = -d_{11}\cos^2\psi - d_{14}\cos\psi\sin\psi. \qquad (1)$$

In order to excite piezoelectrically the flexural mode in the YZ- and YX-planes, two different types of electrode arrangements are necessary. Fig. 2a shows the usual form of electrodes for excitation of the YZ flexural mode: two pairs of electrodes are arranged on either side of a bar on its YZ faces. Fig. 2b shows the electrode arrangement for the excitation of the YX flexural mode: four electrodes are arranged parallel to the major surfaces of the bar. Usually the electrodes are plated. The distributions of the electric field for the two electrode arrangements are shown in Fig. 3a and 3b representing a cross section of a bar with its length parallel to the Y axis. In both cases one-half of the bar is expanding, the other half contracting, thus causing the bar to bend. In case (a) the plane of flexural motion is the YZ-plane, in case (b), the YX-plane. If the length of the bar lies in the YZ-plane and parallel to Y', the other dimensions parallel to X and Z' respectively, the same conditions hold.

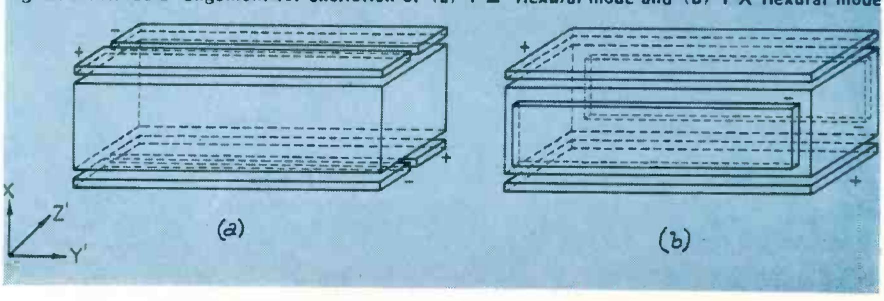
Temperature Coefficient

The temperature coefficients of frequency $(Tf)_{ext}$ for the length extensional mode and $(Tf)_{flex}$ for the flexural mode, differ by

$$(Tf)_{flex} - (Tf)_{ext} = Tb - Tl, \qquad (2)$$

where Tl is the coefficient of linear expansion in length direction of the bar, and Tb is the linear coefficient of expansion in the direction of width b in the plane of flexure. Considering a bar parallel to the Y-axis, Tl is given by the linear coefficient of expansion in the Y direction which is $\alpha_x = \alpha_y =$

Fig. 2: Electrode arrangement for excitation of (a) Y'Z' flexural mode and (b) Y'X flexural mode



Quartz Crystals As A-F Resonators

$13.7 \cdot 10^{-6}/°C$. When the bar vibrates in the YZ flexural mode, the frequency-determining breadth is parallel to the Z-axis and $Tb = \alpha_z = 7.5 \cdot 10^{-6}/°C$. The temperature coefficients of flexural and length extensional modes differ according to Eq. 2 by the values of $-6.2 \cdot 10^{-6}/°C$. For the YX flexural mode the dimensions determining the frequency are parallel to the X- and Y-axes. The coefficient of linear expansion Tb is in this case determined by α_x, thus making the difference in Eq. 2 equal to zero.

It is well known that the length extensional vibrating bar of the orientation $\psi = 5°$ (+5°X cut) provides zero temperature coefficient. From this it follows that the YZ flexural mode of the +5°X cut has a temperature coefficient of about $-6.2 \cdot 10^{-6}/°C$ for narrow bars and even greater for wider bars. However, it also follows that the Y'X flexural mode of the +5°X bar has a zero temperature coefficient of frequency. The Eq. 2 for a bar rotated about an angle ψ considering the Y'X flexural mode becomes

$$(Tf)_{flex} - (Tf)_{ext} = (\alpha_x - \alpha_z)\sin^2\psi. \qquad (3)$$

To reduce the temperature coefficient of frequency of the Y'Z flexural mode of a bar, usually too high for practical purposes, the NT cut was developed.[3] The orientation of this NT cut is defined by the rotational symbol, xytl : 0° to 8.5°/±38° to ±70°. Rotation about the length direction of the bar decreases the temperature coefficient of frequency but simultaneously reduces the piezoelectric excitation. The effective piezoelectric coefficient d'_{12} for rotation through the angle θ about the Y' axis is

$$d'_{12} = -(d_{11}\cos^2\psi + d_{14}\cos\psi\sin\psi)\cos\theta. \qquad (4)$$

A rotation of $\theta = 90°$ transforms the YZ flexural mode of vibration into the YX flexural mode, which, however, cannot be excited by the electrode arrangement shown in Fig. 2a. With the rotation the temperature coefficient of frequency varies between the values of the YZ and YX flexural modes, and the piezoelectric excitation decreases, becoming zero at 90°. The NT cut is thus a compromise between a reduced temperature coefficient of frequency and an excitation still usable.

Examples

Table 1 gives typical examples for the dimensions of +5°X bars excited in the fundamental Y'X flexural mode. The frequency for this mode is given by

$$f = 5740\,\frac{b}{l^2}, \qquad (5)$$

where f is in kc/s, b and l are in mm. The first column in the Table gives the frequency f, the second column the length l of the bar, the third column the breadth b paral-

(Continued on page 92)

Fig. 4: Early lab model of X-bar YX flexural mode resonator

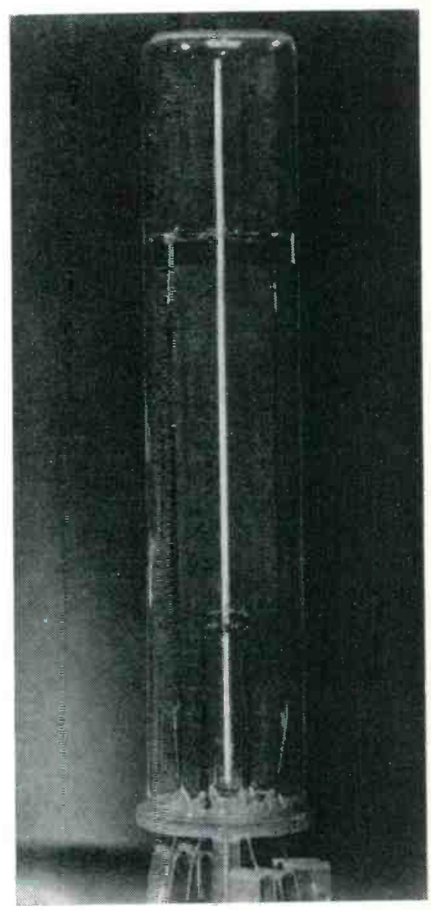
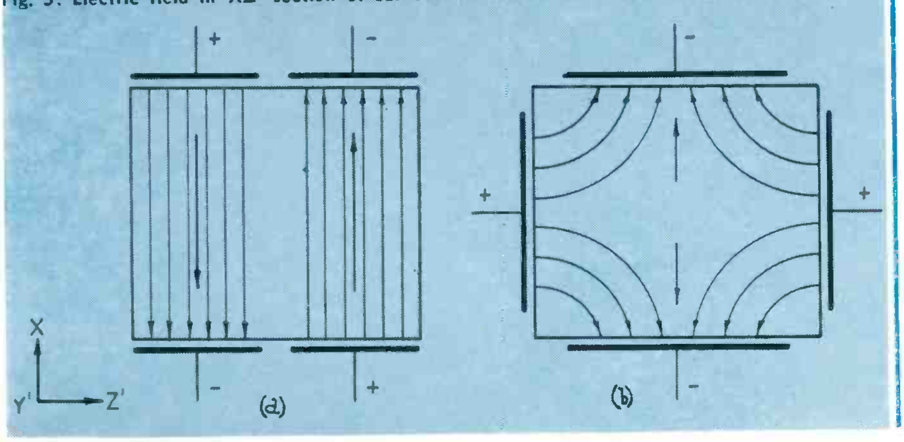


Fig. 3: Electric field in XZ' section of bar stimulated for (a) Y'Z' mode and (b) Y'X mode



Modular Design—Progress

By L. M. MATTHEWS

Three years have passed since the Navy's Bureau of Aeronautics announced the development of the system of electronic equipment design called Tinkertoy. It is appropriate at this time to review the progress of electronic design of the Tinkertoy or modular type, and to summarize the advances.

Tinkertoy

The fundamental objective of the Tinkertoy design was to decrease the labor requirements for production by more complete mechanization of assembly techniques. The development program by the Navy and the Bureau of Standards resulted in a completely unorthodox design for electronic equipment; a ceramic wafer, unconventional printed tape resistors, and silvered ceramic capacitors as the basic elements.

In addition, the interconnections between modules were to be printed wired boards. An important goal of the development program was the standardization of shape and of handling means for portions of the electronic package. A standard shape module was required as a basic assembly structure for combining various quantities of components.

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Acceptance by a large segment of the electronic industry of the use of unconventional components is necessary if the Tinkertoy program is to be successful. To achieve the objective of the project, each major assembly plant ultimately must perform all the operations in the manufacture of components which go into electronic equipment. The goal is to make each plant self-sufficient, so that in a case of wide-spread damage due to enemy action, production could continue.

Industry Acceptance

With these aims in mind, a review of the industry acceptance of the Tinkertoy construction style may be undertaken. It is worthwhile to note that there are at least three companies engaged in manufacturing Tinkertoy components. These companies start with raw materials, manufacture resistors and capacitors, and assemble modules. Two of the companies are at this time manufacturing modules which are suitable for use in commercial electronic equipment only. The third manufacturer builds completed assemblies which meet military specification requirements. A development program is continuing at the NBS, aimed at producing better and more stable resistance compounds, and higher value inductors for application to the basic ceramic wafer building block.

One firm has made available, through commercial radio parts distributors, a kit of standardized modules which have been designed around the NBS Standard Circuits Handbook. The kit allows an equipment designer to pick from the shelf a complete circuit, in operating condition, to insert into his breadboard for evaluation of the performance of a system of modules. This added step of standardization is an inevitable long-range consequence of the need for more electronic equipment and a continuing shortage of capable design engineers. The kit includes video amplifier circuits, power supply regulator circuitry, and others. The modules are arranged to receive a miniature tube on one end with the socket permanently affixed to the module itself. The performance of the circuits in a system may be evaluated readily by a simple plug-in and take-data technique.

A present limitation in the use of ceramic wafer modules is in the application of Tinkertoy designs to high frequency amplifiers. It has been found that a practical upper frequency limit of about 60 MC exists. This limitation is primarily due to the lengths of riser wires and printed wiring interconnec-

Fig. 1: Typical unit of modular construction, compact & rugged

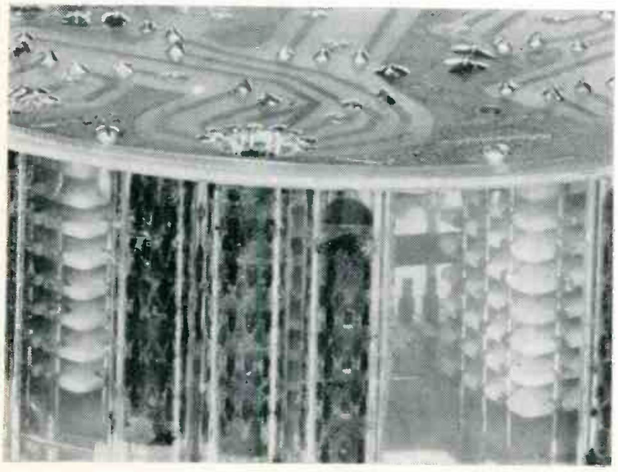


TABLE 1

TEST	UNITS TESTED	AVG. SWEEPS TO FAILURE
Vibration—12g 10-500 cps, 10 min/sweep	8	220
Vibration—16g 10-500 cps, 10 min/sweep	8	125
Vibration—20g 10-500 cps, 10 min/sweep	8	184
Combined Environment 12g, 10-500 cps, 10 min/sweep —67°F, 50,000 ft. atmos. press.	17	156
Humidity over range of 159°F to ambient at >95% relative humidity 1 cycle per day	3	36
High Temperature 100°F—230°F, 30 min. cycle	3	no failures in 63 cycles

and Problems

Tinkertoy, electronic building block program, is gaining industry acceptance as well as conquering technological obstructions in its fight for equipment standardization

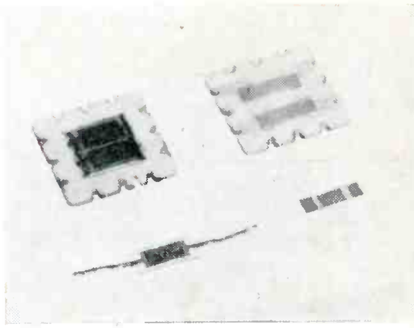


Fig. 2: Mtd. & unmtd. resistors, (l.) encapsulated; (r.) old style precured tape

tions. This lead length problem is further aggravated when it is necessary to mount the vacuum tube associated with the module in a separate location.

Military Equipment

The basic design of military equipments being manufactured differs somewhat from the original concept of project Tinkertoy. The principal difference is in the use of completely self-protected resistors and capacitors installed on wafers containing holes for lead insertion.

It was found expedient and desirable during development to obtain a preliminary evaluation of a representative module unit of the production design. This was necessary because of the very high reliability required for the equipment. A complete design for a component assembly was made well in advance of final design information. From this completed design a lot of approximately 60 assemblies was built.

Ten of these units were used in preliminary evaluation tests, and the remaining 50 were given complete environmental evaluation. An early consideration in the adoption of the ceramic module as a basic element for this equipment was the promise of adequate strength. Preliminary investigations indicated the possibility of achieving substantially improved reliability, due in part to more precise manufacturing control and to an inherent ruggedness in the design of the basic portions of the equipment. The mounting arrangements for resistors and capacitors in the ceramic wafers are much more secure than in conventional style of construction for military equipment. Mechanical resonant frequencies associated with the riser wires and ceramic wafers in the modules are very much higher than those available in standard sheet metal chassis and terminal board construction.

(Continued on page 154)

Standards For Hi-Fi Equipment

As a result of the editorial, "High Fidelity at the Crossroads," in the June 1955 issue of Tele-Tech & Electronic Industries, there was formed the Ad Hoc Subcommittee on High Fidelity under chairman A. W. Friend, and with the very active support of B. B. Bauer, W. E. Kock, H. C. Hardy and D. E. Maxwell.

This group has prepared the following "List of Published Standards That May be Applied to High Fidelity Equipment."

Institute of Radio Engineers

54 IRE 3. S1. Standards on Audio Techniques: Definitions of Terms, 1954. (Reprinted from July 1954 IRE Proc.—50¢.

53 IRE 3. S2. Standards on American Recommended Practice for Volume Measurements of Electrical Speech and Program Waves, 1953. Adopted by ASA. (ASA C16.5—1954). (Reprinted from May, 1954 Proceedings.—50¢.

56 IRE 3. S1. Standards on Audio Techniques: Methods of Measurement of Gain, Amplification, Attenuation, Loss and Amplitude-Frequency Response. (Reprinted from the April 1956 Proceedings.—80¢.

42 IRE 6. S1. American Recommended Practice for Loudspeaker Testing. Adopted by ASA. (ASA C16.4—1942).—40¢

51 IRE 6. S1. Standards on Electroacoustics: Definitions of Terms, 1951. (Reprinted from May, 1951 Proceedings.)—$1.00.

47 IRE 17. S1. Standards on Radio Receivers: Methods of Testing Frequency-Modulation Broadcast Receivers, 1947. Adopted by ASA. (ASA C16.12—1949). —50¢.

48 IRE 17. S1. Standards on Radio Receivers: Methods of Testing Amplitude-Modulation Broadcast Receivers, 1948. Adopted by ASA. (ASA C16.19—1951). —$1.00.

49 IRE 17. S1. Tests for Effects of Mistuning and for Downward Modulation. 1949 Supplement to 47 IRE 17.S1. Adopted by ASA. (ASA C16,12a—1951). Reprinted from Dec., 1949 Proceedings.)—25¢.

52 IRE 17. S1. Standards on Receivers: Definitions of Terms, 1952. (Reprinted from Dec., 1952 Proceedings.)—60¢.

53 IRE 19. S1. Standards on Sound Recording and Reproducing: Methods of Measurement of Noise, 1953. (Reprinted from April, 1953 Proceedings.)—50¢.

53 IRE 19. S2. Standards on Sound Recording and Reproducing: Methods for Determining Flutter Content, 1953. Adopted by ASA. (ASA Z57.1—1954). (Reprinted from March, 1954 Proceedings.—75¢.

American Standards Assoc.

C16.4—1942. Loudspeaker Testing. (42 IRE 6. S1).—50¢.

C16.5—1954. Volume Measurements of Electrical Speech and Program Waves. (53 IRE 3. S2).—50¢.

C16.12—1949, C16.12a—1951. Methods of Testing Frequency-Modulation Broadcast Receivers, with Supplement. (47 IRE 17. S1, 49 IRE 17. S1).—$1.25.

C16.19—1951. Methods of Testing Amplitude-Modulation Broadcast Receivers. (48 IRE 17. S1).—$1.00.

Z57.1—1954. Method for Determining Flutter Content of Sound Recorders and Reproducers. (53 IRE 19. S2).—75¢.

Z24.1—1951. Acoustical Terminology.—$1.50.

Z22.51—1946. Method of Making Intermodulation Tests on Variable Density 16 mm Sound Motion Picture Prints.—25¢.

PH22.52—1954. Cross Modulation Test 16 mm Variable Area Photographic Sound. —25¢.

(Continued on page 128)

Checking DC Parameters of Transistors

By M. E. JONES
and
J. R. MacDONALD

Test circuits for many transistor parameters have been combined to produce a versatile, easily operated tester suitable for large scale parameter distribution studies.

The instrument described in this article was designed to facilitate a study of parameter distributions involving relatively large numbers of germanium and silicon transistors. It is simple to operate and provides accurate and reproducible measurements of transistor dc parameters such as collector-base reverse breakdown voltage BV_{CBO}, static short-circuit forward current transfer ratio h_{FE} between collector and base currents, collector-base and collector-emitter reverse saturation currents I_{CBO} and I_{CEO}, and emitter-base floating potential V_{EBF}. [1] Although these were the parameters of most interest, it is clear that minor modifications of the apparatus will allow similar quantities involving simple permutations of electrodes, such as BV_{EBO} and V_{CBF}, to be measured.

Fig. 1 shows block diagrams of measuring circuits for each of the above quantities; by appropriate switching these circuits were combined in a single unit. The main elements used in the blocks are a dc VTVM, a constant-current supply, and a feedback amplifier.

*M. E. JONES and J. R. MacDONALD
Research Division, Texas Instruments Inc.
Dallas 9, Texas*

Common VTVM

The use of the same VTVM in all six of these measuring circuits is, of course, desirable but puts very stringent requirements on this instrument when high accuracy is required. For example, in Fig. 1-a it must indicate voltages between about 1 and 300 volts and in Fig. 1-f voltages between 10^{-3} and 10 v. It must not load either of these circuits appreciably. For the remaining measurements, it is used to indicate current, with a maximum voltage of 0.1 v. This low value is required so that true short-circuit conditions are well approximated when necessary and the voltage across the measuring resistor is a negligible fraction of the applied voltage.

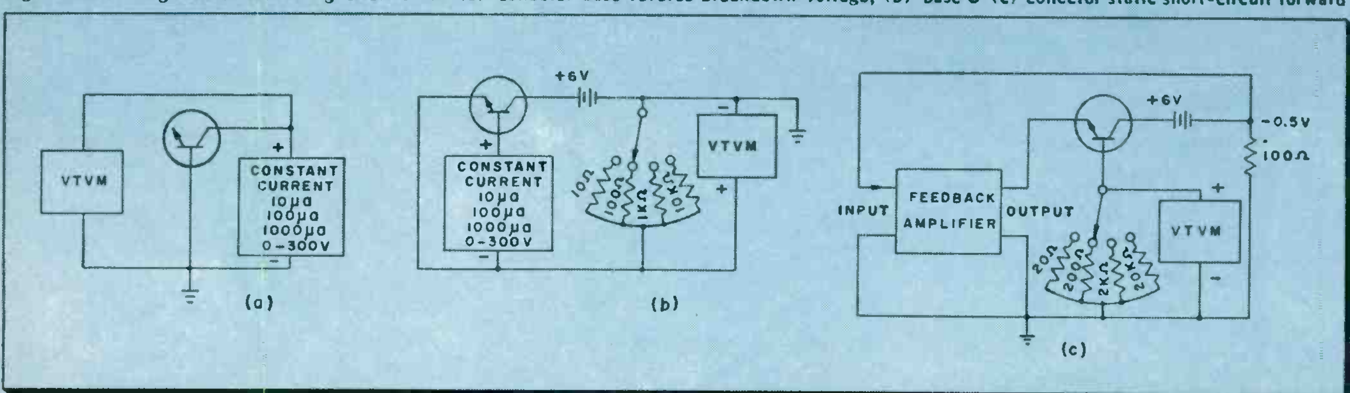
These voltmeter requirements were resolved through the use of the Fluke Model 801 bridge-type VTVM. The unknown voltage is balanced against an accurate internal standard and the measured value is read from the dials of five calibrated switches; at balance the input impedance is infinite.

The maximum reading is 500.00 v. and the minimum resolvable reading is 0.00005 v. Thus, for the above current measurements with 0.1 v. full scale, values within the range of interest, 0.0999 to 0.0100 v., are indicated with three figure accuracy. The use of 0.01 v. full-scale rather than 0.1 v. allows the measurement of currents a factor of ten lower but with corresponding loss in accuracy.

Block Diagrams

Before discussing the other elements of the block diagrams in detail, several of these diagrams themselves require comment. The constant-current supply of Fig. 1-a generates and holds accurately con-

Fig. 1: Block diagrams of measuring circuits for (a) collector-base reverse breakdown voltage, (b) base & (c) collector static short-circuit forward



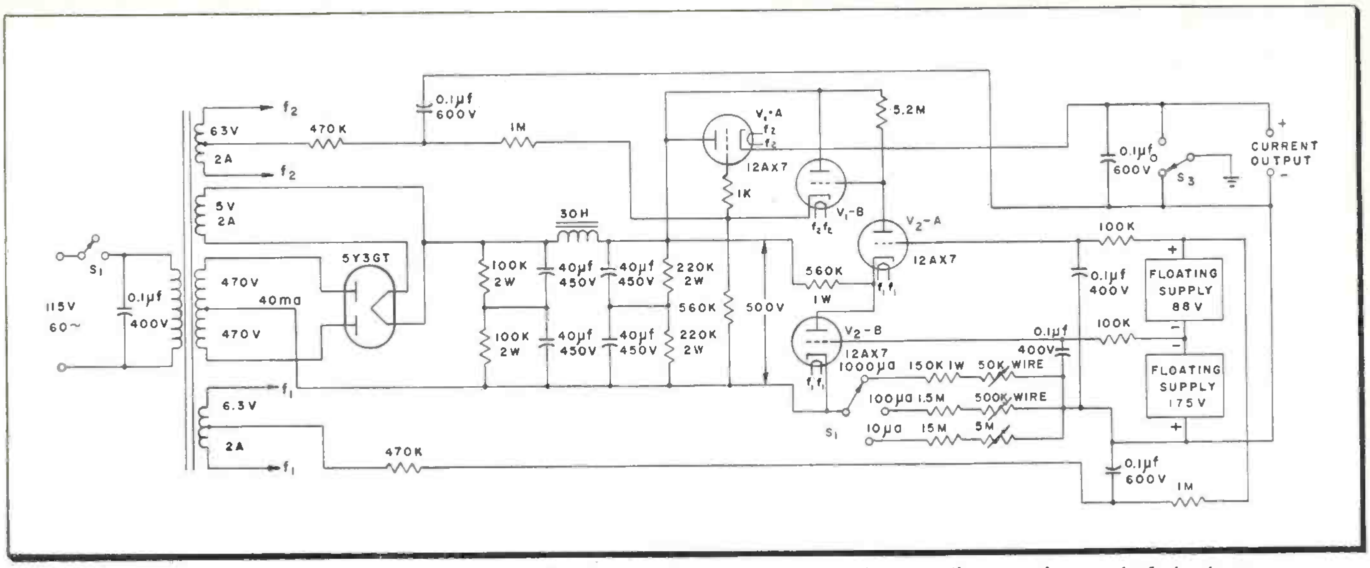


Fig. 2: The constant current supply. The capacitors bridging the floating voltage supplies contribute to the speed of circuit response.

stant any of the three indicated currents in the range of 0 to 300 v.

For collector-base breakdown measurements, the value of 100 μa reverse current has been arbitrarily set as that current at which the breakdown voltage is to be measured. This value is selected to be large compared to ordinary values of I_{CBO} yet small enough to avoid appreciable transistor heating. For silicon transistors, with I_{CBO} values generally less than 0.1 μa, a constant current of 10 μa may be employed but the BV_{CBO} value obtained is usually very close to that found using 100 μa.

Figure 1-b shows a method of measuring h_{FE} in which the base current is held constant at 10 or 100 μa. The current-indicating resistor values are so selected that h_{FE} may be read directly on the VTVM. All current-indicating resistors are adjusted to within 0.1 percent of their indicated values. Table I shows the full-scale values of h_{FE} obtained with 0.1 v. across the various resistors for the two base-current conditions. By measuring h_{FE} for both base currents, an indication of its dependence on current is obtainable. Other values of base current could, of course, be used if desired.

Constant Current

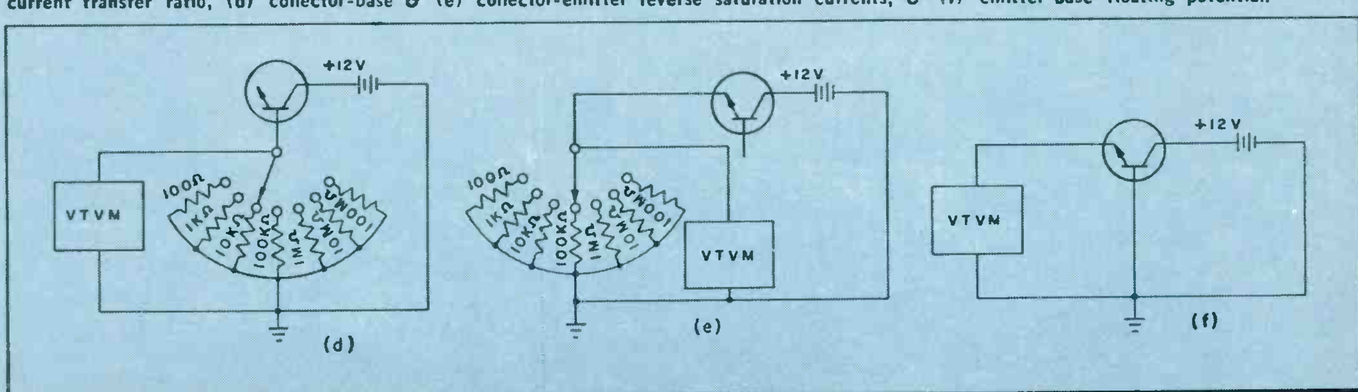
It has become conventional also to measure h_{FE} with a constant collector current, often specified as 5 ma. Figure 1-c shows how h_{FE}^{-1} can be obtained for this operating condition. When 5 ma. is flowing in the collector circuit, −0.5 v. appears across the precision wire-wound 100-ohm resistor. This voltage is accurately balanced in the direct-coupled feedback amplifier against an internal stabilized source of −0.5 v. The output of the amplifier, which can supply 15 ma or more of current, is thus constrained to furnish exactly the emitter current which leads to 5 ma of collector current. The resulting base current is then directly read on the VTVM with the full-scale values of h_{FE}^{-1} shown in Table I. These values may be then converted to h_{FE} readings.

Because of the limitation on amplifier output current, a minimum of about 0.3 is set on the value of h_{FE} measurable by this method with 5 ma. collector current. A transistor having this small a value of h_{FE} is virtually useless, however. By changing the amplifier internal reference voltage, and/or the value of the 100-ohm resistor, measurements may be made with constant collector currents other than 5 ma.

It will be noted that in Fig. 1-d and 1-e full-scale currents less than the minimum value of 10^{-3} μa shown in Table I may be read by either measuring voltages in the range of 0.0099 to 0.0010, by using current-indicating resistors greater than 10^8 ohms, or by both changes. When measuring currents of 10^{-4} μa or less by these methods, accuracy is reduced and balance becomes more time-consuming.

Finally, it should be pointed out that the circuit of Fig. 1-f allows

current transfer ratio, (d) collector-base & (e) collector-emitter reverse saturation currents, & (f) emitter-base floating potential.



Checking Transistors (cont.)

the true floating potential to be measured since there is no VTVM loading at balance. Although the circuits of Fig. 1 are arranged to measure NPN transistors, only superficial changes are required to convert to PNP types.

Parameter Transformation

We have discussed two methods of determining the static short-circuit forward current transfer ratio $h_{FE} = I_C/I_B$. Since I_C contains a contribution from I_{CBO}, the latter's magnitude will affect the value of h_{FE} obtained. For many purposes, however, it is desirable to obtain the dynamic small-signal forward transfer ratio, h_{fe}, which includes no direct contribution from I_{CBO}. In this section we shall show how h_{fe} can be obtained from dc measurements of such quantities as I_{CBO}, I_{CEO}, h_{FE}, I_B, and I_C.

For an NPN junction transistor in its linear region, we may write to a good order of approximation

$$I_C = I_{CBO} + h_{fb}I_E, \quad (1)$$

$$I_E = -(I_B + I_C). \quad (2)$$

It may be mentioned that the quantity h_{fb} has been previously designated as α and is negative. Now from (1) and (2) it follows that

$$I_C = (1 + h_{fb})^{-1}(I_{CBO} - h_{fb}I_B). \quad (3)$$

To simplify this result further we may use the well-known relation

$$h_{fe} = \frac{-h_{fb}}{(1 + h_{fb})} \quad (4)$$

obtaining,

$$I_C = (1 + h_{fe})I_{CBO} + h_{fe}I_B. \quad (5)$$

Finally, if we open circuit the base lead so that $I_B = 0$, (5) leads to

$$I_{CEO} = (1 + h_{fe})I_{CBO} \quad (6)$$

and,

$$h_{fe} = \frac{I_{CEO}}{I_{CBO}} - 1 \quad (7)$$

Thus, h_{fe} can be calculated from measurements of only I_{CEO} and I_{CBO}. Since h_{fe} may depend on I_C, the value of h_{fe} calculated from (7) must be specified as that at the collector current of (6).

Next, we need relations between h_{fe} and the measured h_{FE}. Using the definition of h_{FE}, we may re-write (5) as

$$h_{FE}I_B = I_{CBO} + h_{fe}(I_{CBO} + I_B) \quad (5')$$

yielding,

$$h_{fe} = \frac{h_{FE}I_B - I_{CBO}}{I_B + I_{CBO}}. \quad (8)$$

Eq. (8) shows that $h_{fe} \cong h_{FE}$ only when I_B and I_C are large compared with I_{CBO}. When this condition is not satisfied, knowledge of I_B and I_{CBO} as well as h_{FE} is required to calculate h_{fe}. For a given I_B, such as that specified in Fig. 1-b, the value of I_C to which this h_{fe} corresponds may be calculated from $I_C = h_{FE} I_B$.

Finally, it is sometimes advantageous to eliminate I_B in (5) obtaining

$$I_C = I_{CBO}(1 + h_{fe}) + h_{fe}h_{FE}^{-1}I_C, \quad (5'')$$

which leads to

$$h_{fe} = h_{FE}\left(\frac{I_C - I_{CBO}}{I_C + h_{FE}I_{CBO}}\right). \quad (9)$$

When I_C and I_B are again large compared with I_{CBO}, this equation shows that $h_{fe} \cong h_{FE}$; otherwise, I_C, I_{CBO}, and h_{FE} are needed to calculate h_{fe} for the value of I_C at which measurements were carried out.

(*Continued on page* 82)

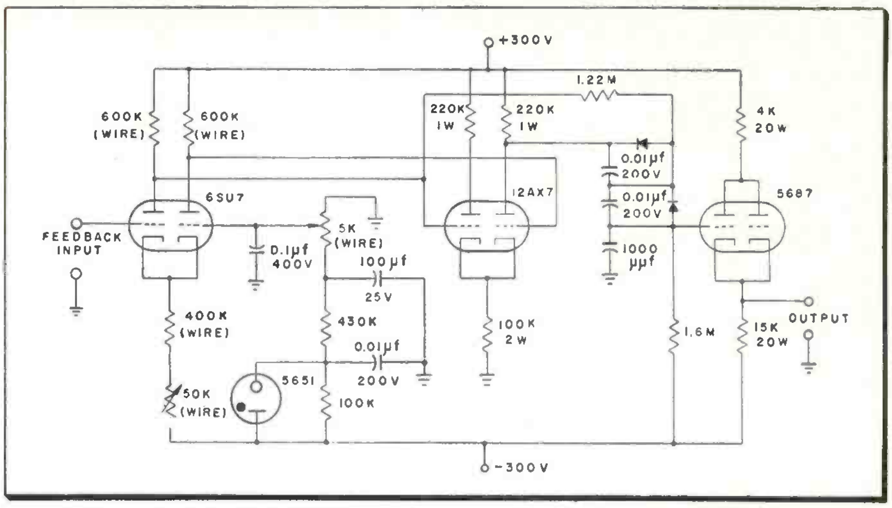
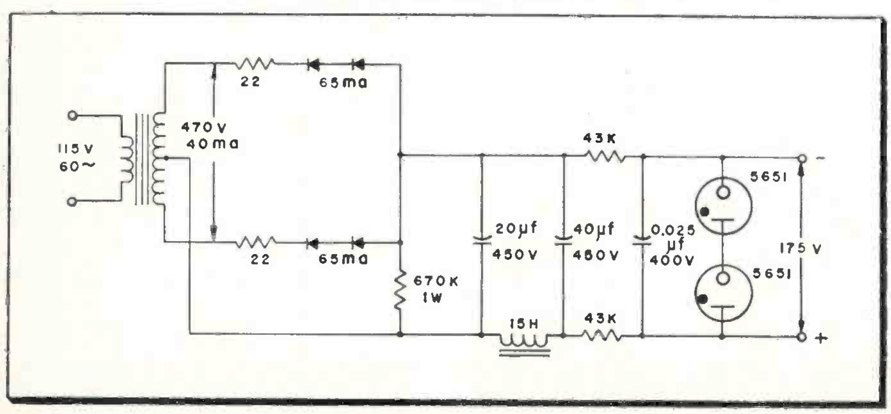


Fig. 4: Feedback amplifier varies emitter current to maintain fixed collector current.

TABLE I

h_{FE}			h_{FE}^{-1} with I_C = 5 ma.		I_{CBO}	
Resistor Value Ohms	Full Scale Reading I_B = 10 µa	I_B = 100 µa	Resistor Value Ohms	Full Scale Reading	Resistor Value Ohms	Full Scale Reading (µa)
10	10^3	10^2	20	1	100	10^3
100	10^2	10	200	10^{-1}	1K	10^2
1K	10	1	2K	10^{-2}	10K	10
10K	1	10^{-1}	20K	10^{-3}	100K	1
					1M	10^{-1}
					10M	10^{-2}
					100M	10^{-3}

Fig. 3: One of the two floating voltage supplies



A Unique Printed Circuit Capacitor

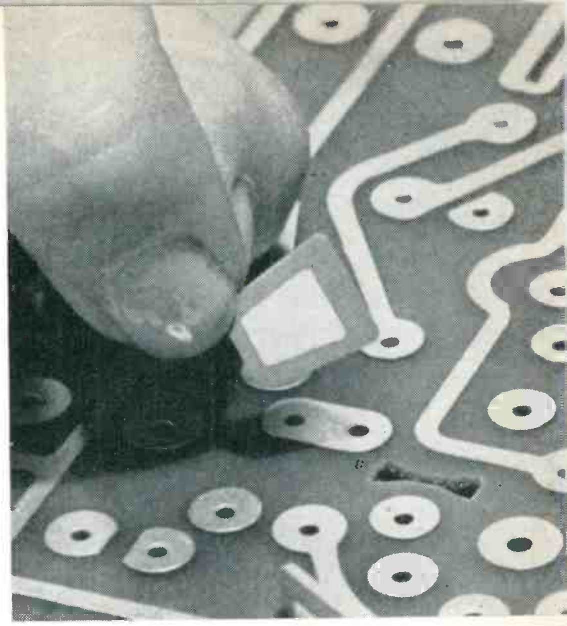


Fig. 1: Flat, tapered, leadless "Wejcap"

Compact design, automation, and quantity requirements of printed circuitry demands a component termination which solves the problems inherent in axial lead units.

By J. R. WOODS

The long standing design concept of components with leads literally ties the modern combination of printed wiring and dip soldering to the past. While circuit wiring has become a neat geometric pattern on an insulating base board, component lead wires and their attending problems are still very much with us.

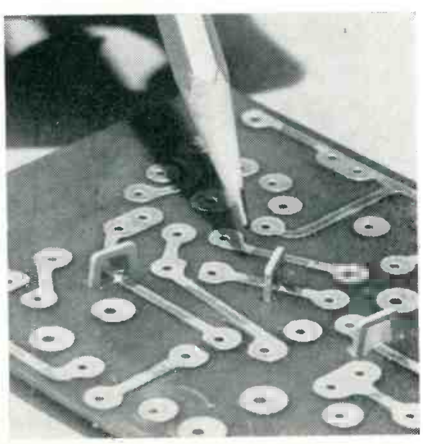
Although component manufacturers have kept pace with the electronic industries, many of the products for use with printed wiring are standard units with redesigned terminals. While this approach effects a minimum delay in design and production it does not solve the problems of lead inductance, time consuming manual placement, or, in mechanized assembly, a need for facilities for crimping, pointing, trimming and clinching the leads to the underside of the wiring board.

A new type of flat, tapered edge, leadless component named "Wejcap" capacitors (Fig. 1) was recently introduced by the General Electric Co. of Auburn, N. Y. "Wejcap" capacitors are inserted by manual or mechanized placement into a slot in the printed wiring board. A slight pressure wedges them securely to prevent floating as they are dip soldered to bond them to the printed wiring.

Already used in several TV receiver applications, "Wejcap" capacitors offer a basic cost reduction over conventional disc shaped capacitors, and eliminate or greatly minimize the problems engendered by their leads. Laboratory tests have shown that ceramic dielectrics used for capacitors without protective coatings must withstand a pressure of 4000 psi while submerged in a grainless dye for extended periods and survive with zero dye absorption. This, coupled with careful selection of electrode silver and optimum electrode firing for highest capacity, lowest losses and best electrode bond, is the basis for the success of the new capacitors.

"Wejcap" capacitors having dielectric constants as high as 6000 have operated successfully in 95% relative humidity and 40° C while polarized at 500 vdc for 500 hrs. At the end of this time test units measured essentially as good as initially with power factors being less than 1.5% and insulation resistance greater than 10^9 megohm micro-microfarads. Capacities decreased in an amount commensurate with that predicted from the aging curve of the dielectric. In this instance capacities decreased about 4% per time decade which is considered good for K 6000 material.

Fig. 2: "Wejcaps" soldered into circuit



An accelerated life test is also imposed upon the new components by sampling and subjecting them to twice rated dc working voltage at 85° C for 500 hrs. No breakdowns are permitted and capacity and insulation resistance shifts are checked against allowable limits.

A high voltage breakdown test consisting of three times rated dc working voltage for 1 min. is applied to all test samples after high humidity and accelerated life tests. Voltage breakdown through the dielectric is practically unheard of with "Wejcap" capacitors because of their rugged .035-in. thickness. If the applied dc test voltage is raised to many times rated, breakdown will occur around the edge of the dielectric body rather than through it. No leakage path is created by the arc because there is no organic coating to carbonize. The capacitors are as good as new after this type of induced or accidental breakdown for this reason.

On the tip of every design engineer's tongue will be the question of silver migration, and rightfully so, for under certain condi-

(*Continued on page 157*)

J. R. WOODS, Production Engr., General Electric Co., Auburn, N. Y.

John M. Cage
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J. S. Powers
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G. J. Argall
Exhibits Chmn.

Preview of 1956 *NATIONAL ELECTRONICS CONFERENCE*

"Fifty Years of Progress Through Electronics" is the theme of the 12th Annual National Electronics Conference opening October 1 at the Hotel Sherman in Chicago.

More than 10,000 are expected to attend the three-day technical meeting and exhibition, which will feature 24 technical sessions, approximately 100 papers on electronic research, development and application, and a record number of 240 commercial exhibits on display.

Jointly sponsored by the AIEE; Illinois Institute of Technology, Chicago; the IRE; Northwestern University; and the University of Illinois, the 1956 NEC elected Robert R. Jenness, of Northwestern, as President, with John M. Cage, Purdue University, as Chairman of the Board of Directors, and John S. Powers, Bell & Howell, Chicago, Executive Secretary.

Also participating in the 1956 NEC are these universities: Michigan State, Michigan, Purdue and Wisconsin; and, RETMA and the Society of Motion Picture and Television Engineers.

Three luncheon addresses will be among the highlights of the meetings. Dr. John P. Hagen, Director, VANGUARD Project at the Naval Research Lab, Washington, will speak on Monday, Oct. 1; Dr. Frederick L. Hovde, President of Purdue, is the speaker on Tuesday, Oct 2; and Dr. Herbert Scoville, Jr., Asst. Director, Central Intelligence Agency, Washington, is scheduled on Wed., Oct. 3. All luncheon sessions begin at 12:30 p.m. in the Bal Tabarin Room of The Sherman.

Dr. Hagen plans to discuss earth satellites and space travel, while Dr. Scoville will compare U. S. and Russian technical education policies. Dr. Hovde's subject was not announced in advance of ELECTRONIC INDUSTRIES' press time.

L. T. De Vore, Program Chairman for the 1956 NEC, has announced that a feature of the Conference will be three half-day educational sessions, dealing with information theory, radio isotopes

KEY SPEAKERS at Luncheons, (From left): Dr. J. P. Hagen, Oct. 1; Dr. F. L. Hovde, Oct. 2; and Dr. H. Scoville, Oct. 3.

and solid state. It was pointed out by the Program Chairman that the tutorial phase of the program is "designed to provide a rounded picture of the newest developments in three important areas of the electronics field."

Chairmen of the educational sessions will be: Prof. R. M. Fano, M. I. T., information theory; Dr. Leonard Reiffel, Armour Research Foundation of Illinois Tech., radio isotopes; and J. P. Jordan, General Electric, Syracuse, solid state.

Technical sessions on the opening day, October 1, will be concerned with components and materials, instrumentation, measurements, receiver techniques, data storage systems, servomechanism theory and applications.

The program on October 2 will cover: information theory applications, magnetic amplifiers, solid state devices and applications, network and filter theory, data processing systems, microwaves, and radio isotopes.

Concluding sessions on October 3 will feature papers related to solid state, high power audio systems, network synthesis, antennas, quality control and reliability, automation techniques, medical electronics and pulse techniques.

"Simulation of Hydraulic Systems" will be the subject of a concurrent session to be held by the Midwestern Simulation Council the afternoon of October 3, for those specializing in this field.

NEC Exhibits Chairman Gordon J. Argall said that many of the leading electronics manufacturers and research labs are planning exhibits at the 1956 Conference.

An NEC Party is scheduled for 7:15 p.m. on Tuesday, October 2, in The Sherman's Bal Tabarin Room. In addition, there is a special program for the ladies attending the Conference, including a tour of Chicago's Station WNBQ television studios in the huge Merchandise Mart building.

It was announced that technical papers presented at the NEC will be published in Volume 12 of the "Proceedings of the NEC," which may be ordered before, or at, registration. The volume will be published early in 1957.

LIST OF NEC EXHIBITORS

EXHIBITORS	BOOTH NO.
Ace Electronics Associates, Somerville, Mass.	224
Aerovox Corp., New Bedford, Mass.	111, 112
Allied Radio Corp., Chicago	19, 20, 21
Alpha Metals, Inc., Jersey City	89
Amco Engineering Co., Chicago	208
American Bosch Arma Corp., (Arma Div.), Garden City, N. Y.	200, 201, 202
American Institute of Electrical Engineers, New York	Lobby "B"
Amphenol Electronics Corp., Chicago	141
Jay C. Angel & Co., Chicago	95, 96, 97
Arnold Engineering Co., Marengo, Ill.	187
Associated Research, Inc., Chicago	164
Ballantine Laboratories, Inc., Boonton, N. J.	155
Barry Controls, Inc., Watertown, Mass.	185
Beckman Instruments, Inc., (Berkeley Div.), Richmond, Calif.	32, 33
Beckman Instruments, Inc., (Shasta Div.), Richmond, Calif.	10A
Bendix Aviation Corp., South Bend, Ind.	57
Beta Electrical Corp., New York	78
Bird Electronic Corp., Cleveland	91
Bomac Laboratories, Inc., Beverly, Mass.	46, 47
Boonton Radio Corp., Boonton, N. J.	119, 120
Bowmar Instrument Corp., Fort Wayne	134
Branson Corp., Boonton, N. J.	169
Burgess Battery Co., Freeport, Ill.	54
Burndy Engineering Co., Norwalk, Conn.	207
Burroughs Corp., (Electronic Instruments Div.), Philadelphia	90
Cambridge Thermionic Corp., Cambridge 38, Mass.	203
Carrier Corp., (Spectro Electronics Div.), San Gabriel, Calif.	72, 73
Coil Winding Equipment Co., Oyster Bay, N. Y.	109
Color Television, Inc., San Carlos, Calif.	38
Communication Accessories Co., Hickman Mills, Mo.	103
Alfred Crossley Associates, Inc., Chicago	82, 83
Davenport Manufacturing Co., Chicago	19A
Design Tool Corp., New York	167
Donner Scientific Co., Berkeley, Calif.	171
Allen B. DuMont Lab., Clifton, N. J.	60, 61, 71
E. I. DuPont de Nemours—Co., Inc., Wilmington, Del.	266,227
Dynapar Corp., Skokie, Ill.	168
Eastern Air Devices, Inc., Dover, N. H.	52
Edin Co., Inc., Worcester, Mass.	8
Elastic Stop Nut Corp. of America, (A'G'D' Div.), Elizabeth, N. J.	58
Electra Manufacturing Co., Kansas City	104
Electric Indicator Co., Inc., Springdale, Conn.	6
Electro-Instruments, Inc., San Diego	16
Electro-Measurements, Inc., Portland, Ore.	24
Electro-Mec Lab., Inc., Long Island City, N. Y.	222
Electro Products Lab., Chicago	121
Electro-Pulse, Inc., Culver City, Calif.	27
Electronic Associates, Inc., Long Branch, N. J.	55, 56
Elgin Metalformers Corp., Elgin, Ill.	196, 197
El-Tronics, Inc., Philadelphia	76, 77
Empire Devices Products Corp., Bayside, N. Y.	181
Everett Associates, Inc., Chicago	170
Fairchild Controls, Hicksville, N. Y.	131
Federal Telephone & Radio Co., Clifton, N. J.	149, 150
Fenwal Electronics, Inc., Ashland, Mass.	34
Freed Transformer Co., Inc., Brooklyn, N. Y.	175
Gamewell Co., Newton Upper Falls, Mass.	88
General Electric Co., Schenectady	12, 13
General Precision Laboratory, Inc., Pleasantville, N. Y.	30
General Radio Co., Cambridge	142, 143
Gertsch Products, Inc., Los Angeles	122, 123
Goe Engineering Co., Los Angeles	65
John Gombos Co., Irvington, N. J.	110
Harry Halington, Chicago	233
Hathaway Instrument, A Div. of Hamilton Watch Co., Denver	206
A. W. Haydon Co., Waterbury, Conn.	135, 136
Heath Co., Benton Harbor, Mich.	137, 138
Helipot Corp., South Pasadena	67, 68, 69
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Hewlett-Packard Co., Palo Alto	113, 114
Hickok Electrical Instrument Co., Cleveland	225
Hitemp Wires, Inc., Westbury, N. Y.	223
Huggins Laboratories, Inc., Menlo Park, Calif.	172
Hughes Aircraft, Culver City	17, 18
Indiana Steel Products Co., Valparaiso, Ind.	11
Institute of Radio Engineers, New York	Lobby-A
International Electronic Research Corp., Burbank, Calif.	66
International Resistance Co., Philadelphia	183, 184
Kay Electric Co., Pine Brook, N. J.	1, 2
Kay Lab., San Diego	86, 87
Kearfott Co., Inc., Clifton, N. J.	31
Keithley Instruments, Cleveland	195
Kenco Labs., Flushing, N. Y.	126, 127
James Knights Co., Sandwich, Ill.	198-A
Lansdale Tube Co., Div. of Philco Corp., Lansdale, Pa.	211
Librascope, Inc., Burbank, Calif.	171
Erik A. Lindgren & Assoc., Chgo.	28, 29
Litton Industries, Inc., Beverly Hills, Calif.	162, 163
Magnetics, Inc., Butler, Pa.	156, 157
Magnuson Associates, Chicago	50
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Measurements Corp., Boonton, N. J.	100
Mepco, Inc., Morristown, N. J.	53
Microdot, Inc., South Pasadena, Calif.	178
Millivac Instrument, Schenectady	148
Minneapolis Honeywell Regulator Co., Minneapolis	220
F. L. Moseley Co., Pasadena, Calif.	84, 85
Mycalex Corp. of America, Clifton, N. J.	49
Narda Corp., Mineola, N. Y.	7
New Hermes Engraving Machine, N. Y.	165
New London Instrument Co., Inc., New London, Conn.	212, 213

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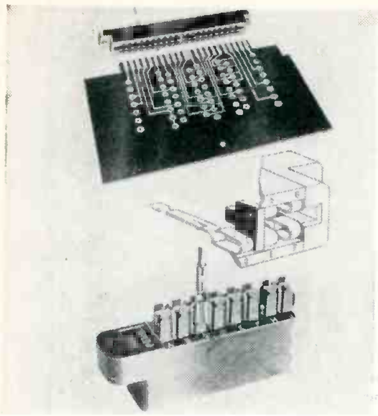
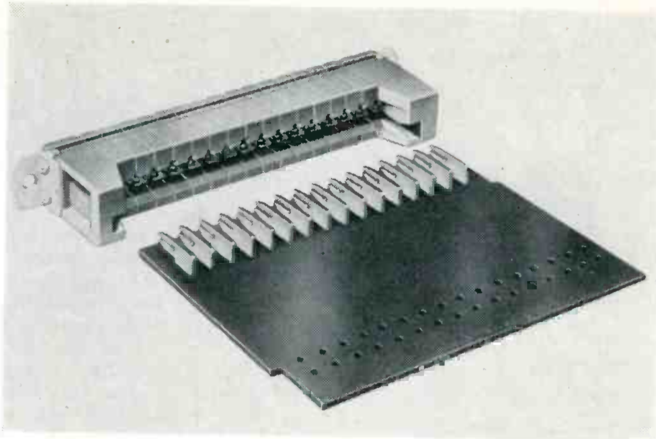


Fig. 1 (l) Typical printed circuit connector

Fig. 2 (r) Printed circuit utilizing new forked contacts



New Design in Ruggedized

By DR. H. E. RUEHLEMANN

During recent years the use of standard components on phenolic based printed wiring boards has been accepted by the industry as the most feasible and economic production technique. In addition, a circuit standardization has been accomplished.

The basic principle of this new design trend is, that any equipment consists of a number of units which are connected together to form the final apparatus. The connector therefore, plays an important role in modern electronic design.

New types of connectors became a necessity during the recent developments in the electronic industry. In the printed circuit technique the components are mounted close to the board which results in a wafer-like nature for the sub-assembly. In order to create complete equipment, several of such wafer-like subassemblies must be connected to a mother board and the entire unit after packaging has a shelf-like construction.

To accommodate such a design, connectors have been developed by the industry for several years which can be mounted to the mother board and which have a variable number of female contacts encased in a housing. The tail ends of these female contacts are made for printed circuit or conventional wiring. Which type is used in an equipment depends on the design of the mother board.

All these connectors use the printed circuit of the board as the mating male part, which is brought to one side of the board to mate the corresponding female contacts of the connector. An example of such a connector is shown on Fig. 1.

Connectors of this type have been widely accepted by the industry although they have certain shortcomings. The contact performance of this connector is greatly determined by the copper layer of the printed circuit, which forms the mating male part of the connector. This part cannot be replaced with a more suitable contact material, which will withstand corrosion and wear. For stringent military requirements. connectors of this type are not reliable enough.

New specifications and investigations of suitable test methods of connectors are under consideration at various agencies and companies. It has been found that the reliability of the static connection is the most important requirement for the printed circuit connector. They are classified as semi-permanent connections. This means that some of these connectors are plugged-in once and have to operate over the entire life of the equipment; some of them are disconnected and reconnected only for replacement purposes; and some have to withstand continuous disconnections and reconnections for several thousand cycles.

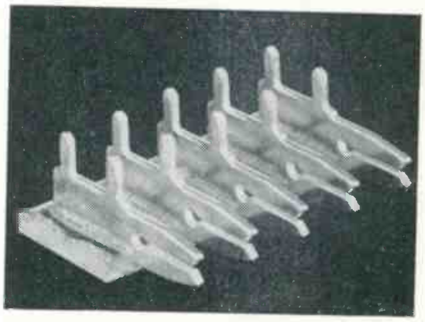


Fig. 3: Contacts pre-assembled to mfg. strip

Common to all connections is reliable operation under severe environmental conditions. Standard test procedures, which are described in various specifications, have been adopted and must be met. These requirements are well known to the art, while design

DR. H. E. RUEHLEMANN,
Dir. of R&E,
ELCO Corp., M St. Below Erie, Phila., Pa.

Interchanging circuits to produce various characteristics has increased demand for a connector capable of producing the same contact resistance after repeated insertions. Described here is a unique design which shows no appreciable change after 3000 cycles.

P-C Connectors

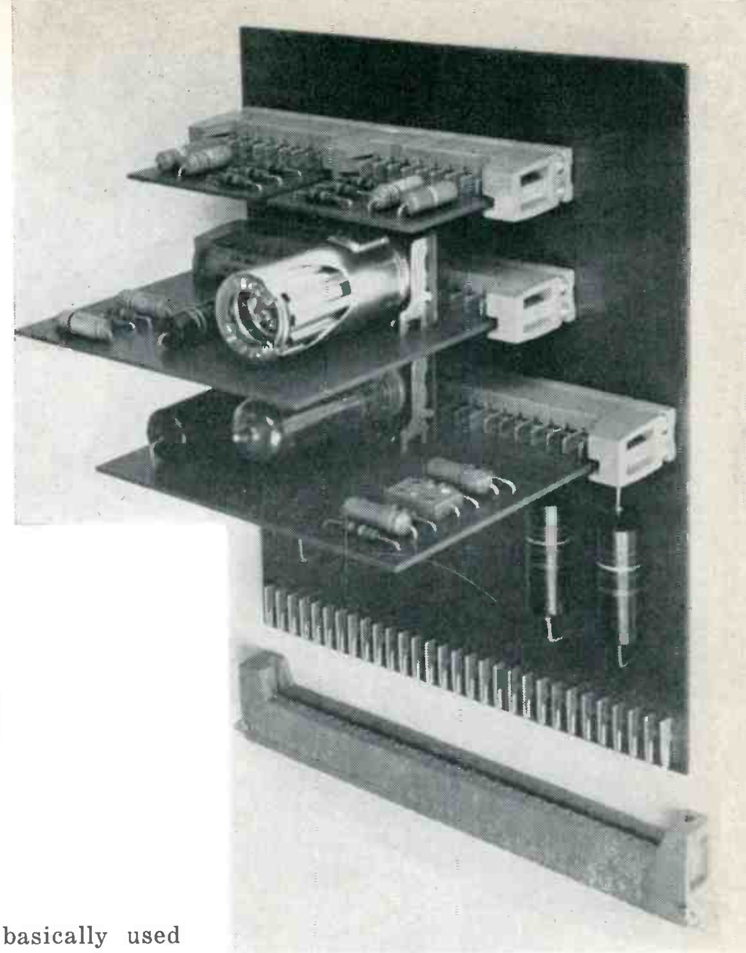


Fig. 4: Packaged P-C unit. Note tube mtgs.

principles have been established to create reliable connectors. But, for printed circuit connectors, some additional requirements must be met.

The wafer-like construction of printed circuit demands arrangement of the contacts along a row to mate with the printed circuit at one edge of the board. It must be easily possible to vary the number of the contacts to meet the circuit requirements. The connector must allow the mounting to a mother board, where in turn the female contacts must facilitate connection to a printed circuit or to a conventional wiring. The contact spacing should be of the decimal system in multiples of .025 inch, preferably .100 inch or .200 inch. The connector must provide alignment for the boards during insertion, because thinner boards have a tendency to lose their straightness during soldering and storage.

A new type of connector has been designed to meet these requirements, which in addition to the well established general specifications for connectors, offers high insulation and high voltage breakdown under various environmental conditions. The most important part of such a connector is its contact.

A well established and patented contact design is basically used in this type of printed circuit connector, which is modified only to meet the design requirements for printed circuit connectors.

In this contact the male and female parts are alike. They are sheet metal stampings of fork-like structure. In use the contacts are mated at 90° to each other to allow the fork-like members to mesh with each other for the entire length of the contact.

The contact area is provided by a 45° bevel running the full length of the forks. This results in four separate contact areas for each contact.

Table I shows that the insertion and withdrawal force is almost uninfluenced by the number of insertions. Tests were performed on an 8 contact connector. There is only a slight decrease in withdrawal force due to burnishing the contact surface during the first 3,000 insertions and withdrawals. Uniformity in withdrawal force also means uniformity in contact resistance, which is extremely low, less than .002 ohm, and practically unchanged by this test.

A printed circuit connector, which uses these contacts, is shown in Fig. 2. The female contacts are inserted in a housing. This housing is made in a sectional design consisting of a number of center sections and a left and right end-section. Between each section, a female contact is fastened.

The end-sections are designed to guide the printed circuit plate during insertion and to hold mounting brackets of various shapes. Warping of the boards can be corrected by additional guides at each center section.

The male contacts of this connector are mounted directly to the printed circuit board. They are equipped with two legs, which are inserted through the board via two holes of .046 inch diameter at .200 inch spacing. These legs are mechanically fastened to the board by a simple staking operation, thus providing a mechanical connection between the contact and the printed circuit wiring at the bottom of the board. These legs are additionally connected by soldering to the printed circuit while dip soldering the board.

The design uses a simple and reliable method which has been developed to stake the contacts to

(Continued on page 158)

Potting Methods For Variable R-F Inductors

By K. M. MILLER

REDUCTION in size of avionic equipment has led to a thorough investigation of variable r-f inductor design, with special attention to the attainment of stable Q characteristics. The end result of this study was miniature coils occupying a space of only .66 cu. in., with stable Q in excess of 100 over the 200 to 1750 KC frequency range. Fig. 1 shows the miniature inductors compared to a postage stamp. One of the inductors has been bisected to reveal its construction.

Many materials and processes were sampled before the end design was achieved. Let us quickly review the highlights of the development program as it actually occurred. These facts have been obtained from engineering notebooks covering the project.

Establishing a Standard

A "standard" coil was established as a starting point. This coil represented the desired inductance of a typical coil to be used in the end equipment. The tuning capacities for two moderately separated frequencies were noted. This was helpful in providing information regarding the distributed capacity of the winding.

Coil Data:

180 turns 7/41 SSE.
Core Stackpole 1848.
Cups Stackpole S52.

Nominal values, untreated winding in a grounded can, were:

Frequency	"Q"	"C"
200 KC	180	462
400 KC	140	106

Fig. 1: Sub-miniature inductors vs. Stamp

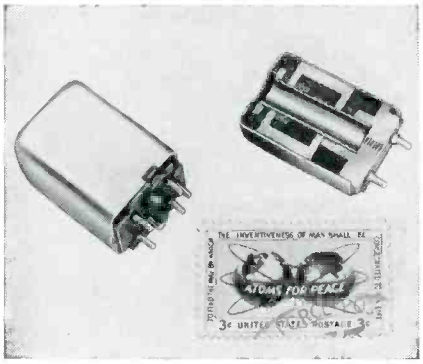


TABLE I

	After Potting			After 24 hrs. in a pressure cooker @ 5 psi	
	Freq.	"Q"	"C"	"Q"	"C"
1. XXXP coil form and vacuum impregnation of the winding with Mitchell Rand #3937B Wax.	200 KC	158	462	35	—
	400 KC	122	103	19	—
2. XXXP coil form covered with a single wrap of M.M. .003″ thick cellophane tape (standard office tape) prior to winding with Nyltex and encapsulating with Scotchcast LV Epoxy resin.	200 KC	155	462	100	463
	400 KC	112	100.4	45	98
3. Same as 1. above except Texel cellophane tape (standard office tape) was employed in place of M.M. tape.	200 KC	154	462	90	460
	400 KC	112	100	37	97
4. Same as 1. above except M.M. #5 tape was spiral wrapped (one layer) in place of M.M. cellophane tape.	200 KC	150	462	121	461
	400 KC	105	99.7	62	97
5. A special machined coil form with .015″ wall thickness made from Alkyd Plaskon 440A. No tape employed.	200 KC	140	460	130	462
	400 KC	85	100	71	98

Specimen No. 5 appeared to have the most desirable characteristics.

K. M. MILLER, Mgr. of Engr., LEAR, Inc., Santa Monica, Calif.

TABLE II

Freq.	"Q"	After 15 hrs. in tap water at 70°F.	After 24 hrs. in boiling tap water	After 16 hrs. soak in saturated salt water at 70°F.	After 312 hrs. soak in saturated salt water at 70°F.
200 KC	160	160	160	160	160
400 KC	119	119	119	119	119

TABLE III

	Original		After 3 hrs. at 95% humidity, 130°F. then cooled to 70°F.		After 18.5 hrs. soak in tap water at 70°F.	
Freq.	"Q"	"C"	"Q"	"C"	"Q"	"C"
200 KC	162	462	152	462	129	462
400 KC	113	99.7	97	99.7	68	98.5

TABLE IV

	"Q"				
Material	Original dry condition	Boiled 1 hr. in tap water	Boiled 2 hrs. in tap water	Boiled 5 hrs. in tap water	Boiled 10 hrs. in tap water
Mycalex	99	—	—	91	93
Melmac	93	85	65	35	34
Alkyd 422	80	79	78	76	75
Bakelite	98	90	84	84	73
UREA compound	99	96	94	58	38
XXXP Phenolic	97	—	—	82	72

Note: Specimens had surface moisture removed before recording data.

By using proper technique, Q stabilization may be improved up to 600%. Humidity tests show that variance, after potting, can be eliminated.

TABLE V

Specimen and Treatment	Initial "Q"	After 4 hrs. suspended over boiling tap water	After 24 hrs. soak in 70°F. tap water
1. Melmac—no treatment.	94	85	39
2. Melmac soaked in DC200 at 350°F. for one hr.	99	98	67
3. Melmac vacuum impregnated with DC200 at 70°F.	96	91	63
4. 5-30 mmfd Erie resistor Type 552 trimmer soaked in DC200 for 1 hr. at 350°F.	98	88	83
5. Phenolic XXXP switch wafer soaked in DC200 for 1 hr. at 350°F.	97	83	81
6. Alkyd 422 coil base soaked in DC200 for 1 hr. at 350°F., then baked 2 hrs. at 200°F.	99	96	90
7. 7 pin mica filled phenolic tube socket.	99	95	90

Specimen No. 6 proved to be of most interest for consideration in the final design.

In an attempt to eliminate a serious moisture leakage path from the I.D. of coil form to the I.D. of the winding and through the exposed surface of winding, an XXXP phenolic coil form was wrapped with a non-shorting turn of .001 inches thick aluminum foil. The assembly was then embedded with Minnesota-Mining's Scotchcast LV low viscosity epoxy resin. Results: Negative. The Q value was extremely low, apparently due to the proximity of the aluminum foil to the I.D. of the coil winding.

A "standard" inductance was then wound on XXXP and impregnated in CIBA Epocast Number III. Table 3 indicates the recorded data.

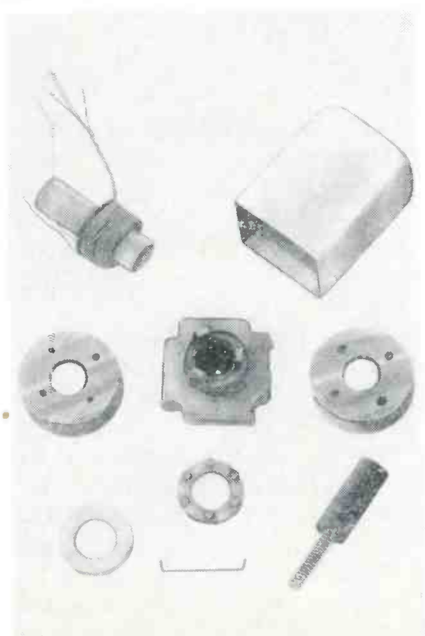
Visual inspection revealed blistering of thin sections of the potting compound. The blisters contained deposits of water. The drop in Q was considered excessive.

The next specimen was wound again on XXXP phenolic form. This time it was wound with Belden Nyltex Litz wire. It was hoped that this wire insulation would have a greater resistance to the transmission of moisture. The assembly was also embedded in Scotchcast LV epoxy resin. The changes in electrical characteristics due to potting are interesting.

Frequency	"Q"	"C"	
200 KC	160	462	Before embedment
400 KC	130	100.8	
200 KC	154	462	After embedment
400 KC	112	100	

At this point in the program it was concluded that the major contributor to loss in Q due to moisture was the moisture leakage path through the coil form. Therefore, five samples were prepared using different methods to minimize or eliminate this leakage path. Briefly the condensed test results and nature of the samples are shown below. At this time it was decided to expedite the humidity tests. After many methods were considered, it was concluded that the "take a bite, not a nibble" approach would be followed. This was accomplished by placing the specimens in a conventional home-cooking type pressure cooker. The specimens were subjected to immersion in boiling water with an internal pressure in the cooker of approximately 5 psi. During all of the previous tests and those listed in Table I, the coil forms were attached and wired to a mica filled phenolic (melmac) combination base and electrical terminal block.

Fig. 2: Components used in complete coil



Next, an effort was made to determine a suitable insulating material for the base/terminal block assembly. Six (6) materials were chosen. The evaluation was made by standardizing a Booton Model 260 "Q" meter. A frequency of 425 KC and 50 mmfd was employed. A "Q" of 100 was the selected reference value. Each specimen was in turn placed across the "C" terminals of the "Q" meter. Changes in the "Q" meter readings are shown in Table 4.

The possibility of utilizing the non-wetting characteristics of the Dow Corning DC200 silicone fluid in combination with common insulating materials was exploited. Again a standardized "Q" meter was employed.

Frequency = 425 KC,
C = 50 mmfd, Q = 100

Observations are indicated in Table 5.

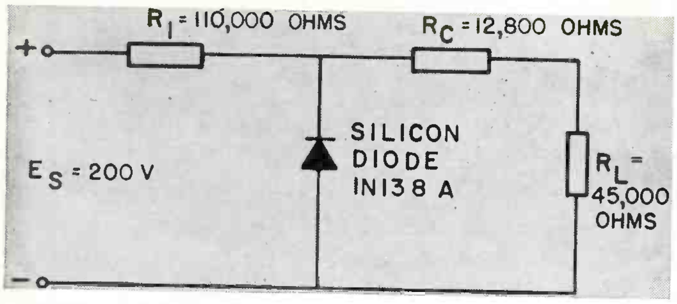
Measurements, Table 2, were then made with a typical assembly using the above materials.

Final Design

After studying all of the previous data, a specimen was made employing the following features:

1. Molded Alkyd Plaskon 440A—coil form.

(*Continued on page* 132)

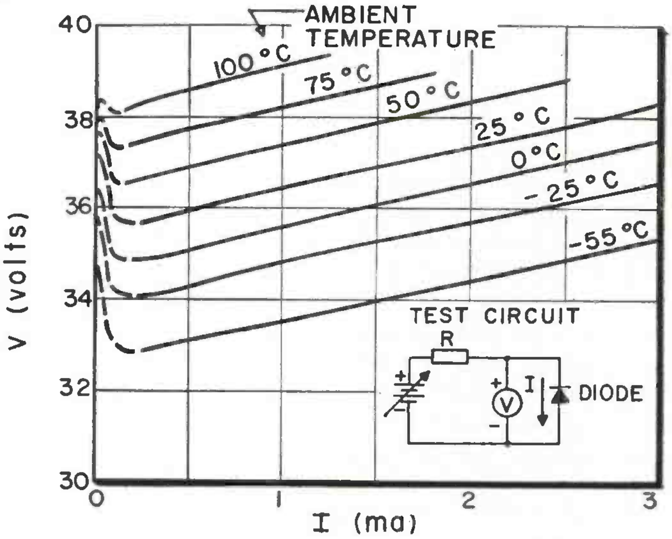


By D. A. Burt

New Product Engineering Dept.,
Westinghouse Electric Corp.,
Pittsburgh, Penna.

Fig. 1: Practical diode reference

Fig. 2: (R) 1N138A breakdown region



Unique characteristics of silicon diodes near the breakdown point make them suitable for simple, reliable current or voltage reference circuits. Design equations for such circuits are given, and a practical constant-current circuit is described

Current Reference For Magnetic Amplifiers

IF an increasing direct voltage is applied to a silicon junction diode in the blocking direction, a small leakage current flows until a point is reached where breakdown occurs. After breakdown, the voltage across the diode changes only slightly while the current through the diode changes rapidly. This characteristic of relatively constant voltage can be used in reference devices so long as the power rating is not exceeded.

A simple reference circuit consists of a diode with a current limiting resistor in series. E_s is a direct voltage supply. R_1 is a regulating resistor and R_2 is the load resistor. Before breakdown is reached, the voltage across the diode is almost proportional to E_s. After breakdown, the voltage across the diode, and also across R_2, remains relatively constant compared with E_s as long as the diode is in the breakdown region. R_1 limits the current and allows E_s to vary over a desired range without burning out the diode with high current.

Breakdown Region

Characteristic curves for a type 1N138A silicon junction diode operating in its breakdown region are shown in Fig. 2. The voltage across the diode does not remain exactly constant after breakdown, but varies with the current through the diode. For this reason a silicon diode does not provide a perfectly constant reference voltage. The small peak of voltage near zero current is associated with noise which is present in some diodes around the knee of the curve. The amount of noise varies from diode to diode and is usually limited to the low current region after breakdown. References must be designed so the diode does not operate in this noisy region because of the erratic voltage fluctuations which occur.

An increase in ambient temperature causes an increase in breakdown voltage, but the slope of the breakdown characteristic changes little. The change in breakdown voltage is roughly 0.1%/°C for diodes of the above type. An increase in current through a diode causes a temperature rise which has the same effect as an increase in ambient temperature. This has the effect of increasing the slope of the characteristic curves in the breakdown region.

Design Equations

The silicon diode and the resistors, R_1 and R_2, must be selected to meet the desired requirements for a reference. A design will have to consider the magnitude and variation of supply voltage, the magnitude and allowable error of the output, and the effect of ambient temperature. The following presents one approach to the design of a diode reference.

To be better able to write equations for understanding the operation of the reference circuit, the diode is replaced by an equivalent circuit in Fig. 3. The equivalent circuit consists of a battery of voltage, E_d, in series with a resistor, R_d. E_d is the voltage at which breakdown occurs, and R_d is the slope of the characteristic curve after breakdown. I_1 and I_2 are loop currents in Fig. 3. The equivalent circuit holds only when E_s is sufficiently large for I_1 to be positive.

Writing eq. using Kirchhoff's voltage law around the loops formed by I_1 and I_2 and solving for these currents gives:

$$I_1 = \frac{E_s R_2 - E_d (R_1 + R_2)}{R_1 R_2 + R_1 R_d + R_2 R_d} \quad (1)$$

$$I_2 = \frac{E_s R_d + E_d R_1}{R_1 R_2 + R_1 R_d + R_2 R_d} \quad (2)$$

Error will be defined as

$$\epsilon = \frac{\Delta I_2}{I_2} \quad (3)$$

where ΔI_2 is a change in the output current, I_2, due to a change ΔE_s in the supply voltage, E_s. Substituting eq. (2) into eq. (3) gives

$$\epsilon = \frac{\Delta E_s R_d}{E_s R_d + E_d R_1}$$

Rearrange this eq. to give

$$\epsilon = \frac{\Delta E_s / E_s}{1 + (R_1/E_s)(E_d/R_d)} \quad (4)$$

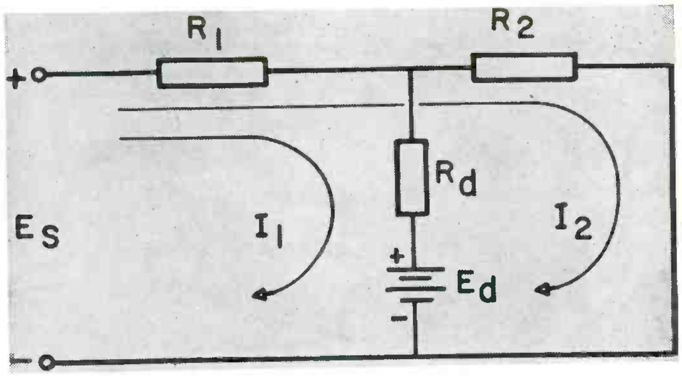


Fig. 3: Equivalent circuit

The power output of the reference is given by

$$P_o = I_2^2 R_2 \quad (5)$$

Using these equations, a practical method of reference design will be developed. It will be assumed that the diode to be used has been selected. Selection of a diode will be largely a matter of experience, and characteristics to produce good reference operation will be discussed in a later section. Selection of the diode fixes the values of E_d and R_d and two limits, $I_{1\,max}$ and $I_{1\,min}$. $I_{1\,max}$ is the maximum reverse current that can be put through the diode as determined from the diode power rating. $I_{1\,min}$ will generally be the current value above which no noise occurs, but it can be any value greater than zero that is determined by the designer.

Reference requirements known to the designer are the allowable output error (ε), the desired magnitude of the output current (I_2), and the expected variation in supply voltage ($\Delta E_s/E_s$). The known quantities are now ε, I_2, $\Delta E_s/E_s$, E_d, R_d, $I_{1\,max}$, and $I_{1\,min}$.

An examination of eq. (4) shows that R_1/E_s is the only unknown. The eq. may be solved for E_s/R_1 as given below

$$\frac{E_s}{R_1} = \frac{\epsilon E_d/R_d}{(\Delta E_s/E_s) - \epsilon} \quad (6)$$

The value selected for E_s will then determine R_1.

A relationship between E_s and the output current, I_2, will be developed. This will allow E_s to be selected to produce a desired output current or will give the value of output current produced by a given supply voltage, E_s. Rewrite eq. (2) as

$$I_2 = \frac{R_d (E_s/R_1) + E_d}{R_2 + R_d + R_2 R_d/R_1} \quad (7)$$

Solve eq. (1) for R_2 to get

$$R_2 = \frac{E_d + I_1 R_d}{(E_s/R_1) - (E_d/R_1) - I_1 [1 + (R_d/R_1)]} \quad (8)$$

Into eq. (8) substitute $I_{1\,min}$ for I_1 and $E_{s\,min}$ for E_s, where $E_{s\,min}$ is the minimum value of the supply voltage. This will cause R_2 to have a value such that I_1 will equal $I_{1\,min}$ when E_s is reduced to $E_{s\,min}$. The resulting eq. is

$$R_2 = \frac{E_d + I_{1\,min} R_d}{(E_{s\,min}/R_1) - (E_d/R_1) - I_{1\,min} [1 + (R_d/R_1)]} \quad (9)$$

Substitute R_2 from eq. (9) into (7) and solve for R_1 without breaking up any of the known ratios E_s/R_1 or $E_{s\,min}/R_1$.

$$R_1 = \frac{E_d + I_{1\,min} R_d}{(E_{s\,min}/R_1) - I_{1\,min} - I_2 \left(\frac{(E_{s\,min}/R_1) + (E_d/R_d)}{(E_s/R_1) + (E_d/R_d)} \right)}$$

For $E_{s\,min}$ substitute $E_s - \Delta E_s/2$ and then in the last term in the denominator substitute the expression for E_s/R_1 from eq. (6). After rearranging and simplifying, the result is

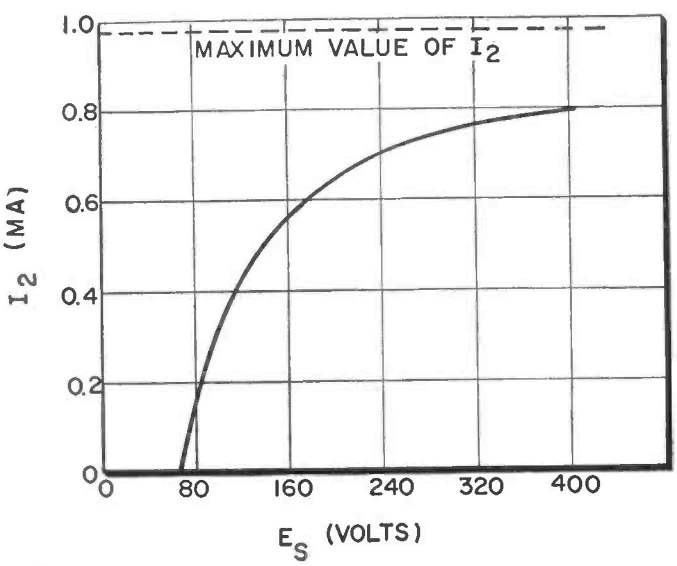


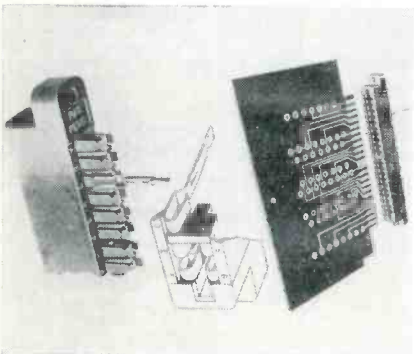
Fig. 4: Selecting I_2 for 1N138A

(*Continued on page 136*)

New Printed Circuit

CONNECTORS

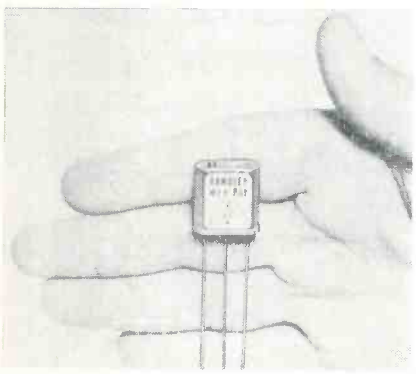
A new improved line of connectors for use with printed circuits is now available. Five sizes are offered; 12, 20, 30, 36, and 44 contacts, individually located on both



sides of the board. The contacts are designed to make good connections with the printed circuitry regardless of normal warpage or variation in thickness inherent in the boards. This is accomplished by the double spring action incorporated in the contact form. **ELCO Corp., Philadelphia.** ELECTRONIC INDUSTRIES & Tele-Tech. (Ref. No. 10-1).

TRIMMER

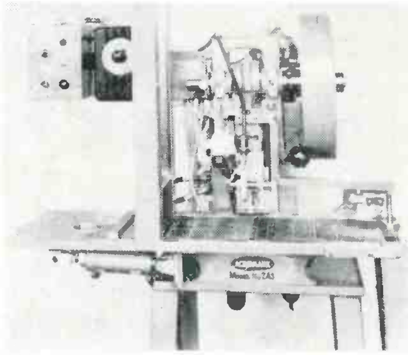
Designed especially for printed circuit use, this new miniature wire-wound trimmer potentiometer features resistances from 100 to 40K ohms, resolutions ranging from 0.3% to better than 0.1%, power rating of 1 watt at 40°C, and a metal case which can be potted or sealed. The wiper position is varied over the full resistance by a self-locking 40 turn



screw adjustment. The unit is ¾ by ¾ by 5/16 in., weighs only 5 grams, and requires no bracket. **Handley Electronics Inc., Van Nuys, Calif.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-4).

STAMPING MACHINE

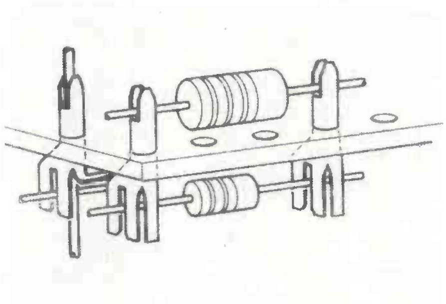
Phenolic plates with copper circuits are marked in color with circuit identification or assembly numbers. It is provided with a pre-set counter for any desired



number up to 1000. The machine then counts, marks, and ejects automatically all circuit plates placed in the magazine. The ejector in turn replaces the marked plates in another magazine, all in perfect sequence. Speed is 3600 marked plates per hour. **Acromark Co., Elizabeth, N. J.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-2).

TERMINALS

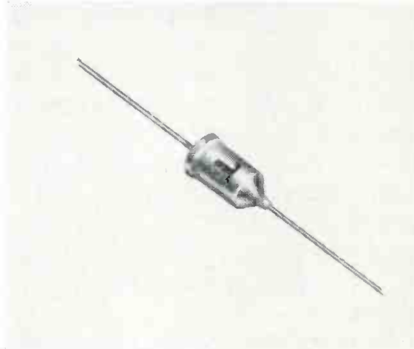
Remarkable new push-in "Zip" terminal needs only to be pushed into the 0.093 in. hole of a wall or deck and holds itself in without staking; and the serrated slots grip inserted wires tightly for testing or dip soldering. The push-in "Zip" terminal is a formed strip brass terminal having a partially tubular end which fits into the holes in the board and is held by spring tension. The upper por-



tion has a narrow tapered slot with serrated edges, which firmly grip the wire lead of any size between 0.030 and 0.045 in. **Vector Electronics Co., Los Angeles.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-5).

RECTIFIERS

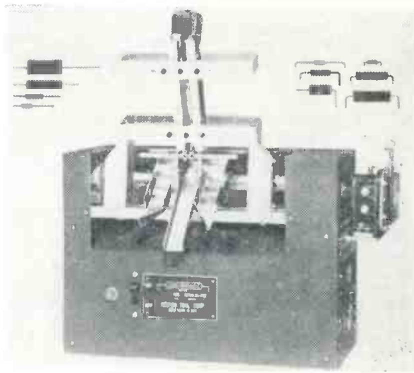
A new series of hermetically-sealed miniature silicon rectifiers is particularly well suited for critical applications requiring high temperature operation of



compact power supplies. These rectifiers are available having peak inverse voltage ratings from 50 to 400 v. They have maximum forward current ratings of 200 ma at 150°C. The lead-mounted construction enables easy printed board or terminal board mounting. **Transitron Electronic Corp., Melrose, Mass.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-3).

LEAD BENDER

An automatic machine capable of preparing 14,000 pigtail components per hour is now available. Coaxial leads of resistors, capacitors, diodes, coils, and similar units are automatically bent to right angles and cut to any length, equal or unequal. It was especially designed to prepare coaxial lead components for insertion in

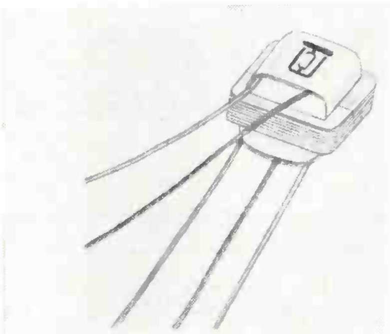


printed board circuits. Simple, easy adjustments permit quick set-ups and rapid changes in lead length and distance from angle. **Design Tool Corp., New York.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-6).

Components and Equipment

TRANSFORMERS

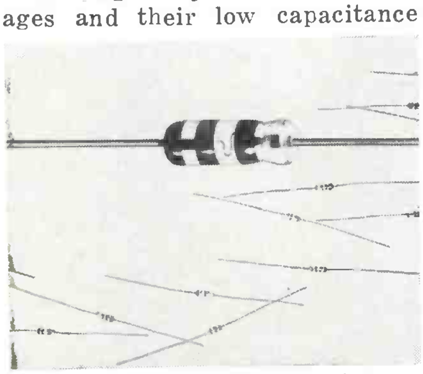
A stock line of ultra-miniature push-pull transistor transformers has been introduced for immediate delivery. Size is only 3/8 by 3/8 by 11/32 in. Weight 0.005 lbs. Sup-



plied with 4 in. color coded leads suitable for use in dip soldered printed circuits. Molded nylon bobbins, high-nickel laminations, and Mylar insulation are used to permit maximum size reduction. Primarily designed for transistor circuitry in guided missiles and airborne equipment. Stock units also available for single-ended and vacuum tube applications. **Micro-tran Co., Valley Stream, N. Y.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-7).

GERMANIUM DIODES

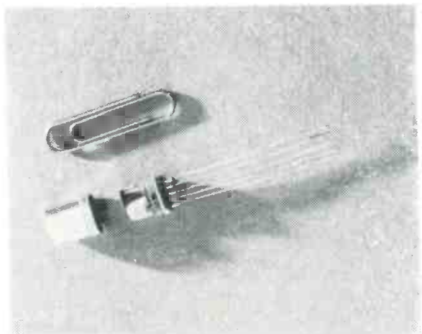
New series of glass-sealed, bonded-junction germanium diodes, types 1N497 through 1N502, feature high forward conductance, high back resistance and a variety of peak reverse voltages. Their wide range of peak reverse voltages and their low capacitance



make them suitable for varied applications such as computers, magnetic amplifiers, modulators, demodulators, and low-power rectifiers. **CBS-Hytron, Lowell, Mass.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-10).

RELAY

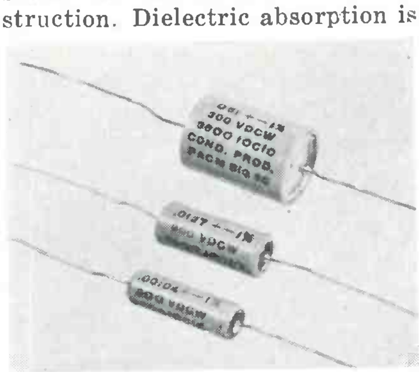
The world's smallest electronic switching device is now in mass production. Prototype models of the relay have been proven at better than 3 million cycles of opera-



tion without failure. Samples are available with 1000, 500, 200, and 50 ohm coils with 100 mw sensitivity. It is available from stock with a 2000 ohm coil. Weighing only 1/16 oz., and measuring 1/3 by 1/2 in., it is a radical departure from standard relay design achieved through the application of watch manufacturing skills. **Elgin National Watch Co., Elgin, Ill.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-8).

CAPACITORS

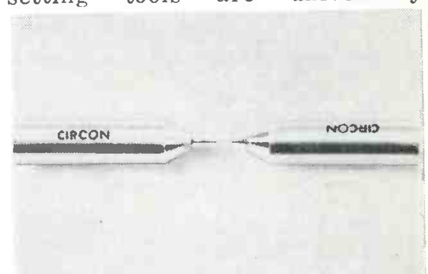
High insulation resistance and excellent capacitance stability are the features of these new precision miniature metal tubular polystyrene capacitors. Range is from .0001 to 1 mfd. and voltage range is from 100 to 1,600 vdc. Both inserted tab and extended foil construction. Dielectric absorption is



.05% and insulation resistance at 25°C is 1 x 10^{12} ohms. Power factor at 1 kc, maximum of .05% **Condenser Products Co., New Haven, Conn.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-11).

EYELET TOOLS

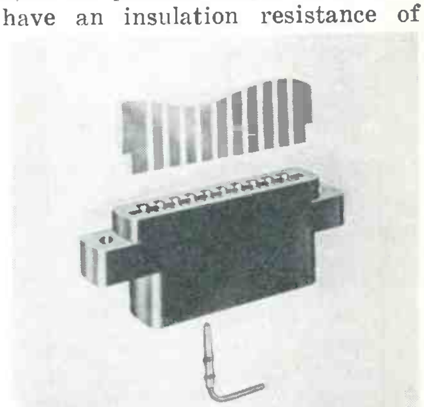
New eyelet tools are now available which will provide flexible, inexpensive tooling for precision, high quality eyelet rolls. These setting tools are universally



adaptable to basic machines available and may be used in a drill press, arbor press, kick press or any other device which will provide the required reciprocating action. The tools come in a full range of sizes for eyelet sizes from 3/64 to 1/8 in. body diameter and lengths from 1/16 to 7/16 in. **Circon Component Co., Goleta, Calif.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-9).

PRINTED CIRCUIT CARD RECEPTACLE

Line of double-row, printed card receptacles, designated as Series UPCR-DTP, feature beryllium copper contacts with taper-pin terminals embodied within a high-compression solid molding. Available in 6, 10, 15, 18 and 22 contacts per row, for 1/16 in. and 3/32 in. printed cards, receptacles have an insulation resistance of



over 100,000 megohms and voltage capacity of 2200 v ac (RMS) at sea level, and 600 v ac (RMS) at 60,000 ft. **U. S. Components, Inc., New York.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-12).

For product information, use inquiry card on page 113.

Design for a Simple

Radiation dosage rate is determined by timing flashes of a neon lamp in a relaxation circuit incorporating a partially shielded, radiation sensitive CdS crystal. Complete design details for a simple, battery-powered indicator are given.

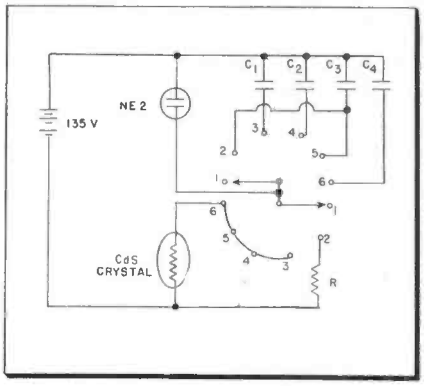


Fig. 2: Neon flashes show dose rate

By H. J. PEAKE, P. T. COLE, H. RABIN, J. J. LAMBE, and C. C. KLICK

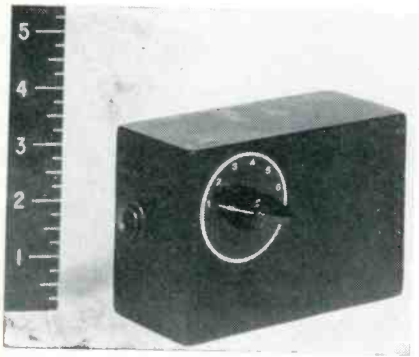


Fig. 1a: Dosage rate indicator

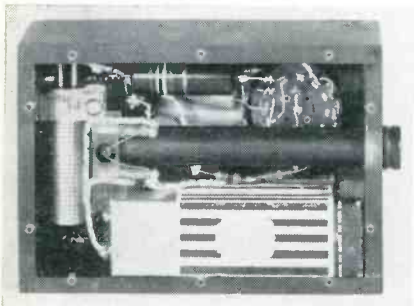
A RECENT AEC announcement pertained to the dispersal of radioactive materials subsequent to the detonation of nuclear weapons, which if at, or near, the earth's surface may result in radioactive "fall out" over a very large area. This "fall out" will produce dangerously high gamma-ray intensities which diminish in a period of days or weeks. It may be desirable to have available a small, simple, reliable, inexpensive device to indicate gamma-ray dosage rate to:

1. Permit the intelligent choice of shelter in which to wait for the radiation to diminish,
2. Determine when evacuation is feasible,
3. Select the best evacuation path and
4. Preclude panic due to false estimates of the radiation.

A cadmium sulfide (CdS) crystal exhibits a nearly linear change of conductance with gamma-ray dosage rate. This property, along with high stopping power as a solid and higher current yield than any other known solid, makes the CdS crystal a good choice for incorporation in a simple radiation detector. Frerichs[1] has investigated the response of solids to gamma rays and Jacobs[2] has adapted CdS to X-ray detection in commercial equipment.

Using a CdS crystal as the sensing element the dosage rate indicator shown in Fig. 1 has been constructed and tested. The device, by means of the circuit in Fig. 2, indicates gamma-ray dosage rates from less than 0.1 Roentgen per hour (R/hr) to over 1000 R/hr in 4 decade ranges. Dosage rates are "read" by counting the flashes per sec. of a neon glow lamp.

Fig. 1b: CdS is in shield at left



Insertion of earphones in series with the glow lamp provides greater detection sensitivity (cps per R/hr). Earphones produce an audible click each time the glow lamp fires, even if firings are not visible because of lowered energy in the discharge.

Theory

In the simple relaxation circuit, Fig. 3, charge accumulates on the condenser until the condenser voltage reaches the ignition voltage (E_i) of the neon glow lamp. The lamp "fires" and discharges the condenser until the condenser voltage falls to the extinction voltage (E_e) of the lamp. Thereafter the condenser voltage is cyclic as shown in Fig. 4(a); condenser current varies as in Fig. 4(b). The time required for the condenser voltage to drop from E_i to E_e is negligible here, since the resistance of the "fired" neon lamp is a few thousand ohms compared to the 10^9 - 10^{12} Ω resistance of a cadmium sulfide crystal. Thus the charging time constant is at least 10^6 times the discharging time constant.

Analysis of the relaxation circuit yields equations for the condenser voltage and current as follows:

For $0 < t < t_1$

$$e_c(t) = E\,(1 - \epsilon^{-t/\tau})$$

and

$$i_c(t) = \frac{E}{R}\,\epsilon^{-t/\tau};$$

for $t_1 < t < t_2$

$$e_c(t) = E - (E - E_e)\,\epsilon^{-(t - t_1)/\tau} \quad (1)$$

and

$$i_c(t) = \frac{E - E_e}{R}\,\epsilon^{-(t - t_1)/\tau}$$

where E = battery volts, ε = 2.718 (Napierian base), t = the time, t_1 = time at which first ignition of glow lamp occurs, and $\tau = RC$. For $t > t_2$ the circuit action is repetitive.

H. J. PEAKE, Director, P. T. COLE, H. RABIN, J. J. LAMBE, and C. C. KLICK, U. S. Naval Laboratory, Washington 25, D. C.

Radiation Dosage Indicator

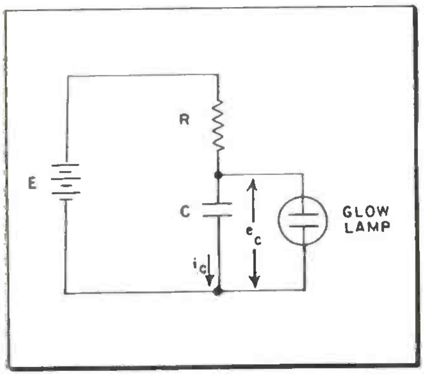


Fig. 3: RC-glow lamp relaxation circuit

As shown in Fig. 4 (b), the value of i_c an instant before the time t_2 (at which the lamp ignites) is $\frac{E - E_i}{R}$. Substituting this value of i_c in eq. (1) and solving for the period of oscillation,

$$t_2 - t_1 = \tau \ln \frac{E - E_e}{E - E_i},$$

or

$$f = \frac{1}{t_2 - t_1} = \frac{1}{\tau \ln \frac{E - E_e}{E - E_i}} \qquad (2)$$

where f = the relaxation frequency. Eq. (2) gives a good approximation of the frequency and does show the manner in which circuit constants affect the frequency.

For $E = 190$ v, $E_i = 76$ v, $E_e = 62$ v, and $\tau = 1.54$ ($R = 32$ MΩ, $C = 0.0482$ μfd.), eq. (2) gives $f = 1.07$ cps.

The measured frequency for these circuit values was very nearly 1 cps. For a battery voltage E of 135 v, τ must be increased to approximately 4.7 to obtain a 1-cps frequency.

Variation of the relaxation frequency with battery voltage is of interest. The slope of the frequency-voltage relationship is obtainable by differentiating eq. (2). However, it is possibly simpler and clearer to study the plot of eq. (2) as shown in Fig. 5. Here, in order to plot only one characteristic, both sides of the equation have been multiplied by τ; then τf is plotted as a function of E, the measured values of E_i and E_e having been inserted. The slope of the straight-line function, τf vs E, is 0.0724 v^{-1}. To find, for example, the change of frequency with battery voltage for $f = 1$ cps, $\tau = 4.7$, and $E = 135$ v, we have $\frac{0.0724}{4.7} = 0.0154$ cps/v. Thus a 10-v drop in battery voltage will result in a frequency decrease of approximately 15%. Similarly for a 90-v battery ($\tau = 1.54$, $f = 1$ cps), 0.0724/1.54 = 0.047 cps/v, or about three times the change for 135-v operation.

After the relaxation circuit becomes repetitive ($t > t_1$), the average capacitor current is, from eq. (1).

$$i_{c\,av} = \frac{1}{t_2 - t_1} \int_{t_1}^{t_2} \frac{E - E_e}{R} \epsilon^{-(t - t_1)/\tau} dt$$

$$= \frac{1}{\ln \frac{E - E_e}{E - E_i}} \frac{E_i - E_e}{R} \qquad (3)$$

The capacitance (C) does not appear in the expression for $i_{c\,av}$. Thus, for a wide range of capacitance value the $i_{c\,av}$ is constant, although the frequency of relaxation changes in inverse proportion to the capacitance.

Cadmium Sulfide

Photoconductive solids, such as cadmium sulfide; exhibit an increase in conductance upon absorbing incident energy. When a CdS crystal is irradiated, the energy-level distribution of the electrons in the crystal is changed. Specifically, some electrons are raised from the valence band, or from intermediate-level "traps", to the conduction band where they are free to flow as current if influenced by an applied voltage. Electrons freed by irradiation represent an increased conductance compared to the "dark" or zero-irradiation value.

In a CdS crystal the number of electrons in the conduction band at any time is nearly a linear function of the radiation intensity incident on the crystal [1, 2]. For intensities up to at least 2000 R/hr then

$$G = K_1 J$$

where

G = conductance of CdS crystal,
K_1 = proportionality factor, and
J = radiation intensity.

Since $G = 1/R$, eq. (2) may now be written

$$f = K_1 \frac{1}{C \ln \frac{E - E_e}{E - E_i}} J$$

to show the linear relation between relaxation frequency and radiation intensity.

The response of CdS crystals, as for all solids with high atomic numbers, is strongly energy dependent. The response to "soft" (50—100 kev) gamma rays may be nearly 20 times the response to "hard" (250 kev and greater) gamma rays. To offset this energy dependence the CdS element in the dosage rate indicator has been provided with a perforated lead shield which can be seen at the left in fig. 1 (b). This technique is similar to that previously developed for the DT-60 phosphate glass dosimeter[3]. The shield is made of 35-mil lead sheet with a square matrix of 13-mil holes drilled on

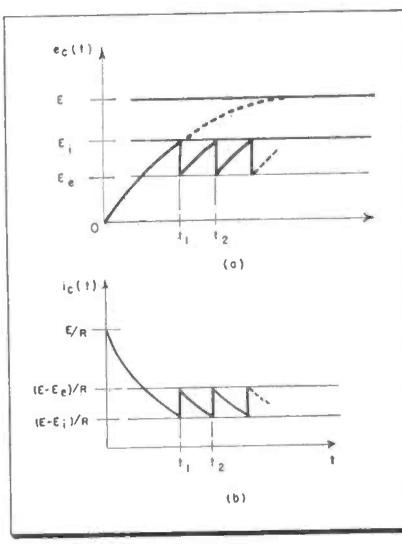


Fig. 4: Condenser voltage (a) and current (b)

Dosage Indicator (Cont.)

1/16-in. centers. Checks made at radiation energies of 100, 200, and 1200 kev produced relative responses of 0.9, 1.2, and 0.9 respectively. The 100 and 200-kev source was the unfiltered output of an X-ray source; 1200-kev energy was from a cobalt-60 source.

The Indicator

As shown in the schematic diagram, Fig. 2, only 9 circuit components are used. Operation is controlled by a rotary selector switch. In pos. 1 the circuit is open. Pos. 2 provides a battery voltage check; R is chosen so that the relaxation frequency is once per sec. In pos. 3, 4, 5 and 6, condensers C_1, C_2, C_3, and C_4 (each shunted by the Ne-2 glow lamp) are respectively switched in series with the CdS crystal and battery. For 1 flash per sec. the dosage rate is: pos. 3, 1 R/hr; Pos. 4, 10 R/hr; pos. 5, 100 R/hr; pos. 6, 1000 R/hr. In each switch position the glow-lamp flash rate is nearly linear with dosage rate; e.g., 2 flashes per sec. in position 4 indicates 20 R/hr and 1 flash each 2 sec. in position 5 indicates 50 R/hr. In making a radiation measurement the timing of the flashes can be done by means of the second hand of a watch or by reference to pos. 2 which provides 1 flash per sec.

The dosage rate meter is housed in a plastic box measuring 5 x 3-⅜ x 2¼ in. Total weight is 1 lb., 6 oz., two-thirds of the weight being the box alone. Both the size and weight are readily reducible by straightforward means. Observation of the lamp flashes is accomplished by means of the viewing tube, visible in Fig. 1 (b), which extends from the glow lamp on the left through the box on the right.

Care must be exercised in the mounting used to support the leads on the CdS crystal. Since the crystal resistance is quite large, supports on the crystal leads must be of high-resistance non-hygroscopic material. The bakelite support used on the first unit has been replaced on subsequent models by one made of polystyrene; the resulting increased leakage resistance seems to be satisfactory for good performance in a humid atmosphere.

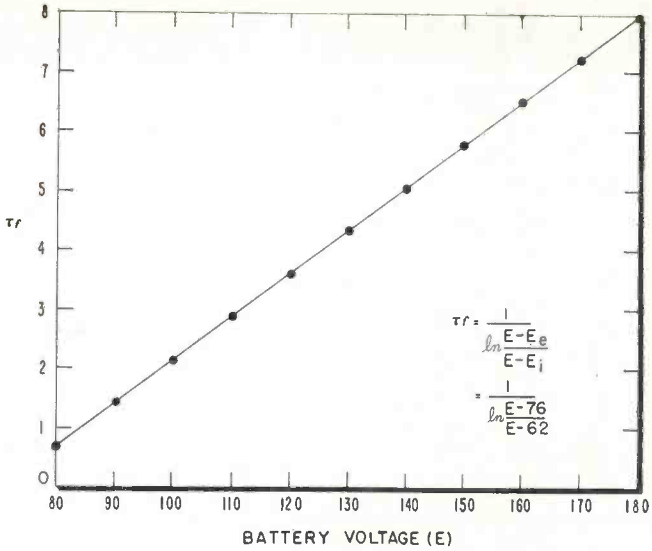


Fig. 5: Frequency vs supply voltage

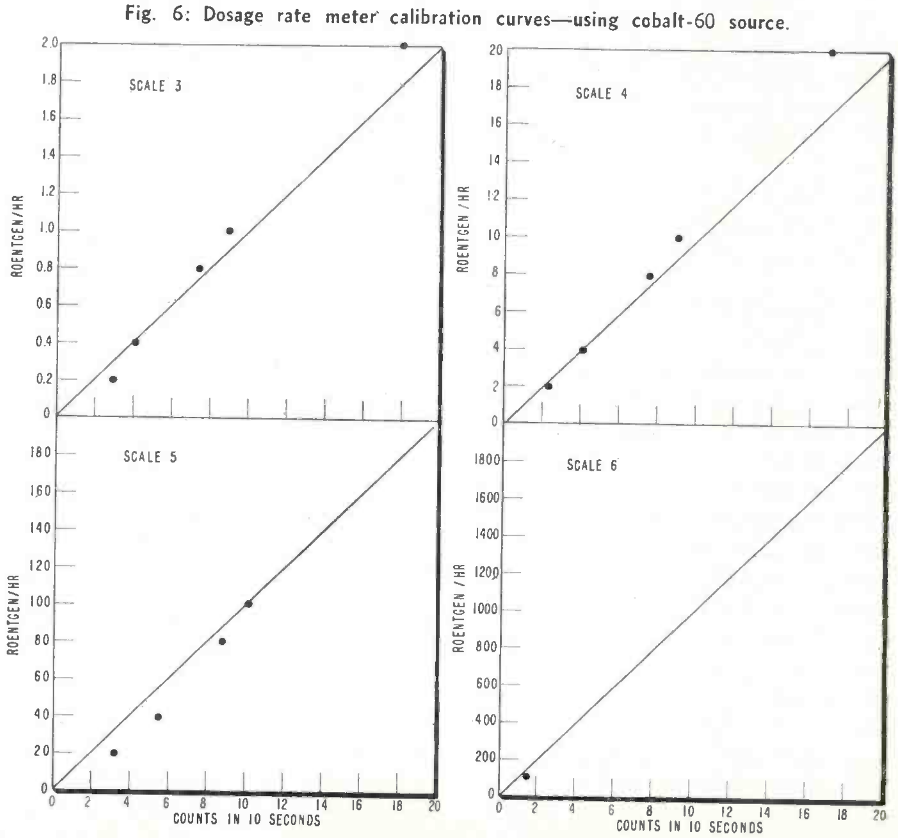
The results of a calibration of an instrument are given in Fig. 6 where the points are measured in the range from 0.2 R/hr to 100 R/hr using a cobalt-60 source. The straight lines are drawn through the nominal value of each range. Deviations of the measured points from the line do not appear to be serious considering the simplicity of the indicating system. Corrected values of capacitance for each scale are chosen for a particular CdS crystal by this calibration method. Representative values of the capacitances determined by such a calibration are as follows:

$C_1 \cong 800\ \mu\mu fd$, $C_2 \cong 0.005\ \mu fd$, $C_3 \cong 0.04\ \mu fd$, $C_4 \cong 0.4\ \mu fd$.

References

[1] R. Frerichs, J. A. P., 21, 312 (1950).
[2] J. E. Jacobs, Electronics, 24, Aug. p 125; Oct. p 172 (1951).
[3] J. H. Schulman, W. Shurcliff, R. J. Ginther, F. H. Attix, Nucleonics, 11, No. 10, p 52 (1953).

Fig. 6: Dosage rate meter calibration curves—using cobalt-60 source.



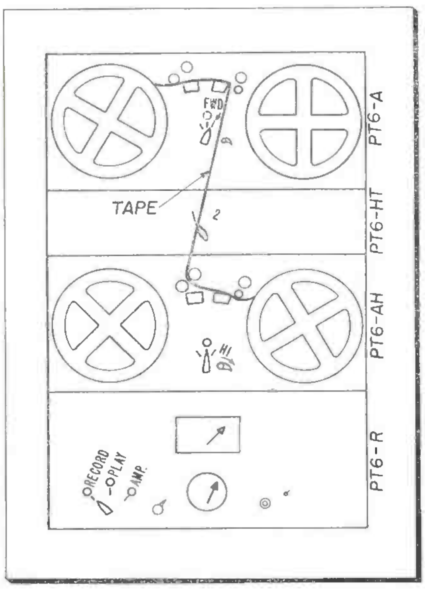
CUES for BROADCASTERS

Practical ways of improving station operation and efficiency

Echo Effects

H. E. HERRON, Ch. Engr.
KCIL, Houma, La.

A WAY to produce echo effects, ideal for station call letters includes two rack-mounted Magnecorders, complete with the PT6-HT throw-over switch panel, and one portable tape machine. The station console was put on Audition and the console output fed to the portable tape machine by Remote #1. The console output is also fed to the top Magnecorder by Remote #2. The tape is threaded as shown in the diagram. The top Magnecorder is set to Record and the throw-over switch is set to #1, which is the top machine. The PT6-HT throw-over switch provides a 60 ohm cue output for the bottom tape, and at KCIL this is connected to Channel #1 on the console.



Arrangement for echoing call letters

Thus we can record on the top tape and playback the bottom tape at the same time. By placing Channel #1 in Audition the output of the bottom Magnecorder will be fed through the console audition system and into the remote lines. The portable tape machine and the top Magnecorder are placed in operation. The fast forward lever on the bottom Magnecorder is then depressed. Words or letters to be "echoed" can be selected by either putting the remote #2 switch in the neutral (off) or cue position. We found this system to work fine on station call letters, but not very well on sentences. We also experienced better results by using 5 in. reels.

Overload Protection

DONALD L. GULIHUR, Ch. Engr.
KLVL, Pasadena, Tex.

KLVL has a Collins Model 20-K 1 KW transmitter, requiring 3-phase 220-v. power. There are no dc overload protection devices. The filaments and low voltage plates are protected by fuses in the primary of their respective transformers. The 3-phase power is used only to furnish high voltage for the 813 driver, the 833 finals, and the 833 modulators. Overload protection for these stages is furnished by "dash-pot" type breakers in series with two of the 220 v. phase legs in the primary side of the high voltage transformer.

Experience has shown that if these dash-pots are set "lean" enough to furnish positive protection to the finals in the event of an excitation failure, it becomes impossible to 100% tone modulate the transmitter and even high amplitude, sustained, musical passages will kick the transmitter "off-the-air."

A decision must be made whether to set the dash-pots "lean" and reduce modulation, or set them "heavy" and take a chance that excitation will not fail. KLVL decided to take a chance. After a disastrous experience, that cost us a hundred dollars worth of 833-A's, we decided to add dc overload protection, in the form of a Guardian Series 200, 12 v. dc coil shunted by a 15Ω, 4 W., wire-wound pot. This combination is inserted between the final amplifier filament center-tap and ground in series with the final amplifier plate milliammeter.

Necessary connections are easily made. On a terminal strip I located in the bottom of the cabinet under the blower, the shunt is removed from 114 & 115. The coil and shunting pot. are connected to these terminals. The shunt between I6 & I12 (interlock circuit) is removed and connection made to a pair of relay contacts which are

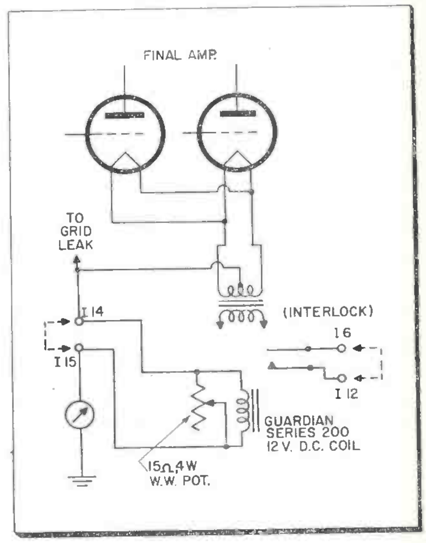


Diagram indicating circuit changes

closed with the coil unenergized. The relay shunting pot. is then adjusted so that the relay contacts will open when the final amplifier plate current reaches 800 ma. It has been found that with a tripping current of less than 800 ma, the relay will tend to chatter on high modulation peaks and may drop the transmitter "off-the-air." This arrangement costs less than $5.00 and it has been found to be positive in the event of excitation failure or other overload. There is no appreciable danger to the 813 driver because this stage has a cathode bias resistor.

Recorder Speed Instability

F. F. CHERRY, Ch. Engr.
KFNF, Shenandoah, Ia.

Among several available makes of truly portable tape recorders in general use by broadcasters, there are many of the Minitape brand. Many users have had the same difficulty that we experienced here at KFNF, namely speed instability after the machine is somewhat older. After trying just about everything to correct this trouble, we discovered a surefire remedy.

After long hours of trying, it was discovered that if the motor armature is cleaned thoroughly, and especially between the segments of the commutator, and a new set of brushes is installed each 30-40 hours of running time, that you can count on 100% satisfaction in respect to stability.

Measuring Rate-of-Climb

"Magic Tee" unit designed for Navy's "Pogo-Stick" fighter uses doppler effect for accurate indication of vertical velocity

By S. H. LOGUE

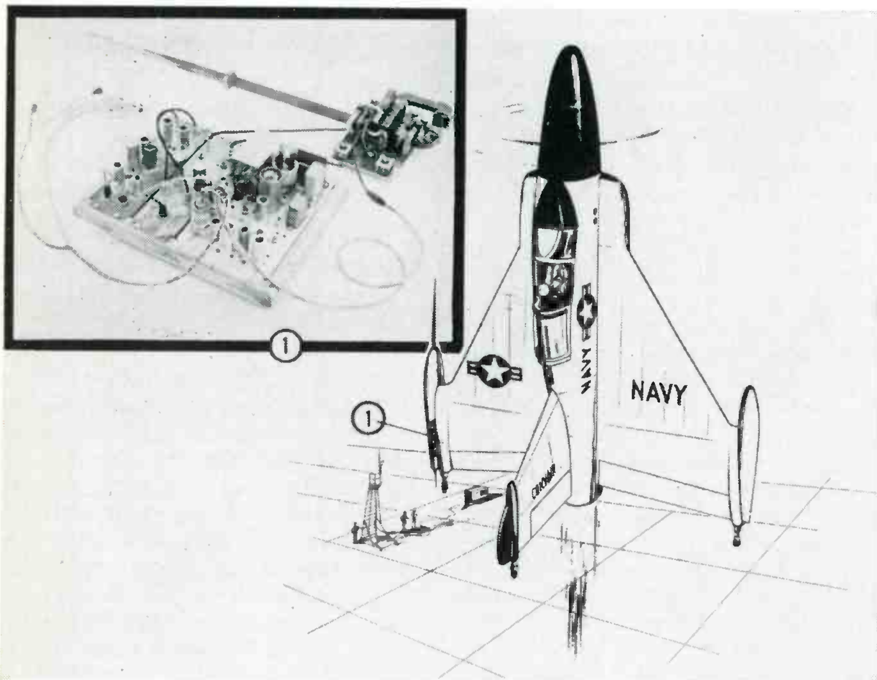
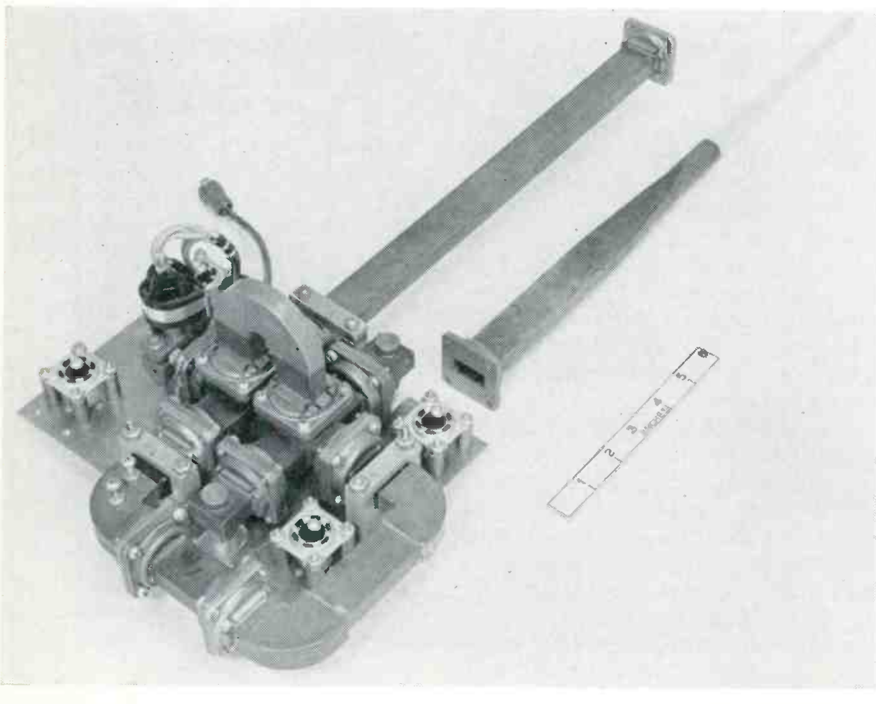


Fig. 1: 10 KMC doppler unit guides XFY-1 "Pogo-Stick" landing

Fig. 2: Doppler radar assembly



The ability to visually estimate vertical velocity decreases as the altitude of the observer increases and he gets farther away from objects that could otherwise be used for reference. The effect is enhanced if horizontal velocity is absent. For this reason vertical takeoff fighter aircraft, such as the Navy XFY-1 "Pogo Stick" built by Convair, require accurate determination of vertical velocity, both magnitude and direction. At altitudes above one hundred feet the pilot's ability to estimate his velocity by observing the ground is insufficient to allow safe operation of the aircraft during landing and hovering maneuvers. The conventional barometric rate-of-climb indicators are sluggish in their response and suffer from misleading fluctuations in turbulent air and thus are not suited for this application. A study was made to determine if an all-electronic system could be used to provide the desired instrumentation while avoiding the limitations of other systems and yet be reasonably compact.

Principle

The electronic rate-of-climb meter shown in Fig. 1 is essentially a CW doppler radar operating at 10,000 mc and using the ground below the aircraft as a reflecting surface. The frequency of the reflected energy is compared with the transmitted energy and any difference, the doppler resulting from vertical velocity, is measured. Since there are ten wavelengths per foot

S. H. LOGUE, Senior Electronics Engineer, Convair, San Diego, Calif.

by Doppler Radar

at 10,000 mc, each foot change in altitude changes the radar path length by two feet, or twenty wavelengths. Thus each foot per second of velocity produces a twenty cps doppler frequency. By using this principle the meter has the following advantages:

(a) The doppler frequency is an accurate and direct indication of velocity.

(b) The system will work to zero altitude.

(c) Frequency is more easily and accurately measured than most other electrical quantities.

(d) The frequency of a signal is not altered by amplifier distortions, thus such distortions have no effect on system accuracy.

Direction Sensing

Since the same doppler frequency results for a given velocity, regardless of whether the aircraft is ascending or descending, some means must be provided for sensing the direction of the velocity. A dual channel microwave receiving system, as shown in Fig. 2, is used for this purpose. Its operation is described by the block diagram in Fig. 3. The klystron generates one watt of power which enters the H arm of a waveguide magic tee where it divides between the two side arms. One half of the power is transmitted out through a dielectric-rod antenna, while the other half goes into a 30 db attenuator pad and then to the E arm of a second magic tee where it divides again and enters two crystal mixers. The unavoidable cross-coupling between the H and E arm of the first magic tee is adjusted to —33 db and used to provide a signal to the H arm of the second magic tee. This signal also divides between the two crystal mixers. Thus 0.5 mw of local oscillator power is supplied to each crystal. The phase relationship between these signals is shown in Fig. 4. Note that the E and H arm local oscillator voltages are of equal amplitude and differ in phase by 90°. This phase difference is obtained by proper choice of waveguide path lengths. The H arm voltages between the two crystals are in phase while the E arm voltages differ in phase by 180°, which is a basic property of the magic tee.

The weak ground-reflected signal is received by the antenna. It divides between the E and H arms of the first magic tee, and the E arm output then enters the H arm of the second magic tee where it divides between the two mixers. This signal voltage is shown on the vector diagrams in Fig. 5 as S. Since S differs from the two local oscillator signals by the doppler frequency, its vector representation will rotate relative to the E and H vectors at the doppler rate. Vector R is the sum of these three signals, S, E, and H. The tip of R traverses a circle, and equal time intervals on the circle are numbered in sequence, one through four. A plot is also shown of the amplitudes of R at each mixer crystal as a function of time. These amplitudes correspond to the mixer output voltages. Note that the output from mixer B leads mixer A by 90°. As shown, the ground return signal, S, is higher in frequency than E or H, which is the case for a descending aircraft. On ascent the frequency of S is lower than E and H, and R would then rotate clockwise. For this case, mixer A would lead mixer B by 90°. Thus the phase between the two signal channels indicates the direction of the aircraft velocity.

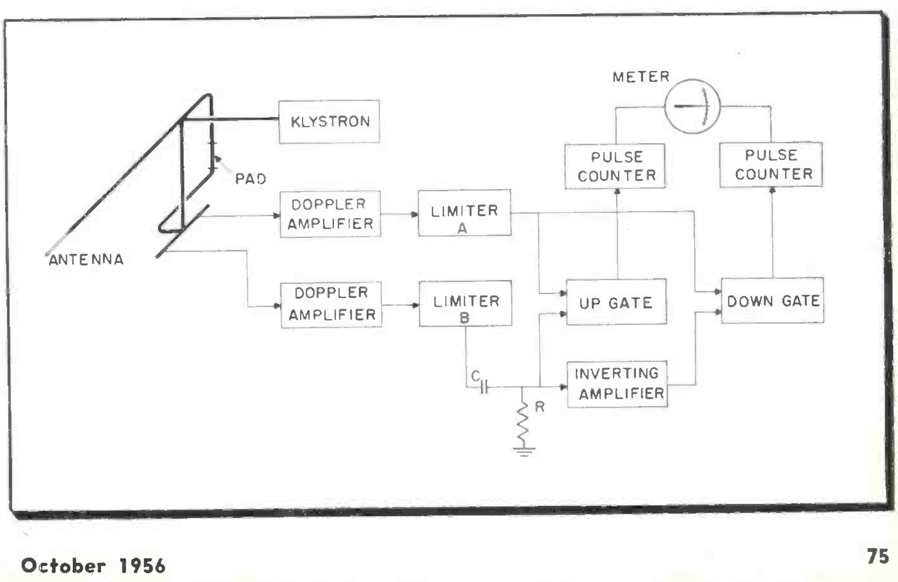
Noise Rejection

Two doppler amplifiers, each with a 100 db voltage gain, increase the mixer outputs to suitable levels to operate the amplitude limiters. Bistable multivibrators are used to provide limiting. A basic property of multivibrators is that their outputs switch between two fixed voltage levels, independent of the input, which provides a high degree of immunity from changes in signal level. Their triggering levels are set to prevent spurious meter indications due to thermal noise when no ground return signal is present, a disadvantage of more conventional limiters.

The limiters operate a set of gates that sort the "up" cycles of doppler frequency from the "down" cycles. Each gate consists of a cathode follower in which the cath-

(*Continued on page* 146)

Fig. 3: Block diagram of climb meter



WASHINGTON

News Letter

Latest Radio and Communication News, from The National Capital, and Previews of Things to Come

FREQUENCY ALLOCATION—Because of the tremendous and continuing expansion of the radio communications and electronics services—not just television, but the wide range of non-broadcast operations which are becoming so important to nearly every facet of the nation's economy—experts are looking to the FCC to make a re-examination of the entire radio spectrum, and, in all probability, a frequency reallocation proceeding during the next twelve months. The FCC reappraisal, while conducted by the full seven-member Commission, will probably be sparked by Commissioner T. A. M. Craven, the engineer member of the FCC.

ALLOCATION SHAKEUP—The frequency requirements of aviation with the jet age, together with the ever-increasing density of air traffic from passenger, cargo, business and private aircraft, bulk in the number one priority place in a spectrum reallocation in the views of many key government officials concerned with spectrum allocations. It is realized that Air Traffic Control for aviation of the immediate future must have adequate and reliable frequency allocations; and, of course, ground-air radiocommunications to aid the pilots of the jet aircraft as well as those of the slower-speed short-haul airlines' fleets and the private-business airplanes, must be flexible and efficient without any elements of failure. Television and mobile radio services, it is contended, can be fitted in after the spectrum needs of aviation are fulfilled.

TELEVISION FUTURE—In light of the thinking in Washington circles on the importance of an immediate reappraisal of the entire radio spectrum, authoritative government and FCC sources have indicated to Electronic Industries' Washington bureau that the Commission may well lean towards a plan of TV deintermixture rather than an eventual transition of all television to the UHF region. Comments on deintermixture and all-UHF plans have been submitted in volume to the FCC during this past month and more are still to be filed. There appears at this writing to be considerable support for the views of Dr. Allen B. DuMont, founder and head of the Allen B. DuMont Laboratories, that there should be areas of VHF-stations-only, requiring such signals because of terrain or need of extended coverage, and UHF-stations-only should be the rule wherever such signals would give full area coverage.

PRIVATE MICROWAVE—The controversy in microwave operations between the private owners of microwave systems and the microwave facilities made available for industries and organizations by the telephone companies has been a very difficult problem for the FCC. The Radio-Electronics-Television Manufacturers Association has completed an extensive analysis and survey of the technical aspects, eligibility criteria, and other non-technical phases of private microwave operations to assist the FCC in its formulation of regular rules for private microwave systems. In general, the RETMA recommendations on the technical aspects for private microwave rules contain basic guidelines that the new rules: "be as few as required, control radiation rather than design equipment or specify techniques, not unnecessarily restrict advancement in the art, obtain maximum utilization of the spectrum, establish baselines for the protection of manufacturers and users investment, and avoid if possible, serious changes on present systems."

SAFETY SERVICES—The "daddy" of mobile radio—the public safety services embracing police, fire and similar governmental protection operations—will continue to enjoy high priority in any frequency reallocation, FCC Commissioner Rosel H. Hyde emphasized in a recent address. He indicated that the FCC would adhere to the important claims of the public safety radio services for more spectrum requirements in any move of television channels from the latter's present VHF band. In fact he pointed out that police radio would be in a good position of being beneficiaries in any reallocation program. It might be noted that other mobile radio operations—industrial, highway, forestry, petroleum, trucking and utilities—are also seeking increased spectrum space for the growing operations of their services.

CLOSED CIRCUIT TV—Recent requests to the FCC for closed circuit television included telecasting of police lineups with Dage equipment between several Ohio cities and the plans of the New York State Power Authority for this service in connection with its power project on the St. Lawrence Seaway. Both these are illustrations of the growing importance of closed circuit television to the nation and reasons for its expansion.

National Press Building
Washington 4

ROLAND C. DAVIES
Washington Editor

1956 Directory of
Printed Circuit Manufacturers

Listed below are the names and addresses of all firms in the U. S. manufacturing printed circuits, printed circuit materials or related items. The firms are listed alphabetically under the product or products they manufacture.

AMPLIFIERS

Abatron Electronic Eng'g Co PO Box 529 Dayton 9 Ohio
ACF Electronics Div ACF Industries Inc 800 N Pitt St Alexandria Va
Air Associates Inc 511 Joyce St Orange NJ
Airborne Instruments Lab 160 Old Country Rd Mineola LI NY
Amelco Inc 2040 Colorado Ave Santa Monica Calif
American Bosch Arma Corp Arma Div Roosevelt Field Garden City NY
American Metrix Corp 15 Exchange Pl Jersey City 2 NJ
ARF Products Inc 7627 Lake St River Forest Ill
Atlantic-Central Mfg Co 10 Esplanade Ave Pitman 9 NJ
Avion Instrument Corp 299 State Hwy #17 Paramus NJ
Baird Associates 33 University Rd Cambridge 38 Mass
Baldwin Piano Co 1801 Gilbert Ave Cincinnati 2 O
Bendix Aviation Corp Pacific Div 11600 Sherman Way N Hollywood Calif
Berkeley Div Beckman Instruments Inc 2200 Wright Ave Richmond Calif
Bruno-New York Industries 460 W 34 St NY 1
Centralab Div Globe-Union Inc 900 E Keefe Ave Milwaukee 1 Wis
Centronics Corp 21-04 122 St College Point 56 NY
Circuitron Inc 115 E Main St Rockville Conn
Cole Instrument Co 1000 N Olive St Anaheim Calif
Computer Control Co 92 Broad St Wellesley 57 Mass
Crown Eng'g 3821 Commercial NE Albuquerque NM
Daystrom Instrument Archibald Pa
Demco Products PO Box 5042 Phila 11 Pa
Digital Products Inc 7643 Fay Ave La Jolla Calif
DuBrow Devel Co 235 Penn St Burlington NJ
DuKane Corp St Charles Ill
Dwyer Engineering Co PO Box 483 Nashua NH
Eclipse-Pioneer Div Bendix Aviation Corp Teterboro NJ
Electronic Control Systems 2136 Westwood Blvd Los Angeles 25 Calif
Electronic Industries Inc 7649 San Fernando Rd Burbank Calif
Electronic Tube Corp 1200 E Mermaid Lane Phila 18 Pa
El Mec Labs 730 Boulevard Kenilworth NJ
Emerson Radio & Phonograph Corp 14 & Cole Sts Jersey City NJ
Endevco Corp 161 E California St Pasadena Calif
Eng'g Research & Devel Co Addison Ill
Federal Telephone & Radio Co Div IT&T Kingsland Rd Clifton NJ
Ford Instrument Co Div Sperry Corp 31-10 Thomas Ave Long Island City 1 NY
Freed Electronics & Controls 200 Hudson St NY 13
Gates Radio Co 123 Hampshire St Quincy Ill
General Precision Lab 63 Bedford Rd Pleasantville NJ
Goldak Co 1544 W Glenoaks Blvd Glendale 1 Calif
Goodyear Aircraft Corp 1210 Massilon Rd Akron 15 O
Hallamore Mfg Co 2001 E Artesia Long Beach 5 Calif
Herlec Corp 6th & Beech St Grafton 1 Wis
Interelectronics Corp 2432 Grand Concourse NY 58
International Research Assoc 2221 Warwick Ave Santa Monica Calif
Int'l Testing Service Div Jackson & Church 321 N Hamilton St Saginaw Mich
IQ Industries 6110 Wilshire Blvd Los Angeles 36 Calif
Lear Inc 3171 S Bundy Dr Santa Monica Calif
Lel Inc 380 Oak St Copiague NY
Librascope Inc Burbank Div 133 E Santa Anita Ave Burbank Calif
Magnasync Mfg Co 5517 Satsuma Ave N Hollywood Calif
Mohawk Business Machines Corp 944 Halsey St Brooklyn 37 NY
Non-Linear System Del Mar Airport Del Mar Calif
Pacific Mercury TV Mfg Corp 5955 Van Nuys Blvd Van Nuys Calif
PCA Electronics Inc 2180 Colorado Ave Santa Monica Calif
Phen-O-Tron Inc 455 Main St New Rochelle NY
Photocircuits Corp Sea Cove Ave Glen Cove NY
Plastics & Electronics Corp 272 Northland Ave Buffalo 8 NY
Qualitone Co 4318 Upton Ave S Minneapolis 10 Minn
Radionics Inc 1040 N York Rd Towson 4 Md
Rheem Mfg Co 9236 E Hall Rd Downey Calif
RS Elextronics Corp 435 Portage Ave Palo Alto Calif
Sanders Associates Inc 137 Canal St Nashua NH
Springfield Enterprises PO Box 54 Springfield Gardens 13 NY
Square Root Mfg Corp 391 Saw Mill River Rd Yonkers NY
Stancil-Hoffman Corp 921 N Highland Ave Hollywood 38 Calif
Standard Coil Products Co 2085 N Hawthorne St Melrose Park Ill
Stavid Eng'g Inc US Hwy #22 Plainfield NJ
Techron Corp 254 Friend St Boston 14 Mass
Telephonics Corp Park Ave Huntington LI NY
Thompson Clock Co H C 38 Federal St Bristol Conn
Tri-Dex Co PO Box 1207 Lindsay Calif
United Electrodynamics Div United Geophysical Corp 1200 S Marengo Ave Pasadena Calif
Virginia Electronics Co River Rd at B & O RR Wash 16 DC
Walkirt Co 145 W Hazel St Inglewood 3 Calif
Webster Labs Inc Stanley 5225 W St Charles Rd Berkeley Ill
Wheeler Insulated Wire Co 150 E Aurora St Waterbury Conn

CAPACITORS, FIXED & VARIABLE

ACF Electronics 800 N Pitt St Alexandria Va
Aerovox Corp 740 Belleville Ave New Bedford Mass
Aerovox Corp Pacific Coast Div 2724 Peck Rd Monrovia Calif
Ajax Condenser Co 932 W Wrightwood Ave Chicago 14 Ill
Allen-Bradley Co 136 W Greenfield Ave Milwaukee 4 Wis
American Condenser Co 4410 N Ravenswood Ave Chicago 40 Ill
Astron Corp 255 Grant Ave E Newark NJ
Beck's Inc 298 E 5 St St Paul 1 Minn
Broadway Coil Co 5638 Broadway Chicago 40 Ill
Capacitor Corp 203 S Main St Stillwater Minn
Cardwell Electronics Productions Corp Allen D 97 Whiting St Plainville Conn
Centralab Div Glove-Union Inc 900 E Keefe Ave Milwaukee 1 Wis
Chicago Condenser Corp 3255 W Armitage Ave Chicago 47 Ill
Condenser Products Co Div New Haven Clock & Watch 140 Hamilton St New Haven 4 Conn
Cornell-Dubilier Electric Corp 333 Hamilton Blvd S Plainfield NJ
Deutschmann Corp Tobe 921 Providence Hwy Norwood Mass
DuMont Airplane & Marine Instruments 15 Williams St NY 5
Electrical Utilities Co 2425 St Vincent's Ave La Salle Ill
Electro Motive Mfg Co Willimantic Conn
Electron Products 430 N Halstead Pasadena Calif
El-Menco Willimantic Conn
Erie Resistor Corp 644 W 12 St Erie Pa
General Electric Co Apparatus Div 1 River Rd Schenectady 5 NY
Glenco Corp 212 Durham Ave Metuchen NJ
Good-All Electric Mfg Co Good-All Bldg Ogalala Neb
Gudeman Co 340 W Huron St Chicago 10 Ill
Gulton Mfg Corp 212 Durham Ave Metuchen NJ
Hansen Electronics Co 7117 Santa Monica Blvd Los Angeles 46 Calif
Herlec Corp Div Sprague of Wis Inc Grafton Wis
Illinois Condenser Co 1616 N Throop St Chicago 22 Ill
Maida Development 214 Academy St Hampton Va
Mallory & Co P R 42 So Gray St Indianapolis 6 Ind
Micomold Electronics Mfg Corp 1087 Flushing Ave Brooklyn 37 NY
Mitronics Inc 232 13 Ave Newark NJ
Mucon Corp 9 St Francis St Newark 5 NJ
Muter Co 1255 S Michigan Ave Chicago 5 Ill
National Capacitor Co 18 Webster St Brookline 46 Mass
Onondago Pottery Co Electronics Div 1858 W Fayette St Syracuse NY
Phen-O-Tron Inc 455 Main St New Rochelle NY
Philco Corp C & Tioga Sts Phila 34 Pa
Photocircuits Corp Glen Cove NY
Plet Mfg Corp 225 Belleville Ave Bloomfield NJ
Potter Co 1950 Sheridan Rd N Chicago Ill
Pyramid Electric Co 1445 Hudson Blvd N Bergen NJ
Radio Condenser Co Davis & Copewood Sts Camden 3 NJ
Sanders Associates Inc 137 Canal St Nashua NH
San Fernando Electric Mfg 1509 1 St San Fernando Calif
Sangamo Electric Co Box 7 Marion Ill
Sangamo Generators Sub Sangamo Electric Co Springfield Ill
Skottie Electronics 204 Bridge St Peckville Pa
Solar Mfg Corp E 46 & Seville Los Angeles 58 Calif
Southern Electronics Corp 239 W Orange Grove Ave Burbank Calif
Sprague Electric Co Marshall St North Adams Mass
Stackpole Carbon Co Tannery St St Marys Pa
Standard Condenser Corp 3749 N Clark St Chicago 13 Ill
Stupakoff Ceramic & Mfg Div Carborundum Co Latrobe Pa
Sylvania Electric Products 1740 Broadway NY 19
TV Hardware Mfg Co 919 Taylor Ave Rockford Ill
United Condenser Corp 3400 Park Ave NY 56
United Electronic Mfg Corp 542 39th St Union City NJ

COATINGS

Beck's Inc 298 E 5 St St Paul 1 Minn
Bigelow Chemical Products 98 Bigelow St Quincy 69 Mass
Biggs Co Carl H 2255 Barry Ave Los Angeles 64 Calif
Borden Co Chemical Div 350 Madison Ave New York 17 NY
Borthig Co George C PO Box 115E Rutherford NJ
Central Coil Co 1720 N Luett St Indianapolis 22 Ind.
Dolph Co John C Monmouth Junction NJ
Dwyer Eng'g Co PO Box 483 Nashua NH
Electronic Plastic Corp 130 St & 90 Ave Queens 18 NY
General Cement Mfg Co 919 Taylor Ave Rockford Ill
Haynes Laboratories Inc C W 61 Chandler St Sprinfield 4 Mass
Industrial Accessories Inc 77 S Broadway Long Branch NJ
Insulated Circuits Inc 115 Roosevelt Ave Belleville NJ
Javex Box 646 Redlands Calif
Lacquer & Chemical Corp 214 40th St Brooklyn 32 NY
Londom Chemical Co 1535 N 31 Ave Melrose Park Ill
Mackay Inc A D 198 Broadway NY 38
Mallincrodt Chemical Works 2nd & Mallincrodt Sts St Louis 7 Mo
Metz Refining Co 369 Mulberry St Newark 2 NJ
Micro-Circuits Co New Buffalo Mich
Minnesota Mining & Mfg Co 900 Fauquier Ave St Paul 6 Minn
PCA Electronics 2180 Colorado Ave Santa Monica Calif
Sampson Chemical & Pigment Corp 2830 W Lake St Chicago 12 Ill
Steel Protection & Chemical Co Bridge St Mooresville Ind
Technic Inc 39 Snow St Providence 3 RI
Techron Corp 254 Friend St Boston 14 Mass
Zophar Mills Inc 112 26 St Brooklyn 32 NY

COILS

Ace Coil & Electronics 916 Lincoln Hwy Metuchen NJ
Aerovox Corp Pacific Coast Div 2724 Peck Rd Monrovia Calif
All-Tronics Inc 45 Bond St Westbury NY
Arted Co 367 Worthington St Springfield 3 Mass
Automatic Mfg Corp 65 Gouverneur St Newark 4 NJ
Automatic Processing Co 1335 N Wells St Chicago 10 Ill
Beck's Inc 298 E 5 St St Paul 1 Minn
Better Coil & Transformer Corp 2000 Main St Goodland Ind
Broadway Coil Co 5638 Broadway Chicago 40 Ill
Cambridge Themionic Co 445 Concord Ave Cambridge 38 Mass
Cardwell Electronics Productions Allen D Plainville Conn
Centralab Div Globe-Union Inc 900 E Keefe Ave Milwaukee 1 Wis
Central Coil Co 1720 N Luett St Indianapolis Ind
Centran Inc PO Box 168 Greensburg Ind
Ceramet Co 5905 Broadway NY 63
Coilcraft Inc Jandus Rd Cary Ill
Dwyer Engineering Co PO Box 483 Nashua NH

(Continued on page 80)

Eaton Associates Moodus Conn
Electrolab Inc 76 Atherton St Boston 30 Mass
Electrometic Inc 106 Olson St Woodstock Ill
Essex Electronics 550 Springfield Ave Berkeley Heights NJ
Gavitt Wire & Cable Co Div American Hard Rubber Brookfield Mass
General Cement Mfg Co 919 Taylor Ave Rockford Ill
General Instrument Corp 65 Gouverneur St Newark 4 NJ
Hansen Electronics Co 7117 Santa Monica Blvd Los Angeles 46 Calif
Johnson Electronics Inc 521 Elwell St Orlando Fla
Keystone Products Co 904 23 St Union City NJ
Lear Inc 3171 S Bundy Dr Santa Monica Calif
Methode Mfg Corp 2021 W Churchill St Chicago 47 Ill
Microtran Div Crest Labs 84-11 Rockaway Beach Blvd Rockaway Beach LI NY
National Coil Co PO Box 1237 Sheridan Wyo
North Hills Electric Co 203-18 35 Ave Bayside 61 NY
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Phen-O-Tron Inc 455 Main St New Rochelle NY
Photocircuits Corp Sea Cliff Ave Glen Cove NY
Printed Circuits Inc 36 Tunxis Ave Bloomfield Conn
QLC Corp 409 Main St Greenport LI NY
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Sanders Associates Inc 137 Canal St Nashua NH
Stanwyck Winding Co 137 Walsh Ave Newburgh NY
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Techron Corp 254 Friend St Boston 14 Mass
Tele Coil Co 2733 Saunders St Camden 5 NJ
Teleradio Eng'g Corp Wilkes-Barre Pa
Tel-Rad Electronics Corp 73-20 Trotting Course Lane Glendale 27, NY
Thordarson-Meissner Mfg Div Maguire Industries Inc 7th & Belmont Mt Carmel Ill
Tri-Dex Co PO Box 1207 Lindsay Calif
Union Spring & Mfg Co 1057 Summit Ave Jersey City 7 NJ
Wheeler Insulated Wire Co 150 E Aurora St Waterbury Conn
Wilco Corp 546 Drover St Indianapolis 21 Ind

CONNECTORS

Aircraft-Marine Products 2100 Paxton St Harrisburg Pa
Alden Products Co 123A N Main St Brockton Mass
Amphenol Electronics Corp 1830 S 54 Ave Chicago 50 Ill
Anton Electronic Labs 1226 Flushing Ave Brooklyn 37 NY
Armel Electronics Inc 840 Fifth Ave Brooklyn 32 NY
Beck's Inc 298 E 5 St St Paul 1 Minn
British Electronic Sales 23-03 45 Rd Long Island City 1 NY
Buggie Inc H H PO Box 187 Toledo 1 Ohio
Cambridge Thermionic Co 445 Concord Ave Cambridge 38 Mass
Cannon Electric Co 3209 Humboldt St Los Angeles 31 Calif
Cinch Mfg Co Jones Div 1026 S Homan Ave Chicago 24 Ill
Circon Component Co Santa Barbara Municipal Airport Goleta Calif
Citation Products Co 233 E 146 St NY 51
Connector Corp 6025 N Keystone Ave Chicago 30 Ill
Continental Connector Corp 30-30 Northern Blvd Long Island City 1 NY
Dage Electric Co 67 N 2 St Beech Grove Ind
Danbury Knudsen Inc PO Box 170 Danbury Conn
Defiance Eng & Microwave Corp 81 Albion St Wakefield Mass
DeJur-Amsco Corp 45-01 Northern Blvd Long Island City NY
Eagle Electronics Corp 177 Hart St New Britain Conn
Eby Co Hugh H 4701 Germantown Ave Philadelphia 44 Pa
Elco Corp M St below Erie Ave Phila 24 Pa
Garde Mfg Co 588 Eddy St Providence 3 RI
General Cement Mfg Co 919 Taylor Ave Rockford Ill
General Electric Co Wiring Develice Dept 95 Hathaway St Providence 7 RI
Gorn Electric Co Stamford Conn
Graphic Circuits Div Cinch Mfg Corp 221 S Arroyo Pkwy Pasadena 1 Calif
Herlec Corp 6th & Beech St Crafton 1 Wis
Hermetic Seal Products Co 37 S 6 St Newark 7 NJ
Hubbell Inc Harvey State St & Bostwick Ave Bridgeport Conn
Industrial Products Box 148 Danbury Conn
Insuline Corp of America 186 Granite St Manchester NH
Johnson & Hoffman Mfg Corp 31 E 2nd St Mineola NY
Lerco Electronics 501 S Varney St Burbank Calif
Malco Tool & Mfg Co 4025 W Lake St Chicago 24 Ill
Mallory & Co P R 420 S Gray St Indianapolis 6 Ind
Methode Mfg Corp 2021 W Churchill St Chicago 47 Ill
Microdot Inc 1826 Fremont Ave S Pasadena Calif
National Fabricated Products Inc 2650 W Belden Chicago 47 Ill
Pix Mfg Co 75 Hudson St Newark 3 NJ
Precision Metal Products Co 41 Elm St Stoneham 80 Mass
Richardson Co 5860 Spring Oak Dr Hollywood 28 Calif
Richardson Co 2790 Lake St Melrose Park Ill
Sanders Associates Inc 137 Canal St Nashua NH
Teleradio Eng'g Corp Wilkes-Barre Pa
Ucinite Co Div United-Carr Fastener 459 Watertown St Newtonville Mass
Union Electric & Machine Corp Moulton & Monroe St Georgetown Mass
U S Components Inc 454 E 148 St NY 55
Vector Electronic Co 3352 San Fernando Rd Los Angeles 65 Calif
Viking Electric 21343 Roscoe Blvd Canoga Park Calif
Volkert Stampings Inc 222-34 96th Ave Queens Village 29 NY
Waltham Horological Corp 711 Broad St Lynn Mass
Winchester Electronics Willard Rd Norwalk Conn

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Allied Photo Engravers 153 W Huron St Chicago 10 Ill
American Printed Circuits Co Box 282 Metuchen NJ
Breck's Inc 298 E 5 St St Paul 1 Minn
Brubaker Mfg Co 9151 Exposition Dr Los Angeles 34 Calif
California Plasteck Inc 225 E 4 St Los Angeles 13 Calif
Continental-Diamond Fibre Div Budd Co Newark Del
Erie Resistor Corp 644 W 12 St Erie 6 Pa
Farley & Loetscher Mfg Co Dubuque Iowa
Farnsworth Electronics Co—Div IT&T Corp PO Box 810 Fort Wayne Ind
Formica Co 4614 Spring Grove Ave Cincinnati 32 O
Glass Products Co 6911 S Chicago Ave Chicago 37 Ill
Hallamore Mfg Co 2001 E Artesia Long Beach 5 Calif
Lamtex Ind Inc 51 State St Westbury NY
Long Inc Thomas J 215 Stonehinge Lane Carle Place LI NY
Mica Corp 4031 Elenda Street Culver City Calif
Murray Plastics Co 26 Cottage St Poughkeepsie NY
National Vulcanized Fibre Co PO Box 311 Wilmington 9 Del
Photo Chemical Products 479 Walton Ave NY 51
Photocircuits Corp Sea Cliff Ave Glenn Cove NY
"Q" Circuits 32 Laskie St San Francisco 3 Calif
Revere Copper & Brass Inc 230 Park Ave NY 17
Richardson Co 2790 Lake St Melrose Park Ill
RS Electronics Corp PO Box 368 Sta A Palo Alto Calif
Sanders Associates 137 Canal St Nashua NH
Sel-Rex Precious Metals Inc 229 Main St Belleville 9 NJ
Shamban Eng'g Co 11617 W Jefferson Blvd Culver City Calif
Spaulding Fibre Co 310 Wheeler St Tonawanda NY
Stavid Eng'g Inc US Hwy #22 Plainfield NJ
Synthane Corp Montgomery Ave Oaks Pa
Taylor Fibre Co Norristown Pa
Technograph Printed Electronics Inc 185 Valley St Tarrytown NY
Teleradio Eng'g Corp Wilkes-Barre Pa
Tingstol Co 1461 W Grand Ave Chicago 22 Ill
Trimount Plastics Co 71 Dudley St Arlington Mass

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ACF Electronics Div ACF Industries Inc 800 N Pitt St Alexandria Va
Admiral Corp 3800 Cortland St Chicago 47 Ill
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Aerovox Corp Pacific Coast Div 2724 Peck Rd Monrovia Calif
Airflyte Electronics Co 21 Cottage St Bayonne NJ
Alden Products Co 117 N Main St Brockton 64 Mass
Allied Engraving & Stamping 17 Elm St Buffalo 3 NY
Amelco Inc 2040 Colorado Ave Santa Monica Calif
American Metaseal Co 3337 Lincoln Ave Franklin Park Ill
American Printed Circuits Co Box 282 Metuchen NJ
Ansley Mfg Co Arthur New Hope Pa
Atlas E-E Corp Bedford Airport Terminal Bldg Bedford Mass
Austin O 128 32 St Brooklyn 32 NY
Autel Electronics Co 1947 Framingdale Rd Westfield NJ
Automatic Processing Co 1335 N Wells St Chicago 10 Ill
Beck's Inc 298 E 5 St St Paul 1 Minn
Bendix Aviation Corp Bendix Computer Div 5630 Arbor Vitae St Los Angeles 45 Calif
W H Brady Co 727 Glendale Ave Milwaukee 12 Wis
Broadway Coil Co 5638 Broadway Chicago 40 Ill
Brubaker Mfg Co 9151 Exposition Dr Los Angeles 34 Calif
Buckbee Mears Co Lindeke Bldg St Paul 1 Minn
Burnell Co Inc 45 Warburton Ave Yonkers 2 NY
California Plasteck Inc 225 E 4 St Los Angeles 13 Calif
Cardwell Electronics Production Allen D Plainville Conn
Centralab Div Globe-Union Inc 900 E Keefe Ave Milwaukee 1 Wis
Centronics Co 21-04 122 St College Point 56 NY
Cinch Mfg Co Jones Div 1026 S Homan Ave Chicago 24 Ill
Circon Component Co Santa Barbara Municipal Airport Goleta Calif
Circuitron Inc 155 W Main St Rockville Conn
Citation Products Co 233 E 146 St NY 51
Continental-Diamond Fibre Div Budd Co Newark Del
Cornell-Dubilier Electric Corp 333 Hamilton Ave S Plainfield NJ
Cramer Co 5905 Broadway NY 63
Croname Inc 3701 Ravenswood Ave Chicago 13 Ill
Davelle Labs Inc 145-68 228 St Springfield Gardens 13 NY
Daystrom Instrument Archbald Pa
Defiance Eng & Microwave Corp 81 Albion St Wakefield Mass
Demco Products PO Box 5042 Phila 11 Pa
Dwyer Engineering Co PO Box 483 Nashua NH
Eaton Associates Moodus Conn
Eby Co Hugh H 4701 Germantown Ave Phila 44 Pa
Electralab Div Farrington Co Needham Heights Mass
Electrolab Inc 76 Atherton St Boston 30 Mass
Electrochemical Industries Jacques St Worcester 3 Mass
Electronic Mechanics Inc 101 Clifton Blvd Clifton NJ
Electronic Control Systems 2136 Westwood Blvd Los Angeles 25 Calif
Electronic Specialty Co 5121 San Fernando Rd Los Angeles 39 Calif
Electron-Radar Products 1041 N Pulaski Rd Chicago 51 Ill
Elm Labs 18 S Broadway Dobbs Ferry NY
El Mec Labs 730 Blvd Kenilworth NJ
Emerson Radio & Phonograph Corp 14 & Coles Sts Jersey City 2 NJ
Eng'g Research & Development Co Addison Ill
Erie Resistor Corp 644 W 12 St Erie 6 Pa
Espey Mfg Corp 528 E 72 St NY 21
Etched Products Cor 39-01 Queens Blvd Long Island City 4 NY
Farnsworth Electronics Co Div IT&T Corp PO Box 810 Fort Wayne Ind
Farrington Mfg Co 76 Atherton St Boston Mass
Federal Telephone & Radio Co Div IT&T 100 Kingsland Rd Clifton NJ
Flett Laboratory 3711 Marshall Rd Drexel Hill Pa
Ford Instrument Co Div Sperry Rand Corp 31-10 Thomson Ave Long Island City 1 NY
Formica Co 4614 Spring Grove Ave Cincinnati Ohio
Gavitt Wire & Cable Co Div American Hard Rubber Brookfield Mass
General Electric Co Broadcast Equip & Commercial Equipment Div-Electronics Park Syracuse NY
General Electric Co Components Dept Auburn NY
General Electric Co PO Box 1122 Syracuse NY
General Precision Lab 63 Bedford Rd Pleasantville NY
Glass Products Co 6911 S Chicago Ave Chicago 37 Ill
Glenco Corp 212 Durham Ave Metuchen NJ
Goldak Co 1544 W Glenoaks Blvd Glendale 1 Calif
Graphik Circuits Div Cinch Mfg Corp 221 S Arroyo Pkwy Pasadena 1 Calif
Gulton Mfg Corp 212 Durham Ave Metuchen NJ
W & L E Gurley 514 Fulton St Troy NY
Hallamore Mfg Co 2001 E Artesia Long Beach 5 Calif
Hanson Electronics Co 7117 Santa Monica Blvd Los Angeles 46 Calif
Herlec Corp 6th & Beach Sts Grafton Wis
Hi-Q Aerovox Corp Olean NY
Hubbell Inc Harvey State St & Bostwick Ave Bridgeport Conn
Hugh Eby Co 4701 Germantown Ave Phila 44 Pa
Isolanite Mfg Corp Warren Ave Stirling NJ
Insulating Fabricators of N E 69 Grove St Watertown 72 Mass
Insuline Corp of America 186 Granite St Manchester NH
Integrated Mica Corp 202 Franklin Pl Woodmere LI NY
Interelectronics Corp 2432 Grand Concourse NY 58
International Crystal Mfg 18 N Lee Ave Oklahoma City 2 Okla
International Resistance Co 401 N Broad Phila 8 Pa
Javex Box 646 Redlands Calif
Johnson Labs Willard Rd Norwalk Conn
Lambda-Pacific Eng'g Inc PO Box 105 Van Nuys Calif
Lear Inc 3171 S Bundy Dr Santa Monica Calif
Lectra Inc 153 W Huron St Chicago 10 Ill
Librascope Inc 808 Western Ave Glendale 1 Calif
Magnavox Co Fort Wayne 4 Ind
Mallory & Co Inc P R 42 So Gray St Indianapolis 6 Ind
Maryland Electronic Mfg Corp 5009 Calvert Rd College Park Md
Methode Mfg Corp 2021 W Churchill St Chicago 47 Ill
Micro-Circuits Co New Buffalo Mich
Mitronics Inc 232 13th Ave Newark NJ
Molded Insulation Co 335 E Price St Phila 44 Pa
Mycalex Corp of America 125 Clifton Blvd Clifton NJ
Nameplates Inc 425 E 101 St Brooklyn 12 NY
North American Model Products 9802 Warwick Rd Warwick Va
Onondaga Pottery Co Electronics Div 1858 W Fayette St Syracuse NY
Pacific Industrial Electronics 521 5 St San Francisco 3 Calif
Patterson Moos Div Universal Winding Co 90-28 Van Wyck Expressway Jamaica 18 NY
PCA Electronics Inc 2180 Colorado Ave Santa Monica Calif
Permanent Label Corp 578 Summit Ave Jersey City 6 NJ
Phen-O-Tron Inc 455 Main St New Rochelle NY
Photo Chemical Products 479 Walton Ave NY 51
Photocircuits Corp Sea Cliff Ave Glen Cove NY
Plastic Accessories Inc 93 Mercer St NY 12
Plastic & Electronics Co 272 Northland Ave Buffalo 7 NY
Precision Metal Products Co 41 Elm St Stoneham 80 Mass
Printed Circuits Inc 36 Tunxis Ave Bloomfield Conn
Printed Electronics Corp 7 North Ave Natick Mass
"Q" Circuits Co 32 Laskie St San Francisco 3 Calif

(Continued on page 122)

New Test Equipment

VTVM

New vacuum Tube Voltmeter (Type LV-10), for laboratory and industrial testing, incorporates an AC voltmeter covering a range from audio to UHF frequencies; a

DC voltmeter with 100 megohms input resistance; and an ohmmeter capable of measuring resistance from 0 to 1000 megohms. Accurate measurements to 700 mc, and voltage measurements as high as 32,000 v DC and 1600 v AC. **RCA, Camden,** N. J. ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-13).

TRANSISTOR CHECKER

Simple, accurate junction transistor checker measures collector leakage with base grounded, collector current at zero base current (base open) and base to collector current gain at 4.5 v. on the collector. Self-powered. Meter

reads gain directly. Pin jacks connect to base emitter and collector circuits for plugging in clip leads. $31.50. **Instant Circuits, Div. of Alfred W. Barber Labs.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-14).

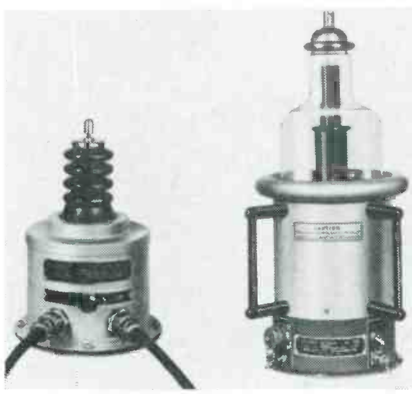
MICROWAVE SIG. GEN.

Ultra broadband microwave signal generator, Model MSG-34, covers S, C, and X Band frequencies —4200 to 11,000 mc—with a power output of 1 mw. Features

include: provision for external modulation by multiple pulses; automatically tracked power monitor; and non-contraction oscillator choke. Internal pulse and square wave modulation from 10 to 10,000 pps at pulse widths of 0.2 to 10 μsecs. **Polarad Electronics Corp., Long Island City,** N. Y. ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-15).

CAPACITANCE DIVIDERS

Two capacitance voltage dividers for accurate measurement of peak pulse voltages pulse of ¼ to 10 μsec duration or continuous wave frequencies from 5000 cycles to 10 MC. Accuracy — ±5%. Model VD-35 has a 35,000 peak



volts and division ratios of 200 to 1 and 50 to 1. Model VD-100 from 250 to 100,000 peak volts, and division ratios of 500 to 1, 100 to 1, and 10 to 1. **Press Wireless Labs, Inc., distributed by Vectron, Inc.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-16).

L-F OSCILLOSCOPE

Low frequency oscilloscope, Model 130A, has nearly identical horizontal and vertical amplifiers. The amplifiers provide a maximum sensitivity of 1 mv/cm or 10 mv

full scale deflection with pass bands from dc to 300 kc, and can accept balanced inputs on the five most sensitive ranges. **Hewlett-Packard Co., Palo Alto, Calif.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-17).

BARRETTER BRIDGE

Model 202-C Standard Barretter Bridge is designed to measure the voltage and power of high-frequency signals in the range of 2 MC to 1000 MC. Resistive pads can be used to extend the voltage and power ranges upward. Bridge

network of the Model 202-C contains a Bolometer which produces a resistance unbalance proportional to the signal. **Measurements Corp., Boonton, N. J.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-18).

New Laboratory Equipment

TOROIDAL TAPE WINDERS

A series of automatic tape winding machines for the toroidal coil field whose operational performances feature: core turning table with automatic feed, variable

pitch control and special manual feeding attachment for hand winding. Models U-9, U-14, and U-20, to wind tape from ⅜ in. to 1 in. **Universal Manufacturing Co., Hillside, N. J.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-19).

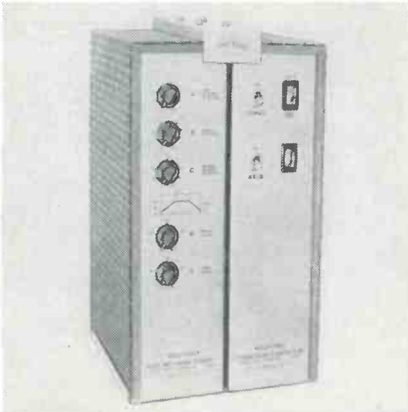
ROTARY SWITCH

New rotary switch, type 32 CM, is 1¾ in. in diameter by 1 11/16 in. in depth. Has 3 poles on a single deck; may be ordered with as many as 9 positions/pole with shorting type action, or 5 positions/pole with non-shorting type action. Solid silver alloy con-

tacts, rotors and slip rings, and gold plated turret solder lug. Rotor and stator material is XXXP phenolic. **The Daven Co., Livingston, N. J.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-20).

AC WELDING CONTROL

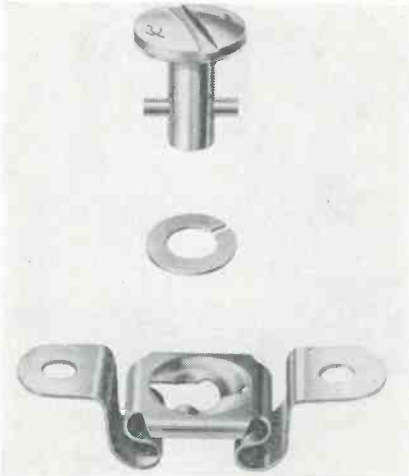
AC resistance welding control, the Raytheon Heat Program Timer, makes possible the spot welding of metal surfaces coated with oxide, grease, carbon, etc.



Timer provides for small parts welding on a production basis. Used with a 2 or 5 KVA thyratron contactor and welding transformer, the timer provides current which varies according to a pre-established "Program". **Raytheon Mfg. Co., Waltham, Mass.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-21).

FASTENER

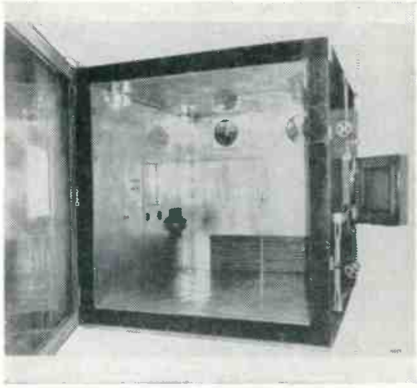
New quarter-turn, 5F Fastener, small and light weight, provides a high strength-weight ratio particularly adaptable to thin materials and miniaturized equipment. For use on miniaturized equipment like airborne electronics,



small electro-mechanical and computing devices and communications components. **Camloc Fastener Corp., Paramus, N. J.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-22).

LOW-TEMP. CHAMBER

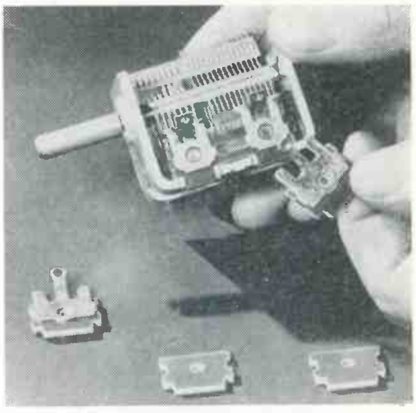
The low-temperature environmental test chamber permits constant interior adjustments without sharp environmental tempera-



ture changes. This low-temperature test chamber has a range of —100°F to +220°F (+2°F); relative humidity range of 20% to 95%, 35°F to 180°F, 35°F minimum dew point; special operation of 5% to +160°F; heat dissipation load of 30,000 BTU/hr. at —70°F. **Tenney Engineering Inc., Union, N. J.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-23).

PHENOLIC LAMINATE

New electrical grade laminate, Phenolite E-2040, for applications where extremely low cold flow are important, is a paper-base sheet laminate bonded with a special phenolic resin. Features include low moisture absorption and good



dielectric strength, and ease of hot punching and shearing. In sheets up to 39 x 47 in. and thicknesses of from .010 in. to ¼ in. **National Vulcanized Fibre Co., Wilmington, Del.** ELECTRONIC INDUSTRIES & Tele-Tech (Ref. No. 10-24).

Checking Transistors

(*Continued from page* 58)

Constant Current Supply

The circuit of this supply is shown in Fig. 2. It is designed to supply accurately constant current over an output voltage range of 0 to 300 v. Three currents, 10, 10^2, and 10^3 μa are available but others both within and outside this range could be obtained with only minor modifications.

Two floating voltage supplies are used in the constant current supply. The circuit of one of them is presented in Fig. 3. It is conventional except that both output terminals are isolated from ground. The 88-v. supply is similar except that only one 5651 stabilizer tube is employed, together with larger isolating resistors.

Circuit Operation

Operation of the circuit is as follows. The external current to be held constant flows also in the series resistors adjacent switch S_2. The resulting voltage drop (near 175 v.) minus the bias necessary for tube V_2-B is balanced against the highly stabilized output of the 175-v. floating supply. Any differ-

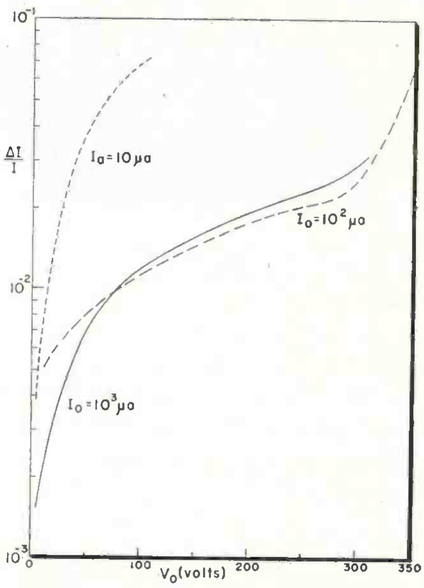


Fig. 5: Results of current stability tests

ence is amplified by the cascode amplifier V_2, passes through the cathode follower V_1-B and determines the bias voltage of the series tube V_1-A. Phase relations are such that the error voltage applied to V_1-A changes its series current in

(*Continued on page* 84)

For product information, use inquiry card on page 113.

(*Continued from page* 82)

such sense that the error is reduced by the feedback. The variable series resistors near S_2 are used to adjust the external current to exactly the rated value for each switch position. It will be noted that either output terminal may be grounded. The 0.1 μf capacitors bridging the floating supplies contribute to the speed of response of the circuit.

Amplifier

The cascode amplifier formed by the two halves of V_2 differs from a usual cascode circuit by the addition of the 560K resistor feeding the plate of V_2-B. The additional current supplied by this resistor greatly increases the g_m of V_2-B which, in turn, increases the voltage gain of the circuit.[2] The gain for a signal applied between grid and cathode of V_2-B and measured at the plate of V_2-A is 4000, an order of magnitude larger than that obtained without the 560K resistor.

A measure of the success of the circuit in holding a given output current, I_0, constant is the relative change in I, $\Delta I/I_0$, versus output voltage. To make such measurements, the output voltage was changed by varying an accurately known resistor across the output. Fig. 5 shows the results obtained for the three nominal current ranges. These currents were adjusted to their correct values at essentially zero output voltage.

It will be noted that for $I_0 = 100$ μa, the current has only deviated from its zero-voltage value by 2.5 percent at 300 v. output. In measuring BV_{CBO} this current value will be most used in the output voltage range of 50 to 200 v. Since the dependence of BV_{CBO} on current around 100 μa is small, deviations of the current from its nominal value of the order of one or two percent are entirely negligible.

Line Variations

Although the relative current deviation for 10 μa nominal current is seven percent at 100 v. output, this current range will generally be used in measuring h_{FE} with output voltages of only a volt or so, where the deviation is negligible.

(*Continued on page* 86)

(*Continued from page* 84)

The dependence of $\Delta I/I_0$ on line voltage has also been investigated. For $I_0 = 10^3$ μa, $\Delta I/I_0$ varied by about two percent for line voltages ranging from 105 to 130 v. RMS. Slightly greater variations were observed with I_0=100 μa, and 15 percent variation was observed over the range from 110 to 120 v. RMS for I_0=10 μa. This increased variation arises from the reduction of g_m of V_1-A caused by reduced heater voltage. When long-term constancy of I_0 is required for this range, the line voltage should be stabilized.

Although the equivalent supply voltage and internal resistance of the constant current supply vary with output voltage, their values for $I_0 = 100$ μa in the neighborhood of 10 v. output are 20,000 v. and 200 megohms respectively. At 100 v. output, they have decreased to 8700 v. and 87 megohms. These figures show what large supply voltages and series resistances would be required to duplicate the performace of this constant current supply without the amplification and negative feedback used.

Feedback Amplifier

The circuit of the feedback amplifier is presented in Fig. 4. A voltage proportional to transistor collector current is balanced in the input differential amplifier tube against a stabilized voltage set to -0.5 v.; the error signal is then amplified and appears at the output, which is connected to the emitter of the transistor. Thus, no matter what the h_{FB} or h_{FE} of the transistor, the circuit supplies the necessary emitter current (within the operating range of the amplifier) to produce 5 ma of collector current.

To ensure accurate balance between the input signal and the internal -0.5 v. signal, the input tube is a 6SU7, which is closely balanced. Further, the 600K wire-wound plate resistors for this tube are equal to better than one percent. There are two uncommon features in the circuit of Fig. 4. One is the use of diodes operating in their reverse breakdown region as dc coupling elements. In this region, a voltage drop nearly independent of current appears across them and their dif-

(*Continued on page* 89)

GRADUATE RESIDENCE CENTER ESTABLISHED AT LOS ALAMOS

Los Alamos Scientific Laboratory has completed arrangements with the University of New Mexico for the establishment of a Graduate Residence Center at Los Alamos. This program will provide the opportunity for employees and residents to meet all of the requirements for the master's degree in the physical sciences and engineering (including Nuclear Engineering) by attendance at evening classes. Some of these courses are taught by Laboratory personnel outstanding in their fields.

In addition, there are extensive course offerings in the undergraduate and technician training fields for those wishing to pursue academic training related to their jobs or for their own development.

Complete information about career opportunities and the academic training programs can be had by writing,

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* Motors are shown at same reduction as this photo of standard paper clip.

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ENGINEERS AND MANUFACTURERS

WG

(*Continued from page* 86)
ferential resistance is hence very low. In the present case, each diode drops approximately 100 v. The use of these diodes increases the gain of the amplifier by a factor of almost two.

Positive Feedback

The other uncommon feature is the use of direct-coupled positive feedback introduced by means of the 1.22 megohm resistor. Without this resistor, the input-output voltage gain of the amplifier is about 1600. When the resistor was connected and adjusted for maximum gain at low frequencies, a value exceeding 6 x 10^5 was measured. Even in the absence of output-input negative feedback such as that produced by connecting the output and input terminals together, the circuit was stable with this high gain and no oscillation could be produced with any value of the positive feedback resistor. Note that both sides of this resistor are at very nearly the same dc potential. The use of positive feedback to achieve a very high gain is economical and leads to an amplifier of high precision since the extremely high gain reduces the offset voltage between the input signal from the collector and the internal stabilized voltage to a negligible value and reduces the output impedance of the circuit when connected to a transistor to a fraction of an ohm and may even make the output impedance slightly negatitve.

To ensure that adequate emitter currents can be supplied, a high-g_m 5687 miniature double triode with sections paralleled is used as the output tube. The positive and negative supply voltages are derived from the two floating supplies of the constant-current circuit. For the present purpose, no gas-tube stabilization is used with these supplies.

As a test of the amplifier, its input and output were connected and the internal standard voltage adjusted to make the output exactly -0.500 v. as measured with the Fluke VTVM. On changing the line voltage from 105 to 135 v., no more than one mv change in this voltage was noted. Next, with complete feedback of output to input and

(*Continued on page* 90)

(*Continued from page 89*)

-0.5 v. output, loading of the output with resistances connected to ground was investigated. It was found that the output impedance was slightly negative, causing the magnitude of the output voltage to rise from a no-load value of 0.5000 v. to a maximum value of 0.5227 v. with 29 ohms load connected. Below 29 ohms load, the voltage was equal to the load resistance times the constant current of 18.4 ma. flowing in the cathode resistor of the output tube. If a larger limiting current were required, it could be obtained by increasing the quiescent current of the cathode-follower output stage. Without positive feedback, the output voltage was found to be essentially independent of load until a load of 30 ohms was reached, where the magnitude of the voltage had dropped to 0.4996 v. The above measurement together with operational tests employing transistors showed that the amplifier performed its function most satisfactorily.

References

1. We employ herein the letter-symbol nomenclature proposed for semiconductors by the IRE, 10 October 1955.
2. V. H. Attree, "A Cascode Amplifier Degenerative Stabilizer," Electronic Eng., Vol. 27, pp. 174-177; April 1955.

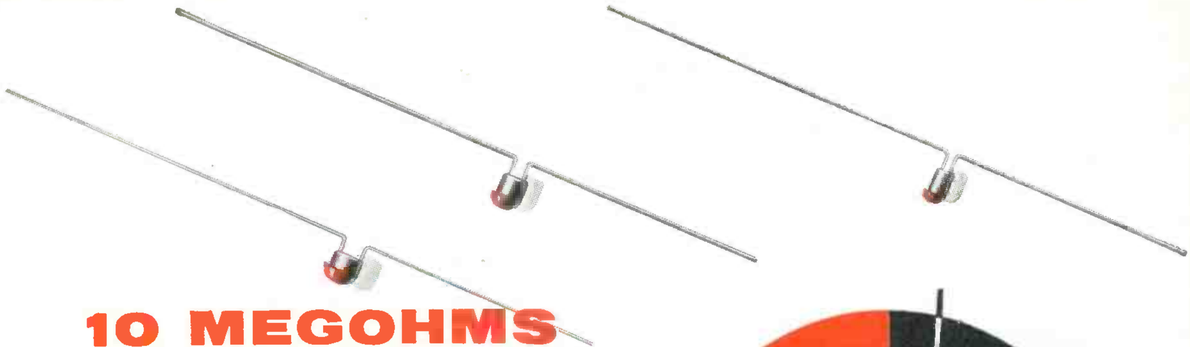
Police Forces to Try "Line-ups" via TV

Using a microwave radio link for closed-circuit telecasting of "line-ups," the police forces of Euclid, Ohio, and Cleveland are giving a two-month trial to such interchange of information by TV with temporary authority granted by the FCC.

Frequencies granted on a developmental experimental basis are in the area of 2090-2110 mc in the studio-transmitter link and remote TV pick-up band. Dage Electronics equipment is being used, and at no cost to either city for the trial.

3M's Gets into TV Tape Recording Field

Minnesota Mining & Mfg. Co., St. Paul, has entered the TV tape recording field through the purchase of the Electronic Engineering Div., Bing Crosby Enterprises, Los Angeles, for a reported $1,000,-000.



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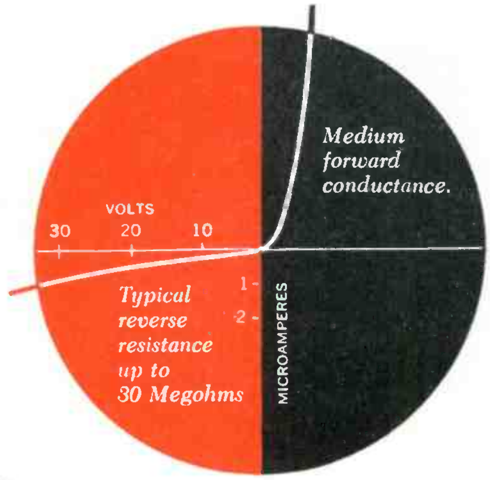

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Quartz Crystals

(*Continued from page* 53)

lel to the X-axis. The last column gives the thickness t parallel to the Z′ axis.

The mounting of these bars can be provided in the usual way by soldering small wires at the nodal points in the plane perpendicular to Z′.

An example of a bar excitable in the YX flexural mode, mounted as described above and sealed in a vacuum tube, is shown in Fig. 4. The frequency is 400 cps, the dimensions are l = 119 mm, b = 1.0 mm, t = 2 mm. The vibration of this bar can be made visible by high excitation, as shown in Fig. 5.

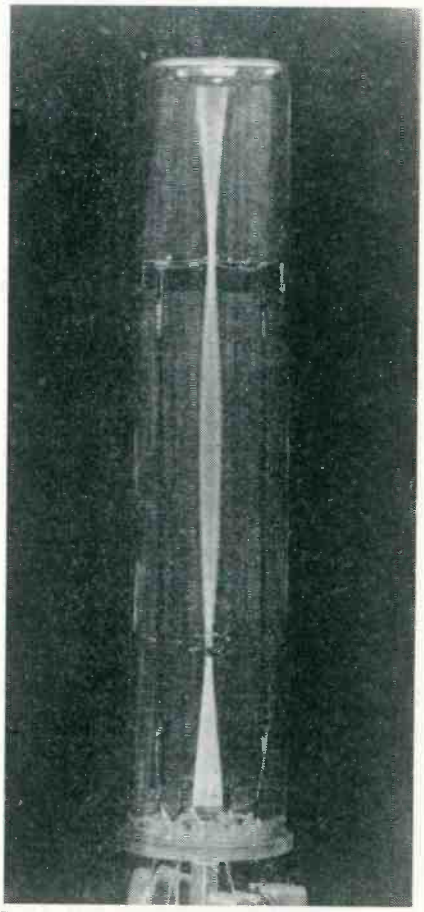

Fig. 5: Vibration of quartz bar in YX flexural mode under high excitation

The YX flexural mode shows a further advantage over the YZ flexural mode because of the difference in electrode arrangement: for the same frequency the cross section of the YX bar can be made considerably smaller since the required four electrodes are distributed on the four long surfaces instead of two. This method of excitation results furthermore in a reduction in the length of the bar, as follows from Eq. 5. The lower limit for the frequency is given by the size in the Y-direction of the quartz crystal available and the practical lower limit of the width of the bar.

Synthetic Quartz

Large quartz stones are required for the production of flexural mode bars vibrating in audio frequencies since the Y-dimension required is relatively long. Such stones of natural quartz tend to be in short supply and rather expensive.

Synthetic quartz crystals of the new Y-bar type are particularly well adapted for processing into flexural mode bars.[1] These crystals are normally grown such that the length in the Y-direction is about 6½", and the cross section about 1¼" in the Z-direction and ⅝" in the X-direction.

The length of the crystals nearly parallels the long dimension required in a resonator, and the height (Z-direction) is ample for cutting +5°X bars and NT cuts with excellent efficiency with respect to the material.

The crystals are grown from high purity silica at relatively high pressure and temperature in an alkaline solution confined in suitable pressure vessels of special steel.

The quality of synthetic quartz is high, being free of twinning and greater than 90% usable. The crystals have natural faces which aid orientation for cutting. The synthetic crystal is produced in one optical form. Currently this is the right-handed, although left-handed bars can be made available. This similarity of form is a further convenience for the production of flexural resonators.

The ordinary synthetic quartz crystal of the Y-bar type undergoes a small waste of material when it is trimmed at the +5° angle. A recent development avoids this loss: It has been found possible by choice of seed orientation to grow quartz such that the synthetic crystals have approximately the +5° orientation in its length. This means that in the production

(*Continued on page* 94)

(*Continued from page* 93)

of the resonators the quartz crystal is cut substantially parallel to its length.

In the same way the length of the crystal can be oriented in the growth process to other angles in the vicinity of +5°.

It happens further that the crystal oriented at about +5° with respect to the Y-axis grows faster than the usual Y-bar crystal by about 11%, thus providing an additional economy.

Table I

f kc/s	l mm	b mm	t mm
.5	117	1.2	2
1.0	93	1.5	2
2.5	59	1.5	2
5.0	42	1.5	2
7.5	34	1.5	2
10	29	1.5	2
15	26	1.8	2
20	27	2.5	2
25	24	3.0	2

References

1 Bechmann, R. and D. R. Hale, "Electronic Grade Synthetic Quartz," Brush Strokes (Brush Electronics Co., Cleveland) Vol. 4, No. 1, pp. 1-7, 1955.
2 Beckerath, H. von, "Piezoelectrically excited audio frequency flexural vibrations of quartz bars having very small temperature dependence," Verhandlungen der Deutschen Physikalischen Gesellschaft, Vol. 23, p. 92, 1942.
3 Mason, W. P. and R. A. Sykes, "Low-frequency quartz crystals having low temperature coefficients," Proc. Inst. Radio Eng., Vol. 32, pp. 208-215, 1944.

Notes: At the time of the project on which above material was based, Dr. Bechmann was employed at Clevite Research Center, Cleveland.

The Y-bar synthetic quartz crystal was developed for the U.S. Signal Corps under contract.

AM for Polar Routes

Transmitting equipment for three radio stations in Greenland has recently been supplied by Marconi's Wireless Telegraph Co., Ltd., Chelmsford, Essex, England. One station is to be used for ground-to-air communications on the Trans-Atlantic and Trans-Polar air routes from Europe to North America. The other two stations will serve Scandinavian Airlines System's Trans-Polar route from Scandinavia to Tokyo. Each station will have a dual installation of Type HC.205 transmitters—one for operation, one for standby. One station is to be installed at the world's northernmost radio location, less than 600 miles from the Pole.

All Hughes diodes resemble each other—externally. Germanium point-contact or silicon junction, they are all glass-bodied* and tiny (actual dimensions: 0.265 by 0.105 inch). But minute, meticulously controlled variations in the manufacturing process impart individual characteristics to the diodes, make them just right for specific applications. This gives you the opportunity of selecting from a line which includes literally hundreds of diode types.

So, when your circuitry requires varying combinations of such characteristics as . . . high back resistance . . . quick recovery . . . high conductance . . . or high temperature operation, *specify Hughes*. You will get a diode with mechanical and electrical stability built in. You will get a diode which was manufactured first of all for reliability.

*Nowhere else have glass packaging techniques been developed to a comparable extent, for the Hughes process has many unique aspects. They are difficult to duplicate, yet are instrumental to the manufacture of diode bodies which are completely impervious to contamination and moisture penetration.

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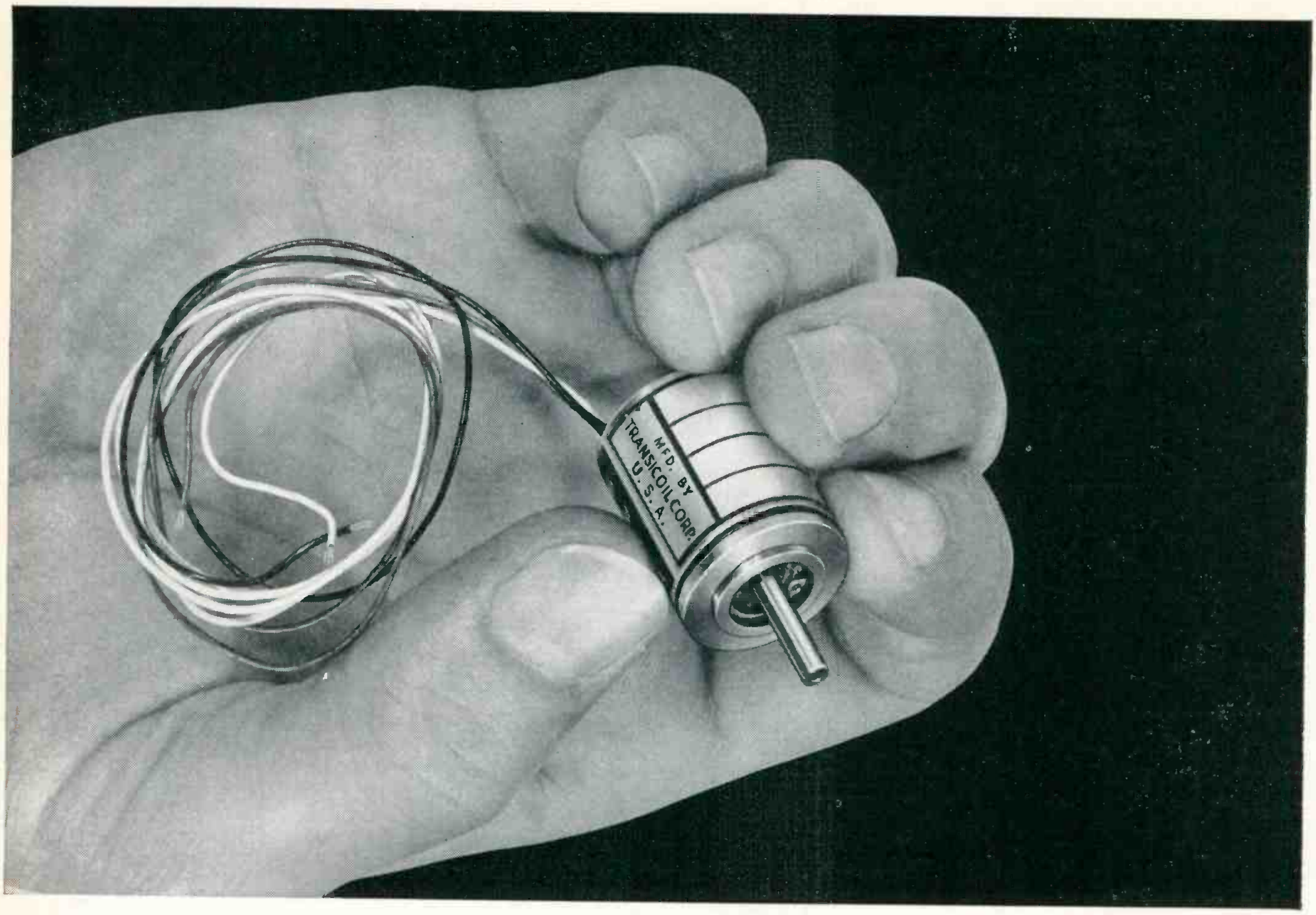
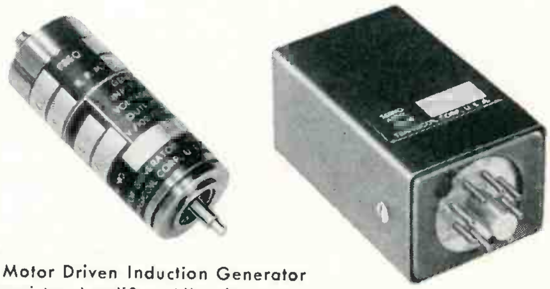


NEW Size 8 servo combination rivals Size 9 performance



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Compared with a Size 9 control motor—until now, the smallest practical unit available—Transicoil's new Size 8 measures only 0.75 inches in diameter, 10% smaller, and weighs only 1.4 oz., 40% lighter. Yet it operates on standard voltages from 26 to 52 volts, and 52 volts with center tap, at 400 cps, permitting push-pull transistor application.

Hence, just as Transicoil's introduction of plate to plate wiring eliminated the transformer, once necessary in servo systems, the Size 8 units and transistor amplifiers mark another milestone in miniaturization.

This is just one more example of how Transicoil can solve your control problems whether they involve miniaturization or control complexity, and go on to manufacture systems and components of the utmost precision and accuracy. You pay only for results—on a fixed fee basis for equipment delivered and performing properly.

Technical data on the new Size 8 combination and the transistorized amplifier is yours for the asking. But you'll end up with a better system if you write outlining your servo control problem.

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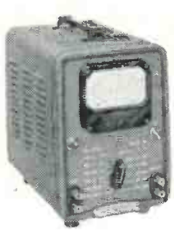

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-hp- 410B, industry's standard for vhf-uhf voltage measurements. Wide range 20 cps to 700 MC, response flat within 1 db full range. Diode probe places 1.5 μμf capacity across circuit under test; this plus 10 megohm input impedance prevents disturbance. Instrument combines highest quality ac voltmeter with dc voltmeter (122 megohm input impedance) and ohmmeter covering 0.2 ohms to 500 megohms. $245.00

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BOOKS

Elements of Pulse Circuits

By F. J. M. Farley, Published 1956 by John Wiley & Sons, Inc., 440 Fourth Ave., N.Y.C. 16, N.Y. 151 pages. Price $2.00.

This book is addressed primarily to physicists and research workers who wish to obtain an introduction to pulse circuits. It is assumed that the reader is already familiar with radio tubes and elementary receiving technique, and accordingly the fundamentals of radio practice are either taken for granted or briefly reviewed: the application to pulse waveforms is then tackled immediately.

Although mathematical statement is used occasionally in the interests of brevity and precision, the approach is mainly non-mathematical, the emphasis being on a direct understanding of the physical principles involved.

Management for Tomorrow

Published 1956 by Chilton Co., Chestnut & 56th Sts., Phila. 39, Pa. 195 pages. Price $6.00.

A collection of well thought out contributions to the broad management picture of the future. Covering all the key areas of interest it is a valuable part of any business library. Management principles and problems in basic fields such as General Administration, Production, Distribution, Finance, Industrial Relations, and Relation Staff Services are discussed by outstanding personalities, professionals, executives, administrators who consistently exercise independent judgment in business, governmental department or agency, institution, college or consulting firms.

Asymptotic Expansions

By A. Erdélyi. Published 1956 by Dover Publications, 920 Broadway, New York 10, N. Y. 114 pages, paper bound. Price $1.35.

An introduction to various methods for the asymptotical evaluation of integrals containing a large parameter, and the study of solutions of ordinary linear differential equations by means of asymptotical expansions.

The only modern work available in English on this important topic, it presents a large number of subjects carefully developed. Introduction to the theory is followed by the most important methods for asymptotic expansion of functions defined by integrals; the remainder of the book concerns solutions of equations.

Applied Electrical Measurements

By Isaac F. Kinnard. Published 1956 by John Wiley & Sons, Inc., 440 Fourth Ave., N.Y.C. 16, N.Y. 612 pages, Price $15.00.

The subject matter is treated within the framework of the familiar

(*Continued on page* 100)

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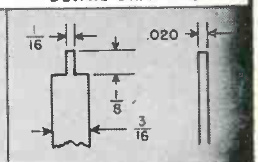
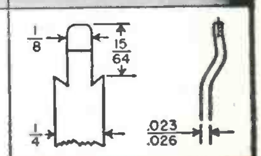
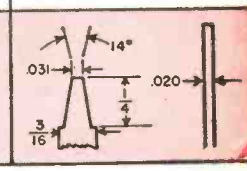
a	**Square Tipped**—for light-gauge printed circuit boards up to 1/16″ thick.	
b	**Snap-In**—for 1/16″ printed circuit boards subject to vibration or inversion. Terminals lock rectifier in place.	
c	**Tapered**—for maximum ease of insertion in heavy-gauge printed circuit boards up to ⅛″ thick.	

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Along with the information on theory and applications, a method is shown for analyzing and synthesizing measurement devices and systems. This method gives a logical "feel" for the subject and thus aids over-all understanding in this very broad area of study.

Digital Differential Analyzers

By George F. Forbes. Published 1956 by George F. Forbes, Industrial Mathematician, 10117 Bartee Ave., Pacoima, Calif. 196 pages. Price $7.50. Paper bound.

An application manual for digital and Bush type differential analyzers.

Introduction to Distributed Amplification

By Harry Stockman, S.D. Published 1956 by SER Co., 543 Lexington St., Waltham, Mass. 240 pages, paper bound. Price $2.90.

The definition, theory, and basic principles of distributed amplification are explained thoroughly before design considerations are presented. Useful appendices on the background for the design are also included.

TV Repair Questions and Answers, Vol. 5 (Sound & L-V Circuits)

By Sidney Platt. Published 1956 by John F. Rider Publisher, Inc., 480 Canal St., New York 13, N. Y., 120 pages, paper bound. Price $2.10.

This fifth and final volume on practical television servicing covers servicing of the sound sections and low-voltage circuits. Servicing techniques and procedures are given full coverage, while the electronic theory is kept to a minimum.

RCA Technical Papers (1951-1955), Index Vol. III

Published 1956 by RCA Review, Radio Corp. of America, RCA Labs, Princeton, N. J. 64 pages, paper bound.

A chronological index of technical papers on subjects in electronics and related fields by personnel associated with RCA, followed by a section arranged alphabetically by authors and a subject classification section.

ASTM Standards on Electrical Insulating Materials (with related information)

Published 1956 by American Society for Testing Materials, 1916 Race St., Phila. 3, Pa. 656 pages, paper bound. Price $6.00.

The changes since the previous edition issued in 1955 comprise methods of testing silicone insulating varnishes and a recommended practice for cleaning plastic specimens for insulation resistance testing.

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FERRITES—*a milestone in communications engineering!*

In today's communications engineering, ferrites are ranked with transistors in importance. Ferrites, modern cousins of the ancient lodestone, have more than doubled the efficiency of radar and microwave operations.

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This new group of solid state materials makes possible the continuous search by radar, instead of the intermittent "pulse" sending and receiving of World War II. To fully understand all the implications and probable uses for ferrites, reserve your copy of this special October *Proceedings of the IRE* ferrites issue. It will take its place in the history of radio-electronics along with the transistor issue of November, 1952, and the solid-state electronic issue of December, 1955. You will want to read and refer to it for years to come!

SPECIAL OCTOBER ISSUE CONTAINS 27 IMPORTANT ARTICLES ON FERRITES:

"Resonance Loss Properties of Ferrites in the 9KMC Region" by S. Sensiper, Hughes Aircraft Co.

"Magnetic Resonance in Ferrites" by N. Bloembergen, Harvard Univ.

"Methods of Preparation and Crystal Chemistry of Ferrites" by Donald Fresh, Bureau of Mines

"Topics in Guided Wave Propagation in Magnetized Ferrites" by Morris L. Kales, Naval Research Lab.

"Frequency and Loss Characteristics of Microwave Ferrite Devices" by Benjamin Lax, Lincoln Lab., MIT

"The Non-Linear Behavior of Ferrites at High Microwave Signal Levels" by H. Suhl, Bell Telephone Laboratories

"Dielectric Properties and Conductivity in Ferrites" by L. G. Van Uitert, Bell Telephone Laboratories

"The Elements of Non-Reciprocal Microwave Devices" by C. L. Hogan, Harvard Univ.

"Fundamental Theory of Ferro- and Ferri-Magnetism" by J. H. Van Vleck, Harvard

"Ferrites as Microwave Circuit Elements" by G. S. Heller, MIT

"Radiation from Ferrite-Filled Apertures" by D. J. Angelakos, Univ. of Calif., Berkeley, Calif.

"Anisotropy of Cobalt-Substituted Mn Ferrite Single Crystals" by P. E. Tannenwald and M. H. Seavey, MIT

"Birefringence of Ferrites in Circular Waveguide" by N. Karayianis and J. C. Cacheris, Diamond Ordnance Fuze Labs., Washington, D. C.

"Ferrite-Tuned Resonant Cavities" by C. E. Fay, Bell Telephone Laboratories

"Ferrite Tunable Microwave Cavities and the Introduction of a New Reflectionless Tunable Microwave Filter" by Conrad E. Nelson, Hughes Aircraft Co.

"Permeability Tensor Values from Waveguide Measurements" by E. B. Mullen, G. E., Syracuse

"A New Ferrite Isolator" by B. N. Enander, RCA Labs.

"Ferrite Directional Couplers" by A. D. Berk and E. Strumwasser, Hughes Aircraft Co.

"Intrinsic Tensor Permeabilities on Ferrite Rods, Spheres, and Disks" by E. G. Spencer, L. A. Ault, R. C. LeCraw, Diamond Ordnance Fuze Labs., Washington, D. C.

"Magnetic Tuning of Resonant Cavities and Wideband Frequency Modulation of Klystrons" by G. Jones, J. C. Cacheris, C. Morrison, Diamond Ordnance Fuze Labs.

"Microwave Resonance Relations in Anisotropic Single Crystal Ferrites" by J. O. Ortman, Harvard Univ.

"Anomolous Propagation in Ferrite Loaded Waveguide" by H. Seidel, Bell Telephone Laboratories

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New Tech Data For Engineers

Electronic Services

Six Division offices and branch locations are listed in a four-page folder telling of the nation-wide electronic services of Altec Service Co., a Div. of Altec Companies, Inc., 161 Sixth Ave., New York 13. Firm offers servicing for electronic, electro-mechanical and electro-acoustic devices and systems in such fields as facsimile, industrial TV magnetic tape recording and reproducing, and ultrasonic. (Ask for B-10-1)

Potentiometer

A small brochure on the Dipot high-precision multiturn potentiometer has been issued by Servonics, Inc., 822 N. Henry St., Alexandria, Va. Specs, operation and basic details of Dipot are given. Four catalog sheets on DC analog computer systems are also available. (Ask for B-10-5)

Rotary Solenoids

A two-color, 8-page booklet describes and illustrates the line of high-torque rotary solenoids made by Oak Mfg. Co., 1260 N. Clybourn Ave., Chicago 10. Booklet contains a dimensional chart, mechanical supplements, and eight engineering data charts. (Ask for B-10-6)

Testing Cores

Pulse Patterns for Testing Cores is a technical bulletin providing information for manufacturers and users of tape-wound or ferrite cores on benefits of using Burroughs pulse control systems to test cores by digital techniques. Designated Technical Bulletin 136, the material has been prepared by the Electronic Instruments Div., Burroughs Corp., 1209 Vine St., Philadelphia 7. (Ask for B-10-7)

Panel Instrument Data

A comprehensive four-page panel instrument data sheet, Form 81556-T, has been published by Triplett Electrical Instrument Co., Bluffton, Ohio. Sheet contains full-size scales of various types of panels, plus dimensional diagrams of round, rectangular and special instruments on which panels are used. Typical external shunts and illuminated meters are also shown. (Ask for B-10-8)

Magnetic Storage Systems

Illustrated brochure in color describes Monrobot magnetic drum systems and components. Electronics Div. of Monroe Calculating Machine Co., Morris Plains, N. J., offers publications, which also discusses read/record heads and magnetic selection circuits; highlight is a 2,000,000 bit drum. (Ask for B-10-9)

Solder Melting Tanks

Spec sheets and a brochure describing retangular solder melting tanks are available. Materials are illustrated and include specs and prices. Details of application in printed circuit fabrication are included by maker, Waage Electric, Inc., Kenilworth, N. J. (Ask for B-10-10)

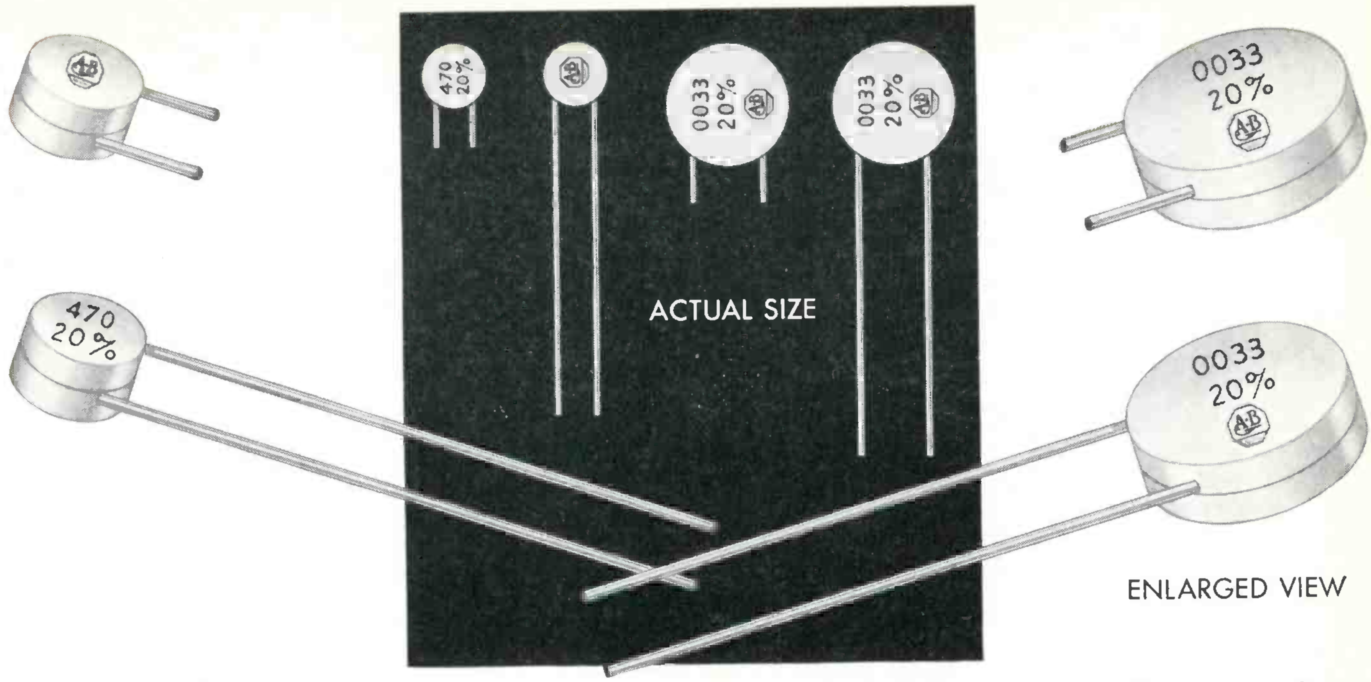
Printed Circuit Connectors

Bulletins 101, 102A and 103 describe and illustrate Series 5,000 printed circuit varicon connectors, 90° printed circuit tube-sockets, and Series 6,000 printed circuit varicon connectors, respectively. Details and specs are included in sheets offered by Elco Corp., M St. near Erie Ave., Philadelphia 24. (Ask for B-10-11)

Printed Circuit Tolerances

Tech. Bulletin P-9, from Photocircuits Corp., Glen Cove, N. Y., discusses standard printed circuit tolerances, and includes an illustration and specs. (Ask for B-10-12)

 For product information, use inquiry card on page 113.



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Since the ceramic shell takes the place of the usual resin coating, there is no resin on the lead wires, making it possible to solder closer to the dielectric disc with resultant lower series inductance. These capacitors can be supplied with long or short leads for manual or automatic assembly operations.

Allen-Bradley encased capacitors are another contribution to the military effort to obtain superior electronic components. Send for data on these ceramic encased capacitors, today.

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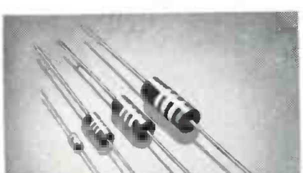

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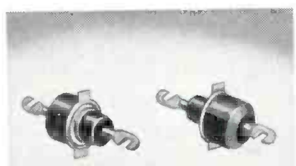

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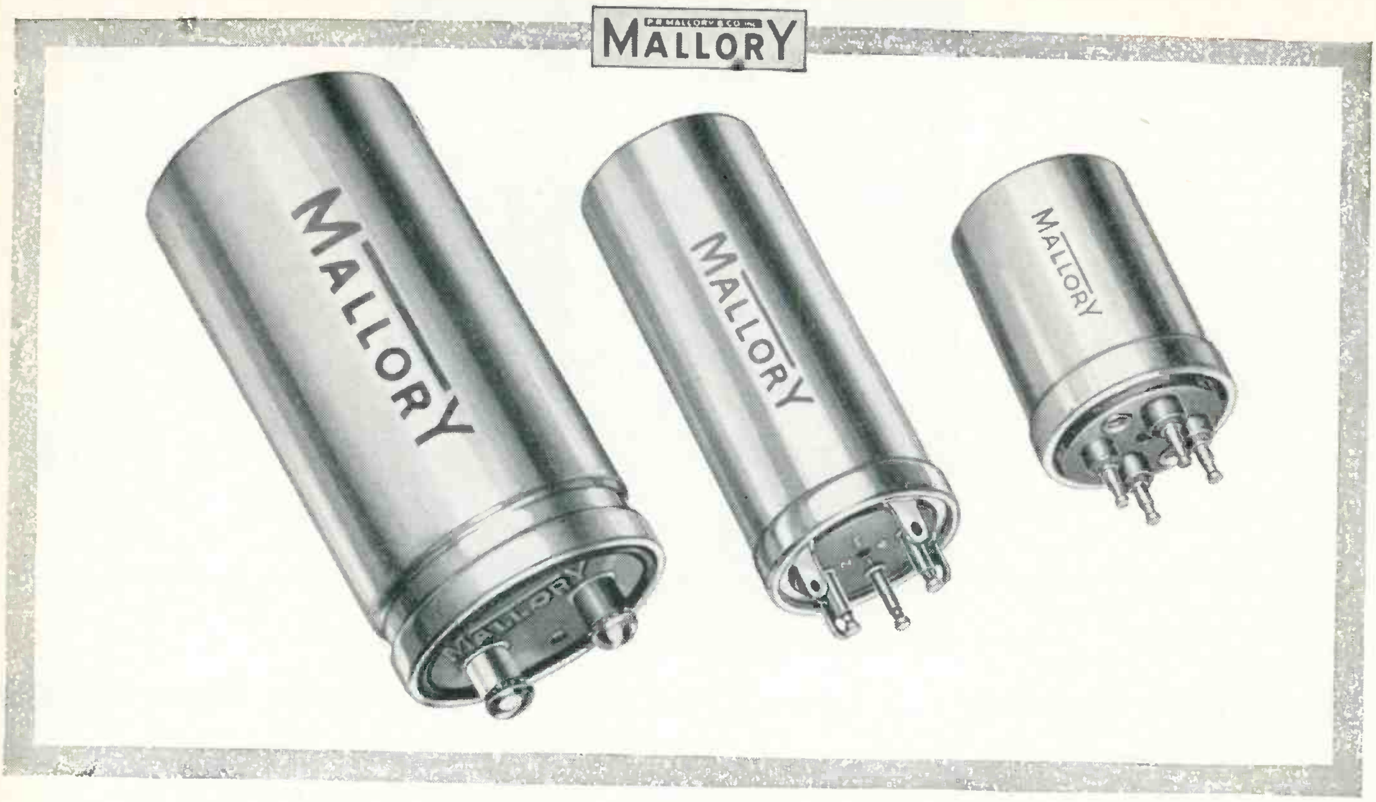

For Extra Capacitor Life and Reliability—Mallory Telephone and Computer Grades

Certain types of electronic equipment demand the ultimate in reliability and long life in all components . . . either because replacement would be highly expensive or because complex circuits require extreme stability. For applications of this sort, beyond the range of standard commercial products, Mallory manufactures electrolytic capacitors known as telephone and computer grade. These capacitors have premium characteristics obtained by special techniques in processing.

To assure highest quality, extra precautions are observed in the selection of materials, and in manufacturing . . . even beyond the extreme care normally practiced in making Mallory commercial grade capacitors. Special electrical processing operations produce exceptionally low leakage current and series resistance. Rigid pretesting assures as much as twenty years' life on a statistically high percentage of capacitors of this grade.

This extra measure of performance is available in three different series of Mallory capacitors:

- Units manufactured to conform in appearance and construction with current telephone standards.
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Mallory capacitor specialists will be glad to consult with you on the selection and application of special grades for your special circuit requirements.

For all capacitor needs . . . see Mallory first!

For the great majority of civilian and military electronic circuits, Mallory supplies a complete line of commercial and JAN grade electrolytic capacitors. All can be counted on to render superior performance at economical cost. Mallory also manufactures the famous FP—the pioneer fabricated plate capacitor rated for continuous duty at 85° C.; also miniature and subminiature electrolytics, tantalum capacitors, motor starting capacitors. Write or call for complete data.

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

For product information, use inquiry card on page 113.

OCTOBER 1956

ABSTRACTS & REVIEWS of
WORLDWIDE
ELECTRONIC ENGINEERING

ELECTRONIC INDUSTRIES & TELE-TECH

International ELECTRONIC SOURCES

PUBLICATIONS REVIEWED IN THIS ISSUE

Abbreviation	Publication Name
Aero D.	Aero Digest
Ann. de Radio.	Annales de Radioelectricite
Arc. El. Uber.	Archiv der elektrischen Ubertragung
Auto. Con.	Automatic Control
Avto. I Tel.	Avtomatika i Telemekhanika
Bell J.	Bell System Technical Journal
Comp.	Computers and Automation
El.	Electronics
El. Des.	Electronic Design
El. Eng.	Electronic Engineering
El. Eq.	Electronic Equipment
El. Ind.	ELECTRONIC INDUSTRIES & Tele-Tech
El. Mfg.	Electrical Manufacturing
El. Rund.	Electronische Rundschau
Freq.	Frequenz
Bul. Fr. El.	Bulletin de la Societe Francaise des Electriciens
Hochfreq.	Hochfrequenz-technik und Elektroakustik
J BIRE.	Journal of the British Institution of Radio Engineers
J IT&T.	Electrical Communication (Technical Journal of IT&T)
J UIT	Journal of the International Telecommunication Union
NBS J.	Journal of Research of the National Bureau of Standards
Nach. Z.	Nachrichtentechnische Zeitschrift
Onde.	L'Onde Electrique
Phil. Tech.	Philips Technical Review
Proc. AIRE.	Proceedings of the Institution of Radio Engineers (Australia)
Proc. IRE.	Proceedings of the Institute of Radio Engineers
RCA.	RCA Review
Radiotek	Radiotekhnika
Tech. Haus	Technische Hausmitteilungen
Toute R.	Toute la Radio
Wirel. Eng.	Wireless Engineer

Also see government reports and patents under "U. S. Government."

ANTENNAS, PROPAGATION

Some Comments on Wide Band & Folded Aerials, by E. Willoughby. "J BIRE." Aug. 1956. 8 pp. The impedance-frequency characteristic of simple cylindrical aerials is discussed and it is shown that the bandwidth may be considerably improved by the use of appropriate correcting networks.

Microwave Communication Beyond the Horizon, by A. G. Clavier. "J IT&T." June 1956. 9 pp. The author reviews line-of-sight techniques and traces the historical development of beyond-the-horizon propagation; presenting basic attenuation curves, discussion of fading, and frequency dependence of transmission level.

Beyond-the-Horizon 3000-Megacycle Propagation Tests in 1941, by A. G. Clavier and V. Altovsky. "J IT&T." June 1956. 16 pp. The author presents an historical development and describes equipment used in 1941 tests.

Back-Scatter Ionospheric Sounder, by E. Shearman and L. Martin. "Wirel. Eng." Aug. 1956. 12 pp. Single-Station Equipment for Oblique Incidence Propagation Studies in the band 10-27 MC is described, and the results of experiment presented.

Mixed Path Ground Wave Propagation: 1. Short Distances, by J. Wait. "NBS J." July 1956. 15 pp. The author extends the results obtained by Bremmer in his formulation of the problem of propagation of ground waves over on inhomogeneous conducting earth.

Vertical Radiation and Tropical Broadcasting, by A. Dickinson. "J BIRE." July 1956. 7 pp. Results of a general survey of the subject are presented, together with some specific practical recommendations.

Calibration of Six-Mast Adcock DF-Equipment, by K. Baur. "Nach. Z." July 1956. 7 pp. Inherent system error is described and necessary calibration measures explained.

The Present Situation of Researches in the Field of Tropospheric Scattering, by J. Grosskopf. "Nach. Z." July 1956. 15 pp. A general summary, based on American, French, and English papers, is presented on the subject of the theoretical and experimental results in the field of tropospheric scattering.

Radio and Television Interference, by M. Smith. "J BIRE." Aug. 1956. 9 pp. The author presents the result of a survey of the principal causes of interference to domestic radio and television; detection and suppression measures are considered.

AUDIO

Loudspeaker Design and Application, by A. McLean. "Proc. AIRE." May 1956. 12 pp. An analysis of the waveform of human speech at the vocal cords and at the lips is presented. Further analysis of musical sounds is included. The author outlines demands on loudspeakers and present limitations.

Use of Sound Reinforcement in Reverberant Buildings, by A. Nickson and R. Muncey. "Proc. AIRE." May 1956. 4 pp. The intelligibility of reinforced speech in a large reverberant building may be improved by the use of a suitably placed directional loudspeaker column. The design of such a column is described.

The Olson Music Synthesizer, by F. Winckel. "El. Rund." Aug. 1956. 5 pp. The historical development and present circuitry of the Olson synthesizer are described. Various parts for the production of pitch, intensity and wave form alterations are considered.

The Oscillation of the Basilar Membrane at Excitation by Pulses and Noise Measured with an Electric Model of the Inner Ear, by H. Bauch. "Freq." July 1956. 13 pp. A network containing a sequence of 65 T sections is used as the equivalent for the pressure distribution along the basilar membrane. The obtained pressure distribution and associated membrane configuration for sinusoidal, error-curve, and band-pass noise input are reported and plotted.

On the Different Possibilities of Representing Acoustic Spectra, by L. Cremer and L. Schreiber. "Freq." July 1956. 13 pp. A computed spectrum may be plotted as either amplitude or decibels against either frequency or octave units. For a measured spectrum, characterization of the filter data on the diagram is proposed. The spectrum corresponding to the ear response is best expressed in individual loudness levels with special precautions for summation and overlapping. Particular attention is given to the various deviations of the physiological response from the acoustical measurements.

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To obtain copies of U.S. patents, and research reports on military and government projects reviewed here, send payment indicated directly to federal agency as instructed in section entitled "U.S. Government."

International ELECTRONIC SOURCES

Audio Amplifiers, by F. Langford-Smith. "Proc. AIRE." May 1956. 7 pp. A discussion of the design and testing of audio amplifiers is given. Methods of comparing the performance of different amplifiers are considered.

CIRCUITS

Wide-Range Voltage Stabilizers, by F. Benson and L. Bental. "El. Eng." Sept. 1956. 5 pp. A brief review is given of methods which have been developed to provide a stabilized supply with a wide voltage range and whose output can be adjusted down to a very low voltage. Details of one form of such a stabilizer are given with some information about its performance and limitations.

The Analysis of Three-Terminal Null Networks, by T. O'Dell. "El. Eng." Sept. 1956. 3 pp. A method of analysis is described which is particularly suitable for three-terminal networks that exhibit infinite attenuation at one frequency. The popular twin-T and bridged-T networks are analyzed as examples.

Characteristics for Half-Wave Rectifier Circuits, by H. Enge, "El. Eng." Sept. 1956. 6 pp. Voltage regulation characteristics, form factor, first harmonic, and peak current values are given for half wave rectifiers with common type loads, all in non-dimensional variables.

A Solution to the Approximation Problem for RC Low-Pass Filters, by K. Su, and B. Dasher. "Proc. IRE". July 1956. 6 pp. A method for investigating the transfer functions of RC low-pass networks is presented. By mathematical manipulations, the several quantities essential in describing the quality of each frequency characteristic; the pass-band tolerance, the stopband-passband ratio, and the stopband attenuation can be expressed in terms of several geometrical quantities in the transformed plane and the parameters of the transformation function. The transformation used is a function involving elliptic functions.

A Simple 11 Watt Amplifier, by J. Bouriez. "Toute R." July-August 1956. 2 pp. The amplifier uses two symmetrically mounted EL 84 tubes, the characteristics of which are presented. It has a linear response between 10 and 30,000 cycles. Detailed design data are given.

Investigations Concerning Nyquist's Criterion, by H. Barkhausen and E. G. Woschni. "Hochfreq." May 1956. 5 pp. An experimental method is developed which permits plotting Nyquist's diagrams for positive and negative attenuations by simulating the inductive and capacitive decrements in suitably inserted and dimensioned resistors. A sine wave is used in the measurements. The method is applied to a conventional pentode oscillator, and a detailed report of the results is included. Good agreement between experimental and computed values is reported.

Initial Transients in Frequency Modulation, by A. Ditl. "Hochfreq." May 1956. 10 pp. An FM theory is developed which permits the computation of FM transient behavior; experimental results in support of the theory are presented. It is held that for small frequency swings the FM transients are identical with AM transients but large transients occur for large frequency swings, which large transients present an upper limit for the admissible frequency swing in FM-television transmission.

Disc-Seal Triode Amplifiers, by G. Craven. "Wirel. Eng." Aug. 1956. 5 pp. Design and application considerations for a resonant-type coupling network for disc-seal triodes are discussed.

Operating Features of a Power Amplifier with its Plate Circuits Supplied from an AC Source, by O. M. Minina and D. E. Polonnikov. "Avto. i Tel." April 1956. 6 pp. The paper describes the flow of reverse current through an electronic tube which is operating as a power amplifier and which has an ac plate supply. Experimental results are given which show that the reverse current lowers the efficiency and output power of the stage, and also increases its inertial properties. Recommendations are given for the elimination of the harmful effect of reverse current.

Operational Amplifier Has Chopper Stabilization, by D. Robinson. "El." Sept. 1956. 4 pp. Design considerations in obtaining a high order of zero-offset stability in computer amplifiers are considered, and such an amplifier is described.

COMMUNICATIONS

International Maritime VHF Radiotelephone, by F. Wylie. "J UIT." June 1956. 5 pp. Marine needs in the VHF range are described and recommendations for frequency allotments and utilization made.

Supervision and Fault Location in Local Cables by Means of Compressed Air, by J. Lennertz and G. Nebel. "Nach. Z." July 1956. 6 pp. A report on supervisory equipment for pressurized local telephone cables is followed by a discussion on cable sheath fault location by means of simultaneous measurements of the air flow at the cable ends.

Examination of an Eight-Channel Telegraphy System with Automatic Error Correction, by M. Corsepius, H. Logemann, and K. Vogt. "Nach. Z." July 1956. 4 pp. Investigations with a combination of two sets of time-division-multiplex-teleprinter-system-with-fault-correction equipment with the F1-Duoplex transmission system for use on short wave radio links are reported.

A Very Low Frequency Receiver with High Selectivity, by C. Fowler. "J BIRE." July 1956. 4 pp. A description is given of the design of a super-heterodyne receiver having very high selectivity, sensitivity, and gain stability for use in the freqency band 6 to 36 KC. The high selectivity is obtained by means of controlled increase of Q-factor of the tuned circuits of the i-f amplifiers, using mixed positive and negative feedback.

COMPONENTS

Potting Methods For Variable R-F Inductors, by K. M. Miller. "El. Ind." Oct. 1956, 3 pp. Development of potted variable r-f inductor coils is described. Final units exhibit Q stability even under extreme humidity conditions.

Flexural Mode Quartz Crystals As A-F Resonators, by R. Bechmann and D. Hale. "El. Ind." Oct. 1956. 4 pp. The use of quartz bars as audio oscillators is described, as well as new techniques for producing cultured quartz crystals with the necessary length and axis orientation.

Current Reference For Magnetic Amplifiers, by D. A. Burt. "El. Ind." Oct. 1956. 4 pp. Unique characteristics of silicon diodes near the breakdown point are discussed which make them suitable for simple, reliable current or voltage reference circuits. Design equations are given, and a practical constant-current circuit is described.

Energy Source Delivers Half-Sine Pulses, by L. Rosenthal. "El." Sept. 1956. 3 pp. A thyratron pulse generator is described. Circuit can also be adapted to measure frequency.

A Unique Printed Circuit Capacitor, by J. Woods. "El. Ind." Oct. 1956. 2 pp. Capacitors with unique terminations have been developed to meet the unique demands of printed circuit techniques.

Modular Design-Progress and Problems, by L. Matthews. "El. Ind." Oct. 1956. 2 pp. A progess report is given of Tinkertoy, the electronic building block program. This program is gaining industry acceptance as technological obstructions are conquered.

New Design in Ruggedized P-C Connectors, by H. E. Ruehlemann. "El. Ind." Oct. 1956. 3 pp. A description is given of a program to develop a printed circuit connector giving reproducible contact resistance on frequent reinsertions.

A Delay Block Which Uses Magnetic Recording, by V. A. Ivanov. "Avto. i Tel." April 1956. 5 pp. Information is provided on the results of the design and testing of a delay block which utilizes magnetic recording. The magnetic tape makes it possible to introduce pure lag when simulating feedback control systems. A description is given of the principle upon which the circuit operates, its construction and its operative results.

Contribution to the Theory of the Goniometer and the Coordinate Transformer, by K. Baur. "Freq." July 1956. 9 pp. Each directional antenna of an array is connected to a coil, all coils being arranged in a circle. A rotor (one or two loops) mounted inside the circle is adjusted for minimum voltage output to indicate the direction of a received wave. The resulting magnetic field is computed from the field equations, the inductive coupling evaluated, and the resulting output calculated. Error sources are discussed.

Film Resistors of Nitride Compounds, by E. Layer and E. Olson. "El. Mfg." Sept. 1956. 6 pp. Characteristics of nitride film resistors now in the lab. development stage are discussed. The authors indicate suitability for applications where small size, low temperature coefficient of resistance, and high stability are needed.

Magnetizing and Demagnetizing Permanent Magnets, by R. Parker. "El. Mfg." Sept. 1956. 8 pp. Practical techniques for the magnetization of today's magnetic materials, with their high coercive forces, are presented.

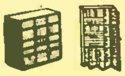
Forced-Air Techniques for Cooling Electronic Equipment, by M. Mark and M. Stephenson. "El. Mfg." Sept. 1956. 7 pp. Equations for basic heat transfer by convection, radiation, and conduction are given.

Potentiometer Tachometer Has High Sensitivity, by G. Davidson and M. Pavalow. "El." Sept. 1956. 4 pp. Simple, sensitive tachometers using linear potentiometers are described.

High-Speed Printer for Weapons Testing, by J. Fahnestock. "El." Sept. 1956. 4 pp. A numerical print-out system giving rates to 150, 4-digit measurements a second is described.

A Fast-Acting Phase Conscious Indicator, by D. Davies. "El. Eng." Sept. 1956. 3 pp. A phase-sensitive rectifier circuit of the gated type is described. Particular features are high rejection of second, third, and multiples of these harmonics, plus a high rejection of quadrature signals. A practical circuit is described in detail, and a short mathematical analysis of the mode of operation is included.

The Lead Sulphide Photo-Conductive Cell, by M. Smollett and J. Jenkins. "El. Eng." Sept. 1956. 3 pp. A theoretical and practical description of the lead sulphide photocell is given, together with a number of possible applications.



COMPUTERS

Simulation of the Phenomenon of Hydraulic Impact in the Pressure Pipes of Hydroelectric Stations, by A. A. Pervozansky and R. A. Poluektov. "Avto. i Tel." April 1956. 14 pp. The paper examines an electromechanical model which reproduces the phenomenon of an hydraulic impact; this model is based on the method of "physical analogies." An approximate solution is given for the problem of a hydraulic impact in a simple connecting pipe for the case of low-pressure installations; this solution is valid for any law which may govern the guiding device. On the basis of the solution the paper proposes a simple computing-decision circuit which simulates the phenomenon of hydraulic impact.

The Problem of Applying Electronic Simulators to the Investigation of Long-Duration Processes of Feedback Control, by V. V. Gurov. "Avto. i Tel." May 1956. 6 pp. The paper examines the methods for realizing the principle of "ground isolation" in decision amplifiers in order to combat losses between the input and output. It is shown that in order to reproduce processes by means of electronic simulators that have large time constants it is necessary to use decision amplifiers with automatic null-level stabilization and to combine them with dividers. A method of designing such dividers is given.

Concerning a New Method of Calculating with High Frequency Currents, by H. J. Uffler. "Ann. de Radio." July 1956. 13 pp. The electromechanical computing process described here enables algebraic operations to be performed with considerable accuracy, stability, and simplicity. Working at a frequency of 472 KC, the computing chains comprise passive elements only.

General Condition for the Mean-Square Error In a Dynamic System, by V. S. Pugachev. "Avto. i Tel." April 1956. 8 pp. The paper derives the general necessary and sufficient condition which defines an operator A of a given class R; this operator realizes the minimum mean-square error of the approximation of a random function Y(z) by means of the random function AX(t). This general condition yields all of the known equations for optimum dynamic systems of various classes in the form of particular cases.

Two Electronic Computers Share a Single Problem. "Comp." Aug. 1956. 4 pp. A description is given of the cooperative functioning of two dissimilar electronic computers on one problem. Application significances are outlined.

An Electronic Back-Lash Analog, by S. P. Onufriuk and A. A. Feldbaum. "Avto. i Tel." June 1956. 11 pp. The authors present an analysis and description of electronic back-lash analogs; an experimental test of an electronic back-lash analog is described.

Trends in Computer Input/Output Devices, by J. Carroll. "El." Sept. 1956. 8 pp. Proceeding from the premise that the ideal computer should accept data in basic form without translation and should present its output data in directly usable form, the author examines present devices potentially capable of achieving this ideal.

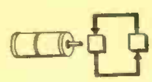
A Circuit for Analogue Formation of xy/Z, by M. Somerville. "El. Eng." Sept. 1956. 2 pp. A quarter squares multiplier, using a triangle carrier waveform in the squaring circuits is extended to give division simultaneously with multiplication. This is achieved by controlling the slope of the triangle carrier waveform so as to be proportional to the divisor Z.

Application of Electronic Computors to Engineering and Economical Problems, by M. J. Carteron. "Bul. Fr. El." July 1956. 8 pp. The performance characteristics of computers are outlined and the importance of various properties for special application is discussed. Examples of engineering and economic problems solved by computers are included and future developments are indicated.

Tridac—A Research Flight Simulator, by J. Gait and J. Nutter. "El. Eng." Sept. 1956. 5 pp. The basic computing elements and unique features of the large tri-dimensional machine at the Royal Aircraft Establishment, Farnborough, England, are discussed, followed by a detailed analysis and comparison of the three approaches to the axis transformation problem, with reference to the requirements of TRIDAC.

IRE Standards on Electronic Computers: Definitions of Terms, 1956. "Proc. IRE." Sept. 1956. 8 pp.

Design of Computer Circuits for Reliability, by W. Renwick. "El. Eng." Sept. 1956. 5 pp. Factors influencing the choice of components and mechanical design are discussed. The advantages of marginal checking are pointed out and the ways in which circuit design can facilitate this are discussed.



CONTROLS

Use of Operational Calculus in the Investigation of Transient Processes in Servomechanisms with a Saturating Amplifier, by M. Nadler. "Avto. i Tel." May 1956. 4 pp. The paper describes a method for calculating the transient response of a servomechanism with an amplifier such that when a large signal acts at the input, the amplifier operates over a region which exceeds the linear region of its characteristic. All other elements of the system are considered to be linear.

Pneumatic Ratio Controllers without Mechanical Dividers, by G. T. Berezovets. "Avto. i Tel." May 1956. 7 pp. A description is given of two types of ratio controllers which do not contain mechanical dividers. The controller of the first type is designed for maintaining the standard quantity in the ratio constant; the controller of the second type allows automatic correction of the given ratio according to a third parameter, or else the remote control of the magnitude of the ratio.

Analysis of the Interference Rejection of the Transmission of Remote Control Commands, Using the Methods of Potential Interference Rejection Theory. II, by G. A. Shastova. "Avto. i Tel." May 1956. 8 pp. The paper determines the potential interference rejection of the transmission of commands by complex signals when the average power of the signal is limited and normal fluctuating interference is present. Single and multiple commands are analyzed, as well as the effectiveness of protection from false commands.

A New Low-Temperature Control Component, by D. Buck. "Auto. Con." Aug. 1956. 4 pp. The author describes the Cryotron, a device utilizing magnetic destruction of superconductivity. Practical applications are suggested.

The Analysis of Thermoresistors Operation in Thermocontrol System Based on the Use of Relay Effect, by G. I. Pavlova and I. T. Sheftel. "Avto. i Tel." June 1956. 10 pp. The authors consider the main characteristics of thermistors intended for thermocontrol systems. Various methods of controlling a system are considered on the basis of an analysis of conditions of thermistor operation.

The Combined Reproduction of Random and Non-Random Signals by Linear Servo-Systems, by V. I. Kukhtenko. "Avto. i Tel." May 1956. 6 pp. The paper examines linear servo-systems whose input signal can be separated into two components: a random component and a functionally specified component. An optimum system is defined as one in which the mean-square value of the difference between the random components of the input and output signals is made a minimum, and in which the difference between the functionally specified component of the input signal and the forced oscillations caused by this component is equal to zero at each instant in time. An equation is derived for determining the transfer function of a linear servo-system, and a solution for the equation is obtained.

Calculation of Transients in Nonlinear Control Systems, by Ya. Z. Tsypkin. "Avto. i Tel." June 1956. 13 pp. This article deals with the calculation of transients in intermittent or sampling control systems where controlling pulse duration is proportional to the error. When the error deviations are finite these systems are essentially nonlinear. The author examines an intermittent control system with internal feedback as an example.

An Approximate Probability Analysis of the Operational Precision of Essentially Nonlinear Automatic Systems, by I. E. Kazakov. "Avto. i Tel." May 1956. 26 pp. This paper develops an approximate method, based on theoretical probability analysis, for investigating the operational precision of essentially nonlinear automatic systems. The method takes random perturbation of arbitrary form into account. The static transfer characteristics of typical nonlinear elements are analyzed, and the method of statistical linearization is generalized to apply to groups of nonlinear elements. Examples of the application of these techniques are given.

The Autonomy of Multi-Loop Systems Which Are Stable When the Steady-State Accuracy Is Increased Without Limit, by M. V. Meerov. "Avto. i Tel." May 1956. 15 pp. The paper shows that in a number of cases autonomy is very desirable even if it leads to a certain worsening of the regulation process of individual regulated quantities. Thus the problem of the autonomy of such systems acquires independent significance. A number of different types of systems are analyzed (objects with self-equalization and ideal regulators, integral systems, objects with self-equalization and a regulator described by a first-order equation, etc.), and a specific example is analyzed.

Application of Canonical Expansions of Random Functions to Problem of Determining Optimum Linear System, by V. S. Pougatchev. "Avto. i Tel." June 1956. 11 pp. This article contains a generalization of the theory of canonical expansions of random functions developed by the author.

Simple Photoelectric Cell Operated Tracking Device for Astronomical Telescopes, by H. H. Rabben. "El. Rund." July 1956 2 pp. A photoelectric cell operated tracking device for telescopes is used for automatic control of the hour motion gear and the declination motion. It comprises 2 pairs of photoelectric cells mounted in an auxiliary tube behind a diaphragm covering the object image which are connected to a circuit and relay arrangement described in detail permitting of a tracking accuracy of 2 to 3 seconds.

Counters Control High-Speed Flash, by S. Dorsey. "El." Aug. 1956. 4 pp. Previous methods of operating stroboscopic flash lamps involved flashing all lamps until the powering capacitor bank was discharged. The method described here uses electronic computer components to energize flash units at predetermined intervals and for predetermined numbers of flashes.

Improved On-Off Stabilization Systems, by R. Bass. "Aero D." Aug. 1956. 5 pp. A new synthesis procedure for on-off control systems is presented through which the delays arising from time-lag and hysteresis in the relay or contactor can be eliminated.

DC Bridge-Balanced Electronic Amplifier Stages, by A. A. Sokolov. "Avto. i Tel." April 1956. 9 pp. The paper provides the design equations of the typical, most widely used "standard" balanced dual-triode dc amplifier stages. The results of calculation agree sufficiently well with experimental results. The formulas given are designed for use in the design calculation of dc amplifiers.

INDUSTRIAL ELECTRONICS

Ultrasonic Gauging in Shipyards. "El. Eng." Sept. 1956. 1 p. A simple, accurate method of gauging the thickness of corroded plates in the hulls of tankers is described.

Lighting in Trains and Other Transport Vehicles with Fluorescent Lamps, by L. P. M. ten Dam and D. Kolkman. "Phil. Tech." June 1956. 8 pp. Special types of tubular fluorescent lamps for the lighting of trains, buses, and small ships have been developed for battery supplies of 72, 100, or 110 v using a current regulator tube (tungsten filament in a non-inflammable mixture of hydrogen and nitrogen) as ballast. When using 24 v batteries, the direct current is converted into AC by means of a centrifugal converter making use of a rotating mercury jet.

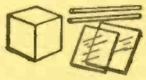
The Electric Field of a Dielectric Heating Work Circuit, by N. H. Langton and E. E. Gunn. "J BIRE." Aug. 1956. 11 pp. The electric field of the simplest type of work circuit of a dielectric heater is considered, in which the lower capacitor plate is larger than the upper. The extent of the fringing effect and the relation between size of specimen and size of capacitor plate for uniform heating are considered. The paper describes the theoretical investigation of this type of field, and some experiments on field plotting using an electrolytic analog.

Characteristics of Magnetic Amplifiers with Feedbacks, by N. M. Tsyshenko. "Avto. i Tel." June 1956. 8 pp. Approximate formulas are given for characteristics of magnetic amplifiers with feedbacks with active load resistance. Magnetic properties of cores of saturable reactors and their dimensions, load resistance, and semiconductor rectifier parameters are taken into consideration in the calculation of the abovementioned characteristics.

Shunted Load Magnetic Amplifier and its Application for Protection Gears, by G. V. Subbotina. "Avto. i Tel." June 1956. 9 pp. The behaviour of series and shunted load magnetic amplifiers is compared for static and transient conditions. The curves of iron volume per unit capacity for calculation of shunted load magnetic amplifiers are given. The author describes the possibility of applying shunted load magnetic amplifiers for the protection of gears.

System for Multiple Instrumentation Outputs, by J. Ryskamp. "Auto. Con." Aug. 1956. 4 pp. A general description is given of the Central Automatic Digital Data Encoder at the Lewis Flight Propulsion Laboratory.

Design of Magnetic Amplifiers With Toroidal Cores, by O. A. Sedykh. "Avto. i Tel." May 1956. 15 pp. The paper determines the optimum core dimensions and coil parameters which permit the realization of the maximum gain for a toroidal-core magnetic amplifier. Possible deviations from the optimum dimensions are evaluated in relation to using magnetic material of standard dimensions. The analysis includes a discussion of the particular features of designing magnetic amplifiers with minimum weight or dimensions for given values of load power, current variation factor and power gain. The dependencies of the minimum steel volumes upon the intensity of the magnetizing field are used for the purposes of the design.



MATERIALS

Magnetic Alloys For the Cores of Magnetic Amplifiers and the Curves of These Alloys When They Are Simultaneously Magnetized by DC and AC Fields, by O. I. Aven. "Avto. i Tel." April 1956. 6 pp. The paper cites data for a number of Soviet soft-magnetic alloys which are most suitable for cores of magnetic amplifiers. Curves are given for simultaneous magnetization by dc and ac fields. These curves are required for the design of magnetic amplifiers.

The Use of Epoxide and Polyester Resins in the Electronics Industry, by R. Q. Marris. "J BIRE." Aug. 1956. 6 pp. The chemistry, electrical, and physical properties of polyester and epoxide resins are discussed and some of the advantages and disadvantages of the two classes described. Special attention is paid to encapsulation considerations.

MEASURING & TESTING

Introduction to the Study of Magneto-Optical Phenomena in Ferrites, at Super-High Frequencies, by J. Benoit. "Onde" June 1956. 9 pp. This is essentially a literary survey on the present state of this art. The effects on an electromagnetic wave passing through ferrites at various orientations to the magnetic field of the ferrite are explained and experimental set-ups for their measurements are described. Decoupling, change in wave polarization, attenuation, modulation, etc. can be obtained.

On a Method for Routine Evaluation of the True Electron Density Distribution in an Ionospheric Layer from the Sweep-Frequency Recordings of this Layer, by W. Becker. "Arc. El. Uber." May 1956. 8 pp. A method is presented which permits distinguishing between Epstein, consine-shaped, or parabolic layers; determining the true height of the maximum and the electron contents of the layer from the variation of the apparent height with frequency.

A Precision Frequency Meter Designed at the Noiseau Measurement Center, by J. Boulin. "Onde" June 1956. 9 pp. A receiver-frequency meter for the decimeter-wave range is described. The received frequency is heterodyned and applied to an oscilloscope simultaneously with a known frequency. Design details are discussed and circuit diagrams included. It is intended to measure extremely weak and/or noisy signals.

The Measurement of Luminous Flux of Light Sources: Choice and Characteristics of White Envelopes for Photometric Spheres, by M. J. Terrien. "Bul. Fr. El." May 1956. 5 pp. This is a report of the research conducted at the "Bureau International des Poids et Mesures" on white diffusing envelopes to be used in Ulbricht spheres. Sensitive methods for measuring reflection coefficients exceeding 0.8 of white and monochromatic light are discussed. Improvements due to the improved sphere paint suggested by Middleton (Ill. Eng. 1953, U.S.) are included.

Design For A Simple Radiation Dosage Indicator, by H. Peake, et al. "El. Ind." Oct. 1956. 4 pp. Complete design details for a simple, battery-powered indicator of radiation dosage rate is given. Device uses neon lamp in a relaxation circuit incorporating a radiation-sensitive CdS crystal.

The Study of Thermal Conductivity Problems by Means of the Electrolytic Tank, by F. Reiniger. "Phil. Tech." July 27, 1956. 9 pp. This article describes the use of an electrolytic tank for the study of steady state thermal conductivity problems, and discusses the use of this technique to investigate the thermal behavior of an oil-cooled copper X-ray anode with a small thin plate of tungsten embedded in it.

Concerning the Theory of the 90° Deviation Mass Spectrometer, by D. Charles. "Ann. de Radio." July 1956. 19 pp. The author presents a detailed examination of the formation of the image for single and double collection and the influence of the width of the objective slit. Required source stability is deduced, with the permissible limits for chromatic aberration. The influence of mechanical and electrical adjustments and of mechanical precision on image formation are considered.

Frequency Response of Second-Order Systems With Combined Coulomb and Viscous Damping, by T. Perls and E. Sherrard. "NBS J." July 1956. 21 pp. Curves obtained with an analog computer are presented for the magnification factor vs frequency ratio of second-order systems with combined coulomb and viscous damping.

European Instrument Designs, by R. Feldt. "El. Des." July 15, 1956. 4 pp. Designers abroad have been remarkably successful in developing precise and versatile instruments; those which are simple to read by semi-technical personnel and which save time for engineers and production people alike. Presented here are unusual and interesting design features of some of the foreign equipment.

RADAR, NAVIGATION

Measuring Rate-of-Climb by Doppler Radar, by S. Logue. "El. Ind." Oct. 1956. 3 pp. A "magic tee" unit designed for the Navy XFY-1 vertical take off fighter uses the doppler effect for the accurate indication of vertical velocity.

Stable Local Oscillator for S-Band Radar, by W. Dauksher. "El." Sept. 1956. 3 pp. Useful for phase-measurement radar techniques, a local oscillator having excellent short-term frequency stability is described.

Some Problems of Secondary Surveillance Radar Systems, by K. Harris. "J BIRE." July 1956. 27 pp. The author considers the system engineering of a secondary surveillance radar, comprising a ground interrogator and airborne transponders, for use in an air traffic control system.

A Precise New System of FM Radar, by Mohamed A. W. Ismail. "Proc. IRE." Sept. 1956. 5 pp. The author describes a new system of FM radar by which both the range and the speed of the target can be accurately measured.

Maximum Angular Accuracy of a Pulsed Search Radar, by P. Swerling. "Proc. IRE." Sept. 1956. 10 pp. An investigation into the limits imposed by receiver noise on the accuracy with which the angular position of a target can be determined by a pulsed search radar is reported. The relation between the estimation of angular position and the problem of target detection is discussed.

Weather Radar, by H. Hinzpeter. "El. Rund." Aug. 1956. 2 pp. High altitude wind measurements are carried out by means of balloons carrying angular reflectors. This is tracked with 10 cm radar. Besides radio telemetering equipment is used permitting altitude measurements with reference to the barometric altitude formula. Errors occurring at such measurements are discussed and hydrodynamic applications of this equipment are explored. Application possibilities of a radar transponder are considered.

SEMICONDUCTORS

P-N-P-N Transistor Switches, by J. Moll, M. Tanenbaum, J. Goldey, and N. Holonyak. "Proc. IRE." Sept. 1956. 9 pp. The design, fabrication, and electrical characteristics of silicon PNPN transistors for use as switches is discussed.

Two-Terminal P-N Junction Devices for Frequency Conversion and Computation, by A. Uhlir. "Proc. IRE." Sept. 1956. 9 pp. Design principles for semiconductor diodes are derived from the analysis of idealized PN junctions.

Power Transistors, by H. Schreiber. "Toute R." July-August 1956. 5 pp. The non-linear amplification factor of power transistors, i.e., transistors with large contacting faces and cooling provisions, pose linearity problems, it is pointed out. Two samples were studied and their properties are discussed. Families of curves are presented as well as circuit diagrams including numerical values. Design calculations are presented.

Design Calculations For Circuits With Semiconductor Thermoresistors Which Are Indirectly Heated, by N. P. Udalov. "Avto. i Tel." April 1956. 8 pp. On the basis of an analysis of the voltampere characteristics of an indirectly heated thermoresistor it is proposed that during the calculations the effect of the current in the heating circuit can be replaced by an equivalent temperature increment of the surrounding medium. For this purpose the concept of a "heating characteristic" is introduced.

Quasi-Complementary Transistor Amplifier, by H. Lin. "El." Sept. 1956. 3 pp. Design considerations, including distortion, frequency response, and noise in transistor amplifiers are discussed. A transistorized phonograph amplifier is described.

CRT Power Supply Uses Transistor Oscillator, by P. Toscano and J. Heffner. "El." Sept. 1956. 4 pp. 10 kv supply derived from 80 v. supply is described. 12.5 kc transistor oscillator with output voltage doubled and rectified is used.

Checking DC Parameters of Transistors, by M. E. Jones and J. R. MacDonald. "El. Ind." Oct. 1956. 4 pp. A tester for plotting parameter distribution of production batches of transistors is described within which test circuits for many transistor parameters have been combined.

Servo Amplifiers Use Power Transistors, by B. Benton. "El." Sept. 1956. 3 pp. Developments in transistor servo amplifiers are described.

Silicon Junction Power Diodes, by D. Mason, A. Shepherd, and W. Walbank. "J BIRE." Aug. 1956. 11 pp. The physical processes responsible for conduction in silicon are described, and the characteristics responsible for superiority to other rectifiers are discussed.

Application of Germanium Transistors in Apparatus of Protection, Telemechanics, and Communication Channels of Power Systems, by G. K. Martynov and V. V. Pavlov. "Avto. i Tel." June 1956. 11 pp.

Graphical-Analytical Method for Plotting the Voltampere Characteristic of a Two-Terminal Network Which Contains a Transistor, by N. I. Brodovich. "Avto. i Tel." April 1956. 5 pp. The paper analyzes the graphical construction of the voltampere characteristic of a two-terminal network which contains a point-contact transistor that is connected into a grounded-base circuit. The graphical construction is illustrated by means of an example using a commutational circuit; voltampere characteristics are given which are obtained graphically for various values of the circuit parameters.

Measurement of Parameters Determining the Functioning of Transistors at High Frequency, by J. Riethmuller. "Ann. de Radio." July 1956. 10 pp. A description is given of methods utilized for semi-conductor elements in order to determine frequency-independent equivalent-circuit elements, together with a brief description of the devices which have been built for these measurements. A few results of measurements are given.

TELEVISION

A New Beam-Indexing Color Television Display System, by R. Clapp, E. Creamer, S. Moulton, M. Partin, and J. Bryan. "Proc. IRE." Sept. 1956. 5 pp. The Philco "Apple" system is described. A single electron beam excites vertical color phosphor stripes. Beam current is modulated by transmitted color video signal and selfgenerated index signal which indicates the location of the beam.

A Beam-Indexing Color Picture Tube — The Apple Tube, by G. Barnett, F. Bingley, S. Parsons, G. Pratt, and M. Sadowsky. "Proc. IRE." Sept. 1956. 4 pp. A detailed description of the Apple tube itself is given, including production techniques required by the unique features of the tube.

Current Status of Apple Receiver Circuits and Components, by R. Bloomsburgh, W. Boothroyd, G. Fedde, and R. Moore. "Proc. IRE." Sept. 1956. 5 pp. A review is presented of the components and circuits of a developmental color television receiver utilizing the Apple type of display.

Directions of Improvement in NTSC Color Television Systems, by D. Richman. "Proc. IRE." Sept. 1956. 15 pp. A discussion is presented of possible directions of improvement in the NTSC color television standards by compatible modifications.

Phase Linearity of Television Receivers, by A. van Weel. "Phil. Tech." July 27, 1956. 19 pp. The author suggests that difficulties arising with regard to phase linearity can be met with a phase-linear i-f amplifier which would be no more expensive than a conventional i-f amplifier. Proposal is applicable to Gerber standard and American standard TV transmissions.

Influence of Phase Errors on Image Quality of Video Transmissions, by H. Griese and P. Klopf. "El. Rund." Aug. 1956. 5 pp. Transient phenomena are investigated with random frequency response of phase for a frequency response of amplitude which is constant up to a steep decay boundary frequency of 5 MC. The practicability of various time delay definitions for the normalization of frequency responses of phase are discussed. A method for the operational measurement of side band phases of video transmitters is described.

Light Beam and Vidicon Film Scanner, by W. Dillenburger. "El. Rund." Aug. 1956. 3 pp. The two scanning devices are compared as to their operation and adjustability. The necessity of film shrinkage compensation implied by light beam scanning, flickering phenomena, beam current adjustment, gamma adjustment and afterglow compensation are considered.

The Superorthicon Video Camera Tube, by R. Theile. "El. Rund." Aug. 1956. 2 pp. Selection of a favorable operating point for optimal performance, the adjustment of the blacking factor, and camera amplifier features are considered. Means of avoiding some inherent drawbacks are discussed.

Standardisation of Television Equipment at Radiodiffusion-Television Francaise, by L. Goussot. "Onde." June 1956. 10 pp. This article describes the main technical features of video frequency television studio equipment used at R. T. F.

The Amplitude of the Chrominance Carrier in the NTSC-System, by H. Grosskopf. "Nach. Z." July 1956. 4 pp. The author reviews the principles and operation of the NTSC color TV system.

The Sudwestfunk's Television Transmitters, by H. Goldmann, E. Kniel, and A. Hein. "Tech. Haus." March-April, 1956. During the period 1953 to 1955, Sudwestfunk has constructed the five high-power television transmitting stations it was allocated under the Stockholm Plan. Tables compare the installations at Weinbiet, Hornisgrinde, Raichberg, and Koblenz from the technical point of view. It becomes evident from this comparison to what extent the orographical and climatic conditions of the sites influenced the technical design of the installations.

The Development and Present State of Television Coverage in the Service Area of the Sudwestfunk, by H. Eden. "Tech. Haus." March-April 1956. 7 pp. The Sudwestfunk developed its television network during the period 1953 to 1955. In addition to the five high-power transmitting stations at the Feldberg/Schw., Hornisgrinde, Koblenz, the Raichberg, and Weinbiet, provided for in the Stockholm Plan, five television satellites were erected. These serve the most important towns which are either not covered by the high power stations at all or only unsatisfactorily. The paper concludes with an outline of the state of coverage of the SWF service area as of the Spring of 1956.

Light Beam and Vidicon Film Scanning Devices—a Comparison on the Gerber Standard Base, by W. Dillenburger. "El. Rund." July 1956. 4 pp. On the basis of the 625 lines Gerber Standard equipment developed in Germany the light beam and the Vidicon film scanning devices are compared concerning image quality, expense, adjustment and operation. The advantages and drawbacks of both scanning devices are extensively discussed, the most important advantage of the Vidicon scanner consists in the small dependence, for a vast range, of image quality from density and blacking factor of the scanned film.

TUBES

An 8-mm Klystron Power Oscillator, by R. Bell and M. Hillier. "Proc. IRE." Sept. 1956. 5 pp. The development of a CW klystron oscillator as a low-noise transmitter for the 8-mm band is described, and details given for its performance.

A Method of Tuning Resonant Cavities, by W. Haywood. "El. Eng." Sept. 1956. 3 pp. A method of tuning resonant microwave cavities over a bandwidth of approximately one per cent is described.

International ELECTRONIC SOURCES

Tubes for Direct Digital Counting, by P. Cheilik. "El. Des." Aug. 15, 1956. 3 pp. Five one-envelope counting tubes are discussed: the Phillips tube, the Burroughs beam switching tube, the cold cathode bi-directional glow transfer tube, the cold cathode unidirectional glow transfer tube, and the IBM tube.

On Dimensioning the Helix in the Traveling-Wave Tube, by W. Klein. "Arc. El. Uber." June 1956. 5 pp. The dependence of gain, attenuation, space charge, relative beam diameter, etc., are discussed and various important relationships are graphically presented. Prevention of self-excitation is considered and optimum dimensions are indicated.

Analogy of Vacuum Tubes and Transistors, by H. Beneking. "Arc. El. Uber." May 1956. 8 pp. The mathematical equivalence of vacuum tubes and transistors is pointed out. General analogy, frequency limits, basic circuits, characteristic quantities and their measurements, and four-terminal networks including equivalent circuits are considered.

Kinescope Electron Guns for Producing Non-circular Spots, by R. Knechtli and W. Beam, "RCA". June 1956. 22 pp. In some cathode-ray-tube applications, small spot size is a necessity. This paper describes two types of electron guns. One type, using a line crossover rather than the conventional point crossover, is suitable for producing narrow, elongated spots. The other type, employing an electron-illuminated aperture as an electron-optical object, can produce sharply defined spots of any desired size and shape. These guns have been found experimentally to produce spots whose current density equals or exceeds that of the best available guns of conventional design.

The Electron Donor Centers in the Oxide Cathode, by R. Plumlee. "RCA". June 1956. 44 pp. The electronic chemical potential serves as the basis of a new interpretation of the chemistry of the oxide cathode in particular and of electronically active solids in general. This principle allows disposal of several fundamental irregularities in earlier interpretations of cathode chemistry through which the F-centers, presumed to be formed from "excess barium" and oxygen vacancies, have been previously identified as the electron donors. On the basis of recent literature it is concluded that the F-center model is not valid.

The Nature of Power Saturation in Traveling Wave Tubes, by C. Cutler. "Bell J." July 1956. 36 pp. The non-linear operating characteristics of a traveling wave tube were studied using a tube scaled to low frequency and large size. Measurements of electron beam velocity and current as a function of rf phase and amplitude show the mechanism of power saturation. Factors contributing to traveling wave power saturation are discussed.

Theory of the Transverse-Current Traveling-Wave Tube, by D. Dunn, W. Harman, L. Field, and G. Kino. "Proc. IRE." July 1956. 9 pp. An analysis is presented of a traveling-wave tube in which unmodulated DC current is continuously introduced along the length of the tube and is removed after traveling a fixed distance in the presence of the circuit field. This change in the DC current distribution as compared with that of a conventional traveling-wave tube results in three forward-growing waves instead of one; one growing exponentially as in the conventional tube, one growing linearly, and one growing as the square of distance. Expressions for the over-all gain of a forward-wave amplifier of this type are derived as a function of the usual parameters plus an additional parameter related to the distance traveled by electrons in the inter-action space.

One Knob Tunes Klystron Oscillator, by J. Altman and K. Craft. "El." Sept. 1956. 4 pp. An electronically stabilized reflex Klystron frequency source is described.

Traveling Wave Tube Application for Measuring Purposes, by A. Lauer. "El. Rund." July 1956. 3 pp. Dynamic measuring methods with active or passive wobbulator systems are employed for the investigation of dm or cm wavelength circuits. A 4000 MC measuring wobbulator equipment with a recently developed traveling wave tube of large bandwidth and high output is considered. Adaptation, quadripole and cycle measurements executed thereby are described. Finally, the employment of the traveling wave tube as oscillator is briefly entered upon.

Ceramic Receiving Tubes Defy High Temperatures, by R. Jurgen. "El. Eq." Aug. 1956. 3 pp. Developmental programs for ceramic receiving tubes are reported. Three different tubes are described.

An Experimental Transverse-Current Traveling-Wave Tube, by D. Dunn and W. Harman. "Proc. IRE". July 1956. 9 pp. A transverse current traveling-wave tube employing a flat helix and a skew beam is described. The tube operates as an amplifier over the frequency range from 1 to 2 KMC with a power output of the order of 30 milliwatts. Tests showing a gain vs voltage characteristic markedly different from that obtained with a conventional traveling-wave tube are reported.

Traveling Wave Tube Impedance, by C. Ammerman. "El. Des." Aug. 15, 1956. 1 p. Discussion and typical curves of output impedance of the type S-166A traveling wave tube over the range 2 to 4 KMC are presented.

Electrostatic Memory Tubes and Their Applications, by Ch. Dufour. "Ann. de Radio." July 1956. 16 pp. The author presents a theoretical review of memory tubes and an outline of existing types; barrier grid storage tube, transmission grid-control tube, induced conductivity tube for radar PPI-to-TV transformation, and picture retention receiver tubes.

U. S. GOVERNMENT

Research reports designed (LC) after the price are available from the Library of Congress. They are photostat (pho) or microfilm (mic), as indicated by the notation preceding the price. Prepayment is required. Use complete title and PB number of each report ordered. Make check or money order payable to "Chief, Photoduplication Service, Library of Congress," and address to Library of Congress, Photoduplicatiton Service, Publications Board Service, Washington 25, D. C.

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When an agency other than LC or OTS is the source, use the full address included in the abstract of the report. Make check or money order payable to that agency.

RF Wattmeter AN/URM-73(XA1) PB121096), USAF. July 1955. 81 pp. $2.25. (OTS) Covers the investigation, development, and design of an r-f wattmeter to be used in field and depot testing. The wattmeter measures powers in the high and medium power ranges over the 20 to 1000 MC frequency band, using a high-power precision attenuator and a heater-thermocouple detector delivering DC voltage to a panel meter.

Magnetic Arbitrary Waveform Generator (PB121157), by C. B. House, Naval Research Laboratory. May 1956. 10 pp. 50¢. (OTS) Describes development of a generator which will produce periodic waveforms in which the magnitude, slope, polarity, slope polarity, and points of inflection may be controlled at will by simple resistance or voltage changes. When used with a compatible analog computer system, it provides output transfer functions which may be tailored to any complexity desired.

Regulated Power Supplies With Silicon Junction Reference (PB111814), by D. G. Scorgie, Naval Research Laboratory. Aug. 1955. 13 pp. 50¢. (OTS) The silicon junction diode makes a valuable adjunct to the magnetic amplifier for producing regulated DC voltage or current. In addition to achieving regulation on the order of 0.1%, the power supplies built to illustrate the operating principles were lighter and probably more reliable than their electronic counterparts. By proper choice of circuitry, regulated voltage could be held independent of temperature, supply frequency, and supply voltage through the required ranges.

Effect of a Ground Discontinuity on a VOR (PB121228), by S. R. Anderson and A. E. Frederick, CAA Technical Development Center. May 1956. 20 pp. 50¢. (OTS) Tests were conducted to determine the effect of an abrupt ground discontinuity on the course accuracy of a very-high-frequency omnirange. It was indicated that satisfactory operation is attained when the antenna is located four feet above the terrain and not less than 63 ft. from a ground discontinuity. Equations describe some phenomena observed during the tests.

(OTS) Method is presented for calculating the mixer admittance matrix Y^1 which results when an ohmic impedance is connected in series with a diode mixer described by an admittance matrix Y. As a result of this analysis, the usual criterion for good high-frequency mixing, i.e., that the product of the spreading resistance and the barrier capacitance be small compared with unity, is criticized and a new figure of merit is proposed.

II: Experimental Discussion (PB 119462), by G. Fellows. 81 pp. Mic $4.80, pho $13.80. (LC) Experimental measurement of the intensity spectrum at the output of a half-wave vth law detector fed by narrow band noise and an unmodulated carrier. Included is a discussion of the design of the analyzer, based upon an analysis of expected statistical and system errors.

Battery Analyzer for Use in Storage Battery Studies (PB 111932), by G. Work and C. Wales, NRL. Feb. 1955. 20 pp. 50¢. (OTS) Analyzer features simplicity and accuracy of control, a wide scope of variables measured and a complete, continuous record. Optional equipment adapts the basic unit to many types of cycle operations including time and voltage cutoffs.

Computer Components Fellowship No. 347. Quarterly Report No. 9, Oct. 11, 1952-Jan 10, 1953, Under Contract No. CLN AF 19/122/376 (PB 119729), by J. Boroman, F. Schwertz, A. Milch, B. Moffat, R. Steinbach, and J. Mazenko, Mellon Institute. Jan. 1953. 128 pp. Mic $6.30, pho $19.80. (LC) Four sections. First 2 summarize findings about the use of nonlinear resistors in logical switching circuits and of the influence of various experimental parameters on the voltage-current characteristics of such resistors. Section III describes a chemical which shows color hysteresis in the range between 0° and 100°C. This chemical appears to be potentially adaptable to the design of long-term storage devices or to high-speed printing. Section IV discusses a scheme for using saturable reactors as gates.

Proceedings of the Conference on Atmospheric Electricity Held at Wentworth-by-the-Sea, Portsmouth, N. H., May 19-21, 1954. (PB 121004) Edited by R. Holzer and W. Smith. Nov. 1955. 255 pp. $4. (OTS) 27 papers on atmospheric electricity. Subjects include electrical conductivity of air, electric and magnetic field effects of lightning, thunderstorm electrification, etc.

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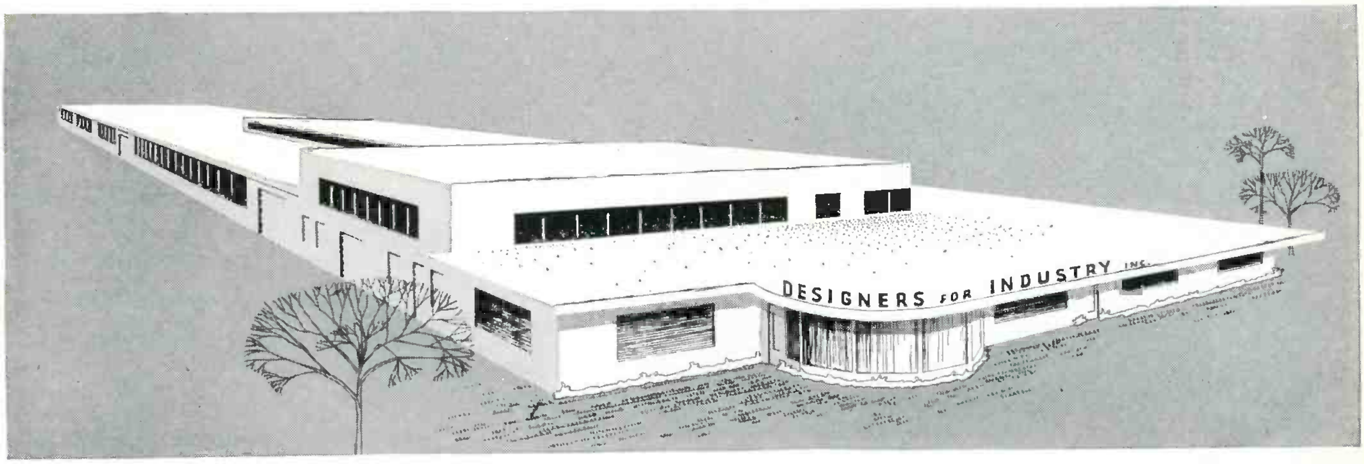

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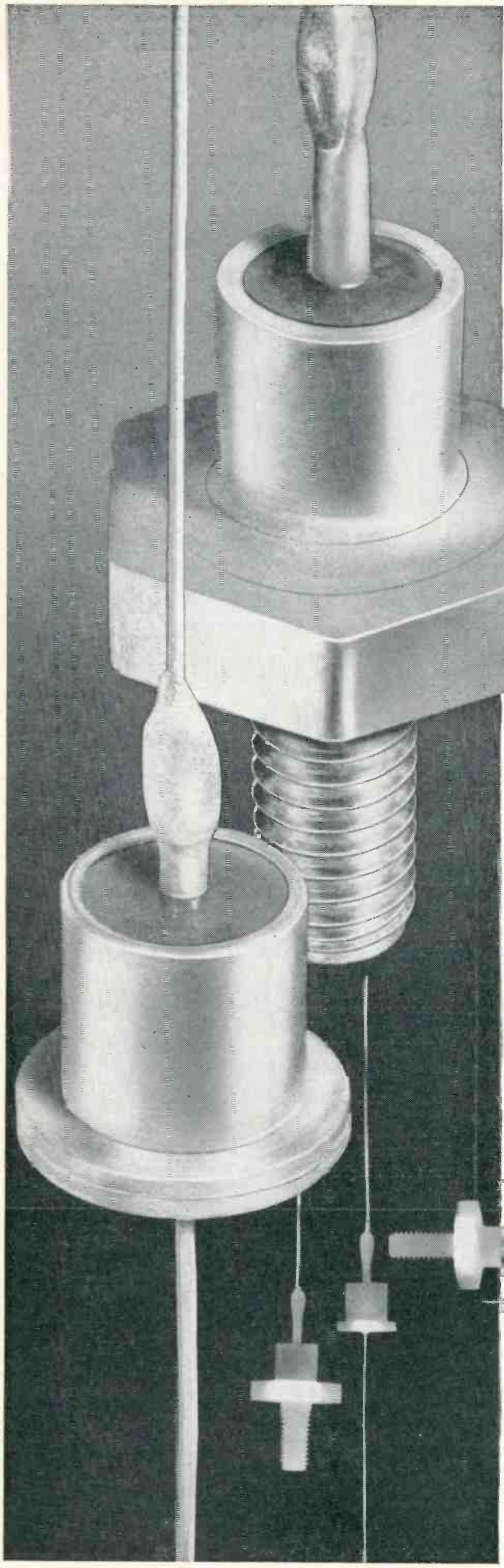

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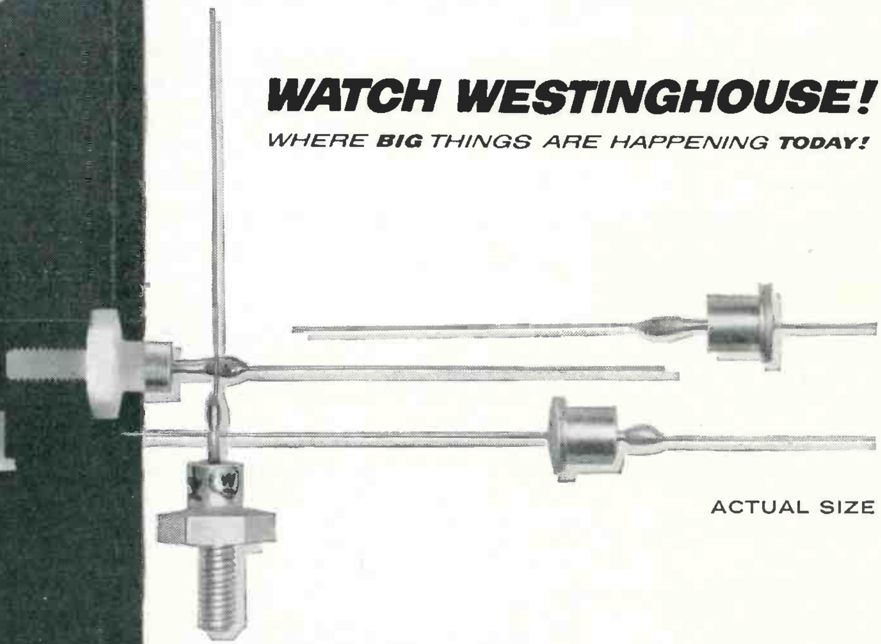


ACTUAL SIZE

News of Reps

RMS Export Sales Corp., 2016 Bronxdale Ave., New York 62, has appointed **Sol Budd & Assoc.** to handle all Canadian stock, including service and repairs. All items will be warehoused by Sol Budd & Assoc. at 2921½ Dufferin St., Toronto 10.

Trilby Engineering Co., Detroit, will handle sales of rotating components, monitoring and control components, and standard electrochemical breadboard parts in Michigan and in Toledo for Helipot Corp., Newport Beach, Calif., a Div. of Beckman Instruments, Inc.

Perlmuth Electronic Assoc., Los Angeles, have added three men to their component sales force: **Richard A. Young, William D. Smith.** and **Guy L. Cowperthwait**; and two to the instrumentation engineering group; **Harry D. Dickinson,** engineer, and **Henry P. Kohnen,** missiles.

G. S. Marshall Co., Pasadena, Calif., is constructing a new main office building at 2065 Huntington Drive, San Marino, Calif. The one-story, air-conditioned building covers 7,500 sq. ft. of area.

Northport Engineering, Inc., 186 N. Fairview Ave., St. Paul 4, has been named rep for North and South Dakota and Minnesota by Perkin Engineering Corp., El Segundo, Calif., for the Perkin line of DC and AC power supplies.

Triplett Electrical Instrument Co., Bluffton, Ohio, has named four new sales reps: **George Petitt Co.,** 349 Ashland Ave., River Forest, Ill. (distributor sales in Chicago and N. E. Ill.); **Al Quackenbush,** 2629 N. 77th St., Chicago (distributor sales in E. Wis., E. Iowa, and N. W. Ill.); **Knoblock & Malone,** 4000 N. West Ave., Chicago (industrial sales, E. Wis., N. Ill., and E. Iowa); and **Len Kinkler,** 1505 Park Royale Blvd., Port Credit, Ont. (Quebec, New Brunswick, Nova Scotia, Prince Edward Is., Newfoundland and Ontario, excluding cities of Ft. Williams and Port Arthur).

Henry Lavin Assoc., New England reps, have moved to their own building on U. S. Route 5A, Meriden, Conn.

Rene Sonnenfeldt has been appointed a sales engineer for the **Bart-Messing Corp.,** Belleville, N. J.

Land-C-Air Sales Co., Tuckahoe, N. Y., has opened a new warehouse and office at 154 Marbledale Rd., Tuckahoe. **Eugene Black** and **Roy Usilton** have joined the Land-C-Air staff as sales engineer and salesman, respectively.

(*Continued on page* 116)

News of Reps

(*Continued from page* 115)

W. L. Cunningham & Assoc., Elmhurst, Ill., has been named Mid-West regional representative for Kaar Engineering Corp., Palo Alto, Calif. The Cunningham organization has become affiliated with the **Larry A. Chambers Co.**, Chicago, to handle Wisconsin-Illinois industrial sales of Continental Carbon and Wirt Co. products.

Cubic Corp., San Diego, has named **George E. Merer** as its sales contract rep for the District of Columbia area. His office is at 929 15th St., N. W., Washington 5.

U. S. Components, Inc., New York, has appointed **Hyde Sales Co.**, 3250 S. Dexter St., Denver, as its engineering and sales rep for the Rocky Mountain region.

Construction of a new building has been announced by **Yewell Associates, Inc.**, Waltham, Mass. The 8,000-sq. ft. office and service facility will be located on Old Middlesex Turnpike, Burlinton, Mass., and ready early in 1957.

Robert E. Nesbitt Co., Dallas, has been appointed district sales rep in Texas and Oklahoma for Sola Electric Co., Chicago.

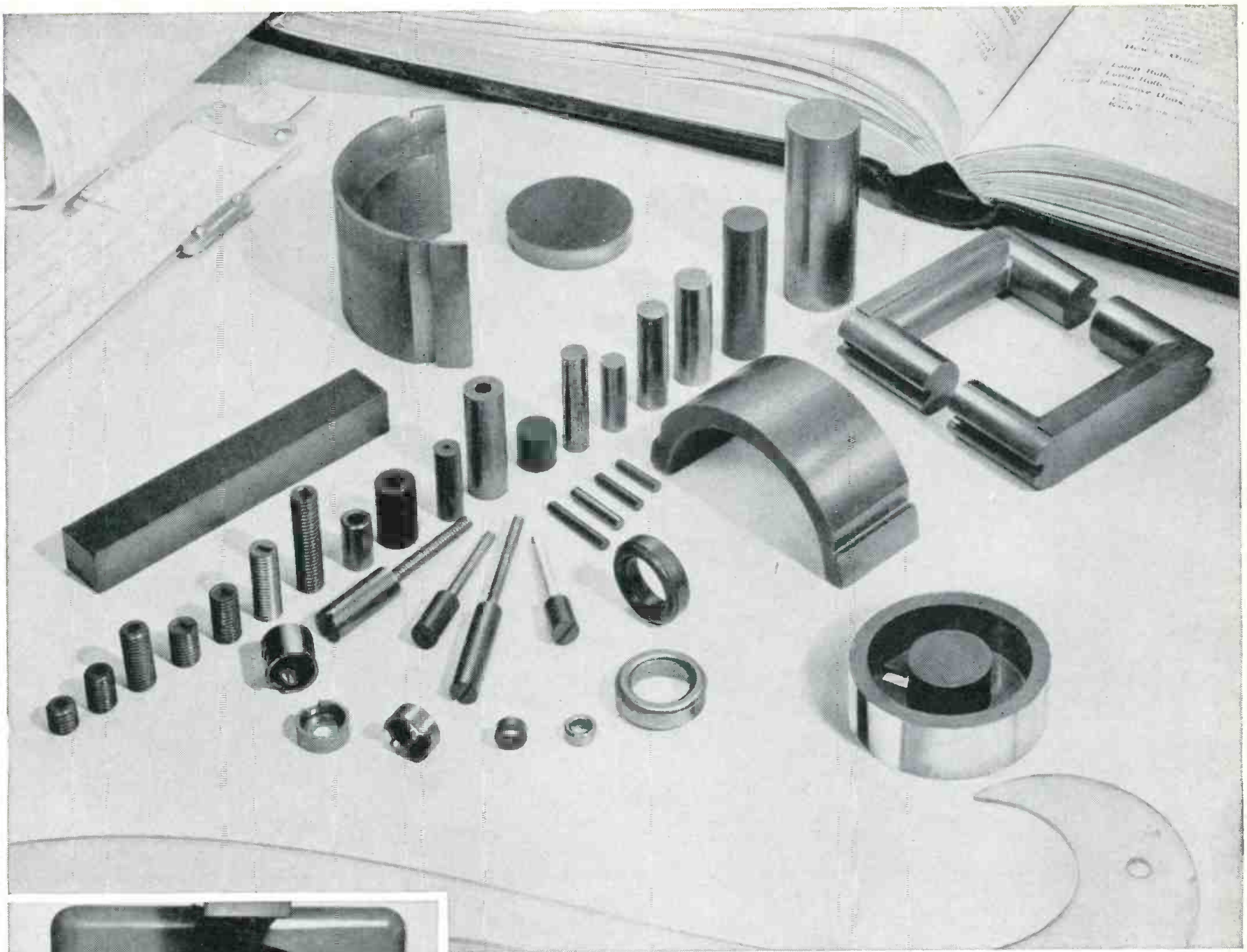
Frank McSweeney has consolidated his jobber lines with **Robert O. Whitesell & Assoc.**, Indianapolis, and has become an associate member of the firm.

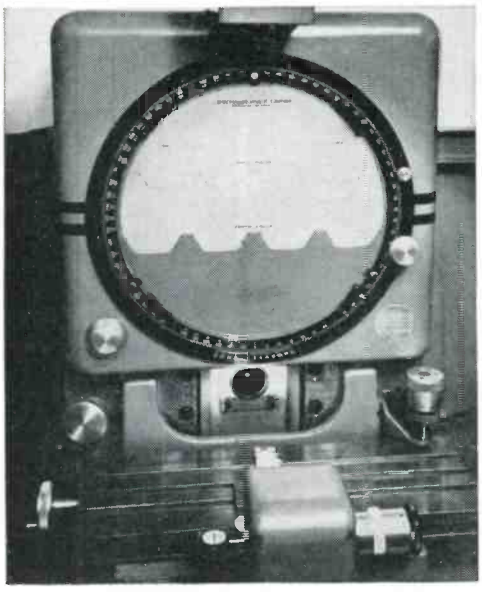
G. S. Marshall Co., Pasadena, Calif., reps, will handle sales for Helipot Corp., Newport Beach, Calif., a Div. of Beckman Instruments, Inc., in California, Arizona and Nevada.

Gulton Industries, Metuchen, N. J., has added these reps and field engineers: **Reynolds, Inc.**, Providence, in Rhode Island and portions of Mass. and Conn.; **Pitchford Scientific Instruments**, Pittsburgh, in the Greater Pittsburgh area; and **J. A. Reagan Co.**, Albany, N. Y., Northern N. Y. **Paul Devine**, Washington, covering the District of Columbia area; and **Jack Sarty**, Warwick, R. I., for New England, are the new field engineers.

Electronic Engrg. Reps (EER) will present second annual Road Show on this schedule: Oct. 15—Henry Hudson Hotel, New York; Oct. 17—Garden City Hotel, Garden City, N. Y.; Oct. 19—West Orange (N. J.) Armory; Oct. 24—Penn-Sherwood Hotel, Philadelphia; and Oct. 26—Molly Pitcher Hotel, Red Bank, N. J.

Fred F. Bartlett & Co., 160 Morlyn Ave., Bryn Mawr, Pa., is a new electronic manufacturers' rep for E. Pa., So. N. J., Md., Del., D. C. and Va. Bartlett was formerly Broadcast Sales Mgr., Philco Corp.'s Govt. & Industrial Div., Philadelphia.





IRON POWDER CORES

to meet your highest requirements

★ *For QUALITY*

★ *For DIMENSIONAL ACCURACY*

COMPARATOR-CHECKED

to insure precision parts

Threaded cores are checked on an optical comparator at 100-x magnification to assure exact conformance. Arnold quality control of iron powder cores includes the maintaining of rigid electrical, physical and dimensional specifications unmatched in the industry.

Write for a copy of Bulletin PC-109

Contains essential data on processing, control methods, applications, types, sizes, suggested use frequencies, etc. of Arnold iron powder cores.

ADDRESS DEPT. T-610

Here are the essential facts to keep in mind about iron powder cores—and Arnold. As illustrated above, we make a wide selection of cores, from simple cylinders to special cores of complicated design. That includes all standard types and sizes of threaded cores, cup, sleeve, slug and cylindrical insert cores you may require: for use in antenna and RF coils, oscillator coils, IF coils, perm tuning, FM coils, television RF coils, noise filter coils, induction heating and bombarder coils, and other low frequency applications. Also, a standard series of iron powder toroids is being engineered at this time, which will conform to the standard sizes proposed by the Metal Powder Association. • We'll appreciate the opportunity to supply your needs . . . *let us quote on your requirements.*

WSW 6044

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

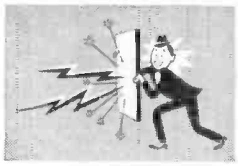
DISTRICT SALES OFFICES . . . New York: 350 Fifth Ave.

Los Angeles: 3450 Wilshire Blvd. Boston: 200 Berkeley St.

A good combination...for an argument

Laminated plastics... a combination of properties that *speaks for itself!*

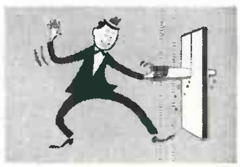
Many industrial applications require materials that can deliver more than one property and can perform more than one function. Such a material is Synthane laminated plastic. This widely used basic material satisfies such diverse property requirements as good tensile, compressive and flexural strengths, low moisture absorption, low dielectric constant and low power factor, light weight and easy machinability. Various grades of Synthane are available to the designer in order to provide him with **just the right combination of properties** according to the mechanical, electrical and chemical requirements of his application.



DIELECTRIC STRENGTH

LIGHT WEIGHT

WEAR RESISTANCE



EASILY MACHINED

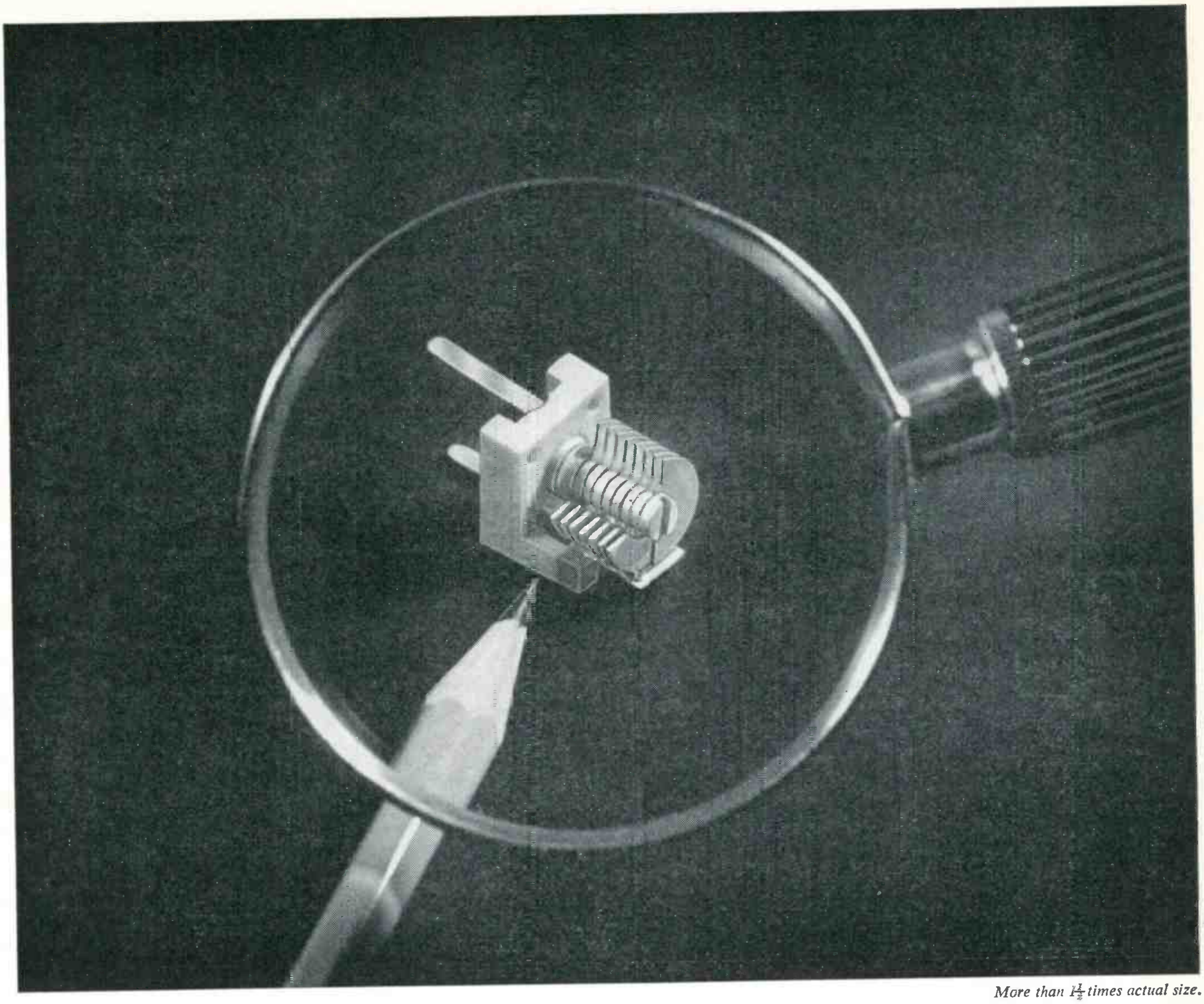
This insulation plate made of Synthane has to take the toughest kinds of outdoor punishment. Used in heavy-duty generators for bulldozers and tractors, it must battle all kinds of weather, road dust, oils, greases, and vibrations. In addition to meeting these tough service conditions, Synthane also possesses the necessary light weight, mechanical and dielectric strengths, good machining properties, and the ability to be post-formed to the desired shape.

A wide choice of combined properties! Synthane offers over 30 individual grades in sheets, rods, tubes, moldings, and completely fabricated parts. Send for free illustrated catalog today.

SYNTHANE

SYNTHANE CORPORATION, 11 RIVER ROAD, OAKS, PA.

For product information, use inquiry card on page 113.



More than 1½ times actual size.

NOW! even smaller air trimmer capacitors

For every type of electronic equipment—printed wiring board or conventional chassis—Radio Condenser's new Series 75 trimmers mean more circuit in less space. Measuring just 25/64" x 7/16" x 17/32" behind mounting surface, they're the tiniest trimmers ever made in the United States.

Three capacitance ranges are available, as tabulated below. Each is equipped with plug-in tabs for printed wiring board insertion, as well as two holes for conventional screw mounting. The sturdy low loss ceramic body, brass plates soldered and silver plated, assure a rugged unit, able to take extreme shock, vibration and temperature change. Capacitance is easily varied by means of a screwdriver slot in the rotor shaft.

Insulation resistance, "Q" and thermal stability characteristics are excellent.

Complete Engineering data and specifications for the new Series 75 Subminiature Trimmer capacitors are provided in Bulletin TR-123, available free on request. Write Radio Condenser now for your copy.

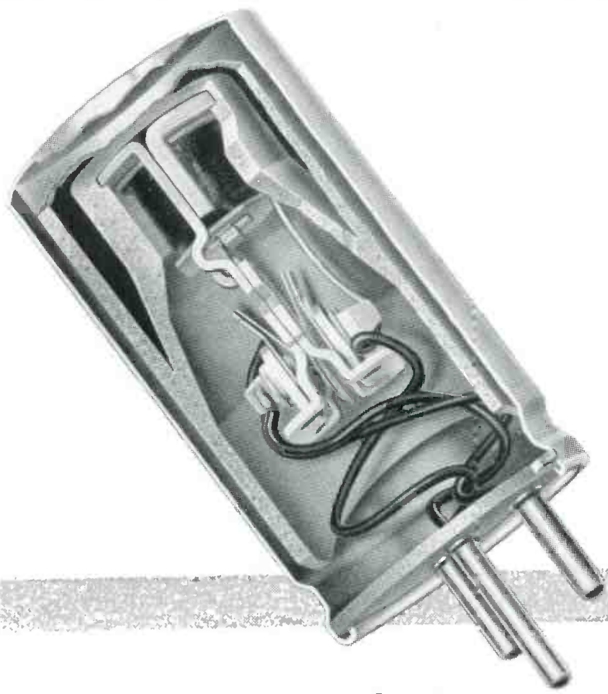
RADIO CONDENSER
MINIATURE AIR TRIMMER CAPACITORS

Type No.	Min. Cap. μμF	Effective Max. Cap. μμF	Air Gap	No. Plates
875001	1.2	5	.014	9
875002	1.2	10	.008	11
875003	1.5	15	.008	15

RADIO CONDENSER CO.

Davis & Copewood Streets • Camden 3, New Jersey
EXPORT: Radio Condenser Co., International Div., 15 Moore St., N.Y. 4, N.Y.,
CABLE: MINTHORNE
CANADA: Radio Condenser Co. Ltd., 6 Bermondsey Rd., Toronto, Ontario

For product information, use inquiry card on page 113.



Completely new design concept eliminates usual button contact, provides larger contacting area. New units have far longer life, lowest noise level yet . . . but cost no more.

Vibrator life increased 50 to 100% . . . in newest Mallory design

STANDARDS of vibrator performance never before possible are being set by the latest development in Mallory vibrator engineering. Through the use of new design and materials, contact is made directly between vibrating reed arm and side arm—eliminating conventional contact buttons—providing far greater contacting area and longer life.

And in addition, a further refinement in the mounting of the vibrator establishes a new high standard of quieter operation.

The results of these new design concepts are important to everyone who designs, makes or uses vibrator-powered equipment.

Life is increased 50 to 100% . . . due to greater contacting area and far lower rate of wear.

Sticking of contacts is eliminated.

Complete uniformity of characteristics is made possible by this simplified design, which permits automatic production and adjustment techniques.

Extra-quiet operation. Mechanical hum is held to a new low level, due to the lighter mass of the mechanism, and to noise-squelching Mallory refinements.

Smaller size for equivalent load rating.

The new Mallory 1600 series vibrator is now available for auto radios, headlight dimmers, garage door openers and many other applications. In addition, the new leaf spring contacting concept is available in another new Mallory vibrator—the 1700 series for two-way communications equipment and other heavy duty applications.

Expect more . . . Get more from

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

Serving Industry with These Products:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical — Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials
Parts distributors in all major cities stock Mallory standard components for your convenience.

For product information, use inquiry card on page 113.

P-C Directory

(Continued from page 78)

Radio City Products Co 101 W 31 St NY 1
Radio Corp of America Camden 2 NJ
Raytheon Mfg Co 529 W Dickens Ave Chicago 29 Ill
Revere Copper & Brass 230 Park Ave NY 17
Rex Electronics Corp 1351 E DeLoss St Indianapolis 3 Ind
Richardson Co 2790 Lake St Melrose Park Ill
RS Electronics Corp 435 Portage Ave Palo Alto Calif
Samson Chemical & Pigment Corp 2830 W Lake St Chicago 12 Ill
Sanders Associates 137 Canal St Nashua NH
Sequola Process Corp 871 Willow St Redwood City Calif
Shamban Eng'g Co 11617 W Jefferson Blvd Culver City Calif
Solar Mfg Corp E 46 St & Seville Ave Los Angeles 58 Calif
Sound Devices Inc 129 E 124 St NY 35
Spaulding Fibre Co 310 Wheeler St Tonawanda NY
Sprague Electric Co Marshall St North Adams Mass
Stackpole Carbon Co Tannery St St Marys Pa
Stavid Eng'g Inc US Hwy #22 Plainfield NJ
Standard Coil Products Co 2085 N Hawthorne St Melrose Park Ill
Star Fuse Co 235 Canal St NY 13
Stupakoff Div Carborundum Co Latrobe Pa
Taylor Fibre Co Norristown Pa
Technograph Printed Electronics Inc 185 Valley St Tarrytown NY
Techron Corp 254 Friend St Boston 14 Mass
Teleradio Eng'g Corp Wilkes-Barre Pa
Thermyte Inc 414 Amory St Boston 30 Mass
Thompson Clock Co H C 38 Federal St Bristol Conn
Tri-Dex Co PO Box 1207 Lindsay Calif
TV Labs Inc 5045 W Lake St Chicago 44 Ill
Union Elec 1057 Summit Ave Jersey City NJ
US Components Inc 454 E 128 St NY 55
U S Eng'g Co 521 Commercial St Glendale 3 Calif
Vacumet Inc 1009 W Weed St Chicago 22 Ill
Vokar Corp Dexter Mich
Visart Inc 2634 Park Ave NY 51
Walkirt Co 145 W Hazel St Inglewood 3 Calif
Westinghouse Electric Corp Metuchen NJ

PRINTED CIRCUIT EQUIPMENT

Abatram Electronic Eng'g Co PO Box 529 Dayton 9 Ohio
Acoustica Associates 2 Shore Rd Glenwood Landing LI NY
Automatic Processing Corp 1335 N Wells St Chicago 10 Ill
Bruno-New York Industries 460 W 34 St NY 1
Citron Component Co Santa Barbara Municipal Airport Goleta Calif
Defiance Eng & Microwave Corp 81 Albion St Wakefield Mass
Design Tool Corp 80 Washington St NY
Electronic Control Systems 2136 Westwood Blvd Los Angeles 25 Calif
Eraser Co Rush Wire Stripper Div 1068 S Clinton St Syracuse 4 NY
Erie Resistor Corp 644 W 12th St Erie 6 Pa
Federal Tool Eng'g 1384 Pompton Ave Cedar Grove NJ
General Research & Supply 572 S Division Ave Cedar Rapids 3 Mich
Gundlach Mfg Co 38 E Main St Fairport NY
Hillyer Instrument Co 54 Lafayette St NY 13
Huppert Co K H 6830 Cottage Grove Ave Chicago 37 Ill
Malco Tool & Mfg Co 4025 W Lake St Chicago 24 Ill
Mallory & Co Inc P R 42 So Gray St Indianapolis 6 Ind
Printed Electronics Corp 7 North Ave Natick Mass
Remington Rand Univac 1902 W Minnehaha Ave St Paul 4 Minn
Sanders Associates Inc 137 Canal St Nashua NH
Technograph Printed Electronics 185 Valley St Tarrytown NY
U S Stoneware Corp Akron Ohio
White SS Co 10 E 40 St NY 16
Wiedemann Machine Co 4272 Wissahickon Ave Phila 32 Pa

RESISTORS, FIXED & VARIABLE

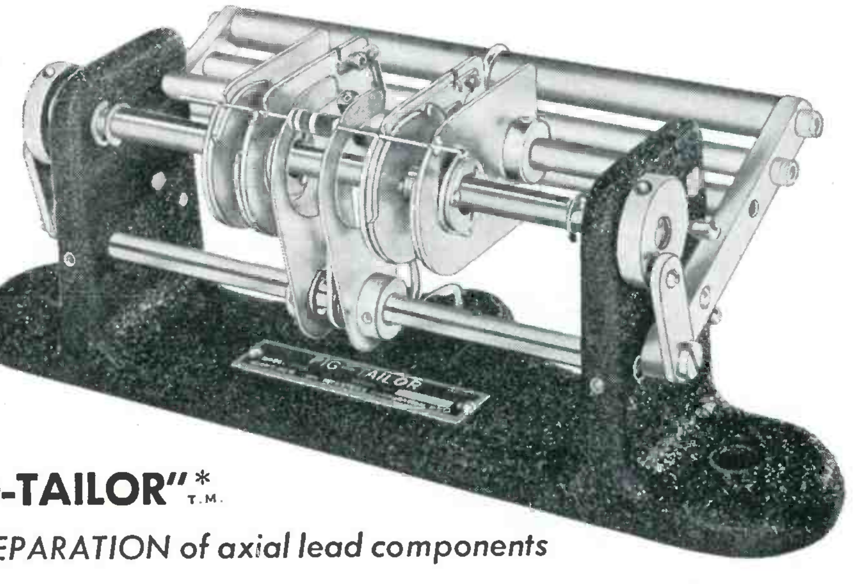
ACF Electronics 800 N Pitt St Alexandria Va
Aerovox Corporation & Divisions 740 Belleview Ave New Bedford Mass
American Barrograph Corp 599 Sackett St Brooklyn 17 NY
Automatic Processing Corp 1335 N Wells St Chicago 10 Ill
Beck's Inc 298 E 5 St St Paul 1 Minn
British Electronic Sales 23-03 45 Rd Long Island City 1 NY
Buckbee Mears Co Lindeke Bldg St Paul 1 Minn
Campbell Industries 3806 St Elmo Ave Chattanooga 9 Tenn
Centronics Corp 21-04 122 St College Point 46 NY
Chicago Telephone Supply Corp 1142 W Beardsley Ave Elkhart Ind
Clarostat Mfg Co Washington St Dover NH
Dale Products Inc PO Box 136 Columbus Nebr
Daven Co Route 10 Livingston NJ
Daystrom Pacific 11150 LaGrange Ave W Los Angeles 25 Calif
Dwyer Engineering Co PO Box 483 Nashua NH
Electra Mfg Co 4051 Broadway Kansas City Mo
Emerson Radio & Phonograph Corp 14 & Coles Sts Jersey City 2 NJ
Erie Resistor Corp 644 W 12 St Erie 6 Pa
General Electric Co PO Box 1122 Syracuse NY
Glenco Corp Durham Ave Metuchen NJ
Hansen Electronics Co 7117 Santa Monica Blvd Los Angeles 46 Calif
Herlec Corp 6th & Beech St Grafton 1 Wis
Jevex PO Box 646 Redlands Calif
Lectrohm Inc 5560 Northwest Hwy Chicago 30 Ill
Mallory & Co Inc P R 42 S Gray St Indianapolis 6 Ind
Mel-Rain Corp 2100 Fletcher Ave Indianapolis 3 Ind
Mepco Inc 37 Abbett Ave Morristown NJ
Muter Co 1255 S Michigan Ave Chicago 5 Ill
Onondago Pottery Co 1858 W Fayette St Syracuse 1 NY
Philco Corp C & Tioga Sts Phila 34 Pa
Picco Instruments & Controls Corp 3593 Hayden Ave Culver City Calif
Reon Resistor Corp 117 Stanley Ave Yonkers NY
Resistance Products Co 914 S 13 St Harrisburg Pa
RHO Eng'g Co 2240 Sepulveda Blvd Los Angeles Calif
Ruckelshaus Labs John G Madison NJ
Sanders Associates 137 Canal St Nashua NH
Shallite Inc 10 Mill St Paterson NJ
Sprague Electric Co Marshall St North Adams Mass
Stackpole Carbon Co Tannery St St Marys Pa
Stupakoff Div Carborundum Co Latrobe Pa
Tru-Ohm Div Model Eng'g & Mfg 2800 N Milwaukee Ave Chicago 18 Ill
Welwyn Int'l 3355 Edgecliff Terrace Cleveland 11 Ohio

SOLDER

Alpha Metals Inc 56 Water St Jersey City 4 NJ
Aluminum Co of America 1501 Alcoa Bldg Pittsburgh 19 Pa
Anchor Metal Co 244 Boerum St Brooklyn 6 NY
Baum Chemical Co 820 65th Ave Phila 39 Pa
Division Lead Co 7742 W 61 Pl Summitt Ill
Electrofilm Inc 7116 Laurel Canyon Blvd N Hollywood Calif
Eutectic Welding Alloys 40-40 172 St Flushing 58 NY
Farrelloy Co 1245 N 26 St Phila 21 Pa
Federated Metals Div American Smelting & Refining Co 120 Broadway NY 5
General Cement Mfg Co 919 Taylor Ave Rockford Ill
Johnson Mfg Co Mt Vernon Iowa
Kester Solder Co 4210 Wrightwood Ave Chicago 39 Ill
Malayan Tin Bureau 1028 Conn Ave Washington 6 DC
Mico Instrument Co 80 Towbridge St Cambridge 38 Mass
Modern Wire Co 30-39 Review Ave Long Island City 1 NY

(Continued on page 124)

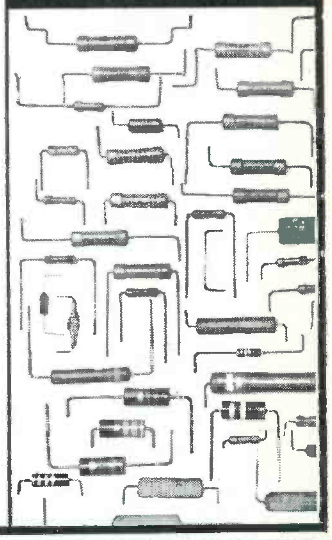
PROVEN-on the assembly line!



"PIG-TAILOR"* T.M.

For PREPARATION of axial lead components

PREPARED COMPONENTS IN SECONDS WITH THE "PIG-TAILOR"



"PIG-TAILORING"

. . . . a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.

The "PIG-TAILOR" plus "SPIN-PIN"—accurately MEASURES, CUTS, BENDS, EJECTS & ASSEMBLES both leads simultaneously to individual lengths and shapes—3 minute set-up—No accessories—Foot operated—1 hour training time.

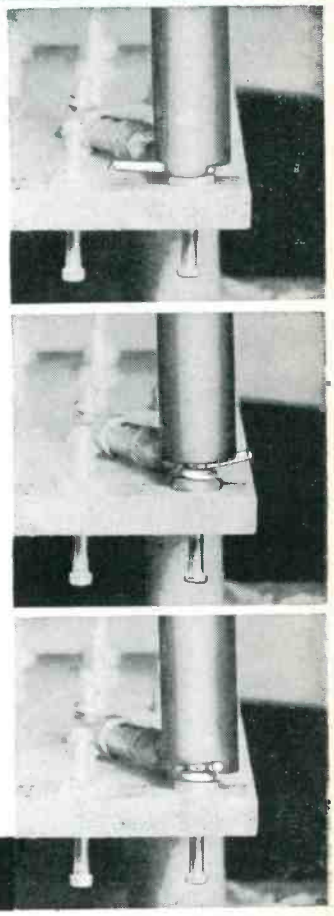
PIG-TAILORING provides:

1. Uniform component position.
2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits.
6. Individual cut and bend lengths.
7. Better time rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery

PIG-TAILORING eliminates:

1. Diagonal cutters!
2. Long-nose pliers!
3. Operator judgment!
4. 90% operator training time!
5. Broken components!
6. Broken leads!
7. Short circuits from clippings!
8. 65% chassis handling!
9. Excessive lead tautness!
10. Haphazard assembly methods!

"SPIN-PIN"* T.M.



FOR ASSEMBLY

Close-up views of "SPIN-PIN" illustrate fast assembly of tailored-lead wire to terminal.

* PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. **TT-10P**

BRUNO-NEW YORK INDUSTRIES CORPORATION

DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT

460 WEST 34th STREET • NEW YORK 1, N. Y.

New York Solder Co 684 E 133 St NY 54

SOLDERING EQUIPMENT

Acoustica Associates 2 Shore Rd Glenwood Landing LI NY
Alcar Instruments Inc 17 Industrial Ave Little Ferry NJ
American Electrical Heater Co Detroit 2 Mich
Berkeley Div Beckman Instruments Inc Wright Ave Richmond 3 Calif
Cole Radio Works 86 Westville Ave Caldwell NJ
Definance Eng & Microwave Corp 81 Albion St Wakefield Mass
Eisler Eng'g 750 S 13 St Newark 3 NJ
Electronics Soldering Iron Co Deep River Conn
El Mec Labs 730 Blvd Kenilworth NJ
Emerson Radio & Phonograph Corp 14 & Coles Sts Jersey City 2 NJ
General Cement Mfg Co 919 Taylor Ave Rockford Ill
Hi-Grade Alloy Corp 1236 S Talman Chicago 39 Ill
Ideal Industries 5127 Park Ave Sycamore Ill
Kahle Engineering Co 1307 7 St North Bergen NJ
Luma Electric Equipment Co PO Box 132 Toledo 1 Ohio
Sta-Warm Electric Co 553 N Chestnut St Ravenna Ohio
United Shore Machinery Corp 146 Federal St Boston Mass
Vemaline Products Co PO Box 222 Hawthorne NJ
Virginia Electronics Co River Rd at B&O RR Wash 16 DC
Waage Electric Inc 720 Colfax Ave Kenilworth NJ
Zephyr Mfg Electronics Div 201 Hindry Ave Inglewood 1 Calif

SWITCHES

Aerovox Corp 740 Belleville Ave New Bedford Mass
Anatron Eng'g Co 10 Congress St Pasadena Calif
Automatic Processing Corp 1335 N Wells St Chicago 10 Ill
Beck's Inc 298 E 5 St St Paul 1 Minn
Brubaker Mfg Co 9151 Exposition Dr Los Angeles 34 Calif
Buckbee Mears Co 4 & Rosabel Sts St Paul 1 Minn
Cardwell Electronics Productions Corp Allen D 97 Whiting St Plainville Conn
Centralab Div Globe-Union Inc 900 E Keefe Ave Milwaukee 1 Wis
Chicago Telephone Supply Corp 1142 W Beardsley Ave Elkhart Ind
Clum Mfg Co 601 National Ave Milwaukee Wis
Daven Co Route 10 Livingston NJ
Eastern Precision Resistor Corp 130-11 90 Ave Richmond Hill 18 LI NY
Endevco Corp 161 E California St Pasadena Calif
Gavitt Wire & Cable Co Div American Hard Rubber Brookfield Mass
General Devices Inc Princeton NJ
Giannini & Co G M 918 E Green St Pasadena 1 Calif
Grigsby-Allison Co 407 N Salem Ave Arlington Heights Ill
Magnavox Co Fort Wayne 4 Ind
Mallory & Co Inc P R 42 So Gray St Indianapolis 6 Ind
Phen-O-Tron Inc 455 Main St New Rochelle NY
Photocircuits Corp Sea Cliff Ave Glen Cove NY
Plastics & Electronics Corp 272 Northland Ave Buffalo 8 NY
Printed Circuits Inc 36 Tunxis Ave Bloomfield Conn
Rockwell Eng'g Co 4065 N New Jersey St Indianapolis 5 Ind
Tech Labs Inc Bergen & Edsall Blvd Palisades Park NJ
Techron Corp 254 Friend St Boston 14 Mass
Torsion Balance Co 35 Monhegan St Clifton NJ
Ucinite Co Div United-Carr Fastener Corp 459 Watertown St Newtonville Mass

TUBE SOCKETS, PRINTED CIRCUIT

Aerovox Corp Pacific Coast Div 2724 Peck Rd Monrovia Calif
Connector Corp 6025 N Keystone Ave Chicago 30 Ill
Eby Co Hugh H 4701 Germantown Ave Phila 44 Pa
Graphik Circuits Div Cinch Mfg Corp 221 S Arroyo Pkwy Pasadena 1 Calif
Haydu Bros of N J Sub Burroughs Corp PO Box 1226 Plainfield NJ
Industrial Hdwe Mfg Co 109 Prince St NY 12 NY
Mycalex Corp of America 125 Clifton Blvd Clifton NJ
National Fabricated Fabrics Div Hoffman Electronics 2650 W Belden Ave Chicago 47 Ill

WIRE STRIPPING MACHINES

Artos Eng'g Co 2753 S 28 St Milwaukee 46 Wis
Eraser Co 1068 S Clinton St Syracuse 4 NY
Stevens Mfg Co George 6022 N Rogers Ave Chicago 30 Ill
Technical Devices Co 2340 Centinela Ave Los Angeles 64 Calif
Wiedemann Machine Co 4272 Wissahickon Ave Phila 32 Pa
Wire Stripper Co 1721 Eastham Ave E Cleveland 12 Ohio

For product information, use inquiry card on page 113.

Rugged EIMAC 2C39B UHF Ceramic Triode Operates up to 250°C

TYPICAL OPERATION
(RF Oscillator 2500mc)

D-C Plate Voltage	900v
D-C Grid Voltage	-22v
D-C Plate Current	90ma
D-C Grid Current	27ma
Useful Power Output	15w

Unilaterally interchangeable with the 2C39A, but designed with outstanding extras, Eimac's ceramic-and-metal 2C39B has proved its advantages in such UHF applications as missiles, air navigational systems and communications systems.

Because of its unique design and ceramic-metal construction, this air-cooled, planar-type, 100 watt triode has an envelope temperature rating of 250°C, ceramic replaces glass. And the copper anode is fitted terminal surfaces are silver plated. Sturdy, low-loss ceramic replaces glass. And copper anode is fitted with lightweight fins for forced air cooling.

Used in systems up to 3000mc, the 2C39B has all the virtues of the 2C39A plus a longer life, more useful power output, and a greater immunity to damage by thermal and physical shock.

For additional information, contact our Application Engineering Department.

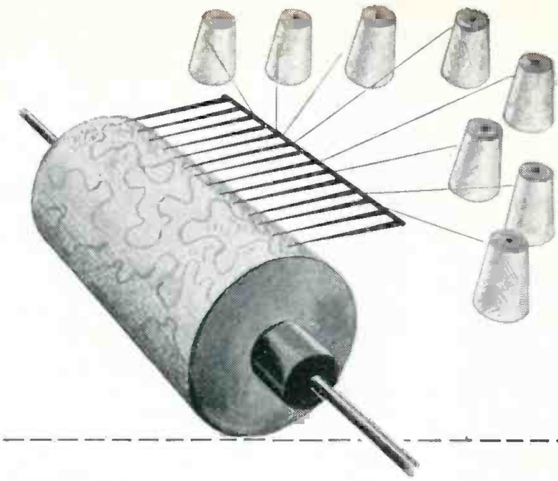
Eimac

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA
The World's Largest Manufacturer of Transmitting Tubes

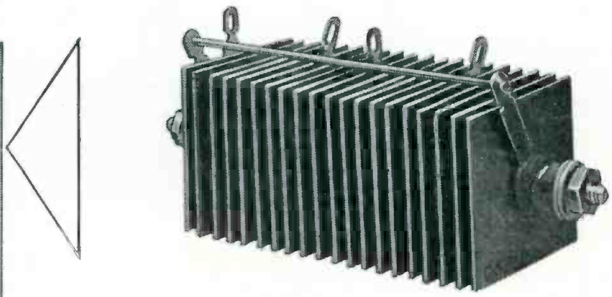
For product information, use inquiry card on page 113.

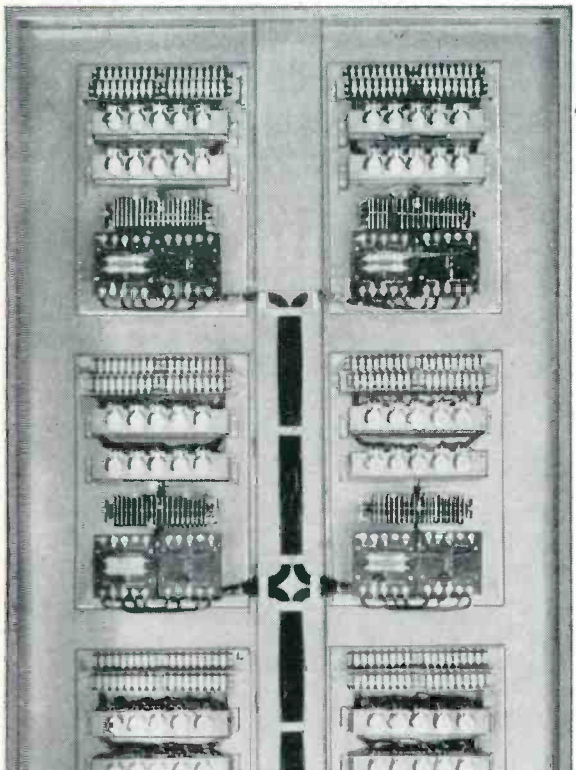
WARNER ELECTRIC BRAKE & CLUTCH CO.

"puts the finger" on automatic rug machinery with the aid of



RADIO RECEPTOR SELENIUM RECTIFIERS





Guiding the 120 electric clutches that act as automated fingers in a new rug tufting machine is a Warner control panel whose key components are six Radio Receptor rectifiers. These fingers "feel" the rug pattern on a revolving roll, send information to the control station from which actuating impulses are relayed to clutches controlling yarn feed.

A Radio Receptor customer for many years, Warner Electric Brake & Clutch Co. utilizes RRco. selenium rectifiers in this application and many others because long experience has proved they can depend upon them for continuous and heavy duty, without fear of costly breakdowns.

If you have a problem in rectification, do as many fine companies do in the United States and throughout the world — Specify RRco. selenium rectifiers. Millions are in service in almost every possible type of circuit. Would you like our most recent literature? Please write section T-11.

RR Co.

Semiconductor Division

RADIO RECEPTOR COMPANY, INC.

Radio and Electronic Products Since 1922

240 WYTHE AVENUE, BROOKLYN 11, N. Y. EVergreen 8-6000

OTHER PRODUCTS OF RADIO RECEPTOR: Germanium and Silicon Diodes, Dielectric Heating Generators and Presses, Communications, Radar and Navigation Equipment.

how DAVIES puts magnetic tape to work

. . . in an automatic recorder, reproducer . . . vibration analysis . . . a dead time simulator . . . a casualty recorder

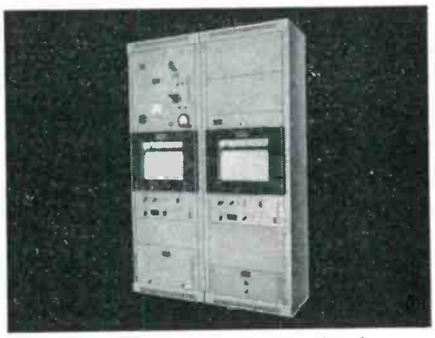
you push the button

With automation putting more and more information on magnetic tape, the tape equipment itself has become a fit subject for automation. Which is why we developed automatically programmed tape equipment. The transport starts, stops, and rewinds automatically . . scans any track or combination of tracks once or any number of times . . . automatically matches tape speed to requirements over a wide range . . . permits fast search and slow read-out . . . and all without human attention. It can also be programmed for continuous recording over hundreds of hours, recording on one track, rewinding, restarting, recording on the next track, etc., without attention.

All this we can do with standard Davies shelf-type equipment. But if your needs are very special, we can also build to satisfy them from the ground up.

what's in a bump

Vibration in an automobile is annoying . . . in a plane, worrisome . . . and in a missile, downright expensive! Vibration, as a result, has been subjected to considerable and serious study. Should you ever want to analyze vibration, the first thing to do is *catch the vibration*. Whether you put a Davies recorder in the vehicle (and they can be installed in missiles) . . . or at the other end of a telemeter link on the ground, somehow get the vibration on magnetic tape. Now you have a lot of complex waves, and you're ready to analyze them, a job best accomplished in the immediate vicinity of a Davies Automatic Wave Analyzer. Fed with a complex wave, it hands back a complete Fourier analysis, graphing every component from 3 to 10,000 cps, and basing the results, depending on your whim, on either linear or square law response. We'll sell you the wave analyzer alone if you wish, but we'd just as soon work up the complete system . . . recording equipment, reproducing equipment, analyzer . . . even the tape.



Davies Automatic Wave Analyzer

the voltage goes round and round

Our dead time simulator is particularly appreciated by analog computers in need of a variable time delay. In heat exchanger problems, for example, it can be rigged to accept a voltage simulating pump speed, and voltages representing temperatures at various points in the exchanger, from the computer. After delaying the temperature analogs for a time inversely proportional to the pump speed analog, back they go to a much relieved computer.

where were you when?

A thorough analysis of process failures can considerably reduce the chance of future failures. Thus the market for continuous logging devices in the process industries. But continuous logging facilities are extremely expensive if the information they print is only important as it applies to events immediately preceding an abnormal condition. For the job of closing the barn door only when a robbery is in the offing, we propose our Casualty Recorder, which works like this: Conditions at critical process points are continuously recorded on the many tracks of a loop of magnetic tape, with loop length determined by the amount of hindsight desired. In normal operation, information is recorded on the tape, passes around the loop, is erased, and new readings are recorded. When an off-normal situation develops, information is fed to suitable read-out devices before erasure for later examination. While this system gives you only the data you need, that's all you have to *pay* for.

COMPLETE DETAILS on the systems covered are available. But it's difficult in booklet form to give any adequate idea of the seemingly limitless applicability of magnetic tape systems in data handling. We'll be happy to pass on what literature *is* available, but we'd rather discuss your data accumulation, storage, or reduction problem with you directly. Just name the time and place.

Davies

LABORATORIES, INCORPORATED
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WEBSTER 5-2700

For product information, use inquiry card on page 113.

Hi-Fi Standards

(*Continued from page* 55)

Z24.11—1954. Method for Free Field Secondary Calibration of Microphones.—50¢.
Z24.4—1949. Method of Pressure Calibration of Laboratory Standard Pressure Microphones.—75¢.

RETMA

SE-101-A. Amplifiers for Sound Equipment. —25¢.

SE-103. Speakers for Sound Equipment —30¢.

SE-104. Engineering Specifications for Amplifiers for Sound Equipment.—25¢.

SE-105. Microphones for Sound Equipment. —90¢.

TR-107. Electrical Performance Standards for FM Broadcast Transmitters.—25¢

REC-134. Magnetic Recorders-Conditions for Measurements and Definitions.—30¢.

***REC-146.** Laterol Disc Recording Characteristic.—25¢.

TR-105B. Audio Facilities for Radio Broadcasting Systems.—35¢.

Attention is called to SE-8-5287-3 "Tentative RETMA Standard: Amplifiers for High Fidelity Equipment," which may be made available in revised form at a later date.

Audio Engineering Society

***TSA-1-1954.** Standard Playback Characteristic for Lateral Disc Recording.—No Charge.

National Assoc. of Radio and Television Broadcasters

***Supplement No. 2 to NAB (NARTB).** Engineering Handbook" (Fourth Edition 1949), NARTB Recording and Reproducing Standards. (June, 1953).—$1.00.

Record Industry Assoc. of America

*Standard on Recording and Reproducing Characteristic.—No Charge.

*The recording and reproducing characteristics of these are substantially equivalent. Note: Reference is also made to British Standard No. 1928:1955, "Gramophone Records, Transcription Disc Recordings, and Disc Recording Equipment" and to Armour Research Foundation, Bulletin No. 92, Magnetic Recorder Licensee Service, "Magnetic Recording Standardization."

SOURCES OF STANDARDS

The Institute of Radio Engineers, Inc.
1 East 79 Street
New York 21, New York

American Standards Association
70 East 45th Street
New York, New York

Radio-Electronics Television Manufacturers Assoc.
11 West 42nd Street
New York, New York

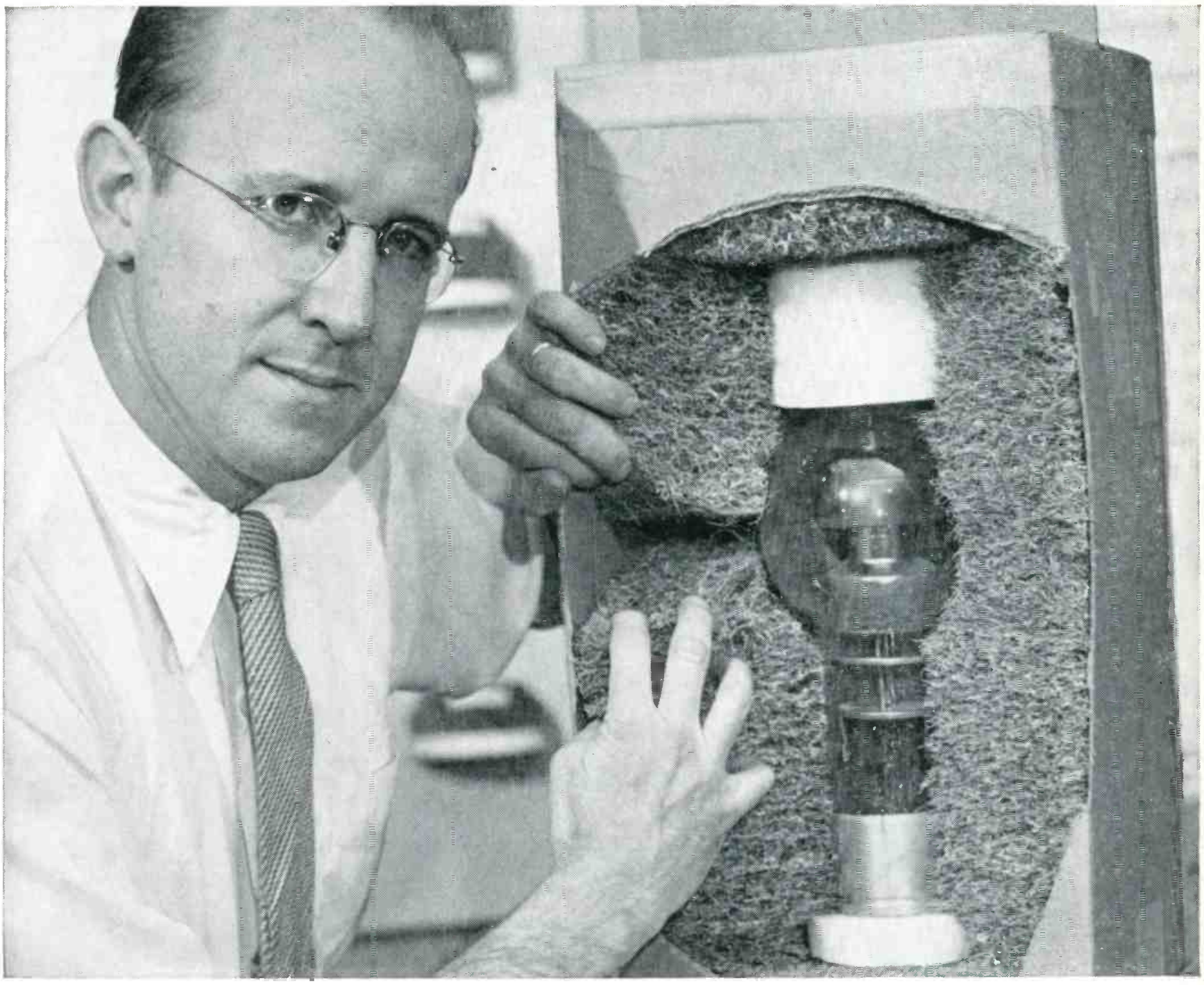
Audio Engineering Society
P. O. Box 12
Old Chelsea Station
New York 11, New York

National Association of Radio & Television Broadcasters
1171 North Street
Washington 60c, D. C.

Record Industry Association of America
1 East 57th Street
New York 22, New York

Magnetic Recording Industry Association
Room 1011—444 Madison Avenue
New York 22, New York

B.F.Goodrich



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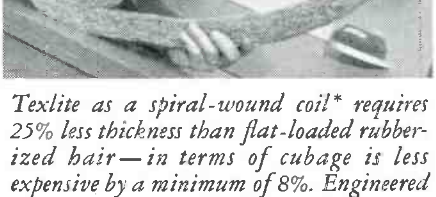
"Shipping damages resulting in loss ratios as high as 20% have been eliminated with Texlite package cushioning material", says Mr. Alfred D. Brown, packaging engineer for United Mineral and Chemical Corporation, Brooklyn, New York.

"Whether the problem is to package and protect unfired ceramics or live warheads" he continued, "the fact is when Texlite has been correctly engineered for a job, the user has discarded other types of cushioning and converted to Texlite exclusively.

"Texlite differs from ordinary rubberized hair cushioning in that it's a scientifically prepared industrial product. We can recommend, with complete accuracy, the exact amount of Texlite necessary for complete and total protection thus reducing freight and packaging charges to a practical minimum."



Texlite as a spiral-wound coil requires 25% less thickness than flat-loaded rubberized hair—in terms of cubage is less expensive by a minimum of 8%. Engineered in this manner, Texlite will not mat down. It shows only 1/7 of the height loss of flat-loaded hair under the same weight, per each 1,000 hours tested.*

Mr. Brown is shown here with a sheet of Texlite which easily cuts to any shape with a paper cutter or sharp knife. If you wish, Texlite can be pre-cut to your specifications.

* *Pat. Pending*

If you would like to know more about Texlite, please write to the address below.

B.F.Goodrich

SPONGE PRODUCTS DIVISION
DERBY PLACE, SHELTON, CONNECTICUT

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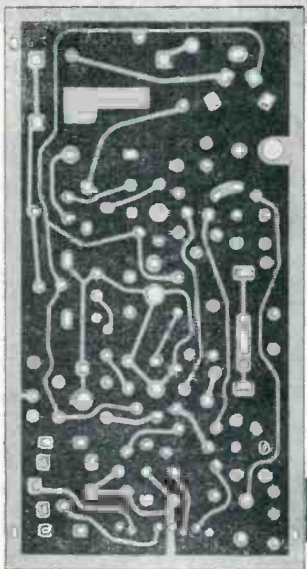
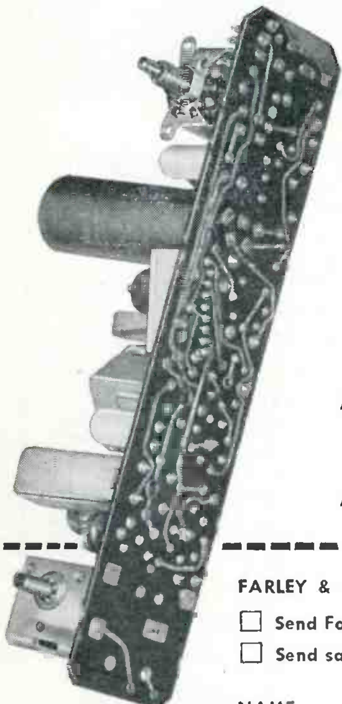


TYPICAL PRINTED CIRCUIT



PORTABLE RADIO CHASSIS USING FARLITE P-630B

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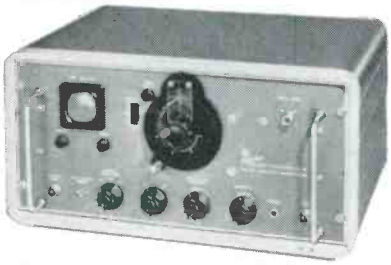
PRD DRY-TYPE LOW-LEVEL MICROWAVE CALORIMETER

Invaluable for any precise low level measurement or power monitoring in systems. Unique, because it measures low microwave power with primary standard accuracy by means of thermocouples. *No troubles with fluids, pumps or thermometers.* Easy to use, accurate, rugged and reliable. Indicates average power regardless of modulation. Provision for null indication against standard dc power.

TYPE 666 FREQUENCY RANGE: 18 to over 75 kmc/s • ERROR: Because the intrinsic error is less than ±1% plus ±20 μw thermal drift, the combined error including instrumentation can be held to within ±3%. Good approximations can be achieved within one time constant (1.5 to 2 minutes) • POWER RANGE: From 30 μw to at least 1 watt cw • SENSITIVITY: 35-40 μv/mw (calibrated for each instrument) • MAX. VSWR: less than 1.2.

PRD HETERODYNE FREQUENCY METER



Especially useful for precision measurements of microwave frequencies where accuracy combined with range is required. *Takes the place of several cavity type meters each of which usually has a more restricted frequency range.* Unlike other heterodyne frequency meters, Type 504 is simple to use. Both CRT and aural presentation are available as well as a new exclusive interpolating dial which saves time and avoids ambiguity. Lightweight, therefore advantageous for field testing of transmitters, receivers and signal generators. Will deliver a signal of precisely known frequency at the RF input connector when used as a calibrating instrument.

TYPE 504 FREQUENCY RANGE: Measures 100 to over 10,000 mc/s. Generates 500 to 900 mc/s and harmonics • INTERPOLATION ACCURACY: 0.03% or better • INPUT SENSITIVITY: −30 dbm at 500 mc/s and above • CALIBRATION REFERENCE: 5 and 50 mc/s quartz crystal standards.

Just a reminder that PRD Polyohm 1% resistors are made of pure chromium evaporated on glass—no carbon. Full load at 120°C. For the toughest applications use the hermetically sealed type. Exceeds MIL-R-10509B specifications, characteristic B.

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- **1-3** Metallized Glass Microwave Attenuators
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- **2-1** Noise Figure and Some Measurement Aspects
- **2-2** Frequency Measurement Devices
- **2-3** Precision Measurements with Slotted Sections
- **2-4** Impedance Considerations in Crystal Mixers and Their Application to UHF Tuner Design
- **3-1** Microwave Detectors for Measurements of Relative Power Levels
- **3-2** Impedance Measurements in the 50-1000 MC/SEC Range with a New Standing Wave Indicator
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- **4-2** A New Metal Film Resistor—the Polyohm
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For product information, use Inquiry card on page 113.

Potting Methods

(*Continued from page* 65)

2. Molded Alkyd 422—base insulator and terminal board.
3. Vacuum impregnation of assembly with Minnesota Mining Scotchcast LV epoxy resin.

The following measurements were then made with a typical assembly using the above materials. Wire insulation appeared to be relatively unimportant.

These coils have been successfully subjected to various military environmental test specifications, such as MIL-E-5272 and SC-D-15914.

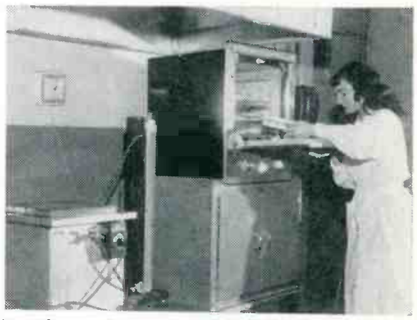


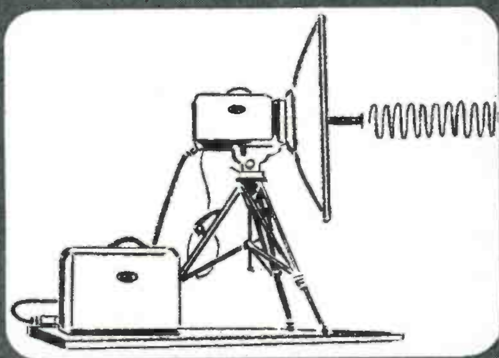
Fig. 3: Impregnating and baking equipment

The actual parts required to complete a typical assembly are shown in Fig. 2. One of the obvious problems is the one of preventing the potting material from filling the inside diameter of the coil form. This must be left open for the adjustable iron core used to vary the coils' inductance. This problem is solved by placing a Teflon plug in the hole during the potting process. After potting, the plug is simply removed since the epoxy resin will not adhere to the Teflon. During the potting procedure, the coil assembly with terminals facing upward, is submersed in the liquid potting compound in a chamber capable of being evacuated. The epoxy compound is maintained at 135° F. Two

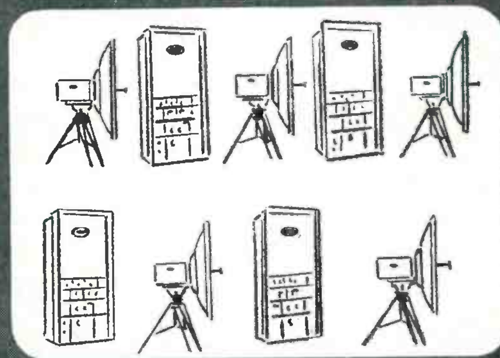
Fig. 4: Universal coil winding equipment

(*Continued on page* 134)

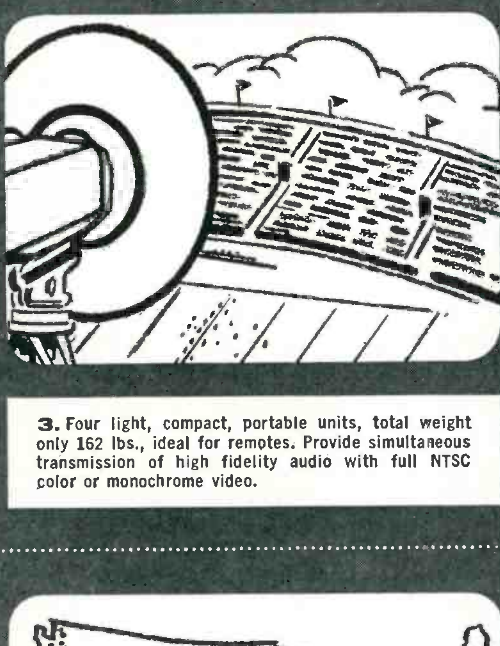
Best-Selling 20-Second Spot



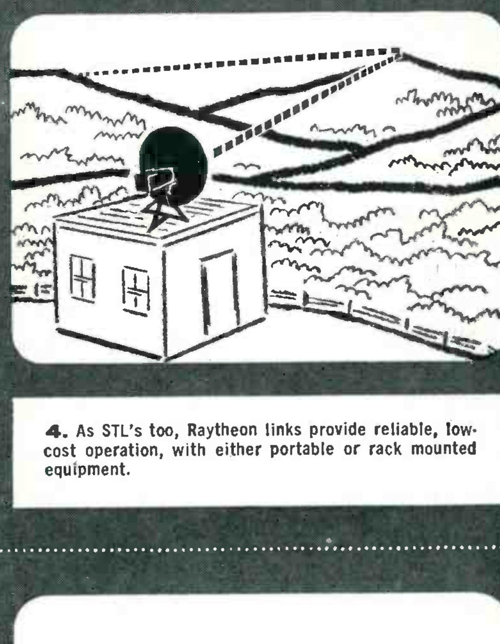
1. This is the famous Raytheon KTR-1000A microwave relay—just one in the biggest line of TV microwave relays in the industry.



2. Available in rack mounted or portable, 100 milliwatts or one watt at 6000 and 7000 mc; and 100 milliwatts in portable at 13,000 mc.



3. Four light, compact, portable units, total weight only 162 lbs., ideal for remotes. Provide simultaneous transmission of high fidelity audio with full NTSC color or monochrome video.



4. As STL's too, Raytheon links provide reliable, low-cost operation, with either portable or rack mounted equipment.

5. These and many other advantages add up to one big FACT—Raytheon KTR links outsell all competitive makes.

RAYTHEON

Excellence in Electronics

6. For full details, please write Raytheon Manufacturing Company, Equipment Marketing Department, Waltham 54, Mass., Dept. 6120.

See Raytheon's exhibit at Rooms 659-660, at the USITA Show; Conrad Hilton Hotel, Chicago, Ill.—Oct. 15-17

(*Continued from page* 132)

evacuating cycles are employed. Both are at a value of 29 in. of mercury. The first is for 45 minutes. The second is continued until bubbles cease emerging from the coil assemblies.

After the impregnation, the cans are wiped clean and cured in an oven for 2 hr. at 225° F. After cooling, the Teflon plugs are removed and the iron cores are threaded into place. The conventional electrical test procedure is applied at this point. It is especially important that the shield can of the coil assembly be grounded during the electrical tests to detect flaws in the potting techniques which may have caused a crack in the epoxy. If the crack extended between the winding and the can, we would have an undesirable moisture trap. For less critical end applications, coils which have small defects in potting can be salvaged by subjecting them to a vacuum impregnation in Dow Corning DC200 silicone fluid. The DC200 will fill the crevices to prevent the entry of moisture. The DC200 should be of 200 centistokes viscosity. Fig. 3 illustrates the simple impregnating and baking equipment. Fig. 4 reveals the winding operation.

Coast Firm Grows

Telecomputing Corp., Burbank, Calif., has acquired Brubaker Electronics, Inc., of Culver City, manufacturer of electronic components and systems. Brubaker will be operated as a wholly-owned subsidiary by Telecomputer. All outstanding Brubaker shares of stock were exchanged for Telecomputer stock.

Elected Chairman

William C. Foster, Executive Vice President of Olin Mathieson Chemical Corp., New York, has been elected Chairman of Reaction Motors, Inc., of which he had been a Director. Olin Mathieson has been associated with Reaction in the field of supersonic aircraft and guided missile propulsion.

For product information, use inquiry card on page 113.

Magnetic Amplifiers

(*Continued from page 67*)

$$R_1 = \frac{E_d + I_{1\,min} R_d}{(1 - \Delta E_s/2E_s)(E_s/R_1) - I_{1\,min} - I_2\,[1-(\epsilon/2)]}$$

Using eq. (6), E_s is found to be

$$E_s = \frac{\epsilon E_d/R_d}{(\Delta E_s/E_s) - \epsilon} \cdot \frac{E_d + I_{1\,min} R_d}{(1 - \Delta E_s/2E_s)(E_s/R_1) - I_{1\,min} - I_2\,[1-(\epsilon/2)]} \quad (10)$$

This is an eq. for E_s as a function of I_2 with all other quantities known. The eq. shows that an increase in I_2 requires an increase in supply voltage. I_2 will approach a limiting value which requires a supply voltage of infinity. Thus, the current output of this type of reference is limited, but it may be increased by increasing ϵ, reducing $\Delta E_s/E_s$, making $I_{1\,min}$ smaller or using a different diode. If the reference is being designed for maximum output current, a plot of E_s versus I_2 may be made and the largest practical value of I_2 selected from the curve.

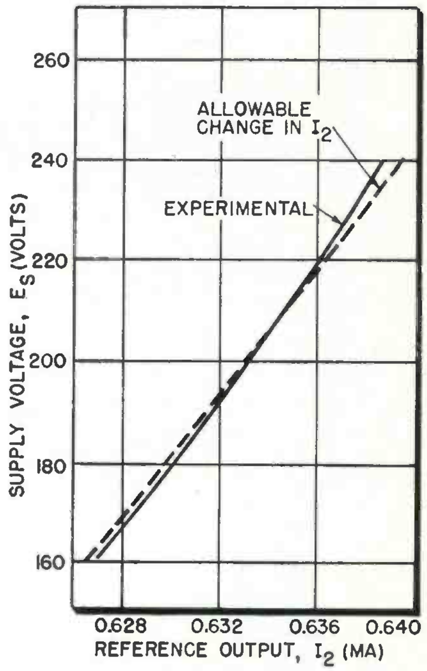


Fig. 5: Accuracy test results

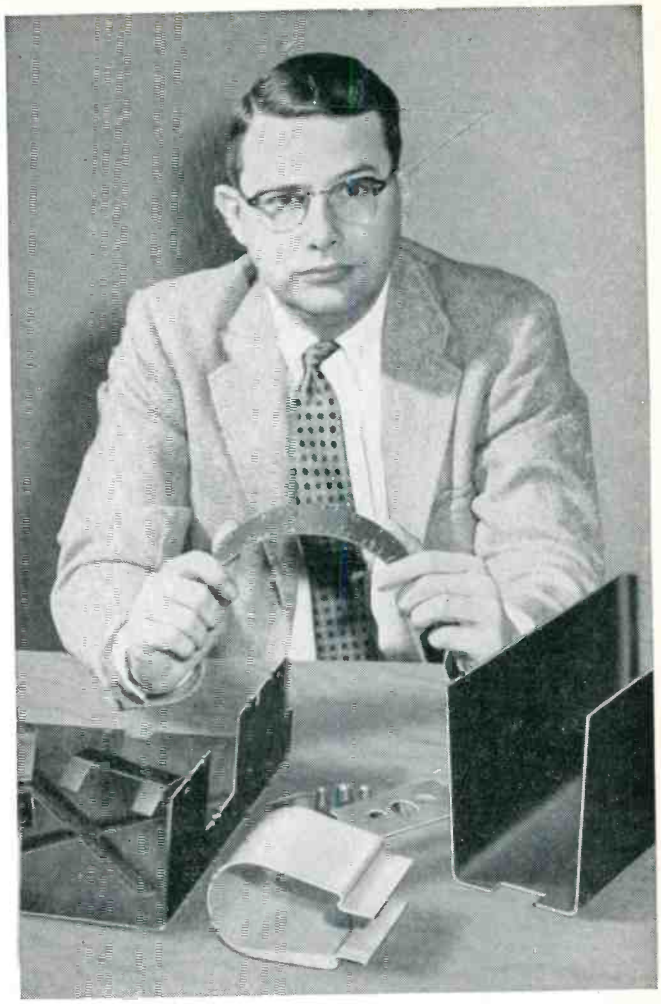
Eq. (10) shows that E_s/R_1 has a minimum limit. If E_s/R_1 becomes small enough that

$$(1 - \Delta E_s/2E_s)(E_s/R_1) - I_{1\,min} < 0$$

then I_2 or E_s will have to be nega-

(*Continued on page 138*)

THE LATEST NEWS ON POSTFORMED PHENOLITE®



R. F. Bogart, one of National's staff of applications engineers, shown holding a postformed copper clad PHENOLITE printed circuit.

Manufacturers slash assembly time, eliminate rejects, improve products with PHENOLITE parts postformed by NATIONAL

Production speeded, unit costs reduced—from plant after plant comes news of big profits and savings through the use of PHENOLITE parts postformed by National.

Reasons for their cost-cutting efficiency are: (1) National makes PHENOLITE in *many* grades with combinations of service properties unmatched in any other type of material, and (2) National's applications engineers and fabricators are experts at adapting PHENOLITE to specific requirements. We can help you all the way from development of a material—through design—to the delivery of fully fabricated parts.

Want to simplify design and speed production? It will pay you—in reduced unit costs or in product improvement at no added cost—to explore the advantages of special, ready-to-use PHENOLITE parts postformed by National. Send us the problem that's nagging you—and be sure to ask for our new 16-page Catalog on PHENOLITE and other National products. We'll send it promptly, without obligation. Simply write Dept. F-10.

Reverse bends and small radii—toughest problems in forming—were involved in shaping this spring-action, snap-on cover for a switch voltage changer. National's postforming technicians used PHENOLITE C-534-F to achieve a 1/16" radius bend.

Corrugated, bent, and punched after forming, this insulator had to be made of extraordinary stock to withstand unusual stresses. National made use of a double die and PHENOLITE C-534-F to form the corrugated component without cracking or fracturing the piece.

Bending and drawing in one operation were difficulties faced in forming this bus bar joint cover. National ended the trouble by using PHENOLITE X-114-A. PHENOLITE can be formed or deep drawn easily—without damage to the material and without expensive dies.

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For product information, use inquiry card on page 113.

(*Continued from page 136*)

tive. This is not possible in the reference circuit being discussed. The minimum limit of E_s/R_1 is then

$$E_s/R_1 = \frac{I_{1\,min}}{(1 - \Delta E_s/2E_s)} \qquad (11)$$

The limit on E_s/R_1 also places a limit on the accuracy obtainable from this type of reference circuit. Substitute eq. (11) into (4) to get

$$\epsilon = \frac{\Delta E_s/E_s}{1 + \left(\frac{1 - \Delta E_s/2E_s}{I_{1\,min}}\right)\frac{E_d}{R_d}} \qquad (12)$$

Eq. (12) is the minimum value of ϵ for given supply voltage variation and diode characteristics.

After E_s has been selected, R_1 can be calculated from eq. (6). R_2 is then found by using eq. (9).

The reference components R_1 and R_2 have now been found. A check must be made to determine if $I_{1\,max}$ will be exceeded when E_s is at its maximum value, $E_{s\,max}$. This is done using eq. (1). The known value of $E_{s\,max}$ is substituted for E_s and the magnitude of I_1 calculated. If I_1 is less than $I_{1\,max}$ for the diode, its rating will not be exceeded. In a few cases the maximum calculated current might be greater than $I_{1\,max}$ and the design must be altered.

The maximum current through the diode can be reduced by decreasing ϵ, which also makes the reference more accurate. In eq. (6) this has the effect of decreasing E_s/R_1. R_1 will now be greater for any value of E_s. The design procedure described previously is then repeated and I_1 again checked at maximum supply voltage. If necessary a further adjustment in ϵ can be made.

If the value of E_s has been fixed, there is a simpler procedure for limiting I_1. R_1 and R_2 will be selected so that when E_s is at $E_{s\,min}$ or $E_{s\,max}$, I_1 will be at $I_{1\,min}$ or $I_{1\,max}$ respectively. Solve eq. (1) for R_2 giving

$$R_2 = \frac{E_d R_1 + R_1 R_d I_1}{E_s - E_d - I_1 (R_1 + R_d)} \qquad (13)$$

Into eq. (13) substitute $E_{s\,max}$ and $I_{1\,max}$ for E_s and I_1, resulting in one eq. Then form a second eq. by substituting $E_{s\,min}$ and $I_{1\,min}$. From these two eq. eliminate R_2 and solve for R_1, giving

$$R_1 = \frac{E_d(E_{s\,max} - E_{s\,min}) + R_d(I_{1\,min}\,E_{s\,max} - I_{1\,max}\,E_{s\,min})}{E_d\,(I_{1\,max} - I_{1\,min})} \qquad (14)$$

After solving for R_1, substitute R_1 and either $E_{s\,max}$ and $I_{1\,max}$ or $E_{s\,min}$ and $I_{1\,min}$ into eq. (13) and solve for R_2. These values of R_1 and R_2 allow operation of the diode over the current range of $I_{1\,min}$ to $I_{1\,max}$.

Both of the last two design procedures cause R_1 to be increased and ε to be reduced. The diode will be restricted to work within its current rating, but I_2 will be reduced as a consequence. These methods need to be applied only when the original design method causes the current rating of the diode to be exceeded.

Temperature Compensation

An increase in ambient temperature has the effect of increasing the breakdown voltage. Although some silicon diodes now on the market have very low temperature coefficients of breakdown voltage, a typical value for many silicon diodes is an increase in voltage of about 0.1%/°C. This is usually constant for most practical purposes over operating temperatures of −55 to +100°C, but will depend on the diode being used. R_d changes very little with temperature as can be seen by the slope of the curves in Fig. 2 remaining constant with temperature.

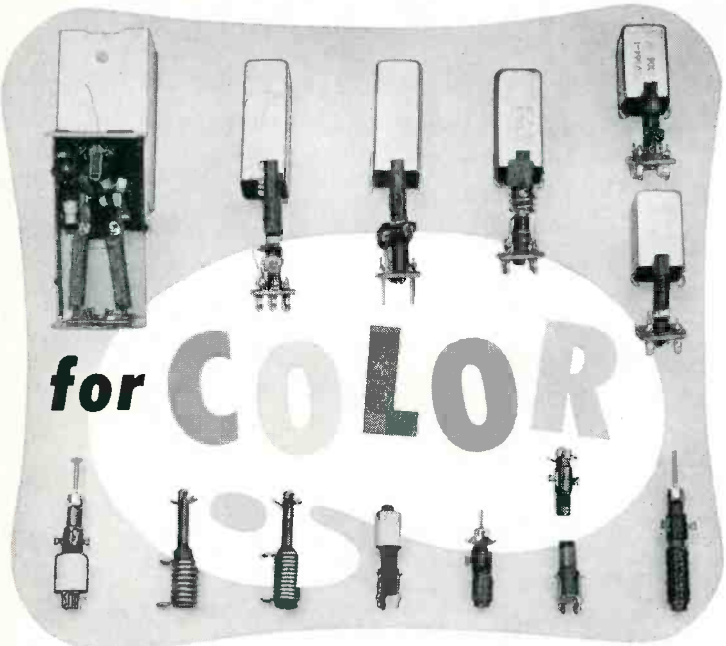
One method of correcting the output for changes in ambient temperature is to place a resistor having a positive resistance temperature coefficient in series with the load. As the temperature and E_d increase, the resistance in series with the load also increases, maintaining constant load current and voltage.

The change in R_2 necessary to maintain I_2 constant as E_d changes with temperature must be found. Solve eq. (2) for R_2.

$$R_2 = \frac{E_s\,R_d + E_d\,R_1 - I_2\,R_1\,R_d}{I_2\,(R_1 + R_d)}$$

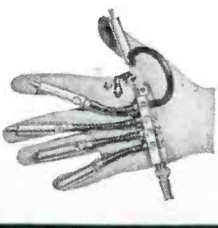
Assume E_d changes by an amount ΔE_d due to a known temperature change. Let R_2 change by an amount ΔR_2 to balance the above equation so I_2 does not change.

(*Continued on page* 140)



CLIPPARD PC-5
Automatic Capacitance Comparator

CLIPPARD PR-6
Automatic Resistance Comparator



(*Continued from page* 139)

$$R_2 + \Delta R_2 = \frac{E_s R_d + (E_d + \Delta E_d) R_1 - I_2 R_1 R_d}{I_2 (R_1 + R_d)}$$

Subtracting R_2 from both sides leaves

$$\Delta R_2 = \frac{\Delta E_d \, R_1}{I_2 (R_1 + R_d)} \qquad (15)$$

R_d and ΔE_d are found when testing the charactertistics of a diode. I_2 and R_1 are known from the design of the reference. ΔR_2 is then known for the temperature change which caused ΔE_d. This gives the necessary change in compensating resistance per degree change in ambient temperature. A positive temperature coefficient resistor that changes resistance at this rate can be selected. The compensating resistor is placed in series with the load. The load resistance is adjusted so that the sum of these two resistors equals the calculated value of R_2 at room temperature.

Since the magnitude of R_2 is going to vary with temperature, the design must be checked to see that this variation is small enough not to cause any adverse effects in the operation of the reference. In particular, $I_{1\,max}$ and $I_{1\,min}$ should be checked at the temperature extremes. It will be found that in most cases there is no appreciable change in the operation of the reference.

Design Steps

1. ε, I_2, and $\Delta E_s/E_s$ should be known.
2. Select diode to be used and determine E_d, R_d, $I_{1\,max}$, and $I_{1\,min}$. The ratio of breakdown voltage to incremental resistance of the diode after breakdown is an important characteristic to consider in determining how suitable a diode will be for reference use. Diodes with higher ratios are better for reference applications.
3. Solve eq. (6) for E_s/R_1.
4. Find E_s as a function of I_2 from eq. (10). E_s is then selected for the desired value of I_2.
5. Calculate R_1 from eq. (6).
6. Calculate R_2 using eq. (9).
7. Check to see that $I_{1\,max}$ is not exceeded at the maximum value of supply voltage by using eq. (1).
8. If $I_{1\,max}$ is exceeded, it may be reduced by reducing ε or by select-

ing new values of R_1 and R_2 from eq. (13) and (14).

9. The change in R_2 necessary for temperature compensation is found from eq. (15). A positive temperature coefficient resistor can then be selected for the compensation.

10. Using eq. (1), calculate I_1 at the temperature and voltage extremes to make sure the diode remains in its proper operating range after temperature compensation.

Diode Selection

Two diode characteristics important to reference operation are E_d and R_d. Their effect can best be seen in eq. (4).

$$\epsilon = \frac{\Delta E_s/E_s}{1 + (R_1/E_s)(E_d/R_d)}$$

E_d and R_d appear as a ratio. An increase in E_d/R_d will allow smaller values of ϵ and smaller values of R_1/E_s. This will provide a reference having greater accuracy and more output current. Diodes selected for reference use should have a value for E_d/R_d as large as possible consistent with the other requirements for the reference. It has been found that diodes having low breakdown voltages will have a higher value of E_d/R_d than diodes having a higher breakdown voltage.

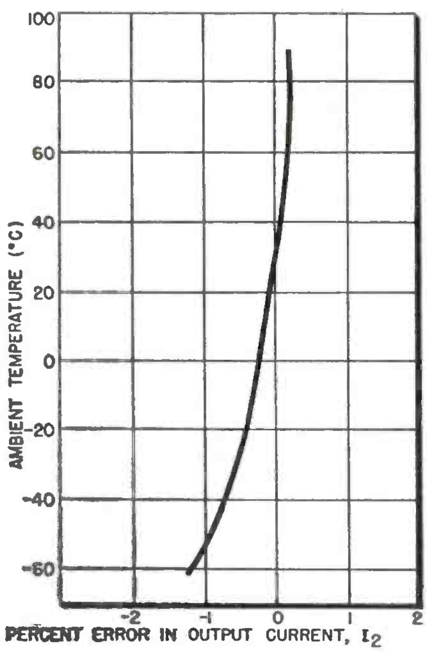


Fig. 6: Ambient temperature error

A Practical Design

To test the design equations derived, a practical diode voltage

(*Continued on page* 142)

reference will be made. The following conditions are arbitrarily set up to be used in the design.

Supply voltage will vary ±20%.

Error in output due to supply voltage variations is to be ±1%.

Output current is to be as large as practical.

Ambient temperature range is −55 to +90°C.

Diode to be used is type 1N138A.

Diode characteristics are determined from test data taken on this diode. E_d and R_d are found to be 35.4 v. and 1020 ohms respectively. Noise ended at about 0.2 ma, so to be safe let $I_{1\,min}$ equal 0.5 ma. $I_{1\,max}$ is determined from the maximum allowable power dissipation for the diode at 90°C and is 1.5 ma.

Using eq. (6) solve for E_s/R_1

$$E_s/R_1 = \frac{\epsilon E_d/R_d}{(\Delta E_s/E_s) - \epsilon}$$

$\epsilon = 0.02$ $\quad E_d = 35.4$ v.
$E_s/E_s = 0.4$ $\quad R_d = 1020$ ohms

The result of the calculation is

$$E_s/R_1 = 1.83 \times 10^{-3} \text{ v./ohm}$$

Eq. (10) is then used to find E_s as a function of I_2.

$$E_s = \frac{\epsilon E_d/R_d}{(\Delta E_s/E_s) - \epsilon} \cdot \frac{E_d + I_{1\,min} R_d}{(1 - \Delta E_s/2E_s)(E_s/R_1) - I_{1\,min} - I_2[1 - (\epsilon/2)]}$$

$\epsilon = 0.02$ $\quad I_{1\,min} = 0.5 \times 10^{-3}$ amps
$E_d = 35.4$ v. $\quad \Delta E_s/E_s = 0.4$
$R_d = 1020$ ohms $\quad E_s/R_1 = 1.83 \times 10^{-3}$ v./ohm

The resulting equation is

$$E_s = \frac{66.3 \times 10^{-3}}{0.973 \times 10^{-3} - I_2}$$

E_s versus I_2 is shown plotted in Fig. 4. The choice of E_s will be determined by design requirements. An arbitrary value of 200 v. will be selected for this design. I_2 from Fig. 4 is then 0.64 ma.

R_1 can now be calculated using the value previously found for E_s/R_1.

$$R_1 = \frac{E_s}{1.83 \times 10^{-3}} \quad \frac{200}{1.83 \times 10^{-3}}$$

$$R_1 = 109 \times 10^3 \text{ ohms}$$

For convenience in obtaining a resistor, let $R_1 = 110 \times 10^3$ ohms. R_2 is found using eq. (9).

$$R_2 = \frac{E_d + I_{1\,min} R_d}{E_{s\,min}/R_1 - E_d/R_1 - I_{1\,min}\,[1 + (R_d/R_1)]}$$

$$R_2 = 56.5 \times 10^3 \text{ ohms}$$

The reference circuit components have now been determined. A check must be made to be sure $I_{1\,max}$ of 1.5 ma will not be exceeded. Eq. (1) is used and $E_{s\,max} = 240$ v. substituted for E_s.

$$I_1 = \frac{E_s R_2 - E_d (R_1 + R_2)}{R_1 R_2 + R_1 R_d + R_2 R_d}$$

$$I_1 = 1.20 \text{ ma}$$

$E_{s\,max}$ will not cause I_1 to exceed the diode rating. If I_1 had turned out to be greater than 1.5 ma, it would have had to be reduced by decreasing ε or using eq. (13) and (14) as described previously.

The reference is to be temperature compensated. A test of this diode showed that E_d increased at the rate of 0.0347 v./°C with ambient temperature. This is substituted into eq. (15) to find how the compensating resistor must change.

$$\Delta R_2 = \frac{\Delta E_d R_1}{I_2 (R_1 + R_d)}$$

$$\Delta E_d = 0.0347 \text{ v./°C}$$
$$I_2 = 0.64 \text{ ma}$$
$$R_1 = 110 \times 10^3 \text{ ohms}$$
$$R_d = 1020 \text{ ohms}$$

The resulting value of ΔR_2 is

$$\Delta R_2 = 53.7 \text{ ohms/°C}$$

This is the rate which R_2 must change with temperature to maintain constant output. Resistors having a temperature coefficient of +0.0042 parts/°C are available. A resistor of 12,800 ohms having this coefficient will be needed. This resistance must be subtracted from R_2 to obtain the value of load resistance.

$$\text{Load resistance} = R_L = 56{,}500 - 12{,}800 = 43{,}700 \text{ ohms}$$

For convenience in obtaining a resistor let $R_L = 45{,}000$ ohms. This will have the effect of reducing I_2 by about 2%. The complete reference circuit is shown in Fig. 1.

The reference circuit must be checked to make sure the temperature compensation does not cause any undesired operation of the diode. At the temperature extremes of −55 and +90°C, calculate I_1 with $E_s = 160$ and 240 v. by using

(*Continued on page* 144)

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(*Continued from page 143*)

eq. (1). The results of these calculations are given below:

Ambient Temp.	E_s	I_1
90°C	240 v.	1.19 ma
	160	0.48
−55°C	240	1.24
	160	0.53

These values of I_1 are all below 1.5 ma so the diode rating will not be exceeded. At 90°C and 160 v., I_1 falls below 0.5 ma, but it is still well above the noise region and will not affect operation.

Test of Reference

This design was tested to find how well it agreed with the calculated results.

Fig. 5 shows the results of the accuracy test at room temperature. The supply voltage, E_s, was varied and the output current I_2 measured. The error was found to be about ±0.9% instead of the ±1% calculated. The magnitude of I_2 at room temperature and with E_s equal to 200 v. was calculated to be 0.64 ma compared with the 0.633 ma found by test. This shows good agreement between design calculations and the actual output and accuracy found by test. I_1 was measured at room temperature with E_s = 160 and 240 v. and was found to be 0.49 and 1.22 ma respectively. I_1 calculated from eq. (1) is 0.495 and 1.21 ma at these two voltages, again showing the test results agree well with the design.

After the accuracy test at room temperature, the reference was operated over the temperature range of −60 to +90°C. At each temperature the supply voltage was set at 200 v. and the reference output current, I_2, measured. A curve of ambient temperature versus percentage change of I_2 from its room temperature value is given in Fig. 6. I_2 changes +0.2% at 90°C and −1.1% at −55°C. An increase in compensating resistance could reduce this error.

Diodes with breakdown voltages on the order of the one used above have low current and high impedance outputs. This type of diode is useful where a reference voltage is needed. For applications requiring a reference current, such as magnetic amplifier circuits, diodes with lower breakdown voltage will allow a higher output current. The design method in this article was developed primarily for current references, but the equations may also be used to design voltage references.

Electronic "Eye" Aids Blind PBX Operators

Weighing less than an ounce, an experimental electronic "eye" has been developed by Bell Telephone Labs to aid blind operators of private telephone exchanges. The "eye" is a tiny, light-sensitive phototransistor unit which fits on the tip of an index finger.

The unit is the only piece of equipment which must be worn by the blind operator in addition to the standard operator's headset. Use of the "eye" does not require any modification of PBX equipment. Bell said this device is "unique" because of its use of transistors, and its extremely small size and light weight.

GE Unveils Airborne Electronic Navigator

Developed under multi-million-dollar Air Force contracts, an accurate, lightweight, completely self-contained airborne electronic navigator has been completed by General Electric's Light Military Electronic Equipment Dept., Syracuse, N. Y.

The system, which could serve as a navigational aid for longer-range aircraft, weighs 150 pounds and eliminates manual navigation problems for pilots of jet fighters who, when operating at today's speeds and ranges, have little margin for navigational error. The navigator does not depend upon any form of ground information or control, and it provides the pilot at all times with an indication of his present position, as well as his course and distance to destination.

The system, basically, incorporates a Doppler radar unit, an earth's rate directional heading reference unit, a miniaturized electronic computer, and the pilot's indicators.

 For product information, use inquiry card on page 113.

Rate-of-Climb

(*Continued from page* 75)

ode current is kept at zero in two ways: the grid is biased negatively below cutoff, and the plate is negative with respect to the cathode. Both grid and plate voltages must increase in the positive direction to produce an output from the gate. Fig. 5 shows typical voltage waveforms associated with the gates. The square wave output from limiter A is connected to the plates of both gates. The output of limiter B is differentiated by an R C network to produce narrow pulses which go to the grid of the "up" gate. These pulses are also inverted in polarity and applied to the grid of the "down" gate. Only when the outputs from limiter A and the differentiator are in the positive direction do pulses come through the "up" gate. Also, the outputs from limiter A and the inverter must be in the positive direction for pulses to pass through the "down" gate.

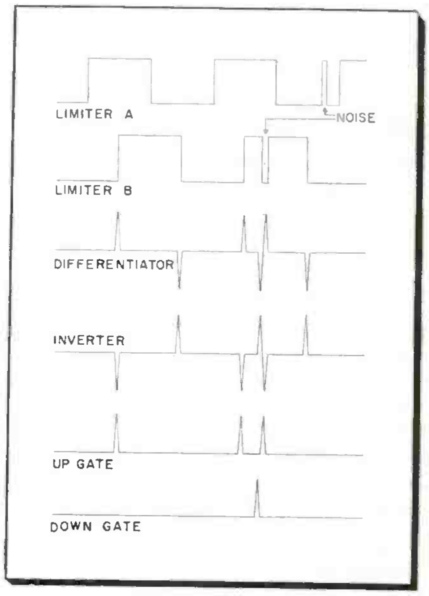


Fig. 4: Mixer vector relationships

The gate outputs go to pulse counters that produce direct current outputs proportional to the number of input pulses per second. A zero-center-scale microammeter mounted in the cockpit indicates the rate of climb. The cockpit meter is connected between the counters and measures the difference between their outputs. "Up" gate pulses then deflect the meter upward, while "down" gate pulses deflect it downward. The waveforms shown in Fig. 5 then correspond to the case where the aircraft is ascending, since pulses are coming from the "up" gate (ignoring for a moment the effects of noise pulses). The case for descent, where the output of limiter B leads limiter A by 90°, can be pictured by inverting the "limiter B" waveform. This then inverts the "differentiator" and "inverter" waveforms and thus interchanges the "up gate" and "down gate" waveforms. Pulses then come from the "down" gate, deflecting the meter downward.

The effects of noise on the gating action is also shown in Fig. 5. Should a noise pulse trigger the limiter A multivibrator, it does not result in pulses from the gates and thus does not deflect the meter. When noise triggers limiter B, it results in a pulse from each gate (providing limiter A is positive). These two pulses produce equal and opposite forces on the meter and result in no net deflection. Thus the gating technique makes use of the fact that noise is not correlated between the two channels to provide noise rejection.

An additional display unit, not shown in the figures, uses four colored lights to assist the pilot in rapidly determining important velocity ranges. It consists of four direct-coupled amplifiers that connect across the cockpit up-down meter and drive four relays, which in turn operate the lights. The amplifier bias voltages are adjusted so each light indicates the desired velocity range.

Safety Features

The rate-of-climb system incorporates a number of features to reduce the possibility of incorrect meter readings:

(a) If the power supply for the electronics changes its output voltage or the klystron currents or voltages change from their nominal values, relays close and actuate a red indicator flag in the cockpit "up-down" meter to warn the pilot of possible faulty operation.

(b) As the aircraft rises, the ground-reflected signal amplitude decreases until one or both of the multivibrator limiters stops operating. The cockpit meter then stops indicating velocity and goes to zero.

(*Continued on page* 148)

There is no gradual decrease in velocity indication as the signal fades. This desirable feature is a consequence of the gating technique employed and the switching properties basic to multivibrators.

Fig. 1 is a photograph of the rate-of-climb system. The electronic construction is of breadboard nature using lay-in chassis that permit portions of the system to be quickly removed for adjustment or maintenance. The chassis on the left contains the limiters, gates, inverting amplifier, and pulse counters, the center chassis contains two doppler amplifiers, and the larger chassis on the right is the high voltage power supply for the klystron and all the vacuum tubes. The electronics unit weighs 23 pounds, and the complete microwave unit weighs 8 pounds. The entire system, except for the cockpit indicators, is housed in a portion of one wing-tip pod. Fig. 1 shows the "Pogo Stick" in hover flight and the location of the electronics. The plastic portion of the dielectric-rod antenna pro-

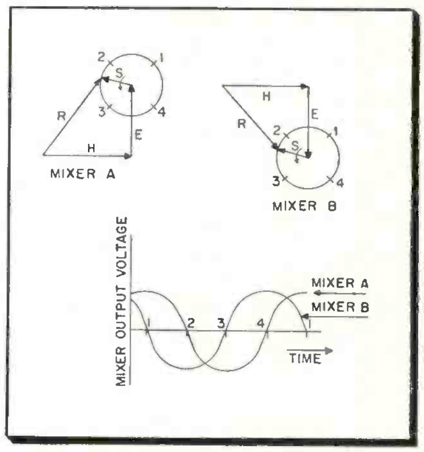


Fig. 5: Typical voltage waveforms

trudes out the rear end of the pod and thus points at the ground when the aircraft is in vertical flight.

Flight Tests

The rate-of-climb system underwent extensive flight testing in a helicopter prior to actual operation in the "Pogo Stick." Initially considerable difficulty was caused by microphonics in various waveguide elements, such as flanges, card attenuators, and magic tee matching elements. The resulting mechanical distortions, although quite small (usually less than 0.001 inch), produced modulations similar to those resulting from the ground-return signal. Better mechanical design relieved this difficulty, but it still remains the primary limitation on maximum altitude. Several flights were run to altitudes of 2300 feet with velocities as great as 10 feet per second up and 30 feet per second down. Operation to this altitude was satisfactory as long as the helicopter attitude did not position the antenna too far from the vertical hereby reducing its gain in the direction of the ground (indications were that for smooth surfaces, such as concrete and asphalt runways, the majority of the radar energy was reflected from a small area directly beneath the aircraft). Operation below 800 feet was not affected by any possible helicopter attitudes. The only means available for checking the in-flight accuracy of the electronic rate-of-climb system was to compare it against a barometric rate-of-climb meter and altimeter. It appeared to be more accurate than either of these instruments.

Some conclusions can be drawn from the results to date.

1. CW doppler techniques provide a direct means for measuring magnitude and direction of rate-of-climb.
2. Overall system performance is mainly limited by mechanical vibrations in the waveguide components.
3. Doppler frequency ambiguities can be satisfactorily resolved by a dual-channel receiving and gating system.

Planes May Soon Get Constant Weather Info.

Weather changes during every minute of flight may soon be available to airline pilots flying the North Atlantic through a "wire"—an airborne radioteleprinter that continually provides latest aerological information from stations in Canada and Scotland. Trans-Canada Airlines is conducting trans-Atlantic flight tests of the new device, developed by Federal Telecommunications Labs, Nutley, N. J., and Creed and Co., London, associates of IT&T.

On the first test, signals were received at a distance of 1,300 nautical miles.

For product information, use inquiry card on page 113.

Printed Circuit Computer Construction

Formica XXXP-36 paper base phenolic resin impregnated copper clad laminated plastic has earned an important place in the

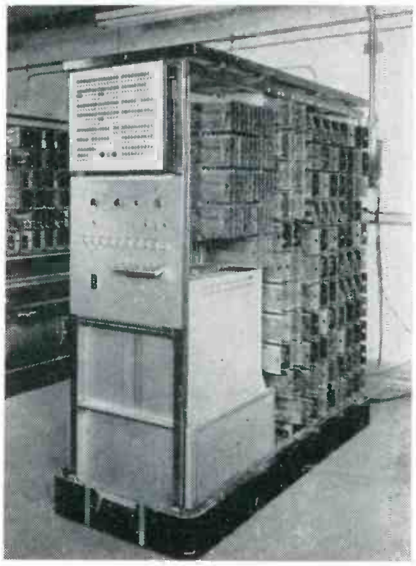


Fig. 1: Univac uses hundreds of P-C boards

Remington Rand Univac File Computer. Hundreds of circuit boards of the type shown in Fig. 2 are used in this ingenious computer, a section of which is shown in Fig. 1.

Formica XXXP-36 is particularly useful in this electronic "brain" since it offers high solder heat resistance (450° F for several seconds), 1,000,000 megohms per square inch insulation resistance, cold punches up to and including 1/16 in., and bond strength of 6 pounds (1 in. strip is pulled perpendicular to laminate).

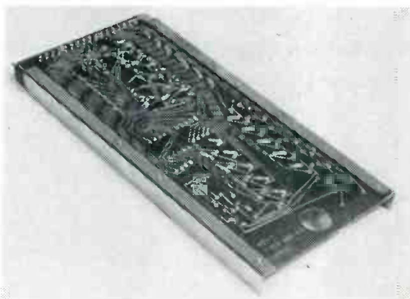
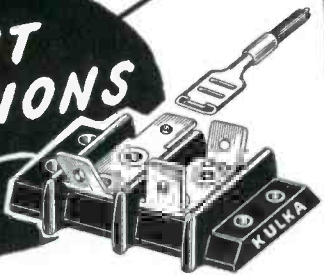


Fig. 2: Typical Formica XXXP-36 P-C board

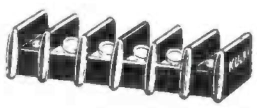
Formica FF-91 glass cloth-epoxy resin impregnated circuit boards used in other Univac computing systems are shown in Fig. 3. Portions of the circuit shown

(*Continued on page* 152)

Make INSTANT CONNECTIONS *without Screws*



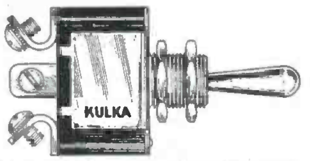
Use "KLIPTITE" TERMINAL BLOCKS (Molded, Barrier-type) with ANGLED TABS Made for AMP, Self-locking Wire Terminals.



Tabs are plated brass and come eyeletted to block, or separately. Tab combinations in various angles, or flat, for single or multiple connections. Several sizes and number terminals.

Other terminal blocks available in approved materials range from subminiature (shown) to jumbo (90 amps).

SINGLE & DOUBLE POLE ELECTRONIC SWITCHES



Toggle handle, aircraft type. Bakelite housing. With screw terminals, or solder lugs. DC, or AC up to 1600 cycles. One-hole mounting.

KULKA ELECTRIC MFG. CO., Inc.

Manufacturers of Electrical Wiring Devices

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Designed Developed and Manufactured For Existing Or New Products

- Engineered For Excellent Performance
- Developed For Your Specific Products
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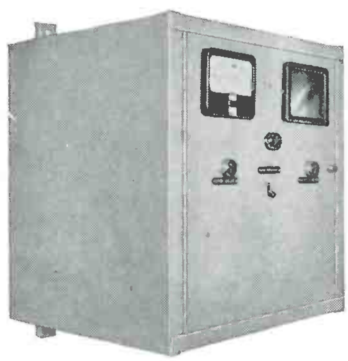
20,000 TRANSFORMER DESIGNS FROM WHICH TO CHOOSE

One good reason for discussing your transformer application with Acme Electric is the possibility that with our background of more than 20,000 designs, we can adapt standard parts to exactly fit special requirements.

For example, the top illustration is that of a 2 KVA 240/480 primary, 120/240 secondary volts, 60 cycle dry type power transformer. The illustration (right) is that of a 1500 watt voltage regulator having a manually adjusted output voltage range from 145 to 240 volts. Basically, the same design, but with modification each unit serves a different purpose.



This is a high voltage power supply for electrostatic dust collecting and air conditioning equipment. Operating on 230 volt single phase, 60 cycle, it supplies 12 KV direct current up to 30 ma. D.C. voltage is adjustable to load.

Your requirements may be more simple than these examples — or more difficult. Send your specifications.

ACME ELECTRIC CORPORATION

8910 WATER ST. CUBA, NEW YORK

Acme ACME Electric
TRANSFORMERS

For product information, use inquiry card on page 113.

(*Continued from page* 150)

at top are gold plated for better contact.

This Formica glass-epoxy grade is particularly well adapted for use in hot, humid conditions, since

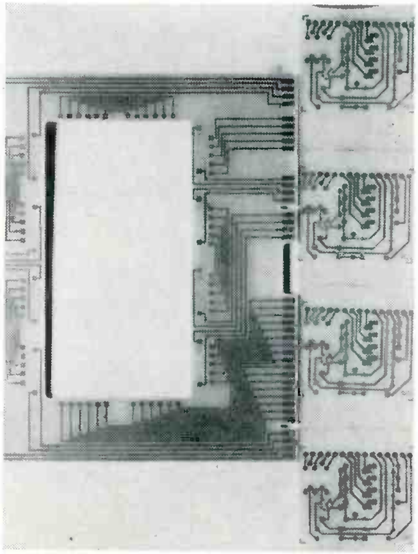
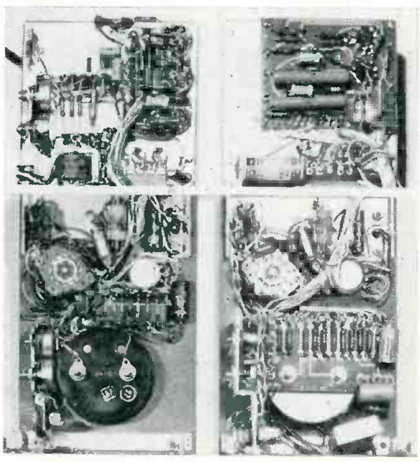


Fig. 3: FF-91 P-C boards used in systems

its inorganic base resists fungus attack, has very high mechanical strength, and punches cold in thicknesses up to and including 1/16 in.

PC Streamlines Instrument Const.

Cleveland Metal Specialties Co., designers & mfgrs. of printed circuits, has convinced Keithley Instruments, Inc. of Cleveland, of the production advantages of printed circuits.



Electrometer before & after using P-C.

Assembly time of the models utilizing printed circuits is approx. 50% of that of non-printed circuit units.

(*Continued on page* 154)

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(*Continued from page 152*)

What is of primary importance to the company is the reduction of the possibility of human error and the present simplicity of trouble shooting in the new model.

Keithley found that it is not necessary to order printed circuits in large numbers for them to be economical. The economies effected would continue to be realized if they were bought one at a time or by the thousands.

"ELECTRONIC STATISTICS"

More than 50% of the cost of military aircraft is for electronic equipment.

* * *

Almost 75% of commercial TV stations have AM counter-parts.

* * *

27¢ out of every sales dollar goes for transportation.

* * *

Only 12 cities in the U. S. have 4 or more TV stations.

* * *

Electronic production:
50%—U. S. Government.
35%—Home entertainment.
15%—Commercial applications.

Modular Design

(*Continued from page 55*)

The test program has shown good results on the block of 50 units which were subjected to a test-to-failure program. The principal emphasis in this program was on vibration environment. In addition, a substantial number of sample units were subjected to a combined environment test. This was also a test-to-failure, and consisted of the application of vibration in the presence of high altitude and low temperature.

Sufficient data were obtained to determine whether the altitude and temperature actually were adding to the severity of the over-all environment. The units were divided into groups of approximately eight, and each group was subjected to a different environment. At the beginning of the evaluation program, the vibration test-to-failure was run by vibrating at 12g, 10 to 500 cps, covering the range from 10 to 500 cycles in ten minutes. A full sweep is considered to be either from 10 to 500 or 500 to 10 cps.

In this environment the units showed an indefinite life, and failures were extremely rare. As a result of this experience the vibration input was increased to 16g, and a second lot started through test. In this lot also, vibration failures were exceedingly small, though the tests were run for an equivalent of up to 2500 minutes of 16g vibration. Since the objective was to determine the actual strength, or ultimate strength, of components of this design, a third lot was subjected to vibration inputs of 20g. Under these conditions, it was determined that a typical Tinkertoy design unit, similar to the package illustrated in Fig. 1, has an ultimate strength very conservatively more than five times that of conventionally designed equipment. The data obtained in the test program are shown in Table 1.

An interesting sidelight on the sample unit test-to-failure program was the introduction of a high amplitude sonic environment, intended to serve as a non-destructive quality control test. This testing was carried out on all units received, and in some initial lots it showed up several cases of improperly soldered eyelets and other cold soldered connections. After these were uncovered and corrective steps taken, the performance indicated above was achieved with the remaining units. From these results it has been concluded that the Tinkertoy basic construction technique can indeed fulfill its early promise of a substantial improvement in reliability.

Component Improvements

An early deterrent to the widespread use of the Tinkertoy style was the relatively wide tolerances of the resistors and capacitors available for use on the ceramic wafers. During the past three years, the stability and accuracy of these component parts have improved substantially but only at the expense of certain of the features of the Tinkertoy design program as originally announced.

The original concept provided for machine application of the resistors to the ceramic wafers as required; transfer machines to pass these wafers through the curing furnace; and an output of finished wafers carrying cured resistors. The more precise and more stable resistors now in use are prepared in a much more conventional fashion. However, the shape and general size of

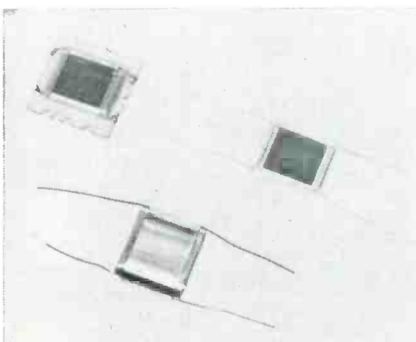

Fig. 3: Old style capacitor (front); basic encapsulated unit and mtd. on wafer (rear)

these special resistors for Tinkertoy use still differ markedly from the conventional type.

To protect resistive elements from external influences, a technique was devised for encapsulating the resistor between two plastic sheets and for attachment of leads. Fig. 2 shows a representative encapsulated resistor beside an old style precured tape resistor. These

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new style encapsulated resistors pass military specification tests and are available on a five per cent tolerance as received. The resistors are rated at ¼ watt dissipation at an ambient temperature of 150° C. The use of wire leads on the resistors requires that the standard ceramic wafer associated with Tinkertoy modules be revised. This revision takes the form of a standard hole pattern into which the wire leads can be inserted. Fig. 2 also shows old and new style resistors mounted on wafers.

In capacitors a somewhat similar problem existed in application to military equipments. In general, capacitors of stable characteristics and of relatively precise value are required. To meet this need, Mylar dielectric capacitors were developed early in the Tinkertoy program. These capacitors were constructed by winding one or two layers of Mylar dielectric and aluminum foil electrodes on a flat mandrel resulting in outside dimensions approximately ½ inch square by 1/16 inch thick. The complete capacitor, after removal from the mandrel, was subjected to heat and pressure to seal the dielectric layers into a solid mass. These capacitors were satisfactory in all regards except for failure to withstand the salt spray test of MIL-C-25.

A substantial step forward in the ability of the capacitors to withstand adverse environments has been the development of a method of encapsulating the entire capacitor in plastic material. Closer process control has also been attained, thus permitting greater accuracy and longer average life on each capacitor, as well as a greater safety margin against over-voltage. Fig. 3 is an illustration of the old and new style capacitors, with a standard ceramic wafer carrying a capacitor ready for assembly into a completed module.

Conclusion

The tests have verified that outstanding reliability may be achieved through careful application of Tinkertoy design techniques. Other problems are constantly arising in the application of modular design techniques, and many of the original objectives of the program are, as yet, unrealized.

Capacitor

(*Continued from page* 59)

tions this phenomenon can occur. The many investigations made and papers written on the subject in the past few years are of great value, but actual test results on the capacitors are believed to be more conclusive. Laboratory tests show that little or no silver migration occurs during the high humidity test previously described.

The applications for "Wejcap" capacitors are the same as for conventional ceramic capacitors—by-pass and coupling uses are the principal ones. Presently manufactured capacities are GMV values from 150 to 1800 mmf. Higher and lower capacities, closer tolerance and temperature compensating units are forthcoming.

Color coding is accomplished by placing small stripes of heat resistant colors along the top edge of the capacitor. RETMA colors are used and since the capacitor is symmetrical, the first color on the left side is three times the width of those following, to indicate the direction of reading.

Of no small importance is the shape and size of the hole in the print wire board. The hole may be a simple rectangle, but experience has shown that a dogbone-shaped hole is more desirable from the standpoint of easier insertion of the "Wejcap" capacitor and strength of the print wire board punches. It is recommended that the length of the hole be such that the capacitor wedges about midway along its taper. The width of the hole at its center is not highly critical, but normally should not exceed the nominal capacitor thickness by six mils, and the printed wire must be brought to the edge of the hole.

Solderability of "Wejcap" capacitors is excellent and is preserved during shipment and storage by plastic-lined cartons to which paradichlorobenzene is added to prevent tarnishing of the silver electrodes. Ordinarily it is not expected that cartons will be opened until ready for use. However, several days' exposure to a normal atmosphere will not appreciably affect the solderability. Should the atmosphere have a very high sulphur content, precautions should be taken. Tarnishing after installation will not affect the capacitors' operation.

The "Wejcap" capacitors are designed specifically to be dip soldered. Recommended soldering time is between 2 and 5-sec in liquid rosin flux and 60% tin, 40% lead solder, between 400° and 500° F. For a dip period exceeding 5 secs, a 2% silver bearing solder is recommended to prevent deterioration of the silver electrodes by the silver. Good fillets will be obtained between the silver electrodes and the printed wire on the board.

"Predicting the Reliability of Airborne Equipment"

This article, which appeared in ELECTRONIC INDUSTRIES & Tele-Tech, Sept. 1956, should have been attributed to co-authors G. R. Herd and C. J. Hedetniemi, Aeronautical Radio, Inc., 1700 K St. N. W., Washington 6, D. C.

2.8 million families said they are seriously considering purchases of television sets by February, 1957.

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DC Connectors

(*Continued from page 63*)

the printed circuit board. The legs of the contacts are shaped in such a way that the same contact can be used for 1/16 and 3/32 in. board. The legs are staked at the outside for 1/16 in. board and mainly at the inside for a 3/32 in. board.

This staking results in reliable fastening of the contact. Tests showed that at more than 45 lbs., applied in direction of the contact axis, the contact becomes loose at the board. The average insertion force for a contact is ½ lbs. Assuming this value may increase to 1 lb. due to minute misalignments of the contacts in a complete connector, the staking still provides a safety factor of 40, and no loosening of the contacts or strain to the solder joint ever is to be expected.

This principle is a deviation from the conventional connector design. Basically, any connector of the past consists of an insulating matter, in which the female contacts are fastened and a second insulating piece with the mating male contacts. In the connector, which is shown in Fig. 2, only one insulator is used, which houses the female contacts. The mating male contacts are free from any surrounding insulator being mounted directly on the printed circuit board. In the printed circuit technique all the conducting elements of the circuit are fastened directly to the board. Standard resistors, condensers, transistors and similar components are fastened directly to the printed wiring by their conducting leads. The logical solution therefore, is also to fasten the contacts directly to the printed circuit board and not to an insulator, which in turn is then mounted on the board.

This new approach in connector design needs some imagination from the designer who does not have to deal with connectors anymore; he has to work with contacts; or in other words with connections. The connector has shrunk to the contact itself.

The contact must now be fastened by the electronic device manufacturer. Two simple ways have been developed for this procedure.

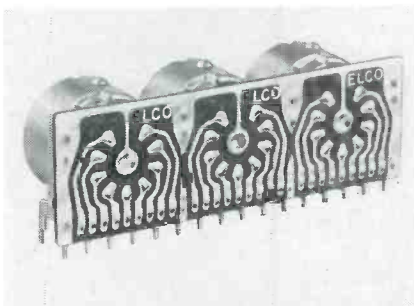

Fig. 5: Right angle multiple tube sockets

One is pre-assembly of the contacts to a mounting strip by the connector manufacturer. This strip consists of insulating material to which the contacts are fastened at proper spacing.

Such a strip with the right number of contacts fastened to it at the exact spacing and correct position can easily be inserted in the printed circuit board, as shown in Fig. 3. The contact legs are properly aligned at the strip and therefore, will enter the holes in the printed circuit board with ease.

The only work which has to be performed on the printed circuit board is to stake the legs to the

(*Continued on page* 160)

board with a simple knife-like staking tool, furnished by the connector manufacturer. No additional tool is required to hold the contacts in the right position during the staking, because the contacts are positioned correctly in the strip.

For high volume mass-production, the use of this holding strip can be circumvented. An automatic assembly device with hopper feeder for the contacts and staking automatically after insertion can be supplied.

During the past years the availability of such or similar linear connectors for printed circuits has created a new type of packaging, which allows the building of smaller units due to better utilization of the space. A typical example of such packaging is shown in Fig. 4. A total of 4 sub-units, which are made as printed circuit wafers, are connected to the mother board in a shelf-like construction.

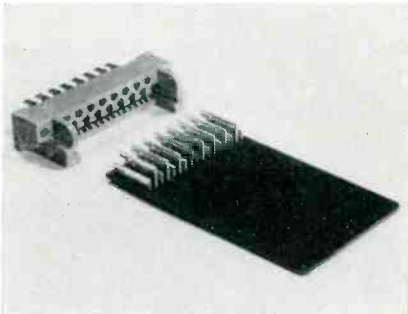

Fig. 6: Sub-miniature connector for P-C

This type of construction has created the need for a different mounting of tubes with their axis parallel to the board. Such a right angle miniature tube socket, with and without shield, is shown mounted on the printed circuit wafers of Fig. 4. This socket also employs the printed circuit technique. The mechanical strength of the socket is obtained by two brackets, which are staked to the board of the tube socket by the socket manufacturer and which are fastened to the printed circuit board by the apparatus manufacturer during assembly. Sockets of this type are electrically connected to the circuitry by wire staples or legs, which in turn are dip-soldered to the printed circuit

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ELECTRONIC INDUSTRIES & Tele-Tech Advertisers—Oct., 1956

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wiring. These staples act only as conductors; they intentionally do not contribute to the mounting strength.

The same technique has been employed in making right angle multiple tube sockets, as shown in Fig. 5. Here a printed circuit plate with the pattern for three 9 pin miniature tube sockets is used to mount three sockets. Four brackets are selected to give this unit sufficient rigidity.

Such design allows the printing of a special combined pattern for the tube socket board to suit the tubes, which are used in this application. In this way, the number of staples can be reduced; and in turn the entire circuit pattern becomes simplified, thus reducing the number of soldered connections and increasing the reliability of the device.

In the sub-miniature field, the voltage requirements are lower and in turn a grid pattern with .100 inch spacing is very common.

A connector designed under the same principles as discussed above but usable in the sub-miniature field, is shown in Fig. 6. This connector has two rows of contacts. The female contacts are fastened in the casting.

The male contacts are staked directly to the board. Two different contact shapes are used, one with its contact areas at the lower row and one with its contact areas elevated at the second row. Each contact has two legs which penetrate the board to the corresponding printed circuit pattern, where they are staked and later automatically soldered to the printed circuit wiring. The two legs of each contact are .200 inch apart, but there is a .100 inch offset between the two types of contacts.

TABLE I

WITHDRAWAL FORCE VERSUS INSERTIONS

INSERTIONS	WITHDRAWAL FORCE
7	6 lbs. 12 ozs.
20	6 " 4 "
100	6 " 2 "
200	6 " 0 "
500	5 " 3 "
1,000	4 " 12 "
2,000	4 " 8 "
3,000	4 " 4 "
5,000	4 " 4 "

New Concept in Transistor Design for High-Frequency Applications in Military and Commercial Equipment, and Entertainment-type Receivers

Designed to provide a "built-in" accelerating field in the base region that propels charge carriers from emitter to collector, RCA-2N247—a germanium p-n-p type transistor—begins a new era in transistor operation at radio frequencies extending from the Standard AM Broadcast band well up into the short-wave bands.

Here is a design that makes possible a significant reduction in base resistance and collector capacitance—substantially increases voltage- and current-handling capability, provides shielding between base and collector leads to minimize interlead capacitance and coupling to adjacent components. The resultant benefits to designers are: (1) high input circuit efficiency, (2) excellent operating stability, (3) good automatic-gain-control capabilities over wide input-signal variations, and (4) good signal-to-noise ratio.

In addition to its major application as a radio-frequency amplifier, RCA-2N247 is also well suited as a mixer-oscillator (converter) and intermediate-frequency amplifier in entertainment-type receivers.

Adaptable to mass-production techniques, RCA-2N247 can provide for the expanding needs of high-frequency commercial and military applications. It is one more example of RCA's intensive development program in semiconductor techniques to provide high-quality transistors—*in quantity*. For more data on Drift Transistor, Type-2N247, write RCA, Commercial Engineering. Or call your RCA Field Representative.

TYPICAL OPERATION AS CLASS A RF AMPLIFIER

Common-Emitter Circuit Base Input Ambient Temperature = 25°C

	1.5 Mc	10.7 Mc
DC Collector-to-Emitter Volts	-9	-9 volts
DC Base-to-Emitter Volts	-0.2	-0.2 volt
DC Collector Current	-1	-1 ma
Collector-to-Base Feedback Capacitance	1.7	1.7 μμf
Input Resistance	1350	170 ohms
Output Resistance	75000	4500 ohms
Power Gain▲	45	24 db

▲Measured in a single-tuned unilateralized circuit matched to the generator and load impedance for maximum transfer of power (transformer insertion losses not included).

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