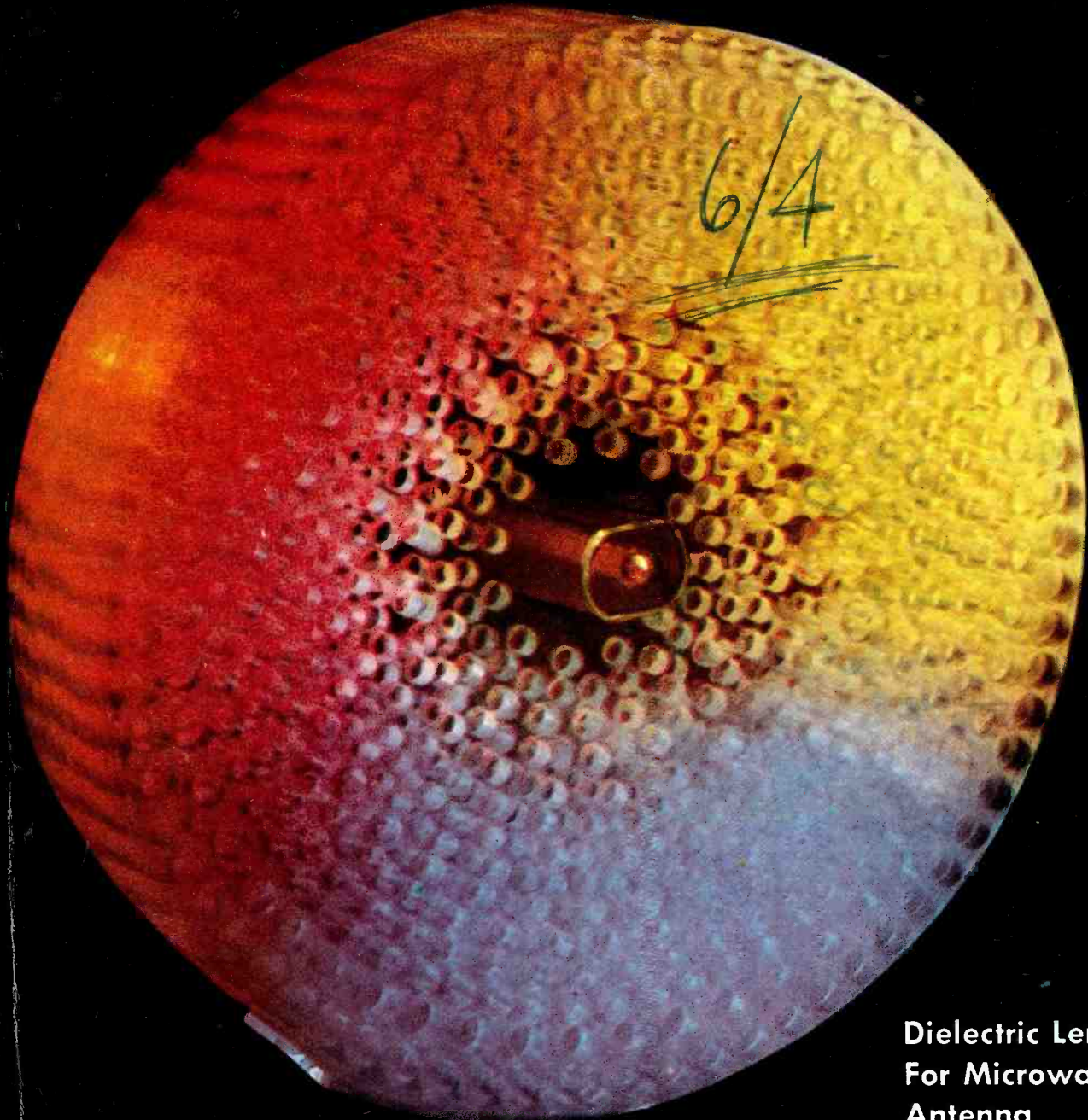


# electronics

JUNE • 1956

A MCGRAW-HILL PUBLICATION • PRICE 75 CENTS



Dielectric Lens  
For Microwave  
Antenna

**ANALOG COMPUTERS for the Engineer** ... page 122

The "Apple" Tube ... page 150

A New Nomograph ... page 170

OUR MILLIONTH FILTER SHIPPED THIS YEAR...

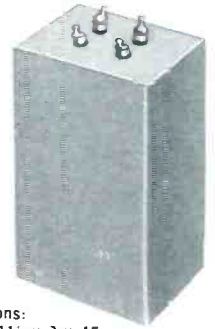
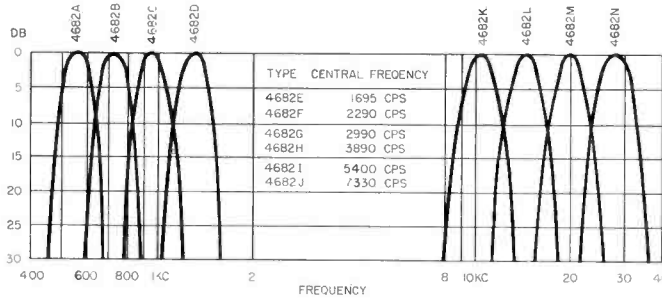
# FILTERS

## FOR EVERY APPLICATION

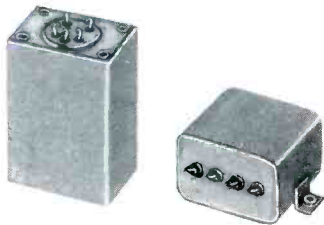


### TELEMETERING FILTERS

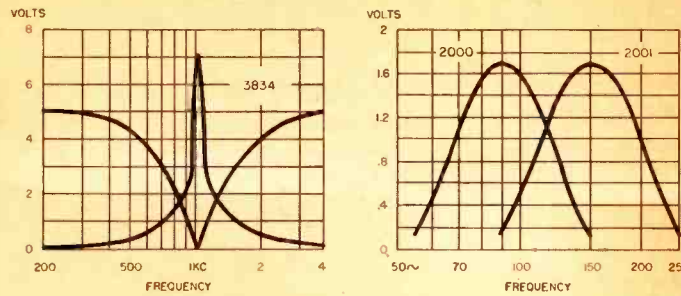
UTC manufactures a wide variety of band pass filters for multi-channel telemetering. Illustrated are a group of filters supplied for 400 cycle to 40 KC service. Miniaturized units have been made for many applications. For example a group of 4 cubic inch units which provide 50 channels between 4 KC and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



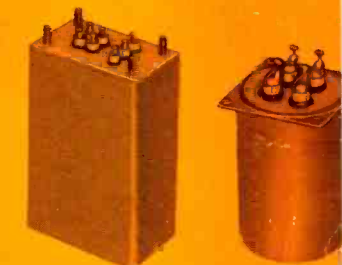
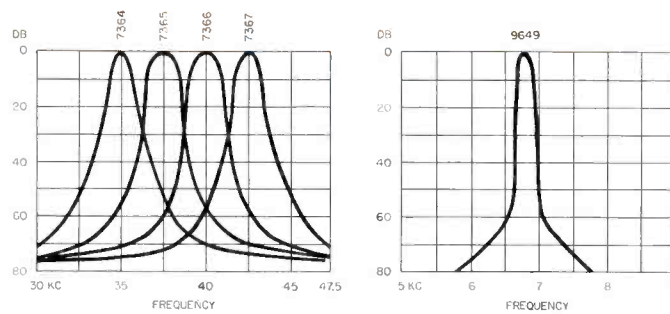
### AIRCRAFT FILTERS

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 (10±0 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

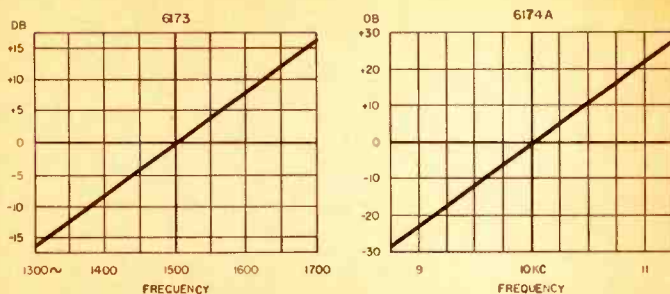
A wide variety of carrier filters are available for specific applications. This type of tone channel filter can be supplied in a varied range of band widths and attenuations. The curves shown are typical units.



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 1⅝ 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"



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**DIELECTRIC LENS FOR MICROWAVE ANTENNA**—Variation of refractive index is obtained by use of voids in base material. The 4,419 holes are cylindrical, and  $\frac{1}{8}$  inch in diameter, in this model made by Melpar. (See page 138) ..... COVER

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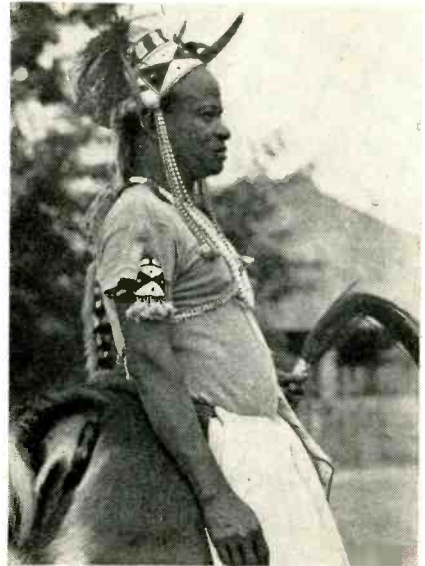
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# SHOP



**SCARED** us too when delivered face up. Message on back from recently retired W. C. White of G-E says even in mid-Africa he can never get very far from a vacuum tube. He has written many articles for ELECTRONICS is now seeing the world with Mrs. White

► **THIS ISSUE** . . . Like most project engineers, we are rarely completely satisfied with our final design each month. There is always the possibility of squeezing a little bit more output from each stage, or of obtaining a shade better frequency stability from an oscillator, to use a couple of similes.

While taking a last look at the articles scheduled for June, we were mildly shocked to discover that the usual vague feeling of dissatisfaction was different this

# electronics

JUNE, 1956

Vol. 29, No. 6



Member ABC and ABP



# TALK

month. To our news nose, the scent seemed nearly perfect.

Feature articles on analog computers, multiplex f-m broadcasting, shipboard telemetry for the Terrier, design of dielectric lenses, simulated radar targets, fabricated computer disk, the Apple tube, low-noise equipment design, a vibrating capacitor inverter, bevatron pulse system, a personal microwave receiver, and a transistor modulator made us feel that Browning was right about the world.

We then remembered that Leap Year gave us a few extra days in our printing schedule at Albany. We took advantage of this to squeeze in a few feature articles that normally could not have been scheduled until a month later.

► **INDUSTRY FEEDBACK . . .** We are currently gathering technical data for a special report.

To streamline the operation we have devised a stapled eight-sheet questionnaire. The first sheet consists of a letter describing "Project Materials" and the other sheets contain 12 questions each about new materials recently made available or soon to be announced for use by design engineers working in electronics.

The booklets are now in the mail to 1,200 companies producing insulating, wiring, alloy, bonding, coating, potting, conducting, magnetic and other materials.

One philatelist-wag on the staff

suggested that the Post Office be asked to issue a special electronics stamp for the mailing. This was licked before it went very far.

If engineering reports, photographs and other data fed back from each firm average half-inch thickness, our pile of material for Project Materials might be 50 feet high. Our high-heeled editorial assistants have already acquired a ladder.

► **WE'RE PROUD . . .** An Award of Merit has been granted associate editor John Markus in a competition sponsored by Associated Business Publications.

The article for which the award was made was "Mechanized Production of Electronic Equipment," published in September 1955 **ELECTRONICS**.

► **ADD CONFUSION . . .** Reactions from readers to the "Little Gem" in last month's *Shoptalk* show that the instrument was even more intriguing than we had hoped. Several pieces of similar apparatus have since been described to us, but none has the ability to produce chaos quite as readily.

Several of the editors put their heads together and came up with a modification which they claim will enhance the usefulness of this device.

By adding an internal battery which is automatically switched into the circuit after the line fuse

is blown, the neon bulb will remain lit and provide sufficient light to help locate and disconnect the "Little Gem" in the ensuing darkness.

Which might mislead some engineers (and the conductor of this column) to conclude that voltage is still on the line!

► **OLD SOLDIER**—As we go to press, the industry is observing National Radio Week and we note with interest the reviews of early techniques and equipment that have been described on broadcasts and in newspapers.

Almost with tears in his eyes, one of our editors tells us that he has carefully preserved one of the first superheterodyne portables, vintage of the 20's. For some years now he has planned to invest in a lot of batteries and check its operation against a modern portable.

Comparison of sensitivity, audio response and other characteristics would be interesting.

He has carefully saved type 99 tubes for spares, hopes the i-f catcomb (i-f 30 kc?) hasn't had moisture penetrate the pitch, and is proud of the untarnished gold appearance of the dials and of the mother-of-pearl inlaid knobs. The set has two beautiful brass-plate tuning capacitors, a curled-up horn loudspeaker and a rotatable loop built into the front cover.

Only the leather handle has deteriorated.

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low  
cost



MODEL VRSAC750  
0-750 VOLT RANGE

## VOLTAGE REFERENCE SOURCE

FOR RESEARCH LABORATORIES • SCHOOLS • PRODUCTION TESTING  
AMPLIFIER GAIN CHECKS • OSCILLOSCOPE CALIBRATION • SERVO TESTING

The Sorensen VRSAC750 Voltage Reference Source is a low cost, highly accurate regulator primarily designed for calibrating AC voltmeters in the 0-750 volt range. It is ideal for use with nearly every power meter commercially available.

Its compact design, simple operation and accurate performance make it extremely useful to the laboratory or the production shop. The VRSAC750 is specifically designed for bench-top operation . . . all controls are within easy reach of the operator, and the reference meter is clear, easy to read, and placed at eye level to insure maximum accuracy of adjustment.

Input voltage range	105-125 VAC, 1 $\phi$
Input frequency	60 $\pm$ 0.5 cps
Input current	7 amperes maximum
Output voltage	1-799 volts in 1-volt steps
Output voltage accuracy	$\pm$ 0.25% at any voltage in 20°-30°C ambient
Harmonic distortion	1% maximum introduced by the unit

SIZE 20 $\frac{3}{8}$ " high, 19 $\frac{3}{8}$ " wide, 12" deep WEIGHT 115 pounds net

**VRSAC10** — A versatile instrument for lower voltage applications featuring high accuracy at extremely low cost.



Output voltage range	10 mv to 10v RMS in three ranges
Calibration accuracy	$\pm$ 0.1% at full scale at 60 cps
Input voltage	115v $\pm$ 10%, single phase
Input frequency	50-60 cps; to 400 cps with slightly less accuracy
Waveform	Distortion is negligible
Regulation with load	0.25% max., with load resistance higher than 0.5 megohm
Regulation with line	$\pm$ 0.25% max.

Write today for complete specifications, performance data, and quotations.



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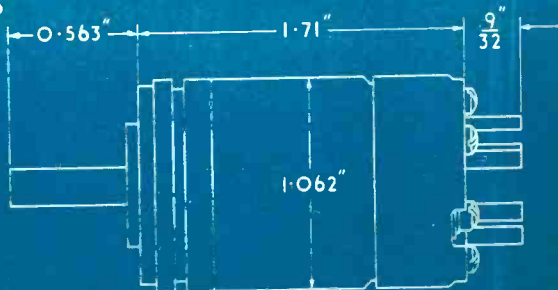
June, 1956 — ELECTRONICS



# MUIRHEAD SYNCHROS

## EXACTLY To BuOrd Spec

### SIZE 11 115V 400c/s



### MUIRHEAD

F11 M-1-A/1 SIZE 11 CONTROL TRANSMITTER

U. S. Bureau of Ordnance Number 11 CX 4a MARK 41 MOD. 1.

Supply 115V 400c/s

Nominal Rotor/Stator voltages 115/90V

#### MECHANICAL DATA

<b>BEARINGS</b>	Single row ball journal bearings	<b>ACCURACY (MAXIMUM ELECTRICAL ERROR)</b>	7 minutes
<b>ROTOR CONNEXIONS</b>	Silver strip brushes, Silver slip rings	<b>MOMENT OF INERTIA OF ROTOR</b>	0.014 oz in <sup>2</sup> 2.5 gm cm <sup>2</sup>
<b>MAXIMUM FRICTION TORQUE (at room temperature)</b>	0.05 oz in 3.5 gm cm	<b>WEIGHT</b>	4.2 oz 120 g

Shaft splined and threaded to enable gear to be fitted.

#### ELECTRICAL DATA

INPUT Rotor		OUTPUT Stator	
<b>WINDING</b>	Single phase	<b>WINDING</b>	3-phase star connected
<b>NO LOAD CURRENT</b>	0.03A	<b>VOLTAGE BETWEEN TERMINALS (No Load)</b>	90V max
<b>NO LOAD POWER</b>	0.7W	<b>RESIDUAL VOLTAGE AT NULL POSITIONS</b>	
<b>IMPEDANCE AT 115V 400c/s</b>	700 + j 3700 ohms	<b>FUNDAMENTAL COMPONENT</b>	45mV max
<b>D. C. RESISTANCE</b>	445 ohms	<b>TOTAL RESIDUAL</b>	75mV max
		<b>IMPEDANCE BETWEEN TERMINALS AT 90V 400c/s</b>	490 + j 2520 ohms
		<b>D. C. RESISTANCE BETWEEN TERMINALS</b>	300 ohms

### MUIRHEAD

F11 M-2-A/1 SIZE 11 CONTROL TRANSFORMER

U. S. Bureau of Ordnance Number 11CT 4a MARK 24 MOD. 1.

Supply to energizing synchro 115V 400c/s

Nominal Stator/Rotor Voltages 90/58V

#### MECHANICAL DATA

<b>BEARINGS</b>	Single row ball journal bearings	<b>ACCURACY (MAXIMUM ELECTRICAL ERROR)</b>	7 minutes
<b>ROTOR CONNEXIONS</b>	Silver strip brushes, Silver slip rings	<b>MOMENT OF INERTIA OF ROTOR</b>	0.014 oz in <sup>2</sup> 2.5 gm cm <sup>2</sup>
<b>MAXIMUM FRICTION TORQUE (at room temperature)</b>	0.05 oz in 3.5 gm cm	<b>WEIGHT</b>	4.2 oz 120 g

Shaft splined and threaded to enable gear to be fitted.

#### ELECTRICAL DATA

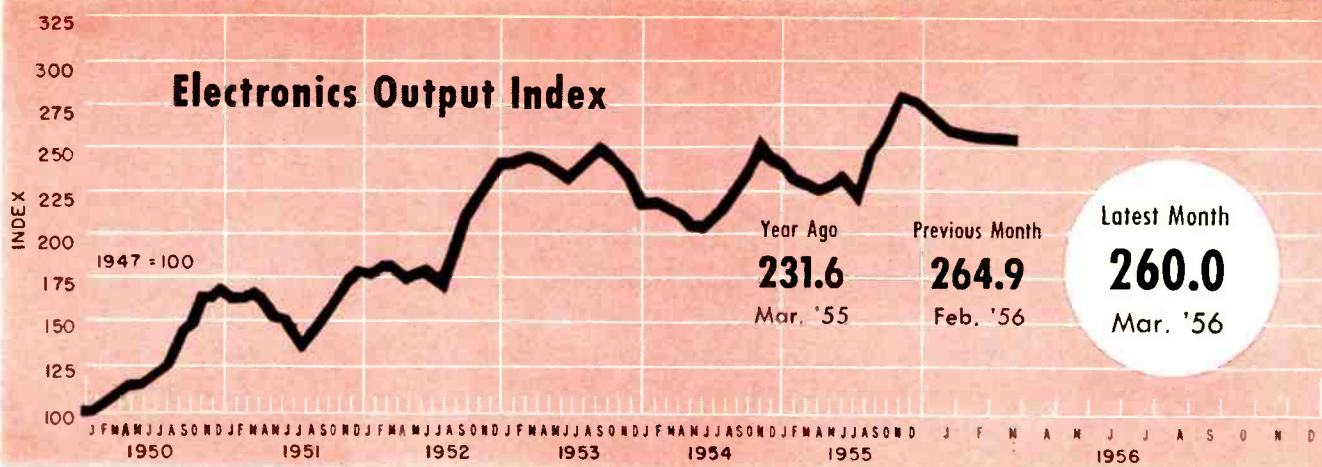
INPUT Stator		OUTPUT Rotor	
<b>WINDING</b>	3-phase star connected	<b>WINDING</b>	Single-phase
<b>SUPPLY FROM TRANSMITTER PER PHASE</b>	90V maximum	<b>VOLTAGE ACROSS 20,000 OHM LOAD</b>	1V per degree
<b>CURRENT PER PHASE</b>	12mA		initial misalignment
<b>IMPEDANCE BETWEEN TERMINALS AT 90V 400c/s</b>	1250 + j 7400 ohms	<b>RESIDUAL VOLTAGE AT NULL POSITIONS</b>	
<b>D. C. RESISTANCE BETWEEN TERMINALS</b>	535 ohms	<b>FUNDAMENTAL COMPONENT</b>	30mV max
		<b>TOTAL RESIDUAL</b>	60mV max
		<b>IMPEDANCE AT 58V 400c/s</b>	680 + j 3200 ohms
		<b>D. C. RESISTANCE</b>	370 ohms

Copies of the above data together with mounting instructions may be had free on request by writing to the address below.

### MUIRHEAD

**MUIRHEAD INSTRUMENTS, Inc. 677 Fifth Ave., New York 22, N. Y.**

United States Sales and Service for MUIRHEAD & CO., LIMITED • Beckenham • Kent • England



## FIGURES OF THE MONTH

	Latest Month	Previous Month	Year Ago
<b>RECEIVER PRODUCTION</b>			
(Source: RETMA)	Mar. '56	Feb. '56	Mar. '55
Television sets, total	680,003	576,282	831,156
With UHF	82,805	78,956	115,726
Color sets	nr	nr	nr
Radio sets, total	1,360,113	1,093,506	1,482,274
With F-M	833	2,660	23,859
Auto sets	478,272	437,611	774,025

	Latest Month	Previous Month	Year Ago
<b>RECEIVER SALES</b>			
(Source: RETMA)	Mar. '56	Feb. '56	Mar. '55
Television sets, units	544,411	530,554	669,794
Radio sets (except auto)	527,649	454,867	451,049

	Latest Month	Previous Month	Year Ago
<b>RECEIVING TUBE SALES</b>			
(Source: RETMA)	Mar. '56	Feb. '56	Mar. '55
Receiv. tubes, total units	42,525,000	37,754,000	41,080,881
Receiv. tubes, value	\$34,849,000	\$30,756,000	\$29,922,192
Picture tubes, total units	848,055	898,063	882,268
Picture tubes, value	\$15,714,365	\$17,136,695	\$17,246,843

	Quarterly Figures		
	Latest Quarter	Previous Quarter	Year Ago
<b>INDUSTRIAL TUBE SALES</b>			
(Source: NEMA)	4th '55	3rd '55	4th '54
Vacuum (non-receiving)	\$9,967,411	\$9,027,845	\$9,338,181
Gas or vapor	\$3,251,621	\$3,438,835	\$3,498,123
Magnetrons and velocity modulation tubes	\$13,726,323	\$10,998,967	\$15,249,651
Gaps and T/R boxes	\$1,578,767	\$1,421,138	\$1,788,780

	4th '55	3rd '55	4th '54
<b>MILITARY PROCUREMENT</b>			
(Source: Defense Dept.)	4th '55	3rd '55	4th '54
Army	\$48,477,000	\$19,477,000	\$44,599,000
Navy	\$20,378,000	\$20,054,000	\$37,328,000
Air Force	\$131,938,000	\$128,023,000	\$92,069,000
Total—Electronics	\$200,793,000	\$167,554,000	\$173,996,000

	Latest Month	Previous Month	Year Ago
<b>BROADCAST STATIONS</b>			
(Source: FCC)	Apr. '56	Mar. '56	Apr. '55
TV stations on air	489	488	453
TV stations CPs—not on air	114	109	121
TV stations—new requests	29	24	18
A-M stations on air	2,872	2,858	2,717
A-M stations CPs—not on air	118	115	98
A-M stations—new requests	275	262	201
F-M stations on air	534	536	539
F-M stations CPs—not on air	13	12	13
F-M stations—new requests	6	4	5

	Latest Month	Previous Month	Year Ago
<b>COMMUNICATION AUTHORIZATIONS</b>			
(Source: FCC)	Mar. '56	Feb. '56	Mar. '55
Aeronautical	45,488	44,570	40,991
Marine	55,175	54,637	49,212
Police, fire, etc.	20,216	19,971	17,599
Industrial	28,454	28,054	23,728
Land transportation	8,849	8,726	7,453
Amateur	146,699	145,427	132,959
Citizens radio	16,262	15,563	10,557
Disaster	327	327	313
Experimental	666	652	600
Common carrier	2,185	2,176	1,860

	Latest Month	Previous Month	Year Ago
<b>EMPLOYMENT AND PAYROLLS</b>			
(Source: Bur. Labor Statistics)	Feb. '56	Jan. '56	Feb. '55
Prod. workers, comm. equip.	385,600-p	389,600-r	358,100
Av. wkly. earnings, comm.	\$74.34 -p	\$74.70 -r	\$70.40
Av. wkly. earnings, radio	\$70.67 -p	\$70.80 -r	\$68.11
Av. wkly. hours, comm.	40.4 -p	40.6	40.0
Av. wkly. hours, radio	39.7 -p	40.0	39.6

	Jan. '56	Dec. '55	Jan. '55
<b>SEMICONDUCTOR SALES ESTIMATES</b>			
Germanium diodes, units	3,300,000	2,690,000	1,700,000
Silicon diodes, units			

	Latest Month	Previous Month	Year Ago
<b>STOCK PRICE AVERAGES</b>			
(Source: Standard and Poor's)	Apr. '56	Mar. '56	Apr. '55
Radio-tv & electronics	450.0	465.2	448.0
Radio broadcasters	524.0	543.2	519.1

p—provisional    r—revised    nr—not reported

## FIGURES OF THE YEAR

Television set production	1,844,632	2,188,252	- 15.7	7,756,521
Radio set production	3,532,243	3,640,144	- 3.0	14,894,695
Television set sales	1,689,178	1,943,992	- 13.1	7,421,084
Radio set sales (except auto)	1,513,722	1,246,038	+ 21.5	6,921,384
Receiving tube sales	120,420,000	117,558,000	+ 2.4	479,802,000
Cathode-ray tube sales	2,638,503	2,639,428	-	10,874,234

	1956	1955	Percent Change	1955 Total
Television set production	1,844,632	2,188,252	- 15.7	7,756,521
Radio set production	3,532,243	3,640,144	- 3.0	14,894,695
Television set sales	1,689,178	1,943,992	- 13.1	7,421,084
Radio set sales (except auto)	1,513,722	1,246,038	+ 21.5	6,921,384
Receiving tube sales	120,420,000	117,558,000	+ 2.4	479,802,000
Cathode-ray tube sales	2,638,503	2,639,428	-	10,874,234



# INDUSTRY REPORT

electronics—June • 1956

## Industry Boosts Plant Expansion Plans

Companies plan to spend more in each year through 1959 than was spent in 1955

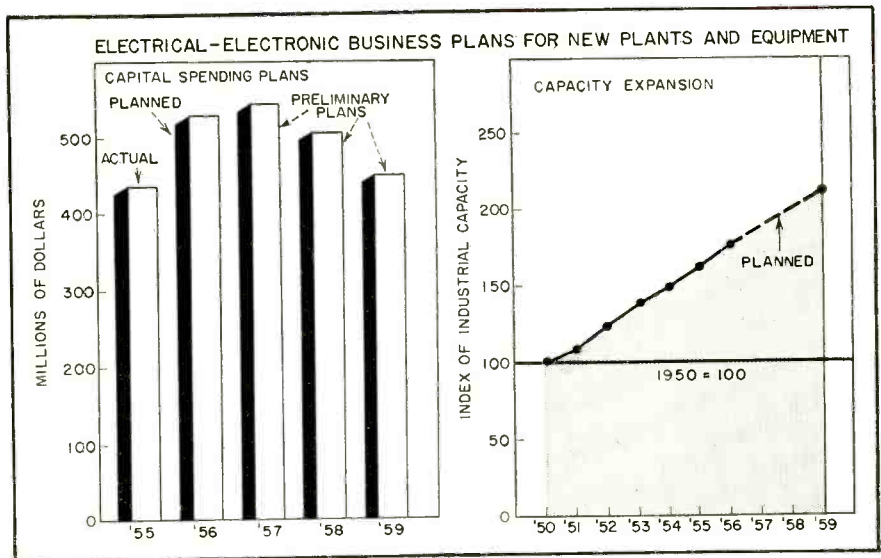
ELECTRONIC and electrical machinery firms plan to spend almost \$528 million for new plants and equipment in 1956, a 21-percent increase over the \$436 million spent in 1955. Plans for 1957, 1958 and 1959 spending are even higher. These are some of the findings in the annual McGraw-Hill survey of Business Plans For New Plants and Equipment—1956-59.

► **Capacity**—If plans remain unchanged, the capacity of the electronics and electrical machinery field in 1959 will be more than double what it was in 1950. Only four other industries can boast a similar expansion record. They are nonferrous metals, machinery, transportation equipment and chemicals.

The industry was operating at 98 percent of capacity at the end of 1955. However, companies prefer to operate at about 88 percent of capacity to have a margin of reserve.

Firms plan to invest about 30 percent of their total capital expenditure in new construction and 70 percent in new equipment in 1956, about the same ratio as shown in previous surveys.

► **Sales**—Electronics and electrical machinery firms expect sales to be 15 percent higher in 1956 than in 1955, and to increase 33 percent between 1955 and 1959.



Electronic and electrical companies expect 18 percent of total 1959 sales to be accounted for by new products. New products are defined as either products not produced in 1955 or products sufficiently changed to be considered new. Development and manufacture of new products is the reason for a third or more of the capital spend-

ing planned for 1956.

► **Research**—Research and development expenditures for the electronics industry is included in the machinery-industry classification. In this category expenditures are expected to rise from \$1.3 billion in 1955 to \$1.5 billion in 1956, to \$1.7 billion in 1959.

## Aviation Wants More Electronics

CAA foresees expanding use of electronics in future traffic control

"WHATEVER the design of future planes, it is certain that electronics will play an important part." So said Civil Aeronautics Administrator Charles J. Lowen in discussing aviation's future on the

occasion of the CAA's celebration of thirtieth anniversary on May 20.

► **Traffic**—The 1965 traffic control, according to Lowen, will be built around four basic components: radar, radar beacon, automatic data link and computers.

► **Codes**—The radar beacon will

make targets easier to see and follow on the radar scopes. By use of codes, the radar target can be identified as a particular aircraft, thus eliminating the present time-consuming identification procedures.

Other radar beacon codes could be provided to tell the controller the altitude of the aircraft and whether the aircraft is under his or some other controller's jurisdiction. The aircraft position, altitude and identification information supplied by the radar beacon, CAA officials forecast, could be fed to computers and to large automatic displays of air traffic.

► **Feedback**—The automatic data link may be designed to provide ground control stations with continuous position information, ground speed and altitude, and in return would automatically feed back to pilots their traffic control instructions, by means of visual displays on the aircraft instrument panel.

First use of data link, according to CAA, probably will be for automatic ground to air transmission on control messages. The second stage will add automatic transmission of requests for air traffic control clearance changes from pilot to controller and the third stage

may be automatic transmission of position from air to ground as a supplement to radar and radar beacons. This stage would provide data for automatic displays at CAA ground control stations.

► **Display**—For the controller, forecasters at CAA look for vastly improved displays to replace present manual posting of flight data on paper strips arranged on flight progress boards. They may be large situation displays covering an entire control area, representing a pictorial representation of the traffic combined with supplementary flight data. Displays may be developed for the individual controller, allowing him to examine specific situations in detail.

Pilots of 1965 will get a high speed collection and distribution of weather information by use of switching centers, magnetic memory drums and 1,200 wpm printers.

► **SWGL** — Automatic hands-off landings in bad weather may be the rule of the day, with the narrow beam localizer, the precision localizer or the slotted wave guide localizer. These are three names suggested for the same equipment. In any event, the SWGL for slotted wave guide localizer, coupled with the FHPTGPP, for flush high precision touchdown glide path projector, will, when perfected, permit automatic hands-off landings, in contrast to present day systems.

► **Ground**—While on the ground at airports, aircraft will be controlled by ASDE (Airport Surface Detection Equipment), another radar-type equipment already developed and in use for evaluation purposes. With ASDE, a picture of the whole airport is before the controller, complete with moving or parked aircraft, making ground control safer and more efficient.

## Navy Examines Industry Capacity

**Estimates 1955 sales at \$7.3 billion and production capacity at \$11.2 billion**

RECENT survey of the electronics industry, by the Office of Naval Materiel shows that production ca-

pability on a one-shift basis, has increased from \$9.7 billion in 1954 to \$11.2 billion in 1955.

► **Sales**—The number of employees in the industry dropped slightly last year from 458,318 to 441,130, whereas the number of companies covered by the survey increased from 509 to 549.

Sales in 1955 increased to \$7.3 billion, as compared with \$6.6 billion in 1954. The survey last year predicted planned production of \$7 billion in 1955, which compares with \$7.3 billion sales of that year. The predicted planned production for 1956, calendar year, is \$8.4 billion. Of this sum, \$3.8 billion will be military.

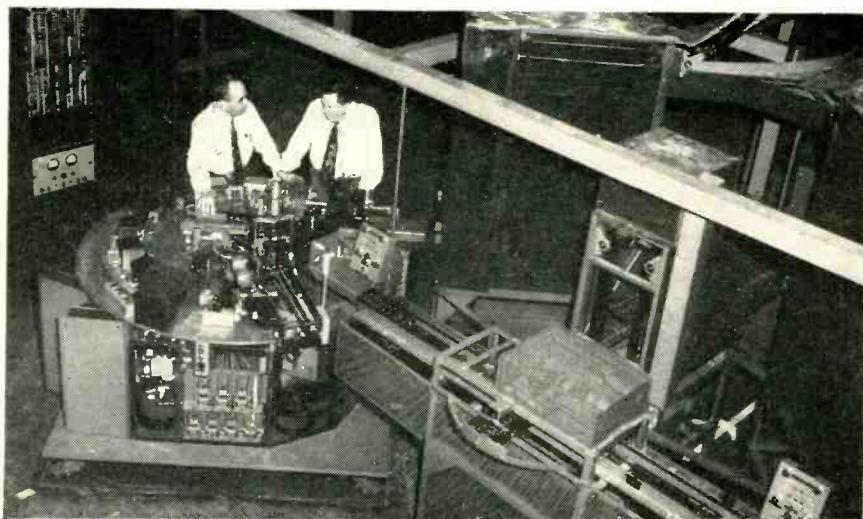
► **Military**—The military backlog reported as of Jan. 1, 1956 was \$4.5 billion which is almost exactly the same as the total reported a year ago. No great change is shown in prime contracts and subcontracts.

From 73 in 1955 the number of companies reporting 100-percent military production increased to 99 in 1956.

The number of companies re-

(Continued on page 10)

## Army Backs Automatic Production

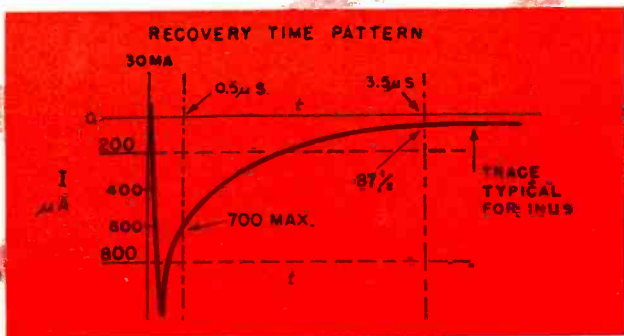


Automatic Component Assembly System (Electronics, p 122, Nov. '55) is readied by General Electric engineers for pilot runs of Signal Corps communications equipment under a \$1-million contract recently received by the company. Another Signal Corps contract, still being negotiated with GE, will cover redesign of the equipments to adapt them for production on the system. It is expected to cover three equipments





**IBM 705**



TYPICAL RECOVERY TIME TRACE FOR THE TYPE IN119

IBM "giant brain"  
with microsecond memory

**...incorporates Sylvania diodes  
with fast recovery time**

The IBM 705 is a "giant brain" general purpose data processing system which incorporates unique flexibility of input-output devices. Its Magnetic Core Memory can recall data at the rate of 9 millionths of a second per character.

To meet the 705's requirements for speed, Sylvania Crystal diodes are designed and measured for fast recovery time.

Recovery time tests, conducted on a 100% basis, are measured for maximum reverse current at 0.5 microseconds and 3.5 microseconds. Back resistance is swept dynamically between zero and -70 volts at 60 cycles and 55°C. Tests are also conducted on the types IN119 and IN120 for minimum drift, flutter, and hysteresis.

Sylvania produces a complete line of

computer diodes, produced and tested under the same standards as the IN119 and IN120. For applications requiring high forward conduction with excellent recovery time, Sylvania offers a complete line of V.L.I. (*very low impedance*) diodes.

Write for complete details on these as well as general purpose Sylvania diodes. Address Dept. F20R.

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porting 100-percent civilian production increased from 79 in 1955 to 97 in 1956.

Of the 549 companies surveyed, 393 are classified as small business and 156 as big business (500 or more employees).

The military backlog as of Jan. 1, 1956, was \$4.3 billion for big business and less than \$200 million for small business.

► **Items**—The data on which the figures are based has been restricted to electronic end items, systems, equipments, major assemblies or subassemblies, and piece parts produced for direct assembly by the fabricator. Special effort was made to exclude data applicable to research and development piece parts and nonelectronic products manufactured by the firms.

ing is done by a 3-by-5 stylus setup controlled by thyratrons—two per character. The present unit has 48 character printing positions. Circuits are arranged in printed modules with four spares provided.

Subsequent printers may include magnetic-tape input through a card-to-tape converter. Such a unit is planned for the Beam data-processing system (Burroughs Electronic Accounting Machine). Still under development is an accumulator for the high-speed printer. This unit will use Ericsson soft-tube counters.

► **Data Processing**—A high-speed electronic data processing system has been announced by Logistics Research of Redondo Beach, Calif. Named Alwac 800, the unit uses 12-digit decimal numbers and performs 11,000 additions, 2,000 multiplications or 13,000 comparisons a second. It sells for \$125,000.

Ten magnetic-drum units can provide 12-million decimal digit storage capacity each with four-millisecond access time. Other auxiliary equipment may include punched-card, line-printer, high-speed paper-tape and electric typewriter input/output as required.

The computer is constructed on the building-block plan. Deliveries are scheduled from 12 to 18 months.



ENGINEER checks out Burrough's electronics printing mechanism as . . .

## Tubes Print at 900 Lines a Minute

First machines to be used in mailing-list maintenance.

Other uses are foreseen

BIDDING for a slice of the \$500-million-a-year punched-card machine market, Burroughs has delivered the first of its Series G high-speed printing equipment to Names Fulfillment, Inc. of Irvington, N. Y.

The customer will use the equipment to print name and address labels for a newsletter aimed at members of a credit and courtesy charge club. Four machines are on order.

► **Savings**—The Series G prints at 900 lines a minute from a punched-card feed. This means more than 41,000 characters a minute. It can sort out cards of subscribers whose contracts are up for renewal and provides an "end-of-

town" marker so that address labels for each location can be conveniently packaged for the post office.

The machine is adept at making changes in mailing lists; users estimate that 30 percent of a mailing list changes each month. It is estimated that the machine can provide 40 percent savings over conventional addressing methods as well as added speed in getting out circulation audits and management information. A mailing list of 1.5 million names can justify rental.

The Series G rents from \$1,650 to \$5,000 a month with Burroughs providing maintenance. The firm reports orders worth \$2.5 million on hand from banks, oil companies, utilities and insurance firms. Deliveries are scheduled next year.

► **Technical Features**—The printer uses 125 electron tubes and about 8,400 semiconductor diodes. Print-

## Companies Push College Recruiting

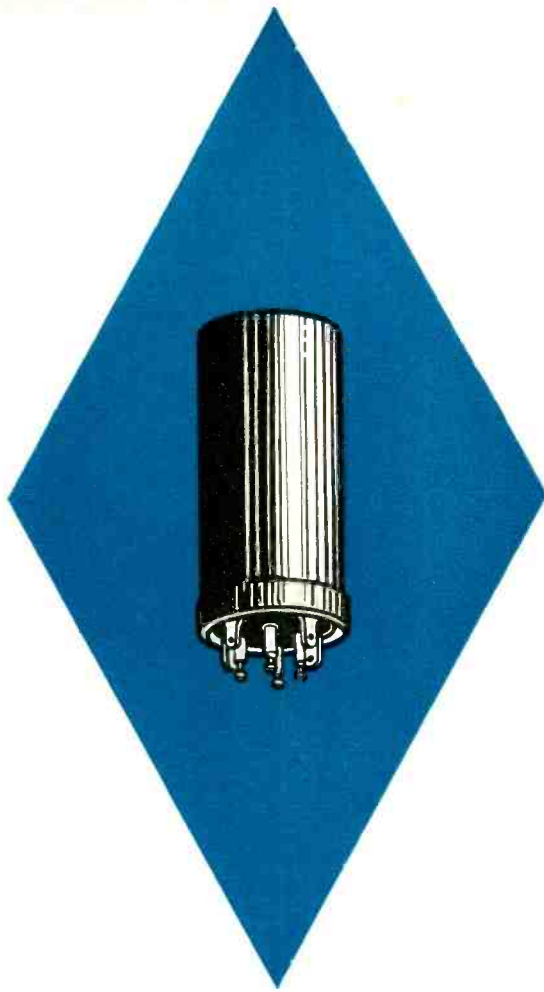
Competition for college graduates brings on systematic, year-round recruiting

STUDY of the college recruiting practices of 240 firms by the National Industrial Conference Board shows that the average company sends representatives to 41 colleges and universities and contacts 12 more by mail and telephone during the year. The Big Ten, engineering colleges and Ivy League schools are the most popular recruiting centers, but interest in the smaller liberal arts schools has been growing.

Although April and May are still

(Continued on page 12)





## **EXTENDED LIFE ELECTROLYTIC CAPACITORS**

*now available for*

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**computers**

**laboratory test instruments**

**industrial controls**

**other electronic applications**

HERE ARE CAPACITORS OF THE SAME *MAXIMUM RELIABILITY* which Sprague has long supplied to the telephone systems . . . now available for your own high reliability electronic applications.

The use of especially high purity materials . . . utmost care in manufacture, constant observation and quality control of all operations have made Sprague Extended Life Capacitors outstanding for their long life and faultless performance.

Type 17D Extended Life Electrolytics have turret terminals and twist-mounting lugs. A special vent construction is molded right into the cover, as are the numbers identifying each terminal. The aluminum cans are covered with a corrosion-resisting insulating coating.

Nineteen standard ratings, all characterized by low maximum leakage current and remarkable life test capabilities are available in the new series. Complete technical data are in Engineering Bulletin 340, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

# **SPRAGUE<sup>®</sup>**

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the big months for recruiting, only one company in four believes the job can be done within this period. Nearly 26 percent of the firms recruit seven months of the year or longer, and more than one out of ten look for men the year around.

The 1955 quotas of 235 companies totaled nearly 19,000 recruits, or an average of eighty recruits per company. About half the demand was for engineers, while sales trainees accounted for 20 percent and general business trainees 11 percent.

Starting salaries for four-year graduates averaged about \$350 per month in 1955. Most of the executives surveyed regarded last year's offerings as too high, but 80 percent predicted they will go higher.

► **Selection**—It takes 100 interviews to produce 15 likely candidates. These 15 are invited to the company, shown around and interviewed by officers and department heads. Eight eventually end up on the company payroll—the rest either fail to receive a bid or accept another firm's offer.

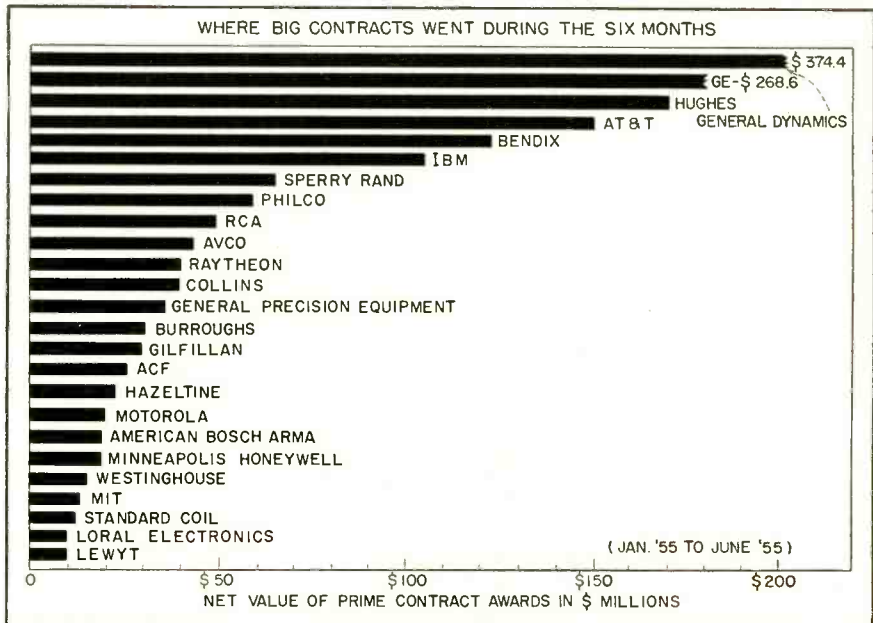
► **Preselection**—Nearly half of the firms try to line up good prospects before their recruiters arrive on campus.

## Photocell Sets Iris Automatically



Electronics moves further into the amateur movie equipment field with the inclusion of a servo-controlled iris on the 16-mm Bell and Howell model 200-EE camera. A photocell energizes a meter-relay to apply power to motor to position iris. Motor and gear train power is obtained from 6 mercury cells

## Defense Business Holds Level



### Defense Department shows firms that get top shares of peacetime procurement

EFFECT of peacetime procurement programs on the electronic industry is indicated in the Defense Department's latest list of the 100 companies that received the largest net volume of military prime contract awards. Twenty-five of the 100 are heavily engaged in electronics.

The awards shown were made from January through June 1955, a period, according to the Defense Department, that should be representative of peacetime procurement. Future reports may be expected to show some shifts in the companies in the list of 100.

► **Portion**—Net value of all military prime contract awards made by the Defense Department in the first six months of 1955 totaled \$8.5 billion. The top 100 companies accounted for \$5.8 billion of this amount. The 25 electronics companies among the 100, accounted for 20.4 percent of the total or \$1.8 billion. Individually, they accounted for amounts ranging from 0.1 percent to 4.4 percent of total procurement.

► **Comparison**—In the five-year

period from July 1950 to June 30, 1955, total net value of military prime contracts awarded was \$123.2 billion. A total of \$19.4 billion went to 23 companies in the electronics field, who were among the top 100 contractors. The 23 accounted for 15.9 percent of total awards during the period. Seven of the firms were awarded over a billion dollars in contracts during the period.

## Railroad Radio Takes On New Growth

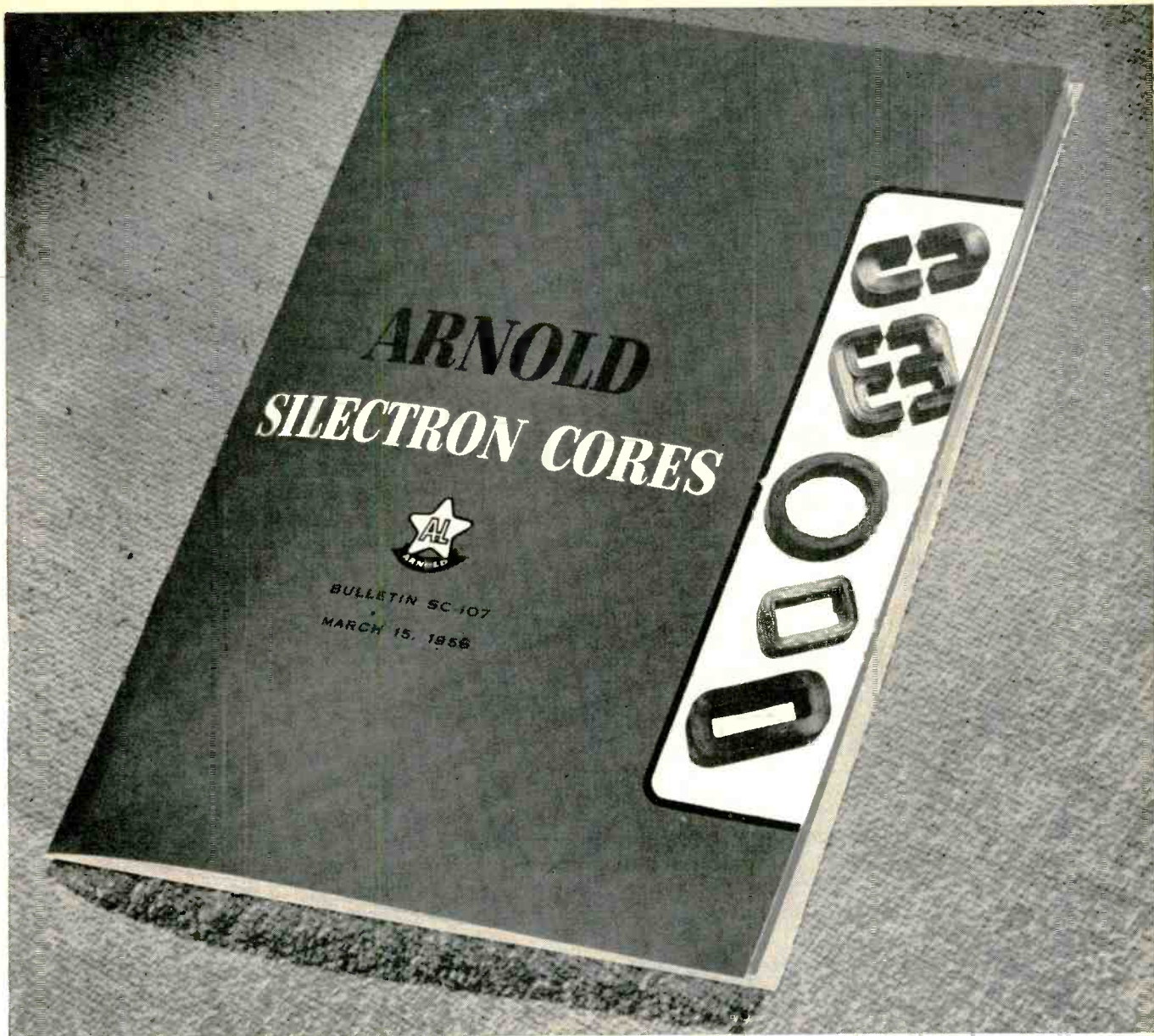
Transmitters increase in number as more railroads adopt radio to speed operations

SIXTEEN more railroads in the United States used radio services during 1955, increasing the total number from 143 to 159. These new users, helped boost the number of stations authorized in the 159-162 mc band from 16,327 to 21,943 for an increase of 5,616. The number of inductive station authorizations decreased during 1955 from 1,798 to 1,704.

► **Transmitter**—As shown in the chart, the number of transmitters

(Continued on page 14)





Here it is—the *Technical Data*  
**on SILECTRON CORES . . . all shapes and sizes**

This new bulletin contains design information on Arnold cores wound from a grain-oriented silicon steel, Silectron. Curves showing the effect of impregnation on core material properties are published for the first time. This 52-page bulletin includes information on cut "C" and "E" cores, and uncut toroids and rectangular shapes. Sizes range from a fraction

of an ounce to more than a hundred pounds, in standard tape thicknesses of 1, 2, 4 and 12 mils.

A new method of tabulating core sizes is introduced, whereby cores are listed in the order of their power-handling capacity. You'll find this Silectron core bulletin a valuable addition to your engineering files—*write for your copy.*

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in railroad radio rose sharply in 1955 with nearly twice as many transmitters authorized during the year as in 1954. Total authorizations increased from about 18,200 to 21,900. Number of licenses continued to rise at about the same rate in 1955 as in 1954.

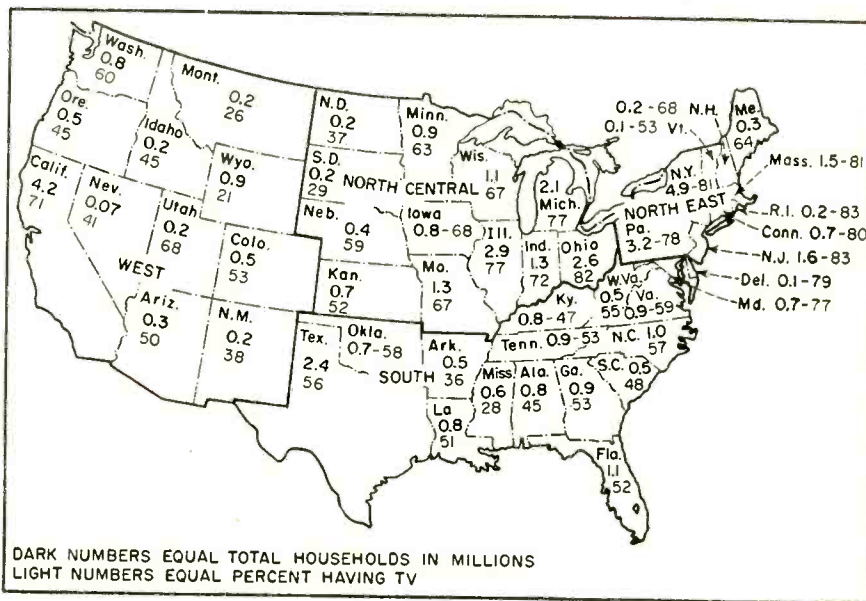
► **Breakdown**—Type of railroad radio service with the largest increase in stations during 1955 was the mobile station for yard-terminal use, which increased from 4,253 to 7,117, a growth of nearly 3,000. Train service mobile stations increased during the year by over 2,000 from 11,020 to 13,435. Base stations for these units climbed from 692 to 846.

Inductive type station authorizations decreased in every category. Train service base stations dropped from 244 to 237 and mobile units dropped from 1,508 to 1,440. Yard terminal base stations declined from 15 to 8 stations and mobile stations, from 31 to 19.

► **Users**—Only 9 U. S. railroads are now using inductive equipment, and each of the nine also has radio in use. The Pennsylvania is the largest inductive user with 1,400 train service units.

Largest user of radio is the Southern with 2,028 mobile and base transmitters for train service and 462 base and mobile units for yard-terminal service. Next is the Missouri Pacific with 1,219 train service transmitters and 31 units in yard-terminal service. It is followed by the Great Northern with 707 train service units and 609 units in yard-terminal service.

## TV Set Concentration Surveyed



Figures recently released give number of tv households by region, state and county

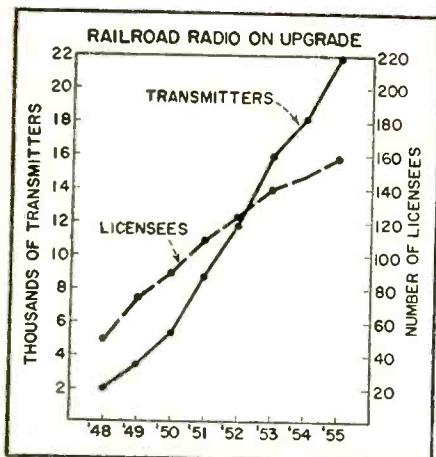
LISTING total households, number of tv households and their percentage, a report by the Advertising Research Foundation will aid the tv industry to formulate future production plans. The figures did not include information on second sets and sets in public places (See ELECTRONICS, p 26, April '56).

► **Regions**—The survey divided the U.S. into four regions. A higher concentration of tv households appeared in the north-central and north-east regions where the percentages ran 72 and 80 percent respectively.

► **City**—Urban tv households ran about 74 percent compared to 67 percent for the nation as a whole. In rural areas, about 46 percent of tv households had one or more sets.

► **Household**—A higher proportion of tv sets were found in households with three, four or five persons compared to the national average. Four-person tv households ran 79 percent.

For the purposes of the survey a household included all persons occupying a dwelling unit such as a house or apartment. Military establishments, rooming houses, hotels and institutions were not included. A tv household was defined as one having one or more tv sets at the time of interview. Sets did not have to be in working order.



## Computer Teams Make More Jobs

Data processing opens several new careers; 170,000 openings seen in 10 years

CARE and feeding of large stored-program electronic computers will become the life work of a rising new group of professional men and women.

The crew at a typical computer installation includes 17 people. Some installations may employ 30 or more. This includes analysts

who adopt computer methods to the firm's operations, programmers who convert business data to computer language, operators and maintenance engineers.

According to IBM there will be about 10,000 stored-program machines in use within the next decade. This means jobs for 170,000 professionally trained people.

► **Training**—Although the universities are offering an increasing

(Continued on page 16)



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Western Electric

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CBS-HYTRON



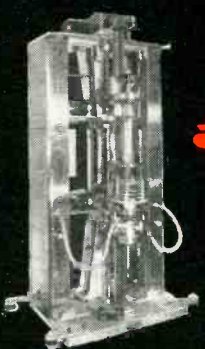
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AUTOMATIC CRYSTAL GROWING  
MACHINE NO. 2650

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First hand, intimate knowledge of the production requirements and techniques in many industries makes Kahle "applications" engineers better able to evaluate your specific production problem.

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number of courses in computer theory and techniques, most computer personnel are trained by computer manufacturers or on-the-job at computer installations.

In the past four or five years, IBM has trained about 400 people. Their customers have trained about 3,000 in the past two to three years to staff machines abuilding. IBM has schools at Endicott and Poughkeepsie, N. Y. and provides training at 14 field locations.

Sperry Rand offers courses in New York and Philadelphia for programmers and maintenance men and a course in fundamentals at several locations throughout the country. Grand total of courses completed in the past three years is 2,551.

► **Background**—Bulk of the programmers and analysts are professional methods people or people with prior tabulating machine experience. Nonetheless, many computer users find it useful to have one or two people with mathematical or engineering training on their staff.

An aptitude test developed by IBM, MIT and the Educational Testing Institute of Princeton has proved helpful in screening applicants for such positions.

► **Installation**—At Pan American World Airways' Long Island City offices three operators running an IBM 705 computer will replace 58 employees presently working on punch-card machines. The displaced people will be absorbed elsewhere in the PAA organization.

The operators will be backed up by five resident IBM maintenance engineers who will give the 705 a one to two-hour workout each morning to detect malfunction or imminent failure. The engineers all have had previous experience on electromechanical equipment and received 10 months training on electronic stored-program machines.

Twenty five top-drawer accounting executives and supervisors from PAA have attended IBM programming schools. This cadre will write programs and integrate the computer into PAA's operations.

## Nonprofit Research Shows Growth

Stepped-up research financed by government and industry boosts the activity

SUBSTANTIAL part of the growing amount of research and development work sponsored by the electronics industry and U. S. industry as a whole is handled by nonprofit research organizations. There are about 40 of the organizations in the U.S. employing over 33,000 engineers and scientists. An estimated \$37.5 million was spent with these foundations in 1951, about 15 percent in electronics, and since then the amount has increased. This is indicated by reports from one organization in the field, Stanford Research Institute.

► **Growth**—From 1948 to 1955, Stanford Research Institute grew from a staff of 25 to nearly 1,200 and its research volume expanded forty-fold. Last year 532 projects were undertaken, 400 for commercial organizations, the balance for government agencies. At least

25 electronics firms were clients and over 15 additional firms in the field are associates of the Institute.

At the end of 1955, contract research was being conducted at an annual rate of \$11.5 million. Revenue for 1955 was \$10.0 million compared to \$7.5 million in 1954, boosting the organization's nine year total to about \$35 million. During 1955, the staff of SRI grew from 914 to 1,163 and 51,000 sq ft of working space was added.

► **Government**—Over half of the total research volume of nonprofit organizations was financed by the U. S. government projects in 1951 and although such research is still an important part of the field, commercial work has increased.

At Stanford, for example, commercial work accounted for about \$5.5 million and government projects about \$4.2 million in 1955 while in 1951 the figures were \$1.8 million and \$1.9 million respectively. Commercial work has surpassed government projects at the Institute since 1954.

## Tubeless Autopilot Flies Light Planes

Under-\$2,000 control unit invades 50,000-plane business executive and private market

A COMPLETE autopilot unit no larger or heavier than a portable

typewriter has been demonstrated in flight, on both single-engine and twin-engine light and medium-weight aircraft, by Federal Telephone & Radio Corp.

Reversing usual design trends,



Autopilot control box mounts on control pedestal of twin-engine Cessna. Pilot is demonstrating adjustment of trim control at left of turn and pitch controls



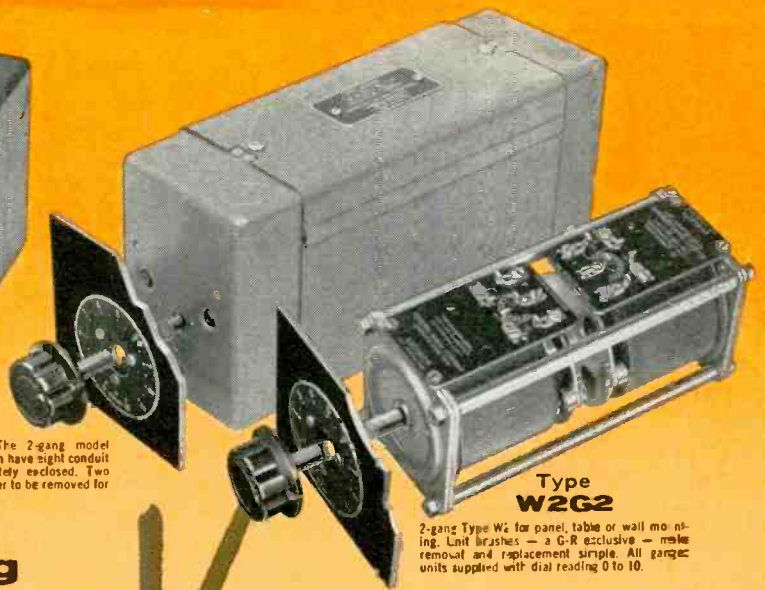
Installing a gyro servo unit in fuselage after removing rear panel of baggage compartment. Cables run from sprocket chains to aileron and rudder controls



**Type W2M**  
 four standard knockouts for conduit or cable connector. Completely enclosed. One screw at top makes terminals available for wiring after unit is mounted.



**Type W2G3M**  
 2-gang enclosed unit. The 2-gang model identical except shifter. Both have eight conduit knockouts and are completely enclosed. Two mounting screws permit cover to be removed for all external connections.



**Type W2G2**  
 2-gang Type W2 for panel, table or wall mounting. Unit brushes — a C-R exclusive — make removal and replacement simple. All ganged units supplied with dial reading 0 to 10.

**Type W2MT**

with carrying handle — to be used in either vertical or horizontal position. Note manually-operated overload reset button and line switch which breaks both sides of the line. Type W2MT3 is identical except line cord is 3-wire grounding type.



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# More NEW VARIAC<sup>®</sup>

## type W2 SERIES

The new W2 Variacs<sup>®</sup> are similar in general construction to the recently announced W5 line except that current and kva ratings are 40% of the Type W5, and their dimensions and weights are materially less.

The basic W2 model has an increased rating of 20% above the Type V-2, which it supersedes.

### FEATURING

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- ★ More Rugged Construction . . . base assembly is made of two identical stamped pieces of wrought-aluminum alloy which is much stronger and more resistant to impact than die-cast types
- ★ Industrial-Type Cased Models completely enclosed in rectangular cases . . . can be panel, behind panel, wall or table mounted . . . 12 ve standard 3/8" knockouts for 1/2" conduit or cable connectors in all models
- ★ Portable Model with built-in, manually-reset overload protector, carrying handle, convenience outlet, line cord and line switch . . . equipped with either 2-wire cord and outlet or

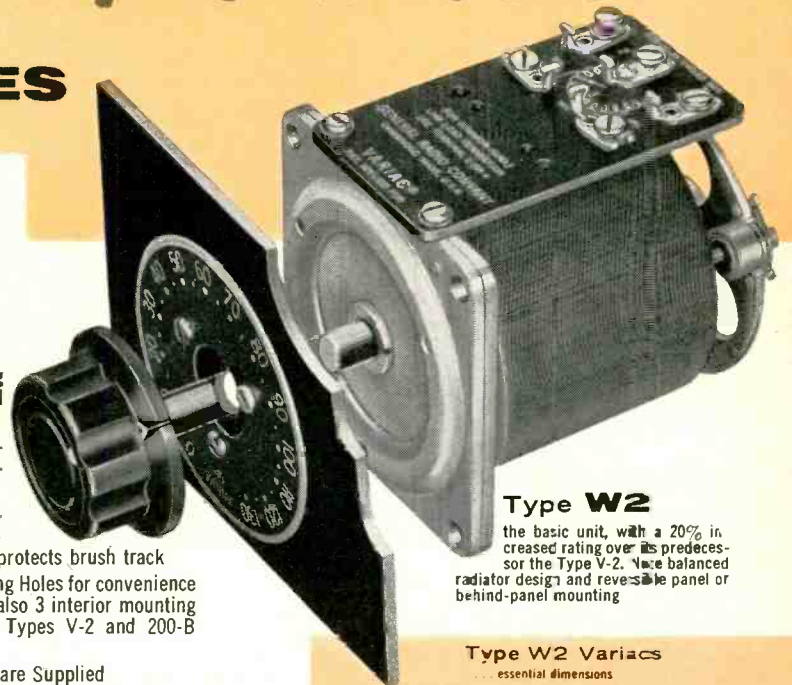
rew 3-wire grounding line cord and 3-terminal plug

➤ Captive and Counter-Balanced Radiator Assemblies

➤ Duratrak Brush Contact Surface (Pat. Pending) . . . disc radiator protects brush track

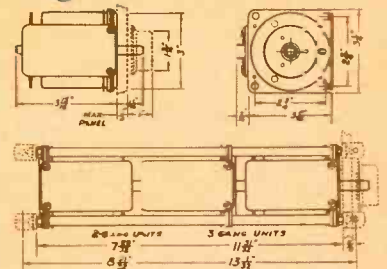
➤ Four Corner Mounting Holes for convenience and extra rigidity . . . also 3 interior mounting holes to match older Types V-2 and 200-B mountings

➤ All Mounting Hardware Supplied



**Type W2**  
 the basic unit, with a 20% increased rating over its predecessor the Type V-2. New balanced radiator design and reversible panel or behind-panel mounting

**Type W2 Variacs**  
 essential dimensions



INPUT		OUTPUT		Type	Price	Description	Dial Calibration
Volts	Max. KVA	Volts	Amperes Rated Max.				
115	0.36	0-115 0-135	2.4 2.4	3.1 2.4	<b>W2</b>	Uncased	0-115 and 0-135
115	0.3	0-115 0-135	2.0 2.0	2.6 2.0	<b>W2M</b>	Case, with conduit knockouts	0-115 and 0-135
115	—	0-135*	2.0	2.0	<b>W2MT</b>	Bench model, enclosed, overload protector, convenience outlet, carrying handle, 2-wire line cord	0-135*
115	—	0-135*	2.0	2.0	<b>W2MT3</b>	Same as W2MT except 3-wire grounded cord terminals	0-135*
230	0.72	0-230 0-270	2.4 2.4	3.1 2.4	<b>W2G2</b>	Two-gang W2, series circuit†	0-10
230	0.6	0-230 0-270	2.0 2.0	2.6 2.0	<b>W2G2M</b>	Two-gang W2 with case, series circuit†	0-10
230	1.25	0-230	2.4	3.1	<b>W2G3</b>	Three-gang W2, 3-phase wye circuit	0-10
230	1.04	0-230	2.0	2.6	<b>W2G3M</b>	Three-gang W2 with case, 3-phase wye circuit	0-10

\*Note — MT models shipped with 0-135 volt output connections. On special order will be supplied with 0-115 volt output and reversible dial plate calibrated 0-115 and 0-135.

†Cannot be used with grounded load

for a Better Buy

Better Buy

**GENERAL RADIO Company**



275 Massachusetts Avenue, Cambridge 39, Massachusetts, U.S.A.

**WE SELL DIRECT**  
 Prices are net, FOB Cambridge or West Concord, Mass.

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Actual size

for airborne applications  
 at **HIGH TEMPERATURES**  
 specify rugged, reliable



**PNP**

fusion-alloy **SILICON**

# TRANSISTORS



The Raytheon Fusion-Alloy Process means superior electrical performance and reliability. It also means that Raytheon PNP High Temperature Silicon Transistors are available *now* in quantities to meet your needs.

Back of that statement is Raytheon's unequalled experience in the production of millions of fusion-alloy PNP Germanium Transistors and Raytheon's new multi-million dollar plant devoted exclusively to mass production of Semiconductors.

All Raytheon Silicon Transistors are aged at 150°C for 100 hours and are cycled between 116°C (steam at 10 lbs. gauge) and minus 60°C.

HERMETICALLY SEALED

0.420" max.  
 0.230" max.  
 0.390" max.  
 0.460" max.

5 4 1

**ABSOLUTE MAXIMUM RATINGS**

Types:  
**CK790 • CK791 • CK793**

Collector Voltage (diode) —100 Vdc  
 Emitter Voltage (diode) —22 Vdc  
 Emitter Current 50 mA dc  
 Collector Dissipation at 135°C 50 mw

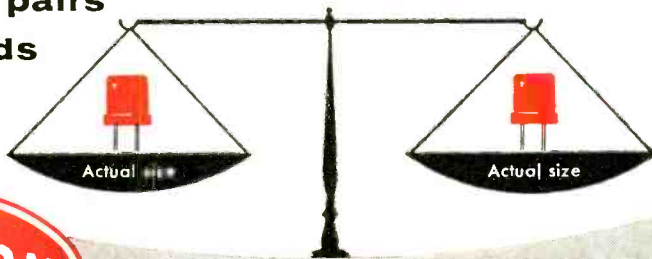
AVERAGE CHARACTERISTICS								
Type	Reverse Current at -20V		Beta	Base Resistance ohms	Collector Resistance kilohms	Noise Factor db (max.)	Collector Capacity μμf	Alpha Freq. Cutoff KC
	Collector μA (max.)	Emitter μA (max.)						
<b>CK790</b>	0.2	0.2	14	1200	500	30	30	400
<b>CK791</b>	0.2	0.2	24	1400	500	30	30	600
<b>CK793</b>	0.2	0.2	16	1300	500	15	30	500

Above characteristics are average except where noted and are taken at I<sub>c</sub> = 1 mA dc; V<sub>c</sub> = -6 Vdc; Ambient temp. 25°C.

**RAYTHEON TRANSISTORS**  
*more in use than all other makes combined*



for **PRECISELY BALANCED**  
matched pairs  
and quads  
specify



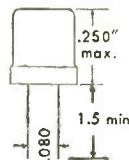
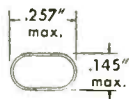
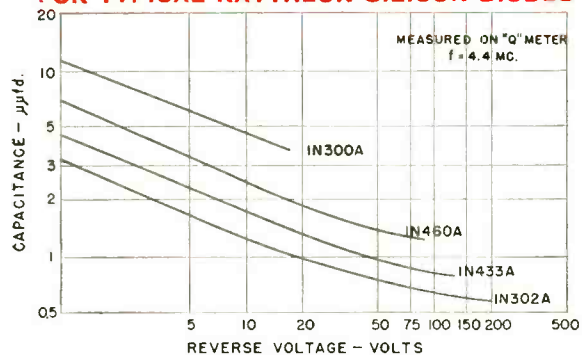
Matched to as close as  $\pm 0.25\%$  at any specified forward current, 25°C — and all matched diodes are stabilized by heat soaking more than 100 hours.

# BONDED DIODES

## RAYTHEON BONDED SILICON DIODES

Type	Peak Inv. Voltage 25°C	Forward Current at +1.0 V (min.) 25°C	Reverse Current at -10 V (max.) 25°C	Reverse Current at specified voltage (max.) 25°C	Rectified Current (max.) 100°C	Rectified Current (max.) 150°C
1N300	15 V	15 mA	.001 $\mu$ A	.001 $\mu$ A at 10 V	40 mA	18 mA
1N300A	15	30	.001	.001 10	50	25
1N432	40	10	.005	.005 10	30	15
1N432A	40	20	.005	.005 10	48	22
1N301	70	5	.01	.05 50	25	12
1N301A	70	18	.01	.05 50	45	20
1N460	90	5	.01	.1 75	25	12
1N460A	90	15	.01	.1 75	40	18
1N303	125	3	.01	.1 100	20	10
1N303A	125	12	.01	.1 100	35	16
1N433	145	3	.01	.1 125	20	10
1N433A	145	10	.01	.1 125	30	16
1N434	180	2	.01	.1 150	18	10
1N434A	180	7	.01	.1 150	25	15
1N302	225	1	.01	.2 200	14	8
1N302A	225	5	.01	.2 200	22	13
CK863	300	1	.01	.3 275	12	6
CK863A	300	3	.01	.3 275	20	8

### CAPACITANCE vs. REVERSE VOLTAGE FOR TYPICAL RAYTHEON SILICON DIODES



HERMETICALLY SEALED



## SEMICONDUCTOR DIVISION

Home Office, Boston: 150 California St.  
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For application information write or call the  
Home Office or:

New York:  
589 Fifth Ave., PLaza 9-3900

Chicago:  
9501 Grand Ave., Franklin Park, TUXedo 9-5400

Los Angeles:  
622 S. La Brea Ave., WEBster 8-2851

SILICON AND GERMANIUM DIODES  
AND TRANSISTORS  
SILICON POWER RECTIFIERS

## RAYTHEON GOLD BONDED GERMANIUM DIODES

Type	Peak Inverse Volts	Forward Volts at 100 mA (max.)	Reverse Current at -10V (max.) $\mu$ A	Reverse Current at specified voltage (max.)	Rectified Current (max.) mA
1N305	60	0.8	2.0	20 $\mu$ A at -50 V	125
1N306	15	0.8	2.0	—	150
1N307	125	1.0	5.0	20 $\mu$ A at -100 V	50

(All data obtained at 25°C)

the unit avoids tubes, transistors or magnetic amplifiers, instead uses standard relays between the sensing switches and the output servomotors. A cam-actuated mechanical feedback system breaks the sensing contacts after each operation.

►**Safety**—Tubeless operation eliminates warmup time, permitting full control immediately after switch-over. A clutch allows the pilot to over-ride the autopilot at any time. Electric power is drawn directly from the plane's 12 or 24-volt battery only when sensing switches call for correction; no other power supply is needed. The gyro operates continuously, but this uses a vacuum line from the engine.

Fail-safe relay contact cross-con-

nections maintain the status quo of the plane if a component fails, giving the pilot time to take over without dangerous hard-over dives.

►**Installed Cost**—Single-engine planes with coordinated aileron and rudder can use a 2-axis unit (17 lb), costing \$1,995. A two-engine plane can use a 3-axis unit (19 lb), priced at \$2,325. Installation costs for both types range from \$500 to \$800 additional.

The gyro servo unit mounts behind the luggage compartment in the fuselage, directly over the control cables of the plane. The turn-bank indicator replaces the conventional unit of this type on the instrument panel. The control unit with its knobs and switches

can be mounted anywhere within reach of the pilot.

►**Market Potential**—Very few of the 48,000 civil aircraft registered today have autopilots, chiefly because of cost and weight. Combined production by Aero Commander, Beechcraft, Cessna and Piper—the big four in the field—is estimated at 5,000 planes for 1956. The current market potential is thus around 50,000 units for a dollar volume of roughly \$100 million, plus \$10 million per year for future production. Much of this will go for the relays, servomotors, electric clutches and gyros used, since assembly involves little more than bolting the units to the open aluminum frame and making connections to a terminal strip.

## Electronics Expands In North Carolina

Missile business leads parade as firms eye southern plant sites

NEED for geographical diversification of critical defense manufacturing of such items as guided missiles has brought about a growing electronics community in North Carolina.

Availability of labor and hydroelectricity and remoteness from smog and possible transpolar ICBM's make the Tar-Heel state appealing as a site for making electronic equipment and parts.

►**Growth**—Since 1947, more than \$70 million has been invested in plants. There are 42 plants in operation or abuilding that will employ about 25,000 workers and encompass more than 5-million square feet of factory area.

In 1939 there were only three electronics plants in North Carolina and these employed only 60 people.

►**Companies**—Western Electric began manufacturing operations in the state in 1946. Foremost products are guidance systems for Nike and other guided missiles.

King-sized electronic plant was built by Douglas Aircraft on the site of the former Charlotte Quar-

termaster Depot. This plant is spawning ground for the Nike.

►**Plants and Products**—A listing of leading electronics manufacturers in North Carolina shows seventeen companies operating or building a total of 28 plants with a total floor area of 5,678,200

square feet. The plants will employ 25,550 workers. Products will include: guided missiles, electronic equipment, communications equipment, electronic parts, capacitors, resistors, batteries, insulated cable, radio and tv cabinets, electron-tube parts, transformers, meters and synchros.



NERVE GAS detector and wide-spaced image orthicon light intensifier are disclosed as . . .



## Army Adds New Techniques

Declassified military equipment for special uses unveiled by manufacturer

THREE new electronic devices for defense were disclosed at the dedication of an RCA plant at Moores-town, N. J.

►**Detector**—A gas detector, to be

used as a field alarm for military personnel, sucks in air and filters it. Chemically impregnated paper tape moves intermittently past one phototube, the air stream and another phototube. Nerve gas in the air discolors the tape, unbalances the phototube currents and triggers bells and lights. Units may be used to protect population and industry.

(Continued on page 22)



# BARRY ADDS NEW WEST COAST FACILITY

## Occupies Plant in Burbank

With its purchase of all physical assets of the United States Sheet Metal Products Company in Burbank, California, Barry Controls Incorporated establishes a Western Division for improved service to the aircraft and missile industry. Operations of the Western Division will include an engineering design section, a shock and vibration test laboratory, a model shop, and production of special designs.

The metal-working facilities of this plant will be used to produce prototypes of vibration-isolating mounting bases and for short-run production of special mounting bases. Stocks of standard isolators will also be maintained here. Barry's present West Coast engineering office will become part of the engineering section of the Western Division.

With the availability of on-the-spot engineering consultation and local model-shop facilities, design and development of complex mounting systems for missiles and jet aircraft will be speeded and valuable lead-time gained for production of prototypes.

# CHIVERS TO HEAD WESTERN DIVISION



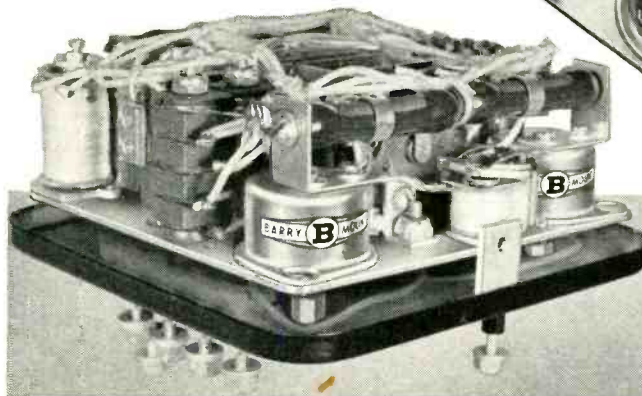
A. S. Chivers, Sales Manager of Barry Controls Incorporated, has been appointed General Manager of the new Barry Western Division. A graduate of Massachusetts Institute of Technology, Chivers joined Barry in 1952 as administrative assistant with the sales department. He was made Assistant Sales Manager in 1953 and Sales Manager in 1955. As General Manager of the Western Division, he will be responsible for the direction of all its activities.

# Here's ALL-ANGL Reliability

*in Minimum Space*

## for JETS and MISSILES

ALL-ANGL Mounts integral with base of relay interlock assembly built by Diaphlex Division of Cook Electric Company for F 86 and F 100.



**The attitude gyro of North American Aviation's F-100 Super Sabre must give reliable indication through every flight attitude — or the pilot won't know which way is up.**

That's why ALL-ANGL Barry Mounts are chosen to protect the delicate sensing relays in the interlock assembly for this vital instrument. Close-tolerance operation in all attitudes demands the certain isolation of vibration — assured by ALL-ANGL Barry Mounts.

### Two added advantages result:

1. Size of the unit is cut 40% by integrating ALL-ANGL mounts, upside down, in the base plate.
2. Short leads replace long cables because the Barry Mounts float the assembly within its case.

When your problem is protection through all flight attitudes, your answer is ALL-ANGL Barry Mounts. Write for data sheets giving detailed information. For recommendations on specific problems, call your nearest Barry Sales Representative.

Barry's Western Division, in Burbank, California, will offer engineering facilities, prototype service, and short-run production of "specials".



F-100 Super Sabre photo courtesy of North American Aviation, Inc.

# BARRY CONTROLS INCORPORATED

## BARRY B MOUNT

SALES REPRESENTATIVES  
IN ALL PRINCIPAL CITIES

707 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS

► **Orthicon**—Detection of light at levels of between  $10^{-3}$  and  $10^{-4}$  foot-candles, corresponding to a cloudy moonlit night, is accomplished with a new image orthicon by increasing certain element spacing. The unit plugs into a tv camera and may be used for night sentry duty by the military.

► **Microphone**—A noise-canceling microphone and headset provide communication at in-plane noise levels around 120 db with a 25-percent increase in word intelligibility over previously available equipment. Noise discrimination is obtained by exposing both sides of the microphone diaphragm to sound thereby canceling its output. Sound close to the microphone, as from the lips, puts more pressure on one side than the other, producing output. Units may also be applied to industries with high noise levels.

## College Radio Comes Of Age

Ivy League campus network time sales show big increase in year

STUDENTS at Brown University in Providence, R. I., founded in 1935 what is now known as college radio. Since then, many another campus has been wired for carrier-current transmission of radio programs that can be picked up on ordinary receivers.

► **Network Affiliation**—In 1948, a number of the northeast college radio stations banded together to form The Ivy Network Corporation. Through this organization, Ivy League stations are able to supplement local advertising revenues with national sponsorship.

The college groups involved include: Brown, WBRU; Cornell, WVBR; Dartmouth, WDDB; Harvard, WHRB; Pennsylvania, WXPB; Princeton, WPRU and Yale, WYBC. By comparison with commercial revenues, Ivy Network's sales of \$40,000 during the last year are merely peanuts. The important aspect is that they represent a 56-percent increase over 1954 sales.

## Radio Astronomy Makes Strides

Lag in our celestial search development gets push as radio telescopes increase

MISSILE guidance, which has fostered scientific research from development of tiny infrared detectors to measuring the exact circumference of the earth, may be adding impetus to development of radio astronomy. Several recent papers have suggested a celestial guidance system based upon radio signals from interstellar space.

Early this year, President Eisenhower called for additional funds to build a major radio astronomy center. He proposed that the appropriation of the National Science Foundation be increased from \$16 million in fiscal 1956 to \$41 million in fiscal 1957. This would provide \$7 million for construction of facilities for basic scientific research including the center.

► **Lag**—Although the foundations for radio astronomy were laid in the U. S. by the late Dr. Karl G. Jansky of Bell Laboratories who discovered radio waves from outer space in 1931, the U. S. has not led in this field.

England has become a world center of the science and has a number of installations in operation. The largest is at Jodrell Bank Experimental Station of the University of Manchester where a large parabolic radio telescope is under construction. It has a 600-ton bowl, 250 feet in diameter and 62.5 feet deep at the focus.

The Jodrell center also has several radio telescopes 20 feet to 35 feet in diameter and a 225-foot fixed type in operation. At other centers in England there are several 24-foot radio telescopes in operation and a large interferometer array.

► **U. S.**—A large parabolic radio telescope now in operation in the U.S. is Harvard Observatory's 60-foot parabola that was dedicated in April. The big dish supplements the University's 24-foot unit. The 50-foot unit at the Naval Research



Harvard University's new 60-foot radio telescope

Lab in Washington, D. C. is another large U.S. instrument.

Within another year the Harvard unit may be exceeded in size by two 90-foot parabolas at the California Institute of Technology. The school recently began operation of a new 32-foot parabolic reflector. Its radio astronomy program has support in excess of \$400,000 from the Office of Naval Research. Another 32 foot unit is also planned for next year.

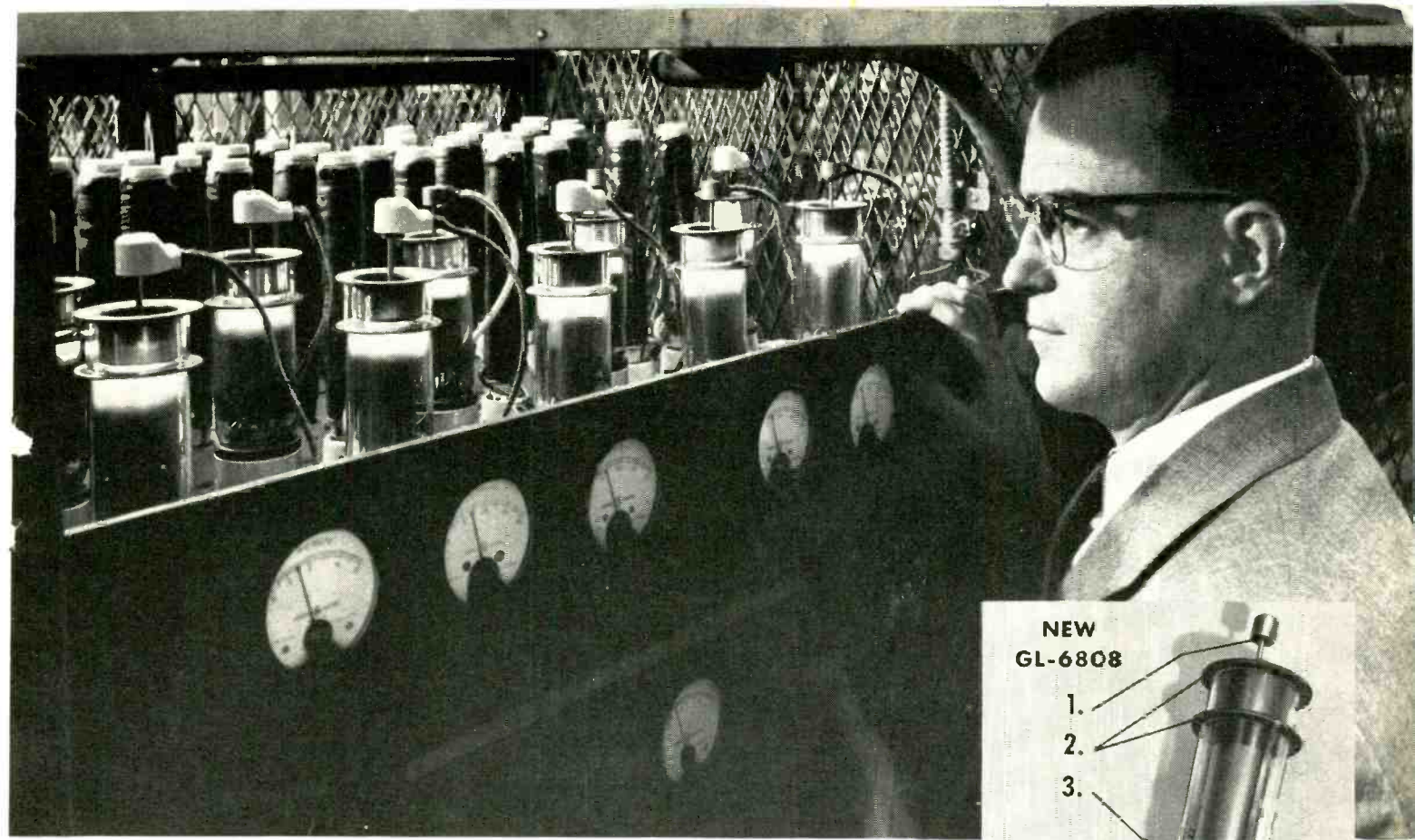
Eventually, these telescopes will be exceeded by a parabolic type with a diameter of 140 feet. It is reported that a U. S. radio telescope with a diameter of 500 to 600 feet is contemplated.

Other parabolic units in operation in the U. S. include a 24 footer at the Carnegie Institution, a 24-foot at Cornell University and a 24-foot unit at the Bureau of Standards in Boulder, Col. Ohio State University has announced that construction will begin late this spring on a reflecting type radio telescope with an eventual size of 700 feet in length by 75 feet high. Also, the University of Michigan is planning a 28-foot radio telescope and other telescopes of comparable size are planned in New Mexico and Alaska. Stanford Research Laboratory also has a sizable radio astronomy program underway.

► **Other Countries**—In the Netherlands, there are two 24-foot para-

(Continued on page 24)





A. W. COOLIDGE of General Electric, design engineer on thyatron tubes, checks a bank of the new thyatrons shown operating on extended life test.

## Warranty hours increased 166% on new G-E thyatrons that replace Type 5545!

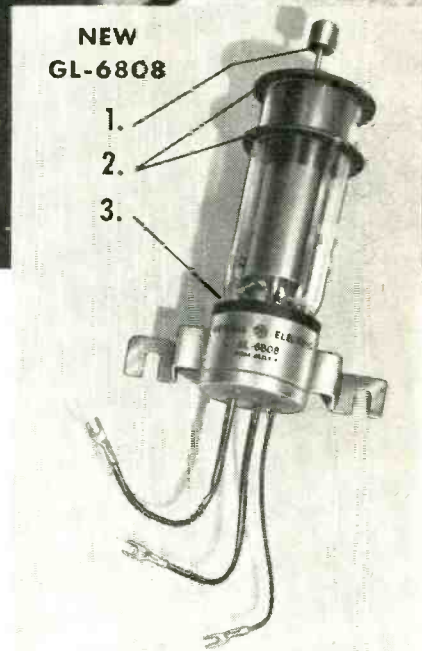
CONCLUSIVE life-test results back up General Electric's 8000-hour warranty of the new GL-6808 and GL-6809 motor-control thyatrons. Predecessor Type 5545 carried only a 3000-hour warranty.

Radically improved tube features account for the increased dependability and long life that have been proved in tests of the new thyatrons. Check the illustration of the GL-6808 at right for three of these advancements in design!

As important as the new tube features, are General Electric im-

provements in metal-glass bonding and other manufacturing processes that bring a *lower tube price*. For . . . in addition to a warranty nearly tripled in hours, increased ruggedness, far greater reliability . . . General Electric's new long-life thyatrons come to you at a price which is substantially less than that of Type 5545!

Ask for full particulars! If you wish, a G-E tube engineer will be glad to consult with you on specific motor-control applications. *Tube Department, General Electric Company, Schenectady 5, N. Y.*



1. Anode terminal is brazed solidly to the lead, won't come off.
2. Outside air cools anode and grid by direct thermal contact; prevents tube overheating, keeps down grid emission.
3. New, strong cement anchors cathode base firmly in place.

GL-6808, shown above, is bracket-mounted, with flying-lead base terminals. GL-6809, below, has spade-lug terminals. A third new type—GL-6807—has pin terminals. Tube design and construction of all three types are identical; ratings same as Type 5545.



*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

162-184

bolos and a new 80-foot parabola in operation. In Australia, the Radio Physics Lab at Sydney has several units in the 20 to 36-foot range and is starting design of a 200 to 250-foot parabola.

France has two radio telescopes of 20 and 35 feet in diameter in operation. In Germany an 80-foot parabola is planned or under construction. It is believed that several up to 20 feet in diameter are operating in the U. S. S. R.

There are radio telescopes in a few other countries. Some are con-

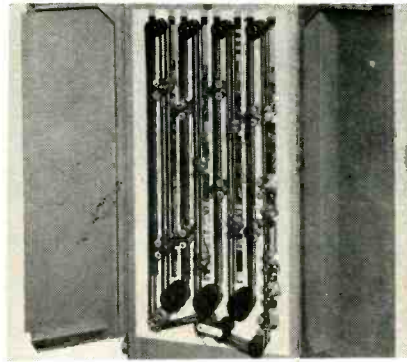
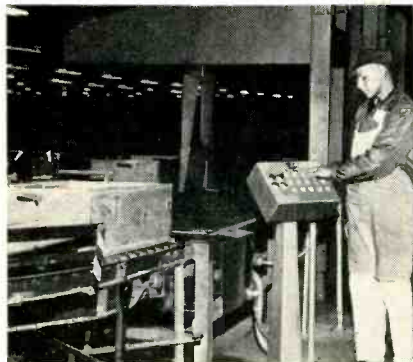
verted from abandoned German radar antennas of World War II.

► **Cost** — A 30-foot parabola, all mounted, costs about \$40,000, a 60 to 80 footer from \$150,000 to \$200,000 and a high-precision 150 footer from \$2.5 million to \$3 million. Some companies in the electronics field have garnered a substantial share of this business. D. S. Kennedy & Co. in Massachusetts is a supplier of radio telescope antennas and is building several for operation in the U. S.

veyor and tape are in synchronization, but the tape is geared down 6-to-1 so that the conveyor speed of 48 feet per minute is represented by a tape speed of only eight feet per minute.

Longest conveyor systems are 500 and 750-foot systems at Hill AFSD, Ogden, Utah.

To enable the system to handle more than one discharge conveyor, five recording heads—one head for each discharge conveyor—are lined up across 35-mm tape. Each head has its own channel on the tape.



OPERATOR pushes button to instruct magnetic tape unit, right, where to discharge box as . . .

## Original Documents Feed Computers

Data readers and encoders may supersede card punches as computer input devices

ONE bottleneck in application of computers to business is feeding data to the machines. It still requires a battery of typists to prepare punched cards which are then fed to card-to-tape converters as a first step in electronic data processing.

► **Dot Patterns**—The Stanomatic, used for more than a year at the First National Bank of Chicago where it helps reconcile 20,000 to 30,000 travelers checks daily, provides an approach to the problem. Standard Register of Dayton, Ohio is readying an updated Stanomatic for the First National.

The unit senses check number, amount and agent bank. Data is recorded on the check as code dots at the time the check is imprinted with the name of the agent bank. The presence or absence of code dots in a predetermined pattern stands for numbers 0 to 9. To determine whether dots are present or not the machine uses a bank of sensing heads each of which uses a balanced-bridge circuit.

The new machine will use over 1,000 electron tubes and will handle 15,000 decimal digits a minute. Besides reconciling travelers checks, the device can be used to keep track of airline tickets or department-

(Continued on page 26)

## Tape Controls Materials Handling

Air Force adopts tape controlled conveyor system to speed warehousing

SEVEN Air Force supply depots have adopted a magnetic-tape-controlled conveyor system that automatically discharges packages in any desired sequence at from two to 20 stations. The system has resulted in savings of more than \$100,000 a year per unit.

Called ASSET, Automatic Selected Station Electronic Timer, the units have been developed and installed by A. J. Bayer Co. of Los Angeles, conveyor manufacturers.

Some 35 units are in operation. They have reduced time necessary to handle a typical warehouse job from 40 hours to four or five hours.

► **Sequence**—When the operator decides the area of the warehouse

to which a package should go, he pushes a selector button for the branch conveyor leading into that area. This energizes the recording head in that conveyor's tape channel.

As the package passes a photocell at the timing line, an impulse is automatically recorded in the selected channel. As the package progresses down the main conveyor, the impulse on the tape moves toward the playback head. When the package reaches its discharge point the tape signal trips a relay operating a pneumatic pusher which sweeps the package off the main conveyor onto the discharge conveyor.

► **How It Works**—The system consists of a magnetic-tape scale model of the actual conveyor layout. An endless loop of magnetic tape represents the conveyor belt. The con-



When you need the very best...



## the **HAMMARLUND** SP-600-JX COMMUNICATIONS RECEIVER

When requirements for performance, dependability and accuracy are most critical, you need the very best — the Hammarlund SP-600-JX Communications Receiver.

The SP-600-JX is designed for professional reception of AM radio telephone, CW telegraph, AM-MCW telegraph signals, and for diversity applications in the range of 0.54 MCS to 54 MCS. It may be used with either earphones or loudspeaker. Output is approximately 2.0 watts. The SP-600-JX has negligible radiation making it ideal for multi-receiver installations and complying with requirements for shipboard installations.

There are so many fine, and outstanding features about the SP-600-JX only the complete technical specifications can tell its unusual story of outstanding performance. Everything that can be done to provide the very best in communications receivers has been done in the SP-600-JX.

*For complete technical information,  
write for Bulletin E656.*



Established 1910

**HAMMARLUND MANUFACTURING COMPANY, INC.**, 460 West 34th Street, New York 1, N. Y.  
INTERNATIONAL DIVISION: 13 East 40th Street, New York 16, N. Y.

### **PERFORMANCE!**

- **Sensitivity**—2.3 uv or better at all frequencies within range of receiver
- **Signal-to-Noise Ratio**—10 db at 20 milliwatts output with RF gain at maximum
- **Image Rejection Ratios**—better than 74 db throughout frequency range
- **IF Rejection Ratio**—at 600 KCS: 2700 to 1
- **AVC Action**—maintains output constant within 12 db when input is increased from 2 to 200,000 uv

store purchases and transactions.

► **Magnetics**—Also in the banking business is ERMA, built by Stanford Research Institute for California's Bank of America. ERMA reads as numbers bars printed in magnetic ink across the backs of checks. The device has 8,200 electron tubes and keeps track of 55,000 commercial checking accounts.

ERMA will be made General Electric's new industrial computer section. New models will incorporate transistors.

The Postronic bookkeeping machine developed by National Cash Register also operates from magnetic-ink patterns on the backs of business forms. NCR has plans for regular production this year.

► **Other Systems**—Burrhoughs has field tested a photoelectric device that reads printed characters directly. Similar machines have been built up by Intelligent Machines and by Laboratory For Electronics. Burrhoughs is also working on a machine that senses a coded phosphorescent-dot pattern on the original documents. IBM is working on direct character reading of symbols printed with magnetic ink.

► **Computer News**—Guided missiles gave emphasis to much computer activity this month. Logistics Research of Redondo Beach, Calif. delivered an ALWAC medium-sized computer to North American. Production for the year will be 24 machines.

Berkeley division of Beckman Instruments has a \$700,000 contract to deliver 14 special digital computers to various Convair locations for handling guided missile test data.

Burrhoughs has announced that it is making ground computers for the guided-missile program.

An all-transistor digital differential analyzer is under development at Stevens Institute of Technology in Hoboken. The unit will be used at the school's towing tank to study design of ships, aircraft and guided missiles.

The unit will supplement, and be about 250 times as fast as, the ETT-100, an electron-tube computer built at the school.

**FUTURE MEETINGS**

**JUNE 4-6:** Second Annual Radome Symposium, Ohio Union, Ohio State University, Columbus, Ohio.

**JUNE 5-6:** Radio Technical Commission for Aeronautics, Spring meeting of Assembly, with Boston sections of IRE and IAS, Statler, Boston.

**JUNE 6-8:** Tenth Annual Convention, American Society for Quality Control, Montreal.

**JUNE 11-15:** Seventh National Plastics Exposition, Coliseum, New York, N. Y.

**JUNE 17-23:** Second International Congress On Acoustics, Harvard, MIT, ASA, Cambridge, Mass.

**AUG. 20-21:** National Telemetering Conference, IRE, AIEE, IAS, ISA, Biltmore Hotel, Los Angeles, Calif.

**AUG. 21-24:** 1956 Western Electronic Show and Convention, Pan-Pacific Auditorium, Los Angeles, Calif.

**AUG. 22-SEPT. 1:** The 23rd Annual British National Radio Show, Earls Court, London.

**AUG. 24-26:** Seventeenth Annual Summer Seminar, IRE, Emporium, Pa.

**SEPT. 10-12:** Information Theory Symposium, IRE, MIT, Cambridge, Mass.

**SEPT. 11-12:** Second RETMA Conference on Reliable Electrical Connections, University of Pennsylvania, Philadelphia.

**SEPT. 14-15:** Sixth Symposium, Mellon Institute, Pittsburgh.

**SEPT. 17-21:** Eleventh Annual International Instrument-Automation Conference and Exhibit, ISA, New York Coliseum, New York, N. Y.

**SEPT. 24-25:** Industrial Electronics Conference, IRE, AIEE, Hotel Manger, Cleveland, Ohio.

**SEPT. 26-30:** New York High Fidelity Show, New York Trade Show Building, New York.

**OCT. 1-3:** IRE Canadian Convention, Automotive Bldg. Exhibition Park, Toronto.

**OCT. 1-3:** Twelfth Annual National Electronics Conference, Hotel Sherman, Chicago.

**OCT. 8-9:** Second National Symposium on Aeronautical Communications, IRE, Hotel Utica, Utica, N. Y.

**OCT. 9-10:** Third Annual Computer Applications Symposium, Armour Research Foundation, Chicago, Ill.

**OCT. 10-12:** Symposium On Applications of Optical Principles to Microwaves, IRE, George Washington University, Washington, D. C.

**OCT. 15-17:** Radio Fall Meeting, IRE, RETMA, Hotel Syracuse, Syracuse, N. Y.

**OCT. 16-18:** Conference On Magnetism & Magnetic Materials, IRE, AIEE, APS, AIMME, Hotel Statler, Boston, Mass.

**Industry Shorts**

► **RETMA** in response to requests from electronics manufacturers, officially defines automation as "the technique of improving human productivity in the processing of materials, energy and information by utilizing, in various degrees, elements of self-control and of automatically executed product programming".

► **Thompson Products** officially revealed that its affiliate, Ramo-Woolridge, is technical director for the Air Force intercontinental and intermediate range ballistic missile program.

► **Data Inserter**, developed by Skiatron, permits an operator to superimpose data upon an incoming radar image for transmission simultaneously over a telephone line.

► **Puerto Rico's Economic Development Administration** in New York now offers U. S. electronics companies a manufacturing cost analysis comparing Puerto Rico with any other site named, without cost or obligation.

► **Nearly** a third of the 14.9 million radios sold in 1955 were replacements for older, worn out sets, according to CBS-Columbia.



# Now...

## A 50 Megacycle Vacuum Tube Voltmeter and Video Amplifier

with the new

# KAY

## Microtter

### SPECIFICATIONS

**Frequency Range:**

100 cycles to 50 megacycles.

**Direct Reading In Voltage Or Decibels.**

**Accuracy:**

± 5% of full scale reading.

**Freq. Response:**

± 1db.

**Voltage Range:**

1 millivolt to 1 volt full scale in 7 ranges.

**Sensitivity:**

Will measure down to 250 microvolts.

**Input Impedance:**

Capacitance 5 micromicrofarads, resistance loading dependent upon frequency (1 megohm at 1 megacycle to 30,000 ohms at 50 megacycles).

**No Tuning**

May also be used as a wide band video amplifier, maximum output approximately 0.5 volts at 75 ohms. Gain of over 45 db.

**Price:**

Model 50: \$495. FOB Plant.

WRITE FOR NEW KAY CATALOG



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Through the use of a unique new design, the new Kay Microtter permits measurement of extremely low voltages at frequencies higher than all existing vacuum tube voltmeters — yet reduces all steady state changes and line voltage variations.

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The Microtter permits complete ease of operation by most personnel. No tuning is required and the meter is direct reading. A single 7-position switch provides *full scale* steps of 1, .3, .1, .03, .01, .003, and .001 v., with the lowest reading at 250 microvolts!

A high impedance probe employing a subminiature tube as a cathode follower is used to drive the wide-band amplifier. The resistive component of the impedance for low frequencies is approximately 1 megohm, decreasing progressively with frequency to 30,000 ohms at 50 megacycles. Probe may be soldered to unit under test.

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In addition to the 28 volt models featured at the right, the following units are also available:

**OTHER 28 VOLT MODELS**

Model	Volts	Amps	Reg.	AC Input (60 cps)	Ripple rms
28-5VFM	0-32 V	5	20% (24-32 V range)	115 V 1 phase	2%
28-10WX	24-32 V	10	± 1/2%	100-125 V 1 phase	1%
28-15VFM	0-32 V	15	20% (24-32 V range)	115 V 1 phase	5%
28-50WX	24-32 V	50	± 1/2%	230 V* 3 phase	1%
MR2432-200	24-32 V	200	± 1/2%	230 V* 3 phase	1%
MR2432-300	24-32 V	300	± 1/2%	230 V* 3 phase	1%
MR2432-500	24-32 V	500	± 1/2%	230 V* 3 phase	1%

\* ± 10%. Also available in 460 V ± 10% AC input. Will be supplied with 230 V input unless otherwise specified.

**6, 12, 115 VOLT (NOMINAL) MODELS**

Model	Volts	Amps	Reg.	AC Input (60 cps)	Ripple rms	
6 Volt	6	5	± 1%	95-130 V 1 phase	1%	
	6-5WX					± 10%
	6-15WX					± 10%
12 Volt	6	15	± 1%	95-130 V 1 phase	1%	
	6-40WX					± 10%
115 Volt	12	5	± 1/2%	95-130 V 1 phase	1%	
	12-15WX					± 10%
	115-17WX					± 10%
MR15125-5	15-125	5	± 1%†	95-130 V 1 phase	1%†	
G125-25**	115-125	25	1 1/2-4%	230/460 V 3 phase	5%	

\*\*Germanium Rectifier Unit †increases to 2% @ 15 V.

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Model MR532-15A

**2-36 VOLTS @ 15 AMPS SPECIFICATIONS**

Regulation: 5-32 Volt Range: ± 1/2%  
2-5 Volt and 32-36 Volt Range: ± 2%  
AC Input: 105-125 Volts, (for 2-32 V.DC), 110-125 V, (for 32-36 V.DC), 1 phase, 60 cps (8 amps)  
Ripple: 1% rms max. (@ 36 volts and full load. Increases to 2% @ 2 volts and full load).

Remote Sensing • Vernier Control



Model M60V

**0-32 VOLTS @ 25 AMPS SPECIFICATIONS**

Regulation: ± 1% @ 28 Volts (Regulation Increases to 2% over range of 24-32 volts; does not exceed 2 volts over 4-24 volt range. Not stabilized for AC line changes.)  
AC Input: 115 Volts, 1 phase, 60 cps (12 amps).  
Ripple: 1% rms (@ 32 volts and full load - 2% rms max. @ any voltage above 4 volts).



Model MR1040-30A

**5-40 VOLTS @ 30 AMPS SPECIFICATIONS**

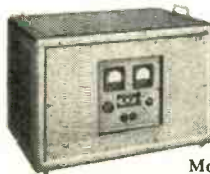
Regulation: ± 1% (over entire 5-40 volt range)  
AC Input: 100-130 Volts, 1 phase, 60 cps  
Ripple: 1% rms



Model 28-30 WXM

**24-32 VOLTS @ 30 AMPS SPECIFICATIONS**

Regulation: ± 1/2%  
AC Input: 100-125 Volts, 1 phase, 60 cps (20 amps). (Unit rated for DC output of 28 volts ± 10% for 95-130 volt input.)  
Ripple: 1% rms



Model MR2432-100XA

**24-32 VOLTS @ 100 AMPS SPECIFICATIONS**

Regulation: ± 1/2%  
AC Input: 208, 230 or 460 Volts, ± 10%, 3 phase, 60 cps (14, 12 and 6 amps respectively). 230 volt input will be supplied unless otherwise specified.  
Ripple: 1% rms

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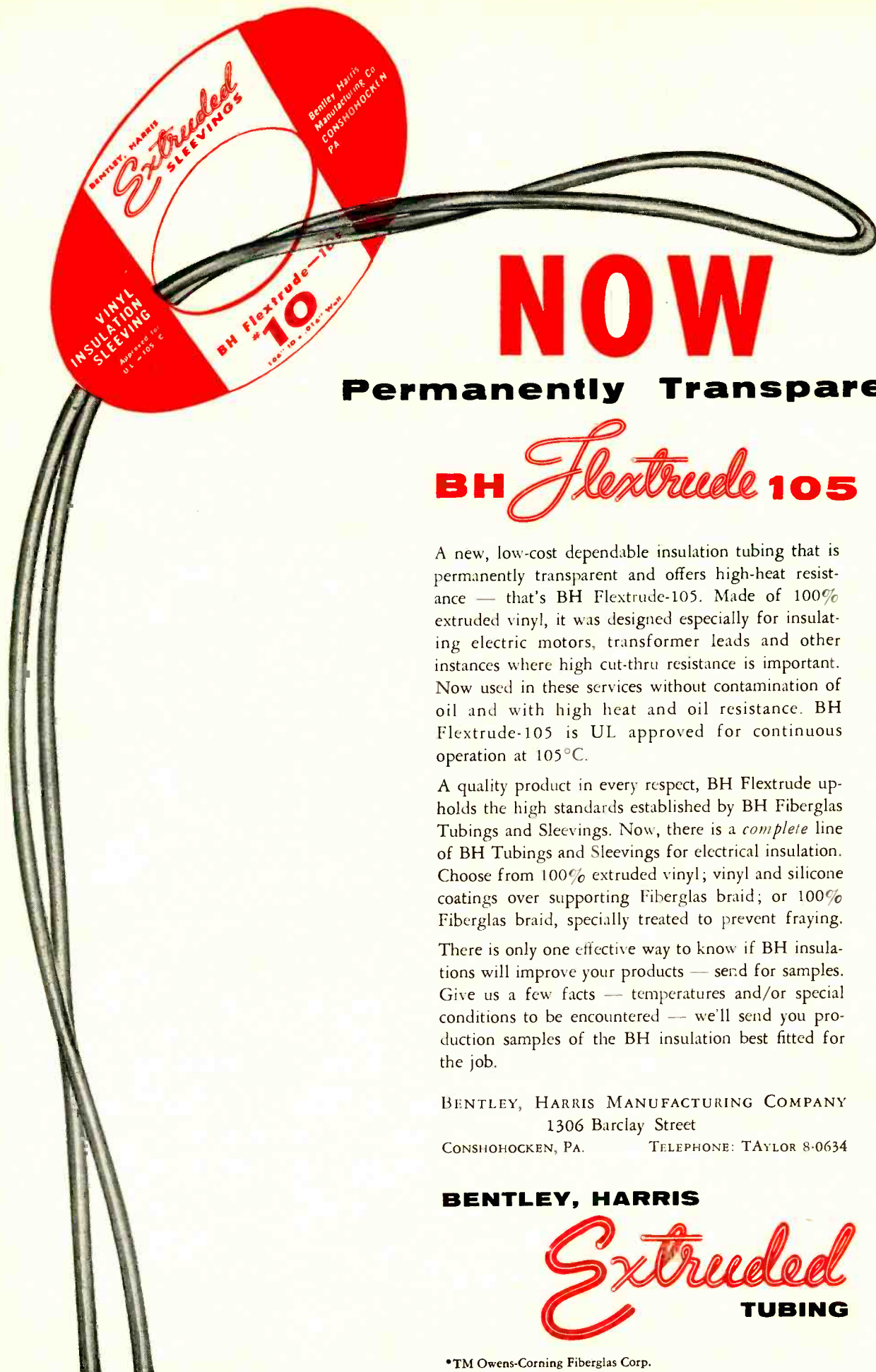
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- ✓ Better Circuit Identification
- ✓ More Beautiful Panels

# 5

### ways better

Hex thumb nut with insert captive with stud.

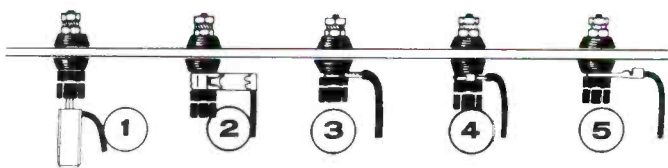
Panel insulator of durable phenolic, molded over brass core frozen to center shaft. Flatted insert for locking to panel.

Twin Hexagonal 10 x 32 brass nuts.

Hole in center shaft for wire up to size No. 12.

Sliding panel-mounted insulator. Flatted insert for locking to panel.

### ways to bind



1 Plug-in for standard 3/4" banana plug

2 Clip-lead to shaft

3 Wire looped around shaft and clamped

4 Wire (up to No. 12) permanently clamped through hole

5 Clamped spade lug connection

The SUPERIOR 5-WAY Binding Post has been the first choice of electrical and electronic equipment designers because it provides flexibility, rugged construction, and assurance of complete insulation. Now you have your choice of SUPERIOR 5-WAY Binding Posts in 5 colors that will help you design more beautiful panels and will aid in easy circuit identification. Write for Bulletin BP456.

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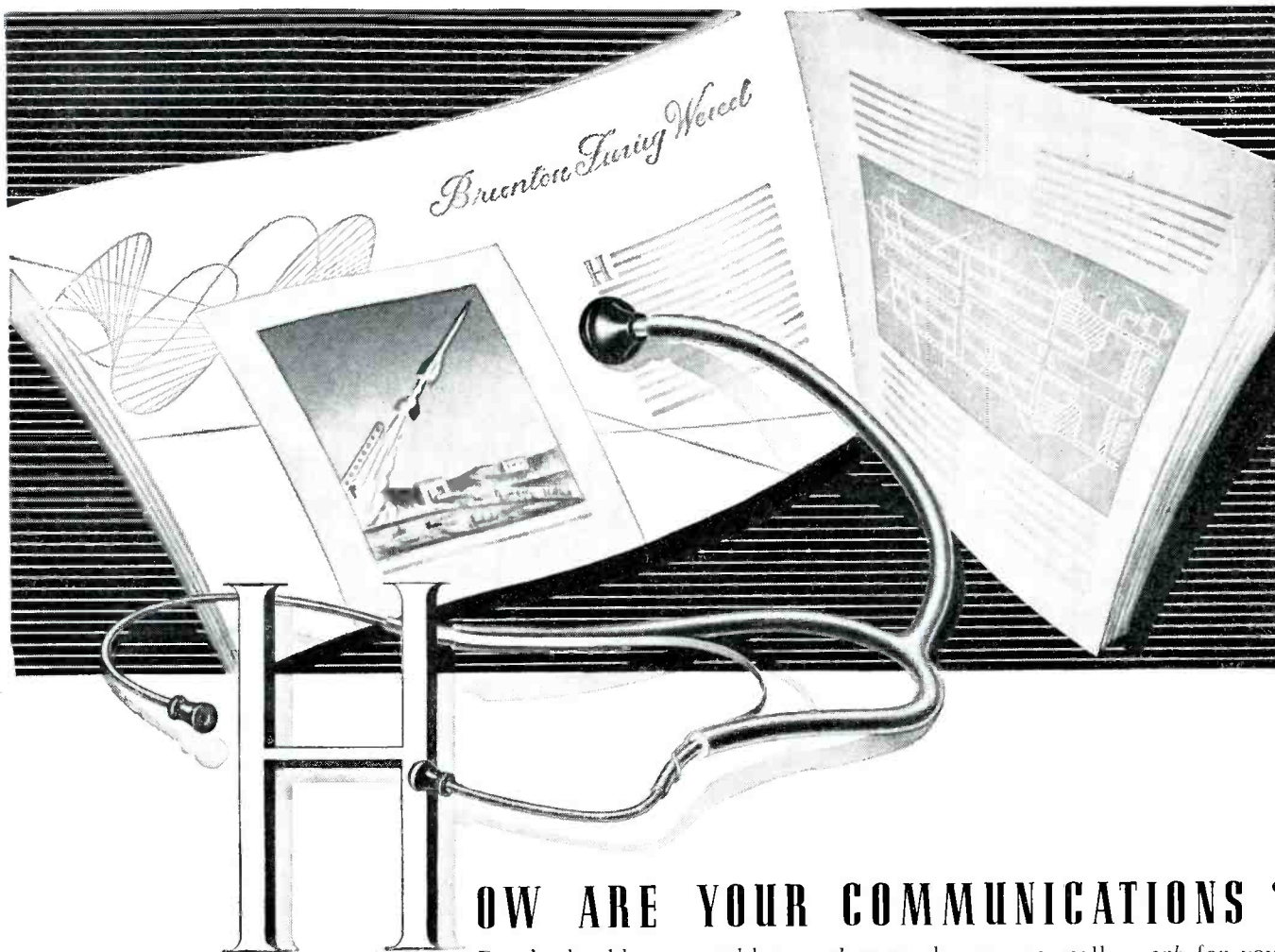
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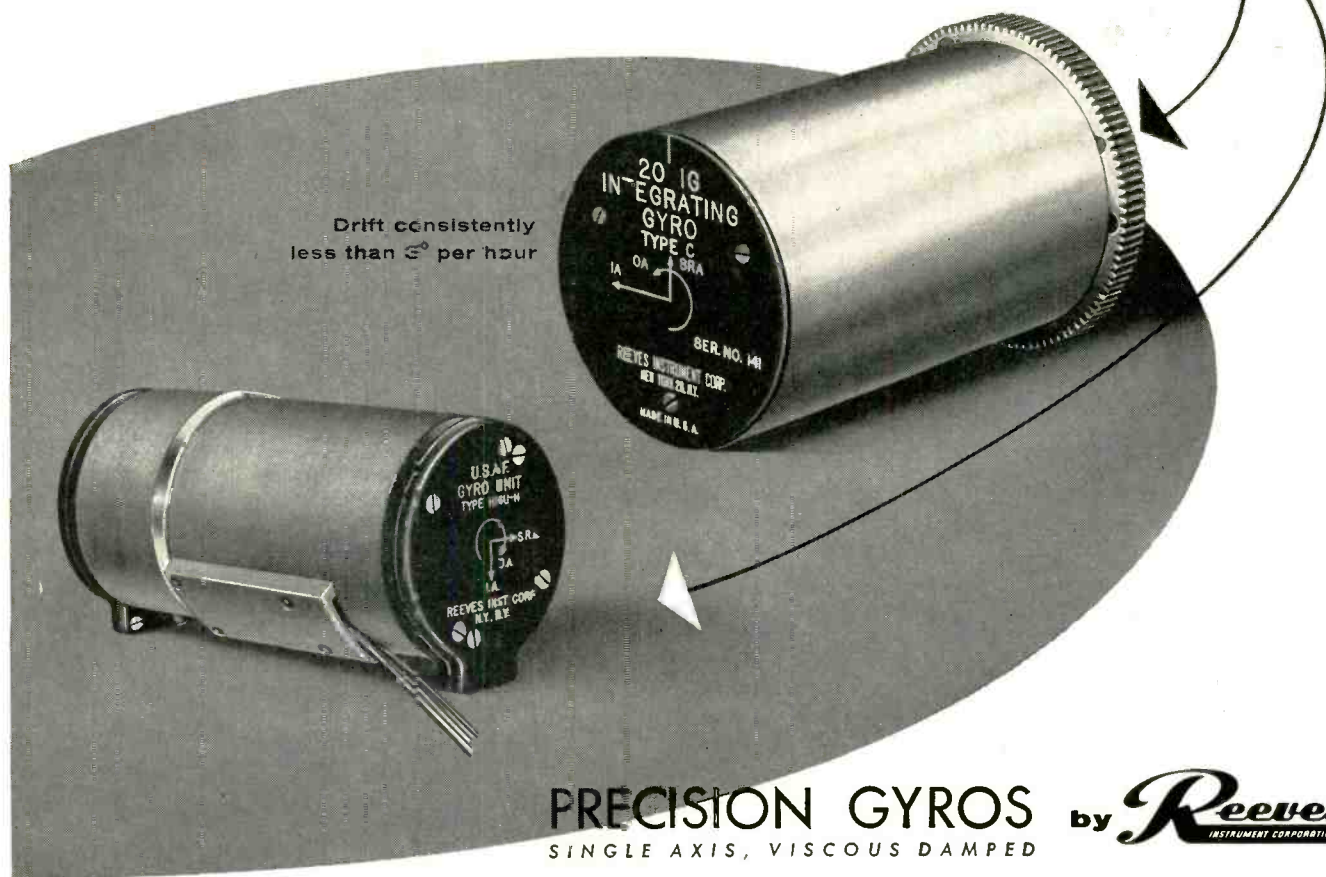
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# reduce costs

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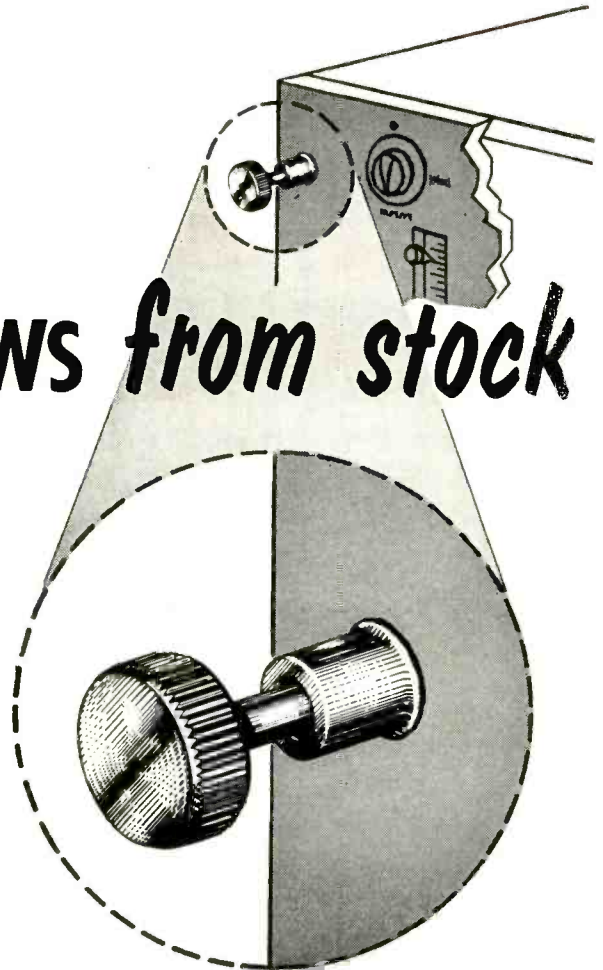
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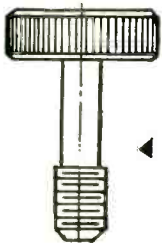
"Floating" screw insures easy alignment no matter how many screws are engaged in a single panel. No special skills or tools needed; installation fast and simple.

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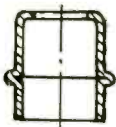
Write for complete information. Southco Division, South Chester Corporation, 233 Industrial Highway, Lester, Pa.



### 3 SIMPLE COMPONENTS



← SCREW



← STAND-OFF



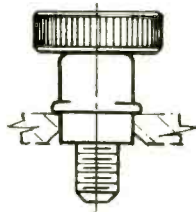
← RETAINING RING

#### EASILY INSTALLED

Stand-off is flanged into panel. Screw is inserted into oversize hole in stand-off and locked in place by retaining ring, which is passed over threads to seat behind last thread.

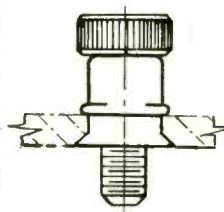
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#### LARGE HEAD ( $\frac{3}{4}$ " diameter)



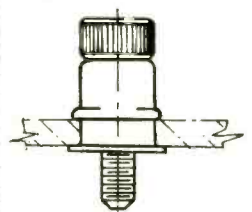
$\frac{1}{4}$ "-20 thread

#### MEDIUM HEAD ( $\frac{1}{2}$ " diameter)



$\frac{1}{4}$ "-20 and  
12-24 thread

#### SMALL HEAD ( $\frac{1}{8}$ " diameter)



10-24 thread

Screw and stand-off are brass, nickel plated. Retaining ring is durable vinyl plastic.

Choice of stand-offs for each screw size to accommodate panel thicknesses from  $\frac{1}{16}$ " to  $\frac{1}{4}$ ".

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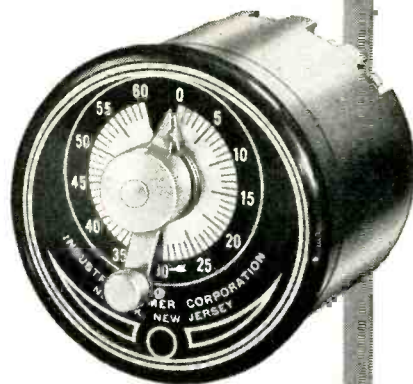
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# need quick service on **TIMERS** for automatic control?



Time Delay Timers

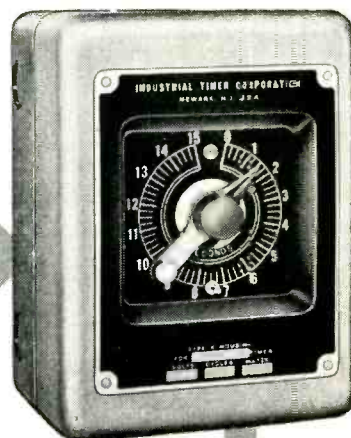
**T**he more automatic control problems we get, the better we like it. For while it's true each automatic control job is a bit different from the rest, the record shows that our 19 years of timer experience has given us the special knowledge it takes to give you the right answers, and in near-record time.

If one of our standard timers won't do your job — or one of the 721 combinations we have thus far developed from our 17 basic units — our engineers will go right to work to develop a new combination that's the one for you. That's the way we grow — and we like it.

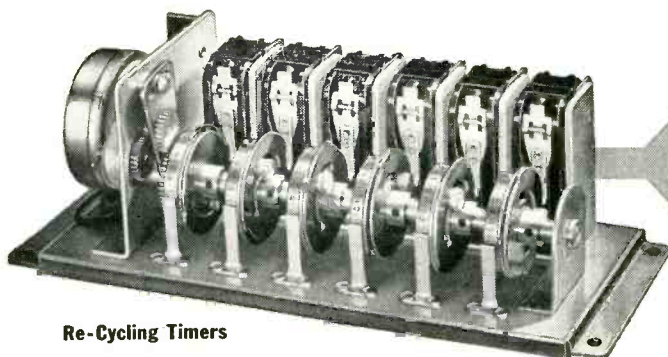
We manufacture a complete line of timers in these 4 broad classifications:

**TIME DELAY TIMERS • INTERVAL TIMERS  
RE-CYCLING TIMERS • RUNNING TIME METERS**

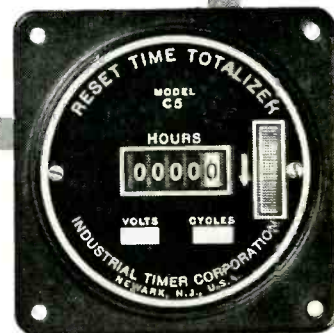
And since we maintain large stocks of our 17 basic units, we can assure you of rapid deliveries — of excellent deliveries even on special orders. So whatever your automatic control problem, you have everything to gain by submitting it to our timer specialists. They'll give you a profitable answer — almost with the speed of automatic control itself.



Interval Timers



Re-Cycling Timers



Running Time Meters

*Timers that Control  
the Pulse Beat of Industry*



**INDUSTRIAL TIMER CORPORATION**

1409 McCARTER HIGHWAY, NEWARK 4, N. J.





- This is a partial list of Lear products. It shows at a glance why Lear offers exceptional opportunities to the ambitious engineer, fledgling or veteran. The great variety of Lear projects —plus a constant, soundly-programmed expansion of *new* developments—assure you of plenty of room to grow in, as well as ample rewards at the very start of your career with Lear.

## Engineers...look before you leap!

### § flight control systems

- Automatic altitude controllers
- Automatic approach couplers
- Automatic Mach number controllers
- Automatic pilots (lightplane)
- Automatic pilots (high-performance)
- Automatic pitch, yaw, and roll dampers
- Automatic rudder controllers
- Automatic wing flap systems
- Missile control systems
- Test equipment

### σ flight reference systems

- No-gimbal-lock vertical gyro indicators
- Stable platforms
- Test equipment
- Three-axis gyro indicators
- Vertical gyro indicators

### γ navigational systems

- Automatic radio direction finders
- Glide slope receivers
- High-latitude gyro compass systems
- Integrated ADF-magnetic compass systems
- Localizer receivers
- Marker beacon receivers
- VHF Omnitrange receivers

### ξ electro-mechanical systems

- Artificial feel systems
- Camera positioners
- Canopy control systems
- Carburetor air door controllers
- Cowl flap positioners
- Convertiplane rotor positioning systems
- De-icing valve positioners
- Engine throttle controllers
- Gas, hydraulic, fuel, valve positioners
- Inlet screen retraction systems
- Inlet vane angle controllers
- Jettison systems
- Landing gear lock systems
- Mechanical advantage ratio changers
- Oil cooler flap controllers
- Parachute door systems
- Precision remote positioning systems
- Supercharger blower shifters
- Test equipment
- Throttle friction controllers
- Trim tab positioners
- Turbo-prop clutch valve controllers
- Wing flap positioning systems

### λ electro-mechanical components

- Linear actuators
- Rotary actuators
- Servo actuators
- Power units
- Actuator controls
- Alternators
- Capstans
- Freewheeling clutches
- Friction clutches
- Magnetic clutches
- Slip overload clutches
- Electromagnetic brakes
- Flex drive n's, hex's, L's, and r's
- Flexible shafts
- Gearboxes
- Handcranks
- Motors (ac and dc)
- Enclosed fan motors
- Explosion proof motors
- Gearhead motors
- High frequency motors
- High temperature motors
- Miniature motors
- Pneumatic motors
- Servo motors
- Torque motors
- Screwjacks
- Load limit switches
- Position limit switches
- Programming switches

### ζ instruments

- ADF indicators
- Altitude indicators, 2-axis
- Altitude indicators, 3-axis
- Directional indicators
- n's indicators
- Integrated ADF-magnetic indicators
- Trim indicators
- Tuning meters
- Omnitrange indicators

### μ instrument components

- Altitude transducers
- Vacuum tube amplifiers
- Magnetic amplifiers
- Printed and etched circuit amplifiers
- Transistor amplifiers
- Displacement gyros
- Dynamic pressure transducers
- Gravity-sensing switches
- Magnetic modulators
- Magnetic powder clutches
- ac and dc servo motors

- Electric gyro motors
- Flag motors
- High-frequency motors
- Torque motors
- Power converters
- Rate generators
- Rate gyros
- Resolvers
- Synchros
- Synchro repeaters

### ψ communications systems

- VHF, VHF, HF, MF, and LF receivers
- VHF transceivers
- VHF, HF, and MF transmitters
- ADF receivers
- Airport traffic transceivers
- Monitoring transceivers
- Portable transceivers
- Telemetry receivers
- Test equipment

### ε communications components

- Audio frequency amplifiers
- Vacuum tube amplifiers
- Magnetic amplifiers
- Power amplifiers
- Printed and etched circuit amplifiers
- Transistor amplifiers
- Aircraft broadband antennas
- Ground plane antennas
- LF-MF whip antennas
- Loop antennas
- Mobile antennas
- Trailing wire antennas
- UHF-VHF whip antennas
- VHF Omnitrange antennas
- Antenna fairleads
- Antenna reels
- Antenna tuning coils
- Cable assemblies
- Coil assemblies
- Crystals
- Dynamotors
- Headsets
- Loudspeakers
- Amplifying loudspeakers
- Noise-cancelling microphones
- Radio noise filters

### η fluid handling equipment

- Absolute pressure switches
- Bombight and instrument desiccators
- Canopy seal pressurizing kits
- Cooling units for electronic assemblies

- Dehydrators
- Fuel flow dividers
- Pneumatic actuators
- Pressurizing control panels
- Alcohol pumps
- Anti-detonant injection pumps
- Ballast pumps
- Bilge and refueling pumps
- Dry air pumps
- Electric motor driven pumps
- Ethylene glycol and coolant pumps
- Ethylene oxide pumps
- Fuel pumps
- Fuel booster pumps
- Fuel filter de-icer pumps
- Fuel transfer pumps
- Hand operated pumps
- Heater fuel pumps
- Hydraulic pumps
- Hydraulic oil booster pumps
- Hydrogen peroxide pumps
- Lube oil and scavenge pumps
- Multiple-element pumps
- Oil transfer pumps
- Scavenge pumps
- Smoke pumps
- Submerged fuel booster pumps
- Vacuum pumps
- Water pumps
- Radar pressurizing kits
- Air relief valves
- Check valves
- Hydraulic valves
- Hydraulic servo valves
- Pressure regulating valves

### φ test equipment

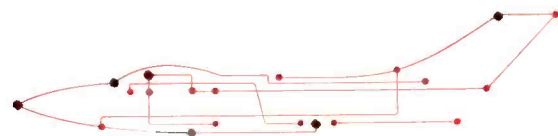
- Bench test cable assemblies
- Electronic test sets
- Field strength meters
- Pressurizing test kits
- Universal electro-mechanical test stands
- Universal motor test stands

### π miscellaneous

- Airborne television installations
- Airplane brake modernization kits
- Auxiliary power supplies
- Electronic chassis assemblies
- Executive airplanes
- Periscope prism selectors
- Precision remote positioners
- Printed circuits
- Radomes
- Wire harnesses

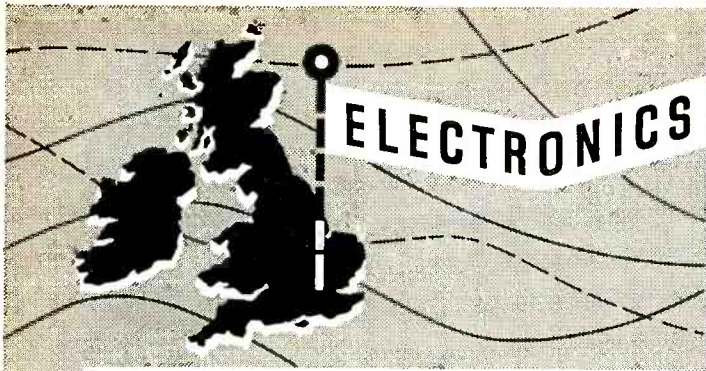
Lear has highly attractive engineering openings right now in Grand Rapids, Michigan; Santa Monica, California; Elyria, Ohio; and in Arizona. Send your technical qualifications immediately to Don Cook, 3171 South Bundy Drive, Santa Monica, California. Your letter and interview will be handled confidentially — by a Lear engineer.

# LEAR



produces for the precision needs of aviation

CP-16 A



*in Britain*

The British Electronics Industry is making giant strides with new developments in a variety of fields. Mullard tubes are an important contribution to this progress.

**For medium power equipments**

**British high fidelity experts choose the**

The Mullard range of high fidelity tubes is accepted in Britain as the standard by which others are judged. This is because many years of research and development have been spent in producing a range that will meet the requirements of high fidelity sound reproduction in all respects. Take the Mullard EL84 for example. A pair of these tubes provide a power output of 10W at a distortion level of less than 1%. Furthermore, their transconductance of over 11,000  $\mu$ mos results in an exceptionally high sensitivity. The EL84 may be used for higher powers too. Two tubes in push-pull will provide outputs of up to 17W at an overall distortion of 4%.

At maximum ratings one EL84 has a plate dissipation of 12W and gives an output of 5-6W for an input signal of less than 5V r.m.s.

Supplies of the EL84 for replacement in British equipments are available from the companies mentioned below.

**EL84**



**Principal Ratings**

Heater	.....	6.3V, 0.76A
Max. plate voltage	.....	300V
Max. plate dissipation	.....	12W
Max. screen voltage	.....	300V
Max. screen dissipation (max. signal)	.....	4W
Max. cathode current	.....	65mA

**Base**

Small button noval 9-pin

**Supplies available from:—**

**In the U.S.A.** International Electronics Corporation, Dept. E6, 81 Spring Street, N.Y. 12, New York, U.S.A.

**In Canada** Rogers Majestic Electronics Limited, Dept. 1J, 11-19 Brentcliffe Road, Toronto 17, Ontario, Canada.

**Mullard**

**ELECTRONIC TUBES**

*used throughout the world*

MULLARD OVERSEAS LTD., CENTURY HOUSE, SHAFTESBURY AVE., LONDON, ENGLAND

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



MEV37



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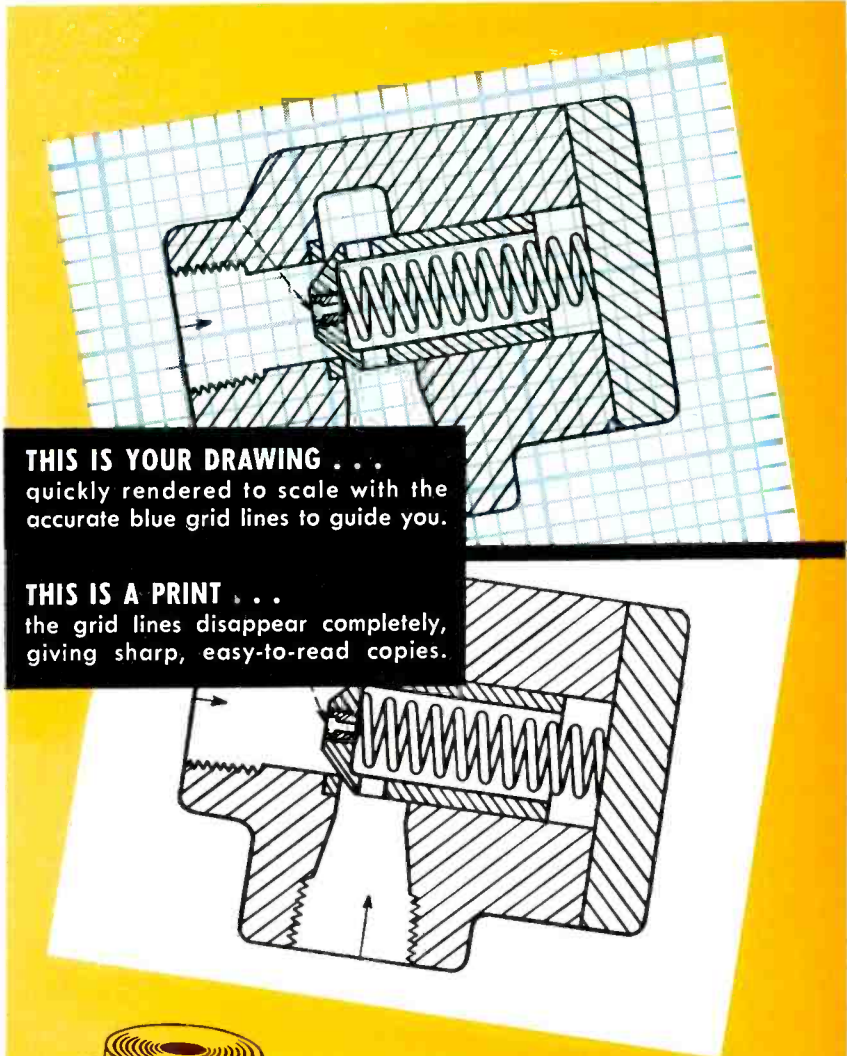


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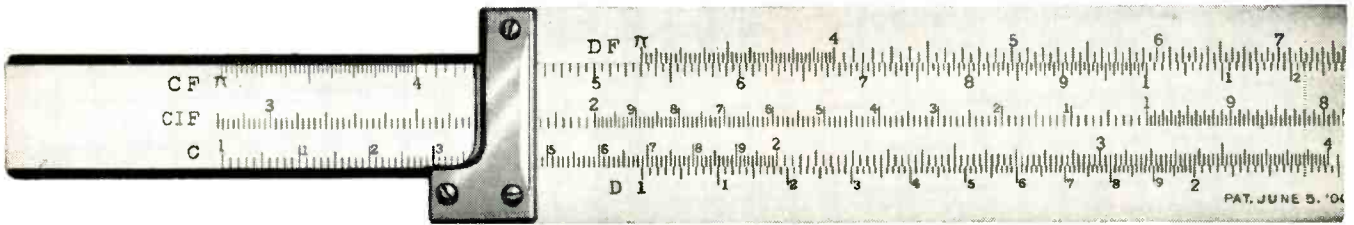
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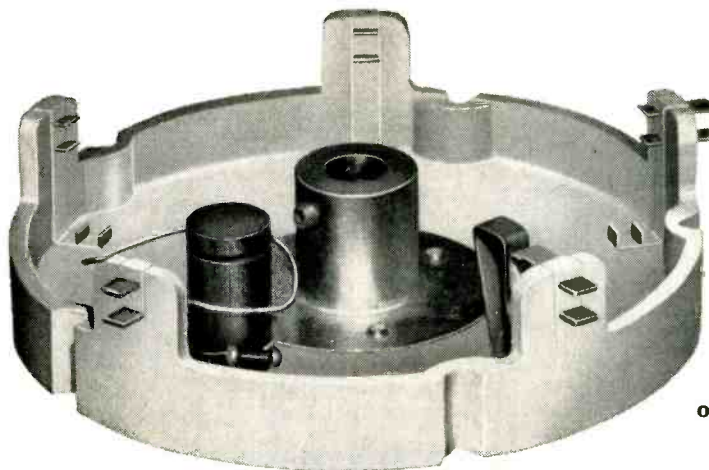
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EL

# Where precision is essential...



## industry turns to PLASKON® Alkyds



Oscillator Turret

**THE HEWLETT-PACKARD COMPANY** of Palo Alto, California, as a manufacturer of electronic equipment, has found that PLASKON Alkyds molding compounds can and do meet all of their exacting specifications!

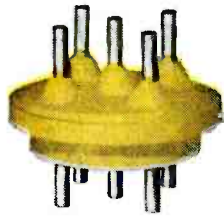
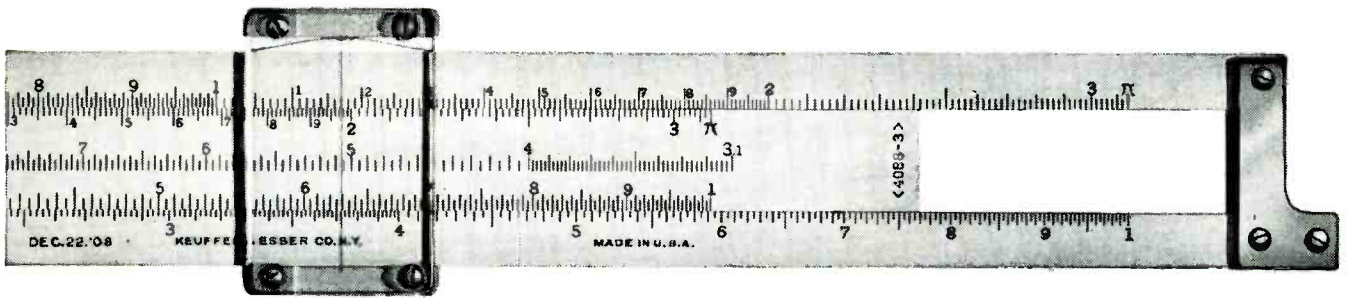
In the VHF Signal Generator pictured above, for instance, a material was needed that could guarantee *absolute* dimensional stability to a component part, thus assuring the instrument's unflinching accuracy. It had to be strong enough to hold silver inserts without loosening during a life of 50,000 cycles. It had to have a low coefficient of thermal expansion,

be readily molded and offer high resistance to heat and arcing.

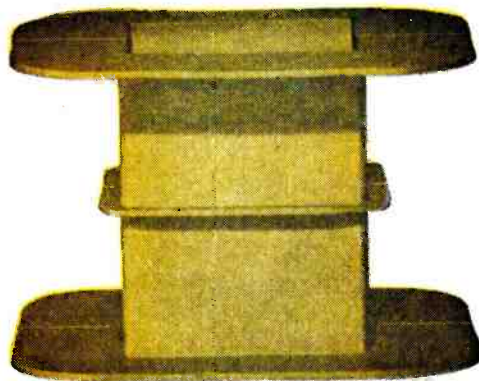
According to Hewlett-Packard, glass-reinforced PLASKON Alkyd molding compound is "the only plastic that met all our requirements." In other instruments, H-P has had equal success with PLASKON Products using both mineral-filled and glass-reinforced alkyds.

We pass this "success story" on to you, with the thought that what PLASKON Products can do for others, they can do for *you* too.





**1. Transformer Terminal**



**2. Transformer Bobbin**



**3. Probe body Insulator**



**4. Coil Case**

"PLASKON Alkyd molding compounds' fast cure has cut our costs considerably," says Ralph E. Lee, production engineer at Hewlett-Packard. "We also get appreciable savings by molding parts such as probe body insulators which formerly had to be machined. PLASKON Alkyd molding compounds' outstanding electrical properties result in higher quality for our components too."

1. PLASKON Alkyd molding compounds give these transformer terminals high insulation and moisture resistance.
2. Transformer bobbins have high strength, even when walls are molded as thin as .040".
3. Probe body insulator has a resistance of at least 100,000 megohms between terminals, with dimensional stability over long periods at 150° F.
4. Through using PLASKON 422 Alkyd molding compound H-P cuts costs by building only one cavity mold for coil cases instead of many.



For further information on PLASKON Plastics and Resins address BARRETT DIVISION, Allied Chemical & Dye Corporation, 40 Rector St., New York 6, N. Y. Hanover 2-7300

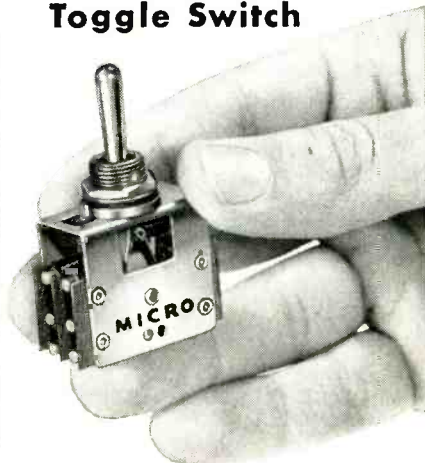


# MICRO precision switches

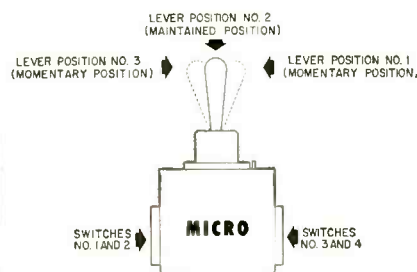
...THEIR USE IS A PRINCIPLE OF GOOD DESIGN

**NEW!**

**An "Electrical Memory" Toggle Switch**



Here is the first in a new series of "electrical memory" toggle switches. It is a four-pole assembly with one pole to indicate which circuit was last operated. It promises to simplify and perhaps revolutionize some basic circuit designs of complicated ground radar units, computer devices, aircraft control panels and other types of remote control equipment.



	Lever Position No. 1	Lever Position No. 2	Lever Position No. 3
Switch No. 1	N.O. To C. Circuit Made	N.C. To C. Circuit Made	N.C. To C. Circuit Made
Switch No. 2	N.O. To C. Circuit Made	N.C. To C. Circuit Made	N.C. To C. Circuit Made
Switch No. 3	N.C. To C. Circuit Made	N.C. To C. Circuit Made	N.O. To C. Circuit Made
Switch No. 4	N.C. To C. Circuit Made	*	N.O. To C. Circuit Made

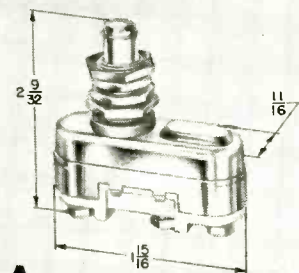
\*N.C. To C. Circuit Made if Lever Last Moved To Lever Position No. 1  
\*N.O. To C. Circuit Made if Lever Last Moved To Lever Position No. 3

The assembly uses three single-pole, double-throw functional basic switches and one single-pole, double-throw "memory" switch.

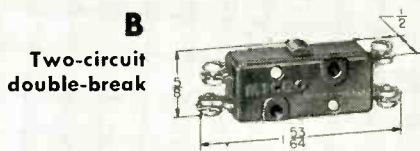
In application the "memory" switch indicates through a pilot light or buzzer which circuit was last operated.

The three functional switches operate at three lever positions: maintained center and momentary from each extreme position.

**Electrical rating of basic switches:** 5 amperes 125 or 250 volts a-c. The d-c rating at 30 volts: inductive—3 amperes at sea level and 2.5 amperes at 50,000 ft.; resistive—4 amperes at sea level and 4 amperes at 50,000 feet.; maximum inrush—15 amperes.

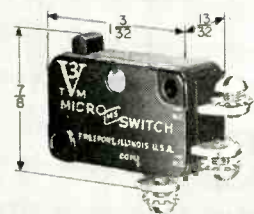
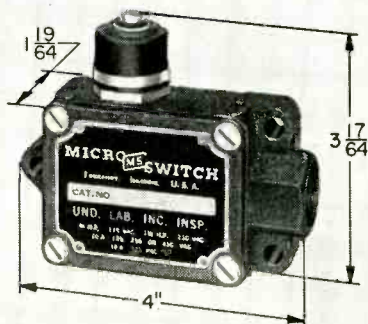


**A**  
High temperature switch



**B**  
Two-circuit double-break

High inrush capacity **C**



**D**  
Small, high capacity



**E**  
Sensitive mercury switch

## A continuous flow of Precision Switch developments anticipates designers' needs

Whatever your requirements for an extremely reliable precision switch, there is—or can be—a MICRO SWITCH product to meet it. It makes no difference whether your switch must control sensitive electronic devices, instruments or heavy automatic machinery. Experienced designers save time and money by checking with MICRO SWITCH—pioneer manufacturer of precision switches.

Illustrated are a few examples of the wide range of MICRO SWITCH units to meet design requirements. These include hermetically sealed switches, switches for control of multiple circuits, switches resistant to high temperatures, heavy duty switches with high electrical capacity and very small switches—all for extremely precise operation.

**A • High temperature switch.** This switch will operate satisfactorily in a temperature range of from  $-50^{\circ}$  F to plus  $1000^{\circ}$  F. Originally designed for use in jet aircraft applications, on or near the after-burner, the switch is equally useful for industrial applications which require high temperature components.

**B • Two-circuit double-break switch** fills the need for a small, two-circuit double-break switch for controlling two isolated circuits. This allows greater flexibility and simplicity of circuit design. A snap-action spring provides quick make and break of both circuits in each double-break circuit.

**C • High capacity, sealed plunger switch.** Compact, easy to mount precision snap-action switch which combines long life and reliability with the capacity to make and break steady state currents of 20 amperes and to handle inrush currents as high as 75 amperes.

**D • V3 small, high-capacity switch:** MICRO V3 switches have extremely high electrical capacity for their size. They were developed to meet exacting design requirements for an extremely small switch with no sacrifice of quality. V3 switches are available with a wide variety of circuit arrangements, operating characteristics and actuators.

**E • Sensitive mercury switch** with  $1/4^{\circ}$  operating angle. Small Honeywell Mercury Switches are designed to meet the demand of small load circuits and applications where space and economy are critical factors. Ratings may often be extended successfully down to micro-volt milli-ampere ranges.

For complete information on any of these switches or the complete MICRO SWITCH line, call the MICRO SWITCH branch near you.

# MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS





# Safety in all weather with TACAN

## HOFFMAN makes the complete airborne portion of the TACAN system—another example of Hoffman integrated electronics at work

TACAN is the trustworthy electronic navigation system that unerringly guides pilots through fair and foul weather every second of the flight. Two compact dials on the instrument panel automatically show the pilot his exact distance and direction from a fixed ground station with an accuracy never before attained. Result: greater safety in *any* weather, *any* place.

Some of TACAN's advantages over other systems include: three times greater accuracy; handles more airplane traffic—allows planes to fly *safely* at closer intervals; permits starting landing approaches further out—minimizes "stack up" of planes waiting to land; meets military requirements for ruggedness, compactness and mobility.

The same teamwork, experience and facilities at Hoffman Laboratories that put TACAN into full scale production are available for you to use—whatever the size or complexity of your electronic needs. Why not discuss your specific systems engineering problem with a Hoffman Labs' representative soon?

### TACAN REQUIRES INTEGRATED SKILLS



Range (distance) indicator  
Azimuth (direction) Indicator



Control Panel



Receiver  
Transmitter  
Strobe circuits  
Reference pulse detector  
Envelope signal detector  
Phase comparison circuits

**CLOSE TEAMWORK** of research, development and production engineering

**TECHNICAL ABILITY** to achieve maximum component density. TACAN contains as many tubes as four TV sets (plus more than 8,000 other parts), takes up half the space of one TV set

**EXPERIENCE AND FACILITIES** to field test complex systems in every conceivable weather condition and environment

**PRODUCTION KNOW-HOW** to build a unit capable of withstanding the rigors of military operations, and the intense G-shock and vibration of carrier deck landings

**INITIATIVE** to develop and produce complete test equipment to make TACAN in use 100% safe and efficient

A subsidiary of  
Hoffman Electronics  
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# Hoffman

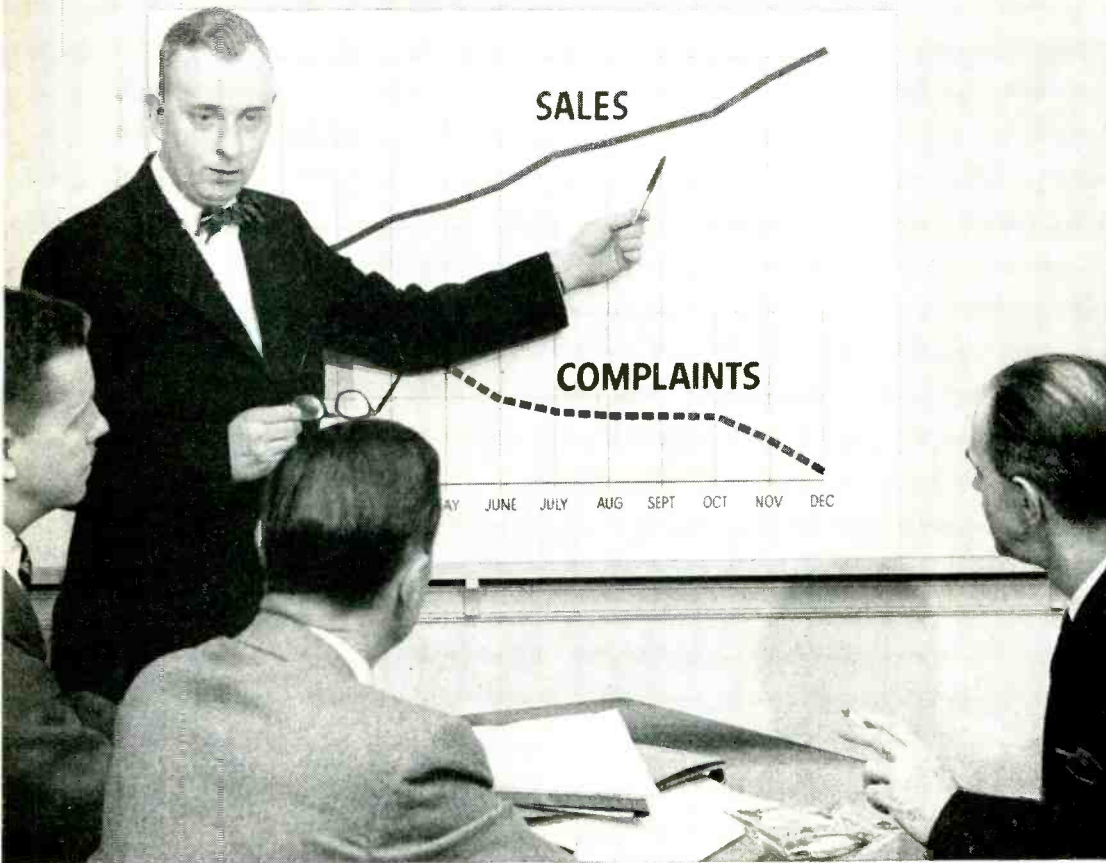
LABORATORIES, INC.

Engineers: For challenging opportunities write: Director of Engineering,  
Hoffman Laboratories, Inc., 3761 South Hill Street, Los Angeles 7, California

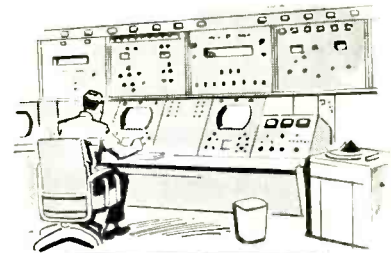




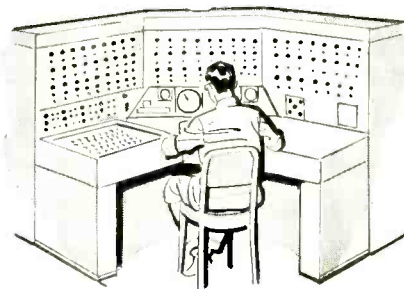
**INDUCTROLS\***  
profitable industrial  
voltage regulation



**RADAR**



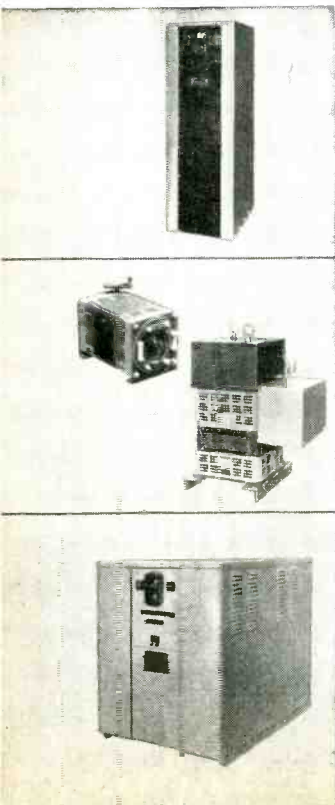
**COMMUNICATIONS**



**COMPUTERS**

*Performance of electronic equipment depends on proper voltage*

# Help assure customer satisfaction; Install G-E Inductrols\* on your equipment



## A G-E INDUCTROL FOR EVERY NEED

**AUTOMATIC INDUCTROL**—Applied where constant voltage is desired, as on radar equipment, electronic computers, induction heaters, rectifiers, welders. Available for single- or three-phase circuits, 600 volts and below.

**HAND- OR MOTOR-OPERATED INDUCTROL**—Provide stepless variable-voltage output over any desired range. For testing, heating, or illumination control, and similar applications. Single- and three-phase—600 volts and below.

**INDUCTROL POWER PACK**—This is a load center unit substitution for a-c power and lighting service. Unit includes a transformer, Inductrol, circuit breakers, and distribution panel board. Generally applied in three-phase circuits—600 volts and below—indoor service.

Yes, even small variations in the voltage supplied to sensitive electronic equipment can result in inaccurate operation, inefficiency, and drastically reduced life (a 10% overvoltage can reduce vacuum tube life by 70%!). However, many users do not realize they have a voltage problem, and when their electronic equipment fails to operate properly, the reputation of the original equipment manufacturer usually suffers.

G-E Inductrols (induction voltage regulators) provide a reliable, economical means of maintaining rated utilization voltage *without introducing harmful waveform distortion*. Installed on your equipment, G-E Inductrols assure proper operation even under adverse voltage conditions. Inherent high short-circuit strength and elimination of brushes make G-E Inductrols a simple, economical solution to voltage problems.

For complete information and application assistance, contact your nearest General Electric Apparatus Sales Office, or write Section 425-2, General Electric Company, Schenectady 5, N. Y.

\*G-E Induction Voltage Regulators

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

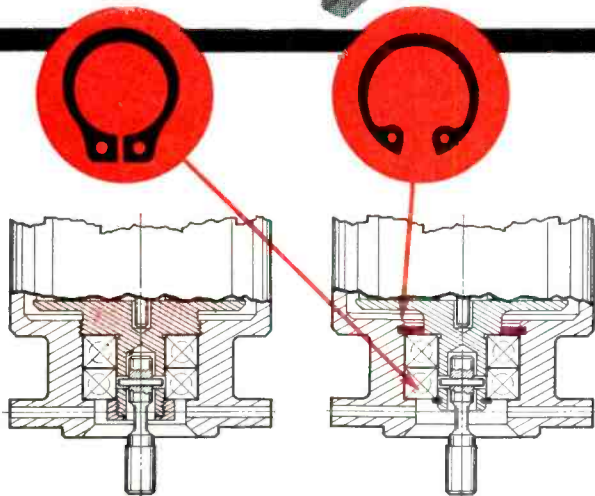


# 10 Waldes Truarc rings speed assembly— Eliminate parts and machining in precision control



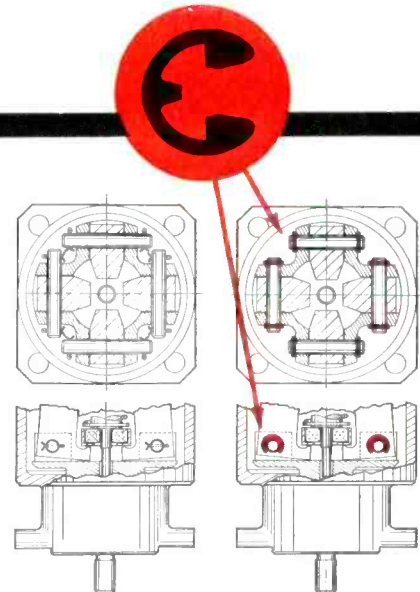
## Kahn Rotary Speed Control

Kahn and Company, Inc., of Hartford, Conn., use a total of 10 Waldes Truarc Retaining Rings in this new mechanical-electric translator for automatic control of rotary speed. Truarc rings act as positioners and retainers to eliminate parts, simplify operations, save labor, and speed assembly.



**Rotor Installation.** In the old way, ball bearing was retained by a threaded shoulder and threaded bearing cup retainer.

**New way,** using two Truarc Rings (Series 5100 and 5000) eliminates 4 threading operations, bearing shoulder and threaded bearing cup. Assembly is quicker and easier, two ounces lighter.



**Flyweight Assembly.** Formerly, 2 holes had to be drilled in each of the 4 pivots, and 8 cotter pins were required.

**The new way,** using 8 Truarc E-Rings (Series 5133), replaces holes with grooves, reduces pivot size, leaves no projecting parts. Rings snap into place, speed assembly time by three minutes per unit.

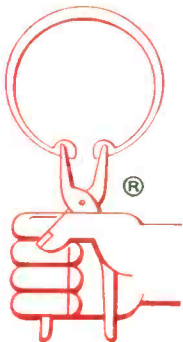
Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product...to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

**36 functionally different types...** as many as 97 different

sizes within a type...5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

**More than 30** engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting... Waldes Truarc Grooving Tool!



Send for new catalog supplement

**WALDES**  
**TRUARC**<sup>®</sup>  
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Waldes Kohlnoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.  
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.

(Please print)

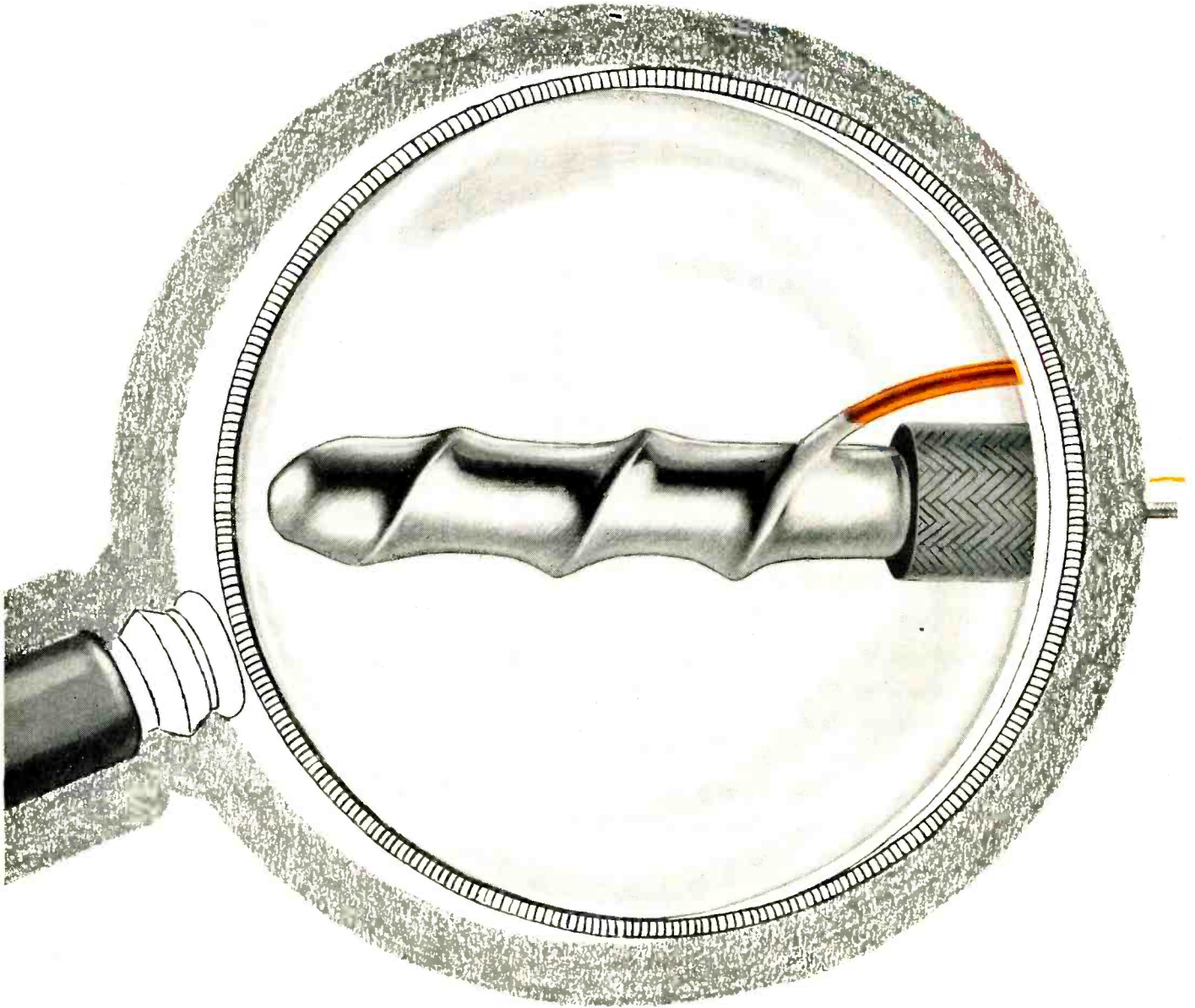
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City..... Zone..... State.....

E-06B

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

**PHELPS DODGE SODEREZE®**

**CUTS**



**FIRST FOR LASTING QUALITY—FROM MINE TO MARKET!**

---



# ENDS STRIPPING, CLEANING— SOLDERING COSTS !

Sodereze—Phelps Dodge's isocyanate-type\* magnet wire—provides:

1. *Low temperature* soldering—no damage to copper conductor.
2. A balance of physical, chemical and electrical properties permitting replacement of existing film wires.
3. Resistance to heat and solvent shock for safer wax or varnish treatment.
4. Excellent resistance to alcohol and most solvents.

---

Phelps Dodge Sodereze was designed to keep pace with industry's growing need for magnet wires that handle easily, reduce over-all costs and fit a variety of exacting design requirements.

The versatility of Sodereze not only permits its use wherever solderable wires are required, but allows replacement of conventional film wires.

\* Isocyanates, when combined with other resins, form Polyurethanes that can be balanced in properties to give the maximum in performance as a magnet wire insulation. Several years of research have been spent on Phelps Dodge Sodereze to accomplish this result. A patent application covering Phelps Dodge isocyanate-type magnet wire has been filed.

*Any time magnet wire is your problem,  
consult Phelps Dodge for the quickest, easiest answer!*

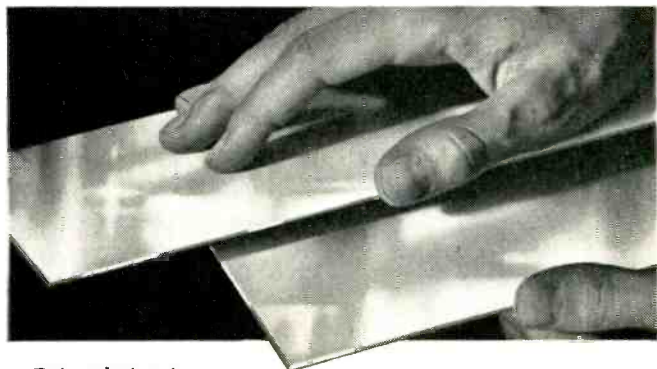
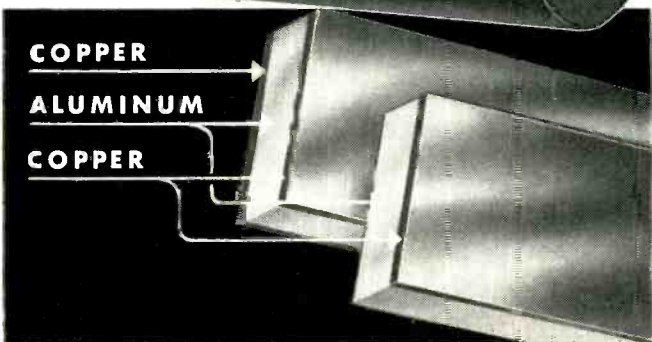


***PHELPS DODGE COPPER PRODUCTS***  
**CORPORATION**

**INCA MANUFACTURING DIVISION**  
FORT WAYNE, INDIANA



# Two Metals are often better than One



...and General Plate Division

## **ALCUPLATE<sup>®</sup>** (Copper clad aluminum)

**is a case in point**

**CUTS COPPER COST BY 15 TO 30%  
CONSERVES CRITICAL COPPER**

ALCUPLATE, made by permanently bonding solid copper to one or both sides of less expensive aluminum, has virtually the same physical and electrical properties as solid copper — at much lower cost.

ALCUPLATE can be stamped, drawn, or formed in a work-hardened state — without annealing — and the copper provides an ideal surface for soft soldering or electroplated finish. This permits fabrication of many parts and products, at savings of 15% to 30% over solid copper.

Here are typical products in which ALCUPLATE is now saving money:

- Electrical terminals, clips and shims
- Small motor housings
- Electronic component cases, cans, brackets, and chassis
- Heat transfer assemblies
- Fin and tube-type radiators

- Printed circuits
- Household utensils
- Costume jewelry and giftware

If you are seeking metals with useful characteristics that can't be found in a single metal or alloy — look to General Plate Clad Metals. If you want stronger or lighter components — or better electrical and mechanical properties — or fewer corrosion problems — or if you are interested in conserving critical metals or reducing parts costs, you should be investigating General Plate Clad Metals.

Catalog PR-700 covering base to base and precious to base clad metals, TRUFLEX<sup>®</sup> Thermostat Metals, composite electrical contact, buttons and rivets are yours for the asking. New PR-226A folder with clad metal samples also sent free. Write for it.

**You can profit by using  
General Plate Composite Metals!**

**METALS & CONTROLS CORPORATION  
GENERAL PLATE DIVISION**

36 FOREST STREET, ATTLEBORO, MASSACHUSETTS





# HUGHES MEMOTRON

A NEW TYPE OF  
CATHODE RAY TUBE

**MAINTAINS** brilliant traces indefinitely.

Now you can examine nonrecurrent phenomena without resorting to photography. The Memotron, a direct display cathode ray storage tube, retains transients—permits leisurely examination on the tube face itself.

There is no blooming or fading. And the high tube brilliance permits its use without a hood, even in well-lighted surroundings.

**DISPLAYS** successive transient writings.

Even the most complex patterns can be superimposed or shifted in position. The Memotron tube thereby enables you to make convenient comparisons and analyses.

**INSURES** superior file records.

When a file record is needed, photography is greatly simplified because all displays occur at a constant, uniform brightness regardless of differences in writing speeds. Therefore, a single camera exposure setting is sufficient.

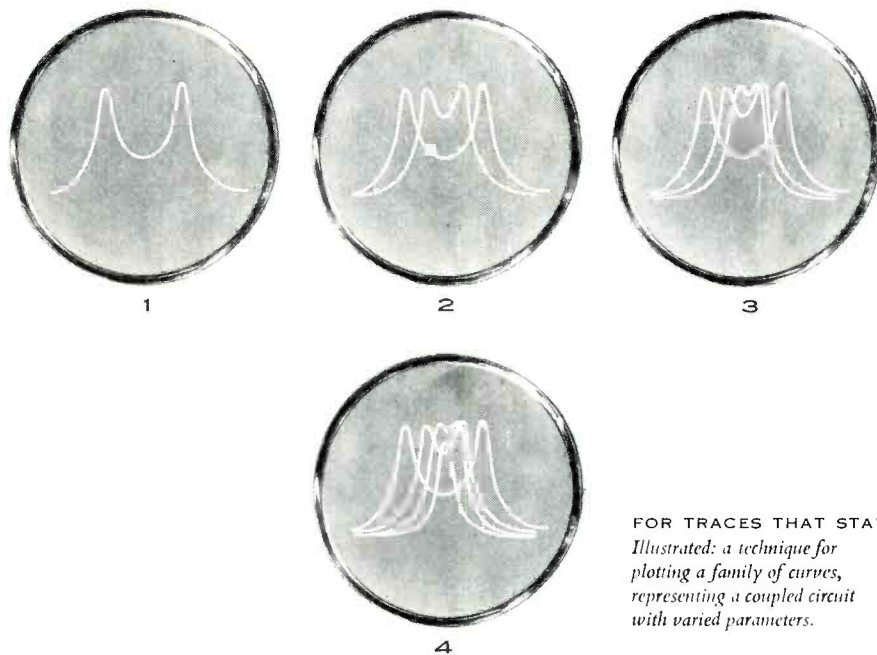
**FUNCTIONS** as curve plotter.

An oscillograph equipped with a Memotron combines, into one instrument, pen-recorder performance at low frequencies and oscillograph performance at high frequencies. Successive writings may be stored to produce a family of curves.

**TYPICAL APPLICATIONS:** As a read-out device for the display of solutions produced by an analog computer . . . for recording shock transients during shock testing . . . in medicine for electrocardiography and vector-cardiography. Our engineers are available for consultation on special Memotron applications.

#### GENERAL SPECIFICATIONS

RESOLUTION . . . 50 to 60 written lines per inch.  
 WRITING SPEED . . . 0 to at least 100,000 inches/second (selected tubes in excess of 100,000 ips).  
 BRIGHTNESS . . . 50 foot-lamberts.  
 USABLE SCREEN DIAMETER . . . 4 inches, maximum.  
 DIMENSIONS . . .  
 Over-all length: 18 1/2 inches, ± 1/2-inch.  
 Bulb diameter: 5 5/8 inches, maximum.  
 Neck diameter: 2 1/4 inches, ± 3/32-inch.



FOR TRACES THAT STAY.  
 Illustrated: a technique for plotting a family of curves, representing a coupled circuit with varied parameters.

## HUGHES PRODUCTS

A DIVISION OF THE HUGHES AIRCRAFT COMPANY

For descriptive literature and information on commercially available oscilloscopes featuring the Memotron, please write:

HUGHES PRODUCTS  
 ELECTRON TUBES  
 Los Angeles 45, California

© 1956, H. A. C.

# Why 371 U. S. manufacturers now enjoy 100% tax



**Governor Muñoz tells why Puerto Rico offers such amazing incentives to new or expanding manufacturers.**

**I**N THIS statement, I shall try to explain Puerto Rico's economic position as frankly as I would to any manufacturer or labor leader who met me face to face.

Puerto Rico is currently making a determined effort to stand squarely on its own economic feet. At present we do not have nearly enough jobs to support our people. We are therefore directing every energy to create more jobs at home, and to curtail migration to the States.

That is precisely why we are going all out to attract every *new* plant we possibly can. But, to date, we are still providing only 25% of the new jobs we need *each year* to keep pace with our expanding labor force. I shall go into details later. But first I want to make two points of my Government's policy absolutely clear:

**1. Puerto Rico has no intention of winning industries away from anywhere. We do not grant tax concessions to runaway plants.**

**2. Puerto Rico's Industrial Development Plan is based on a combination of absolutely ethical incentives. We do not and never will hold out low wages as an attraction to business. My Government's firm philosophy is that wages should rise as rapidly as our economic development permits.**

Let me now describe our basic problem in more detail."

## **Our Problem**

"When people talk of over-population as Puerto Rico's biggest headache, they certainly don't exaggerate.

Our unemployment is high. Our income level is still low—only 25% of the U. S. average. And every year 20,000 more workers swell our under-employed labor forces.

But this is probably putting the cart before the horse. Our real problem is not over-population but *under-development*. What then is our best solution?"

## **Our Solution**

"I am convinced that the answer can only lie in more and more industry. Hence we are pinning our major hopes on our industrial development program, as the main pull of what we call Operation Bootstrap.

From the economic standpoint, Operation Bootstrap has but one simple aim—to develop industry, and in doing so, to encourage U. S. manufacturers to *expand* their operations to Puerto Rico. Operation Bootstrap is, in fact, a bold attempt to increase the well-being of our whole Commonwealth—workers and employers alike. And lest anyone should fear that my country's program might injure the U. S. economy, let me now sound a reassuring note:

**1. The U. S. already has 65 million employed. Puerto Rico only needs to create 150 thousand new jobs to solve its present problem.**

**2. One half of one percent of normal U. S. industrial expansion would achieve our whole economic program.**

I hope these comparisons help to put Puerto Rico's modest needs in proper perspective. But, for good measure, let

me quote a few more figures to show how important a prosperous Puerto Rico is to U. S. business itself:

**In 1955, Puerto Rico's purchases from the U. S. rose to \$580,000,000. Without Puerto Rico as a customer, New York's gross sales would have dropped by \$67,000,000; California's by \$54,000,000; New England's by \$53,000,000.**

So much for statistics. Now just a word about my people, without whose willing co-operation Operation Bootstrap would merely be a sterile dream."

## **Bootstrap Underway**

"Pay us a visit and I think you will be impressed immediately by the whole-hearted faith we Puerto Ricans place in Operation Bootstrap.

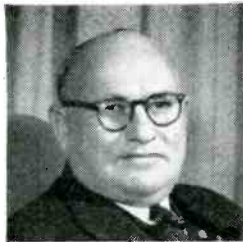
We believe in it deeply and thoroughly—and, with practically no exceptions, support its policies right along the line. Thus, I can promise the same eager, cheerful co-operation to every U. S. manufacturer who expands his industry to our Commonwealth.

Scarcely a month goes by that I am not visited by the Mayors of a dozen Puerto Rican towns, all asking for plants to be erected in *their* areas. There's not a community in all Puerto Rico that would not enthusiastically welcome the arrival of a new factory.

For we all realize that though we have made a promising start up the long, long hill to economic prosperity—the summit is not in sight yet. But the Puerto Rican people have squared up to their challenge and are meeting it in good heart."



# in Puerto Rico freedom



**Beardsley Ruml tells how new or expanding industries (not runaway plants) get tax exemption.**

**S**TART A NEW plant in Puerto Rico and you are not only free from Federal income taxes (they don't apply)—you can be exempt from *local* income taxes too. Your freedom from Federal taxes is *not* a concession. It is a *Constitutional* fact which stems logically from that historic American principle "Taxation without

representation is tyranny.' Puerto Rico has no vote in Congress, and therefore no Federal income taxes—corporate or personal."

#### Protected by Two Constitutions

"Your business is not only protected by the Commonwealth Constitution, it is

permanently guarded by all the guarantees of the U. S. Courts and Constitution, too.

As for your *local* income tax exemption, this is an *added* incentive, offered by the Commonwealth Government to attract new plants that Puerto Rico's economy needs so urgently."

## How you gain from a new plant in Puerto Rico

**1. A better return.** Local tax concessions, freedom from Federal taxes, and lower operating costs will all reflect favorably in your company's balance sheet. See table above.

**2. Abundant, skillful labor.** Puerto Rico's labor force totals 644,000. The Commonwealth operates an ambitious vocational training program, which will even screen workers and teach them *specialty* to operate your machines. The adeptness of the Puerto Rican worker in learning precision skills may be judged by the fact that the following famous companies now have operations in Puerto Rico:

Remington Rand. St. Regis Paper. Beaunit Mills. International Latex. Carborundum Company. Shoe Corporation of America. United Tool and Drill. Sunbeam Electric. Univis Lens. Weston Electrical Instrument Company.

**3. No currency or customs problems.** Puerto Rico is a Commonwealth freely

associated with the United States. It is an integral part of the U. S. economic system. You have none of the problems of operating from a foreign country. Movement of goods, money and people between Puerto Rico and the U. S. is as free as it is between the states of the Union. There's no duty on trade and the U. S. dollar is currency.

**4. Low capital investment.** New single-story, low-rental factories are ready to occupy. The government will even build a *special* one for you on a very small down payment. Abundant electricity, gas and water are just waiting to be connected.

**5. Ideal location.** Puerto Rico is served by 30 ocean lines and 8 airlines. It is only 5½ hours by air from New York—less than 4 from Miami. Goods are actually made in Puerto Rico one day and are delivered in Los Angeles the next. The climate is perpetual Spring. Temperature stays around the balmy 70's most of

### Corporate Tax Exemption

If your net profit after U. S. Corporate Income Tax is :	Your net profit in Puerto Rico would be :
\$ 29,500	\$ 50,000
53,500	100,000
245,500	500,000
485,500	1,000,000

### Dividend Tax Exemption\*

If your income after U. S. Individual Income Tax is :	Your net income in Puerto Rico would be :
\$ 7,760	\$ 10,000
15,850	25,000
25,180	50,000
51,180	200,000

\*Dividends are tax-free only if paid to residents of Puerto Rico by a tax-exempt corporation. Examples are based on Federal rates (Jan. 1, 1956) for single persons.

the year. Swimming, sailing and fishing are superb. Domestic help is plentiful.

#### Is Your Company Eligible?

To find out if your company is eligible for tax exemption in Puerto Rico, call our nearest office:

New York.....MU 8-2960.....579 5th Ave.  
Chicago.....AN 3-4887.....79 W. Monroe  
Los Angeles...WE 1-1225.....5525 Wilshire

#### Or mail coupon for free booklet

Commonwealth of Puerto Rico  
Economic Development  
Administration  
579 Fifth Ave., New York 17, N. Y.  
Dept. EM-61

Mail me "Facts for the Manufacturer" your report of the advantages of Puerto Rico for plant location.

Name \_\_\_\_\_  
Company \_\_\_\_\_  
Product \_\_\_\_\_  
Address \_\_\_\_\_

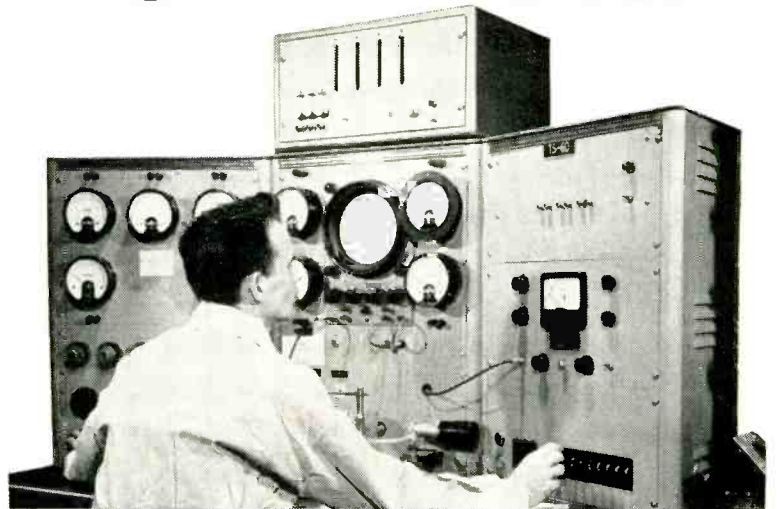
UNMATCHED MICROWAVE TUBE FACILITIES AND EXPERIENCE

ready to go to work for you at

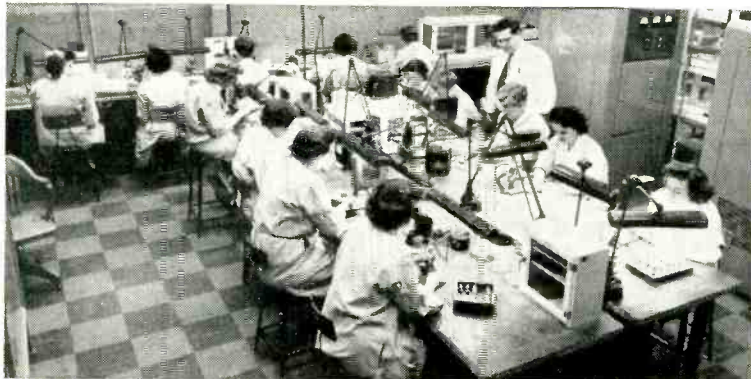
**Bendix**  
Red Bank



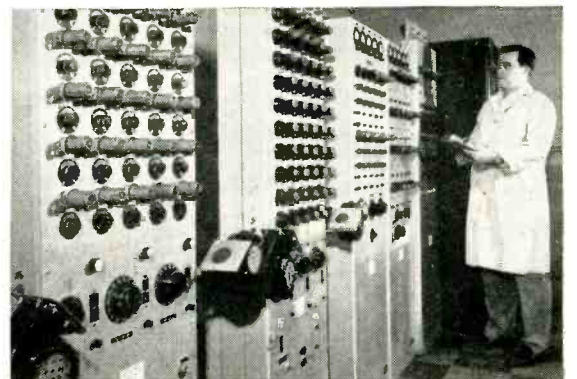
Presetting cavity resonant frequency.



All tubes get complete electrical test.



Typical klystron mount assembly line.



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What do *you* need in klystron tubes?

Makes no difference how complex or unusual your microwave application is. Nor how big or little your order may be. In any case, we have the specialized equipment and know-how to turn out tubes that can do a *better* job for you.

Our microwave people have successfully designed and built klystrons of all types—thermally-tuned, external cavity, integral cavity, mechanically-tuned and ruggedized. An example of one of our latest developments is a ruggedized, mechanically-tuned, K-band reflex oscillator that utilizes the many advantages of dielectric rod tuning . . . and that can be readily scaled up or down in frequency.

If no existing tube meets your needs, we'll be glad to quote on a special tube to do the job. For information, write RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

West Coast Sales & Service: 117 E. Providencia Ave., Burbank, Calif.  
Export Sales and Service: Bendix International Division, 205 E. 42nd St., N.Y. 17, N.Y.  
Canadian Distributor: Aviation Electric Ltd., P. O. Box 6102, Montreal, Quebec





# Six new CBS bonded junction diodes

**HIGH FORWARD CONDUCTANCE  
HIGH BACK RESISTANCE  
EXCEPTIONAL STABILITY**

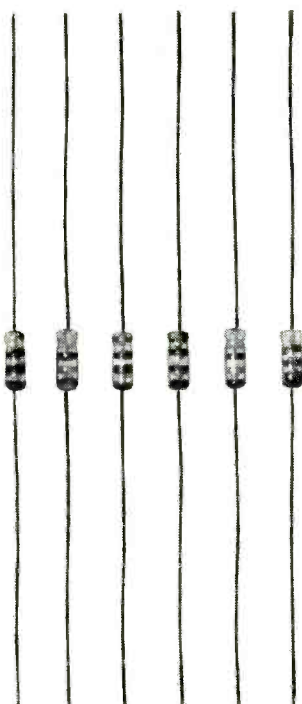
These data on the CBS 1N497-1N502 speak for themselves. Check the low inverse currents at the rated voltages . . . and the low forward voltage drop at 100 ma.

Characteristic	1N497	1N498	1N499	1N500	1N501	1N502
Max. continuous inverse working voltage (volts)*	20	40	50	60	80	100
Max. reverse current @ max. inverse voltage ( $\mu$ amps)	20	25	30	40	40	40
Max. forward voltage drop @ 100 ma (volts)	1	1	1	1	1	1

\*Max. operable recurrent peak voltages are 25% higher.

The very low capacitances of these low-impedance diodes provide high rectification efficiency at high frequencies. Other advantages are fast pulse recovery time . . . subminiature size . . . ruggedness . . . and hermetic sealing. Scrupulous cleanliness throughout manufacture and special processing of the bonded junction help to assure unusually fine stability.

Widespread applications for the CBS 1N497-1N502 include computers, military equipment, control devices, and instruments. Diodes with exceptionally fast recovery time are also available on request. Write for data and application Bulletin E-266 on these latest additions to the growing line of CBS diodes.



*Reliable products  
through Advanced-Engineering.*



**semiconductors**

**CBS-HYTRON**, Danvers, Massachusetts  
A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.

# New trends and developments in designing electrical products . . .

Why General Electric Magnets clad in die-cast aluminum sheaths offer important design and cost advantages over the conventional methods of fabricating magnetic assemblies

THE MAN in the picture below is removing a section of a radar magnetron tube magnet from a piece of equipment that goes by the imposing title of "Lester-Phoenix Horizontal Cold Chamber H-HP-3X 400-Ton Die-Casting Machine."



This machine is in our Edmore, Michigan, magnet plant, and its sole function is to cast aluminum sheaths on General Electric Alnico Permanent Magnets.

These alclad magnets offer designers seven major advantages over conventional methods of fabricating magnetic assemblies.

1. Die casting strengthens the magnet structurally.
2. Whole assemblies can be designed and built as a single "package," speeding the final assembly job at the plant.
3. Design of mounting arrangements is simplified because pins, holes, and screws can be cast into the sheath, instead of the magnet.
4. Responsibility for the entire assembly is centered in a single source, simplifying purchasing procedures, and eliminating costly in-plant assembly operations.
5. Complete magnetic assemblies can be purchased premagnetized and/or pretested.
6. Die casting provides a consistent, more attractive finish for applications where appearance is important.
7. Die casting is a convenient, low-cost mass-production technique for magnetic assemblies that eliminates the problem of attaching crystalline cast magnets to other components.

The following examples will illustrate how these advantages can be turned to practical use.

Figure 1 is a relay drag magnet assembly, typical of those used in the meter and instrument industry. Before the manufacturer switched to this casting, it was necessary to cast a magnet against a piece of steel, bend the steel into the proper shape, and weld the ends together.

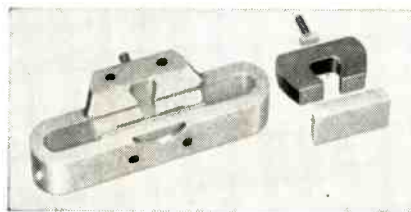


Figure 1

Now, however, magnet, mounting pin, and steel return path are assembled in a single operation—eliminating the difficult 3-stage fabrication job. This assembly—one of the most complex handled by the die-casting machine—illustrates the equipment's tremendous versatility.

Figure 2 is a generator rotor, consisting of eight G-E Alnico magnets held in position on a camshaft by the cast-aluminum matrix.

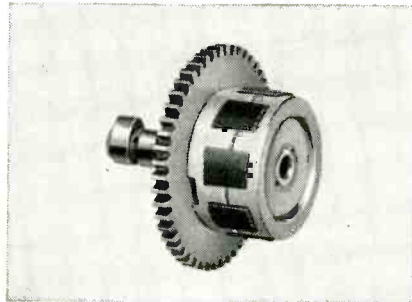


Figure 2

The casting supplements the strength of the magnets (which are subjected to high rotary speeds). And it eliminates difficult grinding, assembly, and banding operations.

The four radar magnetron tube magnets in Figure 3 give some idea of the wide range of sizes the machine is capable of handling. The smallest magnet (bottom, right) weighs only 1 lb., while a quarter section of the largest magnet weighs more than 11 lbs.

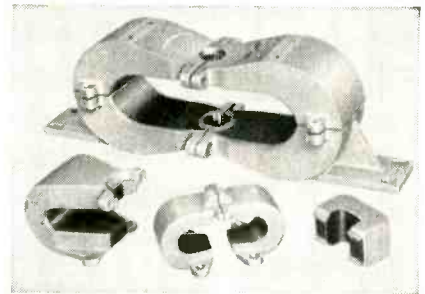


Figure 3

Here, the aluminum sheath improves magnetic stability by preventing direct contact between magnet surfaces and steel objects. In addition, the mounting brackets cast in the sheaths eliminate inserts normally cast in the magnets which would weaken its energy and structure.

Aluminum-sheathed magnets are often far less expensive than conventional magnets . . . especially on long production runs. And, in many of the cases where the unit cost of alclad magnets is higher, the tremendous advantages gained by die casting have more than offset the price difference.

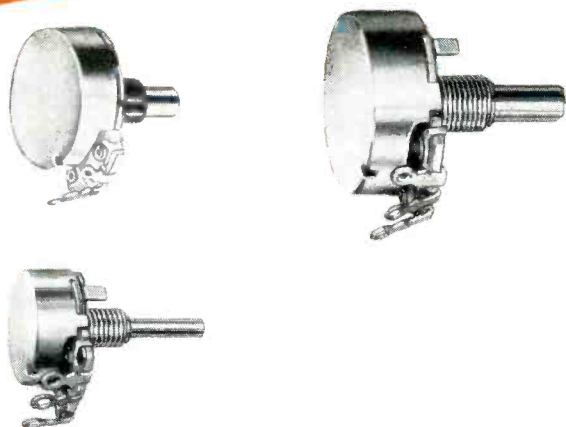
The one best way to find out whether or not die casting is feasible on your application, is to check with a General Electric Magnet Engineer.

You can do this—or obtain information on any other problem in the realm of permanent magnets—by dropping a note to: Carbology Department of General Electric Company, 11137 E. 8 Mile Ave., Detroit 32, Michigan.

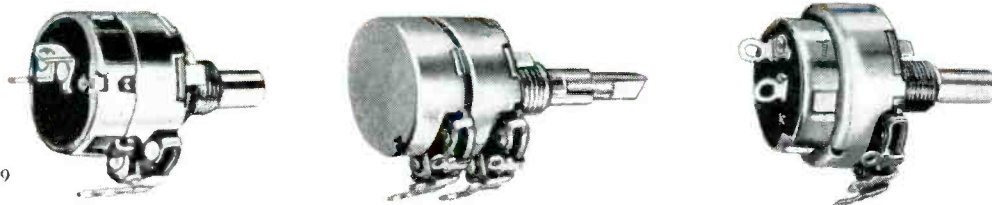
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**GENERAL  ELECTRIC**





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**AC-DC Digital Voltmeter** 0.1% AC, 10 kc. 0.01% DC. Automatic calibration; operates printer.



**$\Omega$**

**Digital Ohmmeter** Accuracy to 0.01%. Automatic operation; operates printer.



**RATIO**

**Digital Ratiometer** DC to 0.01%. AC to 0.01%. Operates printer.



**f, t**

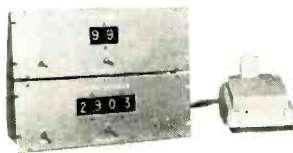
**In-Line Counters** Events-per-unit time.  $\pm 1$  digit accuracy; 100 kc; operates printers. Timer: Universal Counter-Timer.

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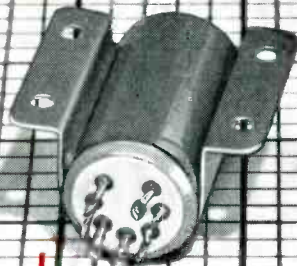
Engineering field offices in major U.S. and Canadian cities.



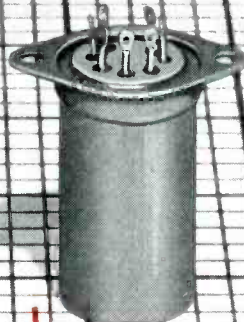
# VERSATILE 60-CPS CHOPPER



Type 175



Type 178



Type 179



Type 176

## Long Life

Here is a miniature 60-CPS chopper of proven life. Manufactured under rigid controls that assure you of uniformity, Type 175 choppers are still operating in the field after 10,000 hours. Life naturally depends on operating conditions; our experience is available to you in planning your circuit to take full advantage of the characteristics listed below.

## Operates in any Position

Quasiresonant drive mechanism operates in any position. As a consequence, you can mount this versatile chopper as is most convenient in packaging your equipment. Where space is limited, use a unit with solder-lug terminals. The chopper is hermetically sealed. Fumes and moisture cannot degrade performance.

## Low Noise

Noise level is inherently low. For still quieter operation, drive-coil leads can be brought in through the top. All types are also available on special order with mu-metal cans.

### Chopper Ratings

Drive	
Frequency	60 ± 6 CPS
Voltage	6.3 ± 0.6 RMS volts
Contacts	
Dwell Time	165 ± 15 electrical degrees
Balance	15 electrical degrees
Phase angle	20 ± electrical degrees
Voltage	0 to 100 DC volts
Current	0 to 2 MA in resistive circuit
Noise	50 RMS microvolts average

Above ratings are for operation in an ambient of 23 C.

### Chopper Application

The chopper is a basic component; a SPDT switch that runs continuously and in synchronism with its drive voltage. It is an excellent modulator; requires no bias to maintain a zero null; produces 100% modulation. It is an equally fine synchronous detector. Choppers are used in such equipments as autopilots, machine controls, test equipments, and stabilized DC amplifiers.

For further details write to



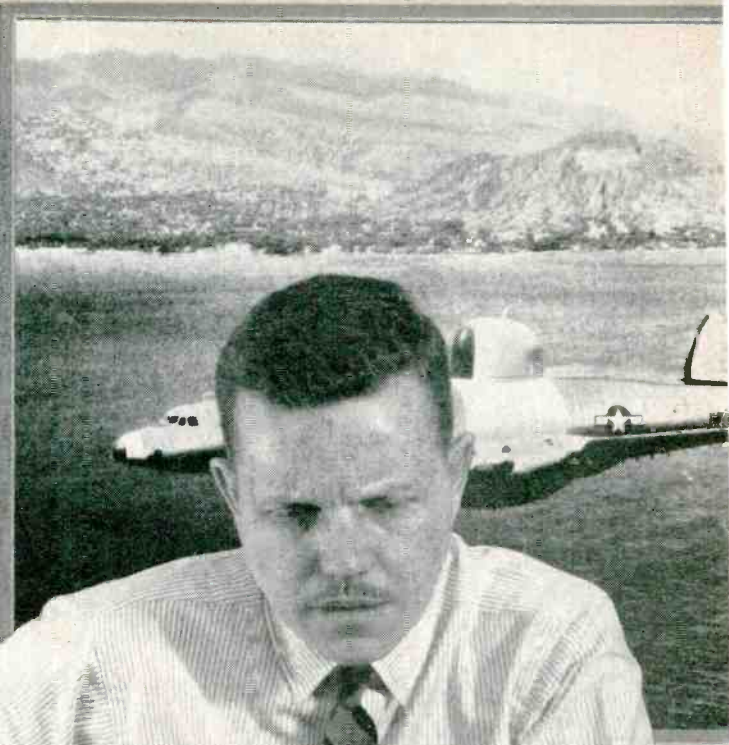
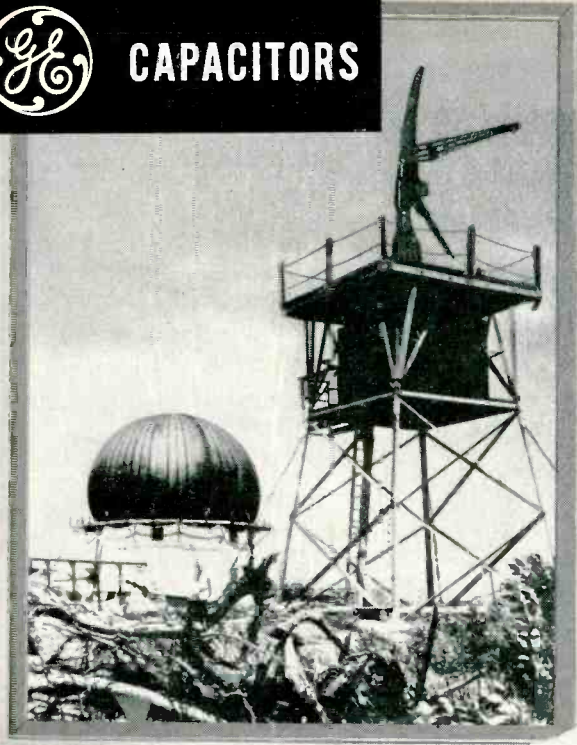
MIDDLE RIVER

BALTIMORE 20, MD.





# CAPACITORS



10 seconds or 10,000 hours, whatever the life span required, G-E pulse-forming network capacitors are engineered for the specific job. The life-test data accumulated over more than twelve years helps G-E engineers meet your special conditions exactly.



# 12 years of test data back your selection of General Electric pulse-forming networks

Capacitor service life requirements from 10 to 10,000 hours filled for hundreds of radar and guided missile applications by accumulated data

Whatever service life your application calls for and whatever the conditions of operation, General Electric can deliver a capacitor pulse-forming network that will give the finest performance for your radar and missile needs.

**The reason** is the wealth of data accumulated by G-E engineers through twelve years of continuous life tests carried out on capacitor pulse-forming networks of practically every type, operating under widely varying conditions of temperature, voltage, and other service factors. From this data and experience, General Electric has established life limitations that enable networks to be produced that will match almost any specification—whether it calls for a service life of 10 hours or 10,000 hours. In addition, to the exacting needs regarding pulse width, rise time, number of pulses per second, and ripple, special requirements also can be met. These include multiple width networks and size reductions based on forced air circulation.

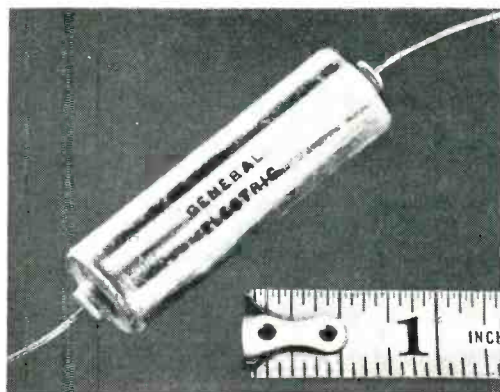
**The secret** of G-E network performance lies in quality manufacture. Capacitor sections are constructed of low-loss kraft paper and high purity aluminum foil. Inductance coils are wound on threaded forms for stability of inductance throughout the life of the unit. Highest quality mineral oil is used for impregnation. Rugged, hermetically sealed cases help protect all components.

**G-E pulse-forming networks** have already proved their dependability in thousands of military installations on aircraft, ships, and on the ground, as well as in highly specialized missile applications. The engineering facilities of the Capacitor Department, Hudson Falls, N. Y., are at your disposal. Your local G-E Apparatus Sales Office will see that you receive application assistance with your network problems. Or write for bulletin GEA-4996 to the General Electric Company, Section 442-32, Schenectady 5, N. Y.

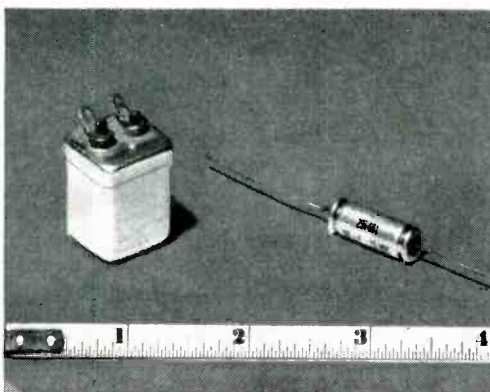
*Progress Is Our Most Important Product*

GENERAL  ELECTRIC

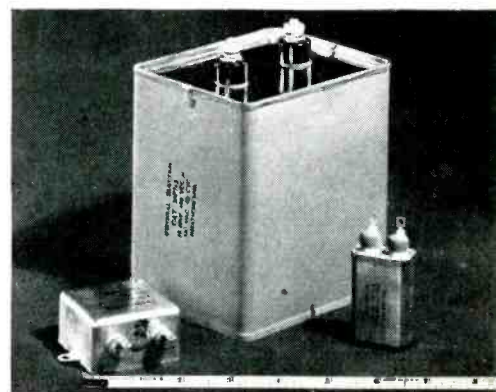
**A FULL LINE OF CAPACITORS FOR THE ELECTRONICS INDUSTRY**



**METAL-CLAD TUBULAR CAPACITORS** for all d-c uses where utmost reliability is required. Ratings: .001 to 1.0 uf, 100-600 v. d-c. Tol:  $\pm 5\%$ ,  $\pm 10\%$ , or  $\pm 20\%$ . Temp. range:  $-55\text{ C}$  to  $+125\text{ C}$  with solid impregnant;  $-55\text{ C}$  to  $+85\text{ C}$  with mineral oil. Write for GEC-987.



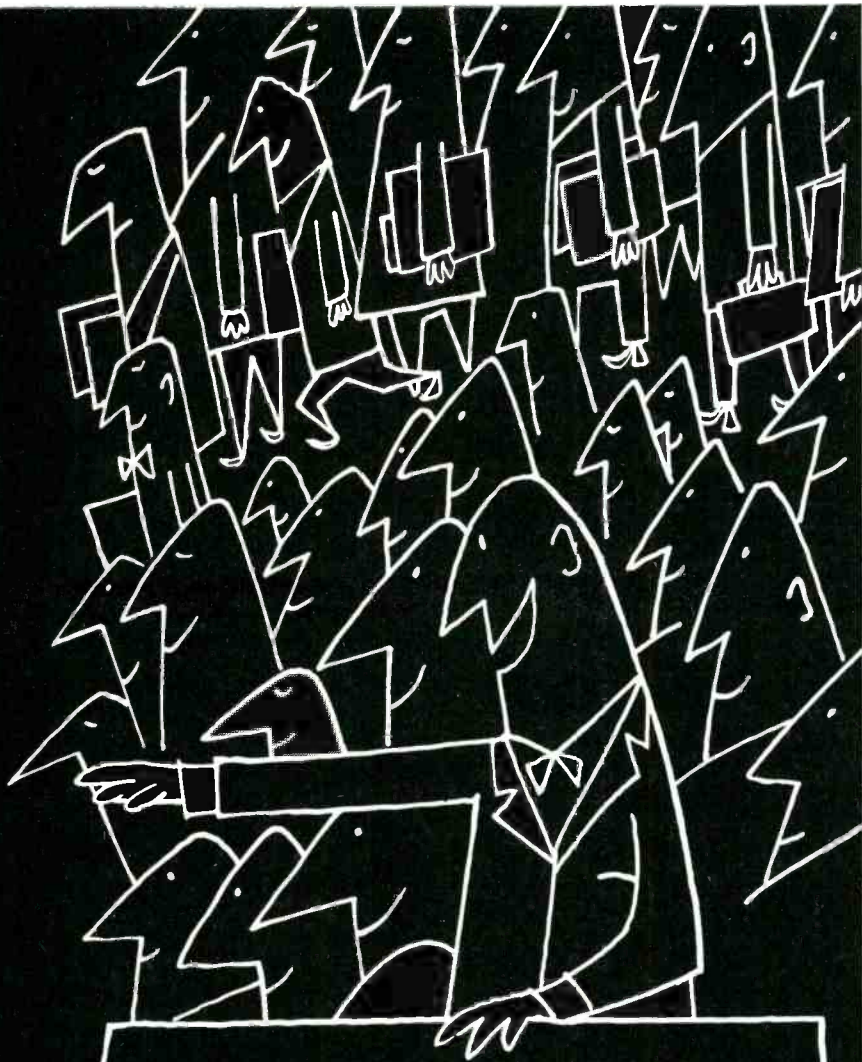
**125 C TANTALUM\* CAPACITORS**—for high speed aircraft and missile systems where quality, long life, and small size are main requirements. In plain or etched foil, and rectangular or tubular designs. Ratings: .25 to 180 uf, 10 to 100 volts. Tolerance:  $+20\%$  (plain foil),  $-15$  to  $+75\%$  (etched). Temp. range:  $-55\text{ C}$  to  $+125\text{ C}$ . Write for GEA-6258. \*Reg. trade-mark of General Electric Co.



**MIL-C-25A CAPACITORS**—for filter, by-pass, and blocking in military equipment. Built to MIL-C-25A specifications. Ratings: .05 to 15 uf at 100 to 12,500 v. d-c in case styles CP50, CP60, CP70 series. Temp. range:  $-55\text{ C}$  to  $+85\text{ C}$ , and  $-55\text{ C}$  to  $+125\text{ C}$ . Write for GEC-810.







### HOW BIG IS **WESCON** ?

More than 30,000 are expected to be drawn to the 670 booths at this year's WESCON. Giant tents outside the Pan Pacific Auditorium will house the overflow of exhibitors, who number 100 more than last year. The Convention will present its program at the Ambassador Hotel concurrently with the Show. 1956 WESCON represents big doings and big business for the electronic industry.

# how August **electronics** merchandises your products and services at the **Wescon Show**

Advertisers in August, *electronics* enjoy three-way merchandising of their products and services during the August 21-24 Western Electronic Show and Convention in the Pan Pacific Auditorium and Annex, Los Angeles. (1) Advertisers announce booth numbers and preview their displays because buyers study the August issue to plan ahead their activities before the hectic show days. (2) Advertisers not exhibiting receive maximum attention for their products and services because all the important people at the Show spend hours with the advertising pages of *electronics*. (3) Advertisers in August, *electronics* who are WESCON exhibitors will receive handsome advertising merchandising displays — the same that made such a hit at this year's IRE Show.

Plan your August, *electronics* advertisement now for best merchandising results. The issue will be in the mail July 26th, well before Show time.

Closing Dates: copy set by publication—**June 25th**  
complete plates—**July 1st**

... booth 1220

# electronics



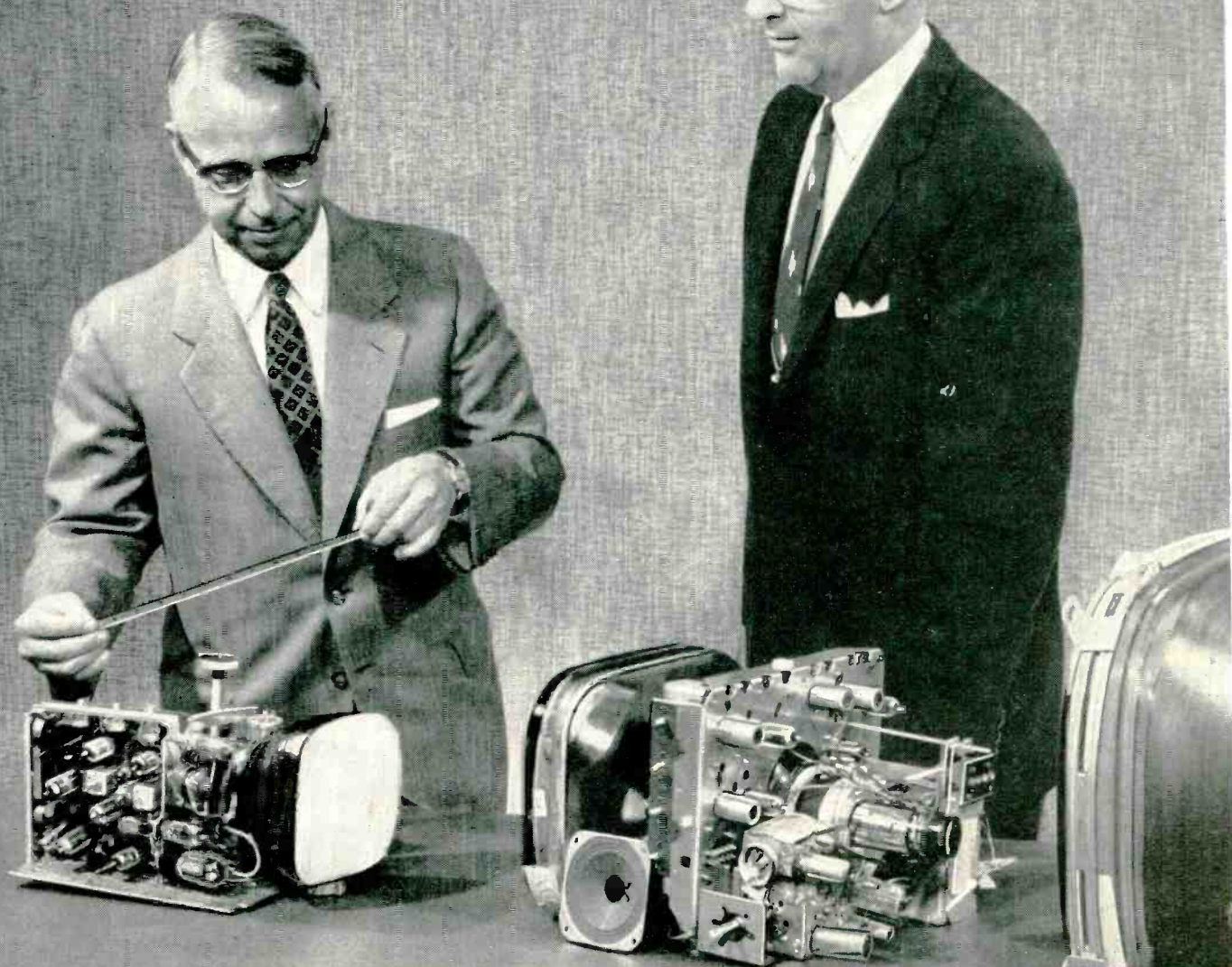
A MCGRAW-HILL PUBLICATION, 330 WEST 42ND STREET, NEW YORK 36, N. Y.



# NOW...G-E SERIES-STRING SMALL TV PORTABLES WITH

New 300 and 450-ma types mean

Dimensions of series-string TV sets are compared by R. V. Bontecou (left), marketing manager, and L. B. Davis, general manager, G-E receiving tubes. General Electric series-string tubes make possible new small size in portable TV receivers—also meet circuit needs up through table models to console sets. Chassis shown in the illustration have 9-, 14-, and 21-inch picture tubes.





# TUBES MAKE POSSIBLE LOW HEAT DISSIPATION!

reduced temperatures, minimum cabinet space!

Series-string tubes for television were pioneered by General Electric, so that designers could match cost-saving with reliable TV performance. Over 50 G-E 600-ma series-string types with uniform warm-up time already are available for use in larger models of television receivers.

Now General Electric targets the needs of the fast-growing market for small second sets and portables with new 300-ma and 450-ma series-string tubes. Power requirements are lower, and less heat is generated. As a result, cabinets can be smaller and lighter than ever before.

The 22 new 450-ma types listed below, include among them a full tube complement for medium-to-small-size series-string receivers. Designers of still more compact sets—down to 8-inch portables—will find that the 8 new 300-ma series-string types plus a 1V2 high-voltage rectifier can be used to make up a complete television circuit.

Ask for G-E series-string tube recommendations to cover your new, small sets now in the drawing-board stage! Address *Tube Department, General Electric Co., Schenectady 5, N. Y.*

## NEW G-E 450-MA SERIES-STRING TUBES

TYPE	PROTOTYPE	TYPE	PROTOTYPE
3AF4-A	6AF4-A	6U8-A	6U8
4BC5	6BC5	8AU8	6AU8
4BN6	6BN6	8BH8	6BH8
4BU8	6BU8	8CG7	6CG7
4CB6	6CB6	8CM7	6CM7
5BQ7-A	6BQ7-A	8CN7	6CN7
5BZ7	6BZ7	9AU7	12AU7
6AQ5-A	6AQ5	17AV5-GA	6AV5-GA
6BK7-B	6BK7-A	17AX4-GT	6AX4-GT
6J6-A	6J6	17C5	50C5
6T8-A	6T8	17DQ6	6DQ6

## NEW G-E 300-MA SERIES-STRING TUBES

TYPE	PROTOTYPE	TYPE	PROTOTYPE
6AU6-A	6AU6	9U8-A	6U8
6CE5 (Note 1)	None	10C8 (Note 2)	None
6CB6-A	6CB6	17H3 (Note 3)	None
7AU7	7AU7	18A5 (Note 4)	None

1. Improved version of 6BC5.
2. Miniature triode pentode, for use in vertical deflection circuit.
3. Miniature damping diode.
4. Octal-base beam pentode. Horizontal sweep tube.

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

162-1A4

# CODE MODULATED MULTIPLE-PULSE MICROWAVE SIGNAL GENERATOR

**Model B 950-10,750 mc**

*Generates multi-pulse modulated carrier for beacons, missiles, radar... provides 5 independently adjustable pulse channels, 4 interchangeable r-f oscillator heads, precision oscilloscope, self-contained power supplies... all in one integrated mobile instrument.*

The Polarad Model B is an essential instrument for testing beacons, missiles, radar, navigational systems such as DME, Tacan, H. F. Loran, etc., where multi-pulse modulated, microwave frequency energy with accurately controlled pulse width, delay, and repetition rate is required for coding.

**A fully integrated self-contained equipment with these features:**

**Four Interchangeable Microwave Oscillator Units**—all stored in the instrument... each with UNI-DIAL control... precision power monitor circuit to maintain 1 mw power output reference level... keying circuit to assure rapid rise time of modulated r-f output... non-contacting chokes.

**Five Independently Adjustable Pulse Channels**—each channel features variable pulse width and delay; has provisions for external pulse-time modulation.

**Precision Oscilloscope with Built-In Wide Band RF Detector** for viewing the modulation en-

velope and accurately calibrating the r-f pulse width, delay, and group repetition rate. Equipped with built-in calibration markers.

**Self-Contained Power Supplies**—Model B operates directly from an AC line through an internal voltage regulator. The coded multi-pulse generator is equipped with an electronically regulated low voltage DC supply. Klystron power unit adjusts to proper voltage automatically for each interchangeable band.

Contact your Polarad representative or write to the factory for detailed information.

## SPECIFICATIONS:

### Frequency Range:

- Band 1 ... 950 to 2400 mc
- Band 2 ... 2150 to 4600 mc
- Band 3 ... 4450 to 8000 mc
- Band 4 ... 7850 to 10,750 mc

Frequency Accuracy ...  $\pm 1\%$

RF Power Output ... 1 milliwatt maximum (0 DBM)

### Attenuator:

- Output Range ... 0 to -127 DBM
- Output Accuracy ...  $\pm 2$ db
- Output Impedance ... 50 ohms nominal

### RF Pulse Characteristics:

- a. Rise Time ... Better than 0.1 microsecond as measured between 10 and 90% of maximum amplitude of the initial rise.
- b. Decay Time ... Less than 0.1 microsecond as measured between 10 and 90% of maximum amplitude of the final decay.
- c. Overshoot ... Less than 10% of maximum amplitude of the initial rise.

### Internal Pulse Modulation:

- No. of Channels ... 1 to 5 independently on or off
- Repetition Rate ... 40 to 4000 pps
- Pulse Width ... 0.2 to 2.0 microseconds
- Pulse Delay ... 0 to 30 microseconds
- Accuracy of Pulse Setting ... 0.1 microsecond
- Minimum Pulse Separation ... 0.3 microsecond
- Initial Channel Delay ... 2 microseconds from sync. pulse
- Internal Square Wave ... 40-4000 pps (separate output)

### Pulse Time Modulation:

- Frequency ... 40-400 cps any or all channels
- Required Ext. Mod. ... 1 volt rms min.
- Maximum deviation ...  $\pm 0.5$  microsecond
- Power Input (built-in power supply) 105/125 v. 60 cps 1200 watts.

Variable width—width of each of 5 pulses can be adjusted independently.

Variable delay—delay between each of 5 pulses can be adjusted independently.



**CODE MODULATED MULTIPLE-PULSE  
MICROWAVE SIGNAL GENERATOR  
Model B**

Pulse-time modulation—input provided in each of 5 pulse channels for external pulse-time modulation.

Variable repetition rate—repetition rate of each group of pulses can be varied.

**AVAILABLE ON EQUIPMENT LEASE PLAN**

**FIELD MAINTENANCE SERVICE AVAILABLE  
THROUGHOUT THE COUNTRY**

**POLARAD**

PROVEN RELIABILITY

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Philadelphia • San Francisco • Syracuse • Washington, D. C. • Westbury • Winston-Salem • Canada, Arnprior, Toronto



# EIMAC X600 Klystron covers 1700-2400mcs at 10kw/cw with less than one watt drive

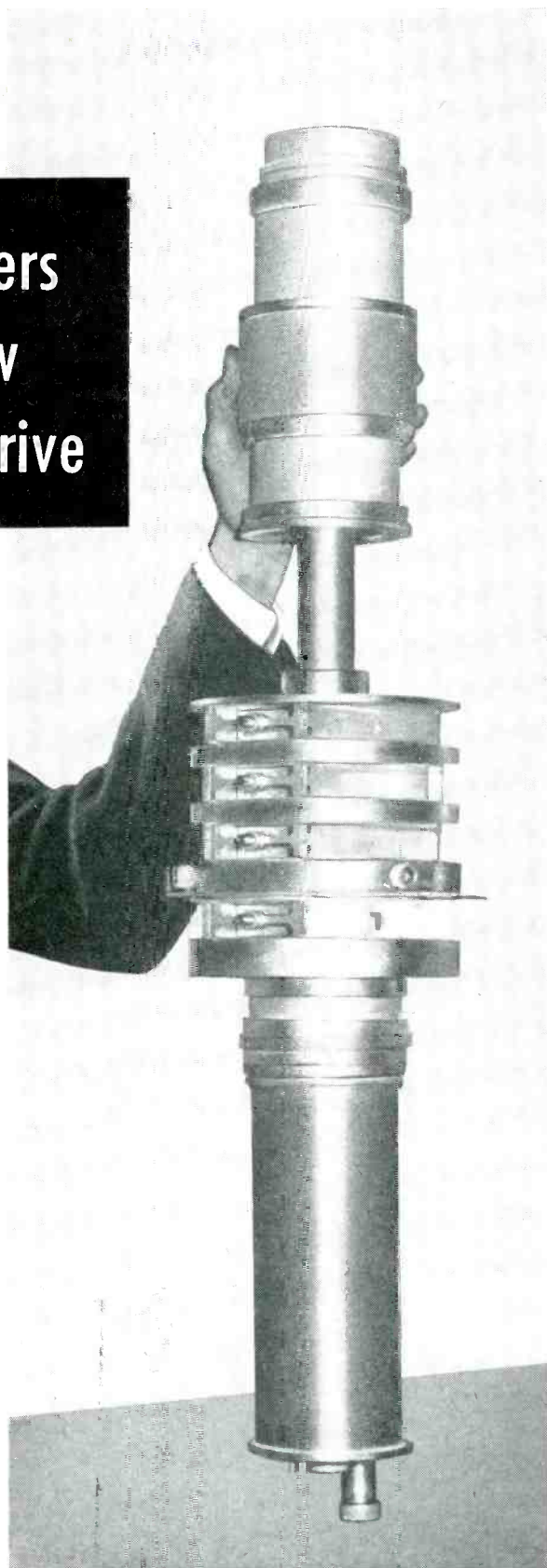
Delivering 10 kilowatts at 1700-2400mcs., the Eimac X600 opens another portion of the spectrum to high power forward-scatter communications. This new four cavity klystron operates at 40% efficiency with power gains up to 50 db.

Exceptionally wide range tuning over 700mc., giving one tube coverage between 1700 and 2400 megacycles, and a large, conservatively rated oxide cathode are bonus features of the Eimac X600. The exclusive Eimac modulating anode makes it desirable for pulse and amplitude modulation applications.

As is the case in all Eimac UHF klystrons RF circuitry is completed outside the vacuum envelope giving equipment manufacturers the exclusive advantages of readily adjustable input and output coupling and individual intermediate cavity loading. Users benefit through accessible tuning elements, ease of maintenance and operating economy.



For information on the X600 and other Eimac klystrons for high power tropospheric scatter and MTI radar systems, contact our Application Engineering Department.

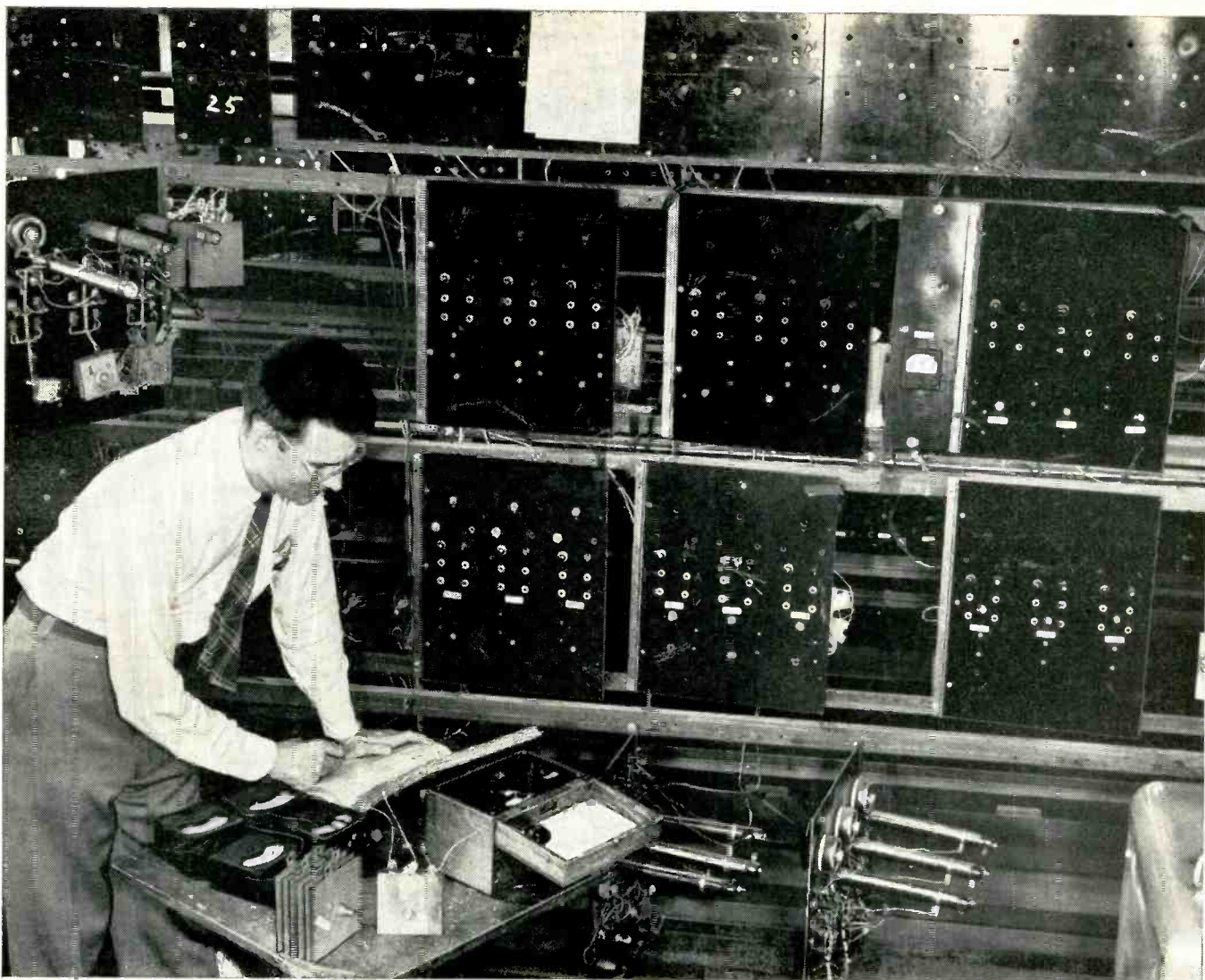


*Eimac*

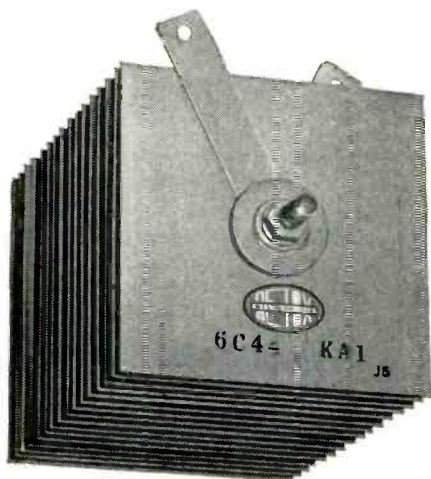
**EITEL-McCULLOUGH, INC.**

SAN BRUNO • CALIFORNIA

The world's largest manufacturer of transmitting tubes



## Life tests of Westinghouse selenium stacks prove lowest forward aging rate in industry



This is another way Westinghouse assures you of product reliability. Life tests are conducted at not less than 35°C ambient. The standard Westinghouse life test method is to operate the stacks continuously at 110% of rated voltage and current output. During the first two years of these tests, practically no increase in forward resistance has occurred. Some stacks have actually decreased in forward resistance during this period.

Such tests establish the quality of the product and the uniformity of cell production. They also prove the superiority of the Westinghouse evaporative process for applying selenium to the cells. This is your assurance of consistent performance for the life of the selenium stack.

For all the facts, call your Westinghouse sales engineer. He'll show you other reasons why it pays to specify Westinghouse selenium stacks.

J-21949

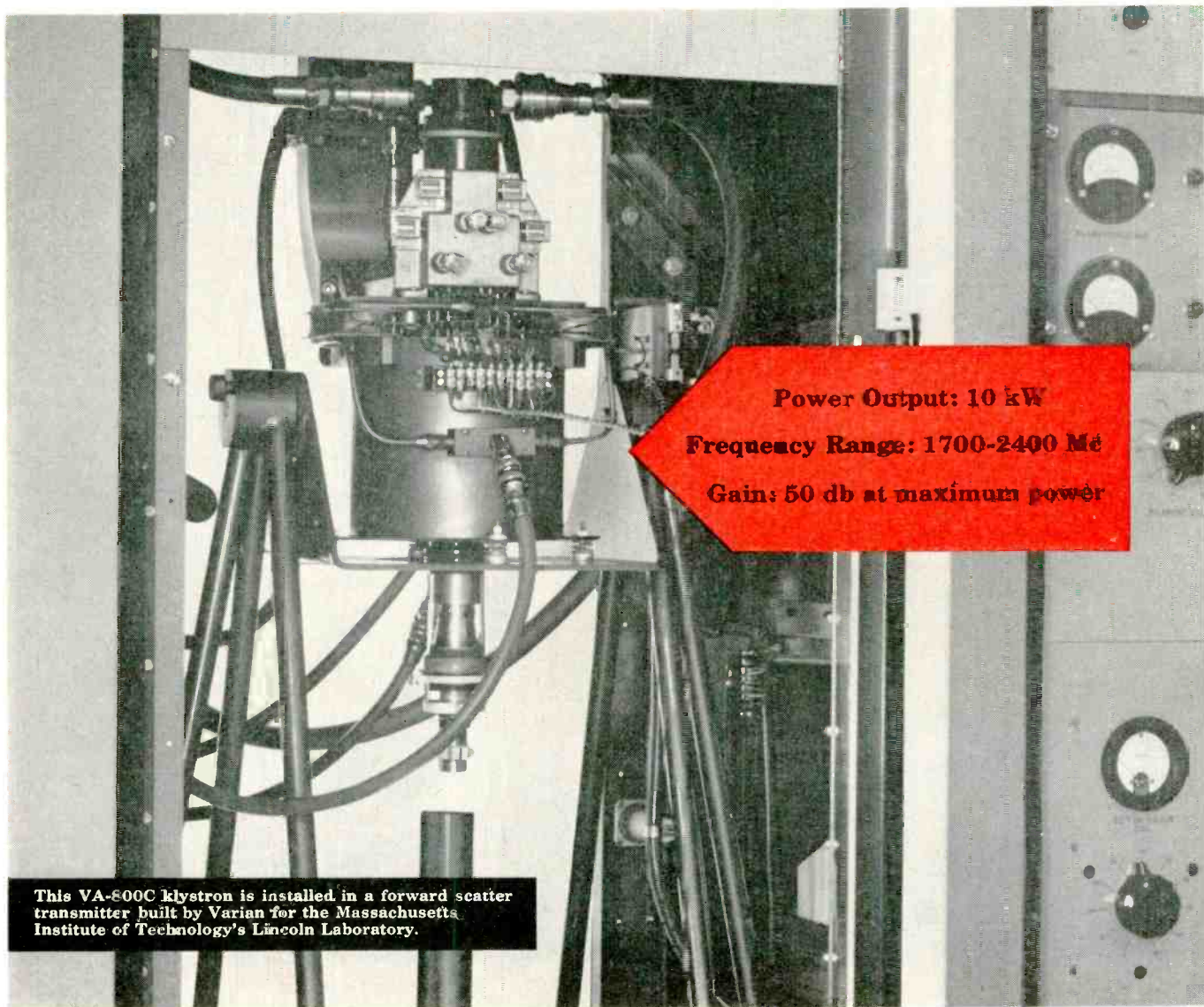
### **WATCH WESTINGHOUSE!**

**WHERE BIG THINGS ARE HAPPENING TODAY!**



# SYSTEM DESIGNERS

now specify VA-800 series klystrons for  
**FORWARD SCATTER COMMUNICATION**



**Power Output: 10 kW**  
**Frequency Range: 1700-2400 Mc**  
**Gain: 50 db at maximum power**

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.

THE  
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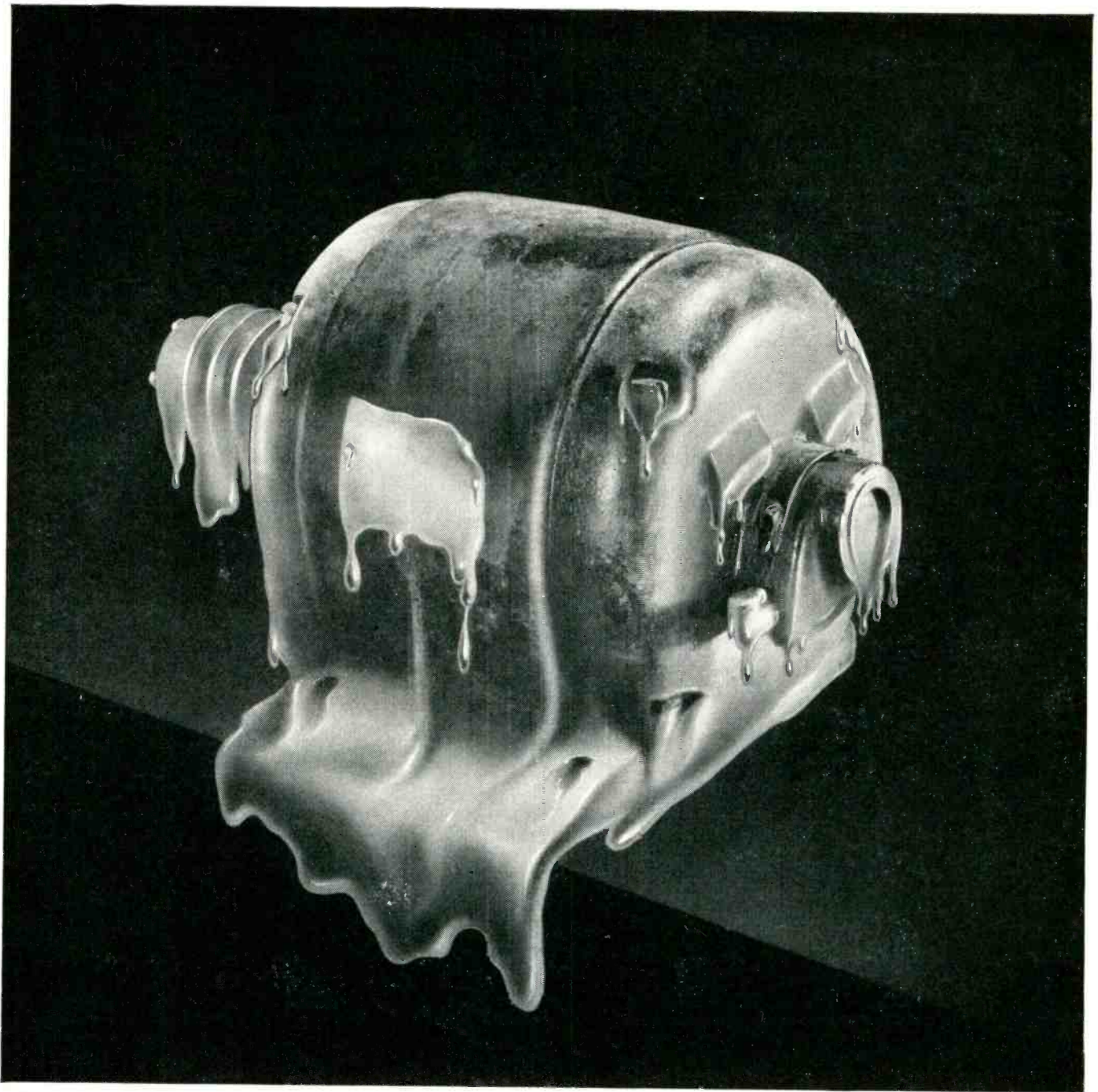


**VARIAN associates**

PALO ALTO, CALIFORNIA

Representatives in principal cities

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If you need to guard against overloads, it'll pay you to use

# Adlake mercury relays



Adlake relays require no maintenance whatever...are quiet and chatterless...free from explosion hazard. Dust, dirt, moisture and temperature changes can't affect their operation. Mercury-to-mercury contact gives ideal snap action, with no burning, pitting or sticking. Time delay characteristics are fixed and non-adjustable.

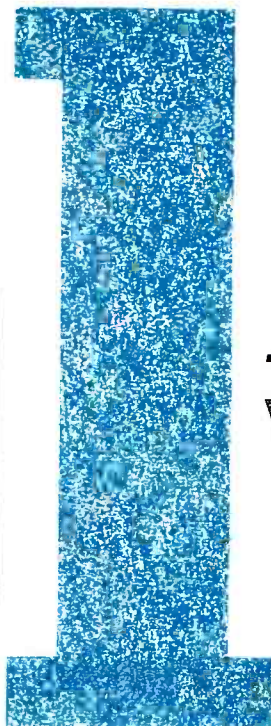
For more information about Adlake Relays, write The Adams & Westlake Company, 1171 N. Michigan, Elkhart, Indiana

**The Adams & Westlake Company**

Established 1857 • ELKHART, INDIANA • New York • Chicago  
the original and largest manufacturers of mercury plunger-type relays







**accuracy,  
0.1 mv to 300 v!**

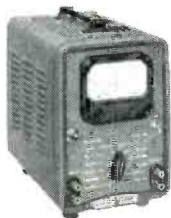
**-hp- 400H High-Accuracy  
Vacuum Tube Voltmeter**

**New! 1% accuracy 50 cps to 500 KC**  
**Frequency range 10 cps to 4 MC**  
**10 megohm input resistance**  
**12 ranges, 0.1 mv to 300 v**  
**Direct readings in volts or db**  
**Functions as stable amplifier**

**OTHER -hp- QUALITY VOLTMETERS**



**-hp- 400AB**, for general ac measurements. Covers 10 cps to 600 KC, 0.3 mv to 300 v. Accuracy  $\pm 2\%$ , 20 cps to 100 KC. 10 megohm input impedance plus 25  $\mu\text{f}$  shunt insures circuits under test against disturbance. Readings direct in volts or dbm. \$200.00



**-hp- 400D**, highest quality, wide range, maximum usefulness. Covers 10 cps to 4 MC, 0.1 mv to 300 v. New amplifier circuit provides 56 db of feedback, (mid-range) for ultimate stability. 10 megohm input impedance prevents disturbing circuits. Sealed or long-life electrolytic condensers; rugged, trouble-free. \$225.00



**-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  $\mu\text{f}$  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

**New -hp- 400H** Vacuum Tube Voltmeter combines broadest usefulness with wide voltage and frequency coverage, and the greatest accuracy ever offered in a multi-purpose voltmeter.

On line voltages of 103 to 127 v, accuracy is  $\pm 1\%$  full scale, 50 cps to 500 KC;  $\pm 2\%$ , 20 cps to 1 MC,  $\pm 5\%$ , 10 cps to 4 MC. Readings are direct in db or volts on 5" mirror scale meter; 12 ranges cover 0.1 mv to 300 v. High 10 megohm input resistance minimizes loading to circuits under test. Stabilized amplifier-rectifier with feedback loop gives high long-term stability; line voltage changes as great as  $\pm 10\%$  cause negligible variation. Overvoltage protection is 600 v on all ranges. Highest quality, rugged construction throughout. \$325.00.

**CALL YOUR -hp- REPRESENTATIVE  
FOR COMPLETE DETAILS**

**HEWLETT-PACKARD COMPANY**

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 CABLE "HEWPACK" • DAVENPORT 5-4451  
 Field Engineers in all Principal Areas

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**Quality, value, complete coverage in voltmeters**



EXTERNAL FIELD REDUCTION OF 10 TO 1 is measured, above, using a magnetic pickup coil and a meter. The housing cover is removed exposing the terminal board. This new stabilizer, like all Sola Constant Voltage Trans-

formers, is a static-magnetic regulator, has no moving parts and requires no manual adjustments or maintenance. It provides automatic, instantaneous voltage regulation within  $\pm 1\%$ , even with primary voltage swings of  $\pm 15\%$ .

## New Sola Constant Voltage Transformer Reduces External Field by 90%

An improved Sola Constant Voltage Transformer design retains all the advantages of the Sola CV principle while providing a 90% reduction in external field and up to 53% lighter weight.

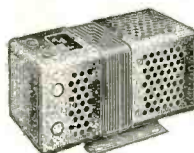
In applications employing "magnetic field-sensitive" electronic equipment, such as high-gain audio circuits, the new Sola CV design offers important advantages. Cathode ray tubes—high-gain amplifiers—microwave plumbing—may be mounted close to the transformer;

usually magnetic shields may be eliminated.

The new housing has a smooth overall contour which minimizes dust accumulation. It is finished in attractive gray hammerloid.

The new Standard Type Sola CV transformer is available in 3 capacities—250, 500, and 1000va. For specific advice on your particular application, contact your Sola representative listed below.

**SO LA** *Constant Voltage*  
**TRANSFORMERS**



Write for Bulletin CV-170D  
SOLA ELECTRIC CO.  
4633 W. 16th Street  
Chicago 50, Illinois

CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • LIGHTING TRANSFORMERS for All Types of Fluorescent and Mercury Vapor Lamps. • SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414 • NEW YORK 35: 103 E. 125th St., TRofalgar 6-6464 • PHILADELPHIA: Commercial Trust Bldg., RIttenhouse 6-4988 • BOSTON: 272 Centre Street, Newton 58, Mass., Bigelow 4-3354 • CLEVELAND 15: 1836 Euclid Ave., PRospect 1-6400 • KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4382 • LOS ANGELES 23: 3138 E. Olympic Blvd., ANgelus 9-9431 • TORONTO 17, ONTARIO: 102 Laird Drive, MArtyfair 4554 • Representatives in Other Principal Cities

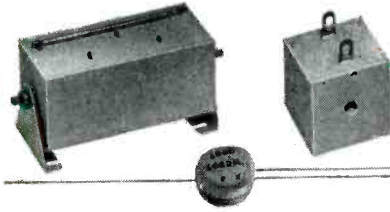


### Standard Heavy-Duty Stacks



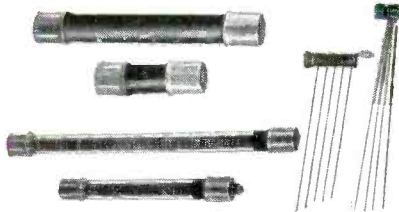
Extremely long life . . . with no maintenance problems. Thousands of voltage/amperage combinations available. Sizes from 11/16" square cells to giant 6" x 10" plates . . . Federal can provide a power rectifier for almost every type of industrial and military equipment.

### Encapsulated Rectifiers



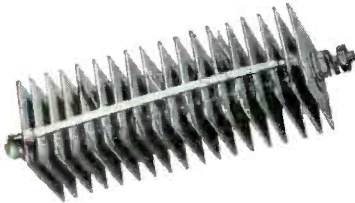
Maximum resistance to impact, acceleration, and vibration. Complete protection from harmful atmospheric conditions. Other electronic components may be encapsulated with rectifier to form a rugged, replaceable "potted" circuit.

### High-Voltage Stacks



250 to 5000 volts/5 to 40 milliamps. Encased in paper, glass, Bakelite, nylon, or metal tubes. Simple fuse-clip mounting of ferrule terminal types. Also, hermetically-sealed types. Uses: CRT high-voltage supplies, photoflash, insulation testers, etc.

### High-Temperature Stacks



For maximum operating life at ambient temperatures up to 150° C. A full range of voltage/current combinations for medium and high temperatures. Ideal for aircraft and military equipment.

### Magnetic Amplifier Rectifiers



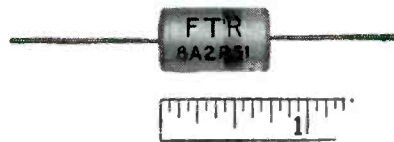
Selenium cells and stacks precisely manufactured, tested, and selected to assure a high degree of stability and very low reverse current. For use with saturable reactors, regulated DC power supplies, etc.

## INDUSTRY and DEFENSE

LOOK TO *Federal*  
FOR THE FINEST IN  
SELENIUM RECTIFIERS

*Why*

### Selenium Contact Protectors



Extend contact life by over 1000 times. Used in inductive circuits to prevent erosion of switch contact surfaces . . . to suppress arcing and rf transients. Minimum effect on release time. Hermetic sealing meets JAN specs. For relays, electromagnets, and telephone systems.

### Pioneering Leadership

Federal is the *original* supplier of selenium rectifiers in the United States . . . leading the field in research, development and production.

### Facilities and Service

Federal's facilities can handle the largest and most complex orders . . . satisfy the rush requirements of customer production peaks. Every order—large or small—is processed through a skilled engineering staff.

### Quality and Economy

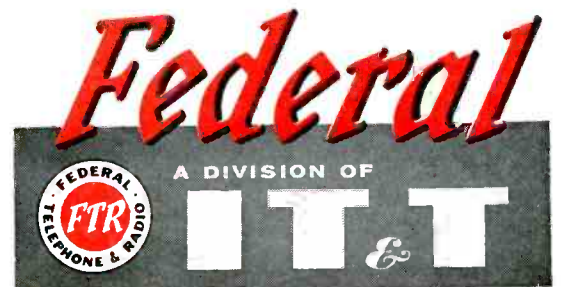
Federal's modern fabrication methods, mass production, intensive quality control, and rigid testing assure a product of highest quality and greatest economy.

LET US KNOW your AC-to-DC conversion problems. For further information on Federal Industrial Rectifiers, call NUtley 2-3600, or write to Dept. F-813A

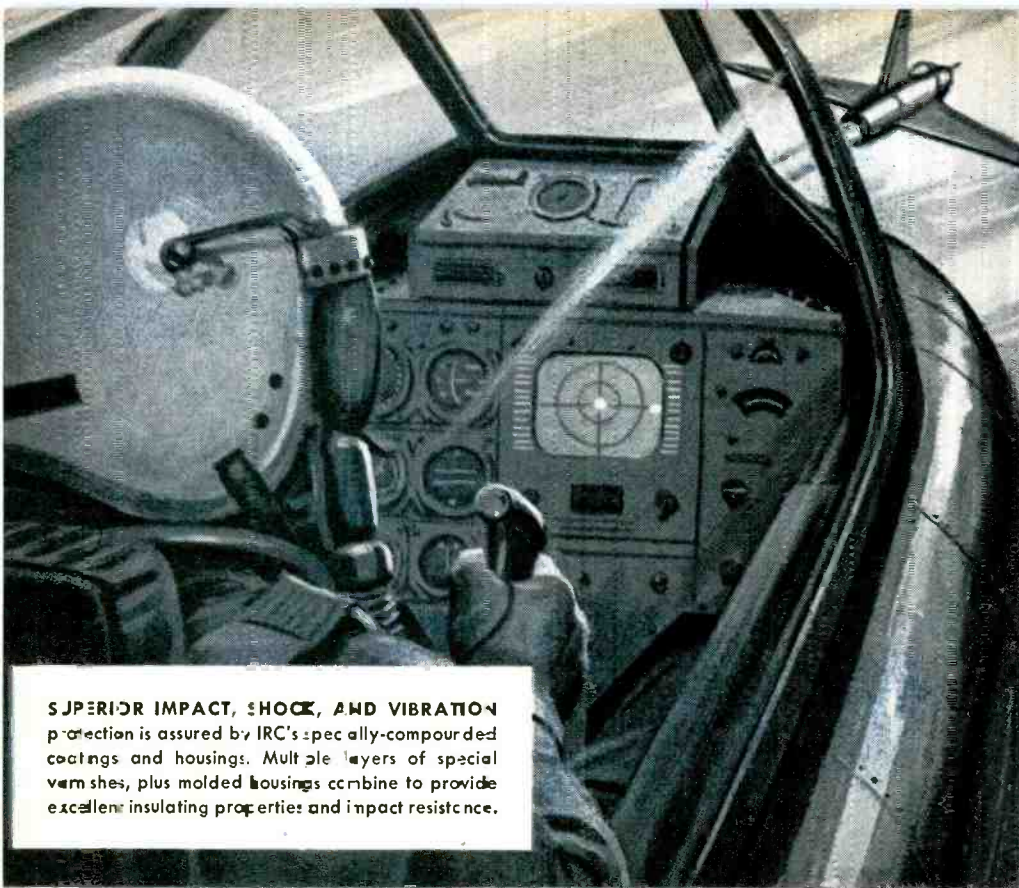
## Federal Telephone and Radio Company

A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION  
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In Canada: Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal, P. Q.  
Export Distributors: International Standard Electric Corp., 67 Broad St., New York



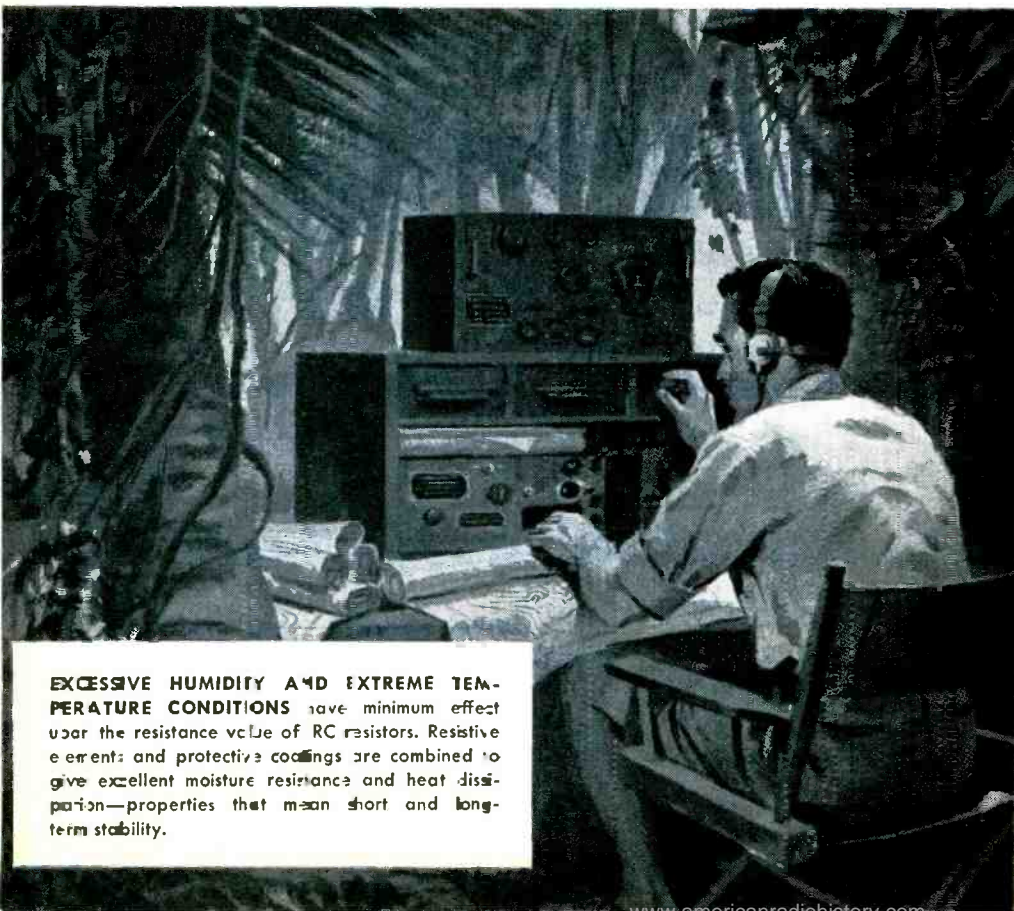




**SUPERIOR IMPACT, SHOCK, AND VIBRATION** protection is assured by IRC's specially-compounded coatings and housings. Multiple layers of special varnishes, plus molded housings combine to provide excellent insulating properties and impact resistance.

In a sense, a resistor is simply a mechanical device for packaging ohms. So it's easy to see why the materials entering into the mechanical package are extremely important to resistor performance. That's why more than one-third of the 200 technicians at IRC are occupied in developing insulating coatings and housings that give *extra* protection

## Extra **IRC**<sup>®</sup> resistor protection pays off ...but you pay no more for it!



**EXCESSIVE HUMIDITY AND EXTREME TEMPERATURE CONDITIONS** have minimum effect upon the resistance value of IRC resistors. Resistive elements and protective coatings are combined to give excellent moisture resistance and heat dissipation—properties that mean short and long-term stability.

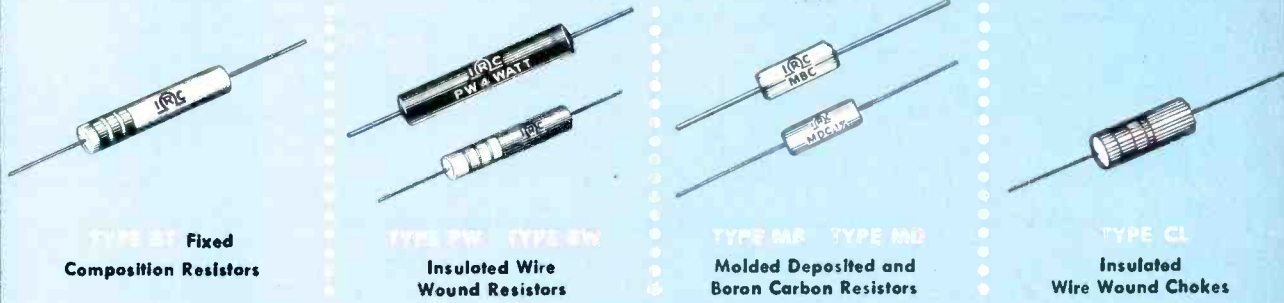
against mechanical damage, humidity effects, and temperature variations.

Out of this never-ending activity come coatings and molding compounds that are custom-tailored for each and every type of resistor. As a result, every IRC resistor gives far more protection from damage and ambient conditions than any other of its type!



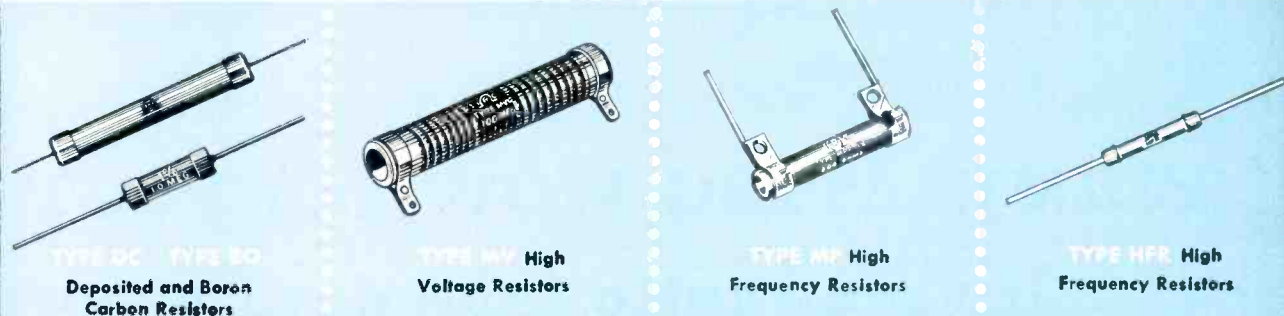
# How IRC resistors give added protection

## molded resistors



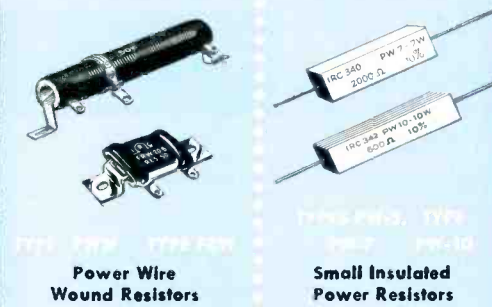
Plastic compounds used in IRC molded resistors are all specified by IRC to combine excellent insulating properties, moisture resistance, and impact resistance.

## varnish coated resistors



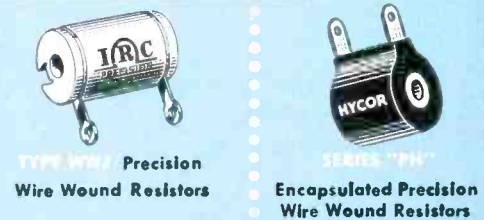
Where mechanical damage isn't a major problem, IRC resistors give excellent protection at lower cost through the use of IRC-developed varnish coatings. Because several layers are applied and cured under specially controlled conditions, these resistors offer superior humidity and temperature characteristics.

## cement insulated resistors



The special cement coatings used to insulate IRC power resistors give excellent mechanical protection. Type PW Resistors, for example, withstand a transverse pressure of 25 pounds. These exclusive IRC cements also permit maximum heat dissipation and give superior moisture protection.

## impregnated and encapsulated resistors



Type WWJ Resistors feature a special compound that thoroughly impregnates the winding and remains stable at varying temperatures. This compound not only gives maximum mechanical protection, but also serves as an insulating barrier and minimizes moisture effects. In IRC encapsulated resistors, the same epoxy resin is used for both the core and the outer housing, thus minimizing the effects of expansion and contraction due to various temperature conditions. This epoxy resin also imparts excellent insulating and moisture-resistant properties to the housing.

Insulated Composition Resistors • Deposited and Boron Carbon Resistors • Power Resistors • Voltmeter Multipliers • Ultra HF and Hi-Voltage Resistors.

Low Wattage Wire Wounds • Resistance Strips and Discs • Selenium Rectifiers and Diodes • Hermetic Sealing Terminals • Insulated Chokes • Precision Wire Wounds.



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Hycor Company, Inc., Vega Baja, Puerto Rico

## INTERNATIONAL RESISTANCE COMPANY

Dept. 234, 401 N. Broad St., Philadelphia 8, Pa.

In Canada: International Resistance Co., Ltd., Toronto, Licensee

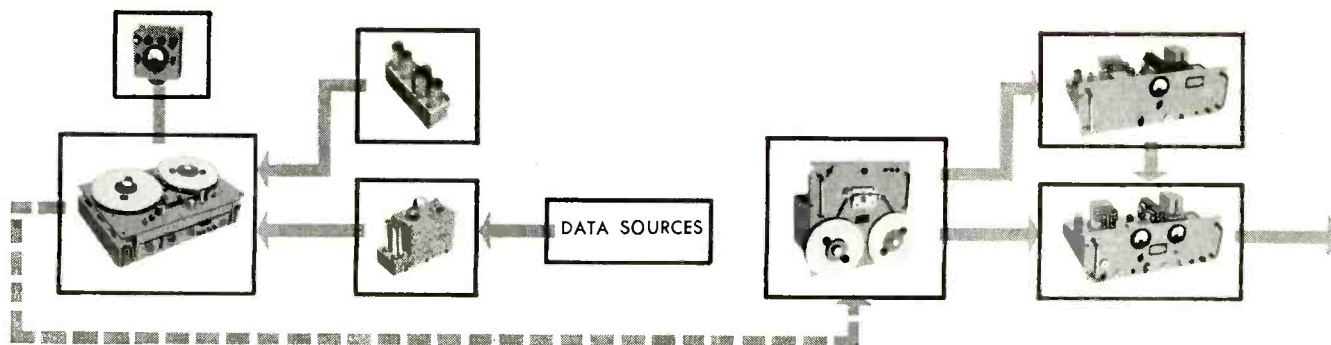
Please send technical bulletins describing  Fixed Compositions  Deposited and Boron Carbons  Low Power Wire Wounds  Power Wire Wounds  High Voltage Types  High Frequency Types  Insulated Chokes  Precision Wire Wounds  Encapsulated Precisions

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City \_\_\_\_\_ State \_\_\_\_\_



Block diagram of a typical FM carrier record-playback system, utilizing electronic wow and flutter compensation.

# ELIMINATING WOW and FLUTTER in magnetic tape data recording

## *"brute force vs. compensation"*

The careful transport design that reduced wow-and-flutter to a negligible factor in audio recording met with little success in critical data recording . . . despite superhuman efforts directed toward "perfect" transport design.

It isn't too difficult to see that even if a perfect transport were devised, it would be extremely costly, and limited to operation under only the most highly controlled conditions. That's why Davies bypasses this "head-on" or "brute-force" approach completely, and uses, instead, the surprisingly simple technique of *electronic* wow and flutter compensation.

As incorporated into a Davies magnetic tape data recording system, compensation *uses* wow

and flutter to eliminate itself. A constant frequency reference signal is recorded simultaneously with the data signals on an adjacent channel. Any tape speed irregularity frequency-modulates the reference signal. On playback, the discriminated reference signal is merely added out of phase to the data signals, almost eliminating first order wow-and-flutter problems.

With compensation, overall system performance is never dependent on the transport. For that matter, many a job for which 0.1% rms wow and flutter recording without compensation would not prove sufficient, can easily be accomplished with a 0.5% rms machine.

The illustration shows a sine



Oscillograph of sine wave, without (left) and with (right) compensation signal subtracted.

wave, recorded on a transport with deliberately introduced 1% peak-to-peak wow and flutter. The uncompensated sine wave is to the left, and the compensated sine wave to the right of the line.

Further information on the role of compensation in magnetic tape data recording is provided in Bulletin 2901, "Wow and Flutter Compensation In Magnetic Tape Data Recording (FM Carrier Systems)", available on request to Davies Laboratories, Inc.

 **LABORATORIES  
INCORPORATED**  
4705 Queensbury Road • Riverdale, Maryland



## Epoxy strengthens accelerometer

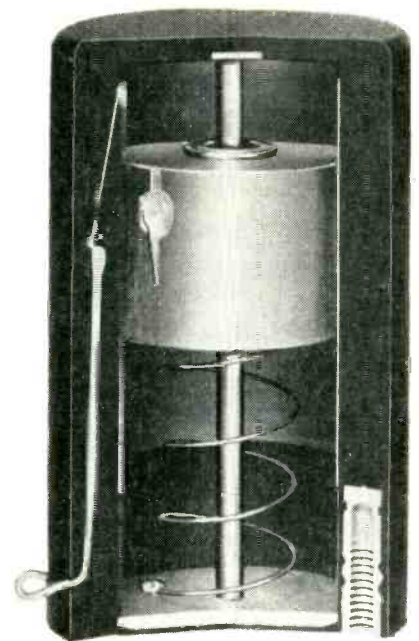
# For violent aircraft maneuvers

This accelerometer or transducer is vital to the fire control mechanism of high-speed military aircraft. As part of an automatic computer, it measures rate of velocity change. The job demands absolute dependability.

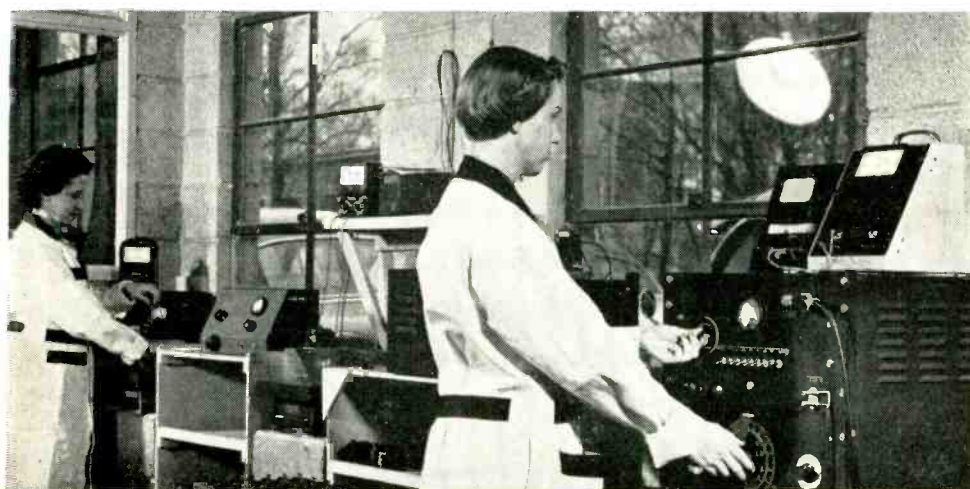
To withstand the mechanical and thermal shocks of aircraft operation, the accelerometer is encapsulated in a hermetically-sealed housing made from a Rezolin compound based on BAKELITE Brand Epoxy Resin. Thousands of fine wire windings are held firmly and safely in position because this resin is compounded to match the thermal expansion characteristics of the assembly's working elements.

Encapsulation and sealing with compounds based on BAKELITE Epoxy Resin is a fast, simple operation; the liquid resin, mixed with its liquid hardener, is poured into place. It quickly cures into a hard, strong structure with outstanding dimensional stability.

Other advantages of BAKELITE Epoxy Resins include excellent adhesive properties, resistance to chemicals and moisture, high dielectric strength, and a wide operating temperature range. As a result, these materials are finding increasingly successful uses similar to the one described here.



The RAM accelerometer is a uniquely designed, extremely low-friction type. Hermetic sealing with Rezolin compounds of BAKELITE Epoxy Resin provides a constant self-damping factor over a wide altitude temperature range. In cross section above, vertical white lines marking cylinder walls are formed by thousands of fine wire windings firmly embedded in epoxy.

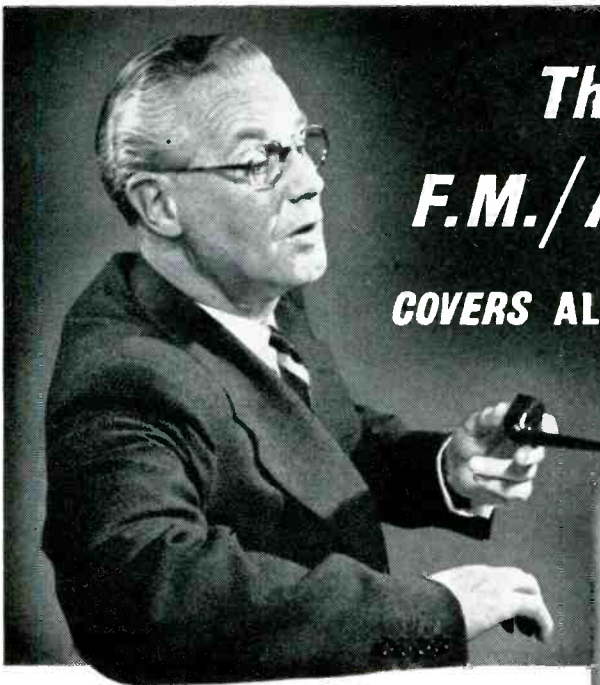


Testing vibration characteristics of accelerometers at the Ram Meter factory. Compounds formulated by Rezolin, Inc., Los Angeles 45, Calif., for Ram Meter Inc., Ferndale 20, Mich.



**BAKELITE COMPANY**, A Division of Union Carbide and Carbon Corporation UCC 30 E. 42nd St., New York 17, N. Y.

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC



# *This* **MARCONI** *F.M./A.M. Signal Generator* **COVERS ALL MOBILE COMMUNICATION BANDS**



The new Marconi Signal Generator type 1066/1 meets all requirements for the design and maintenance of f.m. equipment in the range 10-470 Mc. Here is a precision Marconi instrument for an exacting job.

The oscillator works on fundamentals throughout and there are no spurious submultiple outputs; its temperature compensation and fully-regulated plate and filament supplies give excellent frequency stability. A magnetically-biased ferrite frequency modulator ensures rock steady deviation characteristics. Other major features are the Marconi-patented contactless range turret and a 50Ω piston attenuator which is truly resistive. Engineers will appreciate the separate incremental frequency controls with meter calibration; these enable precise f.m. carrier shifts of as little as 1 kc in 450 Mc without readjustment of main frequency control.

## **F.M./A.M. SIGNAL GENERATOR TYPE 1066/1** **Abridged Specifications**

Frequency Range: 10 to 470 Mc in five bands—all on fundamentals • Frequency Stability: Better than 0.0025% per 10 minutes period after warm-up • Modulation, F.M.: 0 to 20 and 0 to 100 kc deviation monitored and continuously variable • Modulation, A.M.: 0 to 20 and 0 to 80% depth, monitored and continuously variable • Modulation Frequencies: 1 and 5 kc • Distortion due to Modulator: Less than 1% • Output: 0.1  $\mu$ V to 100 mV across a 500 termination • Output Accuracy: Incremental, 0.2 dB; within 2 dB overall • Leakage: Negligible; allows full use of 0.1  $\mu$ V output • Incremental Frequency Controls: Variable, 0 to  $\pm$ 100 kc. Stepped,  $\pm$  5, 10 and 15 kc. • Tubes: 5Z4G, 6AK6, 6CD6G, 6AK5, OB2, 5861, 6C4, 6L6G, 12AT7.

MARCONI F.M. DEVIATION METERS 791C AND 934 ARE COMPANION INSTRUMENTS

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- ⑥ SUPER DURABILITY
- ⑦ VIBRATION RESISTANCE
- ⑧ MAXIMUM RIGIDITY
- ⑨ ECONOMY AND PROMPT DELIVERY

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Consult E-I First

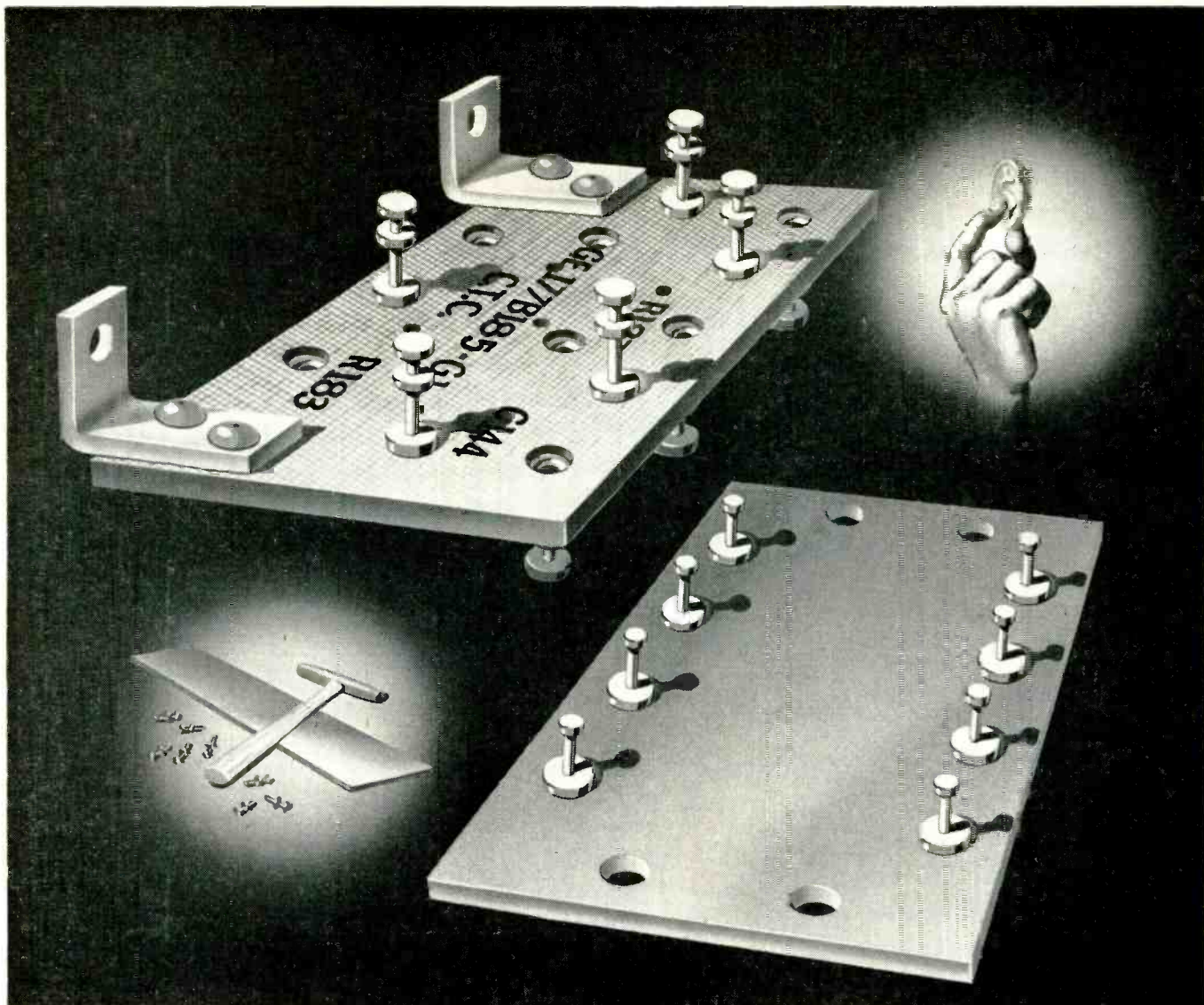
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## Make or buy — which is best for you?

You'll make out better if you let CTC make your terminal boards. Why? The answer is simple.

CTC is equipped to produce quality terminal boards economically. The two key words in that sentence are "quality" and "economy." Here's how CTC can guarantee both.

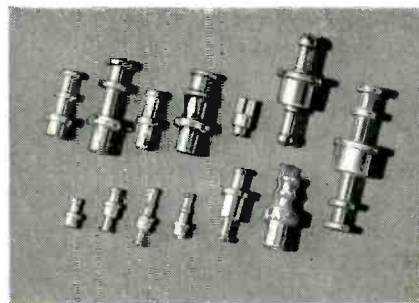
Our swaging machines use tools we designed ourselves that prevent cracked boards and "cracked" rivets. Each terminal is fastened securely — *and carefully*. CTC terminal boards have no "weak spots".

Our finishes and coatings are applied smoothly. There are no wrinkles or heavy deposits. CTC terminals are selected from certified stock that is free from defects. CTC guarantees the terminals themselves — even to the thickness of plating!

The result of this is you are *sure* of the finest terminal boards in the quantity you want them in — and at a price you couldn't duplicate if you made them yourself. Get all the facts. Write for specifications and prices. You'll

agree, you'll make out better if CTC makes your boards. Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge 38, Mass. On the West Coast contact E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles 16, and 61 Renato Court, Redwood City, California.

A LARGE VARIETY OF CTC SOLDER TERMINALS is available ranging from the miniaturized to the larger regular type. Each can be obtained in a variety of shank lengths and finishes and coated with water dipped lacquer for protection during storage.



# CTC

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*makers of guaranteed electronic components  
custom or standard*







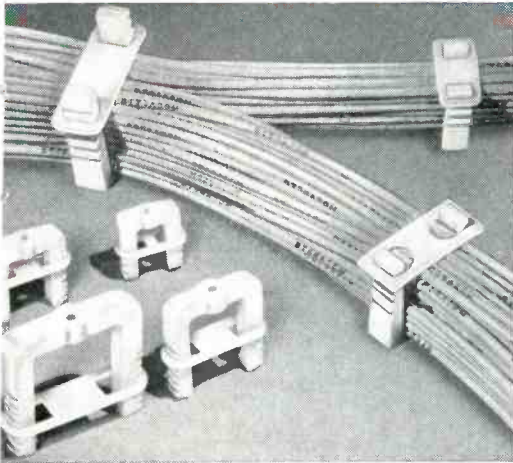
Better Things for Better Living  
... through Chemistry

# ELECTRONIC DESIGN

# NEWS

No. 6-56

PROPERTY AND APPLICATION DATA  
ON THESE VERSATILE ENGINEERING MATERIALS:  
"ZYTEL," "ALATHON," "TEFLON," "LUCITE."



Type-U clamps manufactured by Dakota Plastics Co., Compton, California.

## Type-U clamps of "Zytel" save time and money in wire bundle installations

Combining the characteristics of heat stability, flexibility and impact strength, Du Pont's "Zytel" nylon resin is now being molded as a clamp assembly for holding wire bundles. This clamp makes it unnecessary to tie the bundles, a practice which often resulted in cutting through the insulation.

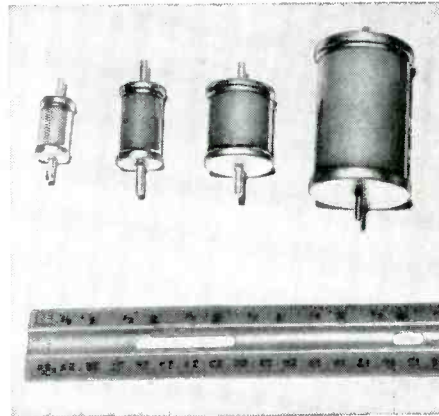
These clamps cut installation and rewiring costs by simplifying application and reducing tool requirements. Fuel resistance of "Zytel" makes these clamps especially useful in aircraft and automobile manufacture.

Du Pont "Zytel" may be just the material you need to solve a design or operation problem. Further data on this engineering material—property tables, typical applications, and production techniques — are available.

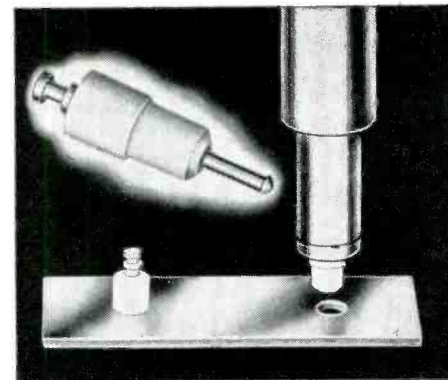
### NEED MORE INFORMATION?

CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

## Superior capacitor dielectrics made possible by unique properties of TEFLON®



These typical capacitors of "Teflon" range in size from .001 mfd at 24,000 volts to .0004 mfd at 6,000 volts. (Manufactured by Condenser Products Co., Division of New Haven Clock and Watch Co., New Haven, Connecticut.)



Standoff and feed-through terminals of "Teflon" are constructed in both miniature and sub-miniature sizes. They provide economy by reducing installation time and assembly costs. These terminals of "Teflon" are one-piece construction and can be simply and permanently mounted into chassis holes by press fitting, using an inexpensive insertion tool—no other hardware is needed. ("Press-Fit" terminals manufactured by the Sealectro Corporation, New Rochelle, N. Y.)

The physical, chemical, and electrical properties of Du Pont "Teflon" tetrafluoroethylene resin offer high insulation resistance at high temperatures. "Teflon" remains flexible through a wide temperature range, from a high of 500°F. to -450°F. It is inert to virtually every commercially employed chemical or solvent.

"Teflon" has zero moisture absorption by A.S.T.M. test, good mechanical strength, low dielectric absorption, small voltage-derating factor for high-temperature operation, high insulation resistance, and a low loss factor. In combination with other materials, "Teflon" is used for power and transmitting applications and for pulse-forming networks.

The properties of "Teflon" are applicable to a variety of uses in the electronic field — in applications where miniaturization and compactness of design are essential, and for uses where equipment is exposed to corrosive action. "Teflon" is unaffected by sunlight or outdoor weathering. Specific electrical uses include insulation and molded parts for all types of motors, transformers and other equipment; and coaxial cables for radar and television.

Complete property and application data on this versatile Du Pont engineering material are available.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department  
Room 226 Du Pont Building, Wilmington 98, Delaware.

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

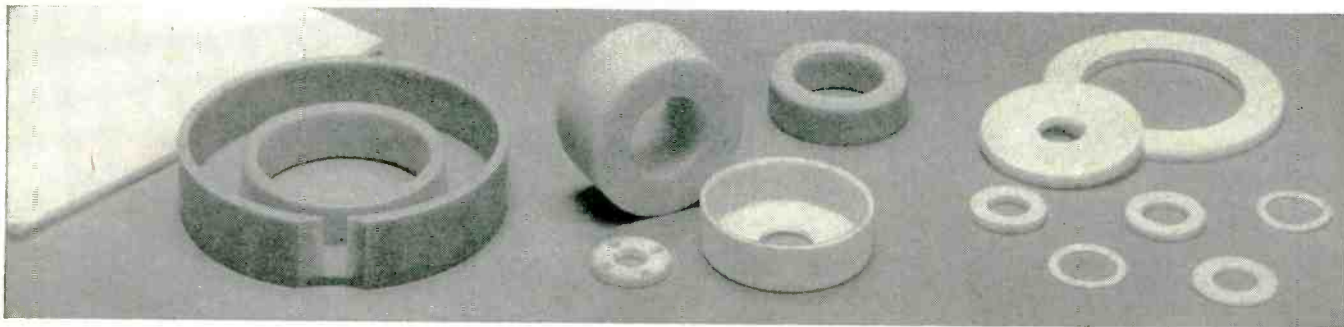
Please send me complete property and application data on Du Pont "Teflon"   
"Zytel"

I am interested in evaluating these materials for \_\_\_\_\_

Name \_\_\_\_\_  
Firm Name \_\_\_\_\_  
Position \_\_\_\_\_  
Type of Business \_\_\_\_\_  
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**DON'T GIVE UP WITHOUT TRYING**



**AN R/M Teflon\* PRODUCT**

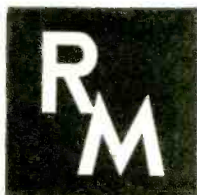


What are you striving for—product improvement?—better equipment performance?—a more economical process? A product made of "Teflon" by R/M could well be the missing link you're seeking. For R/M has been working with this wonder plastic ever since it was produced and, with it, has solved some of the very toughest problems encountered in recent years by electrical and electronics engineers.

It is quite conceivable that R/M has already faced your particular problem and come up with a solution to it. So take advantage of the skill, experience and unmatched help that R/M can offer

you. The many different products pictured indicate R/M's versatility in "Teflon" manufacture. We can fabricate to your own specifications or supply you with "Teflon" in the form of rods, sheets, tubes or tape in 13 colors conforming to military standard color code. For further information, write today.

**Properties of "Teflon":** High dielectric strength • Moisture absorption zero • Unaffected by weather • Excellent heat stability up to 500° F. in continuous operation • As tape, leaves no carbon residue along the discharge path • High impact resistance • Nonadhesive • Stretches easily • Tensile strength 1500-2500 psi. *\*Du Pont trademark*



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plus size and weight advantages. The lower  
losses and greater flux carrying capacity of  
Moloney HyperCores guarantee performance  
which has become the standard of the industry.

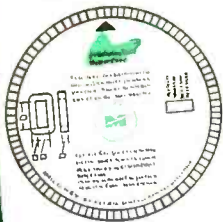
Specify Moloney HyperCores to complement  
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ME56-1

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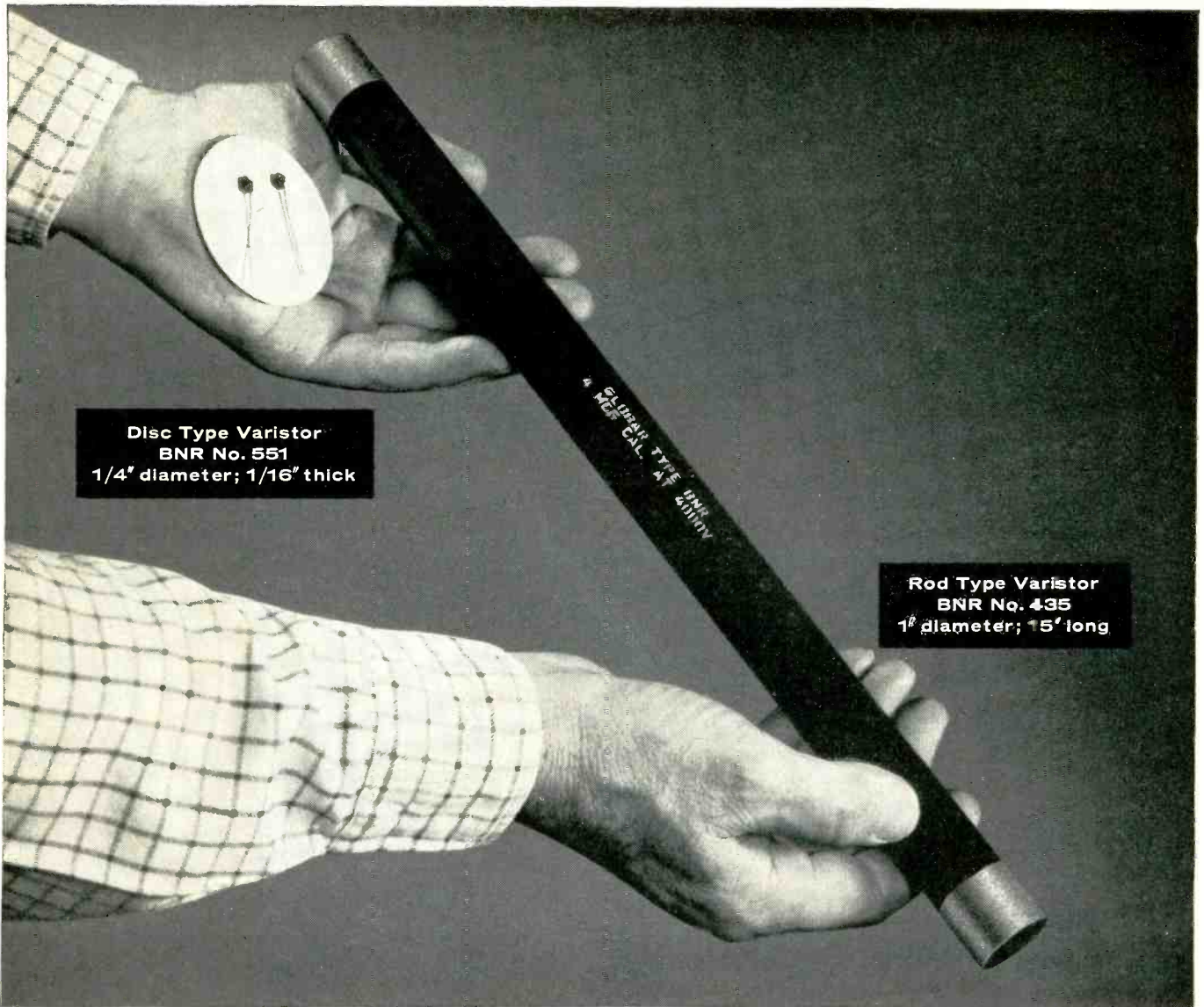
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CATALOG SR206...**

provides complete data including performance characteristics, sizes, weights, list prices and quantity discounts on cores for electronic applications. Send for your free copy today!



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**Disc Type Varistor**  
**BNR No. 551**  
 1/4" diameter; 1/16" thick

**Rod Type Varistor**  
**BNR No. 435**  
 1" diameter; 15" long

## Amplifiers to X-rays...

# **GLOBAR**® *Varistors solve circuit problems*

**FROM AMPLIFIER VOLTAGE** control to X-ray equipment protection, it takes a wide range of body sizes to satisfy all of the circuit applications for voltage sensitive resistors.

**TYPICAL OF THE RANGE** of body sizes available in GLOBAR® Type BNR Varistors are the two varistors pictured above. The miniature disc varistor, Type 551BNR, is used in low voltage control circuits... the large rod varistor, Type 435BNR, in magnetron test equipment.

**WHEN YOU HAVE** a circuit problem where a voltage sensitive resistor may supply the answer, why not take advantage

of Globar Division's experience in design for all kinds of circuit applications!

### **GLOBAR® VARISTORS ARE USEFUL IN ELECTRONIC AND ELECTRICAL CIRCUITS FOR:**

- Reduction of arcing at relay or motor governor contacts.
- Stabilization of rectifier circuits by limitation of peak voltages.
- Voltage control in electronic circuits.
- Protection of solenoids in direct current circuits.

**FREE ENGINEERING BULLETIN** gives complete specifications and uses for GLOBAR® Type BNR Varistors. Ask for Bulletin GR-2. GLOBAR engineers will assist you in circuit design applications...without obligation. Send complete details of your problem to The Carborundum Company, Dept. E 87-611, Niagara Falls, N. Y.

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*Ceramic Resistors*

by **CARBORUNDUM**

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87-611



# Good-ALL capacitors

## Good-All capacitors with **MYLAR\*** dielectric combine **SPACE SAVING SIZE** with remarkably **HIGH INSULATION RESISTANCE**

Other outstanding characteristics include **STABILITY WITH LIFE**, **LOW POWER FACTOR** and **HIGH HUMIDITY RESISTANCE**. Good-All MYLAR dielectric capacitors are widely used in tolerances of 1%, 2% and 5% because of the assurance that later shifts will not wipe out the advantage of initial precision. Shelf life is inherently superior to that of paper dielectric capacitors.

### MARBELITE TYPES 620M & 621M



MYLAR Dielectric. Cased in plastic impregnated tubes and end-filled with tough, durable thermosetting plastic. 620M—extended foil const. 621M is tab.

### SERAMELITE TYPES 620S & 621S



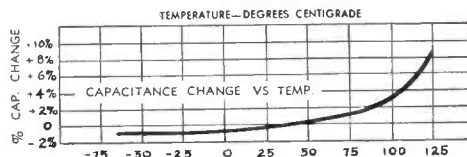
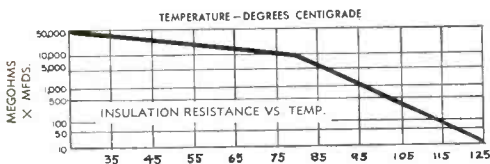
MYLAR Dielectric. Housed in glazed ceramic tubes for use under extremely severe humidity conditions. 620S—extended foil construction. 621S is tab.

\*DuPont's trademark for polyester film.

Insulation resistance.....Greater than 20,000 Megohm Mfds. at 25°C. High IR is retained at elevated temp.  
 Power factor.....Less than 0.5% from +25°C. to +85°C. Less than 1.5% from +25°C to +150°C.  
 Temperature range.....May be operated at rated voltage -65°C to +85°C and to +125°C without derating.  
 Tolerances available.....1%, 2%, 5%, 10% and 20%.  
 Humidity resistance.....These types easily meet the humidity requirements of RETMA specification REC-118-A, Section 2.38.  
 Physical size.....The miniature size of these types is illustrated in the table below.

#### DIMENSIONS OF SELECTED VALUES

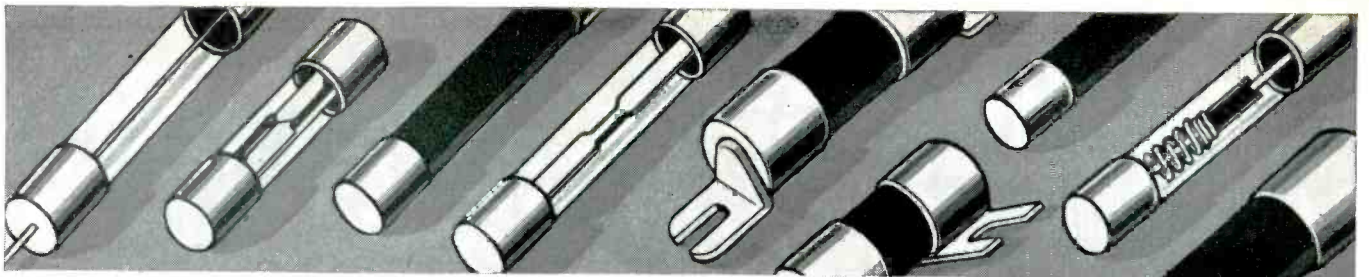
Cap. (mfd.)	620M		621M		620S		621S	
	200V	600V	200V	600V	200V	600V	200V	600V
.01	223 x 27/32	223 x 27/32	223 x 11/16	223 x 11/16	.215 x 27/32	.215 x 27/32	.215 x 27/32	.215 x 27/32
.022	243 x 27/32	243 x 27/32	243 x 11/16	243 x 11/16	.312 x 1	.312 x 1	.312 x 1	.312 x 1
.047	.363 x 27/32	.450 x 31/32	.283 x 27/32	.363 x 31/32	.312 x 1	.360 x 1	.312 x 1	.360 x 1
.1	.363 x 31/32	.450 x 1 1/4	.363 x 27/32	.450 x 1 1/8	.360 x 1	.438 x 1 1/4	.360 x 1	.438 x 1 1/4
.22	.450 x 1 3/16	.610 x 1 1/2	.450 x 1 1/16	.610 x 1 3/8	.438 x 1 1/4	.531 x 1 13/16	.438 x 1 1/4	.531 x 1 13/16
.47	.450 x 1 5/8	.798 x 1 1/2	.450 x 1 1/2	.718 x 1 3/4	.531 x 1 9/16	.625 x 1 7/8	.531 x 1 9/16	.625 x 1 7/8



Our engineers are ready to work with you on special applications.  
 Write or wire for specifications and quotations.



**GOOD-ALL ELECTRIC MFG. CO. OMAHA, NEBRASKA**



## Be sure of dependable electrical protection — Standardize on BUSS Fuses

### Here's why —

To assure you of safe and trouble-free electrical protection — BUSS fuses are tested in a sensitive electronic device. Any fuse not correctly calibrated, properly constructed and right in all physical dimensions is automatically rejected.

That's why you can rely on BUSS fuses to operate properly and protect completely. This unflinching dependability under all service conditions helps safeguard the good name of your product against loss of customer goodwill.

### One source for all types and sizes of fuses —

It's easy for you to select the fuse to meet your requirements. The com-

plete BUSS fuse line includes: standard types, dual-element (slow blowing), renewable and one-time types — in sizes from 1/500 amp. up . . . plus a companion line of fuse clips, blocks and holders.

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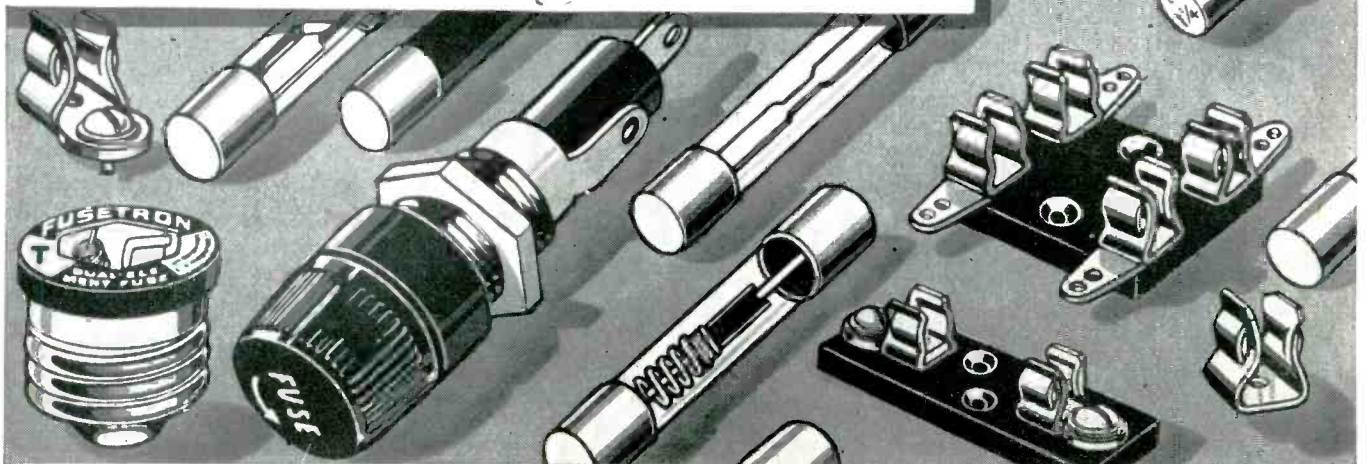
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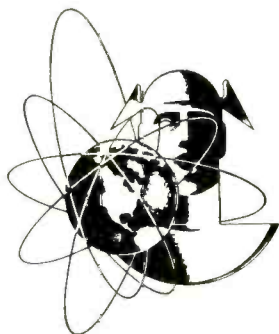
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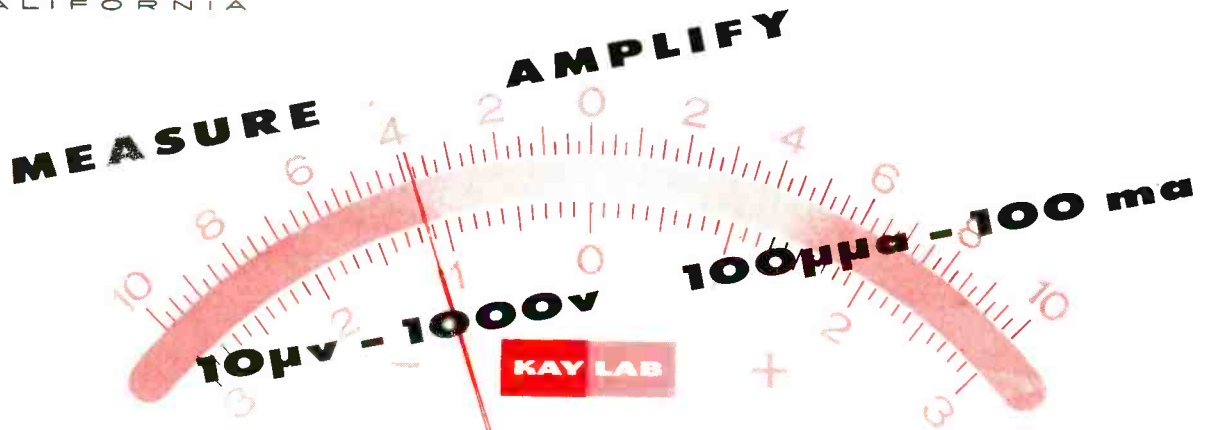
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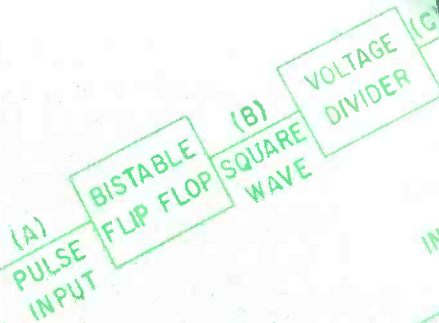
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DRAWN BY WILLIAMS      CUSTOMER  
APPROVED      REFERENCE TYPE F-948 MAGMETER  
DATE 4-9-56      DRAWING NUMBER 090456-1

DRAWING NUMBER 090456-1

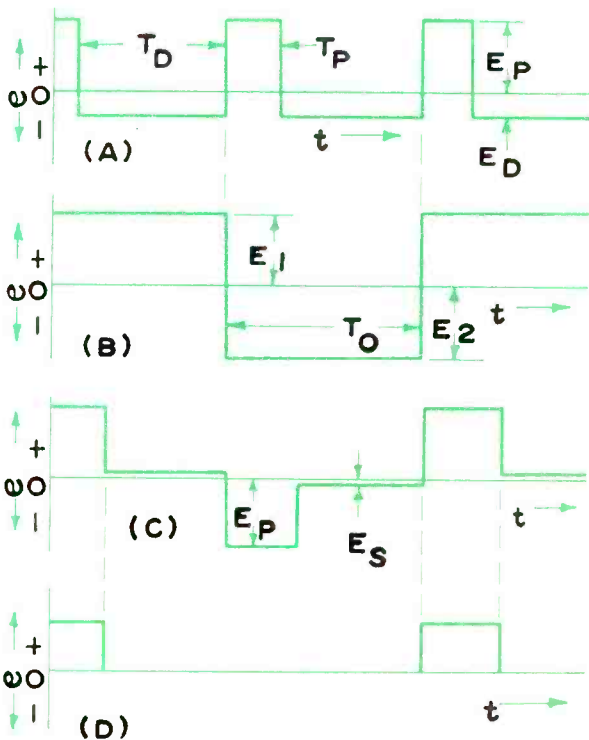
## Circuit Using Magmeter Shows Pulse Rate

MAGMETER is an instantaneous frequency detector; it produces an output proportional to the frequency of its input. This characteristic enables the Magmeter to be used in direct reading pulse rate meters.

The operation of the Magmeter requires that its input contain negligible direct current. Also, the Magmeter must be driven sufficiently hard on each half cycle to completely saturate. The block diagram shows a way to develop the required drive for a Magmeter from a pulse.

Input pulse (A) triggers a bistable flip-flop to produce a balanced square wave (B) having a frequency half the pulse rate. The sketch of wave forms shows these signals. The square wave enters a voltage divider, which limits the voltage (C) applied to the Magmeter.

The Magmeter in turn develops a pulse of fixed volt-second area once each cycle. This area-limiting action of the Magmeter enables the overall circuit to retain its accuracy despite fluctuations in supply voltages. The Magmeter drives a d'Arsonval meter. With Type F-948 Magmeter and a 500-microampere instrument in the above circuit, full scale deflection corresponds to a pulse rate of 1000 pps.



Wave Shapes in Pulse Rate Circuit Shown Above



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# THE SHORTAGE OF SCIENTISTS AND ENGINEERS: Are We Losing the Race with Russia?

**T**HERE is new confidence in the Krenlin. One key reason is expressed in a recent boast of Communist Party Secretary Khrushchev: "The capitalists always regard our people as being backward, but today we have more engineers and more supporting engineering technical personnel than any capitalist country." He promised that this lead would be widened and that communism would be victorious without war.

This boast cannot be dismissed as communist propaganda. Admiral Lewis L. Strauss, chairman of the U. S. Atomic Energy Commission, has warned: "In five years our lead in the training of scientists and engineers may be wiped out, and in ten years we could be hopelessly outstripped. Unless immediate steps are taken to correct it, a situation,

already dangerous, within less than a decade could become disastrous."

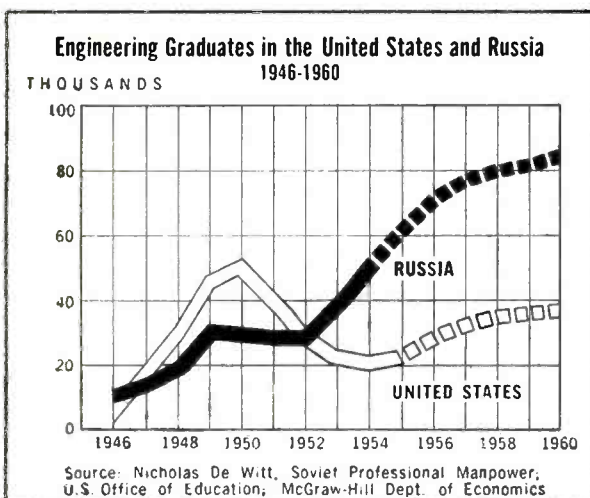
This second editorial in a series on the shortage of scientists and engineers is designed to explore as carefully as possible the facts and the implications of the new emphasis on technical training in the Soviet Union. It draws heavily from the authoritative book *Soviet Professional Manpower*, prepared for the National Academy of Sciences and the National Research Council by Nicholas DeWitt of the Russian Research Center of Harvard and released recently by the National Science Foundation.

## Trend Is Against Us

If the Soviet Union already has a lead in technical manpower, it is not very great. Both the United States and Russia now have around a million scientists and engineers. About a third of the Russian engineers were trained on inferior pre-1935 standards. **It's the trend — shown in the chart — that is alarming.**

Over the last five years we have turned out only 142,000 engineers, compared to an estimated 216,000 in Russia. In 1955 our output was around 23,000 compared to their 63,000. Over the next five years our projected output is 153,000, against at least 400,000 in Russia. There will be an additional 150,000 or more in the satellites and Red China.

In Russia, 30% of the college students are in engineering, compared to 8% here. Another 30% or more take degrees in natural sciences. Moreover, unlike ourselves, the Russians are



ploughing back a large proportion of their science graduates into teaching, which implies a rapid buildup in the future.

## Quality As Well As Quantity

It would be foolhardy to assume that these new Russian graduates are inferior to ours in the quality of their technical training. They start out with much more intensive mathematical and scientific preparation at the high school level. They study harder and longer in college, with more laboratory work and more practical training. Their courses and textbooks seem to be as thorough as ours. Even though the Russian graduates may be overspecialized, they get results.

These results have been striking. The Russians developed both A-bombs and H-bombs faster than we expected, and it's not certain that they had to rely much on espionage. They pushed ahead of us for a while in jet fighter design, and they showed up with a fleet of long-range bombers well ahead of schedule. They are crowding us on nuclear power, electronics and automation. There are grave fears that they have established a lead in the vital field of military rockets.

The goal of Soviet scientific manpower policy includes not only weapon supremacy but also leadership of the neutral and uncommitted areas of Asia, Africa and the Middle East. The Soviet leaders may be bluffing in their offers to export capital, but they are preparing to export Russian scientific and technical know-how in a big way.

## How They Do It

The Russians are determined to win the race for scientific supremacy, and they do not count the cost. **They pay their scientists and engineers salaries that seem fantastic when compared with other Soviet incomes.**

Senior professors, research scientists and top engineers are a major segment of the Russian elite. Their incomes are frequently six to ten times the average industrial wage. (In the U. S. six to ten times the average industrial wage would be \$25,000 to \$40,000 a year.) Housing and other privileges are correspondingly lavish. While preaching equality, the Soviets use capi-

talistic incentives far more boldly than we do. Indeed, practicing engineers and scientists have been complaining about the exalted status of professors and top research people, and salary scales are now being adjusted to give greater emphasis to practical results.

**The Russians are also generous in their aids to education.** Tuition has just been made free at all levels. Undergraduates receive 200 to 500 rubles a month and graduate students 800 rubles (about equal to an industrial wage) to cover living expenses. The biggest stipends go to science and engineering students. College students are deferred from military service, and engineers and scientists often enjoy continued deferment even after graduation.

**Finally, the Soviet leaders can channel engineers and scientists — and all other human and material resources — into any area they choose.** And the areas the Soviet leaders choose are predominantly those that contribute to military or political objectives, rather than to a better life for consumers.

## What's Our Answer?

**We are certainly not going to adopt Soviet methods. We do not want scientific robots, but free men, able to understand and add to our democratic heritage. At the same time, our world leadership in technology — and perhaps even our survival as a nation — will be threatened if we allow ourselves to lag far behind Russia in the training of scientists and engineers.** Ways to keep the United States in the race will be discussed in a later editorial in this series.

*This is one of a series of editorials prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments of particular concern to the business and professional community served by our industrial and technical publications.*

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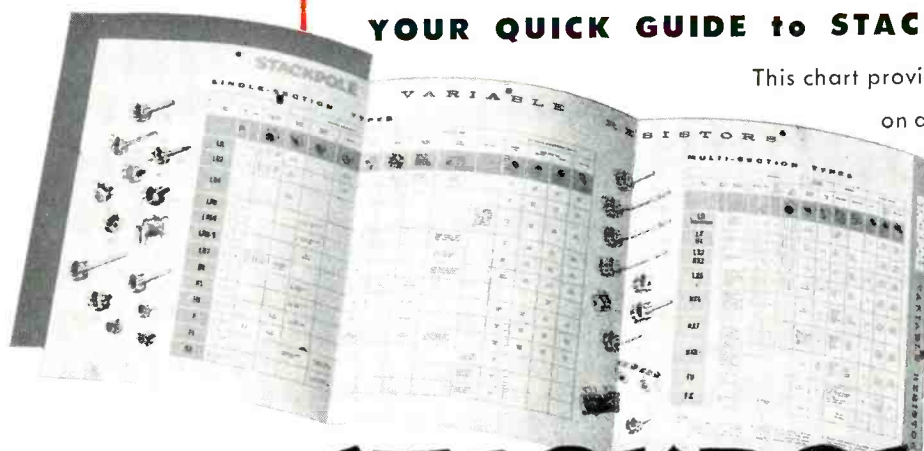
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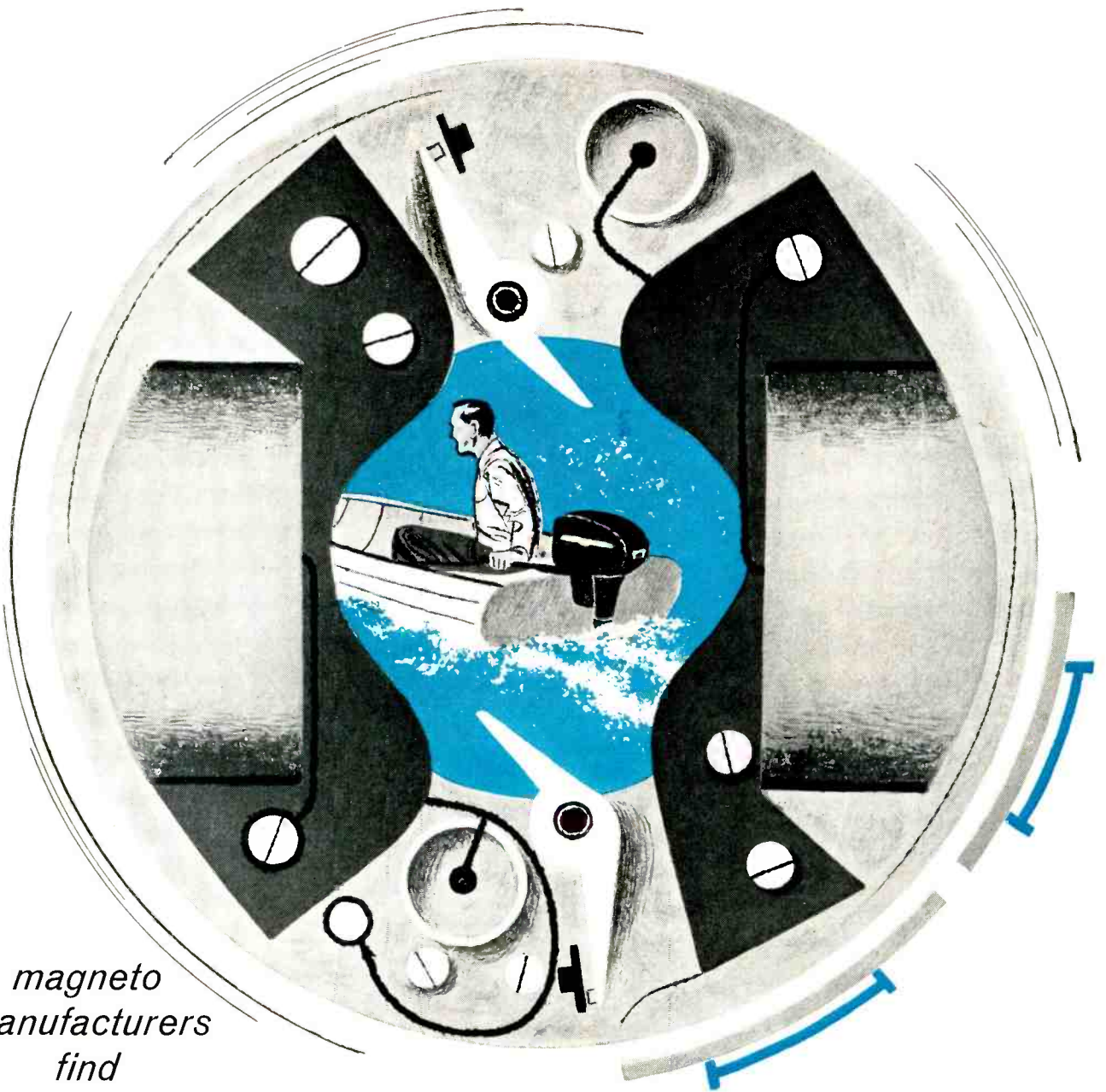
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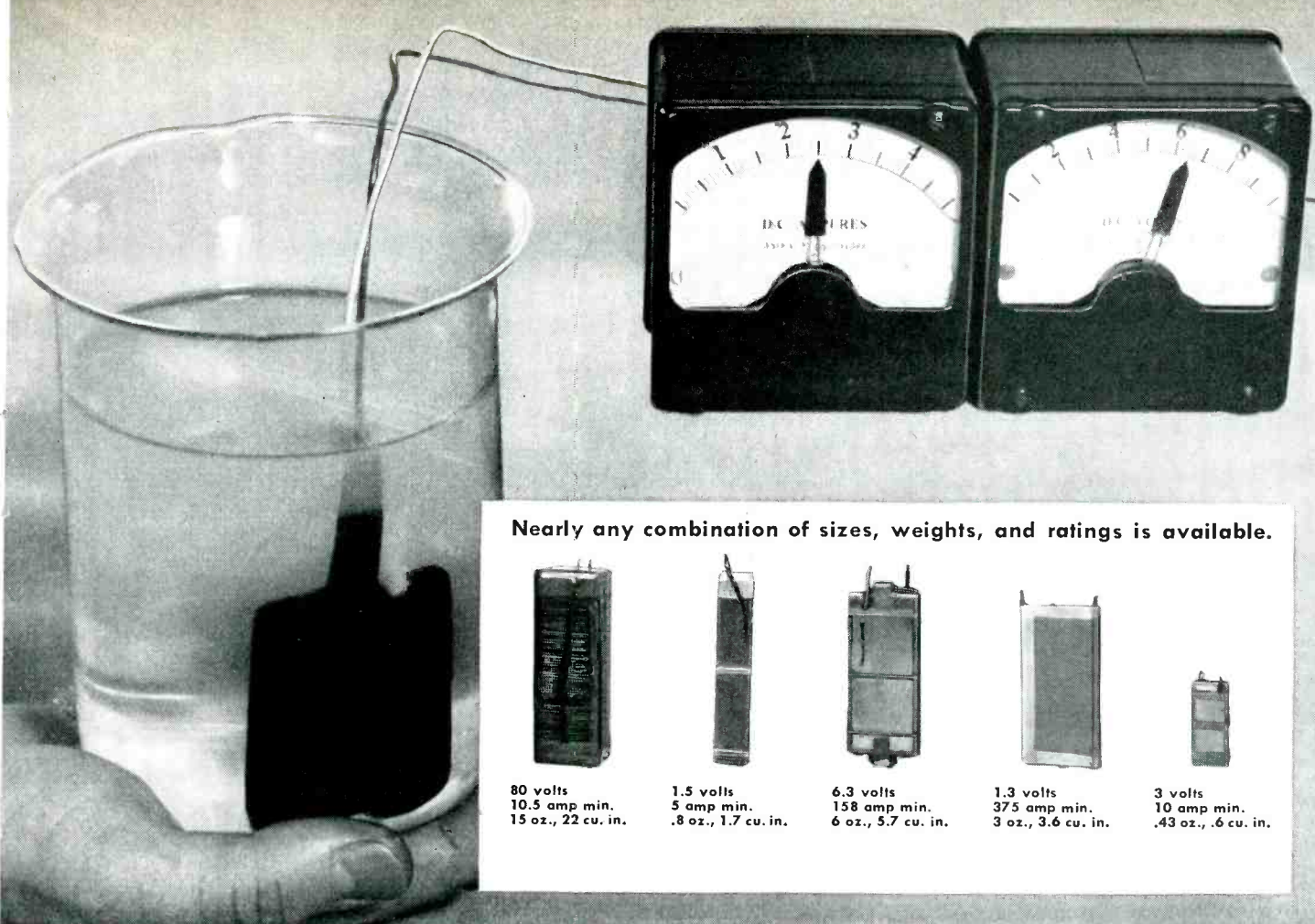
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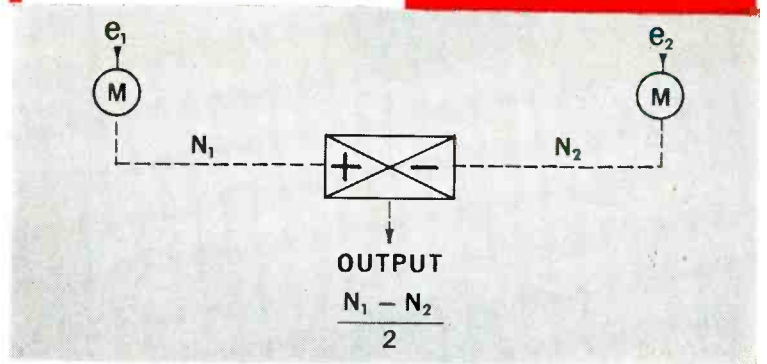
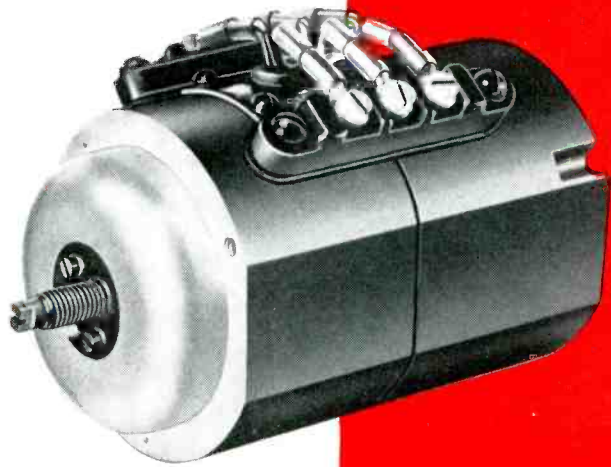


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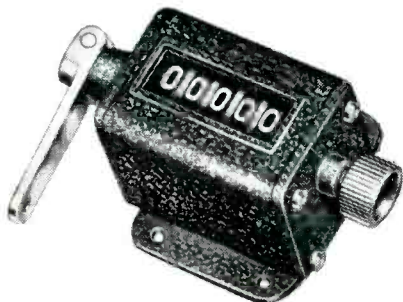
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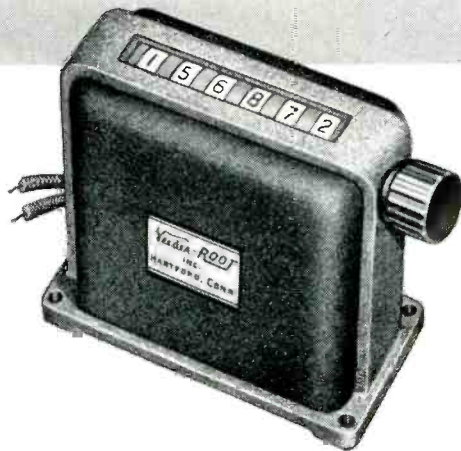
### MECHANICAL COUNTING

Small Resets count strokes, turns, or pieces . . . are used by thousands for moderate duty in parts inspection, quality control, conveyors, machine tools, light presses, etc.



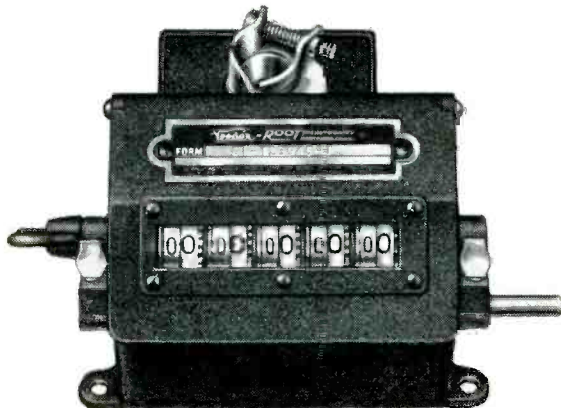
### HAND COUNTING

Where objects or units cannot be counted electrically or mechanically, hand-operated counters like this Hand Tally do the job. For instance, quick spot checks of production or performance, traffic count, inventory, etc. Fits palm of hand, counts one for each pressure of thumb lever, resets to zero by turning knob.



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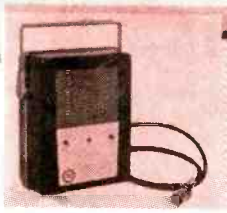
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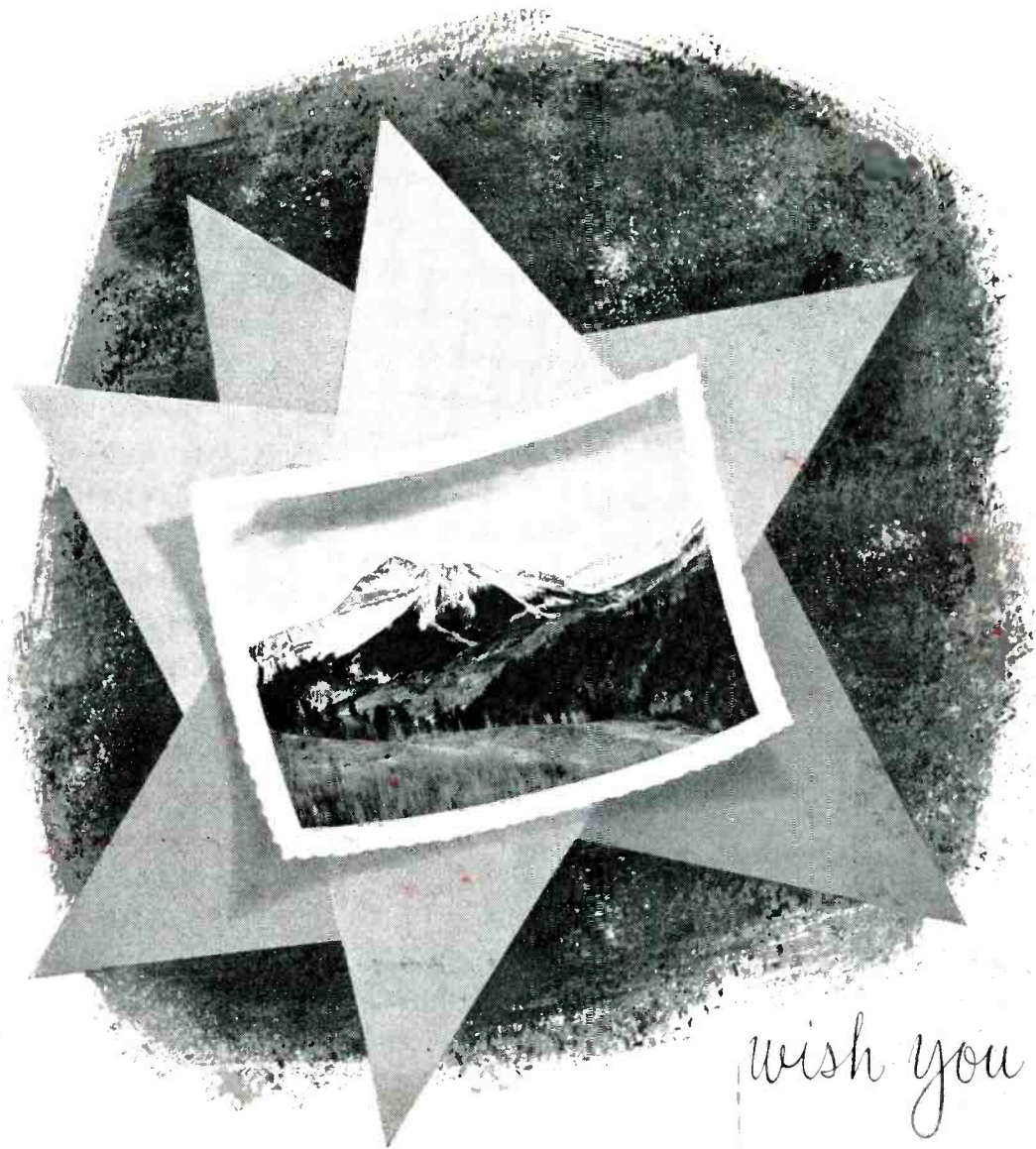
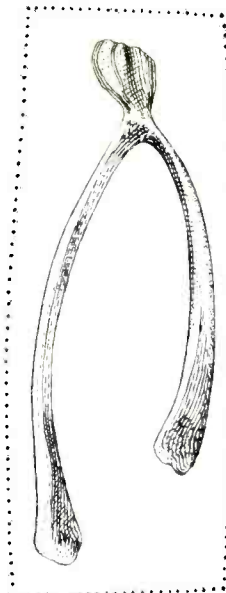
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Leading engineers know that S. E. C. pioneered the current polystyrene capacitors in Guided Missiles and Analog Computers. S. E. C. test data and engineering experience is based on years of research and constant improvement of product.

S. E. C. products have proved the answer to many tough engineering problems by such leading *analog computer manufacturers* as; Electronic Associates, Reeves Instrument, Beckman Instrument, Mid-Century Instrument, Goodyear Aircraft, Donner Scientific, Boeing Airplane Company and such *military contractors* as Northrop Aircraft, Gilfillan Brothers, North American Aviation, Convair, Motorola, Farnsworth Electronics, Bendix Aviation, Federal Tele-Communications and many others.

R. & D. establishments as M.I.T., Jet Propulsion Labs, Cornell Aeronautical Labs, Battele Memorial Inst., Sandia Corp., and many others have chosen S. E. C. engineered components for their prototypes.

### Check these outstanding features for yourself:

- Tolerances as close as 0.1%
- Insulation Resistance as HIGH as  $1 \times 10^{12}$
- Dielectric Absorption as LOW as .0001
- Dissipation Factor as LOW as .0002
- Temperature Coefficient...100 PPM per °C.
- Stability as close as .05% drift in 1 yr.
- Voltage derating . . . none to 170°F.
- *Hermetically sealed for enduring accuracy!*



Tubular .1 MFD-200V



.1 MFD-200V



10 MFD ± 1% 200V  
4-7/16 x 3-1/16 x 2-1/8



1 MFD-200V

*For your most exacting requirements—always specify S. E. C.*

**SOUTHERN  
ELECTRONICS**  
*Corporation*



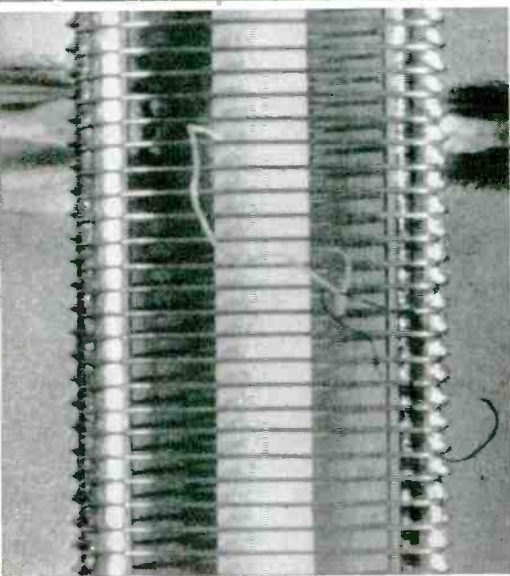
239 West Orange Grove Avenue  
Burbank, California

PIONEERS IN CUSTOM PRECISION CAPACITOR ENGINEERING



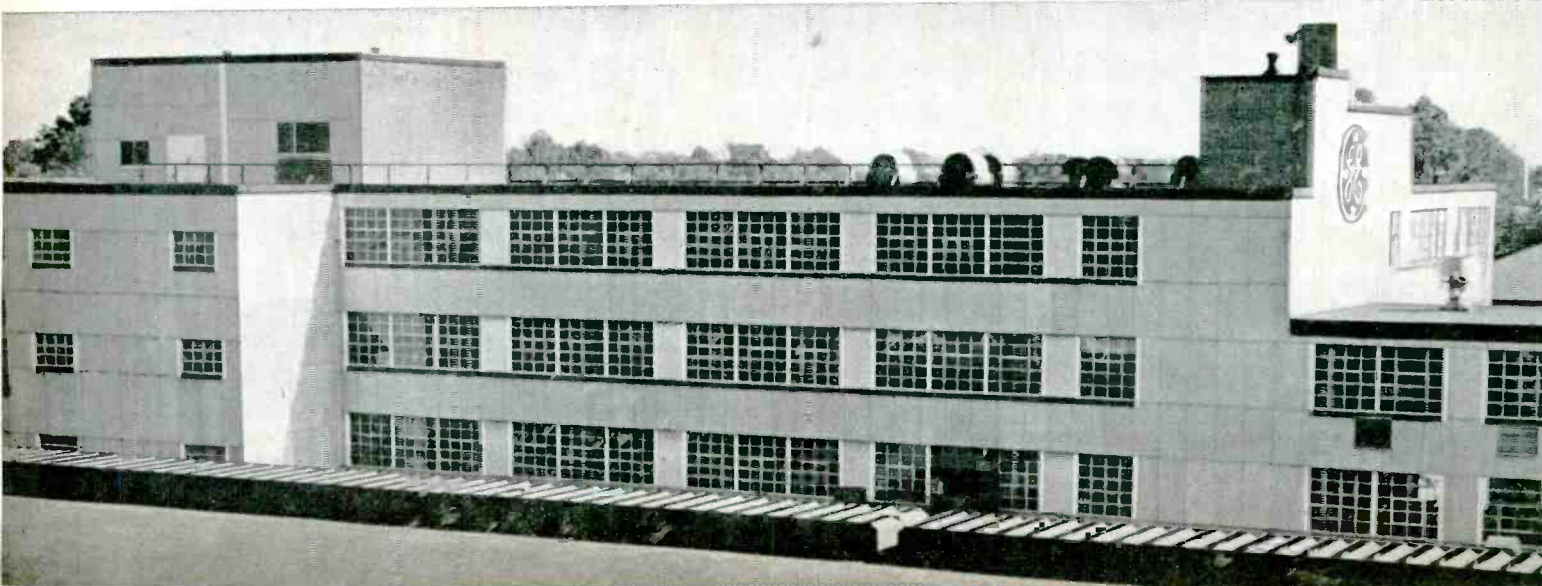
▲ **MANUFACTURED "UNDER GLASS"!** For optimum cleanliness, 6829's are assembled under glass-paneled protective hoods. All G-E employees who build 5-Star Tubes wear rubber finger cots, and their uniforms are lint-free Nylon and Dacron. These precautions are taken to ward off lint and dust, most frequent causes of intermittent tube "shorts".

## FIRST GENERAL ELECTRIC HAS LINT-FREE

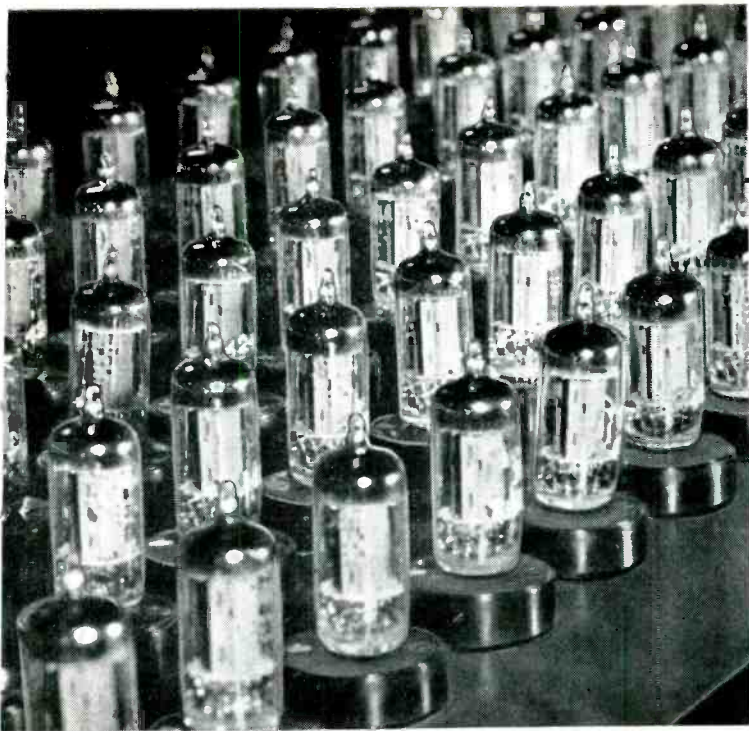


▲ **LINT IS A TROUBLE-MAKER!** The unretouched micro-photo above shows a strand of lint which easily can cause an inter-electrode short-circuit. Dust particles within a tube have the same harmful effect.

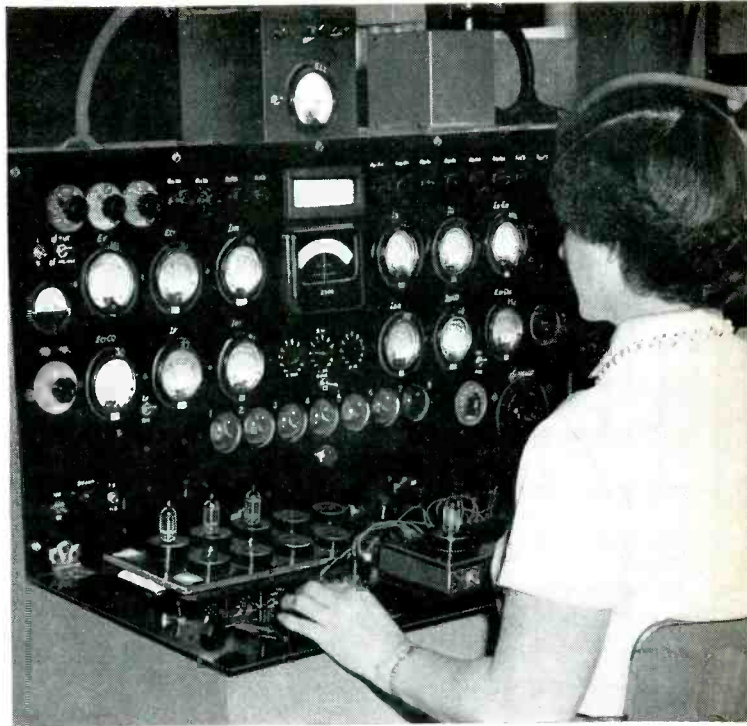
▼ **1200 WORKERS ASSEMBLE 6829's AND OTHER HIGH-RELIABILITY TUBES** in this 5-Star building, located apart from the rest of G.E.'s Owensboro, Ky., tube factory. Because of the special white lintless uniforms, plus immaculately clean working conditions, "Operation Snow White" is aptly used to describe G-E 5-Star Tube manufacture. The entire assembly and inspection area is pressurized, with air that has been filtered, dehumidified and cooled.







▲ **SPECIALLY TESTED . . . BIASED TO CUT-OFF FOR LONG INTERVALS!** Life tests of G-E computer tubes under cut-off conditions, are made in order to be sure no "sleeping sickness", or failure to respond to grid input pulses, develops during inactivity. This is determined by means of periodic interface checks.



▲ **CHECKED FOR COMPUTER-SERVICE CHARACTERISTICS!** G-E computer tubes are specifically tested for those electrical qualities that closely affect tube operation in computer circuits. Among the characteristics checked are zero-bias plate current . . . cut-off performance . . . difference in cut-off between both triode sections.

# 5-STAR COMPUTER TUBE MANUFACTURE FOR ADDED RELIABILITY

**Shock-resistant design—comprehensive cut-off tests—further establish Type 6829  
as the most trustworthy tube you can apply in military computers!**

General Electric, first to design and build a new line of tubes for computers, now pioneers the first 5-Star high-reliability tube for computer circuits—analogue and binary—where airborne, gunnery, or field-transport conditions call for resistance to mechanical shock and vibration.

Type 6829 has the many 5-Star design features that give added strength, such as a compact, sturdy tube cage . . . double mica spacers . . . a double-staked getter. In addition, tube assembly is carried on in immaculate surroundings free

from lint and dust, while special tests assure those electrical qualities that are essential in achieving computer dependability.

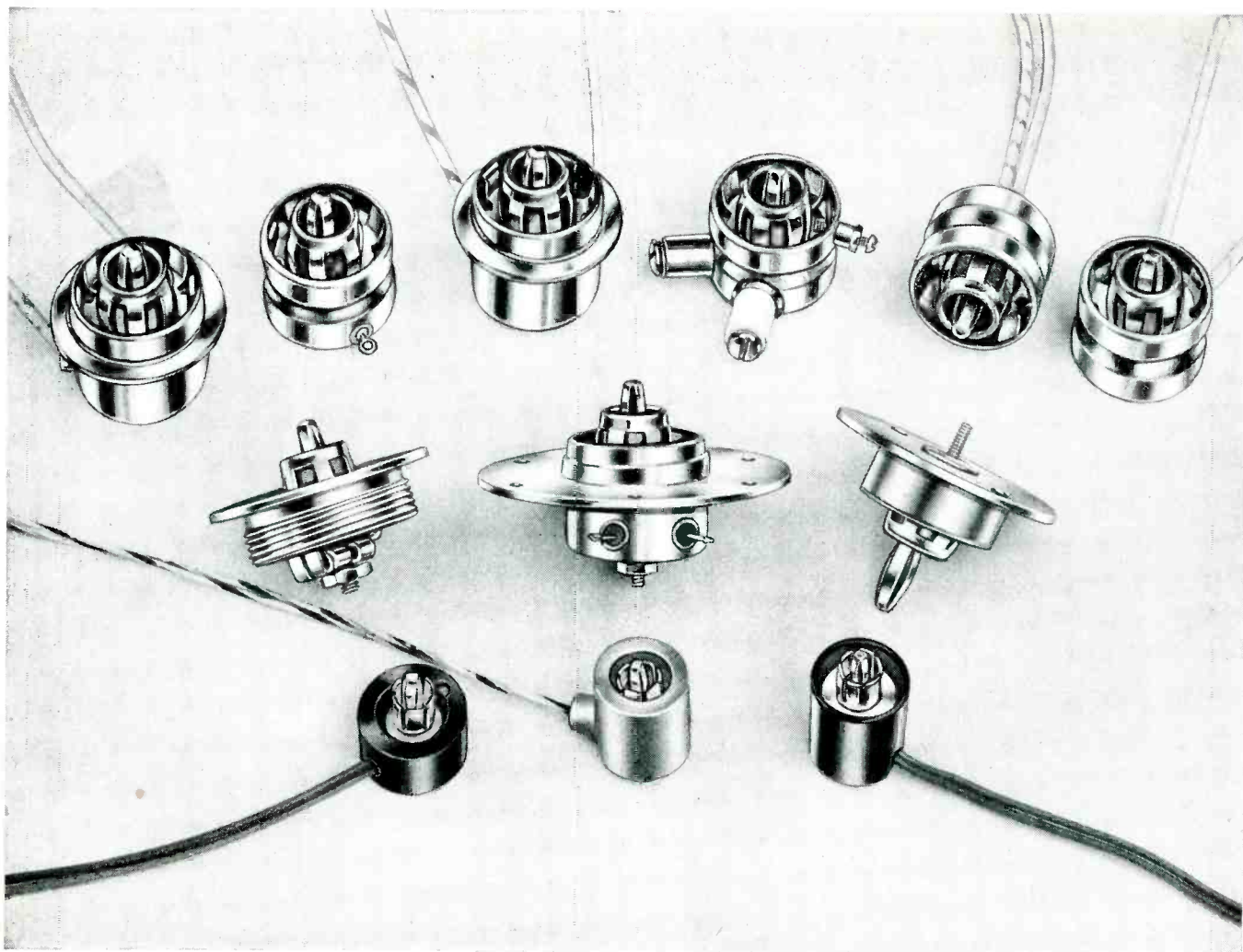
A 9-pin miniature, the 5-Star 6829 has similar characteristics to standard computer Type 5965. The new tube is designed for high-speed circuits—has high perveance, balanced, sharp cut-off qualities, and low heater power requirement (.45 amp).

Get the complete performance story! Write to *Tube Department, General Electric Company, Schenectady 5, New York.*

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**

162-101




## Ucinite Magnetron Connectors

Ucinite manufactures a variety of special connectors for the heater and heater-cathode terminals of magnetrons. Many of these have been adapted for special applications as to size and function to meet the sealing and mounting requirements of high temperature and high altitude operation and other special conditions.

Connectors are coaxial in construction and can be supplied with built-in capaci-

tors for added protection. Connecting leads of any length can be furnished to customer's specifications.

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



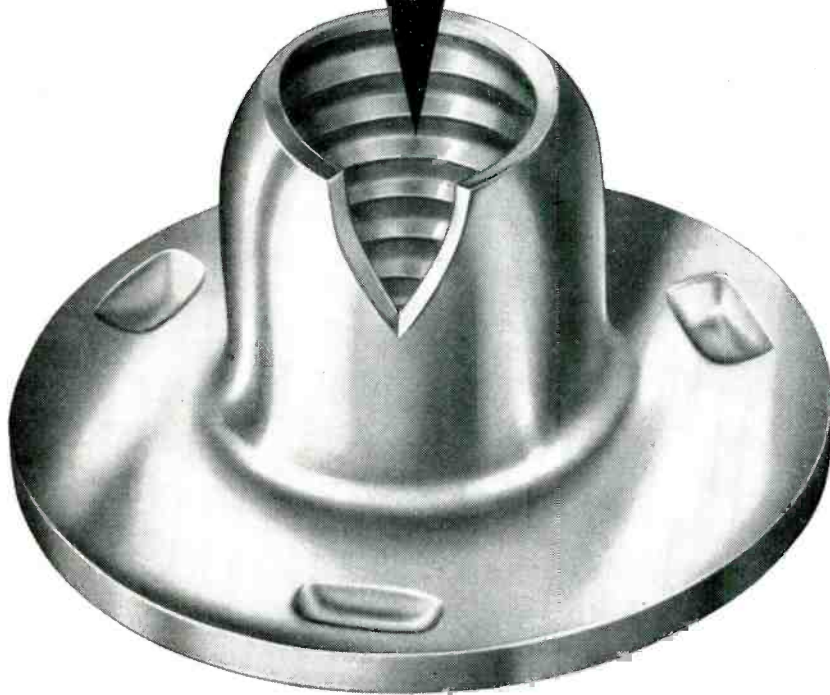
**The**  
**UCINITE CO.**  
*Newtonville 60, Mass.*  
Division of United-Carr Fastener Corp.

*Specialists in*  
**ELECTRICAL ASSEMBLIES,**  
**RADIO AND AUTOMOTIVE**



# NEW V-LOCK TEENUTS®

PATENT APPLIED FOR

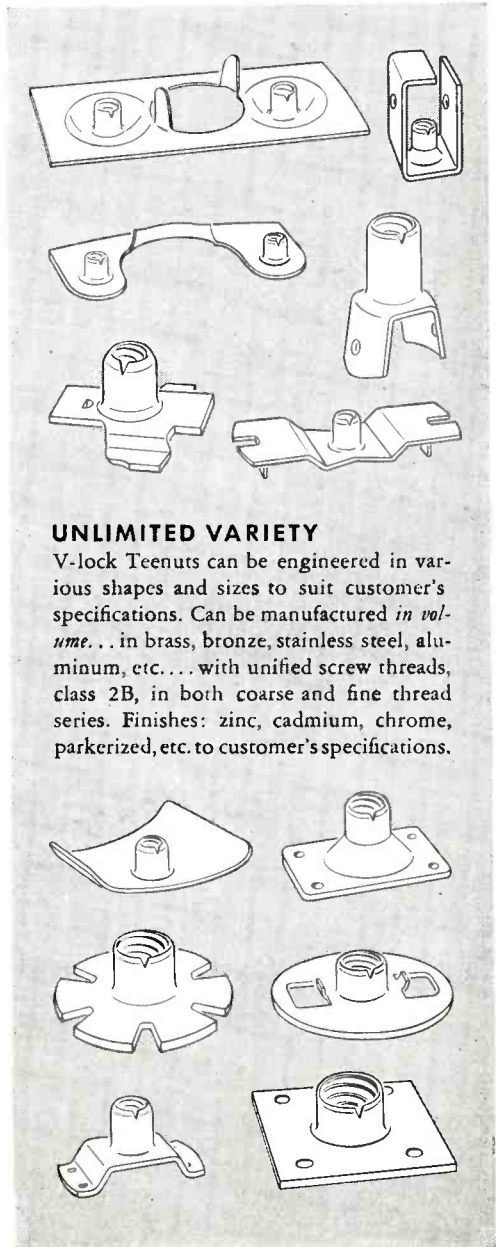


- self-locking
- vibration-proof
- one-piece construction
- proven effectiveness
- highly adaptable
- re-usable

The upper portion of this precision-made Teenut incorporates a V-type notch with the circumference of the barrel compressed inwardly toward the axis to form a permanent set. This makes it a re-usable, prevailing-torque-type, self-locking nut.

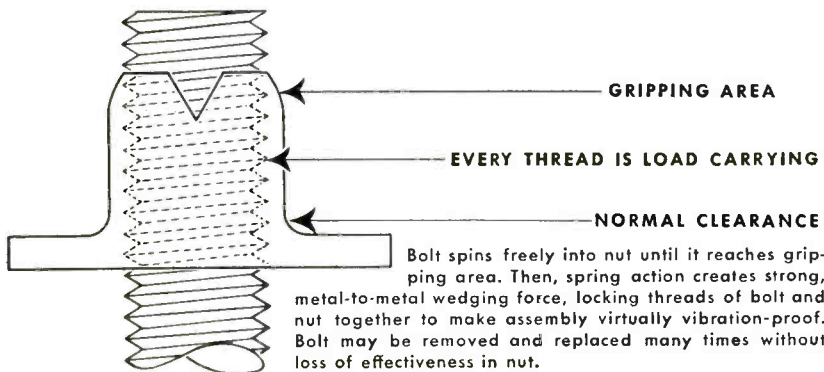
It is a one-piece, self-contained unit in which the self-locking device is an integral part of the design. No non-metallic materials or stamped parts are used so that the V-lock Teenut is not affected by heat or oils and has high tensile strength.

As the V-lock Teenut does not rely on base load to obtain its friction grip, it may also be used as a stop nut. (Indentations in base flange are welding bosses).



## UNLIMITED VARIETY

V-lock Teenuts can be engineered in various shapes and sizes to suit customer's specifications. Can be manufactured *in volume*... in brass, bronze, stainless steel, aluminum, etc... with unified screw threads, class 2B, in both coarse and fine thread series. Finishes: zinc, cadmium, chrome, parkerized, etc. to customer's specifications.



The V-lock Teenut is but one of thousands of special purpose fasteners designed and manufactured by United-Carr to help speed assembly, cut costs and improve product performance. For further information on the V-lock Teenut or for help with any other fastening problem, consult your nearest United-Carr field representative or write us for his name and address.

## UNITED-CARR FASTENER CORPORATION

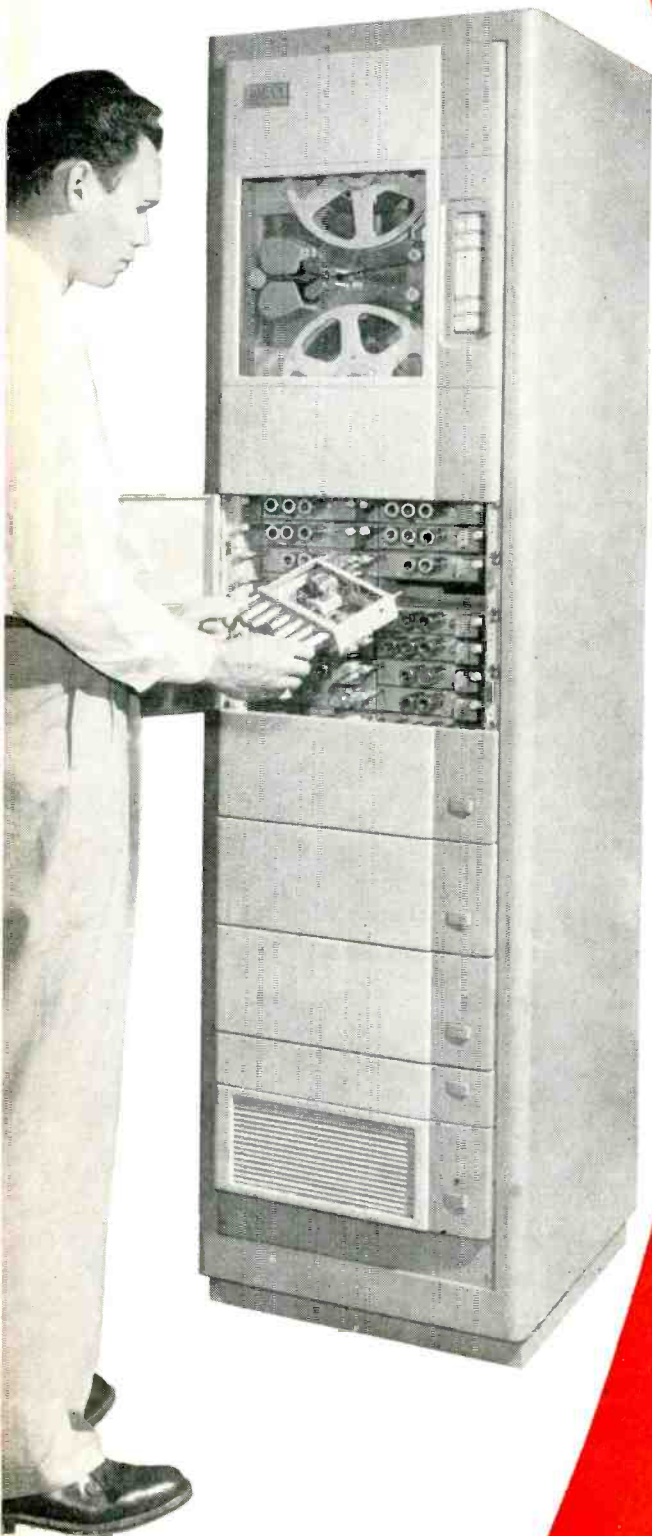
31 Ames Street

Cambridge 42, Mass.



# AMPEX PRESENTS

*the most significant new data  
magnetic tape*



So broad  
in scope  
that it  
extends  
the  
far  
horizons  
of  
scientific  
and  
engineering  
curiosity

Versatility of the Ampex FR-100 permits it to serve virtually any data requirement in the entire D-C to 100,000 cycle/sec. range. Magnetic tape is inherently the most versatile of data-recording mediums and the FR-100 makes broadest use of this scope.

**ANY DATA**— Within its frequency range, the FR-100 can record any data that either originates in electrical form or can be transduced into electrical signals.

**IN ANY COMBINATION**— Any numbers of the FR-100's available tracks can be apportioned to high-frequency data, low-frequency data, transient phenomena and quasi-static measurements. Each will use tape space economically. All will share a common time base.

**A CHOICE OF RECORDING METHODS**— Different types of data are accommodated by plug-in interchangeable amplifiers. These permit each of the FR-100's 2 to 14 tracks to be used for direct recording, FM-carrier recording, or pulse width modulation as needed.

**A SELECTION OF 6 TAPE SPEEDS**  
— Every FR-100 tape transport provides tape speeds of 60, 30, 15,  $7\frac{1}{2}$ ,  $3\frac{3}{4}$  and  $1\frac{7}{8}$  inches per second for optimum balances between recording time and frequency response. They also permit slow-down or speed-up of data in various ratios.

**DATA REDUCIBLE TO ANY FORM**— The FR-100's output is usable in numerous forms: visual records by oscillograph or pen recorder; visual study by oscilloscope; automatic computation by data conversion devices or computers; and regulation or activation of mechanisms by electrical controls.



# THE *modular* FR-100

*recorder since Ampex first pioneered  
for instrumentation*

Performance specifications on the FR-100 are the best of any magnetic tape recorder now in production. Such accuracy adds to the FR-100's versatility. It also makes it the best choice for many well defined applications where quality of performance alone is the criteria for selection.

#### IMPROVED STABILITY OF TAPE MOTION

— The closed loop tape drive and short unsupported tape length reduces peak-to-peak flutter to 0.1% cumulative to 100 cycles or 0.2% cumulative to 1000 cycles at 60 in/sec.

**PRECISE TRACK-TO-TRACK TIMING** — Record and reproduce head stacks permanently aligned with all gaps within a 1/10,000-inch band and azimuth within 0°1'. With FR-100's stable tape motion this provides lowest dynamic interchannel time-displacement error ever available commercially.

**"MIL CONSTRUCTION" THROUGHOUT** — Mil specification E-4158-A components, hardware and finishes are used throughout.

**AMPEX-TO-AMPEX COMPATIBILITY** — Recorded data is interchangeable between all Ampex FR-100s, and 300 and 800 series machines (provided tracks are the same type and tape speeds the same).

**SIMPLIFIED OPERATIONAL MAINTENANCE** — Modular design of the FR-100 reduces most operational maintenance to a simple plug in of spare assemblies with no loss of operating time.

The Ampex FR-100 gives your engineers and scientists a freedom to experiment. In one machine it affords a high portion of all the broadly useful capabilities of magnetic recording. It encourages development of the most effective data recording techniques for your particular specialized needs.

#### CAPACITY FOR BRILLIANT AFTERTHOUGHTS —

The Ampex FR-100 will serve the well defined initial purposes for which it is acquired. But it also provides for the inevitable changes of direction that occur as any research, development or testing program progresses.

**AN OVER-ALL ECONOMY** — The combined characteristics of the Ampex FR-100 are the equivalent of dozens of different modified tape recorders built by Ampex in past years. One Ampex FR-100 may eliminate need for purchase of a succession of special machines.

For complete description and specifications on the Ampex FR-100, write Dept. E 2750

INSTRUMENTATION  
DIVISION

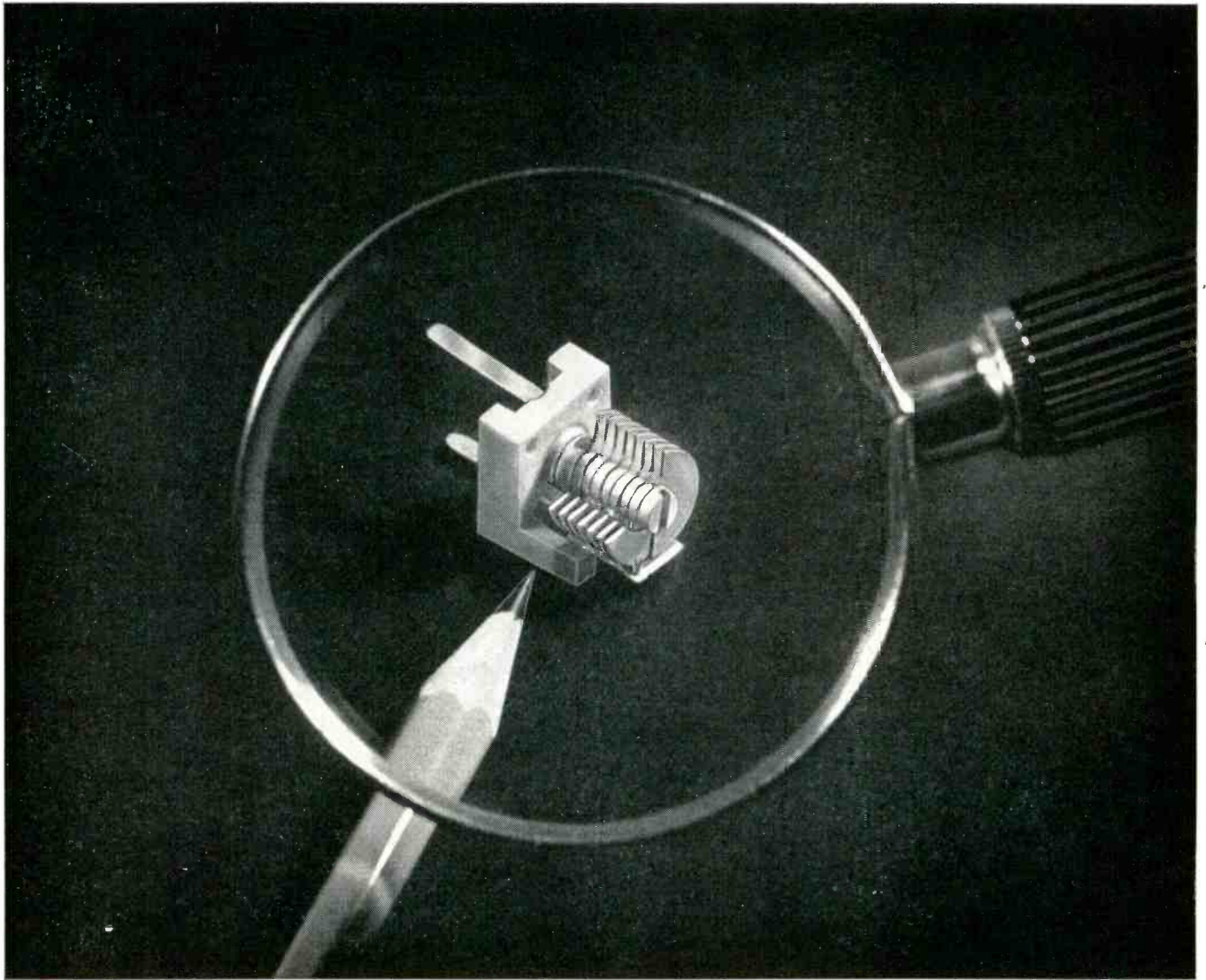
AMPEX  
CORPORATION

FIRST IN MAGNETIC TAPE INSTRUMENTATION

934 Charter Street • Redwood City, California

**District Offices:** Atlanta; Chicago; Dayton; Monclair, New Jersey; Redwood City, California; Silver Spring, Maryland.

**Distributors:** Southwestern Engineering and Equipment Co., Dallas and Houston; Technical Apparatus Co., Boston; Bing Crosby Enterprises, Los Angeles; Ampex-American in Canada.



More than  $\frac{1}{2}$  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  $\frac{25}{64}$ " x  $\frac{7}{16}$ " x  $\frac{17}{32}$ " 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. $\mu\mu\text{F}$	Effective Max. Cap. $\mu\mu\text{F}$	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., 5 Bermondsey Rd., Toronto, Ontario





**ELECTRONIC DIVISION**

# this is electronics?

**yes it is — at OTIS**

(a) To calculate in an electro-mechanical computer, the gears must be machined to an accuracy of .0007 inch.

(b) To simulate a radar beam, the ultrasonic generator must perform to the highest possible accuracy as demanded by a scale reduction of 200,000:1.

(c) To simulate radar distance, the "plumbing" produces water with purity of two parts per million of calcium carbonate and temperature constancy of 1° F.

Here is the science of mechanics pushed to wizardry precision and wedded to the most advanced electronic circuitry... which creates the vital and critical weapons systems now so indispensable for our national defense.

*This is what Otis has accomplished during the past 3 years — and is accomplishing now.*

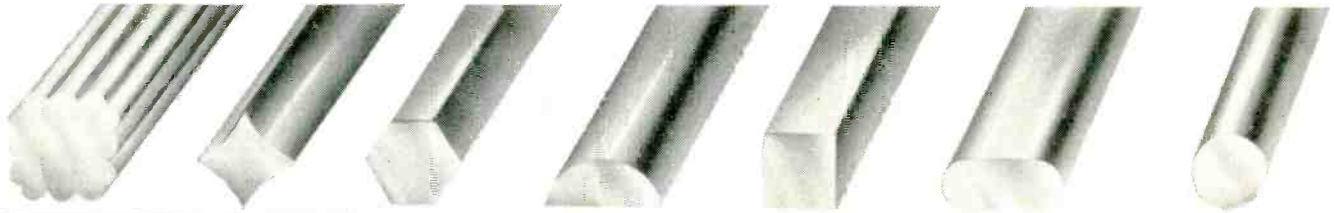
To those who need the performance-proven resources of an organization having comprehensive and diversified experience in the research, development and manufacture of large-scale complex electro-mechanical equipment and systems in the fields of:

- missile guidance and control
- gunfire control
- radar and counter measures
- simulators and training aids
- communication
- special electronic devices
- ultrasonics
- computers
- servomechanisms
- magnetic amplifiers
- testing instrumentation
- electro-mechanical components

— investigate Otis. Write on your letterhead for 32-page history and facilities report.

**OTIS** ELEVATOR COMPANY  
35 RYERSON STREET, BROOKLYN 5, N. Y.  
**ELECTRONIC DIVISION**





## A HANDFUL OF CHIPS...

tells the **COST-CUTTING** story of  
Chase® **FREE-CUTTING** Brass Rod!

Take a close look at the typical chips machined from Chase Free-Cutting Brass Rod. See how short, brittle and tightly curled they are. They could only have come from rod that permits really high cutting speeds and heavier feeds *without gumming or jamming!*

Such remarkable chips also indicate the *quality at low-cost of finished pieces* machined from Chase Free-Cutting Brass

Rod. Smoother, cleaner pieces that take precision threads and sharp knurls—require less polishing—and simplify lacquering, enameling or plating.

The Chase warehouse near you stocks standard mill lengths in many different cross-sections. Special shapes that *save even more* machining time can be made to order.

Write, wire or phone today!

**Chase**   
**BRASS & COPPER CO.**  
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SUBSIDIARY OF KENNECOTT COPPER CORPORATION

*The Nation's Headquarters for Brass & Copper*

Atlanta Baltimore Boston Charlotte Chicago Cincinnati Cleveland Dallas Denver Detroit Grand Rapids Houston Indianapolis Kansas City, Mo. Los Angeles Milwaukee Minneapolis Newark New Orleans New York Philadelphia Pittsburgh Providence Rochester St. Louis San Francisco Seattle Waterbury



Tenth in a series describing REL versatility

# project polevault

REL accomplished the near-impossible on Project Polevault, the first forward propagation tropospheric scatter system in operation anywhere, and to date the world's longest and largest.

Need was desperate for this link from Far Northern radar warning networks to defense command centers in Canada and the United States. REL managed to conceive, design, and produce all the radio equipment between February and September of 1954. This included the 10 kw Klystron amplifiers, the driver transmitters, the dual diversity receivers, and the radio test equipment.

This Herculean achievement enabled the system to operate over its entire length only 365 days from receipt of the original authorization by REL.



## Radio Engineering Laboratories • Inc.

36-40 37th St • Long Island City 1, N. Y.

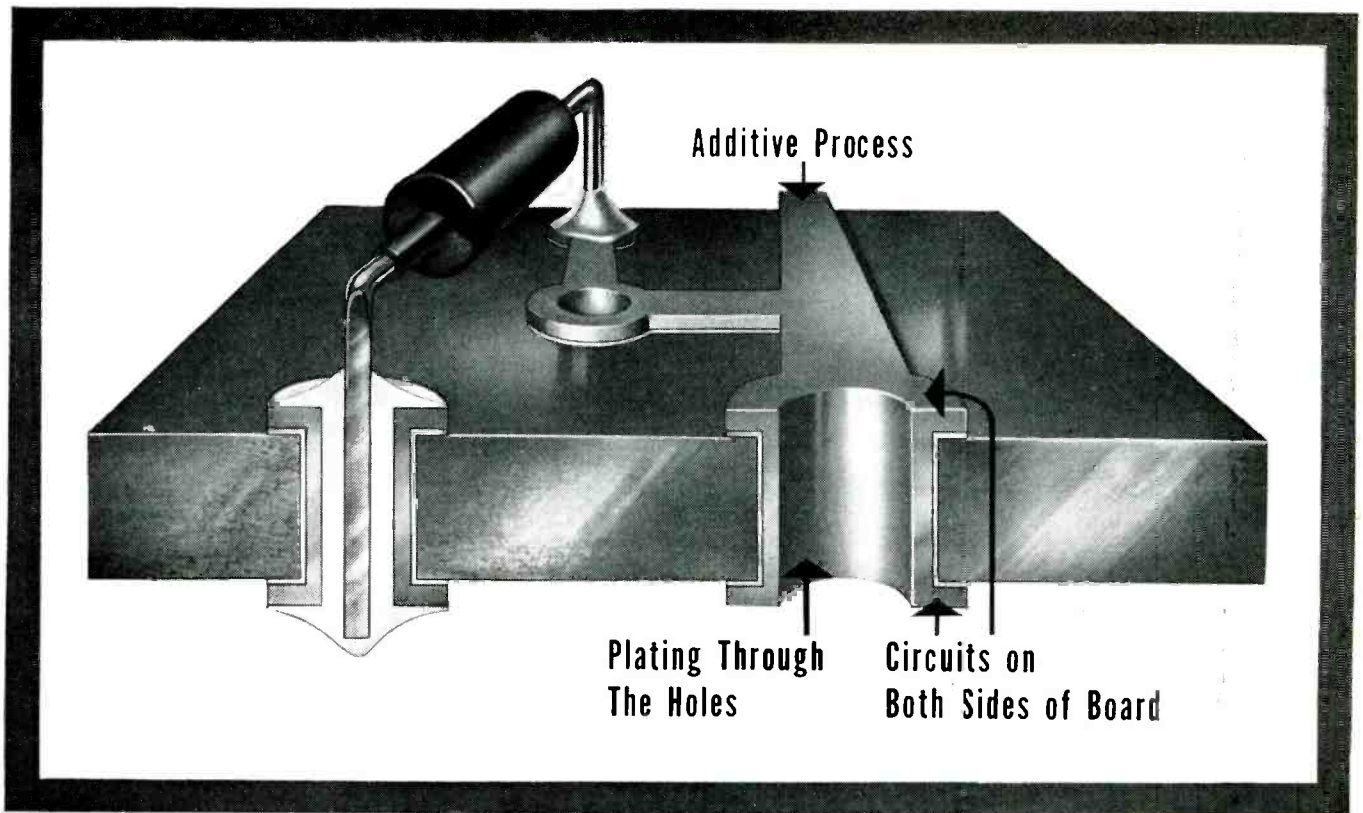
STillwell 6-2100 • Teletype: NY 4-2816

Canadian Representative:

Ahearn & Soper Co., P. O. Box 715, Ottawa

Creative careers at REL await a few exceptional engineers. Address resumes to James W. Kelly, Personnel Director.





## General Electric "Thru-Con" Boards give positive connections through the holes

"Thru-Con" insures accurate solder filleting top and bottom for extreme strength and easier assembly.

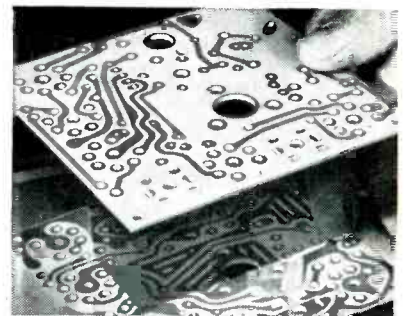
**Original Design Features.** Original General Electric additive-method production techniques provide continuous copper plating through the holes. Positive connections do away with separate staking pins, assure perfect circuits. Costly rejects due to difficult soldering problems are eliminated. If desired, G-E "Thru-Con" boards may provide patterns on both sides, further reducing size and weight.

**"Thru-Con" Boards Serving Many Industries.** Important economies afforded by dependable G-E "Thru-Con" boards are helping manufacturers cut costs and improve profit pictures. Producers of lamps, radios, fans, street lighting

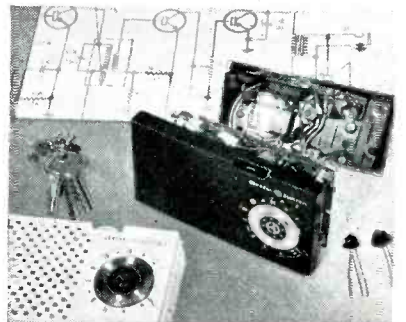
and traffic control units, television receivers, appliances, and control equipment are using "Thru-Con" now.

**Full Production Facilities.** The G-E "Thru-Con" plant is devoted to full-time production of printed circuit boards. New, specially-designed equipment is capable of producing thousands of boards each day. The combination of custom wiring patterns, sizes, and shapes is virtually limitless.

**Investigate G-E "Thru-Con" Boards, Today.** It will pay you to look into the savings "Thru-Con" boards make possible in manufacturing techniques. For a full discussion of your printed circuit program, and a sample "Thru-Con" board, call or write: *General Electric Company, Electronic Components Department, Section X466, Auburn, N. Y.*



G-E "Thru-Con" Printed Circuit Boards offer positive connection through the holes, without staking pins, patterns on both sides if needed. Printed circuitry cuts assembly time; eliminates product bulk, weight; reduces inspection time, parts inventory.



**Positive Proof.** This new transistorized portable radio features a full printed circuit using a G-E "Thru-Con" Board. Combining other advances in electronics with a "Thru-Con" circuit makes possible sweeping changes in size, weight, and styling.

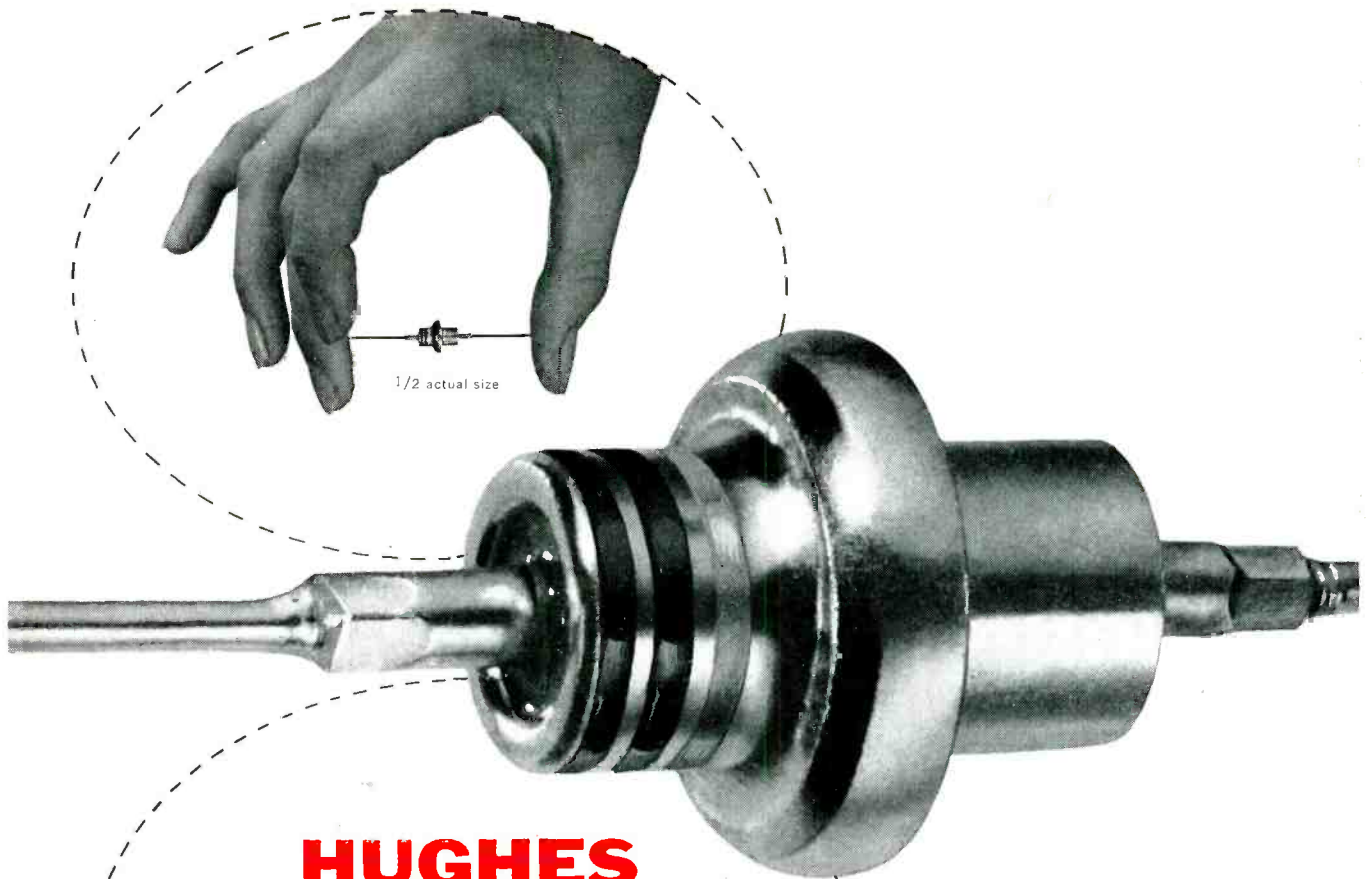
### ADVANCED COMPONENTS FOR THE ELECTRONICS INDUSTRY

★ Printed Circuit Boards ★ Ferrites ★ Distributed Constant Delay Line ★ Ceramics

*Progress Is Our Most Important Product*

**GENERAL  ELECTRIC**





# HUGHES TRANSISTORS

*Germanium...NPN...  
Alloy Junction*

WITH THE UNIQUE COAXIAL PACKAGE

Hughes makes transistors with *axial* leads—quite a departure from the conventional, single-end configuration of most transistors now on the market. This is done for several reasons, all of which add up to one paramount fact: the new style package offers many advantages. It is a *better* package . . .

**BECAUSE:** the small, tubular body with axial leads is just right for horizontal mounting. It saves space, simplifies the physical arrangement of electronic circuitry.

**BECAUSE:** all mountings (horizontal, vertical, heatsink, socket, clip-in) can be made extremely rigid, thoroughly shockproof.

**BECAUSE:** the coaxial configuration assures a more

rugged arrangement of internal transistor elements. **BECAUSE:** no matter how mounted, this package permits the dissipation of more heat, thereby ensuring consistent performance throughout the temperature range of operation.

**CHARACTERISTICS:** high gain . . . nearly negligible alpha crowding, even when current is high . . . more power output at any given ambient temperature . . . high frequency performance at increased power levels.

**APPLICATIONS:** Designed for low-to-medium power operation, these devices perform excellently in: COMPUTERS • SWITCHING CIRCUITS • AUDIO AMPLIFIERS • I-F AMPLIFIERS • OSCILLATORS.

*For the address of our nearest sales engineering office,  
or for descriptive literature, please write:*

HUGHES



SEMICONDUCTORS  
HUGHES PRODUCTS

Los Angeles 45, California

**HUGHES PRODUCTS**

A DIVISION OF THE HUGHES AIRCRAFT COMPANY

© 1956. H. A. C.



Standard Chrono-Tach shown front and center in "deep freeze" engine testing laboratory. (Courtesy of Thompson Products, Inc.)

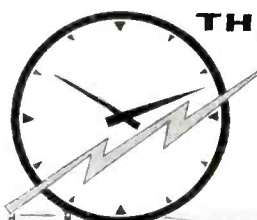
## LOOK TO THE INSTRUMENTS USED FOR DEPENDABLE END RESULTS

In almost every research and testing laboratory the information needed to obtain a specific end result depends upon knowing, to an accurate degree, the speed of revolving shafts, motors, governors or other rotating equipment.

And it's a well-known fact that the end result can be no more reliable than the instruments that are used.

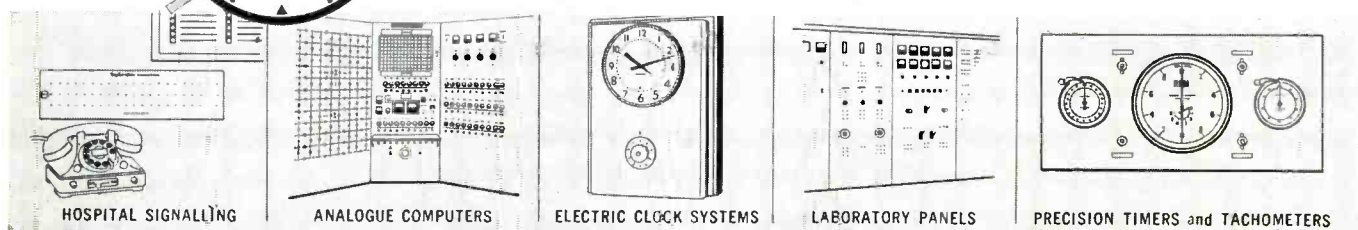
That's why the Standard Chrono-Tachometer plays such an important role in so many industrial, governmental and educational laboratories. Built for *continuous* service, it is a test instrument of extreme accuracy, invaluable wherever the precise measurement of speed of rotation is required.

Write for Engineering Bulletin #218



THE **Standard**  
ELECTRIC TIME COMPANY

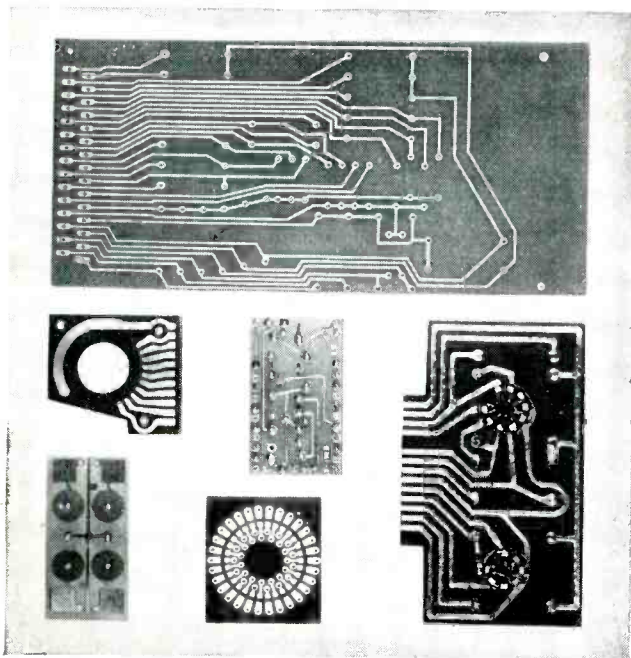
97 Logan Street • Springfield 2, Massachusetts







# For the most dependable printed circuits, you need the high bond strength, workability, heat-resistance of **C-D-F DILECTO<sup>®</sup> METAL-CLAD LAMINATES**



Printed circuits based on C-D-F materials are being used with great success in military electronic equipment, commercial television and radio sets, telephone switchboards—even sub-miniature radio-sonde equipment and hearing aids.

Photos courtesy of Photocircuits, Inc., Glen Cove, N. Y.

**HIGH BOND STRENGTH**—C-D-F's special adhesive for metal-clad Dilecto bonds the copper foil to the plastic without affecting the laminate's superior electrical properties. Heat-resistance, dissipation factor, dielectric constant, dielectric strength, and insulation resistance of the Dilecto base remain unaffected. The closely-bonded foil can be etched cleanly and dipped in hot solder to 450°F. for ten seconds with a guarantee of no blistering or separating. Metal-Clad Dilecto can be punched or machined either before or after etching.

**EXCELLENT WORKABILITY**—On all four Dilecto metal-clad grades, you can solder, punch, saw, and assemble components either by hand or automatically. Thanks to the inherently superior workability of the plastics laminate over that of ceramic-type materials, Dilecto can be dropped, jammed into tight chassis, and otherwise treated roughly on the assembly line and in service.

**HIGH HEAT-RESISTANCE**—Metal-Clad Dilecto Laminates are made of phenolic, epoxy, or Teflon\* resin for various conditions of service and assembly, and have either cellulosic paper or woven glass-fabric base. All are ideally suited to printed-circuit applications in which heat-dissipation is a major problem. Continuous exposure to high ambient operating temperatures in enclosed electronic equipment has no significant effects on Dilecto's electrical and physical properties.

**UNLOAD YOUR HEADACHE HERE!** C-D-F, a big, reliable source of supply, can help you get the most for your printed-circuit money by reducing rejects, lowering fabrication costs, assuring dependable quality every time. Send us your print or problem, and we'll gladly supply appropriate test samples free. See our catalog in the Product Design File (Sweet's) or send for the new 20-page Dilecto catalog. Let your nearby C-D-F sales engineer (listed in Sweet's) help you right from the design stage!

## TYPICAL PROPERTY VALUES

	Copper-Clad PHENOLIC (Grade XXXP-26)	Copper-Clad PHENOLIC (Grade XXXP-28)	Copper-Clad EPOXY (Grade GB-181E)	Copper-Clad TEFLON* (Grade GB-112T)
BOND STRENGTH—0.0014" foil (Lbs. reqd. to separate 1" width of foil from laminate)	7 to 11	5 to 9	8 to 12	4 to 8
MAXIMUM CONTINUOUS OPERATING TEMP. (Deg. C.)	120	120	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil.)	800	800	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35° C. & 90% RH	50,000	25,000	20,000	Over 10 <sup>6</sup> megohms
DIELECTRIC CONSTANT 10 <sup>6</sup> Cycles	4.20	4.20	4.54	2.85
DISSIPATION FACTOR 10 <sup>6</sup> Cycles	0.026	0.052	0.018	0.0006
ARC-RESISTANCE (Seconds)	10	5	120	180
TENSILE STRENGTH (psi.)	16,000 x 13,000	12,000 x 10,000	48,000 x 44,000	23,000 x 21,000
FLEXURAL STRENGTH (psi.)	21,000 x 18,000	18,000 x 16,000	65,000 x 55,000	13,000 x 11,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.40 x 0.35	0.40 x 0.35	13.5 x 11.5	6.0 x 5.0
COMPRESSIVE STRENGTH flatwise (psi.)	28,000	22,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Cotton rag paper	Cotton rag paper	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural greenish	Natural Brown	Natural	Natural

All these standard grades are available with 0.0014", 0.0028", 0.0042", or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

\*duPont Trademark



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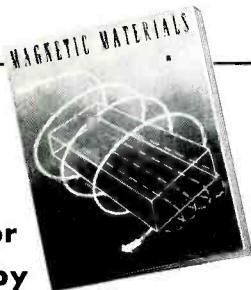
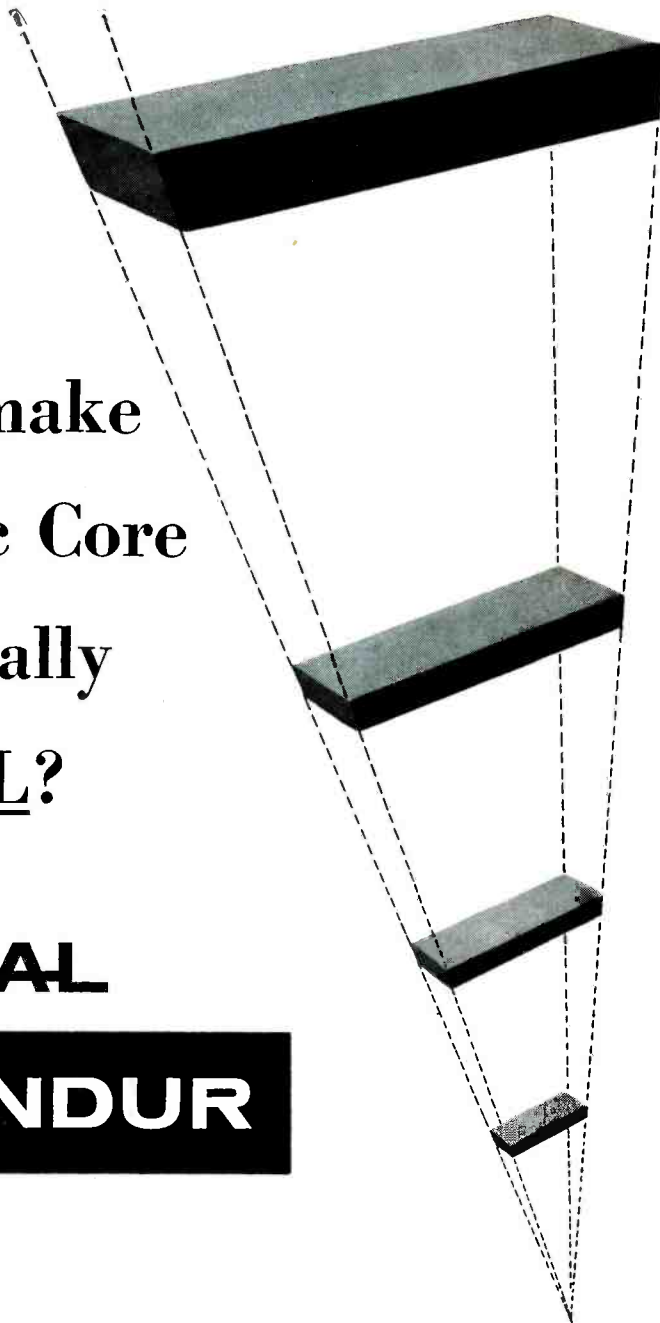
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## for reflectometer measurements on coaxial systems



### 4 all-new couplers!

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**Ideal for power measurements**

**Flat response, high directivity**

**Low SWR, wide band  
performance**

These new *-hp-* couplers save your time by making possible, for the first time, convenient reflectometer measurements on coaxial antennas, transceivers, counter-measures and TV equipment, etc. Each unit centers on a major band but offers 2:1 frequency coverage. Directivity is high, units handle powers to 50 watts cw, and insertion loss is low for permanent installation. The couplers can be used to measure forward or reverse power or to adjust system flatness.

*-hp-* 760 series couplers are compact, sturdy, and precision built of highly heat stable materials for long-term accuracy.

#### SPECIFICATIONS

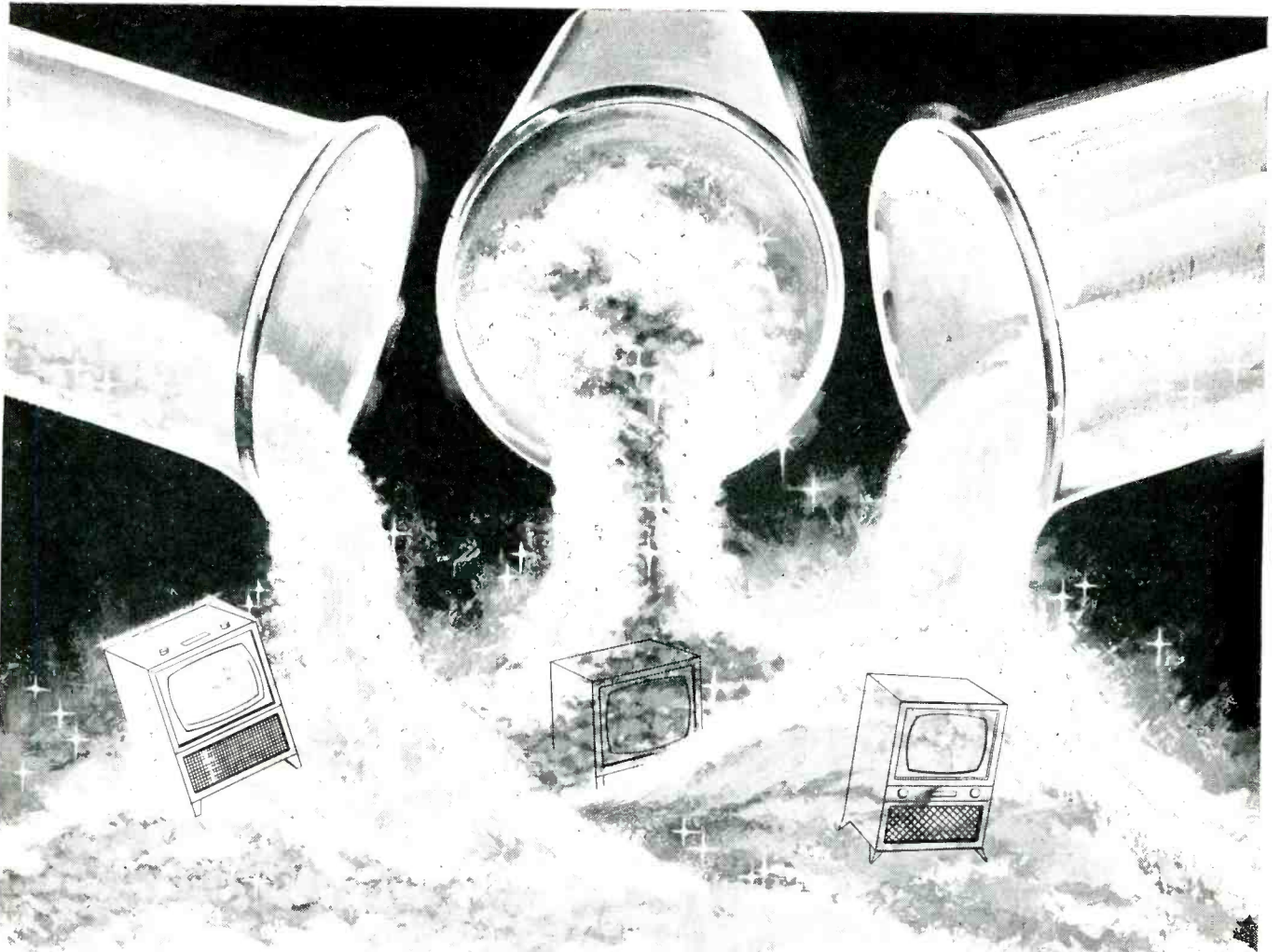
	<i>-hp-</i> 764D	<i>-hp-</i> 765D	<i>-hp-</i> 766D	<i>-hp-</i> 767D
Frequency Range:	216 to 450 MC	450 to 940 MC	940 to 1,900 MC	1,900 to 4,000 MC
Coupling Attenuation:	20 db	20 db	20 db	20 db
Coupling Accuracy:	±1 db	±1 db	±1 db	±1 db
Max. Prim. Line SWR:	1.10	1.15	1.20	1.25
Max. Second. Line SWR:	1.10	1.20	1.30	1.35
Minimum Directivity:	30 db	30 db	26 db	26 db
Prim. Line. Insert. Loss:	Approx. 0.15 db	Approx. 0.20 db	Approx. 0.25 db	Approx. 0.35 db
Price:	\$125.00	\$125.00	\$125.00	\$125.00

All models: Power handling capacity 50 watts CW or 10 Kw peak. Primary Line Connectors: Type N, Male & Female. Secondary Line Connectors: Type N, Female. Reflectometer Detectors: 764D/765D take *-hp-* 476A; 766D/767D take *-hp-* 420B. Size all units: 9" long; weight 2 lbs. Prices f.o.b. factory. Data subject to change without notice.

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# SYLVANIA



Lighting • Radio • Electronics • Television • Atomic Energy





**QUESTION: WHO IS THIS MAN?**

**ANSWER:** He's an electronics engineer. Works for a well-known airframe manufacturer. Senior project leader . . . assigned to a tough telemetering problem. Tight schedule. Lots of headaches. Lots of responsibility.

**QUESTION:** What's he grinning about?

**ANSWER:** Feels good. Something worked out well . . . for a change.

**QUESTION:** Good deal! What happened?

**ANSWER:** Needed three very tricky power supplies. Needed them fast. *Could* have designed them himself, and sweated them through drafting, pounded them through the shop, coaxed them through the lab—you know the routine.

**QUESTION:** Isn't that inefficient?

**ANSWER:** Very. But he didn't. Got smart just in time.

**QUESTION:** What'd he do?

**ANSWER:** Decided that *his* problem was telemetering. *Went to N J E*—*power supply specialists*. They knew just what he needed—saved him time (and money) by pulling out a similar design they'd made for a computer outfit. Suggested some sharpening of the spec, too—something he'd overlooked at first glance.

**QUESTION:** Lucky, hm?

**ANSWER:** Not luck—experience. They build more custom power supplies than anybody else in the business. They're geared for quick action—largest *stock* line in the industry, too. Over 800 models.

**QUESTION:** Did he get his supplies in time?

**ANSWER:** What a question! Think we'd have run this ad if he didn't?

**N J E LEADS THE POWER SUPPLY FIELD.**

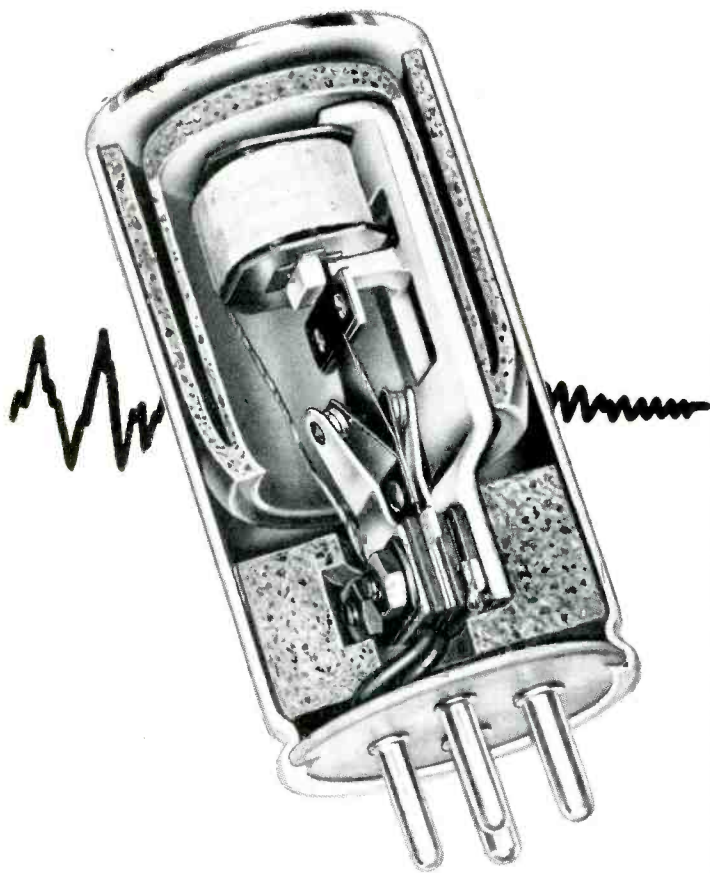
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HUM

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—in Mallory's 25th  
Anniversary Vibrator\*

**R**EVOLUTIONARY design improvements in the latest model Mallory vibrator reduce mechanical hum to the lowest level ever attained in a commercial vibrator.

A look inside the vibrator will show you some of the new ideas that have gone into this outstanding product. Most important is a bell-shaped liner which holds the mechanism from the coil end, effectively isolating the vibrations of the reed element from the case and mounting plug. Combined with an improved design for the cup at the plug end, this liner keeps mechanical "shake" from being transmitted to the chassis regardless of the vibrator's mounting position.

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

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators  
Electrochemical—Capacitors • Rectifiers • Mercury Batteries  
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

Even the lead wires have been re-designed to minimize transmitted noise.

The result is that this improved vibrator actually produces less mechanical hum than the electrical hum coming from the speaker of most auto radio sets.

Equally important to the designer, this premium performance is available *without* premium cost. Price is identical with previous Mallory models.

Plan to take advantage of this new standard of quietness in vibrator operation, in the new equipment you are designing or in circuits you now have in production. Our Technical Bulletin gives full electrical details . . . write to Mallory for your copy today.

\* Patent Pending

*Expect more . . . Get more from*





CROSS  
TALK

► **MERGERS . . .** Called on a couple of small electronics companies that had been taken over by larger ones not primarily in the business, talking with original personnel. Said they liked the reduced pressure, missed privilege of moving fast.

Called on some parent companies to check the other side, found them pleased with what they had acquired technically, puzzled about lack of market statistics with which to judge potential of new ideas.

Conclusion: Few marriages work perfectly in the first year.

► **RELIABILITY . . .** The cryptic abbreviations "Tel. Qual." have been noted on component parts for some time but it wasn't until just the other day that something jogged our bump of curiosity and triggered off an inquiry concerning their meaning.

Said one parts maker who often helps us keep our ear to the ground: "Telephone Quality" is a higher degree of reliability than the customary JAN or MIL specifications for equivalent field duty."

Very flattering indeed to the telephone people, and the first inkling we have had that somebody has been pushing even harder, though more quietly, than the military for reliability. More important, our inquiry elicited the information that it is already possible to produce some compo-

nent parts that are even better than "Tel. Qual."

What to call them?

► **STALEMATE . . .** Here's an impression current in the field:

Engineers want management to test the civilian market with ideas developed while working on government contracts. Management wants very tangible evidence of a market before taking the plunge.

Result: Somebody else, not as conscious of the pitfalls (or more of a gambler), takes a fling at it and opens up new business.

► **REMINDER . . .** Business needs electronic data-processing devices having large and not too finicky funnels at the input, many pigeon-holes at the output and not *too* much brain in between.

► **COLOR CODE . . .** Understanding of the engineering mind was indicated during a recent technical exhibit when a nearby oasis offered certain beverages in bottles with banded necks; blue (75¢), red (85¢), yellow (90¢), green (\$1) and white (\$1.30).

► **LURES . . .** Obviously bothered by the pull of sunny climes, a northeastern manufacturer urges engineers to "come to . . . and enjoy all four seasons; the warmth of summer, the crispness of autumn, the pleasures of snowy winter evenings, and the green freshness of spring."

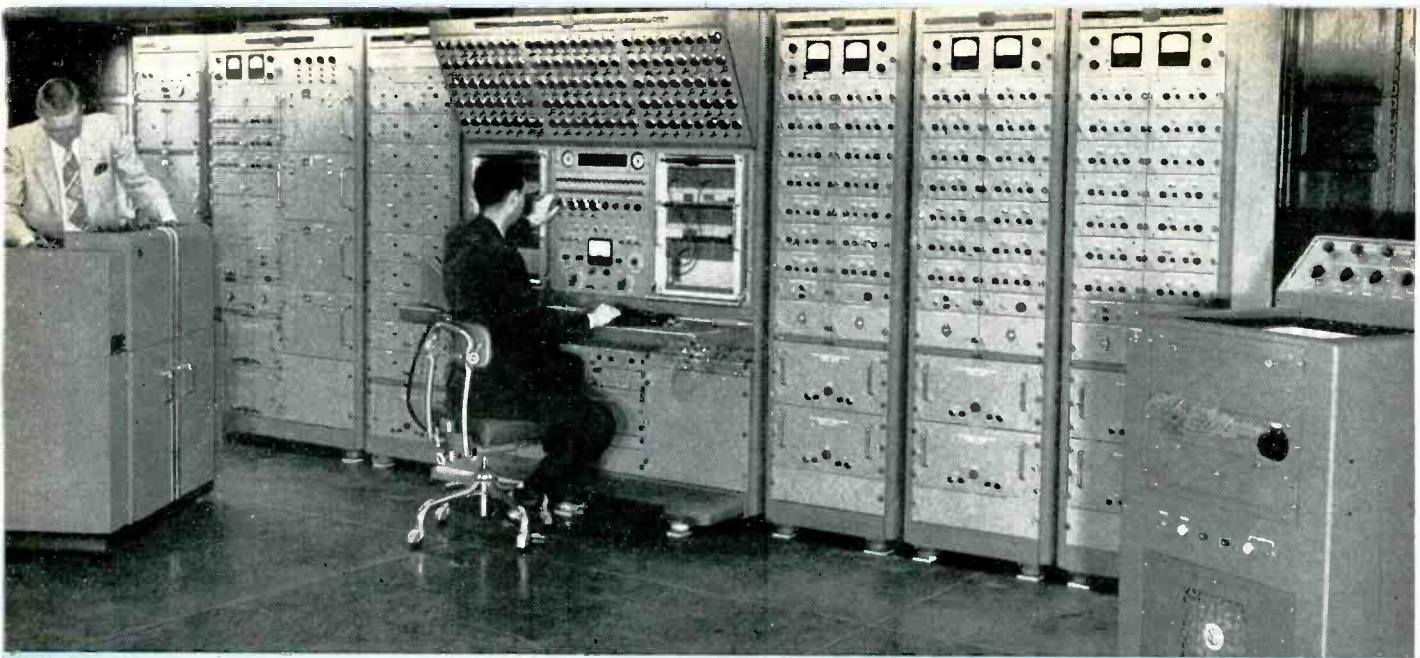
A little farther south, another offers \$500 reward for a competent electronics engineer, payable when the man is hired. Offer does not specify "dead or alive."

LOOKING AHEAD . . .

More automobile record players expected soon. Will probably be compatible with home equipment, turning at some standard speed

*Radio communications barrier may exist around objects moving faster than Mach 10; atmosphere piles up, becoming highly ionized, creating "manmade Heaviside layer"*

New airport-traffic-control radars will have higher resolution, showing people as well as taxiing planes, runways versus grass, perhaps even where grass has been mowed



Analog computing facility, showing plotting boards to left and right of main computer

# ANALOG COMPUTERS

**SUMMARY** — Development of new aircraft, guided missiles and automatic control systems for industry further nourishes 10-million-dollar business. Manufacturers offer electronic computers of varying size and complexity—ranging from desk-top to room size

By **JOHN M. CARROLL**

*Associate Editor, ELECTRONICS*

**E**LECTRONIC ANALOG COMPUTERS are used extensively in the solution of differential equations which play an essential role in aerodynamics, heat transfer problems and circuit design.

There are about 400 analog computers presently in use. Many of these are used by aircraft manufacturers in the design of airframes, guided missiles and jet engines. The analog computer industry derives much of its present impetus from the government's drive for better and better military aircraft and missiles.

## **Industrial Applications**

Analog computers are used also by petroleum companies, atomic energy plants and laboratories and other research and development activities. Vast potential applications lie in the field of industrial process control, design of automobiles and other metal-trades prod-

ucts, and even in automatic highway traffic control.

During 1954 sales of analog computers amounted to \$6 million. In 1955 sales totaled \$10 million. However, the 1955 figure included one large and possibly nonrecurring item—a \$1.5-million analog computer installation for Wright Air Development Center. Sales estimate for 1956 is about \$8 million.

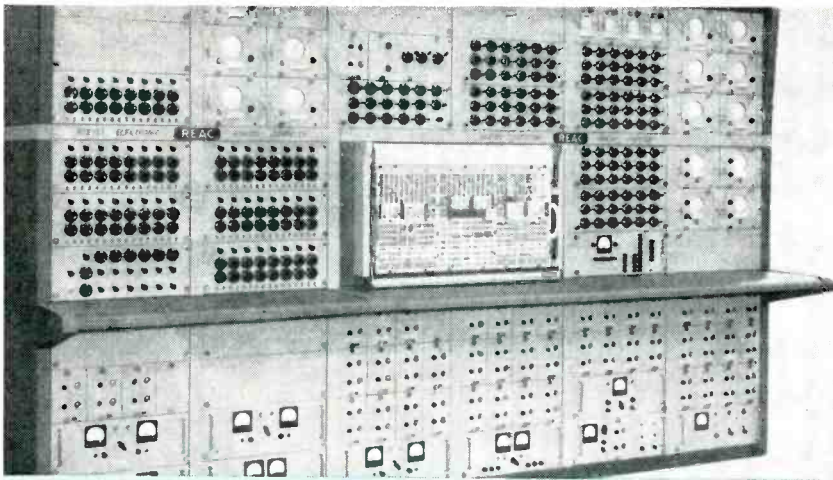
The basic unit of an electronic analog computer is the operational amplifier. Computers may be ranked as to size by the number of operational amplifiers used. Computers range in size from small desk-top units having 24 amplifiers or less to room-sized installations with up to 200 amplifiers. In addition to operational amplifiers, an analog computer contains control equipment; nonlinear equipment such as multipliers, resolvers, rate generators and function generators; and read-

out equipment such as strip-chart recorders, digital voltmeters and x-y plotting boards.

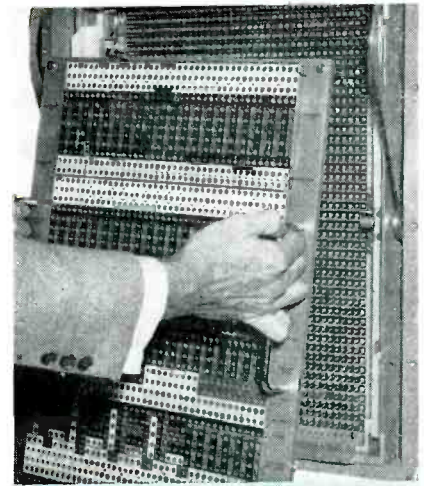
Although computers are available for under \$1,000, a commonly used rule-of-thumb for pricing a computer is \$1,000 an amplifier. This figure includes associated equipment. Computers can cost \$250,000 and up depending, to some extent, on research and development costs. The average computer uses 36 to 48 amplifiers while a computer with 72 amplifiers or more may be considered large. Some of the larger computers include: Project Typhoon at Naval Air Development Center, Johnsville, Pa. and installations at White Sands Proving Grounds; Holloman Air Force Base; Westinghouse Air Arm Division; Allison Division of General Motors; Redstone Arsenal; and Convair in San Diego, California.

The term analog computer as used here refers specifically to





General-purpose analog computer. Potentiometer controls cluster around plugboard



Removable plugboard

# for the ENGINEER

general-purpose problem-solving machines. Several such machines with their pertinent characteristics are listed in Table I. The computers differ in the number of operational amplifiers, which affects the number of variables which can be handled and the order of differential equations the machine can solve. Two representative large general-purpose problem-solving computers are shown in photographs on the first two pages of this article.

## Differences

Some machines offer more than others in the area of nonlinear devices such as multipliers and function generators. Differences exist also in the degree of automaticity provided. Some machines have servos for setting potentiometers from a central location and servo-operated digital voltmeters. Others use manually adjusted potentiometers and have common d'Arsonval galvanometer voltmeters for monitoring.

Other special features available with some machines may include punched paper tape input that provides a form of automatic programming and interchangeable pre-patched plugboards that supply a stored-program feature. A removable plugboard is shown in a

photograph.

Almost every computer has warning lamps associated with each operational amplifier to detect amplifier overloading. In some machines, self-checking features include extremely sophisticated built-in problem checks.

Output from the computer can be displayed on strip-chart recorders which may have six channels or more. Other output devices include digital printers, cathode-ray tubes and x-y plotting boards that yield answers in Cartesian coordinates. Meters, either digital or dial-type, permit monitoring the various computer operations.

Also listed in Table I are a few special-purpose analog computers. These machines may be designed either to solve problems of a specialized nature or to furnish continuous output as part of an automatic control system. Special applications may include calculating gas-flow problems in natural gas pipelines, solving special stress-strain relationships, aerodynamical problems or geophysical field problems. One class of analog computer, not represented in this article but nonetheless important, is the network analyzer used by electric utilities to solve problems in the distribution of electrical power. The dynamic load dispatcher designed for the

electric-utility industry uses techniques taken from the field of general-purpose machines.

Many analog computers are designed as integral parts of weapons systems and other military equipment. The computers are used aboard military aircraft for navigation, bombing and fire-control for both guns and missiles. One computer listed in Table I solves problems peculiar to high-speed aircraft in flight.

## Design Trends

A relatively few companies manufacture general-purpose problem-solving computers. Even in the case of packaged machines, most analog computers sold have a plurality of custom features. One customer may want as many operational amplifiers as the computer can handle while another may sacrifice amplifiers to gain more nonlinear equipment to accommodate his particular class of problems. Analog computing devices can be supplied in plug-in form with which a customer can build up a computer tailored to his specific requirements. Analog computers are available in the form of build-it-yourself kits.

The accuracy of an analog computer is a difficult quantity to state categorically. In all cases it de-

Table I—Analog Computer Characteristics

Manufacturer	Model	Description	Price	Accuracy in percent	Power Consumption in watts	Size
Berkeley Division Beckman Instr. 2200 Wright Ave. Richmond, Calif.	EASE 1032	Large general-purpose automatic computer with building-block construction	From \$10,000	0.1 (computing components)	0.5 amp per amplifier	2×2×6-ft cabinets; minimum 2 cabinets
	EASE 1031	Same as 1032 but manually controlled	From \$6,000	.....	.....	.....
	EASE 1200	Console-controlled large general-purpose automatic computer; solves 50th order differential equations	To \$250,000 (completely filled)	0.01	.....	.....
Boeing Airplane Co. Seattle, Wash.	BEAC 7000	General-purpose computer; solves 12th-order differential equations	\$4,433	1 (computing components)	1,000	23¾×19×81¾ in.
Donner Scientific 2829 7th St. Berkeley, Calif.	30	Desk-top general-purpose computer; solves 10th order linear differential equations	\$995	1	350 v-a	21×18¾×12 in.
Electronic Assoc. Long Branch, N. J.	PACE 16-31R series	Large general-purpose computer with building-block construction	From \$7,500	.....	.....	.....
Goodyear Aircraft Akron, Ohio	GEDA GN215-L3	Linear analyzer; large general-purpose computer; solves 12th order differential equations	\$13,500	0.1	1,000	30×34×72 in.
	GEDA GN215-N3	Nonlinear analyzer	\$8,000 up	0.1	1,000	30×34×72 in.
	GEDA A-14	Large general-purpose automatic computer	\$20,000 up	0.01	1,000 up	72 in. high; area from 6 sq ft
Hall-Scott, Inc. Electronics Division 2950 N. Ontario St. Burbank, Calif.	.....	Desk-top or portable computers; multiplier and function fitter available	.....	.....	.....	.....
Hathaway Inst. (Div. of Hamilton Watch) 1315 S. Clarkson St. Denver, Colo.	RCC-10	Principal-strain computer using dynamometer to solve square root of sums of squares	\$20,000 to \$75,000	2	1,000	6×10×5 ft
Heath Co. (Subs. of Daystrom) Benton Harbor, Mich.	ES-400	Desk-top general-purpose computer in kit form	About \$700	.....	.....	.....
Link Aviation (Subs. of GPE) Binghamton, N. Y.	AEROLOG 211	Three servos solve for lift coefficient, angle of climb, and rate of climb or thrust for level flight; handles 11 input variables	\$17,500	0.1 (full scale)	750	37×31×53 in.
Mid-Century Instrumatic 611 Broadway New York, N. Y.	MC-400	Small general-purpose computer; auxiliary equipment available	.....	.....	.....	.....
	MC-500	General-purpose computer; auxiliary equipment available	.....	.....	.....	.....
Wm. Miller Inst. 325 N. Halstead Pasadena, Calif.	MILAC	Passive-element type computers of varying size	\$100,000	.....	.....	.....



Control Provisions	Checking Features	Output Devices	Operational Amplifiers	Provision for Analog Multiplication	Servo Components
Plugboards, pushbuttons, servo-set pots	Overload lamps; audible alarm	Vm with digital null system—optional; oscillograph recorders, x-y plotters, digital vm and printers	50 per control unit	Time-division multiplier	Multiplication of 5 variables by a 6th; sine-cosine pots available. Coordinate-transform units optional
Manual operation, manual pots					
Serial-type keyboard, punched tape input	Overload indication; built-in problem check; automatic tape checkout	6-channel chart recorder; digital voltmeter;	Handles 160	Over 30	Over 16
Front-panel patching, plug-board optional	Overload lamps	Meter only	12 and 8 for sign changing	Pulse-width, pulse-height multipliers; servo multipliers	4 linear pots; 1 d-c tachometer
Detachable plug-board with plug-in components	Overload lamps; metering all outputs	Meter, terminals for recorder or oscilloscope	10	Accessory time-division multiplier	Uses Dynalysis units
Plugboard and automatic programming	Automatic plugboard verification; problem check system; automatic printer readout	x-y plotters, recorders, oscilloscope, digital print out	As required	Servo multipliers; time-division multiplier; quarter-square diode multiplier	Available as required
Removable plugboard	Overload lamps, stabilization circuits	6-channel chart recorders x-y plotters	24	Servo multipliers; time-division multipliers	Provide multiplication, function generation & sine-cosine resolution; N3J has built-in d-c amplifiers for inversion
Controlled from GN215-L3	Overload lamps, stabilization circuits	6-channel chart recorders x-y plotters	As determined by GN215-L3	Servo multipliers; time division multipliers	Same as above
Removable plugboard	Storage-type overload detectors; self-checking stabilizer amplifiers; marginal checking	6-channel chart recorders x-y plotters	Any required quantity	Servo multipliers; time-division multipliers	Servo multipliers; servo function generator; servo resolver
			Plug-in units; building-block plan		
Plugboard and manually set pots	Automatic overload hold	Meter	Up to 15		
Switched resistance dividers	Meters and lamps for overload indication	Servo-driven dials	23	Servo multipliers	1 product resolver; 1 sine-cosine unit; 3 rate generators
		Servo-driven dials	12	Accessory a-m/f-m multiplier	1 indicating servo
Control panel provides for automatically inserting initial conditions; removable plugboards	Overload lamps; metering	Meters, 6-channel chart recorder available	30	Provision for 3 Servo multipliers	1 indicating servo provision for 3 servo multipliers
	Indicating lamps and meters	Dual log wide-band vm with sign-indicating lights, meters, dual-beam cro	32 in lab model; as required in custom installations	10 arbitrary function multipliers (lab equipment)	

Table I—Analog Computer Characteristics

Manufacturer	Model	Description	Price	Accuracy in percent	Power Consumption in watts	Size
G. A. Philbrick 230 Congress Boston, Mass.	K2 K3	Plug-in electronic computing devices; expandable in standard relay racks to make up complete computers	\$500 to \$100,000	0.1 to 1	200 to 10,000	.....
Reeves Inst. (Subs. of Dynamics Corp. of Amer.) 215 E. 91 St. New York, N. Y.	REAC 400	General-purpose computer; large custom-made computers available	Several hundred to about \$1,000,000	Depends on problem	1,000 to 80,000	20×77-in. cabinets; 1 to 70 cabinets may be used
Southwestern Ind. Electronics 2831 Post Oak Houston, Texas	DRF-1	Solves nonlinear algebraic equations	\$2,000 to \$3,000	1	150	2×2×1 ft
Topp Industries 5255 W 102nd Los Angeles, Calif.	10801-500	Aircraft angle of attack and side-slip computer; furnishes continuous output	.....	0.1 deg	.....	Weights 11 lb 8 oz
Weber Aircraft 2820 Ontario Burbank, Calif.	.....	General-purpose computer; accessories available	\$8,000	1	.....	.....

depends upon the problem being run on the computer. When a computerman refers to accuracy, he may refer to the accuracy of the computing components. Many engineers feel that 0.01 percent represents the ultimate that can be achieved using analog techniques and that further refinement must entail introducing digital tech-

niques. Thus a great deal is heard today about digital differential analyzers. Nevertheless a median value for precision computers of the analog type is 0.1 percent accuracy. In the field of smaller analog machines 1-percent accuracy seems desirable for the type of work to be done.

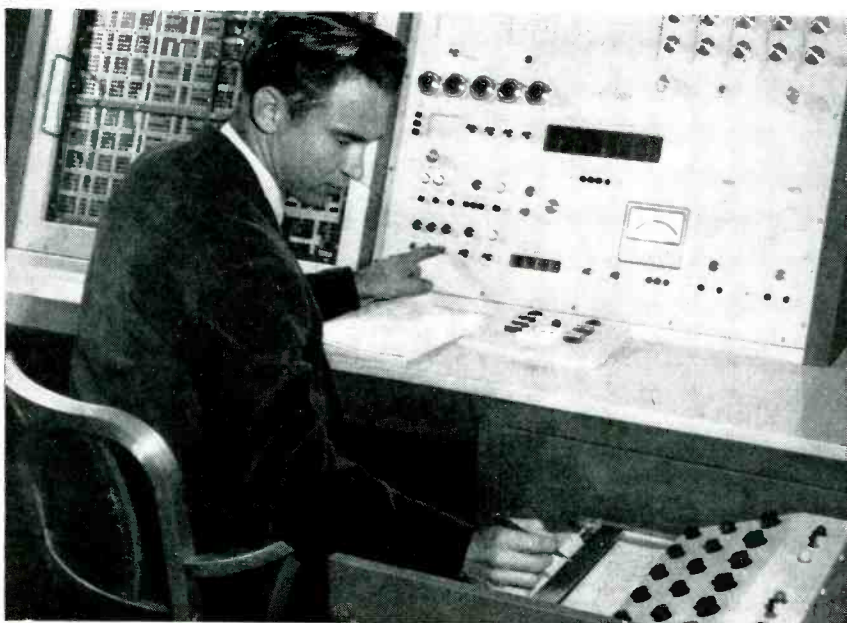
There seem to be two trends in

analog computer design. Activity is evident in the area of computers of 24 amplifiers or less arranged in desk-size consoles or designed for desk-top use.

There is also a trend toward extremely sophisticated control consoles. In this case, the customer first obtains a console supplied with many self-checking features, convenient centralized control—equipped, as far as possible, for automatic operation—and provision for adding 100 or more operational amplifiers, additional nonlinear devices and a variety of output units as computational requirements increase. A computer console featuring centralized control, checking and output equipment is shown in a photograph.

**Background**

Basically, analog computation involves setting up a physical model of the problem under consideration. It is from this characteristic that the name analog derives. The analog computer has the advantage of being able to solve problems in real time, handling a continuous flow of input data as acquired. Analog computers can likewise furnish a



Console for large machine has centralized control, checking and output features



Control Provisions	Checking Features	Output Devices	Operational Amplifiers	Provision for Analog Multiplication	Servo Components
Any desired	Any desired	Any desired	Any desired	Triangular-wave multipliers	None
Plugboard	Overload lamps; master overload light and audible alarm; static and dynamic problem check, time-scale check; vtvm; printer readout; plugboard verifier	Digital vm, electric typewriter, tape punch, 6-channel recorders	12 to several hundred	Servo multipliers; quarter-square diode multipliers; time-division multipliers	Multiplying and resolving servos available
Permanently programmed	Jacks for null galvanometer	Flow meter, strip-chart recorder, digital volume indicator	3	Takes logs, sums and takes antilogs	
Continuous input			1 transistor amplifier	Servo multipliers	Servo-driven pots, transistor servo amplifiers
Prepatched plugboard available	Overload lamps	CRO with dual operative time and instantaneous switching	24		

continuous output to a recorder.

Analog and digital computers should not be thought of as competitive. In many cases they complement one another. When both types of machine are available, a problem can first be run on the analog computer to obtain an approximate graphical answer. The form of the result can guide the programmer in preparing to run the problem on the digital computer to obtain a set of numerical results of required precision.

### Problem Checking

Conversely, an analog computer can provide a check on the truthfulness of results obtained when a problem is worked on a digital computer. It is like doing a problem on an electric calculator and checking the results with a slide-rule.

At Project Cyclone, a large Navy-sponsored analog computing installation in New York, an Elecom 100, a medium-sized digital computer, is used to obtain spot checks as a problem is run on the large analog machine which comprises the main equipment at the installation.

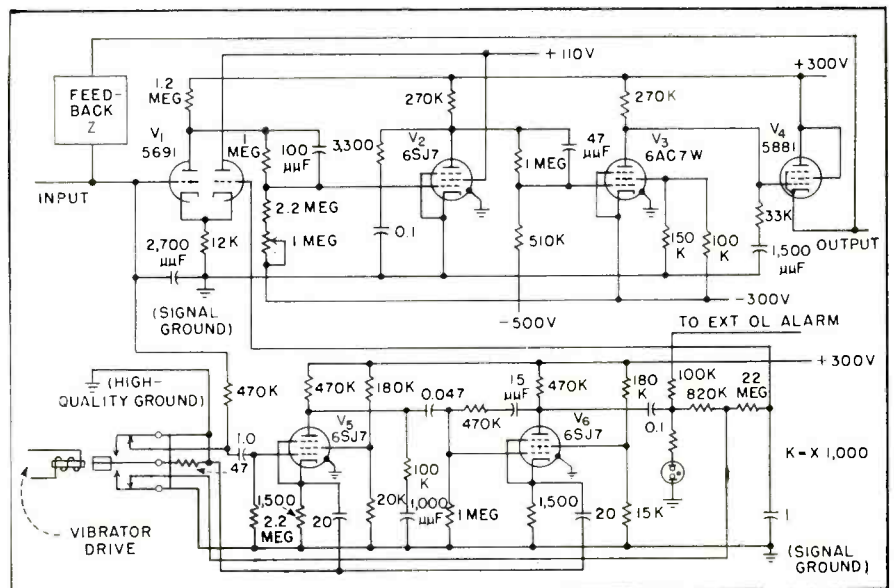


FIG. 1—High-gain operational amplifier is chopper-stabilized to cancel drift. Schematic shows one-half of dual unit

The next step in computer design may be the hybrid computer: a combination analog-digital machine. Besides convenient cross-checking the machine would have other functional advantages. One of the more difficult operations to perform by analog is multiplication. In a hybrid computer, multiplication could conceivably be performed

by digital computing equipment. The analog computer has been called a calculus machine. Integration, so important in solving differential equations, is accomplished by operational amplifiers. This device is what makes the analog computer electronic. Electronic analog computers became important in 1947 when they were used to plot

**Table II—Analog Computer Amplifier Performance**

trajectories for guided missiles under development.

An operational amplifier is an electronic d-c amplifier characterized by extremely high gain and low drift. Other desirable features include low noise, good linearity, adequate bandwidth and sufficient output. Several types of operational amplifiers are listed with pertinent characteristics in Table II.

Depending upon its inputs and the type of feedback impedance employed, an operational amplifier can be used to multiply by a constant, sum several variables or integrate.

**Amplifier Circuits**

The dual chopper-stabilized operational amplifier, one channel of which is illustrated in Fig. 1, incorporates many of the refinements built into analog computer amplifiers. The d-c amplifier section consists of a twin-triode input  $V_1$ , two pentode amplifiers  $V_2$  and  $V_3$  and a triode-connected cathode follower  $V_4$ . Average gain of such a section is approximately 240,000.

To reduce integrator drift, grid current in the first stage is reduced by operating the stage at half its rated filament voltage. Circuit stabilization techniques are concentrated on the first stage since drift occurring here is most damaging to overall amplifier performance.

Under ideal conditions the amplifier output is zero when its input is zero. Tendency of the amplifier to drift causes a spurious output. A corrective signal derived from the spurious output can be fed back to the input to cancel out the effects of drift.

In the case of a positive-going drift, the signal at the output is applied to one contact of a 94-cps synchronous vibrator. By alternately grounding the input, the drift signal is changed to a rectangular wave. The signal is amplified through  $V_5$  and  $V_6$ . The output of  $V_6$  is applied to a second set of vibrator contacts and converted to pulsating d-c. The signal is filtered and coupled to the grid of the second half of input tube  $V_1$  which acts as a cathode follower, applying its output to the cathode of the first half of  $V_1$ . The negative voltage on the cathode yields a

negative voltage at the plate which is applied through the feedback element to the summing junction of the amplifier, where it cancels the original positive-going drift voltage.

**Analog Multiplication**

Besides operational amplifiers and servo amplifiers, electronic circuits are also important in analog multiplication of two or more variables. Methods for accomplishing multiplication of variables vary widely in different analog computers.

Servo multipliers are based on the two-potentiometer principle.

The potentiometers are frequently positioned by feedback servo-mechanisms. The servo systems can be designed to use either a-c or d-c servo amplifiers. Often inductive potentiometers are used as the computing elements. Servo multipliers can be built to obtain the product more than two variables as well as to handle trigonometric functions.

The so-called quarter-square analog multiplier is based upon the mathematical relationship

$$ky = [(x + y)^2 - (x - y)^2]/4$$

Addition and subtraction of the variables are performed by opera-

Manufacturer	Tube Complement	Stabilization	Gain
Berkeley	½ 5963 cath foll, 12AX7 voltage amp, 12AT7 voltage amp & phase splitter, 12AU7 output amp, ½ 12AY7 cath foll, ½ 12AY7 chopper amp, ½ 6U8 voltage amp, ½ 6U8 overload amp	Chopper	1×10 <sup>8</sup>
Boeing	6SN7 phase inverter, 6SN7 high-gain amp, 6SN7 dual cath foll	.....	1×10 <sup>6</sup>
Donner	6AU6 input amp, 6BQ7A output cath foll, OA2 voltage regulator, ½ 12AU7 constant-current gen	.....	1×10 <sup>4</sup> to 3×10 <sup>4</sup>
Electronic Associates	5691 input amp, 6SJ7 and 6AC7 amp, 5881 cath foll, 2—6SJ7 chopper amp	Chopper	6×10 <sup>8</sup> total
Goodyear L-3	6SN7 input; 2—6SL7 interstage 6V6 output	Stabilized	3×10 <sup>7</sup>
Goodyear A-14	5814A input, 2—12AT7 interstage, 5687 output	Stabilized	1×10 <sup>8</sup>
Heath	6U8 input amp, 12AU7 amp & cath foll, 6BH6 constant-current gen	.....	5×10 <sup>4</sup>
Mid-Century	.....	Chopper	<5×10 <sup>7</sup> total
Philbrick	K2-W—12AX7 input, 12AX7 amp and cath foll	Requires K2-P	1.5×10 <sup>4</sup>
	K2-X—12AX7 input, 6AN8 amp and cath foll	Requires K2-P	3×10 <sup>4</sup>
	K2-P (stabilizing amp) 12AX7 chopper amp	.....	1×10 <sup>8</sup>
	K2-B (booster amp) 12BH7A, OB2	.....	0.8
Reeves	12AX7 input diff amp, 6AU6 voltage amp, 5687 cascode power output, 12AX7 a-c balance amp	Chopper	6×10 <sup>7</sup>
Weber	.....	.....	1×10 <sup>6</sup>



Frequency Response in kc	Noise in mv	Linearity in percent	Drift in v	Phase Shift in deg	Grid Current in amp	Output Impedance in ohms	Output
25	5 (rms at grid)	Better than 0.01	$1 \times 10^{-4}$ per day	10 (4 kc)	$1 \times 10^{-12}$	< 0.01	15 or 50 ma $\pm 100$ v
10	5 (rms)	0.1	$1 \times 10^{-2}$ in 8 hr	3 (1 kc)	$1 \times 10^{-10}$	Essentially zero at d-c	10 ma, $\pm 50$ v
.....	1	.....	$< 1 \times 10^{-3}$ per hr	1 (10 kc)	$< 1 \times 10^{-10}$	1	5 ma, $\pm 120$ or 100 v
.....	5 (peak)	.....	$1 \times 10^{-4}$ per sec	.....	$6 \times 10^{-11}$	.....	2 ma, $\pm 200$ v 13 ma, $\pm 100$ v 20 ma, $\pm 100$ v 33 ma, $\pm 100$ v
2 (0.5 db)	2	Negligible nonlinearity	$5 \times 10^{-4}$ in 30 days	0.5 (100 cps)	$5 \times 10^{-11}$	< 20	5 ma, $\pm 100$ v 15 ma, $\pm 100$ v (max)
70 (3 db)	2 (p-to-p)	Negligible nonlinearity	$5 \times 10^{-5}$	-0.01 (100 cps)	$1 \times 10^{-11}$	< 20	25 ma, $\pm 100$ v
.....	.....	.....	.....	1 (1.2 kc)	.....	.....	10 ma, $\pm 120$ v
to 10	5	0.02	$2 \times 10^{-4}$ per 8 hr	0.2 (1 kc)	$< 7.5 \times 10^{-11}$	.....	10 ma, $\pm 100$ v 20 ma, $\pm 100$ v
100	.....	.....	$5 \times 10^{-3}$ per day	.....	.....	< 1	1 ma, $\pm 50$ v
250	.....	.....	$5 \times 10^{-3}$ per day	.....	.....	< 0.2	2 ma, $\pm 100$ v
.....	.....	.....	.....	.....	.....	$2.2 \times 10^7$	.....
.....	.....	.....	.....	.....	.....	300	20 ma, $\pm 55$ v
10	3 (rms)	0.01	$< 2.6 \times 10^{-4}$ per day	17.5 (5 kc)	$3 \times 10^{-11}$	1,000 (nonfeedback)	20 ma, $\pm 100$ v
> 1	.....	.....	$< 1 \times 10^{-1}$	1 (1 kc)	$< 1 \times 10^{-10}$	.....	12.5 ma, $\pm 100$ v 10 ma, $\pm 150$ v

tional amplifiers. The squaring operations are performed by square-law devices. The desired square-law curve can be approximated by straight-line segments produced by diode clippers.

In a time-division analog multiplier, one of the input variables controls the duty cycle of a pulse train. The second variable controls the pulse amplitude. The average or d-c level of the output waveform is a voltage proportional to the product of the two input variables. A similar type of electronic analog multiplier uses one variable to control pulse height and the other to control pulse width.

Another type of multiplier utilizes the a-m/f-m principle. One variable controls the frequency deviation of an r-f carrier. The second variable governs the degree of amplitude modulation of the f-m.

The triangular-wave multiplier is an all-electronic device that uses operational amplifiers and limiters. The inputs are the two variables and a symmetrical triangular wave. Output from the triangular-wave multiplier is a trapezoidal wave whose average value is the product.

Analog multiplication can also be performed by using a log-taking circuit, a summer and an antilog-

taking circuit. Logarithmic multiplier circuits have been built that depend for their operation on the logarithmic characteristic curve of certain electron-tube triodes.

In addition to the computers described in this article, there are a great many other analog computing devices and special-purpose computers used in military equipment and for specialized engineering and scientific work. Their manufacturers include: Avion, Ford Instruments, General Electric, General Motors, Gerber, Librascope, Maxon, Oerlikon, Reflectone, Texas Computers, Texas Instruments and Feedback Controls.

# MULTIPROGRAM F-M

**SUMMARY** — Three additional entertainment programs are sent out on subcarriers located 28, 29 and 67 kc above the main broadcast carrier. Receivers in the coverage area pick up only the regular program. Paid programs are intercepted with special receivers for advertising or background music in stores, restaurants or factories

**M**ULTIPLEXING makes possible simultaneous transmission of four programs on the main carrier of an f-m broadcast station. The main simplex program continues to bring high-fidelity sound to listeners who have standard f-m receivers. The two or three additional multiplex programs can only reach listeners through special receivers that are generally leased to them by the station.

## Triple Service

For example, one of the multiplex programs can be sold as background music with no announcements to restaurants, stores, factories or offices. Another multiplex program can furnish background music and special advertising announcements to a chain of supermarkets.

A third multiplex program might carry stock reports, facsimile or other special services to selected users. Extra income derived from providing these extra services can supply the economic resources needed for improvement of regular simplex programming.

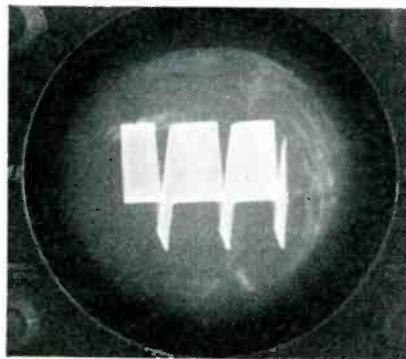
Multiplexing consists in simultaneous addition of frequency-modulated ultrasonic subcarriers to the main carrier of the f-m station. This permits the addition of three programs to the simplex program already being transmitted as shown by the division of the frequency spectrum from 0 to 75 kc in Fig. 1.

## Bands Available

The audio program occupies 0 to 15 kc of the spectrum while the subcarriers are allocated 10-kc

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Oscillogram shows 100-kc saw tooth modulated by 100-cycle signal

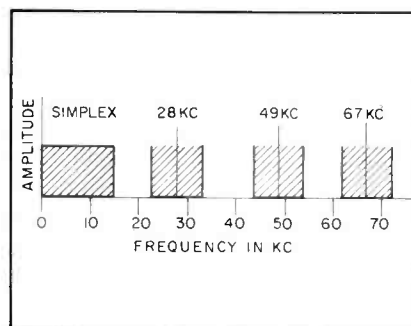


FIG. 1—Division of the audio spectrum for multiplexing

bandwidth each and a guard band of 8 to 10 kc. A study of two-tone frequency-modulation Bessel functions will indicate that there are carrier sidebands extending beyond this range and the adjacent subcarrier could create interference. However, if the index of modulation  $\Delta F/f$  is kept below 23 degrees, the f-m components of the sub-

carrier then consists of only the main carrier and two significant sidebands. These sidebands differ from amplitude modulation only in the matter of polarity.

The complete broadcast multiplex system consists essentially of three units of equipment. A subcarrier generator shown in Fig. 2 uses a beat-frequency oscillator, to provide a frequency-modulated ultrasonic tone at the frequency desired. This is coupled to the special exciter unit in Fig. 3.

Using a balanced modulator in this unit, subcarrier sidebands are added to the main carrier. A special subcarrier receiver (Fig. 4) recaptures the entire f-m program including subcarriers. The desired subcarrier is then selected by tuned stages and discriminated to recover an audio signal that can be amplified and used.

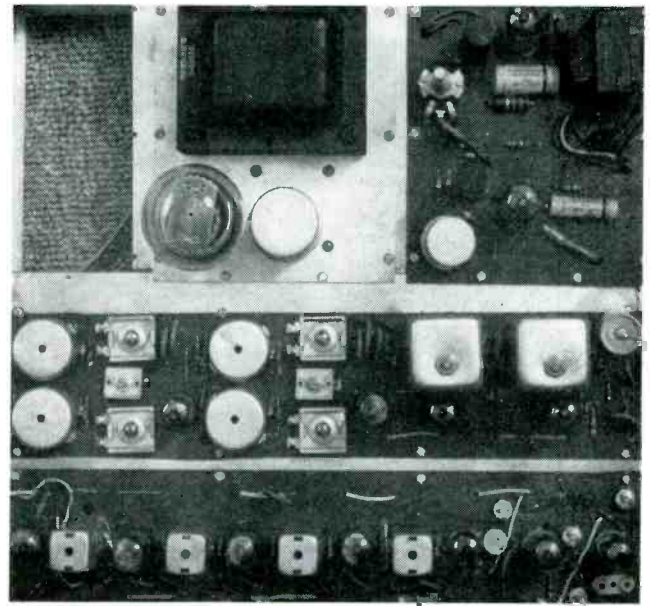
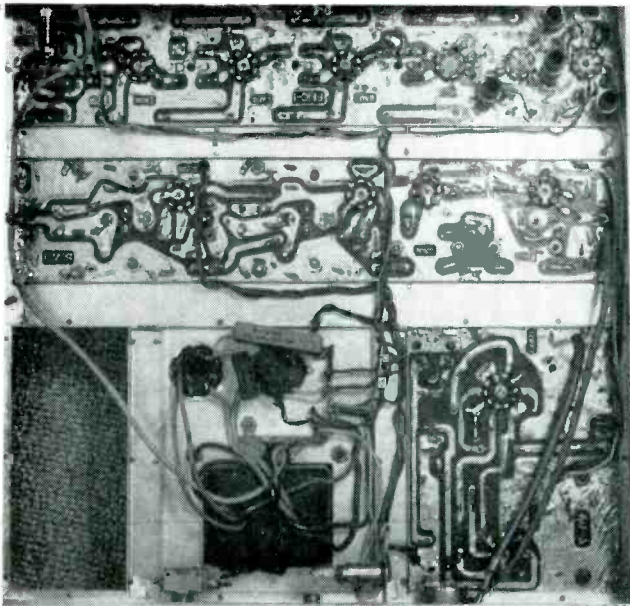
In Fig. 5 is the complete schematic of a single-channel subcarrier generator. Other channels are identical except that the multiplication may be different for interference reasons. The Serrasoid modulator comprises oscillator  $V_1$  and the modulator section  $V_2$ ,  $V_3$  and  $V_4$  modulated by audio-frequency amplifier  $V_5$  and  $V_6$ . The Serrasoid produces a clipped saw-tooth wave of which the amplitude is varied. This in turn varies a pulse in time, thereby exciting the multiplier chain ( $V_7$  through  $V_8$ ) with a frequency-modulated signal.

## Sawtooth Modulation

The photograph of an oscilloscope screen shows the 100-kc saw tooth modulated by a 100-cycle audio sig-



# BROADCAST SYSTEM



Back (left) and front (right) chassis views of receiver using printed circuit techniques

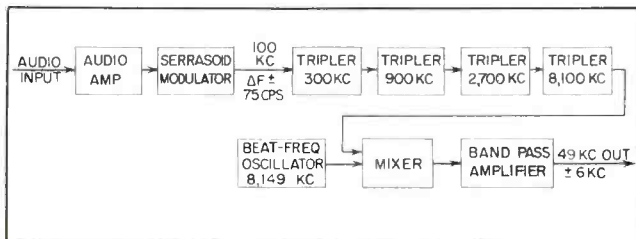


FIG 2—Subcarrier is generated in a separate unit

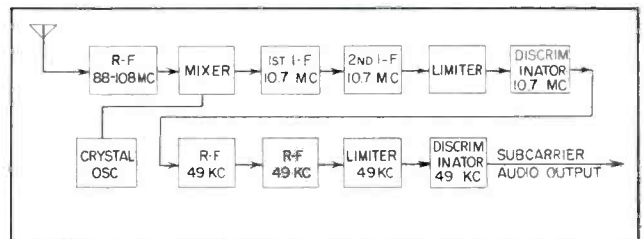


FIG. 4—Receiver block diagram showing one subcarrier output

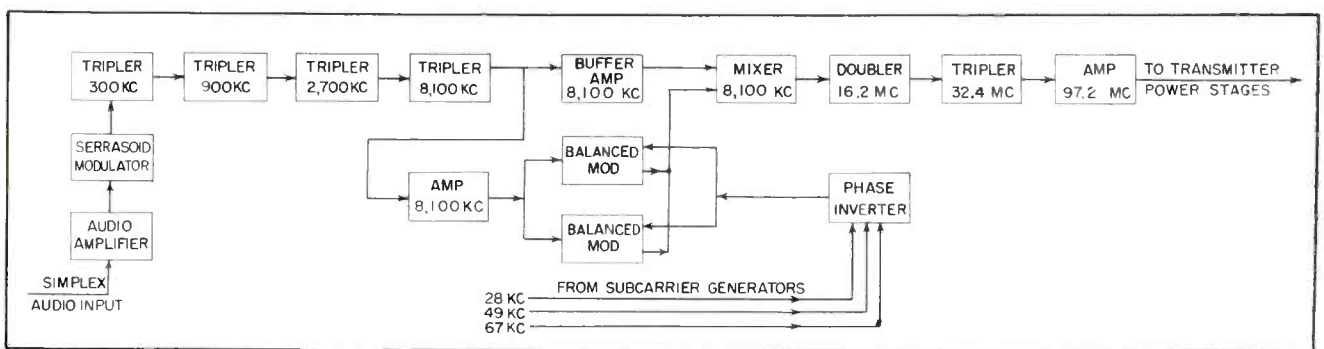


FIG. 3—Exciter unit of main transmitter unit takes subcarrier input at a point beyond which broadcast modulation is initiated

nal. This illustrates the knee of the clipped saw tooth moving horizontally in time to produce frequency modulation. Frequency multiplication is necessary to provide adequate frequency deviation of the 100-kc signal from the modulator. Its deviation is only  $\pm 75$  cycles,

which is not sufficient to provide  $\pm 5$  kc needed for subcarrier signal. When multiplied 81 times to 8,100 kc, there is a deviation of  $\pm 6,075$  cycles, which is adequate deviation.

At the final multiplied frequency, the signal beats with a tripling, crystal-controlled oscillator  $V_{10}$  of

which the multiplied frequency is 28, 49 or 67 kc higher than the frequency from the Serrasoid multiplier chain. This provides a frequency-modulated subcarrier, which is amplified by  $V_{11}$  and then filtered to remove any of the 8,100 kc frequencies. This filter also helps to





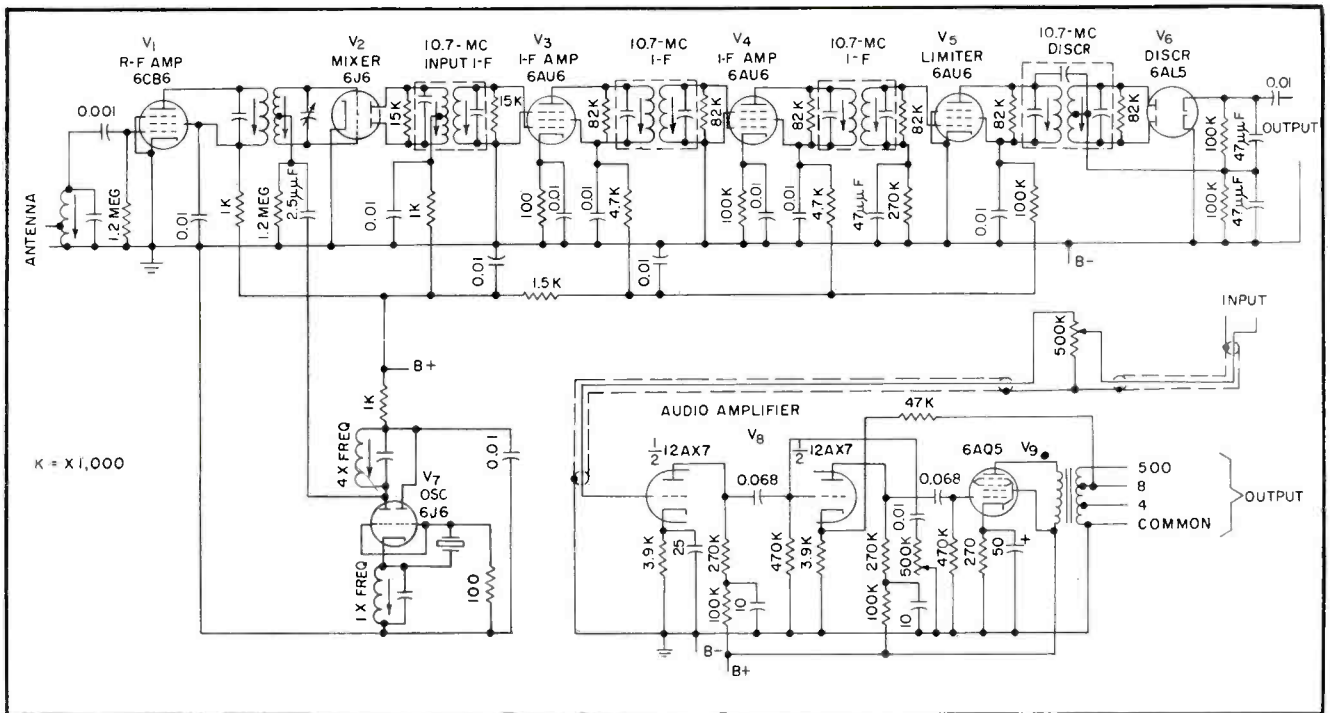


Fig. 7—Main channel receiver with audio amplifier

struction system is used in the receiver. The chassis is divided into five compartments as illustrated. For reasons of economy and reliability, printed circuit techniques are used in construction. The unit may include either a large or small power supply to operate a 3 or 8-watt audio amplifier. It can be used as a tuner to feed an external amplifier.

In Fig. 7 is shown the receiver with a 3-watt amplifier. The balanced-modulator principle is used to provide balanced mixing. This mixer prevents the strong signal of the oscillator from reaching the intermediate-frequency stages and, thereby, causing cross-modulation. It is also possible to correct for phase shift in the receiver by adjustment of the balanced input and output coils.

### Broad Band Response

Standard broadband i-f transformers are used with swamping resistors to provide increased bandwidth. Frequency correction is not used in the output of the discriminator since this would attenuate the subcarrier frequencies. Instead the total output is fed into the subcarrier receiver for selective amplification of the desired subcarrier.

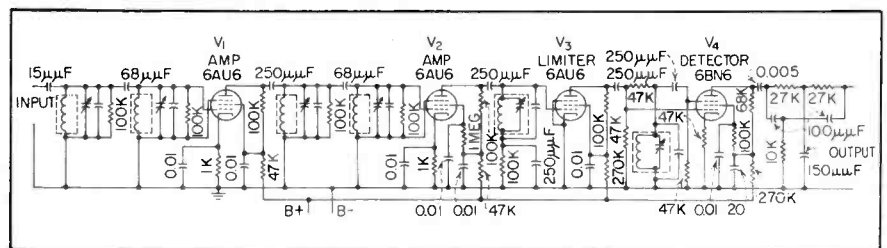
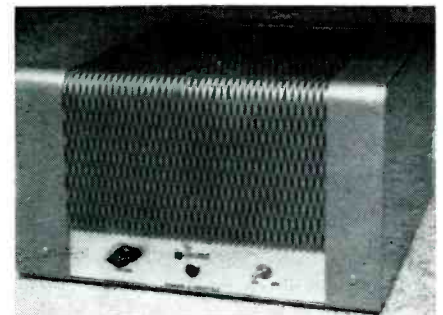


FIG. 8—Subcarrier demodulator is attached to output of main receiver

In the subcarrier receiver (Fig. 8) the first-stage 6AU6 is a plate-starved amplifier to provide selectivity but little gain. The following stage and limiter are conventional, except that they are operating at ultrasonic frequency. The 6BN6 discriminator is a phase and frequency-sensitive device. The grid coil is in quadrature with the incoming signal and is directly coupled, because the interelectrode capacitance is not sufficient for the tube to operate as designed for tv use at 4.5 mc.

The output of the receiver is filtered by a bridged-T network to prevent the subcarrier frequency from entering the audio amplifier. This filter provides 22-db rejection.

Overall performance of the receiver has been such as to result in sensitivities in the order of 2 and 3 microvolts for full limiting in the



Receiver used to reproduce subcarrier signal requires minimum number of controls

subcarrier receiver. This sensitivity results from an action similar to double conversion in the conventional a-m receiver. While the input signal may drop below that necessary to provide full action on the first limiter, the subcarrier receiver rejects the increased noise, amplifies the weak subcarrier signal and then provides adequate limiting in the subcarrier limiter.

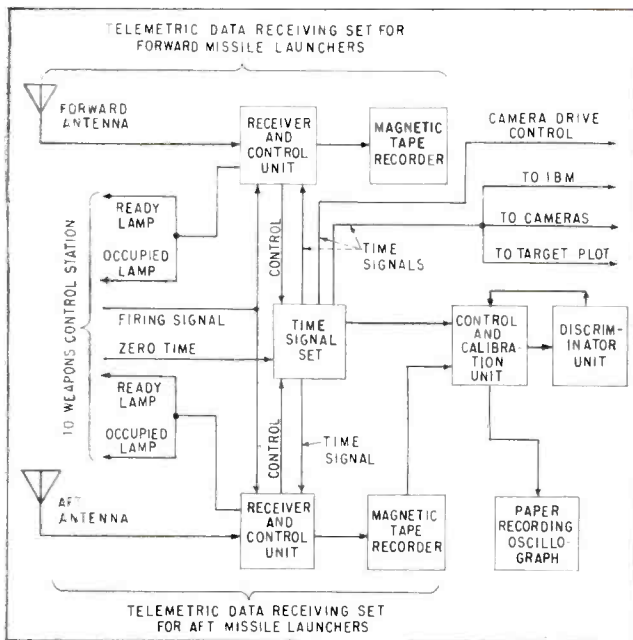


FIG. 1—Simplified block diagram of complete telemetering system used to feed the two magnetic tape recorders

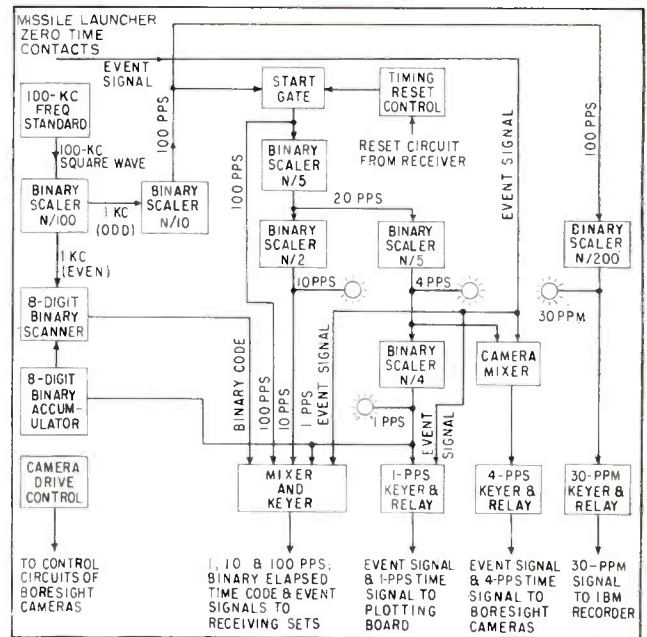


FIG. 2—Time signal set is triggered by contact that closes momentarily when missile leaves launcher, to generate required signals

# Shipboard Telemetering

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*The J. P. Seeburg Corporation  
Chicago, Illinois*

**SUMMARY** — Automatic f-m/f-m telemetering system serving both launchers on U.S.S. Mississippi provides magnetic tape recordings of internally derived data for fleet evaluation of production-type Terrier missiles without interfering with missile fire control system. Six channels accommodate six missiles simultaneously

**T**HE LEVEL OF performance of the many complex systems within an expendable guided missile can most reliably be determined by radio telemetry, because internally derived data stored on some recording medium within an expendable missile is invariably lost or partially destroyed upon flight termination.

## System Requirements

In equipping the battleship U. S. S. Mississippi to perform fleet evaluation of production-type Terrier missiles, the basic requirements of the telemetering system were determined to be:

(1) Collect and store quality con-

trol data for analysis at a shore-based data reduction center.

(2) The overall system error per data channel should not exceed 5 percent from the missile data input point to the reduced graphic records.

(3) The telemetering system should not complicate the missile fire control system nor be a factor in determining missile flight readiness.

(4) The receiving equipment should be capable of simultaneously receiving a total of six telemetering signals and capable of providing 30 minutes of recording time.

(5) The receiving set should be capable of unattended operation and

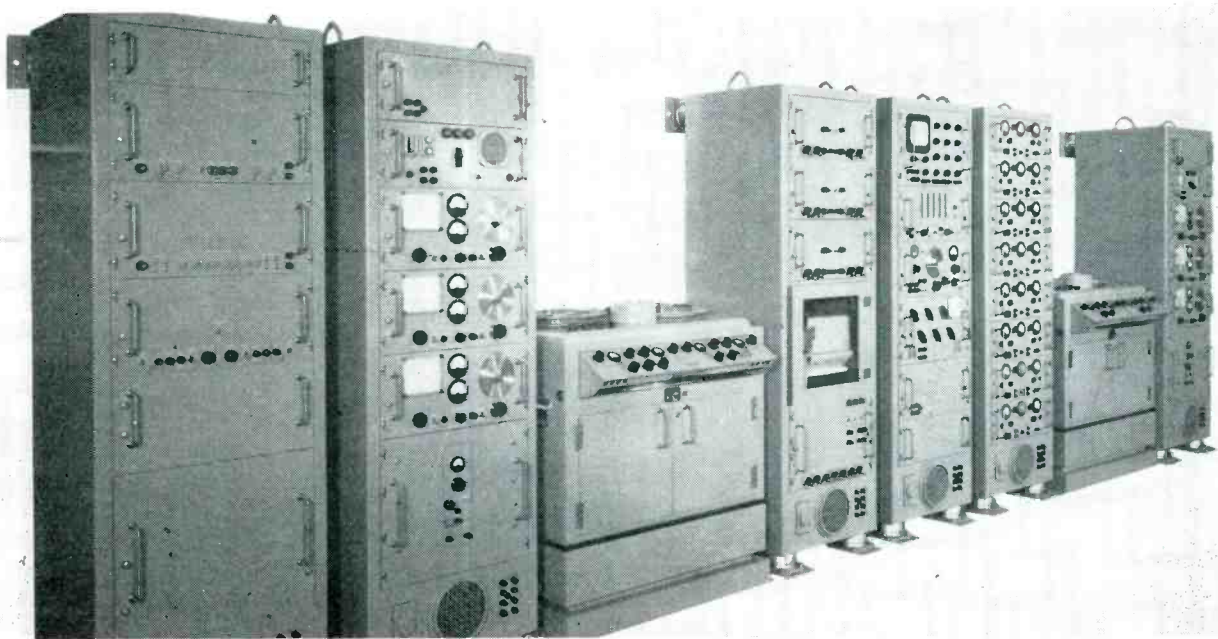
should automatically record all flight data as well as be capable of presenting crude data graphically in real time without the use of photographic processes.

(6) All timing and identification of information must be derived within the telemetering equipment and should be automatically recorded with the flight data.

(7) The telemetering antennas must be kept to a minimum in size and number and must be weather, blast, shock and vibration proof while assuring reception regardless of the attitude of the missile antenna.

Developmental experience had shown that the internal perform-





Complete telemetering installation on U.S.S. Mississippi. Starting from left, eight racks are: 1—time signal set; 2, 3—telemetric data receiving set; 4, 5, 6—telemetric recording set; 7, 8—second telemetric data receiving set

# for TERRIER Missiles

ance of the production missile could be determined by eight continuous channels of information with an allowable error not to exceed 5 percent. The permissible errors for the various data conversion points

in the system were assigned as 2 percent to the telemetric data transmitting set, 2 percent to the shipboard receiving and recording set and 2 percent to the data reduction process.

The total error is not the simple arithmetic sum of the various assigned tolerance values in the system. Records from the U. S. S. Mississippi have repeatedly indicated that the total system error

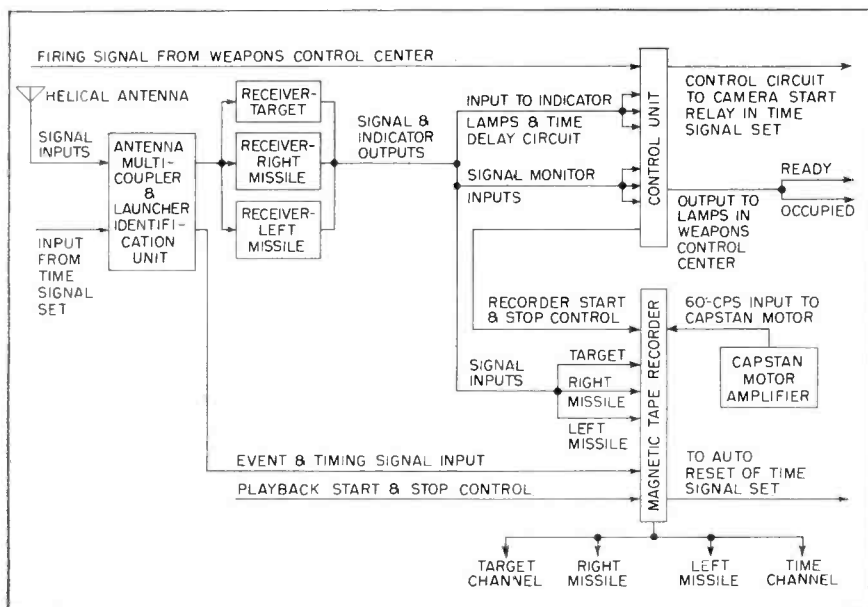


FIG. 3—Detailed block diagram of one of receiving sets, showing provisions for handling three missiles in flight simultaneously with one tape recorder

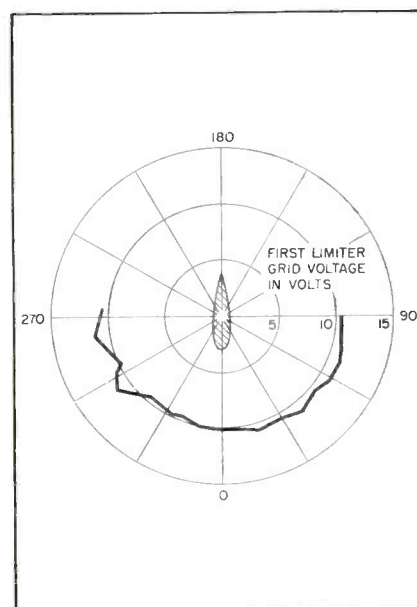
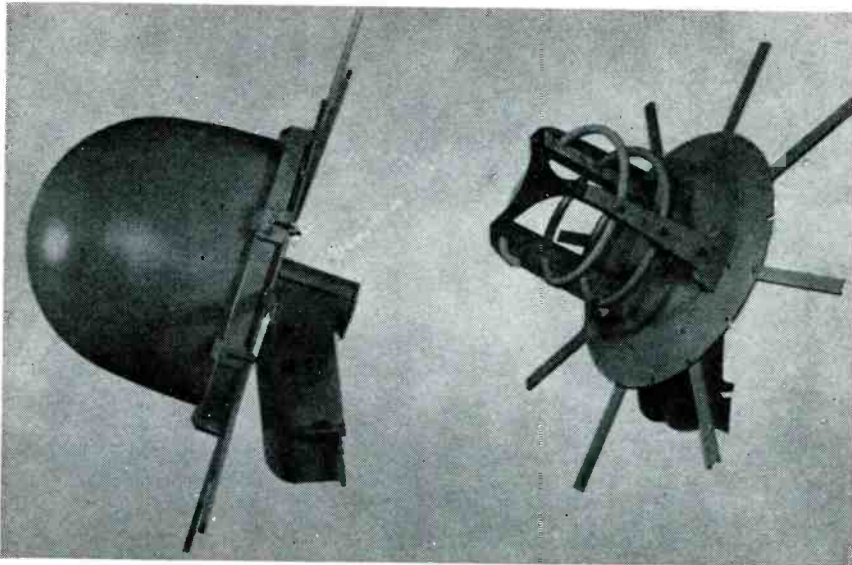


FIG. 4—Antenna pattern for constant slant range of 7,100 yards at 9,000 ft



Three-turn helical antenna used on target-tracking radar mount, shown with protective radome housing. Three melamine supports attached to ground plane hold helix

side events to be easily determined during data reduction.

Each telemetric data receiving set consists of a helical beam antenna, an antenna multicoupler, three f-m radio receivers, a four-channel magnetic tape recorder, a launcher identification unit and the necessary power and control units, as shown on the diagram in Fig. 3. Three tracks on the magnetic tape record the telemetric data from the output of the three receivers and the fourth track records all time, event and identification information. Launcher identification is made by a choice of different tone frequencies of the recorded timing markers. Individual missiles are identified by assigning a given tape track on the recorder to a given arm on the launcher.

does not exceed 2.5 percent for the telemetered information.

The complete electronic installation aboard the U. S. S. Mississippi is shown in Fig. 1. One telemetric data receiving set is assigned to the forward missile launcher and the second set is assigned to the aft launcher. The two receiving sets and the time signal set are controlled by a signal from the weapons control station. This firing signal to any missile will start the magnetic tape recorder of the assigned receiver.

### Missile Launching

At the time of first motion of the missile, contacts on the launcher close momentarily to provide a zero time or event signal to the time signal set. The zero time signal applies 100-per-second timing signal pulses to the time channel of the tape recorder so that timing markers are recorded simultaneously with missile flight data.

After a tape recorder set has been started, it will continue to record on that particular channel until approximately 5 seconds after missile telemetering carrier signal ceases. The set then reverts to standby and provides a telemeter ready signal.

If one or more missiles are in flight when another missile is launched, an event marker is recorded with the data channels of the first missiles so that all data can be correlated in time between

the various missiles. Lamps for ready and occupied conditions indicate availability of a channel.

### Identification

The method of deriving the various time signals from a 100-kc crystal is shown in Fig. 2. A binary code is inserted after every tenth timing pulse by the time signal set to permit elapsed time between mis-

### Antennas

Each antenna is located on the target-tracking radar mount and consists of a three-turn helix mounted on an extended ground plane to provide a beam width of 70 degrees at the half-power points and a gain of 9 over the band of 215 to 235 mc. A Plexiglas radome housing avoids the short-circuiting

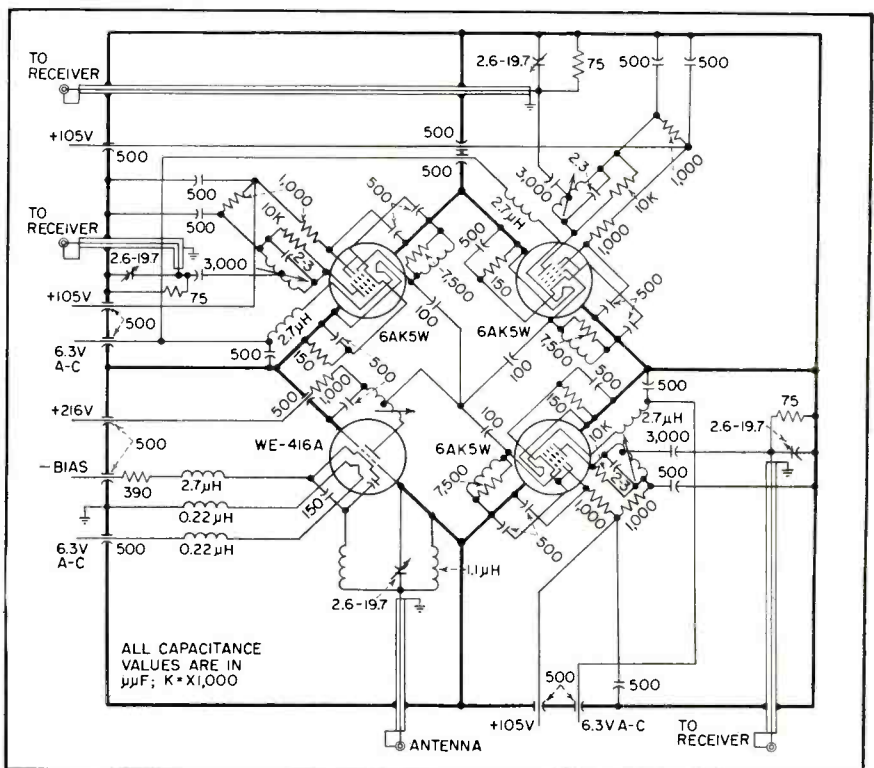


FIG. 5—Antenna multicoupler circuit arrangement used with single antenna (bottom center) to feed three receivers tuned independently in 215-235 mc band



action of salt spray and stack gas deposits across the base insulator of the helix. The radome also provides adequate protection from adjacent gun and missile blast effects.

A matching stub located in the base of the antenna provides an impedance of  $50 + j0$  ohms at the center of the frequency band. This impedance is maintained to a degree necessary to keep the standing wave ratio below 1.1 out to the telemetering band limits.

The axis of the antenna is elevated 35 degrees to avoid large variations in signal strength owing to combining of line-of-sight and missile-to-sea-surface-to-antenna transmission paths that occur with low-flying missiles. A typical antenna pattern, in Fig. 4, indicates that adjacent ship superstructure and sea reflections have no appreciable effect on the received signal.

### Multicouplers

Because of space limitations a single antenna has to provide signals for three radio receivers, necessitating development of the antenna multicoupler unit. To permit independent tuning of the three radio receivers in the specified 215-

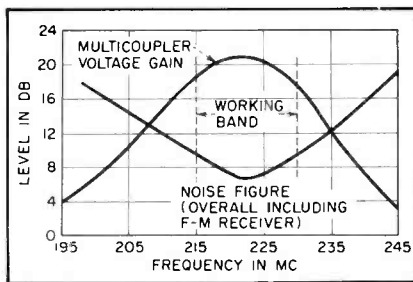


FIG. 6—Response curve of multicoupler and noise figure of complete receiving channel

235 mc band it was necessary to provide this bandwidth in the multicoupler. Another requirement, owing to intermodulation between receivers, was adequate isolation between input terminals of the three receivers. A third requirement was that the signal-to-noise ratio of each receiving channel should not be seriously reduced as a result of parallel operation of the three receivers from one antenna.

A passive coupling network did not offer a ready solution between the conflicting requirements of adequate isolation and bandwidth. The solution of this problem was found in the use of a high- $g_m$  planar triode in a grounded-grid arrange-

ment. This tube has a rated transconductance of 50,000 micromhos and an equivalent noise resistance of approximately 80 ohms<sup>2</sup>, and was originally designed for use in microwave repeater stations. It was found to be satisfactory at the lower frequency when the internal cathode-to-cathode-shell capacitor was supplemented externally through the cathode base pin of the planar triode tube.

As shown in Fig. 5, the type 416A planar triode tube is operated as a grounded-grid amplifier supplying signals to three isolating pentodes<sup>3</sup>. The three 6AK5W grids in parallel presented a loading resistance of 430 ohms and only the high transconductance of the first tube prevents noise figure deterioration in the pentodes. Tubes such as the 6BQ7A have since been made available for use in a cascode circuit with good results<sup>3</sup>.

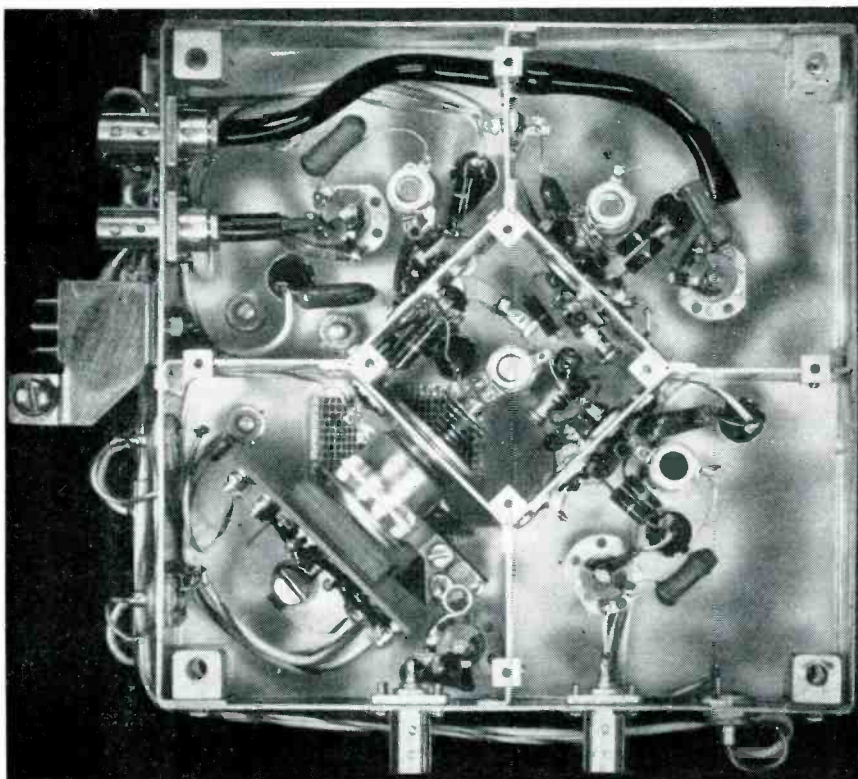
The multicoupler response and the overall noise figure of each receiving channel are shown in Fig. 6. The noise figure of the receiver alone is approximately 10 db, and therefore the multicoupler actually improves the performance of all three receiving channels. Isolation between receivers is 25 db and attenuation of the receiver local oscillator signal at the antenna is more than 60 db.

The system has served as the basis for telemetric data storage design on the first tactical guided missile ships, the U.S.S. Boston and the U.S.S. Canberra.

The equipments described were provided by the J. P. Seeburg Corp. under Contract NOrd 11878, with the exception of the time signal set which was provided by Electronic Engineering Corp. of California. System studies and design and component specifications were prepared by the Vitro Silver Spring Laboratories, Division of the Vitro Corporation of America under Contract NOrd 10378.

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- (3) G. E. Bower and J. B. Wynn, Jr., Antenna Systems for Missile Telemetering, *ELECTRONICS*, p 6, June 1955.



Construction details of antenna multicoupler unit, showing planar triode in lower left quadrant and unique chassis construction used for shielding purposes

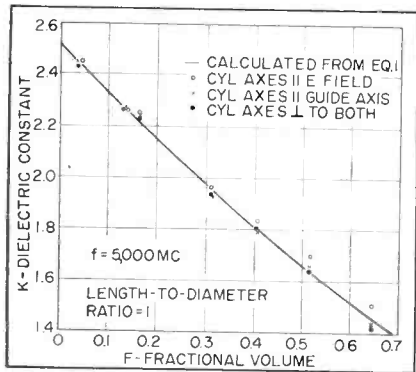


FIG. 1—Dielectric constant for cylindrical-void media

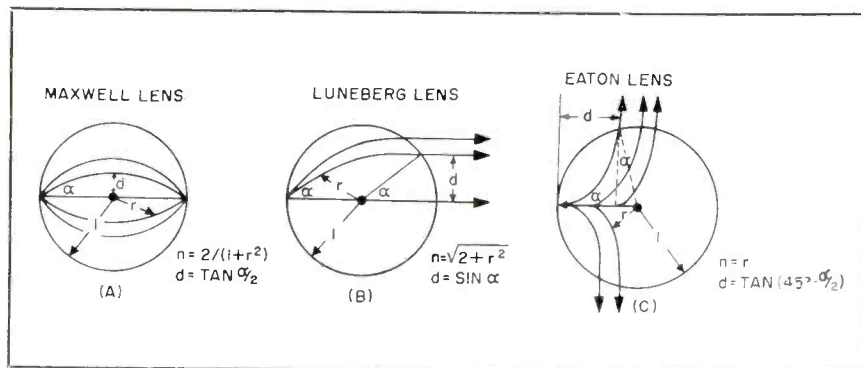


FIG. 2—Cross-sections of spherical lenses and ray paths. Design equations are for index of refraction  $n$  and distance from axis  $r$

# DESIGNING DIELECTRIC

INDIVIDUAL LENSES, in conventional optical designs, have a constant refractive index and lens action is obtained by shaping the surfaces. In microwave optics design, the possibility of a variation in index from point to point within the lens is available, offering the designer another degree of freedom. For example, if it is desirable to minimize the thickness of a lens, focusing can be achieved partly by the lens surface and partly by a variation in the index of the material forming the lens.

## Lens Materials

Materials available for lens design in microwave optics include low-loss dielectric materials such as polystyrene and Teflon. Aluminum-flake or carbon particles in a low-density foam dielectric achieve considerable weight reduction with a slight increase in lens loss. For all of these materials, the index of refraction is the square root of the dielectric constant, so in describing lens designs either of the terms refractive index or dielectric constant can be used.

The most straightforward technique for constructing a microwave lens which possesses a variation in refractive index involves the use of many different materials, each of which has a different refractive index. For example, a spherical lens can be made up of a small spherical core, together with

spherical shells of increasing radii.

The material in each shell can have a different value of dielectric constant or refractive index. By using a sufficient number of shells, the desired lens can be obtained to a reasonable approximation.

The major difficulty in this technique is obtaining the variety of dielectric materials and maintaining the desired dielectric constant from one production run of the material to the next. Most dielectric materials have a variation in dielectric constant of at least 3 percent between various samples. The finite error in dielectric constant places a practical limit on the degree of approximation to the desired refractive index.

## Artificial Dielectric

Another technique involves artificial dielectrics obtained by using the fact that microwave wavelengths are of the order of a few inches, so that obstacles can be formed which simulate the molecules of a real dielectric. As long as these obstacles have small diameters and spacing compared to wavelength, the analysis of the artificial dielectric can be closely related to that of the real dielectric.

The most practical obstacle for general applications has been found to be of spherical shape. For such an obstacle, the refractive index is independent of the direction of the

wave passing through the lens.

It is possible to analyze the effective dielectric constant on the basis of the sphere diameter and the center-to-center spacing. These parameters can be replaced by a concept of fractional volume, that is, volume occupied by the spheres alone, compared to that occupied by the spheres and adjacent medium. The spheres considered were metallic or dielectric materials in a low-dielectric medium or voids in a base dielectric.<sup>1</sup> From the results of this study and a consideration of the mechanical problems involved in forming a lens, void-dielectric material was found best.

The dielectric constant  $K$  of an artificial medium comprised of a cubical lattice of spherical voids is<sup>2</sup>

$$K/K_1 = (1 + 2FC)/(1 - FC) \quad (1)$$

Fractional volume  $F$  is the volume of the voids in unit volume; thus,  $F$  involves the void diameter and

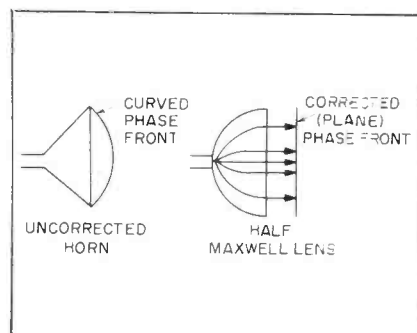


FIG. 3—Indication of phase-error correction through use of half-Maxwell lens



**SUMMARY** — Data for Maxwell, Luneberg, Eaton, Kelleher and modified types of variable index-of-refraction lenses aid antenna designers. New dielectric materials provide considerable weight reduction with slight increase in lens loss. Typical design example for Luneberg lens is covered

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# MICROWAVE LENSES

the void density in number per unit volume. Constant  $C$  is characteristic of the base medium,

$$C = (1 - K_1)/(1 + 2K_1) \quad (2)$$

where  $K_1$  is the dielectric constant of the base medium. It has been found experimentally that Eq. 1 is valid even when the diameter and spacing of voids exceed  $\lambda/4$ .

## Cylindrical Voids

For maximum flexibility in design and ease in machining, cylindrical voids can be used to replace spherical voids.

An experimental program determined the relationship between the cylinders and spheres. Typical measured data is shown in Fig. 1. The solid curve is calculated from Eq. 1, with  $K_1 = 2.515$  (for polystyrene).

The points are experimental and apply to samples having eight cylinders per unit cube (measuring

0.936 inch on a side) and a cylinder length equal to cylinder diameter. Similar data was obtained for length-to-diameter ratios of  $2\frac{1}{2}$ . Maximum fractional volume for the two latter ratios was 16 percent. The largest cylinder diameter for which data is shown is approximately 0.172.

With the exception of a single point at large fractional volume, the maximum deviation of the measured dielectric constant from the value which would be predicted on the basis of spherical voids having the same fractional volume is one percent. This value is of the order of the experimental error. Larger cylindrical voids having a diameter of 0.344 were also tested.

A limited amount of data was taken because of the long length of sample which is required, but even with this very large element, the measured data was within 18 percent of that expected from the

spherical void theory. From these measurements, it is concluded that Eq. 1 is applicable within a few percent to all cases investigated, irrespective of the orientation of the cylinders.

## Metal-Plate Media

A third technique for obtaining a variation in refractive index uses metal-plate media. The refractive index is obtained by considering the increase in phase velocity, which occurs when a wave polarized parallel to a set of parallel plates passes through the plates. This technique has been used successfully in the design of metal-plate lenses where the refractive index is known to depend on the spacing between plates.

If two metallic surfaces are arranged so there is a variation in spacing between the surfaces and if an electric field is introduced approximately parallel to the plates, then the phase velocity, and therefore the refractive index, will vary from point to point in the region between the metallic surfaces. The index approaches one when the spacing between plates is large compared to a wavelength and zero as the spacing is reduced. This technique for obtaining a variation in refractive index is limited to a two-dimensional lens or a three-dimensional structure.

If the spacing between plates is measured always normal to the

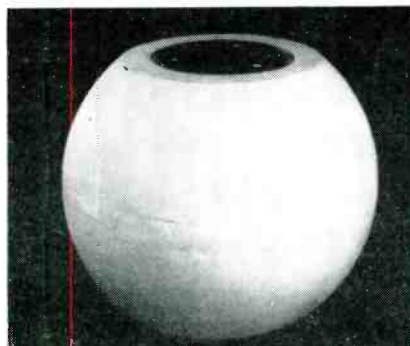


FIG. 4—Spherical Luneberg lens before (left) and after (right) foam binder application

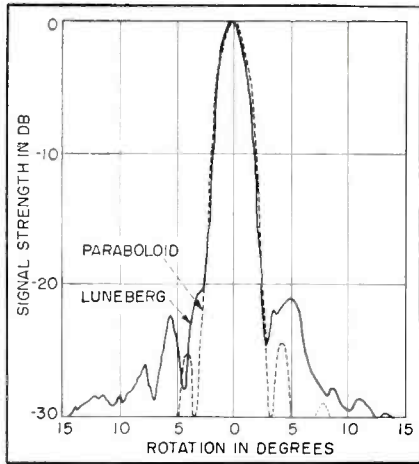


FIG. 5—Radiation patterns of Luneberg and standard parabolic lenses

particular tangent plane containing the electric-field vector, the index of refraction is related to spacing  $a$  and the signal wavelength by

$$n = \sqrt{1 - (\lambda/2a)^2}$$

If the spacing between plates is filled with a dielectric of constant  $K$ , the index is given by

$$n = \sqrt{K - (\lambda/2a)^2}$$

### Spherical Lenses

Once techniques are available for obtaining a variable index material, consideration can be given to the design of microwave lenses having properties superior to those of conventional lenses.

One of the most useful families of variable-index lenses is that in which the lens surface is a sphere with the transmitting or receiving element mounted on the spherical surface. In such an arrangement, it is possible by use of different lens designs to obtain a formation

of the transmitted spherical wave into many different wavefronts, such as spherical surfaces,<sup>2</sup> toroidal surfaces<sup>3</sup> and conical surfaces.<sup>4</sup>

Lenses which have been of most interest up to the present time are elements which yield spherical, plane and cylindrical surfaces; these are the Maxwell, Luneberg and Eaton. Cross-sections of these lenses, together with the ray paths and design equations, are given in Fig. 2.

### Maxwell Lens

The Maxwell lens has been found useful in microwave applications as a correcting element in a sharply flared feed horn. In such a horn, the phase front across the aperture has the quadratic form shown in Fig. 3. Radiation patterns from this horn have, in general, high side-lobe characteristics.

To reduce these lobes, lenses of the dielectric or metal-plate type have been successfully used; however, one-half of the Maxwell lens offers improved possibilities in side-lobe reduction. This can be understood by considering the ray paths through such a lens.

In a sphere of unit radius (Fig. 2A), the ray leaving the feed at angle  $\alpha$  intersects the aperture at a distance  $d$  from the axis given by  $\tan(\alpha/2)$ . This means that the rays, upon passing through this lens, tend to concentrate at the center of the aperture so there is a tapering in the illumination across the aperture.

Since tapered illumination produces low side lobes, it can be expected that better radiation pat-

terns can be obtained from a correcting lens of the Maxwell form than could be obtained with the conventional constant-index lenses.

### Luneberg Lens

The most important lens in terms of application is the Luneberg. This spherical lens accurately focuses an incoming plane wave into a point on its surface. Because of its spherical symmetry, it can focus plane waves arriving from any direction, a characteristic not shared by any other known optical device. Figure 4 shows a Luneberg lens constructed from a void dielectric.

It is useful to compare the Luneberg lens to a paraboloidal reflector with circular aperture. If the diameter of the paraboloidal aperture is equal to the diameter of the Luneberg sphere, then a direct comparison can be made.

Figure 5 shows a typical pattern from the paraboloid, together with a pattern from a Luneberg sphere. Neither pattern represents the best that can be obtained from either antenna. However, they do indicate that the Luneberg lens has a narrower beamwidth than the reflector, but that the reflector shows some improvement in side-lobe level. These pattern characteristics arise from the fact that the paths followed by the rays in a Luneberg lens tend to concentrate energy towards the aperture edges.

The ray making angle  $\alpha$  at the feed (Fig. 2B) intersects the aperture at a distance  $d$  from the axis of  $\sin \alpha$ . This reduction in illumination taper is known to cause an

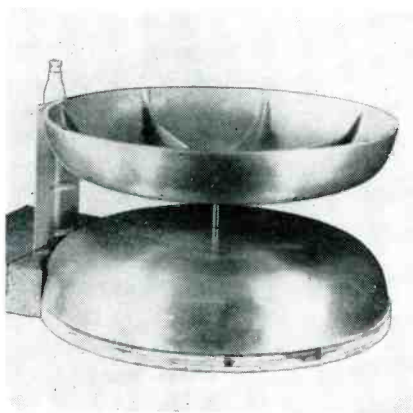


FIG. 6—Two-dimensional Eaton lens. Feed is mounted at left

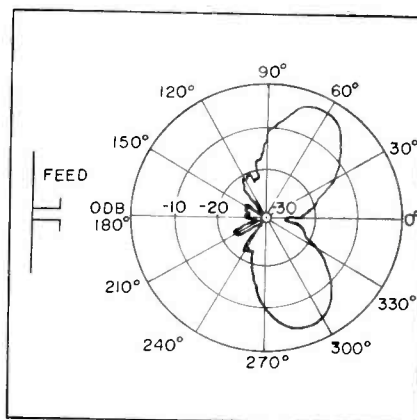


FIG. 7—Radiation pattern of Eaton lens shown in Fig. 6

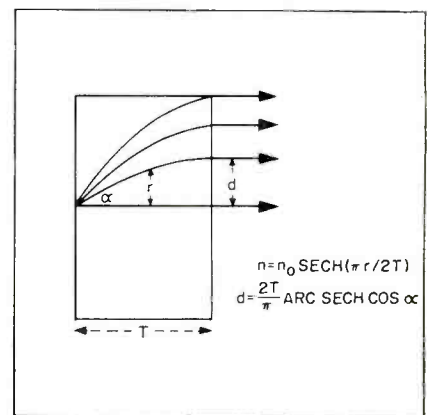


FIG. 8—Cross-section of constant-thickness lens



increase in side-lobe level and decrease in beamwidth.

Consequently, the Luneberg lens cannot be used for extremely low side lobe applications. However, for applications requiring side lobes of the order of 22 db, this lens can be used and, in such an instance, its symmetrical structure gives it a wide-angle performance not attainable by the normal paraboloidal reflector.

The wide-angle performance of the Luneberg lens indicates two general applications. The first of these is for wide-angle scanning. The lens structure can be fixed and a lightweight feed horn rotated so that it always touches the surface of the lens. The beam from the horn-lens combination is swept through an angle equal to the angle of the horn rotation.

Another application utilizes a single lens with multiple feeds. Each feed has a corresponding beam in a direction given by the line joining the feed to the center of the sphere. A number of these feeds can be used to provide coverage over a wide sector of space.

### Eaton Lens

The Eaton lens produces a twin-beam radiation pattern from a single source mounted on the spherical surface as in Fig. 2C.

Consideration of the required index variation, that the refractive index be equal to the normalized radius, indicates the difficulty in constructing an Eaton lens. Since the normalized radius varies from zero to one, the refractive index must have the same variation.

Such values of refractive index cannot be achieved with normal or with artificial dielectrics. The only possibility is the use of a metal-plate medium. Such a medium has only restricted application to the Eaton lens, since it is based on the almost parallel plates previously mentioned. Use of parallel plates restricts the lens to two dimensions, so the complete sphere cannot be realized.

A two-dimensional Eaton lens has been constructed and evaluated. Fig. 6 is a photograph of the lens and Fig. 7 shows a typical radiation pattern. This lens operates over a limited frequency band.

Since the formula for index of refraction contains the operating wavelength, the index of refraction varies when this wavelength is changed.

### Disk-Shaped Lenses

Another useful lens shape is the short cylinder or disk shown in cross-section in Fig. 8. These lenses have a preferred direction or optical axis, whereas spherical lenses perform equally well for waves from all directions. The optical axis of these disk lenses coincides with the cylinder axis, causing the unusual situation of lenses with plane surfaces.

Although the disk-shaped lenses do not have the wide-angle performance typical of the spherical lenses, they have found application in the microwave-optics field. One lens has been used as a feed-correcting element with good results.<sup>5</sup> This corrector is a lens first described by Luneberg. Its index of refraction varies only with the radial coordinate, according to the expression  $n = n_0 \operatorname{sech} [\pi r / (2T)]$ , where  $n_0$  is the axial refractive index and  $T$  is the thickness. Note that the index required is a function of the disk thickness; a change in thickness would alter the lens performance.

The ray making an angle  $\alpha$  at the feed intersects the aperture at a distance  $d$  given by  $(2T/\pi) \operatorname{arc} \operatorname{sech} (\cos \alpha)$ . As indicated in the cross-section, the rays spread at the aperture edges to produce an illumination taper. This taper has been shown to be an approximation to a Gaussian distribution which produces very low side lobes.<sup>5</sup> The exact distribution depends on the lens thickness and the maximum value of  $\alpha$ .

It is of interest to compare this lens with the Maxwell lens, which can also be used as a feed corrector. The incident signal in the waveguide can be easily matched into a Maxwell lens with an index of unity at the lens surface. The constant-thickness lens, on the other hand, has an index requirement which indicates a value of the order of two along the lens axis, with decreasing index away from the axis.

The waveguide transmission line

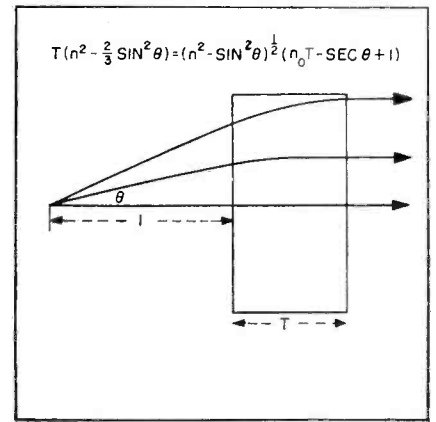


FIG. 9—Cross-section of Kelleher lens

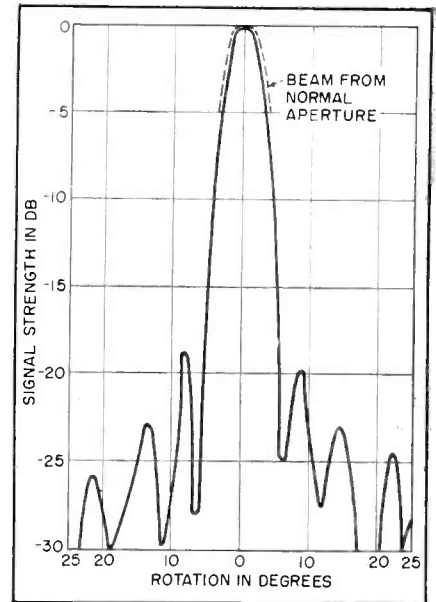


FIG. 10—Radiation pattern of Kelleher lens of Fig. 9

then has the problem of matching a section of air-filled line to a dielectric-filled line. Both lenses have the normal matching problem at the aperture.

The constant thickness lens permits a greater control over the illumination taper and, hence, better control over the side lobes from the corrected feed. Moreover, the depth of the corrected feed can be minimized in the constant thickness design, whereas the best ratio of feed depth to aperture is a value of  $\frac{1}{2}$  for the Maxwell lens. Both lenses are superior to the conventional correcting lenses in that such lenses always have a ratio equal to or greater than unity.

### Kelleher Lens

This lens has the same geometrical form as that of the previous

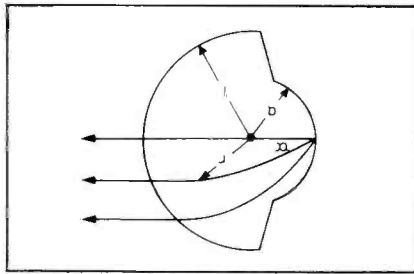


FIG. 11—Cross-section of modified Luneberg lens

disk; the major difference is that the source is placed on the axis of the cylinder at some distance from the lens. This is the only variable-index lens designs now available, which does not have the source adjacent to the lens surface. In this respect, it is most closely allied to the conventional lenses utilizing a constant index of refraction.

The ray paths through a cross-section of this lens are given in Fig. 9. It can be seen that the source has an image at infinity. The expression for the required radial variation in refractive index is more complex than those previously given. This variation is

$$T(n^2 - 2/3 \sin^2 \theta) = \frac{1}{(n^2 - \sin^2 \theta)^{1/2} (n_0 T - \sec \theta + 1)}$$

where  $n_0$  is the index at the axis,  $T$  is lens thickness and  $\theta$  is the angle between the axis and the radius vector from the source point to a general point of the adjacent lens surface.

This lens has been compared to a constant-index lens with shaped surfaces. A typical pattern, shown in Fig. 10, indicates that the beam-width from this lens is narrower than that expected from an aperture of this size. This is probably due to the existence of a trapped field about the periphery of the disk, which tends to produce a greater effective aperture.

A comparison of the off-axis characteristics of the two lenses showed that the variable-index lens was superior. Analysis involving ray tracing has also shown that good off-axis performance can be expected.

An interesting feature of any disk lens is that it can have a periodic structure as the thickness is increased. Any lens with feed adjacent to a surface has ray paths

which are curved to focus at an image point within the thicker lens, then diverge, and again curve to form a second image point and so on until the second lens surface is reached. The radiation pattern obtained depends on the point in the cycle where the second lens surface is introduced.

In the Kelleher lens, a similar periodic structure is obtained by doubling the lens thickness so the rays are curved to form an image at a point symmetrical with the source point. Additional lenses of equal thickness can be introduced at the correct positions to continue the periodic-ray variation.

### Other Lens Shapes

Besides spherical and disk-shaped lenses, several others have been studied in the microwave-optics field. One of these is a modification of the Luneberg lens to minimize lens thickness. This modification permits a reduction in the radius of the lens in the region of the detecting system.

A cross-section through this lens, together with typical ray paths, is given in Fig. 11. A source at infinity is imaged perfectly at the corresponding point on the surface of reduced radius. Three existing expressions for the modified Luneberg lens are listed below for comparison:

$$(1) \quad n^2 = (2a - r^2)/a^2 \text{ for } 0 \leq r \leq a \text{ and } n^2 = (2 - r)/r \text{ for } a \leq r \leq 1;$$

$$(2) \quad 4an^2 = \frac{(1+P)\{\sqrt{\delta(1+a)} + \{4P^2 + (1-a)^2\}^{1/2}\}^2}{(P + \sqrt{\delta a})^2}$$

for  $0 \leq r \leq a$  and  $r^2 n^2 = 1 + \delta(1-r)(r-a)$  for  $a \leq r \leq 1$  where  $P = 1 - r^2 n^2$  and  $\delta$  is a constant;

$$(3) \quad n^2 = (1 + a^2 - r^2)/a^2 \text{ where } a \text{ is the radius of the lens in the reduced region.}$$

### Typical Lens Design

Design of any of the lenses described is relatively simple since the index varies only with one coordinate.

A typical design involves the spherical Luneberg lens whose index varies with radius as  $n^2 = 2 - r^2$ . At this point, it should be observed that the index squared is equal to the dielectric constant, so it is possible to relate the lens-design equation directly to dielectric-constant

values. The design technique found most practical uses the void dielectric of Eq. 1 and 2. The desired sphere is formed from a collection of disks of varying radius, placed one above the other, to approximate a spherical form similar to that in Fig. 4.

There are four steps in the design.

(1) Select base material of dielectric constant  $K_1$  and obtain the coefficient  $C = (1 - K_1)/(1 + 2K_1)$ ; using polystyrene with  $K_1 = 2.52$ ,  $C = -0.252$ . (2) Write Eq. 1 using values of  $K_1$  and  $C$  to obtain a relationship between void dielectric constant and fractional volume;  $K = 2.52(1 - 0.504F)/(1 + 0.252F)$ . (3) Combine the lens equation relating dielectric constant to coordinate value with Eq. 1 to obtain a relationship between coordinate value and fractional volume;  $2 - r^2 = 2.52(1 - 0.504F)/(1 + 0.252F)$ . (4) Compute fractional volume as a function of the position within the lens.

To use the disk assembly technique, note that  $r^2 = d^2 + a^2$  where  $d$  is the distance of the disk from the lens center and  $a$  is the radius coordinate within the disk. The fractional volume is then given by

$$F = 3.97 \left\{ \frac{0.52 + a^2 + d^2}{7.04 - a^2 - d^2} \right\}$$

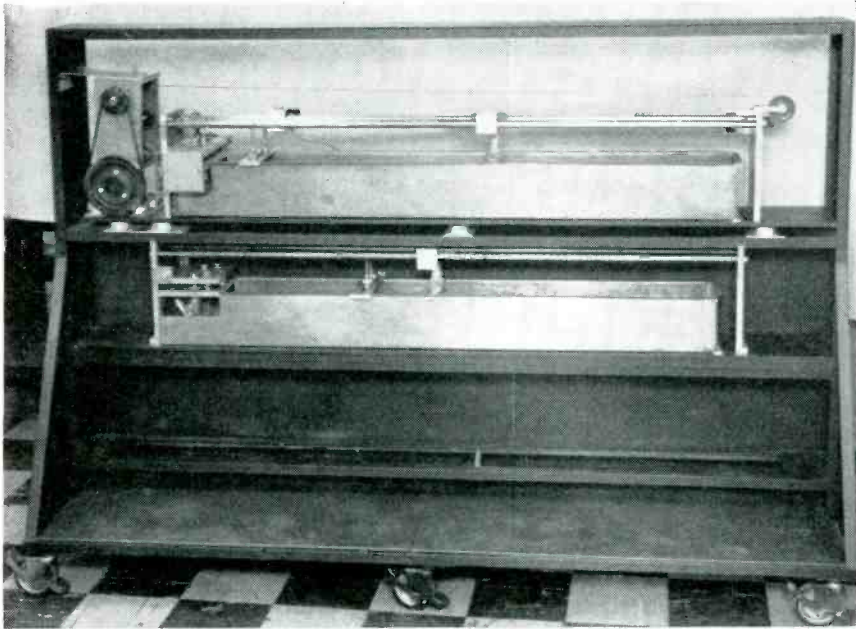
For a disk at a given distance  $d$  from the lens center, the fractional volume at any disk radius is known.

In practice, each disk is divided into annular rings of width less than  $\lambda/4$  so no void will be large in terms of a wavelength. The desired fractional volume in each annular ring is determined from the above equation. This void volume is then obtained by drilling the correct size and number of holes.

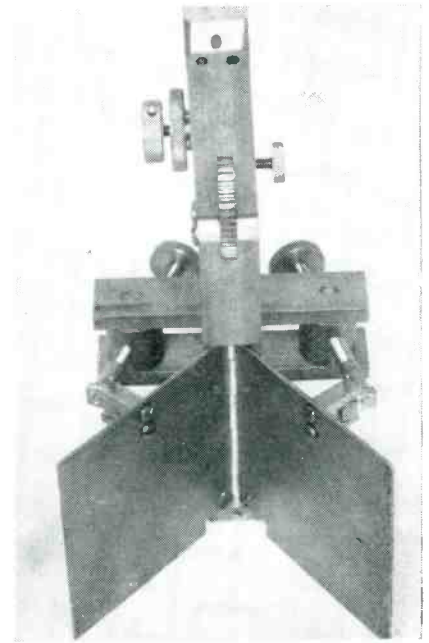
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Variable delay line is on upper shelf, with adjustable-speed motor drive at its right. Fixed delay line on middle shelf and additional line on lower shelf can be connected in series with variable unit to give greater delays



Construction of corner reflector, which is moved through tank by a cable drive. Screws behind hinged vanes adjust angle

# Variable Delay Line Simulates Radar Targets

**SUMMARY** — Two quartz transducers and movable corner reflector in  $3\frac{1}{2}$ -foot water-filled copper tank give time delays ranging from 72 to 1,400 microseconds for simulating moving targets during tests of new radar

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**D**EVELOPMENT OF a new radar target detection system required a delay device which could vary continuously the time delay of a frequency-modulated 5.5-mc sine wave from about 1,400 microseconds down to as small a delay as possible. This device was needed to simulate a moving target.

It was decided that the only practical method of satisfying these requirements, at the time, was by employing an ultrasonic delay line with a liquid medium, the delay

being varied by changing the ultrasonic path length.

In an ultrasonic delay line, electrical energy is converted to acoustical energy by an electromechanical transducer. The acoustical wave is propagated through a medium at a velocity dependent upon the physical constants of the medium. The wave is then converted back to electrical energy using a transducer identical to the first. Large time delays can be achieved due to the low velocity of an acoustical wave through a medium as compared to electromagnetic propagation velocity. For frequencies in the megacycle range, quartz crystals are the most satisfactory trans-

ducers because of their excellent stability and low electrical loss.

### **Liquid Lines**

Before designing a delay line it is necessary to consider several important characteristics of the medium itself and when used with quartz transducers. The only liquid media which have ever been used in practical delay lines are mercury and water. Time delay depends almost entirely on the medium. The delay in distilled water is 204 microseconds per foot, while the delay in mercury is 216 microseconds per foot.

The attenuation in db of an ultrasonic wave in liquids is propor-

tional to the frequency squared. At a frequency of 5.5 mc the attenuation in mercury is 0.49 db per foot of path length, while for water the attenuation is 4 db per foot of path length.

### Equivalent Q of Line

Equivalent electrical circuits of ultrasonic delay lines have been derived by many investigators. Among other things a knowledge of the equivalent circuit helps determine frequency bandwidth and transducer attenuation and is useful in the design of delay lines. An equivalent Q, which has the same definition as the Q of a simple series resonant circuit, has been formulated for a transducer-medium interface. For a mercury-quartz combination  $Q = 0.6$ ; for a water-quartz combination  $Q = 7.5$ . Thus at a center frequency of 5.5 mc, the 3-db bandwidth of a mercury-quartz combination is 9.2 mc, while for water-quartz, the 3-db bandwidth is 740 kc. Since the maximum deviation of the frequency-modulated 5.5-mc sine wave was considerably less than 740 kc, the use of water as a medium was satisfactory in this respect. To achieve a delay of 1,400 microseconds with water meant a path length of about 7 ft.

### Variable Delay

By using a system of ultrasonic transmission and reflection as shown in Fig. 1, the total length of the delay line container (a copper tank in this case) was reduced to 3½ ft. By varying the position of the corner reflector, the delay can be varied. The attenuation in 7 ft of water path is about 28 db

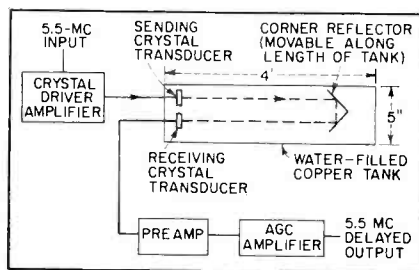


FIG. 1—Ultrasonic delay line and associated amplifiers

and the attenuation of the two quartz-water transducer combinations was calculated to be 28 db, for a total of 56 db at maximum delay.

Lighter weight, ease of handling, availability, lower cost and resistance to shock as compared to mercury led to the selection of water as the medium. A smooth, continuous variation in the delay was achieved by driving the corner reflector with an adjustable-speed motor to adjust the rate of change of delay.

### Crystal Circuits

To achieve the bandwidth necessary to pass the frequency-modulated signal without distortion, it was necessary to load down both the sending and receiving crystal transducers electrically. This load was found to be 1,700 ohms.

Since the amplitude of driving voltage was required to be about 100 volts rms, so that the receiving crystal output voltage was not at too small a level, the class-C tuned power amplifier in Fig. 2 was considered necessary to drive the sending crystal. The input capacitance of the crystal is tuned out by a tuned circuit in the driving

source. The 6CL6 is used to supply grid power to the 6146.

With a positive pulse applied to the PULSE INPUT jack and with proper bias adjustment of both tubes, a pulse-modulated carrier is available at the output. This may be used in measuring the delay and spurious response of the line.

There are tuning adjustments at the outputs of each stage. The gain of the 6146 may be adjusted by varying the grid bias or screen voltage. Six noninductive 10,000-ohm, 2-watt carbon resistors in parallel are used at the output as the bandwidth-broadening load. The crystal driver circuit is completely shielded.

As the delay is varied, the amplitude at the receiving crystal output varies. From maximum to minimum delay, the total amplitude change was about 23 db. To reduce this change to about 1 db, the automatic gain control amplifier of Fig. 3 was added. It consists of three stages of remote-cutoff pentodes and an output power pentode. The interstage coupling networks are synchronous single-tuned tanks. The output voltage is rectified with a crystal diode and the d-c voltage is applied to the grids of the three remote-cutoff tubes. A switch is provided so that the agc may be turned off when aligning the amplifier.

The single-tube preamplifier of Fig. 4 is used to raise the input level of the agc amplifier so the range of input voltage is extended for a given output change of 1 db.

### Changing Frequency

The frequency range of the delay line and associated amplifiers is approximately from 5.25 to 5.75 mc, giving a bandwidth of about 500 kc between the 3-db points. The center frequency can be changed by replacing the crystal transducers with others of different frequency. The only requirements on the crystals are that they fit the crystal holder and have metal-plated faces.

For fundamental-frequency operation at low powers, the upper frequency limit of practical quartz crystals is about 30 mc. With over-tone crystals it is possible to generate ultrasonic waves at frequencies as high as 500 mc, although

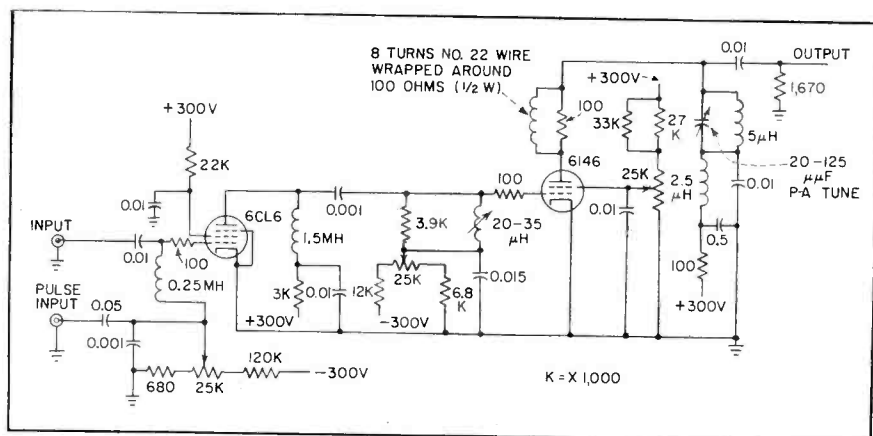
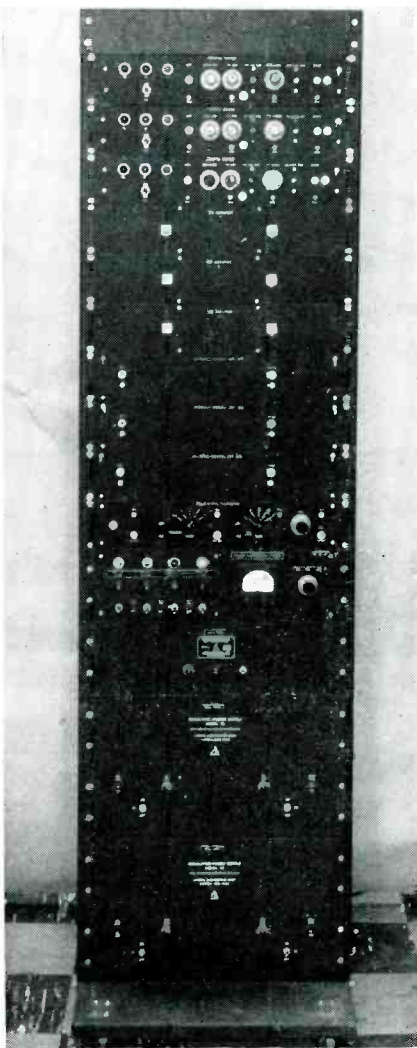


FIG. 2—Driver circuit used to feed transmitting crystal in water tank





Rack containing delay line amplifiers and associated power supplies

the power output is extremely small. The tremendous attenuation in liquids at these frequencies would make them impractical for use in a delay line.

When changing center frequency, the driving and receiving amplifiers must be retuned. The upper frequency limit of the amplifiers, determined by construction and wiring, is about 15 mc. The lower frequency limit of the system is determined by practical limits in the physical sizes of the crystal transducers and tuned circuit components in the amplifiers.

### Minimum Delay

The minimum time delay possible depends on the minimum path length between the two crystal transducers. If the corner reflector is brought up as close as possible to the crystal holders, the total path length is about  $4\frac{1}{2}$  inches. With the

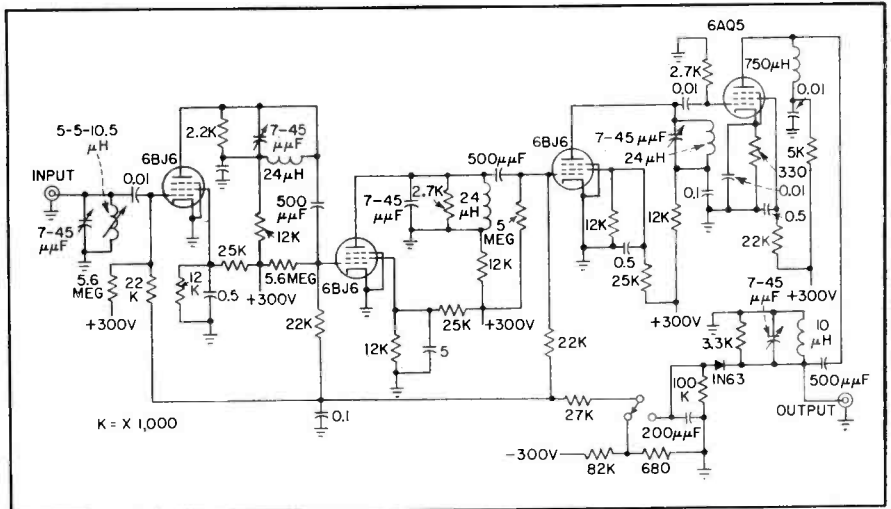


FIG. 3—Amplifier and agc circuits for receiving channels of target simulator

delay in water being 16 microseconds per inch, the minimum delay is approximately 72 microseconds. By removing the corner reflector and having the two crystal transducers face each other, the path length can be reduced to  $\frac{1}{2}$  inch which corresponds to a delay of 8 microseconds. To have the delay vary smoothly from 8 microseconds up, the mechanical arrangement must necessarily be altered.

### Waveforms

The pulse source which was used had width and repetition rate controls. Width of the pulsed carrier output could be varied from about 1 to hundreds of microseconds, the maximum width being limited only by the maximum power output and the output impedance of the pulse generator. The maximum repetition rate was limited only by the maximum rate of the pulse source and the actual frequency of the carrier. Pulses could be applied at as low a rate as desired or randomly, as with a pushbutton-controlled pulse.

Any wave shape, including voice signals, can be used to modulate the

carrier provided the sidebands produced by modulation are within the overall pass band of the system. The modulation source must be capable of supplying a certain amount of power to the crystal driver and must have a source impedance of a few hundred ohms. By detecting the receiver amplifier output with a detector of the proper design, the original modulation waveform is obtained except that it is delayed in time with respect to the original by the amount of delay produced in the tank.

### Applications

Besides its use as a moving target simulator in pulsed radar, this equipment can be used with c-w radar as a moving-target simulator where the signal returning from the target has been shifted in frequency (Doppler shift), the amount of shift being an indication of radial target velocity.

Another use is in the field of acoustics. By summing the detected outputs of a group of adjustable delay tanks, all having the same sine wave or random audio-modulated input, the effects of an unlimited number of combinations of phase shifts in the audio signal can easily be observed and recorded. This might be helpful in the design of sound studios, theaters and microphones.

The system can also be operated as an adjustable pulse-delay device for digital computing, although mercury lines must be used where the shape of extremely sharp pulses must be preserved.

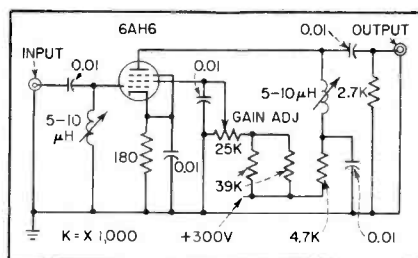


FIG. 4—Preamplifier used between receiving quartz crystal and main amplifier

**SUMMARY** — Frequency divider, counter, gate and wave-shaping circuits control optical circle-dividing machine to produce 16-bit pattern on photosensitive glass disk. Used for analog-to-digital conversion, the code disk has a pattern accuracy of  $\pm 0.0001$  inch and can be made in about 2 hours

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# Pulse Circuits Fabricate

**C**ODE DISKS for analog-to-digital encoders<sup>1</sup> of the type illustrated in Fig. 1 were produced until recently by laborious and time-consuming techniques using circle-dividing machines which are subject to human error.

A machine has been developed which will produce photographically, on a code disk, extremely

accurate 16-bit patterns<sup>2</sup>. The machine includes wave-shaping circuits for driving ribbon-type light modulators to provide sharp pattern edges on disks such as shown in Fig. 2.

## Basic Operation

The circle-dividing machine includes a turntable, rotating at a uniform angular velocity, with a photographic plate clamped to its upper surface. A beam of light is projected from above to expose one circular zone or track on the photographic plate. Mechanical breakdown of the digit encoder is shown in Fig. 3.

A train of oscillations exactly harmonic with the turntable's rotational frequency modulates the light, producing alternately clear and opaque zonal sectors after photographic development.

Figure 4 shows how the light-source modulation is made exactly harmonic to the rotational frequency of the table. A large glass reference ring marked with uniformly spaced, opaque angular dividing lines is attached to the underside of the turntable. A light beam is projected through the reference ring onto a photocell so that an oscillatory signal is generated when the table rotates. For binary code disks a reference track with  $2^{10}$  or 65,536 lines is used producing a reference frequency which is  $2^{10}$

times the instantaneous rotational frequency of the table.

A sixteen flip-flop binary counter chain divides the reference frequency by 2. A square-wave signal is tapped off each flip-flop to make successive zones of the pattern.

## Block Diagram

Figure 5 is a block diagram of the machine as set up for production of binary disks. The photographic plate is clamped to a glass turntable which rotates slowly at a constant speed in an air bearing composed of a spherical and flat portion. A 16-inch circular transparency with 65,536 uniformly spaced radial lines is mounted on a hub beneath the turntable and rotates with it. Present accuracy of the marks on this reference pattern is  $\pm 3$  seconds of arc.

The reference pattern is illuminated by a lamp and a magnified image is projected by microscope lens to a stationary matching pattern. The light then converges onto a germanium photocell which receives the integrated effect of about sixty divisions on the reference pattern. This makes the effect of dust and defects on the pattern negligible.

The electrical signal is essentially sinusoidal, but a steep-front wave is obtained by applying it to a toggle circuit. The resulting square wave triggers frequency dividers to ob-

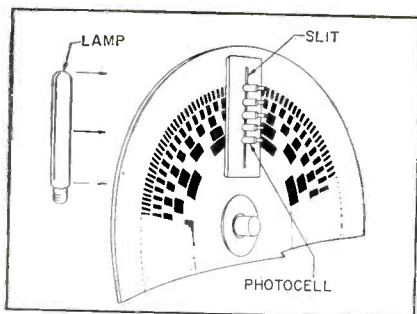


FIG. 1—Analog-to-digital encoding device

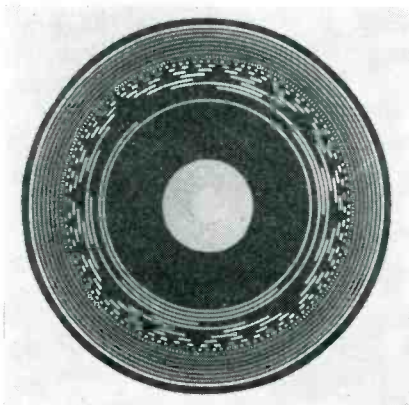


FIG. 2—Complete code disk



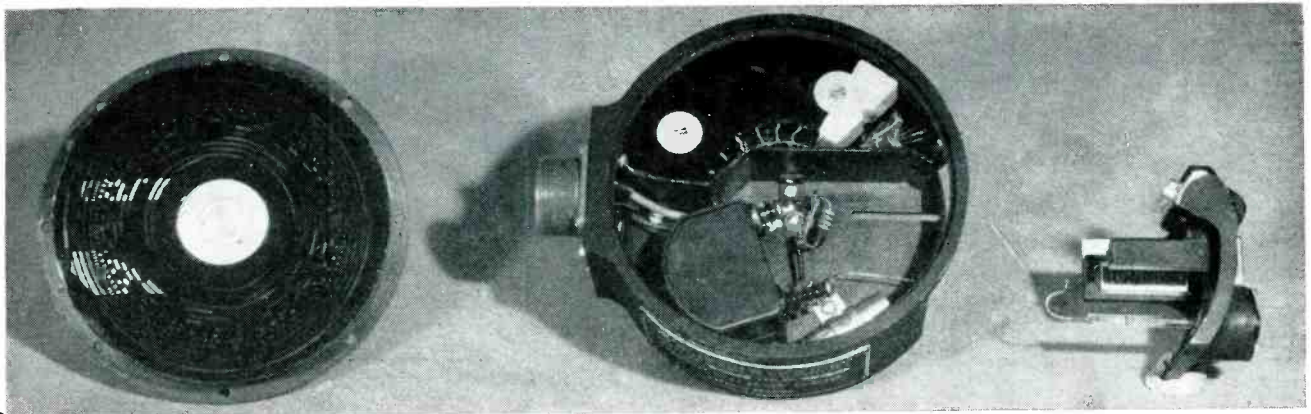


FIG. 3—Electrical housing (center) contains code-plate and bearing assembly (left) and ribbon-filament lamp and photocell assembly

# Computer Code Disk

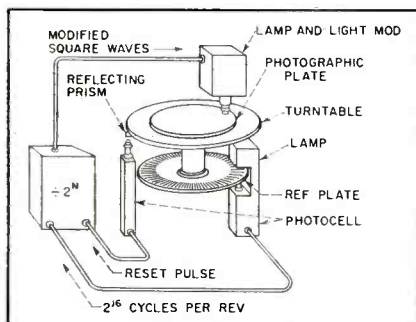


FIG. 4—Method of establishing harmonic relationship between light source and rotating disk

tain new square waves having a frequency suitable for one particular circle of the code pattern.

## Light Control

The flip-flops control the modulation of the light to produce tracks on the photographic plate. To establish proper phase relationships between tracks the entire flip-flop chain is reset to a prescribed condition by a short pulse generated optically at a given point in the revolution of the turntable. Resetting action occurs once every revolution, but is only necessary once before the exposure of each track. The reset pulse must always occur between two given cycles of the signal from the reference circle.

To produce a sharp light pulse for resetting, an optical system magnifies the motion of the edge of the turntable by a factor of twenty. This optical system consists

of a small prism attached to the edge of the turntable, a stationary light source, microscope lens, slit and germanium photocell. A light pulse passes through the slit each time the prism passes over the center of the field of view of the microscope lens. The photocell signal is reshaped by a blocking oscillator.

A reset pulse also controls a revolution counter which operates a gate to transmit the flip-flop

square-wave output for a predetermined integral number of turntable revolutions, thus controlling exposure of the photographic plate. A typical exposure for a 5-inch diameter track is 8 revolutions at 3 rpm using high resolution emulsion.

The gated square wave drives two parallel circuits. The resulting signals are applied to the two ribbons of a Westrex light valve. A tungsten filament image is focused

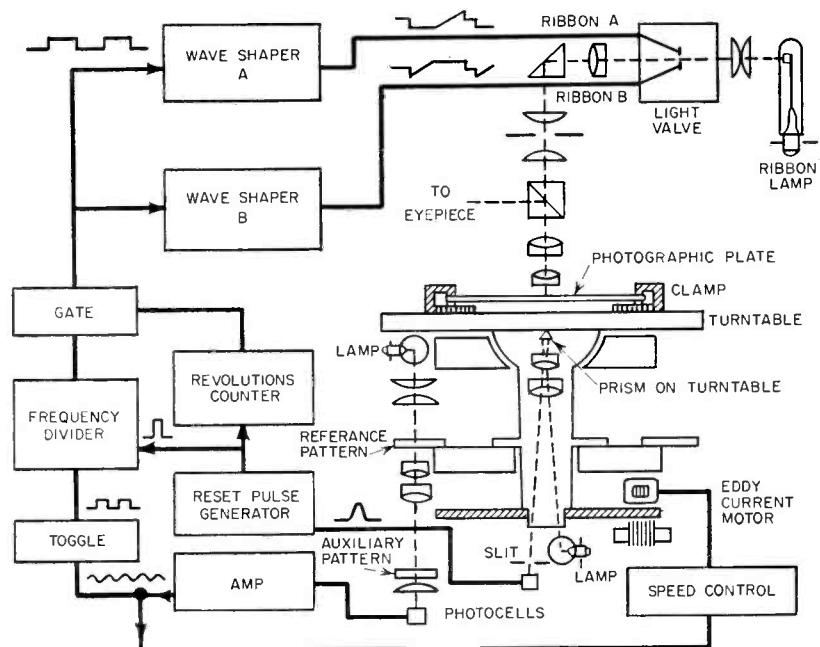


FIG. 5—Block diagram of circle-dividing machine

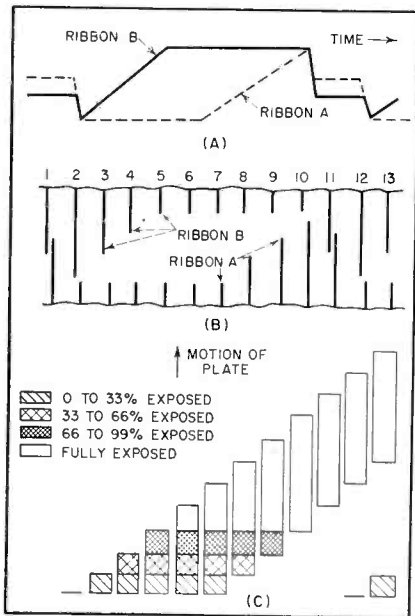


FIG. 6—Correct wave shape insures sharp pattern exposure

on the ribbons of the light valve and an image of the space between

the ribbons is formed on the rotating photographic plate. When rated current is passed through the ribbons they separate a distance of 0.001 inch but the optics reduce the image to 0.0004 inch. A beam-splitting cube sends some of the light reflected back from the plate into an eyepiece so the focus can be observed.

**Optical System**

The main optical system above the turntable slides as a unit along a large prism for adjustment of the radius of each track. The prism is sintered glass with 45-deg surfaces which are ground and polished flat within one wavelength of light. The optical system rests on two glass pads parallel to the prism faces. The system hovers above the prism on a cushion of air about 0.001 inch thick as a result of injecting air at four points on each pad.

When the pads are viewed in monochromatic light, interference fringes are observed. As radius adjustments are made, it is easy to see that the optics are parallel to the prism within one wavelength.

**Turntable**

The turntable is a glass disk 18 inches in diameter. It is flat on both sides within one wavelength of light and the two sides are parallel within 5 wavelengths. Fastened underneath is a piece of glass having the shape of a plano-convex lens with the curved surface spherical within one wavelength of light. The turntable is supported on a piece of flat glass having a matching concavity at the center. Air is injected at three points on the flat surface and at three points on the concave surface also causing the turntable to hover on an air cushion about 0.001 inch thick.

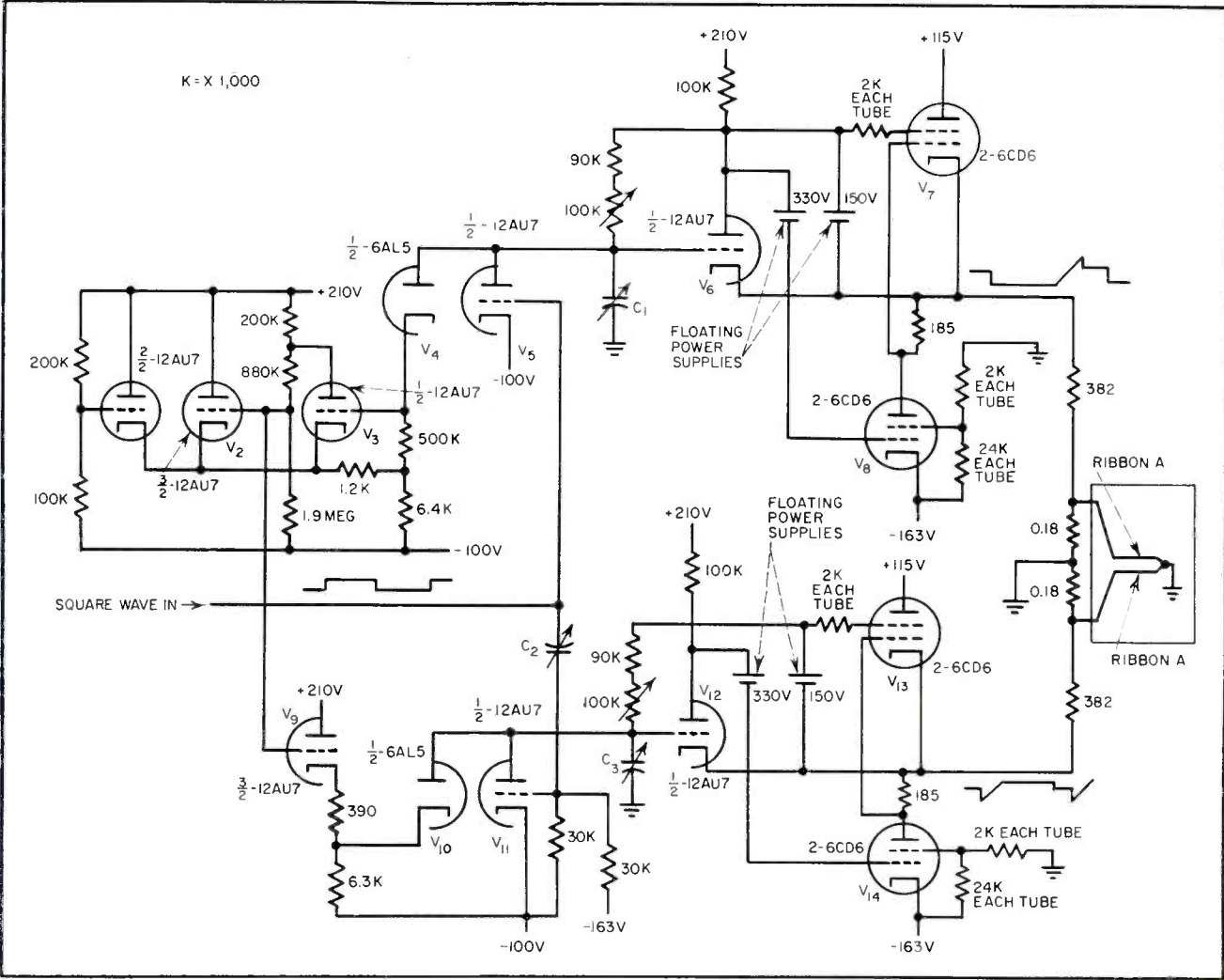


FIG. 7—Wave-shaping circuits for ribbon waveforms to provide pattern accuracy



Motive power for the turntable comes from an attached aluminum disk which is the rotor of an eddy current motor. The motor is part of a servo system which monitors the signal from the reference disk to control the speed. Absolutely constant speed is not essential, but the servo permits a wide-range adjustment of the speed between 1/15 and 20 rpm. A typical speed for making a 5-inch diameter track is 3 rpm.

### Wave Shaping

Since pattern accuracies of  $\pm 0.0001$  inch may be needed at the radial black-white boundaries, an image 0.0001 inch or less wide would be required to prevent blurring if the light were merely modulated on-off. By opening and closing the light-valve ribbons in a special manner, it is possible to use an image as wide as 0.0004 inch without blurring. Then the exposure time can be reduced by a factor of 4.

A sequence of thirteen successive positions of the ribbons is shown in Fig. 6 in relation to the image on the photographic plate that would be obtained if the plate were developed and put back in the same position on the turntable. The edge of ribbon *B* follows the edge of the image in views 2, 3, 4 and 5 and ribbon *A* follows the other edge in views 7, 8, 9 and 10. The progressive exposure of the plate is shown by the shading.

### Wave Generation

The required ribbon waveforms are derived from the circuit shown in Fig. 7. The square wave input is applied to  $V_6$  and  $V_{11}$ . When the square wave goes positive from a negative reference level  $V_6$  will draw considerable grid current permitting capacitor  $C_1$  to charge to nearly -100 volts. When the square wave goes negative  $V_6$  is cut off and capacitor  $C_1$  is allowed to charge through the 90,000 and 100,000-ohm resistors. As the capacitor charges positively with respect to ground, the charging rate is maintained constant by the floating power-supply voltage being applied to the resistors. The capacitor charges linearly until  $V_3$ , whose grid is connected to the cathode of diode  $V_4$ ,

conducts. The cathode of  $V_3$  has been held at a selected voltage by cathode follower  $V_2$ , thus fixing the voltage at which  $V_3$  starts conducting.

Tubes  $V_2$  and  $V_3$  act like a cathode-coupled multivibrator and upon conduction of  $V_3$ , their cathode voltages drop immediately. The grid current in  $V_3$  pulls down the plate voltage of  $V_6$  and the voltage across capacitor  $C_1$  to the level determined by cathode-follower  $V_1$  whose cathode is connected to cathodes of  $V_2$  and  $V_3$ . The grid of  $V_1$  is held at a small positive potential by the voltage divider comprising the 200,000 and 100,000-ohm resistors.

The grid current drawn by  $V_3$  keeps the voltage across capacitor  $C_1$  at a low positive level until the next positive transition of the input square wave on the grid of  $V_6$ . Diode  $V_4$  prevents the grid of  $V_3$  from going more negative than the tube rating allows.

### Power Amplifier

The tubes  $V_6$ ,  $V_7$  and  $V_8$  form a power amplifier with slightly less than unity gain due to inverse feedback. They supply current through the 382-ohm limiting resistor to ribbon *A* of the light modulator.

A shunting resistor of 0.18 ohm connected across ribbon *A* serves as a damper to reduce mechanical resonance so the latter follows the signal faithfully.

The waveform to drive ribbon *B* is generated by the lower portion of the circuit of Fig. 7. The input square wave is differentiated by capacitor  $C_2$ . When the positive transition of the differentiated wave occurs, heavy grid current in the tube  $V_{11}$  flows long enough to charge capacitor  $C_3$  to a chosen negative level. Thereafter,  $V_{11}$  is cut off and  $C_3$  is charged in a linear manner through the 90,000 and 100,000-ohm resistors. The charging of  $C_3$  ceases when its potential reaches the positive level at which conduction occurs in diode  $V_{10}$ .

At the time that  $V_3$  conducts, the grid voltage in  $V_2$  and  $V_6$  drops resulting in conduction in  $V_{10}$  and in lowering the voltage across  $C_3$  to its quiescent value. As in the case of the ribbon *A*, the voltage waveform appearing across  $C_3$  is trans-

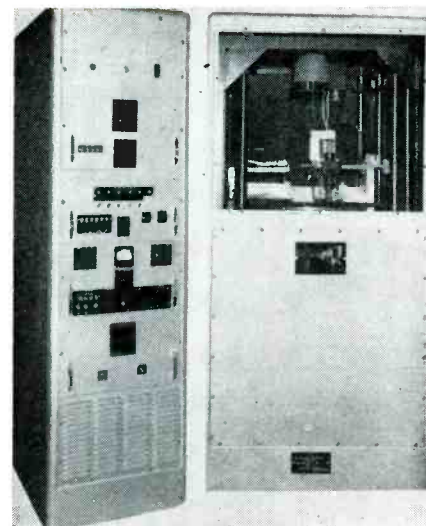


FIG. 8—Complete optical encoder

formed into a current waveform for ribbon *B* and by amplifiers  $V_{12}$ ,  $V_{13}$  and  $V_{14}$  driving the ribbon *B* through the 382-ohm resistor.

### Disk Usage

A completed, 16-digit optical encoder is shown in Fig. 8. It uses an 8½-inch diameter disk with a cyclic code such as that illustrated in Fig. 2. The light source used is a Sylvania S413 lamp, and the light-sensitive cells are 1N85 photodiodes. The lamp is about 2 inches from the disk and the slit is approximately 5 microns wide, spaced 0.003 inch from the disk. In addition to the sixteen code-reading photocells there is a seventeenth photocell opposite a special clear zone on the disk. This is a light-intensity reference producing pulses which compensate the code-reading circuits for changes in intensity due to voltage variations and lamp aging. The author acknowledges the encouragement of J. F. Jordan, and the assistance of V. E. Schmidt and W. H. Mahaney. Also, the contributions of B. Lippel and K. M. Doering of the Signal Corps Engineering Laboratories, Ft. Monmouth, N. J. Most of the developments described herein have been made under Signal Corps contract.

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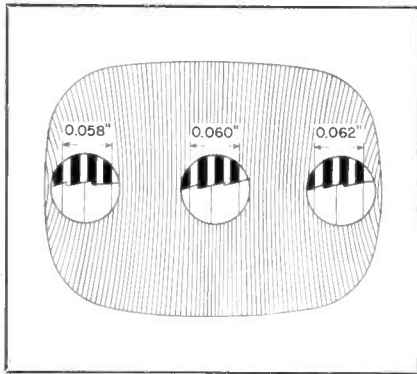


FIG. 1—Pincushion pattern of vertical color stripes on screen

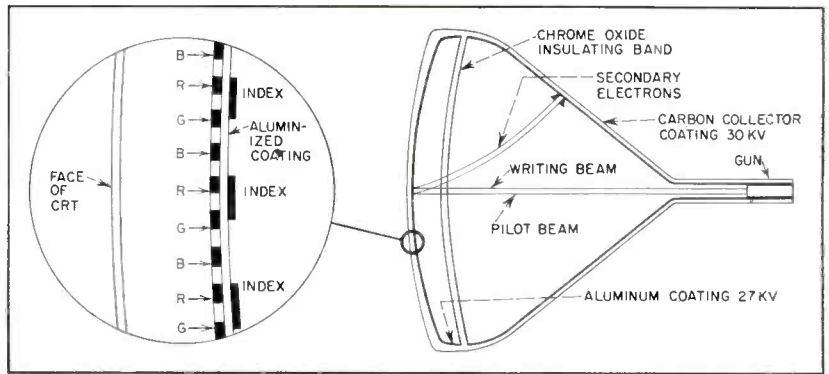


FIG. 2—Cross-section of cathode-ray tube shows pattern of phosphor and indexing stripes. Cross-section at right shows method of collecting secondary electrons

**SUMMARY** — “Apple” tube, developed by Philco, uses beam-indexing principle. Amplitude and phase modulation of scanning spot sequentially illuminate vertical phosphor stripes on tube face. Circuit of developmental receiver is described

## Television Receiver Uses

**T**HE BEAM-INDEXING “Apple” tube design is based on the concept that a single electron beam can sequentially illuminate vertical phosphor stripes arranged in triplets of red, blue and green to produce a color display. The stripes are not contiguous. The spaces between them, as wide as the phosphor lines themselves, are filled with a dark-colored non-luminescent material serving as a guard band.

Triplet pitch is varied over the tube face to match the sweep speed. A slight pincushioning of the stripe pattern compensates for aberrations in the electron optics.

Stripes are applied by a photoresist technique. Guard bands and then red, green and blue phosphors are applied, in succession, by projecting separate photographic masters on the tube face. The screen is

aluminized, and an organic lacquer film is applied over the aluminum by a flow-on technique. Finally, magnesium-oxide indexing stripes are applied behind each red stripe, using a different photographic master. These indexing stripes cover approximately 40 percent of the triplet width, as shown in Fig. 1 and Fig. 2.

The optical center of the projection lens is placed at the tube’s electron center of deflection to make the optical paths follow the electron paths as closely as possible.

### Beam Indexing

The beam position must be accurately known at all times. This requires a precise indexing technique.

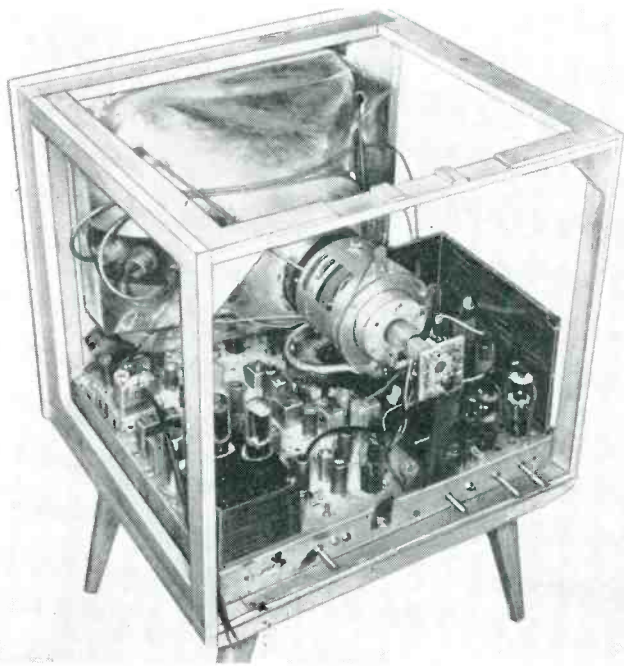
The magnesium-oxide stripe has a high secondary-emission characteristic compared to the alumi-

nized coating. As the beam crosses this stripe, the secondary emission current given off is collected at the anode coating as shown in Fig. 2. The emission-current frequency is the same as that at which the writing beam must be varied to produce colors. However, since the writing beam varies in intensity, so does the secondary-emission current. This produces an undesirable shift in index-signal phase.

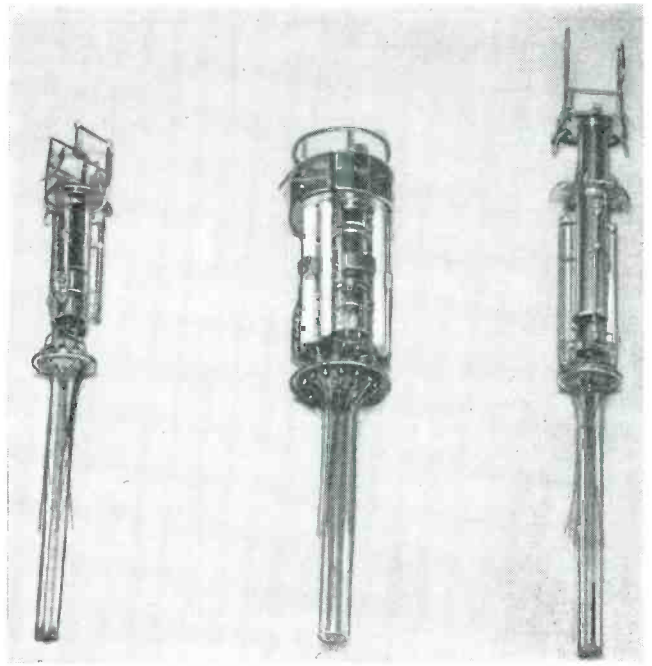
This problem is overcome by introducing a pilot or indexing beam emanating from the same gun. The pilot beam is aligned so that it strikes the same color stripes as the writing beam. It is intensity-modulated at the pilot-carrier frequency. This frequency is above the video and color-signal frequency range.

The writing and pilot beams are produced by the magnetic-focus,





Philco developmental Receiver 7. Parts are mounted on standard chassis. Plate at crt socket contains pilot-carrier oscillator and writing grid circuit. Foil straps bond chassis and crt



Monochrome crt gun (left), Apple gun (center) and shadow-mask gun (right). Use of single cathode and two coplaner grids to generate two beams simplifies gun construction

# ONE-GUN COLOR CRT

triode-design gun shown in cross-section in Fig. 3.

The two beams are formed close together by a single cathode and two separate coplaner control grids. The hole center-to-center separation is 0.029 inch.

The writing-grid aperture is 0.020 inch in diameter and produces a beam cutoff of approximately 150 v. The pilot-beam aperture is 0.014 inch in diameter and produces a beam cutoff of about 50 volts.

The grid aperture is made electrically thin by countersinking the hole to leave the cylindrical portion 0.001 inch thick. The combination of small countersunk grid aperture and close cathode-to-grid spacing results in small spot size on the screen.

A field lens type of convergence electrode causes the beams to cross

at the center of deflection with little effect on focus. The convergence electrode is actually part of the beam shield whose function is to prevent the control voltage of one beam from affecting the intensity or position of the other.

The beam shield is a thin flat disk with two small holes. It is mounted just above the grid aperture, providing a simple shield between the beams and effectively eliminating beam intermodulation. It is not an accelerating electrode and operates at its average free-space potential.

## Indexing Technique

The indexing technique requires a mixer whose output is the sum of the pilot-beam-current frequency and the index stripe frequency. Only one sideband produced at the crt screen is needed for phase in-

formation. Heterodyning this sideband with the pilot carrier produces the reference index frequency needed for color writing.

The equation representing the index stripes scanned by a constant-intensity beam is a Fourier series in cosines. The fundamental component  $A_1 \cos \theta$  principally affects indexing. If its phase is preserved, sufficient information is available for reference.

Figure 4A shows the spectrum of the complete signal appearing at the anode of the crt. Video modulation of writing-frequency harmonics appearing in the writing beam causes the energy concentrations above and below the sideband frequency. This signal is fed to a sideband amplifier whose response must have sufficient skirt selectivity to reject writing-beam interference and still provide short time delay

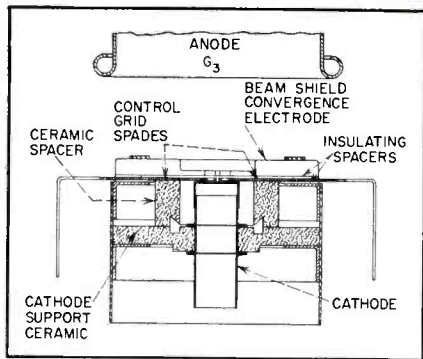


FIG. 3—Cross-section of electron gun shows aperture and grid spacing required to obtain minimum intermodulation between pilot and writing beams

to allow for a realistic amount of horizontal sweep nonlinearity without too much shift in color.

A one-microsecond delay between writing grid and tube screen produces about 10 degrees of color signal phase error for a sweep nonlinearity of  $\frac{1}{2}$  percent.

### Writing Techniques

The video signal and required color-writing signal are shown in Fig. 4B. The illustration depicts relationships required for accurate colorimetry. The color subcarrier available at the output of the receiver second detector, as shown at the left of Fig. 4C, closely approximates the signal shown at the right. The visible difference in the picture due to this discrepancy, is less than 10 color degrees.

To lock the color signal to the stripe sequence, the 3.58-mc color-signal must be converted to a 6.4-mc writing signal. This is done as shown in Fig. 5. The 38.1-mc pilot-carrier oscillator beats with the 3.58-mc color signal, producing a 41.7-mc signal containing the color information. This signal is mixed with the 48.1-mc sideband signal to produce the 6.4-mc writing signal. Pilot beam modulation at 41.7 mc is obtained by mixing the 38.1-mc signal with the 3.58-mc color-reference signal.

The Y luminance signal at the receiver second detector is  $0.30R^{1/\gamma} + 0.59G^{1/\gamma} + 0.11B^{1/\gamma}$  and is used as shown in Fig. 5. If more accurate colorimetry is desired, a monochrome correction signal of  $0.30R^{1/\gamma} - 0.26G^{1/\gamma} + 0.22B^{1/\gamma}$  may be added to the Y signal to produce the de-

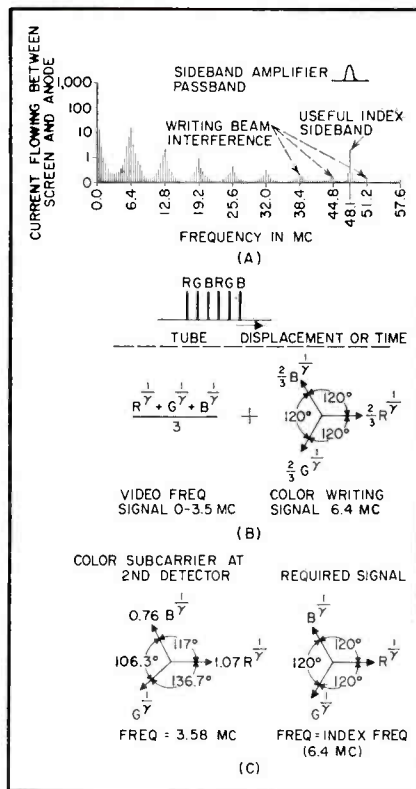


FIG. 4—Indexing signal spectrum (A) appears at screen of crt and is combined with ideal video signal to produce writing signal (B). Actual video signal compared to ideal (C)

sired  $(R^{1/\gamma} + G^{1/\gamma} + B^{1/\gamma})/3$ . This is done by synchronously detecting the 3.58-mc color signal with the 3.58-mc reference signal and adding as shown by the dashed blocks.

The above statements hold true for spot size and line width close to the infinitesimal ideal. In practice, the effects of finite spot size and line width produce a desaturation in color. This is compensated for by increasing chroma gain 33 percent and adding a saturation

correction signal to bias the tube negatively an amount proportional to the color subcarrier amplitude. This effectively reduces the conduction angle, particularly on primary colors.

### Receiver Circuitry

Figure 6 shows a complete receiver in detailed functional form. The circuits outside the dashed block follow conventional color receiver practice.

The horizontal sweep and high-voltage sections are similar to those in monochrome receivers. The pair of 6CD6 tubes are used as drivers and an L-1379 special high-pervance diode is used as a damper. A voltage doubler of 1B3 tubes provides 30 kv. The average beam writing rate is controlled by varying the average bias on the drive tube grids as a function of the writing-frequency discriminator output. The latter compares the writing frequency with the index frequency.

The vertical output stage provides parabolic and saw-tooth voltages which vary the drive-tube bias to provide sweep width modulation at vertical scanning rate.

The 6X4 provides regulated 400 v d-c to the vertical and horizontal oscillators. This regulation keeps horizontal sweep linearity with changing line voltage. The regulated high-voltage outputs are provided to maintain best focus, horizontal sweep and index operation.

The writing signal at the sideband unit is combined with the luminance signal to make a com-

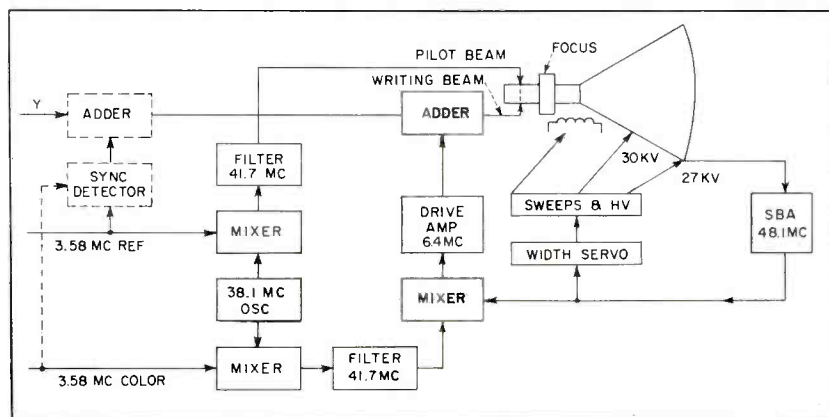


FIG. 5—Technique used to lock the color signal phase and amplitude variations to the screen stripe structure. Sideband Amplifier (SBA) output controls writing frequency



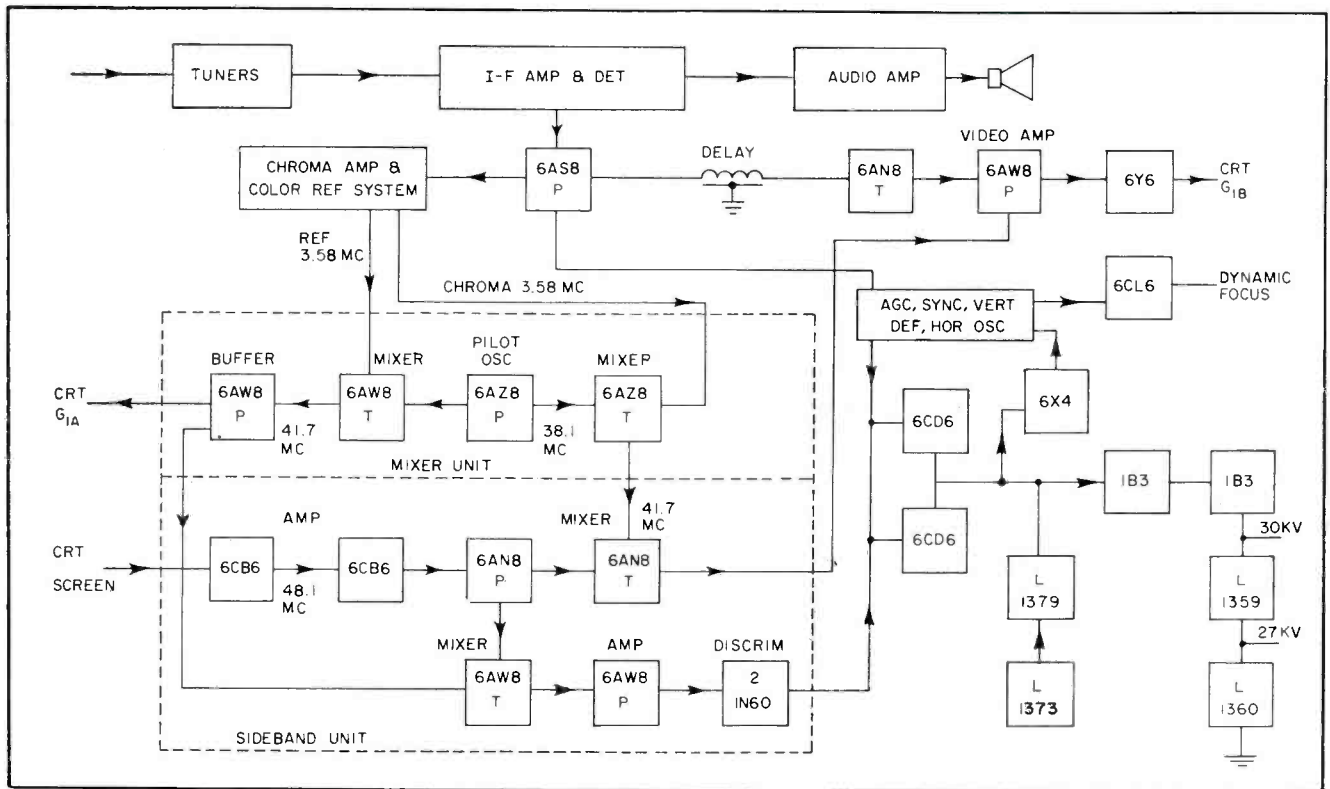


FIG. 6—"Apple" receiver circuit. Main differences are addition of a sideband and mixer unit and specially developed regulator tubes for the high-voltage power supply. Pilot beam is controlled at  $G_{1A}$  and writing beam at  $G_{1B}$ .

posite video signal for the crt writing grid. About 150 v of peak to peak signal is needed for a 40-foot-lambert picture highlight brightness. The master hue control in the color reference system aligns the writing signal phase with the crt screen structure.

### Operation

The index and writing circuits need adequate selectivity to minimize intermodulation. Short delay time is necessary to index accurately chroma writing information to beam position. These requirements are met by localizing the major selectivity at the sideband amplifier input and combining with subsequent broadband (5-mc) stages to give an overall bandwidth of 2 mc for the indexing signal.

To minimize delay, color processing is kept outside the index amplifier chain. Developmental-receiver 7 has circuit delay of about 0.9 microsecond. With amplifier delays of this order, the stability of index frequency will determine hue stability while scanning.

The yoke current waveform is exponential. The crt index stripe pitch is also exponential. By ac-

curately holding average index frequency, by discriminator control of horizontal scanning width, a match between crt color-line geometry and raster geometry is obtained. This allows potentiometers to be used as saw-tooth and parabolic waveform controls.

The earth's field effect on receiver operation is negligible. Also, the proximity of writing and pilot beams minimizes the need to avoid hum fields in the vicinity of the crt.

### Construction

Receiver construction follows conventional practice. All required controls are accessible through either a slot below the control bar in front of the receiver or at the rear of the chassis.

The pilot carrier signal is coupled from the chassis by coaxial lead. Writing frequency signals are carried by open-wire leads.

The yoke focuser mount is conventional in form. The yoke has cylindrical windings with an inside diameter of 2 inches and a  $1\frac{1}{2}$ -inch core length. The dual-gap focuser has six radial permanent magnets which provide 90 percent of the focus strength. Dynamic focus is

supplied by a pair of coils in the housing.

To obtain electron-optical alignment, the yoke is rotated so that a vertical trace is aligned with the color stripes. The centering magnet is then adjusted to place the beam along the focuser axis. Connecting 60 cycles to the dynamic focus coils provides the modulation pattern needed to find the position of proper beam alignment.

Circuit elements formed by the band of conductive coating encircling the screen and the aluminized screen to which it is coupled are tuned to resonance at the index sideband frequency. A coaxial lead connected to the mounting band couples the signal to the sideband amplifier unit.—J. M. K.

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# Designing Low-Noise

## Part IV

**SUMMARY** — Undesirable effects of random noise on amplifier performance can be minimized by proper circuit design. This article, fourth in a series, discusses role of first stage in establishing amplifier noise figure, advantages of pentode and cascode amplifiers over triodes and special high-frequency considerations. Also described are design techniques for handling the random-noise problem in transistors, klystrons and traveling-wave tubes

**F**UNDAMENTAL problems confronting the designer of low-noise equipment involve converting a weak signal into usable form without introducing noise not present in the original wave. Noise figure measures the growth of noise relative to signal in a device when the input circuit is in the cleanest possible state. A noise-free device has a noise figure of unity, but the noise figure of any physical structure must be at least slightly greater than one.

In an amplifier, a low noise figure accompanied by low gain merely transfers a considerable part of the noise problem to subsequent stages. It is only when the signal has been amplified to a value well above any further noise additions that low-noise performance can be evaluated.

The composite noise figure  $F$  of successive stages having noise figures  $F_1, F_2, F_3, \dots$  and corresponding gains  $G_1, G_2, G_3, \dots$  is<sup>1</sup>

$$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \dots$$

If  $G_1$ , the gain of the first stage, is not large compared with unity, the excess of  $F_2$ , the noise figure of the second stage, over unity becomes important. Likewise if the composite gain  $G_1 G_2$  of the first and second stages is not large, the noise figure  $F_3$  for the third stage makes a significant contribution. The relative importance of the noise figure of a stage diminishes as the

total gain provided by the preceding stages is increased.

The practical objective is to reach a sufficient gain in the first one or two stages to make the noise requirements on the remainder of the equipment relatively lenient. If the low-level signal is first applied to a device which performs frequency translation, frequency selection or impedance transformation,  $G_1$  may be less than unity and low values of  $F_2$  and  $F_3$  become even more essential.

### Grounded-Cathode Triode

Consider electron-tube amplification at frequencies which are moderately high but not so high as to complicate the description by electron-transit-time effects. The principal source of noise contributed by the tube is shot effect from random emission of electrons from the

cathode. The usual condition is one of space-charge limitation rather than temperature saturation.

Figure 1A shows the basic equivalent circuit of a grounded-cathode triode amplifier. The signal circuit is represented by an rms voltage  $E_s$  in series with internal resistance  $R_s$  and a thermal rms noise voltage  $e_s$ . Shot noise is represented by an rms voltage  $e_n$  in series with the grid. It is the rms noise voltage which inserted at this point would produce rms noise in the tube output equal to that observed when the grid is shorted to the cathode. It is commonly expressed as an equivalent resistance  $R_{eq}$  such that

$$e_n^2 = 4bkTR_{eq}$$

where  $b$  is the bandwidth,  $k$  is Boltzmann's constant and  $T$  is the absolute temperature in degrees Kelvin.

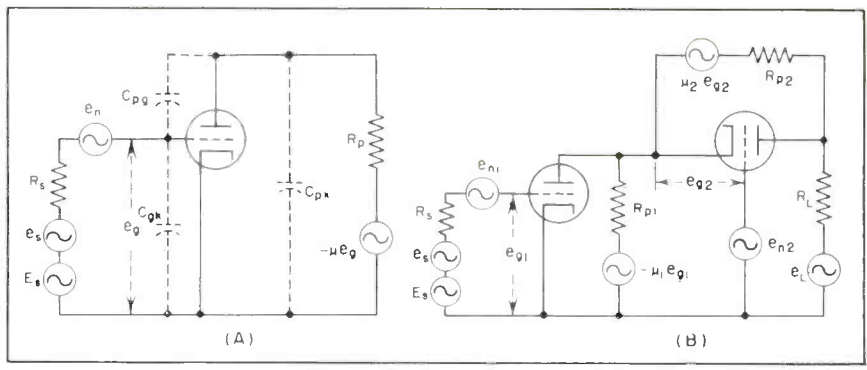


FIG. 1—Equivalent circuits of grounded-cathode triode amplifier (A) and cascode amplifier (B) showing noise sources



# EQUIPMENT

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## Previous Articles

Characteristics and Origins of Noise  
p 154, March 1956

Equipment for Generating Noise  
p 134, April 1956

Techniques for Measuring Noise  
p 162, May 1956

The thermal noise voltage accompanying the signal is

$$e_s^2 = 4bkTR_s$$

Since  $E_s$ ,  $e_s$  and  $e_n$  are in series, the ratio of signal-to-noise power ratios before and after inserting  $e_n$  is

$$F = \frac{E_s^2/e_s^2}{E_s^2/(e_s^2 + e_n^2)} = 1 + \frac{e_n^2}{e_s^2} = 1 + \frac{R_{eq}}{R_s}$$

By definition,  $F$  is the noise figure. Its excess over unity is  $R_{eq}/R_s$  in the frequency range throughout which the equivalent circuit holds.

Gain  $G$  of the triode is the ratio of the maximum signal power available from the output to the maximum signal power available at the input. Neglecting parasitic capacitances indicated by dashed lines

$$G = \frac{\mu^2 E_s^2 / 4R_p}{E_s^2 / 4R_s} = \frac{\mu^2 R_s}{R_p} = g_m^2 R_s R_p$$

where  $g_m = \mu/R_p$  is the transconductance. A working approximation for  $R_{eq}$  up to moderately high frequencies is given by<sup>2</sup>

$$R_{eq} = 2.5/g_m$$

Hence, the noise figure may be written

$$F = 1 + \frac{2.5}{g_m R_s} = 1 + 2.5 \sqrt{\frac{R_p}{G R}}$$

These results indicate that the noise figure excess over unity varies inversely with  $g_m$ .

One method of improving noise figure would be to use triodes in parallel. Two tubes would cut  $F - 1$  in half. Four tubes would be required to get a further division by two. This method would become unwieldy beyond the first step.

In broadband amplifiers, interelectrode capacitances shunt the signal at higher frequencies with resultant loss of gain and furnish a feedback path from output to input causing potential instability. The cure for both difficulties is to reduce the impedance level of both input and output circuits.

This decreases both the shunting and feedback effects of the parasitic capacitances. Unfortunately this means that much of the available gain  $G$  must be sacrificed by mismatching terminations. The noise figure is also deteriorated because the equivalent grid circuit noise resistance  $R_{eq}$  becomes a larger fraction of the input circuit resistance.

A pentode offers lowered values of interelectrode capacitances that permit stable amplification at higher impedance levels for a given bandwidth. The advantage is offset however by the partition noise caused by random variations in the division between plate and screen current. The equivalent resistance  $R_{eqp}$  for the pentode is<sup>3</sup>

$$R_{eqp} = \frac{I_p}{I_p + I_{sc}} \left( \frac{2.5}{g_m} + \frac{20 I_{sc}}{g_m^2} \right)$$

where  $I_p$  and  $I_{sc}$  are the plate and screen currents in amperes and  $g_m$  is the transconductance of the pentode. Since the transconductance of a pentode is  $I_p/(I_p + I_{sc})$  times the triode transconductance

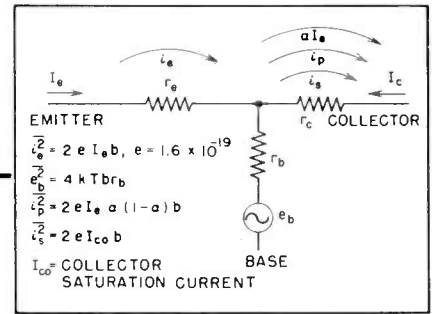


FIG. 2—Equivalent transistor circuit illustrates noise problem

$g_{mt}$  obtained by connecting plate and screen together, this equation may also be written

$$R_{eqp} = R_{eqt} \left( 1 + \frac{8 I_{sc}}{g_m} \right)$$

where  $R_{eqt} = 2.5/g_{mt}$  is the equivalent resistance when the tube is operated as a triode by connecting the plate and screen together.

Noise can be reduced by decreasing screen current and by increasing transconductance. The latter is usually a design objective in its own right. The former may be helped by electron-optical means as for example, in the Philips EF8, by lining up the screen-grid wires to fall in the shadow of the control-grid wires.

## Cascode Amplifier

The cascode amplifier,<sup>3-5</sup> Fig 1B, consists of a grounded-cathode triode followed by a grounded-grid triode. The latter forms an amplifying stage with a low impedance input. It furnishes a stable broadband termination for the first stage while providing amplification to make up the loss from mismatching.

Interelectrode capacitances in the grounded-grid stage are favorably disposed for stability since the feedback capacitance is from plate to cathode rather than from plate to grid. The grounded-cathode stage is stable because the voltage amplification is unity or less.

The transconductance of the equivalent single pentode is equal to that of the first triode. The contributions from shot noise in the two triodes and thermal noise in load resistance  $R_L$  produce only a modest excess over unity in the

noise figure. The value of gain is large enough to make contributions from later stages negligible.

The cascode amplifier has a wider range of application than its use as an untuned amplifier at moderately high frequencies. The same principles are effective for narrow-band tuned amplifiers as a means of improving stability, increasing gain, and reducing noise figure. At higher frequencies where the simple assumptions used in the illustrative example are no longer valid, the cascode continues to perform well.

The differences which arise as the frequency is increased to the region where electron transit times are appreciable include: a change in  $R_{eq}$ , a contribution to noise from induced grid current and a decrease in the input impedance of the grid-to-cathode circuit.

### High-Frequency Noise

The induced grid noise, which is noticeable in subminiature triodes at 15 mc and becomes the principal limiting factor at frequencies above 100 mc, is caused by fluctuations in the current induced in the grid by electrons passing it. One component arises from fluctuations in the electron stream itself. This component is correlated with the shot noise in the plate current.

A considerable part of the induced grid noise is independent of the shot noise. The transit angle fluctuations and variations in total emission caused by the return of some electrons to the cathode in the negative potential region have been suggested as possible causes but do not appear to be quantitatively adequate. Recent work<sup>8</sup> indicates that reflection of electrons by the plate is a substantial contributor.

By use of the cascode circuit an optimum noise figure of 1.06 or 0.25 db has been obtained at 6 mc with  $R_s = 1/G_s = 15,000$  ohms; a noise figure of 1.35, or 1.3 db, at 30 mc with  $R_s = 2,500$  ohms; and a noise figure of 3.5, or 5.5 db, at 180 mc with  $R_s = 400$  ohms.<sup>9</sup> The bandwidths were 1, 6 and 2.5 mc respectively. Omitting the tuning inductor for the first triode grid-plate capacitance increased the noise figure 0.2 db at 30 mc and 2.5 db at 180 mc. Equivalent shot-

noise resistance  $R_{eq}$  and equivalent total induced grid noise conductance at 30 mc have been tabulated<sup>9</sup> for a number of commonly used tubes.

The bandwidth limitation in optimizing noise figures is set by the tube input impedances and stray capacitances. To widen the band would require equalization in the amplifier with a corresponding nonuniform distribution of noise with frequency in the output. The average and spot noise figures would then no longer coincide.

### Transistor Amplifiers

At very low frequencies, the transistor is plagued by  $1/f$  noise or excess noise, which is analogous to flicker noise in vacuum tubes. The power spectrum of this noise falls off approximately in inverse ratio to the frequency and is covered up by other sources of noise above a frequency limit depending on the type of transistor.

In point-contact transistors, the  $1/f$  component is large and dominates throughout practically the entire useful frequency range. Junction transistors have been improved to the point where from about 1 kc up the other sources of noise are limiting.

Other noise sources include thermal noise in the resistive components, shot noise from random passage of the carriers through the junction and partition noise from random division of carriers between base and collector. These sources have a fairly uniform spectrum over the frequency range between disappearance of  $1/f$ -noise and onset of  $\alpha$ -cutoff effects.

### Equivalent Circuit

An equivalent circuit<sup>10</sup> which appears adequate in the uniform range is given in Fig. 2. The noise sources include: current generator  $i_s$  in parallel with the emitter resistance to represent shot noise in the emitter current, voltage generator  $e_b$  in series with the base to represent thermal noise from intrinsic base resistance, current generator  $i_p$  in parallel with the collector to represent the partition noise and current generator  $i_c$  connected in parallel with the collector to represent the shot noise present

in the collector current.

Calculation of the noise figure is straightforward, provided correlation between the noise sources is neglected, since the noise-power contributions from the four sources may be added directly. Correlated noise voltages or currents have phase relations which may have to be taken into account,<sup>10</sup> as in the case of the induced grid noise in vacuum tubes. The effects are small if there is a considerable disparity in size among the various sources.

The signal source resistance giving minimum noise figure is determined by the same methods used in electron-tube circuits. An approximation for the optimum resistance is the open-circuit input resistance. Values from 400 to 1,000 ohms are usually found best.

The noise figure is practically independent of which configuration, common emitter, base or collector, is used. Noise figures of from 4 to 6 db in the range 1-100 kc are obtainable<sup>11</sup> with selected units.

### Velocity-Modulated Tubes

An example of the velocity-modulation type of tube is the klystron amplifier shown in Fig. 3A. An electron gun at the left produces a beam of electrons, which on passing through an input cavity has an a-c velocity ripple impressed on it by the electromagnetic field signal supplied to the cavity from the antenna. This results in a wave of alternating convection density in the beam capable of delivering an enhanced amount of signal power to the output cavity. To obtain substantial gain the impedances of the cavities must be high and hence the bandwidth is relatively narrow.

### Wave-Type Tubes

In a traveling-wave tube,<sup>12</sup> Fig. 3B, the path of the electron beam follows the axis of a helical conductor along which the microwave signal is propagated. There is a distributed interaction between the microwave signal and the induced space-charge wave in the beam, which with proper relations between the beam velocity and microwave propagation velocity can



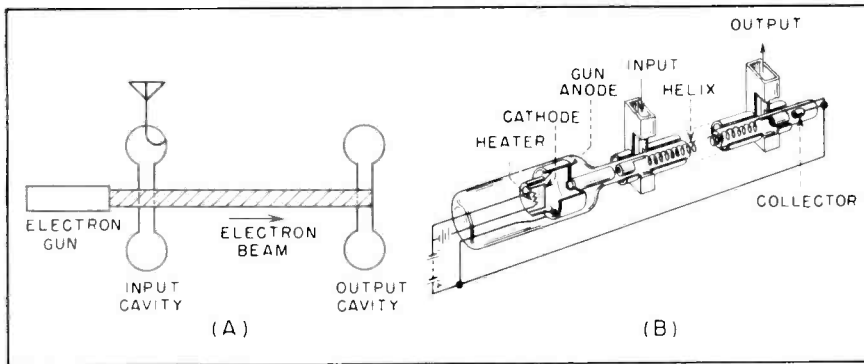


FIG. 3—Microwave tubes illustrating configuration of klystron (A) and traveling-wave tube (B) in which electron beam follows helix

result in an amplified signal in the output from the helix. Since no sharp tuning is required, the bandwidth can be large. For example a 20-percent bandwidth at 4,000 mc is relatively easy to obtain.

Sources of noise in electron-beam tubes are similar to those encountered in other electronic devices. Partition noise arises from electrons being intercepted before reaching the collector. This can be minimized by good focusing of the beam. In the traveling-wave tube there can also be induced partition noise because of radial-field variations across the electron beam.

This is avoided by making the beam diameter small so as not to include much field gradation and also by not allowing the beam to approach closely to the helix. Secondary emission from the collector may produce noise and it is desirable to operate the collector at a sufficient potential to keep secondary electrons from coming back into the interaction field.

### Shot Noise

The most potent source of noise is shot noise in the electron beam.

This shot noise can to a considerable extent be regarded as itself a space-charge wave originating from a single source. The same principles used to amplify space-charge waves can be applied in reverse to attenuate the shot-noise wave before the electron beam is allowed to enter the signal-amplifying structure. By this denoising process it has been possible to obtain noise figures in traveling-wave tube amplifiers in the range

6 to 10 db with midband frequencies in the range from 3,000 to 11,000, mc.

The shot noise manifests itself in fluctuations in the a-c velocity and convection current density of the electron stream. The two components are to a considerable extent correlated with each other and in fact in a drift space following an electron gun, a standing wave pattern occurs in which the velocity maximums coincide with the density minimums and conversely. This behavior may be demonstrated<sup>15</sup> by measuring the noise picked up by a movable cavity along an electron beam.

The minimum values plotted against distance will not be zero, but of the order of 1 percent of maximum. This verifies an approximate theory of space-charge-limited shot noise<sup>14</sup> applied to space-charge waves.<sup>15</sup> In this theory the noise originates from a velocity fluctuation at the space-charge induced potential minimum near the cathode.

The actual multivalued electron velocity throughout the beam cross section is replaced by a single-valued velocity fluctuation with the same rms value. The theory cannot be exact but the fact that the minimums in the standing-wave pattern are relatively small shows that the noise arising from multiple electron velocities in the beam is a second-order effect.

### Denoising Techniques

The actual denoising of the beam has been accomplished by multiple-region guns<sup>16</sup> and by velocity-jump guns.<sup>17</sup> In the former case, the

noise wave is attenuated by several successive anodes at the proper spacing and potential values. In the second case, drift regions are separated by short gaps in which sudden velocity changes are made. This method of denoising is the reverse of the method of amplification by sudden potential jumps between drift spaces.<sup>16, 20</sup> The minimum noise figures attainable by any denoising procedure have been the subject of various studies.<sup>20-25</sup>

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# VIBRATING Capacitor

**SUMMARY** — Low-frequency modulator converts d-c from differential analyzer to 60-cps a-c for use in flight table computer. Sinusoidal current through drive coil vibrates plate of capacitor in R-C circuit. Output has good linearity and waveshape, wide bidirectional operating range and low time lag

**V**IBRATING capacitor modulators have been used in electrometer amplifiers and in electronic multipliers. In these instruments the modulator has been specialized in design and expensive to construct. Electromagnetic, acoustical and mechanical methods of drive for the capacitor plates have been utilized.<sup>1</sup>

## Design Principle

The modulator described employs an electromagnetic drive system originally made for electrometer use. The basic element is a capacitor sealed in a glass envelope and capable of plate vibration by an alternating magnetic field. Since the unit functions without contact, it is not subject to the failures that occur in choppers over long periods of operation.

If a direct voltage is placed across a capacitor and resistor in

series and the capacitor plates caused to vibrate by an external means, an alternating voltage is produced across the resistor whose frequency is equal to that of plate vibration.

Its amplitude is a function of both the applied voltage and the amplitude of the vibration. If the amplitude of vibration is constant, the output is a linear function of the direct voltage.

## Description

The voltage developed across the resistor has an undesirably high source impedance and under conditions of a varying input voltage, a fraction of the modulating signal appears in the output superim-

posed on the modulated carrier.

Conversion of the source impedance to a lower value has been accomplished with a slight loss in gain by a cathode-follower. See Fig. 1A. The unwanted component of the modulating voltage has been eliminated from the output by creating a compensating voltage identical in amplitude and phase. This is developed by applying the input voltage to a resistance-capacitance network  $R_2C_2$  having the same time constant as  $R_1C_1$ . This method is preferable to using filter circuits, which would introduce unwanted attenuation and phase shift in the modulation envelope.

The output is capable of driving a 10,000-ohm load. The isolated secondary of the output transformer permits connection into either balanced or unbalanced circuits.

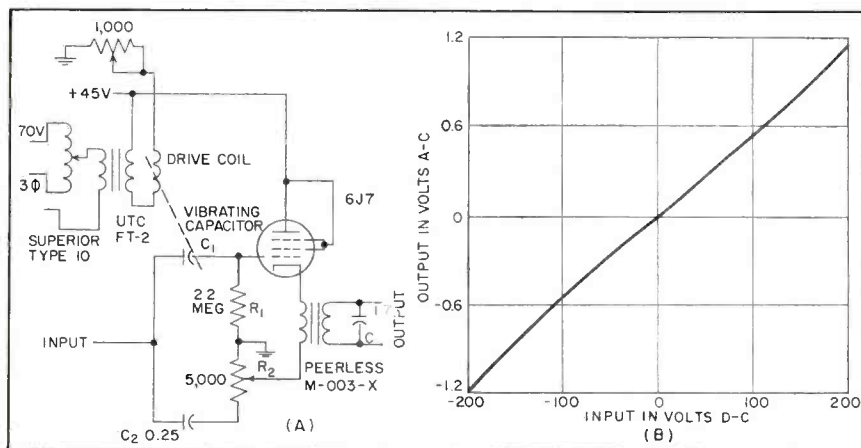
## Plate Drive

The capacitor plates vibrate as they align themselves with the instantaneous magnetic field. One cycle of plate vibration is produced for every half cycle of voltage applied to the drive coil, resulting in frequency doubling. Although the efficiency is about five times greater in this condition, it is usually undesirable.

To obtain operation at the frequency of the drive, the magnetic field must remain unidirectional. By maintaining a constant direct-current flow through the drive coil in addition to the alternating drive voltage, a bias is created that produces a unidirectional field.

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**FIG. 1—Vibrating capacitor modulator (A) and input-output characteristics showing its good linearity (B)**



# Changes D-C to A-C

If the modulator is used where transient response is critical, it must be balanced to remove the component of the modulating voltage that otherwise would be superimposed on the output. A compensating voltage must be created at the transformer primary winding. By choosing the time constant  $R_2 C_2$  identical to  $R_1 C_1$  the compensating voltage is in phase with the modulating component. Then, by adjusting the amount of voltage picked off  $R_2$  the two voltages are in phase and of equal amplitude and the output of the transformer owing to the modulating component is minimized.

These adjustments are made by applying at the input a sinusoidal signal having a frequency at least equal to the highest modulating frequency. The carrier drive is turned off and  $C_2$  adjusted for minimum output using an a-c meter or oscilloscope. Resistor  $R_2$  is adjusted until a lower minimum is obtained. Resistor  $R_2$  and  $C_2$  can be replaced with fixed-value components.

## Calibration

The variable resistor in the drive circuit is a convenient means of adjusting the conversion factor within the limitation that bias current be kept between 100 and 200 ma to maintain optimum waveform and signal-to-noise ratio.

The phase-shift control matches the phase of the output to a reference phase. Control over 120 deg is obtainable without reconnection of the three-phase line.

## Results

Linearity, as shown in Fig. 1B, is within 2 percent between +100 and -100 v input. The error is 7 percent at -200 v and 3 percent at +200 v input. Voltage breakdown of the vibrating capacitor occurs for inputs above 200 v. The exact value of input at breakdown

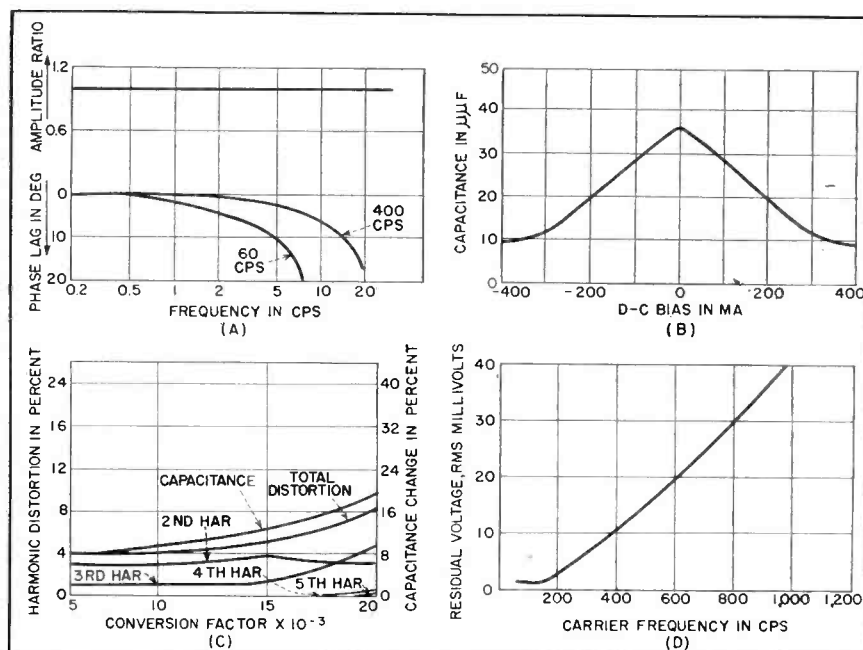


FIG. 2—Frequency response showing phase lag and amplitude ratio (A); static capacitance as a function of drive-coil bias (B); harmonic distortion and capacitance change versus conversion factor (C); and residual voltage as a function of frequency

varies between 200 and 250 v with different capacitors.

Figure 2A shows that modulating frequencies up to at least 10 cps cause no decrease in amplitude ratio. Phase shift in the output envelope relative to the input is 16 deg at 7 cps.

When the carrier frequency is 400 cps, capacitor  $C$  shunting the output winding is unnecessary. No observable drop in amplitude ratio occurs up to at least 20 cps. The phase shift in the envelope is 16 deg at 19 cps.

The static value of the vibrating capacitor  $C_1$  as a function of drive-coil bias is shown in Fig. 2B. Optimum operating bias is obtained at about 150 ma. Data for the curves of Fig. 1B and 2C were taken using this value. Conversion factors up to  $10^{-3}$  can be achieved with total distortion not exceeding 4 percent. The distortion is primarily second

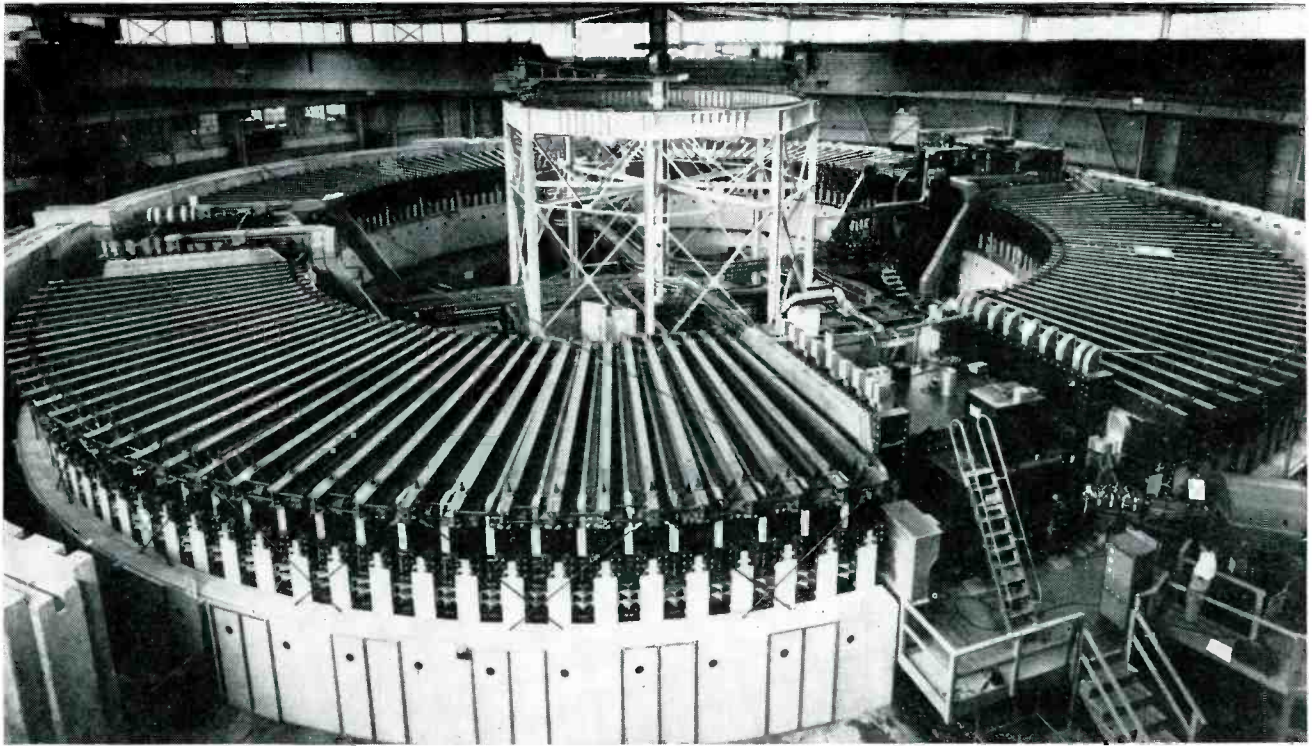
and third harmonic up to high conversion factors where third harmonic becomes predominant.

Residual voltage at the output with the input connected to ground through a low impedance approximates 1.7 mv. Lack of zero residual is due to a coupling between the drive coil and the vibrating capacitor and is difficult to eliminate.

The amount of voltage coupled into the high-impedance grid circuit by the carrier frequency is proportional to frequency and appears to be the limiting factor at higher carrier frequencies. The large residual at higher frequencies causes deviations from linearity at low input voltages. This effect is illustrated in Fig. 2D.

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General view of magnet area of bevatron, with injector area in right foreground

# Bevatron Magnet

**SUMMARY** — Pulsing system provides means of adjusting repetition rate and length of 8,333-amp pulse flowing through magnet of 6.2 billion electron volt machine. Synchronizing pulses for linear accelerator injector and various trigger pulses are derived by scaling down from 2-pps oscillator

**T**HE UNIVERSITY OF CALIFORNIA Radiation Laboratory bevatron is a proton synchrotron which accelerates particles to an energy of 6.2 billion electron volts. The injected particles are protons with an energy of 10 mev. These protons are maintained during acceleration at a constant radius of 600 inches by an increasing magnetic field and are accelerated by power of increasing radio frequency. The maximum magnet current required for 6.2-bev particles is 8,333 amp, at which time the magnet voltage is 12,000 volts. This power is supplied by two identical motor-generator sets and 48 mercury-arc rectifiers<sup>1</sup> which alternately rectify and invert at a maximum repetition rate of 10 magnet pulses per minute.

Each motor-generator set is com-

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posed of a 65-ton flywheel, a 3,600-hp drive motor and a 46,000-kva generator. The two drive motors compensate only for the losses incurred during each cycle of magnet current flow, since most of the energy supplied to the magnet is derived from the rotational energy of the flywheels, generators and driving motors.

### **Bevatron Operation**

The magnet and the two motor-generator sets are in series. During the rectification portion of the cycle, energy is transmitted from the flywheels to the magnet. The initial

magnet voltage is 18,000 volts, which falls to 12,000 volts as the magnet current increases from zero to 8,333 amp. The time required for this operation is about 1.85 seconds, as shown in Fig. 1. This portion of the magnet cycle is used to accelerate the protons, which are injected into the bevatron when the magnetic field is about 300 gauss. The magnetic field rises to about 16,000 gauss when the magnet current is 8,333 amp.

During the inversion portion of the cycle, which follows rectification, energy is returned from the magnetic field through the mercury-arc rectifiers, now operating as inverters, to the flywheels. At the peak of magnet current (8,333 amp) the generator speed has dropped about 7 percent from the



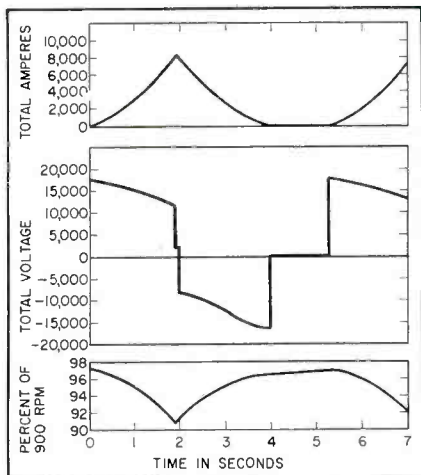
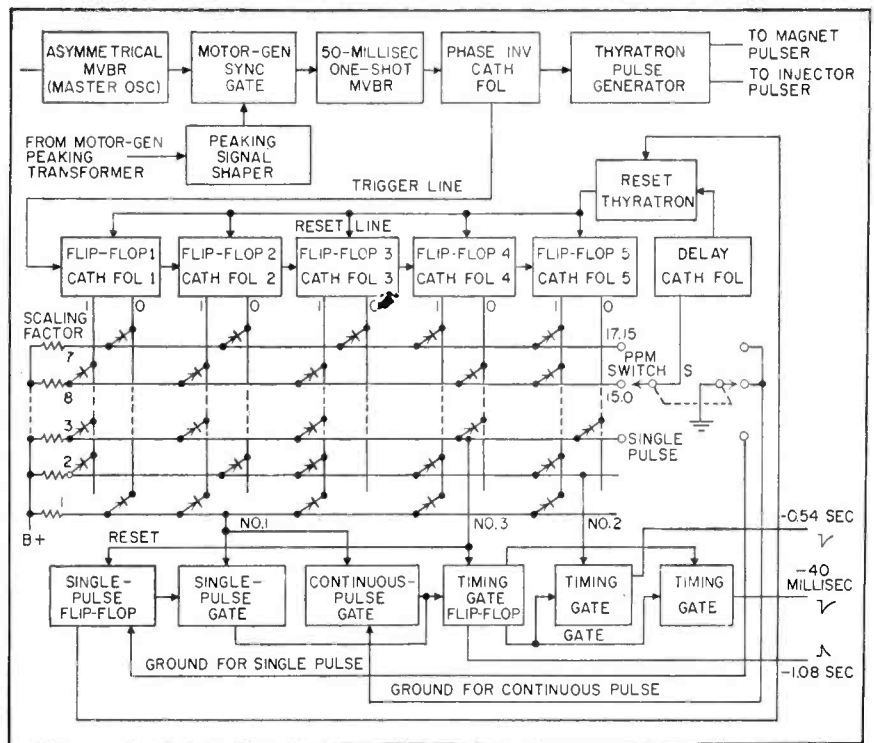


FIG. 1—Magnet power supply characteristics are shown by curves

FIG. 2—Repetition-rate pulse generator using 2-pps master oscillator as reference source for generating various synchronizing pulses required for operation of bevatron magnet system



# Pulse-Timing System

initial value of 860 rpm. The total energy stored in the two rotating flywheels is about 80 megajoules or 125 kwh.

The motor-generator system was designed to provide 10 pulses per minute at full power. The pulse-timing equipment has been designed to allow selection of 12 repetition rates between 4 and 20 pulses per minute and magnet pulse lengths from 0.1 to 2.5 seconds.

The pulse repetition chassis contains the master oscillator and repetition-rate scaling circuits as well as the associated gate equipment. This unit supplies the synchronizing pulses for the injector and trigger pulses for the magnet-pulser chassis.

The magnet-pulser chassis supplies a positive bias to the mercury arc rectifier control equipment, which causes the rectifiers to supply energy to the magnet. This chassis also supplies timing triggers at -1.04 sec, at -0.54 sec, at -40 millisecond, at magnet voltage on and at end of rectification. A synchronizing trigger is also sent to

the injection equipment between magnet pulses. The synchronizing pulse for the injection is supplied by equipment which accurately marks the proper injection field.

The repetition-rate chassis in Fig. 2 supplies three pulses, spaced 500 millisecond apart, and determines how often these pulses are produced. The chassis is synchronized by one of the motor-generator ignitor peaking-transformer pulses. Discrete repetition rates of 4 to 20 pulses per minute or single-pulse operation may be selected by a front-panel switch. An asymmetrical multivibrator operates continuously, its two periods being 480 and 20 millisecond, using the circuit of Fig. 3.

## Repetition-Rate Chassis

During the time that the 20-millisecond pulse is supplied to the motor-generator synchronizing gate, the gate can pass the peaking signal fed from the peaking signal shaper to the 50-millisecond one-shot multivibrator and on to the phase inverter, the cathode follower and the

thyatron pulse generator. This multivibrator assures that one and only one peaking signal can arrive at the phase inverter each time the 20-millisecond pulse reaches the gate.

The pulse fed to the phase inverter is also sent to flip-flop 1. Each pulse received by the flip-flop chain is stored as one count. When the total of the stored counts equals the diode matrix scaling factor, the corresponding matrix horizontal output line suddenly goes positive by about 60 volts. The repetition-rate selector switch supplies this positive pulse to the delay cathode follower and then to the reset thyatron which in turn resets the five flip-flops. A typical flip-flop circuit used on the repetition-rate chassis is shown in Fig. 4.

A delay of approximately 1 millisecond is necessary to allow the associated gate equipment to operate properly. The delay is obtained by an RC circuit which integrates the 60-volt step-function supplied to the delay cathode follower.

When it is desired to pulse the magnet, a ground is supplied to

either the single-pulse flip-flop or to the continuous gate. In either case, the next time that the chain contains one count, a magnet-pulse cycle is started. Pulse 1 is fed through the continuous gate to the timing gate flip-flop, to open both timing gates and allow pulse 2 (-0.54 sec) and pulse 3 (-40 millisecond) to be sent to the magnet-pulsar chassis. This cycle is initiated each time a ground is supplied.

When selector switch *S* is set to single pulse, the chain is reset on 3; however, when a single pulse is initiated, the chain is immediately reset to zero.

Three of the four pulses produced by the repetition-rate chassis are supplied to the magnet pulse-timing chassis, as shown in Fig. 5. These are the output of the thyratron pulse generator, the -0.54-sec

tron pulse generator, the -0.54-sec and the -40-millisecond pulses.

The 0.54-sec pulse starts a 20-millisecond time delay. This tube, in conjunction with relay tube  $V_{14B}$ , operates a relay which discharges a 0.2- $\mu$ f capacitor to provide a positive set pulse to lock out time delay  $V_1$ , flip-flops  $V_2$  and  $V_3$  and prepulse thyatron  $V_5$  to send a reset pulse to the external interval timer.

The -40-millisecond pulse from the repetition-rate chassis appears exactly 500 millisecond after the -0.54-sec pulse. This negative pulse is inverted by  $V_{7A}$  and applied to scope trigger thyatron pulser  $V_{10}$ . It also sets 40-millisecond time delay tube  $V_8$ . When this times out, a negative trigger phase inverter is sent to  $V_{7B}$  to start 20-millisecond time delay  $V_{12}$  that supplies an *on* gate

for pulse-length time delay  $V_{13}$ . This delay controls the length of the rectification cycle, which is variable from 0.1 to 2.5 sec; on timing out, a trigger is supplied through set stage  $V_{40A}$  to a filter time delay. This is a fixed delay of 20 millisecond to allow two 1,400-cycle series-resonant ripple filters to be removed from the magnet terminals before the magnet voltage reverses. After 20 millisecond a set trigger is sent to the synchronized turnoff time delay.

In addition to the set signal, there is a reset pulse, derived from one of the motor-generator phases, which is applied as a synchronizing pulse to the synchronized turnoff time delay. If this synchronizing pulse fails to arrive, the time delay still operates after 20 millisecond and

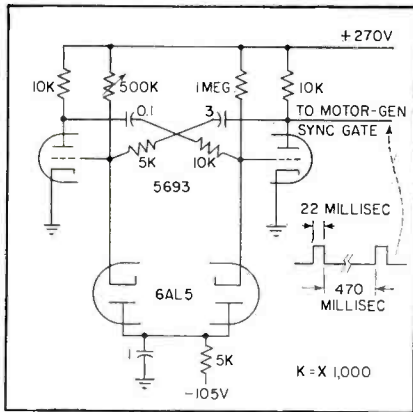


FIG. 3—Multivibrator-type 2-pps master oscillator circuit

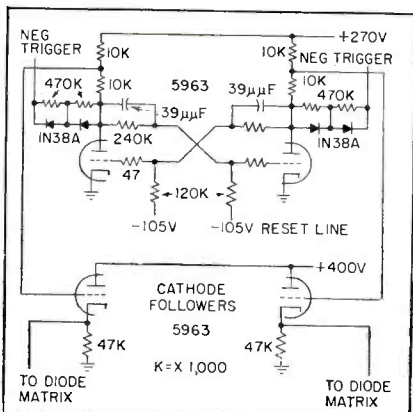
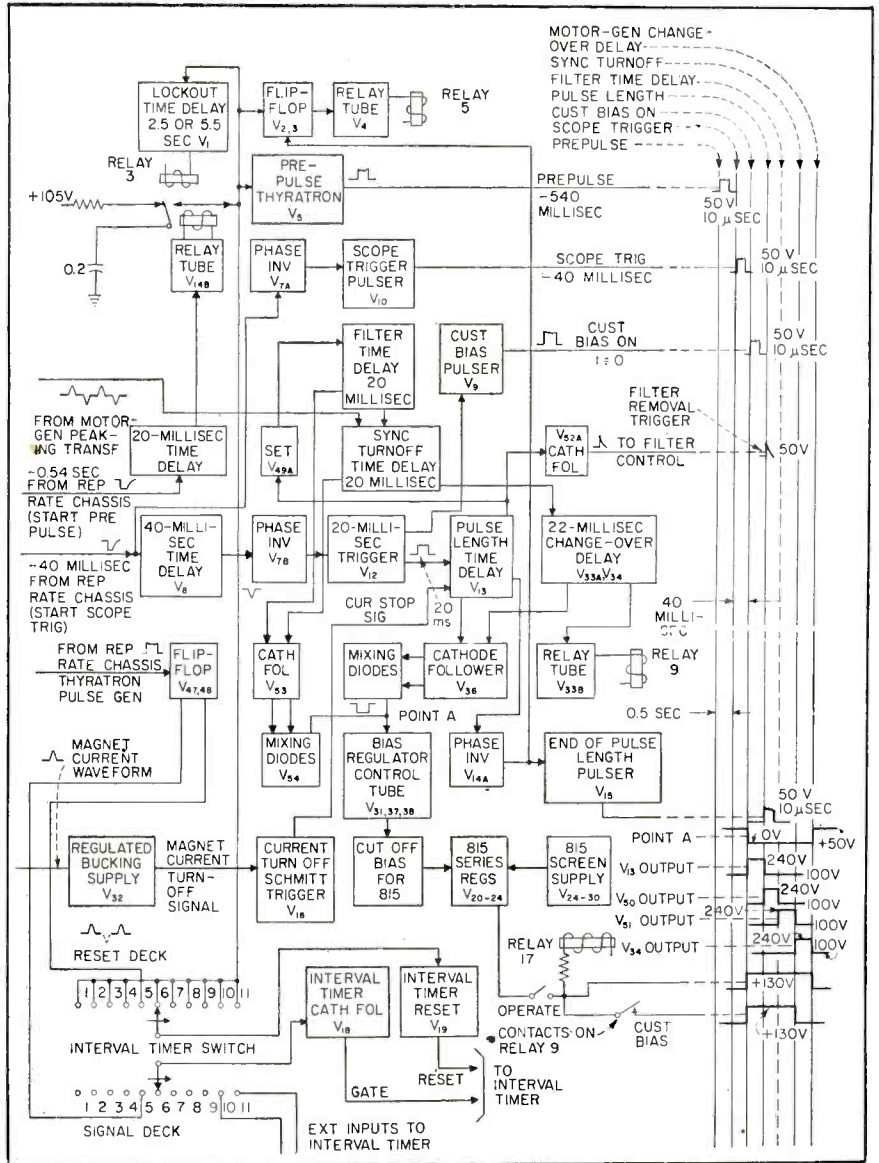
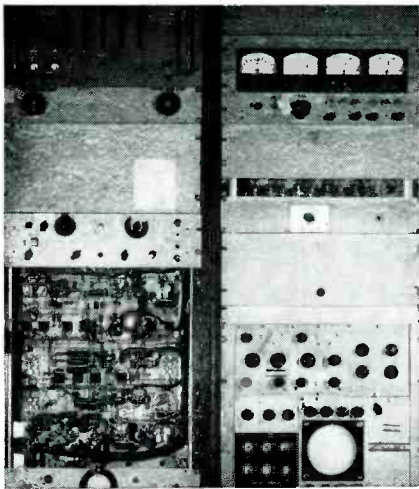


FIG. 4—Typical flip-flop circuit used on repetition-rate chassis

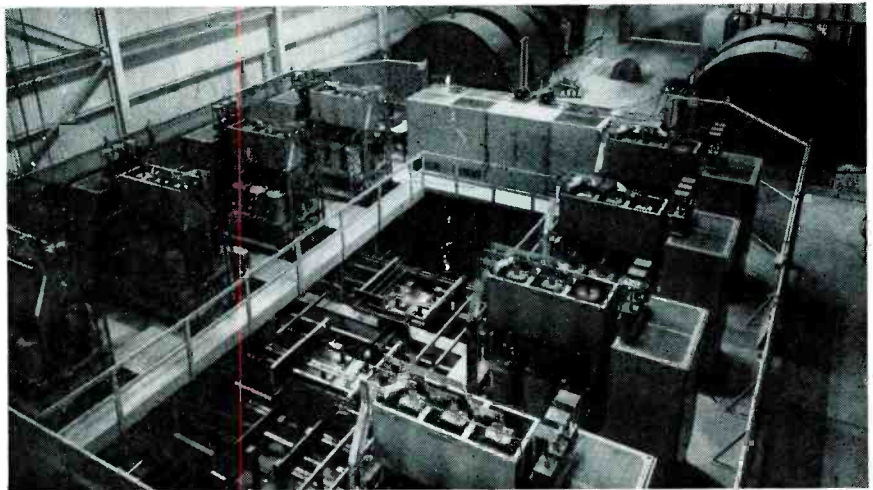
FIG. 5—Basic stages used in magnet pulse-timing system, which receives three pulses from repetition-rate chassis







Pulse-timing system racks



Motor-generator room of bevatron, with ignitrons in foreground

allows the remainder of the circuit to function normally. Thus, both the rise and fall of magnet voltage can be synchronized with a particular machine phase.

A set signal is then sent from the synchronizing turnoff delay to 22-millisecond changeover delay  $V_{33A}$  and  $V_{34}$ . This circuit, in conjunction with relay tube  $V_{33B}$ , operates relay 9 and removes the rectification bias from half the mercury arc rectifier control tubes, thus allowing half the machine to start its inversion cycle 22 millisecond before the other half. This is necessary to reduce the reversal stress on the motor-generator shafts.

Pulse-length time delay circuit  $V_{13}$ , the filter time delay, the synchronized turn off time delay and the 22-millisecond change-over delay are all direct-coupled to bias regulator tubes  $V_{81}$ ,  $V_{57}$  and  $V_{38}$  through cathode followers  $V_{30}$  and  $V_{53}$  and mixing diodes  $V_{35}$  and  $V_{54}$ . From the time that the pulse length is gated on until the end of the 22-millisecond changeover ( $V_{33A}$ ,  $V_{34}$ ) a gate is supplied to the bias regulator circuit to hold it gated on. When pulse length time delay  $V_{13}$  times out, an end-of-rectification pulse is sent through a phase inverter to a thyatron end-of-pulse-length pulser.

The series regulators and screen supply regulators  $V_{20}$  through  $V_{80}$ , using type 815 tubes, required some unusual circuitry to supply 150 volts at 1.1 amp regulated to 1 percent. When available distribution transformers are used the average series regulator tubes have too

much drop, so it was decided to use five dual-pentode tubes with a common regulated screen supply.

In addition to the circuitry just described, this chassis contains monitoring circuits so that the timing of each delay circuit may be checked by an external interval timer. The interval timer switch selects the function to be measured by this unit. The signal to be checked is sent to the timer by cathode follower  $V_{18}$  and a reset signal is generated by  $V_{10}$ .

The magnet pulse length is determined by pulse-length delay  $V_{13}$  and the actual magnet current. A scaled-down replica of magnet current is supplied through regulated bucking supply  $V_{32}$  to Schmitt trigger  $V_{16}$ , used to derive a marker pulse at a predetermined magnet current.

#### Modified Schmitt Trigger

The magnet-pulser chassis contains a new circuit to determine the magnet pulse length  $V_{13}$  and the lockout time  $V_1$ . The basic circuit, a modified form of Schmitt trigger,<sup>2</sup> is shown in Fig. 6. The triode is normally conducting and the de-energized relay is in the position shown. When a positive start gate is applied to the pentode grid, the pentode is caused to conduct, energizing the relay. The grid of the triode is almost immediately lowered to the negative bias voltage  $-E$ .

Because the variable timing resistor  $R$  is returned to positive bias potential  $+E$ , capacitor  $C$  charges toward this potential until the

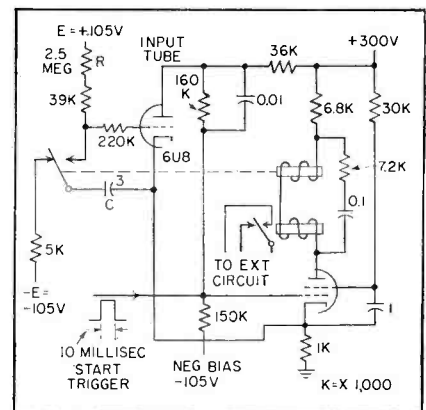


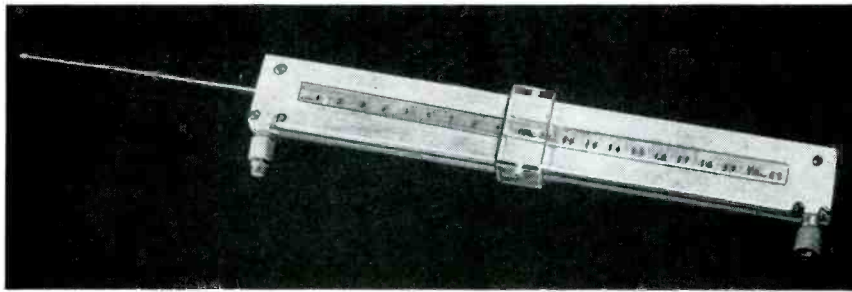
FIG. 6—Modified Schmitt trigger circuit used to determine magnet pulse length

triode just passes the cutoff point, at which time positive feedback around the circuit forces the triode to zero bias and the pentode to cutoff. Because  $C$  is alternately charged and discharged between equal but opposite potentials with respect to ground, the time required for the capacitor to charge from its original negative potential to ground is essentially independent of supply voltage variations.<sup>3</sup>

Acknowledgement is made to D. A. Mack, bevatron project engineer in charge of all monitoring and controls, whose conception of the magnet pulser led to its design and development by the author. All bevatron work has been done under the auspices of the U. S. Atomic Energy Commission.

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- (2) Otto Schmitt, A Thermionic Trigger, *J Sci Instr*, p 24, Jan. 1938.
- (3) S. Wald, Precision Interval Timer, *ELECTRONICS*, p 88, Dec. 1948.



By EUGENE B. HERMAN

Haller, Raymond and Brown, Inc.  
University Park, Pennsylvania

Microwave receiver has appearance of 10-in. slide rule. Whip antenna is extension of slab-line center conductor

# PERSONAL Microwave

**B**ASICALLY the receiver consists of an antenna and wavemeter cavity plus an audio amplifier with hearing-aid ear piece. The receiver schematic is shown in Fig. 1A. The antenna is a telescoping whip which when fully extended is a little over a half wavelength long at the lowest frequency.

The antenna is an extension of the center conductor of a slab line. The slab line serves as the wavemeter resonant circuit for the crystal video detector. The slab line was chosen because its impedance is easily calculated and there is little or no coupling between the inside and outside of the line. It is easy to fabricate, relatively inexpensive, has a reasonably high Q and desirable form factor.

The characteristic impedance of a slab line is

$$Z_0 = (138/K^{\frac{1}{2}}) \log_{10} (4b/\pi d_0)$$

where  $b$  = separation between slabs,  $d_0$  = diameter of center conductor and  $K$  = dielectric constant. See Fig. 1B.

The line impedance was chosen at 50 ohms to provide an approximate match for the crystal detector and to maintain a reasonable Q for tuning the wavemeter. The wavemeter is tuned by a set of sliding contacts. The length of the wavemeter sets the lower limit of frequency at 1,000 mc. The upper limit of 12,000 mc is fixed by the performance of the crystal detector.

The crystal detector is probe coupled into the wavemeter cavity. To maintain high loaded Q for the

tuned circuit, the coupling is kept loose. The Q varies from 71 to 42 as the frequency varies from 1,000 to 10,000 mc. Variation is due to skin effect, antenna loading and loading due to the crystal detector.

The crystal is a Sylvania tripolar video detector, type 1N369A. Since this crystal has a self-contained d-c return, probe coupling is practical. The figure of merit of this crystal is a minimum of 10 measured at 6,750 mc. Tangential sensitivity is -40 dbm over the band. Video resistance is between 4,500 and 18,000 ohms at 25 C. The crystal has a built-in r-f bypass of 7  $\mu$ mf; r-f input impedance is a nominal 65 ohms.

The audio amplifier is a modified Zenith Royal T hearing aid. This is a compact sensitive amplifier whose internal noise is considerably less than that generated by the

1N369A. The output of the amplifier is fed to a hearing-aid ear piece. Any signal detected by the crystal is amplified and made audible.

A signal can be maximized by orienting the antenna, adjusting the antenna length or adjusting the tuning slider. The frequency is measured by measuring the distance between maximums for weak signals or minimums for strong signals. By using the antenna fully extended at the higher frequencies a long-wire antenna pattern is produced which can be used as a crude radio direction finder.

## Performance

The r-f portion of the receiver looks like a slide rule 10 inches long, 1½ inches wide and ⅜ inch thick. The antenna extends beyond the slide rule a maximum of 9 inches.

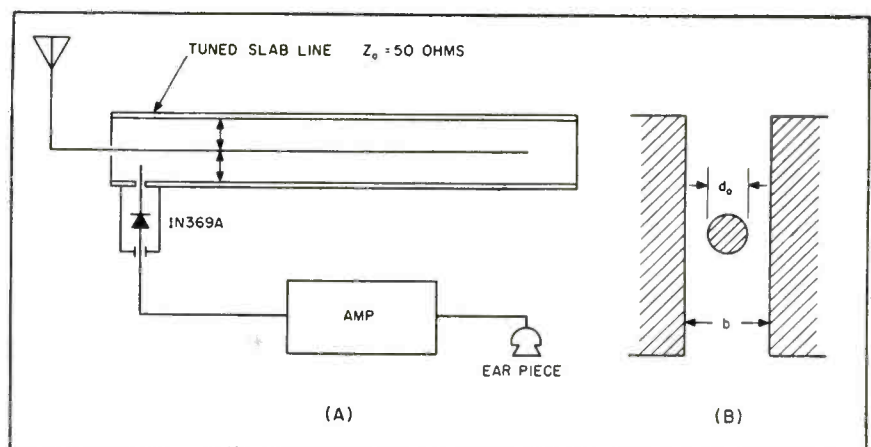


FIG. 1—Tuned slab line acts as wavemeter cavity; tripolar crystal is video detector that feeds hearing-aid amplifier



**SUMMARY** — Crystal detector with slab-line resonant circuit picks up microwave energy and feeds it to hearing-aid amplifier. Result is personal portable for 1,000 to 10,000 mc with sensitivity from  $-35$  to  $-40$  dbm. Possible applications include detection and surveillance, emergency short-distance communications and field-survey work

# Search Receiver

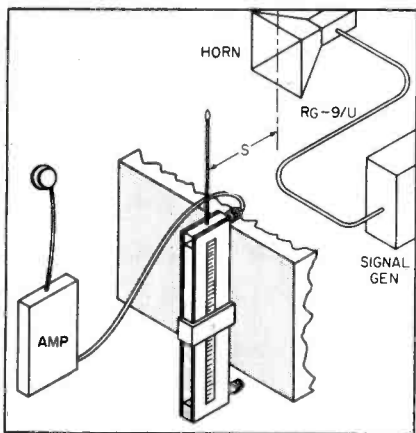


FIG. 2—Shield of microwave absorbing material is used when testing receiver

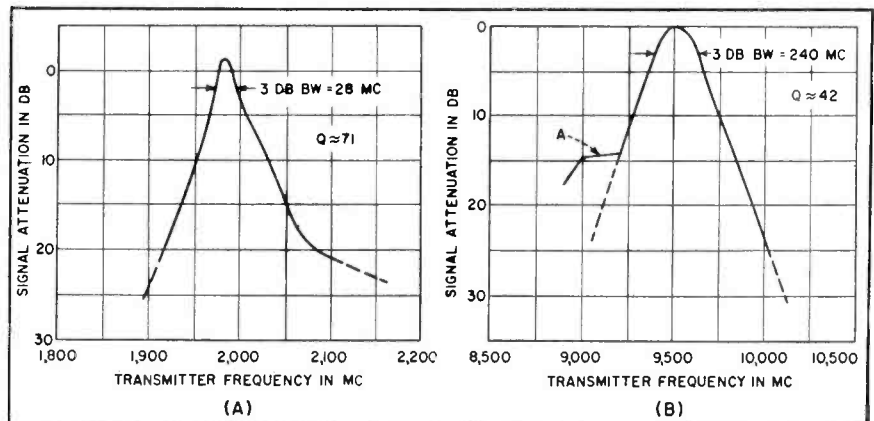


FIG. 3—Response is shown by attenuation in db inserted in test signal generator for low (A) and high (B) ends of spectrum

This is about 8 wavelengths at the highest frequency and a half wavelength at the lowest.

The amplifier is the size of a pack of regular-size cigarettes. The ear piece is a standard hearing-aid component. The total weight of the receiver is less than  $12\frac{1}{2}$  oz.

It is possible to receive a 1-mw signal modulated with a  $12\text{-}\mu\text{sec}$  pulse at a 4-kc rate at a distance of more than 35 feet. Such a signal was radiated from a horn of less than 10-db gain fed by a cable having loss of about 1 db.

A 40-mw X-band signal square-wave modulated at 400 cps was audible 35 to 40 feet away from an open-ended waveguide.

The indicated sensitivity of the receiver was  $-35$  to  $-40$  dbm. This is limited by the tangential sensitivity of the crystal detector. The minimum detectable signal was measured by placing the an-

tenna as close as practical to the radiator and assuming reasonably tight coupling. The signal was attenuated to threshold and the minimum detectable signal measured using calibrated attenuators on the signal generator. Figure 2 shows a setup for measuring response and sensitivity.

### Test Procedure

In a typical test a signal generator was coupled through a short section of RG-9/U cable to a low-gain waveguide horn. The distance  $S$  between the receiver and horn was kept a minimum when measuring minimum detectable signal. When measuring wavemeter response, distance  $S$  was increased to at least  $S > 2D^2/\lambda$  where  $D =$  widest dimension of horn and  $\lambda =$  operating wavelength.

To prevent back scattering from the receiver, amplifier or operator,

microwave absorbing material was placed between the receiver and horn. In spite of all precautions there were indications of reflection at the higher frequencies. This is shown at point A, Fig. 3B.

The response of the receiver was measured for a fixed antenna length and slider position as the transmitter frequency was varied about the tuned frequency of the wavemeter. Figure 3 shows the wavemeter response near 2,000 and 9,500 mc. The response characteristics were sufficiently sharp to enable frequencies to be measured within  $\pm 1$  percent at S-band and  $\pm 2.5$  percent at X-band.

At the lower frequencies the antenna operates best as a quarter-wave whip. However, at the higher frequencies it is possible to increase antenna gain and directivity by extending the antenna several wavelengths.

# Transistor Modulator

**SUMMARY** — Differential-transformer transducer feeds transistorized network employing phase and pulse time modulation for airborne tape recording of accelerations up to 180 g and 500 cps

**D**ESIRABLE FEATURES of transistors in remote measurement and control systems for missiles, guided aircraft and industry have heretofore been offset by the instability of the transfer characteristics. For this reason, a recording and telemetering system has been designed which employs phase and pulse time modulation rather than amplitude modulation.

In this system the transducer, a passive device itself, is modified to provide phase modulation; transistors amplify and limit the signals, which are then converted to pulse time modulation. In this form the information may be directly recorded or telemetered to a remote location, where equipment size and weight are not of paramount importance.

## Phase-Modulating Transducer

The heart of the phase-modulating system is the transducer, the only portion of the system which is amplitude-sensitive. While various types of transducers might be used, a differential transformer was designed to provide acceleration measurements up to  $\pm 180$  g and 500 cps.

This transducer consists of a concentrically wound air-core transformer having one primary winding and two secondary windings connected in series opposition as in Fig. 1A. A core of ferromagnetic material is mounted within the transformer in such a way that its position determines the relative linkage between the primary circuit, *AB*, supplied from a carrier oscillator, and the two secondaries, *CD* and *DE*. The voltage produced across *CE* is proportional to the displacement of the core, with its phase leading the input current by 90 deg when the displacement is in one direction and lagging by 90 deg for displacement in the opposite direction. The core may be coupled to a diaphragm to indicate pressure or to a seismic system to indicate acceleration. This device is designed to operate at carrier frequencies from 400 to 20,000 cps at levels of up to 5 volts input. Primary and secondary impedances are approximately 70 ohms.

This transducer, while fundamentally an amplitude-modulating device, is converted to a phase modulator by the addition of a calibrating resistor *R* and an inductance

*L*, as shown in Fig. 1A. The resistance of *R* is much smaller than the primary resistance. The inductance of *L*, part of the tank circuit of a transistorized oscillator, is much higher than the primary winding inductance. The primary winding of the transducer is part of the carrier oscillator tank circuit, and carries current  $i_r$  (1-kc carrier). In series with the primary winding is the calibrating resistor *R*, across which  $i_r$  produces a voltage  $E_R$ . This is shown as the horizontal voltage vector in Fig. 1B.

The voltage  $E_s$  appearing across the output of the transducer is practically 90 deg out of phase with the input current  $i_r$ ; whether it leads or lags depends upon the direction of core displacement and hence upon the sense of the acceleration. This signal  $E_s$  is added to  $E_R$ , the resultant being  $E_o$ . The phase angle  $\theta$  between  $E_R$  and  $E_o$  is the arc tangent of  $E_s/E_R$ . Since  $E_R$  and  $E_s$  are both proportional to the tank current, phase angle  $\theta$  is independent of oscillator voltage changes. This is a highly desirable feature of the system.

A reference voltage *E* taken from the high side of the oscillator



FIG. 1—Operation of phase modulation network used with differential-transformer accelerometer



# for Airborne Recording

By JAY L. UPHAM, Jr. and ABRAHAM I. DRANETZ

*Gulton Mfg. Corp.  
Metuchen, N. J.*

tank inductor leads  $E_R$  by approximately 90 deg. This is adjusted to exactly 90 deg leading by a phasing network which compensates for the finite  $Q$  of the tank circuit. Note that output signal  $E_O$  and the reference signal  $E$  are the only voltages to be utilized for further processing.

Although voltage  $E_s$  is proportional to the core displacement, phase angle  $\theta$  is determined by the arctangent of  $E_s/E_R$ . Therefore, it may be considered as proportional only through a limited angular range. Figure 1C shows the percentage of deviation of arctangent  $\theta$  from linearity as the phase angle is increased. The practical limit is chosen commensurate with an allowable error of 2.8 percent. This is shown to be a phase angle of  $\pm 18$  deg. The full-scale range of the device is controlled by a choice of  $R$  such that the  $\pm 18$  deg limit is not exceeded. Physically, this resistor, which is approximately 1 ohm, is located for easy change, so that a single transducer can be used for a wide variety of acceleration or pressure ranges.

For telemetering or tape recording applications, the phase in-

formation is processed as shown in Fig. 2.

### Phase-to-Pulse Conversion

The two output signals from the transducer are individually fed to transistorized amplifiers which, by limiting action, produce square waves. The information signal lags the reference signal by an angle of  $90 \pm < 18$  deg or a time of  $0.25 \pm < 0.05$  millisecond. These outputs are then differentiated and added in a simple mixing circuit, creating two positive and two negative spikes. The leading positive and negative spikes correspond to the reference signal; the lagging spikes correspond to the information signal. While it is not necessary to combine these signals, their combination eliminates the need for

separate information and signal channels.

Figure 3 shows a transistorized network used for airborne tape recording. This circuit includes the carrier oscillator, the transducer, an overdriven reference amplifier, an overdriven information amplifier, and a 60-kc bias oscillator for the recording head. Stages  $V_1$  through  $V_5$  constitute the functional section of the circuit, while  $V_6$  is the 60-kc oscillator, which provides bias for the recording head.

Operating analogously to a Hartley oscillator,  $V_1$  provides approximately 25 ma at 1 kc for operation of differential transformer  $T_1$ . The signal appearing at the output of  $T_1$  is amplified by  $V_2$  and some limiting occurs through its injection in  $V_3$ . The output of  $V_3$ , restricted to

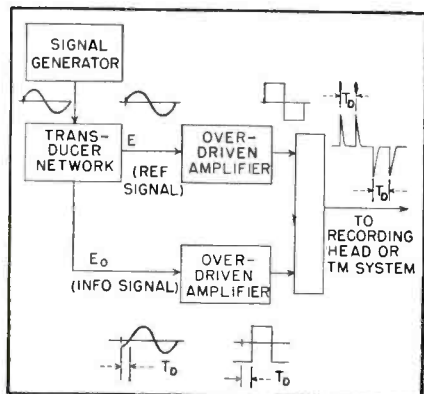
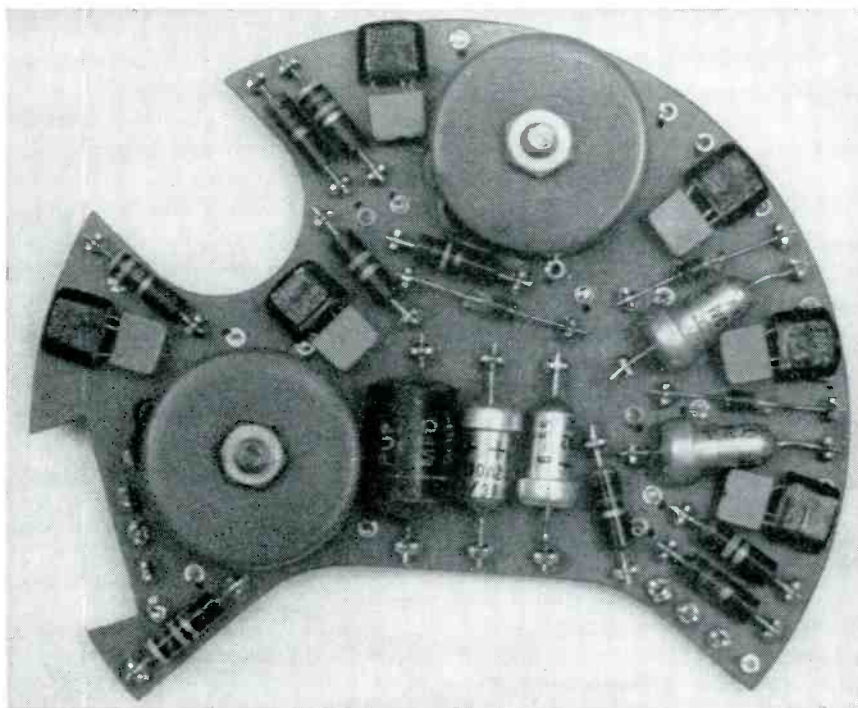


FIG. 2—Phase-to-pulse conversion



Complete airborne transistor network for acceleration channel of in-flight tape recorder occupies 2 cu in. and weighs only 2.5 oz. Use of phase modulation offsets inherent instability and lack of production uniformity in the six transistors employed





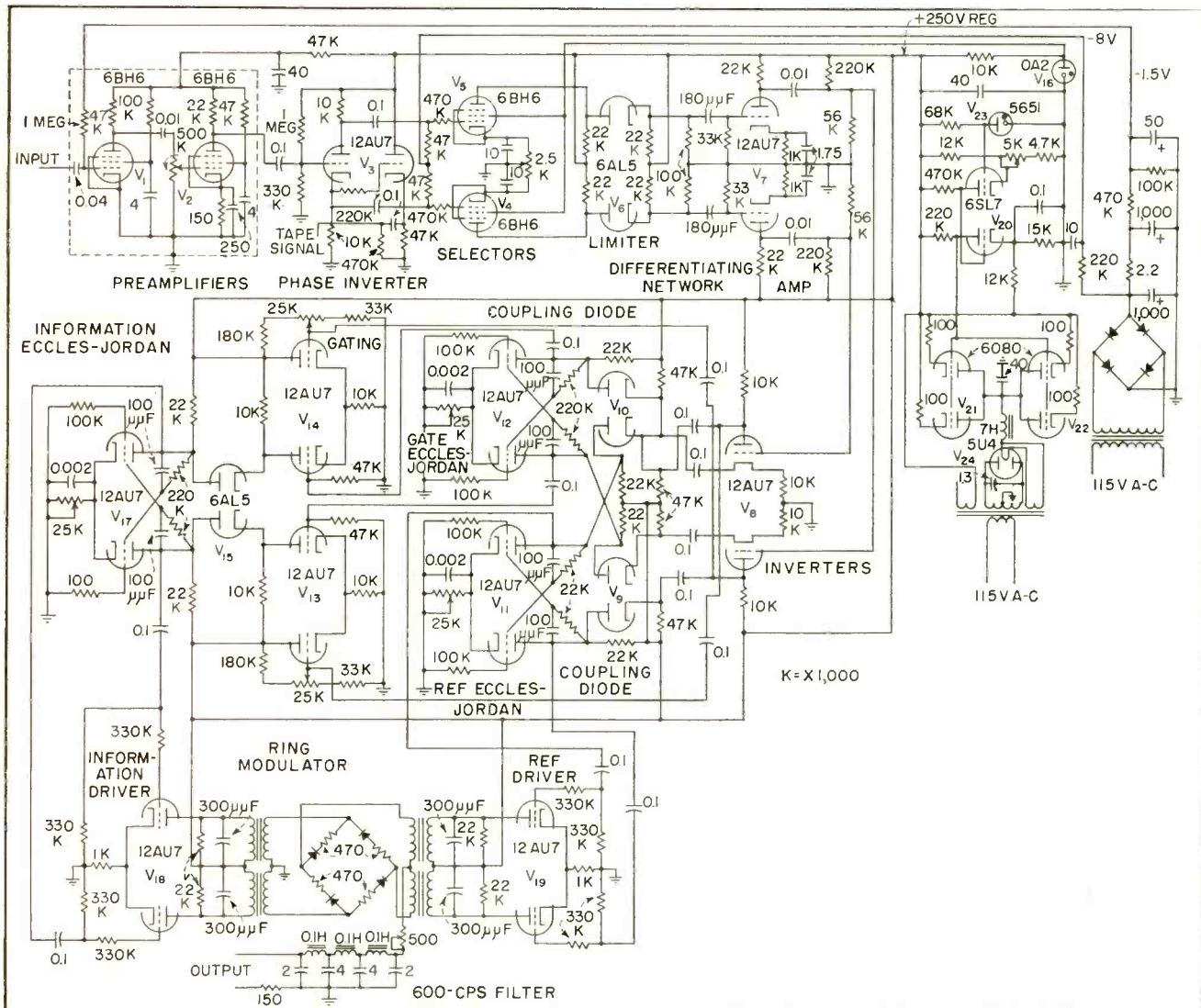


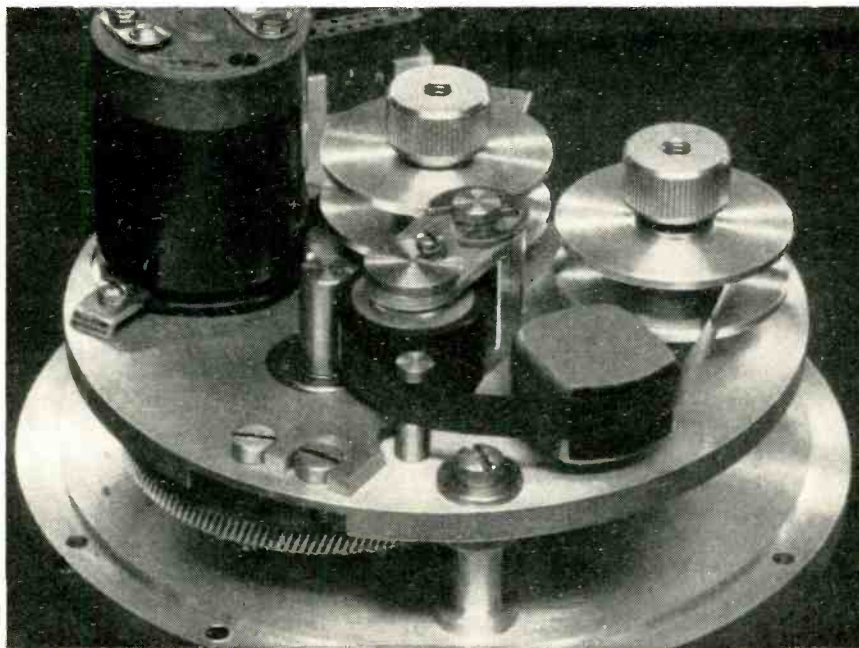
FIG. 5—Circuit of demodulator used for tape playback at ground station after test flight

the temperature-varying transistor impedances in conjunction with the reactive components of the coupling transformers.

### Summary of Characteristics

In spite of these limitations a workable and reliable system has been developed and tested for in-flight recording of acceleration phenomena. The system is extremely versatile and can be readily adapted to the measurement of other functions such as temperature, velocity, pressure or any function that can be converted by analog transducers into a voltage-modulated form.

The actual airborne tape recording device shown was developed by the Galton Mfg. Corp. of Metuchen, N. J., for the U. S. Air Force, Air Materiel Command, under contract number AF33(600) 23938.



Recording tape-drive mechanism used with transistorized modulator network weighs less than 3 lb

# Equivalent R-Z Chart

**SUMMARY** — Parallel components of resistance and reactance in a given frequency range for an unknown circuit can be obtained quickly and easily by use of Q meter and nomographs

**T**HE Q METER is useful in obtaining the parallel components of resistance and reactance of a network. When a number of readings are to be taken over a frequency range, the use of nomographs can provide a saving in time and effort. The procedure for using the nomographs is as follows:

Tune the Q meter to resonance at the measurement frequency,

**By HALLAN E. GOLDSTINE**

*RCA Laboratories  
Radio Corporation of America  
Rocky Point, N. Y.*

using a relatively high-Q shielded coil. Record the frequency, Q-meter capacitance reading and the Q reading. These are  $f$ ,  $C_1$  and  $Q_1$ .

Connect the unknown network

across the capacitance terminals of the Q meter. Without changing frequency, retune the capacitance of the Q meter to resonance. Only measurement values within the proper range can be used, otherwise the readings may not be obtainable on the Q meter.

Record the capacitance and Q with the network connected.

(Continued on page 172)

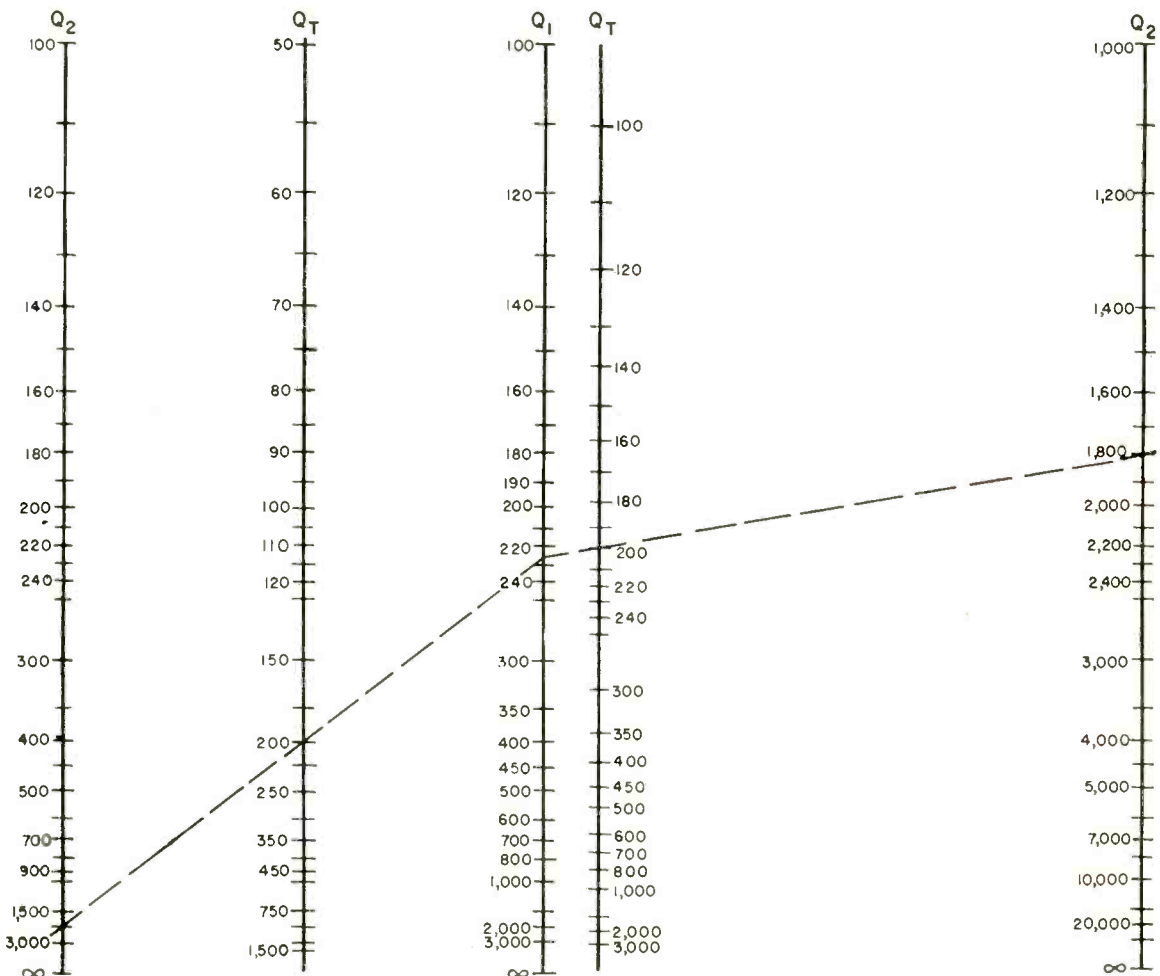
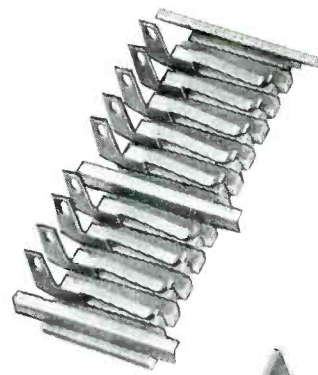


FIG. 1—Chart gives  $Q_2$  value for solution of parallel resistance equation

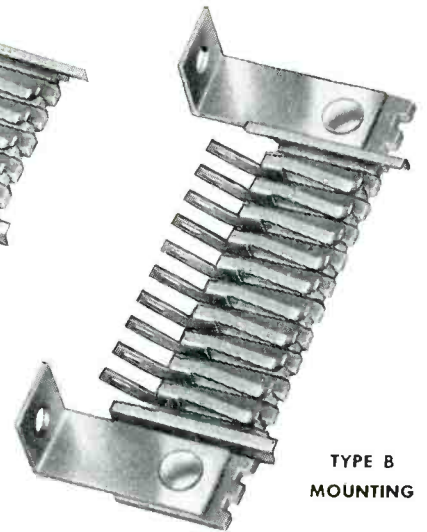


**QUICK, EASY  
ASSEMBLY WITH  
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TYPE P  
MOUNTING



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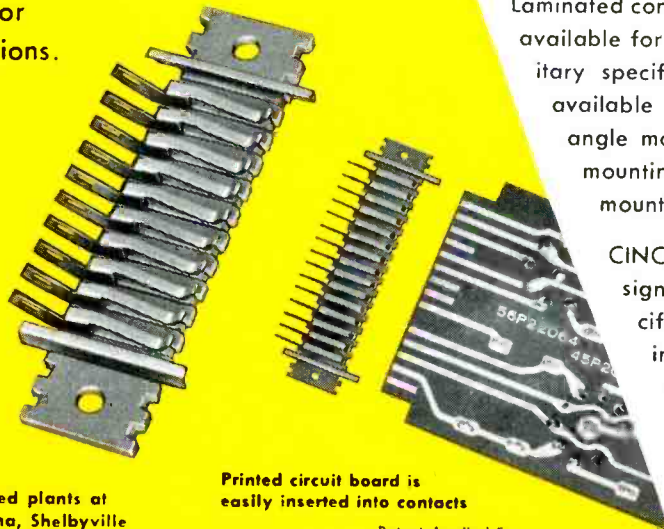


TYPE F    TYPE G    TYPE H

**8 TYPES OF  
CONTACT TAILS**

Eight different contact tail terminations provide for use of A.M.P. "78" or "98" solderless taper tab connections. A standard solder slot is also provided.

Contacts are made of phosphor bronze and are available in a variety of finishes.



TYPE R  
MOUNTING

Printed circuit board is easily inserted into contacts

Patent Applied For

... with the advantages of lower cost, contact float, elimination of moisture traps and positive connector operation over a wide range of board tolerances.

Extended end guides provide positive orientation of the printed card prior to engagement with the connector.

Cinch 50M Edge Connectors are available in any number of contacts from one to 56. The contacts are on standard 5/32" centers. A polarizing guide may be assembled at any contact position.

Laminated connector body materials are available for either commercial or military specifications. Connectors are available with brackets for right angle mounting or .136 diameter mounting holes for rivet or screw mounting.

CINCH will design, or redesign, components to fit specific needs, and will assist in the assembly of components through proven automation technique.

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Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

# Equivalent R-Z Chart

(Continued from page 170)

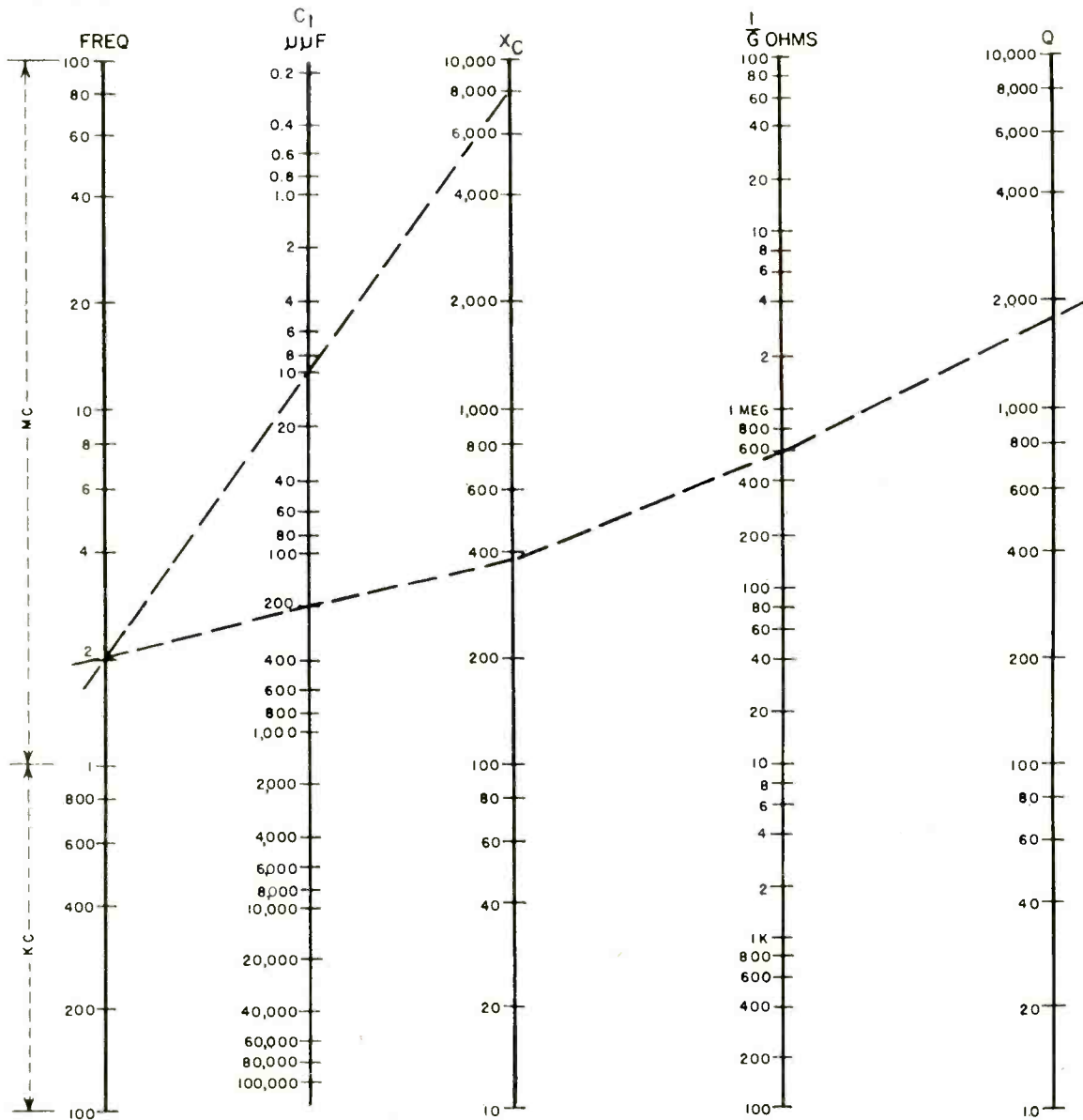


FIG. 2—Nomograph solves equations for both parallel resistance and reactance

The parallel resistance and reactance are

$$\frac{1}{G} = X_C Q_2 \quad Q_2 = \frac{Q_1 \times Q_T}{Q_1 - Q_T}$$

$$\frac{1}{B} = \frac{-j}{\omega(C_1 - C_T)}$$

where  $1/G$  = parallel resistance in ohms and  $1/B$  = parallel reactance in ohms.

As an example, at a frequency of 2 mc the Q meter readings were  $C_1 = 210 \mu\mu\text{f}$ ,  $Q_1 = 225$ .

After connecting the network, readings were  $C_T = 200 \mu\mu\text{f}$  and  $Q_T = 200$ .

Referring to Fig. 1 a straightedge is placed across from 225 on the  $Q_1$  column, through the value of 200 on the  $Q_T$  column, and approximately 2,000 is obtained on the  $Q_2$  column on the left side. To obtain better accuracy for high  $Q_2$  values, the right side of the chart is used. By placing the straightedge on the  $Q_1$  value of 225, through  $Q_T$  value of 200 on the right, the  $Q_2$  value of approximately 1,800 is obtained on the right-hand  $Q_2$  column.

Using Fig. 2, the straightedge is placed on the frequency of 2

mc and the capacitance  $C_1$  reading of 210. The  $X_C$  reading of 380 is read. The straightedge is then placed from 380 on the  $X_C$  column to the  $Q_2$  reading of 1,800 giving a value of 700,000 ohms.

Reactance component  $1/B$  is equal to  $-j/\omega(C_1 - C_T)$ . To obtain this value from Fig 2, set straightedge again on 2 mc, through value of  $(C_1 - C_T)$ , in this case  $210 - 200 = 10 \mu\mu\text{f}$ , and the value of 8,000 is read off the  $X_C$  scale.

The parallel components are thus  $1/G = 700,000$  ohms and  $1/B = -j 8,000$  ohms.



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†Patent applied for

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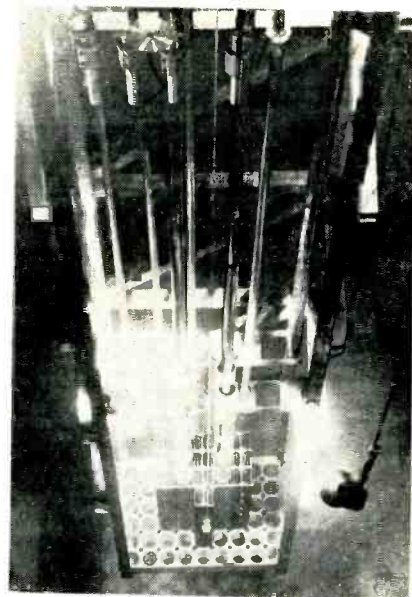
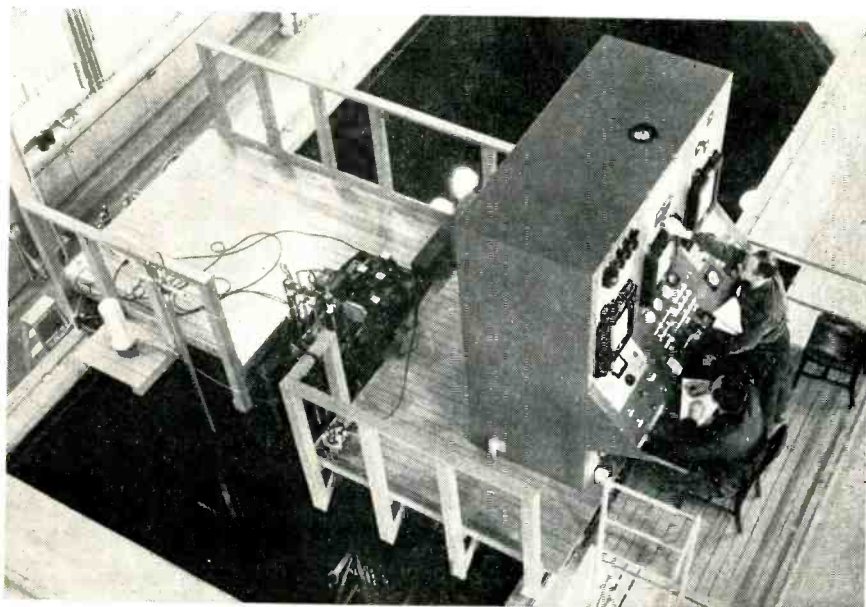
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# Electrons At Work

Edited by ALEXANDER A. MCKENZIE

## Swimming Pool Reactor Controls



Penn State's 100-kw nuclear reactor has a core with gridwork of U-235 fuel elements at the bottom of a 20-foot water tank. The research laboratory at one end of the pool receives neutron beams collimated by holes through a 44-inch concrete shield. Log-count

rate,  $\log N$  (dependent upon reactor flux) and linear servo channels control the reactor during different phases of the reaction. Scram circuits immediately drop safety rods to stop the controlled chain reaction if rate of power exceeds safety limits

## Weather Radar Probes Storms

RADAR weather research is currently a considerable program on Great Blue Hill in Milton, Mass., just south of Boston. This work is carried on jointly by members of the Weather Radar Unit of the Geophysical Research Directorate, Air Force Cambridge Research Center, with offices in Harvard's Blue Hill Meteorological Observatory, members of the Observatory staff and regular Air Force personnel.

With the aid of radar since World War II, considerable new insight has been gained of the structure, development and motion of precipitation areas associated with small and large-scale storms. It now appears likely that through studies of small-scale features, which constitute the large storm systems, im-



FIG. 1—Air Force personnel man Blue Hill 3.2-cm radar around the clock. Control boxes for automatic cameras are above main scope and scope camera assembly is at right



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- ★ **LOW** OUTPUT IMPEDANCE

**KR** Voltage Regulated Power Supplies are conservatively rated and are designed for continuous duty at 50°C ambient.

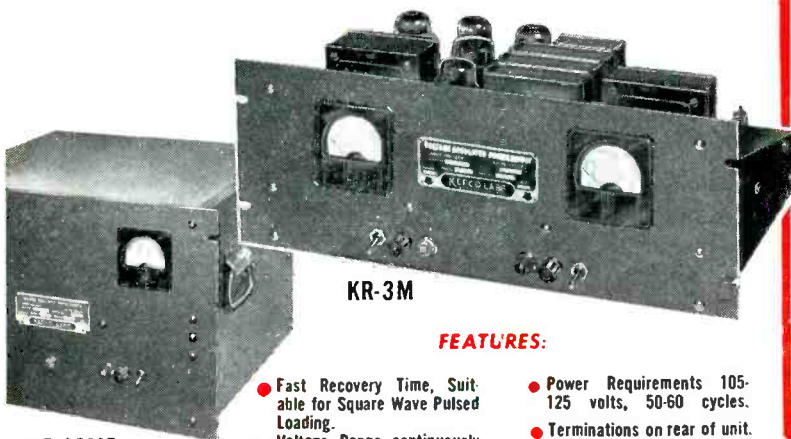
**REGULATION:** Less than 0.2 volts for line fluctuation from 105-125 volts and less than 0.2 volts for load variation from 0 to maximum current.

**RIPPLE:** Less than 3 mv. rms.

**STABILITY:** The output voltage variation is less than the regulation specification for a period of 8 hours.

**RECOVERY TIME:** Less than 50 microseconds. The excursion in the output voltage during the recovery period is less than the regulation specification.

**OUTPUT IMPEDANCE:** Less than 0.1 ohms from 20 cycles to 100KC. Less than 0.5 ohms from DC to 20 cycles. Many units have very much lower output impedance.



KR-18MC

KR-3M

**FEATURES:**

- Fast Recovery Time, Suitable for Square Wave Pulsed Loading.
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  - Either Positive or Negative may be Grounded.
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  - Wire Harness and Resistor Board Construction.
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### 1.5 Amp. KR SERIES

Model	Volts	6.3V AC	Rack Mount			Price
			W	H	D	
KR16	0-150	Each supply	19"	12¼"	17"	\$625
KR17	100-200	has two	19"	12¼"	17"	\$625
KR18	195-325	15 Amp.	19"	12¼"	17"	\$695
KR19	295-450	outputs	19"	12¼"	17"	\$695

### 600 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount			Price
			W	H	D	
KR 8	0-150	Each supply	19"	10½"	13"	\$330
KR 5	100-200	has two	19"	10½"	13"	\$240
KR 6	195-325	10 Amp.	19"	10½"	13"	\$240
KR 7	295-450	outputs	19"	10½"	13"	\$250

### 300 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount			Price
			W	H	D	
KR 12	0-150	Each supply	19"	7"	11"	\$270
KR 3	100-200	has two	19"	7"	11"	\$180
KR 4	195-325	5 Amp.	19"	7"	11"	\$180
KR 10	295-450	outputs	19"	7"	11"	\$190

### 125 ma. KR SERIES

Model	Volts	6.3V AC	Rack Mount			Price
			W	H	D	
KR 11	0-150	Each supply	19"	7"	11"	\$180
KR 1	100-200	has one	19"	7"	7½"	\$ 90
KR 2	195-325	3 Amp.	19"	7"	7½"	\$ 90
KR 9	295-450	output	19"	7"	7½"	\$ 97

To include 3" Current and Voltage Meters, Add M to Model number (e.g. KR 16-M) and Add \$30.00 to the Price.  
 To include Dust Cover and Handles for Table Mounting, Add C to Model number (e.g. KR16-C) and Add \$10.00 to the Price.  
 To include Meters, Dust Cover and Handles, Add MC to Model number (e.g. KR-16 MC) and Add \$40.00 to the Price.  
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portant knowledge relating to the dynamics of the latter will be obtained.

Accordingly, the present effort at Blue Hill is divided into various categories. A summer program, with the aid of cooperative ground observers, seeks to gain more information on local storm characteristics with particular emphasis on the identification of severe storms. Observational and theoretical studies of winter type precipitation are also in progress and attempts are being made to relate quantitatively the radar presentation given by the relatively small storm sectors seen in these cases with the larger systems. These studies appear to offer a way to the better understanding of all the factors which influence and make weather.

The most important item of radar equipment at the Observatory is the CPS-9 with characteristics especially designed for meteorological studies. The CPS-9 characteristics are: wavelength, 3.2 cm; beam, conical, 1 deg between half-power points; pulse length, 0.5 or 5 microseconds; peak power, 125 to 250 kw; pulse repetition frequency, 931 or 186 sec<sup>-1</sup>.

The equipment serves a dual

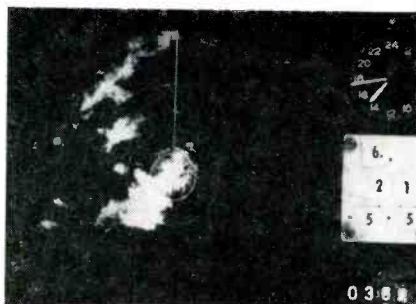


FIG. 2—Photograph of ppi pattern shows thunderstorm echoes

function in that information regarding weather conditions is reported hourly to civil and military interests and research data in photographic form are simultaneously collected, through use of automatic radar scope cameras.

A second important item of equipment is the zenith-pointing radar, which gives a time-height record of heavy cloud and precipitation passing overhead. This radar operates on a wavelength of 1.25 cm, with a peak power of 25 kw and transmits a conical beam 1/2 deg between half-power points. Used in conjunction with this system is an integrating cloud reflectivity contour mapper developed for the Air Force Cambridge Research Center by Polytechnic Research and Development Co.

This device automatically plots discrete contours of constant reflectivity throughout a cloud as it passes overhead, thus presenting a map of the internal structure of the cloud on time-height coordinates. The system depends upon the storage of echoes from 50 consecutive sweeps and counting the number of times the echoes in each range increment exceed a preset threshold.

If the count corresponds to one of four preset values, as determined by the probability distribution of echo amplitudes, a pulse is passed to the recorder. In this way, the reflectivity contours depend only upon the average echo intensity rather than the instantaneous value.

Maximum utility of the radar data is realized when they are used in conjunction with other types of weather information. The location of Blue Hill Observatory in the midst of an elaborate network of weather stations and the regular observations taken at the Hill are very advantageous in providing material for necessary corollary work.

The Blue Hill Observatory is directed by Charles F. Brooks. The weather radar unit is under the direction of David Atlas and the regular Air Force personnel are commanded by Lt. Herman Lintner.

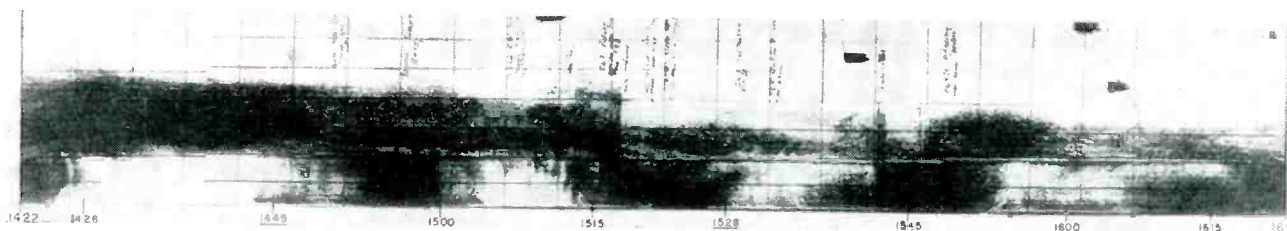


FIG. 3—Portion of time-altitude record of clouds and precipitation passing through the beam of a zenith-pointing 1.25-cm radar. Horizontal lines equal 4,000-foot intervals. Bright band typical of light rainfall shows just under 8,000 feet after 1450. This marks transition from rain to snow. Echoes above 8,000 feet result from ice crystals since water clouds above 10,000 feet cannot be detected

## Transistor Hearing Aid

REDUCTION in the size and weight of hearing aids, but at reasonable cost, has led to development of a four-transistor device sold for \$50 and having a battery cost of 15¢ a month.

In the engineering approach, consideration was first given to the relative cost of four transistors in

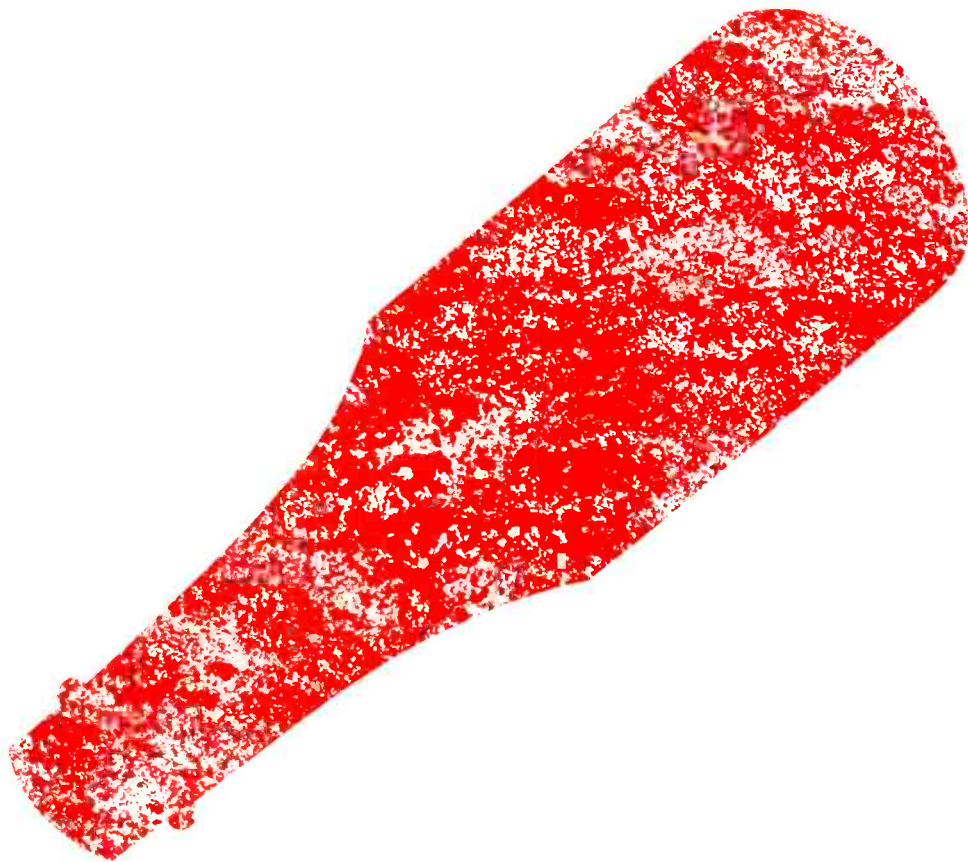
a resistance-capacitance coupled circuit shown in the figure. This thinking permitted replacement of three transistors in a transformer coupled circuit, as used in earlier models.

Capacitors in the extremely small sizes desirable for hearing-aid use have remained expensive. Further-

more, the cost of transistors and coupling circuit components has not been reduced sufficiently to effect a saving by eliminating transformers unless less expensive coupling capacitors can be utilized.

This problem was solved by using somewhat larger capacitors, which are available at a substan-





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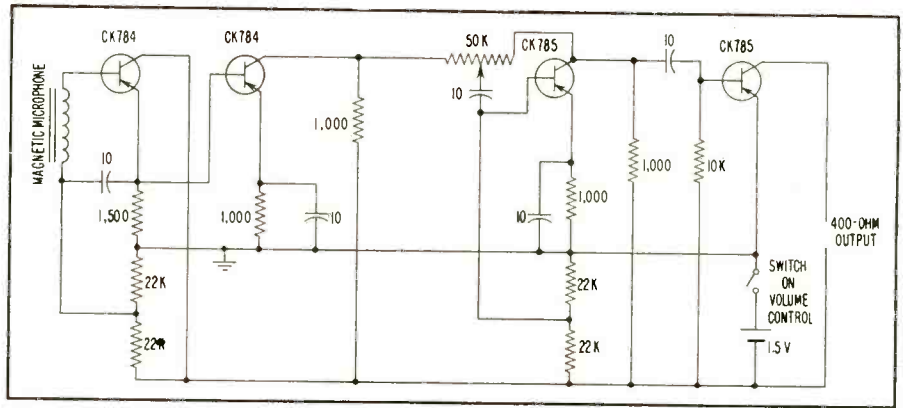
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tially lower price. After removing the transformers, a careful rearrangement of parts to include the less costly capacitors made the transformerless circuit economical.

Elimination of the two transformers also resulted in an 18½ percent weight reduction in an instrument scarcely larger than a conventional cigarette lighter.

The case of the instrument was also considered as a possibility for saving. While it was required to have the durable, noise-free surface established for the Zenith line of hearing aids, the case must effect a saving by being less costly to manufacture and by being less vulnerable to damage in subsequent assembly processes. The problem was solved by changing the customary golden finish to black.



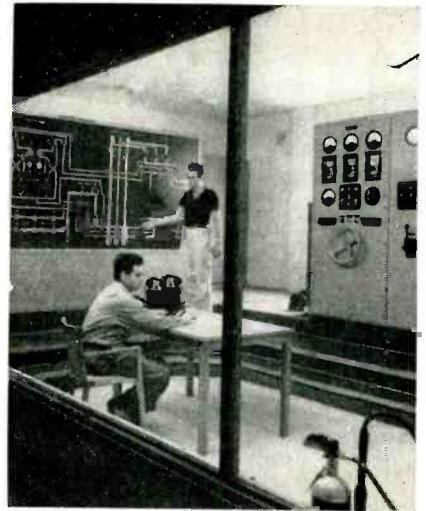
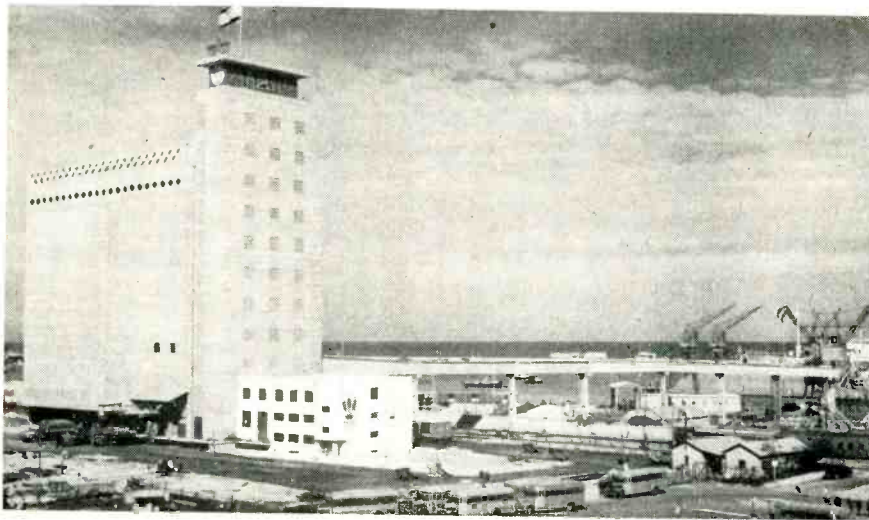
Circuit diagram of the Zenith 50X4 transistor hearing aid

Tone control switch and circuits were also removed from the instrument. Variations in tonal qualities are available to the consumer in the choice of earphone types and other devices such as the plastic inserts

for the earphone that are offered with the aid. Special microphones and power limiting cords are also available.

Information was furnished by J. D. Johnson of Zenith Radio Corp.

## Israel Grain Elevator Control System



Haifa grain elevator is the first in Israel to be electronically controlled. The structure shown (left) is the tallest building in the country, reaching 180 feet in height. Pneumatic equipment (control room at right) for rapid discharge of grain ships has a capacity of 200 tons an hour. One shift engineer controls 44 distribution points. Equipment was designed by Maschinenfabrik Oerlikon in conjunction with Buhler Bros. Co. of Switzerland.

## Tube Drives Transistor Output Stage

BROADCAST receivers for use in pleasure automobiles are undergoing design changes resulting from availability of new techniques. Standardization on 12-volt battery supply instead of the present 6-volt system provides a possibility for eliminating vibrator B supplies.

Transistors, although technically feasible, are not yet inexpensive enough to free receiver circuitry of tubes. However, initial limited use will undoubtedly tend to grow.

One car receiver makes interesting use of a transistor power amplifier driven by a tube, as shown. The preceding tubes, including

r-f amplifier (12AC6), converter (12AD6), i-f amplifier (12AC6) and detector-avc-audio (12F8) are likewise operated at a nominal 14 volts.

These tubes are essentially modifications of existing types that bear different numbers. The 12K5 is a new design. The tubes have been



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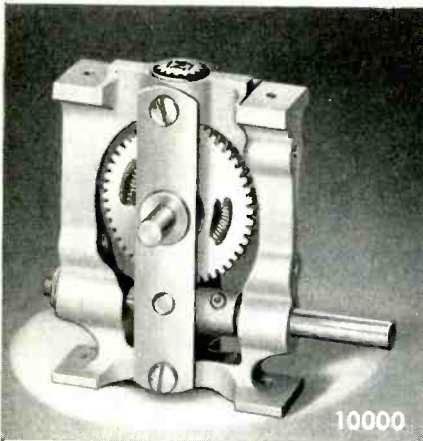


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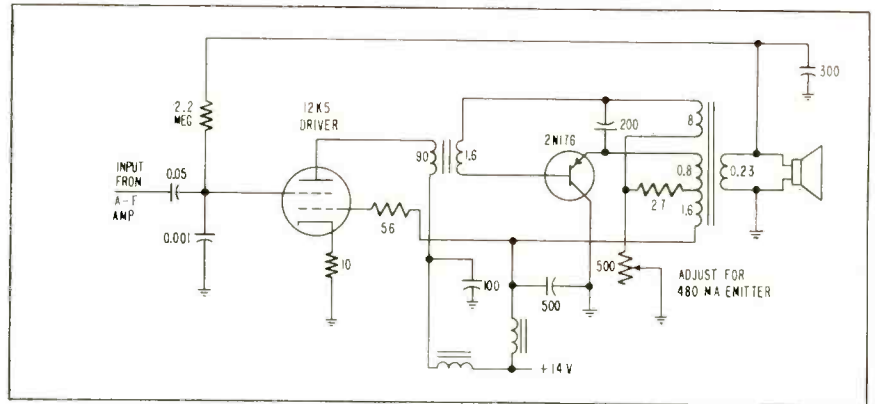


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Final audio stages of automatic-tuning auto radio. Power transistor is driven by space-charge grid tube with nominal 14-volt plate potential

developed for a hybrid receiver that eliminates the vibrator power supply. Such use of tubes is not new. The literature in the 1920's and '30's has many references to low-voltage operation of tubes.

Operation of the 12K5 is based upon the space-charge grid principle wherein the first or inner grid is connected directly to the positive plate supply. The second grid is then the control grid and the tube effectively operates as a triode.

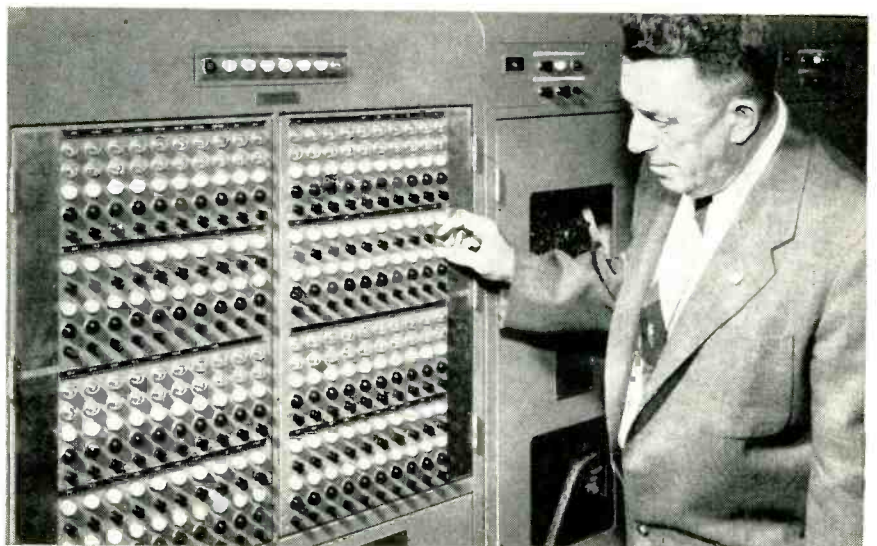
► **Large Cathode** — The combination of cathode and first grid provides an extensive virtual cathode necessary for high transconductance, resulting in as much as 50 mw driver power for the transistor.

While the basic theory of space-charge grid tubes is not new, it has recently been found entirely practical to increase transconductance as high as 15,000 micromhos and obtain even greater power sensitivity.

Typical operating conditions for the 12K5 tetrode as single-tube class A<sub>1</sub> amplifier with the grid 1 and grid 2 potentials respectively 12.6 and -2 volts show plate current to be 8 ma and space-charge grid current 85 ma. Plate resistance is 800 ohms, amplification factor 5.6 and transconductance 7,000 micromhos.

Much of the information above has been furnished by Tung-Sol Electric, Inc., of Bloomfield, N. J.

**Automatic Transcontinental Teleprinter**

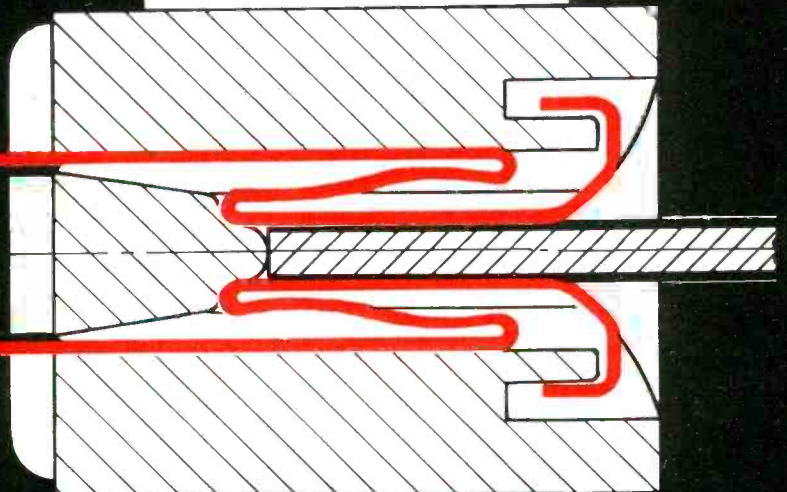
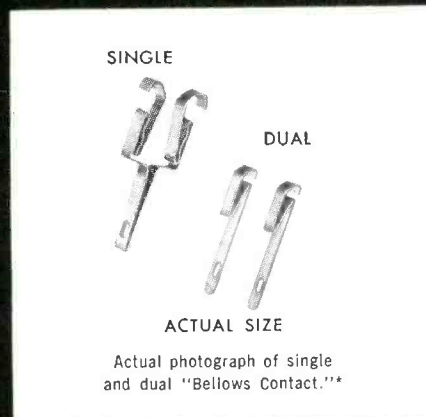


Private-wire system of E. F. Hutton brokerage firm uses 19,000 miles of Western Union circuits to link 21 West Coast, Arizona, New Mexico and West Texas offices with those in New York and Chicago. Electronic control panel at Los Angeles shows operating condition of coast-to-coast system at a glance. Routing and service codes sent with address automatically determine destinations

(Continued on page 182)



**"Bellows  
Action"**\*  
gives you  
100%  
printed  
circuit  
board  
contact



**"Bellows Action Contact" cross-section shows printed circuit board inserted in contact.**

## Continental Connector "Bellows Action Contact"\*

"Bellows" spring action grip clasps board firmly over 100% of printed circuit contact area. Gold-plated phosphor bronze spring retains tension, adjusts to oversized or undersized board while maintaining low contact resistance—less than 20 millivolts at 5 amps! On  $\frac{1}{8}$ " board, for example, "Bellows Action" Contact grips  $.115$ " board as well as  $.135$ " board.

\*Patent Pending

Printed Circuit connectors are available for  $\frac{1}{8}$ ",  $\frac{3}{32}$ " and  $\frac{1}{16}$ " boards... various molding compounds... 3 wiring styles... and 6 to 28 contacts.

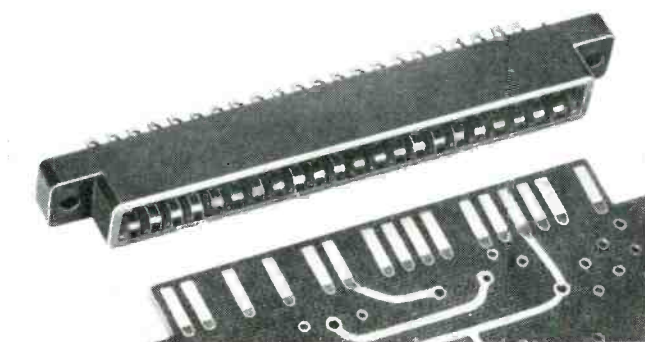
Photo shows typical Continental Connector receptacles utilizing "Bellows Action Contacts." CONTACTS: 6, 10, 15, 18, 22, 28 contacts in single or double rows. WIRING STYLES: eyelet lug for soldering, wire wrap lugs, or 90° angle dip soldering direct to board. MOLDINGS: Mineral-filled Melamine and Plaskon reinforced (glass) Alkyd 440A. Other molding compounds on request.

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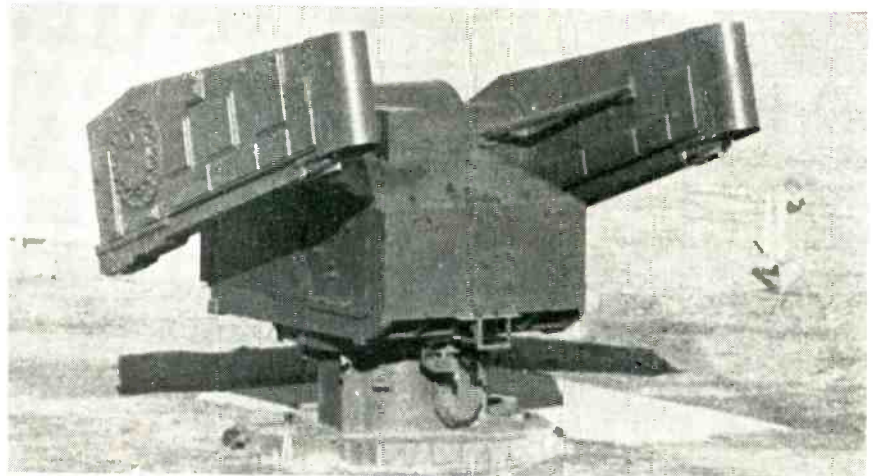
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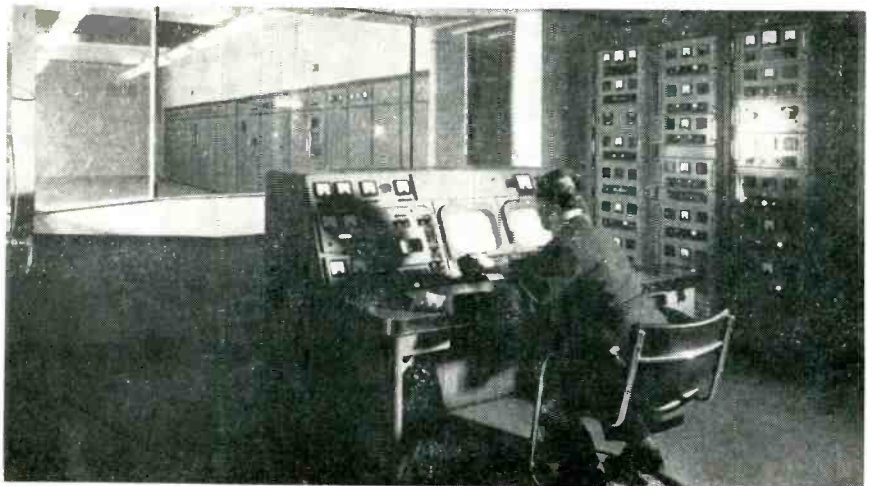
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## Navy Missile Launcher



Shown in partially elevated position, this missile launcher is one of a type designed by W. L. Maxson Corp. for Navy's Bureau of Ordnance

## London's New Television Transmitter



Superseding the famous Alexandra Palace tv transmitter that went into service 20 years ago, the new Crystal Palace station of the BBC was recently put on the air. One bay of transmitters is visible through the window of the control room. Marconi equipment installed includes two 15-kw picture transmitters and two 4.5-kw sound units

## Industrial X-ray Shows In Daylight

PRESENTATION of x-ray images 10,000 times brighter than fluoroscopic images is possible with GE's TVX system. The image can also be magnified in size many-fold, limited only by the size of the tv viewing tube, thus further enhancing inspection for quality control.

The x-ray beam passes through the object under examination and strikes a photoconductive layer of

lead-oxide on the inside of a special tv pick-up tube. A 250-volt electron beam reads the latent image on the lead-oxide layer by scanning it. The electronically amplified image is presented on a kinescope viewing tube.

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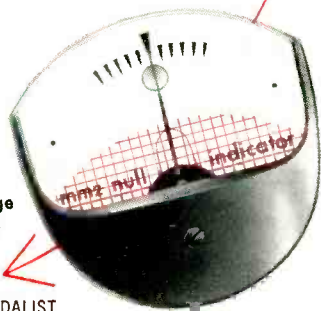


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Display like that of home television screen is used to give brighter picture and protect personnel in industrial x-ray inspection

to inspecting personnel and requiring less protective shielding.

The signal created by the scanning beam can be recorded on magnetic tape and kept for a permanent record or the image may be photographed from the viewing screen.

Industrial use of the system has been tested for a year by a manufacturer of household appliances, who uses it to discern whether the

heating elements he employs contain the proper amount of a critical insulating element. In this application, the voltage required for this fluoroscopic job has been cut from 125,000 to 70,000 volts.

Contrast sensitivity, which is a measure of the visibility of defects, of the new system is roughly comparable with that of conventional fluoroscopy or around 6 to 8 percent. In addition, the contrast of the image can be varied electronically to suit the requirements of the viewer.

The system responds to x-rays generated at voltages as high as 1,000,000 volts, making feasible remote visual inspection of dense products, such as those made of steel. This should prove useful to industries where speed of examination and lower inspection costs are paramount, and it is not essential to make a permanent record on x-ray film.

## Mach Two Wind Control



Control of models in the Southern California Cooperative Wind Tunnel at Pasadena is carried out in this room. At the potentiometer read-out cabinets (left rear) electrical impulses are converted into numbered figures. Data applicable to final design is obtained in a matter of seconds from the adjacent electronic computing center. The tunnel is operated by California Institute of Technology.

## Acoustic Time Regulator

SLOWING DOWN or speeding up the transit of recorded magnetic tape through a reproducer would permit fitting a program exactly into a time interval. However, the resultant lowering or raising of the original audio frequencies would

generally make such a practice undesirable.

A method that permits up to 70-percent time extension and lapsing as much as 150 percent of the recording time without change of the recorded scale has recently been



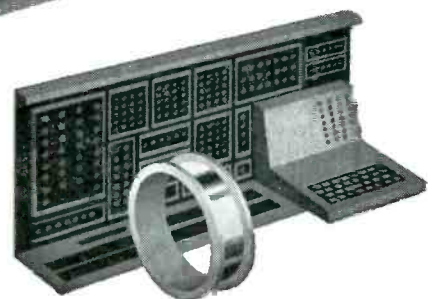
Magnetics, Inc. makes the  
performance-guaranteed  
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Core quality is no longer your worry—it's ours, for we guarantee performance of our tape wound and bobbin cores to mutually agreed upon specifications. What's more, you can specify a host of extra Magnetics, Inc. exclusive features. These include the Aluminum Core Box\*, to withstand the rigors of temperatures to at least 450°F., vacuum impregnation, heavy winding stresses and vibration—and the color-coded bobbin core, for error-free handling in storage and assembly.

Why not write today for your copy of Catalog TWC 100-A? And if you have an application problem, our sales engineers are ready to provide you with expert assistance. *Magnetics, Inc., Dept. E-29, Butler, Pennsylvania.*

\*Patent Pending



Magnetics' bobbin cores, too,  
 are performance-guaranteed!

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CABLE: Magnetics

# REVERE *Permacode*<sup>®</sup> TEFLON-INSULATED WIRE

## *Striped to the core*

PERMACODE is a Teflon-insulated hook-up wire with striping that goes right down to the conductor . . . with colors that won't rub off . . . that heat won't change . . . that are good for the life of the wire. Coding is available in a wide variety of combinations of twin, triple or quadruple stripes selected from fifteen basic solid colors. Insulation quality unaffected by striping process.

Revere PERMACODE — with tough extruded Teflon insulation — offers excellent abrasion resistance and high dielectric characteristics for continuous operation from -90°C to +210°C. Strips clean. Doesn't shrink when soldered. Isn't hurt by the slip of a hot soldering iron.

PERMACODE hook-up wire is available with either solid or stranded silverplated copper conductors. Shielding and jacketing can be furnished. Sizes 28 to 16 gauge in 0.010" wall (600 volt) and 0.015" wall (1,000 volt) thicknesses. Conforms to MIL-W-16878, Types E and EE.

©Revere trade name \*E.I. du Pont trademark

### TYPICAL SPECIFICATIONS — 22 Gauge Permacode Wire

Spark Test Voltage . . . . .	3000 volts
Insulation Resistance . . . . .	Greater than 10 <sup>4</sup> megohm/1000 ft.
Continuous Operating Range . . . . .	-90°C to +210°C†
Flammability . . . . .	Does not support combustion
Operating Voltage . . . . .	600 or 1000 volts
Tensile Strength . . . . .	2000-3000 PSI
Shrinkage . . . . .	Less than 1/8" in 18" at 250°C
Abrasion (Per MIL-T-5438) . . . . .	Passes 30" of 400 grit, aluminum oxide, 1/2 lb. weight
Water Absorption . . . . .	0.0%
Specific Gravity . . . . .	2.2 average
Chemical and Solvent Resistance . . . . .	Excellent

†Wire passes 96 hour, 250°C heat ageing test as required by MIL-W-16878.

Write today for Engineering Bulletin No. 1901 describing Revere PERMACODE wires.



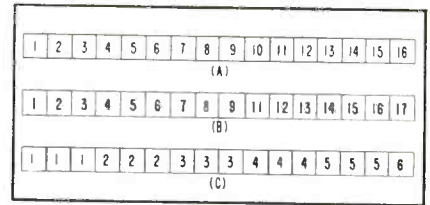
# Revere CORPORATION OF AMERICA

17

WALLINGFORD, CONNECTICUT A Subsidiary of Neptune Meter Company

reported by *McGraw-Hill World News*. The technique, which may be applied to tape dictating machines, has been developed by A. M. Springer.

Two fundamental rules have been



Pickup can be varied from normal intervals (A) or shortening by 10 percent (B) to lengthening by 200 percent (C)

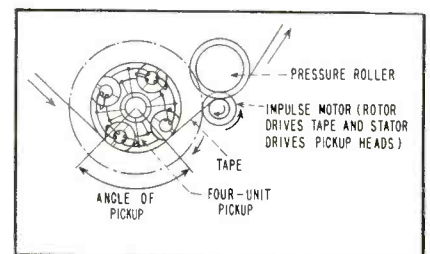
followed. Relative speed between either recording head or pickup head and the sound track must be maintained equal during recording



Acoustic time regulator manufactured by Telefonbau and Normalzeit attached to magnetic tape recorder

and reproduction. Reproduction must be continuous, without interspacing or overlapping.

The device accomplishes its pur-



Simplified representation of means for keeping relative speed constant between pickup head and tape

pose by using four pickup heads mounted on a rotating drum. As the tape is speeded or slowed relative to its recording speed, the speed of the pickup heads is varied in such a way that relative speed of tape and heads is maintained constant. The mechanism, which depends upon a special impulse mo-



# THE *New* CHAMPION

# 350



Not just another low-frequency cathode-ray oscillograph but a decidedly grown up instrument combining the best features of the laboratory standards by Du Mont which have gone before it. All these features and more:

- Exceptional stability—all voltages regulated
- No drift—less than 10 mv in 8 hrs. including 10% line voltage changes
- Identical X- and Y-amplifiers
- Amplitude calibration on both axes
- Accurate X-Y plotting at frequencies from d.c. to 150 kc.
- Ideal for precise phase shift measurements—less than 1° relative phase shift below 150 kc.
- Superior sweep linearity with hard-tube circuit
- Automatic beam brightening on sweeps
- Automatic beam brightening for transient plots
- High brightness—3KV acceleration
- Provision for very slow sweep rates

## CONDENSED SPECIFICATIONS :

**VERTICAL DEFLECTION:** *sinusoidal response, flat to d.c., down not more than 30% at 150 kc; deflection factor, 20 p-p mv/inch.*

**HORIZONTAL DEFLECTION:** *identical to vertical axis except deflection factor, 25 p-p mv/inch (due to higher deflection factor of horizontal deflection plates).*

**SWEEPS:** *mode, driven or recurrent; frequency, 2 cps to 30kc; beam gate, automatic during forward sweep.*

**AMPLITUDE MEASUREMENT:** *(both X and Y axes) range, 0.1, 1, 10 and 100 volts full scale; accuracy, ±5%.*

**PHASE SHIFT:** *amplitude controls at max., less than 1° below 150 kc.*

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ACETRIM\*

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up to 250K,  $\pm 3\%$  linearity

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## Condensed Engineering Data

	ACEPOT (potentiometer)	ACETRIM (trimmer)
Resistance Range	200 $\sim$ to 250K $\pm 2\%$	10 $\sim$ to 150K $\pm 3\%$
Linearity	$\pm 3\%$	$\pm 3\%$
Resolution	extremely high	excellent
Ambient Temperature	$-55^{\circ}$ C to $125^{\circ}$ C*	$-55^{\circ}$ C to $125^{\circ}$ C
Torque	low or high	low or high

The above specifications are standard — other values on special order.

Available in threaded bushing, servo, flush tapped hole or flange mounting, and ganged units. All units sealed, moistureproofed, and anti-fungus treated. Meet applicable portions of JAN specs and MIL-E-5272A standards.

\*New X-500 ACEPOT operates to a new high of  $150^{\circ}$  C.

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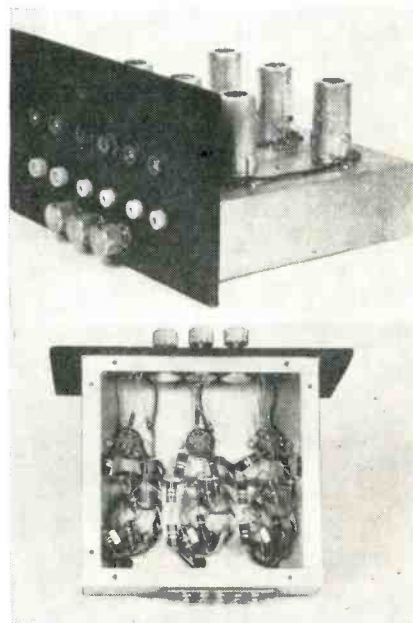
tor with moving rotor and stator, is shown in the drawing.

► **Compensation** — Time extension is obtained by repeated scanning of certain lengths of the sound track during reproduction. Time lapsing is obtained by omitting certain sound-track lengths and by joining the rest as shown in the illustration.

## Low-Cost Amplifier for Analog Computers

By WILLIAM E. WATERS, JR.

Project Engineer  
Tube Research Section  
Diamond Ordnance Fuze Laboratories  
Washington, D. C.



Three-unit summing amplifier chassis suitable for solving three simultaneous linear differential equations of second or third order. Underchassis view shows simple construction of the amplifier

ANALOG COMPUTER function amplifiers currently available, though capable of accuracies between 0.1 and 0.01 percent, are elaborate, expensive and require considerable power-supply equipment.

There are many research applications for which simpler and less expensive amplifiers of 2 to 5 percent accuracy are satisfactory. Also, in educational programs, where the principle of operation of analog computers is to be demonstrated, high accuracy is not needed.

The circuit of such an amplifier



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# PANELSCOPE

by

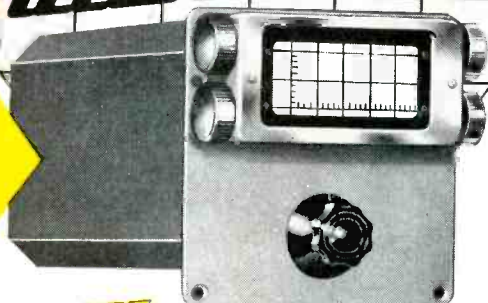
# Waterman

FOR AUTOMATIC  
PORTRAYAL

SIZE:

5-1/4" x 5-3/16" x 10"

5 Pounds



## ANOTHER EXAMPLE OF Waterman PIONEERING...

The Waterman PANELSCOPE is a custom-built cathode ray tube oscilloscope, with simplified operation, and yet available at a low price. The PANELSCOPE concept provides for the following:

- **MINIATURIZATION** — Panel space required is only 5 1/4" x 5-3/16" — depth is 10" and the weight is less than 5 lbs. The PANELSCOPE can be installed in practically any equipment — mobile or stationary air, sea, or land — military or commercial.
- **SIMPLICITY OF OPERATION** — Twist of a single rotary switch provides a synchronized pattern of desired incoming signal (up to 11 circuits) against proper linear time base. This is ideal for monitoring and trouble shooting, as it removes the need of fiddling with knobs as it is done now on general purpose oscilloscopes. The static controls, such as beam, focus, positioning, and graticule brightness are located in tube escutcheon.
- **CUSTOM DESIGN** — A wide variety of — signal amplifiers with response from dc to megacycles and sensitivities from 5 millivolts — synchronized or triggered linear time base generators from 1/2-cycle (and lower if need be) to 2 microseconds — can be specified by you to fit your needs for particular equipment.
- **PARTIAL KIT FORM** — The PANELSCOPE comes fully wired and tested with chosen signal amplifier, linear time base generator and attendant sync. amplifier. The desired signal attenuators, frequency and amplitude determining components, and method of synchronization can be installed either by us or by you.
- **POWER REQUIREMENT** — Less than 10 watts of line power for built-in high voltage supply — The required B+ and heater current as selected by your requirements. For those cases where B+ and heater power is not available, auxiliary power pack can be supplied.

There is a place in your equipment for Waterman PANELSCOPE, a custom built oscilloscope at production prices, although your needs may be but one or two. May we have your requirements?

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S-12-C SYSTEMS RAKSCOPE\*  
S-14-A HIGH GAIN POKETSCOPE\*  
S-14-B WIDE BAND POKETSCOPE\*  
S-14-C COMPUTER POKETSCOPE\*  
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# WATERMAN PRODUCTS

is shown in Fig. 1A. This unit requires only two regulated d-c supply voltages, all resistors are 10-percent tolerance, carbon composition and only one composition potentiometer is used for d-c balance. The photograph shows the construction of a three-unit chassis, a sufficient number to generate solutions of certain linear differential equations of the first or second degree.

The basic summing amplifier circuit is shown in Fig. 1B. The operational equation is

$$E_o = \frac{AR_f}{(1-A) + R_f} \sum_{n=1}^N \frac{1}{R_n} \sum_{n=1}^N \frac{E_n}{R_n} \quad (1)$$

If  $A$  is very large and negative, Eq. 1 may be approximated by

$$E_o = - \sum_{n=1}^N E_n R_f / R_n \\ = - \frac{R_f}{R_1} E_1 - \frac{R_f}{R_2} E_2 \\ + \dots - \frac{R_f}{R_N} E_N \quad (2)$$

Thus  $E_o$  is the instantaneous sum of the various input voltages, each multiplied by the negative real coefficient  $-\frac{R_f}{R_n}$ . The approximate

relation becomes more accurate as the gain is increased. For this reason it is desirable to make the gain as large as practical.

Large gain will also ensure very small interaction among the various input voltages, as well as good accuracy of waveform when using the amplifier in an integrator circuit. The unit shown in Fig. 1A has a gain of approximately 2,000.

The important features of the

Table I—Characteristics of Analog Computer Amplifier

Overall gain	About 2,000
Useful output	±50 v into load of 20,000 ohms
Input grid current	Less than 0.02 μa
Number of tubes	Two twin triodes
Error when used as unity-gain adder	About 1/2%
Ability to hold when used as integrator with time constant of one second	Drifts less than 0.01%/second
Frequency response	Essentially flat to 200 cps



## Ship fast

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UNITED DC-6As offer the cargo protection and dependability of the only radar-equipped cargo flights!

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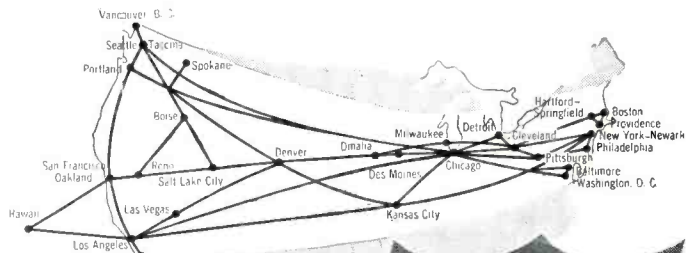
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# BALLANTINE Model 300

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ELECTRONIC VOLTMETERS

Featuring a Logarithmic  
Voltage Scale and  
Uniform Decibel Scale



PRICE \$210.

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 FREQUENCY RANGE . . . . . 10 cps to 150 kc  
 ACCURACY . . . . . 2% ENTIRE RANGE  
 INPUT IMPEDANCE . . . . . ½ meg shunted by 30 uuf

- Stability insured by the exclusive use of wire-wound resistors in the attenuator and feedback network.
- Same accuracy of reading at ALL points on the logarithmic voltage scale and linear decibel scale.
- Only ONE voltage scale to read with decade range switching.
- No "turn-over" discrepancy on unsymmetrical waves.
- Accessories available to extend the range to 20  $\mu$ v and to 42,500 volts.
- Available Precision Shunt Resistors convert voltmeter to microammeter covering range from 1 microampere to 10 amperes.
- Provides 70 DB amplifier flat within 1 DB from 10 cps to 150 kc.

For further information on this and other Ballantine instruments  
write for our new catalog.

**BALLANTINE LABORATORIES, INC.**



100 FANNY ROAD, BOONTON, NEW JERSEY

individual amplifiers are listed in Table I.

The filament voltage should be regulated by the use of a constant-voltage transformer. When using the amplifier as a summing amplifier the gain should be limited to 20, and the maximum resistance connected in series with the input grid should be limited to 1 megohm. It was not found necessary to select either tubes or resistors; improved performance might be obtained, however, if the components are selected. The d-c supply voltages should be adjustable over a range of about  $\pm 5$  percent.

Provision should be made for rebalancing every half-hour or so and two hours at a reasonably constant ambient temperature should be allowed for warm up.

The three amplifiers illustrated contain about \$25 worth of parts. A computer consisting of ten such

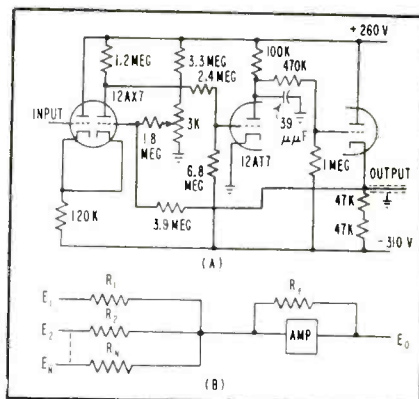


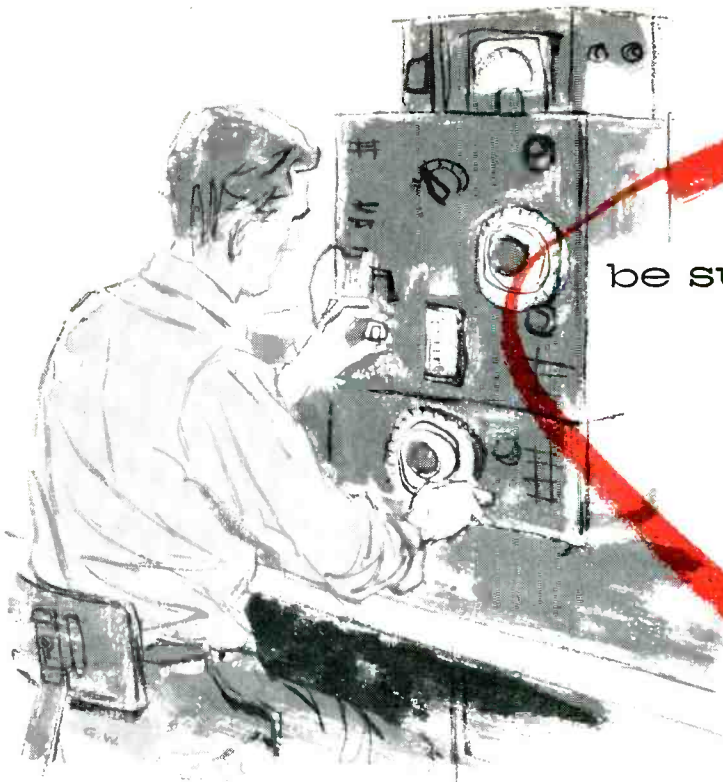
FIG. 1—Computer amplifier (A) gives 2 to 5-percent accuracy using 10-percent tolerance carbon resistors. Basic summing amplifier circuit is shown at (B)

amplifiers, together with control circuits and power supplies, could be built for less than \$250.

Such a computer would permit the solution of many important linear differential equations, with constant or variable coefficients, two simultaneous linear differential equations up to the fifth order, three simultaneous linear equations of the second or third order, certain nonlinear equations (if the non-linearity can be simulated) and the evaluation of many integrals and involved functions.

The absolute accuracy should be about 2 to 5 percent, depending on



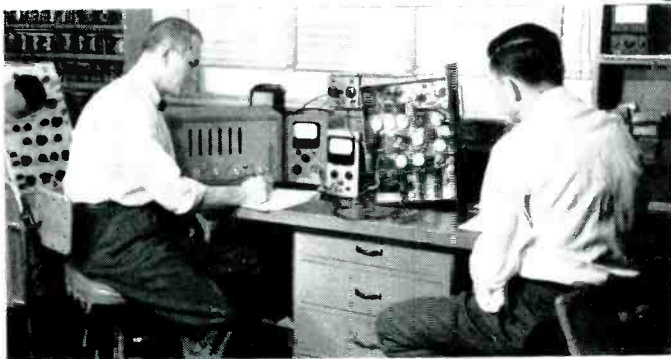


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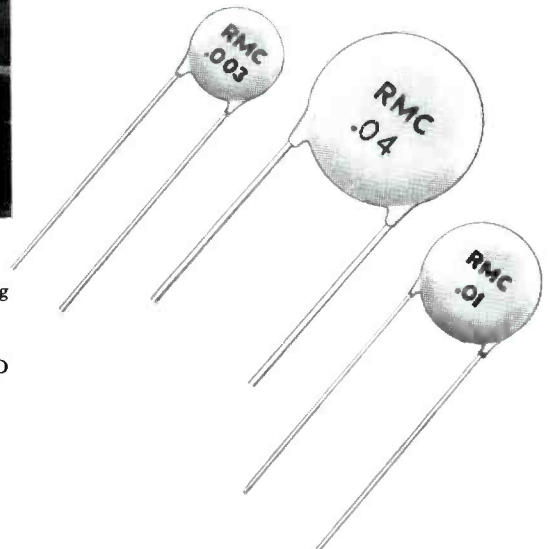


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RMC Type B DISCAPS are designed for by-pass or filtering applications. They meet or exceed the proposed RETMA REC-107-A specifications for type Z5U ceramic capacitors.

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Aerovox Standard-Circuit Modules enable busy design engineers, prototype technicians, experimenters and special-equipment builders to work up breadboard layouts without need of designing, collecting, wiring and testing various components. **Just plug in the Modules**. Individual Modules or complete Kits are available **ONLY** through Aerovox distributors.

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1 DC Regulator, 1 Video Limiter, 1 Low Level Cathode Follower, 1 Dual Cathode Follower or Video Mixer, 1 Intermediate Video Amplifier, 1 Video Driver Amplifier, 1 Multi-Vibrator.

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12-position. XXXP phenolic. Etched copper conductors from each riser position, and with etched copper printed buses around outside perimeter for filament, ground and B plus. Special eyelets at each riser position take banana plugs for jiffy connections.

**Banana Plugs:** 50, to accommodate jumper-cord connections. **Module Catalog, Instruction Manual, Plastic Case.**

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the particular problem, but the repeatability will be much better. Excellent results were obtained using three of the amplifiers to generate sinusoidal, exponential and hyperbolic functions.

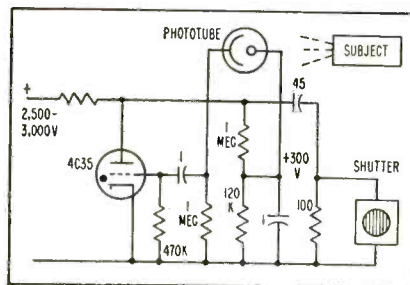
## Electronic Shutter Closes Rapidly

LEAD VAPOR acts as a shutter to prevent multiple exposure when using some rotating-film or mirror-type cameras. Capable of closing in a few microseconds, the shutter is mounted in front of the lens.

The shutter unit comprises 20 turns of 0.005-in. diameter lead wire wrapped around a 2-in. glass slide with copper electrodes attached at each end. Spacers of 0.05-in. Bakelite with 1-in. diameter holes in their centers are set on each side of the slide. Placing  $\frac{3}{8}$ -in. thick 2-in. square slides on the outside and binding with Scotch tape completes the unit.

► **Circuit** — The 45- $\mu$ f capacitor shown in the diagram is charged to 2,750 v. The shutter is operated by triggering the 4C35 thyratron, which discharges the capacitor through the lead wires. The lead evaporates and the vapor condenses on the glass, effectively obscuring the light.

The charging voltage is critical. If it is too low, the wires will only melt. If it is too high, vapor pressure and arcing may shatter the glass. The correct voltage is found

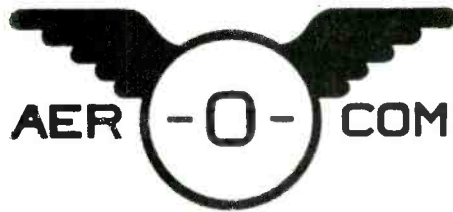


Circuit of the fuse-wire capping shutter

by trial and error for each batch of lead wire. Satisfactory operation is indicated when the wires glow a dim red in the dark.

Blue flashes may occur at the shutter edges, but their intensity





## **DEFINITELY DEPENDABLE!**

# **Aerocom's Dual Automatic Radio Beacon**

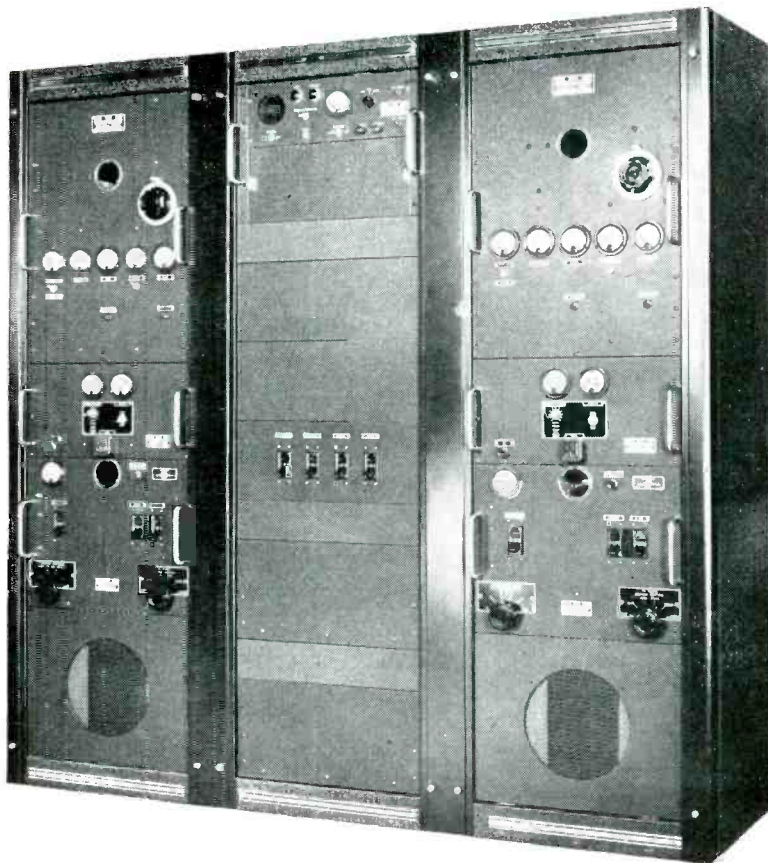
Reliability is built into every part of this dual 1000-watt aerophare unit. Ruggedly constructed and conservatively rated, it provides trouble-free unattended service, and at truly low operating and maintenance cost. It operates in the frequency range 200-415 kcs, using plug-in crystal for desired frequency.

Uses single phase power supply, nominal 220 volts, 50 or 60 cycles. Consists of two 1 kw transmitters with keyer (2 keyers if desired), automatic transfer unit and weatherproof antenna tuner. Each transmitter housed in separate standard rack cabinet, with controls in rack cabinet between the transmitters.

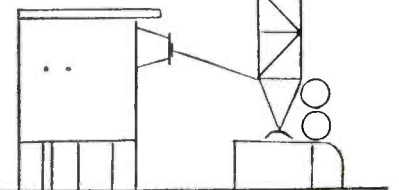
Nominal carrier power is 1000 watts. High level plate modulation of final amplifier is used, giving 30%-35% tone modulation. P-T switch interrupts tone, permitting voice operation. Operates in ambient temperatures from -35°C to 50°C, humidity up to 95%.

Standby transmitter is placed in operation when main transmitter suffers loss (or low level) of carrier power or modulation, or continuous (30 sec.) tone. Audible indication in monitoring receiver tells when standby transmitter is in operation.

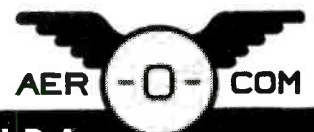
Antenna may be either vertical tower or symmetrical T type.



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will not adversely affect the film. About 30 microseconds after triggering, a density of 3 is reached, which corresponds to a light reduction of 1,000 times.

This information has been abstracted from an article by Edgerton and Strabala that appeared in the March 1956 issue of *Review of Scientific Instruments*.

## Binary Adder Uses Gas-Discharge Triode

By FREDERICK B. MAYNARD

Research Division  
National Union Electric Corp.  
Orange, New Jersey

OF CONSTANT interest as a logic or storage element in computer applications is the neon diode, mainly because of the low power requirements, the natural binary character and storage function inherent in the characteristic.

One of the disadvantages is the difficulty of extracting output signals completely divorced from the effects of input signals. This difficulty is inherent in any two-terminal device.

A gas triode now under development provides an independent electrical output element, and is suitable for compounding in a single matrix designed to do specific arithmetical or logical functions.

The elementary triode cell, shown in Fig. 1, consists of a cathode element of relatively large area, a closely overlaid anode element of fine wire and a probe element lying about half way between the two. In the presence of a sufficiently large voltage difference between the cathode and anode, a discharge takes place, which is limited essentially to a cathode glow.

The probe element is immersed in the top part of this glow and has the property of selectively collecting slower moving positive ions from the discharge and hence tends to charge strongly positive.

Experimental studies have shown that 10 to 20 percent of the current in the main discharge can be extracted from this probe. With a biased load resistor, the voltage excursion of the probe can be as high as thirty volts positive, with-



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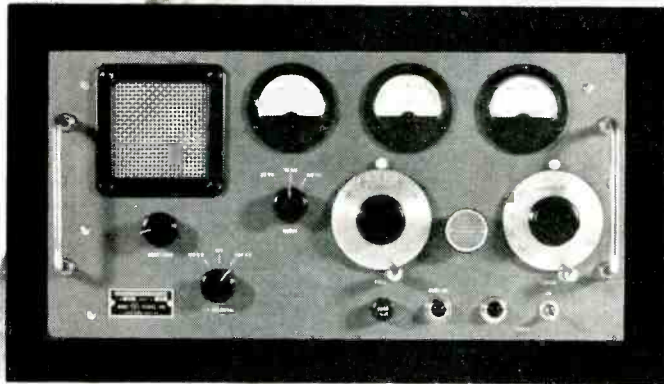
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The Type 1400 is the first receiver designed specifically for telemetry applications to employ crystal control, extremely high adjacent-channel attenuation, and two separate IF channels. One channel is specifically designed for FM/FM telemetry, the other for PWM/FM systems. From the standpoint of selectivity, noise figure, distortion and stability it represents an outstanding advance. The specifications were written with the cooperation of the engineering staffs of the important missile test facilities of all the military services.

### SPECIFICATIONS

Frequency Range	216-245 Megacycles determined by plug in crystals.
Input Impedance	50 ohms nominal.
Noise Figure	Less than 7 db.
Tuning	Tunable over a frequency range $\pm 150$ KC's.
IF Bandwidth	Wide band—500 KC bandwidth at 3 db points. Attenuation $\pm 500$ KC from center frequency greater than 60 db. Narrow band—100 KC bandwidth at 3 db points. Attenuation $\pm 250$ KC from center frequency greater than 60 db.
Signal to Noise Ratio	500 KC Passband. S/N ratio is 40 db for 2 uv of input carrier when carrier is modulated $\pm 100$ KC at a 1000 CPS rate. 100 KC Passband. S/N ratio is 40 db for 1.5 uv of input carrier when carrier is modulated $\pm 50$ KC at a 1000 CPS rate. The above S/N ratios are measured with a 2500 CPS RC lowpass filter at the receiving video output.
Panadaptor Output Frequency	Provision for connecting into a 30 MC panadaptor.
Deviation Meter	Peak reading over frequency range from 400 to 80,000 CPS. Three scales 25, 75 and 150 KC.
External Field Strength Mefer	Output 10 milliamperes into 500 ohm load.
Size	8 $\frac{3}{4}$ " x 19" x 15 $\frac{3}{4}$ "
Weight	Approximately 40 lbs.
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out any tendency of the probe element either to become an active cathode or anode in the discharge itself, nor to cause the initiation of any discharges in other matrix cells sharing the same probe.

This makes possible the development of matrices with output elements arranged in almost any manner with respect to input combinations and opens the way for the development of complex switching structures providing a variety of specific switching functions.

An example of one of the simpler matrix structures is the binary adder shown in Fig. 2. The tube contains a four-cell matrix, with a common probe through two diagonal cells, and a second probe in one corner cell. The fourth cell has no probe since no output from this position is required in the binary addition logic.

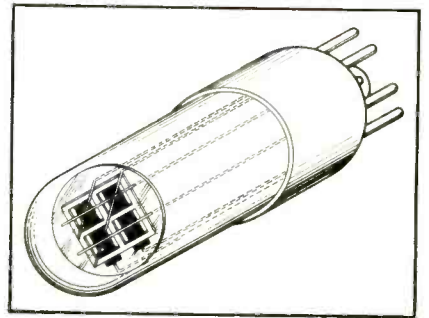


FIG. 1—Binary half-adder uses four gas-discharge cells in one envelope

The addend and augend inputs, can be any kind of element, as a flip-flop or relay, which has the characteristics of a spdt switch. However, since switch *A* operates between anodes and *B* between cathodes, the two switch center terminals must be at opposite polarities of a voltage supply.

At all times, with the exception of the short switching intervals, there is a discharge in one or another of the cells and its position depends uniquely on the precise switch position at that instant. When no signals are applied, the discharge is in the lower right hand corner and no output is obtained.

A signal on *A* transfers the glow to the upper right, and one on *B* to the lower left cell. The signal on the diagonal probe developed in either case represents a sum output as it should according to the binary



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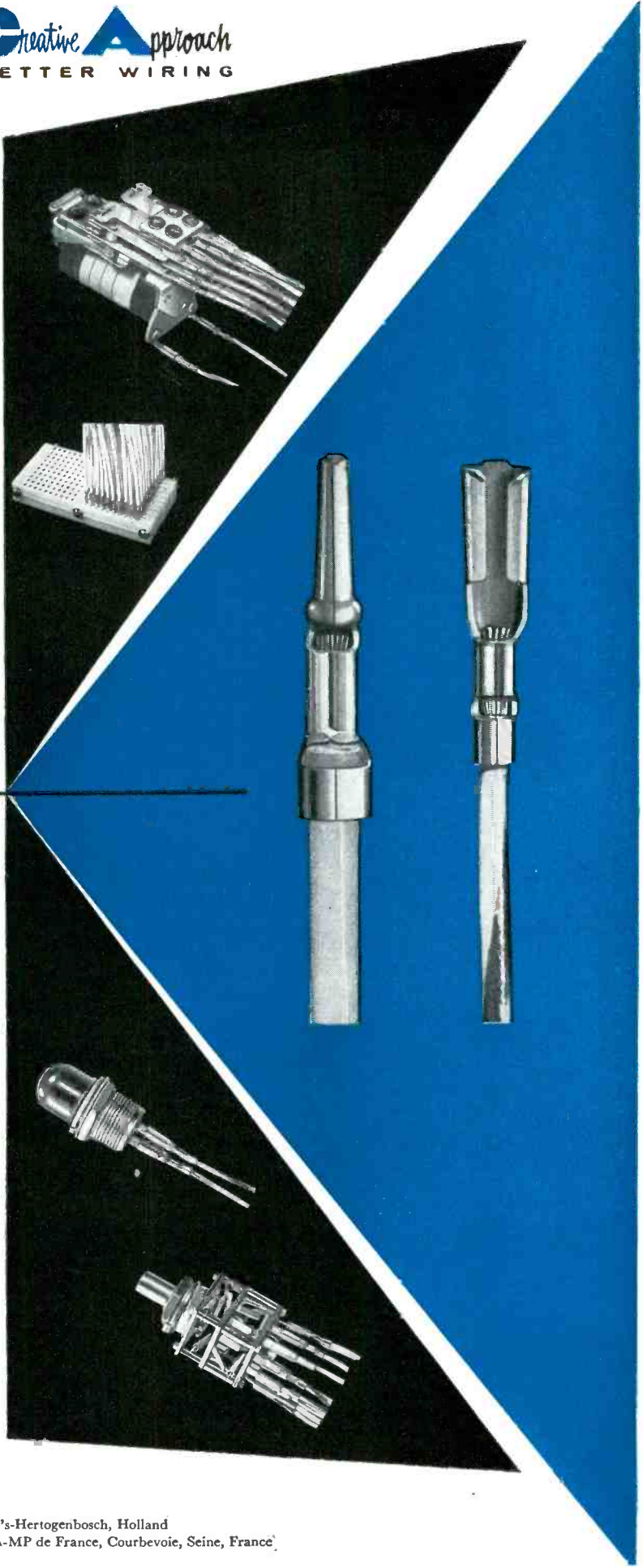
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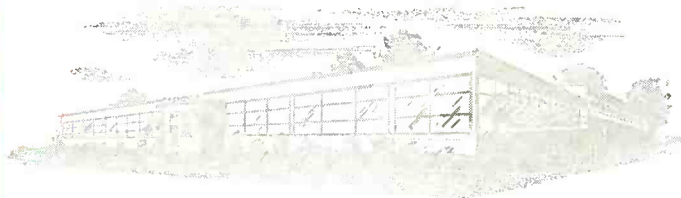
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Today, Calidyne looks forward to new and even wider applications for its products. Calidyne is growing more and more. You are invited to grow with us. Opportunities now exist at Calidyne for capable, congenial engineers in electronics, mechanical design and sales. Technicians and production people are also wanted. If you are interested in this specialized, creatively challenging work, along with the social, civic and educational benefits of good suburban living in Winchester, get in touch with us. Address D. R. Simonds, The Calidyne Company, 120 Cross Street, Winchester, Mass.



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logic. Signals on both *A* and *B* transfer the discharge to upper left, which has the probe representing a carry out.

Meanwhile, the diagonal probe representing the sum may make a slight excursion of 1 to 2 volts resulting from a few stray ions but this small signal is easily eliminated and causes no spurious outputs.

The sum and carry outputs cannot be used directly to drive similar tubes. However, this signal is an ideal drive for a vacuum-tube grid and may be used as such in the manner shown in Fig. 2. Here the load resistor for the probe is also the input grid resistor and the probe and tube grid are both held at the correct bias potentials by the arrangement shown.

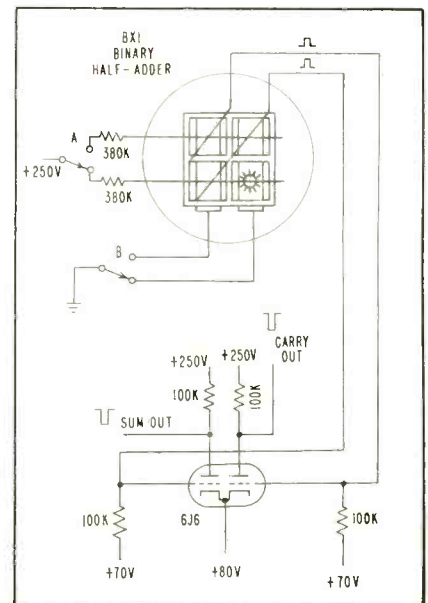


FIG. 2—Probes in gas-tube cathode glow pick up signal to drive output tube

The value of this resistor is 100,000 ohms, which yields a positive-going excursion of about 10 volts. With larger resistors this signal can be made as large as 35 or 40 volts. The current in the main discharge in each cell is approximately 400 microamperes in the experimental tubes so far built. This could easily be increased by several fold if there were any advantage to be gained. The normal probe current is about 50 microamperes.

Measurements of the probable speed of this device have not as yet



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Type R50  $\pm 0.002\%$  ( $15^{\circ}$  to  $35^{\circ}\text{C}$ )

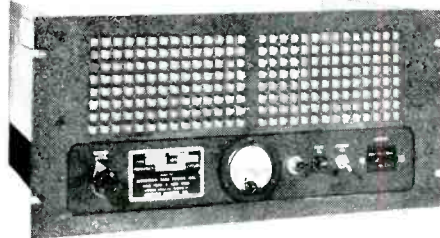
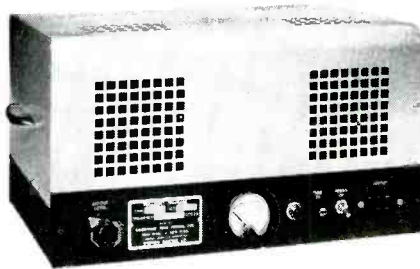
TYPE  
50

Requires double triode and  
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Size, 1" diameter x  $3\frac{3}{4}$ " high  
Weight, 3.5 ounces

## POWER 75 Watt FREQUENCY STANDARD

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INPUT: .....110V, 50 to 75 cycles  
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PANEL model, . 10"x19"x8 $\frac{3}{4}$ " high  
WEIGHT: .....25 pounds

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### FREQUENCY STANDARD

TYPE 50L

### FREQUENCIES

50-60-75 or 100 cy.

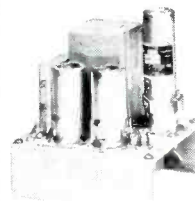
### ACCURACIES

TYPE 50L

$\pm 0.02\%$  ( $-65^{\circ}$  to  $85^{\circ}\text{C}$ )

TYPE R50L

$\pm 0.002\%$  ( $15^{\circ}$  to  $35^{\circ}\text{C}$ )



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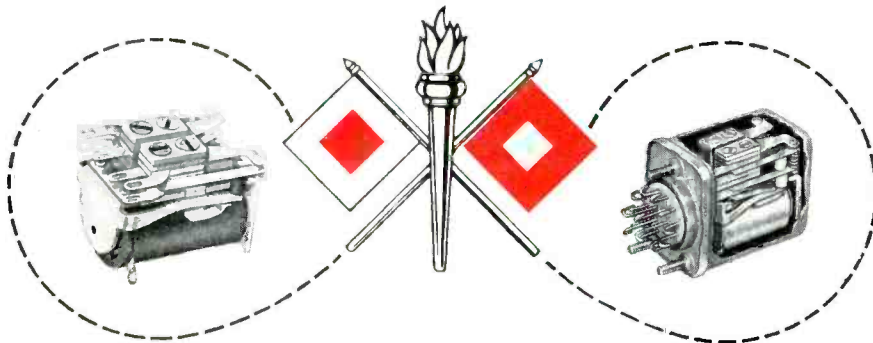
Company \_\_\_\_\_

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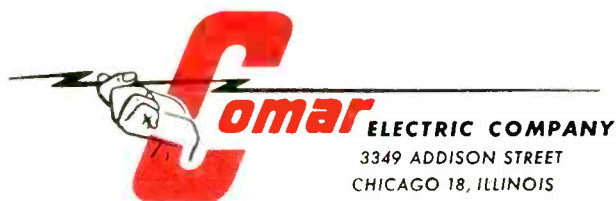
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been made. From indirect measurements, it appears that the probe voltage will reach an equilibrium value within 10 to 20 microseconds of the initiation of the discharge.

The possible effects of deionization time have not yet been fully analyzed. It would appear that even though this time interval may be quite long, in common with other discharge devices, this condition may not seriously limit speed.

If the probe were operated into a sharp cutoff vacuum tube and so biased that the voltage near the top of the excursion completely controls the vacuum tube, the output of the tube would return to zero even though the probe may still have considerable charge from residual ions. In this sense, complete deionization would not be needed before a new signal could be generated. Also, since ionization in one cell does not appreciably affect the characteristics of the adjoining cell, a discharge in a new position can be initiated without interference.

Experimental tubes having as many as thirty cells have been tested. In one of these, any combination of binary 1's and 0's can be impressed across one set of inputs and the probe outputs will give this number rotated or shifted through all possible positions in either direction by scanning the other set of inputs.

Acknowledgement is made of the cooperation of A. W. Kaiser, research engineer, in the inception and experimental work on some of the ideas presented here.

## Fail-Safe Flame Alarm

FAIL-SAFE TECHNIQUES developed by Scully Signal Co. of Boston can be applied to practically all types of electronic, electrical and mechanical systems. A signal representing the safe condition is introduced directly to the monitoring system. The system periodically alters this signal to produce a simulated unsafe condition. The result is a continuous oscillation.

An alarm or protective device is employed, which is normally on and is held off only when an alarm-





# RADIO'S ONE- WAY STREET

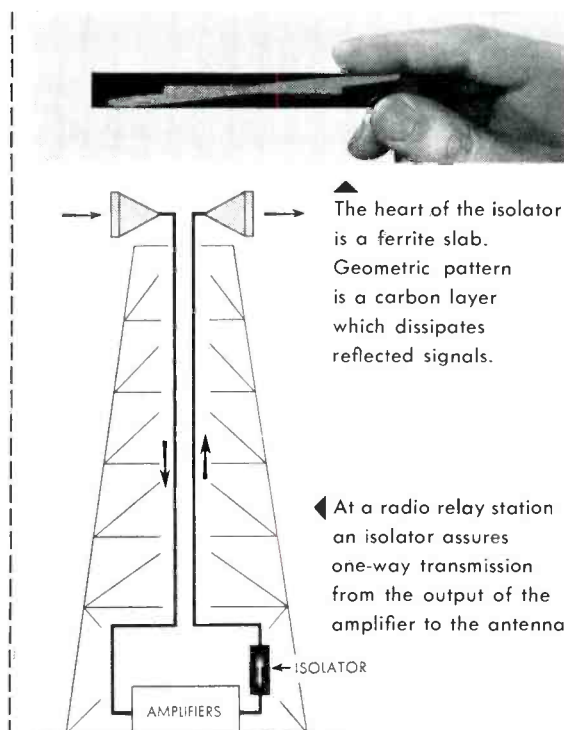
Dr. S. Weisbaum assembles an isolator which he developed for use in a new microwave system. Dr. Weisbaum is a Ph.D. in microwave spectroscopy from New York University. He is one of many young men at Bell Laboratories applying the insight of the physicist to develop new systems of communication.

New radio relay systems for telephone and television now in the making will employ an ingenious device invented by Bell scientists. The device, known as an "isolator," senses which way microwaves are traveling through a waveguide, and stops those going the wrong way.

In the new systems a klystron wave generator sends signals through a waveguide to the antenna. The klystron must be shielded from waves reflected back along the waveguide by the antenna. The isolator stops reflections, yet allows the transmitted signals to go through clear and strong.

This isolator is a slab of ferrite which is mounted inside the waveguide, and is kept magnetized by a permanent magnet strapped to the outside. The magnetized ferrite pushes aside outgoing waves, while unwanted reflected waves are drawn into the ferrite and dissipated. This "field displacement" action results from the interplay between microwaves and a ferrite's spinning electrons. Bell physicists discovered this action during their fundamental studies of ferrites.

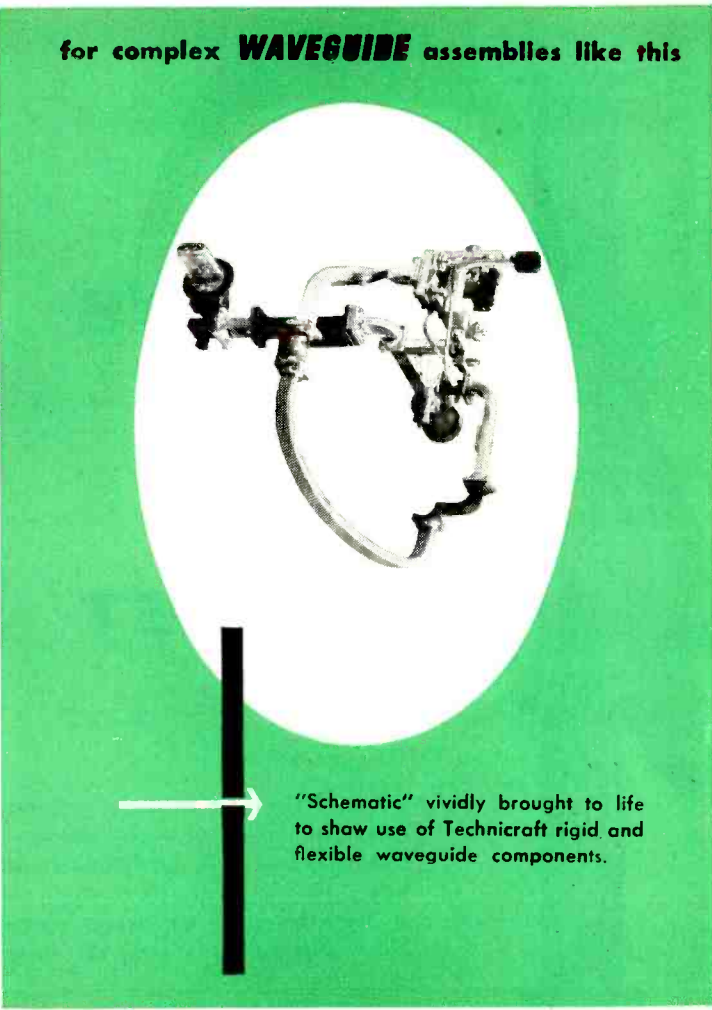
This is another example of how Bell Telephone Laboratories research works to improve American telephony and telecommunications throughout the world.



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suppression circuit receives the oscillating signal. If the normal operating signal fails, a continual nonoscillating unsafe signal will allow the alarm to sound. If the monitoring system fails, the unsafe perturbation will cease and the continual safe signal will actuate the alarm.

A fail-safe flame monitoring system that has been tested extensively is shown in Fig. 1. Here feedback is employed to modulate the flame-probe output. The waveforms shown in Fig. 2 represent basic performance of various fail-safe systems.

The flame-probe system produces a negative d-c signal when the probe is in contact with a flame

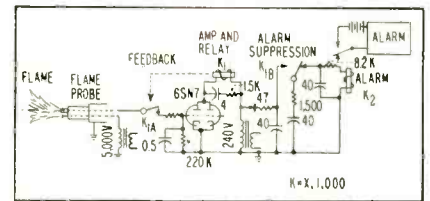


FIG. 1—Circuit of the flame sensing alarm relay

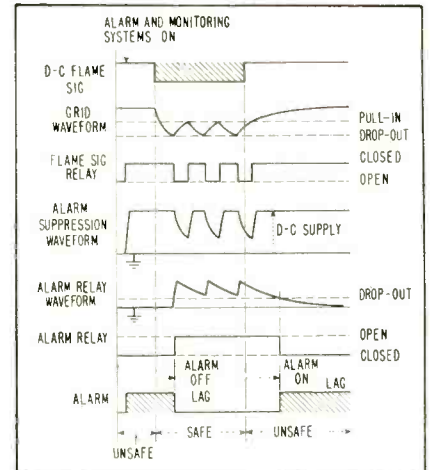


FIG. 2—Waveforms in the alarm and monitoring system

that has been excited with an a-c signal. The feedback-controlled oscillation causes the flame-probe signal to be connected periodically to the amplifier grid to bias the tube off.

Fail-safe protection results since there is no way the flame probe can falsely generate a negative d-c signal. A short circuit to ground could not bias the amplifier off. Short circuiting the a-c supply





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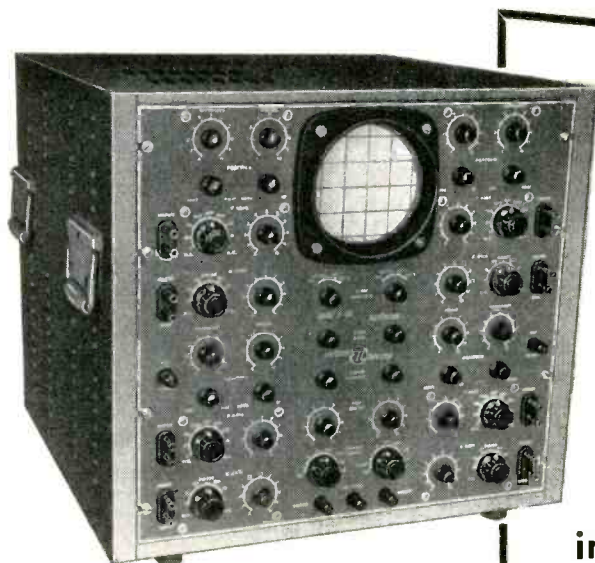
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could not produce a signal to which the shaded-pole d-c relay in the amplifier plate would respond.

The design approach has been applied successfully to fire-detection systems, thermostat controls, intrusion alarms and various photo-cell devices and liquid-level controls.

The frequency of oscillation is determined by the speed with which alarm must be given following failure. The safe-unsafe oscillation period must be slightly shorter than the maximum allowable alarm lag. This in turn determines the discharge time-constant of the capacitor in the alarm relay circuit.

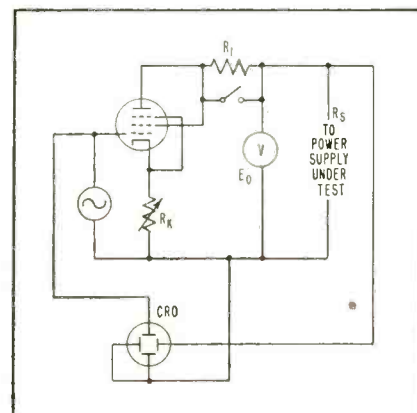
The monitoring of security systems and slow acting processes may only require one oscillation every several minutes. In the surveillance of combustion-control systems and in control of nuclear reactors, an extremely high monitoring frequency may be necessary.

## Simple Circuit Measures Power Supply Impedance

By C. C. STREET

Los Angeles, California

IN TESTING regulated power supplies, gas diodes and other regulat-



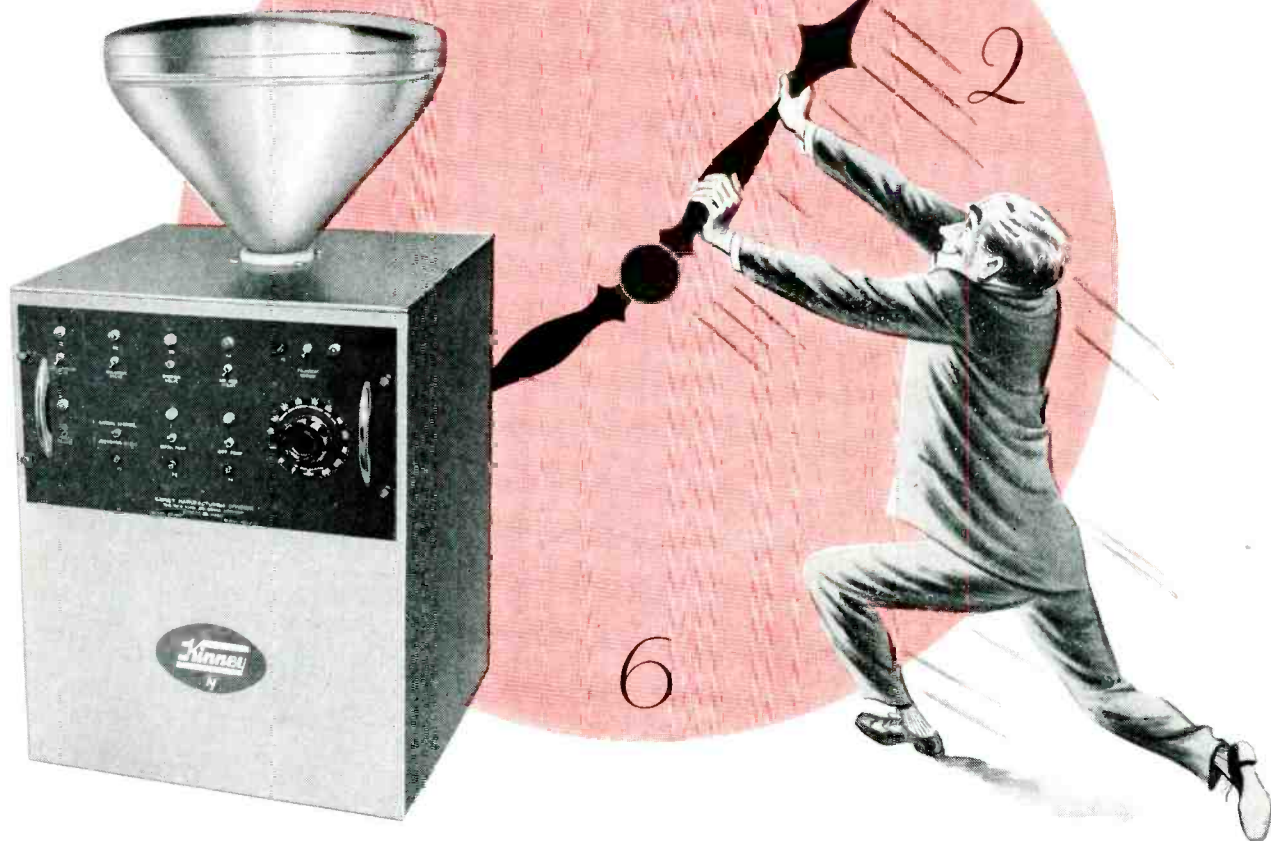
Single-tube circuit gives data for calculating impedance of power supply

ing systems for a source of d-c voltage, a simple test can give a high degree of accuracy in the determination of internal impedance. The basic circuit is shown in the diagram.

The voltmeter used should be a sensitive a-c type or a standard



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8" l. x 5" w. x 5 3/4" h.

Weight:  
4 1/2 lbs.

The PRD Type 219 Standing Wave Detector is the small package, low cost solution for making measurements easily and accurately in the 100 to 1000 mc/s region. By connecting the output to a VSWR indicator, such as the PRD Type 277, VSWR may be read directly on the indicator meter. No special detection equipment is required. The reflection coefficient angle is easily determined merely by rotating the top drum dial to a minimum indication on the meter and reading the angle on the dial *directly in electrical degrees*. No calculations are required. The probe and crystal detector are self-contained.

Usually it is more convenient to work with VSWR and reflection coefficient angle directly instead of with other components of the measured impedance. When other quantities are also of interest, they can easily be read from a conventional impedance chart. Only \$475 f.o.b. N.Y. Write for PRD Reports, Vol. 3, No. 2, and for 1955 catalog.

## Polytechnic RESEARCH

### & DEVELOPMENT CO. INC

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Telephone:  
ULster 2-6800



Midwest Sales Office:  
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Western Sales Office:  
737-41, SUITE 7, NO. SEWARD ST., HOLLYWOOD 38, CAL. — HO 5-5287

broadband meter preceded by an amplifier; the exact gain is not important. Resistor  $R_1$  should be a precision noninductive resistance of a value somewhat near the internal impedance expected in the unit under test. The tube is a pentode having quiescent current capabilities at least as large as the current load under which the power source is to be tested.

The test is carried out by applying a signal to the tube from the audio generator. Voltage  $E_0$  is noted with the switch open and then with the switch closed. Calling these  $e_1$  and  $e_2$ , the internal impedance is

$$R_s = R_1 \frac{e_2}{e_1 - e_2}$$

This arrangement permits a wide latitude of measurement parameters. The quiescent current may be adjusted by  $R_1$ . The magnitude and frequency of the alternating current may be varied by the signal generator. For any one determination the alternating current used is

$$I_s = \frac{e_1}{R_1 + R_s}$$

By connecting an oscilloscope to the circuit as shown any reactive component in the power source may be determined and measured.

## PERTINENT PATENTS

By NORMAN L. CHALFIN  
Hughes Aircraft Co.  
Culver City, Calif.

CHANGES of angular movement in mechanical devices as well as human-body changes resulting from emotional stress are variously detected. Two different devices in the respective fields are described in this month's survey.

### Angle Detector

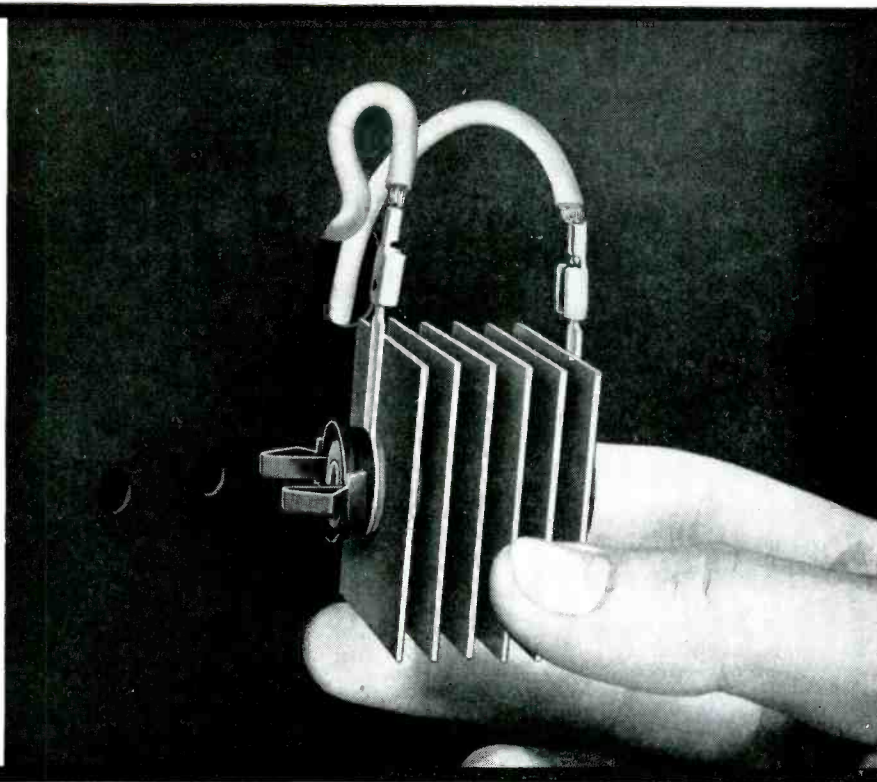
A measuring device for detecting small increments of angular movement is the subject of patent 2,700,758 awarded to G. Smith assignor to Graydon Smith Products Corp., Boston, Mass.

In this invention the measuring device is linearly responsive to angular movement for indication of position on either side of a null point.

A rotatably mounted flux barrier



Radio  
Receptor's  
**NEW**  
money saving  
rectifier  
mounting!



**"QUI-KLIP"** *snap-in type*  
**SELENIUM RECTIFIERS**

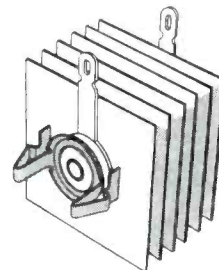
**QUICK MOUNTING! QUICK REMOVAL!**

Spring steel clips with safe edges snap into two round, large tolerance holes in chassis (approx  $\frac{3}{16}$ " dia.,  $\frac{3}{4}$ " c. to c.). Solderless connectors as shown, when used, simplify servicing

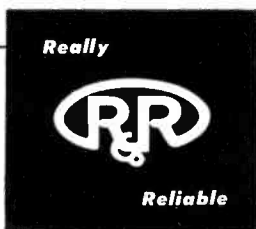
Radio Receptor's unique QUI-KLIP rectifiers will soon make their debut in TV sets produced by one of the country's leading manufacturers, saving them countless dollars in production costs.

QUI-KLIP requires no tools or sockets for mounting. There are no studs to break or threads to strip and the locating tab is now unnecessary. QUI-KLIP provides a positive seat for the rectifier — no rocking. Yet any serviceman can remove the stack quickly by squeezing the QUI-KLIP prongs with his fingers and removing the solderless connectors.

Let us show you how to put the cost saving QUI-KLIP selenium rectifiers to work in *your* production . . . Available in most popular sizes with cells from 1" square to 2" square, for radio, TV and other electronic circuits. For detailed information, write Dept. E-17.



- Speeds assembly time.
- Slashes production costs.
- Simplifies assembly.
- Eliminates stud rejects (No studs or nuts needed.)
- Permits easier replacement in the field.



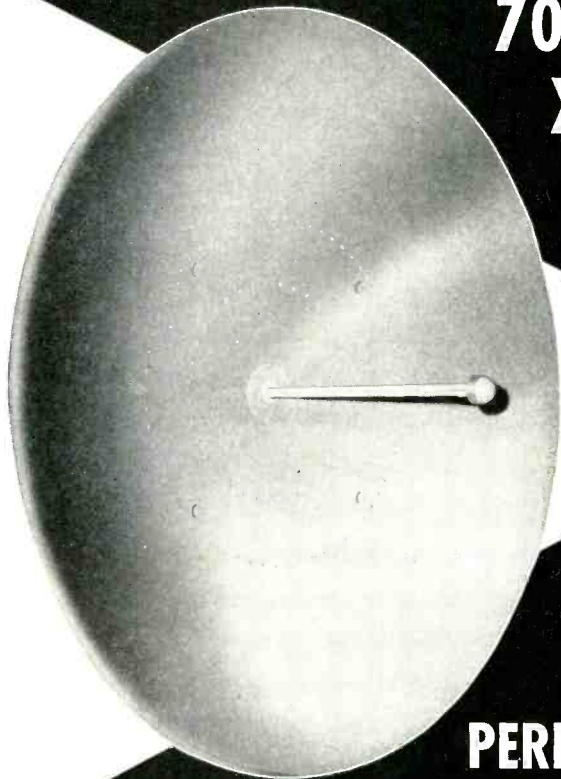
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**GABRIEL ELECTRONICS DIVISION**

THE GABRIEL COMPANY, Needham Heights 94, Massachusetts

device shown in Fig. 1 is attached to a two-window iron transformer core that has a gapped central bridging section and a closed outer section. The flux barrier device when at the exact center of the core gap provides a flux path that is uniform around the two windows.

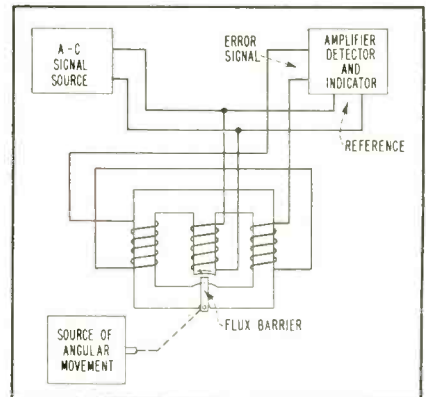
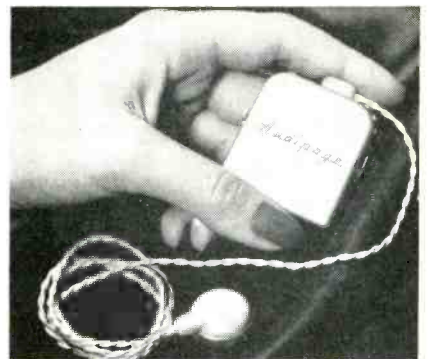


FIG. 1—Two-window transformer with gap and movable bridging section

A winding around the center leg is a primary to which a signal is applied. As the barrier is moved to right or left of center, the flux path through the outer and center legs is greater in one window than another. Windings in the outer legs forming secondaries are connected in series. The resultant error signal output of the series-connected secondaries is applied to a detector, which will indicate displacement in

## Magnetic Paging Receiver



Powered by a mercury battery, the transistor circuits in this magnetic induction receiver pick up audio signals from a wire loop surrounding a room or area. Thirty Audipage units developed by Philco will be used by American Broadcasting Co. at forthcoming presidential conventions. They could also be used to replace public-address systems in hospitals, schools and libraries



**NEW**

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*“Audio-trio”*

**medium power transistors**

**provide 300 mw audio output  
with absolute minimum distortion**

SHOWN  
ACTUAL SIZE

2N223



2N224



2N226



The output transistors 2N226, 2N224  
can be made available in matched pairs.

Regardless of your requirements in medium power audio circuits, Philco "Audio-Trio" PNP transistors provide driver and push-pull performance at maximum power with minimum distortion . . . over a wide range of operating voltages!

Extremely linear DC current amplification up to 100 milliamperes of collector current assures low distortion output at battery supply voltages of 3 to 12 volts in class B push-pull operation.

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**PHILCO PNP GERMANIUM TYPE ALLOY  
JUNCTION TRANSISTOR**

	2N224	2N226	2N223
<b>MAXIMUM RATINGS (absolute values)</b>			
Collector Voltage (v)	-25	-25	-18
Collector Currents (ma)	-150	-150	-60
Collector Dissipation at 45°C (mw) (with heat sink)	100	100	100
Storage Temperature (°C)	-40 to +65	-40 to +65	-40 to +65
<b>TYPICAL OPERATION</b>			
Collector Voltage (v)	-.6	-.6	-4.5
Collector Current (ma)	-100	-100	-2
Large Signal Beta	65	35	
Alpha			.985
Saturation Voltage (v)	-.25	-.25	
Base Input Voltage (v)	-.30	-.35	
Output Impedance (megohms)			1

For Complete Technical information write Dept. E-4.

**LANSDALE TUBE COMPANY, A Division of Philco Corporation, Lansdale, Penna.**

**PHILCO CORPORATION**

**LANSDALE TUBE COMPANY DIVISION**

**LANSDALE, PENNSYLVANIA**

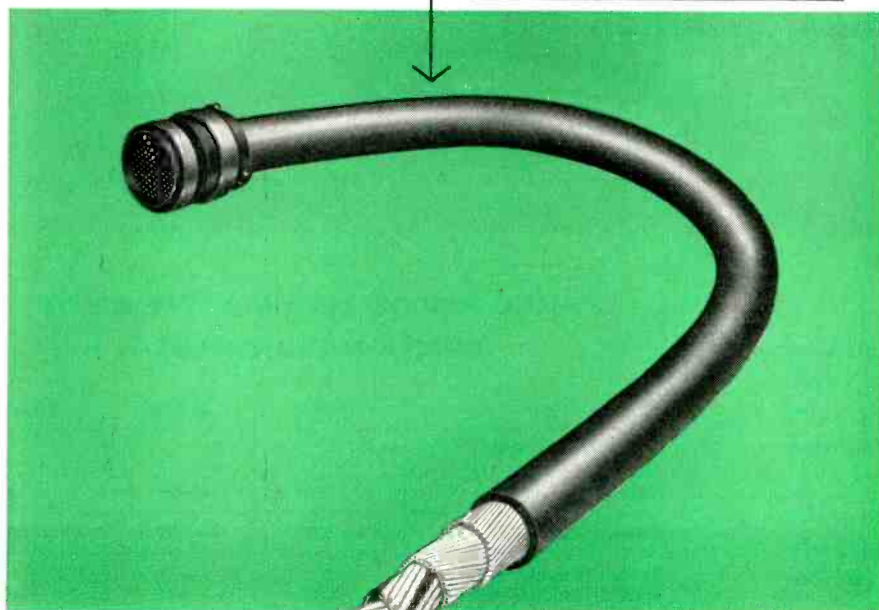
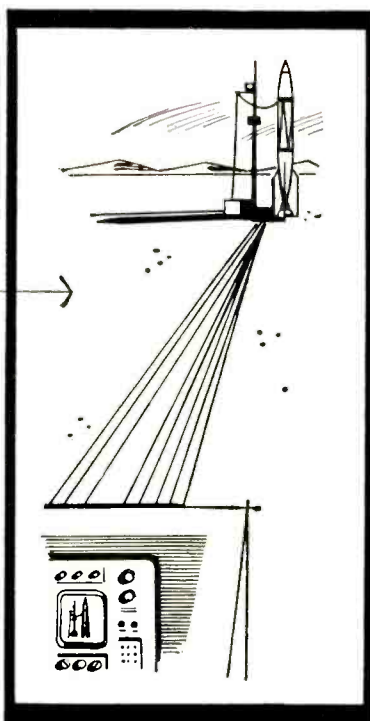
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the form of a phase discriminator output voltage derived from comparison of the voltages in the core secondaries with respect to the applied voltage.

### *Emotion Detector*

A psychometric instrument was awarded patent 2,684,670 issued to V. G. Mathison of Los Angeles, Calif. The invention is entitled "Electropsychometer or Bioelectric Instrument".

It has been long established by psychologists that the body undergoes many changes during emotional stress and other human activity that is subject to electrical sensing instruments.

One of the accompaniments of emotion is a change in the perspiration content of the skin. In the past psychogalvanometers have been cumbersome and the indications difficult to evaluate. A more prac-

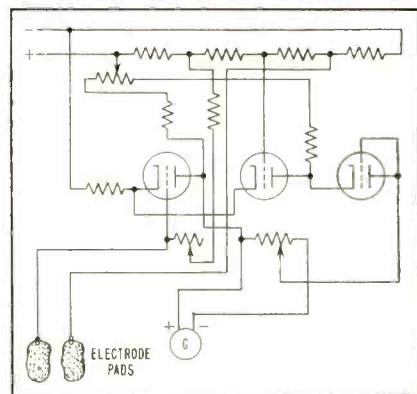


FIG. 2—Bridge circuit indicates conductivity through the body

tical instrument directly indicates the galvanometric effects of the behavior of an individual.

The bridge circuit shown in Fig. 2 is used, wherein the body resistance is measured as it appears across electrode pads held in the hands. As the emotional condition changes, the bridge balance will change to provide an indication on the galvanometer.

The instrument is calibrated in degrees of nervous tension or tone. Increased perspiratory activity would result in decreased resistance. This come about because the moist skin provides a better contact between the electrodes to effect a lower resistance.



# Electronic 'Erector Set' System . . .

Simplifies Circuitry Packaging,  
Cuts Assembly Costs,  
Minimizes Servicing Problems

**SUMMARY**—"Building Block" plug-in chassis system organizes circuits by function, provides for plug-in replacement and fast servicing by non-technical personnel.

## DESCRIPTION

A complete system of integrated terminal card sub-chassis elements designed to snap into plug-in chassis now makes it simple for designers to take full advantage of the new mass production techniques of printed wiring and modular construction in the manufacture of custom-designed systems.

Alden Products Company of Brockton, Mass., is the developer of this system which is based upon standardized pre-punched mounting cards with associated terminals, tube sockets and holding devices which accept resistors, condensers, tubes and other components. The cards may be snapped into place in plug-in chassis units.

This eliminates the usual "rat's nest" point-to-point wiring and facilitates access for assembly and repair.

The terminal cards arrange all the components on sub-chassis in "planes of circuitry" which can be housed in standardized 2", 4", 8" or 17" Alden Basic Chassis. Each chassis contains all the sub-chassis associated with a single electronic function. "Tell-Tale" monitor lights mounted on the plug-in chassis front panel can be employed to give instant indication of service failure.

Plug-in chassis units are arranged in modular metal cabinets called Uni-Racks to make up and house complete systems.



Fig. 1. Circuitry laid out using terminal card mounting system.

## ADVANTAGES

There are a number of primary benefits associated with the Alden System. Fundamentally, the break-down of the circuitry by **function** and the modular assembly concept of components and terminal cards means that even complicated electronic-electrical problems are reduced to relatively simple mechanical assembly problems once the theoretical design stage is passed.

The need for prototypes is eliminated since breadboard layouts can be lifted directly onto the terminal card system with the aid of planning sheets furnished by the manufacturer.

The finished system is easy to keep in service—even for non-technical personnel.

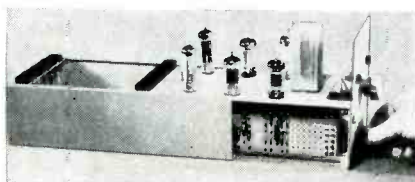


Fig. 2. Alden basic plug-in chassis.

"Tell-tale" trouble lights instantly locate malfunctioning chassis elements and non-technical personnel can replace them with spare plug-in units. The faulty unit can then be repaired and returned to service. In addition, provision for numbered and color-coded in-out leads conveniently grouped at the back of each chassis by Alden Back Connectors enables laymen to make accurate first-level checks.

## APPLICATIONS

A leading research institute received an unexpected order for a computer. Using this Basic Chassis System for housing the circuitry as plug-in units, they assembled the computer so rapidly that more than seven weeks was saved in design time and in the packaging and mechanical engineering phase. Moreover, the flexibility of the system permits periodic up-dating of the computer with more modern circuits as these are developed.

Another important advantage lies in the shortening of required lead time on delivery dates. One manufacturer supplying electronic test gear to the Naval Ordnance Bureau on irregular schedules is able to quote extraordinarily fast delivery on custom equipment because the units go together so fast. This firm starts with a series of standard functions to which are added specialized circuit functions. The chassis are then housed in Uni-Racks and rushed to the job.

In addition to speed, costs are held to a level far lower than is usual for special or custom built equipment and one or a hundred can be produced at little cost variance.

## "ERECTOR-SET" ELEMENTS

**Terminal Cards:** These cards are pre-cut to size, in lengths up to 3 feet. They

are pre-punched with 0.101" holes on 1/4" centers for maximum flexibility in chassis layout.

**Mounting Sockets:** Available for 7, 8, 9 pin connections, miniature and standard octal, tube sockets are furnished for stud mounting or with right-angle brackets for mounting directly to the terminal card. Eleven-pin socket is used for terminal card plug-in base only.

**Miniature Ratchet Terminals:** Stake into terminal card and provide positive grip for feed-through or single-end connections for all pigtail components. Soldering serves only to establish the electrical connection. Lead dress is simplified—excess pigtails are snipped off at the terminal.

**Jumper Strips:** Stake under terminals for either jumper or common wiring. These strips and other wiring can be readily replaced with printed or etched wiring.

**Plug-In Chassis Units:** Built on the modular principle allow organization of circuitry by function and provides housing in replaceable units.

**Front Panel Tell-Tales:** Tiny lamps that provide visual indication of equipment malfunction.

## SIMPLE TO GET STARTED

Alden Products Company offers a low cost "get started" chassis and terminal card assortment kit containing all components to mount, house, fasten and monitor electronic circuitry (Kit #37 shown above, price \$249.50).

This kit will enable you to determine quickly the advantages this system holds for your product development and production.

The Alden Handbook, "Ideas, Techniques, Designs" is supplied with each kit and contains a complete description of the Alden System.

To order your kit or to get further information write to Mr. N. Hearn, Alden Products Co., 6127 N. Main St., Brockton, Mass.

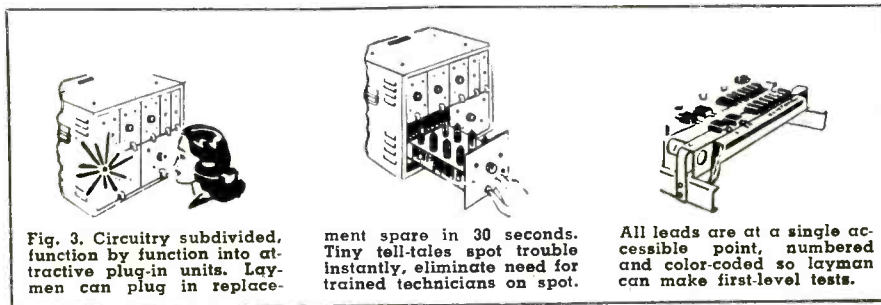


Fig. 3. Circuitry subdivided, function by function into attractive plug-in units. Laymen can plug in replace-

ment spare in 30 seconds. Tiny tell-tales spot trouble instantly, eliminate need for trained technicians on spot.

All leads are at a single accessible point, numbered and color-coded so laymen can make first-level tests.

## Piloted Deburring Tools Clean Punched Socket Holes in Chassis

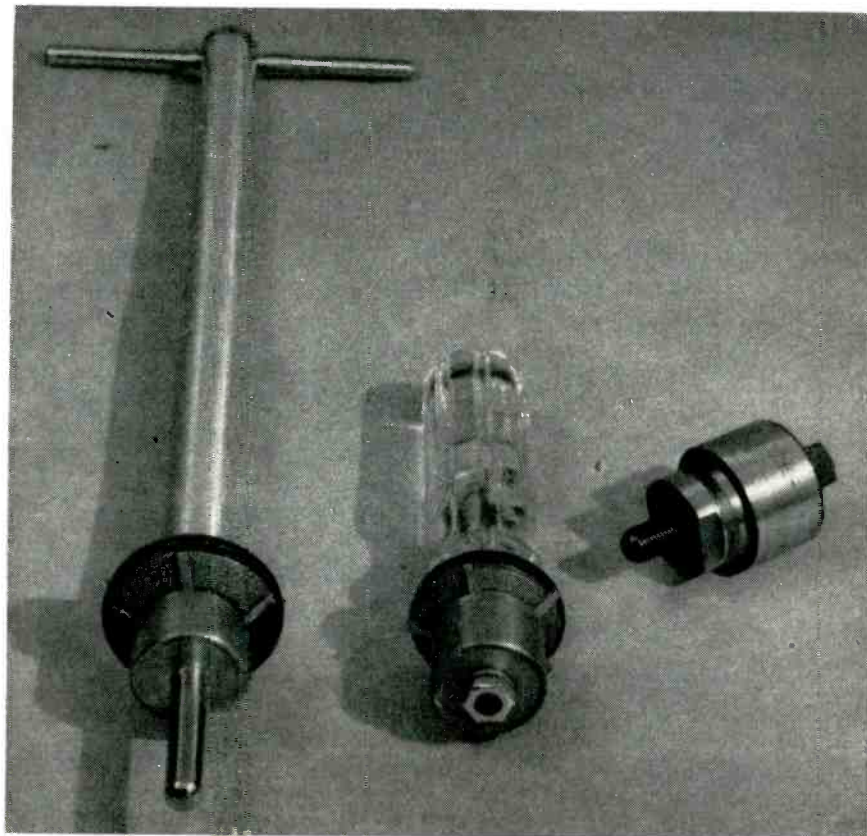
By RONALD L. IVES  
Palo Alto, Calif.

DEBURRING punched socket holes is a necessary but costly and time-consuming operation in reworking much military and commercial electronic equipment.

With skilled personnel, this operation can be performed quickly and efficiently with an automotive valve-seating tool, which is essentially a conical mill having an internal apical angle of about 135 degrees. With unskilled or lightly-built personnel, however, this tool tends to chatter from inadequate pressure and crawl out of the hole due to poor centering.

These troubles have been effectively eliminated by mounting a pilot on each valve-seater. The length of the pilot is about 1 inch and its diameter is the nominal diameter of the punched hole minus about 0.002 inch. This pilot is held to the tool by the  $\frac{1}{4}$ -center bolt normally supplied. The upper surface of the pilot is relieved, to fit closely to the cutter blades, by rotating the blades against the pilot in a lathe.

For ordinary bench use, the valve reseater is fitted with a plastic screwdriver handle. Where it is necessary to work down in a hole



Piloted deburring tools. Left: deburring tool with extension T handle and pin hole finder, for use in awkward locations. Center: deburring tool with screwdriver handle for bench use. Right: Greenlee socket hole punch, 1-1/16 inch in diameter, included to give scale

among the i-f cans, an extension handle with a T made of drill rod is found convenient. For awkward

locations, an extension of the center bolt helps as a hole finder. A conical pilot has also been found useful.

## Color Coding Aids in Matching Auto Radio Tuner Coils to Cores

PERFORMANCE CHECKING of antenna, oscillator and r-f coils for auto radio tuners is combined with matching of coils to cores in two unique test positions at Radio Condenser Co.'s Camden, N. J. plant. Four colors of paint are used on the cores to identify their characteristics. Corresponding colors are used on the coils to specify core requirements. At final assembly, an operator merely inserts in each coil a core of matching color. This

procedure permits use of much broader tolerances in winding of coils and molding of cores, with correspondingly lower production costs.

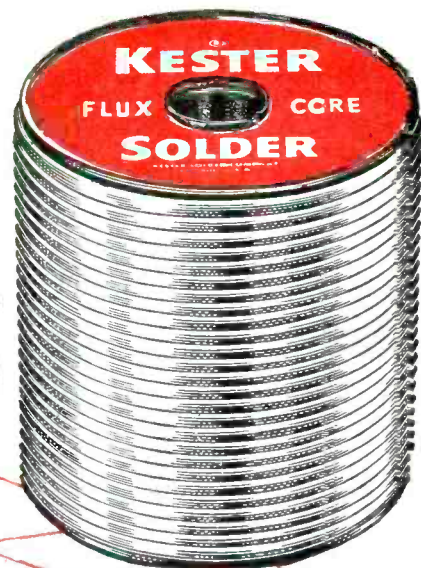
► **Coil Coder**—At this position, the operator drops an assembled three-coil strip into a holding fixture and makes appropriate connections to a special test set. On a slide at the right of the fixture are mounted two standard cores, one serving for the

oscillator coil and the other serving for both the r-f and antenna coils since these must be identical. The standard cores are so mounted on the slide that one core may be flipped over from the antenna coil position to the r-f coil position without disturbing the oscillator core in the central position.

The operator first sets the test set for 1,605 kc by pushing a button, then adjusts for zero beat on the meter, with the moving core be-

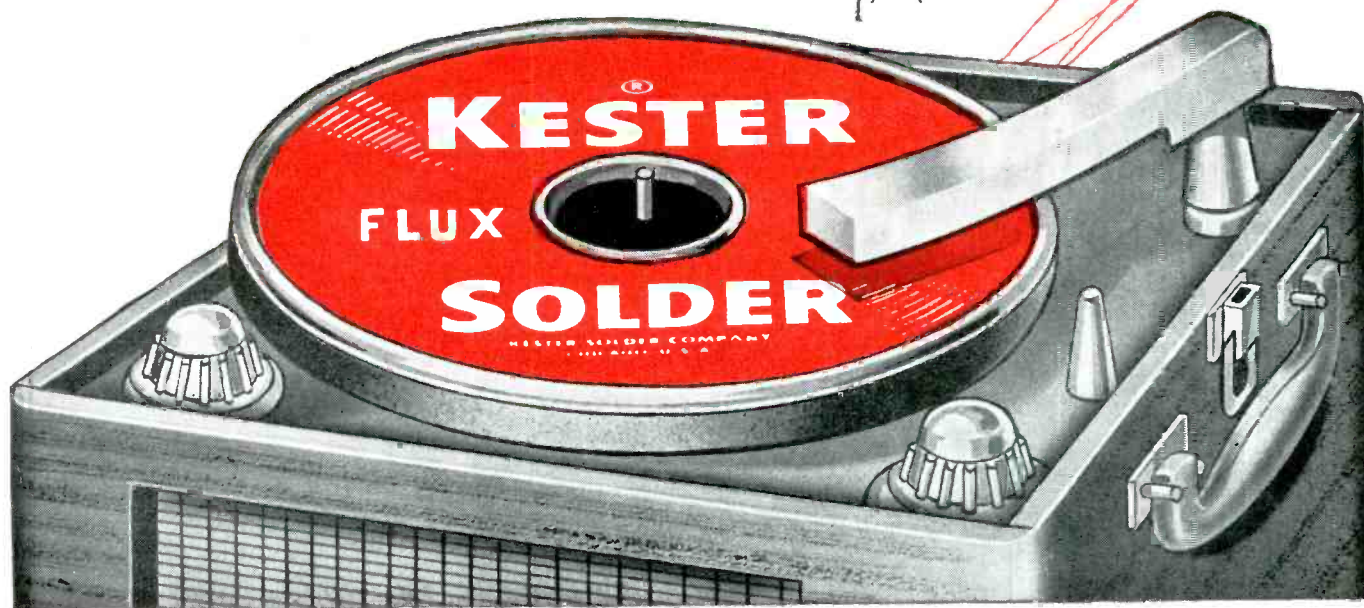


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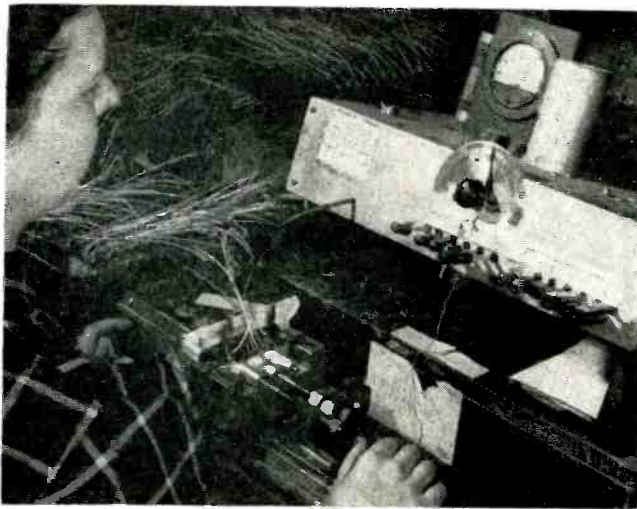
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# KESTER SOLDER

COMPANY 4204 Wrightwood Avenue, Chicago 39, Illinois; Newark 5, N. J.; Brantford, Canada





Coil checker, with coil assembly in position on fixture and with cores pushed into two of the coils. When core slide is retracted, front core is swung up through 180 degrees to rear position to go into rear coil when slide is pushed back



Core checker, with one core in position in vertical test coil mounted on a bench in front of QX checker. The four pads between the boxes on the stand at the right each hold a different color of paint for coding the ends of the cores

ing alternated between the r-f and antenna coils. This performance-checking procedure is repeated at 1,180 kc and at 600 kc. For this lowest-frequency test, the test set indications are translated into core requirements and the appropriate core color is marked on each core housing with a crayon pencil.

► **Core Coding**—For sorting cores, a standard QX checker made by Boonton Radio Corp. is connected to a master coil mounted vertically in front of the operator at the test position. Each core in turn is dropped into this coil for calibration in terms of a standard core. A quick adjustment of the knob on

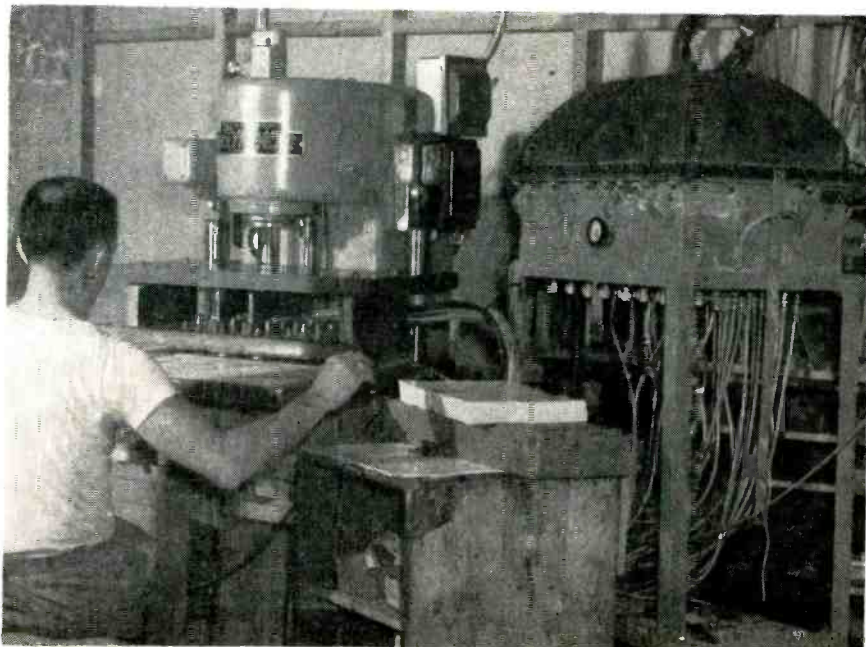
the QX checker while noting the meter reading serves to classify the core. The operator removes the core and pushes its end into a pad holding the corresponding color of paint, then drops the core into the appropriate box on a rack at her right. A fast-drying paint minimizes smearing.

## Hydraulic Press Prints Resistors on Copper-Clad Phenolics

A NEWLY DEVELOPED hydraulic press with split-second accuracy and exact pressure control is print-

ing resistors for electronic applications at Barry Process Co., Brooklyn, N. Y. Production rate is six

to ten resistor impressions per minute.



Press setup for printing resistors on etched wiring boards, using carbon-graphite inks fed through plastic tubes under pressure from container at right

► **Versatility**—A special patented printing head on a 4-ton Denison hydraulic Multipress (made by Denison Eng. Co., Columbus, Ohio) applies volumetrically controlled quantities of a carbon and graphite composition to copper-clad phenolics or ceramic material. More than 100 different liquid compositions may be printed simultaneously, permitting the printing of different values on one substrate in a single printing operation without varying the dimensions of the resistors. Additional flexibility of value is available by variation of resistor dimensions. As a result,  $\frac{1}{4}$ -watt resistors are being produced with values ranging from 100 ohms to 2 megohms, with tolerance values consistently within 6 percent.

► **Method of Operation**—The compounds are fed to the press through  $\frac{1}{2}$ -inch plastic tubes from a



# Systems Engineering at The Ramo-Wooldridge Corporation

**ICBM and IRBM are prime examples** ■ The Intercontinental Ballistic Missile and the Intermediate Range Ballistic Missile, Air Force programs for which we have over-all systems engineering and technical direction responsibility, are prime examples of programs that require the systems engineering approach. Most Ramo-Wooldridge work is of such a systems character, requiring the concurrent solution of a wide variety of interrelated technical and operational problems. Additional examples at R-W are communications, fire-control, and computer programs for the military, and automation and operations research projects for business and industry.

**Pertinent technical fields** ■ Successful execution of systems engineering programs requires that the technical staff include experts in a considerable number of scientific and engineering specialties. At Ramo-Wooldridge some of the pertinent fields are aerodynamics, propulsion, digital computers, information theory, radio propagation, radar, infrared, servomechanisms, gyroscopy, and nuclear physics.

**The kind of team required** ■ A qualified systems engineering staff must include unusually capable theoreticians and analysts who can predict the behavior of complex systems, as well as ingenious experimental physicists who can devise suitable new techniques for measuring actual physical parameters. In addition, the team must include experienced apparatus and equipment development engineers, to insure a high level of practicability in the resulting end products.

*Scientists and engineers who are experienced in systems engineering work, or who have specialized in certain technical fields but have a broad interest in the interactions between their own specialties and other fields, are invited to explore the wide range of openings at The Ramo-Wooldridge Corporation in:*

Guided Missile Research and Development	■	Automation and Data Processing
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DIVISION OF  
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pressurized tank. Tubes run to the top ram of the machine, which is connected to a two-posted die set holding the special resistor ink heads. These heads can imprint the resistor compound in any position on the circuit.

Circuits to be printed are slid under the ram. As the press is cycled, the heads come in contact with the circuit and make the imprint. In doing this, the compounds are sealed off so pressure and material are applied simultaneously. This eliminates leaking and gives

perfect uniformity to the finished resistor.

Exact timing and pressure control are important. Should timing fall short by as much as a half a second, an improper deposit of the compound would result. An automatic time delay keeps the die head on the circuit for the exact time necessary.

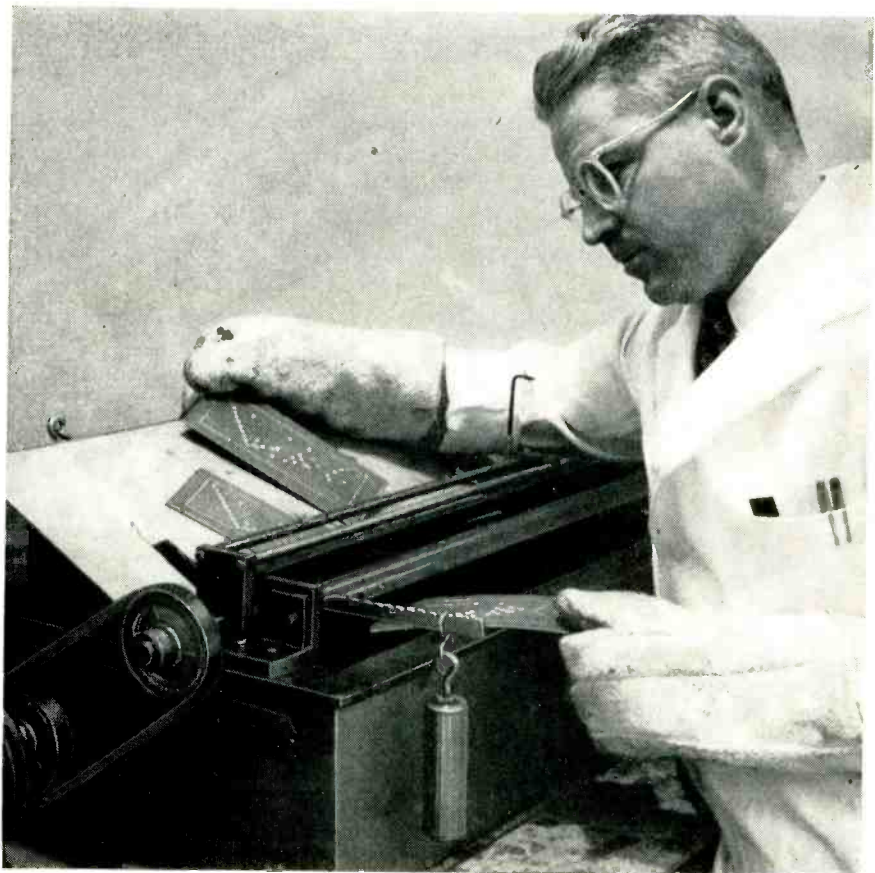
Printed sheets are placed on a continuous conveyor going to the curing oven. In drying, the solvent in the composition dissipates, leaving a 0.015-inch-thick deposit.

## Roller-Coater Tins Printed Wiring Boards

A MOTOR-DRIVEN roller-coating set-up mounted over a solder pot is used at Bell Telephone Laboratories to apply a coating of solder over etched or plated wiring prior to installation of components. This coating makes subsequent dip-

soldering easier and protects the copper against corrosion.

The coating is particularly advantageous for plated-on wiring that has been given a light plating of solder electrolytically. Roller-coating eliminates the need for



Roller-coater setup. Operator is feeding two-sided wiring board between rollers with left hand, for tinning underside, and picking up tinned boards with right hand. Asbestos board at rear is normally slanted downward so boards drop into tote box. Another weighted lever arm is at other end of upper roller

Want more information? Use post card on last page.



# THE ELECTRONIC TUBE

*with*

## A "MILLION" APPLICATIONS

does the work of transistors  
more efficiently,  
more reliably  
more effectively

Now, another revolutionary development from Haydu's research laboratories . . . **The Low Voltage Beam Switching Tube** (type 6701). An electronic achievement of importance in many applications including critical transistor operations.

Haydu's basic ten-position Beam Switching Tube has introduced entirely new concepts for simplifying electronic circuits and designs. This new electronic tube is so versatile that any desired type of sequential or random switching of any number of positions may be obtained.

The Beam Switching Tube has contributed new levels of *speed, reliability* and *economy* in unlimited applications such as:

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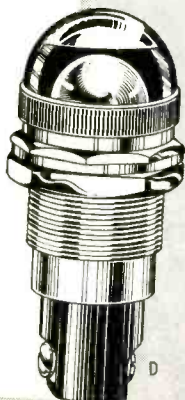
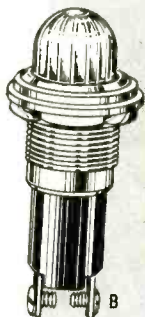
Dialco offers the complete line of pilot lights, from sub-miniature types to giant units with 1½" lenses.

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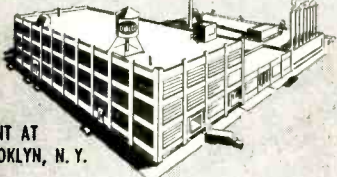


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### PRODUCTION TECHNIQUES (continued)

scrubbing off plating-tank chemicals, eliminates aging problems of plated-on solder coatings and insures that the final job will meet corrosion-resisting specifications for military equipment.

► **Machine Details**—An iron roller tinned with the aid of ammonium chloride flux is rigidly mounted in the solder pot so that it projects about 70 mils above the solder surface. Directly above this roller is a free-floating stainless steel roller, mounted so that a weight on an adjustable arm at each end can be shifted to vary the pressure applied to the wiring board by the upper roller.

To eliminate the problem of dross on the surface of the solder, a mixture of a high-flash-point silicone oil and rosin is floated on the surface of the solder. The wetted iron roller projects above this. Asbestos sheets cover the solder surface except for a slit through which this roller projects, so that

the wiring board cannot be contaminated by the oil.

► **Technique**—The board to be coated is fed between the motor-driven rollers with the wiring side down. Roller pressure and speed are varied depending on the nature and weight of the conductor on the board. The thicker the metal and the more difficult it is to solder, the slower is the speed used and the greater the roller pressure. The thickness of coating desired also affects the choice of speed and pressure; normally the roller-coater is set to apply a solder coating between 0.2 and 0.5 mil thick.

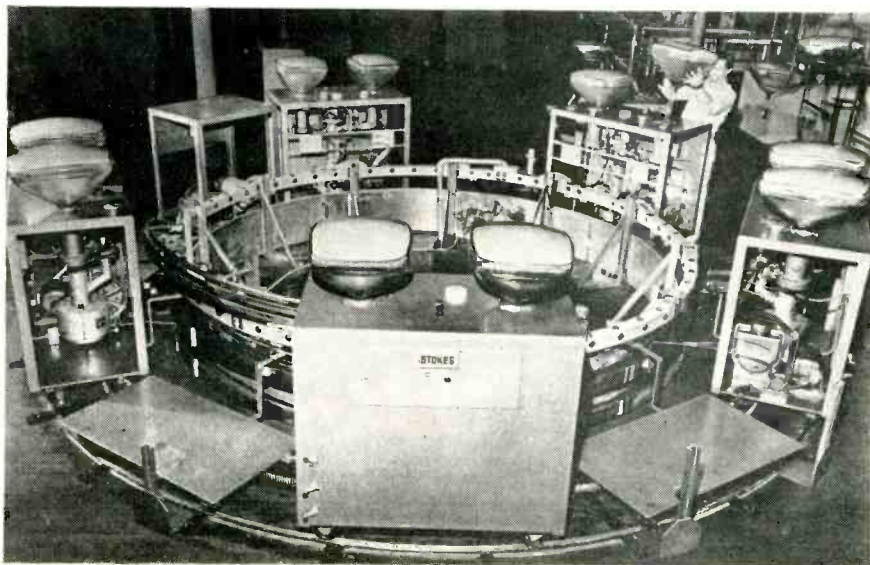
Boards having wiring on both sides are turned over after one pass and put through again. A blotter-type paper sheet is then placed on top of the board to keep the wiring from being scratched by the stainless-steel roller. The paper is also used sometimes with single-wiring boards, to distribute pressure more evenly.

## Dual-Tube Aluminizers for TV Picture Tubes

DUAL-TUBE ALUMINIZING carts running on a circular track only 17 feet in diameter can process two 21-inch picture tubes in a 6½-minute overall cycle from loading to unloading at the Passaic, N. J. plant of Thomas Electronics Inc.

The standard five-cart continuous system made by the High-Vacuum Equipment Division of F. J. Stokes Machine Co., Philadelphia, will turn out 96 finished tubes per hour.

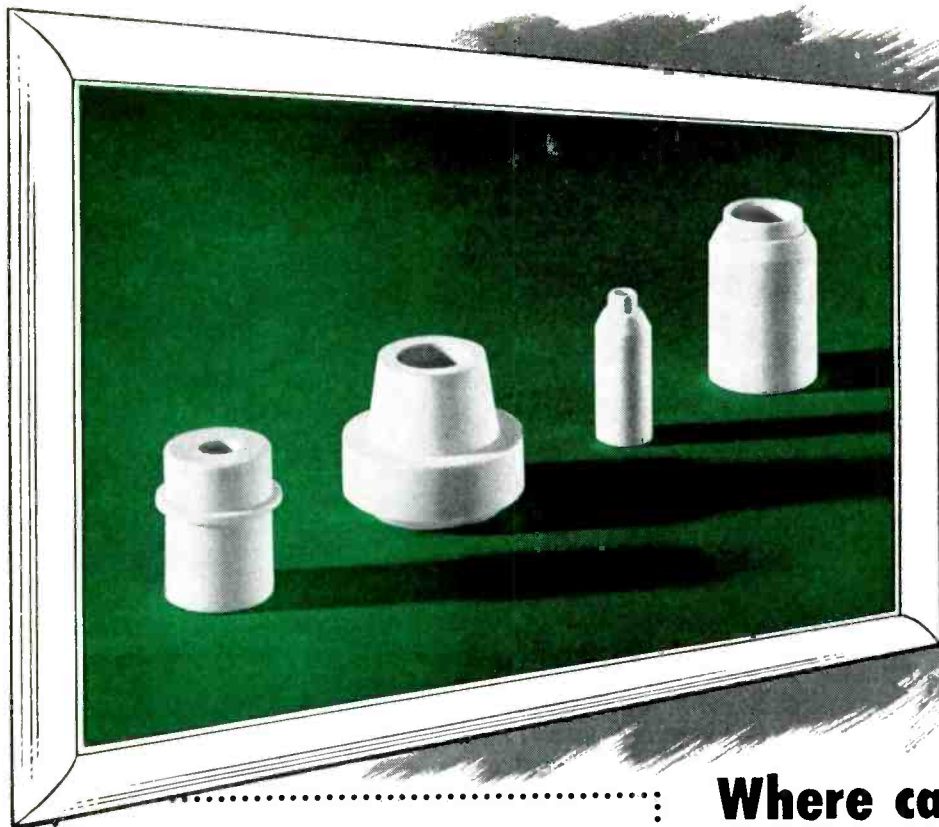
Five additional carts can be added to the standard dollies, to



One man on five-cart system can aluminize 192 tubes per hour. Empty carts on track will hold five more dual-tube carts

Want more information? Use post card on last page.





**RANGE OF PHYSICAL PROPERTIES  
OF ALITE FORMULATIONS  
BASED ON ALUMINUM OXIDE**

Tensile Strength (PSI)	18,000	to	32,500
Compressive Strength (PSI)	150,000	to	290,000
Modulus of Elasticity (PSI)	$30 \times 10^8$	to	$50 \times 10^8$
Specific Gravity	3.30	to	3.80
Coefficient of Linear Expansion (per °C (25°-500°C))	$5.4 \times 10^{-6}$	to	$5.4-8.1 \times 10^{-6}$
Thermal Conductivity (BTU/hr./sq. ft./°F/in.)	80	to	133

**ELECTRICAL PROPERTIES**

Dielectric Constant	@ 60 cy.	9.2
	@ 1 mc	9.0
	@ 1000 mc	8.6
	@ 10,000 mc	8.4
Dielectric Strength	(volts per mil)	250
Power Factor	@ 60 cy.	0.0005
	@ 1 mc	0.0005
	@ 1,000 mc	0.0006
	@ 10,000 mc	0.0008
Loss Factor	@ 10,000 mc	0.0067
	@ 25°C	$10^{10}$
Electrical Resistivity	@ 200°C	$10^{13}$
	@ 400°C	$10^{10}$
	@ 600°C	$10^8$
	@ 900°C	$10^6$

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Alite is a sintered metallic oxide, formed into shape by extruding, pressing, or casting into molds. As formed and sintered, it can be held to reasonable tolerances. By diamond wheel grinding, Alite can be finished to virtually any tolerance required.

The series of Alite Formulations based on aluminum oxides possess physical properties falling within the range shown in the table at the left. Electrical properties of Alite formulation AE-212 are shown immediately below.

In appearance and in its ability to withstand chemical attack, Alite resembles fine quality chemical porcelain. It shows zero water absorption and is vacuum-tight. Its maximum working temperature ranges up to 1300°-1600° C.

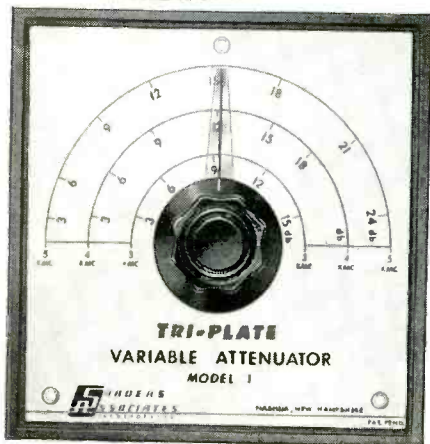
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**Maximum Attenuation** — linear function of frequency (20 db at 4,000 mc)

**Insertion Loss** — less than 1.5 db

**Maximum VSWR** — less than 1.25 at 4,000 mc.

**Characteristic Impedance** — 50 ohms

**Average Power Rating** — 2 watts

**Dimensions** — 5" x 5" x 1/4"

Other Tri-Plate products such as transitions, directional couplers, hybrid rings and special antennae can also be supplied.

Microwave systems will be engineered for conversion to TRI-PLATE and produced to your requirements.

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## PRODUCTION TECHNIQUES (continued)

produce 21-inch tubes at a rate of 192 per hour. Tubes up to 27 inches can be accommodated.

► **Operation**—The new continuous aluminizer is virtually automatic in operation. Only one operator is required to load the uncoated tubes and unload the finished tubes after they have completed their circuit of the track. All operations are executed automatically, actuated by trip switches and electrical contacts on the fixed track.

Each of the ten dollies can carry an aluminizing cart with its own self-contained vacuum pumping system that can evacuate and coat two tubes at once. Using a 10-cfm mechanical pump and a 4-in. high-speed Stokes Ring-Jet booster pump, each cart can pump down and aluminize two 21-in. tubes in the same time as a single tube.

► **Performance**—The dollies run so smoothly that there is a minimum of vibration in the tubes, and practically never a fall-out of the



Installation with hood for trapping exhaust fumes from mechanical vacuum pump during early portion of cycle. Overhead conveyor, part of 2 1/4-mile system at Thomas Electronics, delivers uncoated tubes to aluminizer

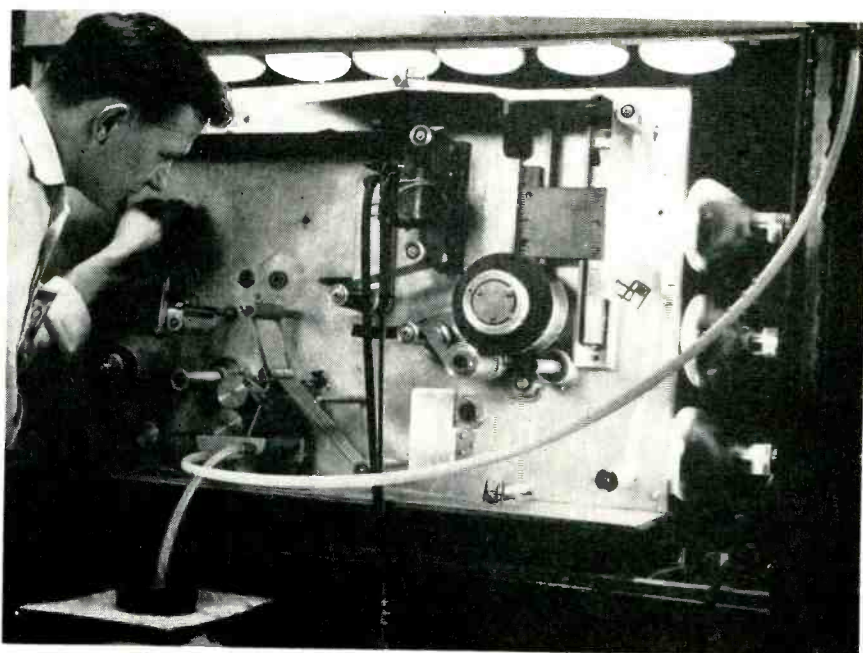
aluminum bundle before vaporization. Also, there is no sputtering of the bundle since the transformer delivers a consistently uniform filament heating current.

## Making Metallized Lacquer-Film Capacitors

By H. G. WEHE

Transmission Apparatus Development  
Bell Telephone Laboratories  
Murray Hill, N. J.

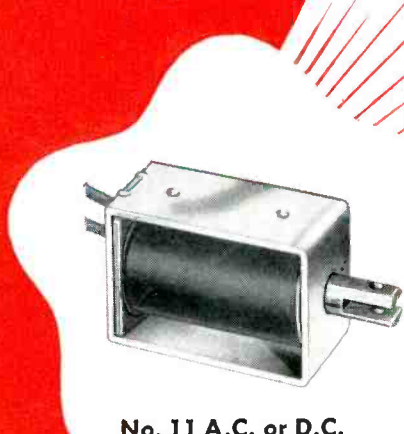
AFTER DEPOSITING metal on thin strips of lacquered paper, the paper can be removed by a new process to leave only a thin film of metallized lacquer. This construction



Operating coating machine roller coater. Hoses lead to trough where rollers pick up lacquer



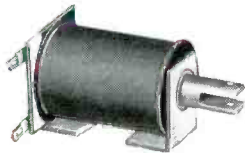
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No. 11 A.C. or D.C.

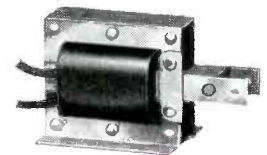
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- Coin Changers
- X-Ray Equipment
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- Electric Organs
- Amusement Devices
- TAS Equipment
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- Vending Machines
- Animated Displays
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- Music Boxes
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No. 1G A.C. or D.C.

A small lightweight unit available for A.C. or D.C. Continuous or Intermittent duty. Adjustable plunger stroke:  $\frac{1}{16}$  to  $\frac{3}{8}$  inches. Lift: up to 15 ounces. Weighs only  $3\frac{1}{2}$  ounces.



No. 12 A.C.

Small A.C. unit with laminated construction. Intermittent or Continuous duty. Adjustable plunger stroke:  $\frac{1}{8}$  to 1 inch. Lift: up to 32 ounces. Weighs only 5.5 ounces.



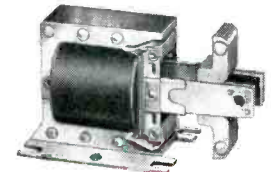
No. 4 A.C. or D.C.

Sturdily constructed with metal frame. Available for A.C. or D.C. Continuous or Intermittent duty. Adjustable plunger stroke:  $\frac{1}{8}$  to  $1\frac{1}{8}$  inches. Lift: up to 24 ounces.



No. 7 D.C.

A rugged D.C. Solenoid enclosed in metal cover for extra protection. Intermittent or Continuous duty. Adjustable plunger stroke:  $\frac{1}{8}$  to 2 inches. Lift: up to 7 pounds.



No. 18 A.C.

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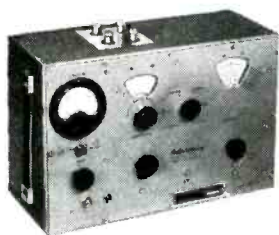
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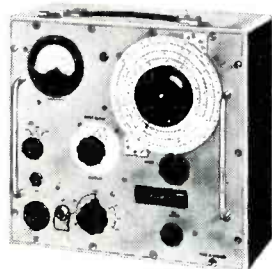


#### ADVANCE RF Q-Meter

■ Priced right, the Laboratory Q-Meter, Model T-1, incorporates an overload-proof VTVM indicator. Model T-1 measures Q, Inductance, Capacitance, and Power Factor at frequencies between 100 Kc and 100 Mc, in six ranges. The frequency oscillator has an accuracy of  $\pm 1\%$ . OUTSTANDING SPECIFICATIONS: Tuning capacitor, calibrated in three scales, indicates Capacitance, 40 to 550 mmfd,  $\pm 2\%$ ; Zl (ohms, Mc) 4,000 to 300,  $\pm 2\%$ ; Lf<sup>2</sup> (uH, Mc) 600 to 50,  $\pm 2\%$ . Q is measured in two ranges, 10 to 100, and 40 to 400, accurate to  $\pm 5\%$  ( $\pm 5\%$  FSD.) Only \$249.50

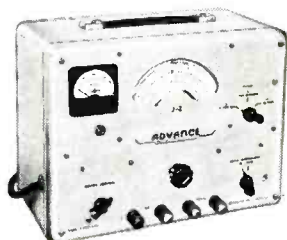
#### ADVANCE VHF Generator

■ Highly versatile, the ADVANCE VHF Signal Generator, Model D-1/D, covers 10 to 300 Mc in six ranges with an accuracy of  $\pm 1\%$ , and offers both square and sine wave modulation, with *direct* calibration. Output voltage, obtained through 75-ohm transmission line, is continuously variable from 1 uv to 100 mv and is calibrated in both uv and db. Accuracy: 10 to 150 Mc,  $\pm 3$  db,  $\pm 1$  uv; 150 to 300 Mc,  $\pm 4$  db,  $\pm 2$  uv. Output is modulated 30% ( $\pm 3\%$ ) by a 1,000 cycles sine wave ( $\pm 100$  cycles) or by a 1,000-cycle square wave ( $\pm 100$  cycles.) Only \$395.00



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■ Model J-2 meets the need for a highly accurate Audio Generator with low distortion. Covers the range from 15 to 50,000 cycles in three bands, with an accuracy of  $\pm 2\%$ ,  $\pm 1$  cycle. The output is continuously variable into 600 ohms: 0.1 mw to 1.0 watt (0.25 to 25 volts)  $\pm 2$  db. Maximum into 5 ohms, better than 1 watt. Total harmonic distortion and hum content above 100 cycles is less than 2% at rated output, or less than 1% at 0.1 watt. Only \$149.50



ADVANCE Precision Attenuators cover the frequency spectrum from audio up to UHF. Model A-38 provides four 20 db steps of attenuation and is useful up to 300 Mc. Model A-55 is designed for extreme accuracy in its RF to VHF range. Model A-57 is an absolutely linear device for operation in UHF range.

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conserves space and is particularly applicable to low-voltage circuits such as those using transistors.

► **Thinness** — Dielectrics two or three tenths of a mil (0.0002—0.0003 inch) thick will withstand much more than the 50 volts required for most transistor applications. Hence, capacitors made from this thickness of material occupy much more space than is necessary. Yet, until the advent of the metallized lacquer-film capacitor, paper or plastic dielectrics thinner than about a quarter of a mil were not commercially available. Even if the dielectrics had been available, equipment to handle them was not. The thinner the films, the more fragile they become. It was necessary to develop procedures for mak-

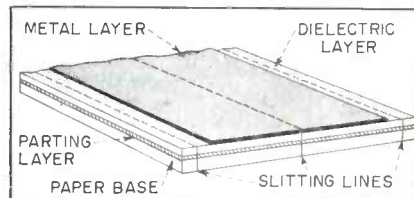


FIG. 1—Pile-up of base, parting layer, lacquer film, and metal. Margins facilitate attaching leads

ing and handling such thin films. The objective was set at about one-tenth of a mil (0.0001 inch) dielectric because experience indicated that this would easily withstand 50 volts.

The lacquer-film capacitor uses a dielectric film only a tenth of a mil thick. The dielectric (usually cellulose acetate) is metallized on one side by vapor deposition of zinc, which provides the electrode. Two strips of this material, when wound together, form a capacitor. This makes possible capacitors one-seventh the volume of metallized paper capacitors.

When the volume of a capacitor is reduced by a factor of seven (independent of housings), the voltage at which it may be used is reduced only by a factor of approximately three. This is due to the fact that for a given capacitance, volume is proportional to the square of the dielectric thickness. However, the voltage rating need be decreased only in direct



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(continued)



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manufactured by the Components Division of

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proportion to the thickness of dielectric. Thus voltage rating has been traded for size reduction to an extent heretofore not feasible.

The lacquer-film capacitor, like the metallized paper capacitor, is self-healing. An internal short-circuit, caused for example by an excessive voltage surge, is automatically cleared by the fuse-like action of the thin zinc electrode. In this way, the defective areas are isolated.

► **Manufacture**—Because of its thinness and fragility it is essential that the plastic (lacquer film) be supported as much as possible throughout its manufacture. For this purpose a strip of ordinary kraft capacitor paper is normally used as a base or belt on which the lacquer film is placed. Figure 1 shows a pile-up of the materials on this belt. First is the paper, which is coated with a parting layer. This is another plastic on which the dielectric layer will be placed and later removed. On top of the parting layer is placed the dielectric layer, whose uniformity and thickness must be carefully controlled. On top of the dielectric layer is placed a layer of metal (zinc) by vacuum vapor deposition. The pile-up of material on its supporting web is then slit to the desired width, as indicated by the dotted lines of the illustration. Two

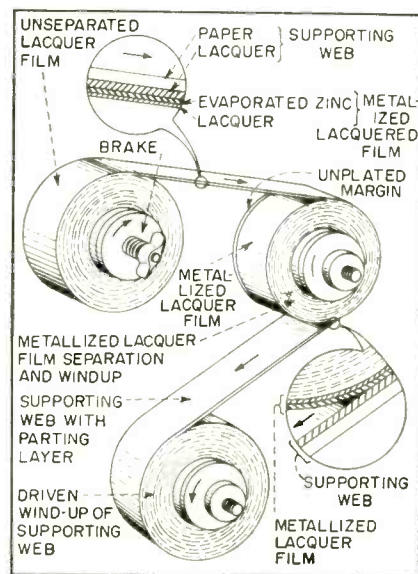
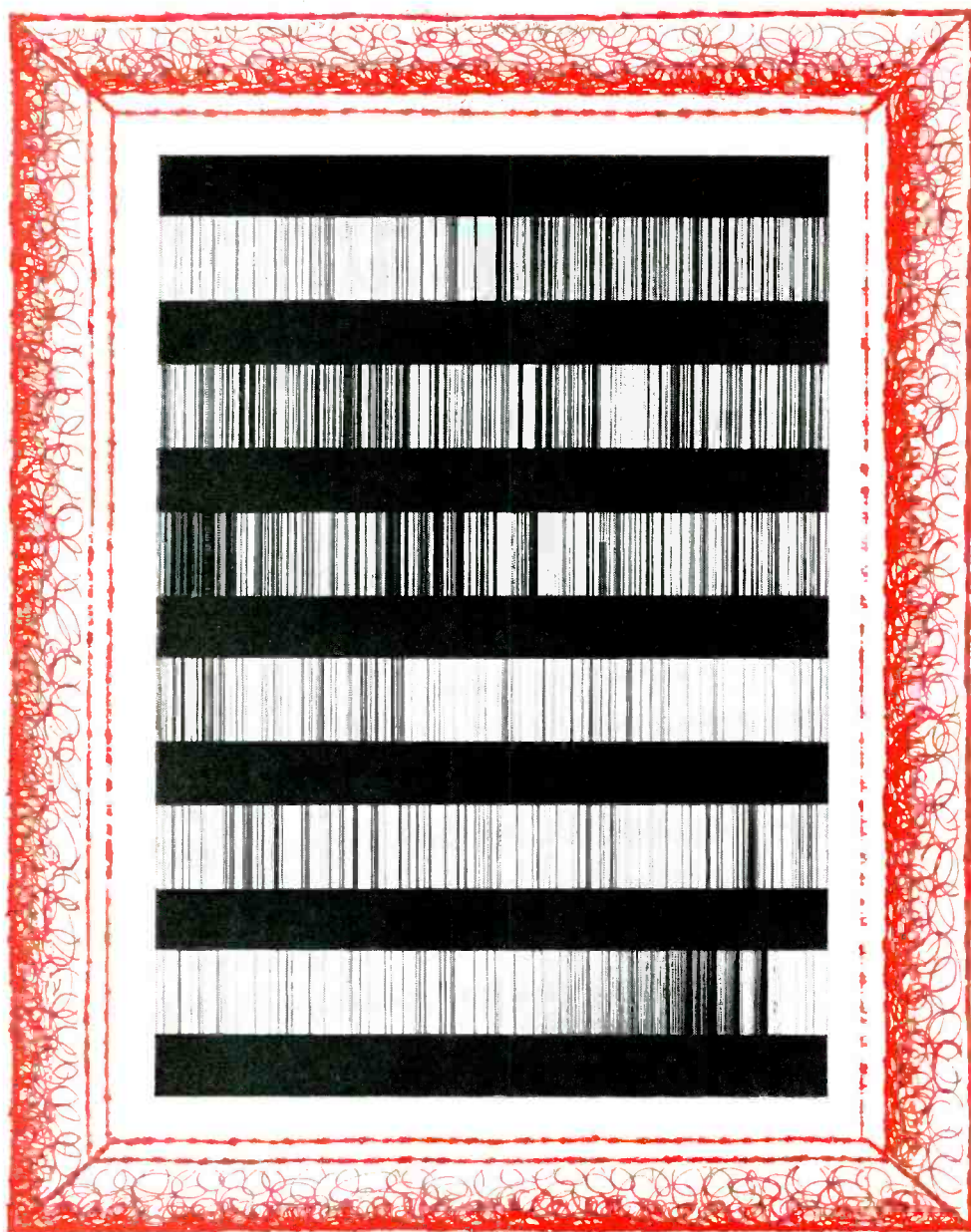


FIG. 2—Method of separating metallized lacquer film from parting layer and supporting web



# PORTRAIT OF A CHAMPION



Nichrome\*, the famous alloy whose spectrogram you see here, is as truly a masterpiece as any Rembrandt or DaVinci hanging in the galleries—and for largely the same reason.

For the principal elements in Nichrome, *anyone* can combine. What gives Nichrome its unapproachable superiority over all other heat-resistance alloys, is the truly personal elements that go into its making—the all-important, highly specialized skills of the Driver-Harris technicians.

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Yes, there is only one Nichrome, and it is made only by Driver-Harris.

And in recognition of its unique properties, the United States Patent Office in August, 1908, granted solely and exclusively to us the trade-mark NICHROME.

\*T. M. Reg. U. S. Pat. Off.



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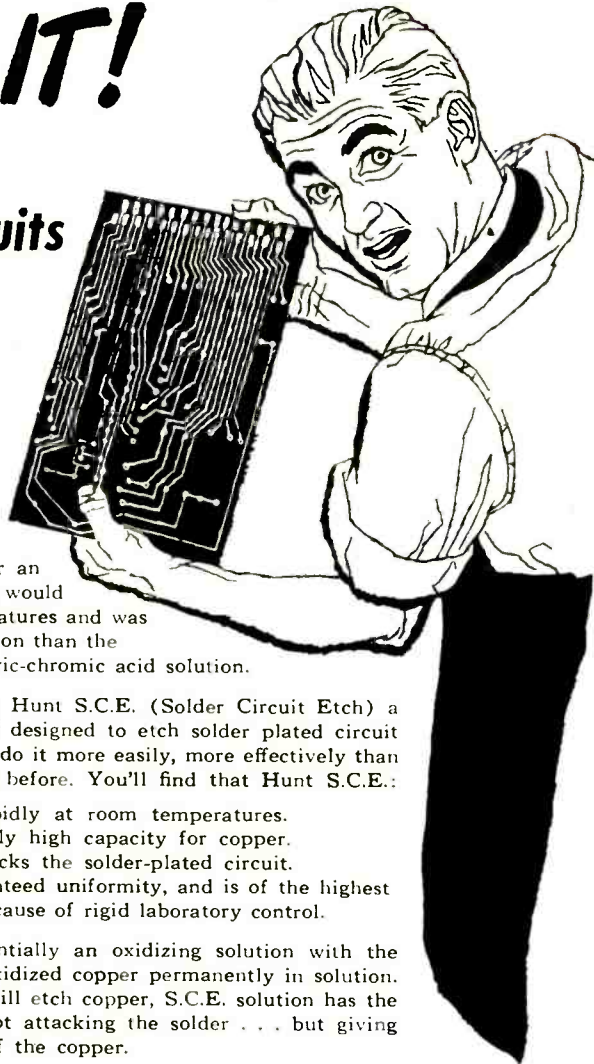
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1. Etches rapidly at room temperatures.
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3. Never attacks the solder-plated circuit.
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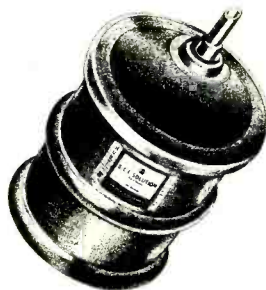
1. 15% increase in etching speed.
2. Immediate action over entire circuit.
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5. Substantial increase in capacity.
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A temperature between 100°F and 120°F is recommended as optimum etching temperature. With splash etching and 110°F temperature, a printed circuit board should etch in 2½ minutes in fresh R.C.E. solution.

Both etchants are described in Technical Bulletins No's 1 & 3 available from your nearest Hunt branch or Palisades Park, N. J.



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strips are thus formed side by side, with margins at the outer edges of the two strips. The metal extends completely to one edge of both strips, as indicated by the center dotted line.

A machine is used for applying two types of laquer, one over the other, in making these capacitors. This machine is of the roller-coater type which applies laquer by a kind of printing process.

Before the layers of lacquer are separated, and while they are both on the supporting web, the metal electrodes are vacuum-vapor deposited onto the dielectric lacquer film. The pile-up is then slit and the metallized lacquer film is removed from its support, as shown in Fig. 2.

At the top is a roll of a pile-up of the web, the parting layer, the dielectric layer, and the metal film. At the bottom is a roll which winds up the waste material, consisting of the web and parting layer. The metallized dielectric is wound up on the middle roll. The winding is started with pressure-sensitive tape, which will lift up the metallized dielectric and start it winding on the middle roll. A brake is applied to the supply roll to maintain tension in the web during the stripping process.

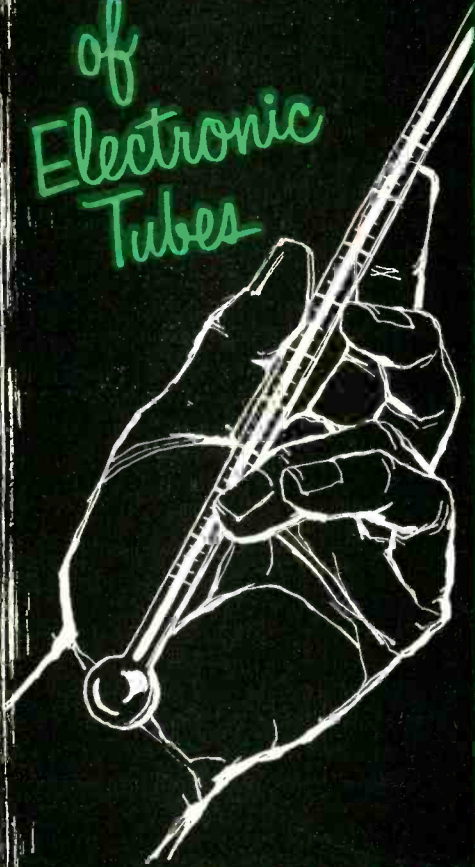
► **Terminals**—After the film is obtained in this manner, it is wound into a capacitor. Two rolls of film are placed in a machine which winds them together with an uncoated margin on opposite edges of each strip. When metal is sprayed on the ends of the unit, it strikes the exposed metal edge of one layer, but not the recessed metal of the other layer. Contact is thus made to the two sides, and the capacitor is complete except for attaching leads and providing a suitable housing. Despite the fragility of the film, surprisingly little difficulty has been experienced with the winding operation.

► **Leakage**—After 2,000 hours on life test at twice rated voltage at 120F, which is probably near the upper limit of temperature to which the capacitors would be exposed in an ordinary room, insulation resistance was still about 1,000



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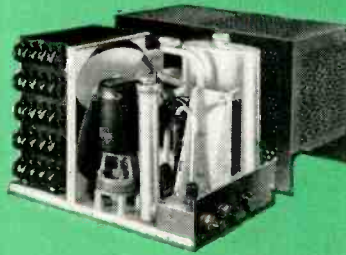
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Eastern Cooling Units provide coolant liquid for maintaining within safe operating temperature limits liquid cooled electronic tubes or similar devices. The units are completely self-contained and usually comprise such components as heat exchangers, fans or blowers, liquid pumps, reservoirs, flow switch, thermostat, etc. Cooling units can be modified as required for varying conditions encountered in land or sea as well as aircraft service. Almost all units are designed to meet such specification as MIL-E-5400 and MIL-E-5272.

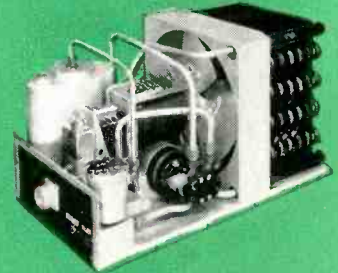
The units shown below are intended only to illustrate the varying requirements which can be satisfied. By utilizing fairly standard components and designs based on broad experience in this field, Eastern is able to provide at minimum cost equipment exactly suiting a specific requirement.

Eastern welcomes your consultation on liquid cooling problems ranging from 200 to 20,000 watts dissipation.

Write for Aviation Products Bulletin 330.



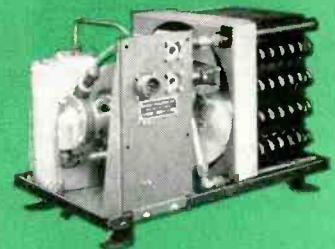
**MODEL MB-175, TYPE 200 DISSIPATION:** 2,000 watts. **ALTITUDE RANGE:** sea level to 50,000 feet. **POWER REQUIRED:** 28 volts D.C. **WEIGHT:** 25 pounds. **SIZE:** 10" x 15-15/16" x 10 3/4" high.



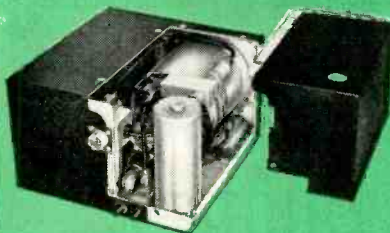
**MODEL E/HT-205, TYPE 200A DISSIPATION:** 1,600 watts. **ALTITUDE RANGE:** sea level to 5,000 feet. **POWER REQUIRED:** 28 volts D.C. **WEIGHT:** 25 pounds. **SIZE:** 10" x 21" x 10" high.



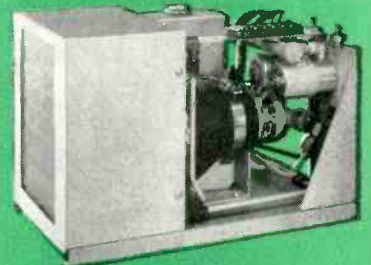
**MODEL MB-177, TYPE 202 DISSIPATION:** 1,700 watts. **ALTITUDE RANGE:** sea level to 50,000 feet. **POWER REQUIRED:** 110 volt, 400 cycle, 3 phase. **WEIGHT:** 27 pounds. **SIZE:** 10" x 19 15/32" x 7 3/4" high, per JAN-C-1720A, size B1-D1.



**MODEL E/HT-210, TYPE 200 DISSIPATION:** 1,500 watts. **ALTITUDE RANGE:** sea level to 10,000 feet. **POWER REQUIRED:** 208 volts, 400 cycle, 3 phase. **WEIGHT:** 35 pounds. **SIZE:** 11 1/4" x 19 1/2" x 12 1/2" high.



**MODEL E/HT-200, TYPE 201 DISSIPATION:** 1,000 watts. **ALTITUDE RANGE:** sea level to 50,000 feet. **POWER REQUIRED:** 28 volts D.C. **WEIGHT:** 14 1/2 pounds. **SIZE:** 10" x 10" x 6" high.



**MODEL NO. 5-A DISSIPATION:** 1,000 watts. **ALTITUDE RANGE:** sea level to 5,000 feet. **POWER REQUIRED:** 100 to 110 volts D.C. **WEIGHT:** 10 pounds. **SIZE:** 7 7/8" x 13 1/2" x 9-1/16" high.



# Don't Gamble With Cable Performance



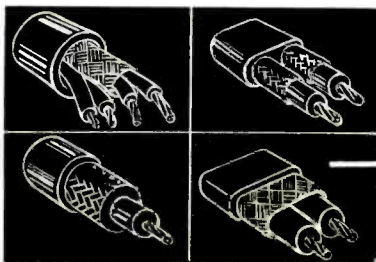
## ...Depend on PHALO!

"Almost" is never enough when it comes to cable performances. You must be 100% certain the cable you select is custom-made to do the job your power engineering plans call for. You must know you can depend on cable performance in every respect.

Many of America's major users of cables have found they can depend on Phalo to produce *exactly* the cable needed.

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Want more information? Use post card on last page.

megohm-microfarads. This compares quite favorably with that of capacitors made by more conventional methods. It is relatively easy to achieve capacitors of one or two microfarads capacitance having power factors less than 4 percent at 10 kc.

## Lead-Cutting Gage



Operator using length of wire to demonstrate how leads of component are cut at right side of gage

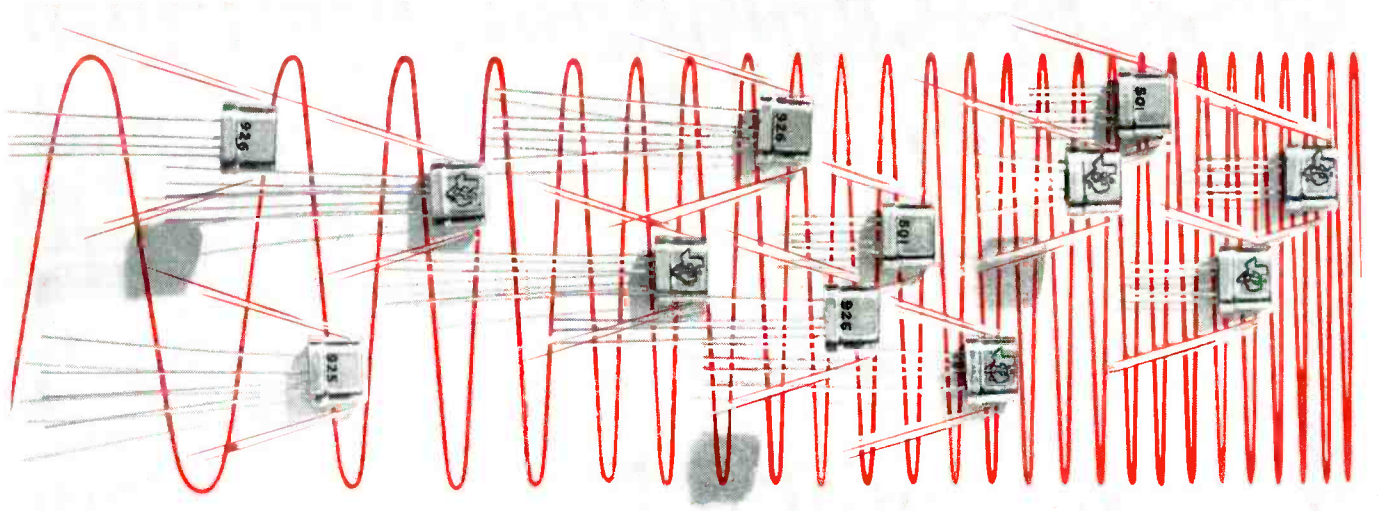
A TAPERED wood jig with fourteen horizontal grooves serves as a gage for cutting leads of resistors and other components to any of fourteen different lengths on a tv subassembly line in the Westinghouse Metuchen, N. J. plant. The operator holds the part against the left side of the gage with the lead resting in the groove of the desired length, then uses side-cutting pliers to snip the lead on the right side of the gage. The tool is hinged to the bench, so that it can be swung down toward the floor in front of the bench when not in use, leaving the work area unobstructed.

## Slicing Tubes for Study

WHEN PRODUCTION difficulties necessitate precision checking of spacings between parts of tubes enclosed by anodes, representative



# VHF transistors NOW!



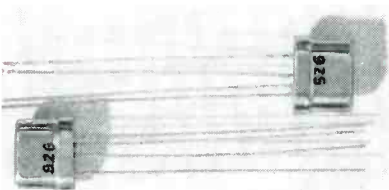
**NEW 'GROWN-DIFFUSED'  
TYPES COMMERCIALY  
AVAILABLE IN  
PRODUCTION QUANTITIES**

**HIGH GAIN VHF TRANSISTORS** with usable power levels and band widths are now immediately available from Texas Instruments . . . another first for the leading producer of silicon and germanium transistors. Your design horizons are now extended to include all-transistor TV, FM, and VHF receivers . . . and transistorized amplifier, oscillator, or switching applications in communications, telemetering, or radar.



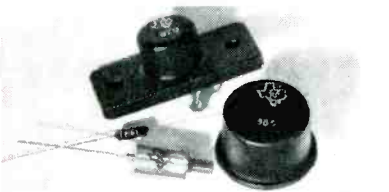
#### **NEW VHF GERMANIUM TRANSISTOR**

**OSCILLATING FREQUENCY IS ABOVE 250 MEGACYCLES** . . . alpha cutoff frequency is 200 mc. Typical gain is 12 db at 100 mc (unregenerative). This performance in a production transistor was unheard of prior to perfection of the "grown-diffused" method — an exclusive Texas Instruments technique.



#### **NEW HF SILICON TRANSISTORS**

**FREQUENCIES TO 30 MEGACYCLES**, rated 30 volts and 125° C, make these "grown-diffused" units ideal for high temperature military and commercial applications. They increase to 10 the types of silicon transistors now available from Texas Instruments, and represent the continual improvement in frequency, gain, and power made by the pioneer producer of silicon transistors.



#### **OTHER NEW SEMICONDUCTOR DEVICES FROM TI**

**NEW HIGH POWER TRANSISTORS** — 12-watt dissipation germanium power transistor and 8.75-watt dissipation silicon power transistor. **NEW HIGH VOLTAGE RECTIFIERS** — full wave and single junction half wave 1500-volt silicon units stable to 150° C. **NEW HIGH CONDUCTANCE DIODES** — 4 types of axial-lead silicon junction diodes with 100 ma forward currents and 0.1  $\mu$ a back currents.

*All these devices in production and available immediately. Write today!*

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**TEXAS INSTRUMENTS**  
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Patents Pending

# NYLON COIL FORMS

A NEW PRODUCT INTRODUCED BY

## CLEVELAND CONTAINER CO.

Makers of CLEVELITE\* . . .

the QUALITY name for Phenolic Tubing

### CLEVELAND'S NYLON FORMS . . .

- . . . are a one-piece precision molded, high temperature form for use with threaded cores.
- . . . eliminate costly assembly operations as they can be had with the collar as an integral part of the form.
- . . . collars are notched to prevent slipping turns, speeding winding operations.
- . . . edges are serrated to provide greater friction when engaged with winding arbor.
- . . . have six internal ribs enabling cores to be pressed into the form, eliminating time consuming, hand threading operations.
- . . . have unique patented chassis lock, eliminating costly mounting clips.
- . . . resist electrolysis indefinitely.
- . . . available in all R.E.T.M.A. standard colors, for easy identification . . . in certain lengths to fit 8/32 and 1/4-28 core sizes.

\*Reg. U. S. Pat. Off.

**THE CLEVELAND CONTAINER COMPANY**

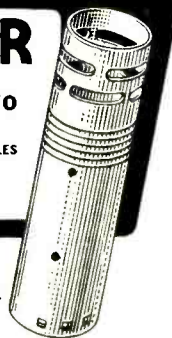
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- WEST COAST: IRV. M. COCHRANE CO., 408 S. ALVARADO ST., LOS ANGELES



Example of slices cut from plastic-filled tube without disturbing positions of delicate grid wires

samples of the production run are carefully opened up and filled with a liquid plastic, such as Plexiglas. When this hardens, the tube can be sliced with a diamond saw to give accurate cross-sections at any desired points. These slices can then be examined under a microscope and critical spacings can be measured. The technique is used in the General Electric receiving tube plant at Owensboro, Ky.

### Potting Connectors with Remeltable Plastic Molds

DISPOSABLE plastic potting molds have been developed for potting electrical connectors in harness assemblies of guided missiles being turned out by the Convair division of General Dynamics Corp. at its Pomona, Calif., plant.

The process is used to cover the electrical connections with synthetic rubber to make them moisture and fungus proof and to increase their resistance to breakage or other damage. The method has eliminated costly production delays and greatly reduced the high rate of operational failures because of electrical harnesses.

Previous to the installation of this method, approximately 40 percent of the harnesses required rework operations. Of the first 200 harnesses made with potted plugs, only 1.5 percent were found to be defective. It is expected that with



Chances are at least  
**98 out of 100**  
that this part  
will be **perfect**

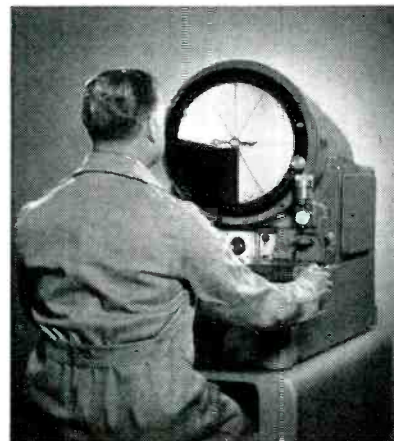
The Metal Stampings Plant, Sylvania Electric Products, Inc., keeps rejects under 2%—even on complex, close-tolerance parts produced at rates to 9,000 per hour. Optical gaging helps set this level.



The diode plate shown above is an example of the complex, mass-produced, parts turned out to close tolerances by The Metal Stampings Plant, Sylvania Electric Products, Inc., at York, Pennsylvania. Tolerances run to  $\pm .001$ "; as many as 10 dimensions must be held, including inner and outer diameters. Yet even on parts more difficult than this—parts with tolerances of  $.0005$ " and forming rates of 9,000 per hour—Sylvania gets an acceptance rate of over 98%.

Inspection on Kodak Contour Projectors helps Sylvania do the job to the satisfaction of its customers, both internal and external. Operators check the first parts produced by every machine to assure correct setup. Then, throughout the run, production samples are checked at regular intervals—making certain each machine is holding to tolerance. The speed with which these parts can be checked using optical gaging methods has helped slash rejection rates more than 50% since Kodak Contour Projectors were installed.

If you have difficult inspection problems involving quantity, speed, close tolerances or hard-to-measure dimensions like shoulders, holes, radii or angles, there's every reason to expect a solution by optical gaging on a Kodak Contour Projector. There's a representative in your area who can tell you more. To get in touch with him, or for a copy of the booklet, "Projection Gaging with Kodak Contour Projectors," write Special Products Sales Division.



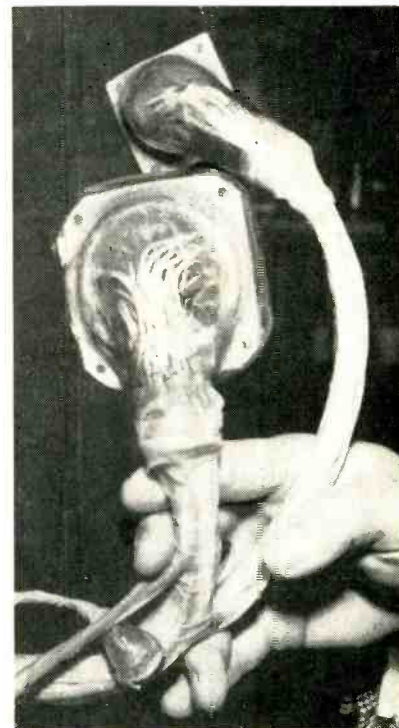
Little training is required to operate a Kodak Contour Projector. Operators sit comfortably in a fully lighted room. The work gets out in a hurry.

**EASTMAN KODAK COMPANY, Rochester 4, N. Y.**

**the KODAK CONTOUR PROJECTOR**

**Kodak**  
TRADE-MARK

# ENGINEERING TIMETABLE



Molds in place, ready for injection

## 1:50 P. M. HOLDING THE CURVES

The curves, of course, are not on the highway, but on the oscilloscope. The men? Fairchild Guided Missiles Division engineers. The project? Testing advanced equipment for a new FGMD project.

Working from start to finish on their project *as a team*, these engineers typify the group spirit of engineering at Fairchild Guided Missiles Division. To bring problems to solutions faster, to speed progress in such fields as inertial guidance, passive guidance and radar, and many other projects, FGMD engineers pool their collective talents, experience and inventiveness. And, they see their work through from idea to success.

Investigate the opportunities on the right. If you see one you're qualified for, arrange an interview. You'll like what you see at Fairchild Guided Missiles Division.

Send your complete resume to R. B. Gulliver. He'll give it prompt attention.

### Senior Electronics Engineers:

Missile systems

### Senior Electronics Engineers:

Servo and Analog Computer experience

### Project Engineers:

Electronics or Electromechanical background

### Senior

### Aerodynamicists:

Supersonic Aerodynamics, includes performance, stability and control analysis



... WHERE THE FUTURE IS MEASURED IN LIGHT-YEARS!

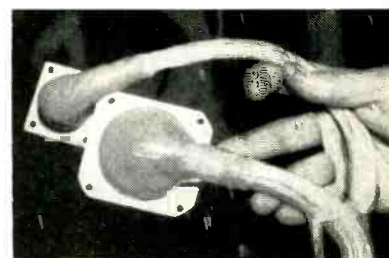
# FAIRCHILD

GUIDED MISSILES DIVISION • WYANDANCH, LONG ISLAND, N.Y.

*A Division of Fairchild Engine and Airplane Corporation*

continued research the amount of rework will be further reduced. In addition, Convair found that it could effect a saving in man-hours required to turn out the assembly by use of the potting method.

The process involves making a plastic butyrate mold, fitting it over the connection or terminal to be potted, filling the mold with a Thiokol-type synthetic rubber and curing the rubber for 4 hours in an oven at 120 F and removing the mold. The process is now being



Rubber plug body completed



Molds after use, ready to be melted for reuse to reduce cost of process



For industrial and high temperature applications!

# International Silicon power diodes!

Operating temperature range:  $-55^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$

PIV ratings from 50 volts to 600 volts

Rectified DC current range: 100 ma to 1.25 amperes\*

\*Mounted on cooling fins.

**IN FULL  
PRODUCTION!**

International silicon diodes are the result of  
8 years experience in the development of advanced  
rectifier products... all manufactured to the highest standards  
of reliability in the industry! INTERNATIONAL RECTIFIER  
the complete line-SELENIUM - GERMANIUM - SILICON

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No solders or fluxes  
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**TWO STYLES AVAILABLE**  
Standard type for  
Industrial Power Supply  
Application.  
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for magnetic amplifier  
application.

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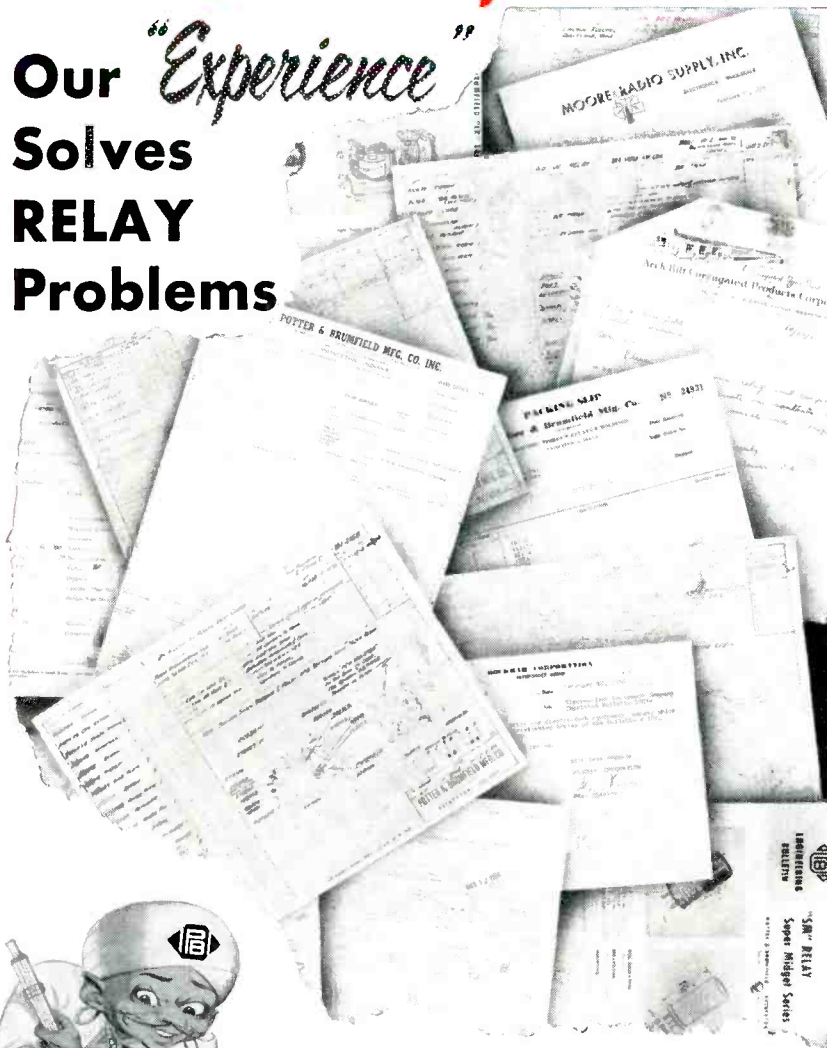
NEW YORK: 132 E. 70TH ST., TRAFALGAR 9-3330 • CHICAGO: 205 W. WACKER DR., FRANKLIN 2-3889

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**Samples and quotations gladly furnished.**

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PRINCETON, INDIANA

SUBSIDIARY OF AMERICAN MACHINE AND FOUNDRY COMPANY



**RS Series Relay**  
illustrated  
low cost & sensitive  
type relay



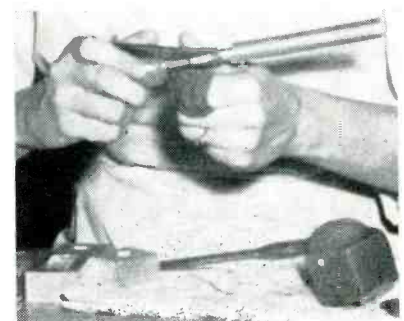
Dipping matrix in liquid plastic to form mold to be used for potting

used on practically all electrical connections in the guided missile.

► **Initial Problems**—One problem involved finding a potting agent that would flow easily to cover the wires and connections, had suitable dielectric properties and would harden or cure easily. Thiokol met these specifications but hardened so rapidly that it had a very short work life.

A proper material for molds also presented a problem. Various materials, including metals, were tried, but the result was always the same. The rubber would stick to the mold. Finally Butyrate Westcoat clear 202 plastic was tried and it worked. The same plastic is being used today.

Once the rubber hardens, on most substances, nothing will remove it. This presented several problems, one involving the people employed in the potting process. The rubber would stick to their clothes and also to their skin. It was solved by providing



Stripping mold from matrix



# Now, it's "earth satellites"

The imagination of engineers, scientists, and laymen alike has been wetted by the exciting prospect of launching the first man-made earth satellites! Called project "VANGUARD," it is planned as the high-point of the world's longest "year"—the eighteen months between July 1, 1957 and December 31, 1958 of the *International Geophysical Year*.

First presented in a symposium, March 20th at the IRE Convention, this scientific, history-in-the-making event is detailed well in advance for you in the special June "earth satellite" issue of *Proceedings of the IRE*. Because it is written by men in charge of project development, this will be the basic textbook of applied electronic technology in the satellite field.

This definitive issue presents the working data of placing in orbit, construction of the satellite, telemetering and other pertinent information. Herein are stated the objectives and scientific gains to be achieved by the "earth satellite" program.

You will find in this special issue a complete explanation of:

1. tracking the missile—by radio and optics,
2. gathering data from the missile—by radio transmission, propagation, and intermittent reception from widely separate points on earth—and the rapid computations to be based on such data.

You will also find practical application of this development to other electronic fields in this up-to-the-minute symposium. You'll find the "satellite" issue of *Proceedings of the IRE* a publishing event of great value.

Price to non-members... \$2.00

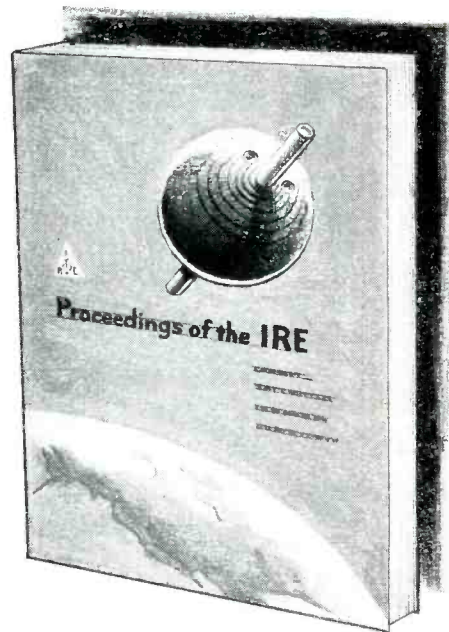
(All IRE members will receive this June issue as usual. Extra copies to members, \$1.00 each.)



**The Institute of Radio Engineers**

1 East 79th Street

New York 22, N. Y.



## CONTENTS OF THIS SIGNIFICANT ISSUE:

**"Symposium: The U. S. Earth Satellite Program—Vanguard of Outer Space,"** Chairman: W. R. G. Baker, General Electric Co., Syracuse, N. Y.

**"The International Geophysical Year Program,"** by Joseph Kaplan, National Academy of Sciences, Washington, D. C.

**"The Exploration of Outer Space with an Earth Satellite,"** by J. P. Hagen, Naval Research Laboratory, Washington, D. C.

**"Placing the Earth Satellite in its Orbit,"** by M. W. Rosen, Naval Research Laboratory, Washington, D. C.

**"Telemetering and Propagation Problems of Placing the Earth Satellite in its Orbit,"** by D. G. Mazur, Naval Research Laboratory, Washington, D. C.

**"Tracking the Earth Satellite and Data Transmission by Radio,"** J. T. Mengel, Naval Research Laboratory, Washington, D. C.

**"Optical Instrumentation of the Earth Satellite,"** by F. L. Whipple, Harvard University, Cambridge, Mass.

**"The Scientific Value of the Earth Satellite Program,"** by J. A. Van Allen, State University of Iowa, Iowa City, Iowa.

### PROCEEDINGS OF THE IRE

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Enclosed is \$2.00

Enclosed is company purchase order for the June, 1956 issue on "Earth Satellite"

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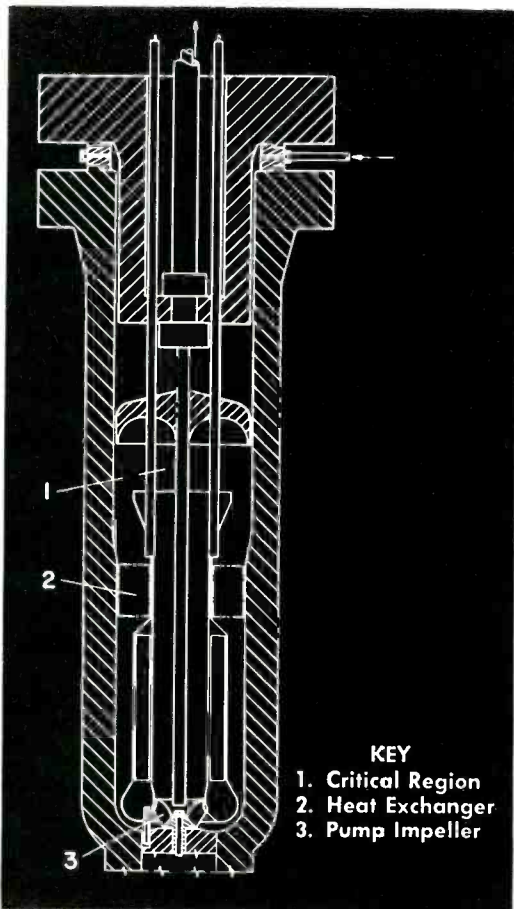
Company \_\_\_\_\_

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# 1 of 5



**KEY**  
 1. Critical Region  
 2. Heat Exchanger  
 3. Pump Impeller

This simplified drawing of an experimental homogeneous type power reactor, now in the final assembly stage, shows one of five nuclear reactor projects currently under way at Los Alamos, where the world's first homogeneous reactor was designed and built and is still in operation.

Indicative of the importance of these experiments is the Laboratory's thirteen year record in active research, design and development in this major field of basic scientific interest.

Many challenging projects in nucleonics, physics, chemistry, metallurgy, mathematics and engineering support these as well as other of the Laboratory's diverse activities.

Top-level scientists and engineers interested in long-range career opportunities at one of the nation's foremost scientific laboratories can secure complete information by writing

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 Division 903

**los alamos**  
 scientific laboratory  
 OF THE UNIVERSITY OF CALIFORNIA  
 LOS ALAMOS, NEW MEXICO



Loading injection gun with rubber compound in preparation for potting



Injecting rubber compound to form plug body around cables and connector

them with smocks to cover their clothing and rubber gloves to protect their hands.

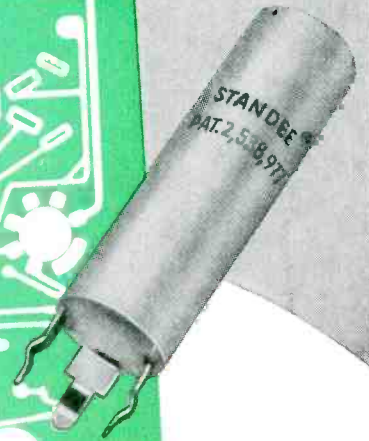
Special equipment was also needed for injecting the rubber into molds around connections. The gun finally adopted resembles a cross between a grease gun and a giant hypodermic syringe, lined with a special substance to which the rubber will not adhere.

Dielectric loss through the potting compound also presented a



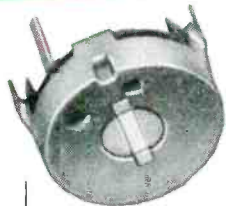
Keeping in step with fast-stepping  
**PRINTED WIRING...**

**CLAROSTAT**  
**PRINTED WIRING**  
**CONTROLS and RESISTORS**



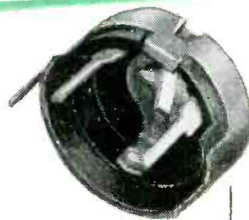
**SERIES 43 CONTROL**

- 1 ohm to 50,000 ohms. Wire-wound. Plus/minus 10%. Closer tolerances available. 2-watt rating.
- 1 1/8" diameter X 9/16" deep.
- Terminals reversed to meet printed-wiring requirements.
- Rotation: Mechanical, 300°; effective, 280°.



**SERIES 39 CONTROL**

- Screwdriver-adjusted for semi-permanent settings.
- Available as rheostat or potentiometer. Wire-wound. 2-watt rating.
- Terminals designed for printed-wiring connections.
- 4 ohm to 5,000 ohms; plus/minus 20%.
- 3/4" diameter X 3/8" deep.



**STANDEE<sup>®</sup> RESISTOR**

- Terminals designed for printed-wiring circuitry. Spring-clip action locks STANDEE securely during soldering phase of assembly.
- Available in 10 watts to 30 watts.
- 6000 to 21,000 ohms. (Wattage and Ohmage based on length).
- Five lengths — 1 1/2" to 4"
- Plus/minus 10%. Closer tolerances available.
- Resistance element wound on glass fiber core, sealed in steatite tube.
- Standee permits maximum heat dissipation above printed-circuit mounting panel.

Three typical printed-wiring components by Clarostat. Others available. Ease of installation in sub-assemblies of printed-wiring

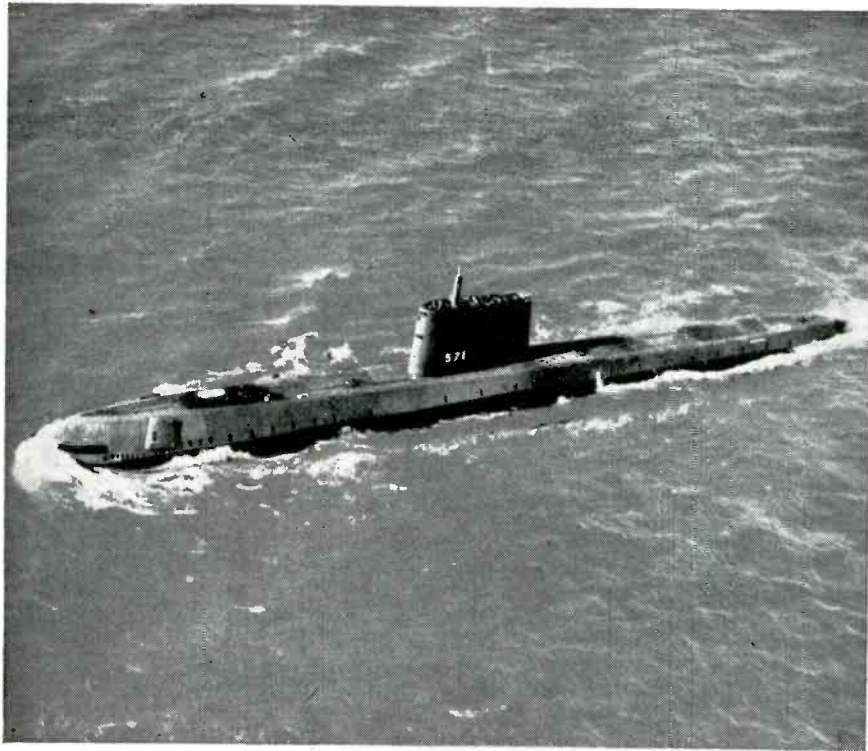
circuitry, accounts for low cost factor. Always, there's a Clarostat control or resistor to meet every application need.



Let us collaborate in your printed-wiring and other automation requirements and problems. Latest Engineering Data on request.

*Controls and Resistors*

**CLAROSTAT MFG. CO. INC., DOVER, NEW HAMPSHIRE**  
In Canada: Canadian Marconi Co., Ltd., Toronto 17, Ont.  
Manufactured under license in Great Britain by A. B. Metal Products Ltd., 17 Stratton St., London W. 1, Concessionaires for British Commonwealth except Canada.

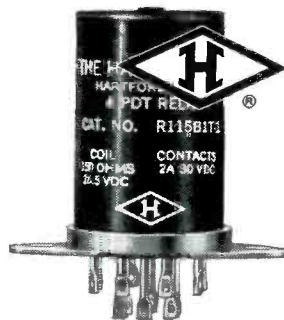


Official U. S. Navy Photograph

## 'Diamond H' Aircraft-type Relays Go to Sea in the Nautilus

Their reliability proven in such critical land and air applications as guided missiles, jet engine controls and fire control systems, "Diamond H" miniature, hermetically-sealed, aircraft-type relays were chosen by Westinghouse for an important role in the world's first atomic-powered submarine. They're used in the reactor control system of the Nautilus.

Possible performance characteristics of "Diamond H" Series R 4 PDT relays span such broad ranges that the modifications which can be arranged to meet particular sets of requirements are almost endless. They're fully described in Bulletin R250, a copy of which is yours for the asking. Our engineers will gladly work with you to develop a variation for your specific need.



### THE HART MANUFACTURING COMPANY

202 Bartholomew Avenue, Hartford 1, Conn.

problem in some components of the product. Use of varnish and a sleeving material over terminals before potting was the solution here.

Convair people involved in the development of the potting process include assistant division manager R. C. Loomis, assistant foreman Steve Herman, H. P. Miller of Experimental Engineering, Herb Vooigt of Manufacturing Engineering and Engineering's electric and electronic production design group under Raymond Soward.

### Push-Along Test Line For Printed Radios

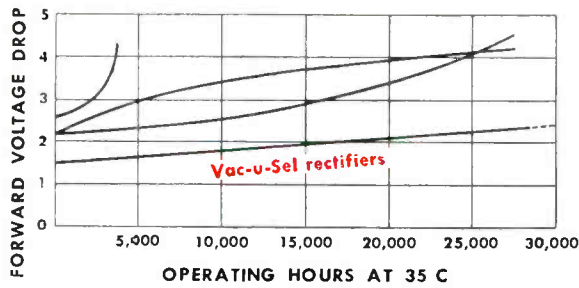
ALL ALIGNMENT and test operations for a Westinghouse radio receiver are carried out while the etched wiring board is mounted in a test rack that is pushed down the line at regular intervals by an air cylinder setup. As the test racks move past, each operator performs her assigned test and alignment operations. This gives the final test line the same precision of timing and the same production rate as the



Alignment position on push-along test line. Cutout in vertical support board permits reaching bottom adjustment screw of i-f transformer with tool in left hand



**A COMPARISON GRAPH** between General Electric Vac-u-Sel rectifiers and three other makes, showing the change in forward voltage with time. Note that all other makes have at least doubled their forward resistance (completely aged) in less than 30,000 hours. Vac-u-Sel rectifiers' long life makes them ideal for such applications as business machines.



WHEREVER LONG SERVICE IS ESSENTIAL . . .

# G-E *Vac-u-Sel*\* Rectifiers Will Give 80,000 Hours of Reliable Life

When you're designing a circuit for a business machine or other essential-service type of industrial machine, two important objectives are absolute dependability and maximum life. Therefore, it will pay you to take advantage of the special characteristics of General Electric Vac-u-Sel rectifiers. This long-life rectifier has more than adequately proved its dependability in many years of outstanding service.

**THE VAC-U-SEL RECTIFIER IS UNIQUE** in that it is manufactured by an exclusive sphere-type, vacuum-evaporation process, which G.E. has been using for over 15 years. The ultimate benefit is 80,000 hours life expectancy at full-rated current and voltage. This is at least  $\frac{1}{2}$  longer than the life expectancy of ordinary selenium rectifiers under the same conditions.

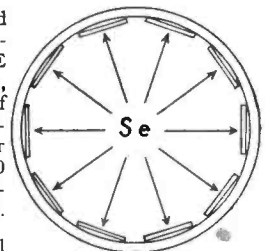
In addition, the Vac-u-Sel rectifier gives you low forward resistance, and minimum heat loss.

A full line of Vac-u-Sel rectifiers is available. Contact your nearest G-E Apparatus Sales Office, or write for Bulletin GEA-6273 to: Section 461-42, General Electric Co., Schenectady 5, N. Y.

\* Vac-u-Sel is a trade-mark of the General Electric Co. It designates top-quality selenium rectifier cells manufactured by a unique sphere-type vacuum-evaporation process. Vac-u-Sel rectifiers are produced by the Rectifier Department, Lynn, Mass., headquarters for silicon, germanium, selenium and copper-oxide component rectifiers.

## THE SECRET'S IN THE SPHERE

A vacuum-tight sphere is used to evaporate selenium onto aluminum plates. This unique G-E process results in a more even, natural-crystalline formation of selenium. It also eliminates contaminants, and permits better control over the more than 100 variables encountered in the manufacture of selenium rectifiers.



The end result is a Vac-u-Sel rectifier made by a precision process more closely related to a science than an art. This makes it possible to accurately predict performance, repeat the same dependability, and maintain the same high quality.

*Progress Is Our Most Important Product*

GENERAL  ELECTRIC



**TWO-WAY RADIO**  
communications equipment

VHF-FM FOR: MOBILE AIRCRAFT MARINE MOTORCYCLE PORTABLE BASE	VHF-AM FOR: AIRPORT VEHICLES GROUND STATIONS POINT-TO-POINT	VHF ANTENNAS REMOTE CONTROLS ACCESSORIES
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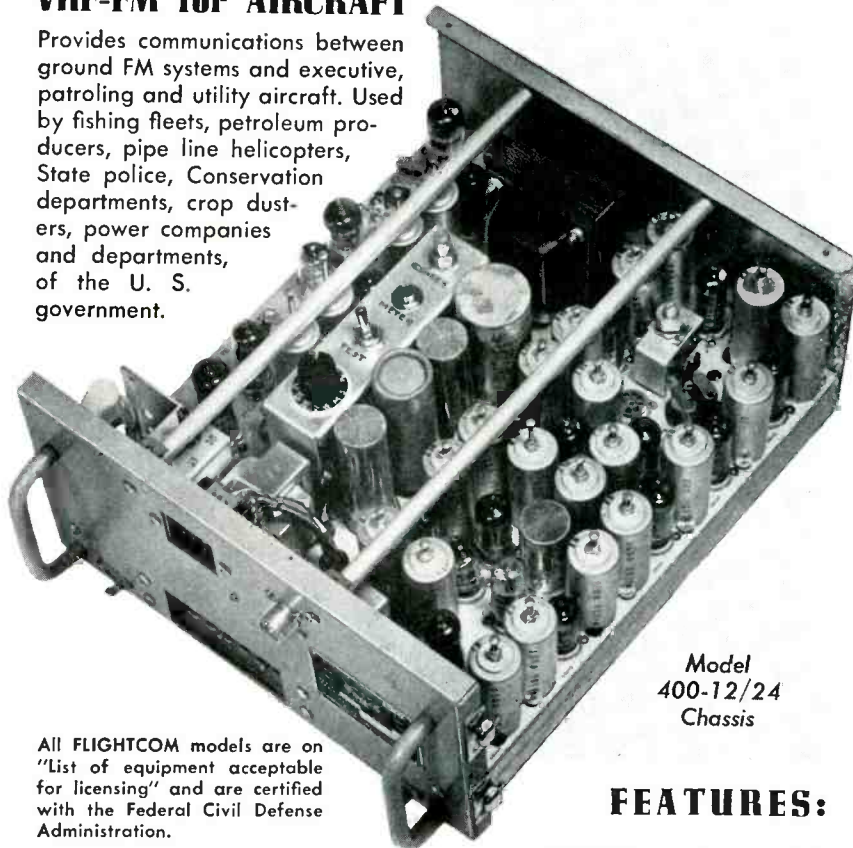


# FLIGHTCOM

MODEL 400-12/24 SERIES

## VHF-FM for AIRCRAFT

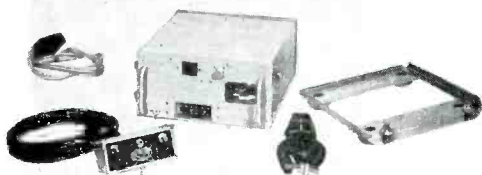
Provides communications between ground FM systems and executive, patrolling and utility aircraft. Used by fishing fleets, petroleum producers, pipe line helicopters, State police, Conservation departments, crop dusters, power companies and departments, of the U. S. government.



Model 400-12/24 Chassis

All FLIGHTCOM models are on "List of equipment acceptable for licensing" and are certified with the Federal Civil Defense Administration.

## FLIGHTCOM PACKAGE



Model 400-12/24

### FEATURES:

- **COMPACT** . . . Case size 14" x 11 1/2" x 6 1/2"
- **LIGHT** . . . 22 lbs. (without antenna and speaker)
- **POWERFUL** . . . 25 watts output
- **UNIVERSAL** . . . instantly changed from 12 volt to 24 volt operation
- **EFFICIENT** . . . low battery drain: on 12 volt—total standby, 4.5 amps, transmitting 10 amps. on 24 volt—total standby 2.5 amps, transmitting 5 amps.
- **LOUD** . . . 1 watt minimum with less than 8% distortion.
- **PERFORMANCE** . . . identical with ground systems.
- **QUALITY** . . . exceptional value/price ratio.

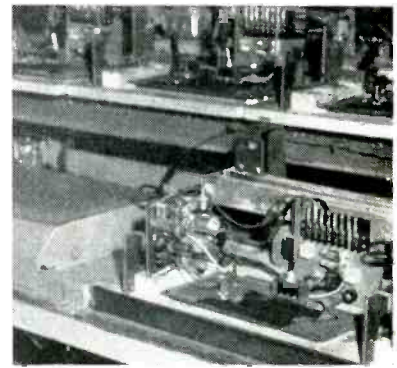
ATTENTION DEALERS!  
Write for available territories.



DESIGNERS AND MANUFACTURERS OF RADIO COMMUNICATIONS EQUIPMENT

# COMMUNICATIONS COMPANY, Inc.

FOUNDED 1938 CORAL GABLES, MIAMI 34, FLORIDA



First position on test line, showing how connections are made from radio to test rack. Push-along air cylinder is mounted under sheet-metal hood at left and controlled by timer. Empty racks come back over conveyor at rear

similarly designed push-along assembly line for this set.

The wiring board is held upright in a grooved wood block. A vertical support with pads presses against the bottom center of the board to serve as a backstop when pressure is applied during alignment adjustments.

The line cord of the wiring board is plugged into a receptacle on the test rack. The test rack in turn receives its power from a trolley duct running the length of the test line at the rear. Each test rack has its own loudspeaker, with clips for connecting to the loudspeaker leads of the radio.

Antenna leads are pushed into clips mounted on a loop antenna fastened flat on the test rack, for pickup of signals from radiating signal generator leads running under the test line.

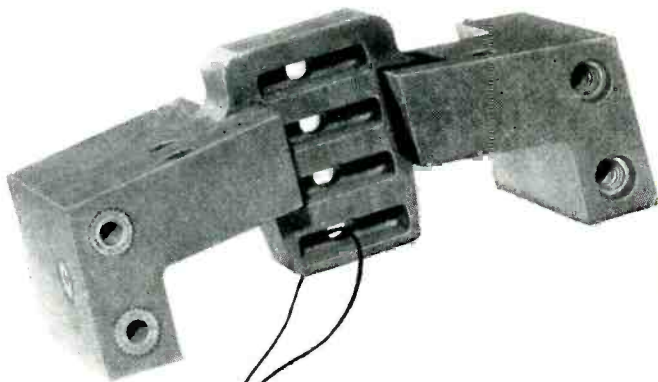
At alignment positions, pushbutton control boxes provide a choice of signal frequencies.

## Ultrasonic Cleaner for Etched Wiring Boards

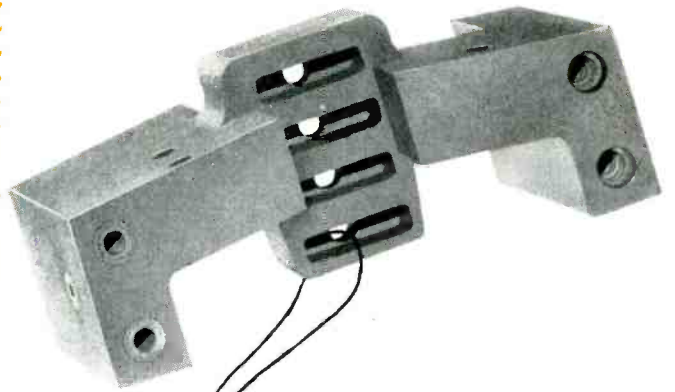
A CUSTOM-DESIGNED ultrasonic cleaner for the removal of solder flux, chemical residues, grease and dust from etched wiring boards after dip-soldering has been made by McKenna Laboratories, Santa Monica, California, for a major West Coast aircraft manufacturer.

Previously, the most satisfactory means of cleaning these boards was hand scrubbing, using a detergent





STANDARD  
LAMINATED PLASTIC  
\$ 2.30 lb.



SPECIAL  
**Formica**  
GRADE  
\$ 1.78 lb.

## HOW **Formica** IMPROVED FABRICATED PART PERFORMANCE AND SAVED 23%!

Formica studied performance requirements, developed a special grade, produced a better part, and saved the customer 52c a pound.

Are you buying laminated plastic properties you don't need? Or are you paying the penalty of poor product performance because you've been short-changed on essential properties?

You can never be sure until you have a Formica fabricating engineer check your performance requirements. Tell him what you need, where and how you'll be

using your fabricated part. Then he'll select the *one grade* that's best and most economical for you.

With 52 standard grades, and a competent research staff to develop special new ones, there's never any compromise with grade selection at Formica. And design modifications recommended by Formica fabricating engineers will further help to produce a better part, frequently at big savings.

This fabricating service is part of Formica-4, designed to give you the best grade at lowest cost for your application. Call your Formica district office or send us your blueprints and your performance requirements. Formica Corporation, subsidiary of American Cyanamid, 4640 Spring Grove Ave., Cincinnati 32, Ohio.

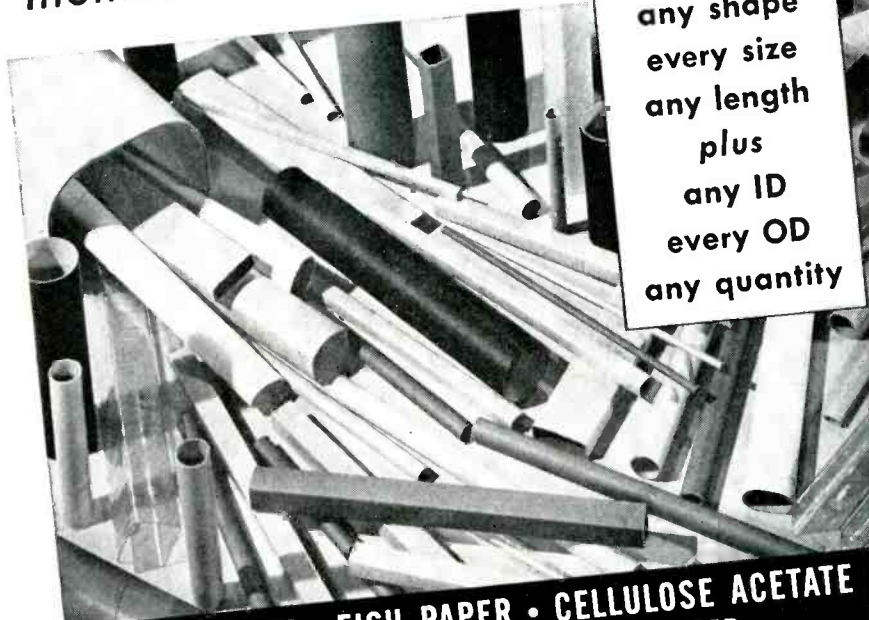
Your *blueprint* tells only *half* the story...

... tell us your performance requirements and we'll save you money



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**Precision** OFFERS YOU  
 HIGHEST QUALITY, LOW COST PAPER TUBING

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 any shape  
 every size  
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 any ID  
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 COMBINATIONS • PHENOL IMPREGNATED**

Round, square, rectangular, triangular, any shape, any size — Precision Paper Tube Co. can provide *all* your paper tubing needs. Your specifications are met to the most exacting tolerances. Precision Paper Tubes are sturdy, crush resistant, have high tensile strength and excellent dimensional stability.

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Precision-made on specially designed equipment, using the finest materials, to provide maximum tensile strength, light weight, more winding space and other essential electrical and mechanical characteristics.

Furnished in any size or shape. Supplied plain or fitted with leads, slots or holes. Flanges cut to specification, plain or embossed. Tube ends swaged to lock flanges.

Send Specifications for samples. Ask for illustrated folder.

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Northern Ohio, Western Penn.: Cleveland, Ohio, Atlantic 1-1060

Indiana, Southern Ohio: Logansport, Indiana, Logansport 2555

California: Pasadena, California, Sycamore 8-3919

Canada: Montreal, Quebec, Canada, Walnut 0337

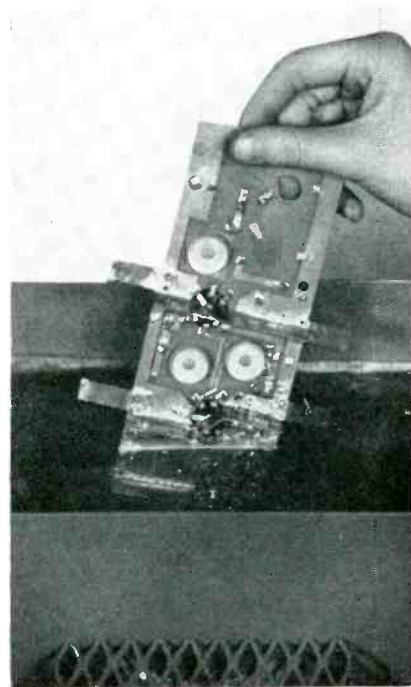


**PRECISION PAPER TUBE CO.**

2041 W. CHARLESTON ST.

CHICAGO 47, ILL.

Plant No. 2: 1 Flower St., Hartford, Conn.



Dip-soldered board being inserted in tank for ultrasonic cleaning

and a stiff-bristled brush. This method was unreliable from the standpoint of reproducibility and was time-consuming and quite inefficient.

► **Tank Setup**—The new ultrasonic cleaning setup is driven by a 750-watt McKenna ultrasonic generator. The cleaning tank is 7 inches wide, 10 inches deep and 25 inches long. Two barium titanate transducers are mounted on the long sides of the tank, slightly offset from each other, so both sides of the board may be cleaned at the same time. A metal guard is mounted at the rear of each transducer as a safety precaution.

► **Results**—Tests conducted by the aircraft manufacturer indicate that this ultrasonic cleaning of etched circuit boards gives a degree of cleanliness equal to or greater than that provided by hand-scrubbing or soaking, takes less time than that required for hand-scrubbing and much less time than soaking. It makes possible very close control of processing variables and practically eliminates human error as a significant factor in obtaining a designated standard of cleanliness.

Because of these advantages, the ultrasonic setup lends itself to complete mechanization of the chassis-



ADVANCED DESIGN  
CUSTOM - SUBMINATURE

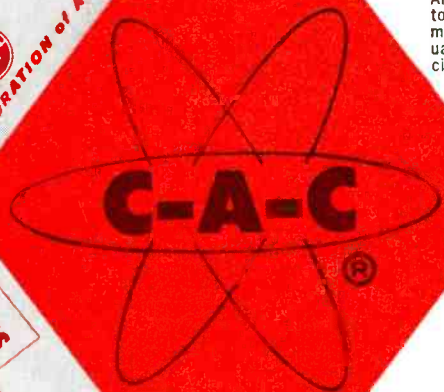
# Toroids

WESTERN UNION  
Western Electric  
MELPAR, INC.  
KELLOGG SWITCHBOARD  
WILCOX ELECTRIC COMPANY

**Bendix**  
AVIATION CORPORATION  
UNION PACIFIC RAILROAD



RADIO CORPORATION of AMERICA  
**HUGHES**  
Aircraft Radio  
A Division of Lockheed Aircraft Corporation



## Why is it? . . .

In 7 short years, CAC has reached a dominant position as an exclusive toroidal coil winding and component producer.

## Why?

We believe it is due to meticulous care, advanced research—and to the specialized skill of our people. Thankful for the trust important customers have placed in us, we are ever mindful of a growing responsibility—YOU CAN DEPEND ON CAC!

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### STEEL CASED TOROIDS

Hermetically sealed to MIL-T-27 specifications—mounting area minimized—lo-hum pickup—hi-perm cases — standard inductances in stock.



### SUB-MINIATURE FILTERS

All types of filters—toroidal inductors and special capacitors for maximum stability, sharpness, and attenuation—advanced design and printed circuit techniques make possible high degree of miniaturization—hermetically sealed construction.



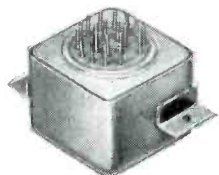
### DELAY LINES

Designed to your specifications—of lumped constant type. Ideal for sonar applications.



### SATURABLE REACTORS

Transformers: Up to 12" OD x 5/8" ID x 4 1/2" high—handling 16 to 38 wire on largest units—miniature transformers to 48 AWG.



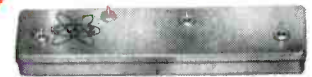
### HI-CYCLE TRANSFORMERS

- Range—400-6000 cps
- Efficiency—up to 95%
- Wattage—6 mw—200 watts
- Temperature —55° to +155° C
- Depicted—6 KC 100 Watt Unit
- Less than 1.65 cubic inches



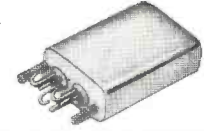
### PLASTIC CASED TOROIDS

CAC compression molded toroids have become the standard of the industry. Incorporated in most advanced military and domestic applications. Stocked units for immediate shipment.



### TUNED CIRCUITS

- For Printed Circuit Applications
- Multiple Tuned Transformers
  - Delay Lines
  - Tuned Circuits
- W — 1"  
L — 4 1/4"  
H — 7/16"



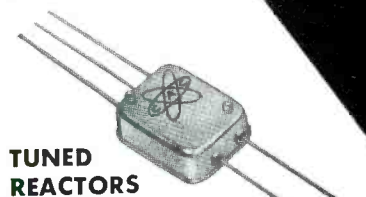
### PULSE TRANSFORMERS

Customized toroidal units. Blocking oscillator and pulse coupling transformers for specific applications. Nth degree subminiaturization.



### MAGNETIC AMPLIFIERS

Toroidal construction and quality materials provide: high gain per stage—fast, stable response. Multiple, electrically isolated input and output windings—line frequencies 60 cycles, 400 cycles and higher—operating temperatures —55° to +100° C—hermetic sealing to MIL specs.



### TUNED REACTORS

- Applications:
- Servo Systems
  - Data Telemetry
  - Remote Frequency Control
- Illustrated—High Frequency Reactor Tuned by Varying D.C. Current.
- W — 1"  
L — 1 1/4"  
H — 15/32"

### DISCRIMINATORS

Linear frequency sensitivity and temp. compensated. May be packaged with MAG AMPS to produce control functions from small signals.

SANGAMO ELECTRIC COMPANY  
GENERAL ELECTRIC

Westinghouse  
Motorola  
CROSLEY

Air Associates

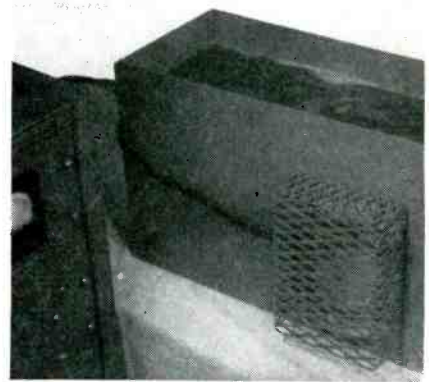
Precision  
Delivery  
Quality



Thinking of  
**SMALL  
RELAYS?**

**ADVANCE**

*builds 'em  
for heavy loads  
and long  
service!*



Method of mounting barium titanate transducer on side of tank. Wire screen protects unit

cleaning operation. It may be expected that equipment of this type will fill an important place in automatic production lines.

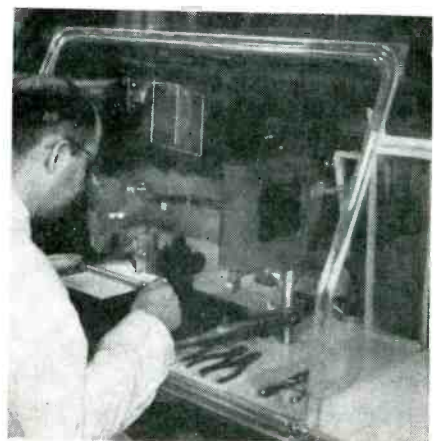
**Dust-Lint Control  
in Tube Plants**

By P. R. PONDY

*Bell Telephone Laboratories, Inc.  
Murray Hill, N. J.*

DUST-LINT CONTROL is essential in electron tube fabrication areas when maximum reliability is to be achieved. An extensive quantitative study of dust-lint concentrations (levels) in electron tube assembly areas resulted in methods of obtaining a low dust-lint level in such areas. These methods include filtering and conditioning the air supply, use of dust-excluding hoods and control over dust and lint generating activities and apparel.

In assembly areas a low dust-lint level in the air supply can be at-



Method of using hood in connection with critical electron tube assembly operation

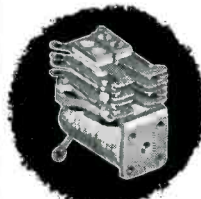
**Cramped quarters** don't cramp the style of ADVANCE midglets and miniatures. You can use them on loads up to 5 amperes continuously... and at three times their rating intermittently—with complete safety. They'll resist shock and vibration... stand up under temperature extremes. You'll find them readily adaptable to any mounting need... any type of duty. Some examples:



**"Tiny Mite"**

**MK SERIES**

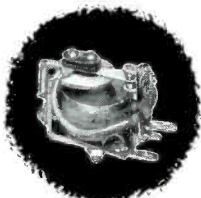
This ultra-small dc relay occupies less than 1/2 cu. in. mounting space! It's stable under vibration and shock... plated to prevent corrosion. Operate time is 5 milli-seconds. Contact rating: .5 amp.



**Miniature Telephone Type**

**TQ SERIES**

Only .94 cu. inches in size, yet this relay carries 5-amp. loads in any combination up to 4 PDT. Mechanically secured throughout, it's extremely efficient. Non-gassing insulation. Withstands 10G vibration. Temp. range: -55° to +125°C.



**General Purpose Midget**

**MG & MF SERIES**

Endless uses for this midglet ADVANCE relay. It's engineered for high efficiency and low price. Operates in any position, with positive contact. Light vibration and shock resistance. Two-amp. or 5-amp. contacts.

**Hermetic enclosures** on these types are impervious to varying climatic conditions... are sealed and carefully checked against leakage.

Write for literature on any of the above series, or the complete ADVANCE line.



**ELECTRONICS DIVISION**

**ELGIN NATIONAL WATCH COMPANY**

FOR RELAYS: 2435 N. Naomi Street, Burbank, California

*Sales Representatives in Principal Cities of U.S. and Canada*



**DOW CORNING  
CORPORATION**

# Silicone News

FOR DESIGN ENGINEERS

## INCREASE ACCURACY OF SEXTANTS

Air bubble rides in a chamber filled with a Dow Corning silicone fluid to improve the performance of one of the most accurate instruments ever developed for the celestial navigation of aircraft.

The periscopic sextant produced by Burton Manufacturing Co., Los Angeles, includes a timing and averaging mechanism, a controlled periscope, and a bubble-type sextant.

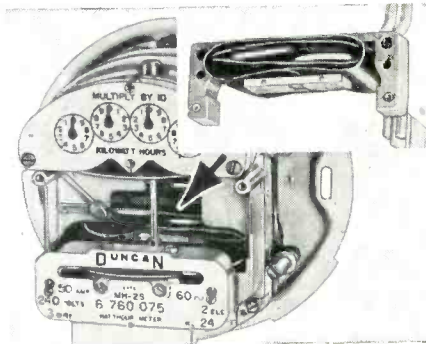
The silicone fluid used to help compensate for changes in ambient pressure and temperature during operation, was originally specified by the Bureau of Aeronautics and the Air Force. Developed especially for this application, Dow Corning F-323 Fluid has an extremely low cloud point and a viscosity of only 0.65 centistokes. Low viscosity minimizes bubble movement due to aircraft acceleration.



Freedom from clouding and low viscosity are retained at temperatures ranging from -65 to more than 170 F. The silicone fluid shows no sign of thickening, color change or gumming after more than 3 years of service. No. 85

## CLASS H MOTOR STILL ON TEST AFTER 56,038 HOURS AT 240 C

At 10 A.M., June 6, 1946, a Class H insulated 5 hp motor was generator loaded to operate at its test temperature of 240 C in Dow Corning's motor test labs. Every 500 hours since it has been shut down and exposed to 100% relative humidity for 24 hours. As of 11 A.M. April 1, 1956, this motor was still on test after 56,038 hours at an average copper temperature of 240 C! That's equivalent to 341 years operation at the Class H temperature of 180 C.



## Current Meters Have 400% More Capacity With Silastic Insulation

With power requirements of the average household doubling every eight to ten years, Duncan Electric Manufacturing Company, Lafayette, Indiana, exercised considerable foresight in developing 50-amp socket-type watt-hour and demand meters that can handle continuous loads as high as 200 amperes. Duncan designers utilized the dielectric and physical properties of Silastic,\* Dow Corning's silicone rubber, in engineering 4 times more capacity into a standard size meter.

The copper specified for the current coil of the new meter is considerably larger than that normally used. This means that the space available for the current coil insulators—a set of rubber belts known as "britches insulation"—is, in Duncan's words, . . . "limited and, therefore the insulation must be of the very best type."

It must resist surges caused by lightning and withstand maximum loads for long periods of time without deterioration. The insulation must also have enough physical strength to prevent damage during shipment or installation, and be completely resistant to cold flow. Moreover, it must retain its dielectric and physical properties for the full life of the meter, usually about 30 years.

To meet these rigid requirements Duncan specifies insulators fabricated from Silastic.

\* TM REG. U. S. PAT. OFF.

No. 86

Now available—1956 Reference Guide to Dow Corning Silicone Products. A concise, comprehensive, 12 page reference that is convenient-to-use. It's packed with data, properties, and information on how you can use silicones in designing new equipment, improving performance and reliability of original equipment. No. 87

## Silicone Lubricant Improves Operation of Voice Recorder

To further extend the usefulness and maintenance-free life of their unique "Voice-Master" dictation recorder, Magnetic Recording Industries of New York has changed to silicone lubrication of all moving parts.

Since the consistency of the silicone lubricant remains relatively constant over a wide temperature span, the Voice-Master "can be moved directly from an automobile at below freezing into a warm room and operated immediately at proper speed." Moreover, relubrication of the unit is seldom, if ever, necessary.



Although the silicone lubricant costs more initially than the petroleum grease used previously, Magnetic reports the increased cost per unit is so low that "in reality it adds nothing to the cost of the complete Voice-Master." No. 88

## "151 Uses for Silicones in Metalworking."

A reprint from STEEL, condenses and lists known applications for silicones in Design, Production, Maintenance and Miscellaneous categories. Provides a quick reference as to how Dow Corning Silicones help solve problems in many segments of the metalworking industry. No. 89

## Design Edition 21

**DOW CORNING CORPORATION - Dept. 4806**  
Midland, Michigan

Please send me 85 86 87 88 89

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TITLE \_\_\_\_\_

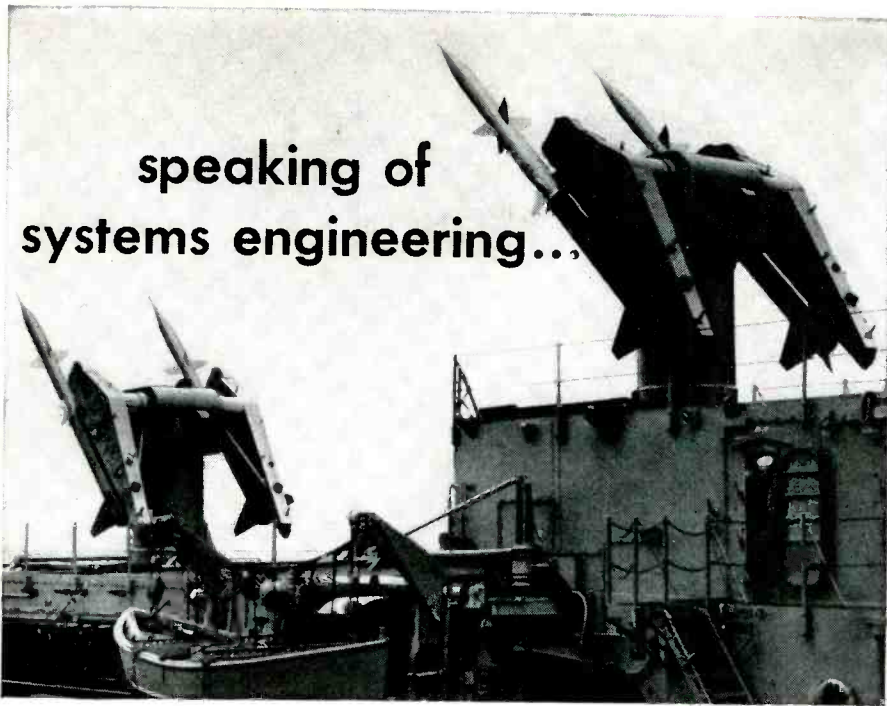
COMPANY \_\_\_\_\_

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ATLANTA • BOSTON • CHICAGO • CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEW YORK • WASHINGTON, D. C. (Silver Spring, Md.)  
Canada: Dow Corning Silicones Ltd., Toronto; Great Britain: Midland Silicones Ltd., London; France: St. Gobain, Paris

# speaking of systems engineering...



OFFICIAL U. S. NAVY PHOTOGRAPH

**T**HE USS Boston, recently commissioned as the first guided missiles warship in history, carries the newest and most powerful weapons afloat.

Vitro Laboratories takes pride in the Navy's "well done" for its part in the systems engineering of the missiles installation and launching system on the Boston.

Another first in the important new field of systems engineering is the comprehensive multiple-range timing system conceived, developed, installed and operated by Vitro for armament testing at the Air Force Armament Center in Florida. By means of pulse electronics, a time signal generator establishes base "central" time measured in 10,000ths of a second. The system transmits time signals to remote ground and airborne stations for precision command timing and time identification of action photographs.

These are but two of many examples of Vitro's role in systems engineering of the most advanced kind. They are forerunners of significant new systems applicable across a broad industrial spectrum.

Vitro Laboratories is now building a million-dollar laboratory to make its staff and facilities available for new industrial and governmental projects.

Write for detailed information to

**VITRO LABORATORIES**, 962 Wayne Avenue, Silver Spring, Md.

A Division of

**Vitro** CORPORATION of AMERICA  
261 Madison Ave., New York 16, N.Y.

- ☞ Research, development, weapons systems
- ☞ Uranium mining, milling, processing, refining
- ☞ Nuclear and process engineering, design
- ☞ Rare metals, heavy minerals, fine chemicals
- ☞ Refinery engineering, design, construction
- ☞ Ceramic colors, pigments, chemical products

tained by three-stage filtering, using an oil-impregnated paper filter, an electrostatic filter and a dry bonded glass-fiber filter. After filtering, it is desirable that the air be conditioned to about 50 percent relative humidity and a temperature of  $75 \pm 2$  degrees F in order to reduce contamination from perspiration and to avoid effects of static charge at lower relative humidity.

► **Measuring Dust** — Conditions conducive to low and high dust-lint levels were determined by counting particles falling onto clean dishes exposed in the test areas. The resulting data are presented in Fig. 1. This graph shows

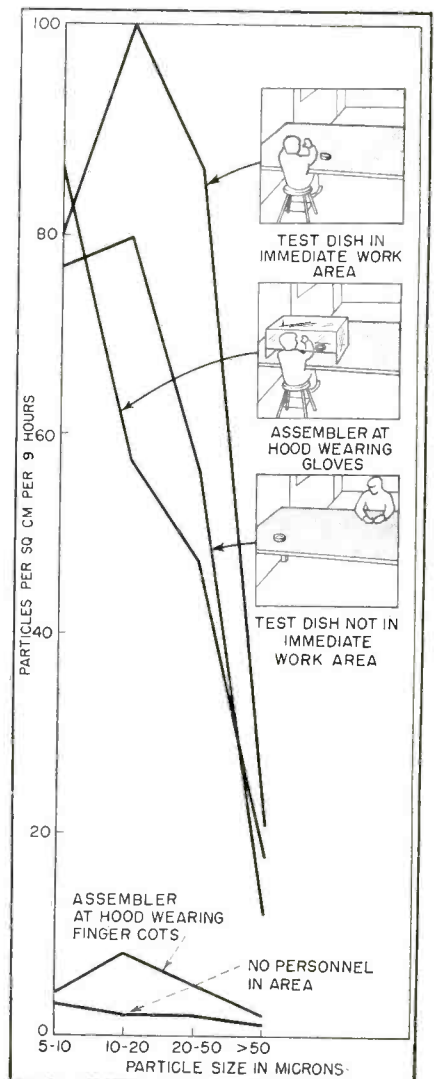


Fig. 1.—Particle size distribution on test dish exposed in various assembly areas. Note that curve for assembler at hood wearing finger cots, falls in same low region as dish count with no personnel in vicinity of work area






# KOVAR

## glass-sealing alloy



**EXPERIENCE**  
of users proves  
the superiority of  
**KOVAR ALLOY**

*because it*  **MATCHES PERFECTLY**  
 **FUSES READILY**  
 **BONDS PERMANENTLY**

# KOVAR<sup>®</sup>

*makes the **BEST** glass-to-metal seals*

For more than 21 years, Kovar has been the first choice of users of glass-sealing alloys. Kovar holds its leadership because of its uniform quality, its availability in all desired forms and the Technical Service provided by the Stupakoff organization.

easy to join to other metals by welding, soldering or brazing; it is available in the form of sheets, strip, wire, rod and tubing—as well as fabricated into cups, eyelets, leads, etc.

This unique metallic alloy matches perfectly the thermal expansion characteristics of certain hard glasses; it is

Twenty-one years of manufacturing and research experience guides Stupakoff engineers in the application and use of Kovar Alloy. Let our technical service help you gain the benefits it offers!

-  20 YEARS
-  20 YEARS
-  18 YEARS
-  20 YEARS
-  14 YEARS
-  15 YEARS
-  13 YEARS
-  17 YEARS
-  8 YEARS
-  20 YEARS
-  7 YEARS
-  20 YEARS
-  9 YEARS
-  15 YEARS

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# Stupakoff

DIVISION OF

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LATROBE,  
PENNSYLVANIA

**The CARBORUNDUM Company**



**True Hermetic Sealing  
assures Maximum Stability**

# in **AMPERITE** **RELAYS and REGULATORS**

**Simplest • Most Compact • Most Economical**



STANDARD



MINIATURE

## Thermostatic **DELAY RELAYS** **2 to 180 Seconds**

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- Hermetically sealed. Not affected by altitude, moisture, or other climate changes.
- SPST only — normally open or normally closed.

**Amperite Thermostatic Delay Relays** are compensated for ambient temperature changes from  $-55^{\circ}$  to  $+70^{\circ}$  C. Heaters consume approximately 2 W. and may be operated continuously. The units are most compact, rugged, explosion-proof, long-lived, and — inexpensive!

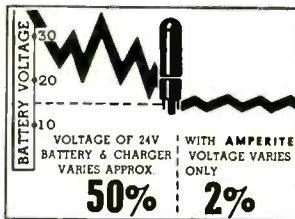
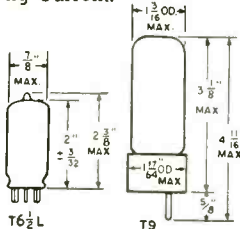
TYPES: Standard Radio Octal, and 9-Pin Miniature

**PROBLEM? Send for  
Bulletin No. TR-81**

Also — **Amperite Differential Relays:** Used for automatic overload, under-voltage or under-current protection.

## **BALLAST REGULATORS**

Amperite Regulators are designed to keep the current in a circuit automatically regulated at a definite value (for example, 0.5 amp.) ... For currents of 60 ma. to 5 amps. Operate on A.C., D.C., Pulsating Current.



Hermetically sealed, they are not affected by changes in altitude, ambient temperature ( $-55^{\circ}$  to  $+90^{\circ}$  C.), or humidity ... Rugged, light, compact, most inexpensive.

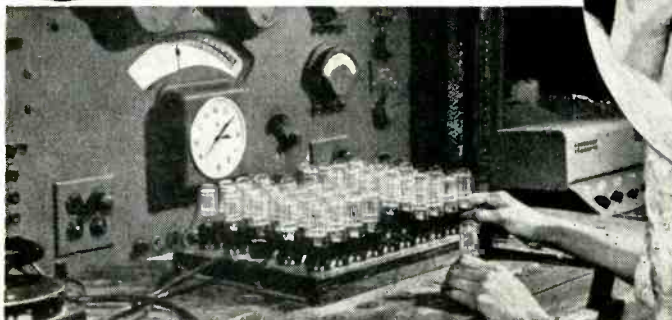
Write for 4-page Technical Bulletin No. AB-51

**AMPERITE CO., Inc.**

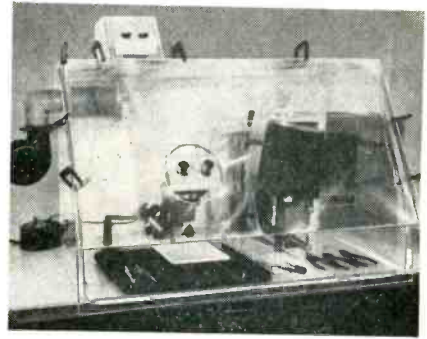
561 Broadway, New York 12, N. Y.

Telephone: CAnal 6-1446

In Canada: Atlas Radio Corp., Ltd.  
50 Wingold Ave., Toronto 10, Ontario.



Individual inspection and double-checking assures top quality of Amperite products.



Construction details of hood as made by P. M. Lennard Co., Inc., Jersey City, N. J.

that high dust-lint levels are prevalent in open assembly areas whenever personnel are present. Since filtered air is supplied to the areas, the problem is apparently one of internal generation. Therefore, the activity of personnel and the apparel they wear are chief causes of the high concentrations of dust and lint observed.

Tests were also made with a transparent plastic dust-excluding hood operated under positive pressure developed by a blower-filter system coupled directly to the hood. Here, low dust-lint-level air flushes through the hood continuously. The curves in Fig. 1 show that the dust-lint level in hoods is high only when an assembler working at the hood wears dust-lint generating gloves. Compared to open-area assembly, a 15-fold lowering in level was observed when operators wore rubber finger cots in carrying out assembly operations under hoods. This stresses the benefits derived from the use of the hoods and the importance of control over the hand apparel worn by assemblers.

► **Housekeeping**—In areas receiving good quality air, control of internally generated dust and lint can be instituted by keeping transient traffic to a minimum, isolating sensitive operations from dust-lint generating operations, selecting nongenerating apparel for personnel and using properly designed dust-lint excluding hoods for assembly operations.

It is imperative to maintain control of dust and lint during storage and/or processing as well as during all phases of manufacture if the benefits of control measures are to be reflected in the performance of electron tubes and other devices.



# Reliability in Printed Circuits...

 **Textolite**<sup>®</sup> 11541

## COPPER-CLAD LAMINATE

- ★ BETTER BOND STRENGTH
- ★ RESISTS HEAT DURING SOLDERING
- ★ BETTER PUNCHABILITY
- ★ MORE CONSISTENT DIELECTRIC PROPERTIES
- ★ CLAD ONE OR BOTH SIDES
- ★ AVAILABLE IN FLAT, UNWARPED SHEETS



G-E TEXTOLITE Grade 11541 is a high insulation resistant laminate designed for a wide variety of electronic applications.

When faced one or both sides with copper foil, G-E TEXTOLITE 11541 copper-clad laminate is ready for printing and etching.

The high bond strength of G-E TEXTOLITE 11541, in flat sheets, adds greatly to its ease of fabrication. G-E TEXTOLITE 11541 also offers high heat resist-

ance—goes through dip soldering temperatures without blistering.

TEXTOLITE 11541 offers excellent electronic insulation properties for printed circuitry. (Typical high-resistance value—300,000 megohms after 96 hours at 35° C. in 90% relative humidity.)

For a new ease of fabrication, as well as greater economy and more dependable printed circuits, specify G-E TEXTOLITE 11541 copper-clad laminate—a result of research and engineering by General Electric.

when the properties have to be right  
specify **G-E Textolite**

*Progress Is Our Most Important Product*

**GENERAL**  **ELECTRIC**

G-E Textolite® Laminated Sheets, Tubes and Rods • Irrathene® Irradiated Polyethylene • Silicone Insulation • Mica and Mica Mat Insulation • Insulating Varnishes • Varnished Cloth and Tapes • Sealing and Filling Compounds

General Electric Company  
Laminated and Insulating Products Department  
Section EL-66, Coshocton, Ohio  
 Please send me technical data on G-E Textolite 11541 for printed circuits.  
 Please have your representative call.

NAME .....

FIRM .....

STREET .....

CITY ..... ZONE ..... STATE .....

# New Products

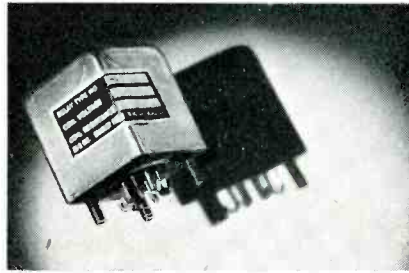
Edited by WILLIAM P. O'BRIEN

69 New Products and 80 Manufacturers' Bulletins Are Reviewed  
. . . Control, Testing and Measuring Equipment Described and  
Illustrated . . . Recent Tubes and Components Are Covered

## SUBMINIATURE RELAY

hermetically sealed

HI-G, INC., Bradley Field, Windsor Locks, Conn., has announced a sub-miniature, hermetically sealed, space saving relay measuring 1 in. sq by 1 3/64 in. high to meet and surpass applicable portions of MIL-R-5757C. It features operating temperatures to 125 C with long-life characteristics at rated contact

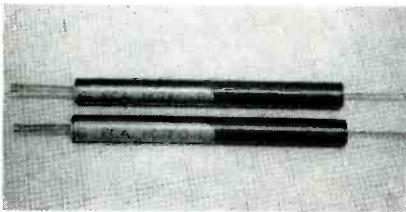


loads of 2 amperes at 28 v d-c or 115 v a-c. Coil resistance range is 50 to 10,000 ohms. Hook terminals or straight pins for plug-in and printed circuit applications are standard.

The relays may be obtained in form A, B or C contact arrangement with a maximum of two poles. They are available for a-c operation with internally mounted silicon rectifiers.

## DELAY LINES

for color television



PCA ELECTRONICS INC., 2180 Colorado Ave., Santa Monica, Calif., has available color tv delay lines. Characteristic impedance of the lines is 1,600 ohms. They can be obtained with delay times of 0.4 and 0.7  $\mu$ sec. Phase response is adjust-

able during manufacture to compensate for phase shift in customer's i-f and video amplifiers.

They are packaged in 1/2 in. phenolic tubing 5 1/2 in. long  $\pm$  1/8 in. Hookup lead wire may be either insulated stranded or solid tinned copper wire. These lines are wax impregnated and will not be affected by high humidity.

## TAPE HANDLERS

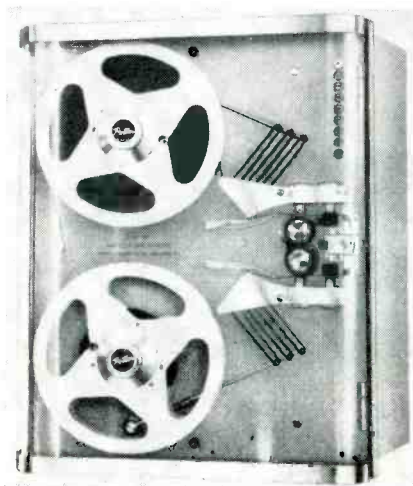
feature speeds to 75 ips

POTTER INSTRUMENT Co., INC., 115 Cutter Mill Road, Great Neck, N. Y., announces a new series of digital magnetic tape handlers. Features of the model 905 series include tape speed up to 75 ips with 3 ms starts and stops. Tape widths of 1/4, 1/2, 3/8, 3/4, 1 and 1 1/4 in. may be used.

► **Extras**—Other new features include fast rewind in both forward and reverse directions, requiring 2 1/2 minutes to rewind 2,400 ft of tape. A hinged rear door of the rack-mounted unit provides access to all wiring connections and the remote control terminal strip. Quick threading is facilitated by a mechanical arrangement that retracts

tension sensing arms, permitting changing of tapes in seconds.

Model 905 is automatically



stopped when the end of reel of tape approaches, when line voltage fails or drops below a prescribed minimum, or in the event of a tape failure. All machine functions may be controlled by conveniently-grouped front-panel pushbuttons or by remote contact closures or pulses.

## RESISTANCE ELEMENTS for six specific waveguides

METAVAC INC., 45-68 162nd St., Flushing 58, N. Y., announces a new line of metalized eyelet waveguide resistance elements featuring glass-to-metal soft soldering.

The metalized components are negligibly thin compared to the highest microwave frequencies,



# Sylvania "Originals"

GAS FILLED  
TYPES  
0B3  
0D3  
5644

RELIABLE  
TYPES  
5670  
5814 WA

RADIO AND  
TELEVISION TYPES

1L6 6BZ6  
1X2B 12AD7  
5U4GB  
6AW8A  
6BA8A  
6BC8

ELECTRONIC  
CONTROL TYPES

6D4  
5643  
6308

COMPUTER  
TYPES

7AK7  
6350  
6814

MILITARY  
TYPES

5636  
5719  
6111  
6021  
6788

...on every branch of  
the Electronic Family Tree

ORIGINAL equipment designers know that when there is a need for something new in a tube Sylvania is there to take up the slack. That's how many of these Sylvania-registered types were originated.

Other Sylvania "Originals" are the products of a continuous research pro-

gram maintained to keep the designer supplied with the tools of advanced equipment design.

Within this highly productive decade, hundreds of Sylvania "Originals" account for the lion's share in popularity as well as volume in every important phase of electronics.

 **SYLVANIA**

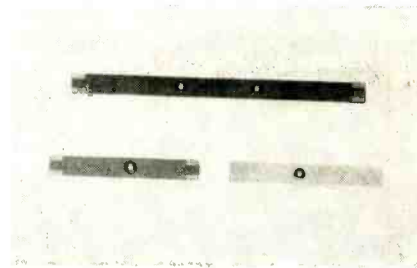
SYLVANIA ELECTRIC PRODUCTS INC.  
1740 Broadway, New York 19, N. Y.  
In Canada: Sylvania Electric (Canada) Ltd.  
University Tower Building, Montreal

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

noninductive, and their noise level is barely measurable. By precise evaporation, the resistance films are held to an accuracy of 1 percent, and their low temperature coefficient of resistance of approximately 75 parts per million per deg C is achieved.

These elements meet Specs MIL-

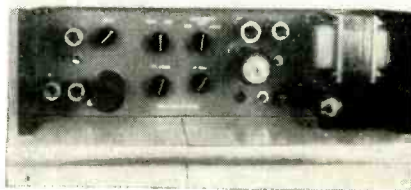
A-11052A and are available in six specific sizes for use with waveguides RG-48/U, RG-49/U, RG-50/U, RG-51/U, RG-52/U and RG-90/U. Other types and sizes of attenuator plates with metalized eyelets will be fabricated to customer's requirements. Sample quantities are available on request.



## EQUALIZER-AMPLIFIER

for video cable

RON ELECTRIC Co., 23 Edsall St., Nanuet, N. Y., has announced the EA-4 video cable equalizer-amplifier. It provides a simple means of equalizing RG-11/U type cable lengths up to 2,000 ft for a response flat to beyond 5 mc.



► Uses—The product is useful for

tv stations, closed-circuit tv installations, radar systems and many

others requiring the transmission of wide-band video or pulse information over coaxial cables.

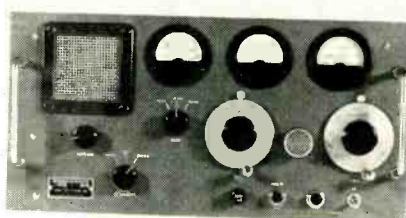
This unit is supplied complete with electronically regulated power supply on a single rack-mount chassis. It is also available in a portable case for field use or in a weather resistant steel enclosure for permanent outdoor mounting.

Price is \$290. Complete information and specifications are available.

## TELEMETRY RECEIVER

is crystal controlled

NEMS-CLARKE, INC., 19 Jesup-Blair Drive, Silver Spring, Md., has available a new design in a crystal controlled, double conversion telemetry receiver. Type 1400 operates in the 216 to 245 mc frequency range, and a choice of two different i-f bandwidths of 500 kc or 100 kc may



be made from the front panel by means of a selector switch. The narrow bandwidth i-f is primarily intended for a reception of pwm/f-m and ptm/f-m signals with a nominal deviation of  $\pm 50$  kc. Included in the receiver is a peak frequency deviation meter which is useful in setting up the desired frequency deviation of individual sub-carriers.

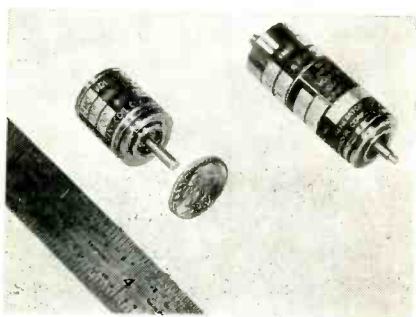
## SERVO UNITS

only  $\frac{3}{4}$  in. in diameter

TRANSICOIL CORP., Worcester, Pa., has announced a size 8 servo motor and motor driven induction generator. Only  $\frac{3}{4}$  in. in diameter, the size 8 control motor is 40 percent lighter in weight and 10 percent smaller in diameter than the size 9. An all-transistor amplifier has

also been developed to power the servo combination as a highly miniaturized package. When required, Transicoil will also furnish a converter to drive a counter for analog-to-digital conversion.

► Applications — Need for this small system abounds in the aviation field for rocket and missile research and development, navigation instruments, electronic controls for aerial cameras, and other applications requiring accurate, split-second servo control limited in space and weight. Great industrial application will be found in instrumentation and automatic control.



One of the main advantages of the size 8 units is that despite small size they can be wound for standard voltages and push-pull application, by means of a patented technique.

Complete technical specifications for control motor and generator are available.

## EXPERIMENTAL KITS for designers and engineers

ERIE RESISTOR CORP., Erie, Pa., has available PAC (packaged assembly circuit) experimental design kits. These kits are designed to enable engineers and designers to experimentally produce working breadboard prototypes and establish de-



# For ACCURATE HIGH SPEED SWITCHING..

*Specify*

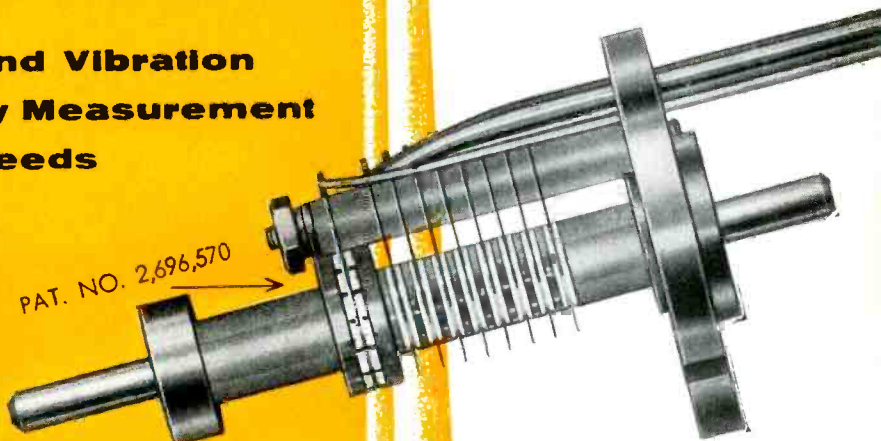
## ELECTRO TEC miniature ultra-low torque Precision Selector Switch

- Withstands Shock and Vibration
- Offers High Accuracy Measurement
- Operates at High Speeds

This new Electro Tec Precision Selector Switch is ideal where miniature size, low friction torque, high accuracy, and low electrical noise at high speeds are requirements. Simplified circuits and long service life recommend it for a wide variety of uses including sampling, pulse generation for precision measurement, telemetering and strain gage applications, in aircraft, missiles, servos, computers, etc. Switch design incorporates many exclusive features that have gained industry-wide acclaim for Electro Tec precision slip rings, commutators and brush blocks.



PAT. NO. 2,696,570

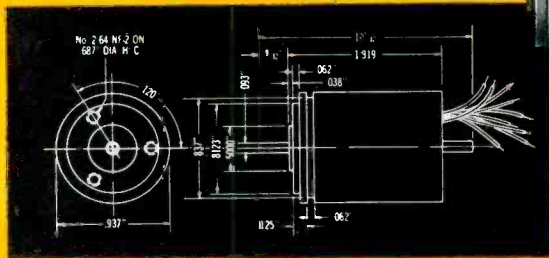


CALL OR WRITE  
FOR ILLUSTRATED BROCHURE

8 or 10 position switches in standard size 10 synchro housings are available for immediate delivery; other circuit combinations supplied to specifications.



ACTUAL SIZE



**Electro Tec Corp.**

SO. HACKENSACK  
NEW JERSEY  
Tel.: HUBBARD 7-4940



## SYSTEMS ENGINEERS

*Electronic—Electro-  
Mechanical...for computers  
...fire control designs*

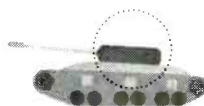
Librascope has openings for "career men to be assigned to the Special Devices Department—one of the four autonomous engineering development divisions, where each individual works closely with management—stays with his project from start to finish. Categories include: analog and digital fire control systems engineers, transistor specialists, servomechanisms engineers, and many others.

Military projects in the Special Devices Division cover all phases of applied technology—mechanical, electronic and optical, starting with basic devices such as photo-reconnaissance cameras, photo-transistors, rocket and gun sights...and extending to complete systems involving analog and digital computers.

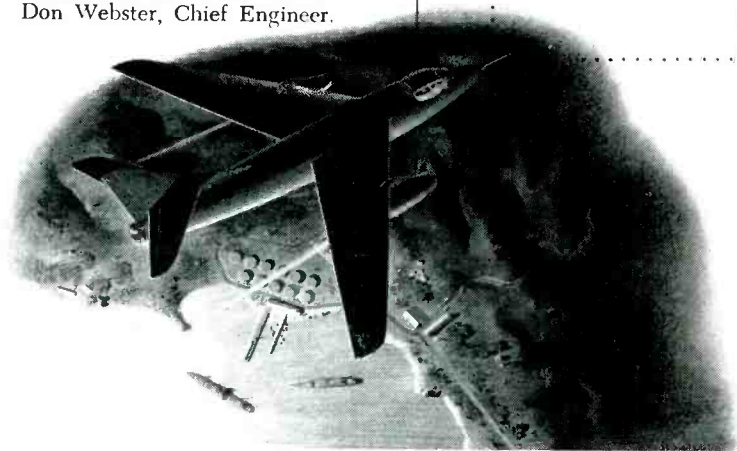
Join a company that has the "young man's" viewpoint—pays well, assists in relocation—provides subsidiary benefits and professional advancement. Contact Don Webster, Chief Engineer.



The Douglas A4D atom bomber is equipped with gun and rocket sights designed and produced by Librascope.



Tanks... land navigation and fire control systems are long range Librascope projects.



When a Navy photo-reconnaissance plane makes a jet-propelled "camera strike," the payoff is assured by Librascope viewfinder equipment.



A SUBSIDIARY OF  
GENERAL PRECISION EQUIPMENT CORPORATION

LIBRASCOPE, INC. · 808 WESTERN AVE. GLENDALE, CALIFORNIA

sign centers using this modular technique.

► **How Available**—Kits may be had in 3 models, 5, 10 and 20 percent. The 5-percent kit includes 145 RETMA resistor values and 50 RETMA capacitor values. The 10-percent kit contains 73 RETMA resistor values and 32 RETMA capacitor values, while the 20-percent kit contains 37 RETMA resistor values and 17 RETMA capacitor values.

All kits include a universal wiring board which employs the standard 0.2-in. grid system and will provide a means of circuit design which will closely duplicate the finished printed wiring PAC layout. Each kit has 1,000 eyelets for use in mockup bus wiring.

The 5-percent kit is priced at \$125, the 10-percent kit at \$75, and the 20-percent kit at \$50.



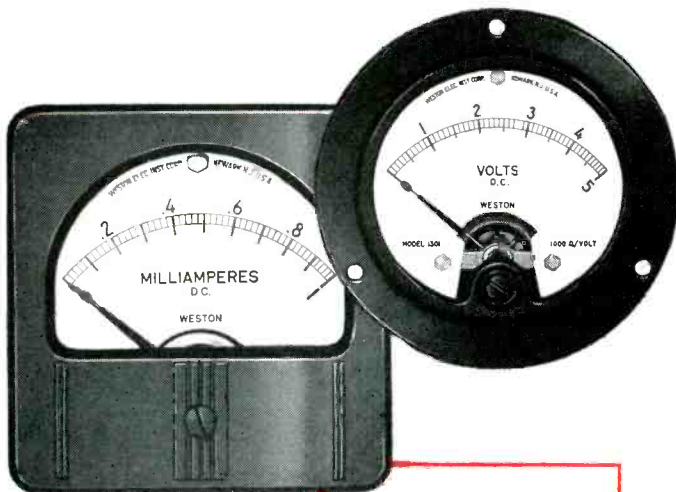
### PULSE COUNTER variable scale type

BURROUGHS CORP., Detroit 32, Mich. Type 1750 variable scale counter features a better method of displaying the count in a digital system, as well as greatly improved operating characteristics. The unit is applicable to any counting need whether it be for a preset counter, a burst counter, a scaler or an adder. Not only is each count represented visually by means of a neon indicator, but also electronically in the form of a d-c signal, thereby allowing the unit to act also as a sorter, a pulse distributor, a converter or a coding device.

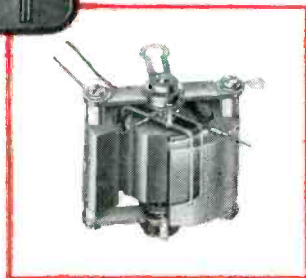
► **Technical Data**—The counter input accepts 0.1  $\mu$ sec, 30-v pulses, amplifies and standardizes them, and then applies these pulses to



# QUALITY RIGHT TO THE CORE



Weston CORMAG<sup>®</sup> mechanism shown in phantom cutaway — a compact, light-weight permanent magnet moving-coil mechanism; self shielded from the effects of external magnetic fields.

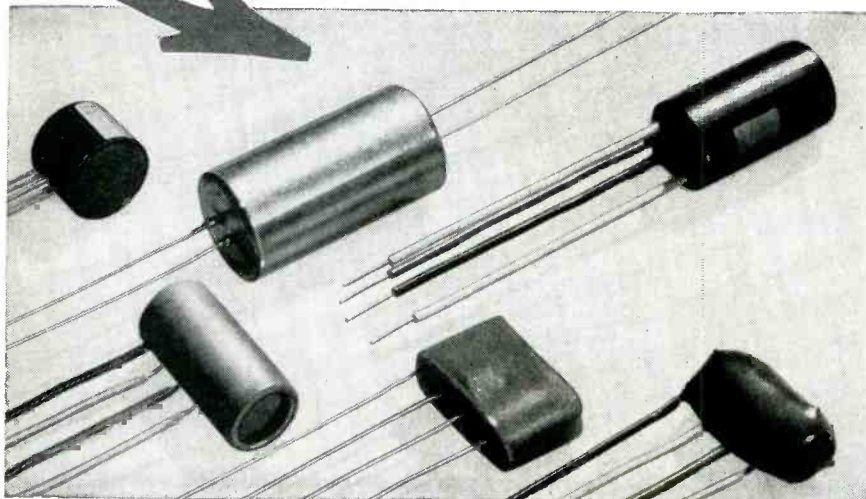


Everything about the Model 1301 line of Weston panel instruments is different . . . from the terminals and lance type pointer right through to the core-magnet mechanism . . . not forgetting the lower price. The big attraction, of course, is the highly perfected Weston CORMAG<sup>®</sup> mechanism which provides excellent shielding from external fields, thus permitting their use interchangeably on magnetic or non-magnetic panels without need for adjustment, and eliminating any inter-effect of instruments on one another when mounted in close proximity. For the complete story on the 1301 line, and on other WESTON instruments for panel use including the famous *ruggedized* line, consult your nearest WESTON representative, or write WESTON Electrical Instrument Corporation, 614 Frelinghuysen Ave., Newark 5, N. J. A subsidiary of Daystrom, Incorporated.

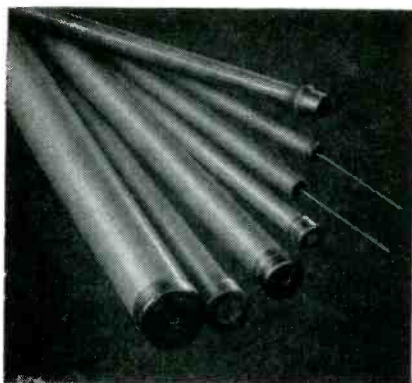
## WESTON CORMAG<sup>®</sup> PANEL INSTRUMENTS

# UNION

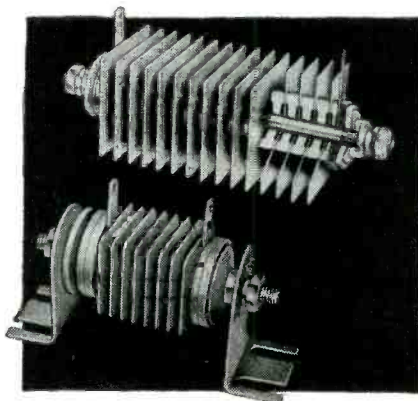
## SELENIUM RECTIFIERS fitted to your application



SPECIALLY DESIGNED COMBINATIONS of standard UNION selenium rectifier cells range in size from  $\frac{1}{8}$ " to  $\frac{1}{2}$ " diameter rated from 2.5 to 40.0 milliamperes per cell on a single-phase full-wave bridge basis.



"SELENIUM SLIMS" in five ratings ranging from 1.25 to 20.0 milliamperes and maximum peak inverse voltages from 36 to 9360 with condenser input filter. Available in diameters from  $\frac{1}{8}$ " to  $\frac{1}{2}$ ".



POWER RECTIFIERS with solid stack assembly range in size from 1" x 1" to 5" x 6" and with convection cooling are rated from .80 to 10.0 amperes per cell on a single-phase full-wave bridge basis.

*Our engineers can help you in designing the best rectifier for your applications. Write for catalog.*

# 75 Years

1881



1956

OF EQUIPMENT AND SYSTEMS ENGINEERING . . . . .

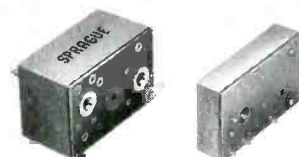
**UNION SWITCH & SIGNAL**

DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY  
PITTSBURGH 18, PENNSYLVANIA

NEW PRODUCTS

(continued)

the grids of a beam switching tube where they are counted at speeds from pushbutton to 500 kc. The beam switching tube, where the count is stored, has 10 stable beam positions. The output of each of these positions is available in the form of a d-c voltage pulse, 90 v from the position on which the beam is formed, 60 v from the other 9 positions. Scale factors of 2 through 10 are available merely by turning a knob. Provision is also made for automatic zero reset without cycling.



### SHIFT REGISTERS for digital computers

SPRAGUE ELECTRIC Co., 35 Marshall St., North Adams, Mass. Magnetic shift registers for use in airborne and ground digital computer applications operating at frequencies of 30 kc, 100 kc, and 200 kc are available as standard.

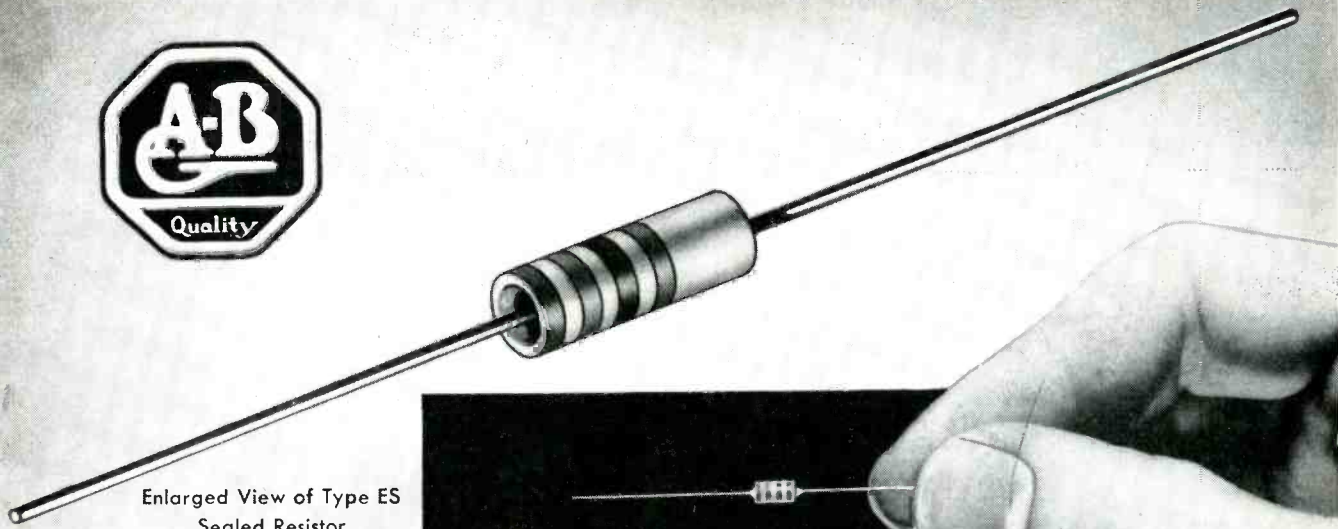
A complete description of 4 different types of plastic-embedded register assemblies and one metal-encased register assembly to fit various application needs is given in engineering bulletin No. 550-C, available on business letterhead request.

Two of the plastic-embedded styles are shown in the photograph. One has short pin leads for use with printed wiring boards while the other, for use in stacked register assemblies, has its own banana plugs and jacks for interconnection of units.

### SWEEPING OSCILLATOR provides high level output

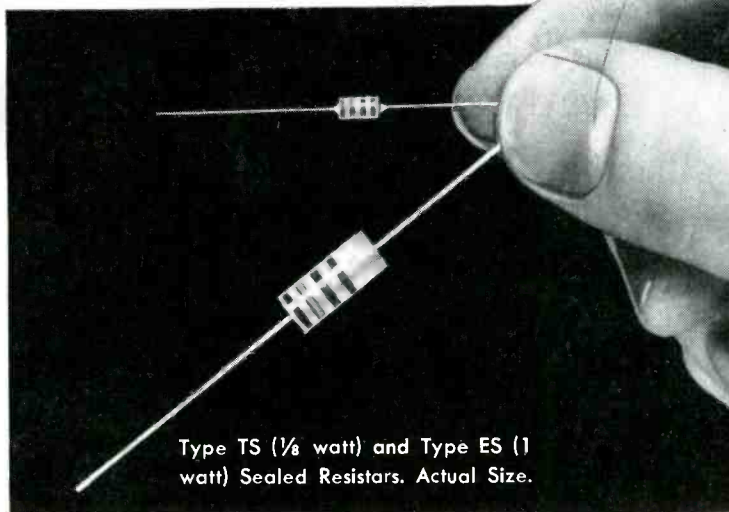
KAY ELECTRIC Co., Pine Brook, N. J., has announced the RF-P Marka-Sweep, an all-electronic sweeping oscillator with marks. New design provides high level (1.0 v) output automatically held





Enlarged View of Type ES Sealed Resistor

*It cannot be true — But,*



Type TS (1/8 watt) and Type ES (1 watt) Sealed Resistors. Actual Size.

*Here is what the new A-B hermetically sealed composition resistors will do!*

**Unaffected by humidity or moisture**

Humidity and moisture have been nuisance factors to all composition resistors. The type of hermetic sealing built into the new A-B Type TS and Type ES resistors entirely eliminates this possible objection.

**Higher temperature rating**

Special techniques have made it practical to increase the operating temperature beyond the rating heretofore considered "safe" with composition resistors.

(Type TS: .125 Watt... 70°C, 0-derating at 110°C)  
(Type ES: 1 Watt...70°C, .5 Watt...120°C, 0-derating at 165°C)

**2% and 5% tolerances**

The amazing stability incorporated in Allen-Bradley composition resistors has made a 2% tolerance a realistic and usable circuit design possibility.

**Extremely low noise level**

All microphonic noise, occasionally encountered in composition resistors due to shock and vibration, has been eliminated.

**From 10 ohms to 500,000 megohms**

Although normally supplied in the standard ranges from 10 ohms to 22 megohms, these resistors are also available for special applications in extremely high resistance values, the

limits being determined largely by the capability of the measuring equipment.

**Catastrophic failure impossible**

For the first time a resistor is now available having characteristics approaching wire-wound "precision," plus the established reliability of the A-B hot-molded composition units, assuring complete freedom from catastrophic failure.

**Designed for manhandling**

The hot-molded Allen-Bradley composition resistor in its ceramic enclosure and high temperature end seals results in an unusually rugged construction, possessing uniformity of size and configuration, making these resistors ideal for mechanical handling.

**Allen-Bradley quality and uniformity**

Experience gained from the production of hundreds of millions of hot-molded resistors, combined with typical Allen-Bradley quality control, has produced a resistor unique in performance and especially adaptable for the always increasing critical applications of military and computer circuitry. You will want to become better acquainted with this new development in resistors! Representative values can be furnished for test.



Allen-Bradley Co.  
110 W. Greenfield Ave., Milwaukee 4, Wis.

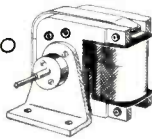
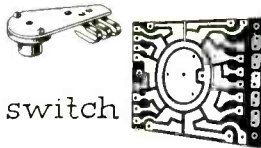
Please send me technical data on the A-B hermetically sealed resistors.

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_

SUPPOSE you could drive a rotary switch continuously or one segment at a time; suppose each alternation (or pulse) applied to a motor advanced the switch exactly one step; suppose you could "pulse" it as fast as 100 counts per second.<sup>†</sup>



YOU CAN  
with the  
**SIGMA**  
**CYCLONOME\***  
**STEPPING**  
**MOTOR**

Here is a motor that probably is unlike any motor you ever saw before. Though synchronous, it will operate on DC pulses as well as AC. Each pulse moves the shaft through 18° of rotation—no more, no less. Its operation is ratchety, but, since this is accomplished magnetically, there is no ratchet. This of course means it will go pretty fast (130 cps) without wearing out—and at a cost a lot lower than other devices that will hold together at 130 cps.

The most obvious application for the Cyclonome\*, since it was introduced several months ago, was in the Sigma Cyclonome\* Counter where, hooked up to a Veeder-Root drum register, it counts to six figures up to 8,000 counts per minute. From there, uses range all the way from missiles to gambling machines.

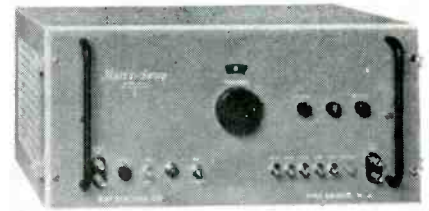
CYCLONOME\* STEPPING MOTOR SPECIFICATIONS

	Type 12A
Size . . . . .	1 7/8" x 1 1/8" x 2 3/8"
Torque . . . . .	1.3 inch/oz.
Inertia . . . . .	.6 gram/cm <sup>2</sup>
(Equal loads will reduce max. speed 70%)	
Max. speed, stepping . . . . .	150 cps (15 r. p. s.)
Max. speed, synchronous . . . . .	600 cps (60 r. p. s.)

† THIS IS HOW WE DO IT IN OUR LABORATORY.  
THE SWITCHES ARE NOT REGULARLY FOR SALE.

\* TRADE MARK

**SIGMA INSTRUMENTS, Inc.**  
62 Pearl Street, So. Braintree, Boston 85, Mass.



constant over both frequency sweep and frequency range.

► **Specifications** — Range includes all 12 vhf tv channels plus i-f channel centered at 43.5 mc. Its r-f output is 1.0 v rms into 75 ohms; flat within ± 0.3 db over sweep width; constant within ± 0.5 db between bands. Sweep width is at least 15 mc on all bands. Sweep rate is variable around 60 cps, locks to line frequency. Attenuators are switched 20, 20, 10, 6 and 3 db plus continuously variable 6 db. Both internal and external pulse type markers are provided. Price is \$695.



**DYNAMIC MICROPHONE**  
for broadcast or p-a

ALTEC LANSING CORP., 9356 Santa Monica Blvd., Beverly Hills, Calif. The slender 680A dynamic microphone introduces the "Acoustic-Gate" principle to provide high-quality broadcast performance throughout an extended frequency range. A peripheral sound entrance channel of 2-mil width, the unit provides an acoustical resistance loading, virtually independent of frequency to the front of the diaphragm, thereby eliminating h-f peaks and extending the smooth



# In the many fields using Iron Powders...

## When you seek the utmost in

I. F. Cores (TV)

Permeability Tuner Cores

I. F. Cores (BC)

FM tuning cores

Core resistivity

Low modulation and hysteresis

Low modulation, but good permeability

Stability

Density

Green Strength

Smooth machining

Sintering at low temperatures

Finest particles

Magnetic fluids, dispersibility

Permeability

Purity — for high purity alloys

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## G A F. Carbonyl Iron Powders

TH, SF, J

L, HP, MR, GQ4

E

J, W

J, W

SF

C, GS6

E, TH, SF

HP

L, HP, MR

E, TH, SF

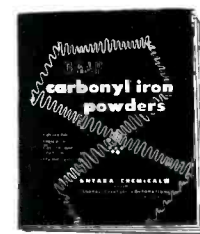
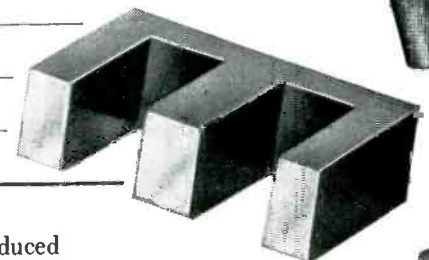
E

SF, W

E, L

HP, GQ4

L



Today there are eleven types of GAF Carbonyl Iron Powders — each produced to rigorous standards of uniformity. Their characteristics vary by type.

Ask your core maker, your coil winder, your industrial designer how these powders can increase the efficiency and performance of the equipment or product you make. They can reduce weight, size, and also decrease cost. If your requirements call for other characteristics or different degrees of performance than are offered by any of our standard types, we welcome the opportunity to work with you in developing new grades of iron powders.

Let us send you literature giving the applications and working properties of GAF Carbonyl Iron Powders. Send for your free copy today.



## ANTARA CHEMICALS

A SALES DIVISION OF

GENERAL ANILINE & FILM CORPORATION

435 HUDSON STREET • NEW YORK 14, N. Y.



*From Research to Reality...*

# 50 ohm Coax Terminations dc to 4 KMC!



## 6 new instruments! 1 to 20 watts coverage!

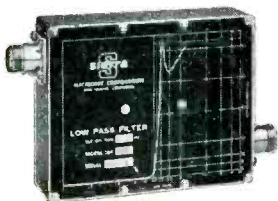
New Sierra 160 series Coaxial Terminations are ideal for use with directional couplers, or in other applications requiring wide frequency range and low VSWR. They provide extremely high stability, and will dissipate full rated power continuously up to an ambient temperature of 40°C. Derating permits operating at still greater ambient temperatures. Terminations are completely shielded, and may be used to adjust transmitters without radiation. They are also useful for converting Sierra Bi-Directional Power Monitors to a termination type wattmeter.

### SPECIFICATIONS

Model	Power*	Connectors**	VSWR
160-1F	1 watt	Type N fem.	{ Less than 1.06, dc to 2 KMC; less than 1.08, dc to 4 KMC. }
160-1M	1 watt	Type N male	
160-5F	5 watts	Type N fem.	Less than 1.08, dc to 4 KMC.
160-5M	5 watts	Type N male	
160-20F	20 watts	Type N fem.	{ Less than 1.08, dc to 1 KMC; less than 1.15, dc to 4 KMC. }
160-20M	20 watts	Type N male	

\*Up to 40°C ambient. \*\*Other connectors supplied to order.

Additional power ranges to be announced.



### New LOW PASS FILTERS

Sierra 184 series Low Pass Filters have an insertion loss not more than 0.4 db in pass band, sharp cut-off, 1.5 VSWR or less, and rejection greater than 60 db from 1.25 to 10 times cut-off frequency. Five models: for cut-off frequencies of 44, 76, 135, 230, 400 MC. Power range 250 watts in pass band, 25 watts in rejection band.

Write for Bulletin!

### Sierra Electronic Corporation

San Carlos 2, California, U. S. A.

Sales representatives in major cities  
Manufacturers of Carrier Frequency Voltmeters, Directional Couplers, Wave Analyzers, Line Fault Analyzers, Wideband RF Transformers, Custom Radio Transmitters, VHF-UHF Detectors, Variable Impedance Wattmeters, Reflection Coefficient Meters, Calorimeters, Water Loads, Thermopiles, Ion Gauge and Ion Gauge Amplifiers, Phase Changers.

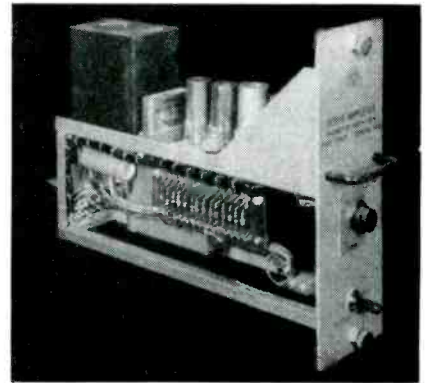
1663

# sierra



frequency response over an exceptionally wide range.

The design also lessens the effects of wind, water, dirt or weather, and allows the microphone to be used under adverse conditions.



### SERVO AMPLIFIER magnetic type

SERVO CORP. OF AMERICA, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y. The 2307 magnetic servo amplifier is a 400-cycle unit with an output capacity of 18 w, driving any 115 v, 400 cycle two phase servo motor rated at 18 w per phase. Up to four inputs can be totaled in the input summing network. Any desired ratio of inputs is available. With the gain set at maximum, a single input of 80 mv will provide the full output. The output is 90 deg out of phase with the input to provide proper phase shift for a two phase motor.

It is available as a Servomation building block or as a specially packaged unit to meet the demands of limited space or restricting ambients.



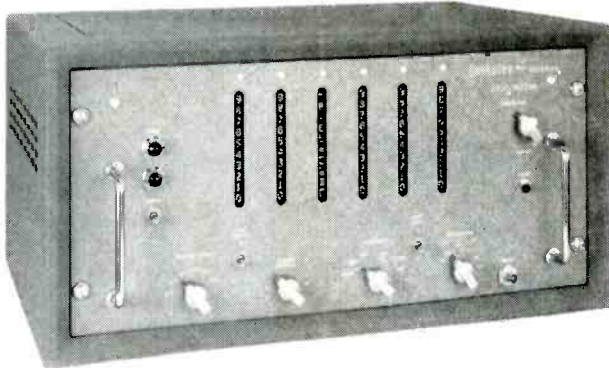
### GRID CONTROL is packaged unit

VECTROL ENGINEERING, INC., P. O. Box 1089, Stamford, Conn. Illustrated is the packaged VecTrol unit



more for your money  
from the leader in the field!

# Berkeley



MODEL 7160—Frequency range, 0 cps to 1 mc

**MODELS**  
**7150 and 7160**

## EPUT\*

### METERS

#### DESCRIPTION

BERKELEY EPUT\* METERS automatically count and display the number of events that occur during a precise time interval. Events may be any mechanical, electrical, optical or other physical occurrence that can be represented by changing voltages. Capable of counting random or regularly occurring events at rates to 1,000,000 per second (Model 7160), the EPUT\* meter is a highly flexible instrument.

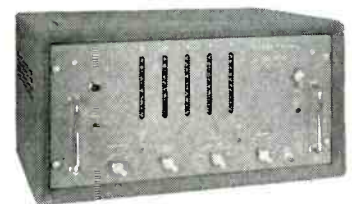
It is useful as an electronic tachometer, secondary frequency standard, frequency or period measurement device, or as a multipurpose laboratory instrument. Operation is simple and results are presented in direct-reading decimal form.

#### FEATURES

- 1 0.1 v rms sensitivity
- 2 Step attenuators; trigger-adjusted noise discriminators
- 3 More stable frequency dividers
- 4 Electronic (not relay) reset
- 5 External frequency standard input connection
- 6 AC or DC coupling of all input circuits; 10 megohm input impedance
- 7 Multivoltage accessory socket to power photocells, etc.
- 8 Binary-coded output with direct connection to digital printers, data converters, inline readouts, etc.
- 9 Crystal-controlled time marker output
- 10 Unitized modular design
- 11 Larger, brighter readout numbers
- 12 Modern-styled all-aluminum cabinets

#### BRIEF SPECIFICATIONS

	Model 7150	Model 7160
Range:	0 cps to 100 kc	0 cps to 1 mc
Accuracy:	± 1 part in 10 <sup>7</sup> , ± 1 count	± 3 parts in 10 <sup>7</sup> , ± 1 count
Time Bases:	10 μ sec to 1 sec, decade steps	1 μ sec to 1 sec, decade steps
Input Requirements:	0.1 v rms, dc or ac-coupled, 10 megohms impedance	
Power Requirements:	117 v, ± 10%, 50-60 cps, 175 watts (approx.)	
Display Time:	(Automatic reset), adjustable, 0.05 to 5 sec. Manual reset also provided	
Dimensions, Weight:	10¼" H x 20¾" W x 16½" D, 60 lbs. (Cabinet mount); (Also available in rack mount)	
Price:	\$775.00 f.o.b. factory	\$995.00 f.o.b. factory



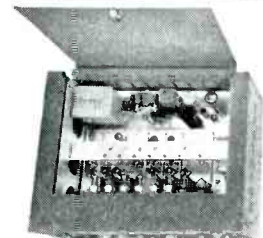
MODEL 7150—Frequency range, 0 cps to 100 kc



MODEL 5916—In-Line Remote Readout connects directly to EPUT\* meter. Illuminated in-line figures reduce error and fatigue; ideal for remote observation of data.



MODEL 1452—Digital Printer, prints data on standard adding machine tape. EPUT\* meters will also drive data converters to operate IBM card punches or teletypewriters.



Accessibility is an important feature of BERKELEY 7000-Series instruments. Modular chassis design permits rapid checking or replacement of components and sub-assemblies.

Technical bulletins and application data files are yours for the asking; please address Department G-6

\*TRADEMARK REG.

# Berkeley

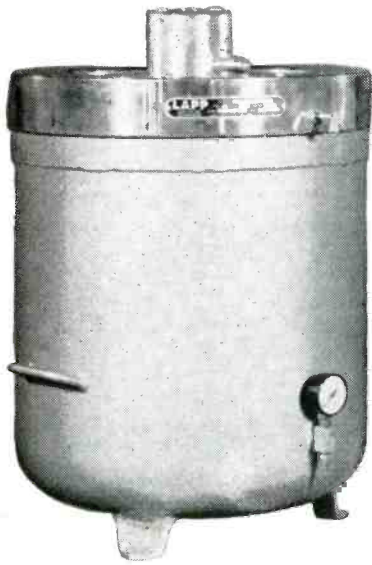
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96

## For High Voltage, High Current CAPACITANCE

... in small space  
... and trouble-free



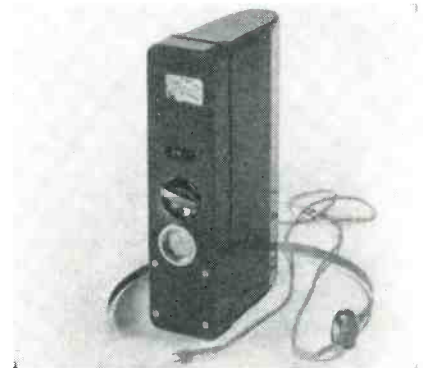
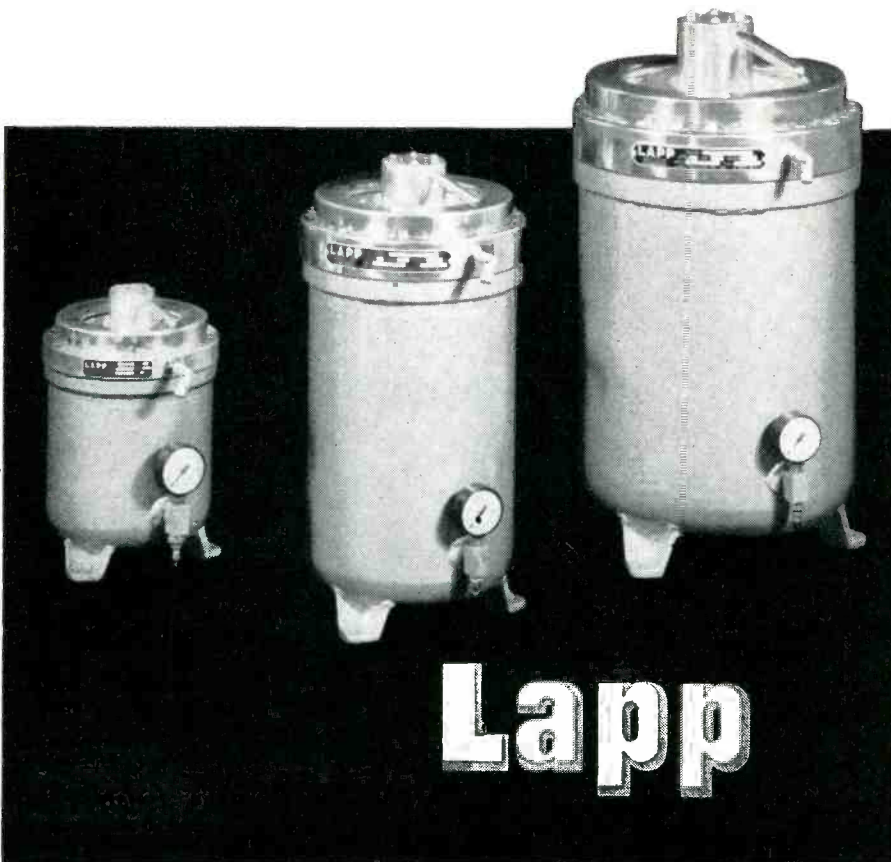
For lump capacitance at high voltage and/or high current, Lapp Gas-Filled Condensers offer the advantages of extreme compactness... low loss... high safety factor... elimination of puncture hazard... construction with gaskets which can be externally tightened under full operating pressure... assurance of *long trouble-free service*. Variable and fixed units are available with capacitances to 30,000mmf; current ratings to 400 amps at 1 mc; operating voltages to 80 Kv peak. Write for Bulletin 302 with complete description and characteristics data. Lapp Insulator Co., Inc., Radio Specialties Division, 901 Sumner St., Le Roy, N. Y.

for proportional control of 60-cycle single-phase half or full-wave thyatron outputs up to several kw, with d-c control signal less than 1 mw. Four isolated d-c control windings will provide control in accordance with several independent signals.

► **Makeup**—The unit comprises a patented sensitive phase shifting network of rugged static components sealed hermetically in a can, and providing phase shift up to 300 deg. Linear proportional phase shift of 180 deg is obtainable with small d-c control signal.

► **Other Features**—The control is fail-safe and no grid bias is required to insure thyatron cutoff when the control signal is removed. It eliminates all control tubes in feedback circuits for voltage-regulated power supplies, adjustable speed motor drives, program speed controls, servo motors, magnetic or eddy current clutch or brake controls, and process controls in general.

It also features high sensitivity designs for thermocouple signals down to  $1/1,000 \mu w$ . Other designs for controlling mercury arc rectifiers are available up to 50 kw output. Complete literature is available.



## RADIATION DETECTOR fits in pocket

NORTH AMERICAN PHILIPS CO., INC., 750 South Fulton Ave., Mt. Vernon, N. Y. The PW4010 light-weight radiation detector easily fits a man's pocket. The unit is approximately 1.7 in. thick, 4.1 in. wide, 6.6 in. high, weighs about 25 oz and is designed for locating sources of beta and gamma radiation. It is



# NEW

# CHANNEL

## Sanborn

## oscillographic

## recording

## system



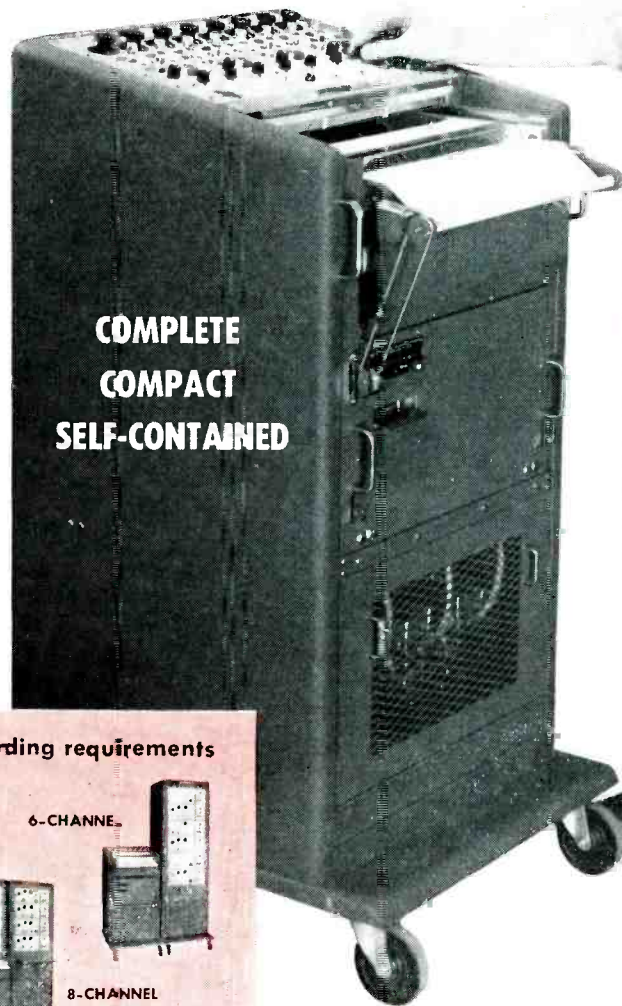
**PRIMARILY**

**FOR USE WITH**

**ANALOG COMPUTERS**

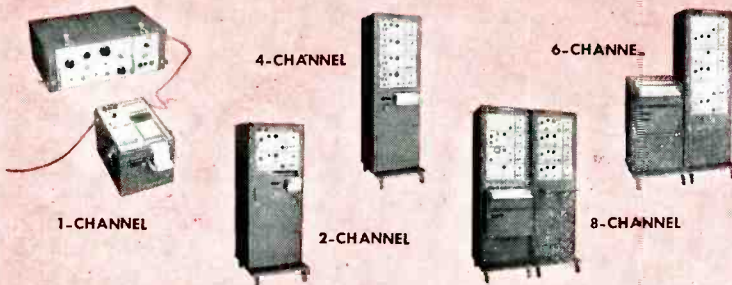
**T**his new self-contained 8-channel oscillographic recording system, primarily for (but not limited to) analog computer recording, measures only 46½" x 27" x 22". In a single, space-saving mobile package, the user has a complete system for analog computer readout recording. Input cable connections are easily made at the top of the back panel. Eight groups of controls for the eight channels are conveniently located on the sloping top panel. Driver Amplifier chassis are easily withdrawn from the lower part of the console for inspection. Paper loading is quickly done from the top.

Features of the Model 158-5490 system include 0.1v/cm to 100v/cm sensitivity; over-all linearity of 0.25 mm over the entire 4 cm of the chart; drift less than 0.5 mm/hour; push-pull or single-ended input; miniaturized dual-channel DC amplifiers of improved current feedback design; 5 meg. input impedance each input lead to ground; true rectangular coordinate recording; nine chart speeds from 0.25 to 100 mm/sec. Frequency response is flat to 20 cps, down 2 db at 60 cps for all amplitudes to 4 cm peak to peak.



**COMPLETE  
COMPACT  
SELF-CONTAINED**

**FAMOUS "150" SYSTEMS . . . for all recording requirements**



In laboratories, production testing facilities and field installations nationwide Sanborn 150 Series Oscillographic Recording Systems are proving their versatility and value. Users have a choice of basic systems ranging from 1 to 8 channels . . . "packaged" as portable units or in vertical mobile cabinets . . . and twelve interchangeable plug-in preamplifiers permitting rapid, economical changeover to new input requirements.

Sanborn will gladly furnish complete descriptive data on the new 158-5490 System and all "regular 150" systems, or engineering assistance on your recording problems, whenever you wish. Contact your Sanborn Representative, or write to . . .

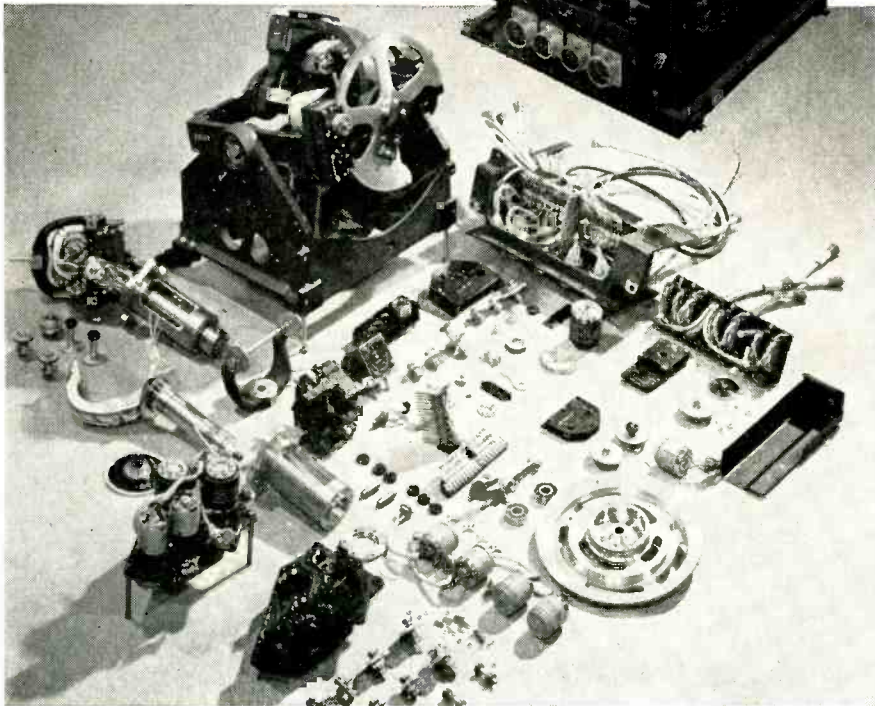
## **SANBORN COMPANY**

INDUSTRIAL DIVISION

195 MASSACHUSETTS AVE., CAMBRIDGE 30, MASS.

# Can you use help

with  
precision headaches  
like this?



## Let General Mills work them out for you

Right now our systems engineering people and our factory can be at your service if you need volume piece parts or assemblies such as

- electro-mechanical systems or components
- fine-pitch, instrument-type gears
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Right now you can utilize the experience of our creative engineers and precision production plant—the same men and machines that have handled prime and sub-contract work like the bombing system computer above, the B-47's Y-4 bombsight, and similar complex systems. And of course we offer full laboratory and environmental testing facilities.

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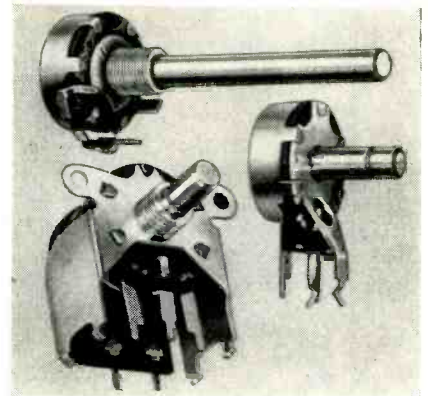
**ASK FOR FREE NEW BOOKLET** covering complete manufacturing capacities and capabilities. Write, wire, or phone Dept. EL6, 1620 Central Ave., Minneapolis 13, Minn., STerling 9-8811.

**MECHANICAL DIVISION  
OF General Mills, Inc.**

useful for measuring radiation exposure of laboratory workers and for checking intensity levels during research investigations.

► **Construction**—The new radiation detector has a 1.5-v penlight-type filament battery, two 30-v miniature-type anode batteries and a 15-v subminiature-type grid bias battery. The unit employs a halogen-quenched counter tube (type 18502) that operates at 350 v, and a special diode-pentode oscillator tube (type 95106). The main switch has 6 positions: off; start; low sensitivity; high sensitivity; anode voltage; and filament voltage. The calibration switch has 4 positions: anode battery off; anode voltage 60 v; anode voltage 55 v; and anode voltage 47.5 v.

The new detector uses a special circuit that draws current from the anode batteries only when the Geiger tube registers counts. This feature greatly prolongs the life of the anode battery.



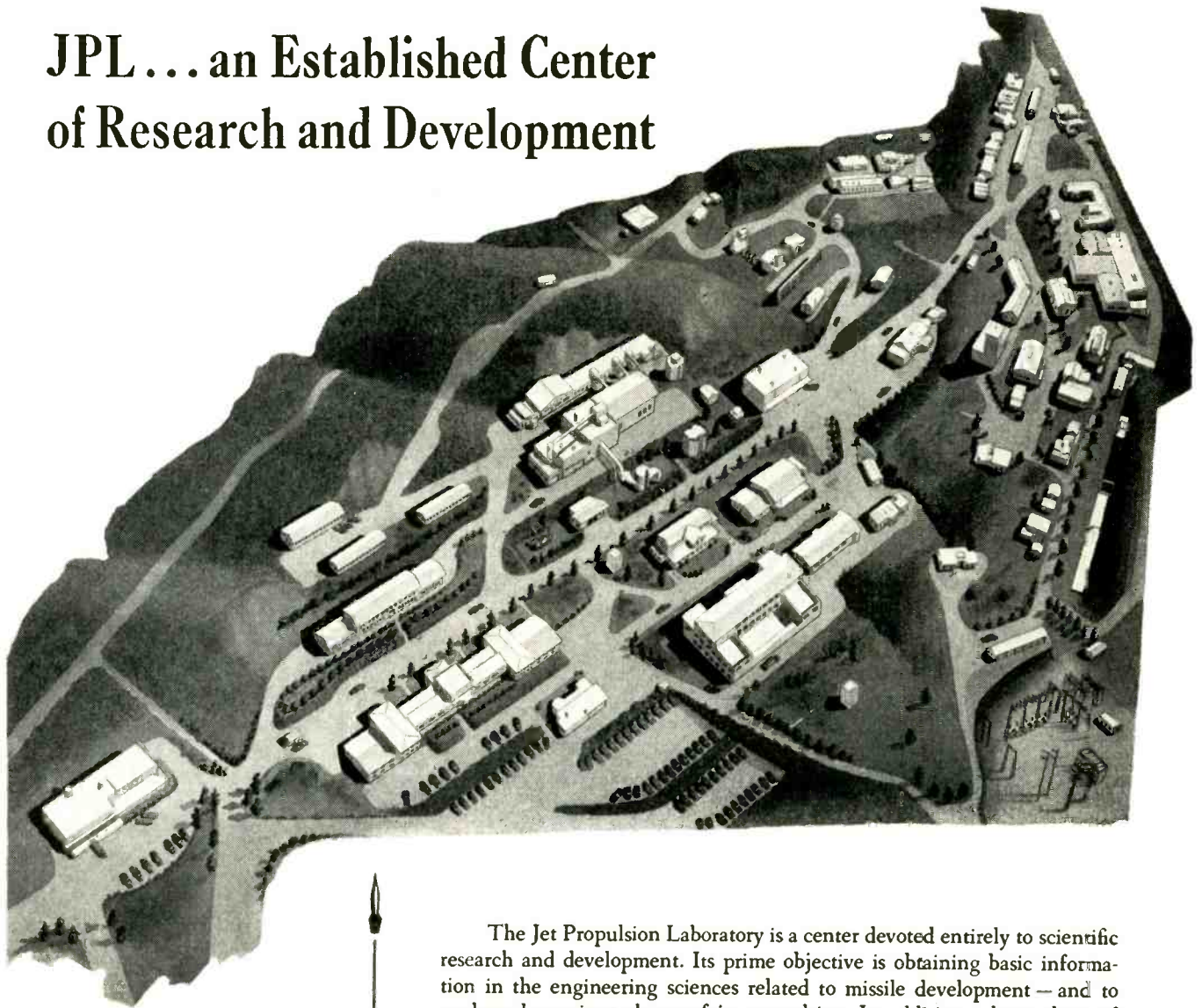
## VOLUME CONTROLS for printed circuits

P. R. MALLORY & Co., INC., Indianapolis, Ind. A new line of carbon volume controls is especially designed for simplified mounting on printed electronic circuits. A number of models are available, including types for mounting directly on the circuit panel, self-supporting snap-in models for top of panel mounting, and threaded bushing types.

Terminals are shouldered, with small solder tabs to facilitate connection with minimum solder. Mounting tabs and terminals are accurately positioned to assure fast



# JPL... an Established Center of Research and Development



★ At this time we are particularly interested in interviewing graduate engineers and scientists in the fields of aerodynamics, aircraft structures, mechanical engineering, chemistry, chemical engineering, heat transfer, electronics, systems analysis, electro-mechanical instrument design, instrumentation, metallurgy, nuclear physics and solid state physics.

These men should be definitely interested in scientific research and development relating to the problems of the future.

The Jet Propulsion Laboratory is a center devoted entirely to scientific research and development. Its prime objective is obtaining basic information in the engineering sciences related to missile development — and to explore the various phases of jet propulsion. In addition a large share of its program is devoted to fundamental research in practically all of the physical sciences.

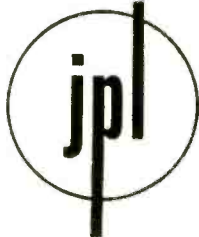
The Laboratory extends over more than 80 acres in the foothills of the San Gabriel mountains north of Pasadena. It is staffed entirely by personnel employed by the California Institute of Technology and conducts its many projects under contracts with the U.S. Government.

Exceptional opportunity for original research coupled with ideal facilities and working conditions have naturally drawn scientists and engineers of a very high caliber. These men, working in harmony, are building a very effective task force for scientific attack on the problems of the future.

An unusual atmosphere of friendliness and cooperation is apparent at the "Lab" and newcomers soon sense the warmth of their acceptance. New advanced projects are now providing some challenging problems — and good jobs for new people.

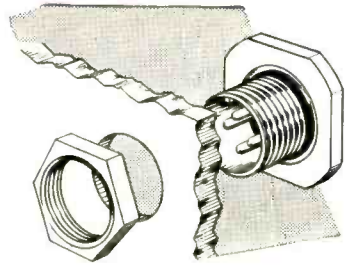
If you would like to develop your skill and knowledge at the "Lab" and, at the same time, help us solve some of our problems — write us today.

CALTECH



## JET PROPULSION LABORATORY

A DIVISION OF CALIFORNIA INSTITUTE OF TECHNOLOGY  
PASADENA, CALIFORNIA



# Bendix JAM NUT RECEPTACLES

Easy to install, to service, to replace



Jam nut receptacles offer such positive savings in assembly time that it will pay you to check into their application on your product. These receptacles permit bench wiring of harness and sub-assemblies prior to final installation with proven savings in assembly labor.

Just consider these design advantages—only one mounting hole required per receptacle—no extra gasket required—no user problem of sealing around screw holes—no extra hardware necessary such as screws, washers or nuts.

Write for complete detailed specifications



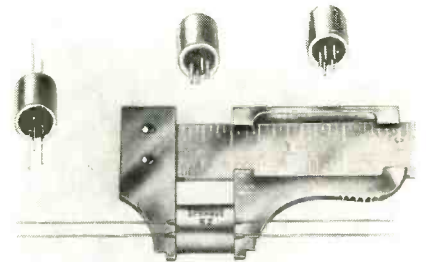
SCINTILLA DIVISION  
SIDNEY, NEW YORK



Export Sales and Service: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

foolproof assembly by automatic production machines.

All models incorporate a high stability resistance element which minimizes drift under severe temperature and humidity conditions, and provides low electrical noise level.



## PULSE TRANSFORMER in ultrasmall size

SPRAGUE ELECTRIC Co., 35 Marshall St., North Adams, Mass., has available subminiature pulse transformers which meet all the performance requirements of the miniature series widely used in computers and military electronics. The new ultrasmall transformers are furnished in both single and double ended constructions, the former for use with printed wiring boards, and the latter for use in conventional types of assemblies.

Complete descriptions of 32 standard subminiature transformers are given in engineering bulletin 503, available on business letterhead request.

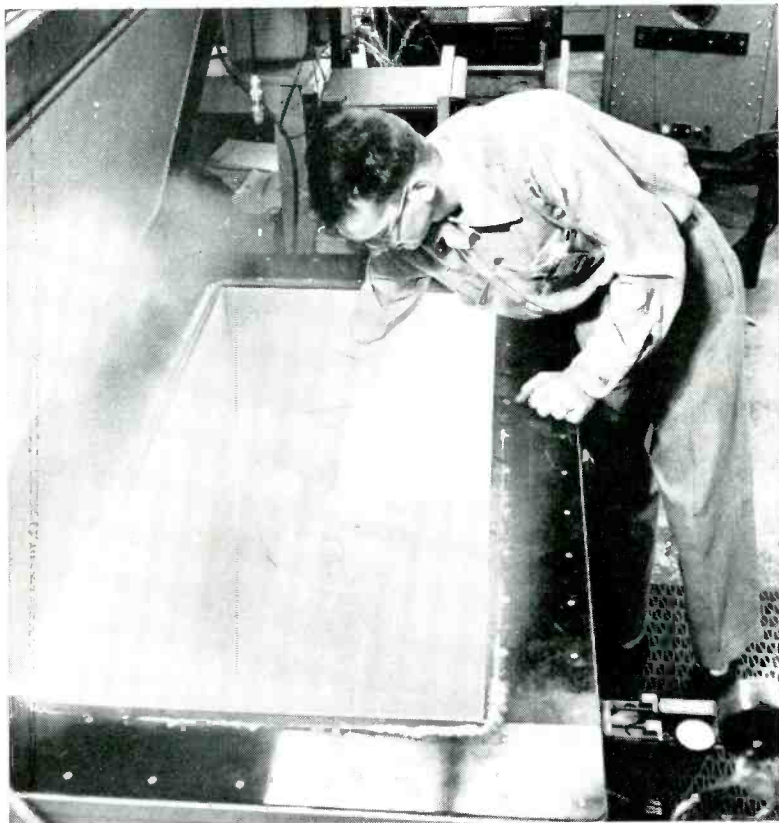


## SERVO AMPLIFIER a transistorized unit

M. TEN BOSCH, INC., Pleasantville, N. Y. Model 1800-0100 is a miniaturized, hermetically-sealed, plug-in transistor servo amplifier. It is primarily intended to receive signals from a synchro control



# Thousands of dollars per month saved when DRYair replaced premium-grade nitrogen in testing electronic equipment



*A cloud of fog forms as moist air from the room meets the  $-67^{\circ}$  air in the test chamber.*

**E**LECTRONICALLY-CONTROLLED pneumatic actuators built by the Electronics Division of Thompson Products, Inc. of Cleveland maintain 400 cycles per second within limits of plus or minus one per cent—classed as “phenomenal accuracy” by men who know. Regulation and testing of this equipment is carried on in cold chambers simulating environmental conditions of altitude and temperature.

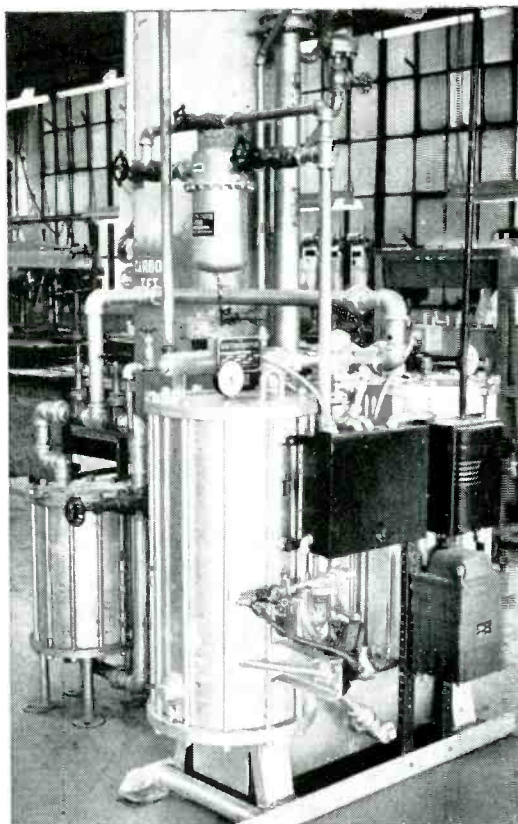
Standard bottled nitrogen was used at first to drive these mechanisms, but it quickly froze up as it has a dewpoint of  $-50^{\circ}\text{F}$ . Then they went to

premium-grade nitrogen having a dewpoint of  $-70^{\circ}$ , but this costs 70 cents per cubic foot and as many as seven bottles of nitrogen were used per unit.

Now they have this Lectrodryer. It takes air from the shop line, cleans and dries it to  $-70^{\circ}\text{F}$ . dewpoint, actually saving them thousands of dollars every month. Thus the Lectrodryer pays for itself many times over.

Have you a moisture problem? Write, giving data on it, to Pittsburgh Lectrodryer Company, 359 32nd Street, Pittsburgh 30, Pennsylvania (a McGraw Electric Company Division).

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.  
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.  
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.



*A recent check revealed that this BAC-150 Lectrodryer\* is delivering air dried to a  $-70^{\circ}\text{F}$ . dewpoint.*

**LECTRODRYERS DRY  
WITH ACTIVATED ALUMINAS**

# LECTRODRYER

\* REGISTERED TRADEMARK U. S. PAT. OFF.

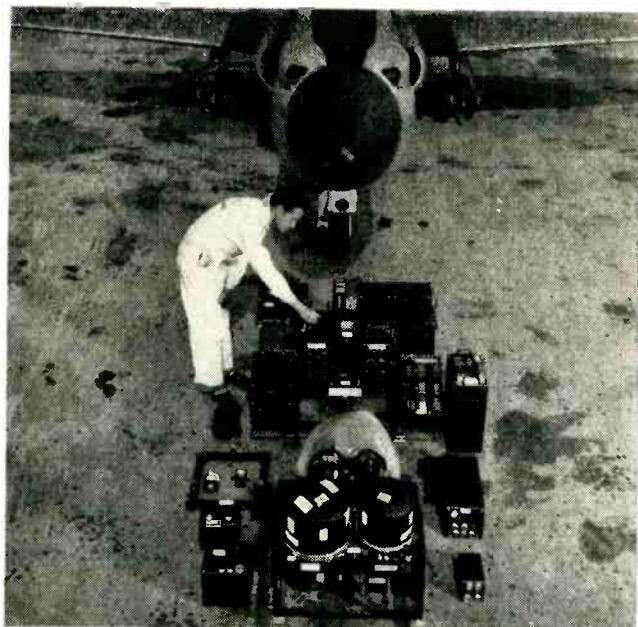


Photo courtesy of Hughes Aircraft Company, Culver City, California.

## Billions of operations here with Bristol Syncroverter® high-speed relays

How do you build reliability into a fire control system for interceptor planes—a system containing as many components as 200 TV sets; but occupying only 29 cubic feet?

The obvious solution is to use reliable components, so the design engineers at the Hughes Aircraft Company selected Bristol Syncroverter high-speed relays for the high-speed relay requirements of the Hughes Fire Control System.

Their operation is unaffected *during shock up to 30G's, and vibration (10-55 cps) of 10G.* This high-speed relay, which meets military specifications, is completely reliable in *dry-circuit applications* as well as in *low-power applications.*

Bristol Syncroverter high-speed relay. Covered by patents.



### Versatile relays meet a wide variety of requirements

Your applications of high-speed relays in such equipment as air-to-ground telemetering, analog and digital computers, aircraft or missile control, carrier current switching and the like may call for different specifications from those below. You'll find the high-speed relays you need—including miniature (70 gram) relays—in Bristol's broad Syncroverter line. Write us. The Bristol Company, 152 Bristol Road, Waterbury 20, Conn.

#### TYPICAL PERFORMANCE CHARACTERISTICS

Temperature range:  $-55^{\circ}\text{C}$  to  $100^{\circ}\text{C}$ .  
 Operating shock: 30G; 11 milliseconds duration.  
 Vibration: (10-55 cps): 10G  
 Contact ratings: up to 28v, 200 ma.  
 Stray contact capacitance: less than 15 mmfd.  
 Pull-in time (including bounce): as low as 200 microseconds.  
 Drop-out time: 300 microseconds.  
 Life: At least 1000 hours at 400 operations per second.  
 Mounting: Octal tube socket.

**BRISTOL** Points the Way in  
Human-Engineered Instrumentation

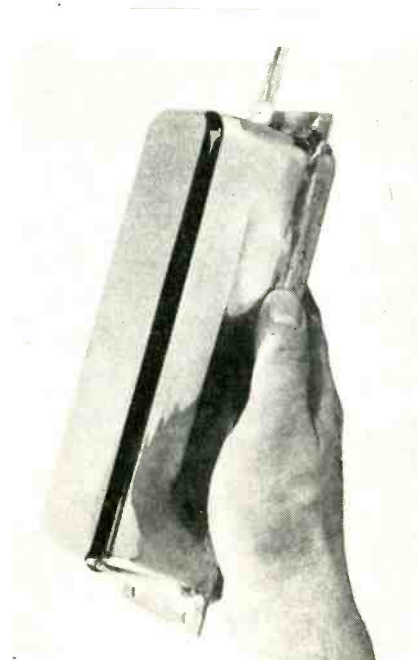
AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

6.15

transformer and to operate a Kearfott type 422185 servo motor or equivalent. The amplifier is designed to meet the environmental requirements of specification MIL-E-5400.

Dimensional drawing, characteristics chart, and physical and electrical specifications are given in a recent bulletin.

The unit described is priced at \$165.



### SEALED TRANSDUCER for ultrasonic cleaning

BRANSON ULTRASONIC Co., Div. of Branson Instruments, Inc., 194 Richmond Hill Ave., Stamford, Conn., has available hermetically sealed ultrasonic power transducers and improved generators operating at 40 kc.

The large, uniform radiating surface of the transducers makes them particularly suitable for ultrasonic metal cleaning applications, such as removal of buffing compounds, radioactive contamination, soldering flux, plaster or carbon smut. The transducers can also be used for other processes in liquids which benefit from ultrasonic energy, such as quenching, plating, pickling, de-scaling and dyeing.

The standard LF-15 transducer has a radiating area of 2½ in. by 6 in. The modular design facilitates a wide choice of arrangements, including flush transducer banks, focusing and diverging. Ultrasonic



# Transitron

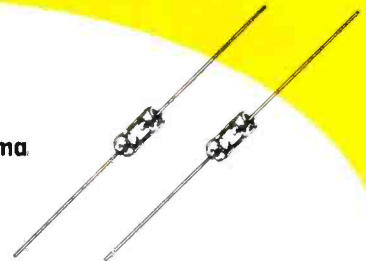
## SILICON DIODES

### HIGH CONDUCTANCE junction types

Type	Maximum Average Forward Current (ma)		Maximum Forward Voltage at 100 ma (volts)	Maximum DC Inverse Operating Voltage
	at 25°C	at 150°C		
1N482B	200	50	1.0	36
1N483B	200	50	1.0	70
1N484B	200	50	1.0	130
1N485B	200	50	1.0	180
1N486A	200	50	1.0	225
1N457	100	25	1 @ 20 ma	60
1N458	100	25	1 @ 7 ma	125
1N459	100	25	1 @ 3 ma	175

#### Features

- Current Ratings up to 200 ma
- Operation up to 200°C
- Low Inverse Current
- Subminiature Size



Transitron's subminiature glass silicon junction diodes feature high forward conductance and reliable operation up to 200°C. Rated for 50 ma forward current at 150°C, they are ideal for low level magnetic amplifiers, power supply, bridge modulator, and similar applications.

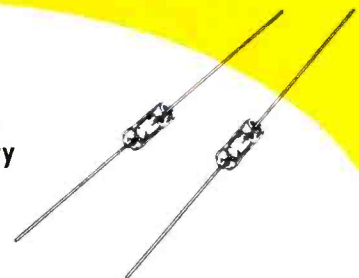
### HIGH FREQUENCY bonded types

Type	Forward Current @ +1V (ma)	Inverse Current at Specified Voltage @ 100°C (µa at volts)	Maximum Operating Voltage (volts)
1N251*	2	10 @ -10	30
1N252	4	10 @ -5	20
S5G	1	10 @ -10	30
S6G	4	50 @ -5	15

\*Military Type

#### Features

- Operation up to 1000 mc
- High Temperature Reliability
- Fast Pulse Recovery
- Low Shunt Capacitance
- Subminiature Size



The silicon bonded diodes are small area junction diodes specifically designed for high frequency circuits up to 1000 mc, and fast switching applications requiring recovery times of .15 microseconds or less. They are particularly useful in detector, discriminator, logic and high speed transistor circuitry. Write for Bulletin TE-1339.

**Transitron** electronic corporation • melrose 76, massachusetts



Germanium Diodes



Transistors



Silicon Diodes



Silicon Rectifiers.



# RADIO INTERFERENCE AND FIELD INTENSITY measuring equipment

Stoddart equipments are suitable for making interference measurements to one or more of the following specifications:

## AIR FORCE—MIL-I-6181B

150 kc to 1000 mc

## BuAir—MIL-I-6181B

150 kc to 1000 mc

## BuShips—MIL-I-16910A (Ships)

14 kc to 1000 mc

## SIGNAL CORPS—MIL-I-11683A

150 kc to 1000 mc

## SIGNAL CORPS—MIL-S-10379A

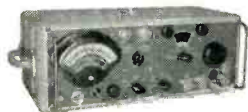
150 kc to 1000 mc

The equipments shown cover the frequency range of 14 kilocycles to 1000 megacycles.

Measurements may be made with peak, quasi-peak and average (field intensity) detector functions.

**F.C.C. PART 15**—Now in effect, the revised F.C.C. Part 15 places stringent requirements upon radiation from incidental and restricted radiation devices. Stoddart equipment is suitable for measuring the radiation from any device capable of generating interference or c-w signal within the frequency range of 14 kc to 1000 mc.

Write Stoddart Aircraft Radio Co., Inc., for your free copy of the new revised F.C.C. Part 15.



NM-10A (AN/URM-6B)  
14 kcs to 250 kcs



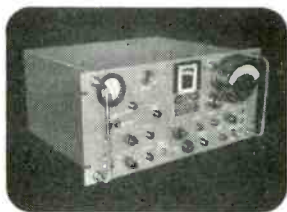
NM-20B (AN/PRM-1A)  
150 kcs to 25 mcs



NM-30A (AN/JRM-47)  
20 mcs to 400 mcs



NM-50A (AN/URM-17)  
375 mcs to 1000 mcs



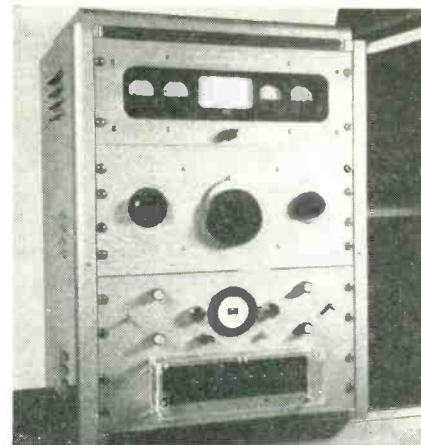
The Stoddart NM-40A is an entirely new radio interference-field intensity measuring equipment. It is the commercial equivalent of the Navy type AN/URM-41 and is tunable over the audio and radio frequency range of 30 CPS to 15 kc. It performs vital functions never before available in a tunable equipment covering this frequency range. Electric and magnetic fields may be measured independently over this range using newly developed pick-up devices. Measurements can be made with a 3 db bandwidth variable from 10 CPS to 60 CPS and with a 15 kc wide broadband characteristic.

# STODDART Aircraft Radio Co., Inc.

6644-A SANTA MONICA BLVD., HOLLYWOOD 38, CALIFORNIA • Hollywood 4-9294

energy of the proper intensity can be applied as required by the shape of the part.

Generator-transducer combinations are available, with radiating areas of 30 sq in. to 8 sq ft. Cost of the complete equipment ranges from \$23 per sq in. of radiating surface down to \$14 per sq in.



## TWT POWER SUPPLY provides three outputs

LAWN ELECTRONICS Co., E. Freehold Road, Freehold, N. J. Model 5003 universal traveling-wave-tube power supply provides three outputs: a 0-5,000 v negative cathode supply; a 0-500 v anode supply, and 0 to 20 v a-c or d-c filament supply. All voltages are continuously variable.

► **Features**—The h-v supply is regulated to 0.002 percent for both line and load variations, and the ripple voltage is less than 25 mv peak to peak. Extreme stability is obtained by correcting the d-c amplifier drift by an a-c amplifier. Price is \$2,250.

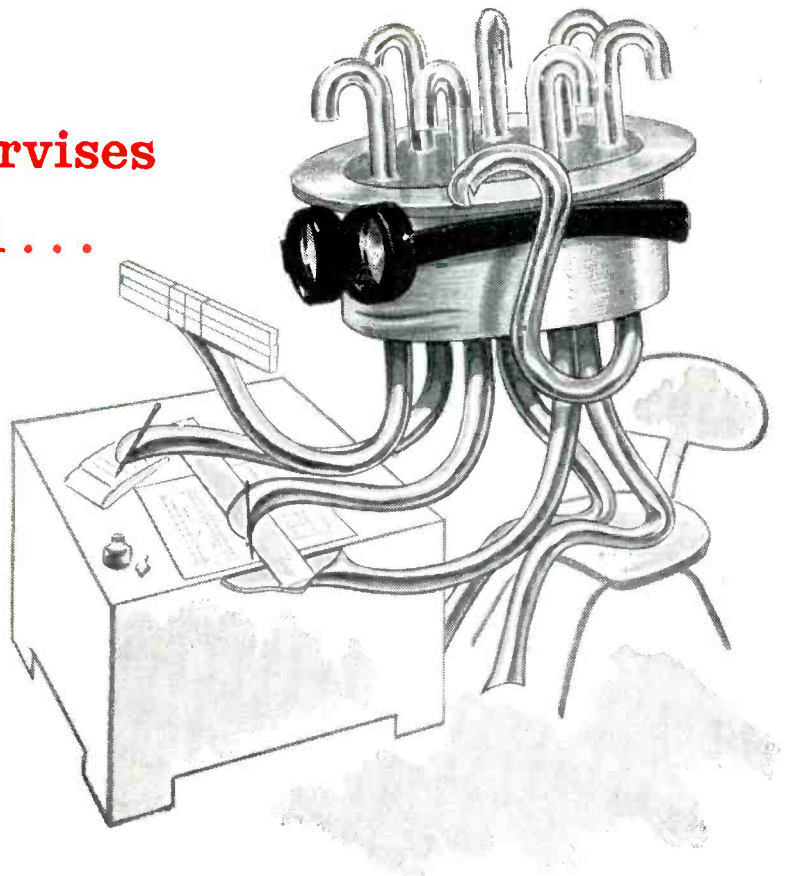
## LEAK DETECTOR for production-line testing

CONSOLIDATED ELECTRODYNAMICS CORP., Pasadena, Calif. Type 24-210 portable leak detector for production-line testing combines low cost with high sensitivity.

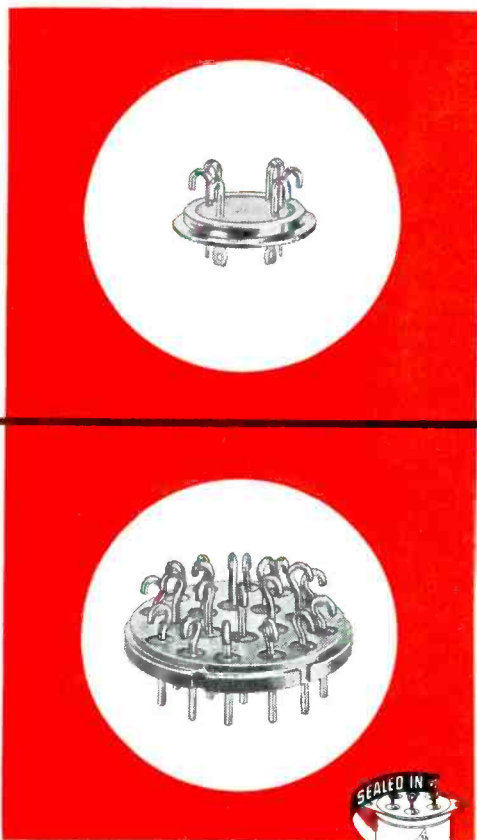
► **Uses**—It may be employed to show the existence or absence of extremely minute leaks, to determine the rate of leakage, and to pinpoint the exact location of a



**Our Mr. Smith supervises  
Multi-Header design . . .**



## the most versatile glass-metal seal



Constant Multi-Header design development enables Hermetic to offer a Vac-Tite\* Compression Multi-Header to suit every design and application requirement.

If requirements call for 4 to 28 solid or tubular terminal Multi-Headers with O.D.'s that range from .375 to 1.125 diameters, Hermetic Headers of "all-glass" or "individual-glass" construction can be supplied. However, to meet the most difficult specifications, Hermetic can provide Multi-Headers *as large as you specify with as many terminations as is required* in "individual-glass" construction and solid metal body.

**Consult** Hermetic for standard, as well as specially designed headers, with or without mounting studs, that act as cover and seal.

**Write** for your new addition to "Encyclopedia Hermetica" . . . a 16 page catalog containing the most diversified selection of Multi-Headers ever offered.

\*VAC-TITE is Hermetic's new vacuum-proof, compression construction, glass-to-metal seal.

## Hermetic Seal Products Company

31 South Sixth Street, Newark 7, New Jersey

California Associate: Glass-Solder Engineering, Pasadena

F I R S T   A N D

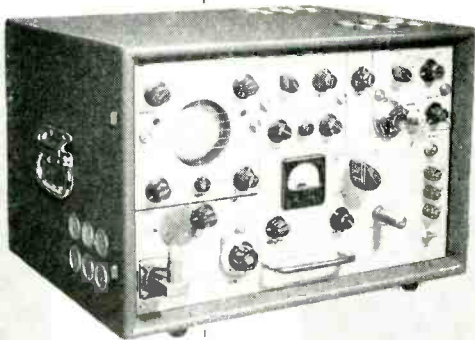


F O R E M O S T   I N   M I N I A T U R I Z A T I O N

A NEW



Combining in one organization a sales, service, engineering and manufacturing group to better serve the Western customers of KEARFOTT COMPANY. Expanded production areas—additional equipment and the latest progressive assembly facility for the production of gyroscope control components, navigational systems, radar components and test equipment.

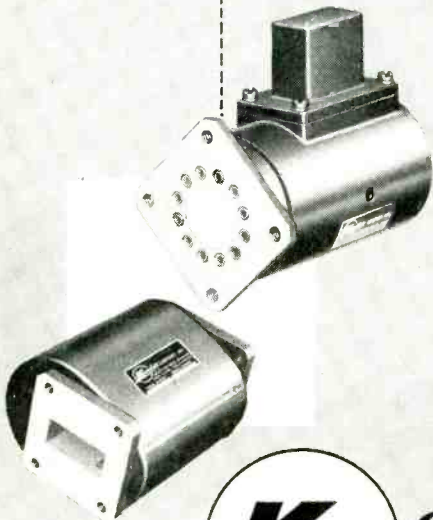


● **KEARFOTT**  
universal test sets for  
X, Ku and C bands

Low cost testing with one convenient unit containing:

- Spectrum Analyzer*
- Power Monitor*
- Wavemeter*
- Signal Generator*

ONE portable unit does it all, on the bench—or in the field.



● **KEARFOTT**  
new rotation-type  
FERRITE ISOLATOR\*

The new Ferrite Isolator is a useful device with applications such as oscillator isolation with the following advantages to system performance:

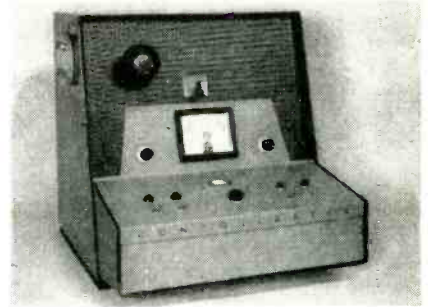
- Reduces long-line loading*
- Prevents undesired frequency shift*
- Insures uniform power output*
- Improves transmitted pulse spectrum*

\*Patented



Write or call today for detailed information on Kearfott Ferrite components and Microwave equipment.

SALES OFFICES  
EASTERN OFFICE: 1378 Main Ave. Clifton, N. J.  
MIDWEST OFFICE: 188 W. Randolph St. Chicago, Ill.  
SOUTH CENTRAL OFFICE: 6115 Denton Drive Dallas, Texas



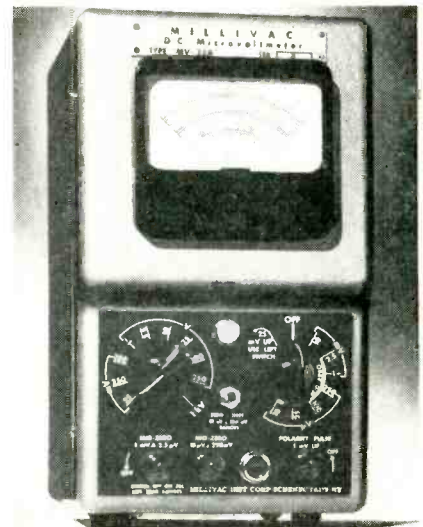
leak. The instrument is a simplified mass spectrometer which responds only to the presence of helium as a tracer gas. It will detect one part of helium in 300,000 parts of air.

► **Applications**—Its uses include testing hermetically sealed parts, high-vacuum systems, drums and other containers—in fact, any product whose excellence depends on a perfect seal.

The 24-210 achieves low cost through advanced design, incorporating new electronic and vacuum components. Through the use of printed circuitry and with only six tubes required, electronic circuitry has been greatly simplified without the sacrifice of reliability.

The new 145-lb unit is 20½-in. high and requires a table area of only 18½ by 22 in.

A more complete description appears in CEC Bulletin 1830.

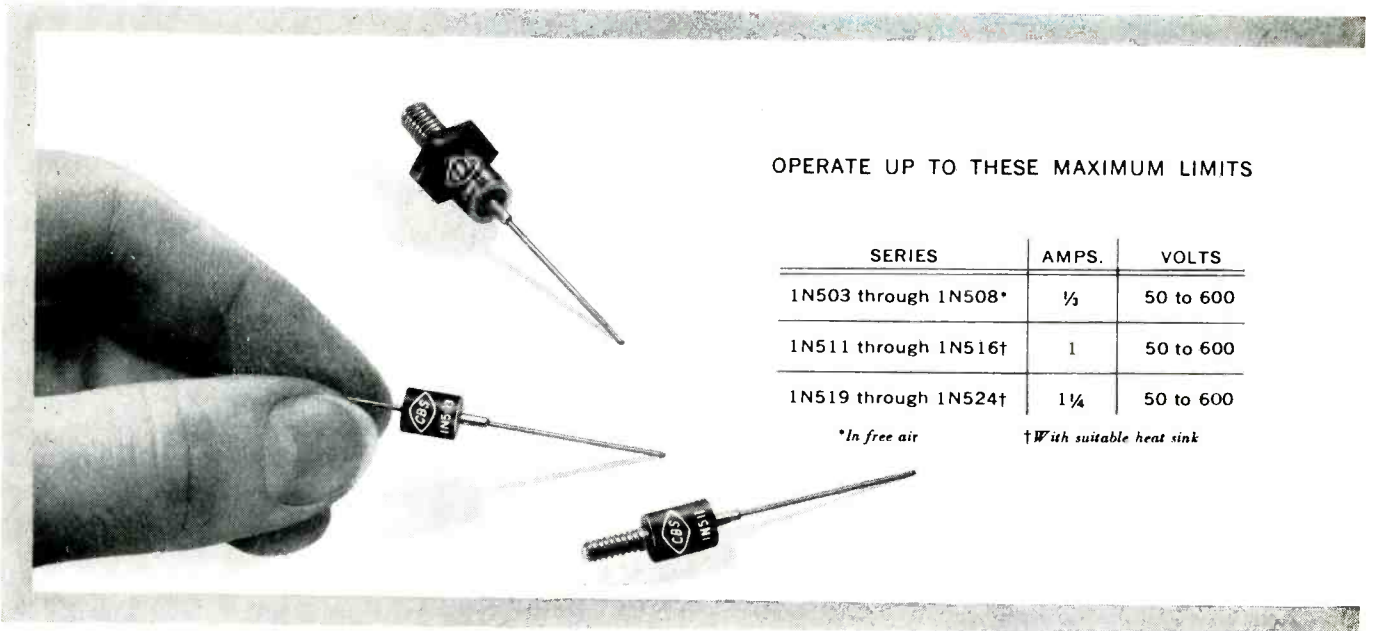


**D-C VOLTMETER**  
combined vtm and trvm

MILLIVAC INSTRUMENT CORP., 444 Second St., Schenectady 6, N. Y. The MV-35A d-c/vtm and trvm



# THREE FAMILIES OF CBS SILICON POWER RECTIFIERS



OPERATE UP TO THESE MAXIMUM LIMITS

SERIES	AMPS.	VOLTS
1N503 through 1N508*	1/2	50 to 600
1N511 through 1N516†	1	50 to 600
1N519 through 1N524†	1 1/4	50 to 600

\*In free air

†With suitable heat sink

**CBS-HYTRON** offers you, in three basic designs, a wide selection of high-power silicon junction rectifiers with uniformly controlled characteristics. All three series feature compactness and high rectification efficiency (up to 99%) at high currents. Low forward and high back resistances give high power handling capabilities. And low thermal resistance permits operation up to 150°C.

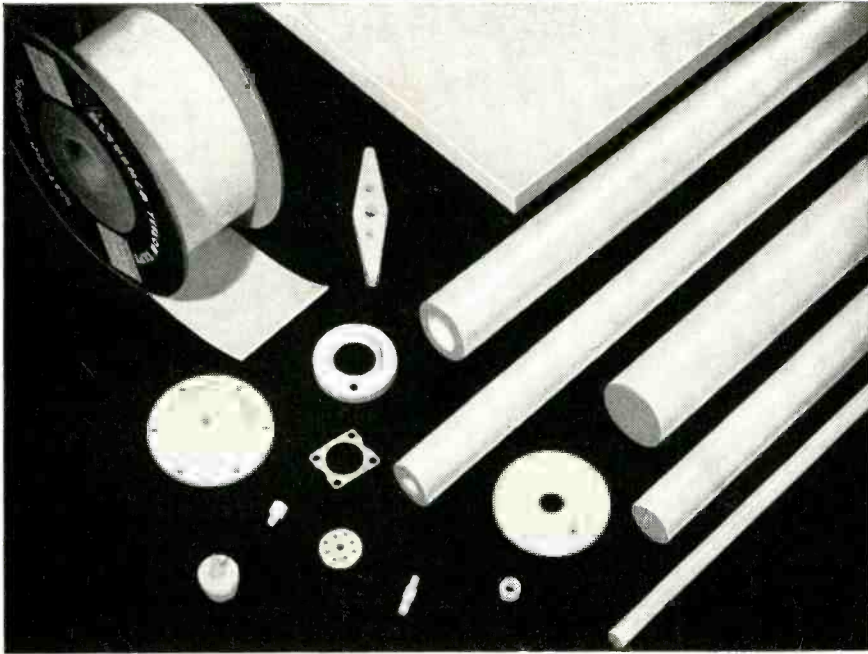
Possible applications are innumerable . . . wherever you need highly efficient, high-current miniaturized rectifiers. As illustrated, the 1N503 series is supplied with convenient flexible leads. And the 1N511 and 1N519 series are designed with screw studs for easy attachment to heat sinks. For complete data ask for Bulletin E-263. Or request a quotation on CBS silicon power rectifiers suited to your applications.

**CBS** **semiconductors**

**CBS-HYTRON**, Danvers, Mass.

A Division of Columbia Broadcasting System, Inc.

*Reliable products  
through Advanced-Engineering.*



## Get All These Important Advantages of Teflon—Plus Low-Cost Fabrication

No other material is proving so versatile in the electronics and electrical field as Teflon. It is now widely used for insulating bushings, terminal connectors, stand-off insulators and many other parts as its applications continue to expand.

### TEFLON'S OUTSTANDING PROPERTIES

Dielectric Constant.....	2.0
Power Factor.....	0.0005
Dielectric Strength, volts/mil.....	400-500
Surface Resistivity (100% R.H.) megohms.....	$3.6 \times 10^9$
Temperature Range.....	-110°F. to +500°F.
Water Absorption.....	nil
Chemical Resistance.....	excellent

### FABRICATION FROM STANDARD SHAPES

POLYPENCO Teflon Shapes are available in rod, tubular bar, tape, slab and flexible tubing—in a wide range of sizes—for fast, easy machining to close tolerances on standard metalworking tools or automatic equipment.

### POLYPENCO TEFLON MEANS QUALITY

In order after order, POLYPENCO Teflon comes to you with uniform, controlled density and maximum dimensional stability. Stock sizes available for immediate delivery from distribution locations throughout the country.

Take this first step toward a more efficient, economical solution to your design problems. Write today for latest technical data.

THE POLYMER CORPORATION of Penna. • Reading, Penna.  
In Canada: Polypenco, Inc., 2052 St. Catherine W., Montreal, P. Q.



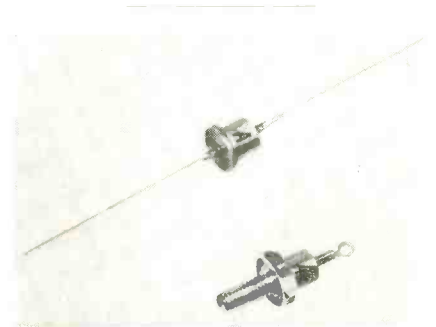
**POLYPENCO™**

Nylon, Teflon\*, Q-200.5 and K-51

\* DU PONT TRADEMARK

features its d-c voltage measuring sensitivity. The instrument has a voltage range of 1 to 1 billion.

► **Other Features**—It contains a high-impedance, chopper type d-c amplifier circuit which covers all ranges from 1 mv to 1 kv full scale. A low impedance direct-coupled hushed transistor amplifier accommodates the more sensitive ranges, the lowest being 0110  $\mu$ v. Hushed transistors operate at zero or reversed collector junction voltage.



### SILICON RECTIFIERS stud-mounted, new voltages

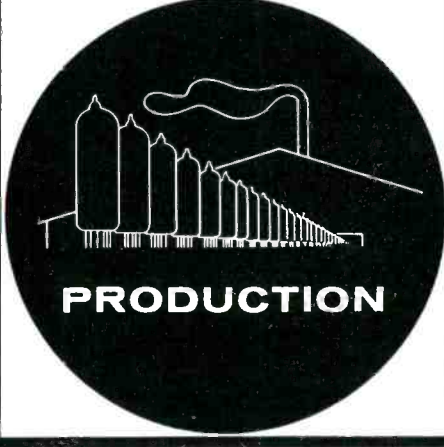
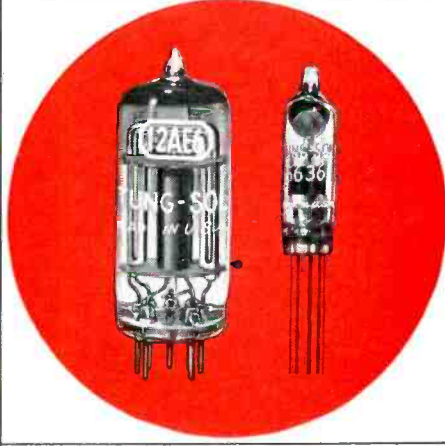
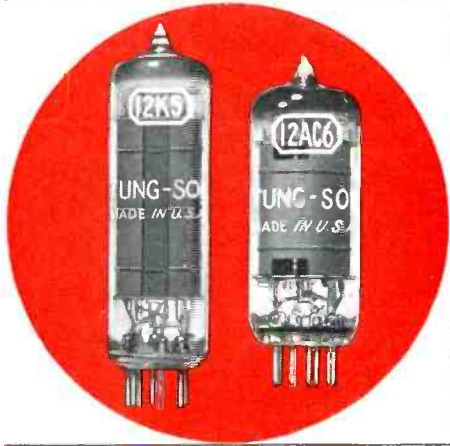
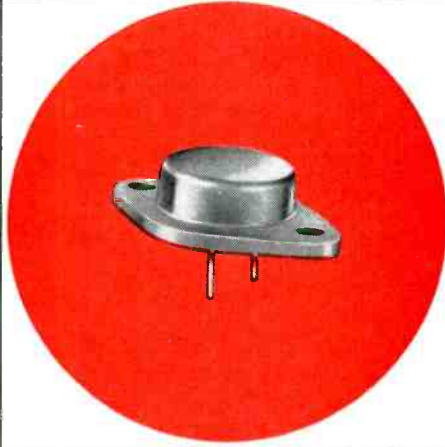
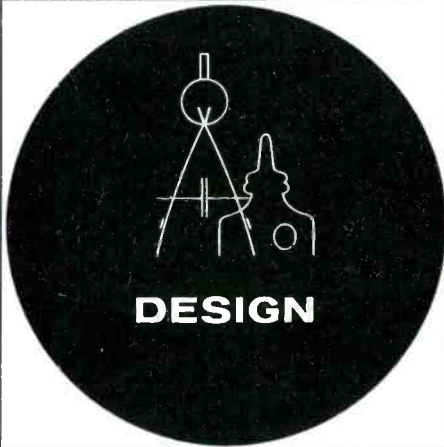
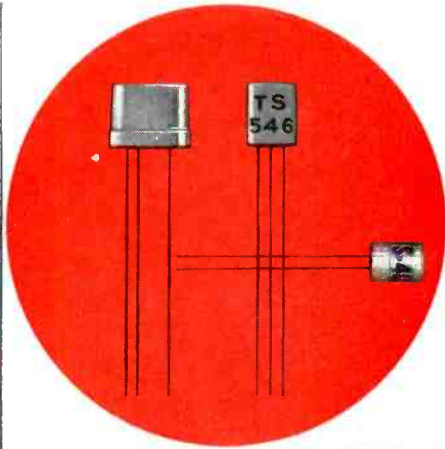
AUTOMATIC MFG. DIV., General Instrument Corp., 65 Gouverneur St., Newark 4, N. J. With addition of a new group of stud-mounted silicon power rectifiers and 800 to 1,000-v types, the company announces production on a complete line of medium power silicon rectifiers, including 22 different types in 8 voltage ranges, for all military and industrial applications.

Both the stud-mounted rectifiers (for bolting directly to a chassis) and the pigtail units (for wiring into the equipment) have infinitesimal reverse leakage current for highly reliable operation. Their all-welded hermetic seal makes possible operation at temperatures ranging from -55 C to +150 C, and they can be stored at temperatures from -65 to +180 C.

The new line now ranges from 100 to 1,000 v, with average d-c output currents of 300 ma for the pigtail types and 500 ma for the stud-mounted types. Typical leakage currents are from 0.005  $\mu$ a to 0.2  $\mu$ a. Power dissipation in free air is only 0.5 w in the pigtail units; 0.75 w in the stud-mounted types.

► **Uses**—They have been designed for use in electronic gear for guided missiles, supersonic aircraft and

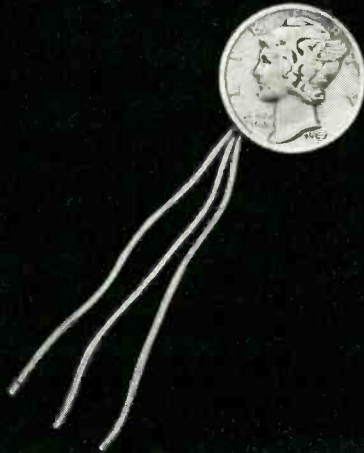




**TUNG-SOL ELECTRIC INC., Newark 4, N. J.**

SALES OFFICES: ATLANTA, COLUMBUS, CULVER CITY, DALLAS, DENVER, DETROIT, MELROSE PARK (ILL.), NEWARK, SEATTLE  
CABLE ADDRESS: TUNGSOL

**PROBLEM:**  
find the "pot"



This is the "Tail" of **A DAYSTROM "POT"**

*The Model 300-00—smallest, most ruggedly-accurate wire-wound potentiometer on the market!*

If you are having trouble finding the right "pot," a "pot" that will fit into the tiniest space, weigh less than an overstuffed feather, and still provide unexcelled accuracy and resolution characteristics, you will want to know about the Model 300-00 sub-miniature, wire-wound potentiometer produced by DAYSTROM POTENTIOMETER, and now improved even over the high-performance original.

So **SMALL** and **COMPACT** it can easily be covered by a dime (3/16 inch thick). One half as large as its nearest competitor.

So **RUGGEDLY ACCURATE** it can be used for the most exacting applications.

- High Power Rating
- Extremely Fine Resolution
- Operable Over Extreme Temperature Ranges
- Designed to stack (21 per cubic inch)

The Model 300-00 is just one of the many production or custom-made potentiometers available from DAYSTROM POTENTIOMETER. The Model 300-00 and its big brother—the 303-00 (higher resistance values)—are available out of stock.

Openings exist for highly qualified engineers.

**POTENTIOMETER DIVISION**

*Daystrom* **PACIFIC** CORPORATION  
11150 La Grange Ave. West Los Angeles 25, Calif.  
A Subsidiary of Daystrom, Inc.

other military equipment as well as industrial power supplies, magnetic amplifiers and communications equipment where size and weight reduction are important.



**DUODECAL SOCKET**  
with easily removable cap

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. Type B duodecal electron tube socket is designed specifically for use with 2BP1 and 2BP11 crt's.

► **Features** — Series 1550 socket features an easily removable socket cap providing complete protection for each individual connection. Wires can be brought out radially from the housing for grouping in a neat, compact cable assembly. Extra barriers provide unusually long creepage paths for high breakdown voltages—6,500 v rms at sea level and 1,500 v rms at 60,000 ft.

Molding compound is mineral filled melamine (MIL-P-14D, type MME). The contacts are made of beryllium copper and silver plated.

Bulletin 50A gives additional information including outline drawings.

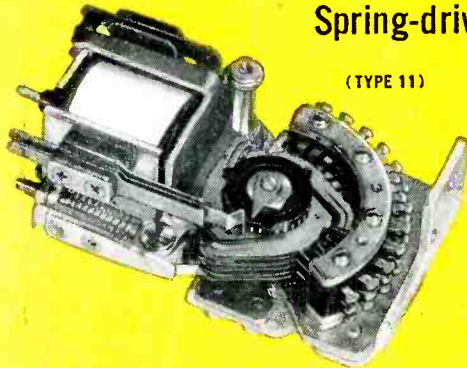
**BASE STATION ARRAY**  
is vertically polarized

MARK PRODUCTS Co., 6412 W. Lincoln Ave., Morton Grove, Ill., announces a vertically polarized omnidirectional base station array for the 450-470 mc region. Model C-10455 antenna consists of a cophased aperture approximately 18 ft in extent. Power gain of 10 db over a half-wave dipole is realized. The vertical pattern



## CLARE

### Spring-driven Stepping Switch

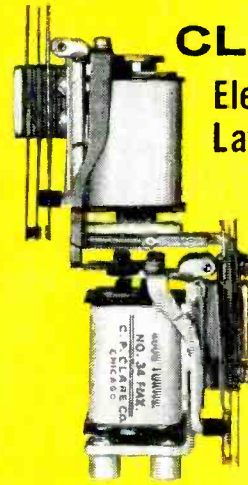


(TYPE 11)

Latest in CLARE line of uni-selectors, or rotary switches for completing, interrupting or changing connections in a succession of electric circuits in response to momentary impulses of current. Provides millions of steps without readjustment. Send for CLARE Bulletin No. 121.

## CLARE

### Electromechanical Latching Relays



Assembly consists of two CLARE a-c or d-c relays with interlocking armatures. One a-c and one d-c relay may also be used. Many of these relays still operating satisfactorily after well over 15,000,000 operations. Send for CLARE Bulletin No. 118.

## New CLARE RELAY designs keep pace with demands of modern high-speed equipment

CLARE RELAYS for use in modern high-speed devices differ in size, shape, appearance and characteristics to meet a wide range of design requirements.

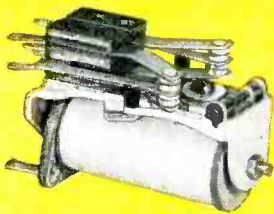
One factor they have in common—ability to deliver accurate and dependable performance for millions, yes even billions, of operations WITH NO MAINTENANCE WHATSOEVER.

A few of these outstanding CLARE developments are shown. There are many more. If your relay problem is new or unusual, CLARE sales engineers, located in key cities, may be able to bring you quickly just the relay you need. Contact C. P. CLARE & CO., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. CLARE & CO., 659 Bayview Avenue, Toronto 17. Telephone: Mohawk 3829. Cable address: CLARELAY.

## CLARE

### Mercury-Wetted Contact Relays

A relay of the utmost accuracy and dependability which is capable of over a billion operations at speeds to 60 operations per second. Cutaway view shows mercury-wetted contact switch sealed in glass. Available with up to 4 switches for multiple circuits. Send for CLARE Bulletins Nos. 120 and 122.

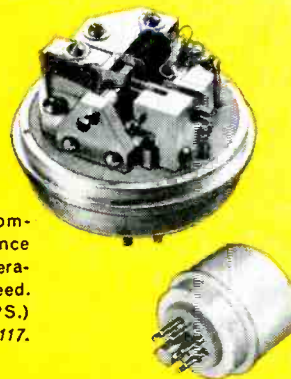


## CLARE Type J Heavy-duty Contact Relay

Increased current carrying capacity is provided by the use of silver heavy-duty contacts which are riveted to the springs. Rating of 10 amperes, 27½ volts d-c. Has exceeded 500,000 operations on motor load of six amperes—inrush current of 15 amperes—at 70,000 feet altitude. Send for CLARE Bulletin No. 119.

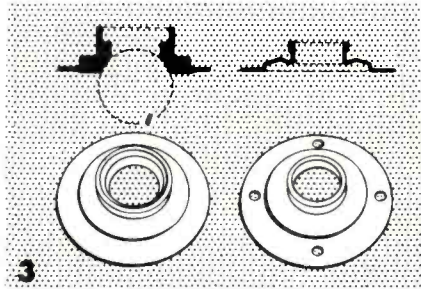
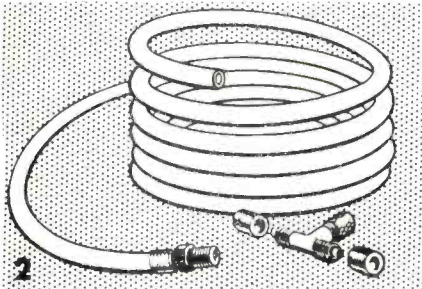
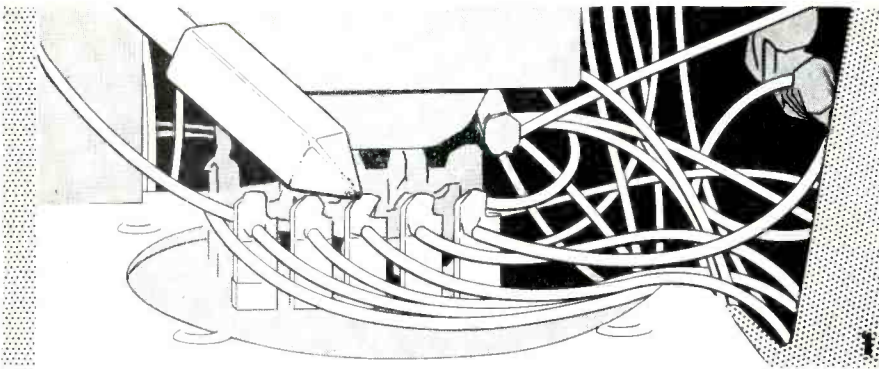
## CLARE High Frequency Impulse Relay

A highly sensitive relay completely free from contact bounce and capable of billions of operations at extremely high speed. (Will follow up to 2,500 CPS.) Send for CLARE Bulletin No. 117.



# CLARE RELAYS

FIRST in the industrial field



## TEFLON

(DU PONT TRADEMARK)

### demonstrates its versatile properties as an engineering material . . . . .

. . . with a combination of electrical, mechanical and chemical properties unmatched by any other single material. Characteristics such as high dielectric strength, complete chemical inertness, resistance to temperatures ranging from  $-450^{\circ}$  F. to  $500^{\circ}$  F., offer design and product improvement opportunities never before possible.

#### 1. SPAGHETTI TUBING — made from Teflon

Wire cable insulation of "Teflon" is not affected by the heat of soldering operations. Operators work easily and quickly when soldering hook-up wires. Teflon occupies only  $\frac{1}{3}$  the space required by other types of insulation. Available from stock in many sizes and colors.

#### 2. FLEXIBLE THIN-WALLED TUBING — of Teflon

An outstanding insulation—the smooth surface of Teflon makes this tubing easy to slide over electrical conductors. Teflon tubing has extremely high dielectric strength, low power factor, wide working-temperature range. Standard sizes from stock . . . any desired color available.

#### 3. CUSTOM MOLDED TEFLON — in thin sections and shapes

Manufactured by Sparta's own patent-applied-for process, Cup, Ball or Shaft Seals, Gaskets, Washers or Diaphragms, give you design advantages (with an ultimate lower cost), than all other ordinary flexible materials.

*The first cost can be the least . . . if it is the last cost!*

AVAILABLE NOW  
FROM ONE SOURCE!

#### PLEASE NOTE:

Complete data on properties and applications available without cost or obligation. Write today for our brochures:

- Teflon Spaghetti and Thin-Walled Tubing Price list and sizes.
  - Custom Molded Teflon in Thin Sections and Shapes
- DEPT. E



# SPARTA

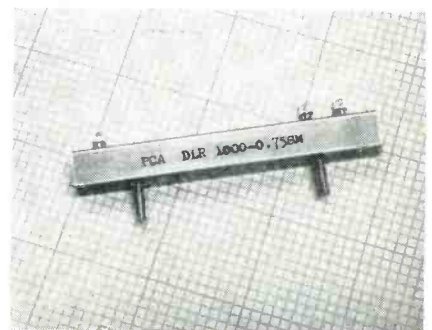
MANUFACTURING CO.  
DOVER, OHIO  
Phone: 4-2755



beamwidth is approximately 6 deg between half power points. Overall length is 22 ft and total weight is 50 lb.

The structure is composed of integrally molded radiating elements in a cellularcore-Fiberglas epoxy molded structure. The closed cell structure prevents formation of moisture internally and adds great stiffness to the unit.

Two versions are offered. One is supplied in 2 sections for assembly on the job and consists of a 14-ft lower section and an 8-ft top section. The other is a solid unit 22 ft. long.



#### DELAY LINES

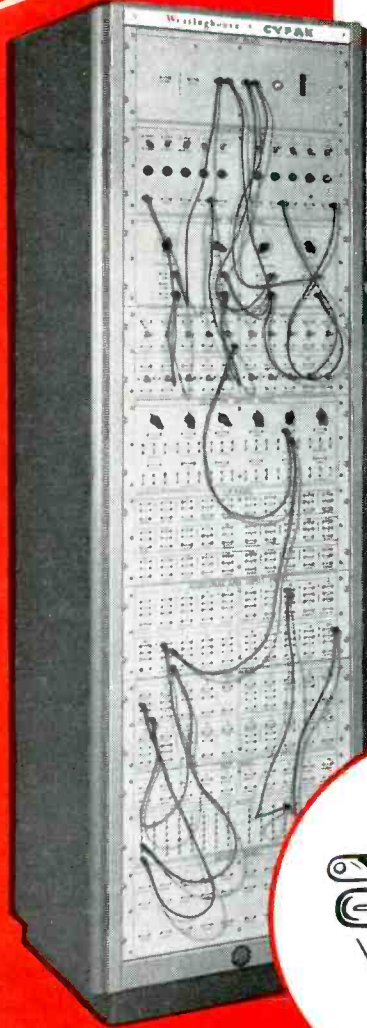
operate from  $-55^{\circ}$  C to  $+125^{\circ}$  C

PCA ELECTRONICS INC., 2180 Colorado Ave., Santa Monica, Calif., has available hermetically sealed delay lines packaged in 0.4 maximum square metal tubing. They are provided with stud for chassis mounting and glass hermetic seals on the opposite surface.

► Types—Designs are available in each impedance level and delay time. One design emphasizes maximum delay per cu in. with a fair rise time. The second combines

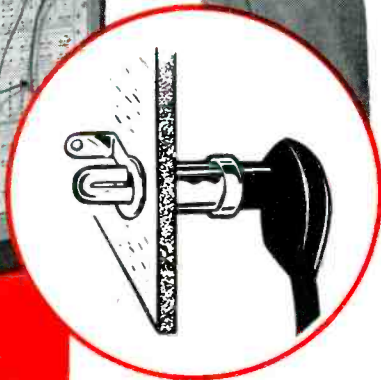


*Locked-in  
Accuracy!*



\*Trade Mark

Magnified view shows how the *Interlock* Type "A" Plug, used in the Cypak Problem Simulator, locks into built-in panel eyelets. Double-ended Jumper Cords are available in standard lengths from 6" to 36" or longer if specified.



# HUBBELL

## *Interlock* PLUGS

provide a dependable, low contact resistance Jumper System for

### CYPAK\*

THE REVOLUTIONARY, NEW

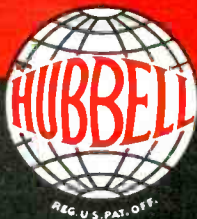
## Westinghouse

## System Control

The unique Cypak System introduces *static control*—with life at least 15 times that of conventional relays—from units that fit in the palm of your hand, and which have no moving parts to wear or erode. Using a logic function approach, decision elements are jumpered together by automatic locking *Interlock* Plugs and Jumper Cords, which afford a constant low contact resistance. *Interlock* Plugs were also specified by Westinghouse, because eyelets were simple to install in quantity within a small area.

Just as Cypak offers a longer life and a higher degree of reliability than conventional relays, so Hubbell *Interlock* Plugs offer more dependable connections, through a *locked contact*, than other connectors on the market.

For Further Information, Write Dept. C



REG. U.S. PAT. OFF.

# HARVEY HUBBELL, INC.

Interlock Electronic Connector Dept., Bridgeport 2, Conn.

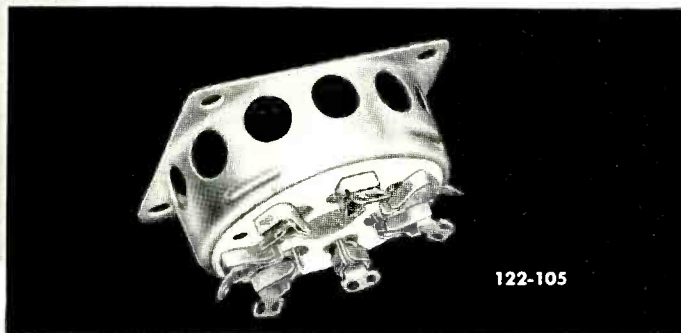


Pat. & Pat. Pats.

# 3 grades for every tube socket... means simplified selection...shorter delivery cycles!



Standardization means different things to different people. To the design engineer or manufacturer specifying tube sockets, Johnson's standardization program permits the maintenance of stock on industrial and military tube sockets as well as standard commercial models. Now you can get immediate shipment of small quantities for development or pre-production runs and small run set-up charges are eliminated in most cases. You'll find, too, that many times a socket ordered to your exact specifications is immediately available in comparable or higher quality at a lower cost due to standardization. Specifications for the three variations of each wafer socket type as follows:



**STANDARD**  
A commercial grade socket suitable for general requirements. Glazed steatite base is DC-200 treated—contacts are of plated brass with steel springs. Etched aluminum shields on shielded types.

**INDUSTRIAL**  
Superior in quality to Standard types, Industrial types have glazed steatite bases, DC-200 treated. Contacts are phosphor bronze with beryllium copper springs .0005 silver plated. Shields on shield types are iridite No. 14 treated aluminum. Fungus resistant cushion washers under contacts.

**MILITARY**  
Top quality for all military requirements. Glazed steatite bases, DC-200 impregnated. Phosphor bronze contacts and beryllium copper springs silver plated .001—hot tin-dipped solder terminals. Fungus resistant glass base melamine cushion washers iridite No. 14 treated aluminum shields on shielded types. Entire socket protected for 200 hour salt spray test.

For complete information and specifications on Johnson tube sockets, write for your copy of booklet 536.

**STEATITE AND PORCELAIN INSULATORS**

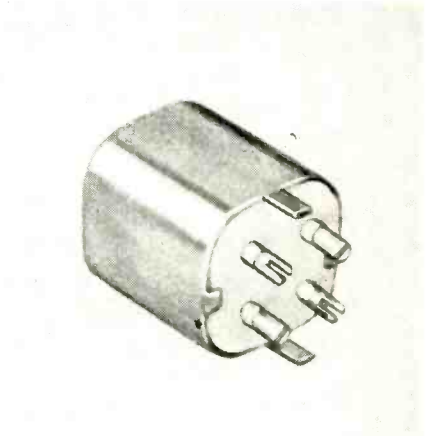
Fracture resistant, dense molded and glazed for low moisture absorption. Stand-Off and Feed-Thru insulators designed with extended creepage paths for maximum voltage breakdown ratings. Types available with built-in jacks to accommodate standard banana plugs. Hardware is nickel plated—excellent for exposed applications. Write for full information.

**E. F. Johnson Company**  
2217 SECOND AVE. S.W. • WASECA, MINNESOTA  
CAPACITORS • INDUCTORS • KNOBS • DIALS • SOCKETS • INSULATORS • PLUGS • JACKS • PILOT LIGHT

moderate delay per cu in. with good rise time. The third emphasizes fast rise time and a low delay per cu in.

► **Uses**—All designs are miniaturized and are commonly used for delaying video pulses, pulse shaping, gating, storage of information in computers, time standards in wave forms, time-modulation, generation of wave forms, and high impedance connecting cables.

They are designed to operate from -55 C to +125 C. The container is cadmium plated and iridite treated to withstand humidity and corrosive atmosphere.



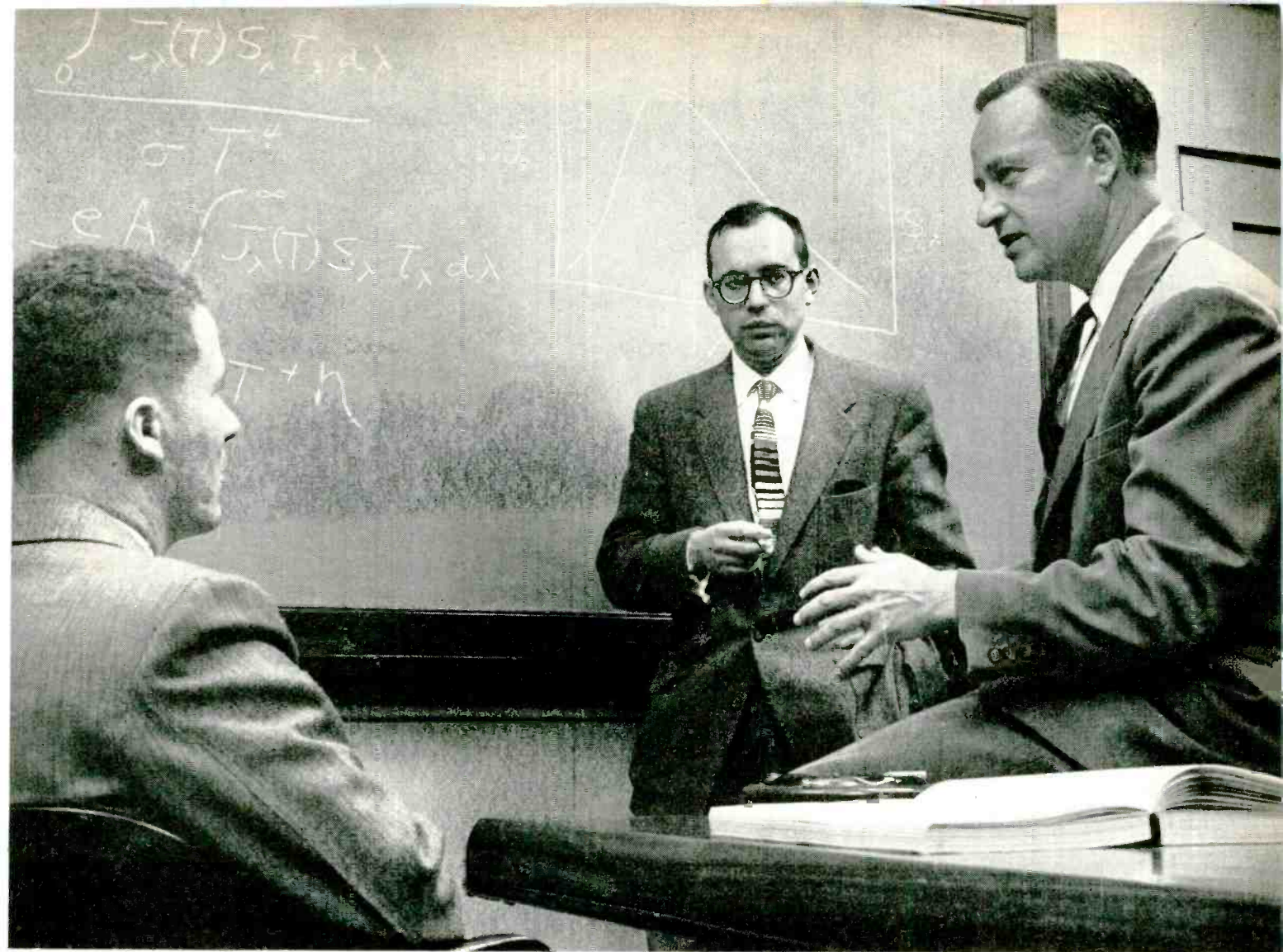
## SHIELDED COIL FORM for printed circuits

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass. The LS-12 shielded coil form has a square shaped plated brass housing, whose dimensions are 1/2 in. by 1/2 in. by 1/2 in. Inside the housing is a coil form with an internally adjustable powdered iron core, tunable from top or bottom. The LS-12 mounts by two tabs that can be inserted through a printed circuit board and can be dip-soldered from one side of the board to complete installation.

► **Uses**—Equipped with two to six terminals, the LS-12 covers a wide range of applications from simple r-f for use with conventional vacuum tube circuitry to i-f transformer using transistors, where as many as six terminals may be required. The unit has a cup core assembly.

The LS-12's are available as





*Dr. Lewis Larmore (right) discusses fundamental problems of radiation transfer in infrared detection with Dr. T. Teichmann (center) and Experimental Physicist Freeman Hall.*

## MISSILE SYSTEMS PHYSICS

Advances in missile systems technology are measured to a great extent by increasing demands imposed on the ability of experimental and theoretical physicists.

With problems of new magnitude now being approached, a high degree of creative effort and individual initiative is required.

New developments at Lockheed Missile Systems Division's Aerophysics and Nuclear Research Laboratories offer a wide range of assignments in fields such as:

- Experiments with shock tubes and their associated problems of instrumentation including studies involving high temperatures and high Mach numbers.
- Infrared measurements of atmospheric transmission and emission from various sources.
- Optical instrumentation for spectrophotometry and emissivity measurements and shock tube spectrographic studies.
- Aerophysics of high-speed vehicles, including heat transfer, flow field and associated areas.
- Fundamental and applied experimental nuclear research, using the Lockheed 3 MEV Van der Graaff accelerator.
- Specialized nuclear reactor system study, design and development.

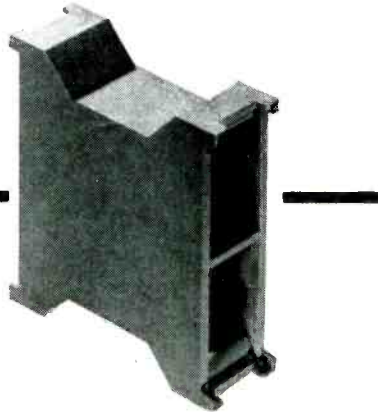
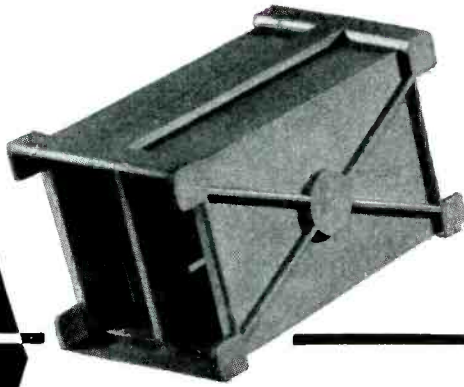
Those possessing keen interest in these and related fields are invited to write. Please address inquiries to the Research and Engineering Staff at Van Nuys.

*Lockheed* **MISSILE SYSTEMS DIVISION • LOCKHEED AIRCRAFT CORPORATION**  
**VAN NUYS • PALO ALTO • SUNNYVALE • CALIFORNIA**



If you use  
**Top Wall  
Hybrids**

**Side Wall  
Hybrids**



Licensed under U. S. Patents  
2739287 and 2739288

**Microwave Development  
Laboratories now supplies,  
from stock, a wide  
variety of designs**

High frequency radar and communications fields find application for MDL Top Wall and Side Wall Short Slot Hybrid Junctions because of their symmetry and inherently low Q. These units were first manufactured and made available by Microwave Development Laboratories. Top Wall Hybrids cover most frequencies from 1200 to 17000 mc/s. Side Wall Hybrids from 1200 to 36000 mc/s. You get exceptional performance with MDL Hybrids. They are easy to assemble, for indexing lugs facilitate brazing to connecting waveguide.

**Engineering Data**

	Top Wall	Side Wall
Terminated VSWR	less than 1.10	less than 1.10
Isolation	in excess of 30 db	in excess of 30 db
Power Division	0.0 db $\pm$ 0.25 db	0.0 db $\pm$ 0.25 db
Material	Beryllium copper or aluminum	Beryllium copper or aluminum

The above are standard specifications—specials are available.

Write for catalog C-356 for complete information on Microwave Development Laboratories' Hybrid Junctions. For best results, consult MDL on any of your microwave component requirements. Complete development and manufacturing facilities are available.



**MICROWAVE DEVELOPMENT LABORATORIES, INC.**

92 BROAD ST., BABSON PK., WELLESLEY 57, MASS.

telephone — WEllesley 5-6252 - 6253

DESIGN • DEVELOPMENT • PRODUCTION

NEW PRODUCTS

(continued)

forms alone or wound to customer's specifications.



**POTENTIOMETER  
for computer application**

ELECTRO-MEC LABORATORY, INC., 47-51 33rd St., Long Island City, N. Y. The new type 18 ultra-low-torque potentiometer is 1.750 in. in diameter. It features a servo type mounting, a vital detail to computer designers. The single and three-gang pots are 0.97 and 1.97 in. long, respectively. Individual pot cups are 0.500 in. long. Ganged assemblies up to 15 cups are available.

► **Technical Data**—Type 18 potentiometer is available with resistance values up to 200,000 ohms, is rated at 2.2 w at 40 C, and the toroidally wound resistor element provides electrical rotation up to and including 360 deg. Standard independent linearity tolerance is 0.3 percent, but 0.1 percent can be supplied. Nonlinear, functional output types are also available to meet the requirement of varying applications. A multiplicity of taps on the resistor element can be made, each positioned with an angular accuracy of  $\pm$ 0.5 deg, and each electrically welded to a single turn of the winding, thus avoiding dead spots.

Dimensions of the new pot conform to those prescribed by the Aircraft Industries Association Committee on Standardization, specification NAS-710.

**TRANSISTOR TESTER  
self-contained, portable**

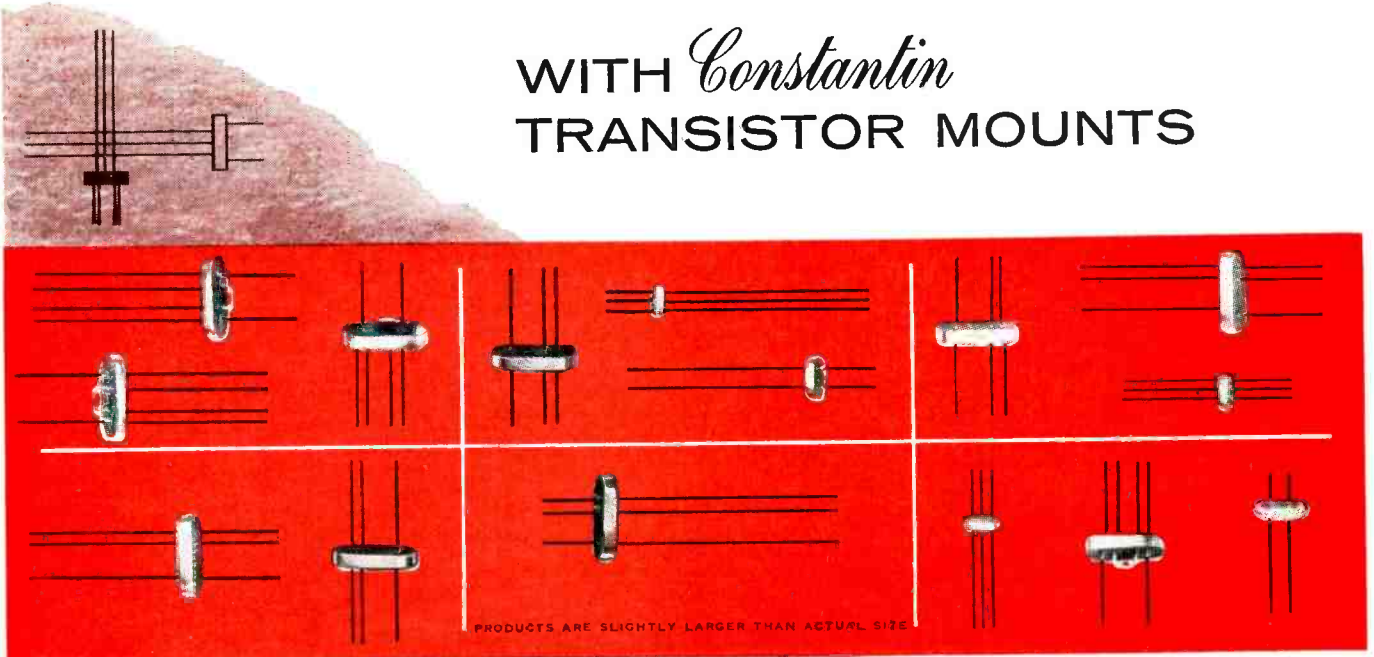
CG ELECTRONICS CORP., Albuquerque, New Mexico. A fast comparative check on *pnp* and *npn* transistors for laboratory, production line



*Less than*

**one % percent rejection**

WITH *Constantin*  
TRANSISTOR MOUNTS



**. . . Compared to  
Leading Manufacturers'  
20% rate of rejection**

These actual production figures were recently compiled by a prominent semiconductor manufacturer . . . and all indications are that Constantin rejection rates are becoming even more infinitesimal! Constantin's six separate check points maintain rigid, meticulous inspection — from start to finished mount . . . 100% final inspection insures perfect units.

Shown here are but a few of the many types of transistor mounts designed and manufactured by Constantin whose many years of experience in glass-to-metal hermetic seal production can solve the most difficult sealing problem.

These are but a few of the reasons manufacturers rely on Constantin for all types of glass-to-metal seals. Write for more complete information about how these quality units can help you — now!

"QUALITY WITH CONFIDENCE"

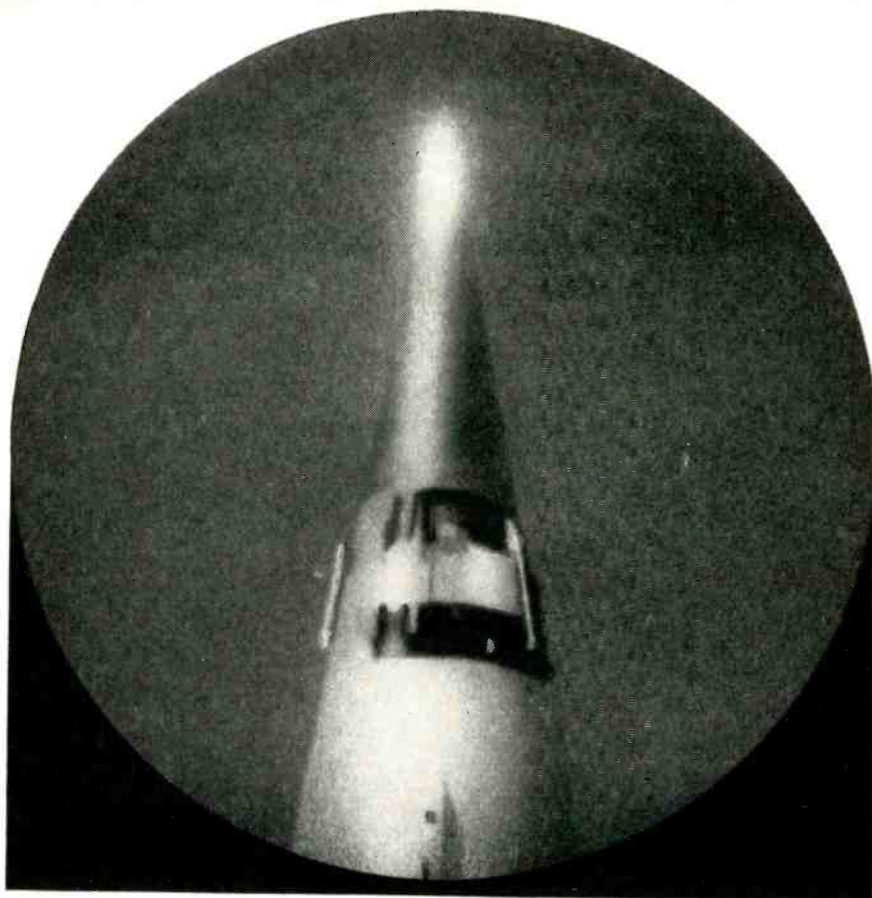


*L. L. Constantin & Co.*

**MANUFACTURING  
ENGINEERS**

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TRANSISTOR MOUNTS • SINGLE TERMINALS • COMPRESSION HEADERS • END SEALS • CRYSTAL BASES • CONNECTORS • MINIATURIZATION



## HOT TIP

*(For Electronicists)*

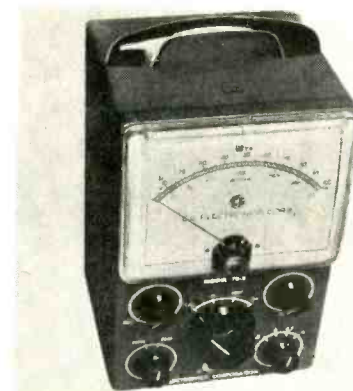
The big count-down has begun! In a matter of months, the tip of a Martin rocket will travel through space at a speed of 5 miles per second—and moments later the first man-made satellite will reach its orbit.

This event, the first of a series of 12 in the Martin-Navy VANGUARD program, will commence a new chapter in the short but exciting story of electronics.

Today, no other engineering organization in the world is more concerned with the outer-space electronics problems of tomorrow.

If you are interested, contact J. M. Hollyday, Dept. E-06, The Martin Company, Baltimore, Maryland.

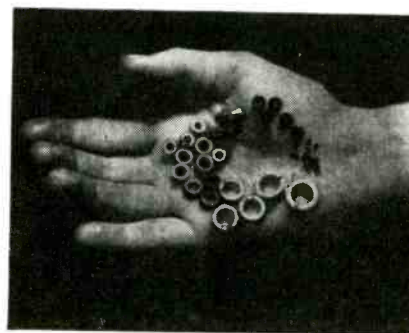
# MARTIN



and radio service use is now provided by a new, completely self-contained, portable transistor tester, model TR-2. It features a 4-in. meter with 2 ranges that allow the operator to read alpha, beta and  $I_{co}$  directly. Alpha tests up to 0.99 and beta to 100. The model is available in a-c or d-c versions.

Emitter current is adjustable from 1 to 10 ma, while a selector switch provides a collector voltage of 1.5 to 6 v to the transistor under test. A calibration control compensates for wide temperature variations.

Housed in an indestructible metal cabinet 4½ in. wide by 4 in. deep by 7½ in. high, the unit weighs 3 lb and operates on a frequency of 1 kc from a self-contained oscillator. Price is \$124.95.



## MAGNETIC CORES with high uniformity

BURROUGHS CORP., Electronic Instruments Div., Philadelphia, Pa., has announced a line of tape-wound magnetic bobbin cores with high standard uniformity.

► **Uses** — Known as Bimags, the cores are intended for use in switching circuits, shift registers, coincident current matrix systems,

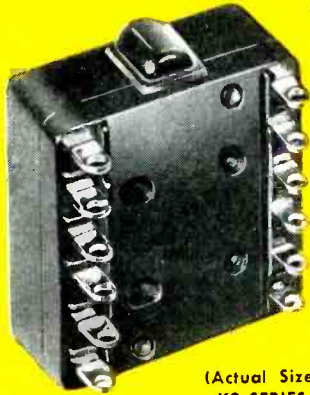


New **ELECTRO SNAP**

SIMULTANEOUS

# TRIPLE-POLE SWITCH

for interrupting 3-phase,  
110 V, 400 cycle AC circuits



(Actual Size)  
K3-SERIES

## TRIPLE-POLE SWITCH

### OPERATING CHARACTERISTICS

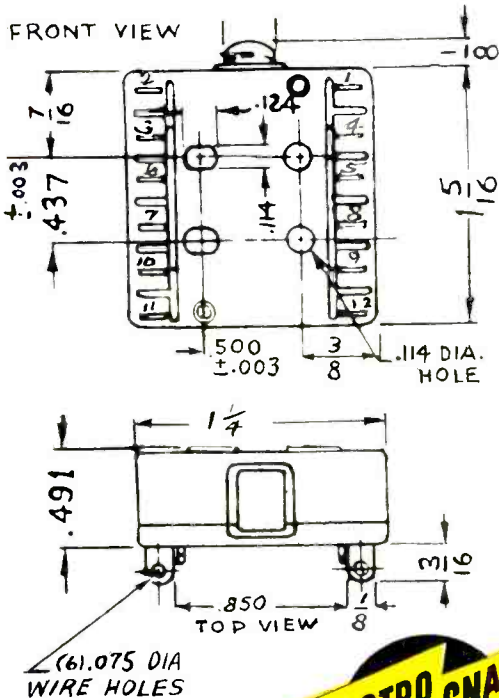
#### CONTACT ARRANGEMENTS:

- K3-4—TRIPLE-POLE, DOUBLE THROW
- K3-2—TRIPLE-POLE, NORMALLY OPEN
- K3-1—TRIPLE-POLE, NORMALLY CLOSED

#### ELECTRICAL RATING:

- 15 AMP 125/250 V.A.C.
- 15 AMP 30 V.D.C. RESISTIVE
- 10 AMP 30 V.D.C. INDUCTIVE

PROBABLE MECH. LIFE.....1,000,000 OPS  
 PROBABLE ELEC. LIFE.....500,000 OPS  
 AMBIENT TEMP. RANGE.....-100° TO +275° F.\*  
 \*(-100° to +375° F. available)



### 6-CIRCUIT CONTROL — in a small package.

Makes possible a wide variety of circuit combinations.

### SIMULTANEOUS "MAKE & BREAK" ACTION

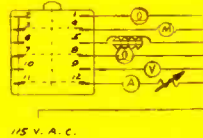
Permits unusual applications, reduces arcing, prolongs switch life and increases electrical capacity.

This completely new Electro-Snap triple-pole switch simultaneously reverses current flow through three windings of a 3-phase motor up to 1 H.P. and interrupts other types of multi-switching installations. Instantaneous snap-action of the three poles is independent of the speed of actuation — even extremely slow moving cams can be used.

The K3-Series offers designers a wide variety of 3-phase circuit hookups for servo-controls, to limit movement of machine members and as a start-and-stop switch which formerly were possible only with complicated relays or a number of separate switches. A large selection of standard actuators is available.

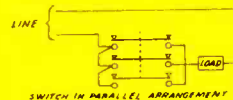
### LOOK WHAT YOU CAN DO WITH IT!

#### Control Six Circuits with ONE Snap

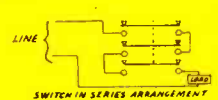


Used in motor control device switch, when actuated, turns on the red light on No. 1, the solenoid on No. 5, the voltmeter on No. 9 and turns off the motor on No. 4, the green light on No. 8 and the furnace and ammeter on No. 12.

#### Wire Movable Poles in Series for High Voltage or in Parallel for High Current



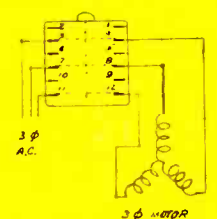
With the switch wired in parallel arrangement, the current is divided into 3 paths through the switch. This permits the switch to be used with a load rated up to 3 times the ampere rating of the switch.



With the switch wired in series arrangement, the current has only 1 path through the switch. The multiple breaks in the current path permits the switch to be used where the line voltage is rated up to 3 times the voltage rating of the switch; ampere rating not affected.

#### Start and Stop Three-Phase Motors

Completely disconnect all current supplied to a 3-phase motor by interrupting 3 phases simultaneously with one snap.



## ELECTRO-SNAP SWITCH AND MFG. CO.

4236 West Lake Street • Chicago 24, Illinois

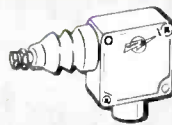
MODERN DESIGN  
IN A COMPLETE LINE  
OF SWITCHES



Sub-Miniature Switch



Multi-Pole Switches



One-Way Limit Switch



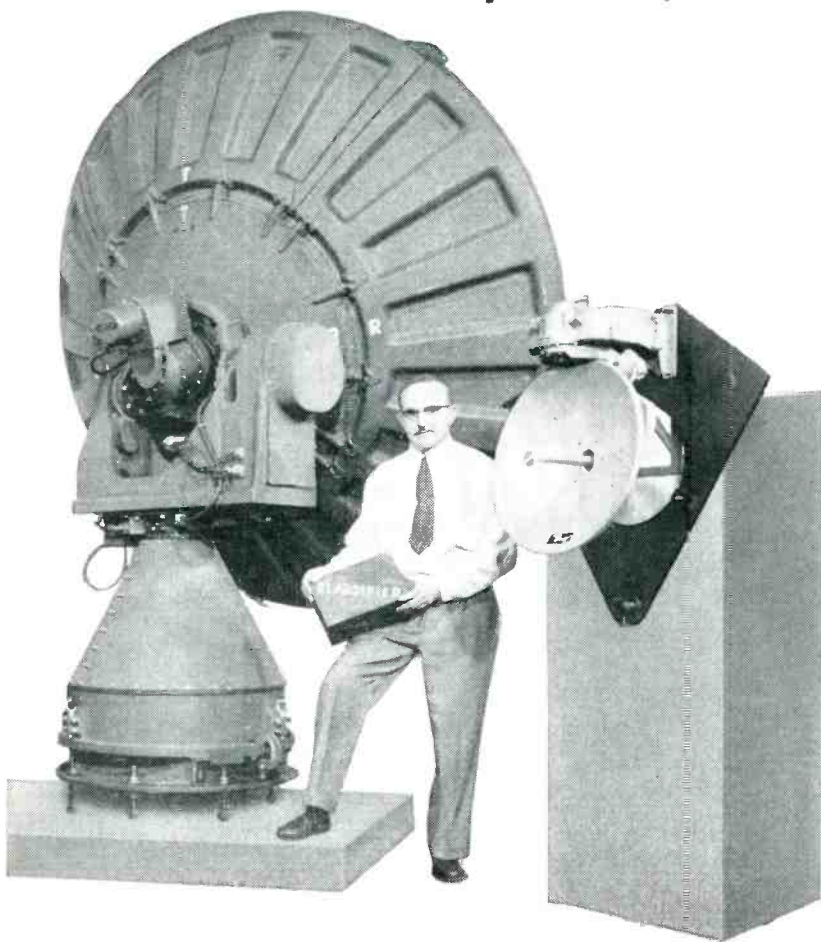
Basic Switch



Hermetically-Sealed Limit Switches

# RADAR ANTENNA DEVICES

by **Bendix**



## Advanced Design and Packaging Techniques Cut Down on Size and Weight

As you can see, we make a wide range of radar antenna devices, including an extremely small one that's classified. And, because of our vast experience in servo-mechanisms . . . and in latest packaging techniques . . . Bendix Radar Antenna Devices are *smaller and lighter*.

**THE GROUND ANTENNA PEDESTAL** (left) is air transportable. Total unit weight is *about half* that of previous models. Segmented parabolic reflector can be *quickly dismantled for transit*. Accuracy is 1.5 minutes at normal temperature and loading. Operational

requirements cover ambient temperature range of  $-65^{\circ}\text{F.}$  to  $+150^{\circ}\text{F.}$  and wind loading up to 50 mph.

**THE AIRBORNE WEATHER RADAR ANTENNA** (right) is designed for circular azimuth scanning at 15 rpm on all modern commercial aircraft. Available in both X-band and C-band. 22" X-band version weighs less than 25 lbs.

For complete details on our line of radar antenna devices, write Department C, **ECLIPSE-PIONEER DIVISION, BENDIX AVIATION CORPORATION, TETERBORO, NEW JERSEY.**

West Coast Offices: 117 E. Providencia Ave., Burbank, Calif.

Room 114, Administration Bldg., Boeing Field, Seattle 8, Washington

Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.



NEW PRODUCTS

(continued)

pulse transformers, and static magnetic memory elements.

The high standard of uniformity achieved in Bimagas is designed to simplify the task of the design engineer in applying magnetic cores as working components in electronic systems.

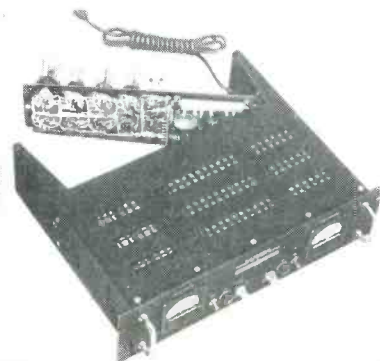
A wide range of standard  $\frac{1}{4}$  in. and  $\frac{1}{8}$  in. cores are now available in Moly Permalloy (thicknesses of 0.00025 in. and 0.0005 in.) and Orthonik (thicknesses of 0.00025 in. and 0.0005 in.). Other cores of various widths, thicknesses and bobbin sizes or materials are available for special application.

## PULSE GENERATOR a quadruple unit

**ELECTRICAL AND PHYSICAL INSTRUMENT CORP.**, 42-19 27th St., Long Island City 1, N. Y. Model 340 quadruple pulse generator generates 4 square pulses of 1 millimicrosecond selectable by front panel selector.

► **Features**—Advantages are 4 separate pulse outputs which can be independently varied in amplitude in 1-db step over the range of 0.006 to 100 v into low-impedance cables. A 0-2 db continuously variable vernier control for all outputs is also included.

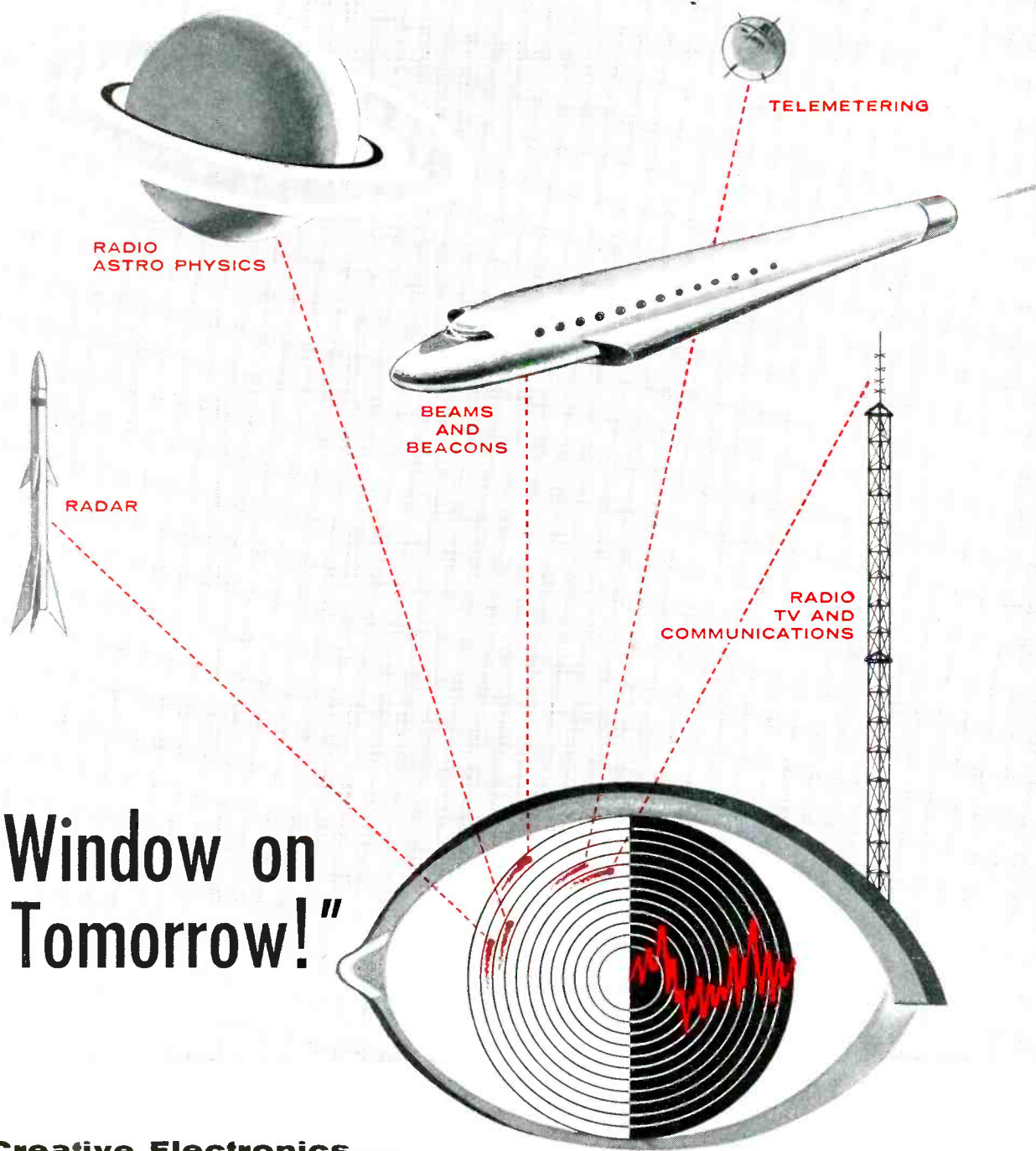
Outputs can be matched to any impedance from 50 to 200 ohms and equipped with any desired chassis jacks.



## POWER SUPPLIES four new rack models

**LAMBDA ELECTRONICS CORP.**, 11-11 131 St., College Point 56, N. Y. Models 281, 281M, 282 and 282M

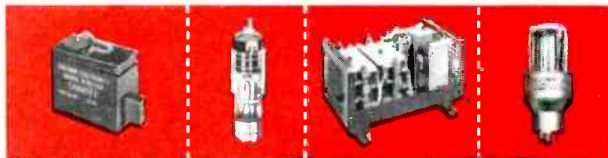




# "Window on Tomorrow!"

**Creative Electronics...**

## **CHATHAM ELECTRONICS AT WORK**



**RADIAC DETECTOR CHARGER** — extremely compact, requires no battery.

**XENON RECTIFIER** — 75° C to +90° C.

**AIRCRAFT CONVERTER** — reduces space and wgt. requirements.

**RUGGEDIZED RECTIFIER** — withstands 980 G shock.

With new problems of unknown magnitude arising almost daily, creative efforts of the highest order are indicated. At Chatham your problems in the realm of electronic tubes, radar components, sonar equipment, nuclear instrumentation, infrared detection and related fields are in the hands of experienced research teams and production engineers. For full information on Chatham Tubes, Aircraft Conversion Equipment, Selenium Rectifiers and custom Equipment also available.



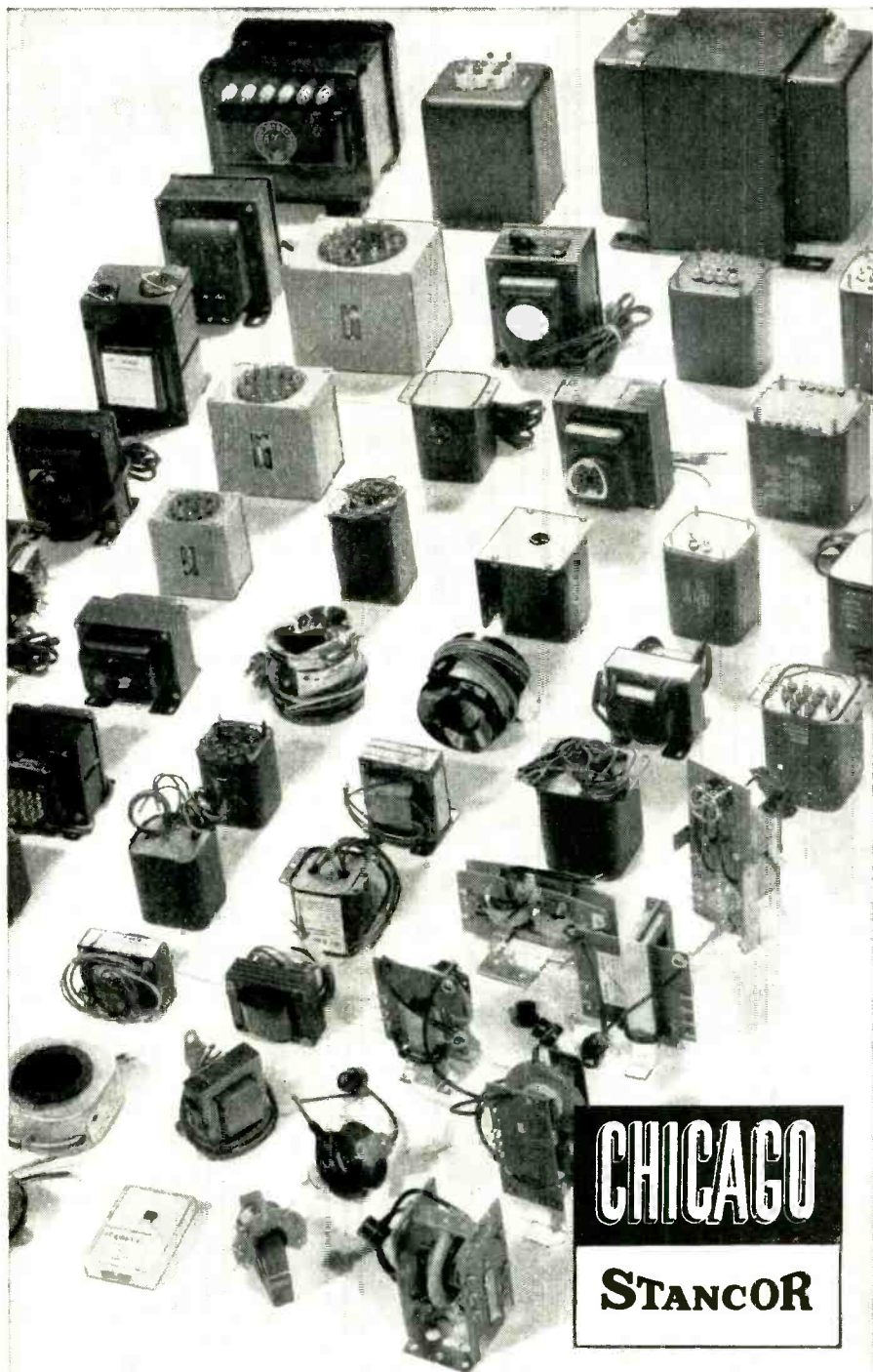
### **Chatham Electronics**

*DIVISION OF GERA CORPORATION*

Livingston, New Jersey — Branch Offices in Principal Cities

DESIGNERS AND MANUFACTURERS

OF ELECTRONIC TUBES, SELENIUM RECTIFIERS, AIRCRAFT CONVERSION EQUIPMENT AND CUSTOM COMPONENTS



**CHICAGO**  
**STANCOR**

If it's variety you want  
**Chicago Standard**  
has it... in stock

**FREE:** CHICAGO STANDARD catalogs listing over 1100 transformers for original equipment and replacement applications.



**CHICAGO STANDARD TRANSFORMER CORPORATION**

3501 ADDISON STREET • CHICAGO 18, ILLINOIS

Export Sales: Roburn Agencies, Inc., 431 Greenwich Street, New York 13, N.Y.

d-c power supplies have a panel height of only 5 1/2 in., allowing added rack space for other components. They are rated for 200 ma, with a range of 125-325 v d-c for models 281 and 281M, and 325-525 v d-c for models 282 and 282M.

► **Advantages** — Special features include fuse failure indicators, transient-free operation, and hermetically sealed transformers and chokes. Other advantages are a stable 5651 reference tube to obtain superior long-time voltage stability; harness wiring; easy-to-read 3 1/2 in. meters on M models; stable, low-noise wirewound reference networks and multipliers; and excellent regulation, low output impedance and low ripple.

Prices range from \$149.50 to \$189.50.



### **PULSE GENERATOR** for magnetic core systems

THE REFLECTONE CORP., Myano Lane, Stamford, Conn., has introduced model 6 pulse generator for use in magnetic core systems. It delivers positive-going rectangular wave current pulses of variable duration, rise time and amplitude.

► **Stages** — It is a 4-stage unit comprising multivibrator, inverter-amplifier, cathode follower and current amplifier.

The design of the multivibrator stage permits the selection of any pulse width from 1 to 40  $\mu$ sec by either instrument controls or the use of two external trigger pulses.

The inverter amplifier stage provides a rise time range from 0.15 to 1.0  $\mu$ sec.

Output amplitude can be varied from 0 to 2 amperes. Input requirements are: standard 0.1  $\mu$ sec pulses, negative, 13 to 30 v; + 150 v d-c, 2.03 amperes; -150 v d-c, 0.04

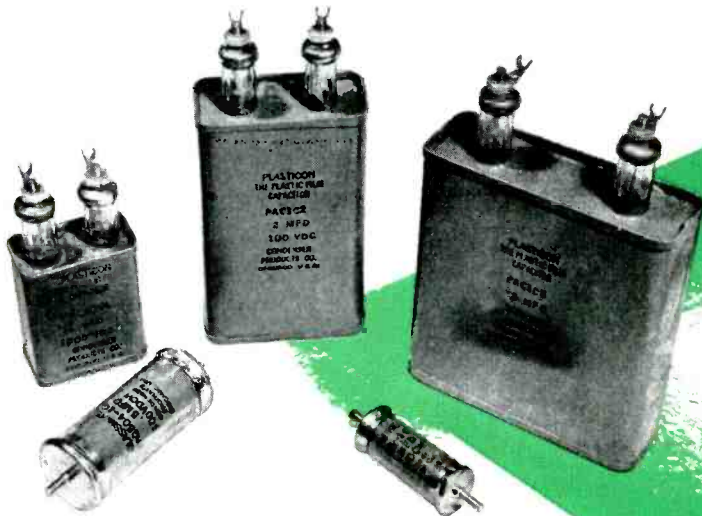


# For High Q and Excellent Capacitance Stability



**PLASTICON CAPACITORS**

are  
made  
with



CP Plasticon Type P Capacitors are available with metal can containers in 22 capacities ranging from 0.1 mfd at 1000 vdc to 25 mfd at 100 vdc; and with tubular "Glass-nike" containers in 22 capacities from .001 mfd at 1000 vdc to 1.0 mfd at 100 vdc.

# NATVAR Styroflex®

Capacitors designed and manufactured by Condenser Products Co., Division of New Haven Clock & Watch Co. are extensively used in calculators, computers, integrating circuits, electronic controls, sawtooth oscillators, and other equipment where stability and low dielectric loss are important.

Natvar Styroflex film is used as the dielectric because it has all of the outstanding properties of polystyrene, plus complete flexibility due to bi-axial orientation during the manufacturing process.

If you need an insulating material with the desirable characteristics of polystyrene—plus flexibility, it will pay you to investigate Natvar Styroflex. Ask for new data sheet ST-1, just off the press.

## NATVAR CORPORATION

FORMERLY THE NATIONAL VARNISHED PRODUCTS CORPORATION

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### Natvar Products

- Varnished cambric—cloth and tape
- Varnished canvas and duck
- Varnished silk and special rayon
- Varnished—Silicone coated Fibreglas
- Varnished papers—rope and kraft
- Slot cell combinations, Aboglas®
- Isoglas® sheet, tape, tubing and sleeving
- Vinyl coated—varnished—lacquered tubing and sleeving
- Extruded vinyl tubing and tape
- Styroflex® flexible polystyrene tape
- Extruded identification markers

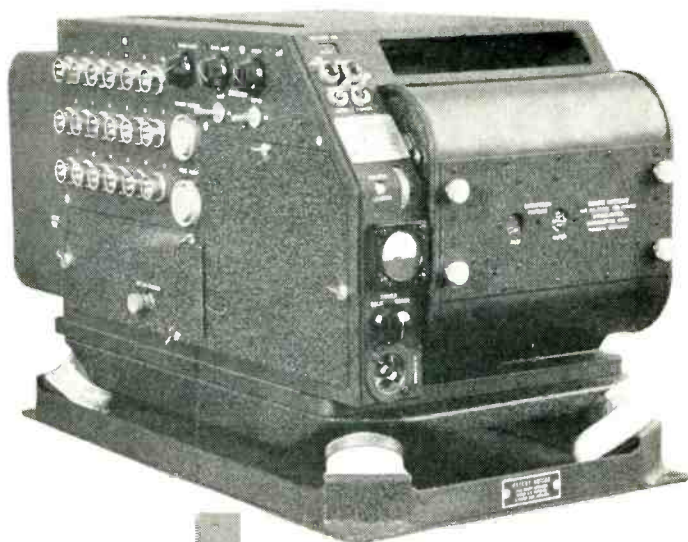
Ask for Catalog No. 23

# 5-114 RECORDING OSCILLOGRAPH

more in use than  
all other  
photographic-type  
oscillographs combined

First used in 1948 . . . since then, thousands of instruments purchased . . . more in use today than all other photographic-type recording oscillographs combined. That's the story of Consolidated's famous Type 5-114 Recording Oscillograph . . . the most dependable, thoroughly proven data-recording instrument in the world today.

The 5-114 has crashed in test planes, yet yielded intact records, accurate up to the very moment of impact. Data in such cases have been invaluable in tracking down the cause of failure and in redesigning the aircraft. (And the oscillographs have *still* been good for years of additional flight-test service!) For the story of the world's favorite oscillograph, write today for Bulletin CEC 1500C-X6.



18 or 26-trace capacity . . . 7" paper or film . . . recording speeds of 1/2" to 115" per second . . . special accessory magazines for recording up to 1000 ft. without reloading; other magazines offer recording speeds up to 500"/second . . . galvanometers available flat to 3000 cps.

## Consolidated Electrodynamics CORPORATION

formerly Consolidated Engineering Corporation  
300 North Sierra Madre Villa, Pasadena, California

ELECTRONIC INSTRUMENTS FOR MEASUREMENT AND CONTROL

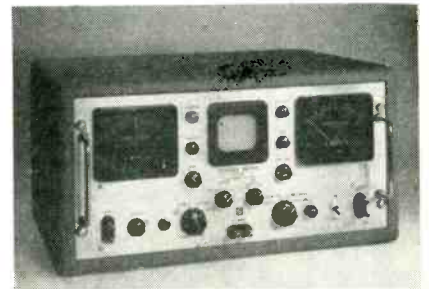
Sales and Service Offices in: Albuquerque, Atlanta, Boston, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, San Francisco, Seattle, Washington, D. C.

NEW PRODUCTS

(continued)

ampere; 6.3 v a-c, 10.6 amperes.

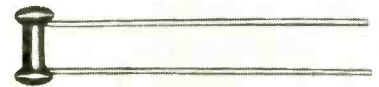
Model 6 pulse generator sells for \$410. Larger quantities will be quoted on request.



### FLUTTER METER with extended bandwidth

D&R, LTD., 402 East Gutierrez St., P.O. Box 1500, Santa Barbara, Calif. Model FL-4 wide-band flutter meter measures flutter frequencies to 5 kc in recorder systems. Using an internal crystal-controlled 14.5-kc oscillator for carrier, one meter reads frequency deviations up to  $\pm 2$  percent from center frequency; the other meter indicates rms flutter with full-scale sensitivity of 2.0, 0.6, and 0.2 percent, and a 3-in. flat-face oscilloscope displays flutter and wow signals with the same peak sensitivity. Selectable filters with 24 db/octave slopes provide flutter analysis from d-c to 30, 30 to 300, 300 to 5,000, and d-c to 5,000 cps.

Price of the unit is \$875 rack mounted, and \$910 with cabinet.



### CARBON FILM RESISTOR subminiature, stable

ARNHOLD CERAMICS, INC., 1 E. 57th St., New York 22, N. Y. Designed for operation at low power levels, the Stemag subminiature carbon film resistor is conservatively rated at 1/20 w. The chemo-carbon film is bonded to the ceramic rod by a special process which assures great affinity between film and ceramic base.

►Features—Stability with time and temperature and a low noise level are some of the resistor's characteristics. Mounting is facilitated



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 inven-  
tory 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

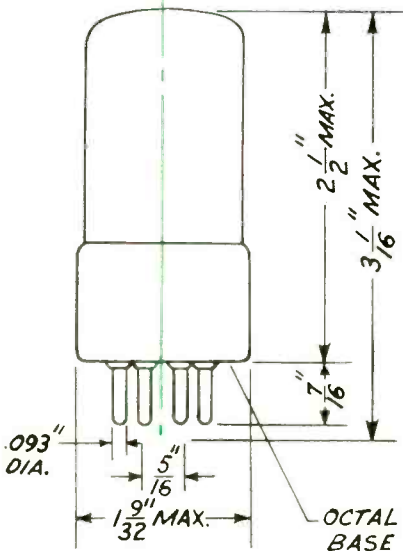
 **MANUFACTURING COMPANY, INC.**

3155 Fiberglas Road • Kansas City, Kansas

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



## A HIGH PRECISION 100kc CRYSTAL UNIT FOR SECONDARY FREQUENCY STANDARDS . . .



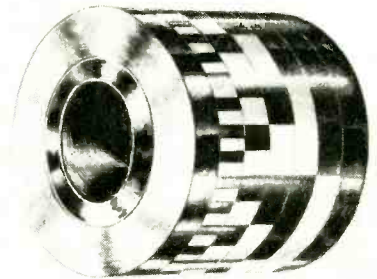
This precision sealed-in-glass crystal unit provides exceptional stability with minimum ageing. Incorporates a DT-cut element designed especially for use in temperature controlled ovens.

**WRITE FOR  
BULLETIN #492**

**BLILEY ELECTRIC COMPANY**  
UNION STATION BUILDING      ERIE, PENNSYLVANIA

by the capless lead construction and the thin size of the leads. Capacitance does not exceed  $0.4 \mu\text{mf}$  measured at 800 cps. They are ideally suited as components for transistor circuits.

Length is 0.295 in.; diameter, 0.114 in.; 5 and 10 percent tolerance.



## SWITCHES AND DRUMS are rotary segmented

AIRFLYTE ELECTRONICS Co., 535 Ave. A, P. O. Box 207, Bayonne, N. J. Designed for use in analog-to-digital converters, shaft-position-to-digital converters and the like, these rotary switches have a wide variety of applications in digital controls and read-outs, machine controls, and pulse code systems.

Drums are available in unambiguous natural binary, cyclical binary, binary coded decimal, and gray code. All other outputs, codes, or arbitrary linear or logarithmic functions are feasible.

Metal segments are diamond turned absolutely flush with plastic to a  $2-4 \mu$  in. finish producing imperceptible brush bounce and make-and-break arc. Being rotary in form, size is held to a minimum, resulting in a unit much smaller than corresponding pancake types.

## SERVO GENERATOR a high-speed unit

JOHN OSTER MFG. Co., Avionic Division, Racine, Wis., has announced a new high-speed high-temperature servo motor tachometer generator.

► **Features**—Type MG-3088's outstanding features are a no-load speed of 19,600 rpm and continuous operation at 140 C ambient temperature. Inertia is 2.85 gm per



# ELECTRONICS ENGINEERS:



## VITAL PROJECTS

# such as **AERO-13** **CHALLENGE YOU** at **Westinghouse** **BALTIMORE DIVISIONS**

The development of this System is but one of a series of challenging projects in airborne, ground and shipboard electronic systems that offer the electronics engineer the true growth potential so important for a real future. Your career at the Westinghouse Baltimore Divisions will be one of unlimited opportunities—including opportunities for work on advanced projects, and opportunities to continue your education toward advanced degrees at the company's expense. If you are interested in this type of career, Westinghouse is interested in you!

### CURRENT OPENINGS EXIST IN THE FIELDS OF:

CIRCUITRY	FIRE CONTROL SYSTEMS	VIBRATION
MICROWAVES	OPTICS	RADAR DESIGN
SERVOMECHANISMS	PACKAGING	FIELD SERVICE
MAGNETIC AMPLIFIERS	TRANSFORMERS	INFRA-RED TECHNIQUES
DIGITAL COMPUTER	ANALOG COMPUTER	COMMUNICATIONS
PROGRAMMING	DESIGN	ANTENNAS

In the nose of the Douglas F4D Skyray fighter interceptor is the new Aero-13 Fire Control System developed by Electronics Engineers at Westinghouse — Baltimore Divisions. This improved system makes possible the detection and destruction of enemy aircraft under no-visibility weather conditions. (Photo courtesy Douglas Aircraft Company, Inc.)

### ADVANCED EDUCATION AT COMPANY EXPENSE

Westinghouse encourages its electronics engineers to continue their education toward both M.S. and Ph.D. degrees. The company pays all tuition expenses.

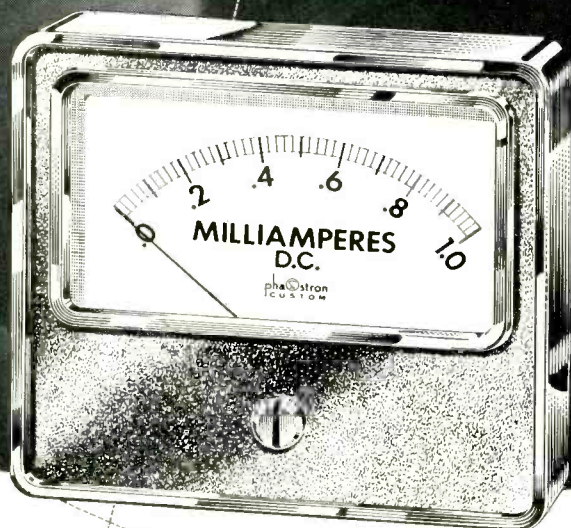
### TO APPLY:

Send resume of education and experience to:  
Technical Director, Dept. 323  
Westinghouse Electric Corp.  
Friendship Airport  
Baltimore, Maryland

**WATCH**  
**Westinghouse**

**Where big things are happening every day!**

# PHAOSTRON



**NEW 3 1/2" Rectangular Meter**

**Now!... Phaostron custom panel meters are available in**

## colors

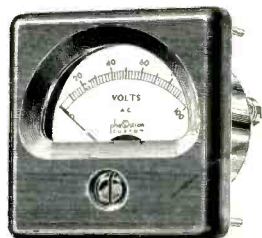
at no additional cost

Time-tested and proven movements, anti-magnetic shielding, insulated zero adjustments and fine accuracy are familiar features of *Phaostron Custom Panel Meters*... now, something new has been added...

### COLOR-CUSTOMIZED PANELS

Handsome harmonizing colors that will give a touch of distinction to your equipment. Send us a color swatch and we will make Phaostron color-customized panels to match... and at no extra cost!

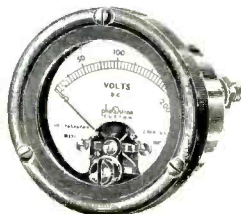
*Phaostron Custom Panel Meters, nine types in 77 Standard Ranges are available at your Parts Distributor. For special requirements, write to the Product Development Department for practical recommendations.*



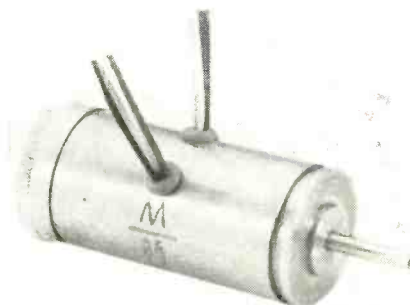
2 1/2" or 3 1/2" square meter



4" x 6" rectangular meter with mirrored scale also available illuminated

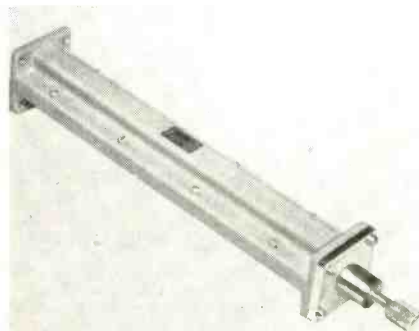


2 1/2" or 3 1/2" round meter



cm<sup>2</sup>. The device consists of a size 11 2-phase 2-pole servo motor and a drag-cup type tachometer integrated into a single compact homogeneous unit measuring 1.03 in. maximum diameter by 2.156 in. long and weighing 4.6 oz.

The motor portion has 26-v 400-cycle input, 0.26 oz in. stall torque minimum and 12.5 w stall wattage. The generator portion has 26 v 400 cycle excitation, 3.7 w input, 0.35 v per 1,000 rpm output voltage, 23 mv residual voltage, 500 ohms output impedance and 1-percent linearity up to 8,000 rpm.



### STANDARD REFLECTIONS verify slotted-line accuracy

THE NARDA CORP., Mineola, L. I., N. Y., is offering a full line of standard reflections providing calibrated reflections of vswr's for use in standardizing reflectometers or verifying the accuracy of slotted lines.

The calibrated reflection consists of a precisely machined undersize waveguide terminated in a sliding termination.

► **Values**—Five accurate values of reflection coefficient are available ranging from 0.00 reflection coefficient to 0.20 reflection coefficient in each of 6 different size waveguides for the following frequencies (kmc): 2.60 to 3.95, 3.95 to 5.85,



**Phaostron Instrument & Electronic Co.**

151 PASADENA AVE., SOUTH PASADENA, CALIF.





Russell C. Westover, Jr., President of Ray Oil Burner Company, tells the secret of

## “How to make hay without sunshine!”

“Make hay at midnight or in a rainstorm? Sure—why not?

“Modern farmers have found a way. They cure it a few minutes after cutting—in big dehydrating plants!

“But there’s one catch. Profits could disappear in a hurry if the fires go out. That’s why they use Ray Oil Burners.

“And that’s why Ray uses Air Express!

“In addition to his own stock, any Ray dealer in the country can draw on our ‘super stockroom’ of 40,000 different parts. It’s only a few hours away by Air Express!

“It has helped build our reputation for fast service. And it saves money! 10 lbs. from San Francisco to Portland, Ore., costs \$3.78 by Air Express. That’s \$1.37 less than the next lowest-priced complete, door-to-door air service.”



**Air Express**



**GETS THERE FIRST** via U.S. Scheduled Airlines

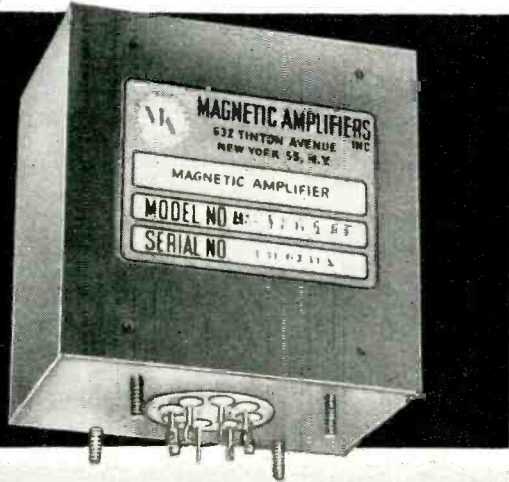
**CALL AIR EXPRESS . . . division of RAILWAY EXPRESS AGENCY**

# NEW!

## MINIATURE

### SERVO

# Magnetic Amplifiers



### Three New AC Servo Types Available..

**STANDARDIZED SERVO SYSTEMS AND OTHER STANDARD TYPES FOR AUTOMATIC CONTROL —**

In addition to new lines illustrated, many standard and higher power magnetic amplifiers are available for applications involving automatic control.

**CUSTOM DESIGNS FOR SPECIAL REQUIREMENTS**

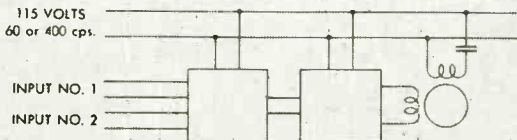
— we design and engineer complete servo or automatic control systems

AFFILIATE OF THE GENERAL CERAMICS CORPORATION



## MAGNETIC AMPLIFIERS • INC

Telephone: Cypres 2-6610  
632 TINTON AVE., NEW YORK 55, N. Y.



#### ● MAGNETIC PRE-AMP + SATURABLE TRANSFORMERS

Supply: 115 volt 400 cps.  
Power output: 3.5, 6, 10, 18 watts  
Sensitivity: 1 volt AC  
Response Time: .03 sec.  
Lowest Cost — Smallest Size  
For further information request Form S493

#### ● MAGNETIC PRE-AMP + HIGH GAIN MAGNETIC AMPLIFIER

Supply: 115 volt 400 cps.  
Power output: 5, 10, 15, 20 watts  
Sensitivity: .1 volt AC  
Response Time: .008 to .1 sec.  
Highest performance — All magnetic  
For further information request Form S496

#### ● TRANSI-MAG\*: TRANSISTOR + HIGH GAIN MAGNETIC AMPLIFIER

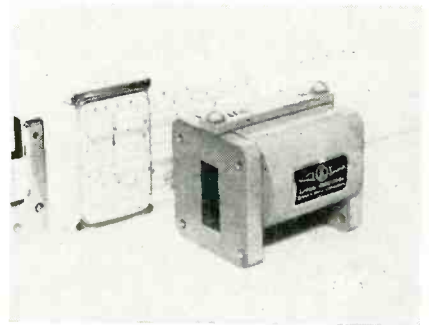
Supply: 115 volt 400 or 60 cps.  
Power output: 2, 5, 10, 15, 20 watts  
Sensitivity: .08 volt AC into 10,000 ohms  
Response Time: .01 sec.  
Fast response at high gain  
For further information request Form S499 (400 cps.); Form S497 (60 cps.)

\*TRADE NAME

NEW PRODUCTS

(continued)

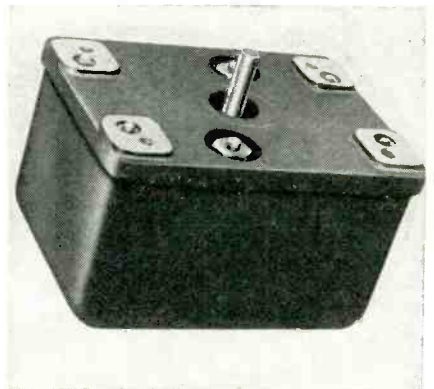
5.30 to 8.20, 7.05 to 10.0, 8.20 to 12.4 and 12.4 to 18.0.



### LOAD ISOLATOR is light and compact

LITTON INDUSTRIES, 336 North Foothill Road, Beverly Hills, Calif. Model X110 ferrite load isolator is designed for use in X-band systems where space and weight are at a premium. Weighing only 1.0 lb, the isolator is only 2 in. long and 2 in. wide. Isolation of 9 db is provided at 100 kw peak power over a bandwidth of 8,600 to 9,600 mc.

Utilizing the resonance absorption characteristics of ferrites, the X110 provides a simple and compact solution to long-line effects and other magnetron loading problems caused by lengthy transmission lines or excessive vswr's.

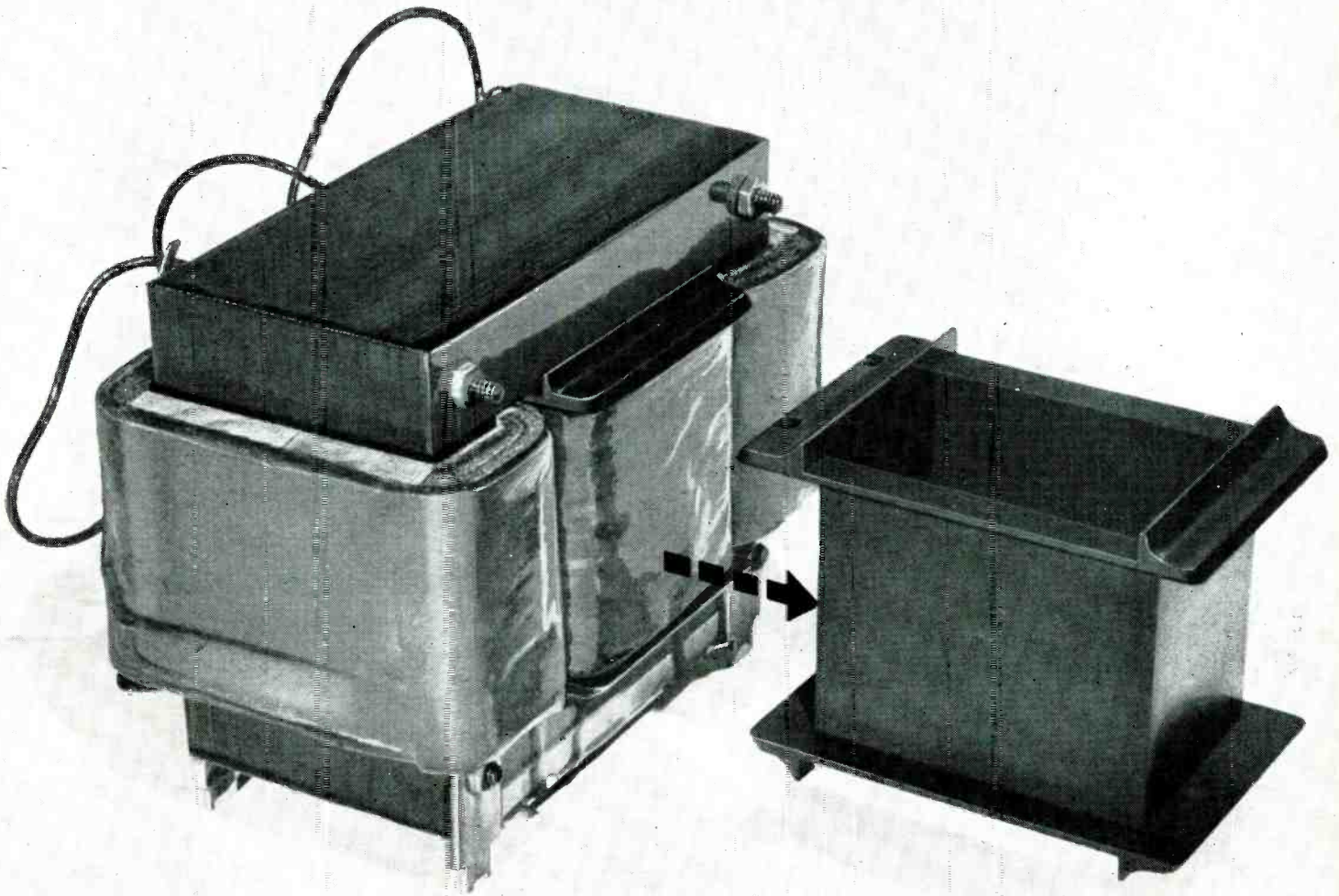


### ROTARY SOLENOID small torque series

LEETRONICS, INC., 30 Main St., Brooklyn, N. Y., announces the availability of their 400 series 60-cycle a-c rotary solenoids. Designed to provide maximum torque in minimum space, it operates on standard voltage with low power consumption. Continuous and intermittent duty types are available from stock, offering 20 deg, 30 deg, 45 deg or



# Raytheon selects **RESINOX\* 3700** for core of new microwave cooking oven transformer



*Monsanto material again demonstrates its outstanding physical-electrical properties!*

Of all materials tested for the core of this intricate assembly—heart of a new microwave cooking oven—only Resinox 3700 qualified on every requirement.

For this highly critical application, Raytheon engineers needed a core material with outstanding electrical and physical properties. Unusual dimensional stability and low shrinkage were vital because the core is first wound, assembled, varnished and then baked at high temperatures. Core cracking under heat had been a common and costly complaint with the materials tested.

Since using Resinox 3700, these expensive losses and rejections of the final transformer coil assembly have been largely eliminated. Result? Faster, more economical production.

Other top-flight qualities of Resinox 3700, of special interest to electrical parts manufacturers, are its outstanding

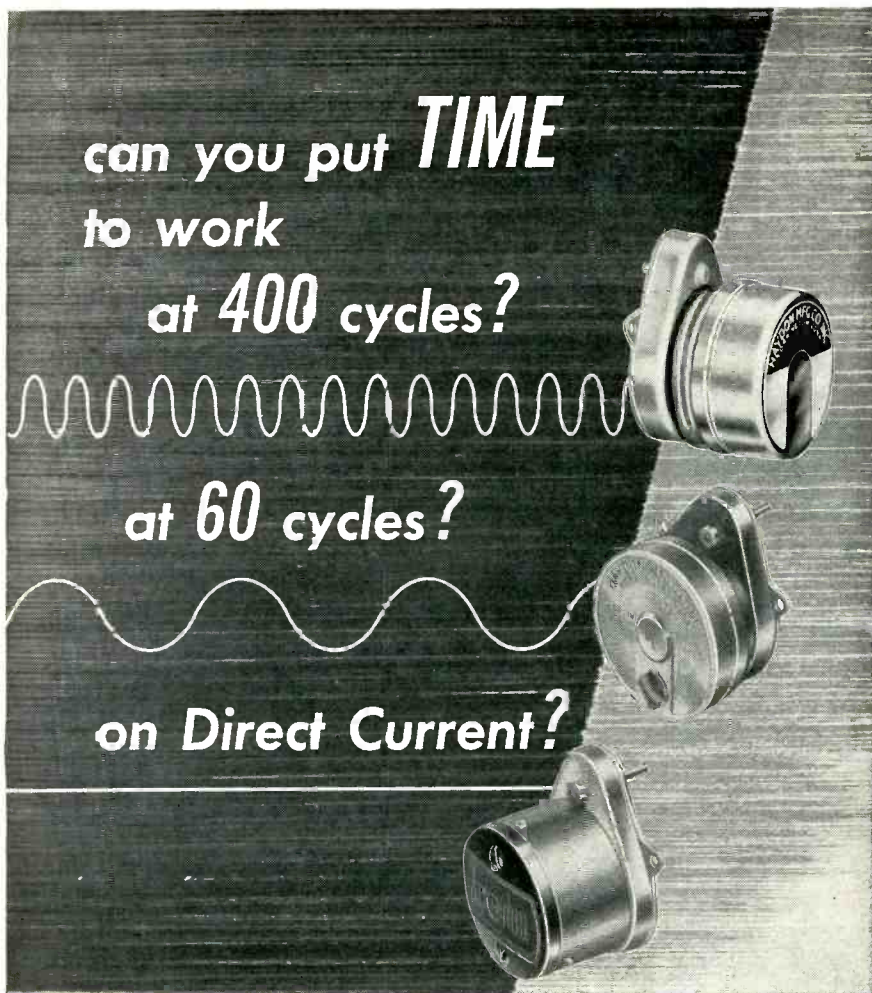
are resistance, dielectric strength, good impact resistance, and excellent moldability.

This complete transformer assembly, used in both home- and commercial-type microwave ovens, is made and patented by Raytheon Manufacturing Co., Waltham, Mass. The core is molded by Spools, Inc., Providence, R. I.

Perhaps Resinox 3700 can solve a critical electrical parts problem for you. Write today for data sheets. Monsanto Chemical Company, Plastics Division, Room 405 Springfield, Mass.



\*Resinox: Reg. U.S. Pat. Off.



If time is an element in the operation of your product or process, be sure to call in your factory-trained HAYDON\* Sales Engineer. HAYDON Timing Motors utilize time, control time, master time . . . precisely, quietly . . . bettering performance and opening new horizons to product and process use.

Put time to work now by writing for the name of your HAYDON timing specialist, and for the catalog, "Electric Timing Motors."

\*Trademark Reg. U.S. Patent Office



A SUBSIDIARY OF GENERAL TIME CORP.



**HAYDON Manufacturing Company, Inc.**

2430 ELM STREET, TORRINGTON, CONN.

- Send me the name of my HAYDON Sales Engineer
- Send me the catalog, "Electric Timing Motors"

NAME \_\_\_\_\_  
 POSITION \_\_\_\_\_  
 COMPANY \_\_\_\_\_  
 CO. ADDRESS \_\_\_\_\_  
 CITY \_\_\_\_\_ ZONE \_\_\_\_\_ STATE \_\_\_\_\_

60 deg (maximum) rotation. Typical intermittent (40 percent) duty model offers 12 in. lb torque at 115 v. Solenoid closes in approximately 0.020 sec.

The 400 series is recommended for gaging, packaging, sorting, automatic assembly and other applications calling for precise repetitive operation.



**CODESCRIBER**  
adaptable to computers

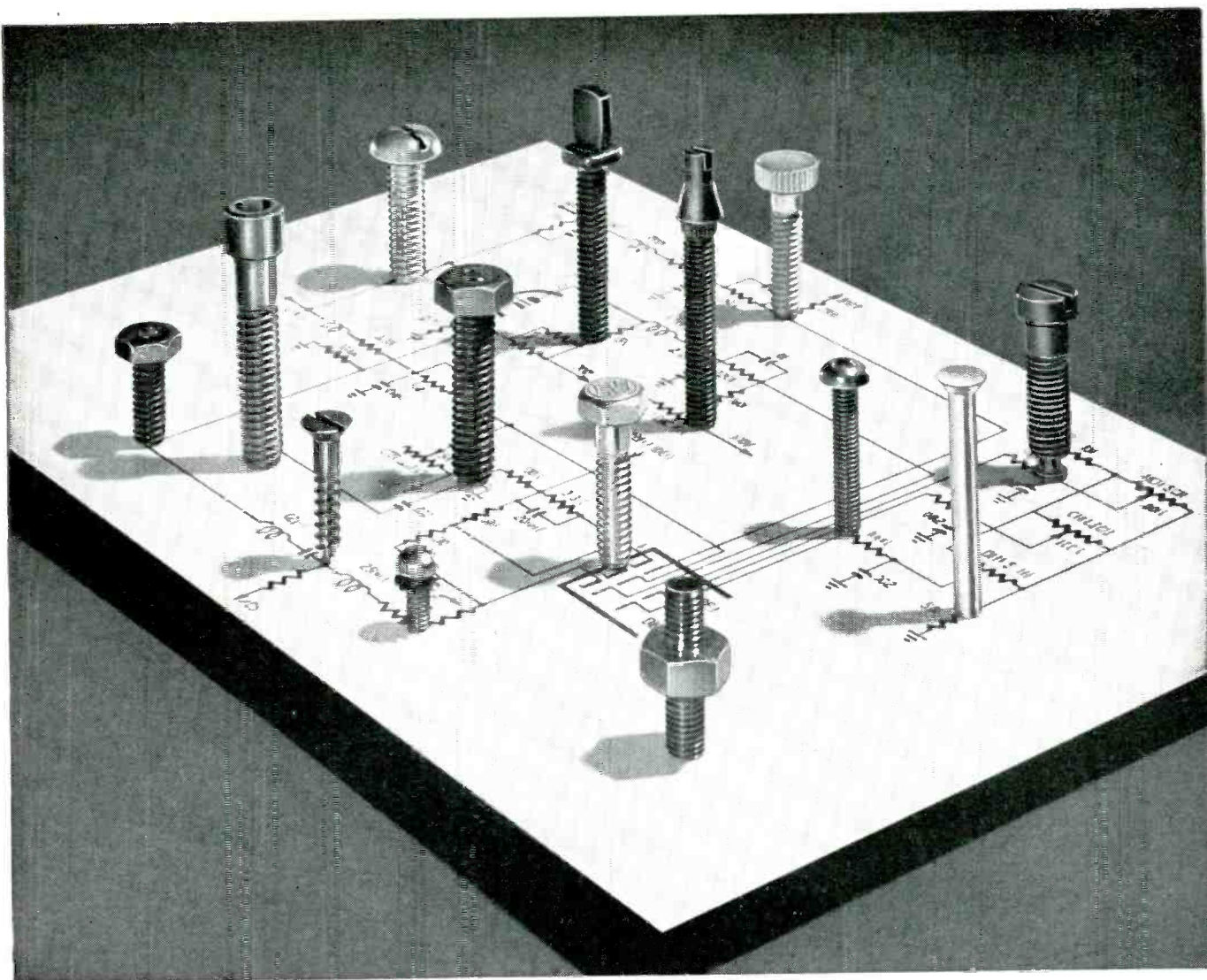
LOGISTICS RESEARCH INC., Redondo Beach, Calif., has developed the Codescriber, a keyboard to magnetic tape device adaptable to any computer. It contains arithmetic circuits for address modification, visual indicators for decimal-digit-readout and register display. Automatic function buttons are provided for automatically inserting all repetitive data as well as sub-routine call-up.

The unit's magnetic tape recorder transcribes this information for use with computer input systems.

**CRYSTAL CALIBRATOR**  
usable to about 55 mc

HAMMARLUND MFG. CO., INC., 460 W. 34th St., New York, N. Y. The XC-100 crystal calibrator is designed as a frequency standard for use in communications receivers. It employs a hermetically-sealed military-type 100-kc quartz crystal oscillator and a 6BZ6 pentode-type tube, operating in a highly efficient circuit which results in effective output every 100 kc. A trimmer





## QUALITY PERFORMANCE *depends on small things*

Manufacturers of electronic equipment recognize that such small things as fastenings are vitally important to the operation of that equipment...to the service that it gives...to the length of life that it serves.

Harper Everlasting Fastenings cost no more and you benefit by:

- The speed of assembly due to the clean threads and precision manufacture.
- The assurance of quality performance due to corrosion resistance and superior strength.
- The improvement in appearance due to the fact that Harper fastenings never rust.

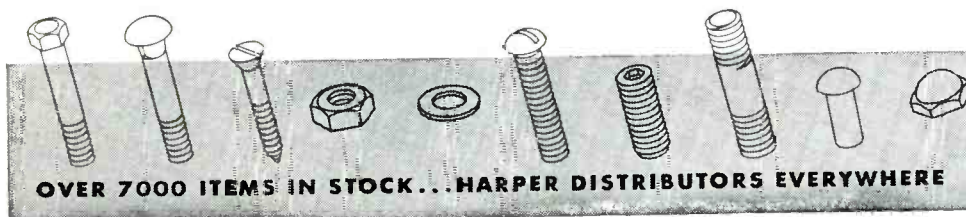
More than 7000 different Harper fastening items are carried in stock in both non-ferrous and stainless steels. See your nearest Harper distributor or write for the Harper catalog.

THE H. M. HARPER COMPANY  
8244 Lehigh Avenue, Morton Grove, Ill.

*If you have a beaded part that you are now milling from bar, it will pay you to investigate the Harper Flo-Form® method of producing such parts in quantities economically. Savings range up to 50%. Information on request from a Harper Field Engineer.*

### Specialists in all corrosion-resistant fastenings

Bolts • Nuts • Screws • Rivets • Washers  
of Brass • Bronze • Monel • Aluminum • Stainless

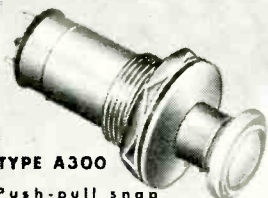


*Everlasting Fastenings*

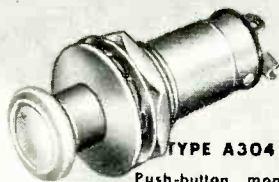
# The HOSTESS CALL LIGHT SWITCH "GOES TO TOWN"



Frequently, where indicator lights must be used in conjunction with switches, modern aircraft design affects a worthwhile weight and panel space saving by using Hetherington switches with *built-in* lights. Developed originally by Hetherington as hostess call lights, these compact little units are now available for a broad range of exacting commercial or military aircraft services. Write for catalog.



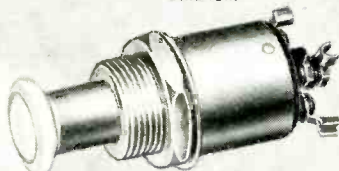
**TYPE A300**  
Push-pull snap switch with "on-off" light and auxiliary momentary contact.



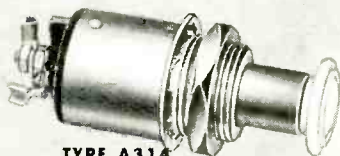
**TYPE A304**  
Push-button momentary-contact switch-indicator light combination.



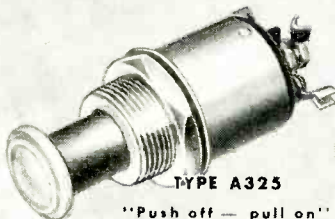
**TYPE A8500**  
"Push off—pull on" or Type A13800 "push on—pull off" snap switch with built-in "on-off" light.



**TYPE A311**  
"Push on, pull off" switch also operates "on-off" independent lamp circuit. "Pull on, push off" Type A312 also available.



**TYPE A314**  
Push-button normally-open momentary-contact switch plus independent, unbroken lamp circuit. Type A315 (not shown) has normally-closed contacts.



**TYPE A325**  
"Push off—pull on" switch with independent unbroken lamp circuit. Developed for bomber fire extinguisher panel.

## HETHERINGTON PANEL INDICATOR LIGHTS

SWITCH-INDICATOR LIGHT COMBINATIONS  
PUSH-BUTTON AND SNAP ACTION SWITCHES  
AIRCRAFT AND ELECTRICAL EQUIPMENT ASSEMBLIES

**HETHERINGTON, INC., Sharon Hill, Pa.**

(West Coast Division: 139 Illinois St., El Segundo, Calif.)



capacitor provides adjustment for zero beat against a primary frequency standard such as WWV.

► **Further Details**—Power requirements taken from the receiver are 6.3 v at 0.3 amperes and 150 to 300 v at 2 ma. The XC-100 measures 3 1/8 in. high by 2 in. long by 1 1/8 in. wide.

The unit is complete with electrical and mechanical installation hardware as well as toggle switch, which may be mounted on the front panel of the receiver.

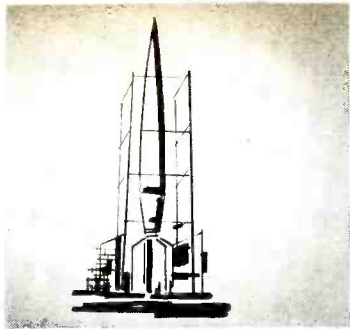


## QUARTZ CRYSTALS small, I-f type

NORTHERN ENGINEERING LABORATORIES, 434 Wilmot Ave., Burlington, Wisc. The high Q, long term stability and reliability formerly available only in the T-9 or larger glass bulbs are now provided in the type T-7. This is the enclosure used on the 12BH7 vacuum tube.

Maximum overall height is 3 1/8

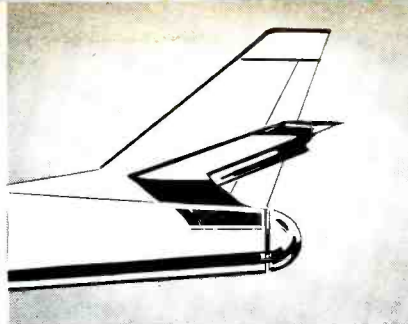




MISSILE SYSTEMS



AERIAL CAMERAS



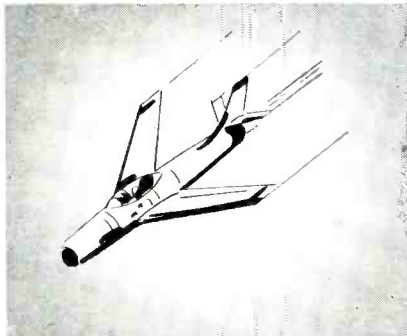
STRUCTURAL TESTING



FLYING SUITS



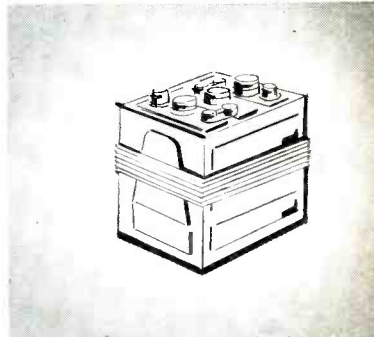
AIRBORNE COMPONENTS



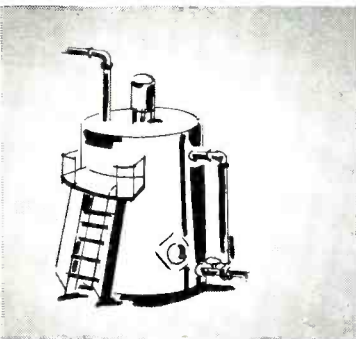
COMPONENT DE-ICING



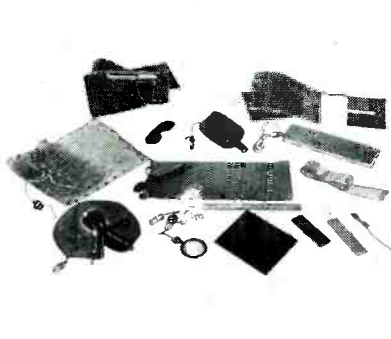
PRECISION INSTRUMENTS



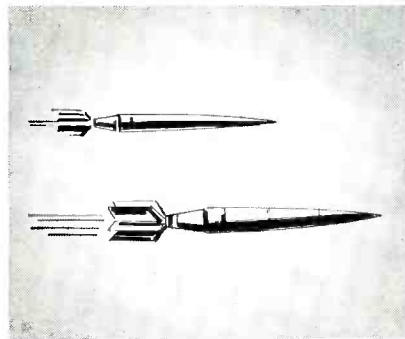
BATTERIES



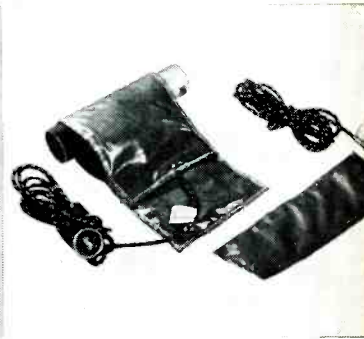
LIQUID STORAGE



ELECTRONIC EQUIPMENT



ROCKETS



INDUSTRIAL PROCESSES

# Here's where G-E heating equipment can help you keep components at operating temperatures

Whenever your equipment, complete systems, or manufacturing process requires the addition of heat to assure proper functioning, General Electric specialty heating equipment can help you quickly and economically.

Problems of supplying heat at high altitudes, keeping critical fuels at correct temperatures, maintaining missile components in a "ready to fly" condition, providing the best thermal environment for manufacturing processes, reducing dangerous component icing in flight, helping to keep personnel comfortable when exposed to extreme cold, providing the optimum operating temperature for electronic and hydraulic components, duplicating high-temperature conditions for structural testing, and many other special applications have all been solved by General Electric specialty heating equipment.

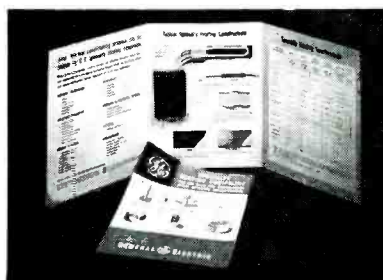
## LET US ANALYZE YOUR SPECIALTY HEATING PROBLEM

A General Electric specialty heating expert is available to work on your particular heating requirement. So, if you have

any specialty heating problem, contact your G-E Apparatus Sales Office or send coupon below for more information.

# GENERAL ELECTRIC

### SEND FOR FREE BULLETIN ON G-E SPECIALTY HEATING EQUIPMENT



General Electric Company  
Section K224-8, Schenectady 5, N. Y.  
Please send me bulletin GEA-6285, G-E specialty heating equipment.

- for immediate project
- for reference only

Name.....  
 Position.....  
 Company.....  
 City..... State.....

the  
**first**  
and  
**last**  
word in  
**visual communication**



*Farnsworth*  
**CLOSED CIRCUIT  
TELEVISION**

"Let's you see . . .  
where you can't be"

From Farnsworth, where electronic television was *first* created over 30 years ago, comes the *last* word in visual communication—Farnsworth Model 600A Closed Circuit Television. Engineered especially for industrial, educational and commercial use this compact, light weight camera and portable monitor is saving time, and money in countless applications. If yours isn't one of them it will pay you to get the facts from Farnsworth—today.

Write Dept. CT 656 for  
complete details.

*Farnsworth*

**ENGINEERS . . .**

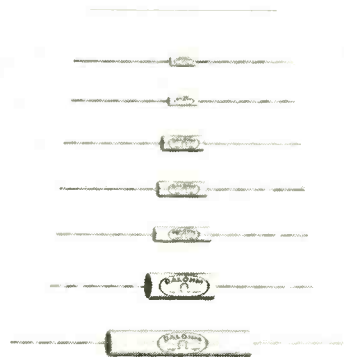
There is a fabulous future at Farnsworth in a wide range of electronic projects for defense and industry. For details, write Director of Employment.

A DIVISION OF

**ITT**  
&

in. and maximum diameter,  $\frac{1}{8}$  in. The 16 to 500-kc range is presently covered by this unit.

An example of performance is the T-7N at 50 kc with a total drift of less than  $\pm 0.0075$  percent from  $-40$  to  $+70$  C and a series resonant resistance of 10,000 ohms. Temperature control units are also available for these crystals.



**CARBON RESISTORS**  
in 4 smaller sizes

DALE PRODUCTS, INC., Columbus, Neb. Type DCH hermetic seal ruggedized deposited carbon resistors, formerly available in 3 sizes and 3 wattages, are now available in 4 additional smaller sizes and 2 additional wattages. They are made to meet the specifications of the proposed MIL-R-10509B.

► **Uses**—The resistors are ideally suited for use in uhf equipment where only the optimum of quality may be tolerated. They are completely high-temperature, alloy-solder sealed in a newly developed envelope of nonhydroscopic ceramic; production tested for resistance to thermal shock, salt-water immersion and humidity; and are ruggedized for incorporation into snap-in component clips.

They have a temperature coefficient of 140 to 500 ppm per deg C; a voltage coefficient of less than 0.002 percent per v; and are supplied with a standard tolerance of 1 percent.

Bulletin R-27A gives further information.

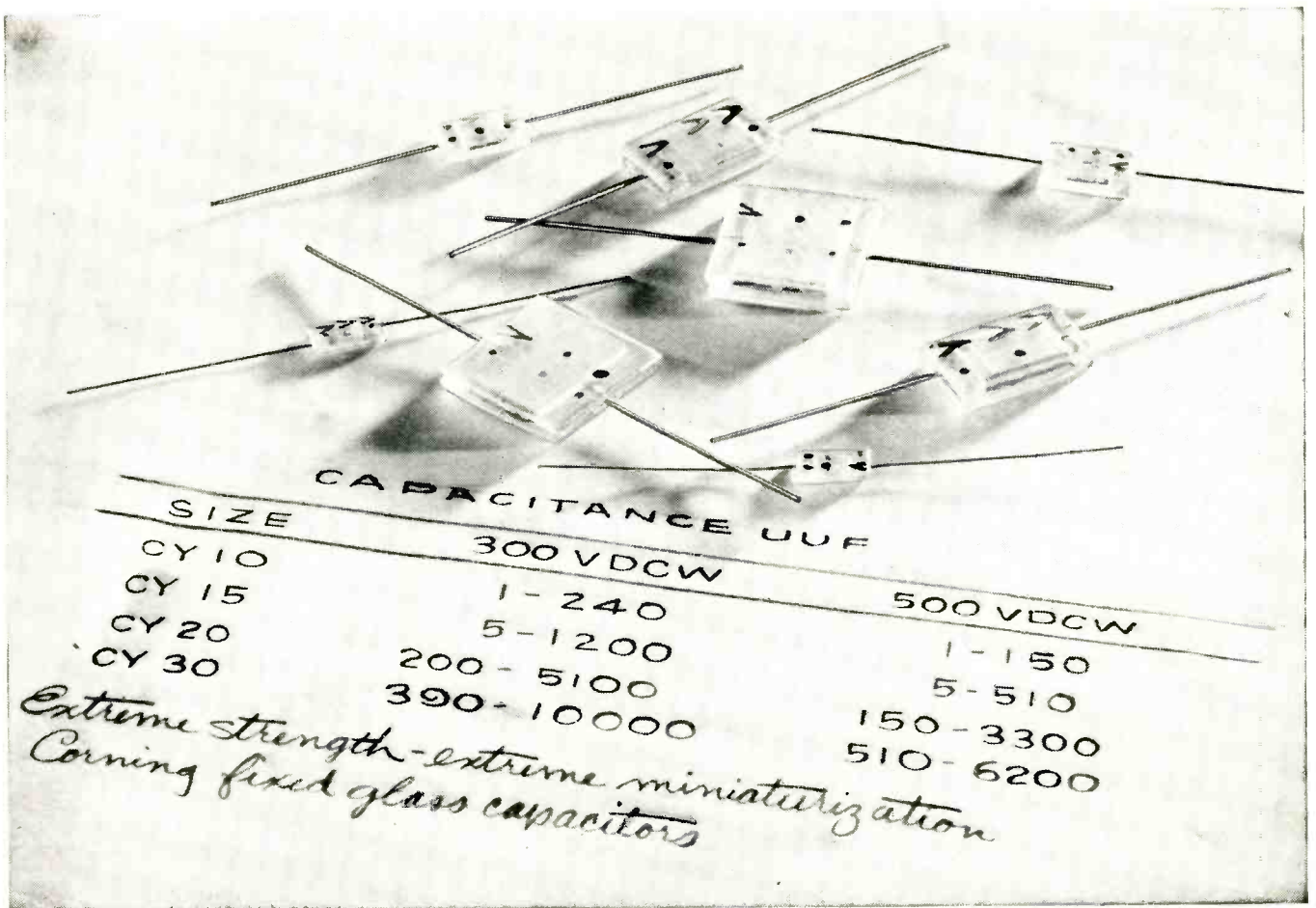
**SWITCH FADER**  
a four-channel unit

KAY LAB, 5725 Kearney Villa Road,  
San Diego 12, Calif. Model ASF-2

**FARNSWORTH ELECTRONICS CO. • FORT WAYNE, INDIANA**

a division of International Telephone and Telegraph Corporation





## You'd have to smash a Corning Capacitor before you could alter its values by mechanical shock

That's how rugged these miniature fixed glass capacitors are. ("Miniature" means about one-third smaller than other kinds of equal capacitance.)

Their strength comes from the way we make them. Layers of conductor and dielectric are sealed together under heat and pressure into a monolithic structure. No mechanical shock short of shattering the seal alters the value. Speaking of values, the table illustrated above shows them.

Because everything is sealed in the same material as the dielectric, nothing outside can get inside.

You can use these capacitors to tem-

peratures of 125° C. and higher with proper voltage derating. Even after repeated temperature cycling, the TC remains the same. And TC stays within close limits over a wide temperature range, varies little between capacitors. Capacitance drift is so close to zero that it's generally less than the error of measurement.

We can make capacitors to your electrical and physical specifications over an unusually varied range. Single, self-supported units can be designed for high voltages or high capacitances. Series parallel combinations still further extend the range.

Circle the reader service of this publication, or write direct for more information about Corning Fixed Glass Capacitors, prices and samples.

### Ask for information on these other Corning Capacitors:

**Medium Power Transmitting**—CY-60 and CY70. Ideal for mobile RF transmitters.

**Canned High Capacitance**—provide the advantages of rugged glass design to your specifications.

**Subminiature Tab-Lead**—up to 90% less volume compared to pigtail types. To your specifications.

**Special Combinations**—the performance and benefits of glass in infinite shapes, sizes and leads. To custom order.

### Other electronic products by Corning Components Department:

Fixed Glass Capacitors\*, Transmitting Capacitors, Canned High-Capacitance Capacitors, Subminiature Tab-Lead Capacitors, Special Combination Capacitors, Direct-Traverse and Midget-Rotary Capacitors\*, Metallized Glass Inductances, Resistors.

\* Distributed by Erie Resistor Corporation



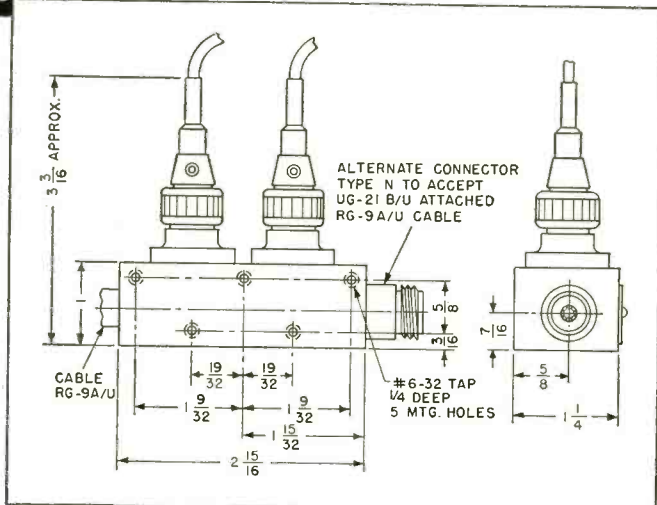
**CORNING GLASS WORKS, 94-6 Crystal Street CORNING, N. Y.**

Components Department, Electrical Products Division

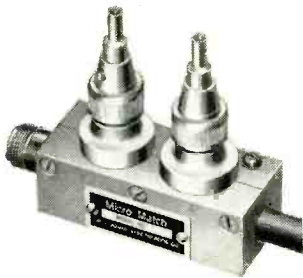
*Corning means research in Glass*



# No Transmitter should be without one!



OUTLINE DRAWING MODEL 575N DOUBLE COUPLER



**WHEN YOU BUILD** MicroMatch Directional Couplers into your transmitters, you add an invaluable feature at extremely low cost — positive confirmation of transmitter performance. Your customers stay sold by the coupler's continuous RF Power indication.

Its VSWR monitor, in addition, stands watch over your customer's transmission line and antenna.

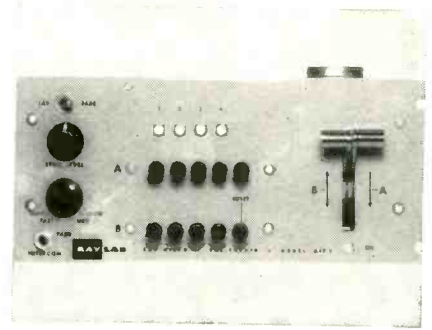
Now incorporated in most modern Government and commercial transmitters, MicroMatch Directional Couplers produce an output essentially independent of frequency over the range of 20 to 2000 megacycles. Couplers are adjusted to produce full scale meter deflection at power levels of 1.2 watts to 120 KW. Accuracy of power measurements is plus or minus 5% of full scale. For complete details on the MicroMatch line of monitoring equipment, write for our 50-page catalog.



**WHEN MICROMATCH IS BUILT IN—  
YOU KNOW WHAT'S GOING OUT**



**M. C. JONES ELECTRONICS CO., Inc.**  
BRISTOL, CONNECTICUT



switcher fader provides automatic and manual video switching and fading. When operated automatically any one of four inputs can be automatically faded or lapped at a preset speed of slow, medium or fast. When operated manually any two of the four channels can be coupled to the lever-type fader.

A unique cascode circuit is utilized which provides maximum attenuation of off channels. The gain of each channel can be independently preadjusted. Provision for sync insertion is included. Keyed clamps are utilized in the video amplifiers. One of the four channels is designed for network and remote fades.

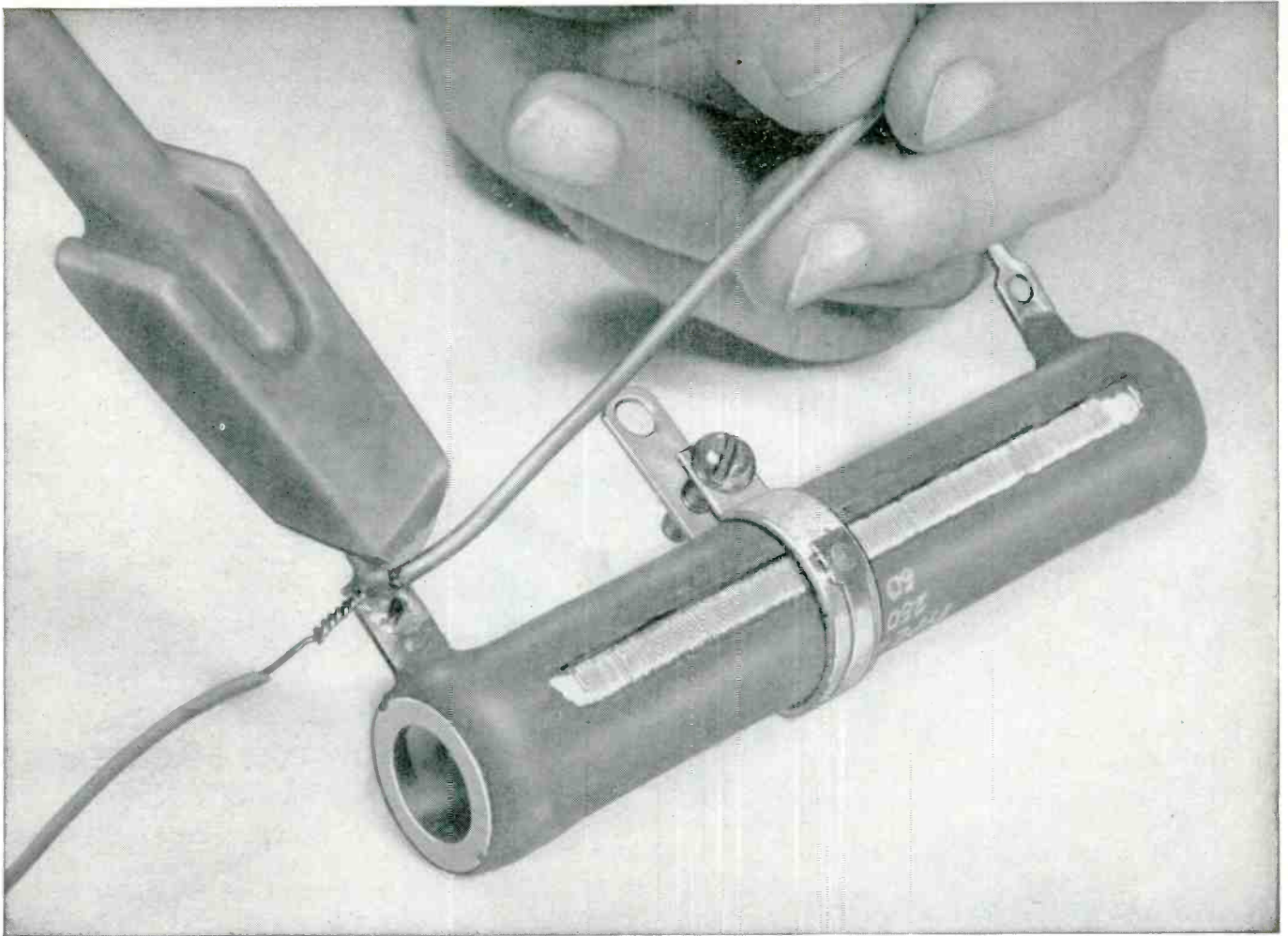
The switcher is fabricated in two units. The compact control panel mounts in a standard 13-in. console housing, and the electronic control package is fabricated for standard 19-in. relay rack mounting.



## **HYDROGEN THYRATRON** designed for limited space

PENTA LABORATORIES, INC., of Santa Barbara, Calif., has available the PL-165 hydrogen thyratron. The new tube has ratings intermediate between those of the 4C35 and PL-5C22, but is no larger than the 4C35. The PL-165 is designed for





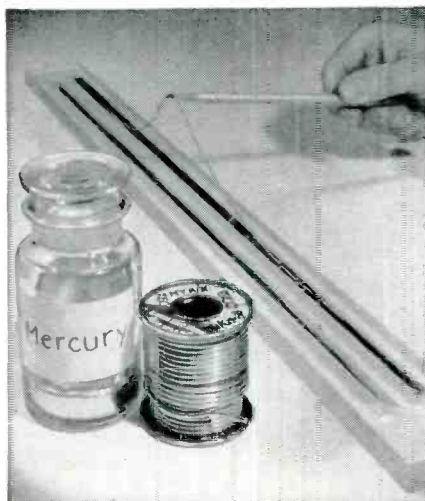
## Why "Dutch Boy" activated rosin core solders give perfect joints nearly every time

"Practically no poor joints..."  
 "50-60% more joints per pound..."  
 "Twice as many chassis wired in a day"

This is what users of "Dutch Boy" activated Rosin-core Solders are saying, today. For National Lead Research has come up with new answers to many old soldering problems.

Take "skips"... the trouble-making breaks in flux core continuity that lead to poor joints, interrupt production, raise reject percentages. Previously these breaks just couldn't be detected prior to use.

Not so, now! National Lead's new mercury bath test shows up "skips" like a sore thumb. In this inspection technique, 18" samples from each batch of cored wire are laid in a mercury bath. Presto! Solder dissolves, leaving entire core afloat, intact, visible. Even a tiny defect is reason enough for National Lead to withdraw the batch from shipment. You never see it.



New "Dutch Boy" mercury bath inspection does away with trouble-making "skips" in core continuity of rosin core solders.

\*Sold under trade term "35-B"  
 \*\*Sold under trade names "Huaz" and "Nuaz"

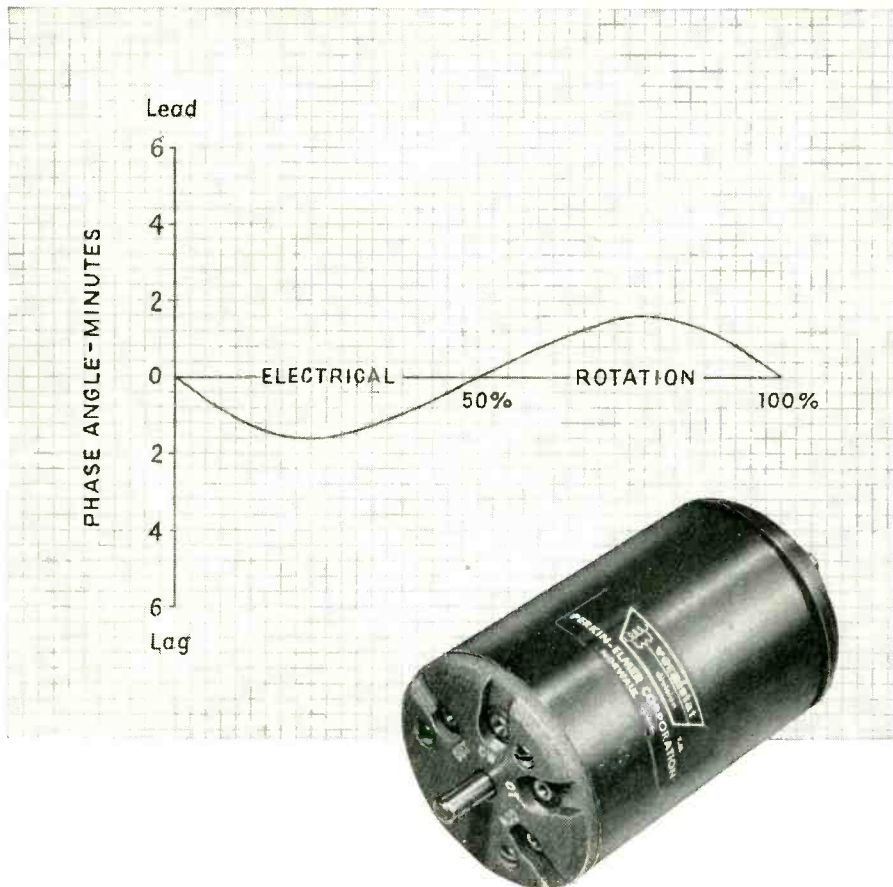
### Other new solder, flux developments

To speed solder flow and increase coverage... new "Dutch Boy" Activated Rosin Flux\*. To prevent "bridge-over" in printed circuits... a highly refined "Dutch Boy" solder, of low melting point and high surface tension. To speed capillary rise and flow... a specially designed "Dutch Boy" non-corrosive solder-flux combination.\*\*

You may want to look into these developments. Or perhaps you need some special solder alloy or flux. National Lead solder specialists will be glad to help. Just write or call National Lead Company, 111 Broadway, New York 6, N. Y.

**Dutch Boy**®  
 SOLDER AND FLUXES





if you work with position servos...  
**HERE'S HOW TO LICK  
 QUADRATURE**

with the **vernistat\*** a.c. potentiometer

If you work with position servos, you have had problems with quadrature. The tighter the servo loop, the more serious unwanted voltage due to phase shift can be.

Quadrature problems are tremendously simplified and more accurate servos are possible when you use the Vernistat. Although it contains a trans-

former, the Vernistat has extremely low phase shift. Phase angle is less than 1.6 min. at 400 c.p.s. in most systems.

The Vernistat is an a.c. potentiometer that combines *high* linearity and *low* output impedance. Size and mounting dimensions are designed to the BuOrd specification for a size 18 synchro.

**SPECIFICATIONS OF MODEL 2B**

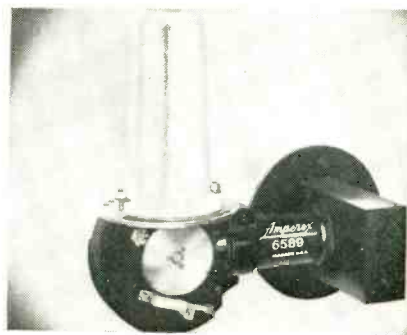
Linearity Tolerance .....	± 0.05%
Minimum Output Voltage Increment .....	0.01%
Electrical Rotation .....	3494°
Mechanical Overtravel (each end) .....	45° approximately
Phase Angle (at 400 c.p.s.) .....	1.6 minutes, maximum
Excitation Frequency .....	20 to 3000 c.p.s.
Output Impedance .....	less than 130 ohms
Input Impedance .....	65,000 ohms, minimum
Maximum Input Voltage .....	130 V. at 400 c.p.s. or 20 V. at 60 c.p.s.

\*TRADEMARK

**vernistat** division  
 PERKIN-ELMER CORPORATION  
 Norwalk, Connecticut

applications where space is limited to that occupied by the 4C35, but where the capabilities of the 4C35 are exceeded.

► **Specifications** — Maximum ratings are: peak plate voltage, 12 kv; peak plate current, 325 amperes. Maximum dimensions are: height overall, 6.25 in.; seated height, 5.63 in.; diameter, 2.56 in.



**LOW-LOSS MAGNETRON**  
 has long-life feature

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y. Type 6589 magnetron is a non-packaged high-power, pulsed, tunable oscillator operating in the 10-cm region. It features a one-piece anode which assures low losses and long-life performances.

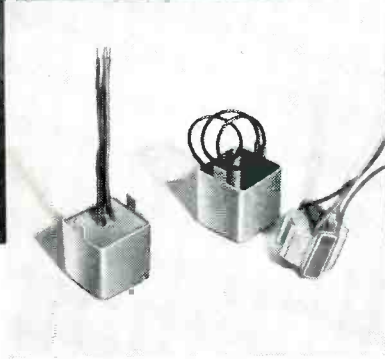
The type 6589 is used with an external magnet having a field density of 2,700 gauss in the air gap. Pulsed power output is 500 kw; pulse voltage is 26 to 30 kw.



**OSCILLOGRAPH TUBE**  
 is a flat-face type

RADIO CORP. OF AMERICA, Harrison, N. J. Type 1EP1 oscillograph tube, having a diameter of only 1 1/4 in., is intended primarily for use in





An Installation of Leeson Coil Winders in the Lenkurt Electric Company plant, San Carlos, Calif. Inset shows, left to right: a Lenkurt miniaturized high frequency transformer fully assembled; the transformer casing; and the transformer coil, precision-wound to extremely close tolerances on a fast Leeson No. 108 Hand Feed Coil Winder.

# LENKURT selects Leeson No. 108 Coil Winders for high-precision accuracy

As a leading designer and manufacturer of carrier equipment, the Lenkurt Electric Company of San Carlos, California, supplies the complex electronic apparatus used throughout the world by telephone companies in adding long-distance circuits. For winding the close-tolerance coils that go into this multi-channel communications equipment, Lenkurt depends on Leeson No. 108 Coil Winders. Chester Scarce, Factory

Manager of Lenkurt, reports:

*"Our transformers call for coils of the finest quality to meet the high-precision standards of modern carrier equipment. We find that Leeson No. 108 Hand Feed Coil Winders give us not only the high degree of accuracy we must have, but worthwhile economy as well."*

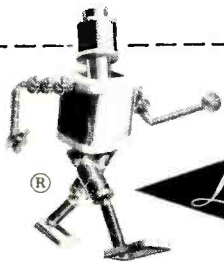
Leeson No. 108 Machines are the easiest to operate, most accurate and flexible hand feed coil winders ever

developed. Winding four to thirty paper-insulated coils in stiek form simultaneously, they reduce set-up time and speed production on long or short runs.

### Get the Facts

on how you can improve and economize your own operations. Use the coupon for further facts on Leeson No. 108 Hand Feed Coil Winders, and for other helpful coil winding information.

238.57



FOR WINDING COILS  
IN QUANTITY...  
ACCURATELY... USE  
LEESONA WINDING MACHINES

## UNIVERSAL WINDING COMPANY

P. O. BOX 1605, PROVIDENCE 1, RHODE ISLAND, Dept. 126

Please send me

- Bulletin on the Leeson No. 108 Hand-Feed Coil Winder.
- Condensed catalog of Leeson Winders.
- Bulletin on the new Leeson Pay-As-You-Profit Plans for purchasing or leasing modern coil winding machinery.

Name.....Title.....

Company.....

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

# AIRBORNE COMPONENTS IN MINIATURE



SHOWN 1/4 SIZE

## SYNCHROS

Kearfott (Penny Size) Synchros offer a reduction in diameter from 1.5 inches to .75 inches and in weight, from 5 oz. to 1.75 oz. In spite of this reduction, accuracy has been improved from 15 minutes to 10 minutes max. error from EZ. Available as transmitters, control transformers, resolvers and differentials.



SHOWN 3/4 SIZE

Kearfott components satisfy all requirements for high accuracy, light weight and small size.

### KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

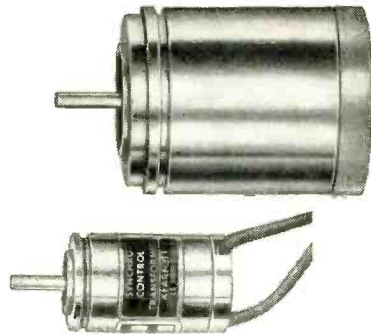
Send for bulletin giving data of Counters and other components of interest to you.

## GYROS

Kearfott 3" Vertical Gyro measures only 3"x3"x4" and weighs 3 pounds. It offers the same accuracy and dependability as its predecessor, three times its volume and weight.

### CHARACTERISTICS

*2 degrees of freedom, accuracy 15 minutes max. of 1/2 cone angle, and erection rate 3°/minute — normal. Erection time — 30 secs max. from any position.*



SHOWN 3/4 SIZE

## SERVO MOTORS

Kearfott (Penny Size) Servo Motors measure only .750 inches diam. x .980 inches and weigh 1.2 oz. They are ideal for instrument servo applications because of their high torque-to-inertia ratio and small size and light weight.

### CHARACTERISTICS

*Stall torque .33 oz.-in., no load speed 6400 R.P.M., time constant .0307 sec.*



A SUBSIDIARY OF GENERAL  
PRECISION EQUIPMENT CORPORATION

## KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 137B Main Avenue, Clifton, N. J.

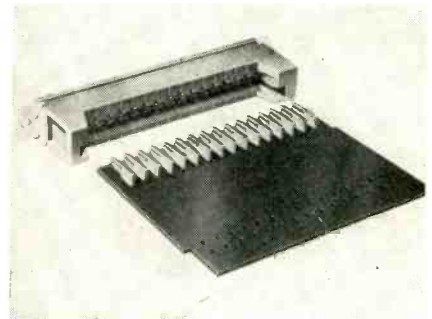
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas

West Coast Office: 253 N. Vinado Avenue, Pasadena, Calif.

lightweight portable equipment, or in continuous monitoring service for large electronic equipment.

► **Features**—The tube utilizes electrostatic focus and deflection. It has a flat face, a minimum useful screen diameter of 1 1/8 in., a maximum overall length of only 4 1/8 in., and weighs 2 oz. Other design features include separate base-pin terminal for each deflecting electrode to permit use of balance deflection, and a small-button unidekar 11-pin base.

The heater of the 1EP1 draws 0.6 ampere at 6.3 v. The screen phosphor is type P1 with medium persistence.



## CONNECTORS

for printed circuit use

ELCO CORP., M. St. below Erie Ave., Philadelphia 24, Pa., has announced the series 5,000 printed circuit Varicon connectors. The female connector is composed of strong interlocking sections with channeled end-sections to guide and orient the printed circuit board. The male contacts are mounted on the printed circuit board, spaced at 0.200-in. centers to match the female connectors. A method of staking the male contact to the board provides permanent contact with the circuitry, without the possibility of wear or lifting of the copper lines.

► **General Specifications**—Current rating is 10 amperes. Withstanding voltage (sea level) is 3,500 v rms, withstanding voltage (3.4 in./Hg) is 900 v rms. Contact resistance is 0.002 ohm. Insulation resistance (dry) is 25,000 megohms minimum. The connector will accommodate 0.062 in. to 0.074 in. thick board with normal warpage. Re-



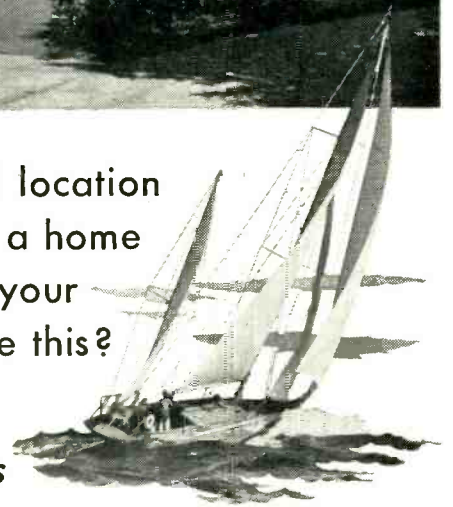
# ENGINEERS... LOOK TEN YEARS AHEAD!



A Douglas engineer lives here

Will your income and location  
allow you to live in a home  
like this...spend your  
leisure time like this?

They can...if you  
start your Douglas  
career now!



Your objectives are probably high professional standing, good income, good security and good living. All four can be achieved at Douglas.

Douglas has the reputation of being an "engineer's outfit," with the three top administrative posts being held by engineers. Maybe that's why it's the biggest, most successful unit in its field. Certainly it offers the engineer unexcelled opportunities in the specialty of *his* choice... be it related to missiles or commercial or military aircraft.

You've looked around. Now look ahead... and contact Douglas.

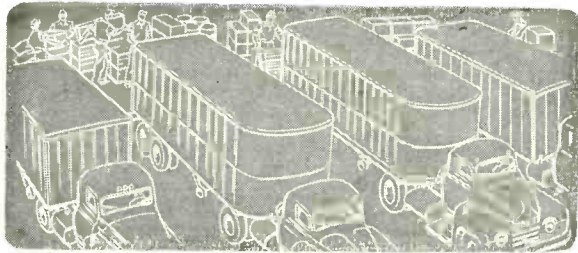
For further information about opportunities with Douglas in Santa Monica, El Segundo and Long Beach, California and Tulsa, Oklahoma, write today to:

**DOUGLAS AIRCRAFT COMPANY, INC.**  
C. C. LaVene, 3000 Ocean Park Boulevard, Santa Monica, California

**DOUGLAS**



**First in Aviation**



## Stymied by success!

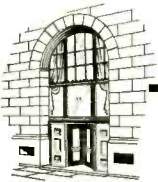
The new line or product is going over like ice cream at a Sunday school picnic, seems to be a smash hit. New customers order, and old ones reorder. Your outgo for materials and payroll jumps right away. Your cash on hand shrinks like late snow under a Spring sun. And you find yourself in trouble, strapped until you can ship and collect on your increased orders . . . What to do?

The problem isn't unique. It is faced by most growing companies. And Textile Banking has helped hundreds of firms find a solution . . . by supplying working capital to keep up with growing business.

If you are a manufacturer or wholesaler, with annual sales of approximately \$1,000,000, our Working Money Plan will *put your sales on a cash basis . . . strengthen your cash position . . . eliminate your credit losses.*

We can show you how to increase your present working capital without borrowing, or incurring new debt—without diluting earnings or interfering with management.

If you have any current or potential financing problem you would like to discuss confidentially with one of our officers, please write.



## Textile Banking Co., Inc.

*Providing operational financing for manufacturers and distributors of furniture, apparel, electronics, plastics and textiles.*

55 Madison Avenue, New York 10, N. Y.

movable polarizing inserts which fit between contacts can be provided. This insert may be located in any desired position.



### LOAD ISOLATORS for C-band magnetrons

LITTON INDUSTRIES, 336 N. Foothill Road, Beverly Hills, Calif. The C1000 series of C-band isolators provides higher power handling capacities. Up to 200 kw peak power can be handled with the C1000 series isolators without external cooling and up to 1 megawatt with external cooling.

Several models are available, capable of handling 1 megawatt and higher peak power with presurization. Within a range of 4,000 to 6,500 mc, isolation up to 20 db can be provided over a bandwidth of 500 mc.



### INTERPOLATION OSCILLATOR for 6 cps to 6 kc

HEWLETT-PACKARD Co., 275 Page Mill Road, Palo Alto, Calif. Model 200J interpolation oscillator is de-



# WESTINGHOUSE SILICON BRIDGES

## *How much power do you need?*

Westinghouse silicon bridge assemblies are immediately available with outputs from 5 to 100 amperes at 50 to 300 volts peak inverse in standard rectifier circuits.

These new pre-assembled silicon bridges by Westinghouse permit a tremendous spacesaving compared to equivalent selenium stacks.

Typical performance figures using four WN-5051-F diodes on 2" x 2" aluminum plates in a single-phase bridge, shown at the right, are:

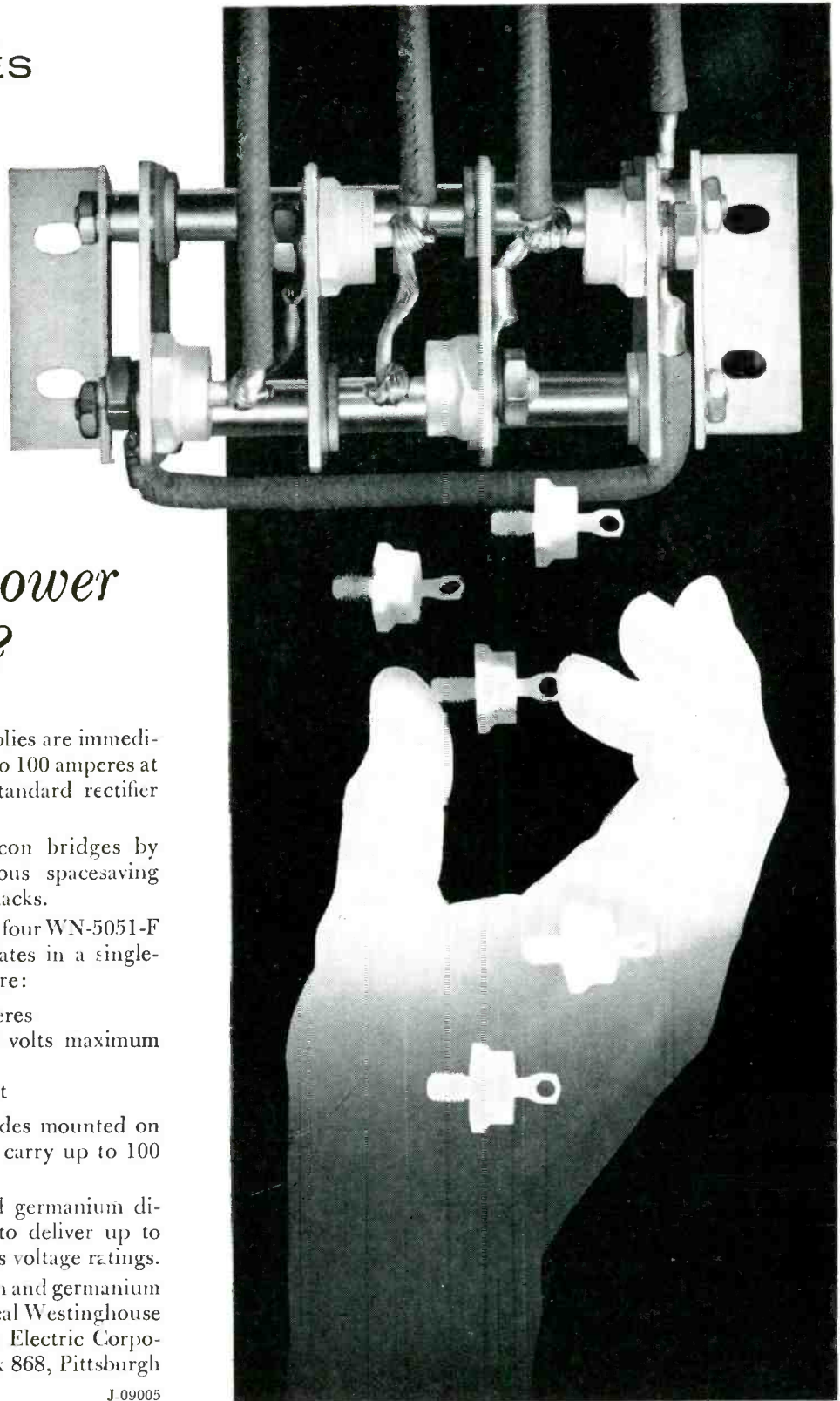
- continuous-load current 25 amperes
- leakage current <20 ma @ 300 volts maximum peak inverse
- natural convection 30° C ambient

A similar assembly with the diodes mounted on 5" x 5" plates with forced air can carry up to 100 amperes continuous.

Other Westinghouse silicon and germanium diodes can be mounted in bridges to deliver up to 600 amperes load current at various voltage ratings.

For detailed information on silicon and germanium bridges and diodes, contact your local Westinghouse sales office or write: Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania.

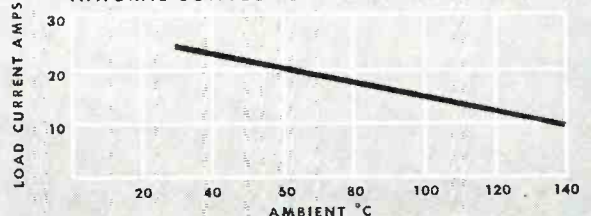
J-09005



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



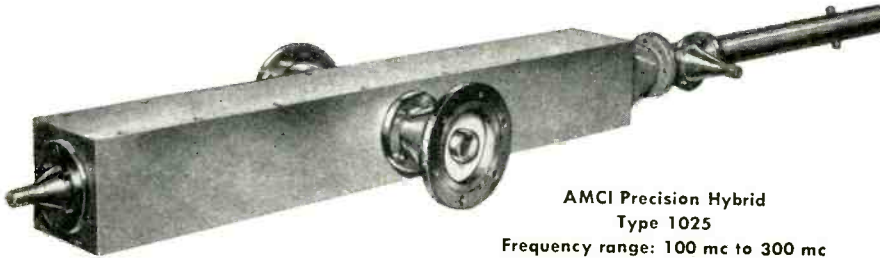
SINGLE-PHASE, FULL-WAVE BRIDGE  
OUTPUT CURRENT VS. AMBIENT TEMPERATURE  
NATURAL CONVECTION — 2" x 2" ALUMINUM PLATES



# NEW TOOLS

for

# R-F MEASUREMENTS



AMCI Precision Hybrid  
Type 1025  
Frequency range: 100 mc to 300 mc

## PERMITS DETECTION OF SWR'S AS LOW AS 1.002

**THE TYPE 1025 PRECISION HYBRID** is a five-terminal, high-frequency network built with particular attention to stability and accuracy of construction. It makes possible the *measurement* of quantities that have been, normally, only estimated. For example: this device can be used to measure at about 200 mc. a reflection coefficient as low as 0.01, with a precision of  $\pm 0.001$  in magnitude and  $\pm 5^\circ$  in phase angle.

**VERY LOW SWR's** can be measured by using the Type 1025 Hybrid with a suitable receiver and signal generator. With additional equipment, the phase angle also can be obtained, permitting point-by-point plotting of impedance curves like the one shown at the right.

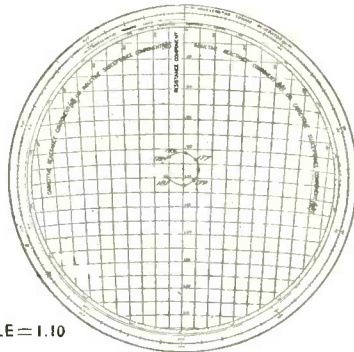
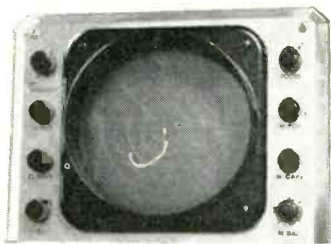


CHART FULL SCALE = 1.10



**DIRECT DISPLAY OF IMPEDANCE** can be obtained by using the Type 1025 Hybrid in conjunction with the AMCI type 1028 Polar Display Unit (frequency range 120 mc to 240 mc) together with a standard d-c oscilloscope and suitable swept oscillator. A typical display is shown in the unretouched photograph at the left.

### OTHER AMCI PRODUCTS

- VHF Television Broadcast Transmitting Antennas
- VHF Television Diplexing Filters
- VOR Antennas
- Slotted Measuring Lines
- Coaxial Line Stretchers
- Transmission Line Hybrids
- Rigid coaxial Transmission line
- Coaxial R-F Switches

signed for measurements where frequencies must be known with extreme accuracy. A 6-in. tuning dial, in combination with 6 ranges, results in an 80-in. effective scale length for maximum readability and resetability. Calibration accuracy is  $\pm 1$  percent over the 6-cps to 6-kc frequency range.

► **Further Data**—The instrument provides an output of 160 mw or 10 v into 600 ohms, or 20 v open circuit. The output is balanced to ground. Distortion is less than 0.5 percent. Frequency stability is  $\pm 2$  percent or 0.2 cps and the frequency response is less than  $\pm 1$  db for the full range.

► **Makeup** — It incorporates the company's resistance-capacitance oscillator circuit. It is equipped with long-life electrolytic capacitors, surface treated insulators, 100-percent inspected transformers, and a precision mechanical drive to assure the utmost ease of operation and minimum maintenance requirements. Price is \$275.



### AIR SYSTEM SOCKET for ceramic power tetrode

EITEL-McCULLOUGH, INC., San Bruno, Calif., has announced the SK-300 air system socket for use with the 4X500A ceramic power tetrode. The socket provides an effective method of cooling the tube with a minimum of forced air.

► **Operation Data**—Design of the socket permits air to pass over the stem terminals of the tube, after which it is guided into the anode



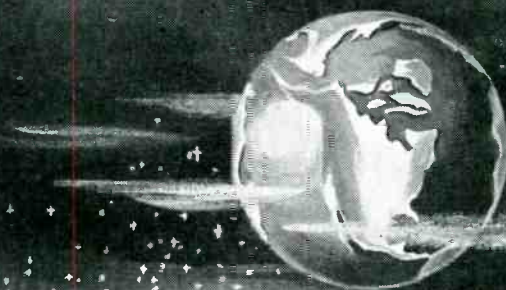
ANTENNA SYSTEMS - COMPONENTS - AIR NAVIGATION AIDS - INSTRUMENTS

# ALFORD

Manufacturing Co., Inc.  
299 ATLANTIC AVE., BOSTON, MASS.



# limitless



## as the future of UNIVAC<sup>®</sup>

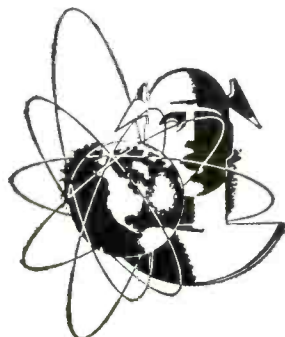
When planning your future, it is necessary to choose that company which presents the most complete program for you. The opportunity at Remington Rand Univac can only be limited by the individual. Excellent salaries, benefits and educational programs are yours to guarantee this limitless future.

At UNIVAC you will be working with men who developed much of the basic knowledge of computers—who designed and produced components being used by the manufacturers in the field—who set the standards that the others follow.

Now is the time to come to Univac where ambition and professional skill find their reward in limitless opportunities in an expanding organization.

### Immediate openings for:

- Computer Sales Engineers
- Product Planning Engineers
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LINCOLN  
LABORATORY

- **Electrical Engineers**
- **Physicists**
- **Mathematicians**

**SAGE** (*semi-automatic ground environment*)

**AEW** (*air-borne early warning*)

**WHIRLWIND COMPUTER**

**SOLID STATE**

**HEAVY RADARS**

**MEMORY DEVICES**

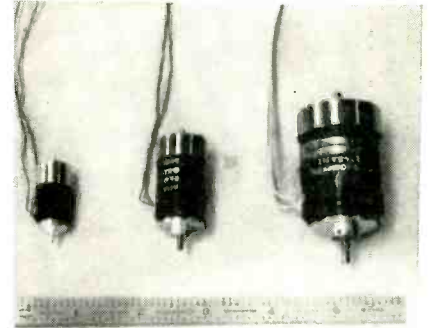
**SCATTER COMMUNICATIONS**

**TRANSISTORIZED DIGITAL  
COMPUTERS**

If you are interested in participating  
in any of these programs address:

**Dr. M. G. Holloway, Director**  
**M.I.T. Lincoln Laboratory**  
**Lexington 73, Mass.**

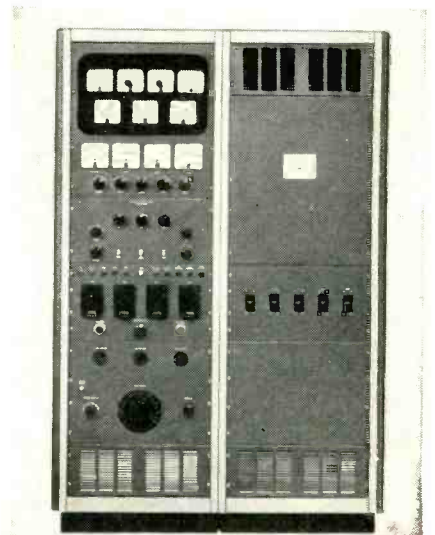
fin assembly by means of a conical fiberglass chimney. Connections are provided for all filament, grid and screen elements of the 4X5000A. The SK-300 is designed for flush mounting.



**MAGNETIC CLUTCHES**  
no end movement of shaft

A. J. THOMPSON Co., Florissant, Mo., has available a new group of magnetic clutches with the following design features: no end movement of shaft; coils are removable and interchangeable; instrument type ball bearings; can be modified for special applications; and with other models available on request.

Minimum clutch torque for the group ranges from 2 in. oz to 90 in. oz; and minimum brake torque, from 2 in. oz to 75 in. oz. Engineering data sheets are available.



**PULSER**  
for high-power t-w tubes

ALTO SCIENTIFIC Co., 855 Commercial St., Palo Alto, Calif., has



TEST

ANALYZE

EVALUATE

# Telemetry Performance Quickly and Accurately

## SIGNAL GENERATOR

*Type 202-D*

*Frequency Range 175-250 mc.*

With the type 202-D Signal Generator, you can quickly and accurately test, analyze and evaluate the performance of telemetry receivers and associated equipment. Note that the frequency coverage of the instrument is provided in a single range between 175-250 mc.

### SPECIFICATIONS:

**RF RANGE:** 175-250 megacycles in one range, accurate to  $\pm 0.5\%$ . Main frequency dial also calibrated in 24 equal divisions for use with vernier frequency dial.

**VERNIER FREQUENCY DIAL:** This dial is divided into approximately 100 equal scale divisions and is coupled to the main frequency dial by a 24:1 gear train. The approximate frequency change per vernier division is 35 kc.

**FREQUENCY MODULATION (DEVIATION):** The FM deviation is continuously variable from zero to 240 kc. The modulation meter is calibrated in three FM ranges (1) 0-24 kc., (2) 0-80 kc., and (3) 0-240 kc. deviation.

**AMPLITUDE MODULATION:** Utilizing the internal audio oscillator amplitude modulation may be obtained over the range of 0-50% with meter calibration points of 30% and 50%. By means of an external audio oscillator the RF carrier may be amplitude modulated to substantially 100%. A front panel jack is provided which permits direct connection of an external modulating voltage source to the final stage for pulse and square wave modulation. Under these conditions the rise time of the modulated carrier is less than 0.25 microseconds and the decay time less than 0.8 microseconds.

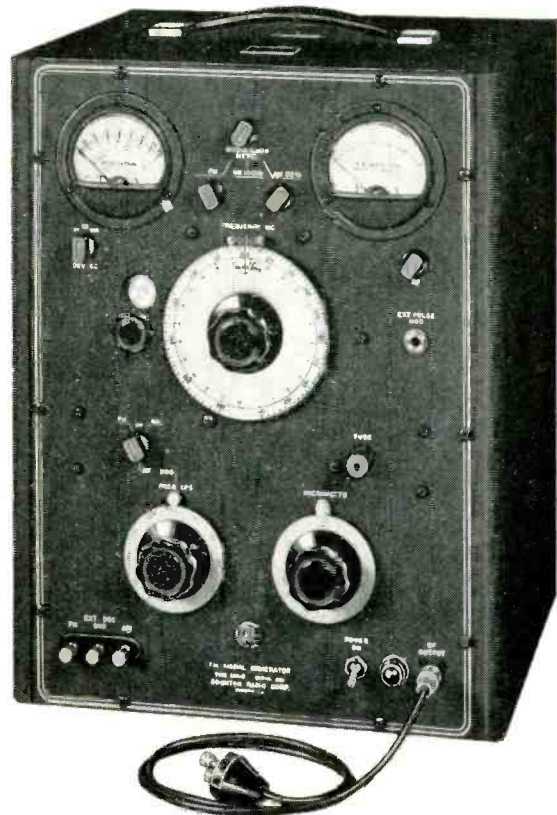
**MODULATION CONTROLS:** Separate potentiometers are provided for continuous control of FM and AM levels.

**MODULATING OSCILLATOR:** The internal AF oscillator may be switched to provide either frequency or amplitude modulation. It may also be switched off. Eight fixed frequencies between 50 cycles and 15 kilocycles are available, any one of which may be selected by a rotary type switch.

**RF OUTPUT VOLTAGE:** The RF output voltage is continuously variable over a range from 0.1 microvolt to 0.2 volts at the terminals of the output cable. The impedance of the RF output jack, looking into the instrument, is 50 ohms resistive.

**DISTORTION: FM:** The overall FM distortion at 75 kc. is less than 2% and at 240 kc. less than 10%.

**AM:** The distortion present at the RF output for 30% amplitude



modulation is less than 3% and for 50% AM less than 6.5. At 100% the distortion is 12% to 15% depending upon the modulating frequency.

**SPURIOUS RF OUTPUT:** All spurious RF output voltages are at least 25 db. below the desired fundamental. Total RMS spurious FM from the 60 cycles power source is down more than 50 db., with 75 kc. deviation as a reference level.

### EXTERNAL MODULATION REQUIREMENTS:

**Frequency Modulation:** The deviation sensitivity is 50 kc. per volt. For external FM the input impedance is 1500 ohms.

**Amplitude Modulation:** Approximately 45 volts are required for 50% modulation and 100 volts for 100% modulation. For external AM the input impedance is 7500 ohms.

**Audio Voltage for External Use:** There is available at the FM external oscillator binding posts about 5 volts a.c. maximum and at the AM external oscillator binding posts, 50 volts maximum.

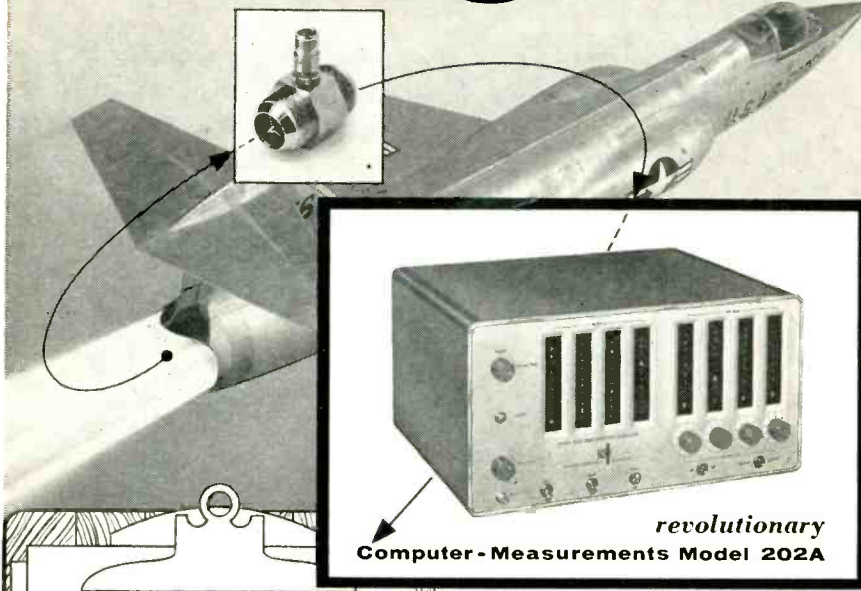
**DIMENSIONS AND WEIGHT:** Outside cabinet dimensions: 17" high, 13½" wide, 11½" deep. Weight: 35 pounds.

Price: \$980.00 F.O.B. Boonton, N. J.



**BOONTON RADIO**  
BOONTON · N · J · U · S · A · Corporation

*translate flow*  
*... into pounds per hour*  
**at a glance!**



*revolutionary*  
**Computer-Measurements Model 202A**

**TIME-FUNCTION TRANSLATOR**

**Applications:**

- ✓ Gallons per minute . . . into Gallons per hour
- ✓ Gallons per minute . . . into Pounds per hour
- ✓ Pulses per second . . . into Gallons per minute
- ✓ Total Count of Gallons or Pounds
- ✓ Tachometer Applications
- ✓ Direct Frequency Measurement
- ✓ Many Others

Translating flow into weight as required for jet engine analysis is just *one* of the *many* uses for the *all-new* Model 202A TIME-FUNCTION TRANSLATOR. The 202A permits *instant* direct read-out of unknown quantities by translating one function of time into another function of time. It eliminates the need for conversion tables, graphs, charts, etc. The variable time base display may be illuminated or blanked at operator option. The versatile 202A fills a long recognized need in electronic measurement.

*Write for complete information and detailed specifications on the Model 202A Time-Function Translator TODAY. . .*

**SPECIFICATIONS:**

Frequency Range:	1-100,000 cycles per second 0-100,000 positive pulses per second
Input Sensitivity:	0.05 volt rms: 10-100,000 cps (5 millivolts optional) 0.07 volt rms: 1-10 cps Positive pulse rise time: 1/2 volt or more per sec.
Input Impedance:	0.5 megohm and 50 mmf.
Accuracy:	± 1 count ± stability
Stability:	Short Term: 1 part in 1,000,000 Long Term: 5 parts per million per week
Time Bases:	0.001 to 10 seconds in 1 millisecond steps 0.0001 to 1 second in 0.1 millisecond steps (0.0001 to 10 sec. in 0.1 millise. steps, 0.001 to 100 sec. in 1 millise. steps optional)
Read-Out:	Direct. Four digits. (Five digits optional)
Display Time:	Automatic: Continuously variable, 0.1 to 10 sec. Manual: Until reset
Power Requirements:	117 volts ± 10%, 50-60 cycles, 250 watts (50-400 cycles optional)
Dimensions:	17" W x 8 3/4" H x 13 1/2" D
Weight:	35 lbs. net.
Finish:	Panel: Light grey baked enamel Case: Dark grey baked enamel <i>Data Subject to Change Without Notice</i>

\*Model FL Flow Pickup: Courtesy—Waugh Engineering Co., Van Nuys, Calif.



**Computer-Measurements Corporation**

5528 Vineland Avenue, North Hollywood, Calif. Dept. 78-F

developed a self-contained pulser providing 14 kv at 100 ma to the cathode of t-w tubes. A unique feature is a bias and gate supply tied to the variable power supply and used to bias the tube to cutoff.

► **Specifications** — The unit delivers gate pulses of 1, 2, 5 and 10  $\mu$ sec with repetition rate variable from 20 cps to 20 kc at a maximum duty of 0.02. Gate current is 0.5 ampere peak or 10 ma average, and voltage droop on top of the pulses is adjustable  $\pm 2$  v. Rise and fall time for all pulse widths is less than 0.15  $\mu$ sec, and peak-to-peak ripple is less than 1.0 percent of amplitude. Amplitude has a 100-percent point adjustable from 0 to 600 v; triggering delay is adjustable from 5 to 50  $\mu$ sec.

The new pulser has metering and viewing facilities for all voltages and currents, including peak gate voltage, collector, helix, anode and gate pulse current, total pulse current and gate pulse voltage. There is also a metered adjustable filament voltage.

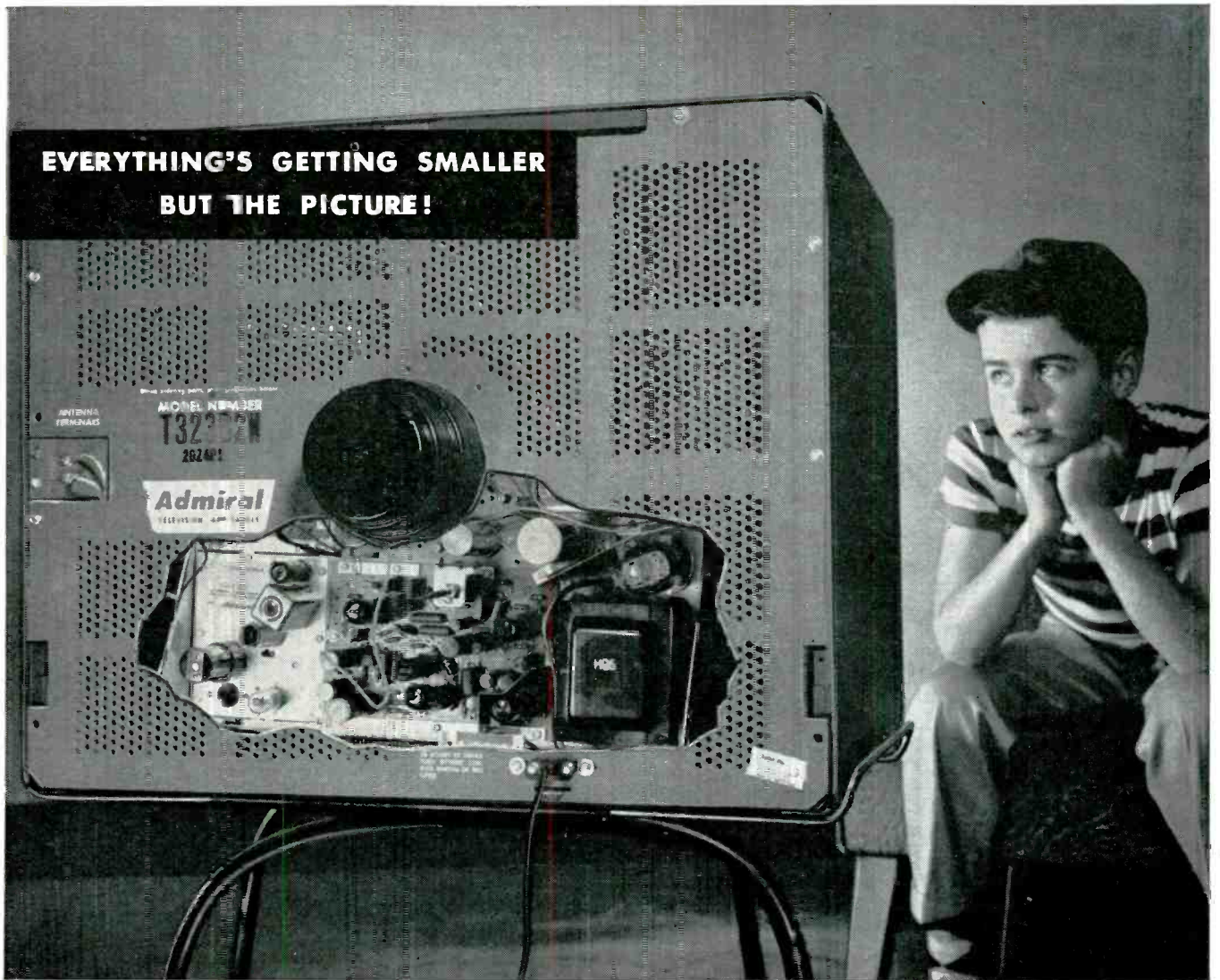
**LOW-NOISE TRANSISTOR is hermetically sealed**

RADIO CORP. OF AMERICA, Harrison, N. J. A new hermetically sealed germanium alloy-junction transistor of the *pnp* type (RCA-2N175) has been announced. It is designed especially for use in the preamplifier or input stages of transistorized audio equipment operating from extremely low input signals. Such equipment includes microphone preamplifiers and recorders.

► **Features**—The 2N175 has a low noise-figure of 6 db maximum and is free of microphonics and hum. The combination of low noise figure and low input impedance characteristic permits the design of audio amplifiers in which the transistor is operated directly from low-impedance, low-level devices. The new transistor has a current amplification ratio of 65 and a matched-impedance power gain of approximately 43 db.

The 2N175 uses an insulated metal envelope and has a linotetrar





## MYLAR<sup>®</sup> makes possible smaller capacitors for new Admiral television sets

"Du Pont 'Mylar'\* polyester film has played a vital role in the development of our '56 line of TV receivers," reports Admiral Corporation. "Extremely thin 'Mylar' permits the manufacture of moisture-insensitive

capacitors small enough to be installed automatically on printed circuit boards of all black-and-white TV sets . . . in short, less cabinet space, bigger picture tube."

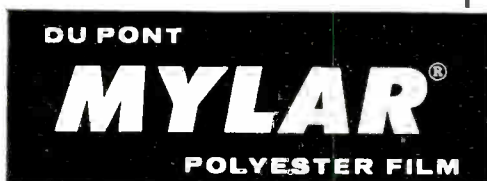
This is only one example of the way versatile "Mylar", used alone or in combination with other materials, makes possible superior per-

formance for motors, transformers and a host of other electrical products.

For more information on how "Mylar" can help you improve product performance, or solve knotty development problems, send in the coupon below. Be sure to indicate the application you have in mind.



BETTER THINGS FOR BETTER LIVING  
... THROUGH CHEMISTRY

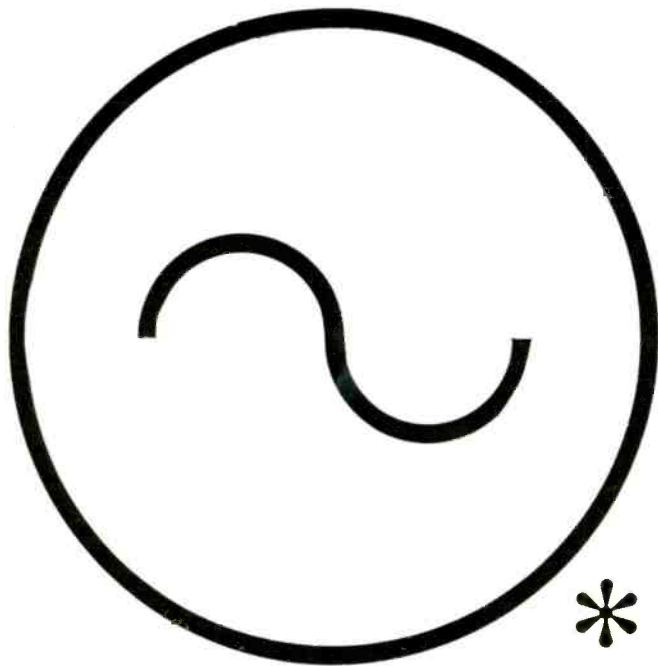


\*MYLAR is Du Pont's registered trademark for its brand of polyester film.

E. I. du Pont de Nemours & Co. (Inc.)  
Film Dept., Room E-6, Nemours Bldg., Wilmington 98, Del.

Please send the new booklet listing properties, applications, and types of "Mylar" polyester film available (MB-4).

Application \_\_\_\_\_  
Name \_\_\_\_\_  
Company \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_ State \_\_\_\_\_



# for insulated wire, one source **Continental**

For the run-of-the-mill wiring problems—or the hundreds of specials—the one source for practically all types of permanently insulated wire—is Continental. Whether it's electronic hook-up wire, military hook-up wire or cable, switchboard AVB—TA—SHFS Cable or Wire . . . Asbestos, Glass, Nylon, Varnished Cambric, Polyethylene, etc. . . the **Always Correct Source** is Continental Wire Corporation. Refer your special wiring problems today to Continental's Wire and Cable specialists.

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Contact: Continental Sales, Box 363, Dept. C  
Wallingford, Conn., Phone COLony 9-7718

**POWER and RHEOSTAT CABLE—TYPE AIA**  
available in Sizes 18 AWG—2,000,000 CM inclusive.



Stranded copper conductor, asbestos insulation, asbestos braid. Heat, flame, moisture resistant impregnation and finish.

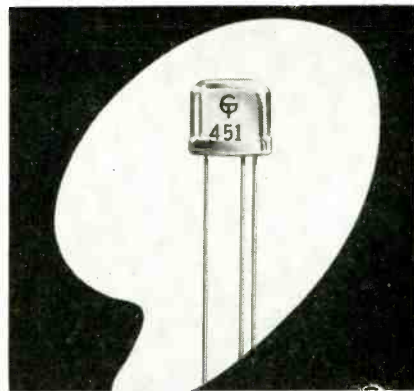
For open installation in high operating temperatures, oil, grease, corrosive vapors or moisture. Maximum temperature 257° F.

# Continental

## WIRE CORPORATION

WALLINGFORD, CONNECTICUT • YORK, PENNSYLVANIA

3-pin base. Diameter is 0.260 in. and seated length is 0.495 in.



### H-F TRANSISTOR

*pn<sub>p</sub>* alloyed junction type

GENERAL TRANSISTOR CORP., 95-18 Sutphin Blvd., Jamaica 35, N. Y., has announced a new germanium *pn<sub>p</sub>* alloy junction transistor. Known as GT-763, the new transistors have been designed for h-f operation as r-f and i-f amplifiers in broadcast receivers and as switches for high-speed computer applications. Units are hermetically sealed in metal cases with glass headers.

Average characteristics (at 25 C) and typical operation (at 455 kc) are listed in a recent catalog bulletin.



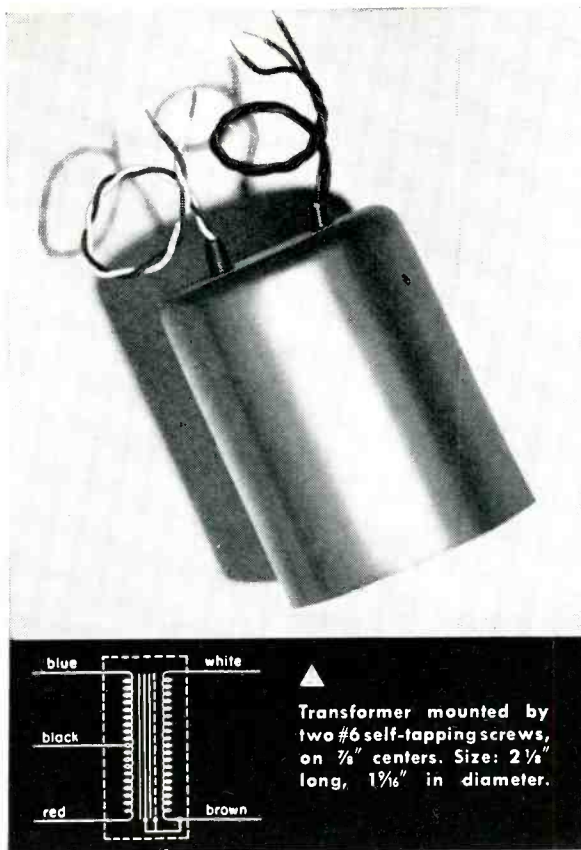
### DELAY GENERATOR

features high accuracy

ORBITRAN Co., P.O. Box 635, Lakeside, Calif. Model 1000-A pulse delay generator provides a positive pulse variable in delay in increments of 0.1  $\mu$ sec from 1.0 to 999.9  $\mu$ sec. Accuracy of delay is  $\pm 0.5 \mu$ sec or 0.1 percent of indicated delay and this accuracy is maintained over the full prf range.

► **Other Highlights** — Additional features include a delayed scope trigger which makes it possible to





# Shielded low-level transformers

for low-frequency a-c  
or chopper-modulated  
signals from 0.0005 to 200 mv.

**N**OW AVAILABLE for your servo, measuring, and coupling circuits. They're proved by years of industrial service as input transformers in *ElectroniK* instruments. They can faithfully handle low-frequency a-c, or chopper-modulated signals from 0.0005 to 200 millivolts. Used with thermocouples or other transducers.

Hum-bucking winding of both primary and secondary gives maximum cancellation of strays. Highly efficient shielding is designed into the transformers. A grounded copper shield provides electrostatic isolation between primary and sec-

ondary. In addition, the shield and one end of the secondary are internally grounded to the core. Magnetic shielding of -40 db is provided by a high permeability outer can.

Choose from the three models below. Order in single units, or by the hundreds. Write today for immediate quotation and prompt delivery.

MINNEAPOLIS-HONEYWELL REGULATOR Co.,  
*Industrial Division*, Wayne and Windrim  
Avenues, Philadelphia 44, Pa.—in Canada, Tor-  
onto 17, Ontario.

● REFERENCE DATA: Write for Specification S900-1.

Choose from three models		355567-1	356326	355567-2
Primary (center-tapped)	turns (1/2 primary) Resistance (approx.) 60 cps impedance Impedance, full pri.	600 30 ohms 1,300 ohms 5,200 ohms	1,094 450 ohms 7,500 ohms 30,000 ohms	3,400 750 ohms 50,000 ohms 200,000 ohms
Secondary	turns Resistance (approx.) Capacity to tune to 60 cycles	9,600 2,500 ohms .015 mfd. 5.7 oz.	17,000 5,800 ohms .001 mfd. 7.1 oz.	12,000 3,400 ohms .003 mfd. 6 oz.
Weight				

**ORDER NOW!**

Prices from \$21.00

(even more favorable  
on quantity purchases)



MINNEAPOLIS  
**Honeywell**

BROWN INSTRUMENTS

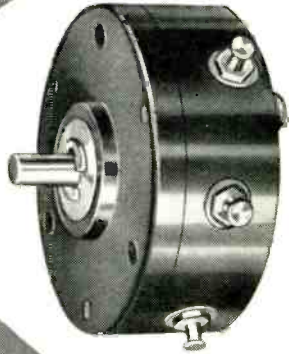
*First in Controls*

Get Precision at a New Low Price!

GAMEWELL'S

G-20  
SERIES

PRECISION  
POTENTIOMETERS



The New G-20 gives you a truly precision potentiometer with many characteristics found only in pots costing twice as much. Here are the outstanding features . . .

- Linearity is 0.5 or better
- Radial or Rear Extension Turret Terminals
- Non-metallic housing uses material of high dimensional stability that is inherently fungus-proof and moisture resistant
- Servo, Threaded-Bushing or Flange Type Mountings
- Power rating 1.5 watts at 65°C (derated to 0 at 150°C)

Gamewell gives you this high quality at low cost by new design techniques and high production methods.

See how many applications can use this new G-20. It is ideal where you require good precision at a bargain price for industrial and commercial apparatus. Gamewell is ready to supply these in quantity now.

THE GAMEWELL COMPANY  
NEWTON UPPER FALLS 64, MASS.

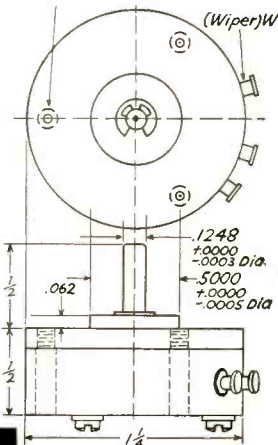


PRECISION POTENTIOMETERS

Manufacturers of Precision Electrical Equipment Since 1855

### Technical Data

Resistance, Max.	63,000 ohms $\pm 5\%$
Resistance, Min.	20 ohms $\pm 5\%$
Linearity Std.	$\pm 0.5$
Electrical Angle	$340^\circ \pm 3^\circ$
Max. No. of Turns	2100
Watts at 65°C	1.5
Torque Max.	1 oz. — in.
Max. Temperature	150°C
Weight	1/4 oz.
4-40 NC-28 3-Holes Equally Spaced on .500 R.	



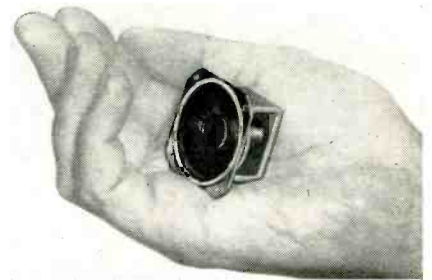
GA 6-2

NEW PRODUCTS

(continued)

observe the delayed pulse (for all delay settings) on a 10  $\mu$ sec sweep with less than 0.01  $\mu$ sec jitter. A built-in mixer circuit which mixes the selected delayed pulse with positive pulse video signals is also incorporated. The mixed output is available for presentation on an oscilloscope and provides an accurate and rapid means of calibrating or checking the delay of video signals.

Typical applications are pulse coded data system checkout, delay line measurements, radar range unit calibration and in pulse equipment development work. Price is \$895.



### P-M SPEAKER for transistorized circuits

ARGONNE ELECTRONICS MFG. CORP., 27 Thompson St., New York 13, N. Y. Size of the new subminiature p-m speaker is only 1 1/2 in. in diameter by 15/16 in. deep. Designed primarily for use with transistorized circuitry, its frequency range and audio output are in excess of requirements for miniature personal portable radios.

The magnet is of Alnico 5-voice-coil impedance is 10 ohms. Total weight of the unit is 1 1/8 oz. Mounting centers are 1 3/8 in. by 1 3/8 in. Suggested list price is \$3.25.

A matching miniature output transformer measuring 3/8 in. by 3/8 in. by 1 1/8 in., 2,000 ohms primary, 10 ohms secondary—is also available.

### BEAM POWER TUBES for tv audio output stage

RADIO CORP. OF AMERICA, Harrison, N. J., has announced two new beam power tubes (types 6CU5 and 12CU5), intended particularly for use in the audio output stage of tv



# ★ Control Components Digest ★

News and notes on resistors, rheostats, relays, motor controls, dimmers and other control components



SYLVANIA'S SOFT BLUE MERCURY VAPOR LAMPS are seen on many modern thoroughfares. Integral Ward Leonard resistor in each lamp contributes to reliable operation.

## Improved mercury-lamp design features sealed-in resistor

Seal it in and forget it, for the lamp's life of 6000 hours plus!

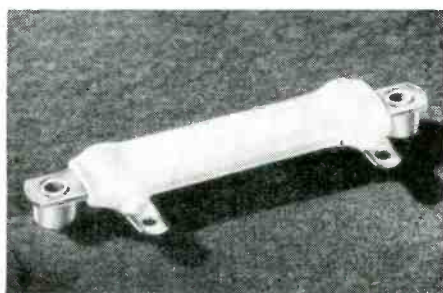
That's the way engineers at Sylvania Electric Products Inc., Salem, Mass., treat the current-limiting resistors in their modern, improved mercury-vapor lamps.

And, naturally, for the heavy-duty, heat-, moisture- and ultra-violet-proof starting resistors, to be sealed up in these lamps, Sylvania engineers chose

Ward Leonard Vitrohms.

These rugged resistors not only take the temperatures (to 750°F), but are immune to the heavy vibration encountered on or near bridges, ramps, railroad crossings or heavily-traveled highways.

Why not let a Ward Leonard engineer show you how Vitrohms can solve your resistor problem. Write to day for complete information.



NEW MINISTRIP RESISTOR

## New miniature power resistor

A new 20-watt Ward Leonard "Ministrip" resistor is now available.

Recommended where space is limited, but where no sacrifice can be made in quality, the new resistor features low, built-in mounting brackets (2-5/16 in. between centers) and an oval-shaped core for maximum strength.

Stock resistance values to 50,000 ohms; 5% tolerance.

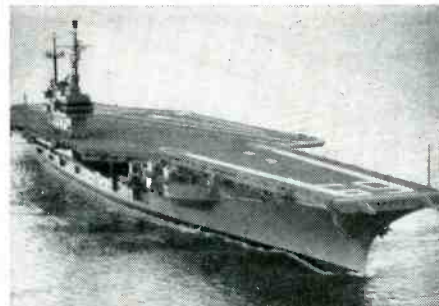
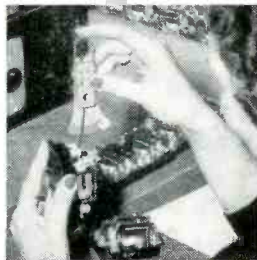
## Failure-free parts key to system reliability

Roughly speaking (and skipping a lot of mathematical subtleties) if you double the number of parts in a complex system—other things being the same—you'll cut in half its life expectancy.

The modern trend is toward more and more complex jobs for electrical and electronic gear. Doubling—and more—the number of parts goes on all the time. And yet it's vitally important that overall system reliability not be impaired. That's why at Ward Leonard you'll find such painstaking attention devoted

to increasing the reliability of our products. From incoming raw material to finished part, our careful attention to every phase of production and every inspection and test assures you of a product you can count on in *your* system.

**CHECKING CONTACT PRESSURE** on a Ward Leonard relay—one of the many 100% inspections and tests that assure its final quality.



USS FORRESTAL. Photo courtesy Newport News Shipbuilding and Dry Dock Company.

## MAG-A-TROL for USS FORRESTAL

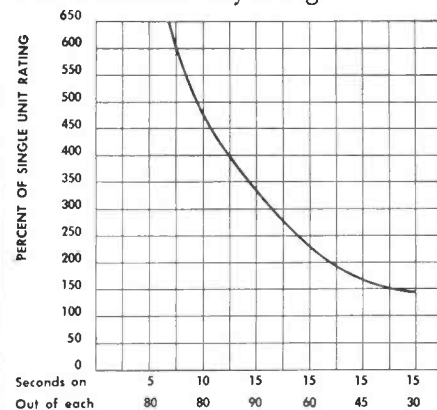
Precision-controlled lights guide pilots to the flight deck of the USS Forrestal, largest aircraft carrier.

The new carrier uses Ward Leonard magnetic-amplifier-type dimmers to insure correct light intensity on the flight deck at all times.

Besides the Forrestal's magnetic amplifier dimmers, Ward Leonard makes *all* types of lighting controls (autotransformer, reactance and resistance) for fluorescent or incandescent lamps.

## Design aid for intermittent duty

A power resistor used only intermittently may be used at wattages in excess of its continuous-duty rating.



The curve above will help designers figure allowable dissipation increases for Ward Leonard Vitrohm and Ribflex resistors for various duty cycles. Assumed maximum temperature rise: 375°C; resistor spacing: 2½ in. This is one of many useful curves contained in our 64-page Catalog #15—ask for it today. 6.7

**WARD LEONARD ELECTRIC COMPANY**  
31 SOUTH ST., MOUNT VERNON, N. Y.



**Result-Engineered Controls Since 1892**  
RESISTORS · RHEOSTATS · RELAYS · CONTROLS · DIMMERS

# Operation Demonstration!



offers  
**FREE  
TRIAL**  
of the  
**800A  
EXTENDED  
RANGE VTVM**

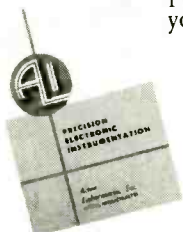


Here's your opportunity to compare the ALI 800A Extended Range VTVM under your conditions . . . without any cost or obligation. This is the same VTVM that has been called the "Measurement Laboratory in one Compact Instrument."

Check the effect of the 800A's highly degenerative amplifier circuit . . . unique circuitry . . . voltage regulated plate and filament supply . . . and high input impedance in terms of greater stability, higher accuracy and extended measurement range.

The 800A is actually a voltmeter, millivoltmeter, milliammeter, microammeter, millimicroammeter, ohmmeter, and megohmmeter in one instrument. Provides accurate measurement from 15 cps to 100 megacycles . . . resistance range from 0.02 to 5000 megohms in 9 steps . . . current range from 0.001 microampere to 0.1 ampere in 9 steps . . . AC voltage range from 0.1 to 300 volts in 8 steps . . . and DC voltage range from 0.1 to 1000 volts in 9 steps. And all this versatility and extended range — with laboratory precision.

Request your free trial now. Absolutely no obligation. Take this opportunity to observe the advantages of the 800A in your own project.



Write today for the ALI  
Handbook of Instrumentation and  
the 800A VTVM Data Sheet

**Acton Laboratories, Inc.**

520 Main Street, Acton, Mass.



receivers. The tubes, which are of the 7-pin miniature type, are similar except that the 12CU5 has a 12.0-v/0.6-ampere heater having controlled heating time to insure dependable performance in tv receivers employing series-heater string arrangement.

► **Power Output**—Because of their high-power sensitivity and high efficiency at low plate and screen voltages, the tubes are capable of providing a relatively high power output. In class A1 amplifier service, for example, either tube when operated with a plate voltage of 120 v and a grid-No. 2 voltage of 110 v, can deliver a maximum signal power output of 2.3 w.



## SHORT FORM RELAYS are hermetically sealed

KURMAN ELECTRIC Co., INC., 35-18 37th St., Long Island City, N. Y., has announced a new hermetically sealed short-form telephone type relay. Designed for use where space economy is an important factor, it offers all the advantages of the long-form telephone relay armature, hinge and contact arms. It can be equipped with many special features including copper slugs for time delay, special contact materials and high voltage insulation.

► **Other Features**—Series SE relay features d-c operation, fast-operate and fast-release with a maximum of 10 form A or 6 form C contacts. It has single or double-wound coils with resistance up to 38,000 ohms and single or double armature with a heavy-duty armature hinge. It can be provided with creepage in-



# New Taylor Copper-Clad Laminates

**now available in production quantities**

## Why Taylor Copper-Clad Laminates Help Capitalize the Full Potential of Printed Circuits . . .

Taylor's ability to use high purity rolled copper—in weights of one, two or three ounces per square foot—assures production of materials that will more satisfactorily meet industry's needs because . . .

Roller copper surface is smoother (freer from pits, pinholes and imperfections) . . . more uniform thickness . . . no sacrifice in conductivity. Result: Consistently satisfactory etching at better production rates.

## Taylor GEC Copper-Clad provides . . .

- Superior electrical and mechanical qualities for critical applications.
- High electrical stability over wide humidity range.
- High resistance to dip soldering temperatures up to 500 F.
- High insulation resistance and surface resistivity after etching.
- Ready punchability.
- Good, uniform copper-to-laminate bond strength.

## Taylor XXXP-242 Copper-Clad provides . . .

- Cold punchability. For intricate punchings—warm to 150 F. max.
- High resistance to dip soldering temperatures up to 500 F.
- High insulation resistance and surface resistivity after etching.
- Translucence. Permits easy checking of circuit alignment on opposite side.
- Good, uniform copper-to-laminate bond strength.

After months of research and experimentation, Taylor is now in production on two brand new copper-clad laminates that give you opportunity to realize—on a sound basis—the full potentials of printed circuit construction.

Produced by an exclusive Taylor process that permits the use of readily available, high purity rolled copper, these laminates are supplied in two grades—XXXP-242 Copper-Clad, with a premium quality phenol paper base material; and GEC Copper-Clad, with a superior epoxy glass base material.

Taylor makes both of these copper-clad laminates in sheets approximately 37 x 49 inches . . . in thicknesses from .015 to .25 inches . . . with copper on one or both sides.

Whatever your experience with copper-clad laminates . . . whatever your ideas on the subject . . . it will be to your advantage to find out just what the new Taylor materials can do for you. Contact the nearest Taylor sales engineer . . . for more information or for your sample order.

TAYLOR FIBRE CO. Plants in Norristown, Pa. and La Verne, California

### Branch Offices

Atlanta	Detroit*	Philadelphia
Boston*	Indianapolis	Rochester*
Chicago*	Los Angeles	San Francisco*
Cleveland*	Milwaukee*	St. Louis
Dayton*	New York*	Rockville, Conn.

\*Teletypewriter service at both plants and these branches.

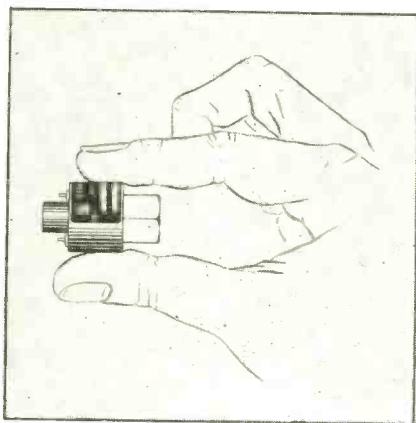
### Distributors

Grand Prairie, Texas  
Houston  
Miami  
Toronto

# TAYLOR

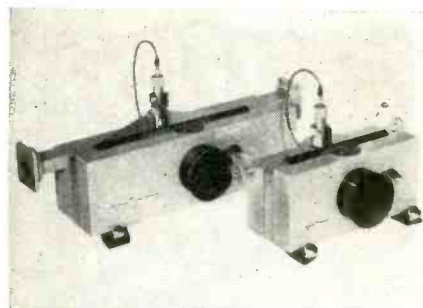
Laminated Plastics  
Vulcanized Fibre

sulation and a plug-in or solder-type header.



### SOLENOID VALVE tiny, straight-through

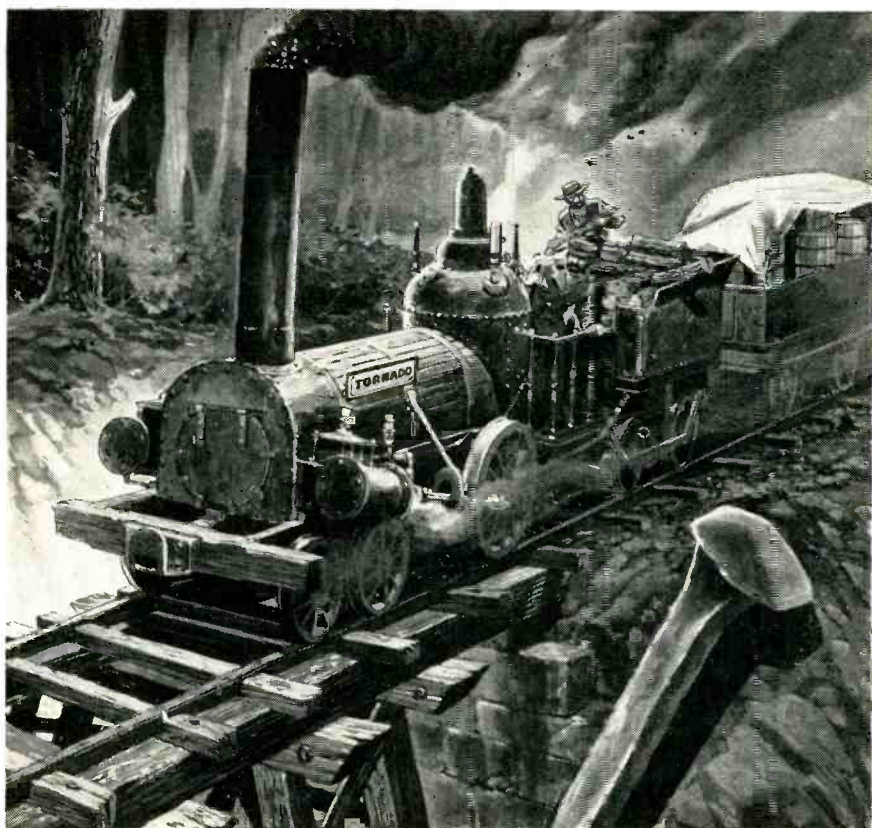
CEDAR ENGINEERING, INC., 5806 W. 36th St., Minneapolis 16, Minn., has announced a subminiature valve designed for guided missile and aircraft control applications. The valve is available in a variety of fittings, normally opened or normally closed, for continuous duty on either a-c or d-c, 2.2 w, 30 psi or 30 in. hg.



### S-W DETECTOR with probe-motion linearity

DEMORNAY-BONARDI, 780 S. Arroyo Parkway, Pasadena, Calif., has announced a high-accuracy standing wave detector for measuring bandwidths ranging from 5.85 kmc to 90 kmc. The instrument uses a 5-point kinematic carriage suspension which assures maximum linearity of probe motion.

To eliminate mismatch due to imperfect milling, the waveblock is precision formed in one piece. This permits high internal uniformity, which in turn provides a uniform path for measured waves, and minimizes residual vswr. The block is



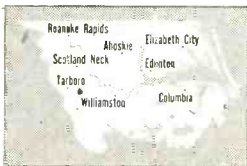
## NORTH CAROLINA'S Keystone Corner

WHERE "THE WORLD'S LONGEST RAILROAD" RAN IN 1840

... fast, modern transportation will serve your plant

161 MILES OF WOODEN TRACKS, surfaced with strap iron, made the Wilmington & Weldon the world's longest railway in 1840. Today, the little line forms part of one of the five major railroads that can serve your plant in this "keystone corner" of North Carolina. That's beside the 20 modern trucklines and 300 steamship lines calling at nearby deepwater ports.

**YOU'RE CENTRALLY LOCATED** on the East Coast, with favorable freight rates to the Mid-west. Coal, peanuts, chemicals, soybeans, lumber, cotton, resin, woodpulp and many other materials roll in at short-haul cost. And a 3,800 mile network of



modern highways brings an ample force of conservative, southern manpower to your plant parking lot.

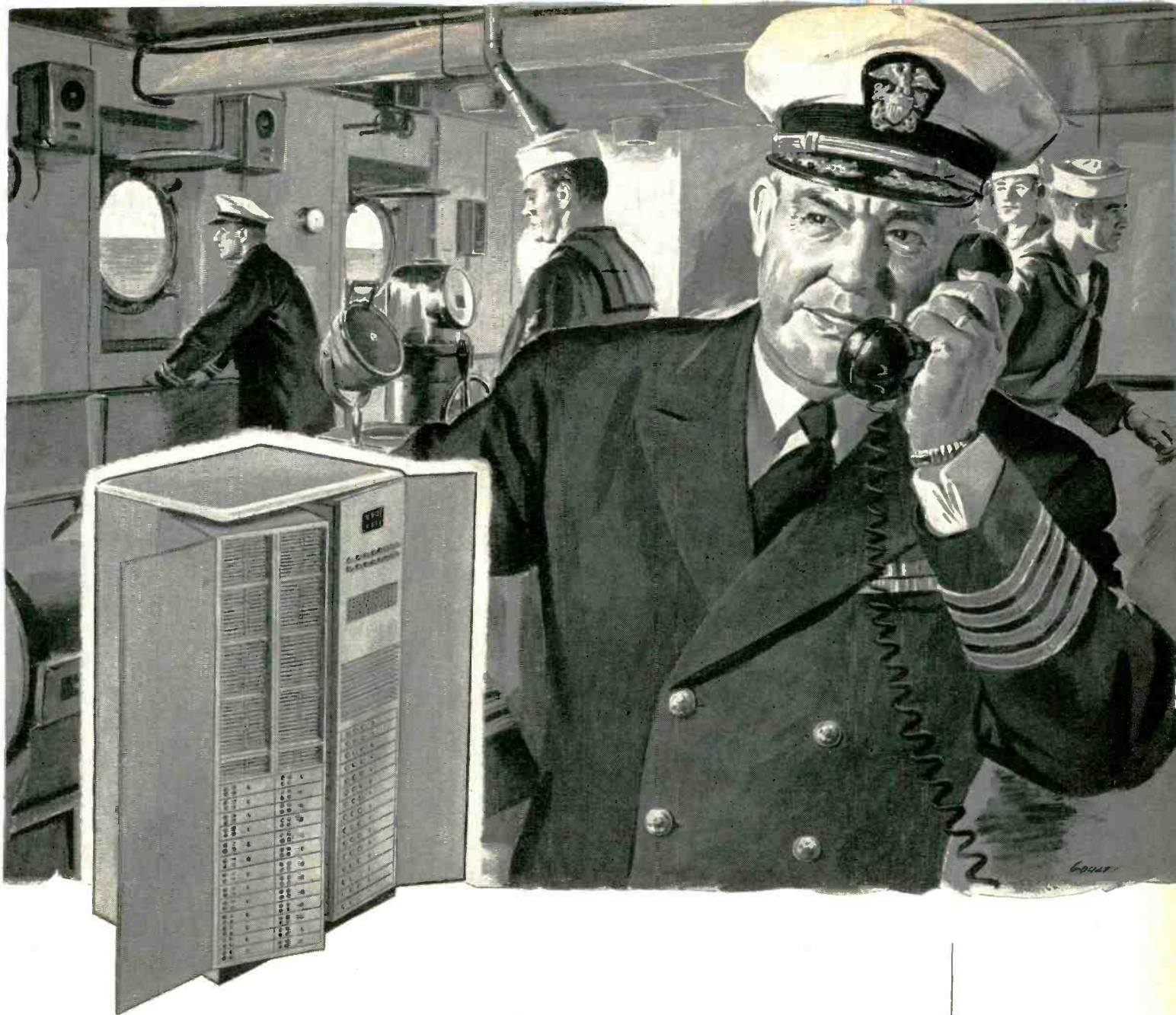
**VEPCO'S NETWORK**—a modern powerfully for your new plant—has added 300,000 new kilowatts of generating capacity in 1955... with 300,000 more under construction and ready soon.

**FOR COMPLETE FACTS** about the mild, no-shutdown climate, abundant water supply from two rivers, taxes, zoning and other "keystone" advantages... PLUS confidential help in selecting choice plant site or ready-built plant—write or telephone VEPco, serving THE TOP OF THE SOUTH.

### VIRGINIA ELECTRIC and POWER COMPANY

Clark P. Spellman, Director—Area Development  
Electric Building, Richmond 9, Virginia • Phone: 3-4261





## World premiere — starring Transistors



The Department of the Navy, Bureau of Ships, receives the world's first completely transistorized dial telephone switchboard . . . designed for minimum space, weight and maintenance.

In this compact switchboard cabinet (72" x 30" x 24") all line finding, circuit switching, tone signal generating, and in fact, virtually all functions of conventional dial telephone switching are performed by transistors and diodes.

Capacity of this prototype electronic switchboard is 100 lines, with fifteen connecting links. The officers and men use their telephones just as

if the switching system were the conventional type. And when the ship on which this telephone system is installed docks in port, ship-to-shore trunk connections are added as easily as an extension telephone in your home.

And for those interested in production details, it's noteworthy that this compact, lightweight system is manufactured with plug-in printed circuits—providing shockproof, lifetime accuracy.

We take great pride in being a team partner with the Navy in this outstanding technological development.

# STROMBERG-CARLSON COMPANY

A DIVISION OF GENERAL DYNAMICS CORPORATION

General Offices at ROCHESTER 3, N. Y.



# transistor and digital computer techniques

APPLIED TO THE DESIGN, DEVELOPMENT  
AND APPLICATION OF

*AUTOMATIC RADAR DATA PROCESSING,  
TRANSMISSION AND CORRELATION  
IN LARGE GROUND NETWORKS*

## Engineers & Physicists

*Digital computers similar to successful Hughes airborne fire control computers are being applied by the Ground Systems Department to the information processing and computing functions of large ground radar weapons control systems.*

The application of digital and transistor techniques to the problems of large ground radar networks has created new positions at all levels in the Ground Systems Department. Engineers and physicists with experience in the fields listed, or with exceptional ability, are invited to consider joining us.

### FIELDS INCLUDE

TRANSISTOR CIRCUITS • DIGITAL COMPUTING NETS •  
MAGNETIC DRUM AND CORE MEMORY • LOGICAL DESIGN •  
PROGRAMMING • VERY HIGH POWER MODULATORS AND  
TRANSMITTERS • INPUT AND OUTPUT DEVICES •  
SPECIAL DISPLAYS • MICROWAVE CIRCUITS

*Scientific  
Staff Relations*

**HUGHES**  
RESEARCH  
AND DEVELOPMENT  
LABORATORIES

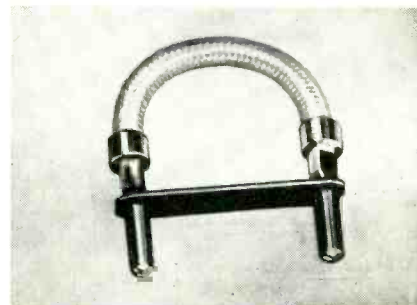
*Culver City, Los Angeles County, California*

NEW PRODUCTS

(continued)

made of nonwarping aluminum, precision-milled to assure absolute alignment with the probe carriage.

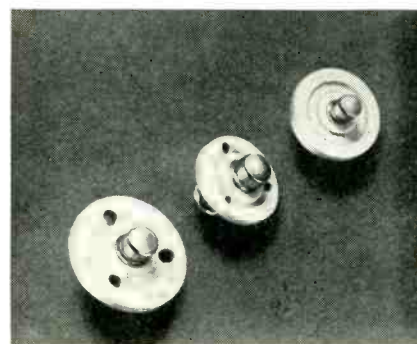
One instrument will handle another frequency band by using a different size waveguide block and probe. Of these, 9 sizes of each are available—all interchangeable in 30 seconds, without loss of accuracy. Thus one carriage and 6 alternate blocks and probes will handle from 12.4 kmc to 90 kmc. Another carriage and 3 alternate blocks and probes will handle from 5.85 to 12.4 kmc.



### FUSE-TYPE RESISTORS plug-in operation

CLAROSTAT MFG. CO., INC., Dover, N. H., has announced the new FZ1-5.6 ohm Fuzohm, a plug-in fuse-type resistor.

They are designed to withstand repeatedly high surge currents without damage, but will fuse when this surge becomes dangerous to expensive components.



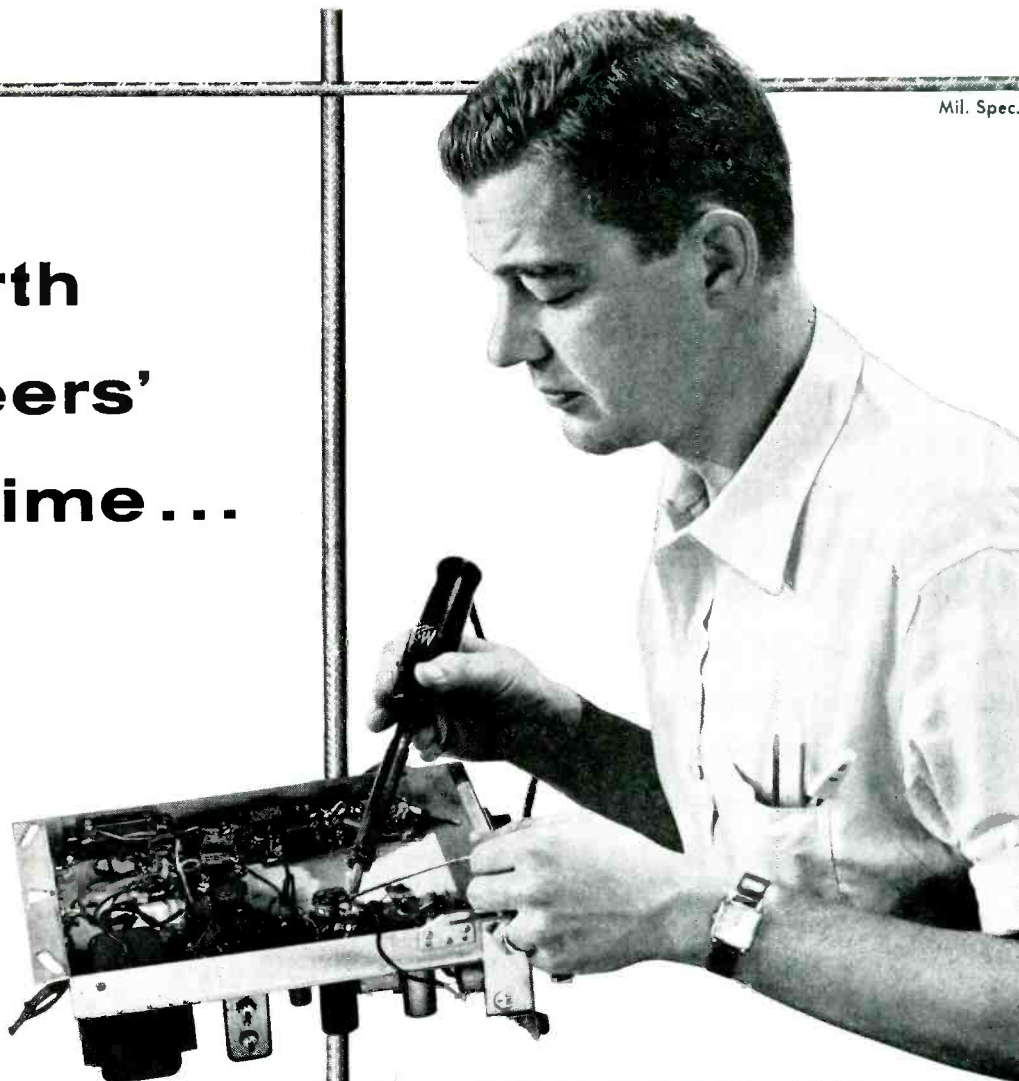
### DISK CATHODE for narrower glass necks

SUPERIOR TUBE CO., 1523 Germantown Ave., Norristown, Pa., has produced a disk cathode which permits manufacturers to use a narrower glass neck in tv tubes, reducing the deflection yoke to ultimately



Mil. Spec.

If it's worth  
engineers'  
time...



Mil. Spec.

...it's worth  
engineered  
electronic wire

**Belden**  
ELECTRONIC  
WIRE

The complete packaged line  
—easy to use. Be sure of  
the right wire engineered  
for the job.

There are 1001 Belden  
wires for every Radio and  
Electronic requirement.

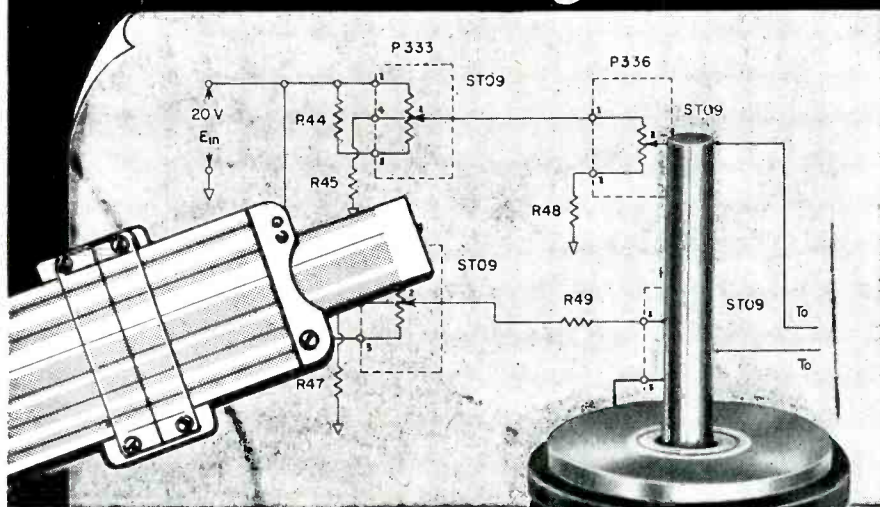
**Belden**

WIREMAKER FOR INDUSTRY  
SINCE 1902  
CHICAGO

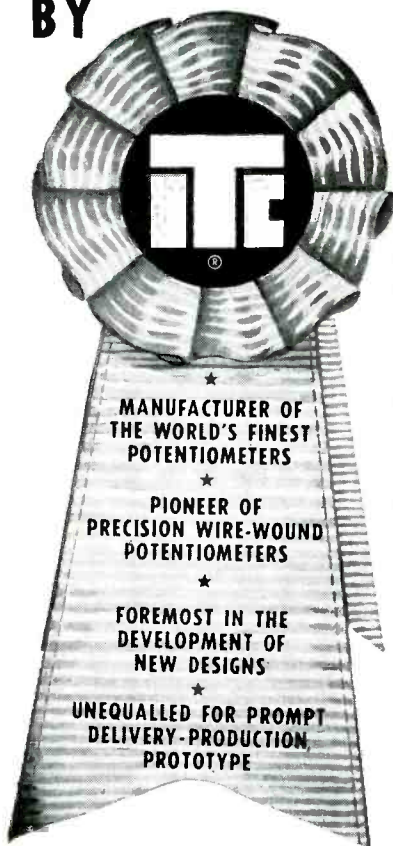
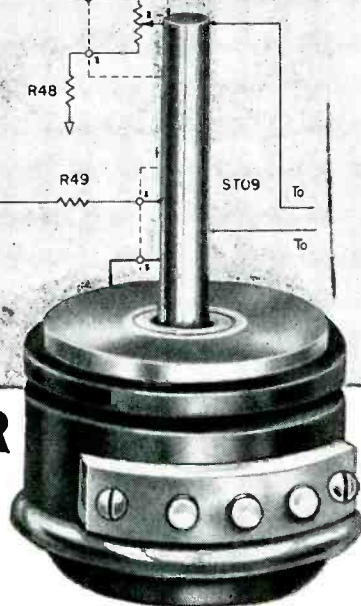
6-8

Magnet Wire • Lead and Fixture Wire • Power Supply Cords, Cord Sets and Portable Cord • Aircraft Wires • Welding Cable  
Electrical Household Replacement Cords • Electronic Wires • Automotive Replacement Wire and Cable

*Where specs are tight...*



## SPECIFY SUPERIOR BALL-BEARING POTENTIOMETERS BY



Designed for those applications where less than the best means failure . . . by the world's first and leading manufacturer of precision single-turn wire-wound potentiometers. Advanced production and quality-control techniques by the pioneer in mass production of precision potentiometers offer unequalled delivery . . . of prototype and production quantities.

All models of the TIC Ball-Bearing Series are designed to the latest industrial dimensions. Servo mounting is AIA standard. Stainless-steel ball-bearing construction is used for low-friction . . . low-torque operation. Other precision mechanical features include precious-metal slider contacts . . . centerless-ground stainless-steel shaft . . . and one-piece stainless-steel clamp ring developed by TIC for simple, precise phasing of individual units of ganged assemblies.

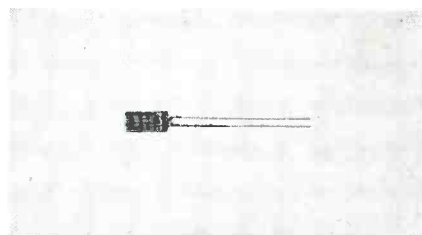
Designed for precision applications in automatic control systems, the subminiature ST09, for example, features standard independent linearity of  $\pm 1\%$  (0.3%, special) of the total resistance, and  $\pm 5\%$  standard total resistance accuracy. High resolution . . . equivalent noise resistance less than 140 ohms . . . wide standard temperature range ( $-55^{\circ}\text{C}$  to  $80^{\circ}\text{C}$ ) increases application versatility. ST09 is available in standard resistances of 100, 200, 500, 1K, 2K, 5K, 10K, and 20K.

*Full specification on the ST09 and other units of the TIC precision ball-bearing series available upon request.*

# TECHNOLOGY INSTRUMENT CORP.

535 Main Street, Acton, Mass., COlonial 3-7711  
 West Coast Mail Address, Box 3941, No. Hollywood, Calif., POplar 5-8620

save in production costs of the tv sets. The diameter of the ceramic disk in the new unit (illustrated in the center) is 0.365-in.,  $\pm 0.005$ -in. in contrast to the standard 0.490, with the same tolerance. The outer diameter of the tube attached to the disk is 0.121-in.,  $\pm 0.001$ -in., in the new unit and in the standard. Complete information is available by writing the company.

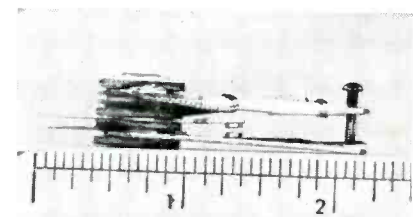


## CRYSTAL PHOTOCELL with improved fabrication

CLAIREX CORP., 50 W. 26th St., New York 10, N. Y. Type CL-2 is a cadmium sulphide photoconductive cell with superior performance characteristics over the CL-1.

► **Improved Fabrication Techniques** — Metallic electrodes are soldered directly onto the crystal. A special ceramic piece having the same temperature coefficient of expansion as the crystal itself is employed as a base for mounting the crystal. No plastic is permitted to come in contact with the crystal.

These techniques result in superior performance characteristics with regard to voltage linearity, noise and stability. Characteristics and charts are available from the company.



## THERMAL RELAY handles 30 amperes

PRECISION MAGNETIC DEVICES, INC., P.O. Box 312, Hackettstown, N. J. The TR-30 relay is designed for heavy duty. Its life is long and



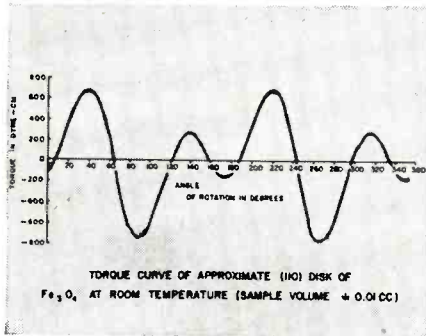
# putting **IDEAS** to work—research at **IBM**

- **Merry-go-round:** Automatic magnetic torque balance, accurate to 0.0006 inch-ounce, used to measure magnetic anisotropy of memory core materials. IBM Bulletin No. 100.
- **Trigger Happy Transistor:** Used in place of a thyratron, new transistor permits high-speed switching of large currents by a low-power electrical pulse. IBM Bulletin No. 101.
- **Incubator Hatched:** Tube elements spaced 1/5000 of an inch apart; assembled in the Very Clean Room.

For bulletins, write to Dept. SA6, IBM, 590 Madison Ave., N.Y. 22, N.Y.

## Merry-go-round

Adding "memory" to machines is no longer a scientist's fancy. It is a fact. Actually, this ability to "remember" is the ability to "recall" information previously entered into the machine. One of the latest and best ways of storing information utilizes the now familiar small, rugged, reliable magnetic cores. Each letter or numeral is stored in a kind of a "Morse code," where a dash is represented by one direction of magnetization and a dot by the other. But, to employ cores more effectively, the IBM Research people are studying a number of very basic things having to do with ferrites. One of these is magnetic anisotropy—which involves the continual measurement of the minute torque exerted in a magnetic crystal by a rotating external magnetic field.



To increase the speed and accuracy of measurement of this property, Ralph Penoyer, of our Ferrite Materials Research Group, has developed an automatic magnetic torque balance that is accurate to 0.0006 inch-ounce, and allows the direction of the magnetic field to change through a 360° arc in one minute. Obtaining and plotting such data was, by standard methods, a laborious, time-consuming process.

Laboratories at Endicott, Poughkeepsie and Kingston, N.Y., and San Jose, Calif.

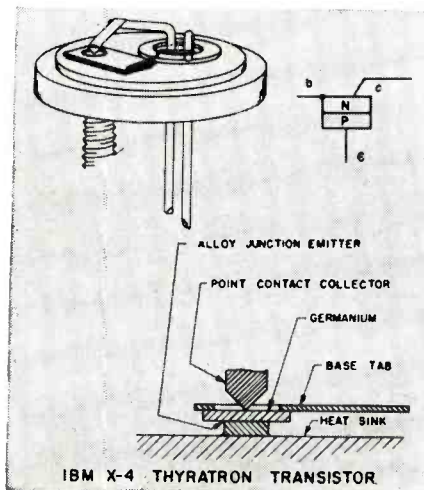
DATA PROCESSING • ELECTRIC TYPEWRITERS • TIME EQUIPMENT • MILITARY PRODUCTS

Full details describing the device, circuit diagrams, method of operation, calibration and accuracy are available in IBM Bulletin No. 100. Write for your copy.

## Trigger Happy Transistor

Everybody is talking about transistors. But, certain problems are not readily solvable by the use of conventional transistors. A typical problem is that of picking up a relay with a transistor controlled by microsecond pulses. So Richard Rutz, of our Semi-Conductor Devices Research Group, took a long look at transistor possibilities in this case. The result: The IBM X-4 Transistor. This new type permits high-speed switching of large currents by low-power electrical pulses. It operates with a turn-on time of two ten-millionths of a second and a turn-off time of one-millionth of a second; experimental models have been made to switch currents as high as 15 amperes.

You can find full scientific data on the X-4, its construction, electrical characteristics, and circuit applications in IBM Bulletin No. 101.



## Incubator Hatched

Dirt, dust and moisture are death to delicate electrical devices. In our experimental component assembly room—which we call the Very Clean Room—at our Poughkeepsie Research Laboratory, we've eliminated the scourges. How do we keep the Very Clean Room clean?

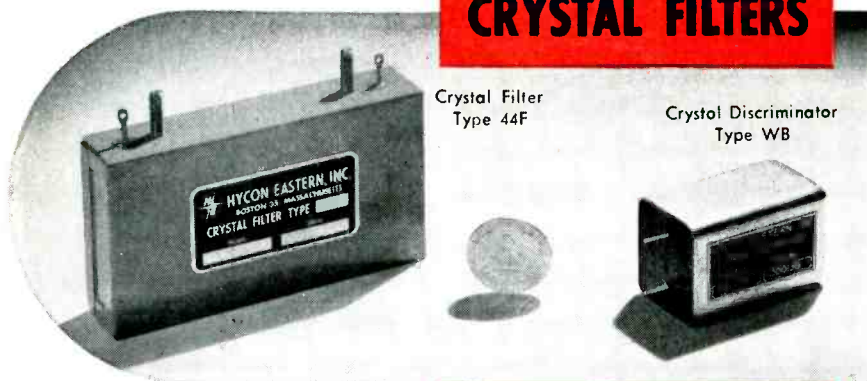


Clean, temperature- and humidity-controlled air is blown into the room, keeping the pressure inside greater than outside. Therefore, when one enters from the outside no dirt enters with him. As a further precaution, he must wear a lintless nylon lab coat over his clothing. Dry, clean, compressed nitrogen replaces compressed air to blow off particles of dirt that may accumulate on an assembly. Since a great deal of work in this room is done under microscopes, with wire as small as one-sixth the diameter of the average human hair, controlled atmospheric conditions are vital.

To learn more about career opportunities available at IBM, write, describing your background, to: W. M. Hoyt, IBM, Room 306, 590 Madison Avenue, New York 22, N. Y.

**IBM**

INTERNATIONAL  
BUSINESS MACHINES  
CORPORATION



## CRYSTAL FILTERS

Crystal Filter  
Type 44FCrystal Discriminator  
Type WB

## for FM Reception by HYCON EASTERN

Through the use of Piezoelectric resonators, filters are now available with extremely high selectivity at frequencies which eliminate the need for multiple conversions in VHF and UHF f-m receivers. The low insertion loss, linear transfer characteristic and non-microphonic quality of these filters permit their location at any point of low signal level such as between the mixer and the i-f amplifier. Using the Hycon Eastern Crystal Discriminator, Type WB, in combination with Crystal Filter Type 44F completely eliminates the need for any lower intermediate frequency. These filters can be produced on short notice in large or small quantities to meet exact performance requirements.

Write for Crystal Filter Bulletin

- SMALL SIZE
- HIGH SELECTIVITY
- LOW INSERTION LOSS
- OPERATING TEMPERATURE:  $-55^{\circ}\text{C. TO } +85^{\circ}\text{C.}$
- EXTREME STABILITY WITH VARIATIONS IN TEMPERATURE.  
FREQUENCY SHIFT LESS THAN  $\pm 0.005\%$  TOTAL FROM  $-55^{\circ}\text{C. TO } +85^{\circ}\text{C.}$
- NON-MICROPHONIC
- UNAFFECTED BY IMPEDANCE VARIATIONS COMMONLY ENCOUNTERED IN TRANSISTOR CIRCUITS
- WORKS DIRECTLY TUBE-TO-TUBE OR TRANSISTOR-TO-TRANSISTOR WITH NO PADDING
- HERMETICALLY SEALED, NO ALIGNMENT OR READJUSTMENT NECESSARY
- VIBRATION AND SHOCK PER MIL-E-5422

### ELECTRICAL SPECIFICATIONS

Center Frequency 13 Mc (Available 10-20 Mc)  
Bandwidth at 6 db Attenuation: 30 Kc (Available with 20-50 Kc Bandwidth)

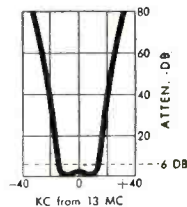
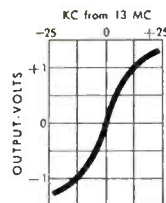
Shape Factor:  $\frac{60 \text{ db Bandwidth}}{6 \text{ db Bandwidth}} = \frac{1.7}{1}$  Maximum

Power Insertion Loss: 6db Maximum

Passband Response Variation:  $\pm 1$  db Maximum

Ultimate Attenuation: 80 db Minimum

Center Frequency Shift:  $\pm 1$  Kc



We invite your inquiry for any Crystal Filter application in the 10 KC to 20 MC Range



**HYCON EASTERN, INC.**  
**COMMUNICATION FILTER DIVISION**

1360 Soldiers Field Road Dept. A-6, Boston 35, Massachusetts  
Affiliated with HYCON MFG. COMPANY, Pasadena, California

power applications such as the output stage of a portable radio receiver.

► Uses—Typical applications are class A amplifiers, driver for PP class B stage, microphone or phono preamplifier, and l-f flip-flop circuit.

Additional data may be obtained by requesting engineering data sheet E-264.

## Literature

**Power Rectifiers.** McColpin-Christie Corp., 3410 W. 67th St., Los Angeles 43, Calif. Bulletin AC-56-A is an 8-page folder illustrating and describing a line of Stavolt automatically regulated power rectifiers. Applications, performance curves and specifications are included.

**TWT Amplifiers.** Hewlett-Packard Co., 3576A Page Mill Road, Palo Alto, Calif. A 4-page folder illustrates and describes 4 traveling-wave-tube amplifiers operating from 2 kmc to 12.4 kmc. Complete specifications on types 490B, 491A, 492A, and 494A are included.

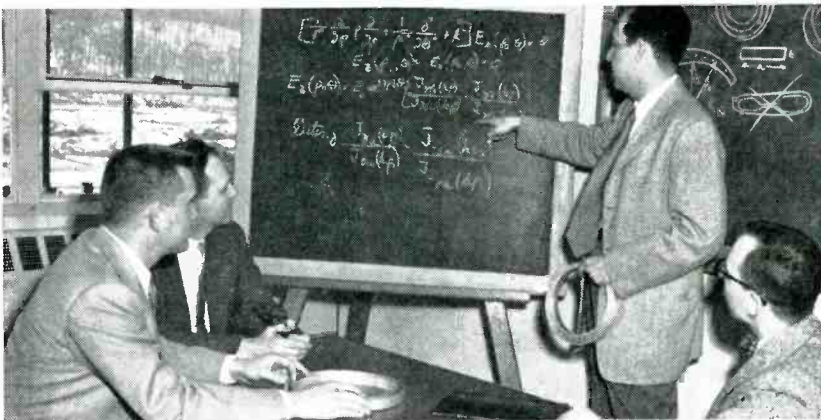
**Induction Heaters.** General Electric Co., Schenectady 5, N. Y. GEA-6388 is an 8-page folder giving specifications, dimensions, operating information, design features and ratings of the company's new line of electronic induction heaters.

**Transistorized Supplies.** Electronic Research Associates, Inc., 67 E. Centre St., Nutley 10, N. J., announces two separate two-color catalogs covering their new line of transistorized regulated d-c power supplies. The bulletins describe new all-transistor designs which feature small size, light weight, high conversion efficiency, low heat dissipation, instant warmup time, continuously variable zero to maximum, nonmicrophonics, and are intended to replace vacuum-tube equivalents wherever used.

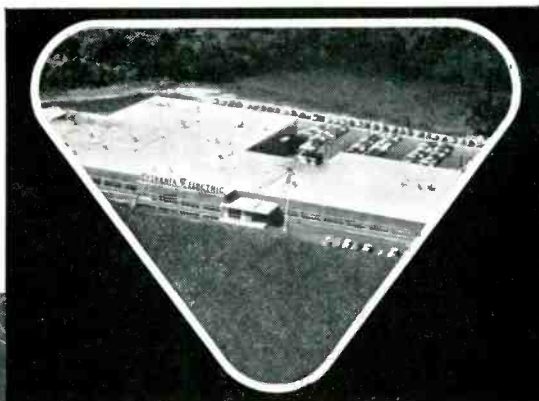
The catalog sheets cover industrial and laboratory types providing regulated voltage output 0 to 50,



**The right people  
with the right facilities  
produce the right solutions**



Sylvania Avionics Laboratory Manager and Department Managers discuss a problem in delay circuiting employing coiled wave guide. Left to right: John Jewett, Laboratory Manager Richard Osgood, Dr. Carl Fallick, and Fred Anderson.



New Sylvania Waltham Laboratories, devoted to advanced projects related to guided missiles and aviation electronics. The air-conditioned building has 120,000 square feet of floor space.

Environmental testing of unique equipment—a radome designed as an integral part of a high-performance airplane wing. Left to right: Dr. Frank Rosato, Frank Lambert, John Ricketts and Joseph Shagoury of the Waltham Laboratories.



## **Radome for airplane wing edge ... a challenging problem in Avionics**

ENGINEERING a radome for the edge of an airplane's wing demands skill and experience in both aerodynamics and electronics. Sylvania's Avionics Laboratory provided these qualities to meet this unique problem in developing an advanced electronic system for a high-performance military aircraft.

Highly advanced electronics projects of many kinds for many environments ... land and sea, as well as air ... are constantly being carried out by engineers of the Avionics Laboratory. They have made notable achievements in computers, radar, warning devices, detection de-

vices, jamming equipment, countermeasures, and counter-countermeasures.

In addition to the Avionics Laboratory, Sylvania's Waltham, Mass., facilities include the Missile Systems Laboratory and the Applied Research Laboratory. Each of the three is engaged in pushing back scientific frontiers in electronics—each is a vital part of Sylvania's Electronic Systems Division.

In all of Sylvania's Electronic Systems Division installations, the *right* people work with the *right* facilities, within a sound managerial environment. That is why they have produced *right* solutions

to a variety of problems, and have made many important contributions in the fields of aviation electronics, guided missiles, countermeasures, communications, radar, computers, and control systems. Whether the problem is military or industrial, Sylvania's business is to come up with solutions that are *producible*.

The Electronic Systems Division has plant and laboratory facilities at Buffalo, N. Y., and Mountain View, Calif., in addition to its Waltham activities. All are staffed with top-ranking scientists and engineers, backed with Sylvania's extensive resources in the electronics field.

### **SYLVANIA IS LOOKING FOR ENTERPRISING ENGINEERS**

*Sylvania has many opportunities in a wide range of defense projects. If you are not now engaged in defense work, you are invited to contact Edward W. Doty, Manager of Personnel, Electronic Systems Division, Sylvania Electric Products Inc., 100 First Avenue, Waltham 54, Mass.*



# **SYLVANIA**

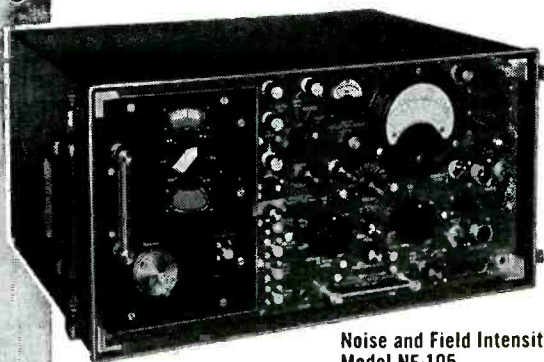


**SYLVANIA ELECTRIC PRODUCTS INC.**

**LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY**

# MEASURE NOISE AND FIELD INTENSITY FROM 150 KC TO 1000 MC— WITH ONE METER!

Quickly • Accurately • Reliably



Noise and Field Intensity Meter  
Model NF-105  
(Commercial Equivalent of AN/URM-7)



T4/NF-105:  
150 KC-20MC



T1/NF-105:  
20-200MC



T2/NF-105:  
200-400MC



T3/NF-105:  
400-1000MC

Empire Devices Noise and Field Intensity Meter Model NF-105 permits measurements of RF interference and field intensity over the entire frequency range from 150 kilocycles to 1000 megacycles. It is merely necessary to select one of four individual plug-in tuning units, depending on the frequency range desired. Tuning units are readily interchangeable... can be used with all Empire Devices Noise and Field Intensity Meters Model NF-105 now in the field.

Each of the four separate tuning units employs at least one RF amplifier stage with tuned input. Calibration for noise measurements is easily accomplished by means of the built-in impulse noise calibrator. With this instrument costly repetition of components common to all frequency ranges is eliminated because only the tuners need be changed. The same components... indicating circuits, calibrators, RF attenuators, detectors and audio amplifier, and power supplies... are used at all times.

Noise and Field Intensity Meter Model NF-105 is accurate and versatile, it may be used for measuring field intensity, RF interference, or as an ultra-sensitive VTVM. A complete line of accessories is available.

NEW YORK—Dlgy 9-1240 • SYRACUSE—SYracuse 2-6253 • PHILA-  
DELPHIA—SHerwood 7-9080 • BOSTON—TWInbrook 4-1955 • WASH-  
INGTON, D. C. — DEcatur 2-8000 • ATLANTA — EXchange 7801 •  
DETROIT — BRoadway 3-2900 • CLEVELAND — EVergreen 2-4114 •  
DAYTON — FUIton 8794 • CHICAGO — ESTebrook 9-2700 • DENVER—  
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0 to 150, 0 to 300 volts at maximum currents of 200 ma. Also described are miniaturized fixed voltage regulated types in incremental voltage steps from 5 to 300 v with maximum current ratings of 200 ma.

Also available is a 5-page technical bulletin which provides technical and operational data on these transistorized supplies.

**Broadband D-C Amplifier.** Kay Lab, 5725 Kearney Villa Road, San Diego 12, Calif. A recent catalog sheet illustrates and describes model 110, a chopper stabilized broadband d-c amplifier. Applications of the unit discussed include: strain gage amplifier, transducer amplifier, scope preamplifier, recorder driver amplifier, and general purpose laboratory amplifier. Specifications are included.

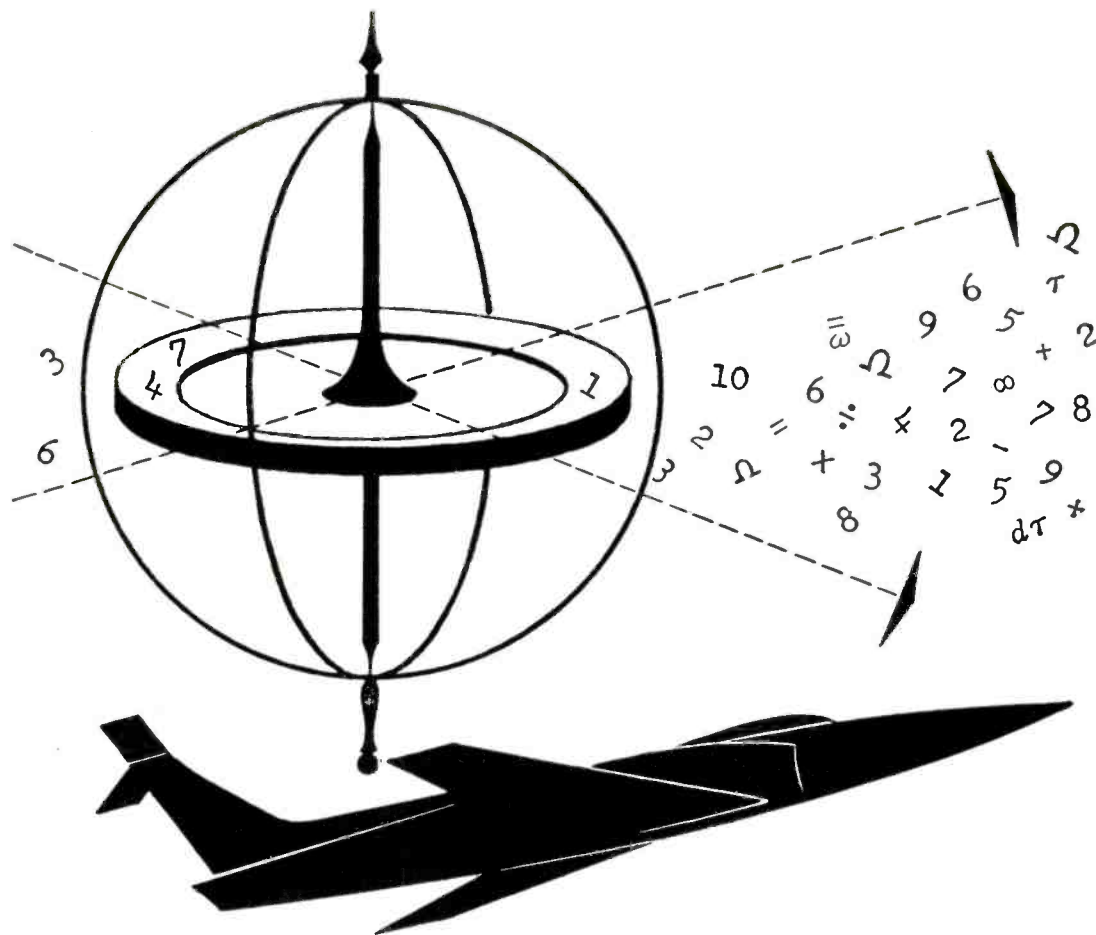
Price of the unit described is \$550.

**Klystron.** Varian Associates, Palo Alto, Calif., has issued a flyer on the VA-97 klystron, a tough, reliable local oscillator tube with performance and design features well fitted for the frequency range of 34 to 35.6 kmc, ideal as the microwave power source for airborne radar and similar applications. Specifications are included.

**Facilities Brochure.** The Reflectone Corp., Myano Lane, Stamford, Conn., has released a new illustrated facilities brochure describing the scope of its operations. It shows a cross section of the company's products ranging from procedure trainers and simulators to precision integrators for use in computers and other data processing systems. Also included is information on the design and fabrication of analog computing systems, ultrasonic diagnosing devices, telemetering systems, x-ray photographic apparatus and other similar devices.

**Audio Components.** Mid-West Coil and Transformer Co., 1642 North Halsted St., Chicago 14, Ill., has published a data sheet giving an illustrated description, specifications, schematic diagram and characteristics curves for its minia-





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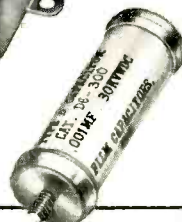
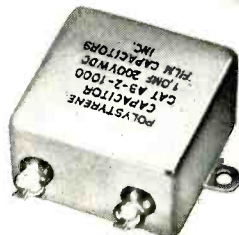
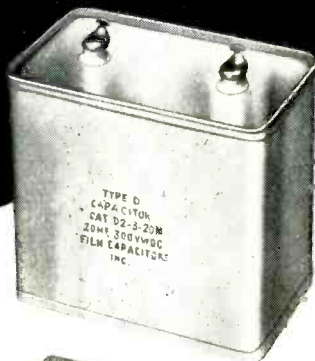
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	POLYSTYRENE	TEFLON
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Voltage Range, DC.....	100 to 30,000	100 to 30,000
Capacitance Range.....	.001 to 20 mf	.001 to 20 mf
Power Factor.....	.02% @ 1 kc	.02% @ 1 kc
Dielectric Absorption.....	.01%	.01%
Voltage Derating at 85°C.....	none	none
Voltage Derating at 125°C.....	not operable	none
Voltage Derating at 150°C.....	not operable	none
Voltage Derating at 200°C.....	not operable	33%
Temperature Coefficient.....	-100 ppm/°C.	-50 ppm/°C.
I.R. at Room Temperature.....	10 <sup>7</sup> megohms/mf	10 <sup>7</sup> megohms/mf
Capacitance Stability.....	0.1%	0.1%

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turized transistor audio amplifier. The reverse side of the sheet covers a line of high-fidelity output transformers.

**Transistorized Mixer - Amplifier.** Baird Associates, Inc., 33 University Road, Cambridge 38, Mass. Technical bulletin TP101 is a two-color data sheet that discusses the outstanding features of a truly portable mixer-amplifier. The device described which has a frequency response within 3 db from 100 to 10,000 cps, is especially recommended for such field applications as remote-pickup recordings and interviews as well as in conjunction with outside p-a systems.

The data sheet is well illustrated with complete electrical and mechanical specifications given. Information on other exclusive features is included, as is a frequency response curve.

**Unit Instruments.** General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. Form 857-A is a new folder illustrating and describing a comprehensive set of building block basic tools for the electronics laboratory. The instruments described provide miniaturized packaging for maximum convenience and minimum use of bench space. Among those discussed are unit oscillators (20 to 2,000 mc), special purpose generators, and unit amplifiers and detectors. Prices and ordering information are included.

**Frequency Meter.** Varo Mfg. Co., Inc., 2201 Walnut St., Garland, Texas. A recent flyer illustrates and describes model 6501 precision frequency meter which features versatility and accuracy. Chief features and specifications are listed.

**Special Purpose Alloy.** Driver-Harris Co., Harrison, N. J. A recent pamphlet is devoted to alloy No. 531, whose specific resistance is 1,000 ohms per cmf, and temperature coefficient of resistance is ±0.00002 ohms per ohm per deg C. Included are physical and electrical properties, a data table and a resistance-temperature chart.

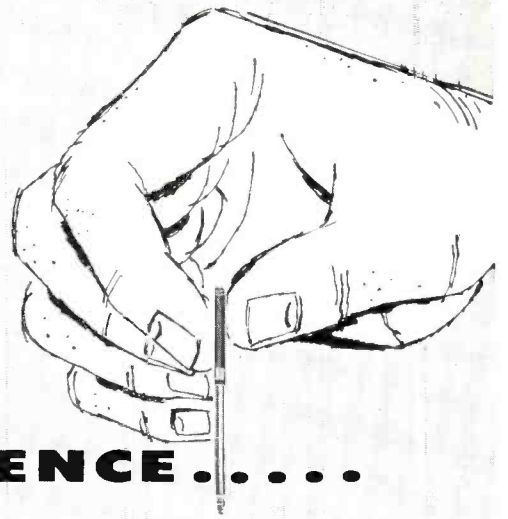
**Electro-Optical Instruments.** Barnes Engineering Co., 30 Com-



# MORE

## CHANNELS.....

## OPERATING CONVENIENCE.....

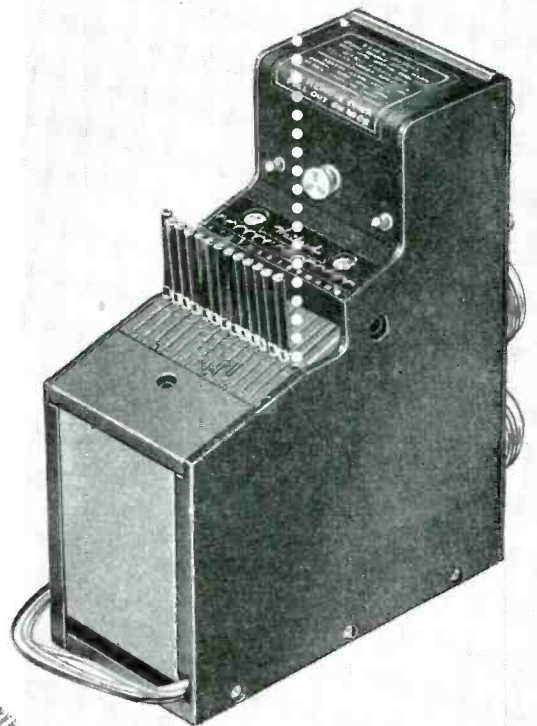
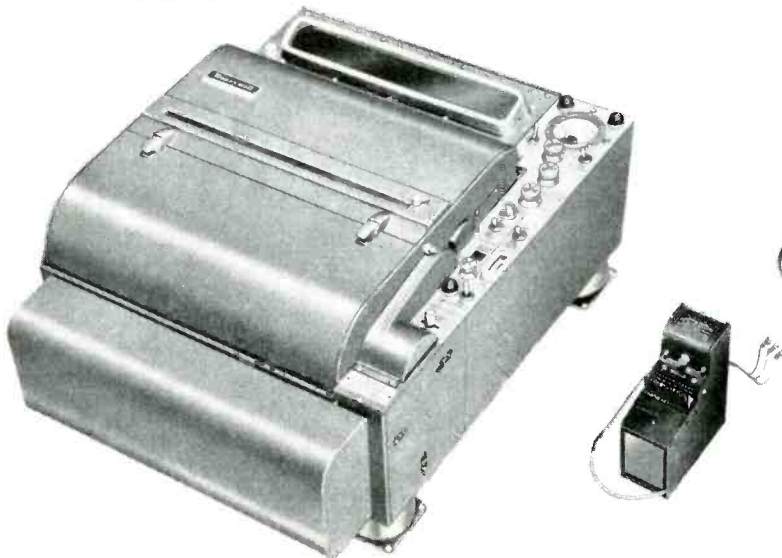


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Model LP-1 showing edge-lit reticule and camera mount bezel

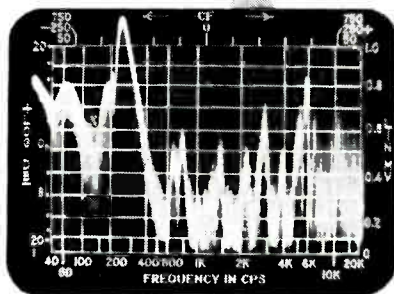
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merce Road, Stamford, Conn. A new 8-page catalog covers several electro-optical instruments for process control. Described in the catalog are: (1) OptiTherm infrared radiometers, instruments used in remote temperature measurement, particularly in the low-level ambient to 600 C range; (2) OptiTherm infrared detectors, high speed thermistor bolometers for detection of infrared radiation; (3) the industrial process refractometer, for controlling the purity of process streams by continuous measurement of refractive index; (4) infrared sources and detector preamplifiers, used as building block components in infrared systems.

**Audio Oscillators.** The Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif. Volume 7, No. 6 of the *Journal* covers three new audio oscillators—types 201C, 200J and 202C. Included are illustrations, circuit diagrams, specifications and prices.

**Power Supplies.** Kepco Laboratories, 131-38 Sanford Ave., Flushing 55, N. Y., recently published a condensed brochure No. B356. It contains the condensed specifications on all the models in the company's standard line of voltage-regulated power supplies. It includes data on several new units.

**Telemetry Receivers.** Nems-Clarke, Inc., 919 Jesup-Blair Drive Silver Spring, Md. Four types of telemetry receivers in the frequency range of 55 to 260 mc are described in a bulletin recently made available. Information covers electrical and mechanical specifications, as well as uses in the f-m/f-m telemetry system.

**Computing and Simulation Service.** J. B. Rea Co., Inc., 1723 Cloverfield Blvd., Santa Monica, Calif. A new 7-page brochure explains the complete services offered for simulation, computing, data reduction and data processing.

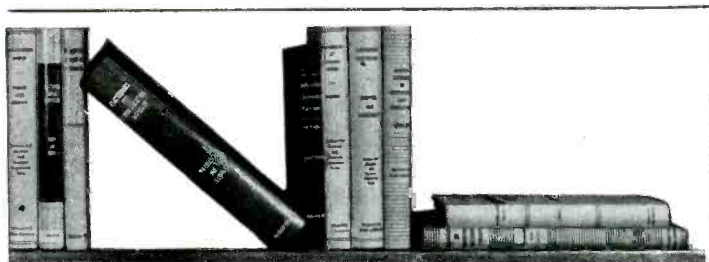
The written explanations are further clarified by descriptive diagrams showing the flow of data. From the problem analysis and preparation service, the data are



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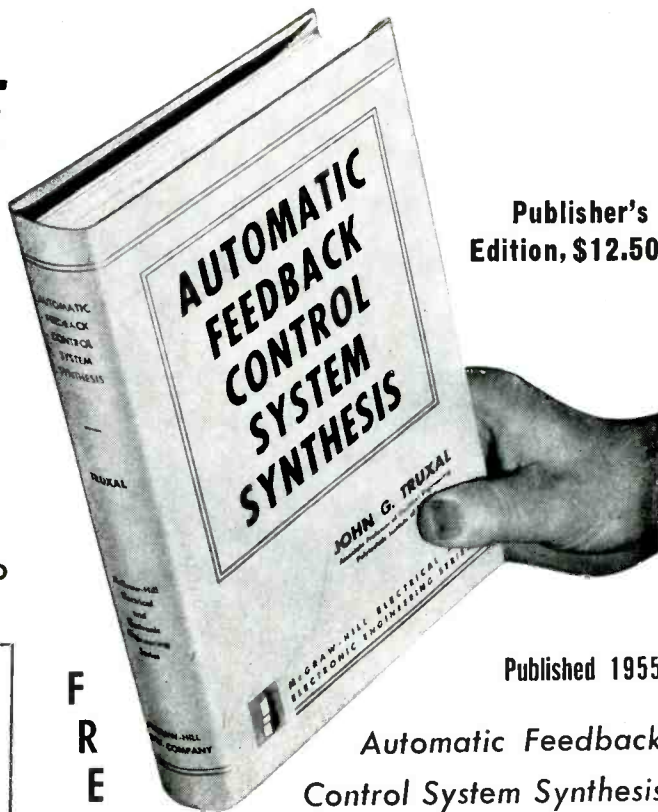
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TYPE	μm F/ft	IMPED.Ω	O.D.
C 1	7.3	150	.36
C 11	6.3	173	.36
C 2	6.3	171	.44
C 22	5.5	184	.44
C 3	5.4	197	.64
C 33	4.8	220	.64
C 4	4.6	229	1.03
C 44	4.1	252	1.03

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**Electronic Panel Meters.** Trio Laboratories, Inc., 4025 Merrick Road, Seaford, L. I., N. Y. Catalog VM-106 describes the company's line of miniature, panel-mounting vtvm's that are small enough to be built into operating or test equipment.

Both a-c and d-c models are described for commercial or military applications as is a new, low-level d-c vtvm designed to meet military specifications.

**Magnetic Core Memory System.** Daystrom Instrument, Archbald, Pa. A single-page bulletin illustrates and describes the company's instrument core storage system, a magnetic core memory system that is simply expandable in word capacity and word length. Dimensions of the system discussed are 4½ in. by 4½ in. by 13½ in. Applications and specifications are given.

**Vacuum Components.** Jennings Radio Mfg. Corp., 970 McLaughlin Ave., P. O. Box 1278, San Jose 8, Calif. An 8-page, loose-leaf perforated folder contains illustrations, specifications and applications of the company's line of variable capacitors, fixed capacitors, relays and switches.

**I-F Amplifiers.** LEL Inc., 380 Oak St., Copiague, L. I., N. Y. A 4-page folder deals with a line of i-f amplifiers for radar and guided missiles. Description, illustrations and specifications for seven models are included.

**Capacitance Bridge.** Boonton Electronics Corp., 738 Speedwell Ave., Morris Plains, N. J. Model 74C, a 3-terminal capacitance bridge that measures direct or grounded capacitance from 0.001 μmf to 11,000 μmf, is covered in a single-page bulletin. Applications and specifications are listed. Price of the unit described is \$850.

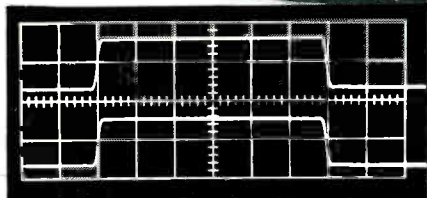
**X-Band Mixer Diode.** Philco Corp., 4700 Wissahickon Ave., Philadel-



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Response of both channels to the same signal. A 0.6- $\mu$ sec pulse is displayed on alternate 0.1- $\mu$ sec/cm sweeps of the Type 545 Oscilloscope with the Type 53/54C Plug-In Unit.

### Type 53/54C Plug-In Unit Characteristics

#### VERTICAL RESPONSE

With Type 541 and Type 545 Oscilloscopes  
 Passband—dc to 24 mc  
 (3 db  $\pm$  1/2 db down at 24 mc)  
 Risetime—0.015  $\mu$ sec

With Type 531 and Type 535 Oscilloscopes  
 Passband—dc to 10 mc  
 Risetime—0.035  $\mu$ sec

#### CALIBRATED SENSITIVITY

Nine steps from 0.05 v/cm to 20 v/cm,  
 accurate within 3% of the panel reading.

#### INPUT CAPACITANCE

20  $\mu$ mf direct, 8  $\mu$ mf with 10x probe (P410)—  
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#### ELECTRONIC SWITCHING

Triggered—for alternate sweep presentations.  
 Free-running at about 100 kc—for single-shot  
 presentations of two simultaneous transients.

Price—\$275

f.o.b. Portland (Beaverton) Oregon

The Type 53/54C Plug-In Unit, with the Type 541 or Type 545 Oscilloscope, handles dual-trace applications over a wide frequency range. Either combination provides two identical amplifier channels with a dc-to-24 mc frequency response, 15-millimicrosecond risetime. Electronic switching can be triggered, displaying two signals on alternate sweeps...or free-running, switching at a rate of about 100 kc. Separate controls for each channel provide for vertical positioning, polarity inversion, sensitivity selection, and selection of ac or dc-coupling. Either channel can be used separately for single-trace applications.

The Type 53/54C is completely interchangeable among Tektronix Type 540-Series and Type 530-Series Oscilloscopes. When used with the Type 531 or Type 535 Oscilloscope it provides better overall passband and risetime characteristics (dc to 10 mc, 0.035  $\mu$ sec) than its predecessor, the Type 53C.

For more information on Tektronix Oscilloscopes with plug-in preamplifiers, please call your Tektronix Field Engineer or Representative, or write to:

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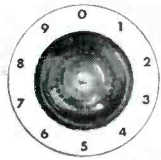
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For Control of: • Sorting Equipment

• Counting and Packaging • Automatic Feeds

Model 7240A counts and indicates the number of input events up to a number (1 to 9,999) preset by four decade switches, at which time a relay operates and the count is held. Automatic recycling or manual reset to repeat the counting operation is provided. Provision is made for use of the equipment as a time interval generator by preset counting of the line voltage frequency.

Capacity: 1 to 9,999 events.

## MODEL 7340A FREQUENCY INDICATOR AND COUNTER

Measures Frequency

Measures Speed or Repetition Rate

Counts Events Per Unit Time

Available with Print-out

Model 7340A counts the number of input events during the duration of a 1 or 10 second gate established by a precision synchronous motor. Indication is directly in events per second, with automatic decimal point location. Automatic recycling is provided, or the measurement may be held and indicated until a manual reset is operated.

Indication: .1 to 9,999 events per second.

Gate Times: 1 sec., 10 sec. or manual.

Accuracy: 0.1%  $\pm$  1 count, based on line frequency.

## MODEL 7440A TIME INTERVAL METER

Measurement of:

• Time Intervals • Periods • Velocity

Available with Print-out

Model 7440A utilizes electrical impulses defining the interval to be measured to start and stop a gate, then counts the number of cycles of an internally generated crystal controlled frequency occurring during this gate. Indication is directly in milliseconds, with automatic decimal point location. Automatic recycling is provided, or the measurement may be held and indicated until a manual reset is operated.

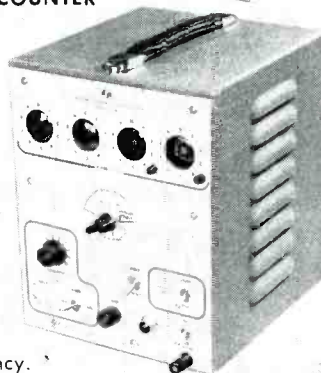
Indication: .1 to 9,999 milliseconds.

Time Bases: 1 KC, 10 KC, or external.

Accuracy: crystal stability  $\pm$  1 count.

Representatives in Major Cities

Write for Complete Data: { 7240A/E  
Our Bulletins { 7340A/E  
7440A/E



phia 44, Pa. Form PC6361-A discusses the 1N263 hermetically sealed point contact X-band mixer germanium diode. Features, applications, specifications and a dimensional drawing are included.

**Digital Delay Generator.** Kaiser Metal Products, Inc., Bristol, Pa. Form 1154 is a single-sheet 2-color bulletin announcing the model 743 precision digital delay generator. The instrument described was developed for accurately generating and measuring time intervals; for use as a radar simulator; a secondary frequency standard (covering 20 cps to 1 mc in 3,000 discrete steps); an elapsed time indicator; and in many other similar functions. The bulletin lists the price as \$2,500.

**H-V D-C Power Supplies.** Beta Electric Corp., 333 E. 103rd St., New York 29, N. Y. Catalog No. 10a deals with the series 1000 rack-mounted h-v d-c power supplies. General description, standard and special features, major specifications and ordering information are included.

**Microwave Receiver.** Polarad Electronics Corp., 43-20 34th St., Long Island City 1, N. Y. Model R receiver, described in a recent 4-page catalog folder, is a portable self-contained and fully integrated unit for the detection and quantitative measurement of microwave signals in the frequency range of 950 to 11,260 mc. Features, description, applications and specifications are given.

**Connectors.** Winchester Electronics Inc., Norwalk, Conn. Illustrations and specifications of a comprehensive line of precision electrical connectors, terminals and accessory parts are shown in a recent 6 page folder.

**Resistors.** True-Ohm Products, division of Model Engineering and Mfg. Inc., Huntington, Ind. A recent bulletin announces the Blue X-60 series resistors which are wound on a fibre glass core made to rigid specifications to insure a uniform winding. The ceramic case of the

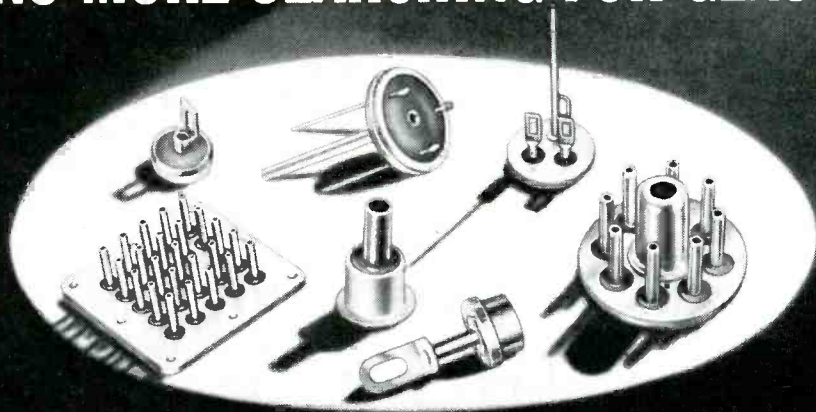
**EP** Electro-Pulse, Inc.

11861 TEALE STREET, CULVER CITY, CALIFORNIA

Telephones: EXmont 8-6764 and TEXas 0-8006



# NO MORE SEARCHING FOR GLASS-SEALING ALLOYS



Photos of parts using glass-sealing alloys, courtesy Electrical Industries, Newark, N.J.

## Superior Tube offers widest selection

EASY-TO-USE SELECTION CHART FOR GLASS-SEALING ALLOYS				
Kind of glass used	Superior Tube alloys to be specified	Condensed Physical Properties		
		Thermal Exp. Coeff.	Density	Temper
Corning Glass Nos. 704, 706, 708, 708AJ	# 42	5.3	0.29	All alloys available in Tempers 1, 2 and 3
Corning Glass Nos. 001, 012, G12	# 52	9.5	0.298	
Corning Glass Nos. 001, 012, 8160	# 4 (Sylvania)	8.5	0.292	
Corning Glass Nos., External 008, 001, 012, 024, 8160	446	10.5	0.273	
Theoretically any glass. Use with feathered edge seal.	OFHC Copper	16.5	0.323	
Corning Glass Nos., Internal 1990, 1991; External, any soft glass	MT-1010	12.5	0.283	

Best place to look first for the glass sealing alloys you need is Superior Tube Company. Wide selection available for virtually all application requirements. Quantities as small as 50 ft. in any size and analysis. Superior Tube Glass Sealing alloys are cold drawn to close tolerances in Seamless or Weldrawn\* form. Sizes from .012 in. to 5/8 in. OD, with walls ranging from .0015 in. to .083 in. maximum. Supplied in random and coiled lengths—8 in. diameter coils up to .075 in. OD, 18 in. diameter coils for larger sizes. 90% of coils are 30 ft. minimum, 10% are 10 ft. minimum. In addition to the standard alloys listed in table, many special alloys are available on special order.

\*T.M. Reg. U.S. Pat. Off. Superior Tube Co.



SUPERIOR TUBE CO.  
2500 GERMANTOWN AVE., NORRISTOWN, PA.  
Please send detailed information on Glass Sealing Alloys.

Name .....

Company .....

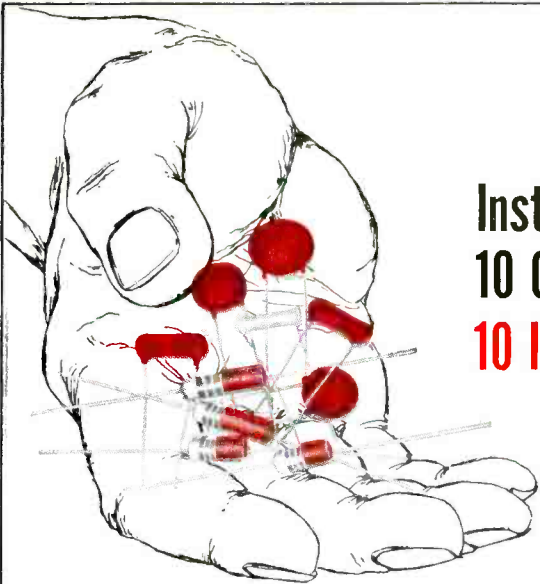
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City ..... Zone ..... State .....

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The big name in small tubing  
NORRISTOWN, PA.

Johnson & Hoffman Mfg. Corp., Mineola, N.Y.—  
an affiliated company making precision metal stampings and deep-drawn parts

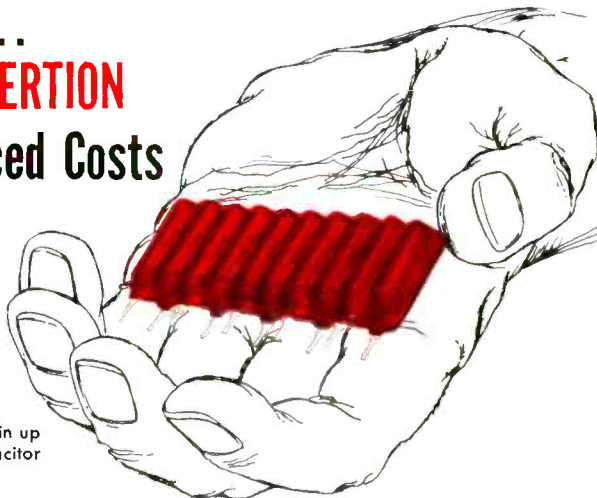


Instead of  
10 Components...  
**10 INSERTIONS**

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**PAC**\*

There are still  
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**BUT...**  
**ONLY 1 INSERTION**  
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\*"PAC" modules can contain up to 90 Resistor and Capacitor elements per unit.

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INFORMATION ON OUR "PAC" EXPERIMENTAL DESIGN KITS

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TRADE MARK  
*electronics*

**ERIE ELECTRONICS DIVISION**

**ERIE RESISTOR CORPORATION**

Main Offices and Factories: ERIE, PA.  
Manufacturing Subsidiaries

HOLLY SPRING, MISSISSIPPI • LONDON, ENGLAND • TRENTON, ONTARIO

resistor described provides excellent insulation qualities and will withstand readily at 1,250 v breakdown test even after being exposed to high humidity conditions for prolonged periods of time.

**Oscillators.** Hewlett-Packard Co., 3552A Page Mill Road, Palo Alto, Calif. Three new oscillators are illustrated and described in a recent 4-page folder. Primary uses, frequency ranges, outputs and prices are listed.

**Wire-Wound Resistors.** Hycor Div. of International Resistance Co., 12970 Bradley Ave., Sylmar, Calif., has available a 4-page bulletin describing the series PH encapsulated precision wire-wound resistors. Complete specifications and descriptions are given for more than 50 types of resistors, ranging from the 0.1-w subminiature with a maximum resistance of 50 K ohms to the 4-w units having 20 megohms resistance.

Resistors described are all capable of accurate performance in environments of high humidity, wide temperature ranges and mechanical shock. Bulletin PH provides full information on units with axial and radial leads, lug types and units designed for use in printed wiring assemblies.

**Precision Bearings.** Industrial Tectonics, Inc., 3684 Jackson Road, Ann Arbor, Mich. Information on antifriction bearings for special applications is now available in catalog AFB-1. Dimensions and load ratings are given for single-row, double-row, deep groove radial, and angular contact bearings.

In addition, general bearing requirements for special designs, high and low temperatures, corrosion resistant and nonmagnetic properties, and electrical conductivity and insulating features are discussed in this 32-page illustrated catalog.

**Alumina Ceramics.** American Lava Corp., Cherokee Blvd. & Mfgs. Road, Chattanooga 5, Tenn. Bulletin No. 562 lists properties of some of the more frequently used AlSiMag alumina ceramics. The ceramics described are designed for performance at high temperatures



and frequencies, and are noted for their great strength and hardness. Electron tube applications are included.

**Electrographic Printing.** Burroughs Corp., Detroit 32, Michigan. Form DCS-2 is a reprint of an article dealing with the electrographic printing technique. In the booklet, a set of criteria for evaluating recording techniques is reviewed. Features, applications and the basic technique of electrographic recording are discussed.

**Electronic Tubes.** Chatham Electronics, Division of Gera Corp., Livingston, N. J. A 4 page folder illustrates and describes a line of electronic tubes for commercial, industrial and military applications. Included are rectifiers, twin power triodes, voltage regulators and reference tubes, thyratrons, hydrogen thyratrons, clipper diodes and special purpose tubes.

**Amplitude Modulator.** Measurements Corp., Boonton, N. J. A 4-page folder deals with the model 115 amplitude modulator, an instrument designed for making measurements on systems requiring up to 100-percent modulation, and on narrow-band receivers where incidental f-m cannot be tolerated. Features, uses and specifications are included.

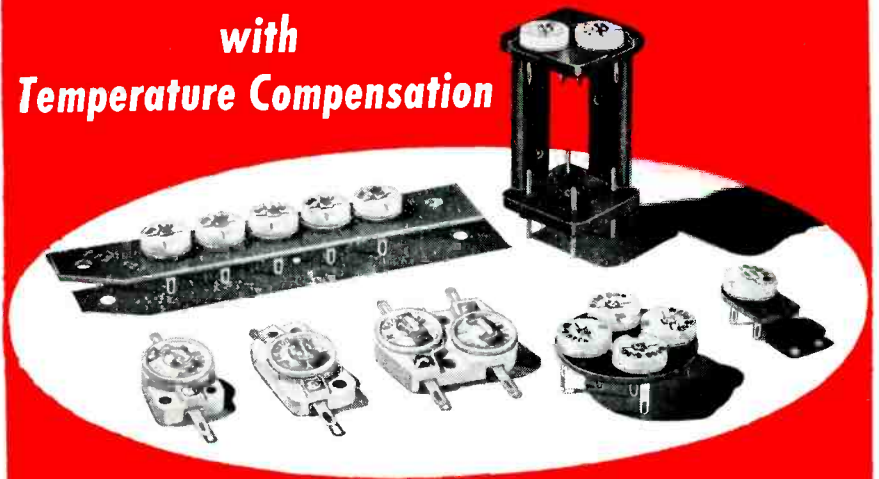
**Power Supplies.** Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif. Bulletin S56 is a 4-page folder illustrating and describing the company's tubeless magnetic amplifier regulated power supplies. Specifications of standard models are given.

**Counting Rate Meter.** Berkeley Division of Beckman Instruments, Inc., 2200 Wright Ave., Richmond 3, Calif., has available a single-sheet bulletin describing the model 2850 counting rate meter. Complete specifications are given. The unit described is priced at \$540.

**Variable Resistor Reference Chart.** Stackpole Carbon Co., St. Marys, Pa., has prepared a handy new file-size chart giving the essential electrical and mechanical charac-

# ACCURATE, DEPENDABLE TRIMMING

with  
**Temperature Compensation**



## ERIE

**CERAMIC TRIMMERS  
CUSTOM CERAMIC  
TRIMMER ASSEMBLIES**

for

### ELECTRONIC INSTRUMENTS, TEST EQUIPMENT and MILITARY APPLICATIONS

ERIE Resistor Ceramic Trimmers are all notable for their fidelity to specifications, their excellent stability, and their straight-line capacity change throughout the total range.

The Ceramic Base Trimmers feature a unique connecting strap which eliminates the possibility of intermittent contact between the adjusting shaft and the silver pattern.

ERIE Ceramicon Trimmers and ERIE Custom Ceramicon® Trimmer Assemblies are available in a wide variety of temperature compensating characteristics, and exceed the electrical requirements for MIL-C81A.

These ERIE Trimmers are widely used in electronic instruments, test equipment, and military applications.

**A NEW ERIE TRIMMER  
for Printed Circuit Boards**



STYLE  
3192

Write for new Engineering Bulletin  
on ERIE Style 3192 Trimmer.

Complete description of all ERIE Standard Trimmers  
is included in Catalog 314-1 . . . Write for it.

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Your immediate needs for one or more relays of any kind are shipped from our greatly enlarged stock which includes hundreds of types in all popular contact arrangements and coil ratings.

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## SCHRACK MOTOR CONTROLLER

These contactors offer several exclusive features including phase protection, adjustable overload from unity to 140% of rating and complete ceramic insulation. Sizes 0, 1, 2 and 3. NEMA enclosures available.



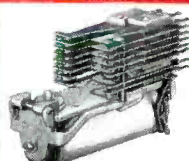
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We can furnish from stock or fabricate practically any telephone type relay: C. P. Clare; Automatic Electric; Phillips Control; North Electric.

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NEW PRODUCTS

(continued)

teristics of the company's variable composition resistors.

Called "A Quick Guide to Stack-pole Variable Resistors," the new chart is printed in two colors on heavy stock suitable for wall, desk-top, or file drawer use. Illustrations and specifications for over 18 basic single and dual-section controls are shown with a tabulation of all possible modifications available on each control, such as printed wiring or wire-wrap terminals, tab or bracket-mounting devices, line switches, phenolic shafts and so forth.

**Coaxial Components.** Microlab, 71 Okner Parkway, Livingston, N. J. Catalog No. 6 illustrates and describes a line of coaxial components. Specifications and applications are given for filters, terminations, attenuators, crystal mounts, tuners, frequency multipliers, impedance transformers and minimum loss pads. A price list is included.

**Temperature Test Chamber.** Stat-ham Development Corp., Los Angeles, Calif. A new 6-page bulletin on the portable and self-contained model TC-2A temperature test chamber is available.

This bulletin describes in detail the operating principle and procedure of the TC-2A temperature test chamber.

The unit discussed is suited to production line tests of small products, such as basic instruments and electronic subassemblies.

Illustrations and diagrams are contained in the bulletin. Price of the unit described is \$550.

**Microwave Components.** Microwave Development Laboratories, 92 Broad St., Babson Park, Wellesley 57, Mass. A new 12-page catalog, C-356, covers in detail the complete line of E and H plane bends and top wall and side wall hybrid junctions.

Illustrations and technical data are included.

**Phase Comparator.** Link Aviation, Inc., Binghamton, N. Y. An illustrated 6-page folder describes the model 201 phase comparator. Publication LP3525 covers the operation and applications of the unit

Write for

**Relay Sales**

Catalog

C-7



which has been specially designed for computer, control and servo-mechanism testing where phase relationship must be accurately determined.

Specifications and advantages of the equipment are listed in the folder. Applications are illustrated.

**C-R Tubes.** Allen B. DuMont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J., has available a guide to electronic equipment designers and research workers in the rapid selection of special crt's for their special requirements.

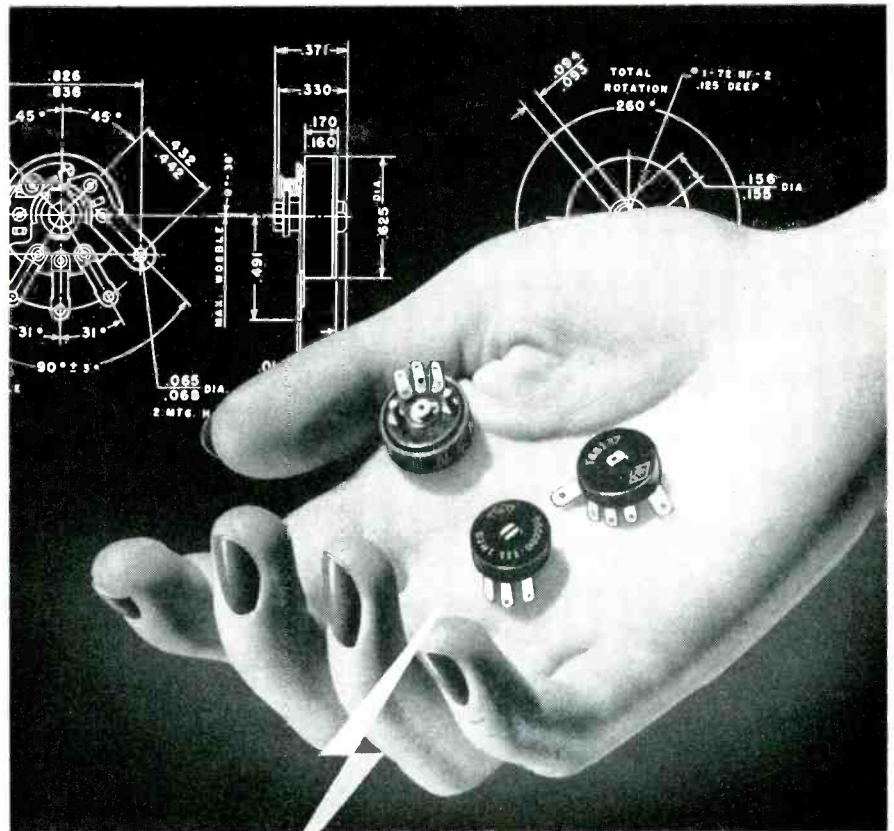
The data sheet lists principal physical and electrical characteristics and applications of 74 DuMont custom-line crt's. The cathode-ray tubes included in the chart lend themselves to such applications as industrial and government radar, oscillographs (from low to uhf as well as t-w and multigun types), flying spot scanners (for tv reproduction and industrial quality and production controls), storage, display, and advanced research in pulse and microwave techniques.

**Hipot Testers.** Peschel Electronics Inc., 16 Garden St., New Rochelle, N. Y., has available literature describing the H series of sensitive Hipot testers.

Hipot testing allows convenient and accurate dielectric testing of equipment, components and materials. With a series H Hipot tester, the high sensitivity shows up leakage currents in insulation which appear to be perfect on less sensitive instruments. The electronic circuit breaker in the unit described deenergizes the h-v at the instant that 5  $\mu$ a of leakage current occurs in the same under test, and prevents destructive arcs.

The testing discussed can be utilized for production testing by either preset pass-reject or exploratory methods; for preventive maintenance on electrical equipment; or for overvoltage testing.

**Microwave Absorbers.** Emerson & Cuming, Inc., 869 Washington St., Canton, Mass., has available a new brochure entitled "Microwave Absorbers." It contains technical information and prices of the company's complete line of absorbers for use in the vhf, uhf and micro-



## **Model 1** **Variable Resistors**

*— they fit the tight spots*

*Adopted as standard where only the best will do, by designers of...*

*Transistor circuits*

*Telephone systems*






*Hearing aids*

*Car radios*

*Military electronic devices*

*Business machines*

*Computers*

-  Centralab Model 1 Radiohms, with or without switches, can solve your variable resistor problems where size, ruggedness, and high quality are desired.
-  Rated at 1/10 watt. Resistance range, 500 ohms to 10 megohms. Seven standard tapers.
-  Enclosed in laminated phenolic dust cover. Metal electro-static shield available.
-  Knob and slotted-shaft types.
-  Not a laboratory curiosity — 6,000,000 are now in use.

*Technical Bulletin 42-164 gives complete engineering data. Write for it.*

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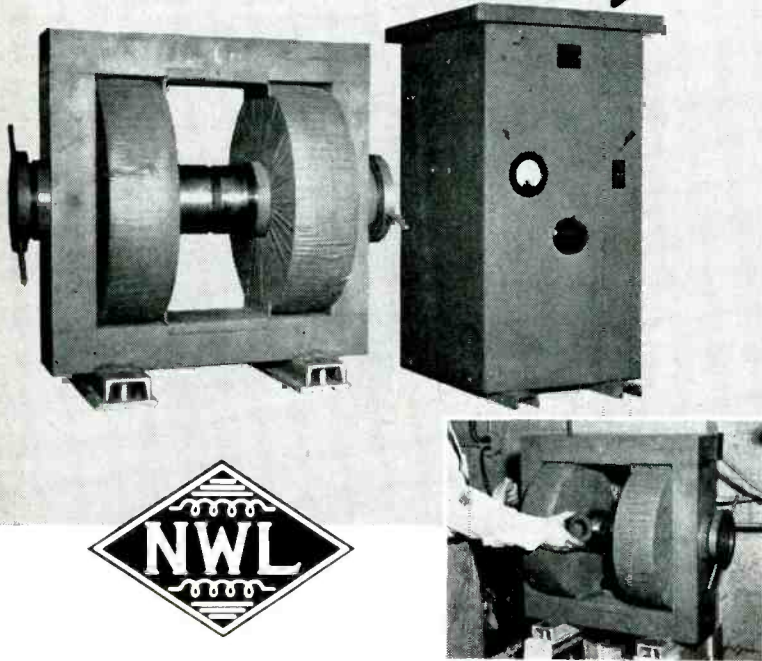
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# EIGHTY THOUSAND AMPERE-TURN ELECTROMAGNET

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**CUSTOM BUILT FOR A MAGNETIC  
MATERIALS LABORATORY**



Materials easily placed in position and removed



Provides:

- adjustable gap between 5" poles
- good working space
- 80,000 ampere-turns intermittent rating
- 40,000 ampere-turns continuous rating

The user's need for a simple means of magnetizing ceramic magnetic materials is filled by this 1600 pound electromagnet and its 1.4 kilowatt NWL low-ripple, variable-voltage controlled 3 phase rectifier.



Established 1920



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ELECTROMAGNETIC EQUIP-  
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wave range. Materials for use on the walls and floors of free space rooms, in antenna housings and in waveguides are described.

**Digital Measuring Instruments.** Non-Linear Systems, Inc., Del Mar Airport, Del Mar, Calif. Catalog 356 is a 28-page booklet with illustrations, charts and characteristics of its full line of precise automatic digital measuring instruments.

The catalog contains information on NLS digital voltmeters, digital ohmmeters, digital readouts, data reduction systems, peak reader systems, digital recording systems, a-c/d-c converters and binary decimal converters. It also has a section devoted to principles and applications of the digital voltmeter, and another describing NLS plant facilities.

**Magnetic Head.** J. B. Rea Co., Inc., 1723 Cloverfield Blvd., Santa Monica, Calif., has available literature covering a single track read and record magnetic head designed specifically for digital computers. The head described has complete flexibility of circuitry—can be transistor driven. This literature contains physical configuration and performance characteristics as well as descriptive text.

**Capacitor Specifications.** Glenco Corp., Metuchen, N. J., has announced the printing of new 2-color specification sheets describing 4 lines of ceramic capacitors produced by the patented Thin-Sheet process. Applications for the units featured include transistorized circuitry, frequency control, bypass and coupling, feedback networks and tuned circuits.

The bulletins give thorough information concerning design features, construction, informative temperature characteristic curves, easy-to-read specifications and specific ordering data. Technical information concerning custom-engineered capacitors in each line is included.

**Alloys for Electronics.** Penn Precision Products, Inc., 501 Crescent Ave., Reading, Pa. The new 8-page, bulletin 7 "Pennrold Precision Strip for Electronics Applications" pre-



sents case history and availability data on thin-gage beryllium copper, phosphor bronze, nickel silver, chromium copper, stainless 17-7PH, invar and magnetic strip down to 0.0005 in. thick. It includes tables on mechanical and physical properties as well as tolerances and applicable specifications.

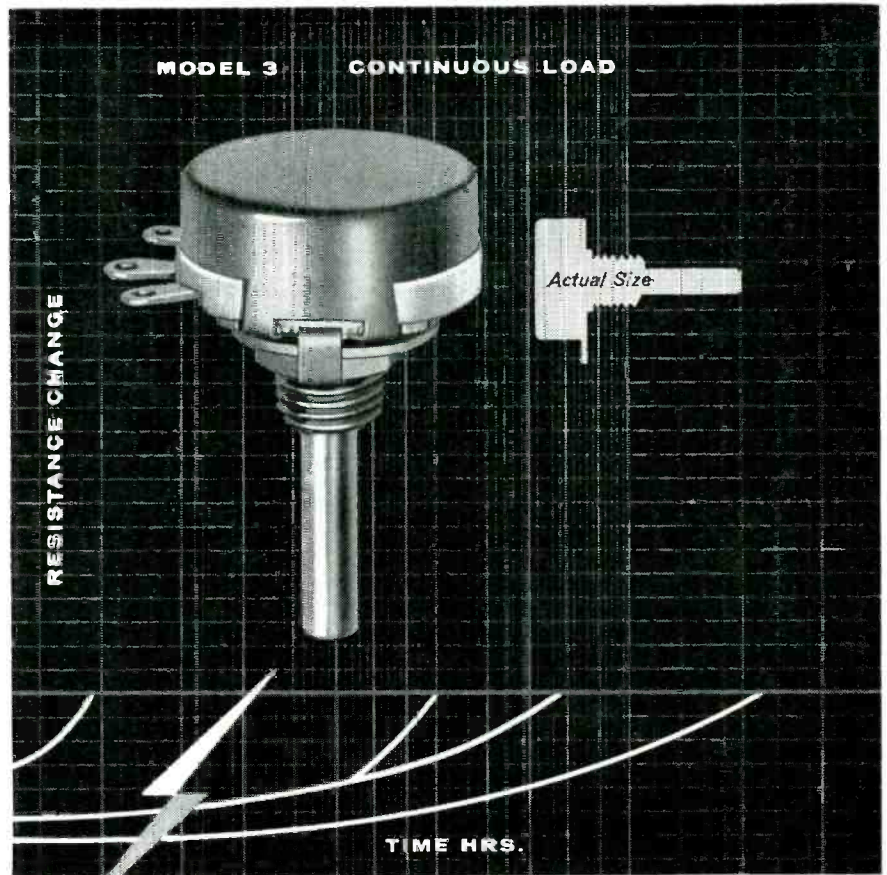
**Inductive Pot.** Transicoil Corp., Worcester, Montgomery County, Pa., has released a technical bulletin covering the important physical and electrical characteristics of a size 11 inductive potentiometer. In addition to a general description the sheet gives a dimensional drawing of the potentiometer, a chart of electrical characteristics, and a typical performance curve.

The type 11L discussed is a 400-cycle infinite resolution potentiometer. Linearity of the unit described is within 0.25 percent through an angular rotation of  $\pm 85$  deg through null to  $-85$  deg. It is available for continuous rotation with slip rings, or with built-in stops to restrict rotation to  $\pm 85$  deg from null.

**Dag Dispersions for Industry.** Acheson Colloids Co., Division of Acheson Industries, Inc., Port Huron, Mich. A fifth revision of the 4-page booklet on dag dispersions for industry lists 41 colloidal and semicolloidal dispersions for electronics and related industries. The products discussed include dispersions of graphite, molybdenum disulfide, mica, vermiculite, zinc oxide and acetylene black. Carriers and diluents are given for each product, along with typical applications and important physical data.

Now on the list is an improved dag dispersion No. 213, an alkyd-resin product containing semicolloidal graphite which forms a durable corrosion-resistant dry lubricating film.

**Microwave Tubes and Components.** Bomac Laboratories, Inc., Beverly, Mass., has released a 6-page folder which gives a partial listing of their tubes and components. Included are specifications for TR, ATR, Pre-TR and attenuator tubes, special shorted TR and ATR tubes, dual and triple TR and ATR tubes,



## Small Size... Big Wattage... Ultra Quality

...at high temperatures

### Typical watt-hour rating

Only 10% maximum  
when used at...

... 1 watt for 1½ hours

... ¾ watt for 35 hours

... ½ watt for 80 hours

... ¼ watt for 300 hours

... ¼ watt, continuous  
rating

### Centralab Model 3 Radiohm®

An ultra-quality variable resistor — less than 11/16" in diameter—in a complete selection of values for all miniature applications, guided missiles, geophysical, telemetering, etc.

Designed for high operating temperatures (125° C.).

Closed-case construction permits sealing and potting.

Also available with sealed, locking bushing.

Technical Bulletin EP-63 gives complete engineering data. Write for it.

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VARIABLE RESISTORS



ENGINEERED CERAMICS



SWITCHES



PACKAGED ELECTRONIC CIRCUITS



CERAMIC CAPACITORS

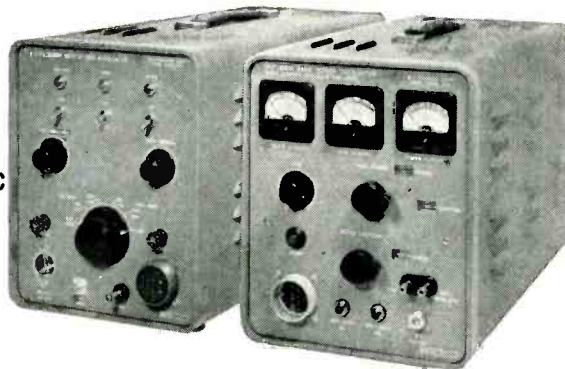
# WIDE-BAND POWER OSCILLATOR

200 to 2500  
mc/sec

40 watts at 200-400 mc  
25 watts at 400-1000 mc  
10 watts at 1000-2500 mc

Provides exceptionally broad frequency coverage and substantial power output in a single source. Offers smooth tuning and precise resetability, with overlapping coverage of the full range in two bands.

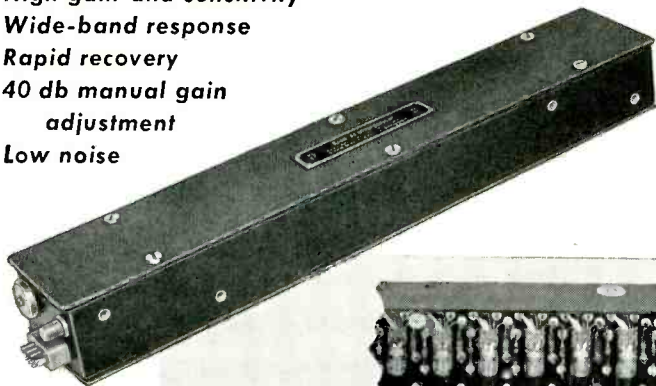
Price, including oscillator and power supply-modulator, \$2250.00 net F.O.B. Long Island City, N.Y. Write for free bulletin.



Frequency ranges....200 to 1050 mc, 950 to 2500 mc  
Calibration accuracy..... $\pm 1\%$  or  $\pm 5$  megacycles whichever is greater  
Resetability.....better than 0.1%  
Modulation.....internal square-wave and sine-wave, 400 and 1000 cps; also external  
Output impedance.....50 ohms (nominal)

## Subminiature I-F AMPLIFIERS

- High gain and sensitivity
- Wide-band response
- Rapid recovery
- 40 db manual gain adjustment
- Low noise



Designed for aircraft and electronic instrumentation, these amplifiers can be furnished to meet specific performance requirements. Typical specifications are given at right.

Model No.	Center frequency mc/sec	Band width mc/sec	Noise figure db	Gain db
M1154	30	12	1.7	100
M1155	60	12	3.7	100
M1156	90	12	5.0	100

Maxson Instruments products include: power oscillators, I-F amplifiers, mag-amp voltage regulators, frequency regulators for aircraft inverters, high-precision phasemeters, ultrasonic flowmeters, acceleration-sensitive switches, and statistical accelerometers. For detailed information, contact our main office or the nearest Maxson District Office.

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NEW PRODUCTS

(continued)

pressurizing windows, spark gap tubes, surge protectors, silicon diodes, magnetrons, reference cavities, shutter tubes, klystrons, hydrogen thyratrons and t-w amplifier tubes. Also included are representative pictures of different types of tubes, and a brief description of Bomac's service to the electronics industry.

**Expanded Scale Frequency Meters.** Arga Division, Beckman Instruments, Inc., 220 Pasadena Ave., South Pasadena, Calif., has released data sheet F1 describing its expanded scale 400-cycle frequency meters for panel mounting. The meters presented in the bulletin are designed for accurate monitoring and control of line frequency. Because they are direct reading, the necessity for estimating intermediate values is eliminated.

The bulletin tells how magnetic components with a minimum of copper and iron are used to save weight. The panel mounting size of both custom and military types is  $3\frac{1}{2}$  in. round. The latter types are ruggedized and sealed. Specifications are listed.

**Precision Components.** Hycor, Division of International Resistance Co., 12970 Bradley Ave., Sylmar, Calif. A 4-page bulletin covering Hycor's complete, expanded line of precision electrical components for industrial control, guidance, telemetering and audio equipment is now available.

Included in the illustrated bulletin G-3 are basic specifications for encapsulated precision wire-wound resistors, encapsulated toroid coils, miniature magnetic clutches, precision wave filters, telemetering filters, precision ratio transformers, miniature toroid power transformers, magnetic amplifiers, decade inductor units, program equalizers, variable filters and variable attenuators.

**Miniature Electron Tubes.** CBS-Hytron, a Division of Columbia Broadcasting System, Inc., Danvers, Mass., is now offering the eighth edition of its reference guide for miniature electron tubes. The new edition supplies pertinent data for



416 miniature types of which 88 are new, and 168 basing diagrams of which 33 are new. This 16-page brochure lists prototypes in larger bulbs.

Bulletin No. PA-1 is profusely illustrated.

**Measurement Equipment.** General Electric Co., Schenectady 5, N. Y. Eighty different devices are covered in a 40-page testing-instruments reference book titled "Measurement Equipment Catalog", GEC-1016. It contains complete product information including applications, sources of additional information and pictures. Ranging from simple thickness gages to the mass spectrometer leak detector, there are instruments for research, production, laboratories and educational use. Measurement categories include color, leak detection, insulation, and radiation monitoring.

**Duodecal Tube Socket.** DeJUR-AMSCO Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A 2-page, 2-color technical data sheet features product information, photographs, breakdown voltages, mounting and clearance specifications of the new series 1550 type B duodecal electron tube socket. Write for bulletin 50A.

**Precision Potentiometers.** General Controls Co., Glendale, Calif., has released a new precision potentiometer catalog. It includes specifications, photographs, drawings and descriptions of the rotary, linear, multiturn and sector designs manufactured by the company.

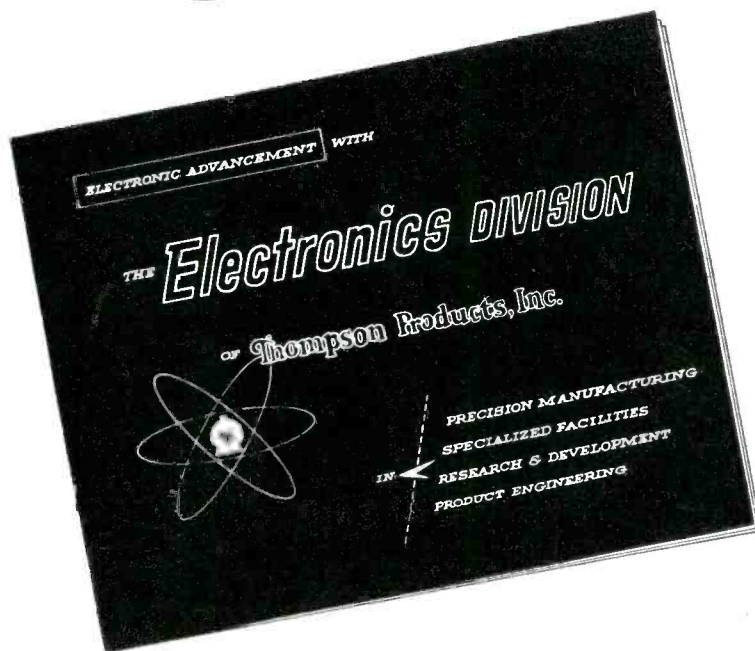
The units described can perform the reciprocal functions of defining the mechanical position of the sliding contact by means of an electrical voltage or current signal, or establish the level of a voltage or current signal by means of the set position of the sliding contact.

**Insulation Testers.** Herman H. Sticht Co., Inc., 27 Park Place, New York 7, N. Y. Bulletin No. 1248 shows in condensed form, nine different types of Megohmer insulation and resistance testers. The publication also shows the company's combination Wheatstone

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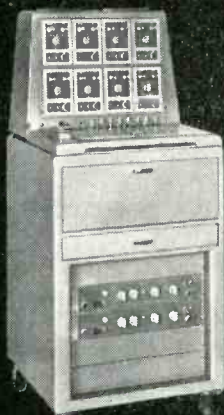
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bridge and Megohmer insulation tester.

**Computer Components.** Librascope, Inc., 808 Western Ave., Glendale, Calif., has available copies of brochure "Computer Components," containing illustrations, details and outline specifications of mechanical and electrical components most frequently used in analog and digital computers. Representatives are also listed.

**Tube Catalog.** Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y. A 12-page catalog contains illustrated information on the following: crystal diodes; microwave crystals; transistors; stroboscopes; flash tubes; klystrons; thyratrons; magnetrons; selenium rectifiers; argon rectifiers; rocket and pencil tubes; TR and ATR tubes; glow modulators; trigger and counter tubes; gas pressure measuring tubes; phototubes; t-w tubes and waveguide windows.

**Microphone Catalog.** Elgin National Watch Co., Elgin, Ill. The company's electronics division has released a 20-page catalog dealing with its line of American microphones and phonograph cartridges. The catalog lists prices, specifications and characteristics of each item.

Highlighting the catalog is a section devoted to the new ceramic turnover and single-needle phonograph cartridges recently added to American products.

**Standard Frequency Comparator.** Specific Products, 14515 Dickens St., Sherman Oaks, Calif., has announced a new bulletin on the model WWVC standard frequency comparator. The unit illustrated in the bulletin is available for precise audio and r-f standards work as well as accurate time interval measurements. Bulletin C-1 contains specifications, panel description and block diagram. Uses, r-f and a-f frequency standards, and antenna kit information are outlined.

**Shielding Enclosures.** Shielding, Inc., Box 217, Riverside, N. J. An attractive 4-page folder gives thorough information concerning design features, construction and applica-



tions of a new type of shielding enclosure. Handy attenuation chart, detailed illustrations of construction details, and easy-to-read ordering data are all prominently displayed.

**Gyros and Pots.** Gyromechanisms Div., Norden-Ketay Corp., Halesite, L. I., N. Y. Bulletin No. 380 gives specifications and characteristics of available compensated vertical gyros, ruggedized fully floated gyros and directional gyros. Also included in the bulletin are miniature precision potentiometers and dual sine-cosine potentiometers.

**Semiconductor Resistivity Test Set.** Baird Associates, Inc., 33 University Road, Cambridge 38, Mass. Technical bulletin TP-104 covers the model JN semiconductor resistivity test set which is especially designed to measure the resistivity of germanium samples. Basic method and its accuracy are discussed and specifications are included.

**Microwave Test Equipment.** Vectron, Inc., Waltham 54, Mass., has published a bulletin on its microwave test equipment and accessories. Included are descriptions and specifications for: a broadband probe (900 to 12,400 mc); a coaxial slotted line (3,950 to 10,000 mc); an L-band slotted line (1,120 to 1,700 mc); and an L-band adapter (waveguide to coax).

**Tube Chart.** General Electric Co., Schenectady 5, N. Y. A quick-selection chart listing GE's 600-ma series-string receiving type tubes, all of controlled heater warmup design, is now available. Chart ETD-1163-A classifies the 48 tube types according to elements; lists typical service, heater voltages, maximum plate and screen dissipation ratings; and gives average characteristics.

**Sealed Connector.** DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y., has announced a 2-color, 2-page technical data sheet on the new series 1400 Continental connector with hermetic seal, which features product information, photos, specifications, mount-

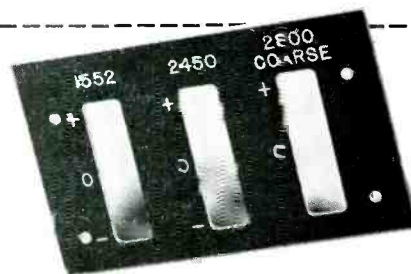


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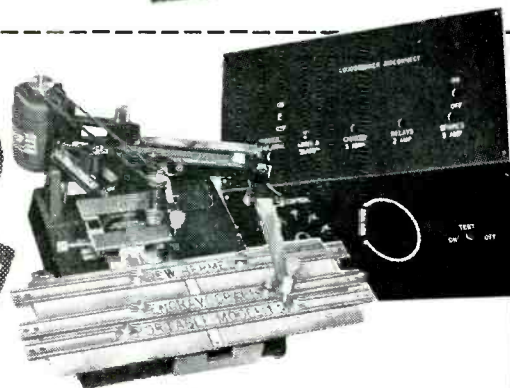
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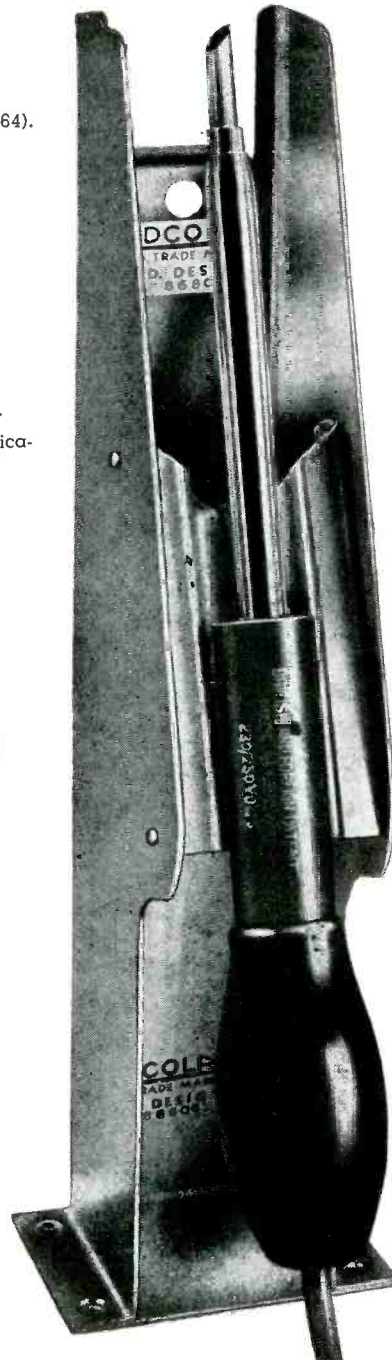
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NEW PRODUCTS

(continued)

ing and clearance dimensions, plus six polarizing key positions with part numbers. Write for bulletin 48E.

**Decimal Digitizers.** Coleman Engineering Co., Inc., 6040 W. Jefferson Blvd., Los Angeles 16, Calif. A new 4-page technical bulletin, No. CR-181, describes the Coleman decimal shaft Digitizers, which are now available in 3, 4, 5 and 6 decade models. The bulletin includes a table of applications showing typical inputs and outputs and describes the method by which the data is converted from one form to another. Generous use has been made of photographs and drawings showing applications of the shaft Digitizers.

**Capacitor Catalog.** Filtron Co., Inc., Flushing, L. I., N. Y., offers a new catalog on subminiature feed-through capacitors for 5-ampere and 10-ampere service, available for commercial and military applications. Trade-named FIL-CAPS, the feed-through units described have an internal circuit arrangement which makes ground-to-line inductance negligible over a wide frequency range (100 kc to 1,000 mc).

The descriptive text provides complete information on construction features and operating characteristics. Complete engineering data on rated current and voltage, insulation resistance, capacitance and dissipation factor are specified. Drawings include typical insertion-loss curves, schematic diagrams of wire lead or lug terminations, and a typical installation on bulkhead or chassis. A list of Filtron part numbers and their military equivalents is also provided.

**Rheostats and Resistors.** Rex Rheostat Co., Baldwin, L. I., N. Y. A 6-page folder contains illustrations, specifications and prices for a wide line of rheostats, resistors, toroidal core winding machines and automatic taping machines.

**Power-Supply Data.** NJE Corp., 345 Carnegie Ave., Kenilworth, N. J., has available a technical data file that provides complete ratings on over 500 stock-model supplies, in addition to a thorough technical



discussion of methods of rating power supply performance, including output range, regulation, ripple, internal impedance, stability and dynamic response.

The new catalog file provides complete technical data on five ranges: high voltage, low current; zero-lag low voltage, high current; standard-grade plate supplies; and laboratory-grade plate supplies. The data file comes complete with price lists, purchasing information and a listing of the company's representatives.

**Germanium Rectifier.** Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif., has available a new bulletin describing the model G125-400 50-kw heavy-duty germanium-type rectifier. Features, specifications and applications are outlined.

The model described has an a-c output voltage range of 115 to 125 v at 400 amperes and is a unique cubicle which can be series and/or parallel connected for voltages and amperages as required.

The bulletin illustrates the 50-kw germanium rectifier unit which is housed in a simple cubicle-type cabinet design.

**Molding Compounds.** Thermaflow Chemical Corp., Tunkhannock, Pa. A file folder contains literature giving complete information on the company's new, high impact polyester (alkyd) glass fiber reinforced molding materials. The file includes a description of the compounds and their physical properties, molding conditions and techniques, product applications, data sheets and price schedules.

**Binary Digitizers.** Coleman Engineering Co., Inc., 6040 W. Jefferson Blvd., Los Angeles 16, Calif. A new 6-page technical bulletin, No. CR-185, describes the Coleman binary and binary coded decimal Digitizers. This bulletin pictures the commutators and digitalizing relay units and shows the details of the internal construction. It also lists various applications of the Digitizers and includes circuit diagrams and specifications.

**Tandem Transistors.** Marvelco Electronics Div. of National Air-

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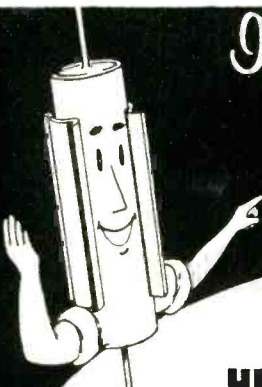



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craft Corp., 3411 Tulare Ave., Burbank, Calif., has available a 4-page technical bulletin on the new tandem transistor. It contains illustrations of fundamental circuitry, description, applications, rating, cutoff frequency, electrical data, maximum ratings and tandem parameters of the new tandem transistor.

**Rack and Panel Connectors.** American Phenolic Corp., Chicago 50, Ill. The new R2 catalog gives a complete listing of the rack and panel connectors manufactured by the company. Blue Ribbon connectors, in standard, miniature and circular types, pin and socket connectors, and printed circuit connectors are included. Dimensions, current ratings and availability are given for each type described.

**VLF R-I/F-I Equipment.** Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif., has available a 4-page illustrated folder on versatile very-low-frequency radio-interference and field-intensity measuring equipment. The literature features the NM-10A, which combines laboratory precision with ruggedness and portability for all-weather field operation over a range of 14 kc to 250 kc.

Also included is information on a complement of accessories designed to accommodate every conceivable laboratory or field problem in locating and measuring voltage and current values of radio signals or radio interference.

**Subminiature Diodes.** Clevite Transistor Products, 241 Crescent St., Waltham 54, Mass. Technical data sheets on a complete line of gold-bonded glass subminiature germanium diodes are available. The sheets cover computer types as well as high-conductance, high-resistance and general-purpose diodes.

Pertinent specifications are given, including type numbers, forward current, inverse current, peak inverse voltage and peak operating current. Mechanical specifications on standard glass plus plastic diodes for automation and clip-in, clip-out applications are furnished.

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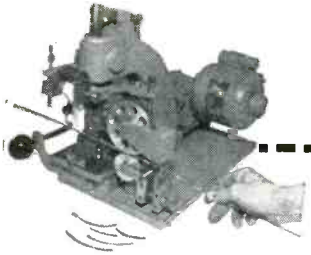
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It is only one of several ACROMARK "standardized" types of wire and cable marking machines. Send samples or specifications and a list of codes for literature and prices.

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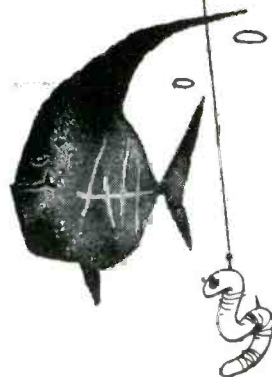


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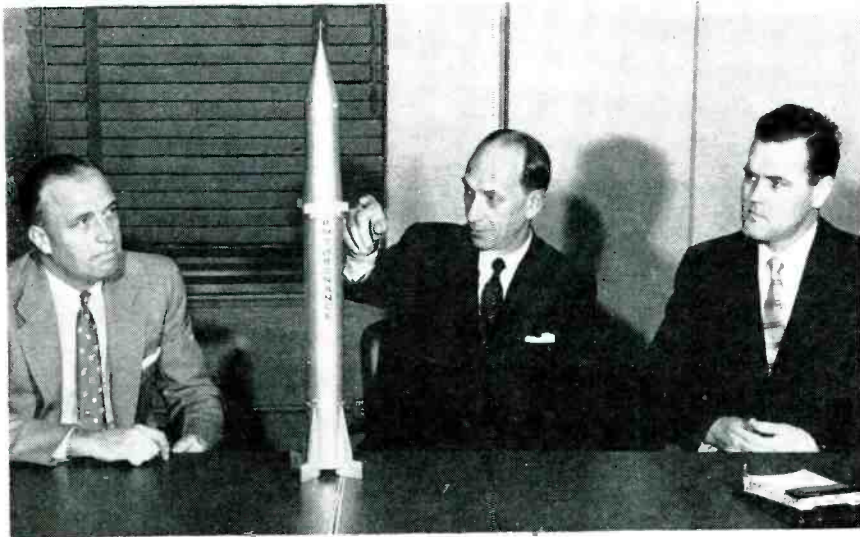
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# Plants and People

Edited by WILLIAM G. ARNOLD

Manufacturers boost plans for additional plant facilities for government and commercial production. Top engineers and executives in the industry move to new positions. More acquisitions and mergers are made by companies in electronics

## Ford Instrument Expands For Missiles Development



Left to right: L. S. Brown, R. F. Jahn, president of Ford, and L. J. Scheuer

FORD INSTRUMENT CO., manufacturer of the guidance system for the Army's Redstone missile, has formed a new missile development division.

The company also leased a building to house laboratories and shops of the division and appointed a management staff for the new division. The expansion move is de-

signed to increase engineering and test facilities on the Redstone missile and initiate development of guidance systems for more advanced ballistic missiles. In addition a new gyroscope test laboratory is being established.

Under the new organization, manufacture of parts and final assembly on the Redstone and other

ballistic missile programs will be handled in the firm's two present buildings in Long Island City, N. Y. A third building is being leased to effect a transfer from present plants of all engineering, development, experimental and test facilities, a modification center and a field service headquarters.

The gyroscopic test laboratory is being built in one of the company's two main plants.

Lawrence S. Brown was appointed manager of the new division with complete responsibility for all company work to be done on both the Redstone and other advanced missiles. In this capacity, he will report directly to Ford Instrument Co. president Raymond F. Jahn.

Brown joined the firm in 1934 as test and field engineer on naval fire control systems, later rose to design engineer and project supervisor.

Lewis J. Scheuer was named director of engineering in the new division. He joined the firm as assistant engineer in 1948.

## Hughes Promotes Four, Plans Arizona Plant Addition

HUGHES AIRCRAFT Co., promoted four top executives.

Howard P. Hall, formerly vice-president-administration, becomes vice-president, secretary and general counsel.

William W. Wooldridge, former vice-president and manager of Tucson, Ariz., operations, becomes vice-president-administration and will move to Culver City, Calif.

Roy E. Wendahl, former sales chief, will move from Culver City to Tucson as manager of the \$12 million plant there, where operations include all manufacturing of the



Left to right, H. P. Hall, W. W. Wooldridge, J. H. Richardson

Hughes Falcon air-to-air guided missile, recently announced as operational by the United States Air Force.

John H. Richardson was named director of military sales; he had been assistant director.

Hughes also announced plans to expand the Tucson, Ariz., plant operations by 500,000 sq ft and 3,000 workers by 1958.

This will bring employment at the Tucson plant to 8,000.

Planning for the expansion will be completed by December, 1956. Construction will start early in 1957



# LOCKHEED in GEORGIA MOVES AHEAD AGAIN!

## Staff of 500 Seen For A-Plane Plant

W. R. Rhoads to Head Dawsonville Project  
To Be Biggest of Its Type in Nation

LOCKHEED Aircraft Corp. wasting no time in the development of nuclear aircraft testing facilities at Dawsonville, announced Tuesday that W. R. Rhoads will head up the Dawsonville project.

Mr. Rhoads, who lives at 220 Osner Dr., N.E., is chief staff engineer at Lockheed's Marietta plant now. He has been with Lockheed since 1941.

He will direct the work of the approximately 500 scientists, engineers and service personnel who will be employed at the Dawsonville site.

LOCKHEED AND the Air Force officially announced Monday night at a dinner at Gainesville that they intend to build a 20,000-acre, multi-million-dollar nuclear aircraft test site just southwest of Dawsonville (population, 350).

And, perhaps as significantly, Lockheed's top Georgia executive hinted that the actual manufacture of a nuclear-powered plane—perhaps the world's first—might take place at Lockheed's Marietta plant.

AND

there's more that can't  
be published — yet

The expected date of  
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expected, but

The world's largest integrated aircraft plant, at Marietta, Georgia, — where we build Lockheed C-130 Turbo-Prop Cargo planes and B-47 Jet Bombers—welcomes this new Lockheed program in Georgia.

Here are projects to challenge the very limits of imagination, vision, ability and capabilities of man!

This new atomic development and its effect on the adjacent manufacturing plant and new Engineering facility at Marietta, creates far reaching additional opportunities for Engineers and Scientists in a wide range of categories in both places.

Here is a program that is literally long range in both scope and product.

Qualified Engineers and Scientists interested in becoming associated with this progressive and rapidly expanding organization are invited to inquire for further information or personal interview.

Write to

ENGINEERING PROFESSIONAL  
PLACEMENT

**LOCKHEED**

AIRCRAFT CORPORATION—DEPT. E-6  
761 Peachtree St., N.E., Atlanta, Georgia



and is scheduled for completion in early 1958.

The electronics assembly plant also is negotiating for 100,000 sq ft of additional space from the Tucson Airport Authority.

## Honeywell Shifts Transistors to Boston

MINNEAPOLIS-HONEYWELL REGULATOR Co. plans to establish its transistor division in a new location in the Boston area.

Since the transistor division was formed two years ago, it has occupied facilities, on an interim basis, in the company's main plant in Minneapolis.

Clyde A. Parton, division director, said new facilities will be leased in Boston to house the division's various activities, including engineering, production and sales. The transfer to the new location will be made as soon as the facilities are available.

Most of the people employed by the division will also be transferred to the Boston area.

The division will establish a new applied research section to expand the application of high-power transistors.

The company's basic research work in transistors will continue at the Honeywell research center in suburban Minneapolis. The Minneapolis research will be concerned with fundamental studies in the semi-conductor field.

## Apparatus Makers Re-elect Officers

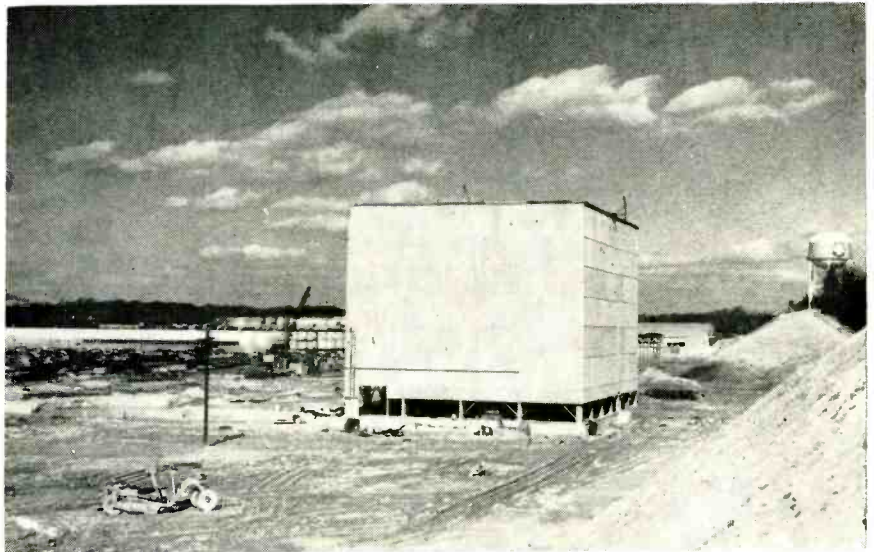
HENRY F. DEVER was re-elected president of the Scientific Apparatus Makers Association.

Dever, president, Brown Instruments division of Minneapolis Honeywell, has been SAMA president for the past year.

R. E. Welch, vice-president and treasurer, W. M. Welch Manufacturing Co., remains as SAMA president pro tempore.

T. M. Mints, president of E. H. Sargent & Co., continues as SAMA treasurer.

## Westinghouse Builds, Names Engineers



Westinghouse new antenna tower building and construction site

THE ANTENNA tower building of the Westinghouse multimillion dollar electronics plant is nearing completion near Baltimore. The section is 120-ft long 80-ft wide and 70-ft high. Since government contract work must begin in this section in the near future, it has received top priority in construction timetables.

Construction on the multimillion dollar plant, which will be adjacent to Westinghouse air arm division plant, began last December and is scheduled for completion July 1 of this year. The new facility will provide a total of 210,000 sq ft of floor space for the manufacture of radar, fire control and missile guidance systems. Engineering laboratories and administrative offices will occupy an additional 140,000 sq ft.

Westinghouse also announced that F. M. Sloan, general manager of the firm's lamp division, has been elected a vice-president of the company. He joined the corporation in 1932 as an engineer at KDKA, In 1947, he became division manager of the radio division, and then operations manager of the television-radio division.

In the tv radio division, P. Dusinberre has been appointed manager of manufacturing for both commercial and defense operations.

He was formerly assistant to the

general manager, E. J. Kelly. He joined Westinghouse in 1954 as assistant to the works manager. Previously, he had been with IT&T.

## Wilson Selects U. S. Missile Chief

SECRETARY OF DEFENSE CHARLES E. WILSON appointed Eger V. Murphree, president of the Esso Research and Engineering Co., to the newly created position of special assistant to the Secretary of Defense for guided missiles.

In his new capacity, Murphree will report directly to the Secretary of Defense. He will be responsible for the direction and coordination of all activities in the Department of Defense connected with the research, development, engineering and production of guided missiles, except those types already adopted for service use. He is expected to devote major emphasis to missiles of the long-range type, particularly ballistic missiles.

In 1934, Murphree was elected vice-president and director of Hydro Engineering and Chemical Co. The same year he moved to New York as manager of development and research for the Standard Oil Development Co., now known as Esso Research and Engineering Co. In July 1937, he was elected vice-president of that organization. In



# 5868 AX-9902

*world's most modern*

**1 KW**

**RF POWER AMPLIFIER**

*and*

**OSCILLATOR TRIODE**

*...another*

**Amperex®**

*exclusive*



Even the quickest comparison of the AMPEREX Type 5868/AX-9902 with the nearest RF power triode in its class will immediately reveal its superiority in every respect.

Unlike its closest equivalent, which is strictly a communications type, the 5868 is a **heavy-duty industrial tube** with enormous overload capacity, equally at home in induction heaters, dielectric heaters, ultrasonic generators, etc.

Instead of the flat metal anode of its nearest competitor, the 5868 has a cylindrical "cotton-reel" **Magnisorb\* anode**, which is incomparably more resistant to high-temperature warping and consequent characteristic changes, has superior gettering action, and dissipates heat more efficiently and uniformly.

Unlike its closest equivalent, which must hang from top and bottom supports, the 5868 presents no layout problems with its heavy, plated, self-supporting, low contact-resistance **5-pin base, which fits the standard plug-in socket.**

Instead of a molded type 7052 glass base, the 5868 has a strain-free **powdered-glass base** requiring minimum cooling.

Unlike its nearest competitor, which is good up to only 30 Mc at maximum ratings, the 5868 operates **up to 100 Mc at maximum ratings** and 120 Mc at reduced ratings.

Instead of a molybdenum grid, the 5868 has a **platinum-clad grid** for lower grid emission and higher permissible grid dissipation. It also has **shorter leads for lower inductance**, excellent inter-electrode shielding and a special helical, **thoriated-tungsten filament.**

Without question, the AMPEREX Type 5868/AX-9902 is a thoroughly modern tube . . . the world's finest in its class!

**CLASS C OSCILLATOR (Continuous Service)†**  
With Rectified, Unfiltered, Single-Phase, Full-Wave Plate Supply

**MAXIMUM RATINGS — Absolute Values (per tube)**  
For Frequencies up to 100 MC

Plate Voltage	3600 volts
Grid Voltage	—320 volts
Plate Current	475 ma
Plate Power Input	2200 watts
Plate Dissipation	450 watts
Grid Dissipation	50 watts

**TYPICAL OPERATION**

Transformer Secondary Voltage (RMS)	4000	3350 volts
Plate Voltage	3600	3000 volts
Plate Current	450	400 ma
Grid Current	100	85 ma
Grid Leak Resistance	3000	3000 ohms
Plate Power Input	2000	1480 watts
Plate Dissipation	450	400 watts
Plate Power Output	1500	1040 watts

†For information on Intermittent Service, contact Amperex Application Engineering Department

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February 1946 he became executive vice-president and in July 1947 was elected president.

### Stromberg Plans West Coast Expansion

STROMBERG-CARLSON planned for the opening of its new main San Diego plant.

The San Diego operation started as the electronics and guidance section of Convair in the summer of 1950. The group, under the guidance of Joseph T. McNaney, undertook research on applications and systems for the Charactron tube.

Last year Stromberg-Carlson became a division of General Dynamics and shortly thereafter the Convair electronics and guidance section was transferred to this new division, establishing San Diego as the location for Stromberg-Carlson's West Coast engineering and manufacturing operations. New applications of the Charactron display tube and broadening of the operations into other fields of advanced electronics have resulted in more than doubling the plant area and number of employees since Stromberg-Carlson took over.

Local officials of the firm say that present plans for Stromberg-Carlson-San Diego call for its expansion substantially into an engineering and manufacturing organization similar to the headquarters plant at Rochester, New York.

Stromberg also announced that Malcolm P. Herrick has been appointed staff assistant to John H. Voss, vice-president in charge of the telephone division.

Prior to his new position, Herrick was chief engineer of Stromberg-Carlson's radio-television division. He has been with the company since 1944. He will assist the vice-president on matters concerning engineering and manufacturing.

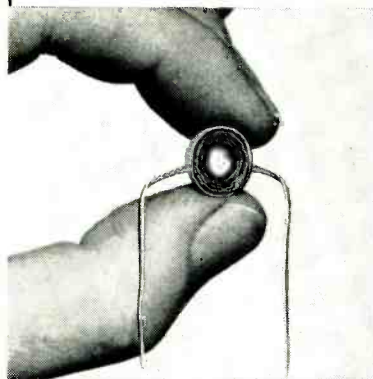
### Texas Instruments Shifts Recorders

TEXAS INSTRUMENTS transferred the production and marketing of its line of recording instruments from Dallas to Houston, Texas. Recorders will be manufactured by TI's instrumentation subsidiary,

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Miniaturized wafer-type coil, with leads, manufactured by Sylvania Electric Products Inc.

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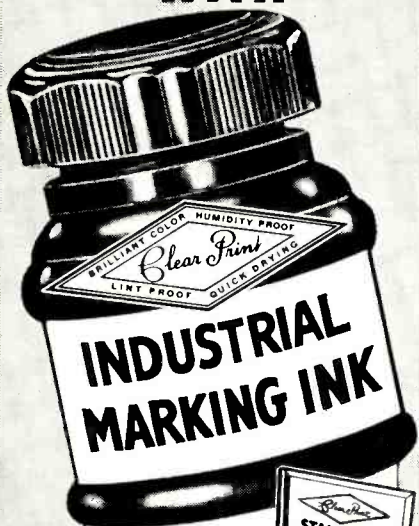
This dramatic new material is dense and homogeneous. It is rolled, not electro-deposited. A square foot weighs only .01162 lb. One pound of this 1/4 mil copper in a quarter-inch width extends almost a mile in length.

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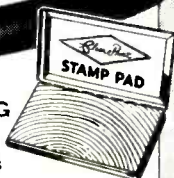
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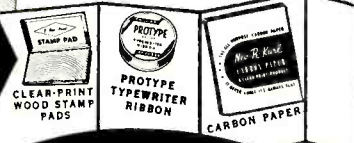
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Houston Technical Laboratories.

The move is being made largely to centralize the manufacture of related items. All recorder activities now come under the direction of R. W. Olson, president of Houston Technical Laboratories.

Among the persons being transferred to Houston in connection with the recorder are Orm F. Henning and Ralph T. Doshier, Jr. Henning has been appointed HTL assistant sales manager. Doshier has been appointed HTL assistant chief engineer and will be in charge of recorder development and design.

### CBS Promotes Division Engineers

HAROLD H. KNUBBE, director of engineering, has been placed in charge of all engineering and developmental activities at CBS-Columbia. He has been with the firm since 1952.

His responsibilities encompass supervision of radio, black-and-white television, color television and industrial electronic engineering activities.

He has been active in the electronics industry for the past 24 years. Previous to his association with CBS-Columbia he was chief engineer for the Sparton radio-television division of Sparks-Withington Co. He has also been associated with the General Instrument Corp. and the Detrola Radio Corp. in the same capacity.

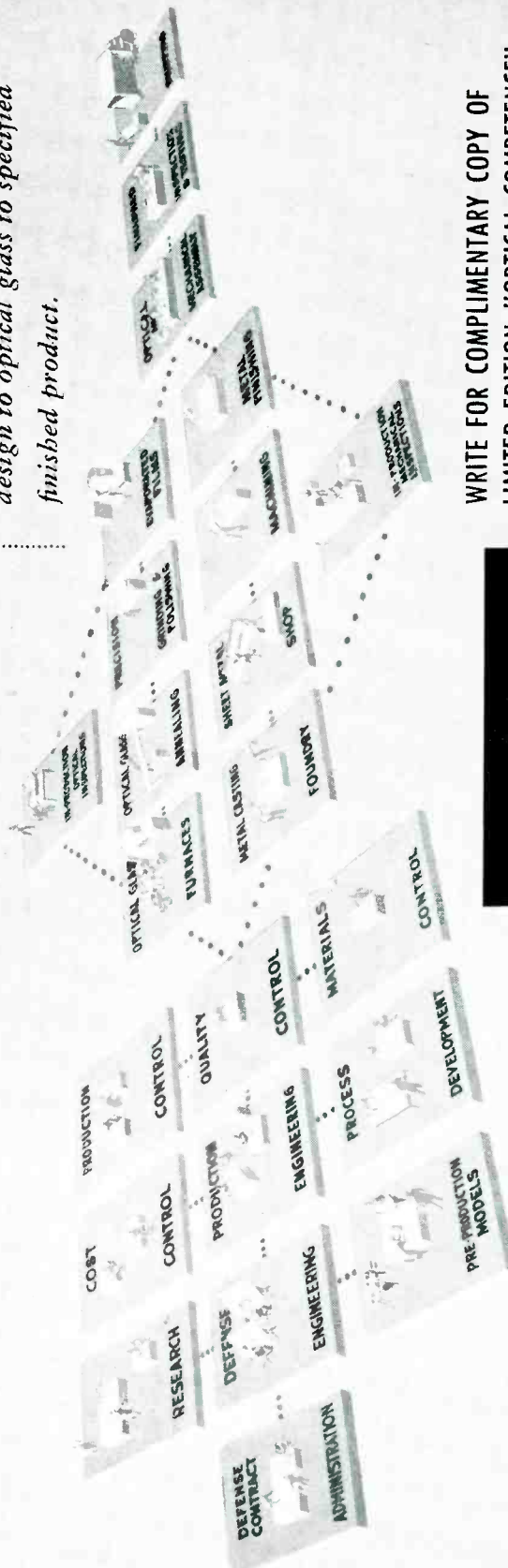
Joe C. Harmony, plant manager at CBS-Hytron's Danvers, Mass. plant since 1952, has been named to the newly created post of manager



Joe C. Harmony

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of receiving tube operations. He joined the company in 1941 as a product engineer. He will supervise the operation of receiving tube plants in Danvers, Salem and Newburyport.

Charles E. Coffin, previously production superintendent, will succeed Harmony as plant manager, Danvers. He joined the firm in 1951. Replacing Coffin as production superintendent is Leo P. Hurley, formerly a supervisor in the Danvers plant grid department. He joined the firm in 1933.

CBS-Hytron also announced the appointment of Jay L. Farley as chief factory engineer at Kalamazoo, Mich. and Edward P. Laffie as director of quality control.

Farley, formerly director of quality control, joined the company in 1950.

Laffie had ten years of industrial engineering experience before joining the firm in 1949. Prior to receiving his new assignment, he was supervisor of quality control at the Salem and Lowell plants.

## Eitel-McCullough Sets Salt Lake Build-Up

EITEL-MCCULLOUGH of San Bruno, Calif., plans to boost employment at its Salt Lake City plant to 500 in two years. The company plans to establish a research center at the Salt Lake plant employing 25 or more scientists; expand by 50 percent present output of high frequency transmitters; establish a new production line handling klystron tubes, now going into production at San Bruno.

## Western Electric Elevates Top Engineers

WESTERN ELECTRIC Co. elected Harold V. Schmidt, A. Pope Lancaster, and William E. Burke as vice-presidents.

Arthur B. Goetze, vice-president of finance, replaces H. C. Beal, now retiring, as vice-president-manufacturing.

Schmidt, who has been engineer of manufacture since 1952, becomes vice-president-chief engineer, a new position reporting to the president and responsible for company-wide

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OUTPUT LEVEL:	0 dbm $\pm$ 2 dbm.	<b>MECHANICAL</b>
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engineering and technical interests of the business. He joined Western as a manufacturing student in 1917.

Lancaster, presently manager of the company's works in Kearny, N. J., is appointed vice-president-manufacturing, eastern area. He has been works manager of the Kearny works since 1952. He joined the company in 1922.

Burke, now manager of the Distant Early Warning Line project which the company has undertaken for the U. S. Air Force, will become vice-president-defense projects. In this capacity, he will have supervision of several additional continental defense projects for which Western Electric is prime contractor to the government. He joined the technical staff at Bell Telephone Laboratories in 1928.

Paul A. Gorman, who has been vice-president-defense projects will succeed Goetze as vice-president-finance. Hardy G. Ross who has been serving as assistant works manager at the Kearny works will succeed Burke as project manager of the DEW Line.

Timothy E. Shea of Summit, N. J., who has been vice-president-manufacturing, eastern area, will become vice-president-personnel and public relations, a new position reporting to the president.

## RCA Selects Parts Head



William T. Warrender

WILLIAM T. WARRENDER, manager of the tube plant of the RCA tube division at Marion, Ind., has been appointed general manager of the recently created components division. He will be succeeded as plant

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**CURRENT:** 200 milliamperes.

**RIPPLE** less than 3 millivolts peak to peak at any current or voltage. Either positive or negative output terminal may be grounded.

**VARIABLE** stabilized bias supply.

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400 milliamperes (any voltage setting) (5-4V).

**EITHER POSITIVE OR NEGATIVE** output terminal may be grounded.

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**VARIABLE** stabilized bias supply.

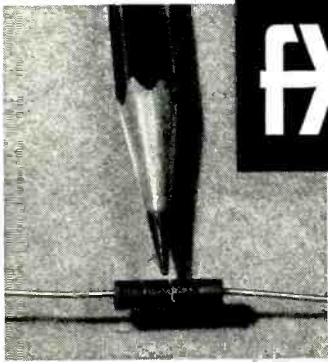
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manager at Marion by Leonard Gillon, manufacturing manager there since 1954.

After 11 years as factory engineer with several tube manufacturing firms he joined RCA in 1936 at the Harrison, N. J., plant.

In 1945, he was appointed department manager in the record division at Camden, N. J., and in 1946, general plant manager. Two years later he became chief engineer of the record division. When the Marion plant was acquired in 1949, he was made plant manager.

## Lockheed Appoints Missile Director

JOHN H. CARTER, former chief of the Air Force guided missile section at Wright Air Development Center, has been appointed associate research director of Lockheed's missile systems division.

He will work directly with Louis N. Ridenour, the missile division's director of research, in implementing the division's research and development programs.

Carter has been assistant director of development planning in Lockheed's corporate organization for the past three years. He joined Lockheed after 15 years in the Air Force where he gained wide experience in the guided missile and aircraft fields.

Lockheed also announced that Michael E. Browne has joined the missile systems division as a senior scientist in the research laboratory's experimental general physics department.

Browne has been with the University of California as a research physicist and research engineer in its physics department and microwave laboratory.

## ORRADIO Plans Tape Plant

ORRADIO INDUSTRIES of Opelika Ala. will build a new plant designed expressly for the manufacture of magnetic recording tape for sound-and-color tv and electronic computers.

The new \$300,000 plant will increase the firm's production facilities 400 percent. Construction is

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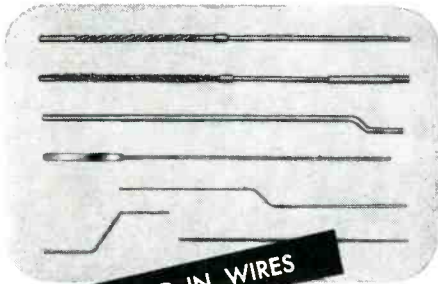


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ELECTRONICS — June, 1956

PLANTS AND PEOPLE

(continued)

scheduled to begin shortly with the new building expected to be ready for occupancy sometime in October.

The building will cover 37,000 sq ft. It will be constructed on a 17-acre tract.

ORRadio Industries was founded by John Herbert Orr, president of the company.

## Hycon Elects Trevor Gardner



Trevor Gardner

TREVOR GARDNER, who recently resigned as assistant secretary of the Air Force, was named chairman of the board of Hycon Mfg. Co. of Pasadena, Calif.

He replaces Harry Oedekerck, who has been chairman since 1953. Oedekerck will continue on the board and remain active in company management.

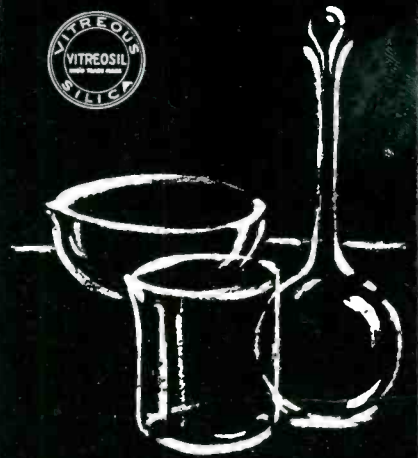
Alden E. Acker is president of Hycon. The company, founded in 1947, manufactures products in the electronic, guided missile, ordnance, and photographic products fields.

An associated company is Hycon Aerial Surveys in Pasadena, which does world-wide aerial mapping and geophysical surveys. The firm's eastern subsidiary is Hycon Eastern of Cambridge, Mass.

Gardner served as civilian head of the U. S. Air Force research and development program for a period of three years until last February. During this time, he directed the Air Force intercontinental ballistic missile program.

Gardner was one of the original founders of Hycon Mfg. company and left the company, severing all connections, to take up government service.

At Hycon Eastern, Alfred J. Pote was appointed executive vice-presi-



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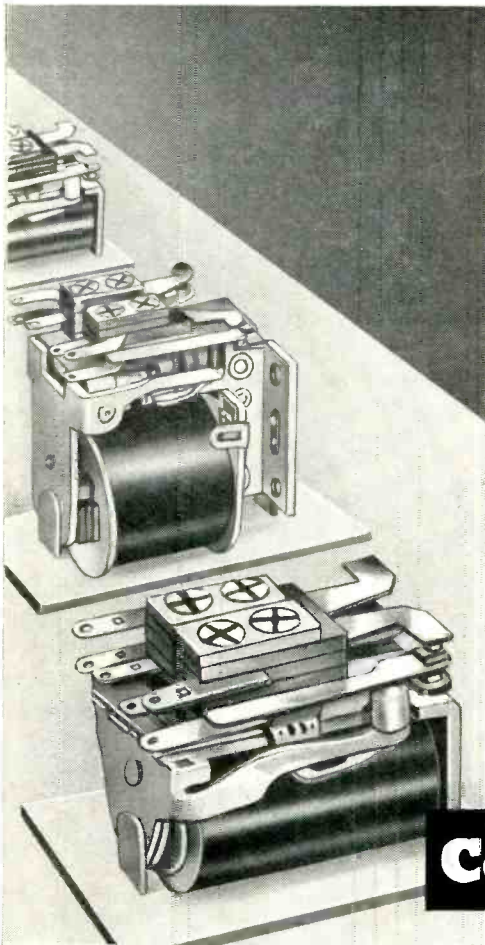
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WOUND



Alfred J. Pote

dent and director of engineering. Howard W. Boehmer was appointed chief engineer.

Before joining Hycon last year as vice-president and chief engineer Pote served at the Lincoln Laboratory of MIT as head of the communication system design group. He worked with Bell Laboratories, Western Electric, Signal Corps Electronic Laboratories and others on scatter propagation.

In addition to basic research on radio propagation, Pote has produced equipment designs for high powered radio frequency sources.

Dr. Boehmer joined the staff of the firm recently as assistant to the vice-president of engineering.

Before joining the company he served as consultant and was in charge of the system analysis and evaluation group at the Lincoln Laboratory of MIT.

Before that he was a research physicist for Stromberg-Carlson.

He was associate professor of physics at the University of Colorado.

## GE Appoints Consulting Engineer

THOMAS A. ELDER has been promoted to the post of consulting engineer in the engineering section of General Electric's power tube sub-department.

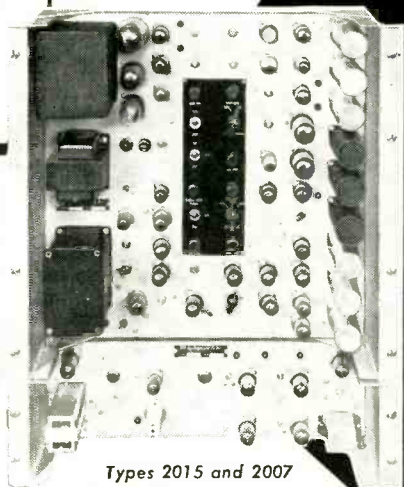
In his new position, he will assist management in the technical evaluation of programs in the power tube field and will act as a liaison with various laboratories working in this field.

From 1940 to 1953 he had

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Types 2015 and 2007  
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INFORMATION



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several technical and supervisory assignments. From 1953 to April, 1955, he served as manager of the design engineering group having responsibility for klystrons, traveling wave tubes, magnetrons, vacuum rectifiers, small microwave tubes and gas-switching tubes. In April, 1955, he was appointed manager of microwave tube product engineering.

### Republic Foil Adds Space

REPUBLIC FOIL and Metal Mills is adding an 8,500 ft extension to its present building. The addition will house new offices and make room for new equipment to be installed later this year.

### Hall-Scott Acquires Douglas Roesch

HALL-SCOTT, INC., formerly Hall-Scott Motors Co., has acquired Douglas Roesch, Inc. of Los Angeles in a cash transaction.

The new acquisition will be integrated into Hall-Scott's electronic division.

Douglas J. Roesch, founder and president of the firm, is joining Hall-Scott as a vice-president and general manager of its electronics division. Roesch produces electronics cable and wire and remote controlled television sets.

The firm is Hall-Scott's third electronics acquisition in less than a year. The other two were Bardwell & McAlister and Dynamic Analysis Co.

### IBM To Build Lab, Names Engineers

INTERNATIONAL Business Machines awarded a general contract for the construction of the company's airborne computer laboratories at Owego, N. Y.

Construction is to begin in May on a total of 408,000 sq ft of floor space which will include an administration building comprising 72,000 sq ft, an engineering structure of 152,000 sq ft, and a manufacturing building of 184,000 sq ft.

The new facility will house the airborne computer laboratories' research development and manu-

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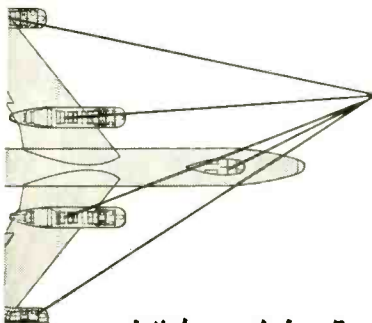
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facturing operations presently located at Vestal, N. Y., and at the firm's manufacturing plant in Poughkeepsie, N. Y. IBM also announced the appointment of Gavin A. Cullen as general manager of the company's new San Jose, Calif., plant. Since 1955 he has been general manager of the Kingston, N. Y., military products center. He has been with the company since 1932.

IBM recently announced that its present San Jose operations will be moved late this year into new facilities, comprising 400,000 sq ft, soon to be constructed.

Robert P. Crago, formerly assistant general manager of the military products center, succeeds Cullen as general manager at the Kingston facility. He joined the firm in 1949. Richard J. Whalen has been named assistant general manager of Kingston. He previously was manager of engineering there, a post to which Harold D. Ross, formerly manager of development engineering at Kingston, has been appointed.

## Motorola Promotes Harold Jones



Harold A. Jones

HAROLD A. JONES has been promoted to national sales manager of Motorola Communications and Electronics.

He formerly was executive assistant to the national sales manager, Eugene S. Goebel, who recently was named vice-president for market relations.

Jones joined Motorola in 1946 as a television receiver engineer. He subsequently served Motorola as

**HIGH**

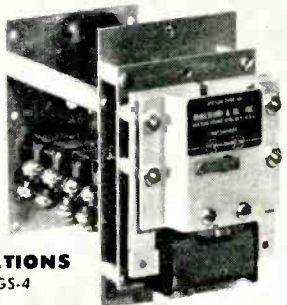
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# BALLOON

**CONTROL INSTRUMENTS**  
require **MAXIMUM** Performance

**MINIMUM** Size - Weight - Power Drain

BRAILSFORD  
AGS TIMERS  
ARE UNMATCHED  
IN THESE BASIC  
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IF YOU HAVE A  
TIMING PROBLEM  
WHERE SIZE,  
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**SPECIFICATIONS**  
Model AGS-4

NUMBER OF CIRCUITS—4 SPDT

WEIGHT—6.1 OZ.

SPEED REGULATION  $\pm 1.0\%$  @  $\pm 50.0\%$  VOLTAGE SHIFT

SIZE—3 IN. X 2 $\frac{1}{4}$  IN. X 1 $\frac{3}{4}$  IN.

POWER INPUT—008 AMP. @ 6 V.D.C.

ALSO AVAILABLE 1—2 OR 3 CIRCUITS

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## PROVEN PERFORMANCE

at elevated temperature ...

a steel ball ...

and a 1,000 gram weight ...

prove that ...

**TEMFLEX\* 105**  
gives you greater resistance to penetration

● In the testing ovens of Irvington's quality control laboratories, the superiority of tough Temflex 105 is proven repeatedly. Weighted, "pressured" with an inserted steel ball that would penetrate older type plastic tubings far sooner, Temflex shows 20% greater strength. Besides passing ASTM D-876 tests, Temflex far surpasses the other requirements of Mil-I-631 C specification. It is QPL approved and has UL approval as a 105° C. tubing. Self-extinguishable, fungus resistant Temflex comes in all standard colors and sizes. Send for samples and literature.

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ELECTRONICS — June, 1956

PLANTS AND PEOPLE

(continued)

a microwave development engineer, 2-way systems engineer and in 1948 was appointed engineering supervisor of advertising and publicity. In 1949 he was named manager of the technical information center, and in 1954 took on the added responsibilities of executive assistant to the national sales manager.

### Transitron Opens New Plant

TRANSITRON, INC. opened a modern 100,000 sq ft plant in Manchester, N. H. The firm moved from New York to the larger quarters which will provide facilities for over 400 employees, plus an enlarged staff of engineers and technical consultants. The principals of the firm Sam K. Lackoff, president; Ralph H. Baer, chief engineer; Leonard Geier, director of purchasing, will make permanent residence in Manchester.

Incorporated in 1951, the company produces a line of electronic signal generators and allied test equipment, in addition to a variety of electronic and electro-mechanical aircraft instruments.

The company recently became a subsidiary of Van Norman Industries of Springfield, Mass.

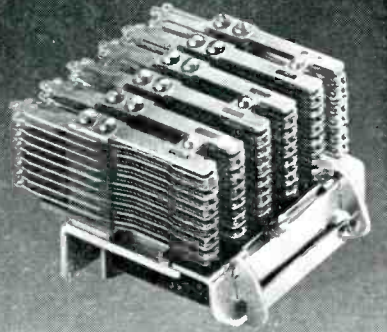
### Topp Plans Merger, Appoints Engineer

TOPP INDUSTRIES of Los Angeles announced merger plans for the acquisition of Haller, Raymond and Brown, Inc. of State College, Pa.

Robert V. Higdon, president of Haller, heads a staff of 250 engineers, scientists, and supporting personnel engaged in electronics, electro-mechanical, and other scientific research and development. He is a former assistant professor of electrical engineering at Pennsylvania State University. Prior to joining HRB, Inc., as a project engineer, he was with Naval Research Laboratory and Norden Laboratories Corp.

B. F. Gira, president of Topp Industries, was formerly president of Bonner Machine Works which merged with the Topp Industries in 1955. Before founding this company, he was with Douglas Aircraft

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In telephone applications ...



now available to you  
**STROMBERG-CARLSON**  
TYPE "B" RELAY

If reliable operation of a large number of contacts has application to your work, you should examine this remarkable relay, manufactured with extreme precision.

Our gang-type "B" relay can be furnished with combinations of A, B or C contacts with a capacity of up to 60 form A contacts. It will accommodate six stacks of spring combinations which, due to special construction, occupy an unusually small space and make the relay desirable for group mounting.

This relay has been for years distributed exclusively and in large numbers to the Independent telephone industry. Expanded production facilities enable us now to offer it to the general engineering world. Like all our relays, it is designed to operate under extreme ranges of temperature and humidity.

On request ... If you will write or call, and state the application you'd plan to use it in, we'll be happy to send additional information, and a catalog of our entire relay line. No obligation, of course.



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A DIVISION OF GENERAL DYNAMICS CORPORATION

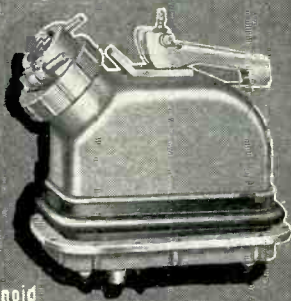
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40<sup>th</sup>  
YEAR  
1910-1950

# Cannon quality in missile launching connectors means safety



GMA—Solenoid  
or Manual Release.  
41 to 140 Contacts.  
Coaxials Available.



GMD—Skid Away  
Release. 22 or 50  
Size 14 Contacts.



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Performance of missile  
launching connectors  
cannot be "hit or miss."  
It must be right! That's  
where Cannon's reputation  
for quality and design  
experience can help you  
with the most complete  
and most reliable line  
available.



Write TODAY for  
GM1 Bulletin.

## CANNON PLUGS

CANNON ELECTRIC CO.  
3209 Humboldt Street  
Los Angeles 31, Calif.

Please Refer to Dept. 120

Want more information? Use post card on last page.

Company as manager of four East-  
ern offices and later as chief pur-  
chasing agent for the West Coast.

The two executives stated that  
according to current plans, their  
companies will combine to develop  
and produce electronic systems for  
aircraft and guided missiles and  
engage in industrial and commer-  
cial projects in addition to their  
defense work.

Headquarters would be located in  
Los Angeles where Topp Industries  
designs and manufactures aircraft  
instrumentation, airborne systems,  
electronic controls, industrial auto-  
mation devices and electro-mech-  
anical equipment. Haller, Ray-  
mond and Brown would continue to  
carry on its electronics research and  
development programs at its State  
College facilities as a subsidiary.

Topp Industries also announced  
that Frank H. Squires has been ap-  
pointed director of quality control.

Squires was formerly quality con-  
trol manager at Lear in Santa  
Monica, Calif. In previous years he  
has held responsible quality control  
positions with Hughes Aircraft Co.,  
Air Associates and Thomas A. Edi-  
son Industries.

He is currently chairman of the  
Los Angeles section, American So-  
ciety for Quality Control.

### Fairchild Camera Promotes Hodgson

RICHARD HODGSON was named ex-  
ecutive vice-president of Fairchild  
Camera and Instrument Corp. His  
appointment followed the resigna-  
tion of John M. Case, who came to  
Fairchild in 1953 from IBM. Case  
was named executive vice-president  
in 1954 with the specific assign-  
ment of planning and implementing  
a program of functional decentrali-  
zation, which he has recently com-  
pleted.

Hodgson, a corporate vice-presi-  
dent and general manager of the  
company's largest division, recon-  
naissance systems, joined Fair-  
child Camera a year ago. He will  
continue as general manager of the  
division. Formerly president of  
Chromatic Television Laboratories,  
he has been a research staff mem-  
ber of M.I.T.'s radiation laboratory  
working on microwave develop-

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your creative and imagina-  
tive ability at North Ameri-  
can's Columbus Division—  
home of the famous Navy  
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highly profitable research  
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ments, radar consultant to the office of the Secretary of War, and civilian radar advisor to Gen. Hoyt B. Vandenburg.

In addition to his military associations, Hodgson has also been a director of television development for Paramount Pictures Corp., assistant treasurer of Allen B. DuMont Laboratories and head of the engineering management division of Brookhaven National Laboratory, A.E.C.

### Sylvania Programs Atomic Expansion

SYLVANIA ELECTRIC plans a multi-million dollar expansion program in the atomic power field.

The first step of the program, which will extend over the next five years, will be new production and development facilities for nuclear fuels and components. The new production plant and laboratory will be constructed on one of several sites under consideration in the East.

The company also announced that Donato J. Bracco has been named manager of the chemistry laboratory.

In his new post, he has responsibility for the company's research programs in such fields as surface chemistry, electrochemistry, solid state chemistry, reaction kinetics, diffusion and analytical research, including radioactive chemical procedures.

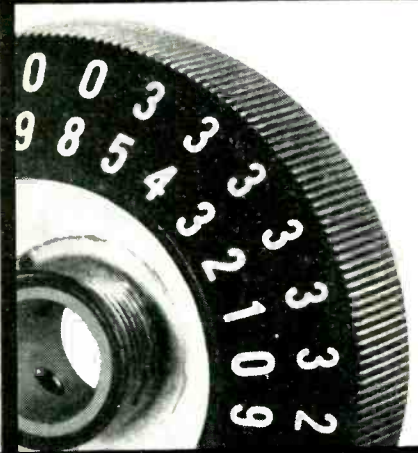
Bracco came to Sylvania in 1947 as an engineer in the physics laboratory. He served in various assignments concerned with physi-



Donato J. Bracco

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The unparalleled design flexibility of the Lackon® photo-marking process may offer you the best solution. With a minimum of gimmicks and gadgetry, Lackon® gives you a panel of unequalled marking accuracy, optimum legibility and lighting uniformity, with excellent resistance to severe environmental conditions. Designed, tested and quality controlled in our government approved laboratory, Lackon® edge lighted panels, knobs and knob skirts meet and exceed lighting, legibility and durability requirements of specification MIL-P-7788.



The Lackon® engineering staff of the United States Radium Corporation will readily assist your panel engineering department during the initial design stage. The cooperative application of their skill and experience in lighting techniques to your panel design will speedily resolve design difficulties, result in decided production economies, and yield a remarkably superior finished product. For information write Dept. E-6

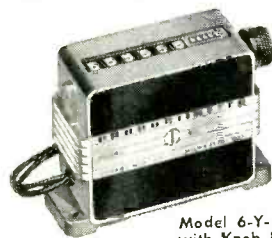
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Regional offices at: 4624 W. Washington Blvd., Chicago 44, Ill.; 5420 Vineland Ave., North Hollywood, Calif.; 36 Avenue Krieg, Geneva, Switzerland; Radelin-Kirk, Ltd., 1168 Bay St., Toronto 5, Ont., Canada

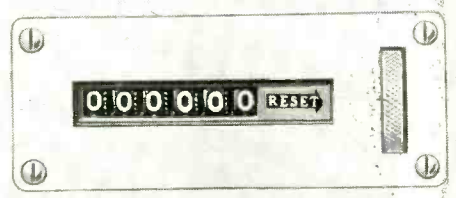
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**VERSATILE**  
*Electric*  
**COUNTING UNIT**  
to your **PRODUCT,**  
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Model 6-Y-1-MF with Knob Reset

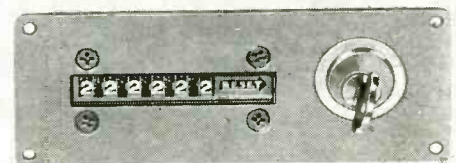
Small, compact — with mechanism entirely enclosed as protection against dust and moisture. Maximum visibility. Records accurate count at high, low and intermediate speeds.

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Aluminum knurled reset knob — entire face flush to front of machine or at control center, singly or grouped. Counter can be placed into panel and fastened from front.



... Tumbler-lock **KEY RESET. ONLY A "KEY MAN" CAN RESET IT!**

Prevents unauthorized tampering wherever this counter is located. Accurate counts up to 1000 per minute.

**PRODUCTIMETERS**  
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OSCILLOSCOPE KIT

FOR COLOR TV!

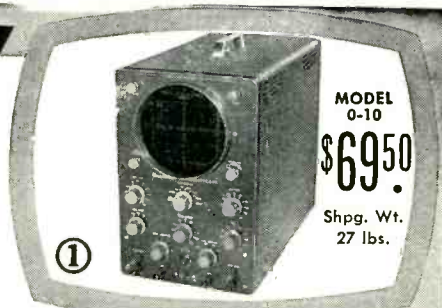
① Check the outstanding engineering design of this modern printed circuit Scope. Designed for color TV work, ideal for critical Laboratory applications. Frequency response essentially flat from 5 cycles to 5 Mc down only 1½ db at 3.58 Mc (TV color burst sync frequency). Down only 5 db at 5 Mc. New sweep generator 20-500,000 cycles, 5 times the range usually offered. Will sync wave form display up to 5 Mc and better. Printed circuit boards stabilize performance specifications and cut assembly time in half. Formerly available only in costly Lab type Scope. Features horizontal trace expansion for observation of pulse detail — retrace blanking amplifier — voltage regulated power supply — 3 step frequency compensated vertical input — low capacity nylon bushings on panel terminals — plus a host of other fine features. Combines peak performance and fine engineering features with low kit cost!

*Heathkit* TV

SWEEP GENERATOR KIT

ELECTRONIC SWEEP SYSTEM

② A new Heathkit sweep generator covering all frequencies encountered in TV service work (color or monochrome). FM frequencies too! 4 Mc — 220 Mc on fundamentals, harmonics up to 880 Mc. Smoothly controllable all-electronic sweep system. Nothing mechanical to vibrate or wear out. Crystal controlled 4.5 Mc fixed marker and separate variable marker 19-60 Mc on fundamentals and 57-180 Mc on calibrated harmonics. Plug-in crystal included. Blanking and phasing controls — automatic constant amplitude output circuit — efficient attenuation — maximum RF output well over .1 volt — vastly improved linearity. Easily your best buy in sweep generators.



MODEL 0-10

\$69.50

Shpg. Wt. 27 lbs.



MODEL TS-4

\$49.50

Shpg. Wt. 16 lbs.



cal and chemical research, and became acting manager of the chemistry laboratory last August. Prior to joining Sylvania he had been with the New York office of the U. S. Atomic Energy Commission, and the titanium division of National Lead Co., in engineering and research capacities.

## Electro Tec Consolidates, Expands Plants

ELECTRO TEC CORP. of South Hackensack, N. J., producer of precision slip ring and commutator assemblies, has integrated the parent company, Electro Tec Corp., with Electro Tec of Florida, heretofore a wholly owned subsidiary, and Instrument Corporation of America of Blacksburg, Va.

The new corporate set-up ties-in with major expansion of plant facilities in all three divisions. Included in the expansion is the Florida division in Ormond Beach, as well as major additions to existing facilities in Virginia and New Jersey.

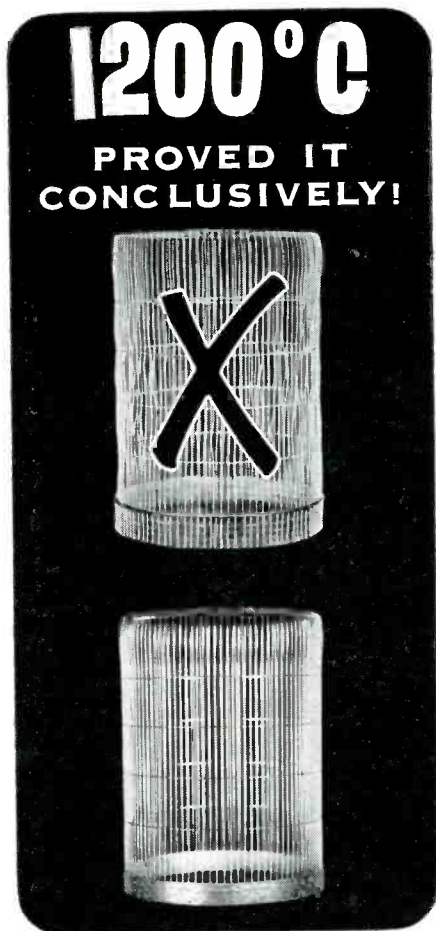
## Baird and Atomic Approve Merger

PROPOSED MERGER between Baird Associates, Inc. and Atomic Instrument Co., both of Cambridge, Mass., has been unanimously approved by directors of both companies, subject to stockholder approvals.

Baird Associates, Inc., has for 20 years designed and manufactured optical-electronic equipment. At the end of the first half of its fiscal year, the company reported total sales of \$1,657,000, compared with \$1,914,000 for the entire fiscal year ending September 30, 1955. Net profit for the six-month period was approximately \$107,000. Baird reports a backlog as of March 31, 1956 of over \$1 million.

Atomic Instrument Company, formed in 1946 for manufacture of components and instruments for the nuclear and electronic industries, reported total orders of \$346,000 for the first quarter of its fiscal year ending March 31, 1956. This represents a gain of 22 per cent over a similar period in 1955. Shipments during this time totaled





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**PROVED IT CONCLUSIVELY!**

**NEW**

**BAKER**

**NON-SAG**

**Platinum Clad Tungsten Wire**

**STANDS UP BEST WHERE HIGH TEMPERATURES ARE REQUIRED!**

In scientifically controlled comparison tests to determine relative sag at elevated temperatures, both platinum clad molybdenum and platinum clad tungsten wire showed very little sag. But at 1200°C the molybdenum sagged seven times faster than the tungsten.

In addition to this advantage, tungsten shows a substantially lower degree of interaction with platinum. Baker's Platinum Clad Tungsten Wire is available in a broad range of diameters.

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ENGELHARD INDUSTRIES

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ELECTRONICS — June, 1956

PLANTS AND PEOPLE

(continued)

\$310,000, 19 per cent over a year ago. As of March 31, Atomic's backlog was nearly \$330,000.

Walter S. Baird, president of Baird Associates, will serve as president of the merged corporation and Leonard Cronkhite, president of Atomic Instrument, will be vice-president in charge of marketing. Principal officers of both companies will assume corporate officer posts.

**Leach Names Julin President**



K. F. Julin

KENNETH F. JULIN has been appointed president of Leach Corp. He has been executive vice-president and general manager since December, 1954.

Leach manufactures relays and other electronic and electrical products.

Julin served as general manager of the Leach Relay Co. before its absorption by Leach Corp. Previously, he was general manager of the Jeffries Transformer Co.

**U. S. Time Sets Electronics Expansion**

THE UNITED STATES TIME CORP. of Waterbury, Conn. is planning to purchase the J. Pierpont Morgan estate at Irvington, N. Y. to establish an instrument research and development laboratory on the property.

The firm seeks to include the 27 room mansion in its instrument research program at Irvington and will pay approximately \$100,000 for the four and a half acres and the two buildings.

Earlier this year the company

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**EECO PLUG-INS**



Every day more organizations are discovering the advantages of using EECO plug-in circuits in developing electronic equipment.

Why not join this winners' circle and prove the advantages for yourself?

Your engineers will be free to concentrate on the design of systems instead of routine circuit detail.

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Your customers will enjoy the satisfaction of superior equipment, the convenience of easier maintenance.

All of which adds up to greater profits, increased customer prestige, and more orders for you.

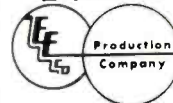
Standard EECO plug-ins, proven by more than four years' service in some of the nation's largest data systems, are available from stock. Custom units can be readily manufactured to your circuit requirements. Costs are actually below those of standard assembly methods. Write for data file No. A-2.

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# PRECISION PHASE METER



Measuring a fraction to .1° with excellent stability.  
.3 volt sensitivity.  
0-18° full scale direct indication of phase angle in degree.  
No amplitude adjustment.

## Type 405 Specifications:

Frequency Range: 8 cps to 100 kc.  
Phase Ranges: 0-18, 0-36, 0-90, 0-180 or 180-198, 180-216, 180-270, 180-360.  
Accuracy: 1/4° relative, ± 2% or ± 1 absolute.  
Input voltage .3 volt to 75 volts.

Price: \$485 F.O.B. Passaic, N. J.

**ADVANCE  
ELECTRONICS LAB., INC.**

451 Highland Avenue • Passaic, N. J.



PLANTS AND PEOPLE

(continued)

took an option on controlling interest in Electronic Specialty Co. of Los Angeles.

## Ramo-Wooldridge Selects Sterner

JOHN STERNER, former vice-president of Baird Associates of Cambridge, Mass., has been named director of flight test operations for the guided missile research division of Ramo-Wooldridge Corp.

Dr. Sterner was associated for four years with the Watertown Arsenal, Mass., metallurgical research laboratory for the Army Ordnance Corps. He left the Arsenal to become one of the founders of Baird Associates with which he was affiliated for eighteen years.

As director of flight test operations, he will serve as the division's director of operations at Patrick Air Force Base, Fla.

## Nuclear Corp Acquires Another Company

NUCLEAR CORPORATION of America has acquired the assets and business of Research Chemicals of Burbank, Calif., in exchange for 22,222 shares of Nuclear's Class A stock.

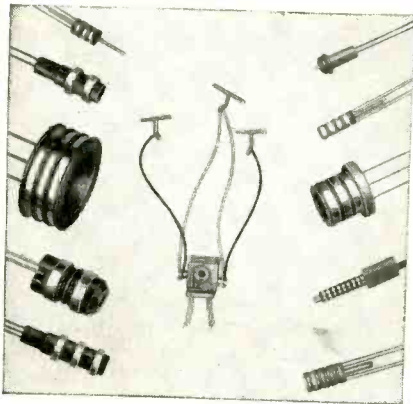
Research Chemicals, Inc. is engaged principally in the separation of rare earths from raw material, or partially processed materials. In 1955, Radioactive Products of Detroit, Mich. was acquired and earlier this year Nuclear bought Central Sales & Manufacturing Corp. of Denville, N. J.

Nuclear manufacturers radiation detection equipment, electronic components and related end-equipment, radio active pharmaceuticals and special chemicals.

## Sorensen Completes European Merger

SORENSEN & COMPANY'S European subsidiary, Sorensen Ltd. of Zurich, Switzerland has merged with Applied Research and Development Ltd., also of Zurich. The newly-formed firm will be known as Sorensen-Applied Research and Development.

Franz Roth, president of A.R.D., will be sales and finance executive



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and other  
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**COLLECTRON CORPORATION**

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of the new company. Paul Corbat, of Geneva, brother of Marcel Corbat, chairman of the board of Sorensen in Stamford, Conn., will direct research, technological and production activities.

### Studebaker-Packard Builds Missile Plant

AEROPHYSICS DEVELOPMENT CORP., a subsidiary of Studebaker-Packard specializing in guided missile research and development work, is building a new \$1.6 million plant in Santa Barbara, Calif. The new facility, to consist of a 56,120 sq ft engineering building and a 45,000 sq ft research building, is scheduled for completion by the end of the year.

The company is moving personnel from Santa Monica to Santa Barbara, and plans to shift projects now in progress to the area as rapidly as possible.

### IT&T Promotes Top Executives



Frederick R. Furth

REAR Admiral Frederick R. Furth, U.S.N. (Retired), has been elected a vice-president of the Farnsworth Electronics Co. division of IT&T. Admiral Furth retired from the U.S. Navy at the end of 1955 to join the Farnsworth organization as special assistant to the president.

He was promoted to the rank of Rear Admiral in 1953, while serving as assistant chief of the Bureau of Ships for electronics.

As Chief of Naval Research in 1954 and 1955, Admiral Furth directed the expansion and use of new techniques in the Navy's con-



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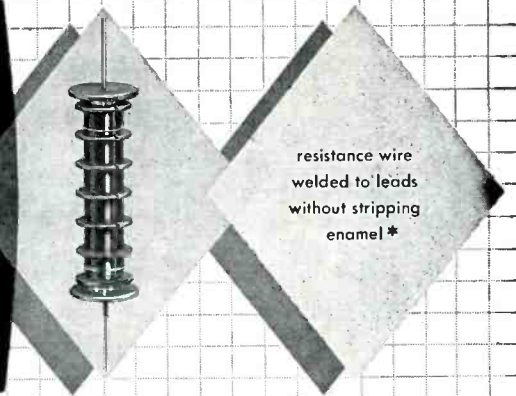
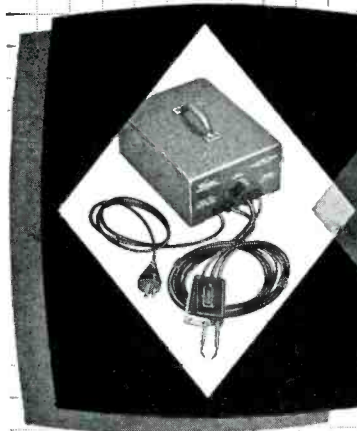
### GOLD INLAY KNOBS

Select your knobs or pointers from GEE-LAR'S huge stock of quality products. Fast service... lower cost—always at GEE-LAR!

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### TERMINATE PRECISION RESISTORS WITH SPEED AND RELIABILITY



resistance wire welded to leads without stripping enamel\*

### precision stored-energy welding

WELDMATIC MODEL 1012 TWEEZER TYPE WELDER welds fine wire to leads or tabs while resistor is on winder. Enamel stripping and flux contamination eliminated, with production time halved. Welded connection is very positive, stable, and rugged.

\*Made by Irco Industries (subsidiary, I.R.C.)



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Write for Complete Technical Information on Stored Energy Welding

## How to Calibrate Your own Instruments



### FAST ACCURATE CALIBRATION

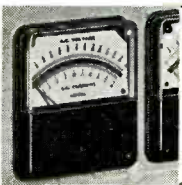
Now possible with one completely self-contained AC-DC calibration standard requiring a minimum of operator training and previous instrument calibration experience.

## Use the Compact Model 829 INSTRUMENT CALIBRATION STANDARD for

- ✓ LABORATORY STANDARDS
- ✓ PRODUCTION TESTING
- ✓ INSTRUMENT REPAIR
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All Circuits, Power Supplies and Standards are contained in One Single Cabinet!

Precise, practically error-proof checking of most types of electrical indicating instruments in daily use is a routine convenience for Model 829 users. Maintenance of quality control by frequent calibration of instruments and allied test equipment can be accomplished within departments by available personnel. A mechanical index explains step-by-step test procedure.



### WESTON Special Meters

used as standards have 5-inch mirror precision scales, knife edge pointers and are adjusted to better than 0.2% accuracy.

Calibration to full scale accuracy of 0.5% can be accomplished for all instruments measuring d-c voltage (22 ranges) from 0.25 mv to 2000 volts, d-c current (22 ranges) from 2  $\mu$ a to 20 amperes, a-c voltage (19 ranges) from 1.5 mv to 1500 volts, and a-c current (14 ranges) from 1.5 ma to 20 amperes. Net price \$2345. FOB Boonton, N.J.

Write for Technical and Application Data.

## Radio Frequency LABORATORIES, INC.

Boonton, New Jersey, U. S. A.

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tinuing support of upper atmosphere research.

Federal Electric Corp. of IT&T announced the appointment of Vice-Admiral Richard H. Cruzen, USN (Ret.) as project manager for the Dew Line.

Federal Electric was recently awarded the contract to operate and maintain the radar chain.

In his new position, he will have full charge of the over-all operation.

He has a background of extensive experience in Arctic and Antarctic service. In 1939 he commanded the U.S.S. Bear, and was second in command under Rear Admiral Richard E. Byrd, in the establishing of bases at Little America, and in Marguerite Bay, Palmer Land, Antarctic.

► IT&T's Federal Telephone and Radio Co. announced the appointment of Earl M. Allen as chief signal officer of the railroad division.

He comes to Federal from Mass Transportation Consultants in New York, where he served as chief consulting engineer for the past year. Identified with the railroad signaling field for more than 40 years, he has made more than 100 patent disclosures for railroad system designs and signal apparatus.

## Magnetic Elects Executive Officers



A. O. Black

ARTHUR O. BLACK has been elected president and William D. Dickey, executive vice-president of Magnetics, Inc. of Butler, Pa., manufacturers of magnetic components for electronics applications.

With only eight customers less than four years ago, the firm now

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## New HYSOL Adhesive Improves Laminates For Printed Circuit Systems

- **DOUBLES** Bond Strength
- **INCREASES** Solder Temperatures

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184 Laird Drive  
Leaside, Toronto 17, Ontario

Want more information? Use post card on last page.

June, 1956 — ELECTRONICS



has over 600 customers.

Black, one of the founders of Magnetics, has acted successively as director of sales and executive vice-president of the concern.

He served several years on the developmental engineering staff of the Naval Ordnance Laboratories.

Dickey served as general auditor and assistant treasurer with H. K. Porter Co. prior to joining Magnetics in 1955 as treasurer.

### Clark Named For U. S. Engineer Development

ROBERT L. CLARK has been appointed executive secretary of the National Committee for the Development of Scientists and Engineers. In establishing the committee, President Eisenhower said: "The National Science Foundation will provide staff services for the committee and provide leadership to other departments and agencies in carrying forward activities which will contribute to a solution of the problem."

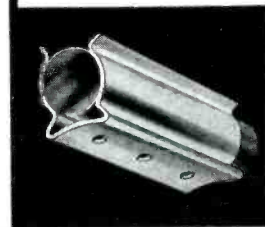
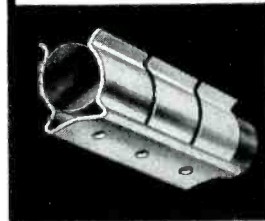
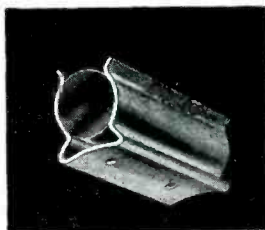
Clark comes to the Foundation from the Office of Defense Mobilization where he has been consultant on the executive reserve since May 1955. Between 1953 and 1955, he was a partner in the firm of Clark, Hitchcock and Associates, resource development consultants.

Chairman of the committee is H. L. Bevis, president of Ohio State University. Vice-chairman is E. A. Walker, dean of engineering at Pennsylvania State.

### American Bosch Promotes Three

SIDNEY E. MILLER, vice-president of engineering for American Bosch division of American Bosch Arma Corp., was named to fill the vacant post of vice-president and general manager of the Springfield, Mass. division of the company. Harold R. Sennstrom, vice-president of product development, succeeds Miller as vice-president of engineering. Kenneth F. Leaman becomes assistant general manager as well as vice-president of manufacturing.

Miller has been associated with American Bosch since 1944 in



## AUGAT Sub-miniature Tube Cradles

- HEAT DISSIPATION
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Protect the efficiency of your sub-miniature tubes, resistors and capacitors in electronic equipment with Augat Tube Cradles. These mite-sized marvels reduce tube temperature by conducting the heat and dissipating it rapidly. Augat Tube Cradles hold tubes firm and steady regardless of external shock and vibration. Once your tubes are inserted in the cradles, they stay put!

Augat Tube Cradles come in three types as shown on the left and may be obtained in cadmium plated spring steel; beryllium copper, silver plated; or silver magnesium nickel where heat dissipation is desired. The base of cradles is convex shaped to provide additional tension when cradle is fastened to chassis. Where additional conductivity is required, shields are available in copper silver plated with gold flash or in silver magnesium nickel material.

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## MODEL 605 WIDE RANGE RESISTANCE BRIDGE

### Features:

- ★ 10 ohm to 100 megohm range
- ★ Simple pushbutton operation
- ★ High accuracy
- ★ Negligible drift
- ★ Guard terminal for high-resistance measurements

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### BRIEF SPECIFICATIONS:

Ranges: 100, 1k, 10k and 100k ohms, 1, 10 and 100 megohms  
 Lowest Meas: 5 ohms  
 Accuracy:  $\pm$  (0.15% of res. meas., + .05% full scale)  
 Drift: Negligible after 30 min. warmup  
 Dimensions, weight: 9 $\frac{3}{4}$ "H x 8"W x 9"D; 8 lbs.  
 Price (f.o.b. factory): \$170.00

Write today for Technical Bulletin 605; please address Dep't. 5G-6

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Expanded Scale Frequency Meters and Voltmeters  
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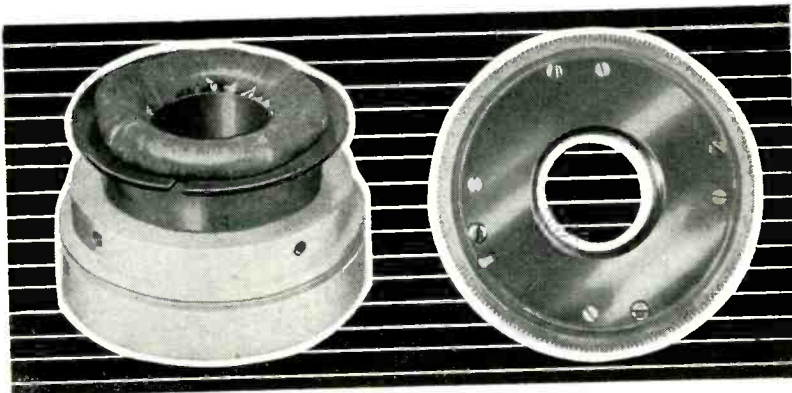
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S-17

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Mahwah, N. J.

PLANTS AND PEOPLE

(continued)

various positions from product engineer on up to his present post. He was formerly associated with the Frigidaire division of General Motors and General Electric.

## White Joins Racon As Chief Engineer



Saul J. White

RACON ELECTRIC Co. of New York appointed Saul J. White as chief engineer. He has been engaged in the audio field for the past 25 years, the last ten as chief engineer for University Loudspeakers. He was formerly with Western Electric Co. and Thomas A. Edison, Inc. In his new association, he will assume responsibility for a complete new series of high fidelity speakers and components.

## Tel Autograph Plans West Coast Move

TELAUTOGRAPH CORP., manufacturers of telescribers, will transfer its manufacturing operations from New York City to the West Coast, following completion of new facilities in Los Angeles late this summer. The new facilities will represent an investment of nearly \$1 million and will enable the firm to complete the westward move of all of its production activities.

The new building project will include construction of two buildings on the five-acre site, containing a total of 80,000 sq ft of floor space. One unit will house the corporation's executive offices, plus Tel-Autograph division administrative, manufacturing, engineering and research facilities. The other will consolidate operations of the





### RELIABILITY FACTORS FOR GROUND ELECTRONIC EQUIPMENT

**JUST PUBLISHED!** Methods and working data to help designers build greater reliability into military electronic equipment. Pinpointing causes of poor reliability. Discusses electrical and mechanical factors, human engineering, and components. Gives results of failed-parts studies. Edited by Keith Henney. 280 pp., 196 illus., \$7.50

### ELECTRONIC ENGINEERING

**JUST PUBLISHED!** Techniques of circuit analysis for radar, television, electronic control, instrumentation, and computers. Gives alternate methods for many circuits, and provides means for combining circuits of different types. Examples relate techniques to practice. Discusses solid state theory, and transistors as circuit elements. By Samuel Seely, Prof. & Chrmn., Dept. of Elec. Engrg., Syracuse U. 525 pp., 782 illus., \$8.00

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**JUST PUBLISHED!** Presents theory and practical techniques for analyzing linear control systems subjected to random inputs. Treats concepts of probability and random time functions in detail. Develops techniques for designing systems containing constant and time-varying components. Provides computational methods for use on computers. By J. H. Laning, Jr., and R. H. Battin, Instrument. Lab., Mass. Inst. of Tech. 429 pp., illus., \$10.00

### AN INTRODUCTION TO REACTOR PHYSICS

Covers elementary nuclear physics and theory of thermal reactors, giving background for reactor design. Calculations, shielding, instrumentation, and radiation are treated. Evaluates a gas-cooled, graphite moderated, natural uranium reactor. Sufficient theory developed for understanding problems in designing all types of thermal reactors. By D. J. Littler and J. F. Raffle, British Atomic Energy Res. Estab. 196 pp., illus., \$4.50

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**JUST PUBLISHED!** FORTUNE Magazine editors tell how 4 billion dollars for research is opening new business opportunities. Reveals opening new research, who pays, how it is carried out, what is accomplished, and what it means to you. By Editors of FORTUNE. 308 pp., 21 illus., \$4.00

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**ELECTRONICS — June, 1956**

firms two wholly-owned electronic subsidiaries, Walter L. Schott Co. and Walsco Electronics Corp., purchased last year as part of the company's diversification program. TelAutograph's third subsidiary, Executive Car Leasing Co., acquired last August, will remain at its present location in Los Angeles.

The firm also announced that Sidney Kasindorf has joined the TelAutograph division in Los Angeles, and will take over direction of product engineering.

Formerly with Federal Telecommunication Laboratories, and Hillier Instrument Company, he has most recently been associated with Packard-Bell Co.

### Clary Enlarging For Missiles

Automatic controls division of Clary Corp. has expanded production and engineering facilities for guided missile and aircraft components.

New appointments to the division's administrative organization are:

Benjamin Ohannesian, assistant manager for the new operations section; Jay Borden, chief engineer, who, with Ohannesian, has been assistant to the general manager; James Garner, chief production engineer for the new production engineering section.


The division's production rate and capacity have been increased by the recent installation of high-speed tool machinery, and additional equipment is planned. The design and development section has been expanded to twice its previous area.

### Burroughs Appoints Computer Head

EDWARD LOHSE has been appointed manager of the newly formed Jupiter division of the Burroughs Corp.'s research activity in Paoli, Pa. He joined the research activity as a department manager in 1955 and will be responsible for the development of a large digital computer for inclusion in a weapons system.

Before coming to the firm he was successively assistant to the chief engineer, chief development engi-


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Sturdy 2 and 3 conductor plugs, reduced in size, are made in a wide variety of terminal and handle styles. Metal handles are baked enamel striped . . . plastic handles in red or black. Screw type, combination clamp and solder lug or plain solder lug terminals.

Jacks make positive electrical contact with standard mating plugs by positive spring pressure. Springs are nickel silver material, insuring long life and maximum solderability. Made in two and three conductor types — open and closed circuit.

Microphone connectors, both cord and panel mounted, are ruggedly made of nickel plated brass.

Send for bulletin giving complete specifications on these new products of a long established manufacturer.

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neer and department head at the Control Instrument Co. of Brooklyn, N. Y. This company was acquired as a subsidiary in 1951.

## Maxson Selects Research Head



Murray Simpson

MURRAY SIMPSON has been elected an assistant vice-president of The W. L. Maxson Corp. of New York. He will head all electronic research and development activities for the company.

Previously, he directed the development of a missile guidance system at Fairchild guided missiles division. Before that, he was engaged in the development of microwave communications equipment at Raytheon.

## Beckman Adds Space In Munich

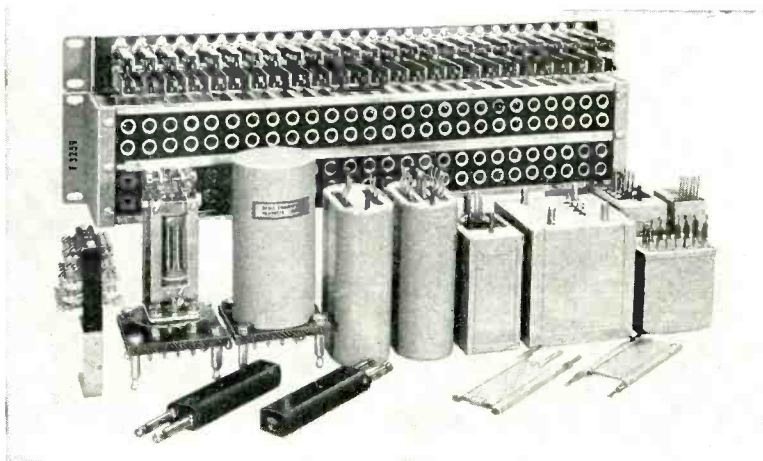
BECKMAN INSTRUMENTS which established a manufacturing plant in the city of Munich, Germany in 1953, has acquired a site there for a new building that will cost \$300,000, accommodate 400 employees and cover 60,000 sq ft over all.

Completion of the building is scheduled for late October.

Beckman Instruments, G.m.b.H., the German incorporation, initially was an experiment with risk capital. Dr. Beckman, president, declared, "A European plant was established because we found it increasingly difficult to compete in European markets due to import restrictions and currency problems.

"We estimated our sales potential when we started in Munich in 1953 with rented quarters and three em-

## COMPONENTS FOR COMMUNICATION SYSTEMS



Radio Engineering Products produces a wide range of standard components for use in communication systems. In most cases these components can be delivered from stock.

**FILTERS:** Filters of advanced design are available for carrier telegraph, carrier telephone, and telemetering systems. These include channel filters, low-pass filters, and line filters.

**JACKS and MOUNTINGS:** Two standard 1 3/4" by 1 9/16" jack mountings are available. Type F6097A mounts 52 single jacks, and type F6097B 26 single jacks. Type F8410 jack is a double jack with parallel break contacts, interchangeable with type 410A.

**REPEATING and RETARDATION COILS:** A large number of standard types are carried in stock. These include voice-frequency and carrier-frequency line coils, hybrid coils, and retard coils for telephone and telegraph applications.

## RADIO ENGINEERING PRODUCTS

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ployees. Today, we are employing 100 persons, the maximum our present facilities will accomodate, and sales have far exceeded our expectations."

Beckman also announced that Thomas Scatchard has been named plant manager for the Berkeley division. He was formerly plant manager of assembly for Merchant Calculators in Emeryville, Calif.

### American Cyanamid Acquires Formica

AMERICAN CYANAMID Co. acquired the business and assets of The Formica Co., manufacturer of plastic laminates.

Formica will operate under its present management as a subsidiary of Cyanamid. D. J. O'Connor, Jr., president of Formica, is president of the new subsidiary.

The \$2.5 million Formica plant expansion program at Evendale, Ohio will increase sheet laminating facilities by 20 percent, according to the company.

### Lab For Electronics Elects President

HENRY W. HARDING was elected president of Laboratory For Electronics in Boston, Mass.

He recently became associated with the company as chairman of its executive committee and for many years has been identified with manufacturing companies.

### Tracerlab Names New Officers

W. E. BARBOUR, JR., was elected board chairman and William O. Faxon president, of Tracerlab. Barbour was a principal founder of the firm and has served as president since its inception.

Faxon has served as executive vice-president and will now be responsible for all of the operations of the newly integrated activities of the company. The company has been consolidating and integrating its nucleonic and x-ray business.

Malvern J. Gross was elected vice-president and general manager of the Keleket X-Ray division. He is currently vice-president and

**DC-AC CHOPPER**

For 60 Cycle Use

Built to rigid commercial specifications.

Twenty-two types, both single and double pole.

Long life.

Low noise level.

Extreme reliability.

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**ACCURACY** (terminal linearity): 0.001% of input in all models.

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**PHASE SHIFT**: dependent on frequency and ratio setting but very small.

Models available to meet military specifications. Choice of manual or automatic (both motor driven and stepping switch) models.

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# NEW! DOUBLE-RANGE Incremental-Inductance BRIDGE

For production and laboratory  
testing of coils  
with d-c and a-c magnetization.

This new, two-in-one instrument provides fast, easy measurement of inductance from .01 to 5 and 5 to 180 henries, with superimposed d-c from one to 500 milliamperes, in inductors up to 150 ohms resistance. Accuracy  $\pm 3\%$ .



## FEATURES

- 1 Direct reading of inductance on large, balance-control dial calibrated for 60 - 400 - 1000 cps, and for use at any intermediate frequency.
- 2 Three-inch 'scope shows phase-difference nulls.
- 3 Panel instruments read direct current and a-c volts.
- 4 Continuous and independently adjustable control of a-c voltage, 0-135 v., and direct current supply, 0-500 ma.
- 5 External-frequency input for measurements at frequencies between 60 and 1000 cycles.

The double-range calibration of the Model 1002-C Incremental Inductance Bridge permits high accuracy in the measurement of low values. Its rapid, simple operation and rugged construction make it equally suitable for production-line and laboratory use. For detailed information, write for bulletin EL-4.

Price \$895.00 complete, net F.O.B. Wayland, Mass.

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director of engineering of the Ritter Co. He has been with General Electric in both the x-ray and nuclear fields. He will be responsible for the engineering, development and marketing of x-ray products.

Construction of Tracerlab's new million-and-a-half dollar plant on Route 128 in Waltham, Mass. is proceeding and transfer of operations from downtown Boston will take place in the fall.

## John Inglis Elects Director

S. M. FINLAYSON has been elected a director of the John Inglis Co. and its associated company the English Electric Co. of Canada. He is president of the Canadian Marconi Co. in Montreal and also president of the Montreal Board of Trade. The John Inglis Co., the English Electric Co. of Canada and the Canadian Marconi Co. are all members of the English Electric Group.

## Schooley Aids Brazilian Navy

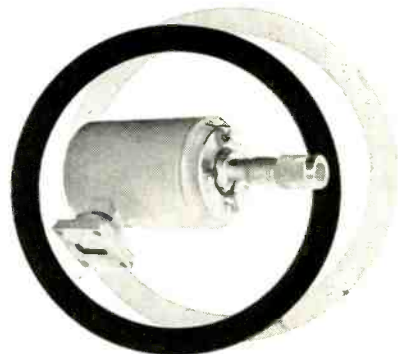


Allen H. Schooley

ALLEN H. SCHOOLEY, superintendent of the electronics division of the Naval Research Laboratory in Washington, D. C., is in Rio de Janeiro assisting the Brazilian Navy in the establishment of a naval research laboratory.

Initial planning of the laboratory, procuring equipment and planning of the first research problems will be included in the assistance furnished by him during his year's leave-of-absence from NRL. The services, which are being furnished under the Mutual Defense

## D-B broad band gas-filled cavity wavemeters



Each instrument covers a wide segment of the total range. Only 11 sizes serve from 2.6 KMC to 90 KMC. Accuracy is so high they may be used as secondary standards. Nitrogen filled and sealed for long life and high Q. Bi-metallic structure provides high degree of thermal compensation. Write for literature.



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101 Series can be furnished with 1/4", .290", 5/16", 3/8" or 1/2" ferrule or cable entrance. Knurled nut securely fastens unit together. Plugs have ceramic insulation and sockets have bakelite. Quality construction. Fine finish. Assembly meets Navy specifications.

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June, 1956 — ELECTRONICS



Assistance Program, were requested by the Brazilian Minister of Marine.

Prior to World War II, Schooley was a radio tube engineer with RCA where he designed and built miniature radio tubes.

Since 1940, he has been with the Naval Research Laboratory, becoming the first superintendent of the electronics division.

### Mycalex Selects Executive Assistant

W. D. KLEPPINGER has been appointed executive assistant to Jerome Taishoff, president of Mycalex Corporation of America and associated companies. He will coordinate the activities of the various departments and companies.

From 1952 until his present appointment he was vice-president of General Ceramics Corp. He served previously with Ford, Bacon & Davis Corp. and The Consolidated Edison Co. in New York.

### American Phenolic Changes Its Name

THE AMERICAN PHENOLIC Corp., manufacturers of electronics components since its organization in 1932, has changed its name to the Amphenol Electronics Corp.

The firm also elected three new board members. They are: M. L. Devine, partner of Cresap, McCormick and Paget; C. H. Lanphier, president and director of the Sangamo Electric Co. and Donald B. Hilliker, vice-president of S. C. Parker & Co.

The company also promoted Rodolfo M. Soria from director of engineering to vice-president in charge of engineering. Edmund A. Stephan was named general counsel for the firm.

### Conrad Names New President

CARL T. ASHBY has been appointed president of Conrad, environmental test equipment manufacturers. He was formerly associated with Servel where he was in charge of research and development for over 17 years. Russell P. Schmelzer is the new secretary and treasurer.

# NEW Jewel-bearing "LO-TORK"



ACTUAL SIZE

## 0.01 ounce-inches

# PRECISION *wire-wound* POTENTIOMETER

Jewel bearings for lowest torque, and superior seal against surroundings that contain abrasive dust, make this new, Model LLT 7/8 Waters pot the ideal unit for high-reliability service where minimum torque is essential. With torque low enough to permit actuation by a Bourdon tube or a bimetallic thermal element, this potentiometer offers new advantages in sensitive-instrument applications as well as in computer, servo, and selsyn uses. Check your needs with these specifications:

Maximum torque: .....0.01 ounce-inch  
 Dissipation: .....one watt at 80° Centigrade  
 Resistances: .....100 ohms to 100,000 ohms  
 Weight: .....½ ounce  
 Outside diameter: 0.885 inch Body depth: 7/8 inch  
 Linearity: 0.5% standard; on special order, 0.25%  
 Winding angle: 354° standard; on special order, 360°  
 Ganging: to six decks with no increase in diameter.

Where the features of a ball-bearing potentiometer are desirable, specify Waters Model LT 7/8 "Lo-Tork" potentiometer.

Write for data sheets on jewel-bearing and ball-bearing precision wire-wound potentiometers.

Do you ever need pots that are "just a bit different"? Maybe we can help you — by modifying a standard Waters design or by taking a bold, new approach. Tell us your need and we'll tell you what we can do.

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Enjoy the benefits of superior, standardized components in your circuits. Jeffers Electronics offers you a full line of R. F. choke coils with a complete range of inductance values... ready for immediate delivery. Write today for our specification sheets.

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fixed composition capacitors

Other Speer Products  
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## New Books

### Electrical Interference

By A. P. HALE

Heywood, London, 1956, 122 p, 15 Shillings

AN ever-growing problem for the electronic engineer is the suppression of interference or the avoidance of its harmful effects. Interference exists as atmospheric, thermal noise or man-made noise. All forms of communication are vulnerable to interference. Perhaps the most vulnerable is television.

► **Man-Made**—This book discusses primarily higher frequency man-made interference, especially that causing unsatisfactory reception by television viewers. The author reveals that during 1954 the General Post Office in Britain investigated some 140,000 complaints.

The book leads off with a discussion of the various causes of interference, including switching noise, discharge through gases and r-f generators. The author discusses how the interfering signals are propagated, both by conduction and by radiation. Succeeding chapters discuss the effects of interference. In this connection several photographs are shown.—J. M. C.

### Advances in Electronics and Electron Physics Vol. VII

By L. MARTON

Academic Press, New York, 1956, 527 p, \$11.50

EACH year the editorial board of "Advances in Electronics and Electron Physics" attempts to present a comprehensive technical survey in several of the more active areas of technical promise.

This year, three major topics are within the broad field of solid-state physics. And well they might be. The transistor and related solid-state devices are becoming increasingly important in the electron art. Subjects presented include: The physics of semiconductor materials, theory of the electrical properties of germanium and silicon and characteristic energy levels of electrons in solids.

► **Astronomy**—A section of the book this year has been devoted to radio astronomy. This also is becoming a topically interesting field, what with proposals afoot for long-range missile guidance utilizing radio signals from space.

Also considered is the subject of analog computers. This chapter gives the engineer an opportunity to bring himself up-to-date in this interesting and important field.

► **Gases**—Two other subjects covered in the book are: sputtering by ion bombardment and electrical discharge in gases. Gaseous electronics is quite a complex subject. The subjects of afterglow, microwave propagation in ionized gases and gyromagnetic effects all come in for consideration.

"Advances in Electronics and Electron Physics" is a book whose annual appearance is indeed awaited anxiously. It certainly provides a convenient way to bring oneself up-to-date in certain fields. Furthermore, it provides a sort of impartial evaluation of the more forward-looking fields of scientific effort.—J. M. C.

### Vacuum Valves in Pulse Technique

By P. A. NEETESON

Cleaver Hume Press, London, England, 1955, 170 p, \$4.50

THIS book is number nine of the electron-tube series in the Philips Technical Library.

According to the preface, "It is the main aim of this book to indicate the methods of determining the behavior of a network in which electronic tubes are used as switches."

The author justifies the book by noting "the ever increasing use of electron tubes in pulse techniques, such as electronic counter-apparatus and computing devices, scalars and radiation counters for atomic research and x-ray application, pulse modulation systems, radar, television, and the like, —."

The subject matter is indicated by the chapter headings: basic theory of switching, application of



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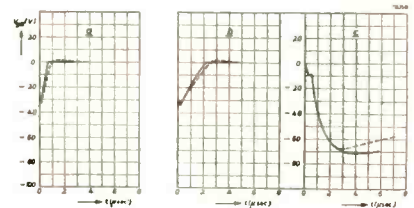
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the theory to simple switching circuits, simple treatment of electron tubes as switches, some elements of the operational calculus, fundamental treatment of electron tubes as switching elements, and the multivibrator family. The multivibrator chapter constitutes more than half of the book.

► **Scope**—As implied by the above headings the author considers switching circuits ranging in complexity from a simple ideal switch with no internal resistance or parallel capacitance to the asymmetrical vacuum-tube multivibrator with positive d-c grid bias. The simpler circuits are solved for voltage or current as a function of time by using differential equations. Following the nine-page chapter on operational calculus the reader is presumed to be sufficiently expert with that approach to follow the derivations concerning various types of multivibrators.

The equations derived are checked by comparing their predictions experimental values.

The style is clear, errors are rare, and there is no hint that the text is a translation. However, the



Grid 2 waveforms for symmetrical (a) and asymmetrical (b and c) multivibrators (reproduced from the book)


reader will be frequently annoyed by the poor placement of figures with respect to relevant text. Further, the method of numbering equations and figures, in which, for example, the numbers 98.7 and 99.7 are successive items in Chapter 7, appeared strange to this reader, especially in view of the fact that successive subsections of Chapter 7 are labelled 7.2.5.3 and 7.2.5.4.

► **Evaluation**—Since the avowed purpose of the author is to elucidate methods of analyzing electronic switching circuits one cannot validly criticize him for failing



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ELECTRONICS — June, 1956

NEW BOOKS

(continued)

to provide a book more useful to electronics workers in their bread-and-butter jobs of circuit design. A reader of this book must not expect it to quickly lead him to the design of, say, a binary circuit having a given trigger voltage and resolving time and a maximum tolerance to changes in supply voltages, tubes and other circuit components.

A reader will be able better to appreciate how the circuit works and the factors controlling rise-times, overshoots, etc. He will be able to predict waveforms of a given circuit by numerical calculation. By such trial-and-error calculations he could arrive at an acceptable design if his mastery of the short chapter on operational calculus had been complete and his patience held out.

However, he will probably proceed more efficiently, if less elegantly, if he builds an analog computer in the form of a breadboard of the circuit under consideration, measures its characteristics, and modifies it in the light of information he may find in this book or elsewhere.—RAYMOND C. WADDEL  
*U.S. Naval Research Laboratory  
 Washington, D. C.*

### Faster, Faster

By W. J. ECHERT AND R. JONES  
*Mc Graw-Hill Book Co., New York, 1956, 160 p, \$3.75*

### Electronic Data Processing for Business and Industry

By RICHARD G. CANNING  
*John Wiley & Sons, New York, 1956, 332 p, \$7.00*

### Electronic Computers and Management Control

By GEORGE KOYMETSKY AND PAUL KIRCHER  
*Mc Graw-Hill Book Co., New York, 1956, 296 p, \$5.00*

IN the area of data processing, the electronic industry is breaking out of the technical confines that have heretofore delineated the field. Thus, business men and management personnel in fields ranging from retail merchandising to rail-roading are talking about electronic

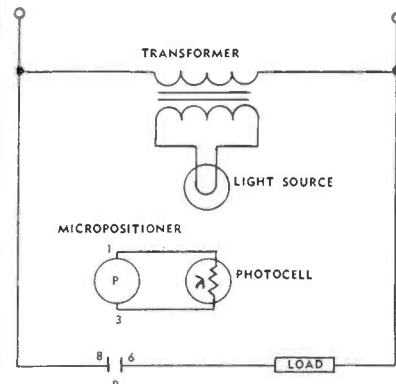


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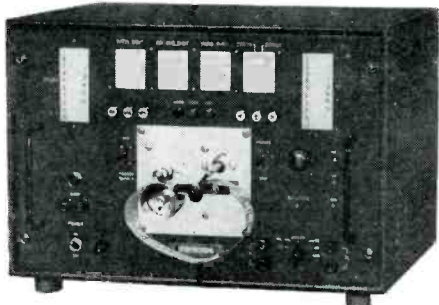
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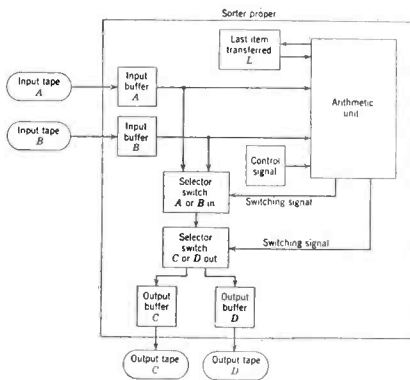
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NEW BOOKS

(continued)

computers. These three books will help them understand what they are talking about.

► **Norc**—The book, "Faster, Faster" explains to the general reader how an electronic digital computer solves problems. The case at point is the IBM Norc. (Naval Ordnance Research Calculator).



Simplified diagram of an electronic sorter

► **Data Processing** — The second book is written primarily for the programmer and systems specialist. It discusses the problems involved in setting up an electronic data processing establishment. The book takes the reader through a systems study which is intended to streamline company operations before bringing in the computer.

► **Management Control**—The third book of this group is written to inform management as to how computers can help solve business problems. It describes how electronic computers operate and surveys electronic methods of data processing from the point of view of internal and external storage.

**Thumbnail Reviews**

**High Temperature Technology.** I. E. Campbell. John Wiley & Sons, New York, 1956, 526 p, \$15. Recent developments in materials, methods and measurements in the high temperature field are described by 35 contributing research workers. Many of the materials discussed are important in the manufacture of electron tubes and components. For example: tungsten, various oxides, carbon and graphite, and cermet.

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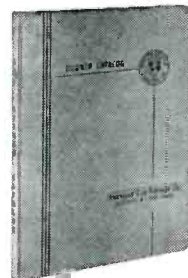
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June, 1956 — ELECTRONICS



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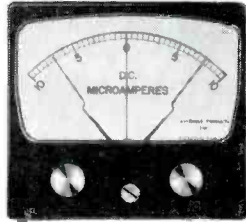
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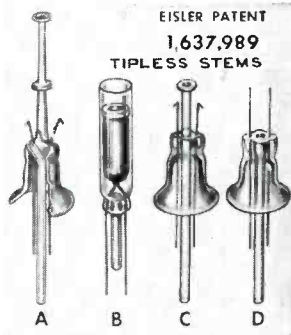
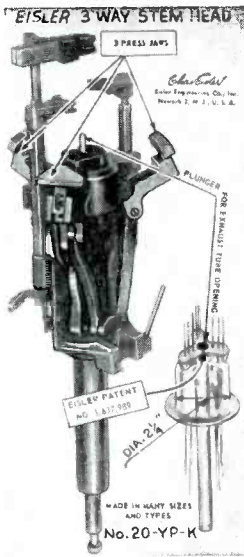
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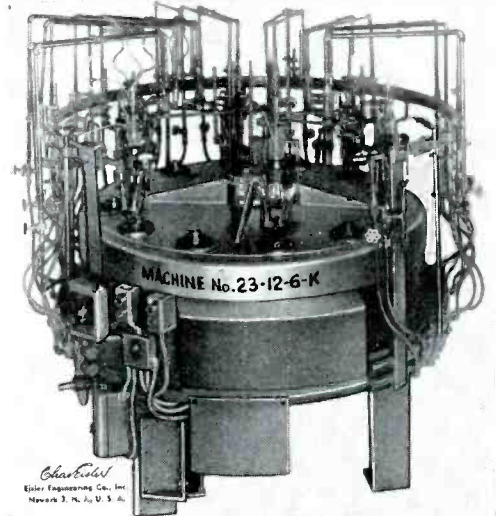
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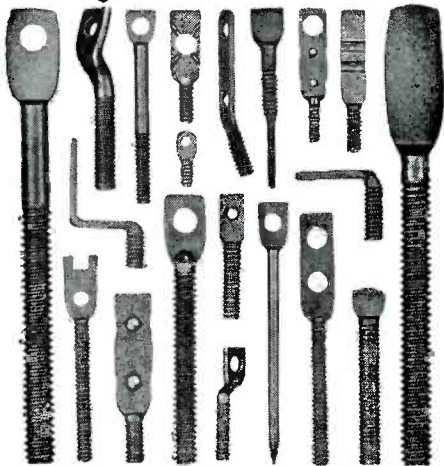


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## Backtalk

### Speed Meter Accuracy

DEAR SIRS:

IN CONNECTION with the article entitled "How Accurate Are Radar Speed Meters?" by J. Q. Brantley, Jr., (Dec. 1955, *ELECTRONICS*), it is incumbent upon electronics engineers who may be called upon as expert witnesses to know the accuracies attainable with a typical unit. The article itself is careful to note some limitations of applicability and is quite typical of the type of expert witness testimony used to uphold the use of radar meters over the nation, but leaves the technical case for the motorist virtually untouched.

Unfortunately for the motorist who only has a \$10-plus stake to defend in a typical fine, he can neither afford, nor has access to, the type of instrument study needed to defend himself. Of more than a dozen higher court cases of record examined during the past year, not one single case had an expert witness for the defense; yet each had an expert witness for the prosecution.

Since justice demands the whole technical as well as legal truth, I suggest a reading of a paper entitled "Radar Evidence in the Courts" published in the journal *DICTA*. . . .

The merits of instrumentation in practical justice can scarcely be judged on the meter accuracy attainable, but must be judged on the basis of accuracy that could be assured under the particular, and often very special, circumstances of alleged violation.

The illusory nature of street test data not checked by laboratory analysis of the instrument may be illustrated by noise tests cited by an expert witness in one case. "Proof" that the instrument reading was not susceptible to noise when subjected to elaborate noise artifices was in reality established over a range in which the instrument meter indication was circuitally clamped and could not have been responsive to newly received vehicle velocity signal either! This was not a contrived test, unknown

to the witness, but just the way the instrument happened to be designed.

The paper points out the fallacy of the presumption that error will ordinarily favor the motorist, and cites numerous more mistaken assumptions which police have testified they followed in practice. . . . The real major error hazard in doppler radar arises from short-term frequency instability and not long-term frequency stability which can be computed to show relatively unimportant error.

The *DICTA* paper does not itself contain the voluminous technical proofs necessary to a complete analysis and does not attempt to do more than call attention to a few of the pitfalls of witness testimony.

Rodney W. Johnson reported tests by a police survey team in Los Angeles (*Tele-Tech*, Jan. '56). It was stated that tests with the equipment on the Los Angeles freeways have shown it to be only moderately satisfactory on heavily traveled roads. To avoid multiple target saturation it was necessary to aim the unit at an angle of about 50 degrees with the roadway. It is further stated that a difference of 6 mph occurred in readings by reason of orientation and that "multiple targets caused considerably more difficulty."

This is representative of the way the instrument is actually being used, somewhat of necessity. Such use contradicts even the manufacturer's limitation of use, which presumes that the instrument will not be used at an angle of more than 10 degrees with the roadway.

The fallacy that the motorist will almost always have the benefit of inaccuracy becomes apparent when note is taken of testimony by patrol officers in court (*DICTA*, Sept.-Oct. 1955) that the instrument was only placed in use by them when it agreed 100 percent with the speedometer reading called out from a police car passing the instrument, checked in both directions. Calling the wide-angle test figure 100 percent of true would then result in a 6 mph too high figure (using Mr. Johnson's figure) when a motorist,



in turn, is intercepted at a nearly parallel angle of normal maximum distance interception down the street.

It is apparent that too many arbitrary procedures are being used which cannot be supported in radar theory, or by the manufacturer's instructions. No note of these inconsistencies has been taken in many of the laws making the radar speed meter readings prima facie evidence of speeding. . . .

Judges, jurors, and police, not pretending to be technical experts, nor pretending to understand technical discussion, are generally willing to believe what they can see. So, they arrange for a side-by-side comparison or radar meter and speedometer readings on the street.

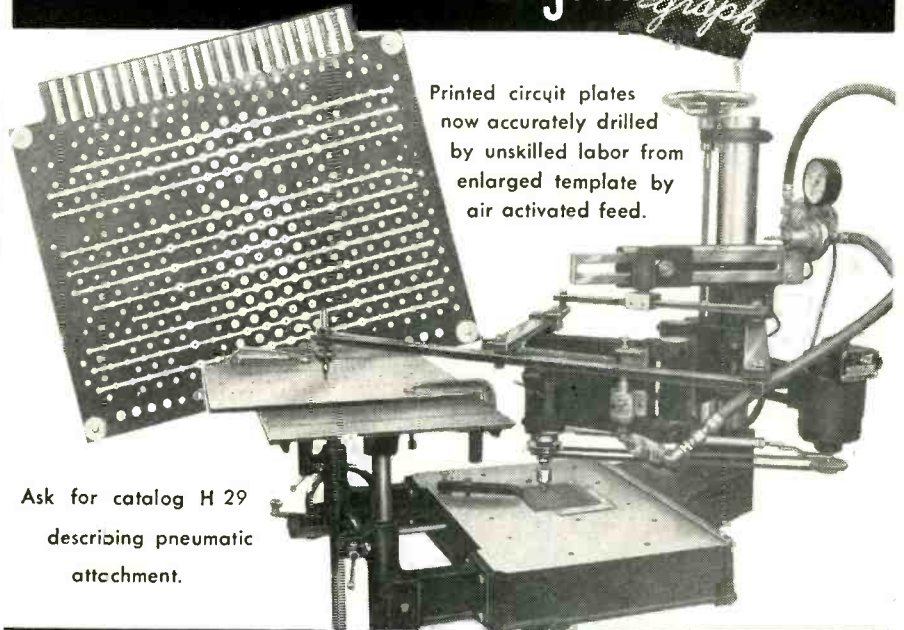
The defendant, contending that noise or some other disturbance must have caused an excessive velocity reading, is invited to stand with other volunteers in a range of strong signal intensity, say 25 ft. or so from the instrument. Each is equipped with whip antennas, cow bells or other noise artifices of choice.

A police car or other car with appropriate witness passengers is then dispatched with instructions to return past the instrument at a prescribed constant speed of, say, 45 mph, no more, no less. As the car passes them at this speed, the volunteers are invited to wave vigorously the whip antennas or what they will. Most likely, the radar meter will be found to have registered up to some level well under 45 mph, stayed there a short interval, and fallen to zero as the car goes on by.

Such a test has been tried repeatedly, probably everywhere radar meters have been used. It is an impressive test, something lay judges and jurors can understand. The immunity to noise is declared "proven," and note is taken that the meter even registered to favor the motorist.

However, let the engineer be wary. He may recall how certain radio receiver or tv antenna measurements could be deceptive if the automatic gain control were not decommissioned. In a different way, before he jumps to any radar speed

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meter conclusions, he should examine the instrument, taking particular note of differences between "test" and "use".

Mr. Johnson all but put his finger on one phase of deception when he notes that it was found necessary to aim the unit at an angle of about 40 degrees with the roadway "to avoid multiple target saturation." The point is that, when noise is tested in the above simulated manner, it may be suppressed in test by effective saturation from even a single target, in a way that it may not be suppressed in actual use, similar though the test may be. This saturation is not due alone to strength of signal but to the design of the instrument itself.

As shown by the diagrams in Mr. Johnson's article, the instrument uses a clamp and expander circuit in conjunction with the counter amplifier. The clamp tends to prevent advance noise registration by preventing amplification without the benefit of the strong signal resulting from car reflection, and the expander tends to suppress noise introduced *after* velocity triggering has already occurred. The tester must therefore be careful to determine that the noise artifices are truly tested in conjunction with the actuating velocity registration, and not in the periods of signal suppression before triggering or after saturation occurs.

The range for triggering by car velocity is normally set to occur at 125 to 175 ft., according to the manufacturer's instructions. When, therefore, volunteers are invited to excite their noise artifices as the test car passes them 25-50 ft. from the instrument, they are only being played for fools, for two reasons. First, prior activation of the expander will have taken care of both essential saturation of the triggered velocity reading, to assure constancy of that reading and suppression of subsequent lesser signals. Second, the falling cosine component of velocity at the wider angle of passing nearer the instrument permits the addition of a certain amount of noise without its being apparent above the higher level of initial velocity registration.

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ELECTRONICS — June, 1956

BACK TALK

(continued)

locity registration unless certain additional requirements were observed. The noise artifices must have been started, not as the car approached the volunteers, but when the car was four to seven times as far down the street, that is, when initial velocity triggering before expander swamping took place. That is where noise may rise above the velocity reading, and that is the reading used in court. Police have testified repeatedly that they read the peak of the curve and, because of the radial or cosine law of angular reception, maximum actuating velocity for a constant speed car occurs at the maximum intercept distance that will trigger the instrument.

Moreover, since the only noise that is of concern to the motorist is that which increases his true velocity reading, testers will only pervert the purpose of test when they only apply such noise artifices as correspond to lower doppler registration than the car velocity. A proper test should include all the noise sources possible in any situation at issue, including short-wave radio interference. The instrument has a greater zone of operation for higher velocity, and use of only low-frequency noise artifices may or may not disturb a velocity reading, depending on whether it is of the nature of electrical interference, microphonism, or physical motion.

The writer has received a communication from a defense plant radar engineer directing attention to the fact that acceleration of a vehicle can cause large errors in doppler readings. This is one of several additional sources of error which were only alluded to in earlier papers to avoid an even longer discussion, but it is true that acceleration can seriously affect the response of such instruments, for example, by overloading the receiver bandwidth. In this connection, it should be noted that considerable variation in operation of speed meters is possible through adjustment of gain and expander control settings.

It is imperative that any data purporting to represent the speed accuracy of such instruments be accompanied by laboratory analysis of the circuits, to determine the

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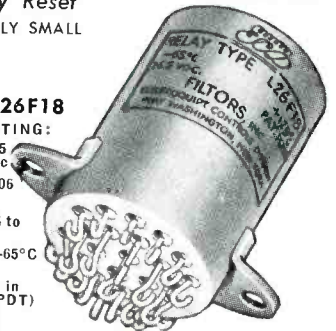
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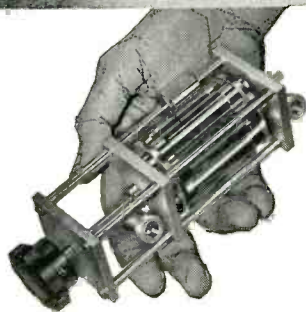
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true thresholds of signal response, before any validity to the data should be given in court.

There is a common conclusion to be drawn from both Mr. Brantley's paper and the separately published paper of which I am a co-author. This is the unquestioned need for establishing standards of performance and test for radar speed meters. This should be done by a scientific commission of indisputable competence, for recommendation of adoption in the governing statutes of all states and municipalities.

When neither the National Bureau of Standards nor the licensing agency for the radar instrument, the Federal Communications Commission, has been asked to set up standards of accuracy, nor even to test the accuracy; and the manufacturer himself "as a matter of policy" declines to make available design or laboratory test data to support his instruction book-claimed accuracy for the instrument, the defendant in court can scarcely be denied the right to ask who does affirm the integrity of the police instrumentation?

Yet, where is such right when legislatures enact laws (as in the Virginia code) and judges take it upon themselves to rule that "the results of such (radar) checks shall be accepted as prima facie evidence of the speed of such motor vehicle in any court or legal proceedings where the speed of the motor vehicle is at issue"?

The decree of a prima facie case, derived from an awesome regard for radar transcending limitations required by radar theory itself, reduces the defendant and all the electronic engineering authority he can muster, to no better status than Galileo—when the Holy Inquisition compelled him to recant and thereafter enunciate only what the Tribunal decreed. . . .

WILLIAM C. COOMBS  
*Section Head, Electronics Division  
Denver Research Institute  
Denver, Colorado*

## Transistor Symbol

DEAR SIRs:

A STANDARD reference designation for transistors was established in 1953. This was accomplished by the Military Standard, MIL-STD-16A, revised May 8, 1953. This specific-

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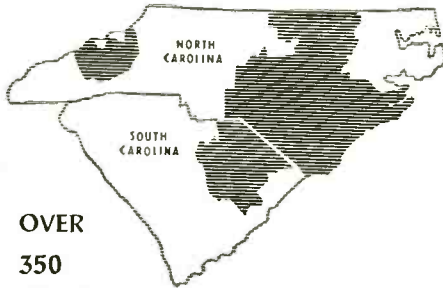
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ation assigns letter Q as the standard reference designation for transistors.

The complete title of this specification is: Military Standard, Electrical and Electronic Reference Designation. It is an unclassified document, available to any contractor who needs it.

The suggestion by Mr. Sienkiewicz, *Backtalk*, p 385, Feb. 1956) to use letter Y is in direct conflict with MIL-STD-16A. Letter Y, is used as a reference designation for oscillator crystals.

Those having trouble with reference designations can profit by reviewing the military specification MIL-STD-16A.

JOHN J. RIVERA  
Senior Designer  
Federal Telecommunications Labs.  
Nutley, N. J.

\* Editor's Note: A similar letter has been received from S. I. Feldman, project engineer at Stelma, Incorporated, Stamford, Conn.

## Gravity and Inertia

DEAR SIRS:  
THE LETTER of Charles C. Littel, Jr., page 502, March 1956 issue of ELECTRONICS, concerning the inertial characteristics of gravity touches on some theories that have appealed to me for some time.

Co-related and seldom mentioned is the ordinary Newtonian mechanics of the earth's mass. Along with the conservation of energy is probably an automatic adjustment of the earth's radius of gyration tending to maintain a sort of conservation of momentum.

Following out this line of thought each particle of mass, even the atom, bears a definite relation to the earth's radius of gyration. Obviously when we transport our weights from one place to another there is a referral affect upon the moment of inertia of the earth's rotating mass. With change in surface distribution of mass there must be corresponding changes in the radius of gyration. It would be resisted by the enormous inertial gyro-energy of the rotating earth.

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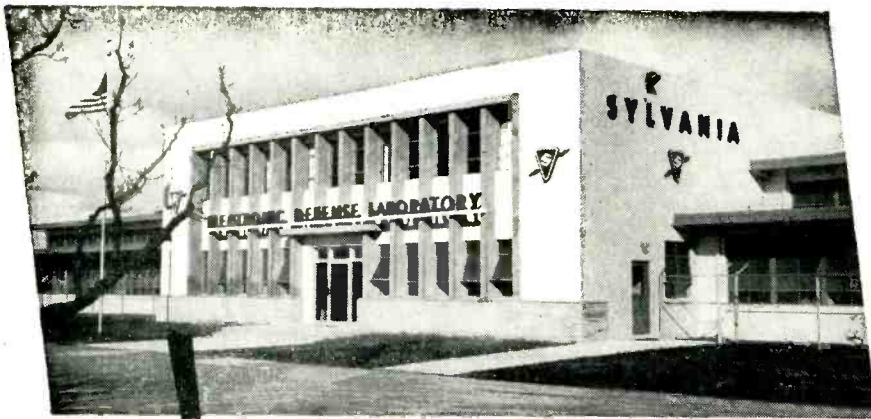
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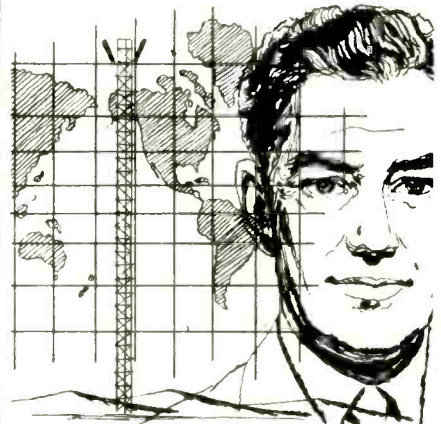


**SYLVANIA**  
SYLVANIA ELECTRIC PRODUCTS INC.

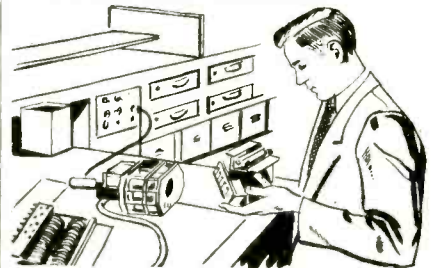
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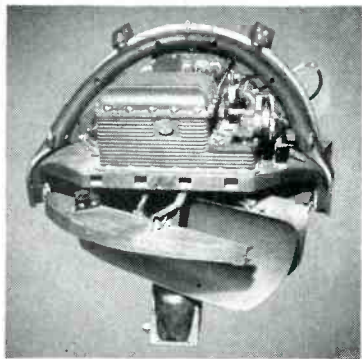
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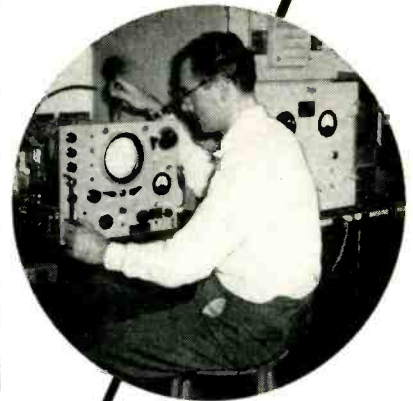
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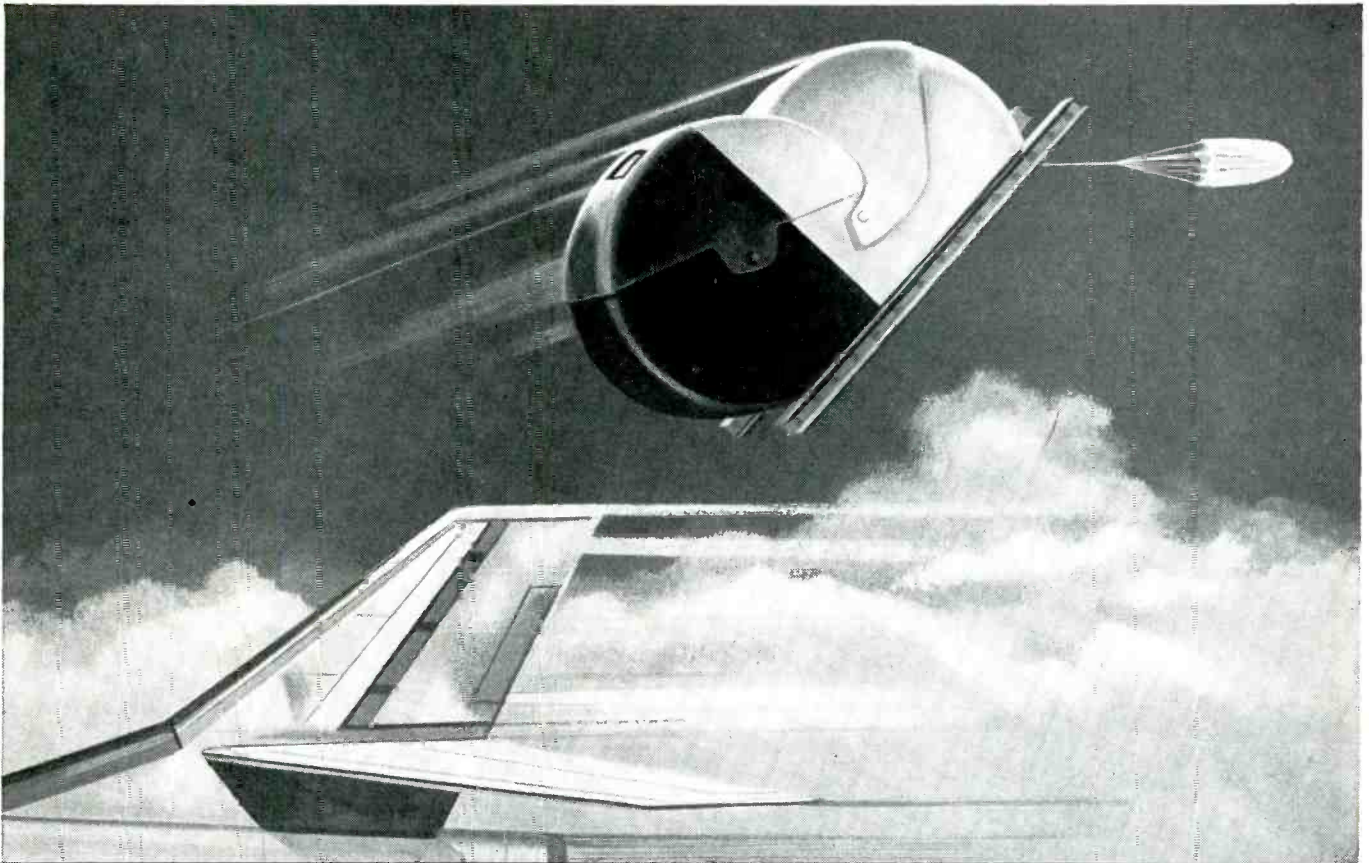
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## The proof of the pudding

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Mr. C. G. Jones, Personnel Department, Goodyear Aircraft Corporation, Akron 15, Ohio.

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# GOODYEAR AIRCRAFT

THE TEAM TO TEAM WITH in AERONAUTICS

Fort Wayne, Ind.  
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Dear Bill:

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Actually, Bill, it wasn't a "story." Just a few honest-to-goodness reasons why he and Marge should make the move and let the family really live as well as let Joe grow professionally.

For instance, do you know what "sold" Marge? The fact that in living here you are only 10 minutes from everywhere—schools, churches, stores etc. and Joe goes home for lunch every day instead of week-ends. She also liked the idea of some 300 lakes within 70 miles. (Guess where they're planning to spend the summer!)

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That's about it, Bill. An engineer with your talents shouldn't be waiting around when he can get in on the ground floor here at Farnsworth in research, development or production engineering in missile guidance and control, radar, microwaves, test equipment, counter-measures, transistor applications etc.

So—why not write, right now to Don Dionne, Farnsworth Electronics Co. Fort Wayne, Ind. (A division of International Telephone and Telegraph Corp.)

You, Joe, I and Farnsworth will be mighty glad you did.

Sincerely, Jack

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# Bendix Aviation Corporation

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YORK, PENNSYLVANIA  
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We don't offer you the moon, but we do offer you a fair shake!

Sincerely yours,

*P.S. If what I've said  
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touch with me!*

*K. F. Umpleby*

K. F. Umpleby  
Chief Engineer

*K.F.U.*

# Engineers

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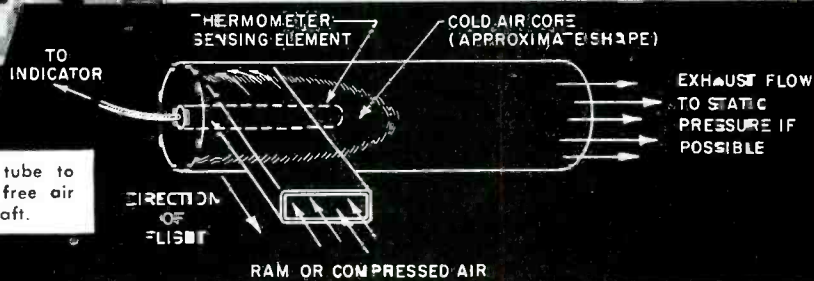
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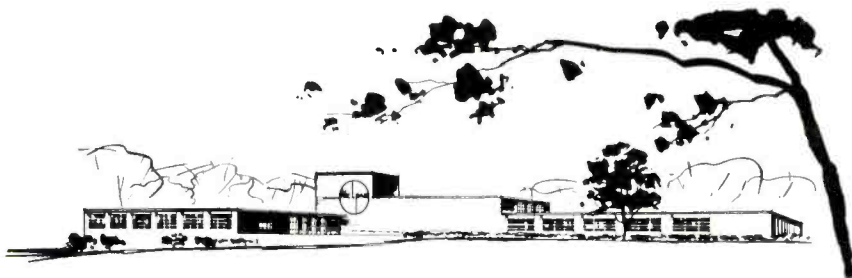
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# Cornell Aeronautical Laboratory, Inc.

OF CORNELL UNIVERSITY

ENGINEERS,  
Electronic & Mechanical  
PHYSICISTS:



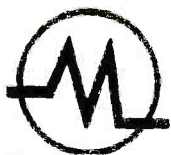
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Write for fuller information. Qualified engineers and physicists will be invited to visit Melpar at Company expense.



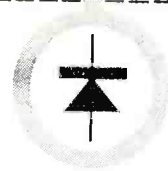
Write: *Technical Personnel Representative*

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## project engineers

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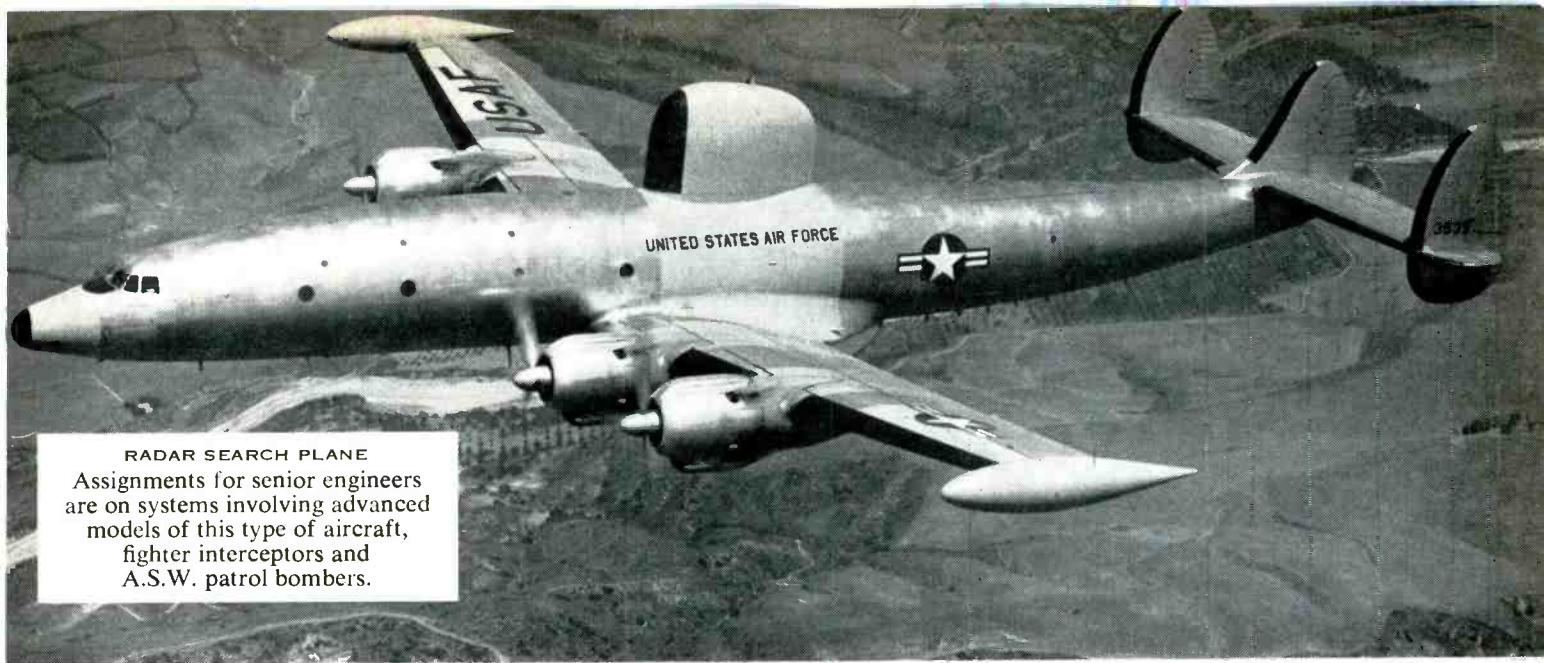
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<p><b>ANTENNA DESIGN</b></p> <p>Duties involve developing requirements for communication navigation and radar antenna systems and participating in design of the systems. Most of the development work in this field is performed at Lockheed Laboratories.</p>	<p><b>COUNTERMEASURES</b></p> <p>Duties involve developing requirements and monitoring programs for advanced electronic countermeasure systems, including receivers, analyzers and jammers.</p>	<p><b>COMMUNICATIONS</b></p> <p>Duties involve developing long-range communication and data link systems, studying meteorological and atmospheric features and guiding antenna design.</p>

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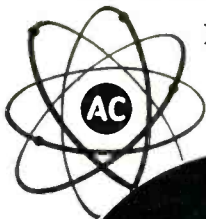


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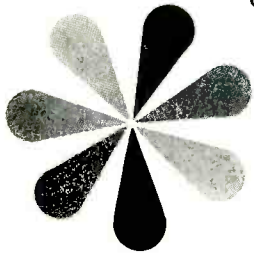
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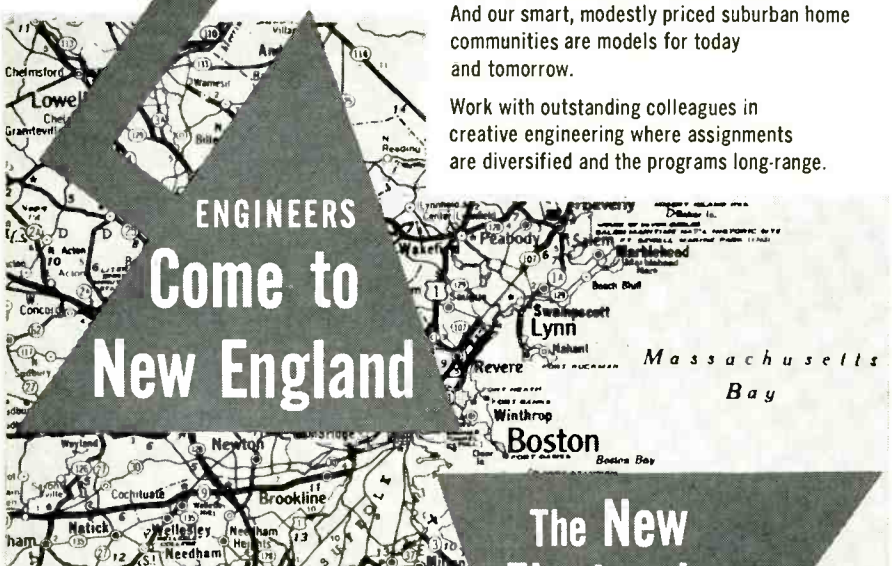
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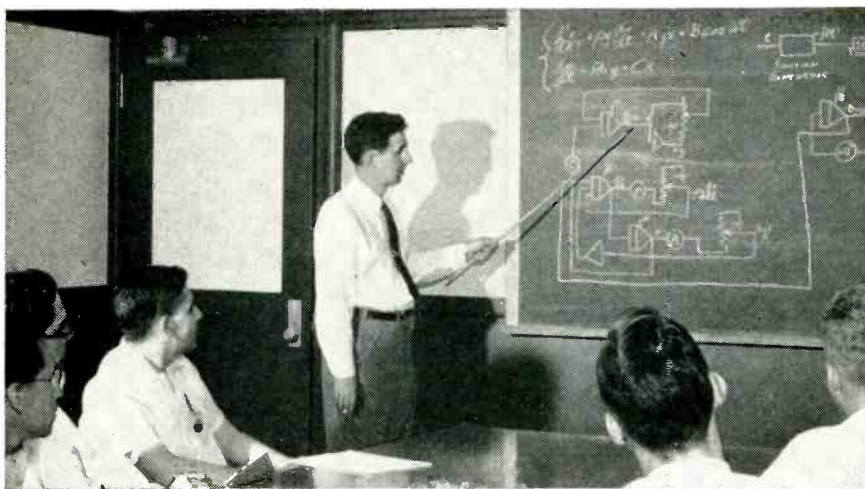
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SCIENTISTS and ENGINEERS

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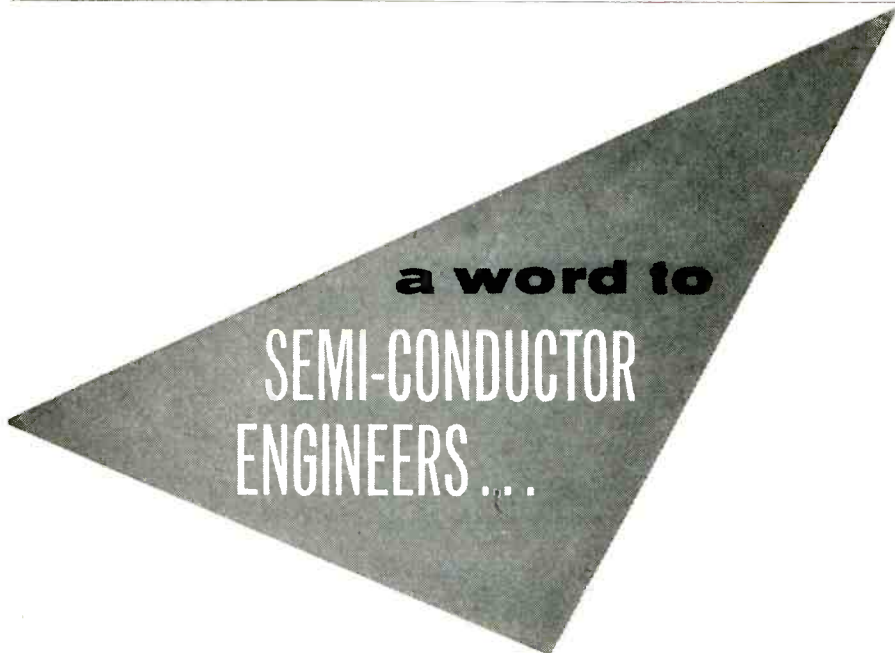
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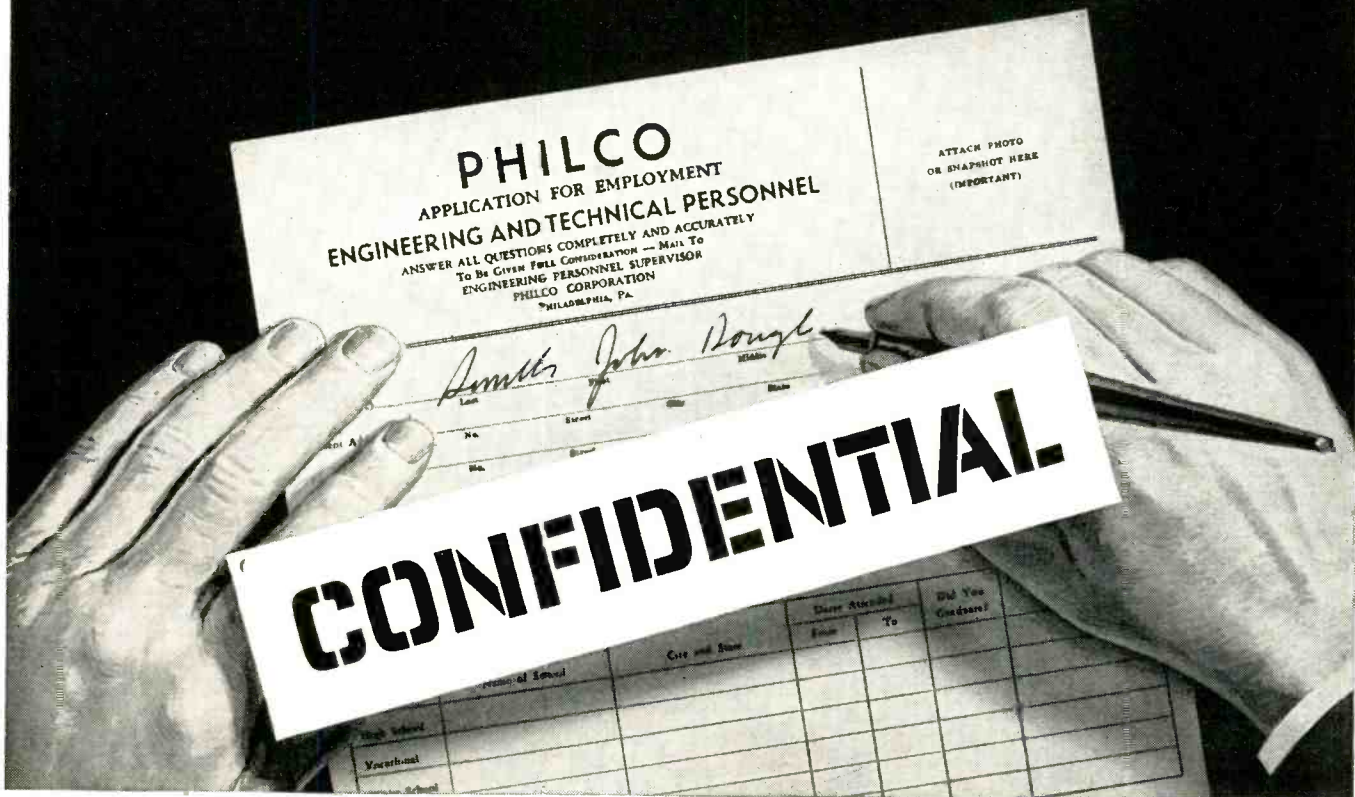
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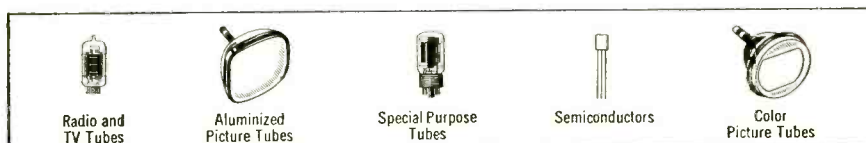
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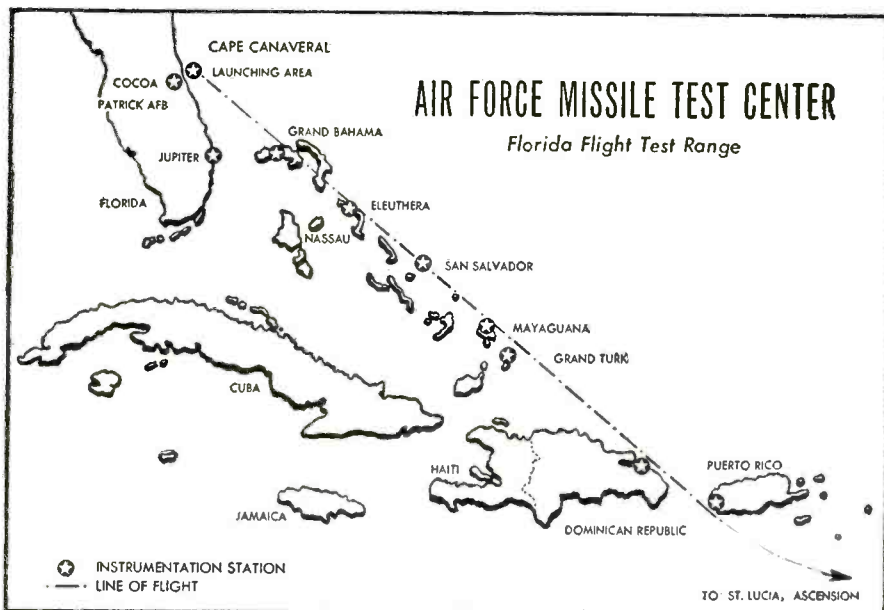
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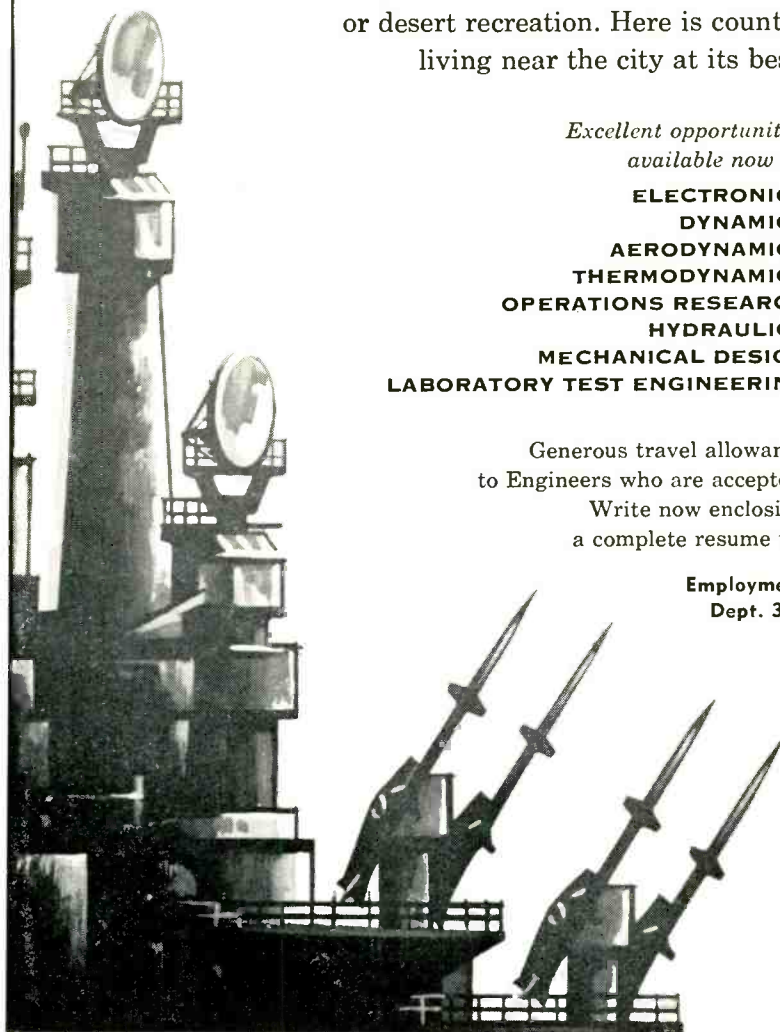
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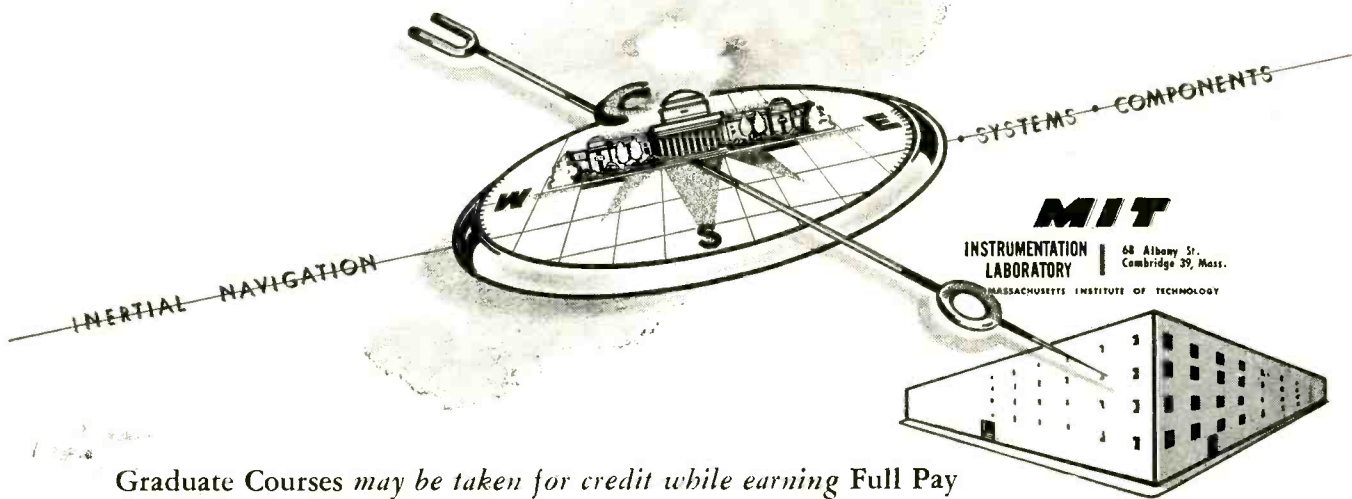
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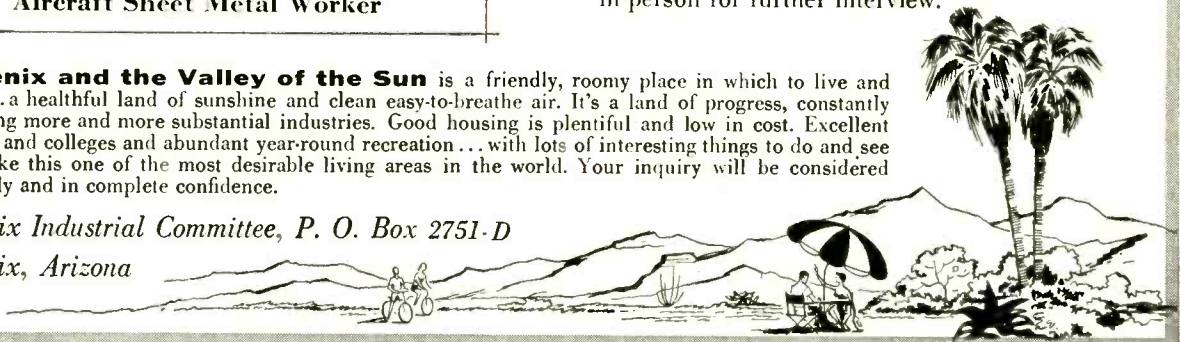
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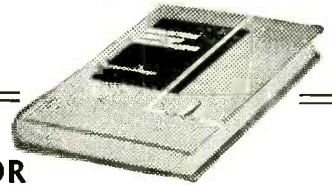
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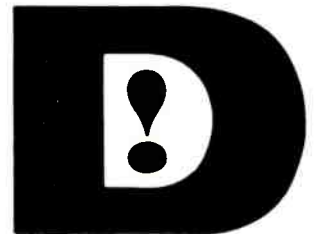
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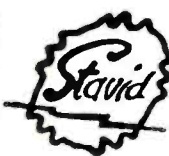
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IN26	6.75	2K50	295.00	5BP1	3.95	249C	4.25	714AY	36.00	861	25.00
IN27	3.50	2K51	35.00	5BP2A	12.00	250TH	19.95	715A	4.50	866A	1.50
IN34A	.79	2K55	25.00	5BP4	3.95	250TL	19.95	715B	9.00	869B	67.50
IN38	1.00	2K56	72.00	5CP1	7.50	252A	3.00	715C	15.00	869BX	50.00
IN43	2.25	3AP1A	10.00	5CP2	9.95	274B	1.00	717A	1.50	872A	3.50
IP25	75.00	3BP1	7.20	5CP7A	18.00	304TH	10.00	719A	15.00	874	2.25
2C39A	13.50	3BP24	5.50	5CP12	15.00	304TL	12.50	720AY	1.50	878	1.50
2C40	12.00	3BP25	5.50	5D21	10.00	307A	2.50	GY	50.00	879	.50
2C43	14.50	3BP26	5.00	5J1P1	20.00	310A	4.50	721A	1.50	884	1.50
2C44	.60	3BP28	8.00	5J1P2	19.50	310B	6.75	721B	7.50	885	1.50
2C46	7.50	EL3C	5.50	5J1P4	27.50	311A	6.50	723A/B	18.00	902P1	6.75
2D29	.99	3C22	75.00	5J23	25.00	312A	3.50	724A	1.95	931A	5.00
2J21A	12.00	3C24	1.75	5LP11A	25.00	323A	15.00	724B	2.25	954	35.00
2J22	9.00	3C31	2.95	5SP7	96.00	350A	4.50	725A	18.00	955	.50
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2J31	24.00	1DP1A	52.10	7DP7	5.00	357A	15.00	726C	45.00	958A	.60
2J32	29.00	3EP1	5.00	7DP14	9.00	368A	4.95	730A	22.50	959	2.25
2J33	32.00	3E29	15.50	12AP4	50.00	371B	1.50	750TL	45.00	E1148	.25

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23400-24500 MEGACYCLES SIGNAL GENERATOR

**SPECIAL! 5,000 V. POWER SUPPLY**

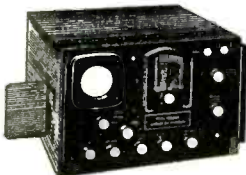
For IP25 Infrared Image Converter from 3 V. Battery Source. **\$9.90**

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**NEW MICROWAVE TEST EQUIPMENT**  
**TS148/UP SPECTRUM ANALYZER**  
**TS147D SIGNAL GENERATOR**

Field Type X Band Spectrum Analyzer. Band 8430-9580 Megacycles.

Will Check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.



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TS12/AP	TS-45	TS126/AP	TS258	
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TYPE CAOT-14 AAT including sweep motor crystal 1N23 with holder and output plug. New **\$32.50**

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FS-1682, Electronics  
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ART-13/T47A	Transmitters	\$175.00
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Patent No. 2,700,070 Intercommunication system see Electronics March 1950 make offer. FS-1342, Electronics.

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**TWIN TRIODE TUBE**

Brand New—Purchased From Original Manufacturer. Laboratory Checked—Guaranteed. Priced Much Lower than equipment price. Production Quantities Available. All tubes subject to your test. Immediate Delivery.

This high performance tube may be used as a power amplifier, as a CW or pulsed oscillator, and as a cathode follower. Equally useful in balanced circuits as a modulator or a servo amplifier, and in countless other applications.

Performance potential equivalent to 2 1/2 times that of a 6SN7GT. Out-performs all other tubes of its class.

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1. For sale in original cases:  
General Electric Motor Generator Set, 7 1/2 H.P., 1800 R.P.M., 440 Volts, 3 Phase, 60 Cycles, with V belt drive to one 5KVA 380 volt, 3 phase, 50 cycle, 4 wire, 1500 r.p.m. alternator with exciter, plus wall mounted control panel with complete instruments.

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**COUNTING-RATE METERS**

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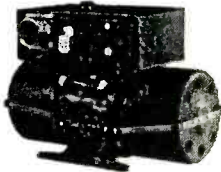
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- 10042-1-A Bendix  
DC Input 14 volts; output: 115 volts; 400 cycles. 1-phase; 50 watt **\$35.00**
- 12116-2-A Bendix  
Output: 115 VAC; 400 cyc; single phase; 45 amp. Input: 24 VDC, 5 amps. **\$35.00**
- 12117 Bendix  
Output: 26 volts; 400 cycles, 6 volt amperes, 1 phase. Input: 24 VDC; 1 amp. **\$15.00**
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Input: 24 volt D.C. 18 amp. 12000 r.p.m. Output: 115 volts, 400 cycle, 3-phase, 250 volt amp, 7 pf. **\$49.50**
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Output: 115 V; 3-phase; 400 cycle; amps .5 Input: 24 VDC; 12 amp. **\$49.50**
- 12126-2-A Bendix  
Output: 26 volts; 3 phase; 400 cycle; 10 VA; .6 PF. Input: 27.5 volts DC: 1.25 amps. **\$24.50**
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Output: 125.5 VAC; 1.5 amps. 400 cycles single phase, 141 VA. Input: 20-30 VDC. 18-12 amps. Voltage and frequency regulated. **\$49.50**
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Input: 26/29 volt D.C., 28 amps Output: 115 volt, 3 phase, 400 cycle, 250 volt amp., .8 pf. **\$59.00**
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Output: 115 volts: 400 cycles; 250 VA; single phase pf. 9-1. DC Input: 26-29 VDC; 25-22 amp; voltage & frequency regulated **\$49.50**
- 778 Bendix  
Output: 115 volt, 400 cycle; 190 VA; single phase and 26 volt, 400 cycle, 60 VA, single phase. Input: 24 VDC. **\$37.50**
- 10285 Leland  
Output: 115 volts AC; 750 VA, 3 phase, 400 cycle, .90 pf and 26 volts, 50 VA, single phase, 400 cycle, .40 pf. Input: 27.5 VDC, 60 amps. cont. duty, 6000 rpm. Voltage and frequency regulated. **\$59.50**
- 10339 Leland  
Output: 115 volts; 190 VA; single phase; 400 cycle; .90 pf. and 26 volts; 60 VA; 400 cycle, .40 pf, Input: 27.5 volts DC, 18 amps cont. duty, voltage and freq. regulated. **\$49.50**
- 10486 Leland  
Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 pf. Input: 27.5 DC; 12.5 amps; cont. duty. **\$70.00**
- 10563 Leland  
Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 pf. Input: 28.5 VDC; 12 amps. **\$35.00**
- PE109 Leland  
Output: 115 VAC, 400 cyc; single phase; 1.53 amp; 8000 rpm. Input: 13.5 VDC; 29 amp. **\$50.00**
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Output: 115 VAC; single phase pf 90; 380/500 cycle; 1500 VA. Input: 25-28 VDC; 92 amps; 8000 rpm; Exc. Volts 27.5 BRAND NEW. **\$30.00**
- MG149F Holtzer-Cabot  
Output: 26 VAC @ 250 VA; 115 V. @ 500 VA; single phase; 400 cycle; input: 24 VDC @ 36 amps. **\$40.00**
- MG153 Holtzer-Cabot  
Input: 24 VDC; 52 amps. Output: 115 volts - 400 cycles, 3-phase, 750 VA. Voltage and frequency regulated. **\$95.00**
- DMF2506M Continental Electric  
24-30 volts input; 5.5-45 amps; cont. duty. Output: 115 volts; 44 amps; 400 cyc; 1 phase; pf 1.0; 50 watts. **\$39.50**

## SENSITIVE INTEGRATING GYROS



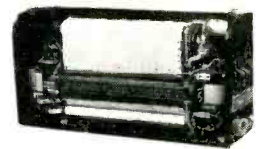
This is the famous HIG gyro which is being used in missile guidance systems, radar stabilization and fine control systems. Gov't cost approx. \$1500.00. Limited quantity available not meeting Gov't Specs. Stock No. 133 **\$25 ea.**

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- 403 Kollsman Autosyn Mtr. 32V 60 cy. **7.50**
- CK5 Bendix Mtr. 2 phase 26V 400 cy. **17.50**
- FPE-25-11 Diehl Servo Mfr. 75/115V 60 cy. **22.50**
- FP-43-1 Resolver 400 cy. **25.00**
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- 999-0411 Kollsman 26V 400 cy. **15.00**
- 1377-0410 Kollsman 26 V 400 cy. **10.00**
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- 2900 Transicoil 115 V 400 cy. **15.00**

## AEROGRAPH RECORDER



ML-320/AMQ-2; Mfg. Eclipse-Pioneer  
Used to record Pressure Millibars 200-1100, Temperature Centigrade -70° to 50°; Air Speed 70 to 300 MPH.; Relative Humidity 10 to 100%. CONTAINS: 4—Autosyns; 1—Servo Mtr.; 1—Vibrator Mtr.; 1—25Z6 Tube; many gears, relay, transformer, etc. Operation: 26 VAC-400 cycle; 2.5 amp. Approx. Dimensions: 20" long x 9 1/2" H x 5" Wide. Weight 16 lbs (approx.) A real buy at .....**\$50.00**

## RATE GYRO TYPE T-2004-3C-A MFG. KEARFOTT CO.



Gyro motor excitation 115V, 400 cy. 3 ph. Take off output: 26 VAC 400 cy. single phase. Rating 20°/sec. Approximate Diameter 3 3/4". Height 2 3/8". Weight 1 3/4 lbs. Hermetically sealed. Equippec with 28 VDC heater. Operates efficiently in range of -54°C to +71°C. Sensitivity 2250 volts/degree at 10K load. This is the famous Gyro used in many military units. Government cost over \$1700.00. New condition. Limited quantity @ .....**\$150.00 ea.**

## KEARFOTT VERTICAL GYRO TYPE T 2103-1A

This vertical Gyro provides an accurate and dependable vertical reference in the form of two 400 cycle signals. A gravity-sensitive vertical reference device is utilized to provide electrical signals to torque motors which maintain the gyro spin axis perpendicular to the earth's surface. The instrument is hermetically sealed. Degrees of Freedom: two degree of freedom gyro with 360° freedom in roll and ± 82° freedom in pitch



PRICE.....**\$200.00**

## SMALL DC MOTORS



- (approx. size overall 3 3/4" x 1 1/4" dia.)
- 5069600 Delco PM 27.5 VDC 240 rpm **\$12.50**
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- 5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2") **5.00**
- 5069625 Delco 27.5 VDC 120 rpm w/governor **15.00**
- MM A-11 Globe PM 24 VDC **7.50**
- 5BA10AJ18 GE 24 VDC 110 rpm **10.00**
- 5BA10AJ37 GE 27 VDC 250 rpm reversible **10.00**
- 5BA10AJ52 27 VDC 145 rpm reversible **12.50**
- 806069 Oster series reversible 1/50 h.p. 10,000 rpm 27.5 VDC 1 5/8" x 3 1/2" **5.00**
- C-28P-1A 27 VDC 1/100 h.p. 7,000 rpm **3.00**
- 7100-B PM Hansen 24 VDC 160 rpm **7.50**
- SSFD-6-1 Diehl PM 27.5 VDC 10,000 rpm **4.00**
- 6-volt PM Mtr. mfgd. by Hansen 5,000 rpm 1 1/4" in dia. 2" long overall **4.00**



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RT-66, 67, 68, 69, 70 GRC  
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**MOBILE RADIO  
SCR-508**

10 Channel FM Receiver and Transmitter. Frequency Range 20-27.9 mc. Receiver is manually tuned, transmitter is crystal controlled. Consists of 2 BC-603 Receivers, BC-604 Transmitter, FT-237 mount. Box 80 xtals BC-606 Control, A-62 Phantom Ant., Headsets, mike, and antenna. Input 12 v. D.C. SCR-608 also available.

**SCR-291A GROUND  
AUTOMATIC DIRECTION FINDER**

1.5-30 mc. automatic direction finder. This equipment used to take bearings on transmitters. Complete equipments available comprising the following: BC-1147A Rec., PN 31, Power Panel BC-1159, automatic bearing goniometer, RC-223 antenna system consisting of 5 masts with legs, MC-412, MC-413 phase inverters calibrating transmitter.

**SCR-536 HANDI-TALKIE**

Freq. range 3.7-5.5mc crystal controlled battery operated handtalkie. The range of this equipment is approximately 2 miles. We can supply these sets to your specified freq. Completely reconditioned and guaranteed. Large quantity available.

**SCR-506A**

Mobile radio transmitter-receiver covering 2-4.5 mc phone and CW. 10-90 watts output 5 channel operation. 12 or 24 volt input. Consisting of: BC653, BC652, Rack, dynamotors, microphone, headset, antenna and mounts, etc.

**AN/APR-4**

38-4000 mc precision receiver consists of receiver and five tuning units to cover the full range. Each tuning unit is calibrated directly in mc. Input 115v 60 cyc.

**SCR-682-A SEARCH  
AND WEATHER RADAR**

**Technical Specifications:**

- 1—Operating freq.—3000cm 10mc.
- 2—Power output—225kw.
- 3—Pulse width—1 micro second.
- 4—ranges—500-240,000 yds. in four ranges. 10,000 yds, 40,000 yds, 160,000 yds, and 240,000 yds.
- 5—360 scan.
- 6—azimuth accuracy 1°.
- 7—7" P.P.I. indicator.
- 8—Antenna beam width 1°.
- 9—110v 60 cyc power input

**AN/ASQ-1  
AIRBORNE MAGNETOMETER**

This is an airborne chart recording magnetometer. The set consists of an amplifier, oscillator, detector head, chart profile recorder, power supply. The equipment has a sensitivity of 2 gamma. The AN/ASQ-1 records on an Esterline Angus recorder disturbance in the earth's magnetic field caused by an ore deposit or a sunken boat or submarine. An indicator is provided that gives a bearing on a magnetic disturbance. Input is 28v DC. Weight about 130 lbs.

**AN/APN-3-AN/CPN-2 SHORAN**

The AN/APN-3 and AN-CPN-2 are airborne and ground. Precision distance measuring installations. This equipment operates on 225 mc. The range is 250 miles with an accuracy of 25 feet. This is the most accurate distance measuring equipment built to date. The AN-APN-3 used with the K-1 computer (also available) will permit taking a photograph up to 250 miles from the CPN-2 beacons completely automatically. The AN-APN-3 can be fed into the aircraft auto pilot to fly it to the drop point. This equipment is very widely used by geological survey companies for oil prospecting and mapping. Power input is 110v 400cyc and 28 DC. COMPLETE SETS AND SPARES ARE AVAIL.

**REMOTE P.P.I.  
REPEATER INDICATORS**

- VD-7" P.P.I. Upright Mount.
- VE-7" P.P.I. Table Mount.
- VF-5" B Scope 5" P.P.I. Upright.
- VG-24" Plotting Table P.P.I. Repeater. This unit just installed in new air control center at Idlewild Airport, N. Y. Very Elaborate System.
- VJ-12" P.P.I. Upright Mount.
- VK-12" P.P.I. Upright Mount.
- VL-12" P.P.I. Upright Mount.

**RADIO TELETYPE TERMINALS**

- AN/SGC-1 Very Compact. Late Model.
- AN/CV-60/URR All Miniaturized. Late Model.
- FRA, FRF, FRF.
- AN/FGC-1

**OTHER EQUIPMENT**

- AN/URC-4 Air-Sea Rescue Trans-Rec.
- AN/ARC-12 and Higher.
- AN/APG-15 and Higher.
- AN/APS-10 and Higher.
- AN/CPN-6, 8, 17 Radar Beacons.
- AN/UPN-1, 2, 3, 4 Radar Beacons.
- AN/APA-17 300-10,000 MC Direction Finder.
- AN/GRC, 3, 4, 5, 6, 7, 8, 9 Field Radios.
- AN/PRC, 9, 10 Walkie Talkies.
- AN/TRC-1, 3, 4, V.H.F. Radio.
- SCR-193 Field Mobile Radio.
- SCR-300A Walkie Talkie.
- SCR-399, 499 Mobile Radio.
- AN/ARM-1 ARC-3 Test Set.
- I-208.
- LAF 90-600 MC Sig. Gen.
- LAE 300-1,200 MC Sig. Gen.
- LAG 1000, 4000 MC Sig. Gen.
- SG-13 Pulse Gen.
- TS-3 S-Band Test Set.
- TS-15 Fluxmeter.
- TS-62 X-Band Echo-Box.
- TS-117 S-Band Wave Meter.
- TS-146 X-Band Test Set.
- TS-173, 174, 175 Freq. Meters.
- TS-250/APN Actimeter Test Set.

**SCR-616—BC-1269**

F.M. & A.M. 145-600mc communications receiver. The receiver is a superhet covering the 145-600mc in 2 bands. The dial is calibrated in megacycles.

**RECEIVER—TRANSMITTER  
FM 20—28 MC**

BC-603 RECEIVER: 20-28 MC variable tuning, 10 Pre-Set push button channels, squelch circuit, 4" speaker; 10 Tubes; 2/12SG7, 2/6SL7, 1/6V6, 1/6J5, 3/6AC7, & 1/6H6. Price: USED: \$29.95  
PLUG for rear of Receiver.....\$1.00  
DYNAMOTOR: 12 V input; Output 220 V 80 MA. #DM-34.....NEW: \$4.95.....REISSUE: \$2.95  
BC-604 TRANSMITTER: 20-28 MC, 30 Watt, companion to BC-603 Receiver. Crystal control. 10 Pre-Set channels, interphone communication; 8 Tubes; 7/16I9 & 1/1624.....USED: \$18.95  
PLUG for rear of Transmitter.....\$1.00  
DYNAMOTOR: 12 V input; Output 625 VDC 225 MA. #DM-35.....NEW: \$12.95.....REISSUE: \$8.95  
FT-237 BASE for mounting Receiver & Transmitter (No plugs required).....USED: \$9.95

BC-500 RECEIVER—TRANSMITTER: FM Crystal Control on 5 channels. 100 KC separation 20-28 MC. Transmitter; 25 Watt output, 7 Tubes; 1/12A6, 3/12SL7, & 2/12SA7. Receiver: 11 Tubes; 1/12SL7, 2/12A6, 3/12SA7, 3/12H6, 2/12K8, & 1/12SJ7. Dynamotor Supply: Receiver 28 VDC 1.2 A input; output 250 VDC 60 MA. Transmitter 28 VDC 4.1 A input; output 550 V 120 MA. Control Panel: For Local Control & outlets for Remote also. Heavy duty 5" speaker. Size: 12" x 25" x 9 1/2". With Schematic and Conversion. Weight: 65 lbs. Price.....NEW: \$59.50

**TELEPHONE EQUIPMENT**

EE-8 Field Telephone—Ideal for private telephone system for two or more phones, up to 17 miles, hand ringer generator with handset, carrying case, uses two flashlight batteries.....Used, Checked: \$14.95  
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RM-13 Remote Control Unit for telephone & radio equipment. Telephone unit same as EE-8; Radio remote, pre-amplifier, 115 V 60 cycle with input & output jacks, DB Meter, one tube amplifier with TS-9 handset.....Used: \$19.95.....NEW: \$24.95

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GENERATOR—115 V. 400 Cycle. 1400 Watt. Single Phase, 28.5 VDC 400 Watt.....USED: \$89.50  
GENERATOR: Motor 3 HP. 115/230 60 cycle single phase Generator 115 Volt, 400 cycle single Phase 1400 Watt & 28.5 VDC 400 Watt, Belt Drive, Reconditioned.....\$195.00

**115 V. 60 CYCLE BLOWERS:**



At left: 115 VAC 60 Cycle SINGLE TYPE—100 CFM—2-1/2" intake; 2" outlet. Complete size: 5" x 6".....\$8.95  
No. 1C939  
115 VAC 60 Cycle DUAL TYPE—100 CFM—4" intake; 2" Dis. Each Side. Complete size: 8" x 6".....\$13.95  
No. 1C880

115 VAC 60 cycle COMPACT TYPE—108 CFM; Motor built inside squirrel cage; 4-1/2" intake; 3-1/2" x 3" Dis. Complete size: 4-1/2" W x 8-3/4" H x 8-1/2" D—No. 2C087.....\$14.95

115 VAC 60 cycle FLANGE TYPE—140 CFM; 3-1/2" intake; 2-1/2" Dis. Complete size: 7-1/2" W x 7-1/4" H x 6-3/4" D—No. 1C807.....\$13.95

115 VAC 60 cycle FLANGE TWIN—275 CFM; 4-1/2" intake; 3-1/2" x 3" Dis. Complete size; 11-1/4" W x 2-3/4" H x 8-1/16" D—No. 2C069.....\$21.95

115 VAC 60 Cycle BLOWER—200 CFM; 4" intake; 3" x 5" outlet. Overall size: 8" x 7" x 6". Bodine Motor NSI-35. Removed from New Equipment #BOD-200.....\$14.95

115-VAC 60 Cycle BLOWER—100 CFM; 3-3/4" intake; 2" outlet; Rd. Flange with Flap Director. Overall size with bracket: 8" L x 6-1/2" W x 7" H. Oster Motor: C2FP-1A; L-R Mfg. Co. Bakelite Blower #2—Overall Size: 3-1/2" x 4-1/2". Price.....\$5.95  
Same as above, but with 12-Curved Director. No. CDBL-2106.....\$7.95

**OTHER BLOWERS:**

- 12/24 VDC—AC CAST ALUMINUM BLOWER—100 CFM—3" intake; 2" outlet. Shunt Motor 4" x 2". 3000 RPM @ 24 VDC.....\$5.95
- 6 VDC SINGLE—100 CFM—No. 6100—USED: \$4.95
- 24 VDC DUAL—20 CFM—Min—No. 2420.....\$7.95
- 10 CFM BLOWER—27.5 VDC; 1/100 HP; 7000 RPM; Oster Motor: C2FP-1A; L-R Mfg. Co. Bakelite Blower #2—Overall Size: 3-1/2" x 4-1/2". Price.....\$5.95
- Same as Above, 12 VDC operation — Price.....\$5.95
- 115 V. 400 CYCLE—10 CFM—Eastern Air Devices Motor J31A—7200 RPM, 1/100 HP. L-R #2 Blower Assy. Overall Size: 4-1/2" x 3-1/2". No. 3110.....\$5.95
- 10 CFM BLOWER—28 VDC .6 A; 5000 RPM. Pioneer Motor SS-2345. Aluminum Blower Housing—Overall Size: 4-1/2" x 3-1/4". Price.....\$5.95

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OB2WA	3.00	2J56	50.00	5R4GY	.90	WE-282B	6.00	464A	1.95	814	1.35	5654	1.25
OV3/VR90	.85	2J61	15.00	5R4WGY	2.75	WE-285A	5.00	RH-507	20.00	815	1.50	5656	7.00
OC3/VR105	.65	2J62	6.50	6AK5W	1.00	287-A	2.20	527	22.50	829	5.00	5657	125.00
OD3/VR150	.65	2K22	14.50	6AN5	2.00	HF-300	22.50	ML-531	4.00	829B	8.50	5663	1.50
ELC1B	1.50	2K23	14.50	6AS6	1.25	WE-300B	5.00	KU-610	3.50	830B	.50	5667	125.00
1AD4	1.25	2K25	11.00	6BM6	25.00	GB-302	5.00	KU-627	10.00	832	3.00	5670	1.50
1B22	1.30	2K26	45.00	6F4	3.25	304TH	8.00	KU-628	10.00	832A	5.00	5675	10.00
1B23	2.75	2K28	25.00	6J4	1.95	304TL	8.95	648P1	5.00	834	7.00	5687	3.00
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1B24A	12.50	2K33A	50.00	6K4	2.25	307A/RK75	1.00	HK-654	25.00	838	.70	5702	1.75
1B26	1.25	2K33B	110.00	6J6W	1.50	WE-308B	15.00	681/686	25.00	842	1.50	5703	1.10
1B27	10.00	2K34	85.00	6L6WGB	2.50	WE-310B	3.00	702A	.50	845	4.00	5718	3.00
1B32	1.00	2K35	175.00	6SK7W	2.00	WE-312A	2.00	WE-703A	1.25	849	17.50	5719	2.50
1B35	4.50	2K39	100.00	6SN7W	2.00	WE-315A	20.00	WE-705A	.75	851	8.00	RK-5721	150.00
1B36	4.00	2K41	100.00	6SU7GT	2.75	WE-316A	.50	706AY-GY	10.00	852	4.00	5725	1.50
1B40	2.00	2K42	125.00	6X4W	1.00	327A	3.50	707B	4.00	861	15.00	5726	.60
1B42	4.00	2K43	110.00	6X5WGT	1.30	WE-336A	5.00	WE-708A	.75	865	.90	5727	1.30
1B45	7.50	2K45	40.00	12DP7	15.00	WE-338A	5.00	714A	10.00	872A	1.35	5744	1.90
1B47	6.50	2K46	200.00	12GP7	15.00	WE-348A	6.00	715A	1.75	884	1.00	5750	2.50
1B51	6.75	2K47	110.00	FG-17	3.95	WE-349A	6.00	715B	4.00	GL-889	35.00	5763	1.30
1B62	4.00	2K48	75.00	RX-21	4.00					GL-889A	50.00	5768	30.00
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1N26	3.75	3B24	1.00	QK-59	25.00					927	1.00	5840	4.50
1N28	5.00	3B24W	5.00	QK-60	25.00					931A	2.50	5844	2.00
1N31	3.00	3B26	2.50	RK-60/1641	1.35					935	4.00	5851	4.00
1N34A	.50	3B29	5.50	RK-61	2.50					957	.35	5852	Q
1N38A	.65	3C22	60.00	QK-62	20.00					958A	.35	5854	Q
1N42	8.00	3C23	5.00	HY-65	1.00					959	1.25	5876	11.50
1N52	.65	3C27	1.00	RK-65/5D23	7.50					991	.35	5896	5.00
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2E26	3.25	4X150A	22.50	218E	15.00					5586	125.00	9002	.55
2E27	.60	5BP2A	5.00	WL-218	15.00					5591/403B	2.75	9005	1.50
2E32	1.00	5CP1	2.00	RX-233A	.75					5611	65.00		
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2J32	12.50	5CP11A	9.50	WE-249B	2.50								
2J33	14.50	5C22	27.50	WE-249C	3.00								
2J34	14.50	5J1A	19.50	250-R	3.75								
2J36	15.00	5JP2	7.00	250-TL	14.50								
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C3J	6.35	OB2	.89	2K54	8.95	5CP7	9.99	26C6/GT	2.99	304TL	12.00	707B	3.95	829B	8.99	1632	.59
C5B	4.49	1B22	1.69	2K55	9.50	5CP11A	14.99	26C6	1.19	307A	1.85	708A	2.99	830B	2.99	1642	1.88
C6J	7.39	1B24	5.99	2K55	9.50	5D21	6.49	28D7	8.99	307A	1.85	708A	2.99	830B	2.99	1642	1.88
CRP RK-		1P30	1.99	2V3 G	1.39	5FP7	3.99	7BP7	6.25	310A	3.99	709A	1.69	832A	7.49	1644	.48
72	.49	2A4/G	1.10	2X2A	.89	5H1	2.49	9LP7	5.00	316A	3.88	713A	24.95	833A	31.50	1606P1	4.99
E1-1C	5.49	2AP1	3.99	3A5	.69	5JP1	16.99	12X3	1.59	329A	4.69	715A	2.65	837	1.99	2050W	2.40
E1C	1.99	2AP1A	6.44	3AP1	5.95	5JP4	14.99	18C	.79	347A	3.88	716B	6.45	838	3.50	2051	.76
EF-50	.80	2BP1	5.99	3B21	1.49	5J32	65.00	21R	1.89	350B	2.99	715C	14.50	837	1.99	2050W	2.40
E1148	.29	1BP11	7.99	3B22	1.49	5J33	7.99	35T	4.99	356B	7.45	717A	.49	841	.59	5851	1.39
EM-3GA	39.50	2C21	.49	3B24W	4.99	5LP1	13.99	35TG	7.25	371B	1.29	718AY/CY/	29.75	845	6.49	5856	3.25
F123A	5.99	2C22	.39	3B25	3.99	5MP1	6.99	53A	2.29	388A	1.49	719A	14.65	851	19.00	5870	2.20
F128A	15.00	2C26	.39	3B25	3.99	5RAWGY	3.19	89Y	.15	393A	4.35	720CY/DY/	29.75	860	3.49	5886	1.79
FG17	4.50	2C28A	.49	3B27	3.49	6C21	19.95	100TH	4.95	394A	2.99	720CY/DY/	29.75	861	19.00	5887	2.69
FG-105	12.99	2C39	4.99	3BP1	2.99	6AC7W	1.50	205B	1.99	434A	6.66	721A	1.49	865	4.49	5702WA	3.10
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HK-24	3.89	2C42	9.75	3C23	5.99							724A	1.15	GL-872A	2.49	5726	1.00
HK-54	3.99	2C43	10.99	3C24	1.50							724B	1.45	872A	1.29	5744	.91
HY-114B	.69	2C44	1.35	3C33	8.99							725A	3.99	878	.90	5763	1.25
KU-610	3.49	2C46	7.49	3C45	6.25							726A	9.50	884	1.00	5814	1.39
HY-65	1.70	2C53	9.90	3CP1	2.25							726B	25.00	885	1.10	5851	3.25
REL-21	1.00																

CRYSTAL	IN21	.59	IN23B	1.10
DIODES	IN21A	.15	IN26	3.55
	IN21B	.99	IN27	.69
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RK-61	3.50	2J22	4.99	3GP1	3.95	6AN5	2.12	217A	2.99	WL-460	8.99	730A	7.95	931A	2.99	5977	3.89
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RK-73	3.69	2C22	5.99	4-65A	15.00	6AS6	1.19	221A	3.99	CK-521AX	1.10	801A	.42	956	.25	8002R	15.50
RK-233A	.69	2J30	14.50	4-125A	26.50	6AS7/G	2.49	233A	1.19	527	14.50	802	2.89	957	.33	8005	4.50
VT5-215A	.69	2J31	14.50	4A-11	.49	6BM6	39.50	242C	8.00	WL-530	19.50	803	1.19	958A	.39	8012	1.85
VT25/19	.49	2J32	13.50	4AP10	4.99	6C4	4.9	249B	2.99	WL-531	6.25	804	1.99	959	1.40	8013	2.50
VT25A/10Y	.39	2J33	13.50	4B22	6.49	6D4	2.99	249C	3.99	532A	.99	805	4.90	991	.39	8013A	3.49
VT67/30 Spec	.26	2J34	13.50	4B25	7.55	6F4	2.99	250TH	24.95	700A/B/C/D/		807W	3.25	CK1005	.46	8020	2.95
VT-158	17.50	2J36	14.00	4B36	4.69	6J4W	1.29	258B	4.49	E	10.99	808	3.15	1608	2.99	9002	.69
VU-111	.19	2J39	11.00	4C27	8.95	6J4W	1.29	258B	4.49	701A	4.99	809	3.15	1608	2.99	9002	.69
1B32/532A	.99	2J49	39.50	4C28	35.50	6K4	3.99	271A	12.99	703A	1.90	810	9.95	1613	.95	9004	.19
QK-59	29.50	2J62	9.00	4E27	12.95	6K4W	1.49	274A	5.95	704A	1.59	811	3.19	1614	1.49	9006	1.19
QK-61	32.00	2K22	14.50	5AP1	2.99	6L4	1.29	277	8.85	705A	1.49	813	11.49	1615	.59		
QK-185	99.00	2K23	16.50	5BP1A	8.99	12A7	.76	282A	1.79	706A	6.75	814	2.49	1619	.92		
VR-78	.89	2K25	16.50	5BP4	2.99	12A7	.76	282A	6.49	706B	14.50	815	1.99	1625	.29		
VR-90	.89	2K28	19.50	5C22	25.00	12CP7	12.95	286A	7.50	706C	17.50	816	1.05	1625	.29		
VR-105	.79	2K33A	59.95	5CP1	3.99	15E	1.25	287A	6.61	706D	35.00	826	.75	1626	.29		
VR-150	.79																

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K513104	1150VCT/0.283A, 1050VCT/0.217A	KS8984	27V/4.3A, 6.3V/2.9A, 1.25V/.02A	2.95
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KS918	6.3V/1A, P/O R-55/ARQ-9	52332	400VCT/35MA, 6.4V/2.5A, 6.4V/1.5A	3.85
KS9608	1233/35MA, 1140VCT/0.7A	68G631	1150-1150V 2MA	2.75
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M-7472426	1450V/1.0MA, 2.5V/75A, 6.4V/3.9A, 5V/2A, 6.5V/3A, P/O ID-39/APG-13	3021334	6.3V/9-1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5/3.5A	4.85
352-7039	640VCT @ 380MA, 6.3V/9A, 6.3V/6A, 5V/5A	KS9445	592VCT/118MA, 6.3V/8.1A, 5V/2A	5.39
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Right Angle Bend E or II Plane, specify combination of couplings desired.....\$12.00  
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 EICOR-ML 3011-5, Input: 13.75 V, 18-4A. Output: 115 V/400-300, 0.25 PF 100 VA. New.....\$50  
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<b>COMBINATION-115V/60~INPUT</b>		<b>CT-407</b>		<b>1.5VCT/2A, 2-2.5VCT/2A, 2-3VCT/2A, 3.50</b>	
CT-518	160-0-160V/70MA, 6.3V/2A, 2.5V/1.75A	\$2.15	PT-766	15KV/30MA	47.50
CT-875	1600V/2MA, 6.3V/6A, 2.5V/1.75A	4.35	PT-034	125V45MA (For Preamp)	1.35
CT-127	900V/25MA PK, 5V/2A, 2V/1.5A	2.79	PT-521	7500V/06A. Half Wave	59.50
CT-006	350-0-350V/120MA, 5VCT/3A, 2.5VCT/12.5A, 2.5VCT/3.5A	4.39	PT-913	2500V12 MA H/SLD.	4.95
CT-965	75V/0.6A, 6.3V/2A	1.95	PT-38-2	37.5/40V AT 750 MA	2.15
CT-004	350-0-350V/190MA, 5VCT/3A, 2.5VCT/12.5A	4.60	PT-87P	860VCT/230MA DC	4.75
CT-002	350-0-350V/50MA, 5VCT/2A, 2.5VCT/7.5A	3.65	PT-876	1500-0-1500V/400MA	12.75
CT-479	7000V/0.18V, 2.5V/5A/17,800V. T	22.50	PT-151	260VCT/0.175A	18.50
CT-403	350VCT/0.265A 5V/3A	2.75	PT-403	Autot. 100V/2A	1.75
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CT-159	2-2.5VCT/3A, 2-22.5V/100MA, 27V/50MA, 40V/50MA	2.35	PT-823	220VCT/75 WATT	2.95
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CT-607	2.3V/2A, 85V/1ACT, 400VCT/1A	3.95	PT-551	2.5V/10AMP	3.20
CT-616	3V/10A, 10.5V/1A, 45V/1A, 60V/1A, 140V/100MA	\$3.75	FT-598A	3V/10A, 12.5V/10A	1.65
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FT-924	5.25A/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 1.2V/7A, 6.4V/10A, 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
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FT-38A	1.7A/2A, 1.7A/2A, 1.7A/2A	7.79
FT-650	2.5V/10A-3KV TEST LO-CAP	7.50
FT-025	2.5VCT/10A, 10KV TEST	6.95
FT-968	5V/6	1.75
FT-580A	2-6.3V/2A, 150V/.05A, 230V/75MA	2.45
FT-964	2.5V/2A	1.39
FT-608	2.5V/5A, 2-3.5V/2A, 5V/2A	2.35
FT-068	5V/2A	1.35

**FILTER CHOKES**

Stock	Description	Price
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CH-CEC	117: 9-50HM/.05-400 MA, 10 KV Test	14.95
CH-113	2.5H/700 MA, 2.5 KV Test 18 Ohms	5.75
CG-044	8.5H/350 MA, 3.5 KV Test 50 Ohms	
CH-291	0-1H/12 A, DCR: 0.3 Ohms	12.50
CH-322	.35H/350 MA-10 Ohms DCR	2.75
CH-141	Dual 7H/75 MA, 11H/60 MA	4.69
CH-69-1	Dual 120H/17 MA	2.35
CH-776	1.28H/130 MA, 75 Ohms	2.25
CH-344	1.5H/145MA/1200V Test.	2.35
CH-366	20H/300 MA	6.95
CH-999	15HY/15 MA-400 ohms DCR	1.95
CH-445	0.5H/200 MA, 32.2 ohms, 3000 V.T.	1.39
CH-170	2x0.5H/380 MA, 25 Ohms	2.79
CH-124	5H/200MA, 3KV Test	4.25
CH-189	12H/300 MA, 3KV Test	4.65
CH-88C	Swing 5-20H/0-300 MADC	5.25
CH-223	Dual: 2H/100MA, 75 Ohms, -2H/100MA, 240 Ohms	1.79
CH-564	Dual 0.5H/100MA, 15 Ohms	1.35
CH-934	5H/200MA, 93 Ohms Tap 3 Ohms	1.25
CH-756	2H/50 MA, 60 Ohms	7.79
CH-511	7.5H/50MA, 0.5 Ohms	1.15
CH-306-1	15H/200 MA, Tap 7.5H, 300 Ohms	2.79
CH-79	0.5H/50 MA, 10 Ohms	.97
CH-5E2	7.5H/50 MA, 60 Ohms	1.15
CH-246	30 H/75 MA, 175 Ohms	1.25
CH-461	5H/100 MA, 2 Ohms (Tapped)	1.55

**SPECIAL VALUES**

10 CM. ANTENNA ASSY. (Airborne). 30" dish with coax. dipole feed. Focal length is 10 1/2" Horiz polarization, 350 deg. azimuth. Tilt: plus and minus 20 deg. 28 vdc drive motor, seslyn takeoff.....\$65.00  
 CRYSTAL OVEN, B liley #CTO 213. Local base, with provision for 2 crystals, 6.3V heater 75 deg. Cent.....\$2.50  
 COAX. SWITCH, 4 on 50 ohms Imp. Fitted with type N connectors. Useful up to 3,000 mc.....\$7.50  
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 Barry shock mounts: nos. 2045, C-2060, C-2070, C-2080 @ 4 ea.....\$45 ea.  
 Trihedral radar reflector, MK-1, aluminum.....\$3.50  
 SPLICER, for 11/16 perforator tape. WECO #X-61859 list 20 SCS #4TW 61859-20. Complete set, with number tape dispenser.....\$8.50  
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 Power supply unit, navy type-PL-2, Input: 115 vac, 60 cy. Output: 135 vdc/10 ma. 90 vdc/5ma; 3 vdc/360 ma. New, complete with spare parts box. To be used with model TBX radio gear.....\$9.50  
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**K-BAND - 1" x 1/2" WAVEGUIDE**

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 PARABOLOID DISH, 18" diam. Spun Aluminum, 8" Focus. For ANX/APS-6.....\$4.95  
 3 CM. DIPOLE and Feed Assembly. (May be used with above dish.) 8 inches long.....\$5.00  
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 3 CM. DIPOLE FEED, 15" L for APS-15.....\$14.50  
 MITRED ELBOW, Cast Aluminum, 1 1/4" x 5/8" W.G. W.E. Flanges "E" Plane.....\$3.50  
 3 CM. ANTENNA ASSEMBLY: Uses 17" paraboloid dish operating from 24 vdc motor. Beam pattern: 5 deg. in both Azimuth and elevation. Sector Scan: over 160 deg. at 35 scans per minute. Elevation Scan: over 2 deg. Tilt. Over 24 deg.....\$35.00  
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 90 degree elbows.....Plane 2 1/2" radius.....\$7.50  
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 ADAPTER, UG-163/U round cover to special BTL. Flange for TS-45, etc.....\$2.50 ea.



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F-29/SPR-2. Hi-Pass, with 1000 mc. Cut-off. Type "N" input and output. 50 Ohms Z.....\$9.50  
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 F-3/AR 400 MC, lowpass 50 Ohms Impedance, type & Connectors 20 1/4" x 1 1/4" dia.....\$27.50

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	VOLTS	AMPS	VOLTS	AMPS	
BDAR83	14		375	.150	\$6.50
35X-059	19	3.8	405	.095	4.35
DM33A	18	7	540	.250	3.95
B-19	12	9.4	275	.119	6.95
			500	.050	
DA-3A*	28	10	300	2.6	3.95
			150	.010	
			14.5	5.	
PE 73 CM	28	19	1000	.350	17.50
BD 89	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	2.95
BDAR 93	28	3.25	375	.150	5.75

† Less Filter. \* Replacement for PE 94.  
 † Used, Excellent.  
 PE 94., Brand New.....5.95  
 Navy type CA10-211444. Input: 105 to 130 VDC. Output: either 26 VDC at 20 amps, or 13 VDC at 40 amps. Radio filtered and complete with line switch. New \$69.50

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 KS8865 CHARGING CHOKES: 115-150 II @ .02A. 32 4011 @ .08A, 21 KV Test.....\$37.50  
 G.E. PE285-1-250-50 PPT "E" CKT. 1 Microsec. Imp @ 350 PPS, 50 Ohms Impedance.....\$69.50  
 KS9623 CHARGING CHOKES: 16H @ 75 MA, 350 Ohms DCR, 9000 Vac Test.....\$14.95  
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6BT	14.00	2K33	90.00	6SU7GT	2.75	5640	8.50	5732	3.00	5964	1.25
6C2	.70	2K41	95.00	6X4W	1.75	5641	6.00	5734	9.00	5965	1.75
6C3/VR105	.65	2K45	35.00	6X4W	4.50	5642	1.00	5744	2.00	6005	1.50
6C3/VR150	.70	2K48	75.00	7CP1	4.99	5643	6.00	5744WA	5.00	6021	1.25
6C8	1.50	2K55	12.50	7UP7	6.50	5645	6.50	5750	1.30	6022	1.50
1B22	1.25	2K56	45.00	7YP2	150.00	5646	6.50	5751	1.75	6045	1.75
1B26	1.00	3P1	2.00	8AT7WA	1.25	5647	7.50	5753WA	4.50	6050	5.50
1B27	10.00	3BP1	2.00	HK-24	2.50	5651	1.50	5763	1.10	6072	POR
1B32	1.00	3CP1	9.00	2526W	3.75	5651WA	3.50	5780	180.00	6073	2.75
1B35	1.00	3CP2	3.50	6X4W	25.00	5652	1.25	5783	1.75	6074	POR
1B35A	7.50	3DP7	6.00	6K62	25.00	5657	125.00	5784	5.50	6080	6.00
1B40	2.00	3DP152	9.00	28D7W	1.35	5659	POR	5784WA	7.50	6080WA	8.00
1B63A	20.00	3CP1	1.95	6X4W	25.00	5660	POR	5785	1.75	6082	3.70
1B58	4.00	3P1	6.00	6K72	.50	5661	4.00	5787	4.85	6096	1.40
1N21	.55	3W2P1	50.00	6K73	17.50	5663	1.25	5794	6.00	6097	1.50
1N21C	12.00	3P1	1.50	6D-93	11.00	5671	1.10	5797	8.50	6098CT	1.75
1N22	.65	3B24	1.00	100T1	6.00	5670WA	3.50	5798	12.50	6100	2.25
1N23	.60	3B24	1.00	100T1G	12.50	5672	1.20	5799	POR	6101	3.50
1N23B	1.50	3B24W	5.00	F124A	40.00	5673	1.25	5799A	POR	6110	5.50
1N25	9.75	3B25	5.00	F124B	40.00	5676	1.25	5800	8.50	6111	6.75
1N26	3.75	3B26	2.50	F129R	150.00	5677	3.25	5803	6.75	6112	6.75
1N31	3.00	3B25	2.75	VT-158	7.50	5678	1.25	5814	1.10	6113	6.75
1N32	1.00	3C22	60.00	HF200	18.00	5680	115.00	5814A	2.00	6130	14.00
1N34A	.50	3C31	1.50	T200	18.00	5686	2.00	5814WA	4.50	6135	POR
1N35	1.75	3C25	8.50	204A	25.00	5687	2.75	5823	2.25	6136	1.75
1N38	1.00	4C35	5.00	211	2.00	5687WA	3.75	5829	2.00	6140	9.00
1N41	8.00	4C35	13.50	220B	50.00	5691	4.75	5829WA	7.50	6141	9.00
1N42	8.00	4C36	20.00	220C	75.00	5692	5.00	5840	10.00	6152	7.00
1N43	2.00	4B4	250.00	250TH	24.50	5693	4.75	5841	6.50	6152	7.00
1N44	POR	4J26	45.00	250TL	15.00	5697	POR	5842	10.00	6152	7.00
1N60	.35	4-125A	17.50	HF300	17.50	5702	1.65	5844	1.30	6211	3.00
1N67	1.00	4-65A	16.00	400A	8.00	5702WA	6.00	5845	POR	6186	2.75
1N68	1.75	4-400A	58.50	304TL	8.95	5703	1.50	5851	4.00	6201	3.00
1N73	3.00	4-1000A	120.00	304TH	7.50	5703WA	6.00	5854	1.30	6211	3.00
4N76	4.00	4N70	1.00	400TH	7.50	5704	1.90	5876	8.00	6222	POR
1N91	1.00	4X150G	30.00	450TH	40.00	5718	3.00	5879	1.40	6236	250.00
1N92	1.75	4X500A	50.00	450TL	35.00	5719	2.25	5881	2.75	6237	POR
1N93	2.00	4B4	21.95	HF-654	24.50	5722	4.85	5886	3.75	6238	POR
1N100	2.25	5BP1	2.50	531	5.00	5725/GAS/W	5.894	5894	1.00	6360	4.50
1N127	1.00	5BP1A	12.50	575A	15.00	6187	3.75	5896	6.00	6386	5.50
2A1P1	6.00	5CP2	5.00	715A	2.00	5725	1.75	5898	7.50	6020/100R	7.50
2B1P1	6.00	5CP2	5.00	715B	4.00	5726	.60	5948/1754	200.00		
NS2A	.75	5CP7	6.00	715C	12.00						
2C27	4.75	5FP7A	2.50	750TL	39.95						
2C39	4.75	5FP7A	2.50	803	2.50						
2C39A	11.00	5FP14A	12.50	810	10.00						
2C40	13.00	5HP4	12.00	811	2.95						
2C42	5.50	5HP4	12.00	812	10.50						
2C43	9.00	5J1P1	9.50	815	1.50						
2C46	6.00	5L1P1	14.00	815	1.50						
2C51	10.00	5NP1	2.00	828	9.00						
2C53	10.00	5NP1	2.00	828	9.00						
2D21	1.50	5X1P1	50.00	832A	4.00						
2D29	.75	5X3P7	50.00	832B	4.00						
2E25	2.25	5Y3WGT	1.90	833A	39.00						
2E26	3.00	6C6M	7.00	838	1.00						
2E29	1.75	6ACT7W	1.50	843	2.50						
2E30	1.75	6ACT7WA	2.50	845	5.00						
2E35	1.95	6AK5	1.45	849	17.50						
2J21	1.75	6AL5W	1.45	853	35.00						
2J22	1.75	6AL5W	1.45	858	275.00						
2J26	3.75	6AN5	2.25	860A	3.00						
2J27	3.75	6AN5WA	3.75	862A	750.00						
2J31	12.00	6AR5W	1.25	862B	30.00						
2J32	12.00	6AR5W	1.25	869B	30.00						
2J33	14.50	6AS6W	2.75	874	1.75						
2J36	15.00	6B6L	2.50	876	75						
2J37	4.00	6AU6WA	1.55	878	50						
2J41	125.00	6BF7W	3.25	880	250.00						
2J42	60.00	6BF7W	3.25	880RA	100.00						
2J51	120.00	6BL6	32.50	892A	165.00						
2J54	35.00	6BM6	25.00	892-R	225.00						
2J55	45.00	6B5ME6A	32.50	893	35						
2J56	45.00	6C4W	4.50	5588	POR						
2J61	12.00	6F4	3.25	5630	3.00						
2J62	5.00	6F4	1.90	5631	75						
2K22	14.00	6J4WA	3.95	5633	8.00						
2K23	14.00	6J6W	1.50	5635	12.50						
2K25	11.25	6L6A	2.25	5636	3.00						
2K26	45.00	6L6Y	2.50	5637	5.50						

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102F	3.00	321A	6.00	423A/6140	8.00
104D	.75	332A	6.00	427A/6141	7.50
121A	3.50	337A	6.75	8/2K26	45.00
122A	6.00	305F	4.85	429A	8.75
221A	7.00	349A	5.75	431A	200.00
244A	7.50	350A	2.75	438A	55.00
249B	3.50	350B	2.75	703A	1.00
249C	3.50	354A	1.00	704A	.85
253A	3.50	359A	2.00	705A	.75
254A	4.75	368A	2.00	708A	.75
259A	14.00	371B	1.00	709A	.65
262B	3.00	373A	5.00	713A	.65
267B	10.00	374A	4.75	717A	1.00
274B	1.00	388A	1.00	719A	9.50
276D (Relay)	8.75	394A	8.00	724B	1.00
282A	7.00	395A	POR	725A	4.00
282B	1.50	396/2CS1	2.35	5842/417A	10.00
293A	12.50	397A/2K56	45.00	5847/404A	10.00
300B	4.00	400A	4.00	708/421A	12.00
305A	60.00	403A/6AK5	1.25	6028/408A	3.50
310A	4.00	403R/5591	2.75	6140/423A	8.00
310B	6.00	404A	10.00	6141/427A	7.50
311A	4.50	407A	4.00	D17846/L	
311B	5.50	408A	3.50	419A	45.00
313C	2.00	412A	4.95	D79512 MAN	15.00
313CA	2.50	416A	35.00		
316A	.50	416B/6280	47.00		

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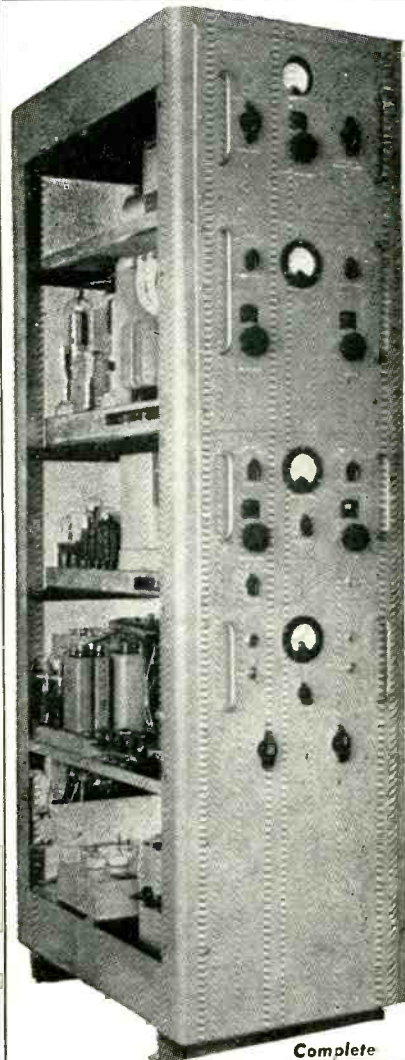
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ST 50 R DPDT	on-moment	.89
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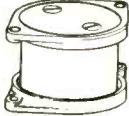


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2KV 03	10.95	2KV 015	1.29
1KV 04	4.95	2KV 00015	.99
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1200WV 01	.59	2500WV 0036	*.69
1200WV 0051	.49	2500WV 001	.44
600WV 016	*.32	2500WV 0001	.29
600WV 02	*.45		
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100 25(H) 3/8 7/16 .79	3000 JLU look 3/16al .54
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OB2	.60	4B94	5.00	FP-54	35.00	597	20.00	CK-1006	2.50
OB3 VR-90	.75	4B97	9.25	HK-54	2.00	GL-546	2.00	SN-1006	6.50
OC3 VR-105	.60	4B31	20.00	T-55	3.50	559	.45	CK-1007	.45
OD3 VR-150	.60	4C37	5.00	VX-55	6.00	575A	6.00	SN-1007A	6.50
EL-C1B/3C31	1.00	4C35	1.75	KK-60 1641	1.25	631-P1	5.00	SN-1007B	8.50
1AD4	1.15	4E27 8001	7.50	KK-61	2.50	WL-639A	17.50	CK-1009 BA	3.00
1AF4	2.50	4J34	25.00	HY-65	.75	WL-652/57	40.00	SC-1016C	6.50
1AG5	2.00	4J38	100.00	KK-65 5D23	6.50	WL-655/58	80.00	CK-1017C	6.50
1B22	1.25	4J39	100.00	FG-67	9.00	WL-681/86	25.00	CK-1026	2.90
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1B45	1.75	EL-C5B 5C30	1.00	KK-75 307A	.75	706A-Y-GY	7.50	1603	3.50
1B47	5.00	5AP1	2.00	75TL	7.50	707B	2.50	1614	1.50
1P21	30.00	5B21	1.00	FG-81A	3.50	WE-714A	7.50	1619	.30
1P22	5.50	5B21	2.00	FG-95	17.50	WE-714AY	25.00	1624	1.00
1P23	7.50	5B21A	4.00	100R	5.00	715B	3.00	1625	.30
1P29 & 30	1.50	5B22A	4.00	100TH	5.00	715C	10.00	1846	50.00
1P36 & 37	2.00	5B24	2.00	WE-122A	1.50	717A	.35	ZB-3900	100.00
2-01C	10.00	5C22	25.00	F-123A	5.00	WE-719A	7.50	R-4330	7.50
2AP1	4.00	5CP1	2.00	WE-123A	2.50	720A-YEY	35.00	5528	5.00
2AP1A	6.00	5CP1A	7.50	F-128A	15.00	721A	.75	5550	25.00
2AS15	5.00	5CP7	6.00	VXR-130	1.65	721B	7.00	5551	40.00
2C38	6.50	5CP7A	8.00	HK-154	4.00	723A/B	8.00	5553	80.00
2C39	4.00	5CP12	10.00	FG-166	7.50	WE-725A	3.00	5556/PJ-8	6.75
2C39A	10.00	5D21	7.50	FG-172	20.00	WE-726A	5.00	5557	3.00
2C40	10.00	5FP7	1.50	OK-181	12.50	WE-726B	18.50	5558	5.00
2C42	10.00	5FP14	7.50	FG-190	7.50	WE-726C	15.00	5560	17.50
2C43	10.00	5GP1	4.00	HF-200	8.50	WE-730A	6.50	5610	1.00
2C44	.45	5HP1	2.00	CE-203	3.50	750TL	40.00	5632	8.50
2C46	6.00	5J29	7.50	203A	3.50	SA-728B	2.00	5634	2.50
WE-2C51	2.50	5J30	5.00	207	25.00	WL-786	12.50	5637	3.75
2D21	.65	5J32	7.50	WE-211C	10.00	801A	.50	5638	6.50
2D21W	1.00	5J31	10.00	WE-211D	8.00	802	2.00	5640	8.50
2D29	1.00	5J2E	5.00	WL-218	15.00	GL-803	2.00	5642	1.00
2E22	3.00	5JP4	5.00	232CH	100.00	804	8.50	5644	6.50
2E24	1.75	5JP5A	5.00	CE-235A	5.00	805	5.00	5645	8.50
2E26	3.00	5JP11	7.50	WE-242C	7.00	807	1.10	5650	85.00
2E29	.75	5LP1	7.50	WE-244A	7.50	807W	2.00	5651	1.25
2E36	1.25	5NP1	2.00	WE-245A	7.50	808	1.00	5654	1.00
2J21A	2.50	5R4G	1.00	WE-249B	3.00	809	2.25	5656	5.50
2J26 & 27	2.50	5R4WGY	2.50	WE-249C	2.50	810	10.00	5670	1.45
2J29	10.00	5X3	3.00	250R	3.75	811	2.75	5672	1.15
2J30	35.00	5X3P1	75.00	250TH	17.50	812	2.75	5676	1.25
2J31-40	10.00	5Z2P2	50.00	250TL	14.50	813 (RCA)	12.00	5678	1.00
2J51	100.00	5Z4P11	100.00	WE-251A	75.00	814	1.25	5681	2.00
2J52	50.00	EL-C6J	6.00	WE-252A	7.50	815	1.00	5692	4.00
2J54	25.00	EL-C6L	5.00	WE-253A	2.50	816	1.00	5693	3.50
2J55	35.00	EL-6C/4B25	8.00	WE-254A	3.50	826	.50	5696	1.00
2J56	50.00	6ACTW	1.00	WE-257A	3.00	SD-828A	6.50	5703	1.00
2J61	15.00	6AD4	2.50	FG-258A	80.00	828	8.50	5720	15.00
2J62	5.00	WE-6AK5	1.00	WE-262B	5.00	829	4.50	5725	1.50
2K22	15.00	6AK5W	1.00	267B	5.00	829B	8.50	5726	.50
2K25	11.00	6AL5W	.50	WE-268A	7.50	830B	.50	5727	1.25
2K30	100.00	6AN5	2.00	FG-271	40.00	832	3.00	5728	9.00
2K33A	50.00	6AR6	1.25	WE-271A	7.50	832A	4.75	5734	9.00
2K34	85.00	6AR6WA	3.75	WE-274B	.90	833A	3.00	5740	35.00
2K39	100.00	6AS6	1.15	WE-276A	7.50	833A	35.00	5750	2.50
2K41	75.00	6AS6W	1.50	WE-282A	5.00	834	5.00	5763	1.25
2K45	30.00	6ASTG	2.75	WE-283A	3.50	836	1.50	5800	7.50
2K47	100.00	6RA5	2.50	WE-285A	5.00	837	1.00	5801	5.00
2K54	5.00	6C21	15.00	WE-286A	6.00	838	1.00	5819	30.00
2K55	5.00	6I4	1.75	287A	2.50	842	1.50	5827	5.00
2P21 (I.O.)	25.00	6I4WA	2.50	WE-300B	5.00	845	3.50	CK-5829	1.25
2V3G	1.25	6I6W	1.50	304TH	7.50	845W	7.50	5842	12.50
2X2A	.90	6L6WGB	2.50	304TL	12.50	851	9.00	5847	12.50
3A4	.50	6SK7W	1.50	307A					

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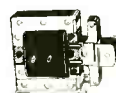
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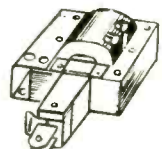
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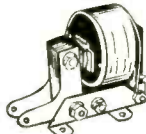
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1N65 .85	3D22A .3.95	450-TH		246A .10.00	417A .8.50	807 .1.20	1684 .8.00	6099 .1.40
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1N69 .85	3D22A .3.95	*****		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
1N70 .85	3D22A .3.95	450-TH		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
1N71 .85	3D22A .3.95	\$47.50		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
1N72 .85	3D22A .3.95	*****		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
1N73 .85	3D22A .3.95	450-TH		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
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1N85 .85	3D22A .3.95	450-TH		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
1N86 .85	3D22A .3.95	\$47.50		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
1N87 .85	3D22A .3.95	*****		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
1N88 .85	3D22A .3.95	450-TH		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
1N89 .85	3D22A .3.95	\$47.50		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
1N90 .85	3D22A .3.95	*****		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
1N91 .85	3D22A .3.95	450-TH		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
1N92 .85	3D22A .3.95	\$47.50		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
1N93 .85	3D22A .3.95	*****		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
1N94 .85	3D22A .3.95	450-TH		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
1N95 .85	3D22A .3.95	\$47.50		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
1N96 .85	3D22A .3.95	*****		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
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1N98 .85	3D22A .3.95	\$47.50		254A .6.50	417A .8.50	807 .1.20	1684 .8.00	6100 .4.75
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T28V12ACC	12 Amp 0.1% Ripple	160
T28V24ACC	0-28 VDC at 24 Amp	155
T28V24ACC	24 Amp 0.1% Ripple	310
T28V50ACC	0-28 VDC at 50 Amp	285
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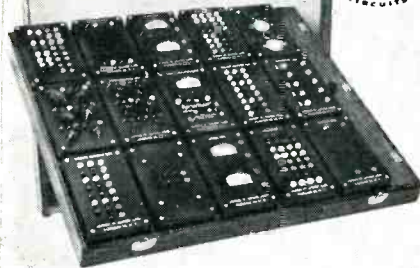
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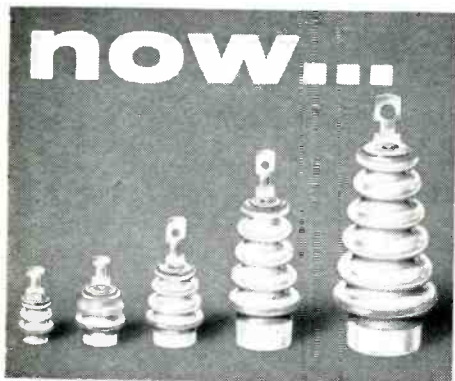
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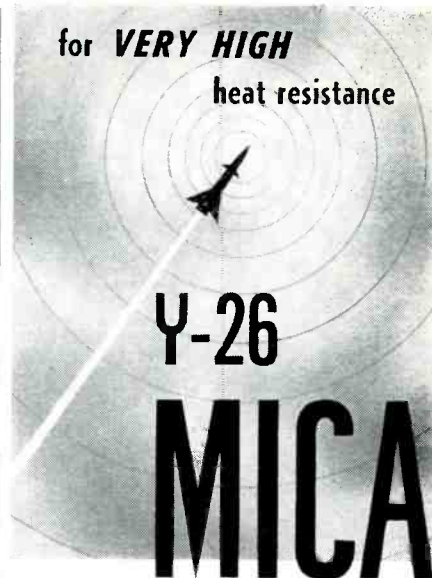
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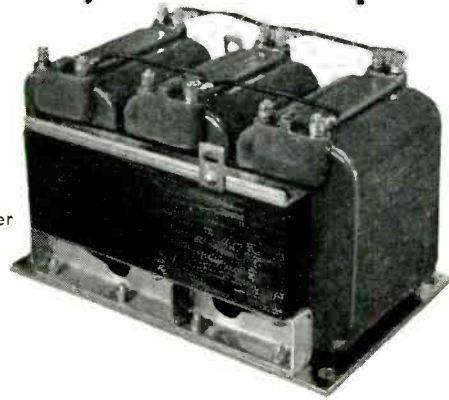
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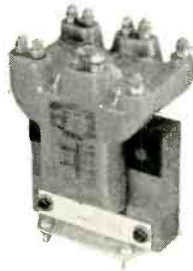
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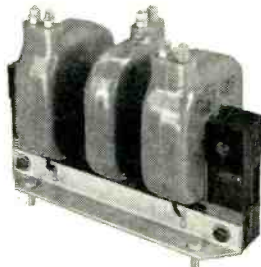


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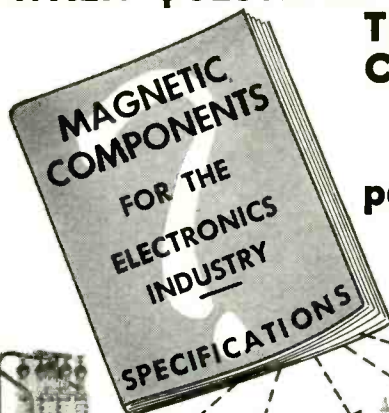


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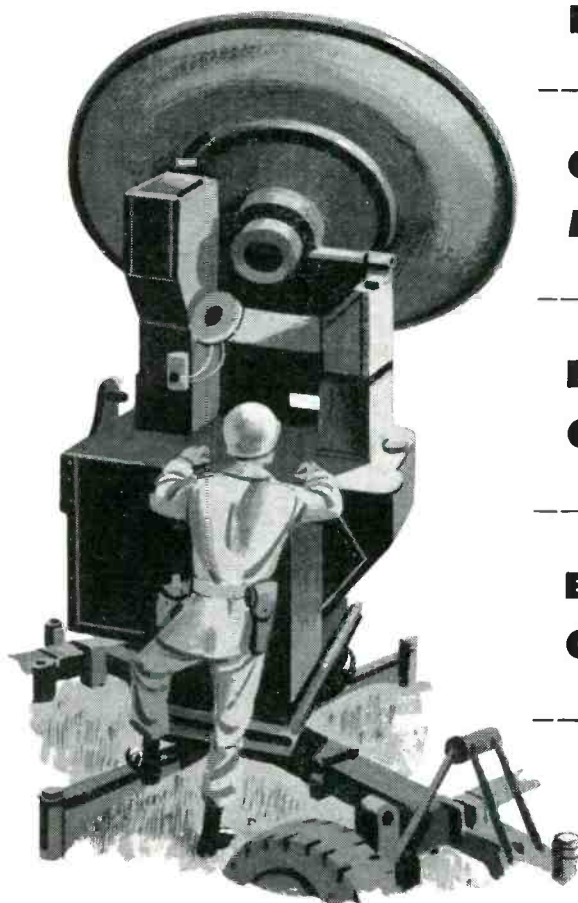
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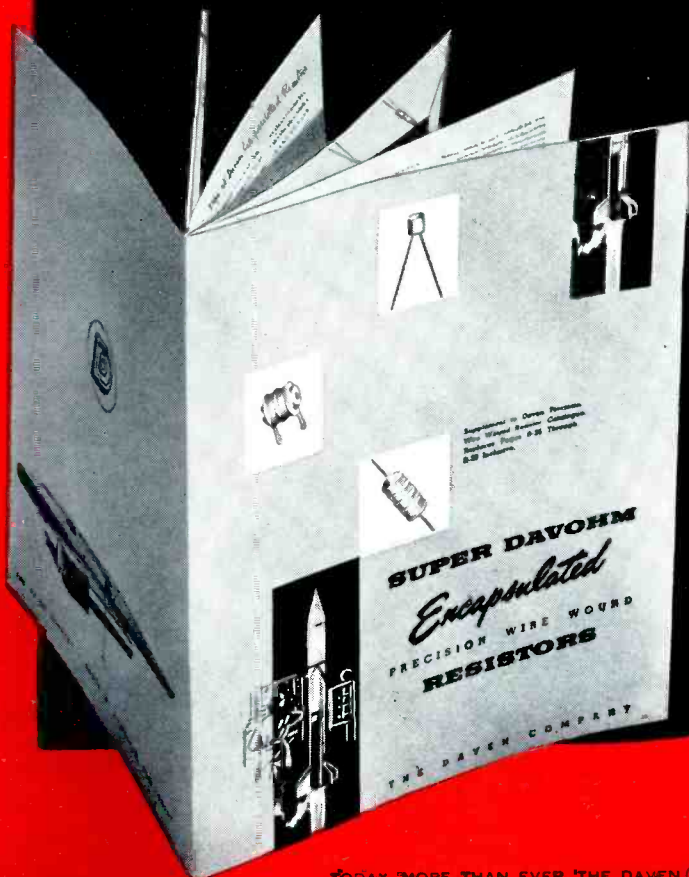
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