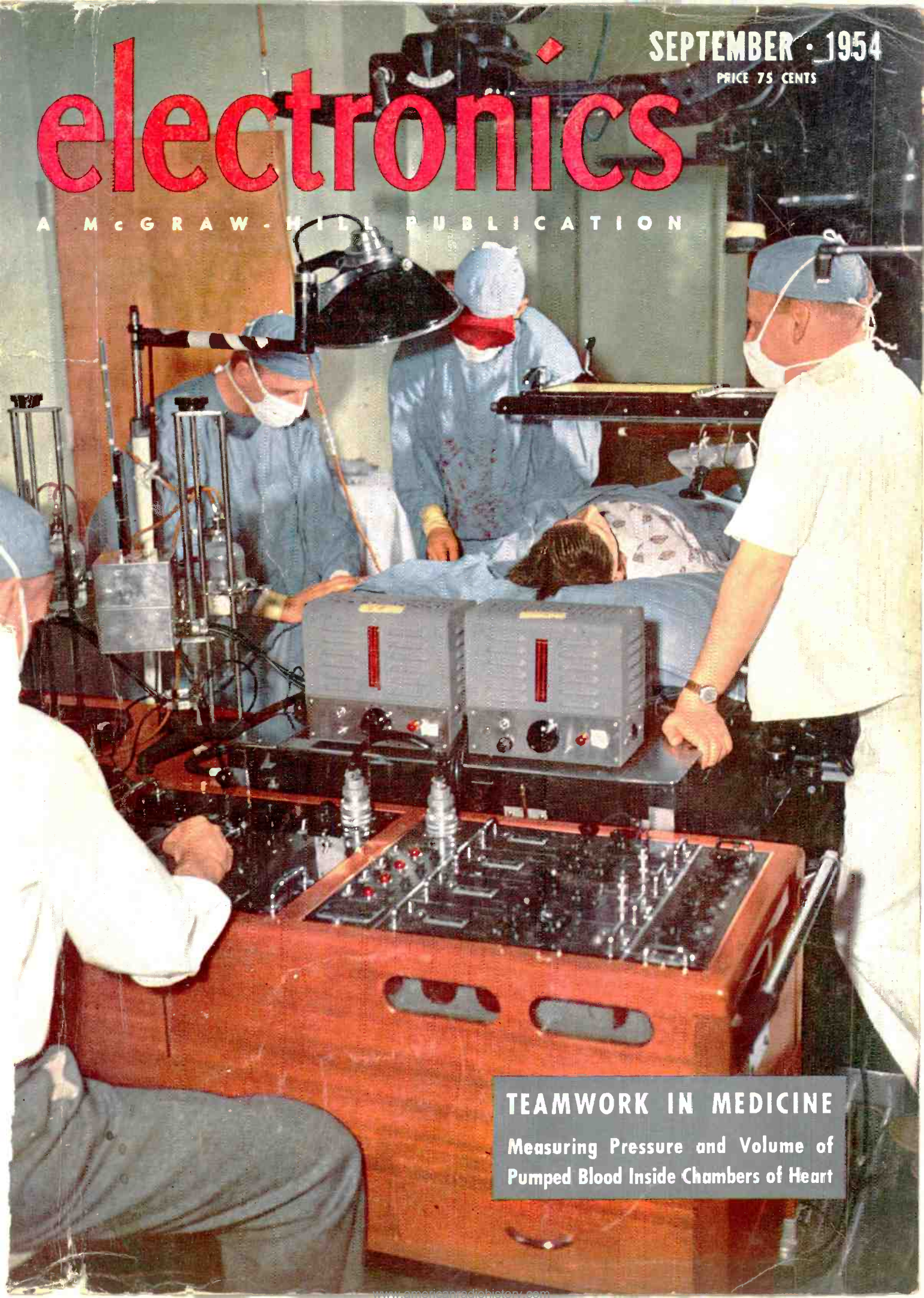


SEPTEMBER • 1954

PRICE 75 CENTS

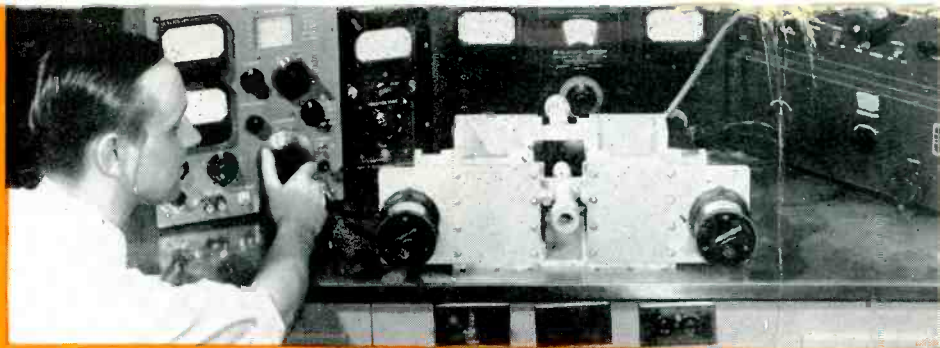
electronics

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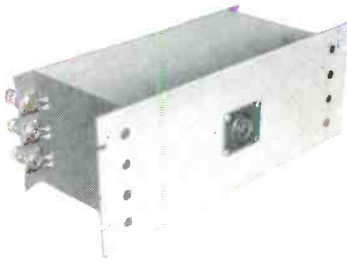
TEAMWORK IN MEDICINE

Measuring Pressure and Volume of Pumped Blood Inside Chambers of Heart

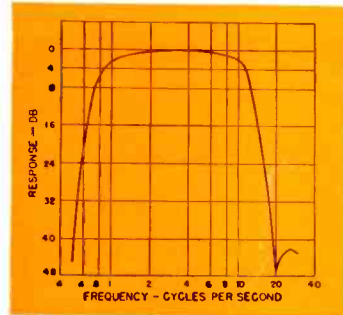
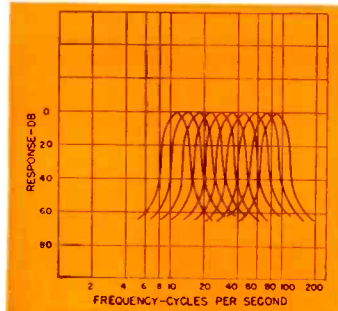


for SPECIALIZED FILTERS

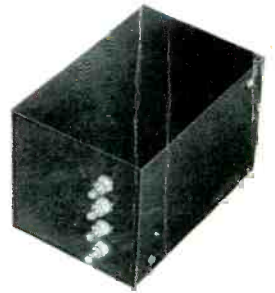
Decades of experience in the design and production of specialized filters have resulted in UTC being a first source for difficult filters. Fifteen years ago UTC was already the largest user of permalloy dust toroids in the world (exclusive of the telephone system). Present designs include a wide variety of core materials, structures, and winding methods to provide maximum performance in electrical requirements and stability. Illustrated below are a few of the thousands of special filter designs in present production.



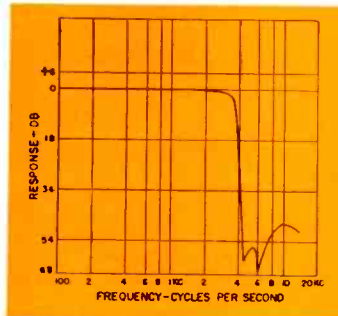
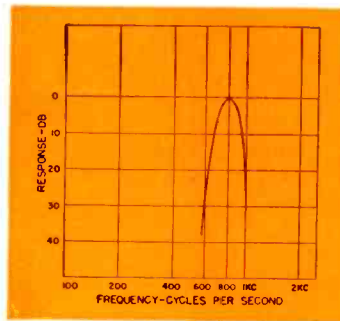
These low frequency band pass filters are held to 1 DB tolerance at the 3 DB crossover ... 600 ohm ... 4 filters per 7 1/2" rack panel.



This ultra low frequency filter has a band pass range of one cycle to 10 cycles ... 50,000 ohms ... 700 cubic inches.



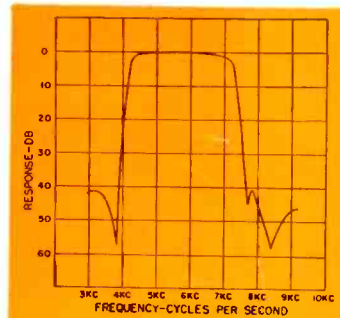
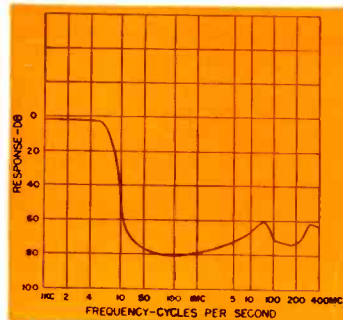
This 600 ohm miniaturized 1 KC band pass filter is housed in a case only 1" x 1 3/4" x 2 1/2".



This 600 ohm miniaturized low pass filter is housed in a case only 1" x 1 3/4" x 2 1/2".



This power line filter provides correct output voltages from sources of 50 to 400 cycles ... noise attenuation is from 14 KC to 400 MC ... 29 cubic inches.



This band pass filter is designed for sharp cut-off at both ends of the range ... 10,000 ohms ... case dimensions 1 5/8" x 2 1/2" x 3 1/4".



United Transformer Co

150 VARICK STREET NEW YORK 13, N. Y.
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "FRAN"

electronics

SEPTEMBER • 1954

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PUBLICATION

TEAMWORK IN MEDICINE—Making cardiac catheterization test on patient with heart disease at Massachusetts General Hospital, Boston. Radiologist, surgeon, heart specialist and chemistry technician collaborate in using special x-ray equipment and electronic devices for obtaining pressure and flow rate recordings. Photo by Donald Withee. Details on p. 184. COVER

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Tubeless Magnetic Amplifier DC Supplies



**Latest
additions
to the
SORENSEN
line!**

Sorenson Tubeless Magnetic Amplifier DC Supplies are designed for applications where utmost reliability is required. The four instruments described below cover a wide range of requirements; additional instruments are under development and will shortly be added to the line.

MODEL MA640 (illustrated above)

Input 105-125 VAC, 1 ϕ , 60 ν
Output 4.5 - 7.7 VDC, adjustable
Load Range 0-40 amperes
Ripple 1% maximum
Regulation Accuracy $\pm 1.0\%$ for any combination of line and load conditions
Recovery Time 0.2 seconds under worst conditions
Size 17" wide, 12 $\frac{1}{4}$ " high, 15" deep. Can be furnished for relay rack mounting. Meters, as illustrated, optional at extra cost.

MODEL MA65

Input 105-125 VAC, 1 ϕ , 60 ν
Output 6 VDC, adjustable $\pm 10\%$
Load Range 0-5 amperes
Ripple 1% maximum
Regulation Accuracy $\pm 1.0\%$ for any combination of line and load conditions
Recovery Time 0.15 seconds under worst conditions
Size For relay rack mounting — 19" wide, 5 $\frac{1}{4}$ " high, 12" deep. A cabinet is available for bench operation. This is an unmetred unit.

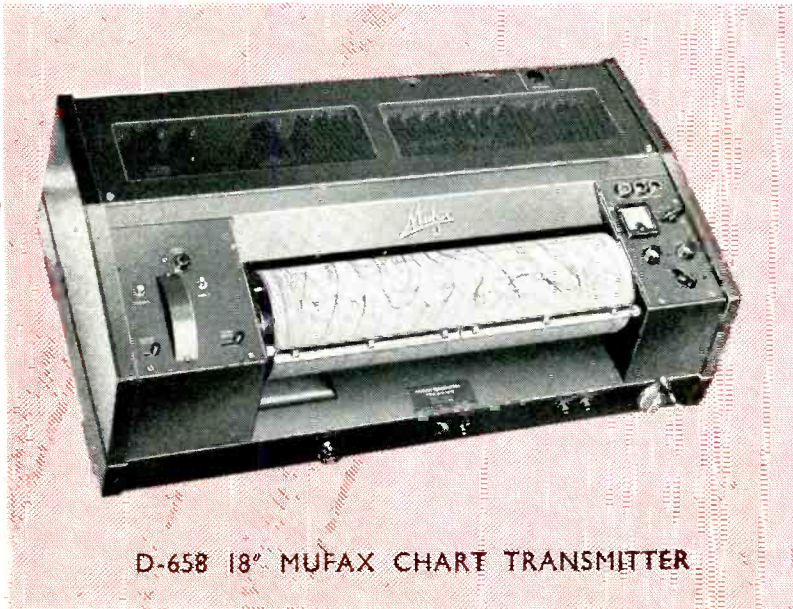
MODEL MA6/15

Input 190-230 on a 208 line, 1 ϕ , 60 ν
 210-250 on a 230 line, 1 ϕ , 60 ν
Output & Load Range 4.5 - 7.7 VDC at 0-100 amperes
 8.5 - 15.4 VDC at 0-75 amperes
Ripple 1% maximum
Regulation Accuracy $\pm 1.0\%$ for any combination of line and load conditions
Recovery Time 0.2 seconds under worst conditions

MODEL MA2850

Input 190-230, 3 ϕ , 4-wire wye, 60 ν
Output 23 - 32 VDC, adjustable
Load Range 0-50 amperes
Ripple 3% maximum
Regulation Accuracy $\pm 1.0\%$ for any combination of line and load conditions
Recovery Time 0.5 seconds

MUIRHEAD—FIRST IN FACSIMILE



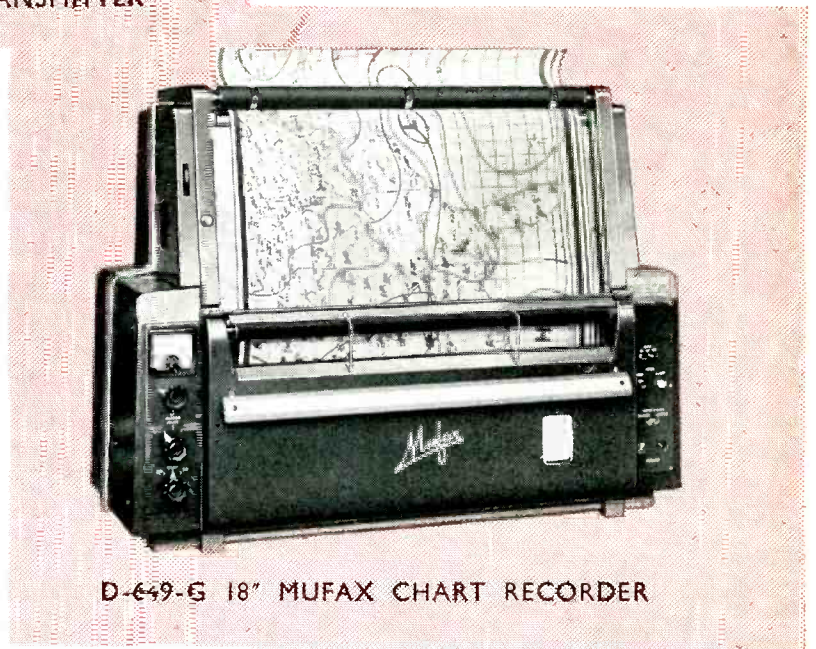
D-658 18" MUFAX CHART TRANSMITTER

THE TRANSMITTER

A chart measuring 18" x 22" can be accommodated on the transmitter drum. Provision is made for automatic operation over a broadcast network including American recorders as well as Mufax machines. An additional high speed facility is provided for use with Mufax recorders only.

THE RECORDER

The operation of the recorder is entirely automatic, and recording is on Mufax electrosensitive paper supplied in rolls sufficient for over thirty hours continuous operation. The recorded chart is immediately visible, requires no processing, and can be examined while being received.



D-649-G 18" MUFAX CHART RECORDER

MUFAX chart transmitters and recorders together provide the first completely automatic system for the transmission of facsimile weather maps. The new Canadian Weatherfax System uses this equipment exclusively.

WRITE UNDER YOUR BUSINESS LETTERHEAD
FOR PUBLICATIONS 8691 & 8696

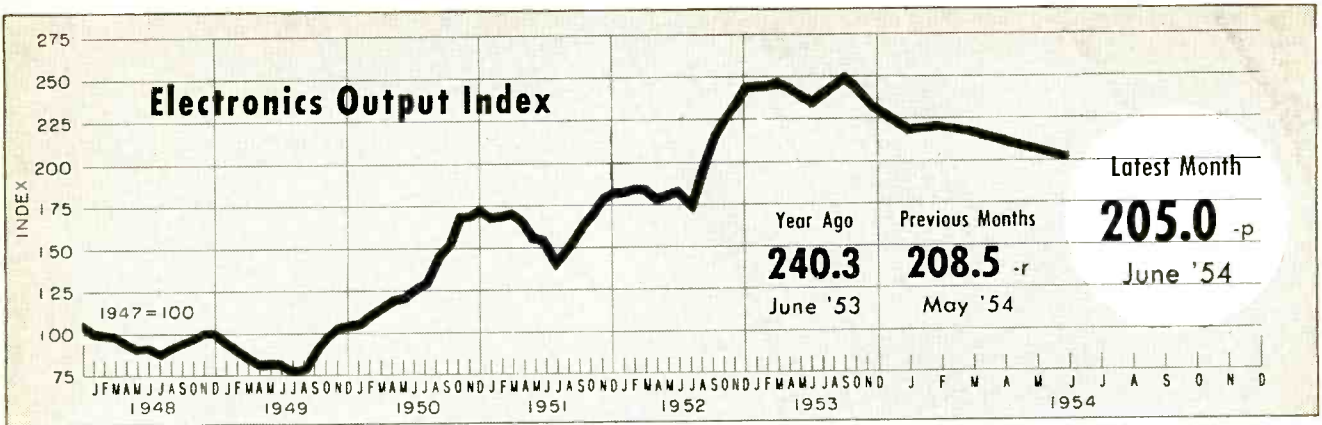
MUIRHEAD

PRECISION ELECTRICAL INSTRUMENTS

TECHNICALITIES

Maximum chart size	18" x 22"
Index of Co-operation	576
Helix and drum speed	1 or 2 r.p.s.
Scanning rate	96 lines/inch
Line signal	AM: 1500c/s carrier
Power supply	95-125V, 60c/s

MUIRHEAD & CO. LIMITED • BECKENHAM • KENT • ENGLAND



FIGURES OF THE MONTH

	Year Ago	Previous Month	Latest Month
RECEIVER PRODUCTION			
(Source: RETMA)			
Television sets, total	June '53	May '54	June '54
With UHF	524,479	396,287	544,142
Color Sets	86,790	99,404
Radio sets, total	1,163,831	722,104	837,655
With F-M	49,875	9,819	15,854
Home sets	287,724	173,480	226,350
Clock Radios	131,144	57,370	132,668
Portable sets	239,189	174,735	141,904
Auto sets	505,774	316,519	336,733

	Year Ago	Previous Month	Latest Month
RECEIVER SALES			
(Source: RETMA)			
Television sets, units	June '53	May '54	June '54
Radio sets (except auto)	431,089	308,728	351,885
	449,116	386,152	537,494

	Year Ago	Previous Month	Latest Month
RECEIVING TUBE SALES			
(Source: RETMA)			
Receiv. tubes, total units	June '53	May '54	June '54
Receiv. tubes, value	42,505,685	28,650,825	31,031,315
Pic. tubes, total units	\$29,634,656	\$20,465,451	\$21,694,500
Picture tubes, value	746,822	584,782	681,937
	\$17,480,475	\$12,062,269	\$13,933,845

	Year Ago	Previous Month	Latest Month
SEMICONDUCTOR SALES			
(Source: RETMA)			
Germanium Diodes	May '53	Apr. '54	May '54
Silicon Diodes	1,466,362	994,949-r	1,001,905

	Quarterly Figures		
	Year Ago	Previous Quarter	Latest Quarter
INDUSTRIAL TUBE SALES			
(Source: NEMA)			
Vacuum (non-receiving)	1st '53	4th '53	1st '54
Gas or vapor	\$10,400,000	\$9,467,331	\$8,971,335
Phototubes	\$3,300,000	\$4,854,222	\$4,589,239
Magnetrons and velocity modulation tubes	\$700,000	\$405,000	\$405,000*
Gaps and T/R boxes	\$10,500,000	\$13,073,095	\$16,135,274
	\$1,700,000	\$1,707,730	\$1,517,426

*4th quarter 1953

	Year Ago	Previous Month	Latest Month
TV AUDIENCE			
(Source: NBC Research Dept.)			
TV Homes, total	July '53	June '54	July '54
	24,519,000	30,411,000	30,717,000

	Year Ago	Previous Month	Latest Month
BROADCAST STATIONS			
(Source: FCC)			
TV Stations on Air	July '53	June '54	July '54
TV Stns CPs—not on air	224	402	409
TV Stns—Applications	284	171	169
A-M Stations on Air	524	14	16
A-M Stns CPs—not on Air	2,466	2,583	2,592
A-M Stns—Applications	122	114	121
F-M Stations on Air	251	158	167
F-M Stns CPs—not on Air	578	553	559
F-M Stns—Applications	21	16	12
	8	5	5

	Year Ago	Previous Month	Latest Month
COMMUNICATION AUTHORIZATIONS			
(Source: FCC)			
Aeronautical	June '53	May '54	June '54
Marine	39,315	41,374	40,154
Police, fire, etc.	40,357	45,762	46,299
Industrial	13,631	15,438	15,697
Land Transportation	17,378	21,313	21,598
Amateur	5,922	6,887	6,891
Citizens Radio	111,289	122,283	123,287
Disaster	3,829	5,706	7,054
Experimental	191	283	283
Common carrier	414	567	586
	1,214	1,613	1,635

	Year Ago	Previous Month	Latest Month
EMPLOYMENT AND PAYROLLS			
(Source: Bur. Labor Statistics)			
Prod. workers, comm. equip.	May '53	Apr. '54	May '54
Average weekly earnings, comm.	407,300	354,300-r	340,200-p
Average weekly earnings, radio	\$65.53	\$66.30-r	\$67.60-p
Average weekly hours, comm.	\$63.36	\$65.35-r	\$66.25-p
Average weekly hours, radio	40.2	39.0-r	39.3-p
	39.6	38.9-r	39.2-p

	Year Ago	Previous Month	Latest Month
STOCK PRICE AVERAGES			
(Source: Standard and Poor's)			
Radio—TV & Electronics	July '53	June '54	July '54
Radio Broadcasters	272.4	308.7	351.2
	269.3	325.9	377.3

p—provisional; r—revised

FIGURES OF THE YEAR

	1953 Total
Television set production	7,214,787
Radio set production	13,368,556
Television set sales	6,375,279
Radio set sales (except auto)	7,064,485
Receiving tube sales	437,091,555
Cathode-ray tube sales	7,582,835

	TOTALS FOR FIRST SIX MONTHS		
	1953	1954	Percent Change
Television set production	3,834,236	2,845,147	-25.8
Radio set production	7,266,542	4,886,559	-32.8
Television set sales	2,775,900	2,805,760	+1.1
Radio set sales (except auto)	3,017,198	2,410,893	-20.1
Receiving tube sales	243,160,348-r	165,709,060	-31.8
Cathode-ray tube sales	5,197,071-r	3,957,238	-23.8

INDUSTRY REPORT

electronics—September • 1954



TRANSISTORIZED TV RECEIVER with inch-thick picture tube is here visualized as an ultimate result of . . .

New Design in Picture Tubes

THIN enough to hang on a wall like a picture or mount on the easel of a table model set, the television screen pictured above in mock-up with pasted-on picture has enough factual engineering foundation to be a portent of things to come. This concept of the television set of tomorrow stems from development work being done by scientists at the GE Electronics Laboratory at Syracuse, N. Y. on miniaturized components and radar display techniques.

► **How It Works**—Though technical details have not been released, it is likely that the new tube will make use of vertical and horizon-

tal grid wires on opposite sides of the phosphor screen. Computer circuitry would feed voltages in turn to succeeding x and y grid wires, so that the phosphor glows where the energized grid wires intersect. Switching of voltages from wire to wire then gives scanning action. The intensity of illumination from each dot must be varied in accordance with the picture signal. With this design large screens are easiest to make, so that picture size is limited only by viewing distance at which the 525-line picture structure blends.

The receiver would in all probability employ transistors, subminiaturized components and printed circuits located in the base

supporting the picture tube. Sound could originate from a low-frequency speaker in the base and from rows of high-frequency electrostatic speakers above and below the picture tube. The tweeters would thus beam the high notes directly at the viewer.

Although prominent manufacturers are known to be working on picture tubes without electron guns, none as yet claim to have solved the many engineering problems involved. Best predictions are that it will take ten years to convert this vision to reality.

UHF Satellites To Expand TV Service

LONG-STANDING PROPOSAL to use satellite stations for filling in shadowed areas has been accepted by the Federal Communications Commission and given a twist that may benefit uhf television.

A satellite as now legalized is an auxiliary station (it must be operated on a uhf channel) that picks up either a vhf or uhf program and relays it on a different frequency. It is not to be confused with a proposed booster that would use very low power on the mother station's frequency to fill in holes in viewer coverage. This policy, effective September 1, will also permit operation of small uhf stations that have no intention of originating programs but will use network or film material.

Broadcasters are not yet sure how the new system will work out. Still effective is the duopoly rule that says no one enterprise may have two stations with duplicating or overlapping coverage. However, the FCC indicates that upon showing of good cause it will waive this rule.

Nor is the multiple-ownership rule waived. Present regulations

limit one company to five tv stations. A satellite counts as one, just as a more powerful outlet, but here again FCC has proposed (but not yet acted) to allow additional uhf stations, bringing the total to seven.

Army Uses Color TV In Front Lines

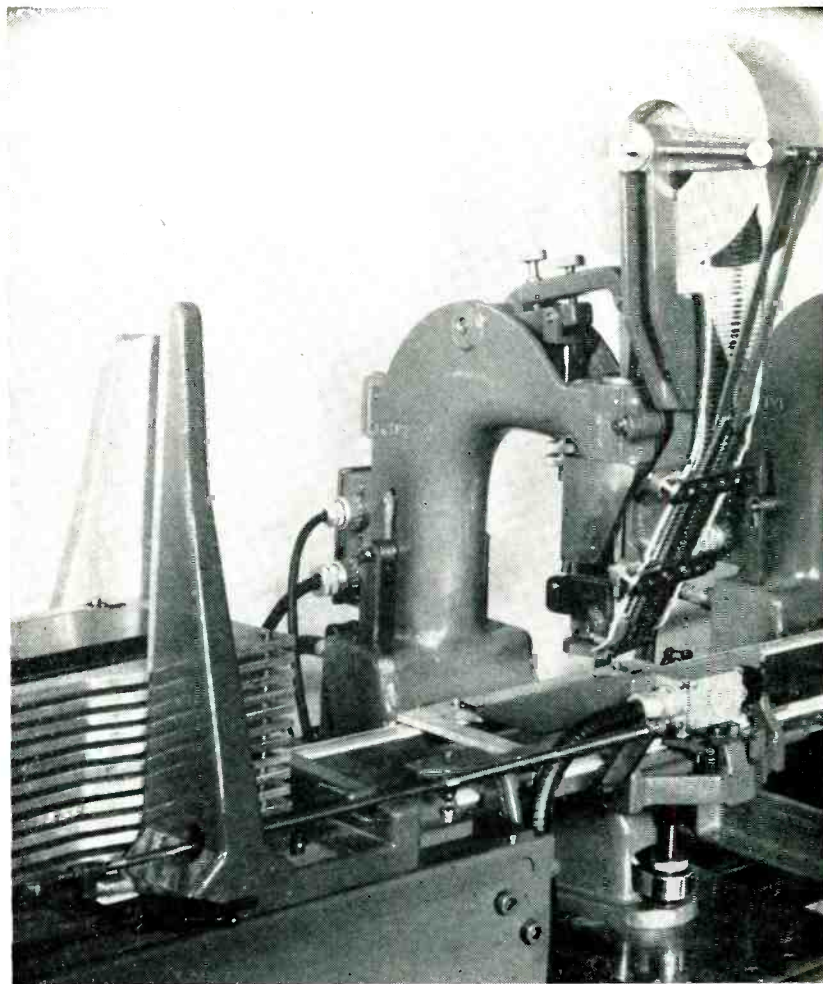
NATIONWIDE tv audience saw how color tv may be used by the Army in time of war to direct front-line operations when the Signal Corps in cooperation with RCA demonstrated it over NBC.

The first half of the telecast used current black-and-white combat tv equipment of the Signal Corps over closed-circuit hookup; the second half was broadcast in color over network tv through NBC's color mobile unit. A water-crossing operation and an assault on an "enemy-held" position were televised by portable and aerial tv cameras in the hands of Signal Corps personnel accompanying the advancing troops. A regimental commander post behind the lines saw the battle on a bank of 8 tv monitors and directed his troops.

► **Dollars**—Cost of a complete tactical tv unit has been estimated by the military at \$12,000 to \$100,000, depending on the tactical unit to which it is adapted. The present intermin tactical tv system consists of three vidicon cameras, each feeding back to a transmitter built into a 3-ton truck and from there by microwave to a monitoring truck. Two cameras and a transmitter were airborne.



Camera at left covers mock assault on pillbox during demonstration



BELTED components fed to stapler-type heads are pushed into printed-circuit board as . . .

New Machine Assembles Circuits

AN AUTOMATIC ASSEMBLY LINE for mounting standard components on printed-circuit boards uses parts-placing heads operating much like stapling machines. The new system, demonstrated by the United Shoe Machinery Corp. of Boston, will turn out 1,200 completed boards per hour, ready for dip soldering.

► **How**—The installing heads, one for each component to be mounted, clip leads to the proper length and insert them in holes drilled in the mounting boards. The boards, set into metal pallets, are moved by a conveyor belt to each installing position. Proper installation of each part is checked by electrical contact on the anvil of each installing unit. The components are

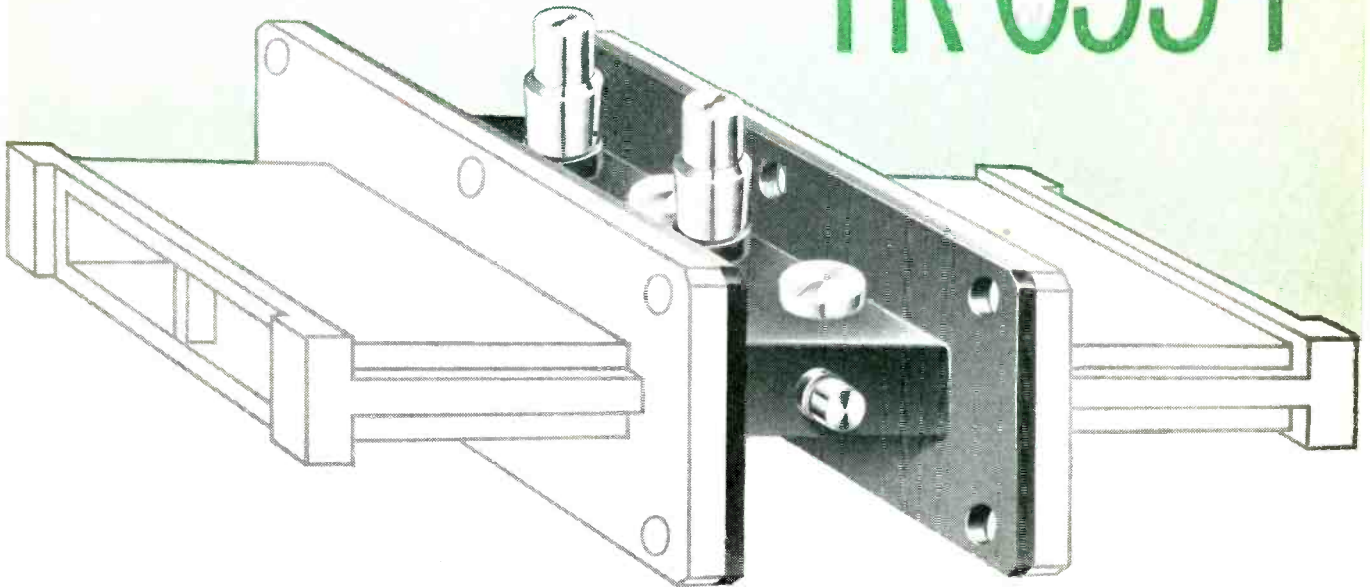
fed to the installing heads on a taped strip from a reel mounted on the unit. (For more details, see the Production Techniques department of this issue.)

► **Future**—The first machines demonstrated will handle only resistors, capacitors, jumper wires and eyelets. These will be installed on assembly lines in three different manufacturing plants for evaluation of operation, versatility and operating costs. If industry reaction is favorable, units for installing tube sockets, transformers and other components will be designed. The first pilot operation is expected to be functioning by September 1, 1954 in an electronic manufacturing plant.

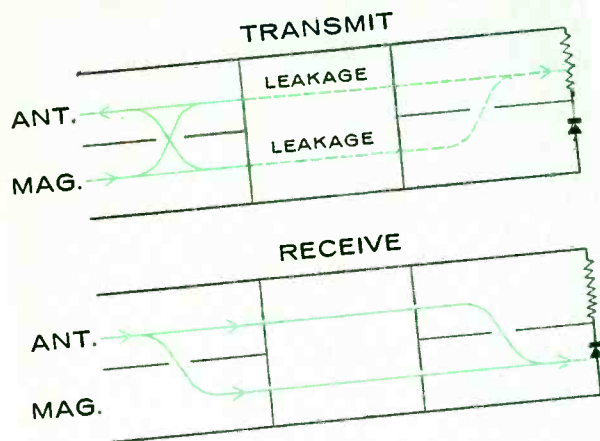
(Continued on page 8)

SYLVANIA NOW OFFERS

A **NEW DUAL** TR 6334



For X-Band Balanced Duplexers



SPECIFICATIONS

Leakage Power	10 mw max.
Spike Leakage Energy	0.1 erg max.
Recovery Time	7 μ sec. max.
Duplexer Loss (Including interaction) less than 1.2 db for any magnetron impedance or phase.	

Here's Sylvania's answer to today's demand for a completely balanced duplexer for use in microwave system design.

Consider these advantages

This new tube is mounted between two readily obtainable short slot hybrid couplers and offers unusually broad band applications (12% band width).

In addition, its simplicity of design permits a reduction in both size and weight, and provides greater crystal protection. For complete information regarding this improved duplexer or other TR and ATR Tubes simply drop a line to Dept. 4E-1609, at Sylvania.

"Another reason why it pays to specify Sylvania."

SYLVANIA

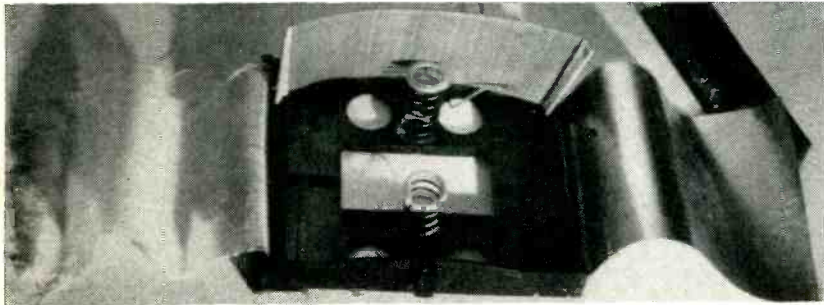
Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.



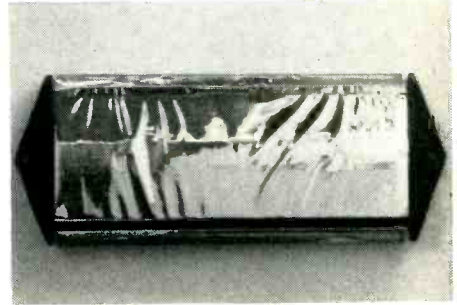
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Building, St. Catherine Street, Montreal, P. Q.

LIGHTING • RADIO • ELECTRONICS • TELEVISION

Electrostatic Speakers Revived For Phonographs



Simplicity means low production cost in German version of electrostatic tweeter. Perforated brass plate (top center) is brought down over tension springs and plastic dielectric sheet backed with gold-foil electrode (right) is put over plate.



Example of American version of tweeter—the Columbia Records kilosphere speaker—which also uses stretched foil electrode.

High-fidelity boom creates market for low-cost tweeters in mass-produced units

TWO LARGE MANUFACTURERS of home phonographs—Philco and Columbia Records—are using electrostatic loudspeakers in their new models. Columbia also uses electrostatic tweeters in its tape recorders. These units, which are used in addition to standard cone loudspeakers, extend frequency response to over 20,000 cycles per second. Phonographs using these speakers have special appeal to

the rapidly growing market of high-fidelity enthusiasts. Television sets and f-m radios constitute a still larger potential market for the low-cost tweeters.

► **Cost**—Both manufacturers are currently producing the electrostatic speakers in their own plants. Initial unit cost for one manufacturer is approximately \$5.70, but production plans call for getting this down to \$4.00 per unit. This manufacturer plans to produce at least 150,000 units this year.

A German-made unit is being imported by Harvey-Wells Elec-

tronics for approximately \$1.25. With volume, this price can drop to \$1.15 per unit.

► **Background**—The electrostatic speaker is by no means new. It was introduced in this country in the 1920's, though did not prove successful because it attempted to reproduce the entire audio range instead of just high frequencies as at present. The speaker was reintroduced here at last year's Audio Fair. In the meantime, the unit has been used as a high-frequency tweeter by at least four German radio manufacturers.

Transistor Production Increases in Volume

GE tools for mass output with new process; Raytheon makes millionth junction transistor

GLIMPSE of the present and future production picture for two transistor manufacturers was given last month when Raytheon produced its millionth germanium junction transistor and GE announced plans for quantity production of the units under its rate-grown process.

► **Plans**—Development work has been largely completed on the new GE process for growing transistor crystal material at high speed. The firm expects to begin sampling to manufacturers late this year. Production limited only by the volume of sales will begin in 1955 at the firm's Syracuse plant.

Prices of the transistors are expected to become competitive with vacuum tubes as soon as electronic manufacturers place orders for comparable quantities.

► **Production**—At present, GE is making a few hundred transistors



Quarter-pound germanium ingot, rate-grown by GE step technique in two hours, gives 2,000 transistors.

a week on its pilot line in Syracuse. A rate-grown ingot is being produced each ten days, which is currently enough to keep the line supplied for about ten days. The firm is presently mechanizing the fabrication process of attaching leads to the transistor bars.

► **How**—The rate-grown process, first announced a year ago, involves varying the heat and withdrawal-rate controls cyclically during the crystal-growing process. As a result, as many as a hundred usable wafer-thin slices of germanium can be cut from a six-inch ingot. With other processes only one useful slice is formed per crystal. The disc-shaped slices are then diced into thousands of bars each several thousandths of an inch long, with a junction layer through the

(Continued on page 10)

IT'S SPRAGUE FOR Ceramic Capacitors

**EVERY TYPE AND RATING FOR
SMALL OR LARGE PRODUCTION RUNS!**

Sprague can provide you with the best capacitors for your requirements. And when it comes to ceramic capacitors, large plants with adequate production and tooling facilities offer prompt delivery for small or large production runs.

In the East, Sprague ceramic capacitors are made at North Adams, Mass., and Nashua, N. H. The Midwest is served by Sprague's wholly owned subsidiary, the Herlec Corporation of Grafton, Wis.

Some of Sprague's newest developments are shown at right. For future developments in ceramic capacitors, look to Sprague for the ultimate in performance, miniaturization, and reliability.

SPRAGUE ELECTRIC CO.

35 Marshall St., North Adams, Mass.

Sprague, on request, will provide you with complete application engineering service for optimum results in the use of ceramic capacitors, and printed resistor-capacitor networks.

NEW! 'RING' CERAMIC CAPACITORS to clean up chassis



Designed to fit around 7-pin miniature tube sockets, these capacitors may contain 2, 3, or 4 sections. They result in a neat physical layout while reducing space to a minimum. Positive positioning of the ultra short leads between the capacitor and socket terminals eliminates lead dress problems and, consequently, allows "hot" circuit designs. Voltage ratings from 100 to 500 d-c. Write for Engineering Bulletin 610.

NEW! FLAT 'PAN' CERAMIC CAPACITORS simplify circuit design



Mounted flat against a chassis with a screw or rivet, these miniature capacitors provide a highly secure mounting. 1 to 4 sections in the shallow pan are insulated and moisture-protected by a phenolic resin. Ideal for military electronics. These units have an unusually high self resonant frequency, and eliminate lead dress problems when mounted adjacent to a miniature tube socket. Available in ratings from 100 to 500 volts d-c. Write for Engineering Bulletin 611.

WIDELY-USED CERAMIC CAPACITORS for electronics, radio, and TV

Shown at left are a few of the many other types of ceramic capacitors available from Sprague. These include:

- Buttons • Discs • Hi-Voltage Moldeds
- Precision Ceramic Trimmers • Plates
- Printed resistor-capacitor networks
- Hermetically sealed, metal cup and tubular precision capacitors

For complete details on any type of ceramic capacitor — it pays to ask Sprague. Write for catalog data on the types in which you are interested.



SPRAGUE

WORLD'S LARGEST CAPACITOR MANUFACTURER

Export for the Americas: Sprague Electric International Ltd., North Adams, Mass. CABLE: SPREXINT

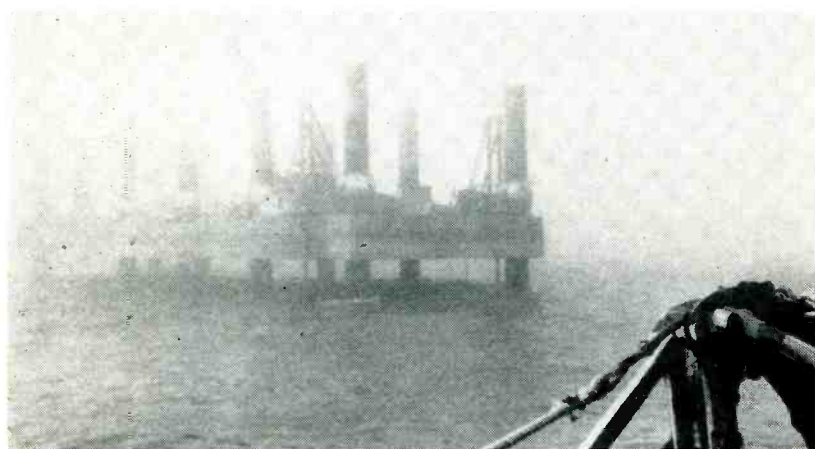
center of each. The more cycles there are in the crystal-growing process, the more layers there are for slicing and dicing.

► **Raytheon**—In announcing the production of its millionth junction transistor, Raytheon pointed out that field failures in actual service are running at the rate of less than 2 percent per year, with well over one billion transistor operating hours to date.

So far the great majority of the

firm's transistor output has gone to the hearing aid industry. Close to 300,000 of U.S. hearing aid wearers out of a total of 1.2 million have already converted from tube to transistor aids.

The company announced that its power and radio-frequency transistors were in the research stage in 1953 and are now in the production design stage, with a good chance of small commercial production before the end of 1954 for sampling to manufacturers.



MAN-MADE ISLANDS like this to appear in open Atlantic as . . .

U. S. Starts Sea Platforms For Radar

Off-shore radar bases to extend along Continental Shelf from Norfolk to Newfoundland

EAST-COAST leg of the nation's radar warning system began to take form as work started on a line of huge radar platforms to be built at sea for the Air Force as far off the Atlantic coast as 125 miles.

Each platform will have about 15,000 sq ft of area. Total construction cost, not including radar, is estimated at \$20,000,000 for some 25 platforms.

► **Facilities**—The platforms will operate as radio and radar aids to navigation and as weather stations, in addition to use as early warning stations. Each will generate its

own electric power and will be connected by radio with shore-based radar stations.

The platforms will have living quarters for 20 to 30 operating personnel a sufficient space for a heliport. At the top of the lighthouse-like tower on each will be a small observatory for housing the radar and weather equipment.

► **Land**—The Air Force also plans to improve facilities at 69 existing land radar installations and begin construction of some 485 new semi-fixed and small automatic radar aircraft warning stations, adding to hundreds of small permanent and semi-fixed stations already in operation. The new automatic stations will bridge gaps in coverage between larger semi-fixed stations.

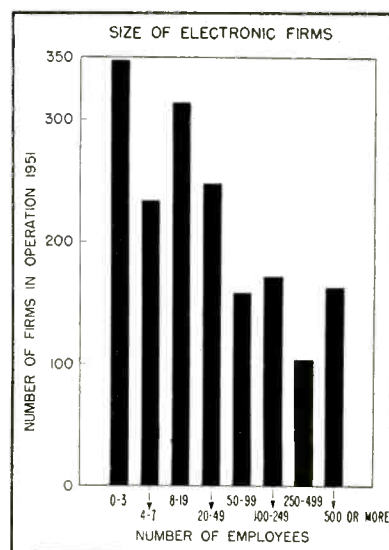
How Electronic Firms Size Up

Companies in the field cover all employment ranges but most firms are small

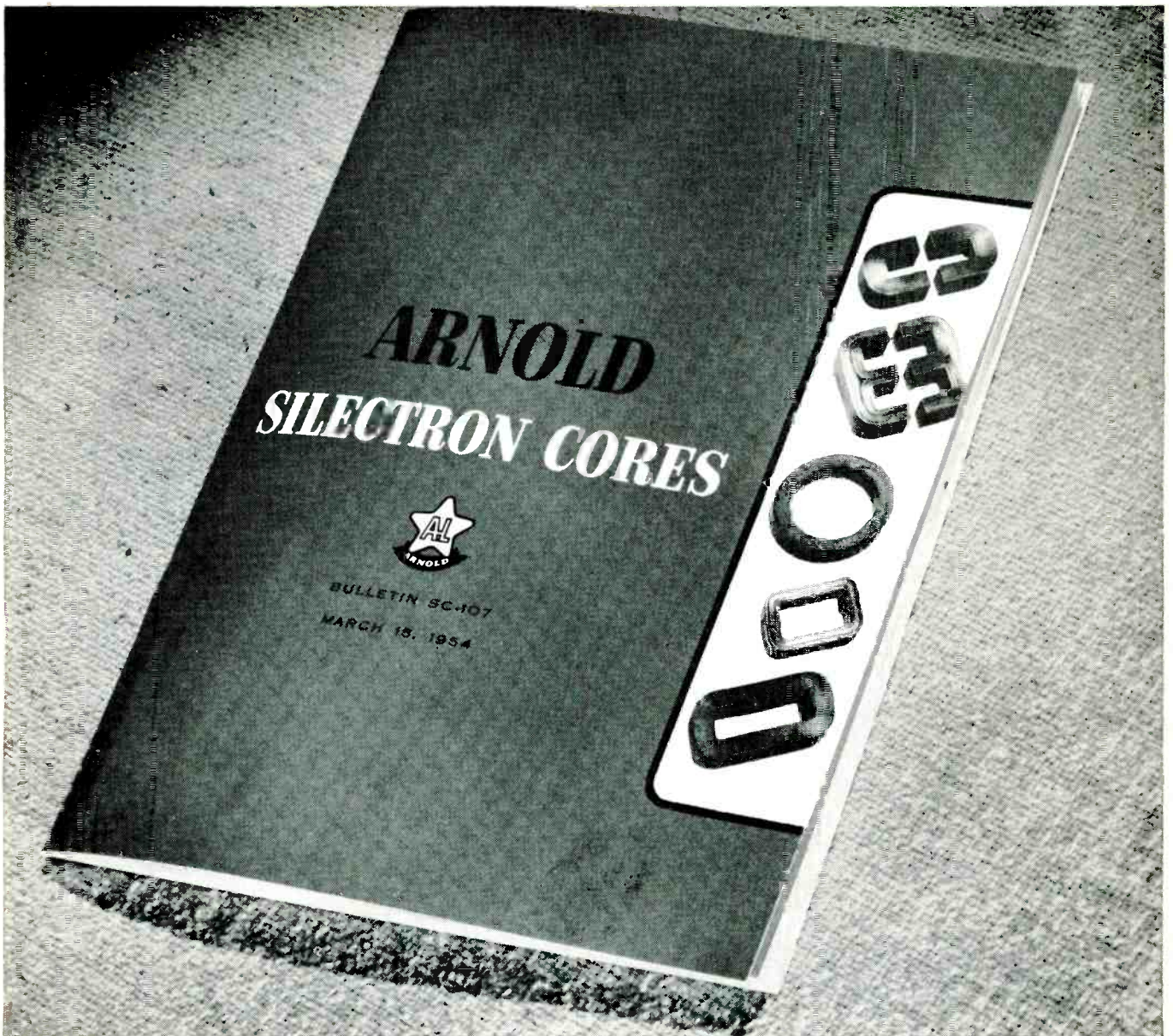
GIANTS of the electronics industry were recently sized up in a tabulation by the National City Bank of New York of the 100 largest U.S. manufacturing corporations in terms of total assets at the end of 1953.

Although most of the firms cover many industries, four can be classified as radio-tv-electrical equipment makers and four more have sizable interests in the field. The eight companies and their total assets in 1953 were as follows: Avco, \$232 million; Bendix, \$329 million; GE, \$1.7 billion; IBM, \$520 million; RCA, \$494 million; Sperry, \$259 million; Western Electric, \$877 million and Westinghouse, \$1.3 billion.

► **Smalls**—Despite the importance that these large manufacturers have assumed in the electronics industry, it is the smaller manufacturers that account for the size of the industry in terms of number of firms. As is shown in the chart, over half of the manufacturers in the communication equipment field



(Continued on page 12)



Here's *New 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 hundreds of 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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W&D 5305

THE ARNOLD ENGINEERING COMPANY



SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

DISTRICT SALES OFFICES . . . New York: 350 Fifth Ave.

Los Angeles: 3450 Wilshire Blvd.

Boston: 200 Berkeley St.

are small companies that employ less than 20 workers and nearly two-thirds employ less than 50. Electrical equipment manufacturers that employ over 500 workers represent only 4.9 percent of the number of companies in the field.

Italian Government Seeks U. S. Licenses

A MOVE to strengthen further its electronics industry was made by Italy with the establishment of an office in New York for Finmeccanica of Rome, a financial holding company controlled by the Italian government. Purpose of the U. S. headquarters is to improve the volume of business between Italy and the U. S. and Canada by entering into as many licensing agreements as possible with the U. S. firms. The agreements are to give the Italian company's plants the benefit of U. S. progress and at the same time allow U. S. firms to supply the Italian and other markets with products identical to those produced here at considerable dollar saving and a reasonable rate of return.

► **Setup**—Finmeccanica controls close to 40 different corporations with about 50 plants and 75,000 workers. Exports for the company, not including offshore procurement sales, were \$51 million in 1953 compared to \$37 million in 1952.

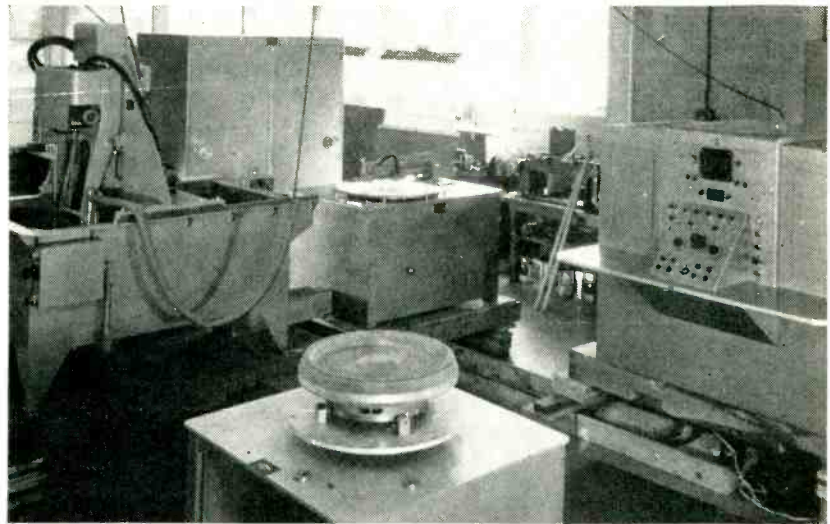
Among the companies that the government-controlled holding company has under its wing are Microlambda of Naples which manufactures radar and other electronic equipment on license from Raytheon, the Marconi Company of Rome which makes radio equipment and tubes and Filotechnica Salmoiraghi of Milan which manufactures some of its precision instruments under Sperry Corp. of London licenses.

Microlambda, which has concentrated mainly on the production of Raytheon radar for the offshore procurement program, employs about 400 workers in its plant in Naples. It has assets of about \$3 million. The firm estimates that billings of about \$400,-

000 were made on electronic products delivered in 1953.

► **Government Assistance**—The U. S. Foreign Operations Administration has set up a plan to protect American business firms against losses from inability to transfer their foreign money earnings in dollar-short countries into U. S. currency. If a company should be unable to exchange its Italian lira or other currencies

into dollars, the U. S. government would provide the dollar exchange up to the amount a company expects to obtain. Raytheon, for example, has obtained a guarantee from the U. S. to cover \$93,500 under a German contract and \$329,000 under an Italian agreement. The amounts represent fees and royalties the firm expects to receive during the lives of the contracts with the foreign companies involved.



ULTRASONICS and digital automation equipment are applied to auto parts inspection as . . .

Nondestructive Testing Cuts Costs

Industries install ultrasonic and industrial x-ray equipment for substantial dollar savings

INCREASING use of nondestructive testing throughout U. S. industry is resulting in substantial sales for some electronic manufacturers.

Ultrasonics and industrial x-ray are two of the methods that are being used extensively.

► **Ultrasonics**—Digital computing and ultrasonics are being used for the inspection of Allison jet engine rotor forgings. Application of SIMAC (sonic inspection measurement and control), a device developed by Sperry Products, is one of the newest applications in non-destructive testing.

The device was developed at a cost of \$300,000. It automatically

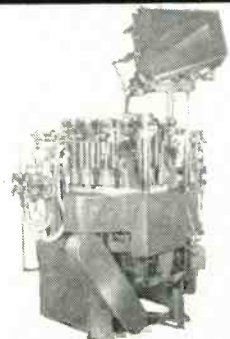
and completely scans a circular part mounted on a rotating turntable immersed in water by beaming ultrasonic waves into it. Beams reflected by structural discontinuities, which may be defects, are logged on a circular chart for interpretation and filing.

A scanning machine, recorder, control cabinet and an electronic console which is also a monitoring station comprise the complete installation. A quartz-crystal transducer in the scanning head transmits short bursts of sound at 5 million vibrations per second. The motion of the scanning head is controlled by a servo-motor which in turn is controlled by an array of holes punched in tape. In all, 60 holes are punched in the tape for each scan line. All operations of the apparatus are controlled

(Continued on page 14)

LARGEST PRODUCER

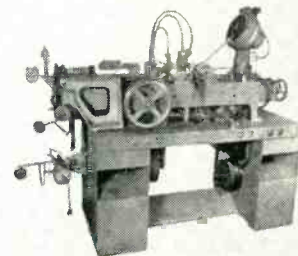
of custom machinery for electronics and allied industries
 sealing... exhausting... bulb making... stem making... wire products



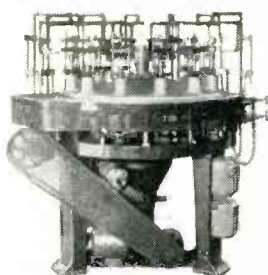
BULB MAKING MACHINE



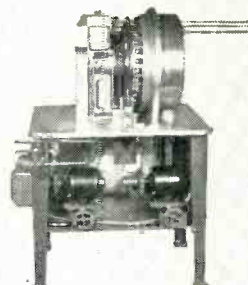
GLASS TUBING CUTTING MACHINE
VERTICAL TYPE



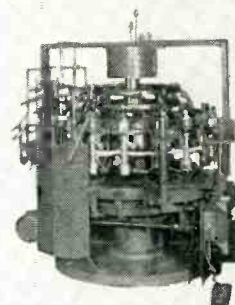
LEAD WIRE WELDING MACHINE



BUTTON STEM MACHINE



GLASS TUBING CUTTING MACHINE
HORIZONTAL TYPE



AUTOMATIC EXHAUST MACHINE

Built into the automatic machinery shown on this page is knowledge of every phase of electronic tube production...

Kahle's machines are engineered to manufacture electronic tubes and component parts so that the burden of "knowing how" to make the product falls upon the machinery itself instead of the manufacturer. Forty-six years of intimate contact with the design and construction of custom machinery together with a long history of pioneering successes in electronics and allied industries, produce the "know-how" in such combinations of machines as the models depicted above. Kahle executives have vast experience in the actual manufacturing of the end products which such machinery produces. This cumulative knowledge is built into the machinery to solve bottlenecks and gives a smooth uninterrupted flow of the finished products for all production requirements.

"Built-in know how" is what makes Kahle's name the password in the electronics and glass industries where production difficulties can be overcome with custom machinery.

Call on Kahle and learn how you can benefit from the company which enjoys the respect of the industry's leaders.

Kahle

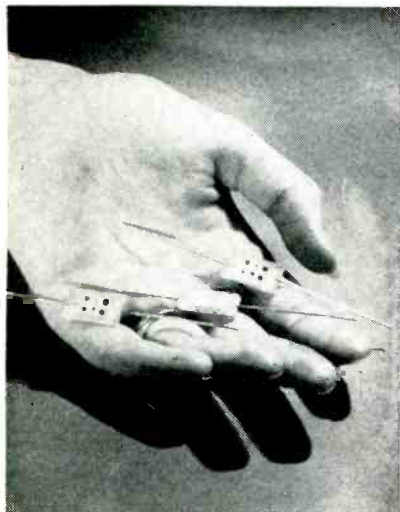
ENGINEERING COMPANY
 1353 SEVENTH STREET • NORTH BERGEN, N. J.

CONTI

in the electronic console. The ultrasonic echo signals are displayed on the face of a c-r tube for visual monitoring.

► **Market**—Size of the potential market that nondestructive testing represents is seen in the estimate that at least \$100 million annually is spent by U.S. industry for nondestructive testing. Some casting firms spend as much as \$25,000 a month on x-ray inspections alone. In the petroleum field it is estimated that more than \$42 million a year is spent in field inspections of tubes and pipes.

Non-destructive testing by electronic and other means has paid off for industry. For example, it has been estimated that x-ray inspection of castings up to 5 feet in diameter costs about \$7.50 per casting while destructive testing averages \$350 a piece.



CAPABLE of high-speed manufacture and independent of imported materials, these . . .

Glass Capacitors Rival Micars

NEW LOOK in fixed capacitors is promised by Corning Glass, now beginning automatic manufacture of small glass blocks for use in communications and industrial electronic circuits.

Quality capacitor units in the postage-stamp size are generally

made from mica with conducting plates of silver vaporized directly onto the mica dielectric. Their capacitance varies little over wide temperature ranges. They require high-grade mica, most of which must be imported and they are expensive.

A few months ago, experimental glass capacitors, admittedly good, cost ten times as much as silver micars. Now, automatic production has dropped costs to as low as 2½ times as much. Corning expects to close the gap in the near

future even further costwise.

► **Replacement Market**—Glass capacitors will not replace silver micars overnight. Although the total range of variation for the glass-dielectric units is less than that of the best silver mica, the latter can be used at lower temperatures than the glass. However, in case of a mica shortage, circuit redesign would allow fuller use of the glass types. One glass unit is almost exactly like the next, making circuit design less tricky.

TV Manufacturers Unveil New Lines

Color set activity heightens; lower prices for monochrome and color tv are evident

MAJOR television receiver producers unveiled their new tv and radio lines for the fall selling season.

► **Color**—Manufacturers made varied approaches in introducing color sets for the fall market. Motorola introduced three 19-inch color sets using the CBS tube at prices starting at \$895. CBS-Columbia planned to show its 19-inch color sets this month.

Emerson announced plans to market a color set at \$695 using RCA's 15-inch tube. This firm does not intend to produce 19-inch color sets but will make 21-inch sets when a tube is perfected.

RCA, which plans to show its new 21-inch color tube this month, reduced the price of its \$1,000 15-inch color set to \$495 and will refund \$505 to customers who bought the set at \$1,000. It is expected that Westinghouse will take similar action on its 15-inch sets. According to RCA, its action was taken to clear distributor and dealer inventories before the introduction of 21-inch color sets.

Philco, which has also developed a 21-inch color tube, announced that it does not intend to offer color tv receivers this year.

Magnavox indicated that it would not sell color sets until a 21-inch tube had proved itself.

Other set manufacturers seemed to be staying on the color fence awaiting further color tube developments.

► **Prices**—Lower-priced black-and-white models were shown with 17-inch table models as low as \$129.-95 and 21-inch table sets at \$149.95. Price ranges of some lines are 20 percent below last season's. Bid for second-set markets by many manufacturers was evident in the resurgence of 17-inch table models now carried by most firms, though Philco has dropped them.

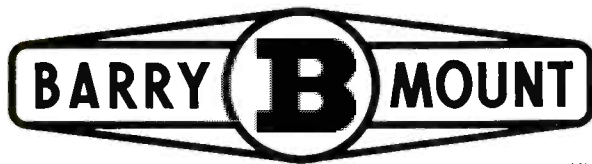
Slight divergence in tube-size trends was evident. One company dropped the 24-inch set from its b-w line while another, which was one of the last to bring out a 24-inch set, has expanded its 24-inch line. Greater use of aluminum tubes was noticeable in new fall lines. For many companies, all but their price leader sets used them.

Financial Roundup

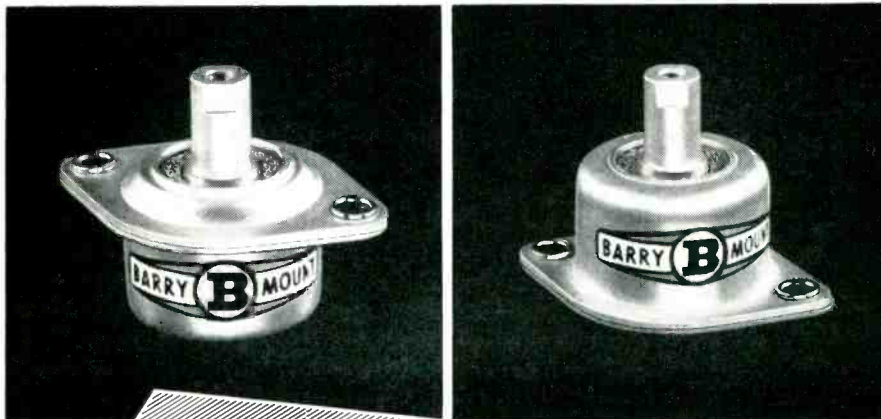
COMPANIES in the electronics field enjoyed, in general, better net profits during the first six months of 1954 than for the similar period in 1953. According to the survey by the National City Bank of New York, the combined net profits of 18 companies in the radio-tv-electrical equipment field for the first half of 1954 totalled \$174.5 million, 17 percent over 1953's first

(Continued on page 16)

the **NEW** miniature
... **ALL-METL**



UNITS SHOWN ACTUAL SIZE



*for all-temperature vibration
protection of airborne equipment*

These new isolators are the latest addition to the famous Barry ALL-METL line.

They are specifically designed to help you meet miniaturization demands under toughest environmental conditions.

Temperature range — from -60°C to $+175^{\circ}\text{C}$

Weight — only $\frac{1}{2}$ ounce per unit isolator

Height — only $1\frac{1}{4}$ " free, $\frac{25}{32}$ " bottomed

Load ratings — 0.1 to 3.0 lbs. per unit isolator

Performance — meet all relevant requirements of
JAN-C-172A/MIL-C-172B

Ruggedized — to meet shock tests under specifications AN-E-19,
MIL-E-5272, MIL-T-5422B, and MIL-C-172B.

Mounting styles — available in plate and cup types, as
illustrated, for 2-hole or 4-hole mounting.

For complete information, ask for your free copy of the new Barry Product Bulletin 542, containing full installation and performance data. And for greatest benefits with these new isolators, let our Field Engineering Service help in the early stages of your equipment design.

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SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

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six months profits of \$149.4 million.

Combined net profits for these companies for the second quarter of this year, totalling \$81.5 million, were 4 percent ahead of 1953's second quarter profits of \$78.3 million. According to the survey which covered 19 manufacturing industry groups, only food, paper, office equipment and automotive manufacturers exceeded the 17 percent profit increase of radio-tv, electrical equipment firms. Following are the reports of 30 companies in the electronics field for the fiscal periods indicated:

Company	1954	Net Profit 1953
Aircraft Radio 6m	\$316,000
Am Bccasting Par-amount Theatres 6m	1,982,000	\$2,587,000
American Machine & Foundry 6m	1,840,000	2,151,000
American Phenolic 6m	252,277	573,651
AT&T 12m	440,230,000	388,541,062
Ampex 12m	26,000	89,000
Bendix Aviation 6m	11,113,149	8,596,601
Clevite Corp 6m	1,646,758	2,015,419
Consolidated Engineering 6m	472,594	365,983
T. A. Edison 6m	459,603	513,165
Fairchild Camera & Instrument 6m	757,699	289,671
General Cable 6m	2,434,657	2,971,347
GE 6m	93,856,000	75,417,000
Hoffman Radio 6m	818,683	697,320
Lear 6m	1,379,558	793,615
W. L. Maxson 9m	1,009,786	646,194
Minn. Mining & Mfg. 6m	11,644,303	9,056,111
Motorola 6m	2,858,301	4,640,679
National Cash Register 6m	5,627,065	5,570,465
Philco 6m	1,735,000	12,216,000
RCA 6m	19,268,000	18,185,000
Raytheon 12m	3,523,000	3,859,000
Standard Coil 6m	1,358,996	2,736,431
Stewart-Warner 6m	1,511,560	2,143,064
Stromberg Carlson 6m	1,177,759	1,071,271
Sylvania 6m	3,522,785	5,169,092
Tempco Aircraft 6m	1,325,328	906,342
Thompson Products 6m	6,490,502	5,357,618
Tung-Sol 3m	1,001,537	1,015,355
Westinghouse 6m	45,359,000	35,660,000

► **Securities** — Ultrasonic Corp. offered 200,000 shares of common stock (par \$5) at \$12.75 per share. Proceeds will be added to general funds for working capital and general corporate purposes.

American Electronics offered 160,000 shares of common stock (par \$1). Proceeds will be used to repay loans and for general corporate purposes.

Master Television filed with SEC covering 1,000 shares of class A stock to be offered at par (\$100 per share) and \$199,000 of 10-year 6-percent debentures to be offered at 10 percent of principal amount. Proceeds are to be used for working capital.

Conventions Use Closed-Circuit TV

Promoters offer packaged facilities; trend renews interest in projection television

MULTI-CITY large-screen closed-circuit television is saving millions of dollars annually for companies with nationwide operations such as Ford, Chrysler, Pan American and IBM. For example, Westinghouse used a private telecast to introduce its new line of appliances, radios and tv sets to 2,000 distributors in 27 cities. Cost was \$75,000 as against \$450,000 necessary to bring the distributors to a central location and pay for their hotel accommodations and sundry expenses. A rule-of-thumb in gauging the cost of a private television hookup is \$1,500 per hour per city.

► **Producers**—Several companies, including Box Office Television and Theater Network Television (TNT) both of New York, specialize in handling closed-circuit television conferences. The Sheraton hotel chain is also interested in the business. Large-screen projection telesets are already installed in five hotels and jeeped-up receivers—that is, home receivers with an added video input—installed in 23 others. Closed-circuit tv is estimated to be a half-million-dollar business this year.

During 1953, the intercity facilities of AT&T were used about 20 times for closed-circuit telecasting service.

► **Sales Meetings**—First intercity large-screen sales conference was put on in 1952 for Lees Carpets. This year about 10 such business meetings have been held. The companies using the service are among the biggest in the country. Their satisfaction with the plan seems evidenced by repeat meetings already on order.

► **Theater TV**—Another form of closed-circuit television involves distributing concerts, operas, football games and prizefights to theaters. There are 93 theaters in 53

cities equipped with large-screen projection television sets. Their total seating capacity is 214,613.

Recently, plans have been announced for a million-dollar network to distribute floor shows to restaurants and night clubs.

► **Equipment**—The large-screen theater sets are of the projection type and provide a 15 × 20 ft picture. When installed these sets cost \$25,000 each. To provide coverage in cities where large-screen equipment is not installed, show promoters have their own portable projection tv sets. For example, Box Office uses 31 portable projection units that throw a 9 × 12 ft picture.

Closed-circuit show promoters indicate that a market exists for portable theater-quality projection equipment that will sell for under \$2,500.

► **Color**—Business and entertainment closed-circuit telecasts thus far have been in monochrome. Color has been used for medical purposes, however, such as when a group of doctors wish to watch an operation. The American Cancer Society has six color tv units for closed-circuit use; Smith, Kline and French have two.

Small Towns Attract Electronics Firms

SMALLER CITIES, many of them dependent on a single industry for employment, are looking to the electronics industry as a stable means of industrial diversification. In Lowell, Mass., a former textile-mill town, a development and industrial commission has been formed to attract industry to that area. Electronics manufacturers are high on their list of desirable types.

► **Inducements**—Low labor and building costs are among the inducements that the Lowell commission offers. In addition, finan-

(Continued on page 18)

for Highest Accuracy

IN A-C / D-C VOLTAGE MEASUREMENTS

The TYPE 1800-A VACUUM-TUBE VOLTMETER

Just consider the features and specifications for this popular measuring tool . . . unsurpassed in Accuracy, Stability, Ruggedness and Operating Conveniences. Thousands are in use in laboratories, schools and research organizations throughout the world.

- ★ The Type 1800-A VTVM is suited not only to accurate measurements at audio and radio frequencies, it in addition gives reliable d-c voltage indications.
- ★ Voltage range — 0.1 to 150 volts, a-c in six ranges and 0.01 to 150 volts, d-c — 0.5 volt range permits accurate low voltage readings — the Type 1800-P2 High-Frequency Multiplier, attached to the probe, extends the a-c voltage range to 1500 volts.
- ★ Basic accuracy is $\pm 2\%$ of full scale on all six a-c and d-c ranges — chart is supplied with instrument for frequency corrections on a-c measurements as high as 500 Mc.
- ★ High Stability — one zero control for all ranges — resetting not required when switching from one range to other.
- ★ Completely-shielded probe contains acorn-type diode rectifier connected to input capacitor — various terminations and fittings may be attached to probe to suit particular application at hand.
- ★ Illuminated meter scale eliminates parrallax in readings — meter is protected from overloads; cannot be burned out.
- ★ High 25-megohm input impedance — 1050 Mc resonant frequency permits accurate measurements at hundreds of megacycles — on d-c ranges, two input resistances: 10 megohms and open grid.
- ★ Current and power measurements also can be made with the 50-ohm termination-unit (supplied) attached to the VTVM probe.
- ★ Low-frequency response is excellent — range is extended to 1500 volts at d-c and audio frequencies with the Type 1800-P3 Low-Frequency Multiplier.
- ★ Operation is from 105 to 125 or (210 to 250) volts, a-c, 50 to 60 cycles — internal voltage regulator eliminates meter fluctuations.
- ★ Line connector cord, Type 274 and 874 termination connectors, 50-ohm coaxial terminating resistor, and spare fuses are supplied with instrument.
- ★ Dimensions are $7\frac{3}{8} \times 7\frac{1}{2} \times 11\frac{1}{8}$ inches — Net Weight, $13\frac{3}{4}$ lbs.



Type 1800-A Vacuum-Tube Voltmeter . . . \$395
 Type 1800-P2 High Frequency Multiplier . . . \$18
 Type 1800-P3 Low-Frequency Multiplier . . . \$35



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 Frequency Standards ★ Impedance Bridges ★ Light Meters
 Megohmmeters ★ Modulation Meters ★ Polyscopes
 Precision Capacitors ★ Oscillators ★ U-H-F Measuring
 Equipment ★ Parts & Accessories ★ Signal Generators
 Wave Analyzers ★ Varicos ★ TB & Broadcast Monitors
 Meters ★ Stroboscopes ★ Null Detectors ★ Motor Controls ★ Wave Filters ★ V-T Voltmeters

cial backing and aid in locating or building plants and in recruiting a labor force are available. In one area designated as an industrial park, a group of one-story buildings designed for horizontal manufacturing operations is being built. The landscaped area will have room for expansion, along with parking and recreation areas.

Electronics companies already building or operating in the area include Raytheon, CBS-Hytron and Cambridge Thermionic Corp. Projects for other firms in the field are planned.

Tubes Submerge With Submarine Cables

SUCCESS of engineers in developing submerged amplifiers with 20-year reliability has triggered an electronic revolution in the submarine cable field. In recent months two underwater cable jobs have been announced by the Bell System in which underwater repeaters will be used.

► **Projects**—Work is already in progress on a \$35 million trans-oceanic telephone cable system which is to be laid across the Atlantic from Newfoundland to Scotland (ELECTRONICS, Jan. 1954, p 20). The cable will have over 100 vacuum-tube repeater amplifiers.

Bell has also proposed construction of an underwater telephone cable system which will stretch 800 nautical miles between Port Angeles, Wash. and Ketchikan, Alaska. Estimated cost is \$14 million. This cable will contain built-in underwater repeaters spaced about 40 miles apart, to boost voice signals. Each employ three vacuum tubes and will be housed in a flexible copper tube about seven feet long and 1½ inches in diameter. The vacuum tubes, specially designed by Bell Labs, are expected to have a life of 20 years. The entire repeater is supported by steel rings to form a structure that is built into the cable and appears as a tapering bulge. The design permits the amplifier to pass through the cable ship's gear along with the cable.

Industry Grows Despite Failures

Business failures doubled last year, but number of firms in operation is higher

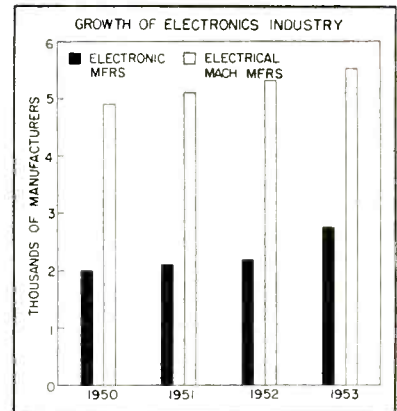
MANUFACTURERS in the electronics industry have continued to increase steadily in number despite a growing list of business failures. More than 2,700 manufacturers for the industry were listed in ELECTRONICS Buyers' Guide in 1953, about 300 more than in 1952. In the 1954 Guide more than 30,000 manufacturers are listed.

Trend of Commerce Department figures for firms in the electrical machinery classification which includes electronic companies indicates an increase of about 200 companies for 1953.

► **Failures**—According to RETMA, 33 electronic equipment and parts manufacturers failed in the year ending in May 1954 compared to 16 in the previous year. Since 1945, 170 electronic manufacturers have had serious financial difficulties although about 35 of these are still in operation.

The 33 companies that failed in the past year had liabilities of approximately \$24.8 million. Twelve of the firms were radio and tv set producers, five produced components, five made military equipments, seven manufactured sound equipment and recorders, three made commercial communications equipment and one manufactured instruments. More than half of the companies seeking reorganization were less than seven years old.

► **Why** — Credit committee of RETMA indicated the circumstances causing the failures of the 33 firms. Lower sales were not seen as a fundamental reason. Most of the companies had been doing a volume out of proportion to working capital. They had high fixed expenses such as rent and interest, which could not be cut back and had accumulated inventory excessive in relation to sales.



Several had taken long-term contracts for the production of complex military or commercial communication equipment at too low a price.

► **Distributors** — According to RETMA, of more than 1,300 parts distributors only 8 experienced financial difficulties last year. Their liabilities totaled \$1.3 million. More than 40 new distributors of the electronic parts entered business during the 12-month period. Many established wholesalers had to have larger quarters to handle heavier inventories for growing sales.

Industrial Instruments Give Few Headaches

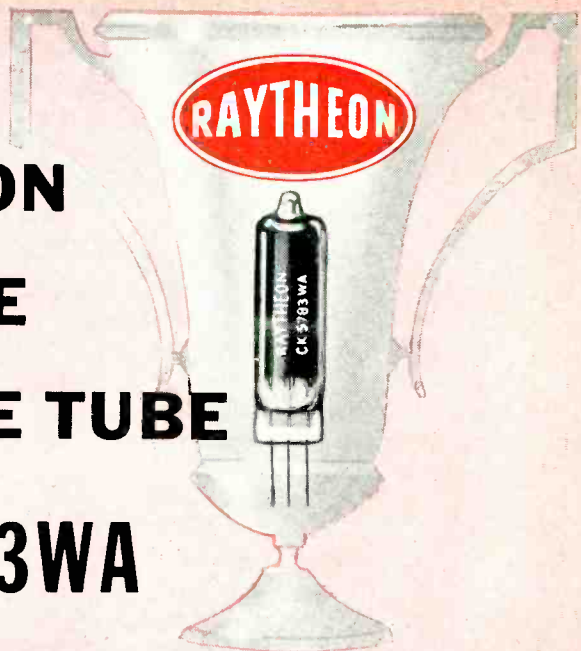
THOUSANDS of noncommunications electronic instruments are giving satisfactory service to industrial users because manufacturers have learned the secrets of foolproof design and personalized service.

One long-established manufacturer says that a high percentage of the equipment sold is never heard from again. A logical conclusion is to assume the gear lives out its entire life without trouble, requiring only routine replacement of tubes.

Such experience may be a matter of environment, too. Where there are competent and interested engineers or technicians

(Continued on page 20)

A NEW CHAMPION SUBMINIATURE VOLTAGE REFERENCE TUBE RAYTHEON CK5783WA



The Raytheon CK5651WA Miniature Voltage Reference Tube likewise possesses each and every one of these ten great performance features.

You now have your choice of Subminiature or Miniature for the most exacting Voltage Reference Tube applications.

● NOTE: Type OB2WA now available to MIL specifications.

LOOK AT ALL TEN of these important performance features of the Raytheon CK5783WA Subminiature Voltage Reference Tube.

1. Tightened Voltage Drop Range: 83-89 volts.
2. Low dark starting voltage — only 115 volts maximum — no higher than for light starting.
3. Wider Ambient Temperature Range: -55°C to 150°C .
4. Lower Temperature Coefficient only -5 mV/ $^{\circ}\text{C}$ maximum, from 25°C to 75°C .
5. Reduced voltage jump*. Maximum value: 5 mV.
6. Reduced drift** (1 hour). Typical value: 50 mV change.
7. Improved repeatability***. Typical value: 20 mV change.
8. Improved stability over 500 hour period (150°C ambient). Typically less than one volt change.
9. Improved stability over 5000 hour period (30°C ambient). Typically less than one volt change.
10. Ability to meet every requirement for military reliable tubes, including shock and vibration.

Notes: *Voltage jump — Maximum sudden jump in operating voltage when operating current is varied slowly over specified range.
**Drift — Maximum operating voltage change during the period of operation.
***Repeatability — Maximum shift in operating voltage between successive firings of the tube.

RAYTHEON VOLTAGE REGULATOR AND REFERENCE TUBES

give you this complete range to choose from — each and every one a great performer

Type	Max. Dimensions		Min. Starting Voltage Supply	Operating Voltage (Approx.)	Min. Operating Current Ma.	Max. Operating Current Ma.	Max. Regulation Volts
	Height (Inches)	Diam. (Inches)					
OA2	2.63	.75	180	150	5.	30.	6
OB2	2.63	.75	127	108	5.	30.	3.5
● OB2WA	2.63	.75	133	108	5.	30.	4
CK1022	2.69	.75	1100	1000	0.005	0.055	20
CK1037	1.75	.40	730	700	0.005	0.100	15
CK1038	1.75	.40	930	900	0.005	0.055	15
CK1039	1.75	.40	1230	1200	0.005	0.100	25
CK5651*	2.13	.75	115	87	1.5	3.5	3
CK5651WA*	2.13	.75	115	84.5	1.5	3.5	2
CK5783*	1.63	.40	125	87	1.5	3.5	3
CK5783WA*	1.63	.40	125	86	1.5	3.5	3
CK5787	2.06	.40	135	100	5.	30.	6
CK5787WA	2.06	.40	135	100	5.	25.	4
CK5962	2.69	.75	730	700	0.002	0.055	15
CK6213	1.38	.40	200	130	1.0	2.5	2

*Voltage Reference Tube



Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

Receiving Tube Division — Home Office: 55 Chapel St., Newton 58, Mass. Bigelow 4-7500
For Application Information Write Or Call The Home Office Or: 4935 West Fullerton Avenue, Chicago 39, Illinois, NATIONAL 2-2770
589 Fifth Avenue, New York 17, New York, PLaza 9-3900 ● 2419 South Grand Avenue, Los Angeles 7, California, Richmond 7-4321

RAYTHEON MAKES ALL THESE:

RELIABLE SUBMINIATURE AND MINIATURE TUBES • SEMICONDUCTOR DIODES AND TRANSISTORS • NUCLEONIC TUBES • MICROWAVE TUBES • RECEIVING AND PICTURE TUBES

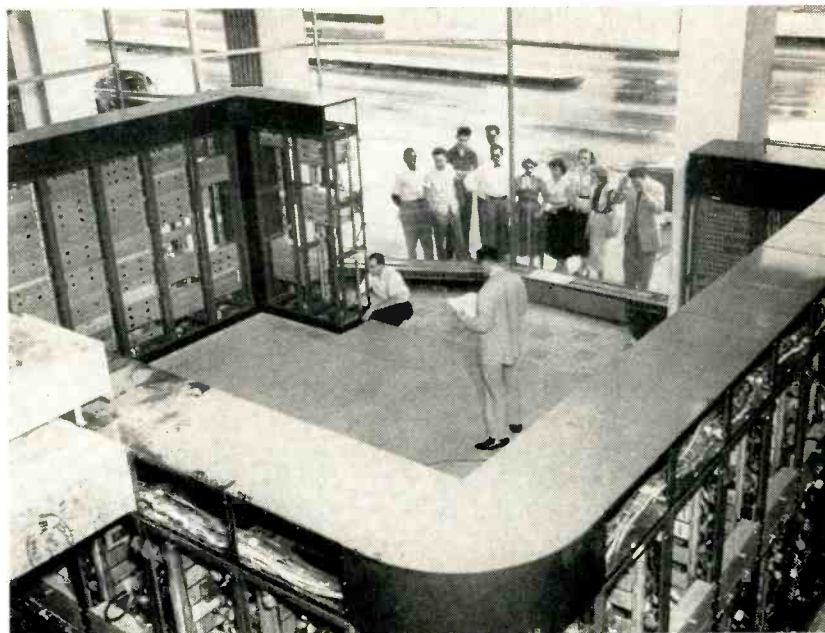
available, there is always less trouble reported than when an average electrician does the servicing.

► **Handling Breakdowns**—Besides building equipment well, there are two tricks for keeping customers satisfied and equipment working. Most manufacturers provide an adequate instruction manual complete with circuit diagrams, typical voltage readings and sometimes oscillograms. Most successful is the list of symptoms, their probable cause and where to look for faulty components. The other trick is getting a badly damaged instrument repaired fast.

Outfits like General Radio prefer to get the equipment into the factory or an authorized service organization where standards are quickly available. Such organizations usually have district engineering offices where customers can discuss ailments over the telephone or bring equipment for first aid by the resident engineer. One distressed visitor who had been making a hundred dollars a day on sound-level measurements got his meter repaired thus in an hour. Other equipment manufacturers may have eight or ten manufacturers' representatives throughout the country who can take care of almost all but the basket cases.

Straight industrial controls are another matter. Because they are more likely to be used under factory than research conditions, companies like Brown Instrument find it desirable to maintain some 50 offices throughout the country from which technicians can be dispatched. Plant people are eligible for a free training course.

► **Service Organizations**—In existence, but not noticeably on the increase, are independent service organizations. According to one manufacturer, growth of this service has not been appreciable during the last ten years. They are predominantly in metropolitan areas where business is plentiful. Some repairmen complain that manufacturers don't like them—want to hoard customer contacts to effect replacement sales.



MORE centers like this one at Burroughs Corp. are being set up as . . .

Computer Applications Multiply

Problems being solved range from Bible study to editorial space analysis

INDICATION of growing use of computers for all types of research is seen in the following list of some of the specific and general types of problems that the devices have worked on:

- Automatic dictionary design for translating foreign languages into English
- Ball bearing design involving determination of the components of stresses and deformation of two elastic bodies in contact
- Adaptation of automatic digital computer to accounting and record keeping
- Computation of mathematical tables
- Determination of lens design
- Bible study to determine which of several Greek manuscripts copies best represent the unknown original
- Design of computers for inventory control
- Factory control and utility customer billing
- Engine life surveys
- Airline scheduling
- Pipe flange design
- Management employment surveys
- Matrix algebra
- Editorial space analysis
- Overhead cost allocation
- Budgetary computations
- Missile design
- Auto traffic-light control
- Punch press control
- Toll road computations
- Weather forecasting
- Payroll computations
- A-c network calculations
- Census report computations

► **Cost**—One computer manufacturer, with a computer service center in operation about 15 months, has completed over 200 jobs for a wide variety of com-

panies. Biggest customers for computer work have been aircraft manufacturers and designers. But electronic manufacturers, telephone companies, government agencies including the armed forces and the Department of Commerce have also been substantial users.

Actual computing time, not including setup, for the wide variety of problems done by centers has ranged from as little as 2 minutes to over 100 hours. At an average rental rate of \$300 per hour, the cost per job has thus ranged widely.

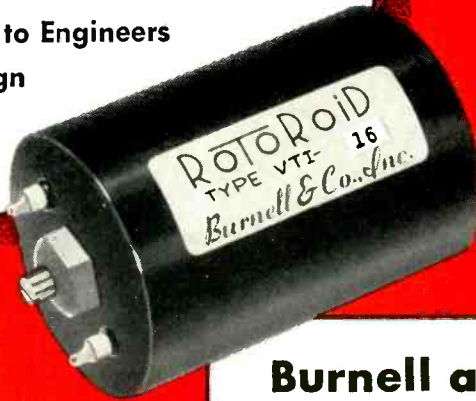
Set Manufacturers Gear Production To Sales

DESPITE higher retail tv set sales throughout the first half of this year, set makers have clamped down drastically on tv receiver output to get rid of inventory built up in 1953's last quarter. How overloaded the industry has been is indicated by the fact that while tv sales through June were 30,000 units above last year's volume for the six months, set production for

(Continued on page 22)

An Announcement

of the Utmost Importance to Engineers
Doing Research and Design
Work in the Entire Audio
Frequency Range.



Burnell and Co., Inc.

is proud to announce the development
of an entirely new product—

ROTOROID®

a Variable Toroidal Inductor (patent applied for)

ROTOROID will prove to be a valuable aid in the solution of many engineering problems—in research and design—and opens new possibilities for production which were previously impractical or impossible.

ROTOROID

- . . . is a continuously variable, stepless toroidal inductor which can provide a 3:1 range of maximum to minimum inductance in 180° rotation of a shaft.
- . . . employs no mechanical resistance contacts and is therefore free of noise and wear.
- . . . requires no DC saturating currents and thereby eliminates the need for circuitry.
- . . . is applicable over the entire audio range (from approximately 300 cps). ROTOROID is not limited to any stock value of nominal inductance. It is available in any value of inductance now available in regular toroids.
- . . . is hermetically sealed and is vibration and shock-proof, can be chassis or panel mounted.



Write Department C for further information.

Burnell & Co., Inc.

Yonkers 2, New York

PACIFIC DIVISION: 720 Mission Street, South Pasadena, California

An outstanding feature of ROTOROID is that, at maximum inductance, it provides the full Q of the toroid it contains. Thus, the user is at once able to take advantage of the high Q characteristics of toroids while at the same time having available a variable inductor not previously available in a toroid.

Applications: Virtually unlimited. Just a few of the many possible uses of ROTOROID are:

- Tunable Audio Oscillators
- Variable Z Devices
- Servo Systems
- Telemetering
- Adjustable Selective Networks
- Variable Phase Shift Networks
- Variable Filters
- Electro-Mechanical Control Systems

Availability: Immediately available: ROTOROIDs VTI-16 and VTI-3 which are equivalent in electrical characteristics to Burnell toroids TC-16 and TC-3 in cases 2¼" in diameter, 3-1/16" long. Soon to be available: two miniature types equivalent to Burnell toroids TCO and TC-6.

FIRST IN TOROIDS AND RELATED NETWORKS

the period was off 26 percent compared to last year.

► **Difference**—In the first six months of this year tv set output only exceeded tv retail sales by some 39,000 units. Last year for the same period, units produced surpassed units sold at retail by over 1 million.

The month-by-month comparison shows the picture in more detail. For January and February, retail sales exceeded production by over 400,000 sets. For the same months last year, however, production was ahead of sales by over 250,000 units. In March, April and May of this year production in each month stayed ahead of sales by some 85,000 units, compared to an excess of about 200,000 units in each of the months last year. Not until June of this year did tv set production pass output for the same month a year ago. It also exceeded sales by 192,257, by far the largest margin for the year.

Industry Shorts

► **Extension** of effective date for compliance by r-f arc welders to FCC rules on r-f radiation has been moved ahead one year, to July 31, 1954. Industry committee is working on methods to reduce interference from such machines.

► **Radio astronomy** research grant of \$250,000 has been awarded to Australian scientists by Carnegie Corp. of New York, part of which will be used to construct a parabolic reflector 250 feet in diameter and some 60 feet deep.

► **Largest** percentage of tv set buying in 1953 was done by the \$7,500 and over income group, which accounted for 21 percent of purchases. The \$4,000 to \$5,000 and \$5,000 to \$7,500 income groups each purchased 19 percent, according to Admiral.

► **Royal assent** was given in July to Britain's television bill setting up an Independent Television Authority to provide for 10 years of commercial tv broadcasting services.

MEETINGS

SEPT. 8-11: Symposium on Propagation, Standards and Problems of the Ionosphere. Laboratories of the National Bureau of Standards, Boulder, Col. sponsored by the NBS Central Radio Propagation Lab.

SEPT. 13-24: First International Instrument Congress And Exposition, Commercial Museum and Convention Hall, Philadelphia, Pa.

SEPT. 15-17: Symposium on Information Theory. MIT, Cambridge, Mass., Sponsors, IRE, AIEE, URSI, ONR, ARDC, SCEL.

SEPT. 16-18: Joint Electron Tube Engineering Council, General Conference, Chalfonte-Haddon Hall, Atlantic City, N. J.

SEPT. 17-18: IRE Conference on Communications, Cedar Rapids, Iowa.

SEPT. 29-30: IRE Symposium on Industrial Electronics, Mellon Institute, Pittsburgh, Pa.

SEPT. 30-OCT. 1: Fifth Annual Meeting of the IRE Professional Group on Vehicular Communications, Rice Hotel, Houston, Texas.

SEPT. 30-OCT. 2: Second Annual International Sight and Sound Exposition, Palmer House Hotel, Chicago, Ill.

OCT. 4-6: National Electronics Conference, Hotel Sherman, Chicago.

OCT. 6-7: First National Annual Meeting of the IRE Professional Group on Nuclear Science. Hotel Sherman, Chicago.

OCT. 13-17: Annual Convention, Audio Engineering Society, Hotel New Yorker, New York, N. Y.

OCT. 14-17: Audio Fair, Hotel New Yorker, New York, N. Y.

OCT. 18-20: Radio Fall Meeting, Hotel Syracuse, Syracuse, N. Y.

OCT. 21-23: Eighth New England Conference of the American Society for Quality Control, Ten Eyck Hotel, Albany, N. Y.

OCT. 22-24: First Annual New England High Fidelity Music Show, Hotel Touraine, Boston.

OCT. 26-28: The Second National Conference on Tube Techniques, Western Union Auditorium, New York, N. Y. Sponsors, Department of Defense.

OCT. 27-30: Thirtieth Annual Convention, National Association of Educational Broadcasters, Hotel Biltmore, New York, N. Y.

Nov. 4-5: East Coast Conference on Airborne and Navigational Electronics. IRE, Sheraton-Belvedere Hotel Baltimore, Md.

Nov. 8-10: Symposium On Modern Advances In Microwave Techniques, Engineering Societies Bldg., New York City.

Nov. 10-11: Conference on Electronic Instrumentation and Nucleonics in Medicine, Morrison Hotel, Chicago, Ill.

Nov. 12-13: National Symposium on Quality Control Methods In Electronics, IRE and American Society for Quality Control, Hotel Statler, New York, N. Y.

Nov. 18-19: Sixth Annual Electronics Conference, Kansas City IRE, Hotel President, Kansas City, Mo.

Nov. 29-DEC. 2: First International Automation Exposition, 244th Coast Artillery Armory, New York, N. Y.

DEC. 8-10: Eastern Joint Computer Conference & Exhibition, Bellevue-Stratford Hotel, Philadelphia, Sponsors, IRE, AIEE, ACM.

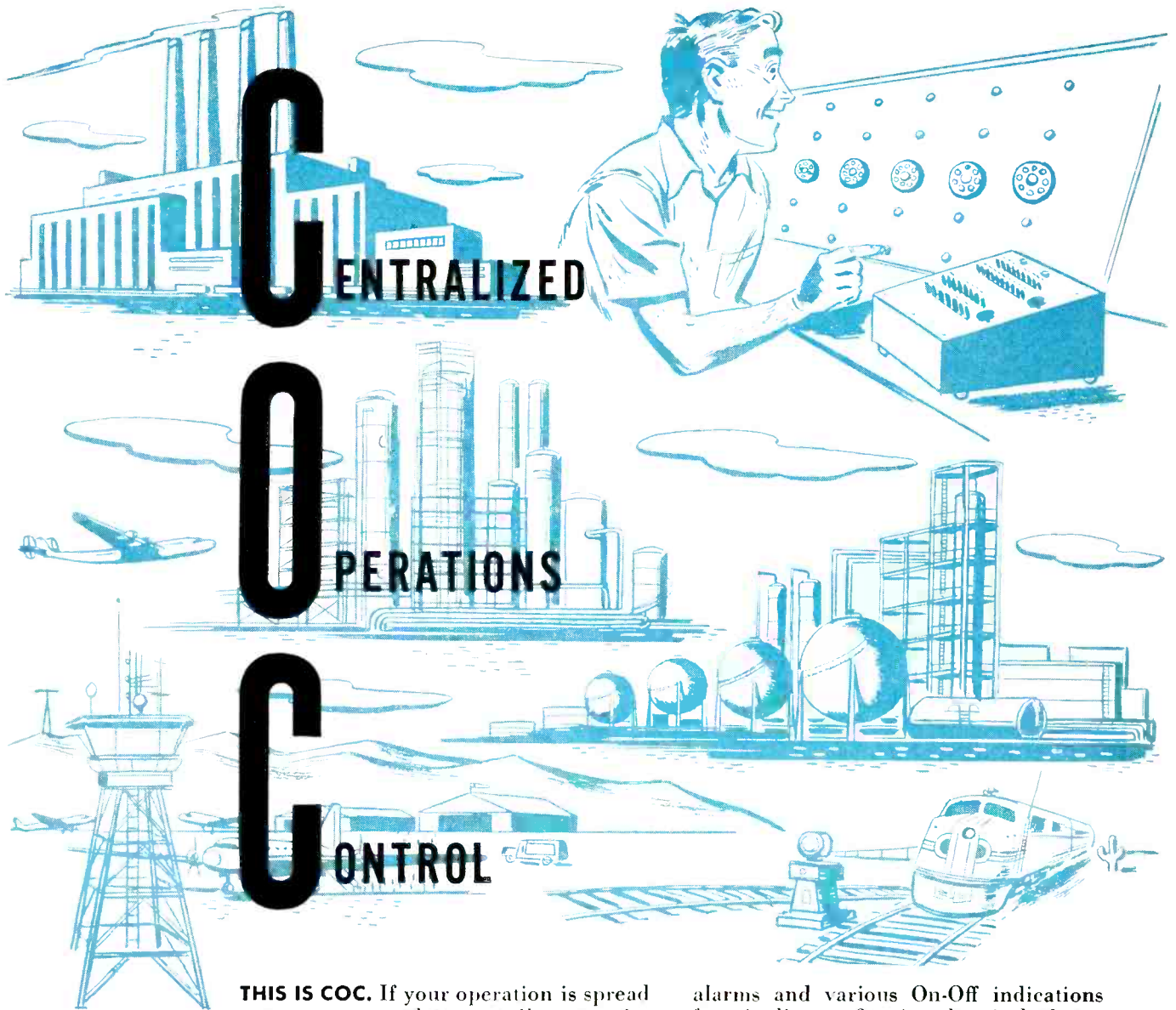
JAN. 17-19, 1955: Fourth Biennial Conference On High Frequency Measurements. IRE, AIEE, URSI, NBS, Washington, D. C.

► **Entertainment** tube type with largest factory sales volume for June was the 6CB6 with total sales of 1.9 million units, according to RETMA.

► **Comparison** of the number of radio listeners and tv viewers in Britain during hours when both services are on the air showed that tv claimed 44 percent of the audience and radio 56 percent. For the same period in 1953 the proportions were 34 percent tv and 66 percent radio.

► **CAA** will provide pilots in southwest U.S. with weather information obtained from civil and military radar on a 90-day trial basis. Almost 200 radars, worth an estimated \$25 million, are being operated by the Air Force, Navy and Weather Bureau.

► **Americans** will own an estimated 7½ million color sets in 1957 and 37½ million in 1964, according to GE tube department research estimates.



THIS IS COC. If your operation is spread out across several acres, miles, counties or even states, and you need control from a single point, you need "COC"—Centralized Operations Control.

If your operation is confined to just one plant or area, but with many points where careful control must be exercised, you need "COC"—Centralized Operations Control.

COC can open a valve or start a pump 500 miles from the control point or it can indicate a liquid level in a tank in your plant yard.

There are varying degrees of COC.

Coming under this broad classification is the Hammarlund "Multi-Gate"® System which provides complete remote control and metering of such quantities as flow, temperature, pressure and voltages, as well as furnishing switching, warning

alarms and various On-Off indications for pipelines, refineries, chemical plants, railroads, public utilities and many other industries. And these operations can be performed over radio, microwave, wire or carrier.

Other Hammarlund remote-control systems are used by airlines and commercial broadcast stations to control unattended transmitters located away from the tower or studio.

Hammarlund "Fleet Control" and Selective Calling Units control the movements of radio-equipped vehicles efficiently and dependably.

Hammarlund "COC" is so broad that it can be adapted to handle practically any problem of remote supervisory control. For more information on COC write The Hammarlund Manufacturing Co., Inc., 460 West 34th Street, New York 1, N. Y. Ask for Bulletin CC-1.



HAMMARLUND

SINCE 1910



How to keep informed on the “with what” part of your business

AT YOUR FINGER TIPS, issue after issue, is one of your richest veins of job information – advertising. You might call it the “with what” type – which dovetails the “how” of the editorial pages. Easy to read, talking your language, geared specifically to the betterment of your business, this is the kind of practical data which may well help you do a job quicker, better – save your company money.

Each advertiser is obviously doing his level best to give you helpful information. By showing, through the advertising pages, how his product or service can benefit *you* and *your* company, he is taking his most efficient way toward a sale.

Add up all the advertisers and you’ve got a gold mine of current, on-the-job information. Yours for the reading are a wealth of data and facts on the very latest in products, services, tools . . . product developments, materials, processes, methods.

You, too, have a big stake in the advertising pages. Read them regularly, carefully to keep job-informed on the “with what” part of your business.



McGRAW-HILL PUBLICATIONS

Now Maintain 100% Modulation Without Danger Of Distortion With NEW PEER Regulated Output Amplifier

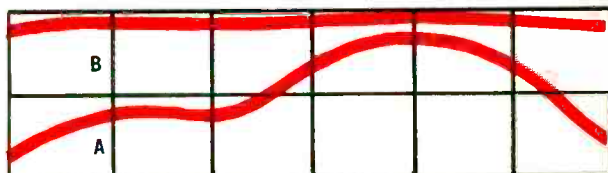
MANY USES

Hundreds of these amplifiers are now being used by the United States and other governments for critical applications in air navigational control.

Now available as a standard stock item at a production price for use by air lines, police radio, commercial communications systems, "professional" amateurs, and others. Suggested uses are:

- Input to any voice radio transmitter
- Input to recorder
- Input to filter or landline
- Input to PA system
- Input to any equipment where it is desired to hold the modulating level close to, but not exceeding, a maximum.

The Peer Model CA-1503 Regulated Output Amplifier enables the utilization of maximum modulation (between 95% and 100%) without danger of over-modulation, distortion, hash, or radiation of interfering signals. In contrast most compression amplifiers offer at best only 75% modulation utilization, while non-regulating amplifiers require maintenance of modulation level at 25% to avoid over-modulation or distortion. The Peer Regulated Output Amplifier eliminates "riding the gain" and does an all-around much better job, especially for



Amplifier Modulation Output "A" shows average modulation level without regulated output amplifier (approx. 25% modulation utilization). "B" indicates average modulation level with the model CA-1503 amplifier (95% modulation utilization).

speech transmission, since it automatically compensates for normal variations in voice and speaking attitude.

STANDARD FEATURES:

Gain 85 db which is adequate for all standard microphones (can be supplied with up to 100 db gain on special order).

Automatic regulating feature holds the output within less than 1 db with variations in input of 20 or more db. Instantaneous increase in input of 20 db causes only a 2 db transient in output which exists for only 1 millisecond. When input is suddenly decreased 20 db, 63% recovery will be obtained in .5 seconds. This is the most advantageous rate for normal speech service but other rates can be provided on special order.

Regulating level can be set for any output level over a 25 db range (normal factory setting is for regulation at 100 mw output).

Output level is nominally 100 mw, but can be increased to 200 mw or decreased to any value—suitable for most transmitting equipment, recorder, and landline applications. Output is brought out in two 150 ohm sections which may be used individually or connected in series for 600 ohm termination. Separate windings allow insertion of series balanced filter if desired (such as instances where the output line is also used for control or signalling purposes).

Automatic balancing circuit maintains balanced push-pull gain, even though tube unbalance may exceed 20 db, without increase in distortion.

Frequency response linear within $\pm 1/2$ db 200-5000 cps.

Precision step attenuators provided in both the input and output. Input attenuator provides maximum of 43.5 db in 1.5 db steps. Output attenuator adjustable in 6 steps over a 20 db range.

Hum and noise level below -50 db (can be made lower on special order).

Total harmonic and hum distortion less than 1%.

Input impedance 25 ohms (± 2 ohms) over entire frequency range—matches most moving coil microphones. Also has built-in 600/25 ohm matching pad for connecting to a 600 ohm line (pad decreases total gain by 20 db). Input has reactive component of less than 10% allowing satisfactory use following critical filter circuits. Other input impedances available on special order. 25 ohm input available from front panel jack and rear terminal strip. 600 ohm input available only on rear terminal strip.

Front panel equipment includes accurate meter indicating the degree of regulation, and standard precision VU output meter. Internal switch allows connecting the monitor circuit to an external VU meter if desired, and terminals are provided for this on the rear terminal strip. The input attenuator and auxiliary microphone jack are also located on the front panel.

Constructed entirely of aluminum with chassis seams welded. Generous utilization of nickel alloy transformer cores allows weight reduction to under 15 lbs. Mounted on standard 19" equipment rack panel. Dimensions 19" W x 6--31/32" H x 10 3/8" D.

Conservative Design for continuous unattended operation. Hermetically sealed transformers and condensers—construction and components meet MIL specifications. Uses miniature individually shielded tubes and all tubes operate well below maximum ratings for long life. All three stages are push-pull.

Standard finish of front panel is black wrinkle, with bright etched aluminum surfaces elsewhere. Other finishes available on special order. Furnished complete with one set of tubes and detailed instruction manual. Net weight 14.5 lbs, shipping weight 27.5 lbs. Standard voltage 115 volts, 60 cycles. Power requirement 24 watts.

Price F.O.B. Benton Harbor \$295.00 IMMEDIATE DELIVERY

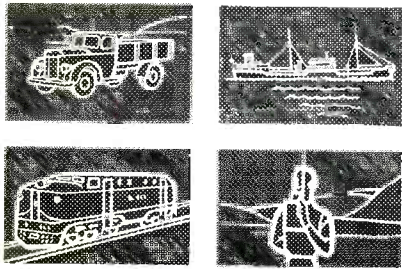


INCORPORATED BENTON HARBOR, MICHIGAN



REPORTER MOBILE RADIO TELEPHONE

For Engineering Communications



• The "Reporter", a compact and economical equipment designed to fit neatly under vehicle dashboards. Also available in transportable form or for use as a fixed station.

In civil engineering, control of mobile vehicles and personnel is all important. The Pye "Reporter", by providing an ever-present link to administrative H.Q., is of inestimable value in speeding up all remote operations and achieving vast economies in plant and manpower. Reason enough that it should feature so prominently in over two thirds of the V.H.F. schemes in the United Kingdom.



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Victoria, Australia.

Pye Ireland, Ltd.,
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Dundrum,
Dublin, Eire.

Pye Radio & Television (Pty.) Ltd.,
P.O. Box 10648,
Johannesburg,
South Africa.

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The new Type M Dynograph Recorder is a high speed direct writing oscillograph providing exceptionally high, absolutely stable, d-c or a-c amplification. It may be used with reluctance type pick-ups without auxiliary equipment. The exceptional stability, sensitivity, and versatility of the Dynograph allow simultaneous direct recordings of a very wide variety of transient variables such as temperature, speed, position, pressure, acceleration, vibration and strain.

The Type M employs individual plug-in amplifiers; and input panels provide all connections for various types of signal pick-ups. It is the most advanced equipment for your direct-writing recording problems.

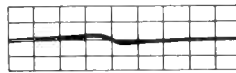
NEW



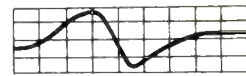
...OFFNER TYPE M DYNOGRAPH RECORDER

WHY THE DYNOGRAPH? For almost every application of direct writing oscillographs, those who have compared features of competitive instruments have chosen the Dynograph—because:

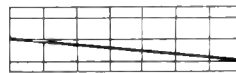
The Dynograph provides thirty times the d-c sensitivity of competitive instruments.* Instead of a barely readable record like this:



The Dynograph gives a large, easily read record like this:



Yet while competitive recorders drift 1 mv per hour* or more



the Dynograph is absolutely non-drifting,



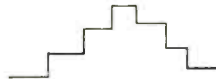
Other recorders require additional amplifiers or preamplifiers for moderate gain d-c; for high gain d-c; for carrier applications (strain gauges or reluctance bridges).



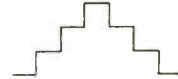
With the Dynograph, one amplifier covers all applications—and does a better job on each!



Pen friction and low torque gives hysteresis on many recorders.



There is no measurable hysteresis on the Dynograph.



Limited pen travel makes recording of large dynamic variations difficult.



Over 8 cm of pen excursion is available in the Dynograph.



Even at moderate sensitivities, other assemblies require considerable warmup time for stabilization.

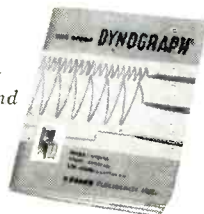


The Dynograph is stable as soon as it is working.



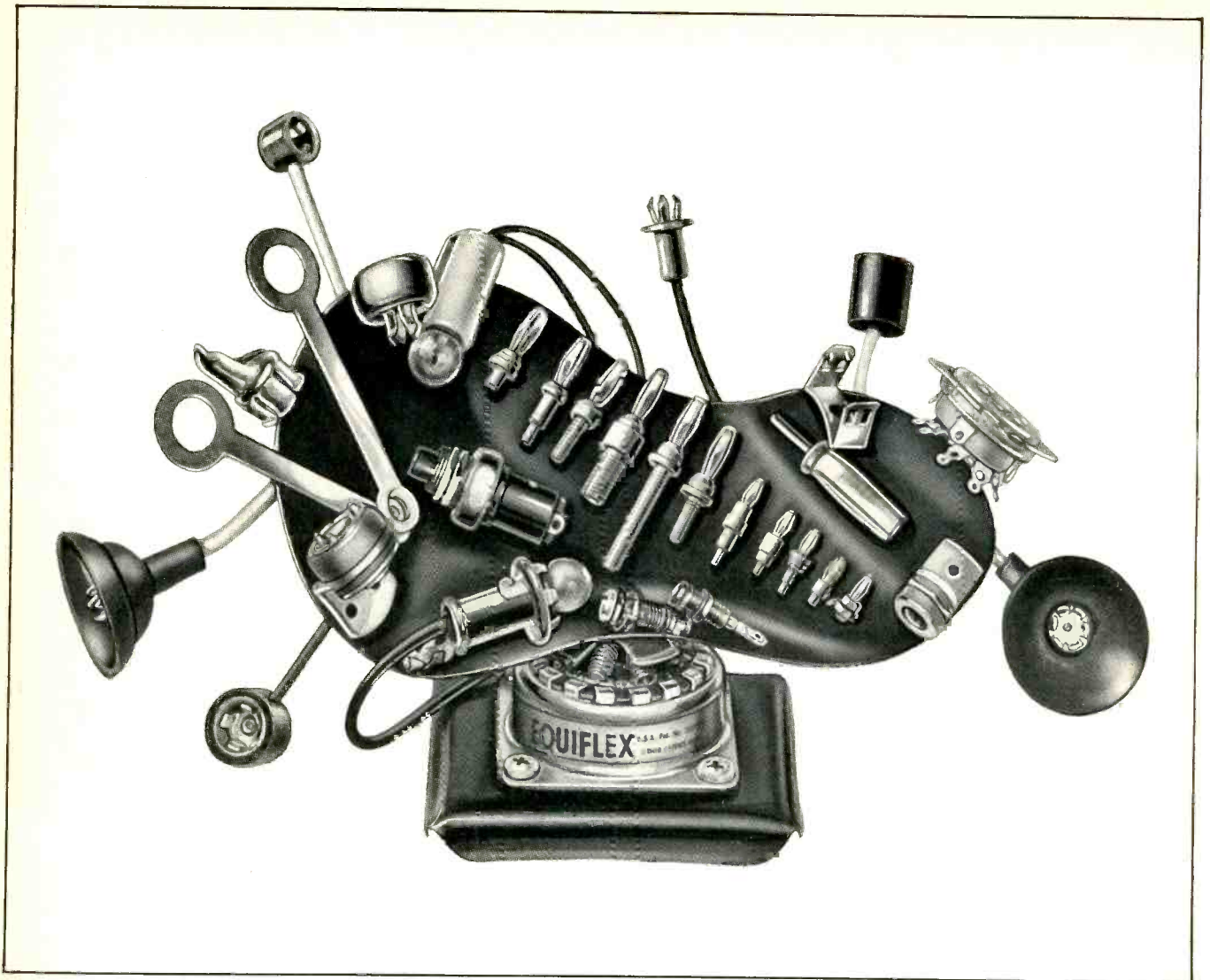
COMPARE AND YOU WILL SELECT THE DYNOGRAPH

Eight page, 2 color bulletin describes technical details and application information. Write for your copy of Bulletin L-742.



* Based on manufacturer's published claims.

OFFNER ELECTRONICS INC.
5324 N. Kedzie Ave., Chicago 25, U.S.A.




Kinzoid Potentiometer

Secret of this formidable device is a built-in correlator which enables it to analyze cocktail conversation, measure the potential in any given situation, and answer the jackpot question. Table model, illustrated, requires higher voltages than are generally available. Battery powered portable models are under development. Component parts may be purchased in quantity from Ucinite, however, and can

be wired to your specifications.

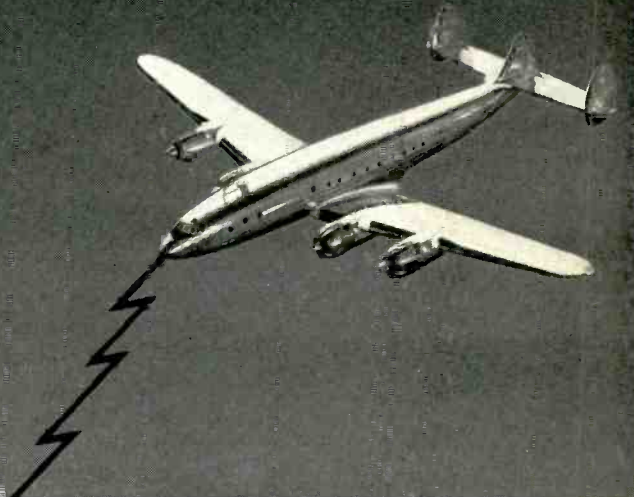
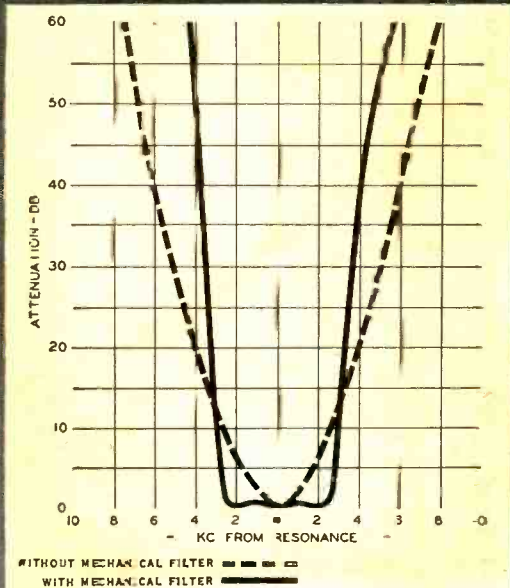
With an experienced staff of design engineers, plus complete facilities for volume production, Ucinite is capable of supplying practically any need for metal or metal-and-plastics assemblies... switches, connectors, shock mounts and small electrical parts of all kinds. Call your nearest Ucinite or United-Carr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



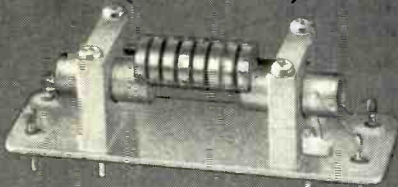
The
UCINITE CO.
Newtonville 60, Mass.
Division of United-Carr Fastener Corp.

Specialists in
ELECTRICAL ASSEMBLIES,
RADIO AND AUTOMOTIVE

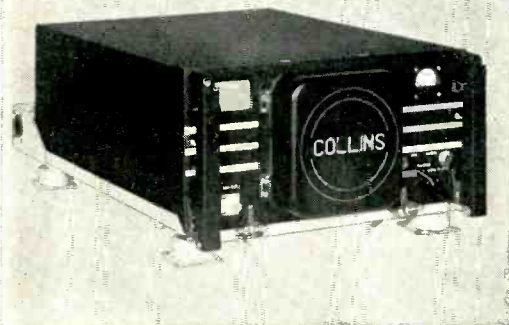
The Collins Mechanical Filter for MAXIMUM SELECTIVITY



Collins Mechanical Filter
(without cover)



Collins 18S-4
Transmitter/Receiver



Today's expanded air-ground radio communications have greatly increased the problem of adjacent channel interference. It has become increasingly difficult to control sideband radiation and maintain good channel selectivity.

Collins has solved these problems by incorporating the Mechanical Filter in the Collins 18S-4A HF Transmitter/Receiver. The Mechanical Filter, recently developed by Collins, produces a better signal-to-noise ratio — greatly increases channel selectivity — practically eliminates adjacent channel interference. The effect of the Mechanical Filter on the 18S-4A's selectivity is clearly shown on the accompanying graph.

Collins 18S-4A provides both receiving and transmitting facilities — up to twenty crystal controlled frequencies assigned anywhere in the range of 2.0 to 18.5 mc. Transmitter output, nominally rated at 100 watts cw or voice, is sufficient to assure communication over very long distances. Full remote control is provided over a positive 26-wire system. The proven performance of the Collins 18S Transceivers coupled with the increased selectivity afforded by the Mechanical Filter in the 18S-4A offers aviation the most advanced transmitting-receiving equipment available today.

For additional information on the Collins 18S-3 or 18S-4 or the Collins Mechanical Filter line, now available to industry, contact your nearest Collins office. Technical brochures will be forwarded on request.

For complete information and technical details, contact the Collins office nearest you.

COLLINS RADIO COMPANY Cedar Rapids, Iowa

261 Madison Ave.
NEW YORK 16

1930 Hi-Line Drive,
DALLAS 2

2700 W. Olive Avenue,
BURBANK

COLLINS RADIO COMPANY OF CANADA, LTD., 74 Sparks Street, OTTAWA, ONTARIO



**EXTRA-THIN
CONSTRUCTION**

**STRENGTH
TO
SPARE**

REG. U.S. PAT. OFF.
SCOTCH
BRAND
Magnetic Tape

90

Extra Play

• Made in U.S.A. by MINNESOTA MINING AND MANUFACTURING COMPANY, Saint Paul, Minnesota

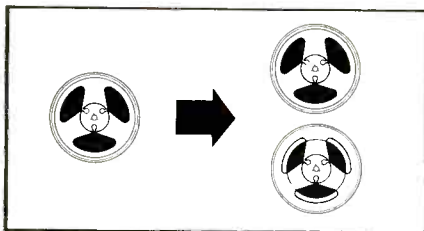
No. 190 A **SCOTCH Magnetic Tape** *Extra Play* 1/4" x 3600 FT.

**INCREASED
FREQUENCY
RANGE**

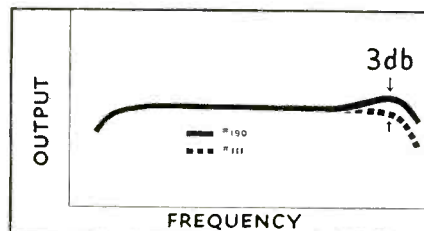
New *Extra Play* tape gives 50% more recording time!

A revolutionary development for radio stations, recording studios—in fact all users of magnetic tape! New “Scotch” Brand Extra-play Magnetic Tape 190A makes it possible to record entire symphonies, lengthy news and sports events without stopping for reel change. With 50% more tape on each reel, new Extra-play tape offers the same recording time found on 1½ reels of standard tape.

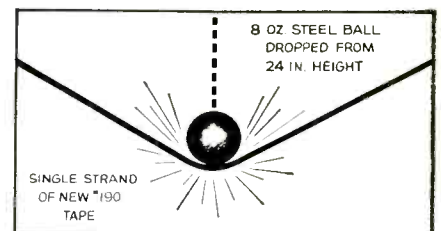
Exclusive feature of new “Scotch” Brand 190A tape is a thinner magnetic coating. Made of high-potency oxide, the new coating has been reduced from standard 0.6 mils to 0.3 mils and the high frequency range extended appreciably. A 30% thinner tape backing offers more uniform hi fi response with crisper, cleaner tones, yet maintains “Scotch” Brand’s reputation for sturdy, long-life tape construction.



EXTRA THIN TAPE—50% thinner, more potent oxide coating, 30% thinner backing permit more 190A tape to be wound on standard-size reel. Result: one roll of new tape does job of 1½ reels of standard tape.



INCREASED FREQUENCY range of new Extra-play tape enables tape machines to produce recordings with greater hi fi response than formerly possible with most conventional magnetic tapes.



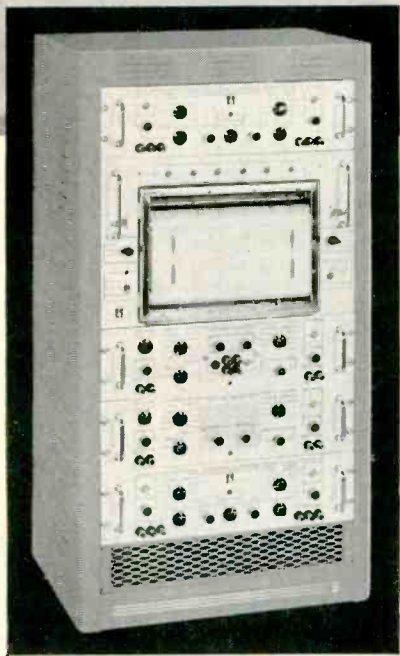
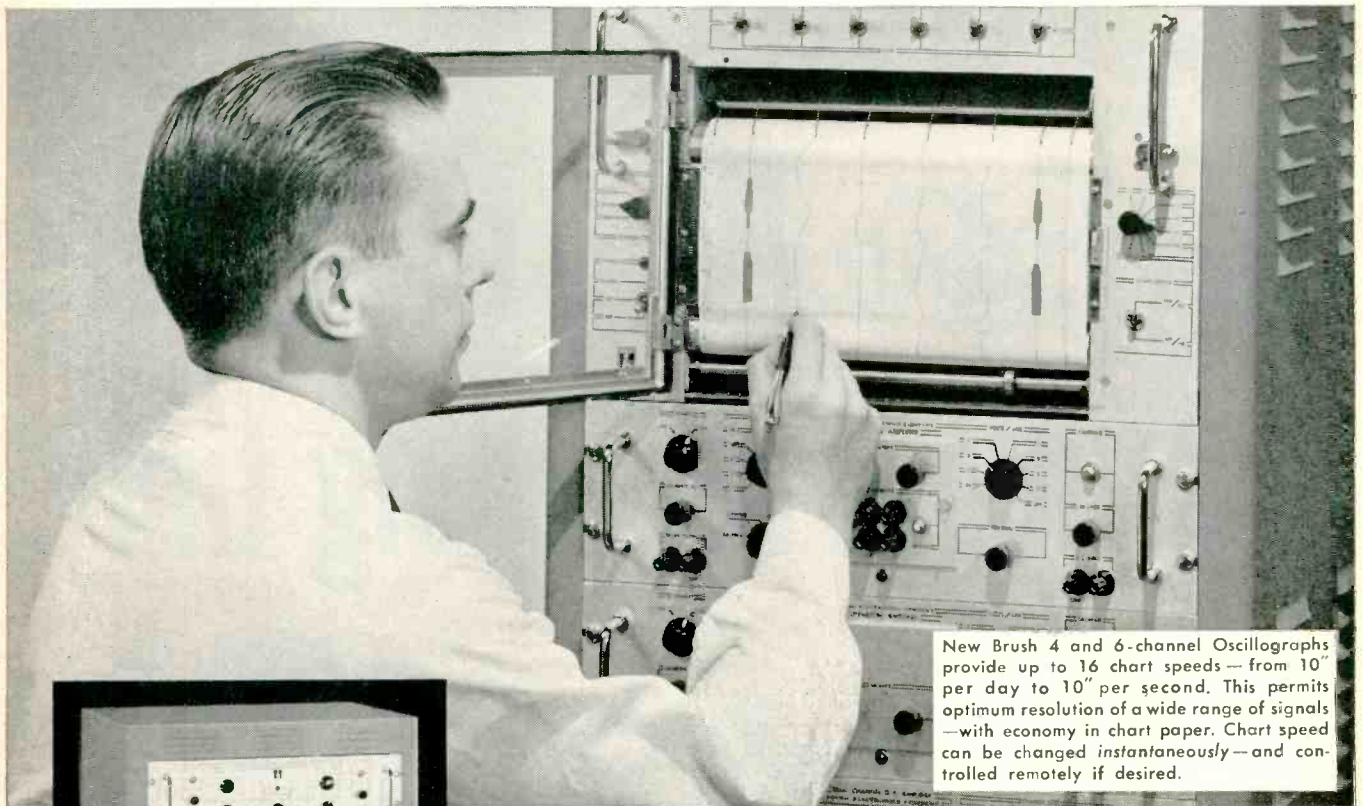
STRENGTH TO SPARE—New 190A tape stands up under even grueling steel ball drop test. Naturally it’s tough enough to withstand severe stresses of sudden machine stops, starts and reverses.

NEW!
REG. U.S. PAT. OFF.
SCOTCH BRAND *Extra Play* Magnetic Tape 190A

The term “SCOTCH” and the plaid design are registered trademarks for Magnetic Tape made in U.S.A. by MINNESOTA MINING AND MFG. CO., St. Paul 6, Minn. General Export: 122 E. 42nd St., New York 17, N. Y. In Canada: London, Ontario, Canada.



FULL RANGE INSTRUMENTATION!



New Brush Recording Systems are designed to meet many mounting requirements — standard 19-inch racks, bench-top, or floor consoles. New Brush Amplifiers are lighter, smaller and can be stacked closely as shown.

Brush Recording Systems have an important place in your research and production instrumentation. Write today or call your nearby representative for complete information. Brush Electronics Co., Dept. K-9A, 3405 Perkins Avenue, Cleveland 14, Ohio. In Canada: A. C. Wickman, Ltd., Toronto.

NEW BRUSH RECORDING SYSTEMS offer you greatest flexibility in measurements



Above: New Brush dual-channel D. C. Amplifier Model BL-530 accepts either single ended or balanced signals, provides a 50 millivolt sensitivity and accurate calibration of the signal to be recorded.

Right: New Brush Universal* Amplifier Model BL-520, when used with the appropriate resistive or inductive transducer, permits measurement and direct recording of physical phenomena: strain, torque, force acceleration, velocity, displacement, pressure, temperature, etc. Maximum sensitivity is equivalent to 1/2 microvolt per chart millimeter; or in strain measurements — .25 microinch per inch. The Amplifier includes a medium gain direct-coupled amplifier section with calibrated attenuator that may be used separately for voltage and current measurements.

*Trade Mark

BRUSH ELECTRONICS

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZO-ELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT
ULTRASONIC EQUIPMENT



COMPANY

formerly
The Brush Development Co.
Brush Electronics Company
is an operating unit of
Clevite Corporation.



Potter & Brumfield RELAYS

SIMPLE • RELIABLE • LOW COST

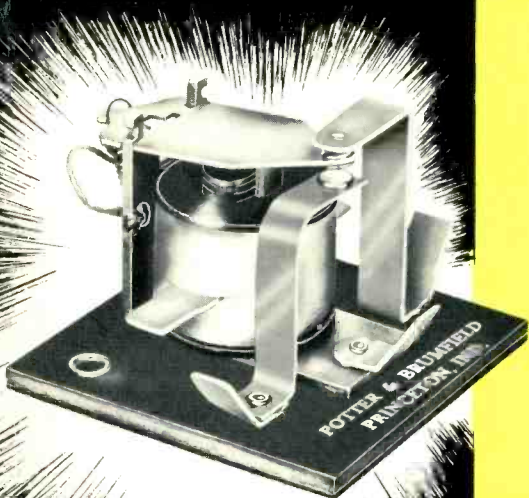
PLATE CIRCUIT SERIES "LB"



The simplicity of the LB design provides the lowest possible cost for a sensitive relay built for long life and unfailing reliability.

1. Coils up to 34000 ohm winding
2. Sensitivity to 3 MA pull-in current (approximately .09 watt)
3. SPDT silver contacts rated 5 amps ($\frac{3}{4}$ HP) with ample wipe
4. Breakdown tested to 500 V RMS
5. Centrifugally varnish impregnated coil
6. One piece back spring and contact arm
7. Laminated base—screw or rivet mount
8. Tinned solder terminals
9. Permanent air armature gap precludes residual sticking
10. Readily readjustable for pull-in
11. Dimensions $2\frac{5}{8}$ " x 1" x $1\frac{3}{8}$ " high—mounting holes $2\frac{1}{4}$ " centers

APPLIANCE SERIES "MW"



The MW general purpose appliance relay is most inexpensive to buy but will serve well in a wide variety of applications.

1. Available with AC or DC coils
2. Large silver contacts rated 5 amps ($\frac{3}{4}$ HP) with plenty of wipe
3. Underwriters creepage spacing
4. Breakdown tested to 1500 V RMS
5. Clip on solderless terminals
6. Heavy copper shading precludes chatter and hum
7. Molded bakelite coil bobbin
8. Laminated bakelite base
9. Varnish impregnated coil for moisture proofing
10. Mounting by either rivets or screws
11. Dimensions 2" x 2" x $1\frac{1}{2}$ " high—mounting holes $1\frac{5}{8}$ " centers

***Samples Available for Immediate Shipment
Quotations on Request***

POTTER & BRUMFIELD • PRINCETON, INDIANA

EXPORT: 13 East 40th Street, New York, New York
Sales Offices in Principal U. S. and Canadian Cities

Potter & Brumfield



offers you the benefits of

20 years' custom engineering

... with more than 100 Basic Relay Types!

These basic relay types have been evolved from the design and production of more than 15,000 different custom relays. Used as they are or with slight modifications they will fit most any and all applications.

Thus you are assured of:

1 Proven Design—P & B standard relays have been field tested under all kinds of conditions, thereby giving long, trouble-free service.

2 Lower Costs—Because these relays are already tooled and manufactured in production quantities—a substantial cost saving is passed along to you!

3 Fast Delivery—Orders for standard relays can be filled from stock or with minimum delay.

4 Available through Distributors—Standard types available through P & B franchised Electronic Parts Distributors in all principal cities.

Potter & Brumfield engineers are available for consultation on special relay problems—design or application.

A FEW OF THE MANY P&B BASIC RELAY STRUCTURES



POWER RELAYS
Heavy (PR) and medium (MR) duty. For across the line power circuits, high current switching—SPST to 3PDT.

PR



PLATE CIRCUIT RELAYS—Actuate on few milliwatts. Fit many applications. LM series also available. From SPST to DPDT.

LB



SUPER SENSITIVE RELAYS Operate on less than 10 MW. Dual coils, 10G vibration resistance. Wide versatility. One Form C-SPDT.

SS



LIGHT DUTY RELAYS
Small, light weight, sturdy. Withstand high vibration and shock. From SPST to 3PDT.

KR



IMPULSE RELAYS
Automatic stop prevents backlash. Precise, repetitive switching regardless of operating speed. DPDT or 4PDT.

AP



400 CYCLE AC RELAYS
For aircraft or ground equipment. Withstand better than 10G shock. Heavy cast mounting foot. SPST to DPDT.

AF



MULTIPLE CONTACT RELAYS—Longer coil provides power sufficient to actuate additional contacts. For multiple switching—SPST to 4PDT.

KL



TELEPHONE RELAYS
Meet practically all telephone relay requirements. Many contact combinations. MH, MT, LT and ST types also available.

MH



SUPER MIDGET RELAYS—Tiny and rugged—plug-in—SPDT. High degree of resistance to vibration and shock.

SM



MULTIPLE LEAF RELAYS For temperature, indicating or protective circuits. Heavy, tin-coated phosphor bronze contact springs. From SPST to 4PDT.

SU



MOTOR STARTING RELAYS Voltage controlled to insure throwout of starting winding when motor reaches rated speed. SPST-NC or SPST-NC-DB.

MS



SUBMINIATURE SENSITIVE RELAYS
Standard 7 pin plug-in. Ruggedized for vibration and shock. Operating power 25MW. Contact load 2 amps.

PW



LATCHING RELAYS Compact—high utility switching. Coils operate on AC or DC. Voltage or current. From SPST to 4PDT.

LK



HEAVY-DUTY SHOCK-PROOF RELAYS Can be mounted in any position. Particularly resistant to vibration and shock. From SPST to DPDT.

SP



MINIATURE DC POWER CONTACTOR—Heavy duty contacts, rated 60 amperes, 28 V DC, non-inductive load. Rugged construction. Withstands high vibration and shock. SPST-NO-DM.

MB

ALL P & B STANDARD RELAYS CAN BE SUPPLIED WITH DUST COVERS OR HERMETICALLY SEALED CANS WITH SOLDER OR PLUG-IN HEADERS

Write home office in Princeton or phone your local P & B Sales Office for new master catalog describing our wide line of basic relay structures, housings and enclosures. Samples, recommendations and quotations promptly furnished on special applications.

P & B Standard Relays available at your local Electronic Parts Distributor

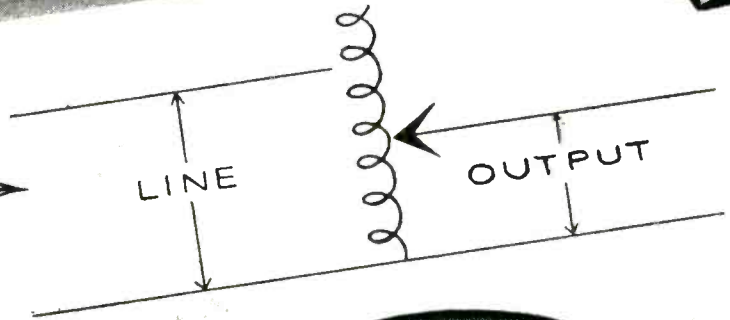
Potter & Brumfield

PRINCETON, INDIANA

EXPORT: 13 E. 40TH STREET, NEW YORK, NEW YORK
SALES OFFICES IN PRINCIPAL U. S. AND CANADIAN CITIES

For Designs that Require Adjustable A-C Voltage

Put this symbol in your circuit and a POWERSTAT Variable Transformer in your products and you'll get:—



- ...Cool operation*
- ...Power savings.. high efficiency*
- ...Does not have to be tailored to the load*
- ...Smooth control - glass smooth commutator surface*
- ...Conservative ratings and easy, simple mounting*



In many applications where you might usually use a rheostat, investigate Powerstat variable transformer to do a better job — and you can get a Powerstat for as little as \$8.50.

You'll find Powerstats are superior. Their dimensional and physical characteristics make them easier to "design into" a product. Their conservative ratings, smooth operation and long life make them a "plus" feature of value.

For the best in continuously-adjustable voltage control use variable transformers. For the best in variable transformers always specify POWERSTATS.

▲ You can choose from a complete standard line of Powerstat variable transformers. Units are offered in manually-operated and motor-driven assemblies for 120, 240 and 480 volt duty in capacities from 150 VA to 100 KVA.



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Manufacturers of: Powerstat Variable Transformers • Stabiline Automatic Voltage Regulators • Voltbox A-C Power Supplies • Powerstat Light Dimming Equipment • Varicell D-C Power Supplies • Superior 5-Way Binding Posts

THE SUPERIOR ELECTRIC CO.
209 Clarke Avenue, Bristol, Conn.

Please send complete literature on Powerstat variable transformers.

Name.....
 Position.....
 Company Name.....
 Company Address.....
 City.....Zone.....State.....



F.M. DEVIATION DIRECTLY MEASURED

THE BESSEL ZERO or "Disappearing Carrier" method of measuring deviation requires complex monitoring equipment, an accurately known modulation frequency, and, finally, mathematical interpretation of results.

With the compact and easy-to-use Marconi Deviation Meter, the modulation frequency need not be known and deviation is directly read on a meter scale.

F.M. DEVIATION METER TYPE TF 934

Carrier Frequency Range : 2.5 to 200 megacycles.

R.F. Input Level : 55 millivolts to 10 volts.

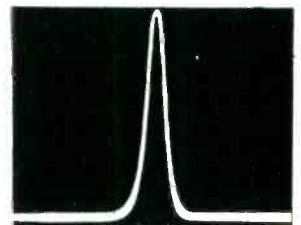
Deviation Measurement Ranges : 0 to ± 5 kc, 0 to ± 25 kc and 0 to ± 75 kc.

Accuracy of Deviation Measurement : $\pm 3\%$ from full-scale to half-scale up to 12 kc and $\pm 6\%$ up to 15 kc.

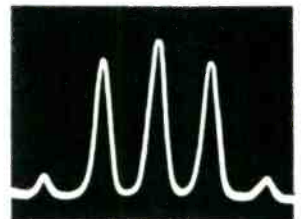
Full data and prices of any of the items listed below will be mailed immediately on request:

F.M. DEVIATION METER TF 934 • UNIVERSAL BRIDGE TF 868
 FM/AM SIGNAL GENERATOR TF 995A • STANDARD SIGNAL GENERATOR TF 867
 Also

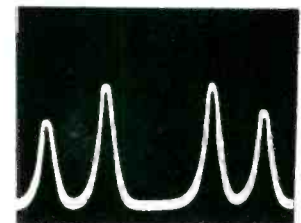
VACUUM TUBE VOLTMETERS • FREQUENCY STANDARDS • OUTPUT METERS
 WAVEMETERS • WAVE ANALYSERS • Q METERS • BEAT FREQUENCY OSCILLATORS



Unmodulated Carrier



Modulation Index 1.3



Modulation Index 2.4
 The Carrier "Disappears"
 BESSEL ZERO METHOD

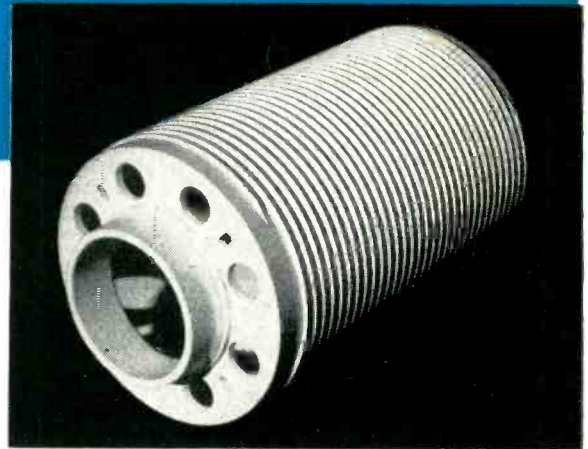
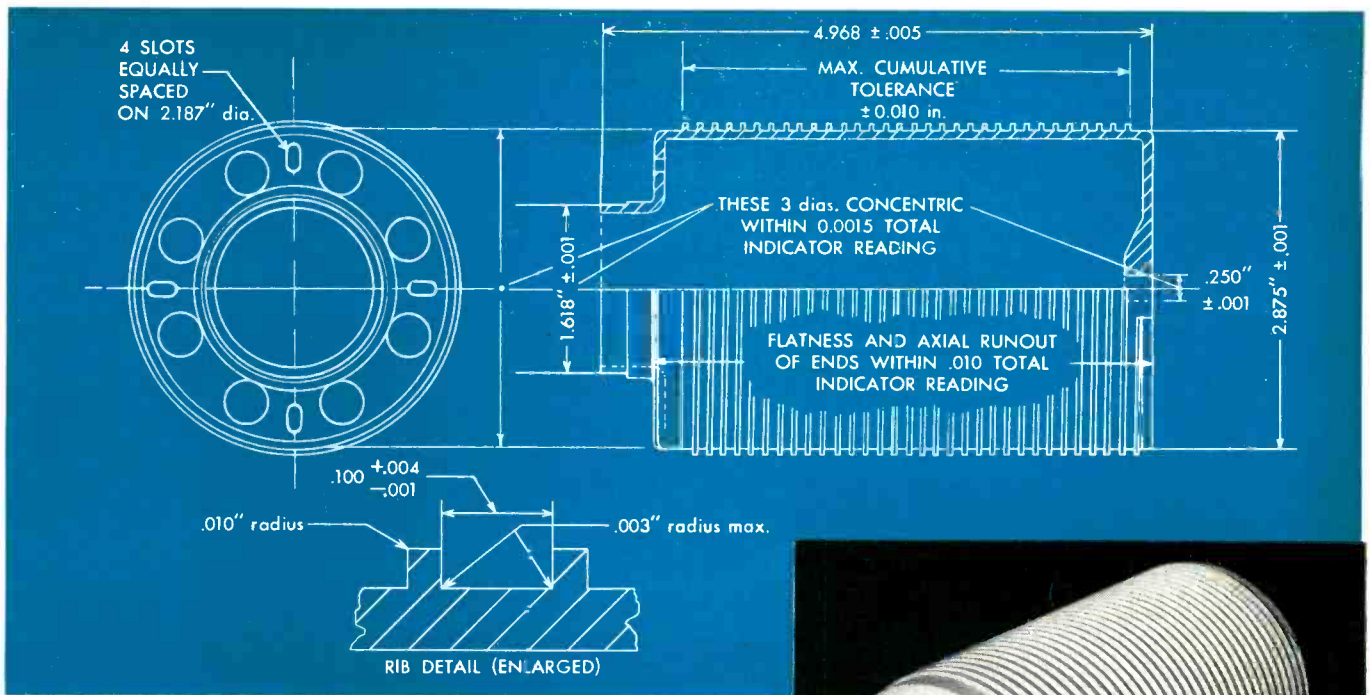
MARCONI INSTRUMENTS

23-25 BEAVER STREET • NEW YORK 4

CANADA: CANADIAN MARCONI CO., MARCONI BUILDING, 2442 TRENTON AVENUE, MONTREAL

ENGLAND: Head Office: MARCONI INSTRUMENTS LIMITED, ST. ALBANS, HERTFORDSHIRE

Managing Agents in Export: MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2



Stupakoff

CLOSE-TOLERANCE Manufacture

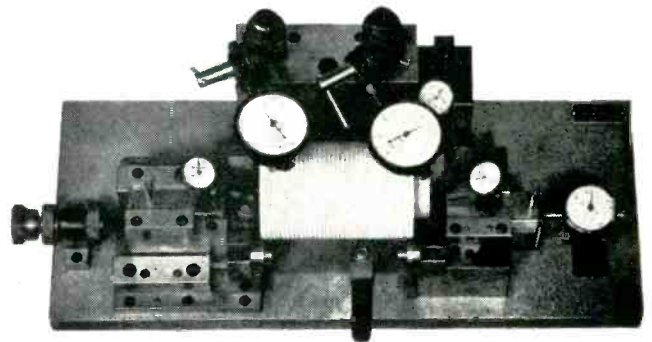
SOLVES CRITICAL COIL-FORM PROBLEM

The ability of Stupakoff to make ceramic parts of exceptional dimensional accuracy solved a critical problem for the Stewart-Warner Corporation. The antenna tuning coil-form illustrated is part of a mobile radio transmitter. The tuning coil—a silver ribbon—is wound between the ribs of the threaded portion, the accuracy of which maintains the proper spacing and number of the coil turns necessary for precise tuning of the antenna to any one of many wave lengths. The close tolerances to which these and other key dimensions are held assure precise assembly of the part in the transmitter and its smooth functioning in operation.

For many years, Stupakoff has specialized in the manufacture of precision ceramic parts—meeting close specifications not only in dimensions, but also in body composition. Our facilities include large, well-equipped laboratories, modern precision production machinery and an experienced staff of quality-conscious technicians.

If precision-made ceramic parts can reduce your costs or improve your products, Stupakoff has the skill, experience and facilities to produce them in the quantity and dependable high quality you require.

This coil form is made from vitrified alumina. Threads and other surfaces are ground after firing. Some of the critical dimensions and tolerances are given in the drawing above.



Specially designed gauge, providing direct readings in ten-thousandths of an inch, checks every coil form for critical dimensions, concentricity, flatness, and axial runout.

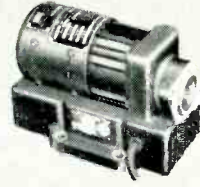
Stupakoff

CERAMIC & MANUFACTURING COMPANY
 LATROBE, PENNSYLVANIA
 DIVISION OF THE CARBORUNDUM COMPANY

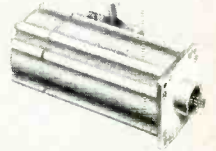




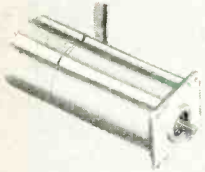
Fast action clutch-brake of unique Lear design utilizing two opposing coils to force clutching and declutching. Increases the speed of both operations. Typical application: digital mechanical computer.



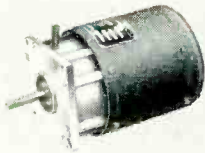
Specially designed Lear motor utilizing offset gear train to allow close tolerance between mounting surface and output shaft. Typical application: aircraft scavenger pump.



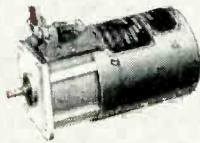
Lear intermittent duty AC motor. Has high torque AC brake capable of stopping both rotor and connected inertia load. Typical application: positioning actuator for jet engine air intake doors.



Lear AC brake motor with exceptional environmental resistance. Non-corrosive materials used throughout, including laminations. Typical application: aileron trim tab actuation.



AC motor of the air-over-totally-enclosed type. Has special mylar high dielectric insulation. Typical application: hydraulic pumps.



Synchronous AC motor. Has exceptional high starting torque which overcomes starting drag characteristics. Provides optimum low temperature operation. Typical application: radar scanning device.



DC intermittent duty motor incorporating Lear Fastop Clutch. Extensively used for heavy duty. Typical application: cowl flap power unit.



Miniature DC motor. Unusual specifications required armature which could be stalled continuously and a field to match 10,000 ohm impedance of vacuum tube amplifier. Typical application: trim tab servo.



Lear DC motor with noise filter designed integrally into special pump base. Totally enclosed and self-ventilated. Typical application: pumps.



Gearhead DC motor. Demonstrates building block flexibility. Gearhead components are available in a variety of gear ratios for all Lear motors. Typical application: guided missile fin actuation.



DC brake motor with quick stopping and high holding torque. Optional thermal protection. Typical application: seat actuator.

Motors by the Million

...and all of aircraft quality!

Although Lear's production of electric aircraft motors impresses by its magnitude, the major emphasis is first, last, and always upon **quality**. It is doubtful that any other company invests as much engineering time into every motor it builds. An entire, top-calibre engineering department is devoted exclusively to motor design, making Lear exceptionally qualified to handle the more exacting and difficult applications which most manufacturers hesitate to tackle.

Lear's excellent **facilities** for the design, engineering, production, and testing of motors are devoted to building *aircraft* motors and aircraft motors alone. Lear motors are designed to meet every applicable military specification.

Lear has accumulated immense **experience** in the manufacture of motors of aircraft quality, having built over one million since 1941. All motors used on precision Lear equipment such as electro-mechanical actuators, vertical gyro indicator systems, and F-5 autopilots, are Lear motors, so they *have* to be good.

Lear is an acknowledged leader in the field of motor noise **filtering**. Noise filters are engineered into Lear motors at the design stage — not added as an afterthought when the product is finished — thus providing substantial savings in weight and space, and tangible bonuses in performance.

Lear motors achieved early prominence through the use of the Lear "Fastop" clutch, and are now available with a complete line of **braking** devices, including both AC and DC brakes of the single-disk and multiple-disk types (which incidentally, are offered as separate components to other manufacturers).

Although all Lear motors are new **designs**, an infinite variety of additional models are available through combination of arrangements used in our regular families of motors, of which only a small part are illustrated here. Thus, Lear-quality models can be designed, and are designed, to meet practically any specialized requirement.

If you need any kind of an aircraft electrical motor — and if you want the best — it will pay you to consult Lear. Write, wire, or phone your nearest Lear Sales Office or Lear, Inc., 110 Ionia Avenue, Grand Rapids 2, Michigan.



LEAR AND RAPIDS DIVISION

EM-5



Gearhead DC motor. Continuous duty, air-over-totally-enclosed type with single stage reduction spur gearing and built-in filter. Typical application: aircraft fuel pump.

Wash., D.C.: 1701 K St., N.W. * San Diego: 429 Robinson Ave. * Dayton: 53 Park Ave. * Seattle: Term'l Bldg., Boeing Field * Toronto, Ont. and Montreal, P.Q.: Railway & Power Engr. Corp., Ltd.

NOW

Heldor

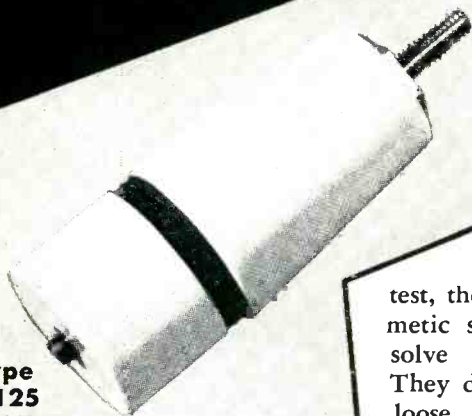
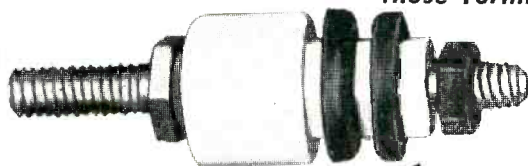
TERMINALS

especially designed to

MEET MIL-T-27

TWIST TEST

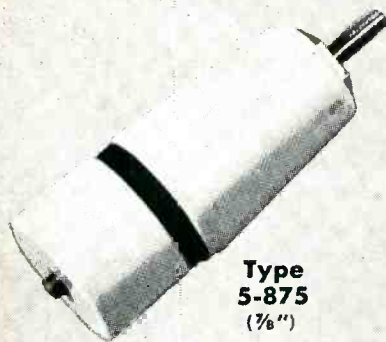
Photograph showing Lock-in Features of these Terminals



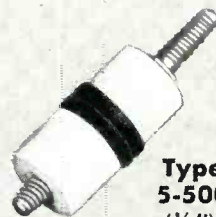
Type 5-1125
(1 1/8")



Type 5-218
(7/32")



Type 5-875
(3/4")



Type 5-500
(1/2")

DESIGNED specifically to meet the MIL - T - 27 twist test, these four compression-type, hermetic seal Heldor Lock-in terminals solve your "twist-test" headaches. They do not turn, twist or become loose. Not only do they possess typical Heldor bushing advantages but they also have increased electrical insulation, the result of an increased length of seatite.

Now available as standard, these four terminals can be revised to meet your specified requirements. Heldor can effect further marked economies with its assembly services — assembly of these and other terminals to covers as well as the final assembly of the finished components. Write for samples and prices based on your needs.

Do it NOW!

Send Data Lock-in Terminals Dual Conductor.

My name Title

Company

Address

NEW

DUAL CONDUCTOR

Heldor announces its new dual conductor HDC-1250. Write for data!



HELDOR MANUFACTURING CORPORATION

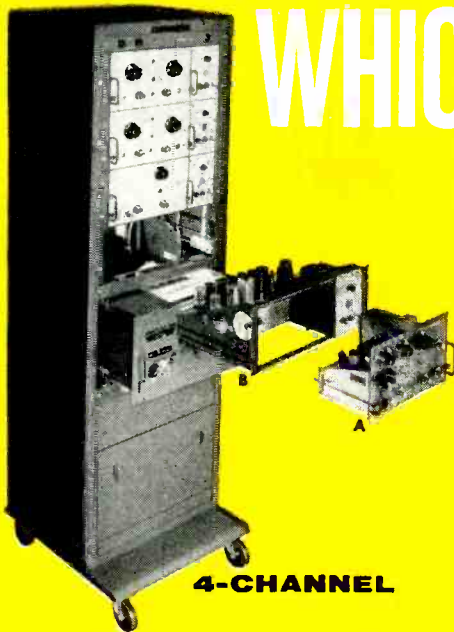
HELDOR HERMETIC SEAL COMPANY, INC.

238 Lewis Street

Paterson, N. J.



WHICH "150" fits your oscillographic recording need?



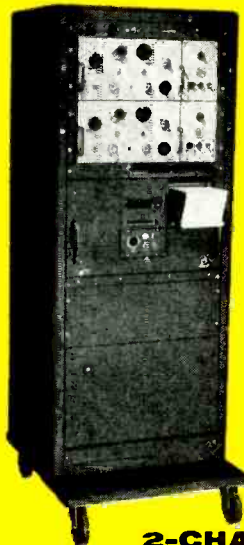
4-CHANNEL

As a graphic example of the design idea that has brought new versatility to industrial recording, a Carrier Preamplifier (A) is shown above in position to plug into a Driver Amplifier in framework with Power Supply (B) which are normally already in place in the Basic Cabinet Assembly.

The identical design principles of the four-channel system are provided in the two-channel, the only difference being the number of channels.

Sanborn "150" Recording Systems that put to use the original design concept of amplifier interchangeability (illustrated at the left) start with either a four-channel or two-channel standard

Basic Assembly, to which the user adds whatever selection or combination of preamplifiers (A) are needed for his recording problem. The standard Basic Assemblies comprise a metal Cabinet, Recorder, and a built-in Driver Amplifier and Power Supply (B) for EACH channel. Presently available Preamplifiers are: AC-DC, Carrier, DC Coupling, Servo Monitor, Log-Audio, and Low Level Chopper.



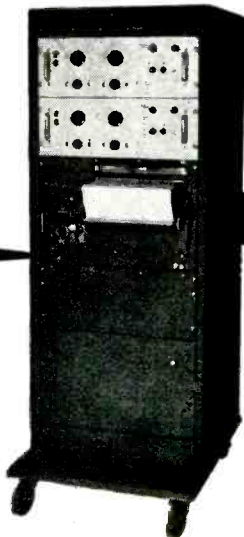
2-CHANNEL

Advantages common to ALL Sanborn Recorders are: inkless recording (by heated stylus) on plastic coated strip chart paper, and in true rectangular coordinates . . . high torque galvanometer movement . . . time and code markers . . . numerous paper travel speeds.

"150"

COMPLETE FOUR-CHANNEL SYSTEM FOR USE WITH ANALOG COMPUTERS

This "150" system consists of a Cabinet Assembly, a four-channel Recorder, and two dual channel DC Amplifiers. Each amplifier is complete with a common power supply. Each measures and records two separate single-ended signals, at sensitivities between one and one hundred volts per centimeter. The two-channel version of this system will comprise Cabinet, two-channel Recorder, and one dual channel amplifier.

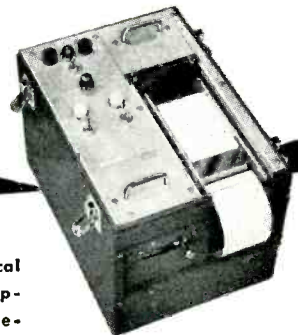


Ask, also, for a copy of the *Right Angle* — a Sanborn publication devoted to oscillographic recording in industry.

"150"

SINGLE-CHANNEL RECORDER

A compact, lightweight unit for use when only one channel is required — provides permanent, inkless recording in true rectangular co-ordinates; five paper speeds (5, 10, 25, 50, 100 mm/sec.); extra stylus for either manual or remote timing and coding marks. Designed for simple, patch cord connection to any of the several "150" preamplifiers (plus driver amplifier and power supply), available soon in portable metal cases.



Catalog and technical data on all "150" equipment available on request.

SANBORN COMPANY
Industrial Division
CAMBRIDGE 39, MASS.

MILLIONS

OF VARIABLE

COMPLETE MILITARY LINE AVAILABLE.

POPULAR MILITARY TYPES ILLUSTRATED.

CORRESPONDING COMPLETE LINE FOR COMMERCIAL APPLICATIONS ALSO AVAILABLE.

5 acres of plant area . . . over 1000 employees . . . making ALL TYPES of variable resistors by the million. . . for ALL your requirements. CTS SPECIALIZES in precision mass production of variable resistors and associated switches . . . makes nothing else.

Most controls available with switches and in concentric shaft tandems or with two controls operating on one shaft. Also available with locking bushing, water sealed bearing and many other special features not illustrated.

Immediate delivery from stock on many JAN-R-94, JAN-R-19 and other types.



WRITE FOR ILLUSTRATED CATALOG—

Describes Electrical and Mechanical characteristics, Special Features and Constructions of a complete line of variable resistors for military and civilian use. Includes dimensional drawings of each resistor

EAST COAST OFFICE

Henry E. Sanders
130 North Broadway
Camden 2, New Jersey
Phone: Woodlawn 6-1668
TWX No. FLANDERS PA 414

WEST COAST OFFICE

Robert A. Stackhouse
928 So. Robertson Blvd.
P. O. Box 35073
Los Angeles 35, California
Phone: Crestview 4-5931
TWX No. BEV H 7666

CANADIAN DIVISION

C. C. Meredith & Co., Ltd.
Streetsville, Ontario
Phone: 310

SOUTH AMERICA

Jose Luis Pontet
Buenos Aires, Argentina
Montevideo, Uruguay
Rio de Janeiro, Brazil
Sao Paulo, Brazil

OTHER EXPORT

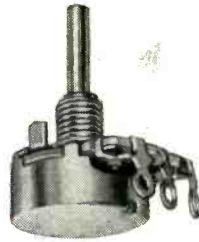
Sylvan Ginsbury
8 West 40th Street
New York 18, New York
Phone: Pennsylvania 6-8239

SOUTHWESTERN U.S.A.

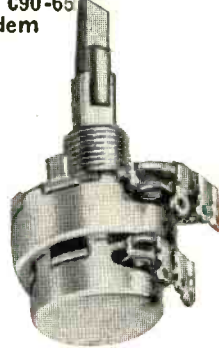
John A. Green Company
6815 Oriole Drive
P.O. Box 7224
Dallas 9, Texas
Phone: Dixon 9918

1/2 watt 70°C, 3/4" diameter miniaturized variable composition resistor.

TYPE 65 (Miniaturized)



TYPE C90-65 Tandem



UNPRECEDENTED PERFORMANCE CHARACTERISTICS

Types 65, 90 and 95 are specially designed for military communication equipments subject to extreme temperature and humidity ranges: -55°C to +150°C . . . aridity to saturation.

1 watt 70°C, 15/16" diameter variable composition resistor.

TYPE 90



TYPE GC-90 With Switch



TYPE C2-90 Tandem



Meets JAN-R-94 type RV4

2 watt 70°C, 1-1/8" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94.

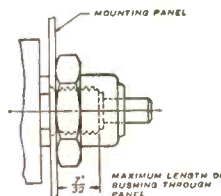
TYPE 95



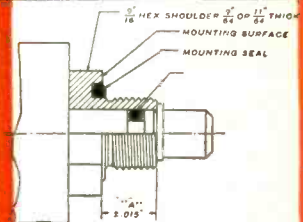
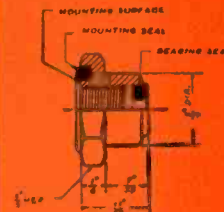
TYPE GC-95 With Switch



TYPE C2-95 Tandem



WATER SEALED MOUNTING AND BEARING FOR TYPE 65



CAN BE SUPPLIED WITHOUT THE WATER SEALED MOUNTING SHOULDER (I) WATER SEALED MOUNTING AND BEARING FOR TYPES 45, 35, 90, 95, 25, 252.



CHICAGO TELEPHONE SUPPLY Corporation

ELKHART • INDIANA

RESISTORS... FOR EVERY NEED

Meets JAN-R-94
type RV3

1/2 watt 1-1/8" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94.

Meets JAN-R-94
type RV2

1/4 watt 15/16" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94.

Meets JAN-R-19
types RA25 and RA30

4 watt 1-17/32" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19.

Meets JAN-R-19
type RA20

2 watt 1-17/64" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19.

TYPE 35



TYPE 45



TYPE 25



TYPE 252



TYPE GC-35
With Switch



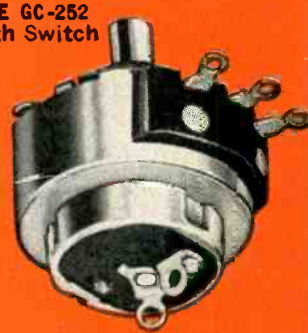
TYPE GC-45
With Switch



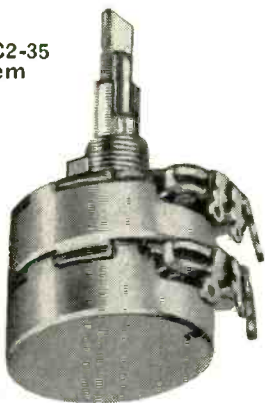
TYPE GC-25
With Switch



TYPE GC-252
With Switch



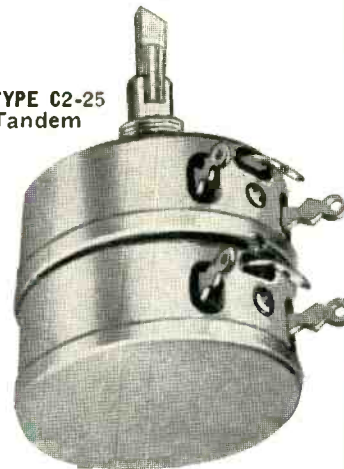
TYPE C2-35
Tandem



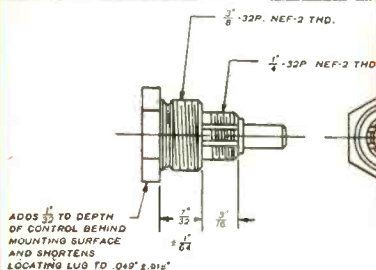
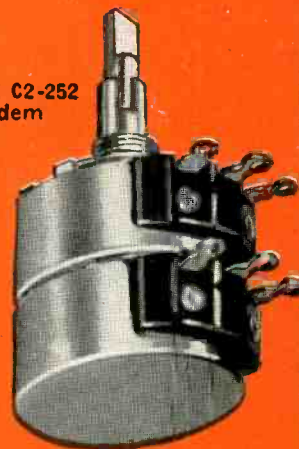
TYPE C2-45
Tandem



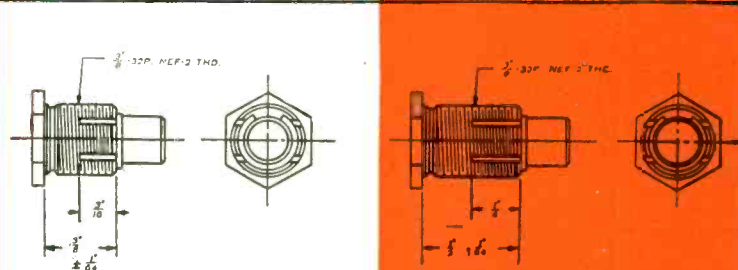
TYPE C2-25
Tandem



TYPE C2-252
Tandem

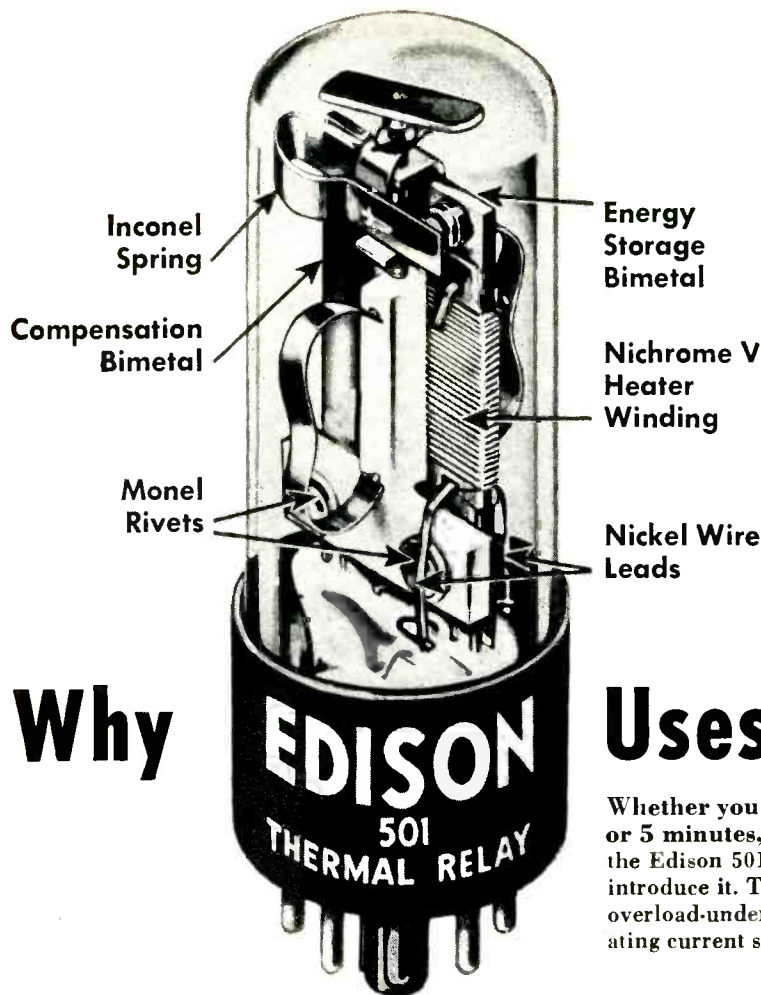


LOCKING BUSHINGS FOR TYPE 65 CONTROL.



LOCKING BUSHINGS FOR CONTROL TYPES 25, 252, 95, 35, 90, 45.

Specialists in Precision Mass Production of Variable Resistors • Founded 1896



Why Uses 7 Nickel Alloys

Whether you need a circuit delay of 2 seconds or 5 minutes, a heating element and bimetal in the Edison 501 Thermal Relay can be selected to introduce it. The relay can also be used as an overload-underload detector, as a cyclically operating current switch, and as an integrator of pulses.

One of the most important requirements in a time delay relay is maintaining contact pressure. The answer in this Edison Time Delay Relay was a preloaded Inconel spring.

Inconel was chosen because it remains strong and resilient, retains its spring properties at the operating temperature of the bimetal elements, and throughout the evacuation and out-gassing process in manufacture.

A second Inco Nickel Alloy, **Monel**, is used for rivets that rigidly support the two bimetal elements. Monel rivets combine corrosion-resistance and high strength. They are easily clinched, too.

Nichrome V*, another high nickel alloy, is specified for the heater resistance wires. It offers long life at high temperatures, and stability during life.

"**A**" **Nickel** wire leads are used for stable electrical characteristics after repeated heating, and for ease of welding.

Invar, for its low expansion, and **Wilson Alloy #20****, for its high expansion, are the two metals bonded to form each bimetallic element of the thermal relay. Both are nickel alloys.

Dumet†, a nickel and iron alloy, is used for glass-to-metal wire leads because it has expansion-contraction characteristics similar to glass and is easily wetted by molten glass for vacuum seal.

If you have a design problem

Follow the example of Thomas A. Edison Incorporated's Instrument Division. When you need metals with special properties for special jobs, look to Nickel and Nickel Alloys. Send for a copy of *Standard Alloys for Special Problems* to get an idea of how many things INCO Nickel Alloys can do.

*Reg. U. S. Pat. Off. Driver-Harris Co.

**Product of H. A. Wilson Co.

†Product of Westinghouse Electric Co.

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



Nickel Alloys

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
"S"® MONEL • INCONEL® • INCONEL "X"®
INCONEL "W"® • INCOLOY® • NIMONIC® Alloys • NICKEL
LOW CARBON NICKEL • DURANICKEL®

New, wide band thermistor and bolometer mounts require no tuning, speed microwave measuring



-hp- 420A Crystal Detector

Employs a silicon crystal to detect rf signals in a coaxial line employing Type N fittings. Covers frequencies 10 mc to 12.5 kmc. Frequency response flat within ± 3 db full range, excellent conversion efficiency. No tuning. Uses modified 1N21 crystal. \$50.00.

-hp- X421A Crystal Detector



X-Band Crystal Detector for use in waveguide systems at frequencies 8.2 to 12.4 kmc. Frequency response is flat within ± 2 db. No tuning. Detector has square law characteristic within ± 1 db over a 40 db dynamic range. \$75.00.



-hp- 477A Thermistor Mount

For coaxial measurements. Provides complete coverage of all frequencies 10 mc to 10 kmc. VSWR is less than 1.5. Operates with -hp- 430B Power Meter for direct power readings. No tuning. Not subject to burnout. Input connector is Type N; output is Type BNC. \$75.00.



-hp- 487A Thermistor Mount

For fast, accurate waveguide measurements. Each mount covers full range of its waveguide frequency. Available for all frequencies 3.95 through 12.4 kmc. No tuning required, VSWR less than 1.5. Not subject to burnout. Operates with -hp- 430B Power Meter for direct power readings. \$75.00 to \$95.00.

Here are four new wide band thermistor and bolometer mounts for use with coaxial or waveguide equipment at frequencies between 10 mc and 12.5 kmc. These new instruments are extremely simple to use, require no tuning, have low VSWR, and may be used with a power meter such as -hp- 430B to provide direct reading measurements.

Brief descriptions of new -hp- 420A and X421A Detector Mounts and -hp- 477A and 487A Fixed Tuned Thermistor Mounts appear at left. The broad complete coverage -hp- line of detectors and mounts is listed below. For details, see your local -hp- sales engineer, or write direct for Technical Bulletin, specifying instrument model number.

Complete Coverage—All Frequencies!

Model	Instrument	Frequency	Element	Price
420A	Detector Mount	10 mc to 12.5 kmc	1N21 Crystal	\$ 50.00
X421A	Detector Mount	8.2 kmc to 12.4 kmc	1N26 Crystal, mod.	75.00
440A	Detector Mount	2.4 kmc to 12.4 kmc	Crystal, Bolometer	85.00*
442B	Broad Band Probe	2.4 kmc to 18.0 kmc	—	35.00
444A	Broad Band Probe	2.6 kmc to 18.0 kmc	—	50.00
475B	Tunable Bolometer Mount	1.0 kmc to 4.0 kmc	Barretter, Thermistor, Fuse	200.00
476A	Universal Bolometer Mount	10 mc to 1.0 kmc	1/100 amp. fuses	85.00
477A	Thermistor Mount	10 mc to 10 kmc	Thermistor	75.00
S485A	Detector Mount	2.6 kmc to 3.95 kmc	Bolometer	125.00*
G485B	Detector Mount	3.95 kmc to 5.85 kmc	Bolometer, Crystal	95.00*
J485B	Detector Mount	5.85 kmc to 8.2 kmc	Bolometer, Crystal	90.00*
H485B	Detector Mount	7.05 kmc to 10.0 kmc	Bolometer, Crystal	85.00*
X485B	Detector Mount	8.2 kmc to 12.4 kmc	Bolometer, Crystal	75.00*
P485C	Detector Mount	12.4 kmc to 18.0 kmc	Thermistor	110.00
G487A	Thermistor Mount	3.95 kmc to 5.85 kmc	Thermistor	95.00
J487A	Thermistor Mount	5.85 kmc to 8.2 kmc	Thermistor	90.00
H487A	Thermistor Mount	7.05 kmc to 10.0 kmc	Thermistor	80.00
X487A	Thermistor Mount	8.2 kmc to 12.4 kmc	Thermistor	75.00

All mounts contain element unless marked (*).

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



**INSTRUMENTS FOR
COMPLETE COVERAGE**

HEWLETT-PACKARD COMPANY

3149A Page Mill Road • Palo Alto, California, U. S. A.

Sales and service engineers in all principal areas.

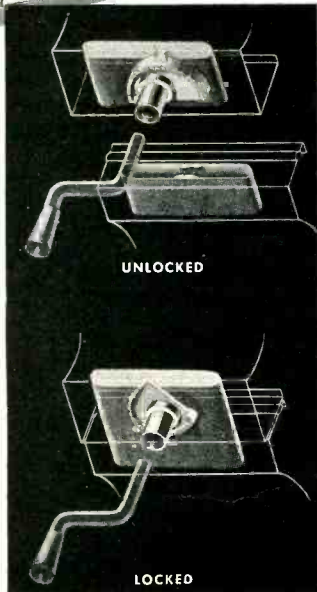
Export Division: 275 Page Mill Rd., Palo Alto, Calif.
Cable "HEWPACK"

"Nothing can go wrong with Roto-Lock performance"

Says Elgin Metal Casket Company



Roto-Lock operation is simple: Serrated, tapered cam engages latch — draws panels tightly together when turned by crank or other hand tool.



Simmons Roto-Lock Fasteners are used by Elgin Metal Casket Co., of Elgin, Illinois, to give its Permaseal Caskets a perfect hermetic seal against air and water. Drawn down with a pressure of up to 1500 lbs., Roto-Lock guarantees an absolutely tight seal and strength far beyond requirements.

President E. B. Stewart of Elgin says: "Roto-Lock worked out particularly well because of the simplicity of its construction, and the fact that it was a lock already in a housing which could readily be sealed. Functionally the lock is very good since it pulls the lid down with ease and is a quick-operating mechanism. In other words, *the locking and sealing operation can be accomplished quickly and easily in a matter of seconds.* Since the whole locking and sealing mechanism contains only one moving part, *there is nothing that can go wrong with the performance of the lock.* Of course, this is important since mal-function at a funeral service would be a serious matter."

and there's a Roto-Lock application to improve your product

Roto-Lock, which makes butt or right-angle joints quickly, is finding wide application in portable shelters, air freight and cold storage shipping containers, walk-in coolers, demountable furniture and scaffolding. It fastens in any misaligned or semi-open position and recesses completely into panels. *Wherever* demountability is important, there's a Roto-Lock application.

Write today for our 36-page catalog. It's filled with applications of Roto-Lock and Simmons' four other special fasteners engineered to improve products and reduce assembly costs.

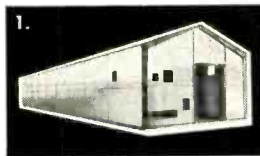
SIMMONS FASTENER CORPORATION

1750 N. Broadway, Albany 1, New York

Simmons

QUICK-LOCK • SPRING-LOCK • ROTO-LOCK • LINK-LOCK • DUAL-LOCK

FASTENERS WITH USES UNLIMITED



Some applications of Roto-Lock:



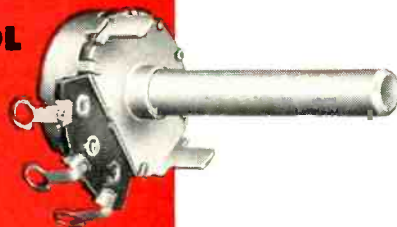
1. Portable Shelter
2. Partition
3. Demountable Refrigerator Unit
4. Demountable Desk



3 Low Cost VARIABLE RESISTORS for COMPACT CIRCUITS

COST-CUTTING TAB-MOUNTING CONTROL

0.5 watt metal shaft type for TV picture adjustment, pre-set gain controls, etc. Tab-mounting cuts mounting time, eliminates hardware. Nine different Stackpole line switches available for this control. *Send for specifications on Type LR-5.*



TAB-MOUNTING "DOUBLE-ENDER"

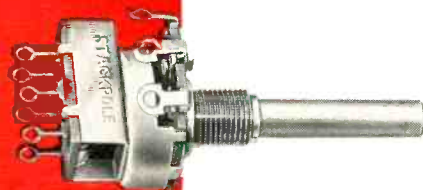
Just right for rear-of-chassis or concealed front panel controls in TV receivers . . . especially in high voltage circuits. Bakelite shaft can easily be adjusted from either side of control. Measures only .894" in diameter, yet handles a full .5-watt. *Write for data on Stackpole Type LR-6.*



MINIATURE TONE CONTROL with SPECIAL

A really versatile space-saver for midget radios, combination receivers, or amplifiers. Helps reduce the number of controls on complicated sets. U.L. Approved .5 amp., switch throws at opposite ends of control rotation—maintains full 270° shaft motion in either position. Ideal for band changing, input or bandwidth switching. *Write for details on Stackpole Type LRSS-150.*

DP-DT SWITCH



Electronic
Components Division
**STACKPOLE
CARBON
COMPANY**

St. Marys, Pa.

STACKPOLE

In Canada: Canadian Stackpole Ltd., 550 Evans Avenue, Etobicoke, Toronto 14, Ontario



KEPCO VOLTAGE REGULATED POWER SUPPLIES



MODEL 750

MODEL	VOLTS	CURRENT	REGULATION	RIPPLE
750	0-600	0-750 Ma.	0.5%	10 Mv.
760	0-600	0-1.5 Amp.	0.5%	10 Mv.
770	0-600	0-2.25 Amp.	0.5%	10 Mv.
780	0-600	0-3 Amp.	0.5%	10 Mv.

DC POWER SUPPLY SPECIFICATIONS

KEPCO Voltage Regulated Power Supplies are conservatively rated. The regulation specified for each unit is available under all line and load conditions within the range of the instrument.

REGULATION: As shown in table for both line fluctuations from 105-125 volts and load variations from minimum to maximum current.

***REGULATION FOR BIAS SUPPLIES:** 10 millivolts for line 105-125 volts. ½% for load at 150 volts.

†All AC Voltages are unregulated.

VOLTS	CURRENT	REGULATION	RIPPLE	6.3 V. I AC. CT.	MODEL
0-1500	0-200 Ma.	0.5%	20 Mv.		1520
0-1200	0-20 Ma.	0.1%	10 Mv.	10 Amp.	1220
0-1000	0-500 Ma.	0.5%	20 Mv.		1350
200-1000	0-500 Ma.	0.5%	20 Mv.		1250
0-1000	0-50 Ma.	0.1%	10 Mv.	10 Amp.	1020
0-600	0-3 Amp.	0.5%	10 Mv.		780
0-600	0-2.25 Amp.	0.5%	10 Mv.		770
0-600	0-1.5 Amp.	0.5%	10 Mv.		760
0-600	0-750 Ma.	0.5%	10 Mv.		750
0-600	0-300 Ma.	0.5%	10 Mv.	10 Amp.	615
0-150 Bias	0-5 Ma.	*	5 Mv.		
0-600	0-300 Ma.	0.5%	10 Mv.	10 Amp.	500R
#1 0-600	0-200 Ma.	0.5%	5 Mv.	10 Amp.	800
#2 0-600	0-200 Ma.	0.5%	5 Mv.	10 Amp.	
0-600	0-200 Ma.	0.5%	5 Mv.	10 Amp.	815
0-150 Bias	0-5 Ma.	*	5 Mv.		
#1 200-500	0-200 Ma.	0.5%	5 Mv.	6 Amp.	510
#2 200-500	0-200 Ma.	0.5%	5 Mv.	6 Amp.	
200-500	0-200 Ma.	0.5%	5 Mv.	6 Amp.	245
0-400	0-150 Ma.	0.5%	5 Mv.	10 Amp.	2400
0-400	0-150 Ma.	0.5%	5 Mv.	10 Amp.	
0-150 Bias	0-5 Ma.	*	5 Mv.		
0-400	0-150 Ma.	0.5%	5 Mv.	10 Amp.	400
0-150	0-5 Ma.	*	5 Mv.		
0-400	0-150 Ma.	0.5%	5 Mv.	10 Amp.	141
100-400	0-150 Ma.	0.01%	1 Mv.	10 Amp.	2000
0-350	0-3 Amp.	0.5%	10 Mv.		730
0-350	0-2.25 Amp.	0.5%	10 Mv.		720
0-350	0-1.5 Amp.	0.5%	10 Mv.		710
0-350	0-750 Ma.	0.5%	10 Mv.		700
100-325	0-150 Ma.	0.5%	5 Mv.	10 Amp.	131
0-150 Bias	0-5 Ma.	*	5 Mv.		
0-300	0-150 Ma.	0.5%	5 Mv.	5 Amp.	315
0-150 Bias	0-5 Ma.	*	5 Mv.		
0-150	0-50 Ma.	0.5%	5 Mv.		150
3-30	0-30 Amp.	0.5%	0.1%		3030
1-13	0-10 Amp.	0.5%	10 Mv.		3200

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

WORKMANSHIP

Workmanship is of a quality with the highest existing production standards and best instrument electronic practices consistent with the intended use of the item as a continuous duty voltage regulated power supply. Oil filled paper condensers and resistor-board construction are included in the design.

FOR NEW POWER SUPPLY CATALOG — WRITE DEPT. No. 789

ASTRON Hy-Met[®] scaled for **small size**, **light weight**



operation
up to
125°C

Metalite Hy-Met* ASTRON capacitors are crafted to feature small size, light weight, and to operate up to 125°C for all types other than cardboard tubular MLL (100°C). ASTRON technicians process the fine quality materials that comprise the famous Hy-Met capacitor line with skillful attention to minute details. *Self-healing* Hy-Met capacitors accept momentary overvoltages and surges without permanent damage—possess high dielectric strength and vastly improved insulation resistance over conventional metallized paper types—are *effectively protected* from humidity—give *low r.f. impedance* due to small size—are ideal for R.F. filters and noise suppression. All these features are common to the Metalite Hy-Met *plus* the greater dependability and longer life derived from added care in construction and quality control. Write today for ASTRON capacitor and filter literature.

*Trademark

ASTRON
CORPORATION



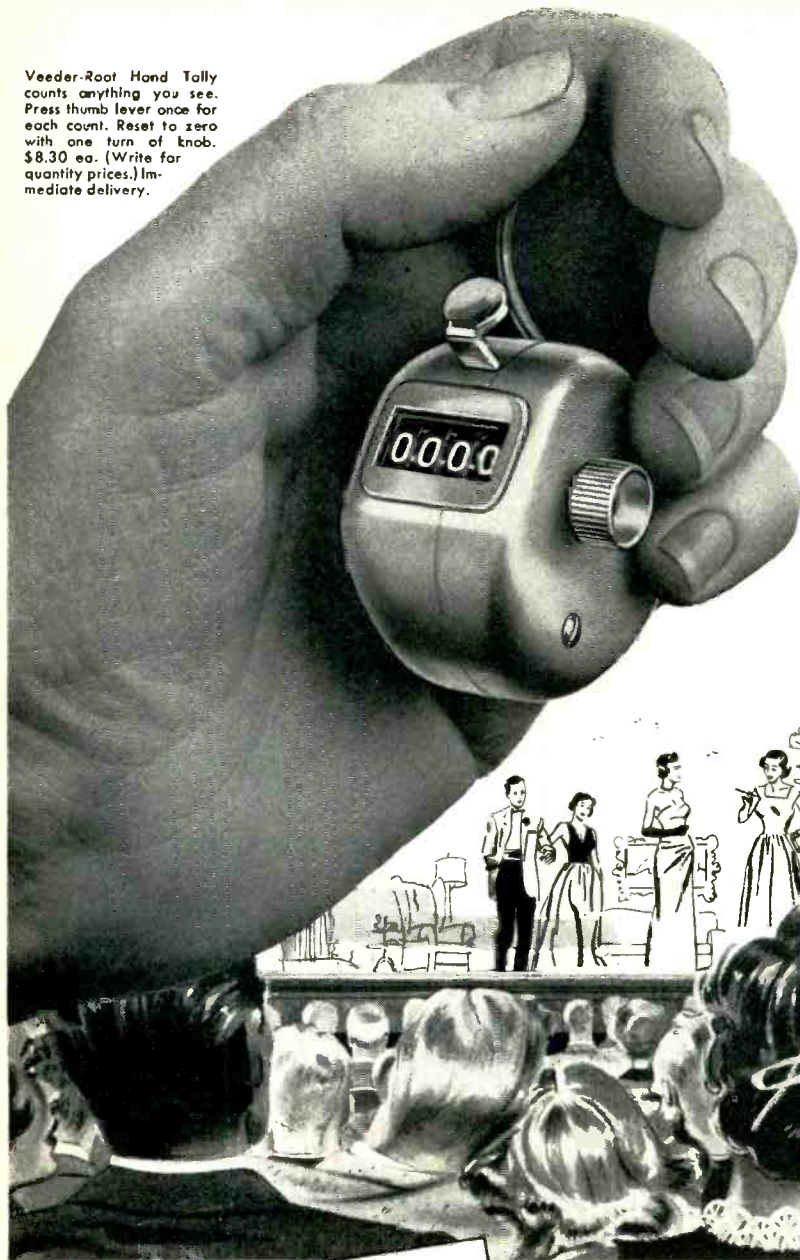
255 GRANT AVENUE

EAST NEWARK, N. J.

Export Division: Rocke International Corp., 13 East 40th St., N. Y., N. Y.
In Canada: Charles W. Pointon, 6 Alcina Ave., Toronto 10, Ontario

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Veeder-Root Hand Tally counts anything you see. Press thumb lever once for each count. Reset to zero with one turn of knob. \$8.30 ea. (Write for quantity prices.) Immediate delivery.



If this Clicks often enough... then the show clicks, too!

Added Evidence that—

Everyone Can Count on VEEDER-ROOT

275 laughs in 113 minutes . . . this was the certified count taken at a recent performance of a Broadway show by two executives of Fact Finders Associates, Inc. . . . both using Veeder-Root Hand Tallies.

This is another one of the hundreds of uses for

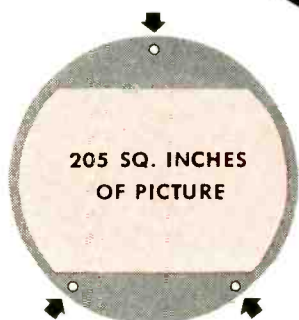
each of the hundreds of Veeder-Root Counters which are made for manual, mechanical and electrical operation. Chances are that *you*, too, can count on Veeder-Root . . . with counters built into your products as standard parts, or attached to your production equipment. We'll help you to figure out how. Write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT



Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"The Name That Counts"



HOW "205" ACHIEVES BIGGEST PICTURE

As its name implies, picture area of "205" is a big 205 square inches. The "205" achieves this maximum utilization of screen area: 1. By photographic printing of tricolor screen directly on inside of curved face. 2. By using a simple, light-weight shadow mask. 3. By positioning the three mask supports above and below the desired screen area . . . where the screen is masked off anyway by the set maker to obtain the desired 4 x 3 aspect ratio. This permits full lateral use of screen.



IT'S CBS-HYTRON FOR NEW COLOR RECEIVING TUBES TOO

TYPE	DESCRIPTION
CBS-Hytron 3A3	Half-wave, high-voltage rectifier
CBS-Hytron 6AM8	Diode, sharp-cutoff pentode
CBS-Hytron 6AN8	Medium- μ triode, sharp-cutoff pentode
CBS-Hytron 6BD4A	Sharp-cutoff beam triode, high-voltage regulator
CBS-Hytron 6BD6	Sharp-cutoff r-f pentode color demodulator
CBS-Hytron 6BJ7	Triple-diode d-c restorer

LEADING TV SET MAKERS PICK "205"

CBS-COLORTRON

LEADING BIG-SCREEN COLOR TUBE

- ... for Biggest Picture
- ... for Superior Performance
- ... for Delivery **NOW!**

The CBS-Colortron "205" is *today* traveling in freight cars and trucks to the nation's leading TV set manufacturers. It was chosen by them, because of: The "205's" larger 205-square-inch screen. The "205's" over-all superior performance. The "205's" easier circuit adjustments. The "205's" absence of "pincushioning" and other distortion. And the "205's" availability in production quantities now!

BIG-SCREEN COLOR TV IS HERE . . . today . . . at CBS-Hytron. Original . . . simple . . . functional . . . advanced design of the "205" made this possible: 1. With its curved screen-mask construction. 2. With its maximum use of the screen area. 3. With its electromagnetically converged three-beam electron-gun assembly. And CBS-Hytron's huge, new Kalamazoo plant stands ready to step up the "205's" availability when needed. Yes, you can look to CBS-Hytron as the leader . . . and major producer of big-screen color picture tubes.

NEW . . . FREE "205" DATA

Keep abreast of big-screen color TV. Four-page sheet on CBS-Colortron "205," RETMA type 19VP22, contains complete data on: Construction . . . operation . . . application . . . installation . . . adjustment . . . electrical and mechanical characteristics. Write for Bulletin E-227 today!



CBS-HYTRON Main Office: Danvers, Massachusetts

A Division of Columbia Broadcasting System, Inc.

A member of the CBS family: CBS Radio • CBS Television • Columbia Records, Inc. • CBS Laboratories
CBS-Columbia • CBS International • CBS-Hytron

RECEIVING • TRANSMITTING • SPECIAL-PURPOSE • TV PICTURE TUBES • CRYSTAL DIODES AND TRANSISTORS

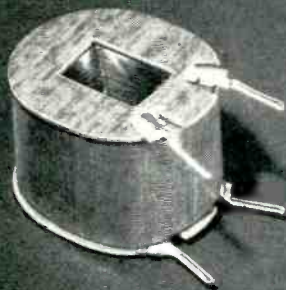
NOW, A REMARKABLE "READY-TO-SOLDER"

PHELPS DODGE

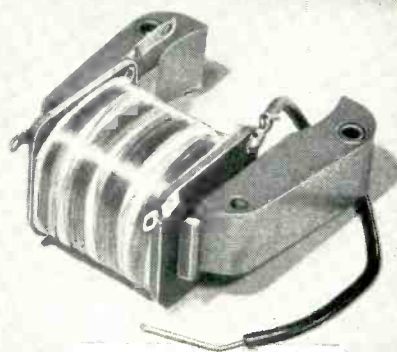
MANY NEW APPLICATIONS POSSIBLE



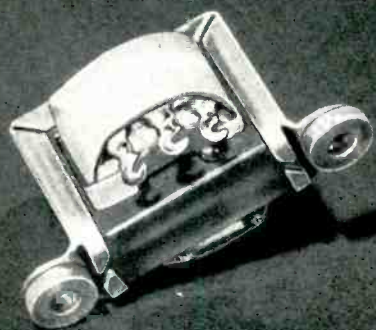
Universal wound TV choke coil



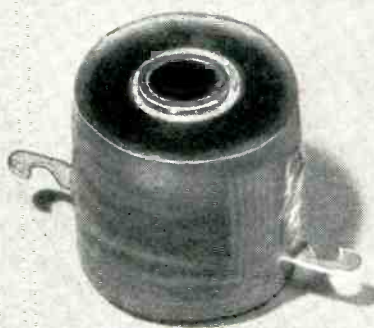
Magnet coil



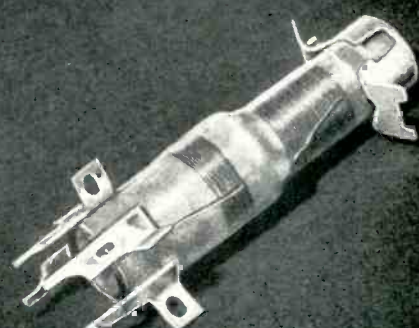
AC-DC motor coil



Transformer coil



Solenoid coil



IF-RF coil

First for Lasting Quality—from Mine to Market!

MAGNET WIRE.....



NEW SODEREZE!



- * **Instant Soldering Without Stripping**
- * **Improved Moisture Resistance**
- * **Good Electrical Properties**
- * **Excellent Flexibility and Toughness**

New Sodereze represents a spectacular advance in ready-to-solder magnet wire. It's a new and typical Phelps Dodge development designed to keep pace with industry's growing need for wires that handle easily, save time, reduce overall costs and satisfy a variety of different operat-

ing conditions. The versatility and outstanding properties of New Sodereze not only permit its use wherever solderable wire has been *proved* practical and dependable but suggest its application in unlimited other electronic and electrical fields to replace conventional wires.

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

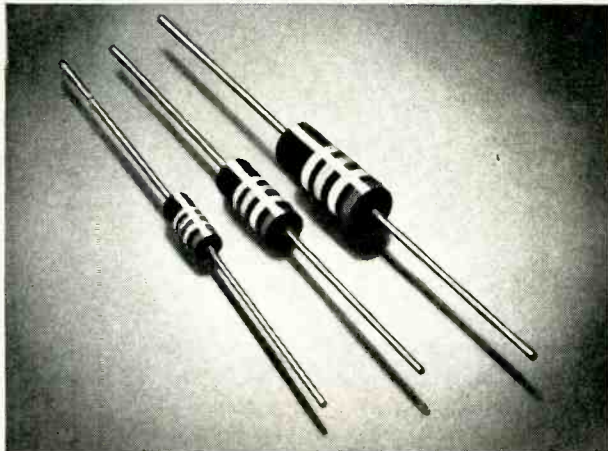
*SODEREZE is a Phelps Dodge Trademark.



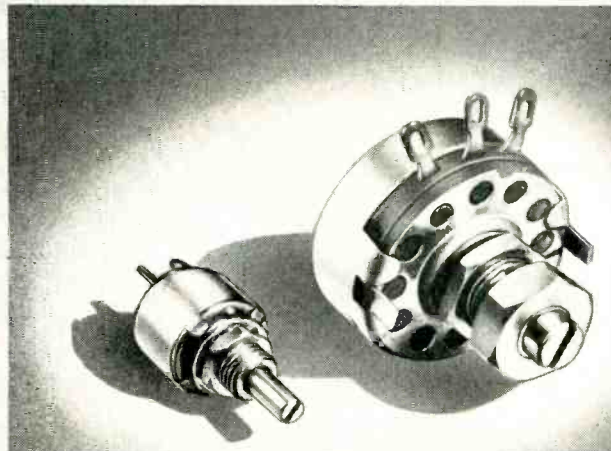
**PHELPS DODGE COPPER PRODUCTS
CORPORATION**

**INCA MANUFACTURING DIVISION
FORT WAYNE, INDIANA**

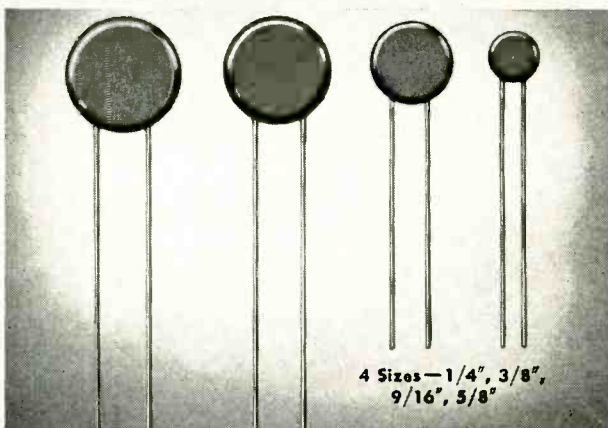
ALLEN-BRADLEY RADIO, ELECTRONIC, AND TELEVISION COMPONENTS



BRADLEYUNITS—FIXED RESISTORS—1/2, 1, 2 WATT

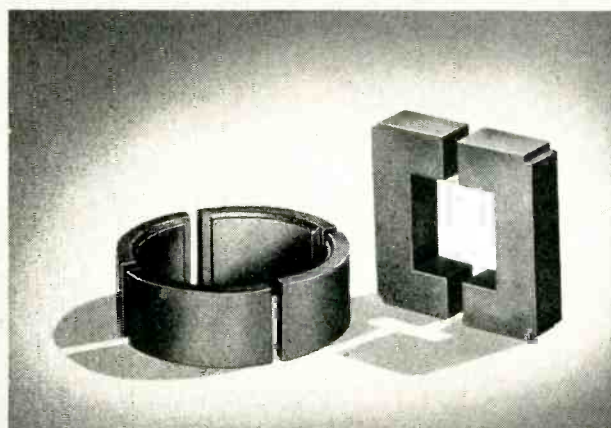


BRADLEYOMETERS—ADJUSTABLE RESISTORS—1/3 & 2 WATT



4 Sizes—1/4", 3/8",
9/16", 5/8"

CERAMIC CAPACITORS—0.00001 to 0.022 MFD



FERRITE QUARTER RING CORES AND U CORES

BUILD QUALITY into your electronic equipment by standardizing on these time-tested quality units

BRADLEYUNITS—Every radio, electronic, and television engineer is familiar with the QUALITY reputation of Bradleyunit resistors. Their extraordinary reliability is due to the fact that they are rated at 70C ambient temperature . . . not 40C. Under continuous full load for 1000 hours the resistance change is less than 6%. Available in 1/2, 1, and 2 watt ratings.

CERAMIC CAPACITORS—Every step in making A-B ceramic capacitors is performed in the Allen-Bradley plant . . . from the molding and sintering of the ceramic discs to the final impregnating and testing of the finished capacitors. Approved by the engineering departments of leading electronic and telephone laboratories. They are not low in price . . . but tops in quality and performance.

BRADLEYOMETERS—Now offered in two sizes — 1/3 and 2 watt. The solid circular resistor can be molded to provide any desired resistance-rotation curve. The shaft, cover, faceplate, and other metal parts are made of corrosion resistant metal. There are no riveted, welded, or soldered connections. Not affected by cold, moisture, or age. The sliding contact improves with age.

FERRITE CORES—The production of Allen-Bradley ferrite parts is held to the same close standards as all other A-B radio and television components. The Allen-Bradley line of ferrite cores will meet all tube requirements. Television equipment manufacturers consider Allen-Bradley as a major source of quarter ring and U cores. Prompt delivery can be made.

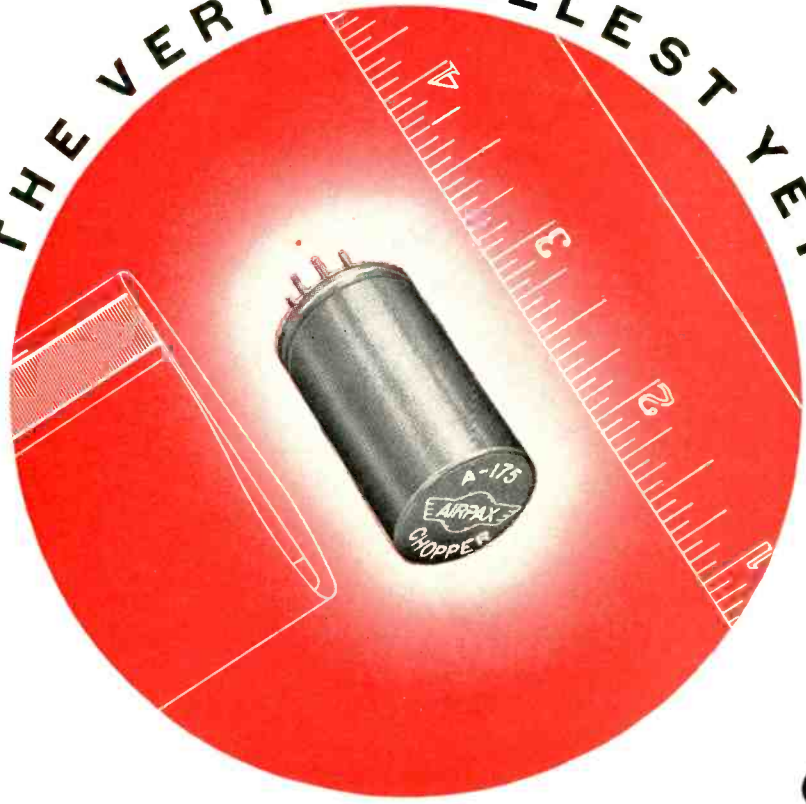
Allen-Bradley Co.
110 W. Greenfield Ave.
Milwaukee 4, Wis.

In Canada—
Allen-Bradley Canada Ltd.
Galt, Ontario



THE VERY SMALLEST YET

AIRPAX
A175
MIDGET
 60 cycle chopper



Phase Angle at 6.3v, 60 cycles is $21^{\circ} \pm 5^{\circ}$, at 30 cycles is nominally 20° , at 100 cycles 26° .

Contacts are SPDT, break-before-make, and are rated up to 100 volts maximum, 1 ma maximum.

Dwell Time is approx. 170° . The nominal value of dwell time changes only slightly from 30 cycles to 100 cycles.

Coil demand at 6.3 volts, 60 cycles, is approximately 37 milliamperes, coil resistance approximately 165 ohms D.C.

Noise with all 3 contacts at one megohm impedance, and with wide band amplifiers, will have an effective value of 50 microvolts or less. The offset of narrow band amplifiers will be very much less. The specification of noise requires careful definition, users should refer to the detail specifications and bulletin 103.

Temperature may be any value from -65°C to 85°C . The nominal phase angle will vary from about 17 degrees at -65°C to 25 degrees at 85°C .

Vibration from 10 to 55 cycles will not damage the chopper up to as high as 30 G. At these higher G values there will be some modulation of the phase angle.

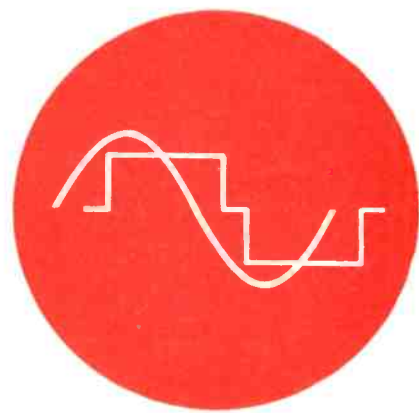
Frequency of operation may be any value from 25 to 110 cycles, to maintain full performance, balance, etc.

Humidity may be any value, except of course for external condensation on the header.

Shock values as high as 50G will not damage the chopper.

Altitude may be any value, as the unit is hermetically sealed.

- wide temperature range
- broad frequency range
- hermetically sealed
- very low noise
- long proven life
- vibration proof
- chatter free
- shock proof
- reliable
- rugged




AIRPAX
 DESIGNERS PRODUCTS COMPANY ENGINEERS
 MIDDLE RIVER BALTIMORE, MD.

TUNG-SOL TUBES FOR



2AF4
(Prototype—6AF4)
Heater Volts 2.35
Heater Current 0.6 A



3AL5
(Prototype—6AL5)
Heater Volts 3.15
Heater Current 0.6 A



3AU6
(Prototype—6AU6)
Heater Volts 3.15
Heater Current 0.6 A



3AV6
(Prototype—6AV6)
Heater Volts 3.15
Heater Current 0.6 A



3BC5
(Prototype—6BC5)
Heater Volts 3.15
Heater Current 0.6 A

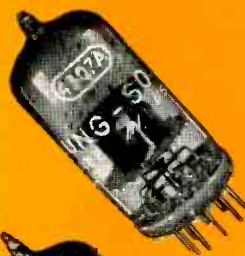


3BE6
(Prototype—6BE6)
Heater Volts 3.15
Heater Current 0.6 A

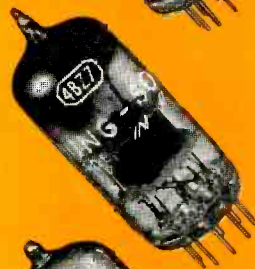


3CB6
(Prototype—6CB6)
Heater Volts 3.15
Heater Current 0.6 A

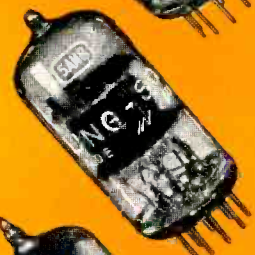
4BQ7A
(Prototype—6BQ7A)
Heater Volts 4.2
Heater Current 0.6 A



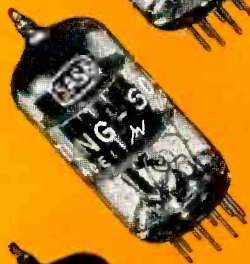
4BZ7
(Prototype—6BZ7)
Heater Volts 4.2
Heater Current 0.6 A



5AN8
(Prototype—6AN8)
Heater Volts 4.7
Heater Current 0.6 A



5AS8
(Prototype—6AS8)
Heater Volts 4.7
Heater Current 0.6 A



5T8
(Prototype—6T8)
Heater Volts 4.7
Heater Current 0.6 A



5U8
(Prototype—6U8)
Heater Volts 4.7
Heater Current 0.6 A



*Using heaters parallel connected

... designed and engineered to highest performance requirements

These are the new Tung-Sol Receiving Tubes for television sets having all of the heaters series-connected across the power line. Thermal characteristics of all the heaters are controlled so that heater voltage surges during the warm-up cycle are minimized, provided of course, that these tubes are used with other types similarly controlled.

Heater ratings are based on 600 milliamperes of current with the heater voltage adjusted for the same power as in the prototype. All other characteristics and ratings are identical to those of the prototype. Use of these tubes provides completely satisfactory receiver characteristics during warm-up.

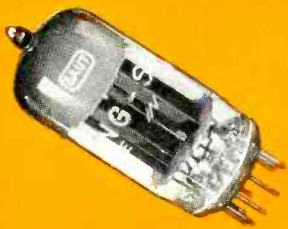
All of the statistical quality control methods which make the performance of Tung-Sol tubes so outstanding, are utilized in the manufacture of these new types. In performance, uniformity and dependability they will be found fully reliable. For more detailed information, write Commercial Engineering Department, Tung-Sol Electric Inc., Newark 4, New Jersey.

Sales Offices: Atlanta, Chicago, Columbus, Culver City (Los Angeles), Dallas, Denver, Detroit, Newark, Philadelphia, Seattle.



Tung-Sol All-Glass Sealed Beam Lamps, Miniature Lamps, Signal Flashers, Picture Tubes, Radio, TV and Special Purpose Electron Tubes and Semiconductor Products.

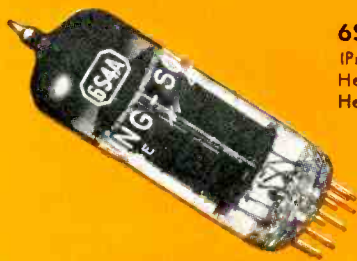
SERIES STRING TV SETS



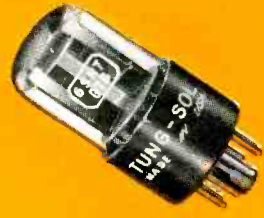
6AU7
 (Prototype—12AU7)
 Heater Volts 3.15*
 Heater Current 0.6 A



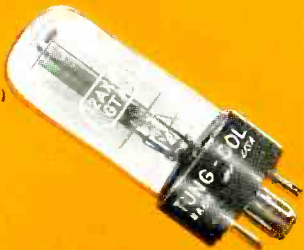
6AX7
 (Prototype—12AX7)
 Heater Volts 3.15*
 Heater Current 0.6 A



6S4A
 (Prototype—6S4)
 Heater Volts 6.3
 Heater Current 0.6 A



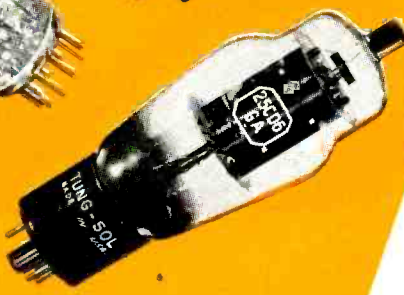
6SN7GTB
 (Prototype—6SN7GTA)
 Heater Volts 6.3
 Heater Current 0.6 A



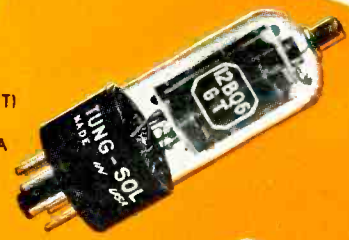
12AX4GTA
 (Prototype—12AX4GT)
 Heater Volts 12.6
 Heater Current 0.6 A



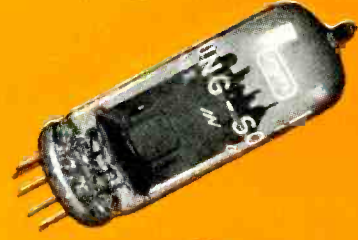
12B4A
 (Prototype—12B4)
 Heater Volts 6.3*
 Heater Current 0.6 A



25CD6GA
 (Prototype—25CD6G)
 Heater Volts 25
 Heater Current 0.6 A



12BQ6GT
 (Prototype—6BQ6GT)
 Heater Volts 12.6
 Heater Current 0.6 A



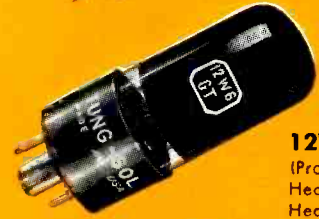
12BH7A
 (Prototype—12BH7)
 Heater Volts 6.3*
 Heater Current 0.6 A



12L6GT
 (Prototype—25L6GT)
 Heater Volts 12.6
 Heater Current 0.6 A



12BY7A
 (Prototype—12BY7)
 Heater Volts 6.3*
 Heater Current 0.6 A.



12W6GT
 (Prototype—6W6GT)
 Heater Volts 12.6
 Heater Current 0.6 A



19AU4
 (Prototype—6AU4GT)
 Heater Volts 18.9
 Heater Current 0.6 A

*Using heaters parallel connected

TUNG-SOL RADIO AND TV TUBES, DIAL LAMPS

Tube life in time-proved GATES 5/10kw AM transmitters "exceeds estimates"

QUINCY
ILLINOIS
U. S. A.

GATES

MANUFACTURING
ENGINEERS
SINCE 1922

Gates Radio Company

Eitel-McCullough, Inc.
San Bruno, California

Gentlemen:

A few years ago our engineering department was requested to design several entirely new transmitters in the 5/10KW power range for both medium and short wave commercial service. — One of the requirements was the establishment of a modern tube complement that would substantially reduce tube cost both initially and in greater life expectancy.

After considerable investigation and exhaustive tests in our own development section, the Eimac 3X2500F3 was decided upon. Performance-wise, the results were excellent but even successful abuse tests could not be a substitute for several years that must pass to obtain records on life expectancy.

These several years have now passed. Gates transmitters employing the 3X2500F3 are all over the world in every kind of service including 24-hour a day international communications, broadcasting and many 5KW mobile units for military service. Checks indicate, as both radio frequency amplifiers and Class B modulators, the life expectancy is not only meeting our original estimates and expectations but in many instances far exceeding them.

We congratulate you on an excellent product that has indeed saved the industry untold thousands in tube expense and again express our appreciation for the excellent cooperation of your engineering department.

Yours very truly,

GATES RADIO COMPANY



P. S. Gates
President



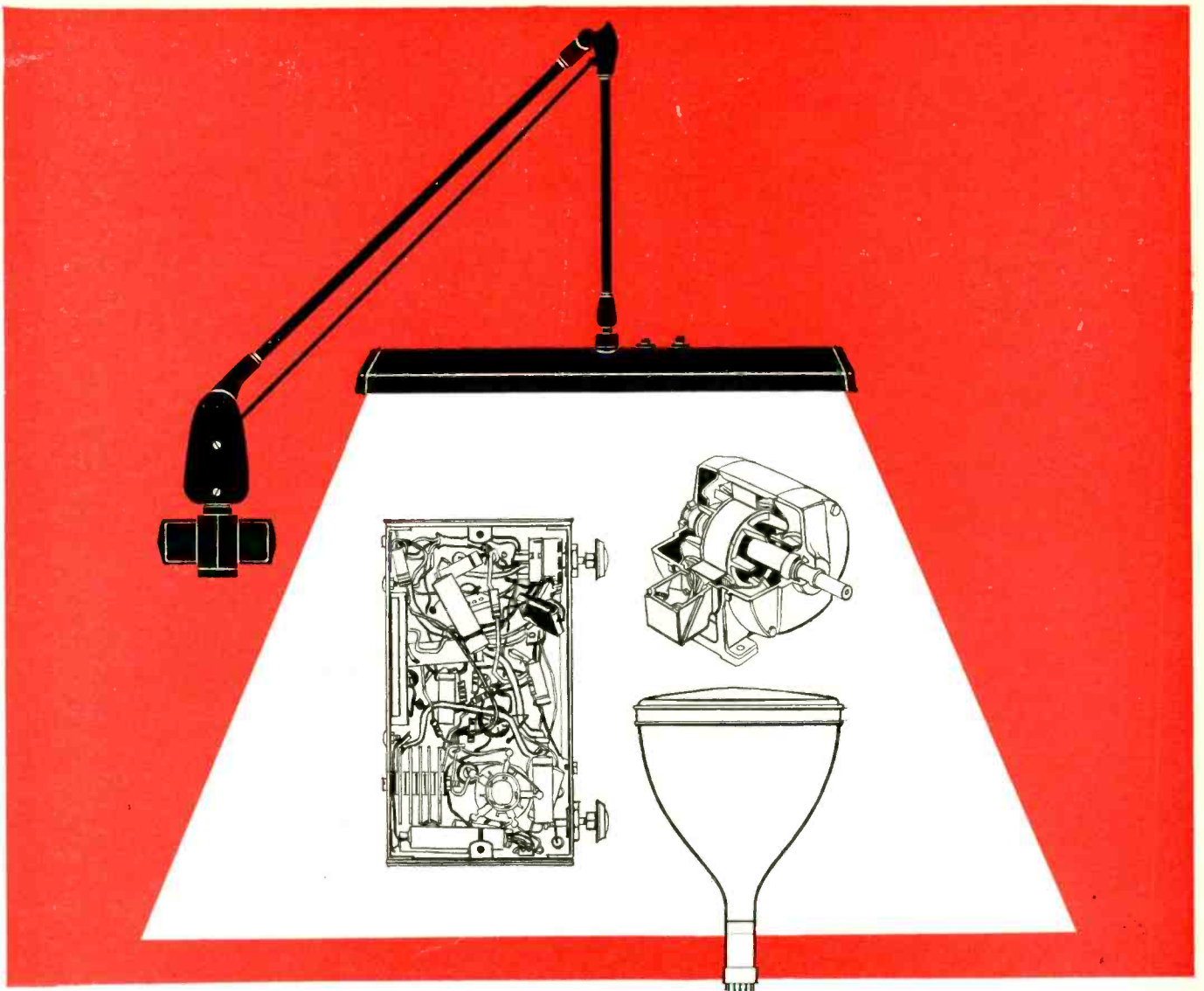
**EIMAC 3X2500F3's
IN GATES 5/10KW AM TRANSMITTERS**

GATES TRANSMITTER	MODULATOR	PA
EC-5B	2 Eimac 3X2500F3's	Eimac 3X2500F3
BC-10B	2 Eimac 3X2500F3's	2 Eimac 3X2500F3's

**Eimac 3X2500F3's featured in
Gates models BC-5B and BC-10B
the world over.**

Eimac

EITEL-McCULLOUGH, INC. SAN BRUNO, CALIFORNIA



from *Hydrazine...*
new light on old soldering problems

For greater efficiency and economy in the production of electrical and electronic components, a remarkable new series of soldering fluxes has been developed by McCord Corporation.

Based on compounds of hydrazine, these fluxes—called CORONIL—are non-corrosive and can be used without hazard. They remove oxides and other films from most commercially used metals such as copper and brass—as well as others—to permit more effective work and fewer rejects. In addition to their use by electrical and electronic equipment manufacturers, these hydrazine-based

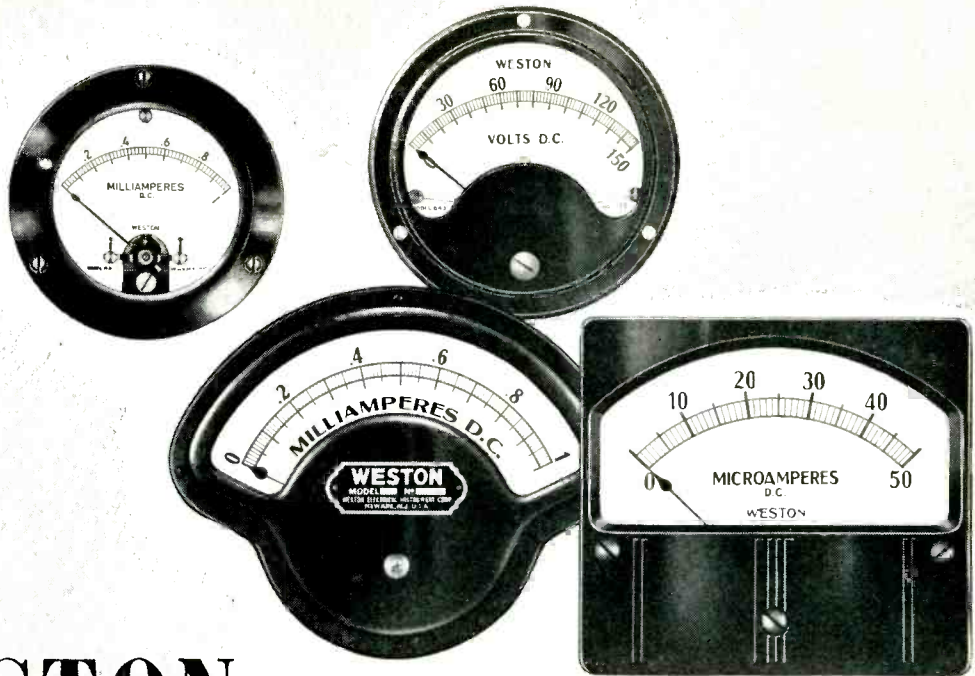
CORONIL fluxes are being successfully applied in the production of automotive radiators and other heat exchangers, carburetor floats, oil strainers, and various other products where safe, non-corrosive soldering is essential.

★ ★ ★

A new data sheet containing the latest information on hydrazine-based soldering fluxes is now available; it refers specifically to the removal of oxides and other films from copper and brass. Write for your copy today.



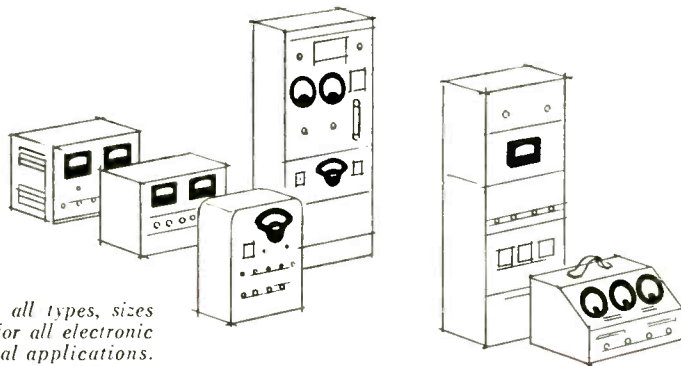
OLIN MATHIESON CHEMICAL CORPORATION
 Baltimore 3, Maryland



WESTON

PANEL INSTRUMENTS...

*...outward evidence
of the high quality
built within
fine electronic equipment*



*Available in all types, sizes
and ranges for all electronic
and electrical applications.
Send for the Panel Instru-
ment bulletin.*

WESTON ELECTRICAL INSTRUMENT CORPORATION, 614 Frelinghuysen Avenue, Newark 5, N. J.



HERMUMIGH SEALED SHIELDED STABILITY

HS SERIES TOROIDS For IMMEDIATE Delivery

TYPE HS715



DIMENSIONS
 Length 2-9/16"
 Width 1-5/16"
 Height 2-13/16"
 Weight 1.4 oz.
 Mounting 2-1/16 x 11/16"
 Screws 6/32" studs
 Cutout 7/8 x 1/2"

TYPE HS254



DIMENSIONS
 Length 1-29/32"
 Width1"
 Height 2-1/4"
 Weight8 oz.
 Mounting 1-5/16 x 9/16"
 Screws 6/32" studs
 Cutout 7/8 x 1/2"

TYPES HS930 & HS395

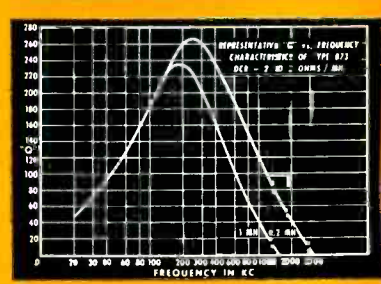
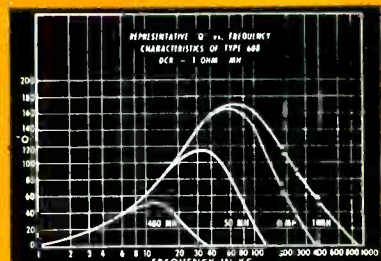
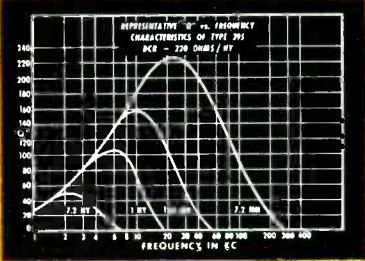
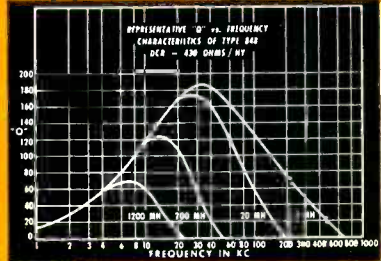
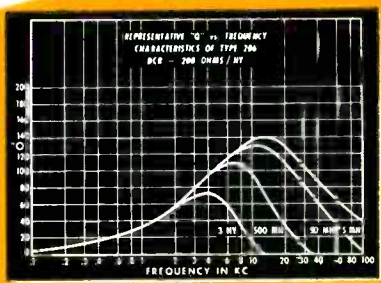
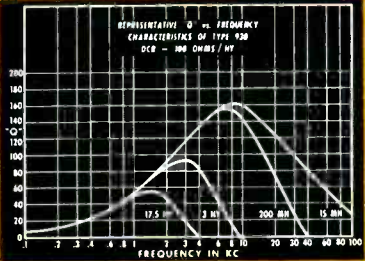
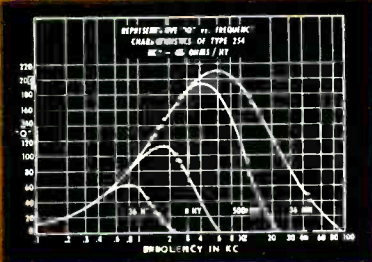
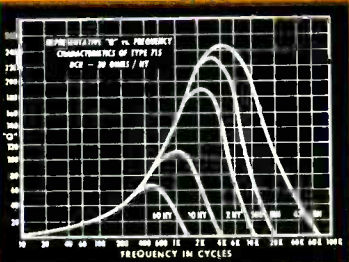


DIMENSIONS
 Length 1-9/32"
 Width 11/16"
 Height 1-23/32"
 Weight4 oz.
 Mounting 7/8 x 9/32"
 Screws 4/40" studs
 Cutout 1/2 x 5/16"

TYPES HS206, HS848, HS608 & HS073



DIMENSIONS
 Length 1-1/16"
 Width 1/2"
 Height 1-1/4"
 Weight 1.5 oz.
 Mounting 3/4"
 Screws 4/40" studs
 Cutout 1/2 x 5/16"



LIST OF STOCKED UNITS

All other values and types on Special Order

Suffix Number	HS 206—	HS 930—	HS 254—	HS 715—
— 1	5.0 MH	5.0 MH	20 MH	24 MH
— 2	6.0 MH	6.0 MH	24 MH	30 MH
— 3	7.2 MH	7.2 MH	30 MH	36 MH
— 4	8.6 MH	8.6 MH	36 MH	43 MH
— 5	10 MH	10 MH	43 MH	50 MH
— 6	12 MH	12 MH	50 MH	60 MH
— 7	15 MH	15 MH	60 MH	72 MH
— 8	17.5 MH	17.5 MH	72 MH	86 MH
— 9	20 MH	20 MH	86 MH	100 MH
— 10	24 MH	24 MH	100 MH	120 MH
— 11	30 MH	30 MH	120 MH	150 MH
— 12	36 MH	36 MH	150 MH	175 MH
— 13	43 MH	43 MH	175 MH	200 MH
— 14	50 MH	50 MH	200 MH	240 MH
— 15	60 MH	60 MH	240 MH	300 MH
— 16	72 MH	72 MH	300 MH	360 MH
— 17	86 MH	86 MH	360 MH	430 MH
— 18	100 MH	100 MH	430 MH	500 MH
— 19	120 MH	120 MH	500 MH	600 MH
— 20	150 MH	150 MH	600 MH	720 MH
— 21	175 MH	175 MH	720 MH	860 MH
— 22	200 MH	200 MH	860 MH	1.00 HY
— 23	240 MH	240 MH	1.00 HY	1.20 HY
— 24	300 MH	300 MH	1.20 HY	1.50 HY
— 25	360 MH	360 MH	1.50 HY	1.75 HY
— 26	430 MH	430 MH	1.75 HY	2.00 HY
— 27	500 MH	500 MH	2.00 HY	2.40 HY
— 28	600 MH	600 MH	2.40 HY	3.00 HY
— 29	720 MH	720 MH	3.00 HY	3.60 HY
— 30	860 MH	860 MH	3.60 HY	4.30 HY
— 31	1.00 HY	1.00 HY	4.30 HY	5.00 HY
— 32	1.20 HY	1.20 HY	5.00 HY	6.00 HY
— 33	1.50 HY	1.50 HY	6.00 HY	7.20 HY
— 34	1.75 HY	1.75 HY	7.20 HY	8.60 HY
— 35	2.00 HY	2.00 HY	8.60 HY	10.0 HY
— 36	2.40 HY	2.40 HY	10.0 HY	12.0 HY
— 37	3.00 HY	3.00 HY	12.0 HY	15.0 HY
— 38	3.60 HY	3.60 HY	15.0 HY	17.5 HY
— 39	4.30 HY	4.30 HY	17.5 HY	20.0 HY
— 40	5.00 HY	5.00 HY	20.0 HY	24.0 HY
— 41	6.00 HY	6.00 HY	24.0 HY	30.0 HY
— 42	7.20 HY	7.20 HY	30.0 HY	36.0 HY
— 43	8.60 HY	8.60 HY	36.0 HY	43.0 HY
— 44	10.0 HY	10.0 HY	43.0 HY	50.0 HY
— 45	12.0 HY	12.0 HY	50.0 HY	60.0 HY
— 46	15.0 HY	15.0 HY	60.0 HY	
— 47	17.5 HY	17.5 HY		

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 6349 N. Clark, Chicago, Ill.
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 6315 Brookside Plaza, Kansas City, Mo.
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 P. O. Box 152, Hamburg, N. Y.
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our performance possible"

says



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Corporation

Chicago Telephone Supply Corporation has succeeded in accomplishing two things indeed difficult to combine, as summed up in their slogan "Specialists in Precision Mass Production of Variable Resistors." They manufacture the high quality variable resistors indispensable to radio, television, and military electronics. In fact, they are the world's largest producers of variable resistors.

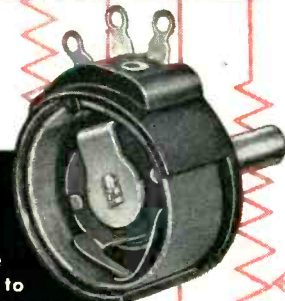
To achieve this outstanding record, they concentrate their entire effort on variable resistors, they maintain close control over all manufacturing processes, and fabricate their own parts under close supervision from basic raw materials. Naturally, they make no secret of the importance to them of high quality materials.

States Chicago Telephone: "To make our raw material program effective, we have stressed the

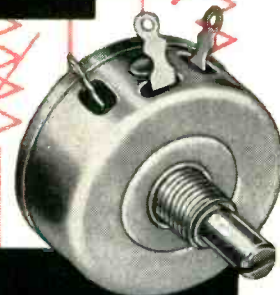
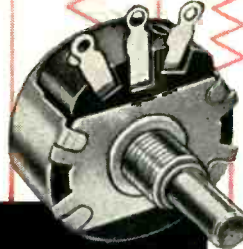


CTS 45 Series $1\frac{3}{16}$ " dia. variable composition resistor with blade type printed circuit terminals.

Cutaway view of CTS 252 Series, $1\frac{1}{4}$ " diameter 2 watt wirewound variable resistor. The total resistance can be varied from 3 ohms to 15,000 ohms, depending upon the size and type of resistance wire used.



CTS 252 Series
2 Watt
Wirewound
3-15,000 ohms



CTS 25 Series
2 Watt
Wirewound
3-25,000 ohms

importance of dependable, quality-minded sources of supply. Driver-Harris is a supplier with these qualities, and Driver-Harris alloys have contributed greatly in making our performance possible. For many years we have been using Driver-Harris Nichrome*, Karma*, Advance*, and other D-H Alloy wires for our resistance windings, with excellent results. We can strongly endorse Driver-Harris' dependability and high quality products."

Nichrome, Advance, and Karma are at your service too, as are more than 80 other D-H alloys developed for application in the electrical and electronic fields. If a high degree of resistance and absolute uniformity of output are "musts" for your product, let us have your specifications. We'll be glad to make recommendations based on your specific requirements.

*T.M. Reg. U.S. Pat. Off.

Sole producers of Nichrome, Advance, Karma

Driver-Harris Company

HARRISON, NEW JERSEY

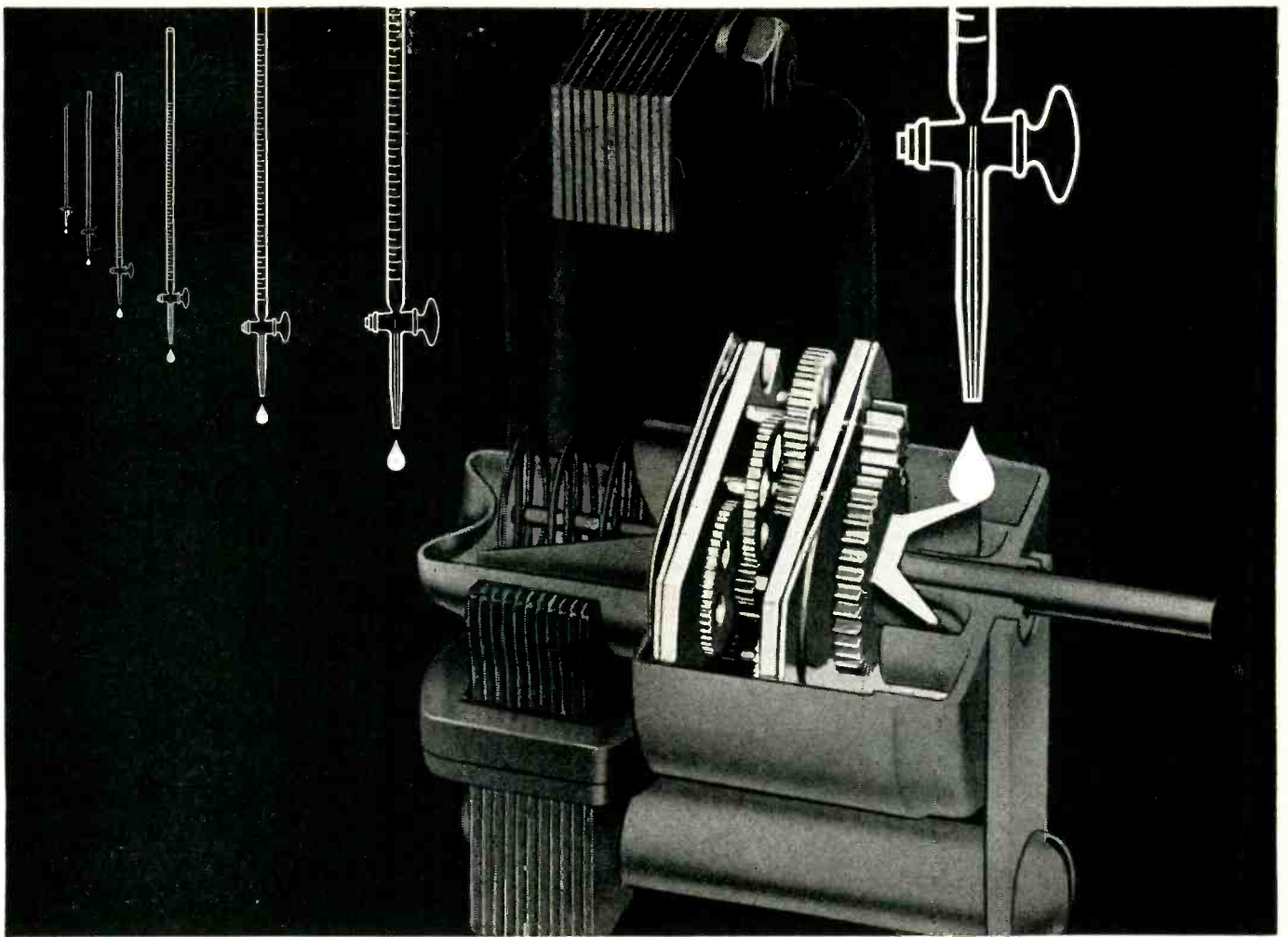
BRANCHES: Chicago, Detroit, Cleveland, Louisville, Los Angeles, San Francisco

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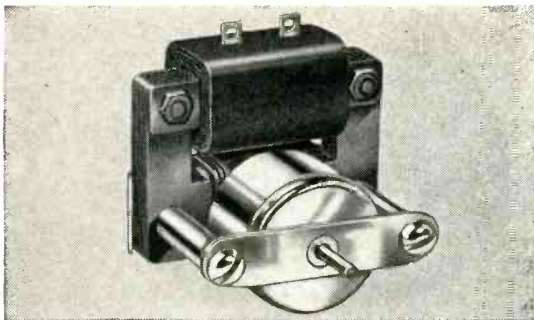


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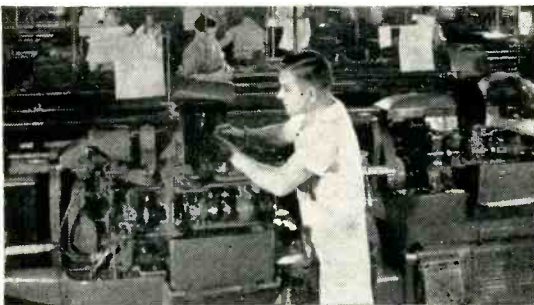
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Telechron motors play a major part in switching many of America's jobs to "automatic." They are unmatched in the field of electric timing with such features as lightweight rotors for instant starting... open-air design for cool running... and truly synchronous performance.



Big production by our automatic screw machines—typical of our large motor plant capacity—plus an experienced engineering staff, assure speed in deliveries.

CONTROLLED, SEALED-IN LUBRICATION LASTS THE LIFE OF THE MOTOR

Too much oil interferes with a timing motor's accuracy. Too little causes excessive wear. The key factor in the instant starting and long life of a Telechron timing motor is its unique controlled system of lubrication.

Each Telechron motor carries a lifetime reservoir of oil sealed in its rotor unit. Capillary action carries the oil to bearings, where its flow is controlled to all moving parts.

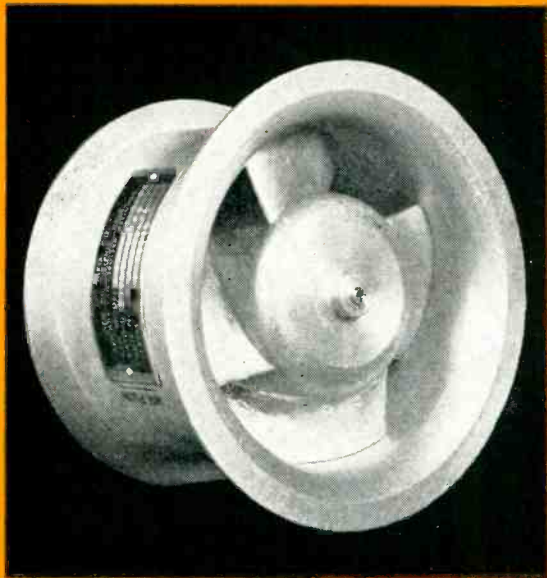
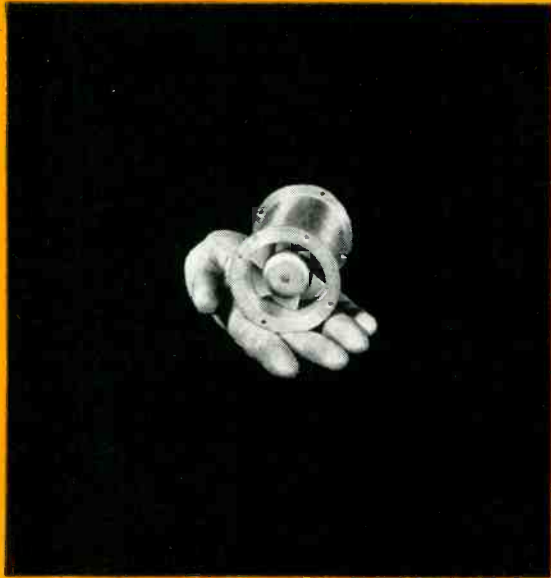
This exclusive lubrication system is one reason why—rating for rating—a Telechron timing motor will outlast and outperform any other synchronous timing motor made.

Telechron timing motors come in a wide range of speeds and torque ratings, for any standard AC power source. Write for full details about our Application Engineering Service. Telechron Department, General Electric Co., 49 Homer Ave., Ashland, Mass.

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MARK OF TIMING LEADERSHIP

From **VERY SMALL...to LARGE CAPACITY**



JOY AXIVANE[®] FANS

are available to meet any
ELECTRONIC COOLING NEED

Joy AXIVANE Electronic Cooling Fans are expressly designed to meet the needs of this exacting field of service. They are built in a complete range to suit any requirements, such as: spot cooling of ventilated units where local high-temperature conditions arise; heat removal from pressurized or hermetically-sealed units; or heat removal where space is so restricted that natural ventilation through the unit or over its surface is insufficient. Important operating advantages of these fans are their strength, high resistance to shock and vibration, and efficiency in low or high-pressure service. Aluminum and magnesium construction keeps weight at a minimum.

Available in sizes from 2" I.D. up, these Joy Fans are built to meet all present Air Force and Naval electronic specifications. They can be furnished with totally enclosed or explosion-proof motors, if desired.

Consult a Joy Engineer

In general, keep these facts in mind: that the light, compact design, low power consumption and high overall efficiency of Joy AXIVANE Fans provide more satisfactory cooling for electronic equipment in either air-borne or surface units.

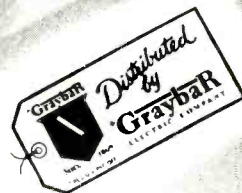
If you have a problem in heat dissipation from electronic units, let us place at your disposal JOY'S experience as the world's largest manufacturer of vaneaxial-type fans. • Write *Joy Manufacturing Company, Oliver Building, Pittsburg 22, Pa.* In Canada; *Joy Manufacturing Company, (Canada) Limited, Galt, Ontario.*



*"Lock
the door"*

**AGAINST
POSSIBLE
INTERCEPTORS** *with*

LYNCH AZ-13 SPEECH PRIVACY EQUIPMENT

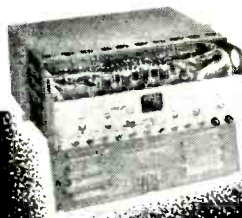


LYNCH AZ-13 equipment added to both ends of your existing land-wire or radio telephone circuit will insure complete privacy of conversation . . . will literally "lock the door against possible interceptors"!

This desirable effect is achieved by intricate electronic circuitry which acts to divide the speech frequency spectrum into numerous small increments, each of which is subjected to a complex modulation process, controllable by the "combination" selector switches. By this method the transmitted speech may be so thoroughly "scrambled" that it will bear absolutely no relation to the original conversation.

This system is similar to an extremely complex puzzle where a solution is possible only when each of the random-order sections is returned to its proper position within the frequency spectrum. Despite the outward complexity of the system, operating personnel require no special knowledge; the coding and decoding functions being accomplished automatically by positioning rotary switches to predetermined settings. The original intelligence is restored clearly at the receiving end of the circuit when proper AZ-13 terminal equipment is used . . . provided . . . selector switches at both ends of the circuit are positioned to identical numbered settings. The decoding procedure is analogous to a combination safe with two geographically-separated combination dial locks, both of which must have exactly the same settings if the safe is to be opened. However, while most safes have only a single combination, the selector system in the AZ-13 makes instantly available, any of two hundred thirty-three different, highly complex combinations!

B-69 FOR LESS RIGID SPEECH PRIVACY REQUIREMENTS



A second Lynch equipment, B-69 speech-inverter is available for use where highest privacy is not essential but where the intent is merely to prevent understanding by the casual listener.

OTHER IMPORTANT SPEECH PRIVACY FACTORS . . .



(1). Different code combinations may be used for each direction of transmission. Interceptors must then cope with 466 different combinations in order to decode both ends of a conversation.



(2). Complexity of the very highest order can be obtained by instituting a cyclic change in coding selector combinations at both ends of the circuit on a prearranged basis.



(3). All of these factors combine to make successful decoding extremely improbable even where identical equipment is used by possible interceptors.

IMPEDANCE - - - LEVELS

The switchboard side of the AZ-13 is either two or four wire, 600 ohm balanced. The line side is four wire and requires separate 600 ohm pairs. The equipment operates on a no gain-no loss basis. Adaptation equipment is available for applications where other impedances and levels are involved.



Contact Our Representatives
For Further Information

LYNCH CARRIER SYSTEMS INC.

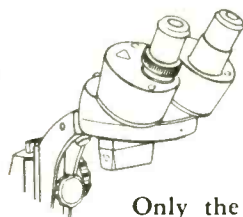
SAN FRANCISCO, CALIF.

Export Department: PHILIPS EXPORT COMPANY, Division of North American Philips Company, Inc.
100 East 42nd Street, New York 17, N. Y., U. S. A. Cables: PHILYORK

*Keeps Production to Capacity
... All Day Long!*

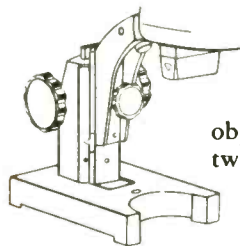
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TRANSISTOR
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**Boosts output, cuts
spoilage, because
anti-fatigue features
assure full-work-day
efficiency!**



**SET AT ANY DESIRED
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Only the B&L Transistor Microscope provides this *individualized* comfort. Full 180° rotatability of inclined eyepiece assembly permits setting at *exact* angle for natural position of head and neck. Operator is free from strain, able to work better, faster.



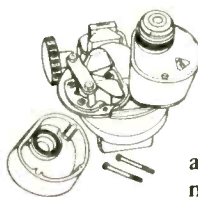
**LARGE, UNOBSTRUCTED
WORK SPACE PERMITS
FASTER, EASIER ASSEMBLY**

Ample clearance between objective lens and stage for hands, tweezers, tools. Focusing knobs are set back, within effortless reach, yet out of the way of jigs and tools.



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OF TINY PARTS . . . NO EYESTRAIN**

Simplifies ultra-precision work by providing clear, sharp magnified images . . . shows work right side up, in natural 3-dimensional relief. Permits hour-after-hour use without eye fatigue . . . in assembly, measurement and inspection.



**SHOCKPROOF, DUSTPROOF FOR LIFE
. . . SAVES MAINTENANCE COSTS,
KEEPS PRODUCTION ROLLING**

Clamps and gibs lock prisms into life-time alignment, safe from shock damage. Permits safe, trouble-free mounting in machine or fixture. Patented Neoprene ring seals out dust. Saves money on repairs, down-time.

WRITE NOW for descriptive literature (D-1036) and for on-the-job demonstration on your own production lines. Bausch & Lomb Optical Co., 61433 St. Paul St., Rochester 2, N. Y.

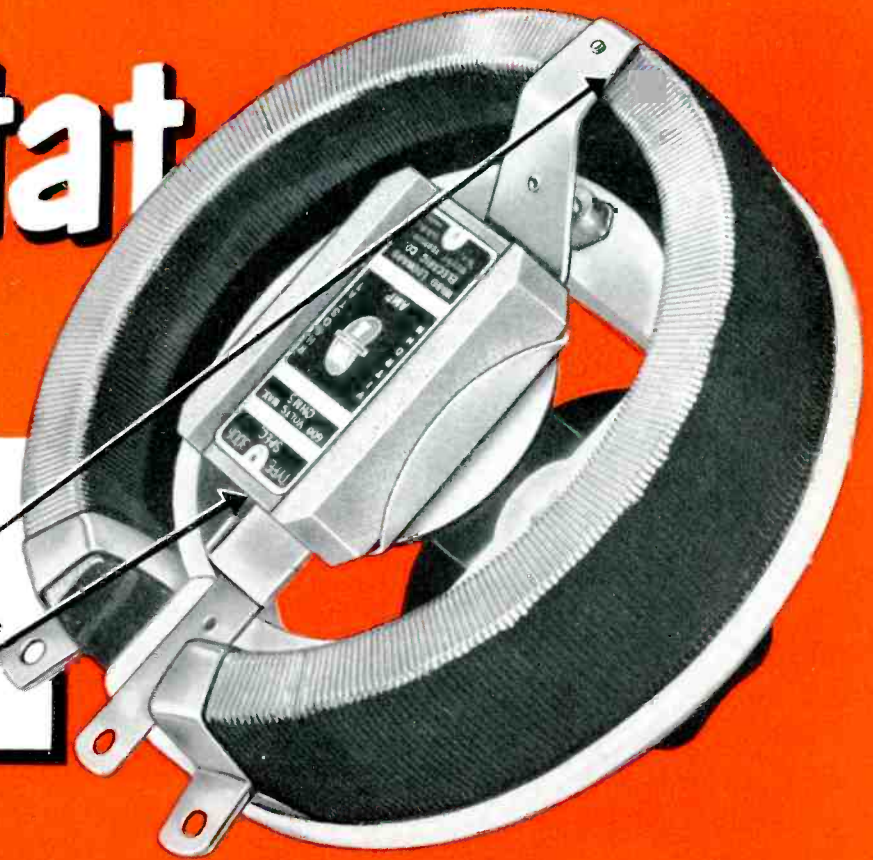
BAUSCH & LOMB



New 300-watt Vitrohm ring Rheostat

Standard sintered self-lubricating contact shoe

Ward Leonard's exclusive extra contact shoe



Exclusive "twin" contact shoes insure uniform contact resistance

You get extra-smooth performance from Ward Leonard's unique double-shoe design which gives you two contacts — one on the collecting ring as well as one on the resistance winding.

Sintered, self-lubricating twin-shoe construction prevents galling or seizing often caused by metal-to-metal contacts

of ordinary rheostats. That's why you get smoother control, more uniform contact resistance and longer operational life from this new Ward Leonard ring rheostat.

Other construction advantages of this biggest, most recent addition to the famous Vitrohm ring rheostat line include the rigid contact arm-housing assembly that eliminates backlash and radial motion. Compression spring in housing insures proper pressure of twin contact shoes on both resistance winding and collector ring. And Ward Leonard's 6" Vitrohm ring rheostat with identical mounting dimensions, shaft diameter and shaft flat as other makes, occupies less back-of-panel space.

For detailed specifications on the new type 300 R ring rheostat, write today for Bulletin 1116. Ward Leonard Electric Co., 400 South Street, Mount Vernon, N.Y.

4.7



**WARD LEONARD
ELECTRIC COMPANY**
MOUNT VERNON, NEW YORK



RHEOSTATS



RESISTORS



RELAYS



MOTOR CONTROLS



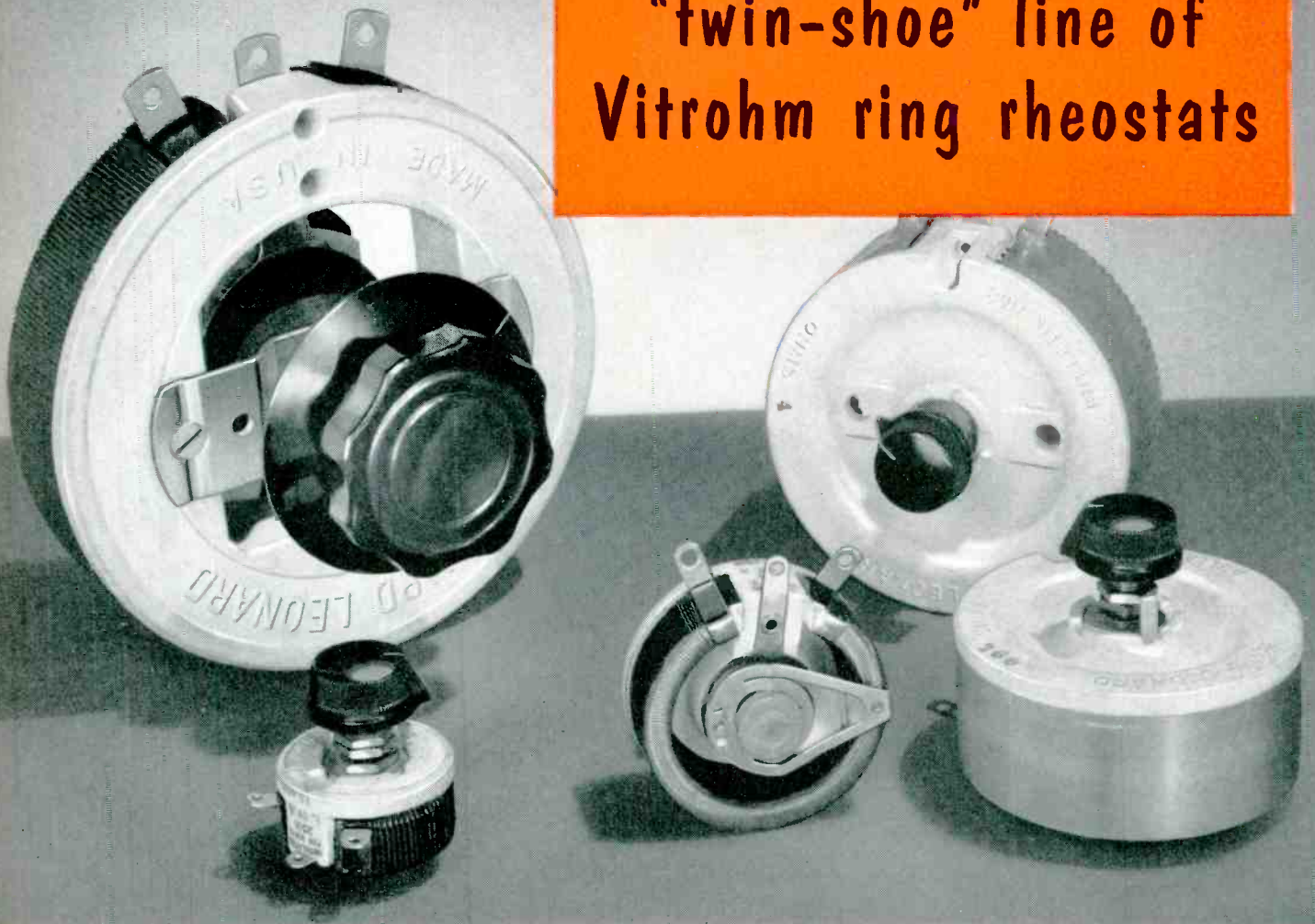
DIMMERS



CHROMASTER

Result-**E**ngineered Controls Since 1892

Meet the exclusive "twin-shoe" line of Vitrohm ring rheostats



If it's performance you're looking for, check these exclusive features of Ward Leonard's complete line (25 through 300 watts) of Vitrohm ring rheostats:

The "twin" contact shoes of sintered material assure uniform contact pressure and unusually smooth, trouble-free operation.

Special alloy resistance wire is toroidally wound on core and held permanently secure by the Vitrohm vitreous enamel.

Core and base are molded of highest quality ceramic materials and bonded together by Vitrohm enamel.

Whether your product is heavy industrial apparatus, sensitive electronic equipment, or a simple appliance requiring rheostats, you'll get more accurate, dependable performance per dollar from the Vitrohm ring line. Write for data-packed bulletins to Ward Leonard Electric Co., 400 South St., Mount Vernon, New York.

Rheostat Type	Watt Rating (based on 300°C Rise)	Total Resistance*		Approx. Number of Steps	
		Min. Ohms	Max. Ohms	at Min. ohms	at Max. ohms
25R	25	1.0	5,000	27	520
50R	50	1.0	10,000	49	998
100R	100	1.0	10,000	41	1041
150R	150	1.0	10,000	43	1240
300R	300	1.0	2,500	40	710

* Wide range of resistance values stocked for immediate shipment.



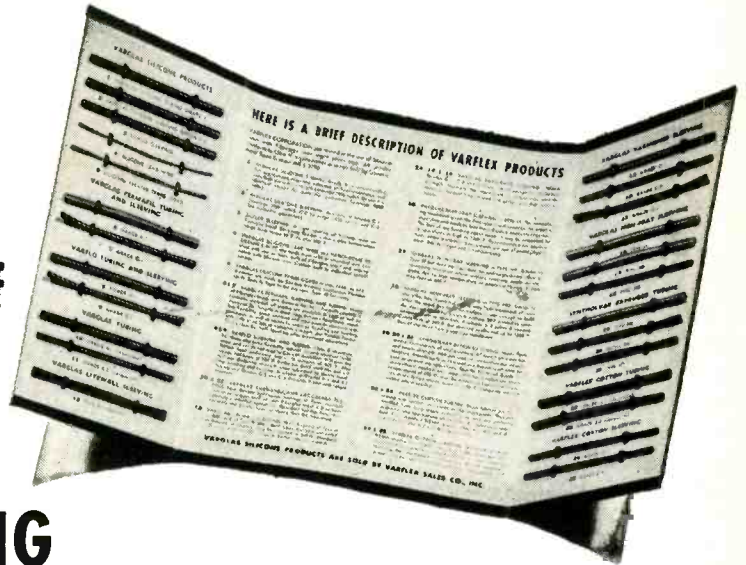
**WARD LEONARD
ELECTRIC COMPANY**
MOUNT VERNON, NEW YORK



Result-**E**ngineered Controls Since 1892

Send for this *Free* **SAMPLE FOLDER...**

Contains
25
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INSULATING
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INCLUDES SAMPLES AND DESCRIPTIONS OF THE FOLLOWING...

VARGLAS SILICONE Class H insulating materials were pioneered by our Laboratory. Retain flexibility, electrical properties and mechanical strength in temperatures ranging from -85°F. to 500°F. Available in tubing, sleeving, lead wire, tying cord.

PERMAFIL-IMPREGNATED VARGLAS TUBING Fiberglass braid coated with General Electric's Permafil resin. Extremely tough, resistant to solvents and elevated temperatures, highly flexible. Can be bent or twisted with little or no loss of dielectric strength. Coils and standard 36" lengths.

VARGLAS SLEEVING AND TUBING Numerous types and grades—including synthetic-treated, varnished, lacquered, saturated, litewall and others.

VARGLAS NON-FRAY SLEEVING Fiberglass braid normalized to remove all organic impurities. It will withstand temperatures up to 1200°F. Recommended where dielectric properties are not paramount. Three types available.

VARFLO TUBING AND SLEEVING Vinyl-coated Fiberglas in full range of sizes, colors and grades. Extremely flexible, with excellent heat aging qualities. Low priced.

VARFLEX COTTON TUBING AND SLEEVING Varnish or lacquer impregnated—for applications where MIL-I-3190 Class A materials are specified. All NEMA grades.

SYNTHOLVAR EXTRUDED TUBING Made in various standard formulations of vinyl polymers. Has high dielectric and tensile strength—will not support combustion nor absorb moisture. Type EG Approved under MIL-I-631A. Several others to meet special requirements.

NEW! VARGLAS SILICONE RUBBER SLEEVING AND TUBING—the culmination of 5 years of research—for applications requiring extraordinary flexibility. Details on request.



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Please send me free folder containing samples of your electrical sleeving and tubing.

I am particularly interested in insulation for:

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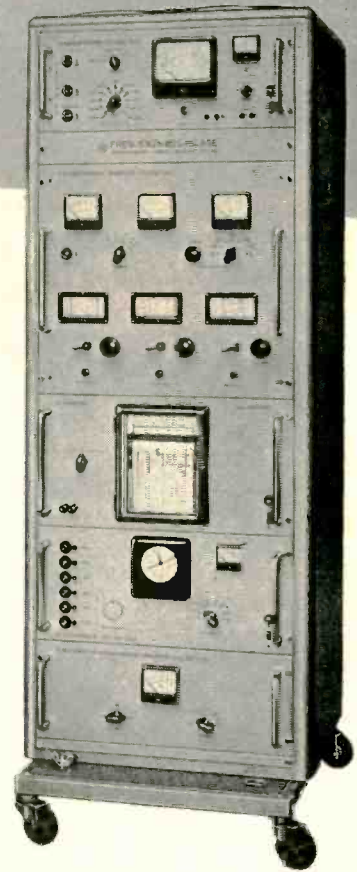
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INSTRUMENT DIVISION, 100 KINGSLAND ROAD, CLIFTON, N. J.

C-D
first again!

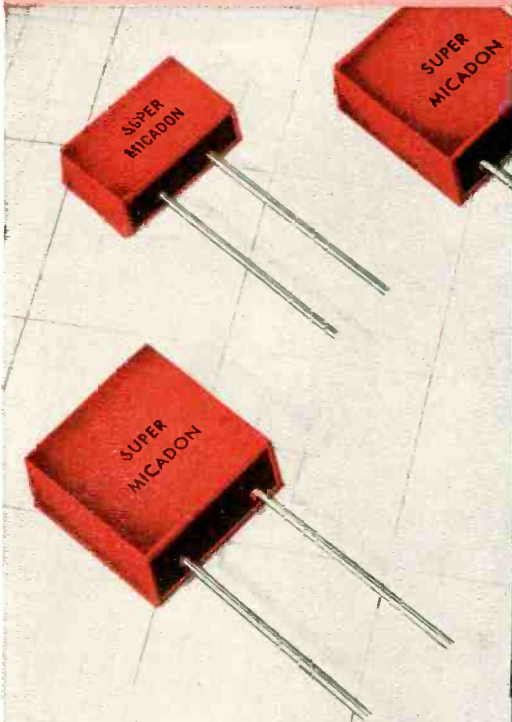
with an entirely new concept
in midget mica capacitor design..*

'SUPER MICADON'

*Read the
chart—
Here's the
proof!.....*

encapsulated mica capacitors

They said it couldn't be done, but C-D did it! 5 to 6 times the capacity in the same space!
Temperature characteristics never before attained
... 10 to 35 times higher insulation resistance!
The world's greatest innovation in hermetic seal
... nearly 20 times the moisture resistance! Nothing like it ever before ... with a life expectancy as high as 19 times greater than conventional types.



*There are more C-D capacitors
in use today than any other make!*

SPECIFICATION	"SUPER MICADON" 1A	CONVENTIONAL CM-30	"SUPER MICADON" 5A	CONVENTIONAL CM-20
CASE SIZE	Same as CM-30	Same as 1A	Same as CM-20	Same as 5A
CAPACITY RANGE at 500 VDCW	To .015 MFD.	To .0033 MFD.*	To .0036 MFD.	To .00051 MFD.
CAPACITY RANGE at 300 VDCW	To .02 MFD.	To .01 MFD.†	To .0051 MFD.	To .001 MFD.
LIFE TEST FAILURES After 4000 Hours at 1000 VDCW (2 x Rated Voltage at 85°C)	4%	76%	Similar results predicted as for Type 1A—pending tests	
TEMPERATURE RANGE	-55°C to +130°C	-55°C to +85°C	-55°C to +130°C	-55°C to +85°C
MOISTURE RESISTANCE After 10 Cycles of MIL-C-5A Test	200,000 Meg.#	10,000 Meg.	300,000 Meg.	15,000 Meg.
INSULATION RESISTANCE at 25°C	1,000,000 Meg.	100,000 Meg.	1,500,000 Meg.	100,000 Meg.
RESISTANCE at +130°C	15,000 Meg. (.005 Mfd.)	500 Meg. (.005 Mfd.)	20,000 Meg. (.001 Mfd.)	700 Meg. (.001 Mfd.)
INDUCTANCE	UP TO 40% LESS THAN FOR CONVENTIONAL TYPES			
PARALLEL PLUG-IN LEADS	Yes	No	Yes	No
MOLDING DEFORMATION	No	Yes	No	Yes
MAX. TEMP. COEFF.	Char. "F"	Char. "E"	Char. "F"	Char. "D"
SINGLE DIRECT LEADS TO FOIL CONTACTS	Yes	No	Yes	No
NEED FOR WAX COATING	No	Yes	No	Yes
MARKING	Stamped with Cap. and Volt.	Color coded—only for Cap.	Stamped with Cap. and Volt.	Color coded only for Cap.

*Even the larger CM-35 case is limited to .0062 mfd. capacity. †Requires larger CM-35 case for this capacitor.
#Over 40,000 Megs. after 20 Cycles.

For over 40 years,
a symbol of
capacitor leadership
... in engineering,
design and
dependability.



Wire, write or call today for descriptive literature,
samples, or engineering assistance to: Cornell-Dubilier
Electric Corp., Dept. K-94, South Plainfield, N. J.

CONSISTENTLY DEPENDABLE
CORNELL-DUBILIER CAPACITORS

PLANTS IN SOUTH PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER AND CAMBRIDGE, MASS.; PROVIDENCE AND HOPE VALLEY, R. I.; INDIANAPOLIS, IND.; SANFORD AND FUGAY SPRINGS, S. C.; SUBSIDIARY: THE RADIANT CORPORATION, CLEVELAND, O.

MOST RELIABLE TUBES YOU CAN INSTALL!



5-Star Tubes



... for aircraft navigation, control, and communications.

SPECIALLY DESIGNED!

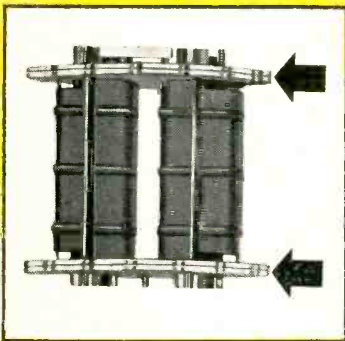
Superior dependability of G-E 5-Star Tubes is designed in, with many special features contributing to performance.

NOT selected tubes, but tubes engineered at the drawing-board level for greater reliability! General Electric 5-Star Tubes are special in every aspect of their design.

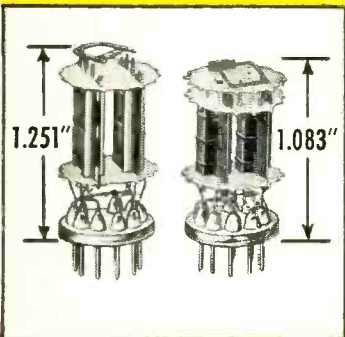
Resistance to shocks and vibration is superior to standard tubes because of double mica spacers, sturdy tube cages, double-staked getters, and other built-in strength and safety features.

Fewer "shorts", more uniform electrical characteristics—these result from heavier, better-insulated heater wire; from steps taken to prevent inter-element leakage; from still other 5-Star design improvements that pay off in stable performance.

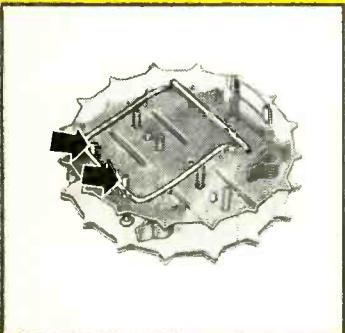
Millions of General Electric 5-Star Tubes—now giving far more reliable service for a longer period of time—prove that increased receiving-tube dependability starts at the design stage!



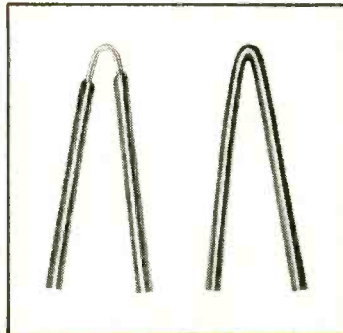
● Double mica spacers at top and bottom brace 5-Star Tube structures ... widen surfaces in contact with glass envelope ... make for a tube that will stand up in hard service.



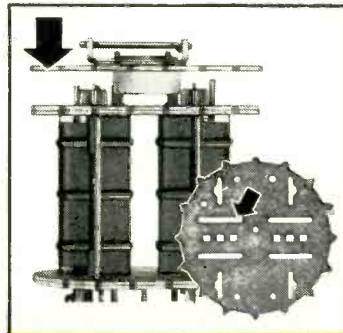
● Compact, sturdy tube cages withstand shocks and vibration. Note that 5-Star GL-5751 (right) is 13% shorter than 12AX7 prototype, with heavier, more substantial design.



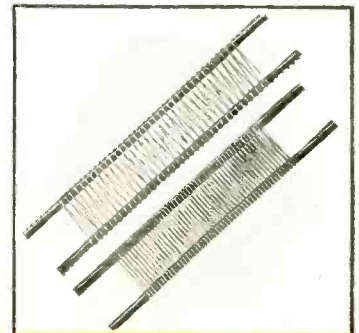
● 5-Star Tube getters are double-staked to the mica spacer beneath. This gives firm support against shocks—is characteristic of strong tube construction throughout.



● 5-Star heater-wire bends are coated a second time to prevent "shorts". Left, how flaked-off coating can expose wire. Right, after special insulating treatment.



● Double plate-to-grid leakage protection in many types! Left: getter flash shield wards off conductive deposits. Right: spacer slots interrupt leakage paths.



● Grid legs of 5-Star Tube (right) are smooth, not nicked. This assures a tight fit where legs pass through spacers, reducing grid vibration and microphonic noise.

SPECIFY THEM FOR CRITICAL APPLICATIONS!



... for 2-way radio emergency communications.



... for radar installations.



... for remote-controlled transmitters and unattended relays.



... for studio and transmitter equipment in AM-FM-TV broadcasting.

SPECIALLY MANUFACTURED!

Utmost care in manufacture follows. G-E 5-Star Tubes are built to only one standard of quality... the highest!

INCREASED reliability brought about by special tube design, is further accented by pre-assembly inspection of individual parts, painstaking manufacture, and thorough testing.

5-Star Tubes are built in separate G-E factory areas, by selected operators whose output features quality, not quantity. Advanced optical equipment is used to magnify parts and to check measurements. Many such inspections involve every 5-Star Tube.

The industry's strictest quality-control standards are observed. Final tube tests are comprehensive and exacting. All G-E 5-Star Tubes receive a final 46-hour "burn-in" before shipment.

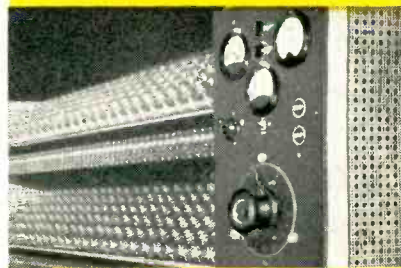
Design, manufacture, testing—all focussed on dependability—join to make G-E 5-Star Tubes the best and most reliable you can install! *Tube Dept., General Electric Company, Schenectady 5, N. Y.*



● 5-Star Tube parts are individually inspected by microscope. Grids are micrometer-gaged for accurate dimensions. These are pre-assembly checks with every G-E 5-Star Tube.



● During rigid short-circuit tests, 5-Star Tubes are tapped with a cork mallet. A single flicker of the short test indicator brings immediate tube rejection.



● Every 5-Star Tube receives a 46-hour "burn-in" under Class A conditions. This avoids early life failures, and assures stable electrical performance.



ATTENTION: EQUIPMENT DESIGNERS!

33 G-E 5-Star Tubes—19 miniatures, 1 glass octal-base, 2 metal, 11 subminiatures—give you a wide choice, enabling you to put high reliability in virtually every socket. Ask for new Bulletin ETD-548C, with full tube listing and application data!



Progress Is Our Most Important Product

GENERAL  ELECTRIC

162-1B10

...how good is
BEST?

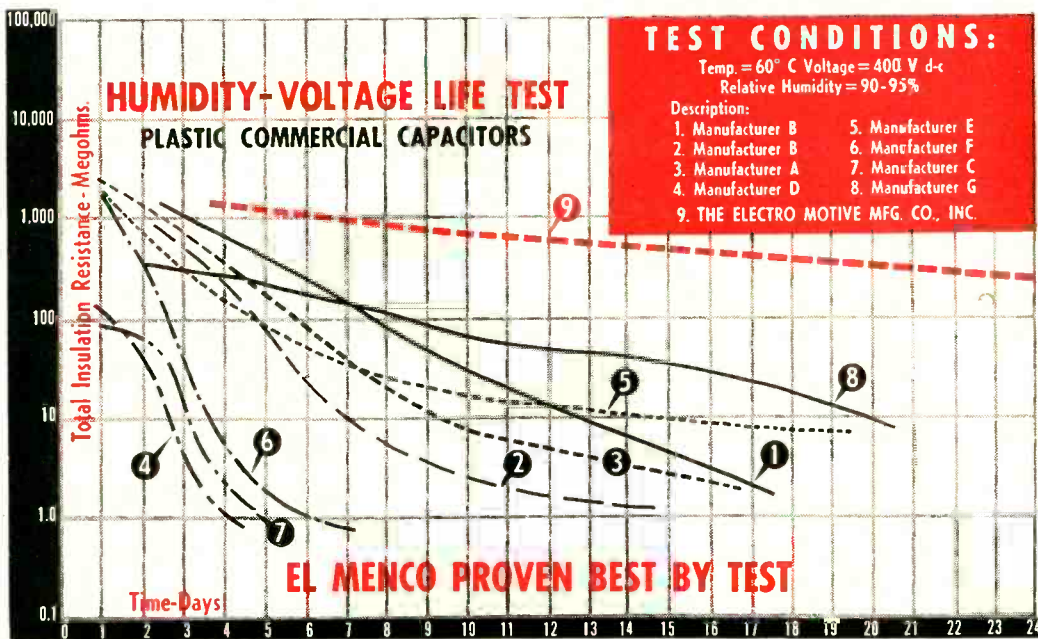


BEST

... By **TEST!**
... By **PERFORMANCE!** *

These curves are authentic recordings taken from actual results obtained from a nationally known independent testing laboratory.

and here's proof!



* CERAMIC CASED PAPER DIELECTRIC CAPACITORS —

* More than 60 million of these capacitors have been used by nationally known radio and television manufacturers with no reported field failures. These ceramic capacitors are available in 200, 400, 600 and 1000 working voltage ratings.

Write for sample and catalog on your firm's letterhead.



Jobbers and Distributors are requested to write for information to Arco Electronics, Inc., 103 Lafayette St., New York, N. Y.

MOLDED MICA

El-Menco
CAPACITORS

MICA TRIMMER

Foreign Electronic Manufacturers Get Information Direct from our Export Dept. at Willimantic, Conn.

THE ELECTRO MOTIVE MFG. CO., INC.

WILLIMANTIC, CONNECTICUT

MORE PROOF that engineers rate Lambda power supplies

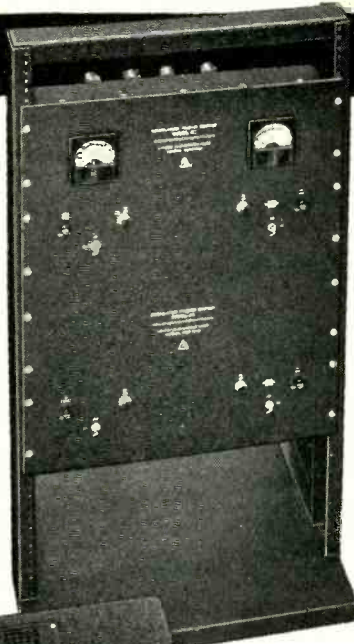
BEST...

REGARDLESS OF PRICE!

**TWO NEW, INDEPENDENT SURVEYS
SHOW WIDE PREFERENCE FOR LAMBDA**

Stock models
which have been
modified to customers'
requirements.

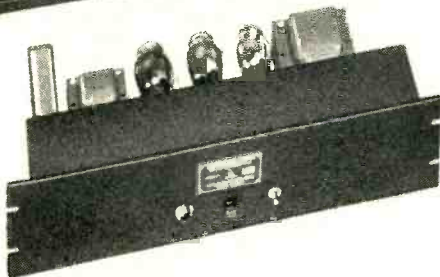
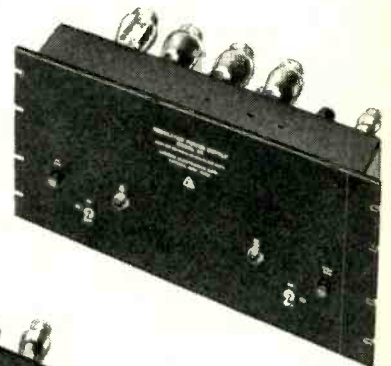
Bench Model 41
Unregulated
0-500 VDC @ 0-200 MA
\$149.50



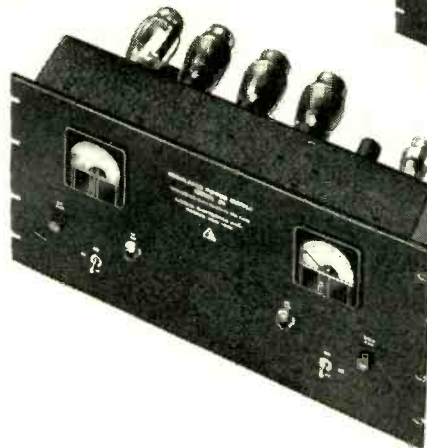
Bench Model 50
0-500 VDC @ 0-500 MA
\$415.00



Bench Model 25
200-325 VDC
@ 0-100 MA
\$64.50



Rack Model 28
200-325 VDC @ 0-100 MA
\$57.50



Rack Model 32
200-325 VDC @ 0-300 MA
\$129.50

Rack Model 32M
200-325 VDC @ 0-300 MA
\$159.50

LAMBDA POWER SUPPLIES ARE RANKED FIRST — 50 per cent ahead of the next identified manufacturer — by engineers who participated in a comprehensive survey of buying practices and preferences just released by one of the leading electronics publications.

Another independently conducted survey, also recently

concluded, places Lambda in the same position of leadership.

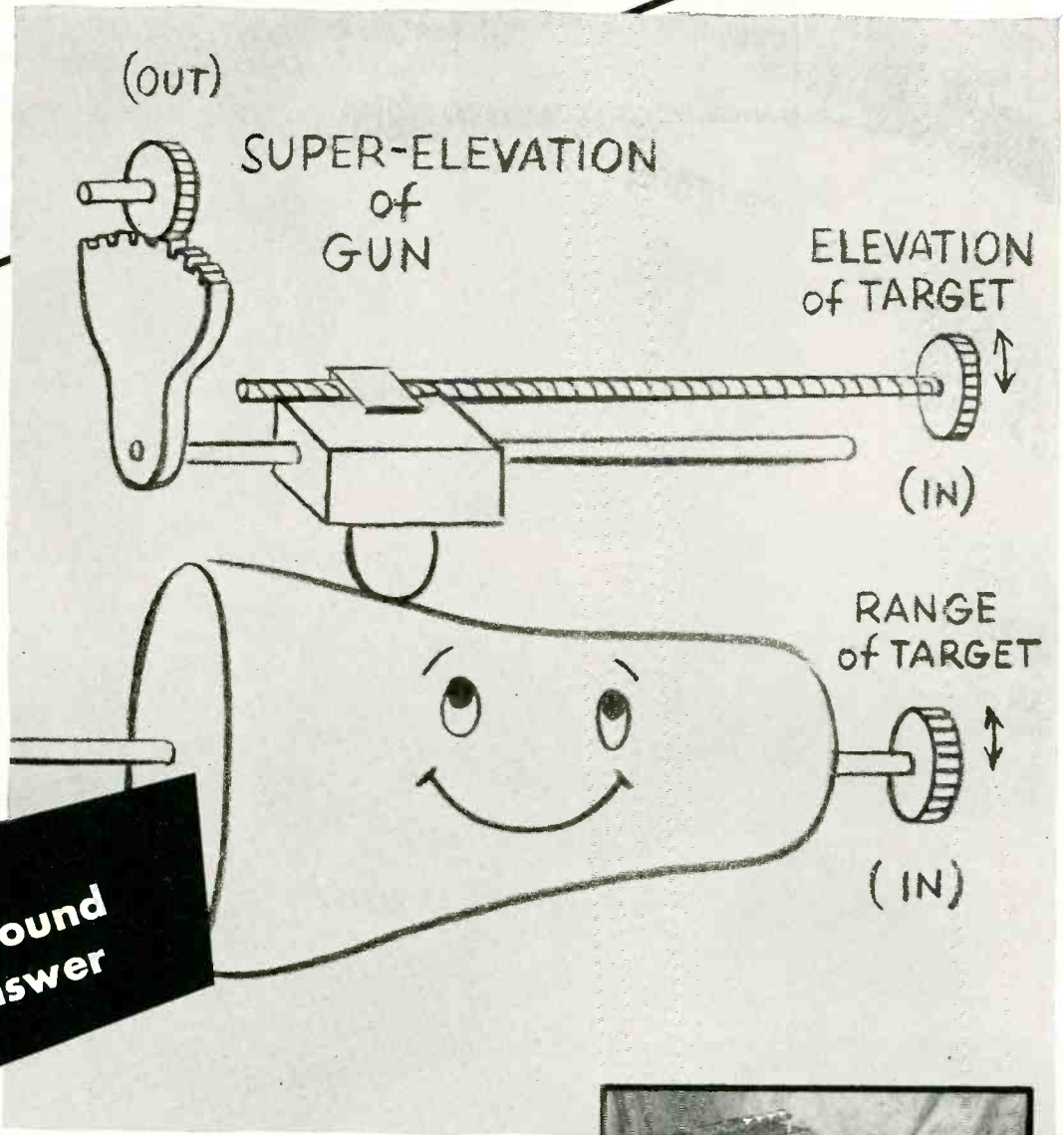
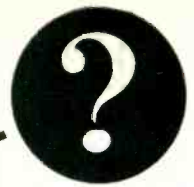
The reasons for this preference for Lambda by men who know power supplies intimately are simple: Lambda power supplies are *precision* equipment — dependable, and attractively priced. Lambda is a pioneer in the development of power supplies and a specialist in this field only.

Send for new *Lambda Power Supplies Catalog 11*

LAMBDA  **ELECTRONICS CORP.**
THE FIRST NAME IN POWER SUPPLIES

103-02 NORTHERN BOULEVARD • CORONA 68, NEW YORK

HOW TO TAP THE BRAIN of a piece of metal



In making computers, such information as mathematical functions can be stored in a precision-cut cam, thus allowing its follower to be displaced in accurate reply to the input position of the cam. Ford Instrument Company designs and makes cams of all sizes and shapes to achieve these results. To manufacture such cams with the precision demanded, the engineers of Ford Instrument have devised remarkable automatic machines which, by following a carefully plotted ink line on a roll of paper, cut the exact shape into the metal. Then, careful point-by-point checks, sometimes as many as 2000 measurements, insure finest accuracy.

If you have a cam problem—call on Ford Instrument Company.



You can see why a job with Ford Instrument offers young engineers a challenge. If you can qualify, there may be a spot for you in automatic control development at Ford. Write for brochure about products or job opportunities. State your preference.



FORD INSTRUMENT COMPANY

DIVISION OF THE SPERRY CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

28



EAST or WEST... NORTH or SOUTH only KARP can offer deep cuts in your enclosure costs!

Distance is no barrier to the money-saving advantages
of KARP'S exclusive "one-stop" Service.

Where else can you find . . .

- ★ 3000 stock tools and dies that eliminate or reduce new tooling costs . . . Complete fabrication, finishing and assembly facilities, in an 88,000 sq. ft. modern plant that permits mass production techniques, assuring . . . Rapid production output geared to cut your inventory needs, through . . . Experienced design counsel and Engineering Service.

Let KARP prove that your initial and production costs on cabinets, enclosures, chassis, and housings can be low, whether you need ten or ten thousand units. There is no obligation for quotations on your blue prints, samples or sketches. Write or phone, today!

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Division of H & B American Machine Company Inc.

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West Coast Plant
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enclosures reflect the skills within

FACILITIES FOR ENGINEERED SHEET METAL FABRICATIONS: in aluminum

or steel • long run or short • spot, arc, gas or heliarc welding • any type finish

- Modern plant—3 city blocks long
- Thousands of dies available
- Most modern of sheet metal fabricating equipment
- U. S. Air Force Certified Welding Facilities
- Air-conditioned spray room . . . complete baking facilities
- Complete sub-assembly facilities



HONEYWELL Mercury Switches

A PRINCIPLE OF GOOD DESIGN

small Mercury Switches to meet demands of—

1. Small load circuits
2. Limited operating space

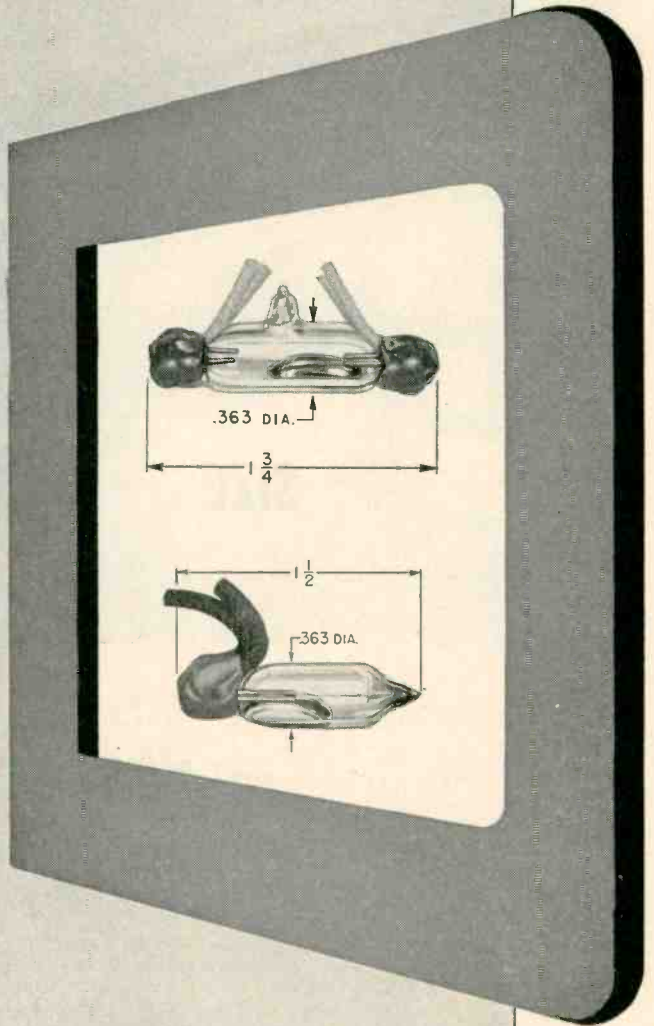
• Ratings of some types of small Honeywell Mercury Switches may often be extended down to micro-volt milli-ampere ranges. They are especially designed for reliable service in low energy circuits for applications where space economy is a critical factor.

These switches are widely used by manufacturers of control and indicating devices, home freezer units, alarms, animated displays and other applications which involve tilt motion and low force.

Whatever your specific requirement, if a mercury switch is indicated, there is a Honeywell Mercury Switch to meet it. In addition to the small switches mentioned here, there are:

- High capacity mercury switches
- Sensitive mercury switches
- Protected mercury switches
- General purpose mercury switches

Let a MICRO SWITCH field engineer, fully experienced in every type of switch application, help you select the right switch for your application. Call the nearest MICRO SWITCH branch office. Ask for Catalog 90.

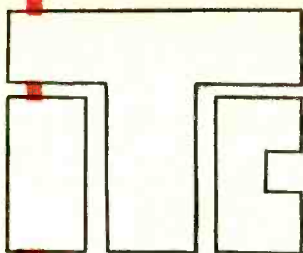


MICRO SWITCH provides a complete line of extremely reliable, small-size, high-capacity, snap-action precision switches and mercury switches. Available in a wide variety of sizes, shapes, weights, actuators and electrical characteristics. For all types of electrical controls.

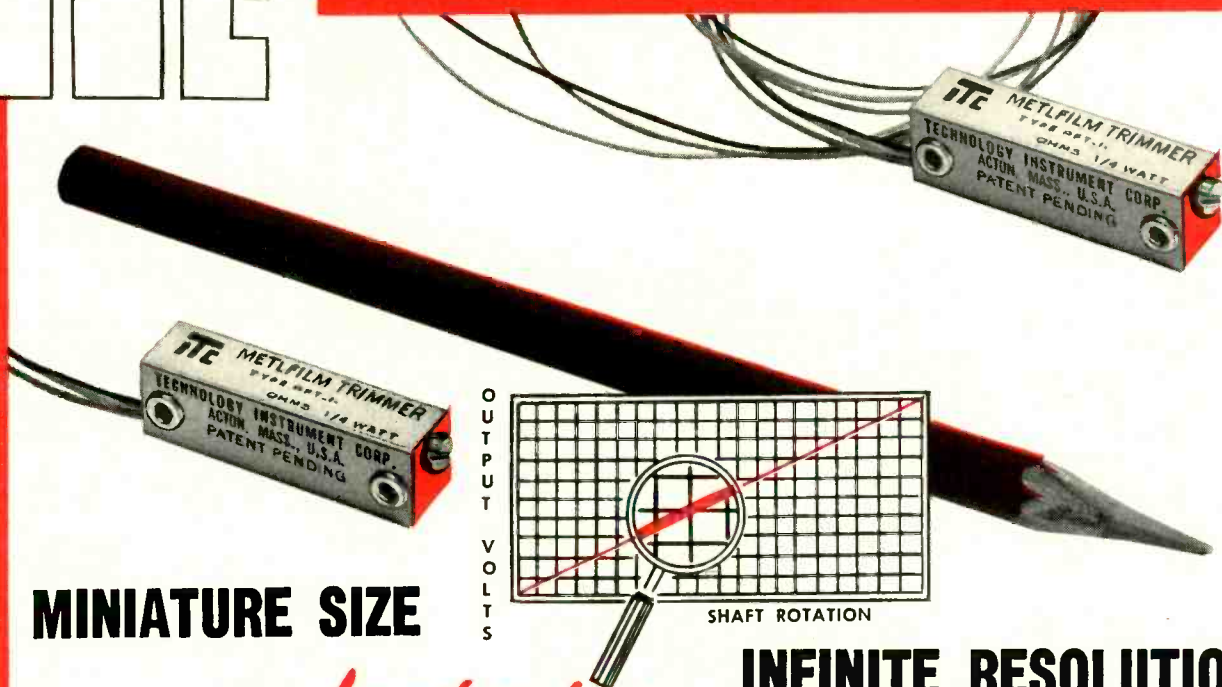
MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY
FREEPORT, ILLINOIS





METLFILM TRIMMER POTS



MINIATURE SIZE

featuring
plus

INFINITE RESOLUTION

"ZERO PHASE SHIFT"

Infinite Resolution

... of the unique deposited metal resistance element embodied in Type RFT Metfilm Trimmer Potentiometer is available over a wide resistance range. 9000° of adjustment, the equivalent of 25 turns of the adjustment screw on which sliding contact rides, permits voltage settings to be set and maintained with extreme precision.

Diminutive Size

... (approximately 3/8" square end surface), permits stacking seven units in a square inch of panel area. Ideal for trimming adjustments in computers, analyzers, telemeter and airborne electronic equipment.

Rugged construction insures dependability despite wide changes in ambient temperature and extreme conditions of salt spray, humidity and vibration.

TIC accumulative Handbook and Catalog on precision potentiometers available at \$2.00

For further details write:

TECHNOLOGY INSTRUMENT CORP.

533 Main Street, Acton, Mass. COlonial 3-7711
West Coast Eng'r'g. Facility 731 No. LaBrea Ave., Hollywood, Calif. Whitney 0108

SPECIFICATIONS

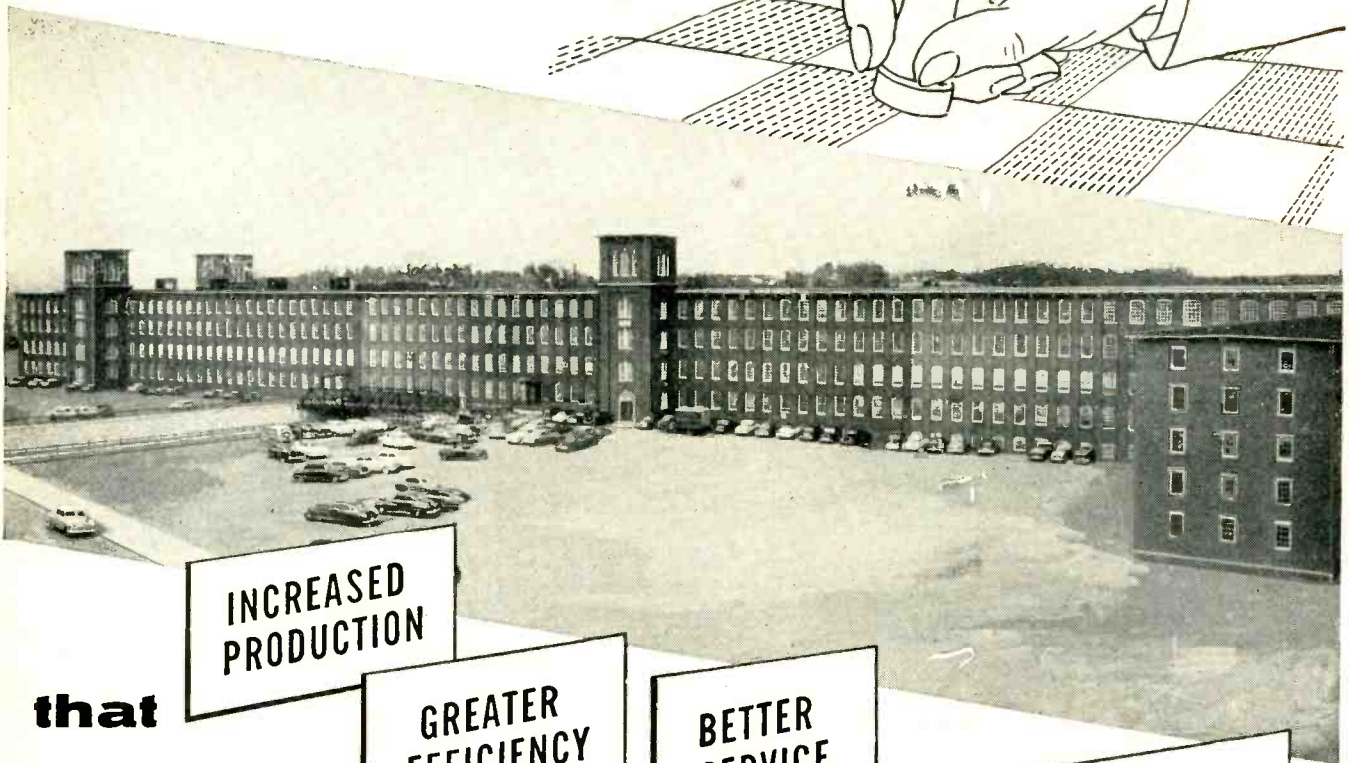
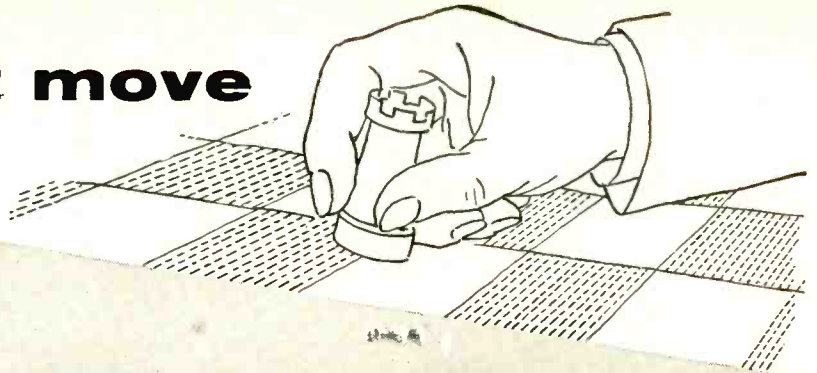
Electrical

Resistance Range: 50-25,000 ohms
 Total Resistance Tolerance: ± 10%
 Independent Linearity: ± 5% of total resistance
 Resolution: Infinite
 Power Rating: 1/2 watt at 40°C, 1/4 watt at 125°C.
 per JAN-R-19 test specification.
 Ambient Temperature Range: - 65°C to + 125°C.
 Temperature Coefficient of Resistance Element:
 .000250/°C (nominal)
 Dielectric Test: 500 volts DC between all leads, shaft
 and mounting eyelets for 5 seconds
 without flashover or breakdown.

Mechanical

Resistance Element: Metal film deposited on inert base.
 Mechanical Rotation: 26 complete turns (nominal).
 Usable Mechanical Rotation: 90% minimum of slider
 travel is on resistance
 element.
 End Stops: Will withstand 1 inch pound maximum
 applied torque.
 Vibration: Exceeds exacting requirements of MIL-E-5272a.

an important move



**that
means —**

**INCREASED
PRODUCTION**

**GREATER
EFFICIENCY**

**BETTER
SERVICE**

FOR  **CUSTOMERS**

Until recently, EAD's expansion was the acquisition of more and more small plants clustered about our main building in Brooklyn. Sooner or later something permanently suitable to our growing needs had to be found . . . and our new plant, in Dover, New Hampshire, is it. Now, under one tremendous roof — with more than 130,000 square feet of working space occupied, and additional space available for future needs — EAD has the elbow room to offer you better service than ever on all your motor and blower requirements. In looking forward to still greater expansion, we recognize the source of our progress — you, our customers and friends — and we shall strive to keep your friendship through constant development of newer and better rotating electrical equipment.

**Solving Special Problems
Is Routine at EAD**

If your problem involves small rotating electrical equipment, bring it to EAD. Our completely staffed organization will modify one of our standard units or design and produce a special unit to meet your most exacting requirements.



EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD



INDUCTION MOTORS



CENTRIFUGAL BLOWERS



TACHOMETER GENERATORS



FANS



ALTERNATORS



GEAR MOTORS

387 CENTRAL AVENUE—DOVER, NEW HAMPSHIRE

CUT TV COSTS, MAINTAIN QUALITY WITH G.E.'S NEW 600-SERIES TUBES!

Now, for the first time, designers can have "series-string" economy at no sacrifice of TV reliability!

- ★ Every G-E 600-Series Tube has same heater warmup time. Greatly reduces tube failures, because voltage will not build up excessively in some tubes while others are warming up more slowly.
- ★ All filaments are 600-ma. They employ special large-diameter wire, with fewer bends for better insulation against heater-cathode shorts.
- ★ 24 G-E 600-Series types are ready now! More coming.

QUALITY TV performance—costs sharply reduced! G-E tube-design service brings you both benefits with the new 600 Series. Now, by means of "series-string" design, you can *save* on transformer and circuitry . . . yet maintain highest standards of receiver dependability, with service callbacks at a minimum.

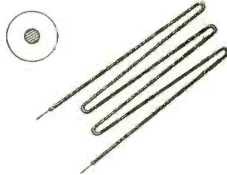
Meet today's stiff TV competition at its own price level, but with far superior performance! Use G-E 600-Series Tubes, *designed for "series-string" operation*. List at right shows wide range of types available. Others soon. Get full information from *Tube Department, General Electric Company, Schenectady 5, N. Y.*

COMPARE HEATER-WIRE THICKNESS AND NUMBER OF BENDS!



G-E 600-SERIES 3AU6

Wire diameter .00366" (coated diameter approximately .009"). 4 strands, with only 3 bends.



STANDARD 6AU6

Wire diameter .00226" (coated diameter approximately .008"). 6 strands, with 5 bends in all.



CHECK YOUR CIRCUIT NEEDS AGAINST THIS LIST!

G-E 600-Series Tubes	Prototypes
3AL5	6AL5 12AL5
3AU6	6AU6 12AU6
3BC5	6BC5
3BE6	6BE6 12BE6
3BN6	6BN6
3BY6	6BY6
3CB6	6CB6
5AQ5	6AQ5 12AQ5
5BK7-A	6BK7-A
5J6	6J6
5T8	6T8
5U8	6U8
5V6-GT	6V6-GT 12V6-GT
6S4-A	6S4
6SN7-GTB	6SN7-GTA
12AX4-GTA	12AX4-GT
12B4-A	12B4
12BH7	12BH7
12BK5	6BK5 25BK5
12BQ6-GA	6BQ6-GA 25BQ6-GA
12BY7-A	12BY7
12L6-GT	25L6-GT
12W6-GT	6W6-GT 25W6-GT
25CD6-GA	25CD6-G

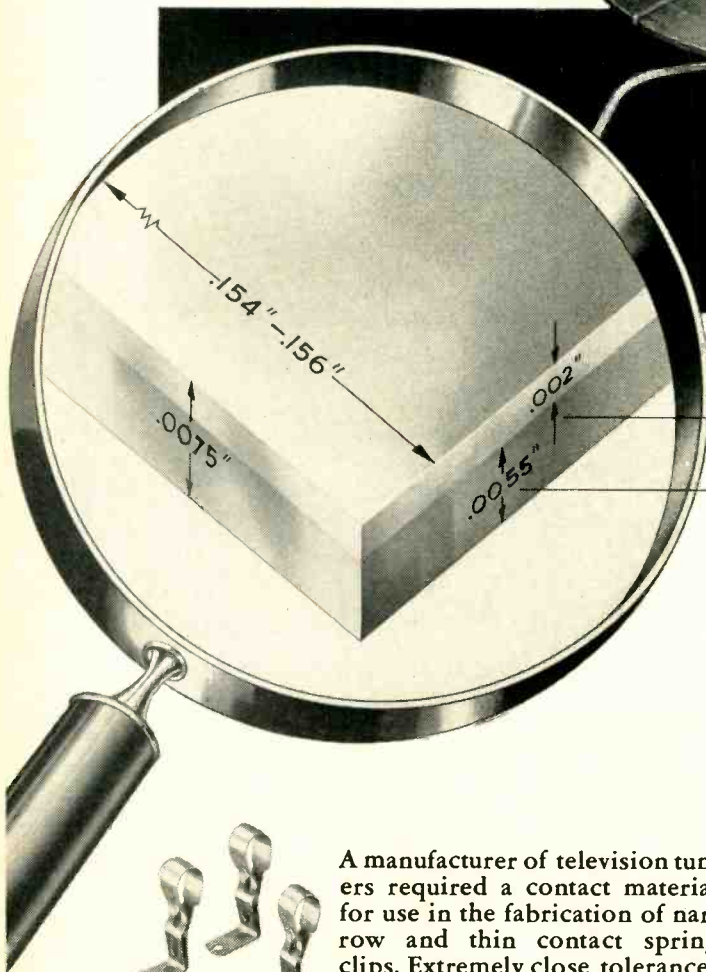
Other types to follow soon

GENERAL ELECTRIC



PROBLEM: Reduce manufacturing costs and waste in fabrication of electrical contact Spring Clips

SOLUTION: General Plate provided the solution with long continuous length coils of coin silver clad to phosphor bronze . . . a Composite Metal



COIN SILVER

PHOSPHOR BRONZE



A manufacturer of television tuners required a contact material for use in the fabrication of narrow and thin contact spring clips. Extremely close tolerances and long continuous lengths were prerequisites.

The problem was presented to General Plate who quickly found the solution with coin silver clad to phosphor bronze and provided the material in coils up to 20 inches diameter of a single continuous length. This saved the manufacturer many dollars by eliminating idle machine time and reducing waste practically to zero. The coin silver gave a non-porous, long wearing contact surface — the phosphor bronze excellent spring qualities.

You, too, can benefit with General Plate raw stock contact materials. They are available in

various combinations, single or double inlay, overlay, single or double edgelay and Top-Lay. General Plate Composite Contact Materials will save you money and enable you to make contact assemblies superior to those produced by other methods.

In addition to raw stock, General Plate fabricates contacts and complete contact assemblies. By letting General Plate fabricate your complete contact assemblies, you will save money, time and trouble . . . needless equipment cost and problems of scrap disposal are eliminated . . . contacts and/or contact assemblies made to your exact specifications are shipped to you ready for installation.

The long experience, diverse facilities and manufacturing skill of General Plate will benefit you in the form of service, quality and savings.

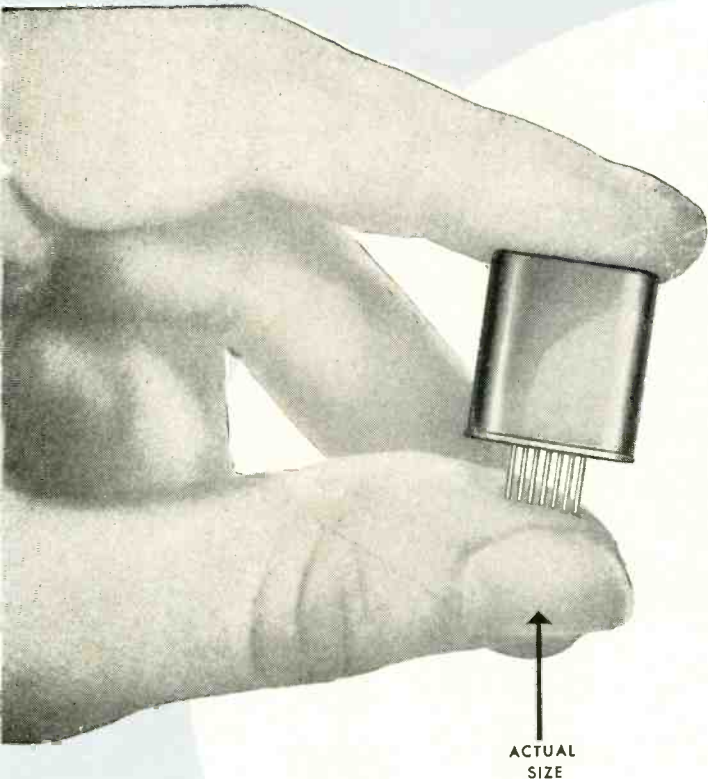
Write for complete information and Catalog PR700.

*You can profit by using
General Plate Composite Metals*

**METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
39 FOREST STREET, ATTLEBORO, MASS.**

New Sub-Miniature Relay

**APPLICABLE TO
PRINTED CIRCUITS**



ALLIED TYPE KH RELAY
weighs .32 oz. —
has low capacity for
RF switching

ELECTRICAL SPECIFICATIONS:

CONTACTS: Maximum of double pole rated at .25 amperes at 26.5 volts DC or 115 volts AC resistive

COIL: Sensitivity—nominal 1.0 watts, maximum 0.3 watts
Resistance—up to 1500 ohms
Voltage—up to 40 volts DC

TEMPERATURE: Minus 60° C to plus 125° C

VIBRATION: 10G up to 500 cycles

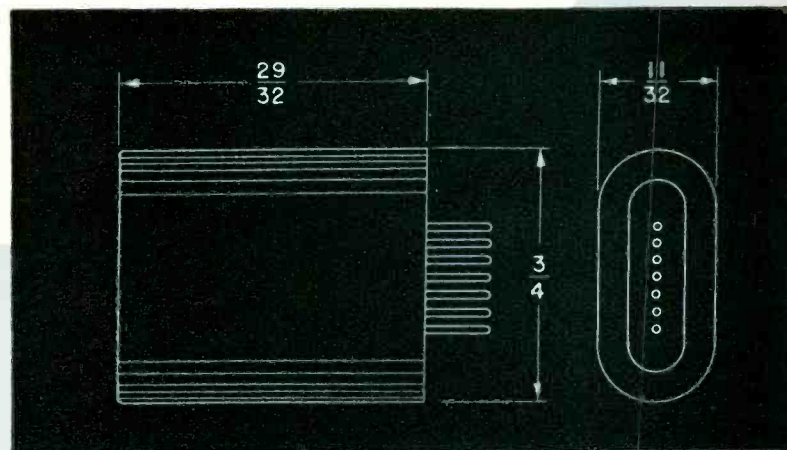
SHOCK: 50G plus (operating)

SPEED OF OPERATION: 1.5 millisecond at nominal voltage direct from battery supply and 1 millisecond with series resistance

ALTITUDE: 70,000 feet or 1.3 inches of mercury

TERMINAL TYPES: Printed circuit, solder terminals and plug-in

CAPACITY: N. O. contact to case 0.85 mmf



Write for catalog sheet giving complete information



ALLIED CONTROL



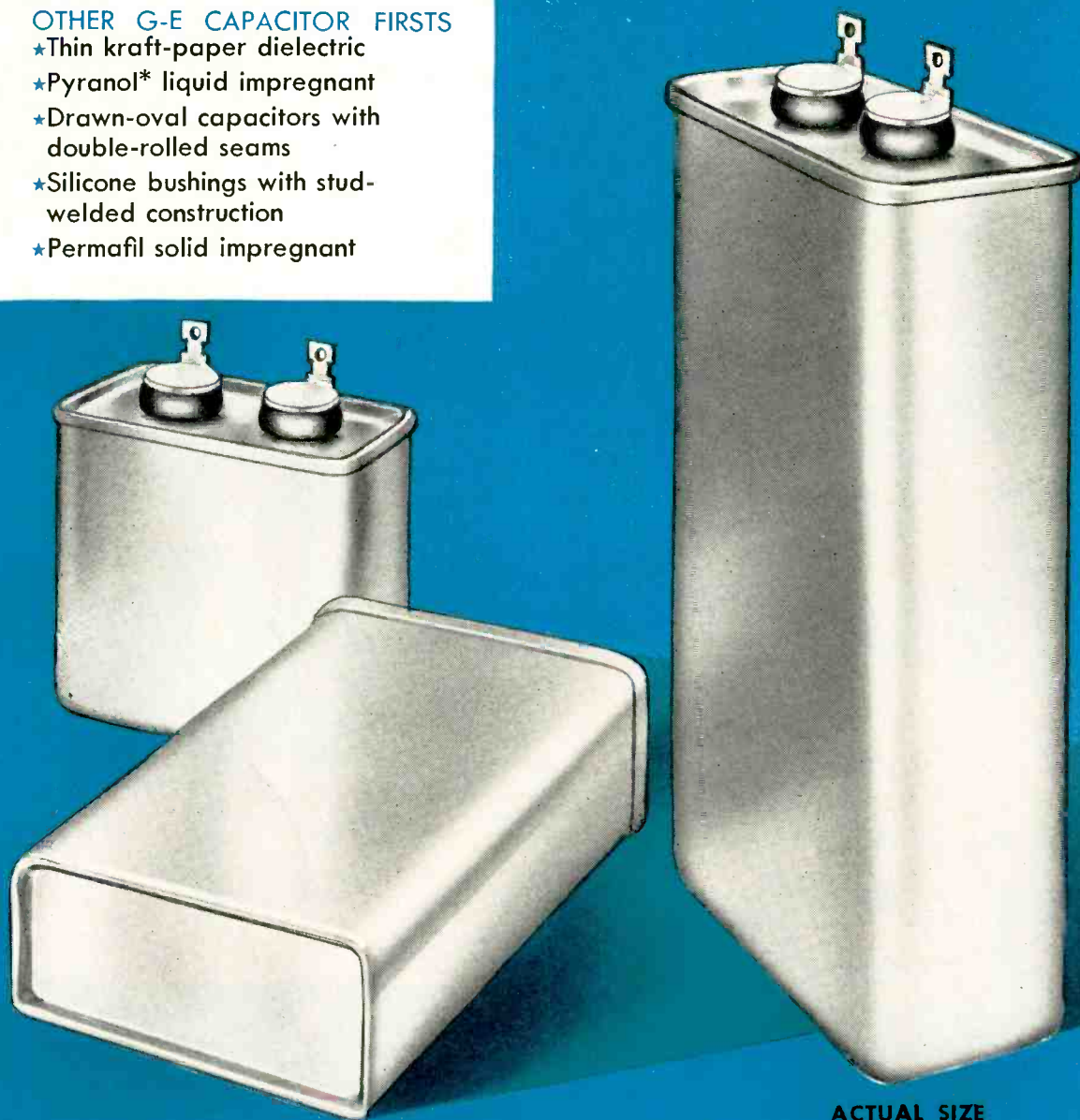
ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N. Y.

ALTD

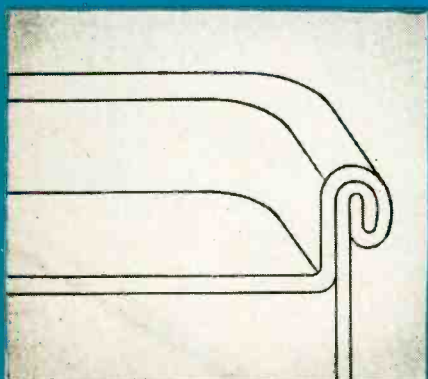
General Electric announces another

OTHER G-E CAPACITOR FIRSTS

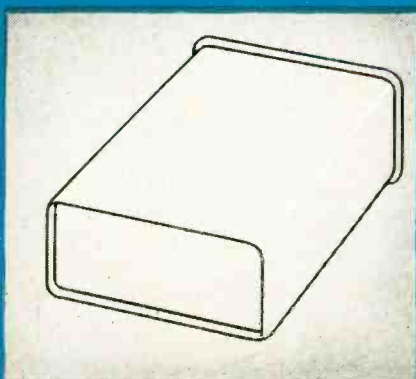
- ★Thin kraft-paper dielectric
- ★Pyranol* liquid impregnant
- ★Drawn-oval capacitors with double-rolled seams
- ★Silicone bushings with stud-welded construction
- ★Permafil solid impregnant



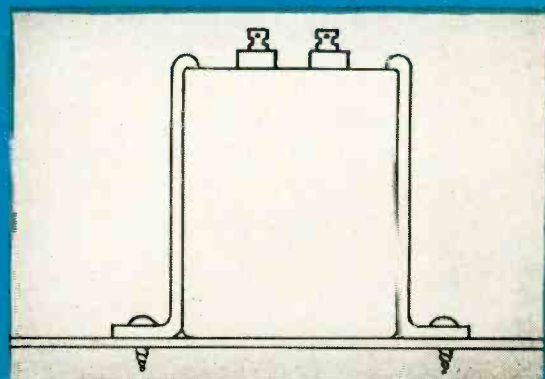
ACTUAL SIZE



SOLDERLESS DOUBLE-ROLLED COVER SEAM makes a mechanically strong, hermetic seal that remains leakproof.



DRAWN-RECTANGULAR CASE has no soldered seams . . . does not depend on solder for mechanical strength and effective sealing.



UPRIGHT OR INVERTED MOUNTING is possible, using footed brackets (above). Bottom of case is indented for inverted mounting.

FIRST to the electronics industry

NEW DRAWN-RECTANGULAR CAPACITORS

- ★ **Solderless, double-rolled cover seam**
- ★ **Seamless case with standard dimensions**

To answer the needs of the electronics industry, General Electric's capacitor engineers have developed a fixed paper-dielectric capacitor in a seamless, solderless case with standard dimensions. Because these new capacitors are the same sizes and have the same mounting dimensions as fabricated units, they can be applied to existing electronic equipment without changing component layouts.

Drawn construction offers the user important advantages. The seamless case is virtually leakproof. There is no dependence on solder for mechanical strength and effective sealing. The double-rolled seam between case and cover further assures a true hermetic seal.

G-E Drawn-rectangular capacitors can be supplied with suitable bushings for a wide range of voltage ratings or special applications. The new units comply with or exceed MIL specifications.

Proof of the dependability of the rugged construction of these new drawn-rectangular capacitors can be found in another General Electric pioneered development, the drawn-oval capacitor, of which there are more than 55 million being used in electrical and electronic equipment today.

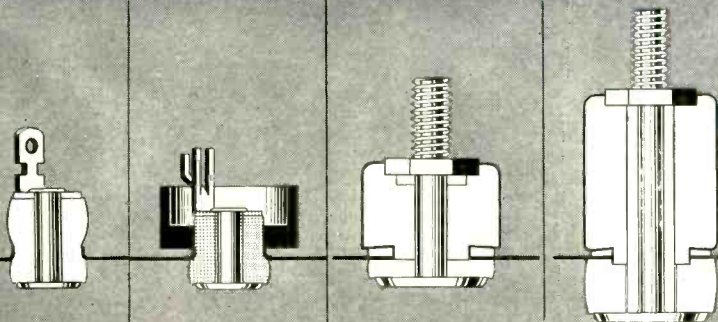
For further information contact your nearest G-E Apparatus Sales Office.
General Electric Company, Schenectady 5, New York.

442-23

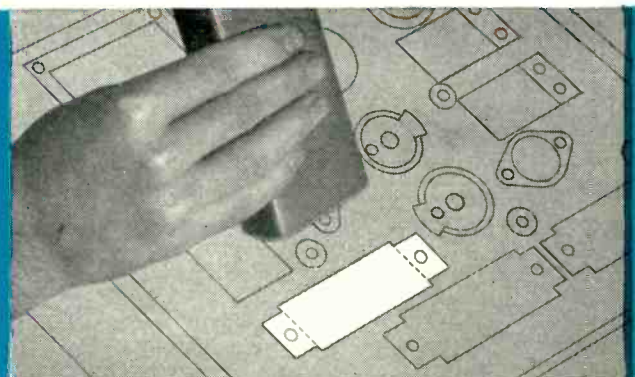
* Reg. trade-mark of General Electric Co.

Progress Is Our Most Important Product

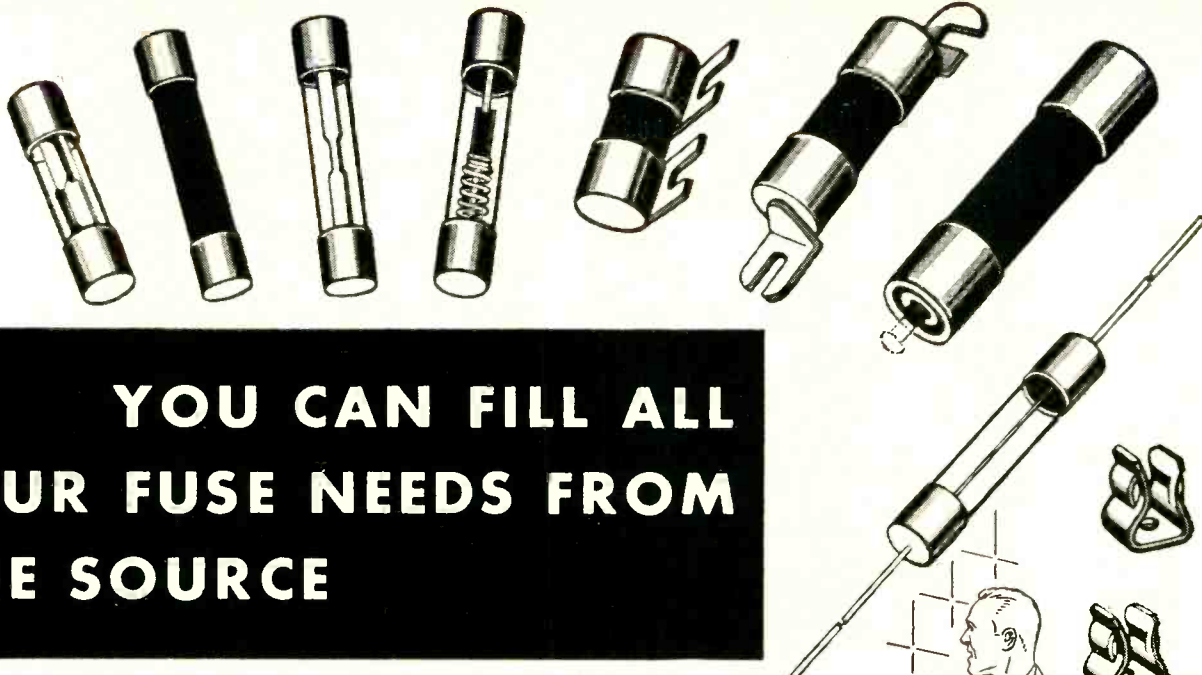
GENERAL  **ELECTRIC**



FOUR BUSHING STYLES can be furnished, depending on rating and application requirements. All bushings are designed to provide a liquid-tight seal along with generous air-strike and creepage distance.



STANDARD CASE SIZES of G-E Drawn-rectangular capacitors are interchangeable with existing fabricated styles. This makes it unnecessary to change drawings or circuit layouts.



YOU CAN FILL ALL YOUR FUSE NEEDS FROM ONE SOURCE

... by Standardizing on *BUSS FUSES*

Just turn to BUSS for all your fuse requirements in any size from 1/500 ampere up. The line is complete:—standard type, dual-element (slow blowing), renewable and one-time types . . . plus a companion line of fuse clips, blocks and holders.

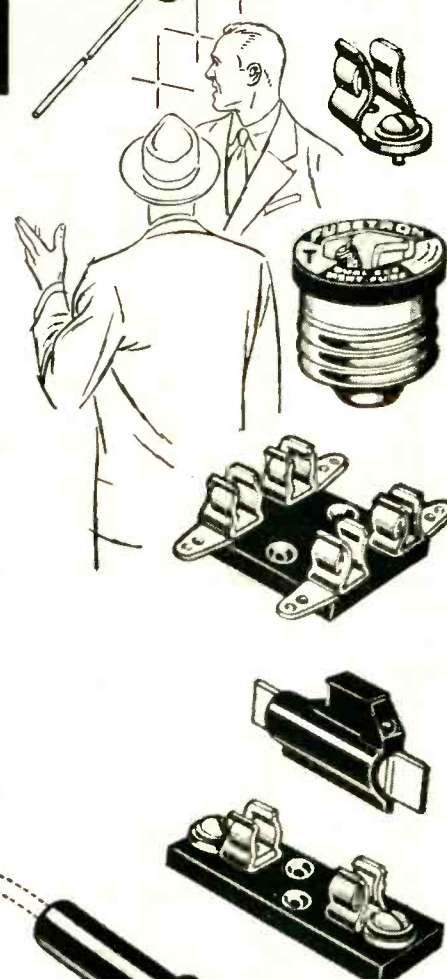
You'll find that by obtaining all your fuses from one source you can save time and money by simplifying your purchasing, stock handling and records.

Why BUSS fuses give "trouble-free" protection.

To make sure of dependable electrical protection under all serv-

ice conditions, — every BUSS fuse normally used by the Electronic Industries is tested in a sensitive electronic device that rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

Should you have a special problem in electrical protection . . . over 39 years of research and practical experience is available to you when you turn your electrical protection problem over to BUSS. The facilities of the world's largest fuse research laboratory will be brought to bear on the problem — helping you select the fuse or fuse mounting best suited to your needs.



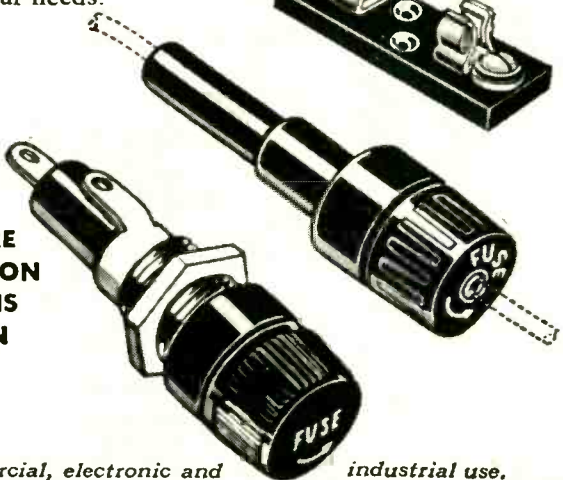
BUSSMANN Mfg. Co. (Div. McGraw Electric Co.)
University at Jefferson, St. Louis 7, Mo.

Please send me bulletin SFB containing facts on BUSS small dimension fuses and fuse holders.

Name.....Title.....
Company.....
Address.....
City & Zone.....State.....

ELRC
954

FOR MORE INFORMATION MAIL THIS COUPON



Makers of a complete line of fuses for home, farm, commercial, electronic and industrial use.



**PROUDLY
WE FLY
WITH THE
C-97
STRATOFREIGHTER**

BENDIX-PACIFIC SALUTES
the Boeing Airplane Company
on its delivery of the
500th C-97 Stratofreighter.

Standard equipment on this and other C-97s is the AN/APS-42A Radar Set, developed and produced by Bendix-Pacific. APS-42A is a material aid to navigation, providing the crew with an excellent "view" of the terrain over which the airplane is passing, showing mountains, lakes, rivers, cities and other vital check-points. APS-42A is also used for weather detection and collision warning. It locates storm fronts in the airplane's path, gives range and bearing of other aircraft in the vicinity.

TOPS IN ELECTRONIC DEVELOPMENT. You can meet your aircraft electronic needs quickly and effectively by calling on Bendix-Pacific's Research and Engineering facilities. Write us for complete information.

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Export Division: Bendix International
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Canadian Distributors:
Aviation Electric, Ltd., Montreal 9

RADAR



SONAR



HYDRAULICS



TELEMETERING

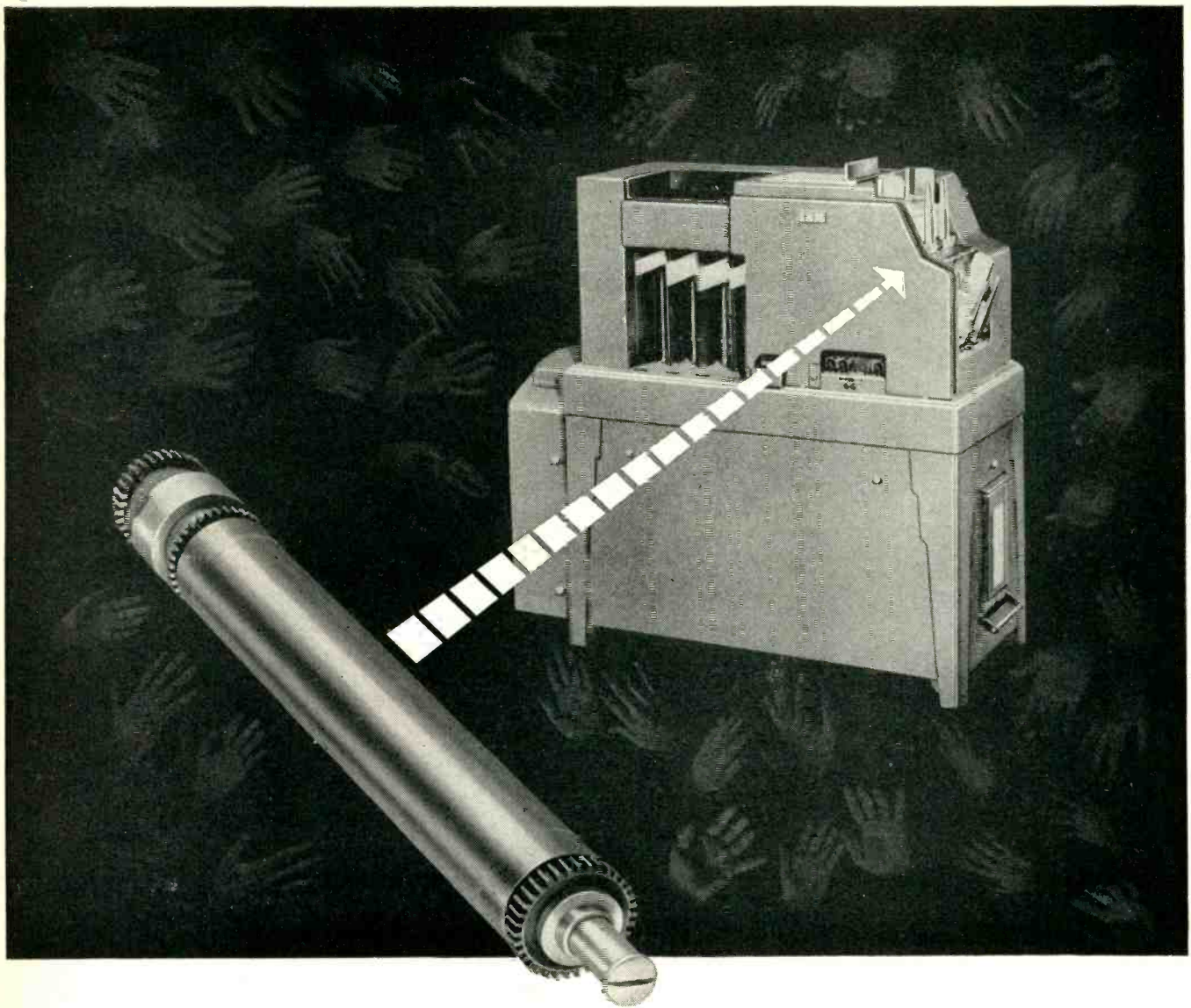


ELECTRO-MECHANICAL



ULTRASONICS





Out of IBM's Collator pops a tubing idea for you!

This is IBM's Collator—a mechanical super-accountant that shuffles, selects, matches and merges punched cards at the rate of four per second!

Heart of this electronic gee-whizzer is an extraordinary kind of tubing—a contact roll over which the cards must pass. Eighty miniature, hard steel brushes finger each card as it skims by—penetrate it through pre-punched holes, touch the contact roll and close the electronic circuit—flipping the card into the right slot.

Collator contact rolls must have good wear resistance to stand this high-speed workout. And they must resist corrosion and be good electrical conductors. So IBM employs Superior WELDRAWN* Beryllium Copper and

low carbon steel composite tubing for Collator contact rolls. This tubing meets IBM's tight specifications for wear resistance, peak hardness and conductivity. Superior supplies the composite tube in $1\frac{1}{8}$ " O.D. with .049" wall.

When tubing troubles put the hex on your plans, call on Superior.

We have years of experience, the modern test and development facilities, and more than 55 analyses in many metals to unravel your problem. Write for a copy of our new Technical Bulletin #7-2 on Seamless and WELDRAWN* Beryllium Copper Tubing. Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.

Round and shaped tubing available in Carbon, Alloy and Stainless Steels; Nickel and Nickel Alloys; Beryllium Copper; Titanium; Zirconium

Superior Tube

THE BIG NAME IN SMALL TUBING

All analyses .010" to $\frac{3}{8}$ " O.D.
Certain analyses in light walls up to $2\frac{1}{2}$ " O.D.

West Coast: Pacific Tube Company

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*Reg. U.S. Pat. Off.

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Plastics for Electronics

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WIDE TEMPERATURE RANGE
 -100°F to +400°F (to +500°F for short periods)
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 Approximately the same as aluminum and brass
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ELECTRICALLY OUTSTANDING
 LOW LOSS — HIGH Q — White Opaque
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for RF and Microwave Insulation
 Low Loss — A thermosetting plastic — will not flow at high-temperatures — Machines easily

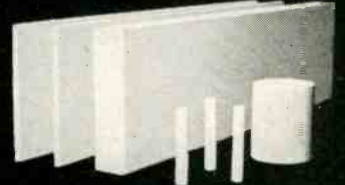
Dissipation Factor below .0005 }
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Stycast® Hi-K

Any Dielectric Constant
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Wide temperature range — Excellent machineability
 Dissipation Factor, 60 to 10¹⁰ cps, below .001



PLASTIC FOAMS

Eccofoam S

Sheet Stock which can be fabricated into a wide variety of items. High bulk densities useable to +300°F. Available in bulk densities from 3 to 25 lbs. cu. ft.



Eccofoam FP

Supplied in liquid form. For foamed-in-place electronic embeddings, sandwich structures, radomes, etc.

IMPREGNANTS for WINDINGS

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Low viscosity — Solvent-free — Excellent adhesion — Useable to +400°F — Volume Resistivity at 75°F above 10¹⁶ at 300°F above 10¹³ ohms-cm³



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Solvent free
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 Wide temperature range
 Easy to use
 High Dielectric Strength

High Frequency Absorber 853

One of several absorbers and/or attenuators for electrical energy. Can be molded to size, made resilient or rigid.

Conductive Plastics and Adhesives

Produced in several bulk resistivity ranges.

Mold Release 1225

Prevents adhesion of plastic to molds used in casting and laminating.



Vacuum Tube Coating 453B

Resilient unicellular coating for sensitive components to be embedded.

Laminating Plastics for Fiber Glass

Ecco L44 for non-porous, void-free laminates in low loss applications — radomes, printed circuits, etc.

Ecco L28 for fiber glass laminates of high volume and surface resistivity — High dielectric strength — temperature range —100°F to +400°F. For terminal strips, mounting boards, etc.



Bulletins Available on all of the above products. Write for them.

Emerson & Cuming, Inc. will quote on production of electronic embeddings, fiber glass laminates and fabricated plastic items.



Emerson & Cuming, Inc.
 PLASTICS for ELECTRONICS

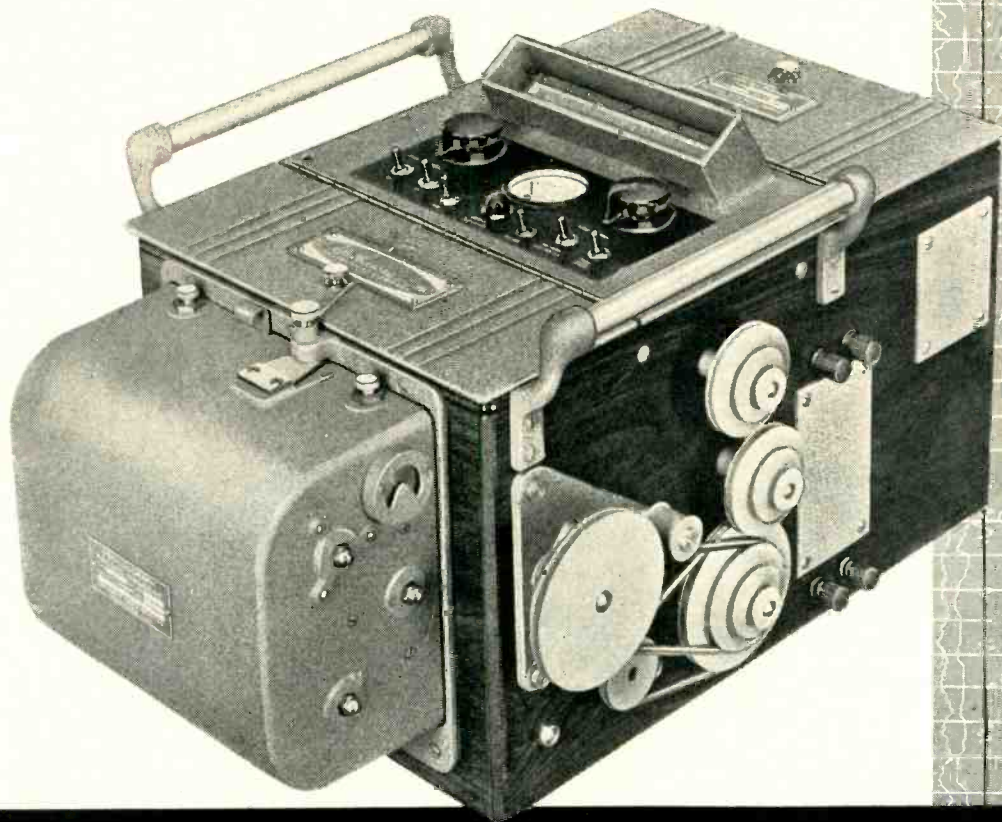
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Attachments available for almost any recording need—

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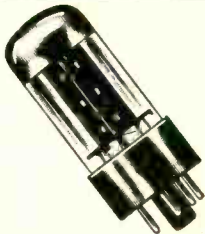
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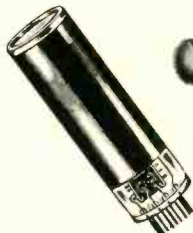

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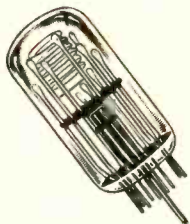
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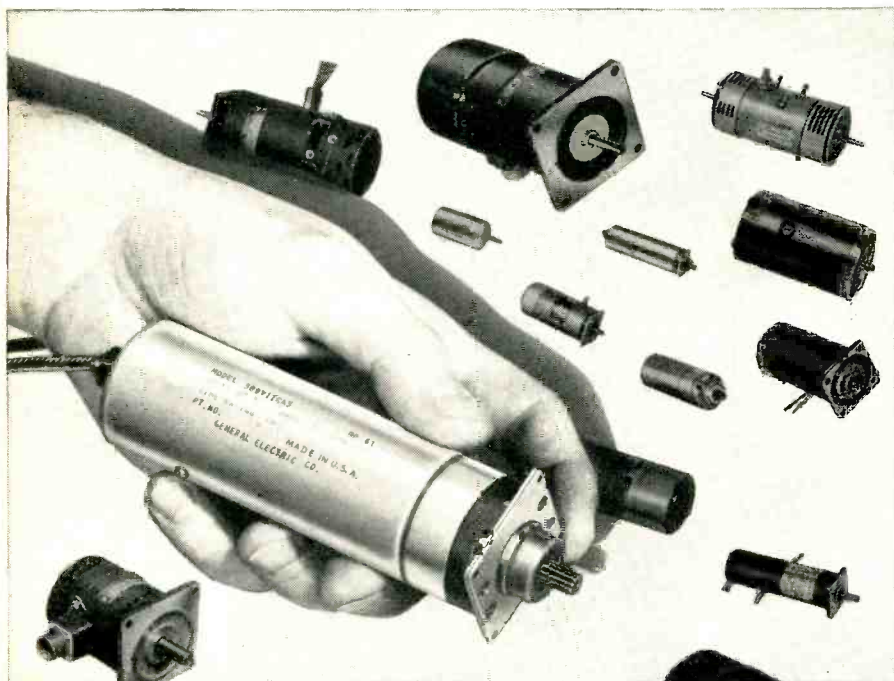
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DESIGNER'S

Wide selection of G-E specialty motors designed to meet your needs



New permanent-magnet, 1³/₈" diameter motors latest addition to aircraft line

Experience gained by General Electric engineers in the design and manufacture of many types of specialty motors is another reason why G.E. is best equipped to supply the aircraft motor you need. In addition, complete testing facilities assure you that your special aircraft motors meet environmental requirements.

Shown at left is one in a series of new permanent-magnet, totally enclosed, shunt motors now part of General Electric's extensive line of aircraft motors. It is rated 1/100 hp, gear-reduced to 130 rpm, and operates on 27.5 volts. Designed for dynamic braking it can be stopped in 1/10 revolution by a fast acting relay. Such performance makes it ideal for radar tuners, actuators, blowers, and similar applications. Write for Bulletin GEC-988.



G-E Hermetically sealed relays feature reliability, high speed

HIGH SPEED RELAY—General Electric's high speed relay can be furnished with contact configurations up to 4 PDT, yet fits in an AN-3304 size can. This versatile relay is more reliable even under severe shock, vibration, extreme temperatures and other adverse conditions. Operating speeds range from 250 microseconds to 1 millisecond. It is available with multiple coils or windings and with multiple independent SPDT units in a single can. Write for Bulletin GEA-6212.

SUBMINIATURE RELAY—Lightweight, reliability, and resistance to shock and high vibration are a few of the important advantages of the G-E subminiature relay. Low capacitance makes it ideal for switching high frequency signals or pulses. Pickup time is 5 milliseconds or less and dropout time is 2 milliseconds or less. It is available with a variety of d-c coil voltages and 400 cycle a-c coil. Write for Bulletin GEA-6211.

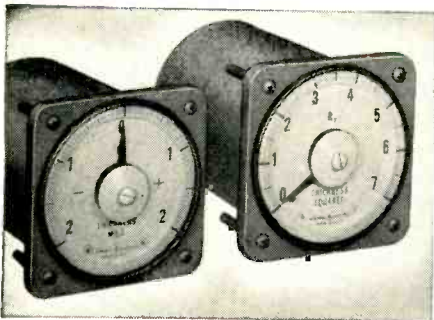
GENERAL



ELECTRIC

DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS



Announcing two new integrating instruments

Mean and standard deviation of variables can now be readily and accurately determined with General Electric's two new direct reading integrating instruments.

Widely applicable, the instruments measure such variables as current, thickness, width, diameter, density, or any other electrical or non-electrical quantity.

Integrating deviation and deviation-squared, the instruments, used with suitable primary detector, reduce statistical analysis of variables to a simple slide-rule calculation. Accuracy of the instruments is about $\pm 3\%$ full scale when integrating over a two-minute period.

For further information about these unique time-saving instruments contact your nearest General Electric Apparatus Sales Office. Write for Bulletin GEC-1230.

Capacitors of many ratings, styles help solve design problems

The variety of case sizes and styles of G-E fixed paper dielectric capacitors makes it easy to select units that meet your needs. Ratings at 236 to 660 volts a-c and at 400 to 100,000 volts d-c are available. All units are treated with Pyranol* impregnating liquid and are hermetically sealed to prevent leakage or contamination. Write for Bulletin GEC-809.

*Reg. trade-mark of General Electric Co.



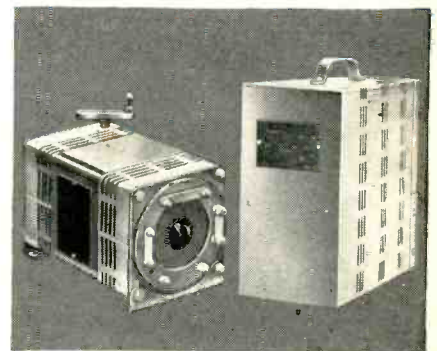
Electronics easily taught

General Electric's More Power to America program, "Industrial Electronics," offers a practical, easily understood 12-lesson sound slidefilm course on the fundamentals of electronics and its applications in modern industry. It is a particularly interesting method for plant management, production men, and electrical and maintenance staffs to improve their understanding of the operation of industrial electronic equipment. Write for Bulletin GEA-5339.



Inductrols—for automatic or manual voltage regulation

G-E Inductrols end the poor performance and excessive burnouts of electronic tubes due to poor voltage. Compact design of these finely controlled regulators lets you fit them into any location. Models are available for indoor service on circuits 600 volts and below, single phase 3 to 240 kva; three-phase 9 to 520 kva. Bulletin GEC-795 covers single-phase inductrols; GEA-5824, 3-phase models.



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for reference only X for planning an immediate project

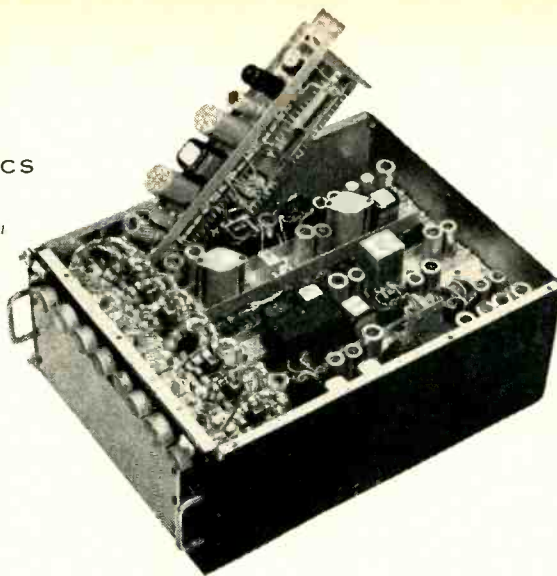
- GEC-988 Aircraft and Ordnance Motors
- GEA-6211 Subminiature Relays
- GEA-6212 High Speed Relays
- GEC-1230 Integrating Instruments
- GEC-809 Paper-Dielectric Capacitors
- GEA-5339 Industrial Electronics Training Course
- GEC-795 Single-phase Inductrols
- GEA-5824 Three-phase Inductrols

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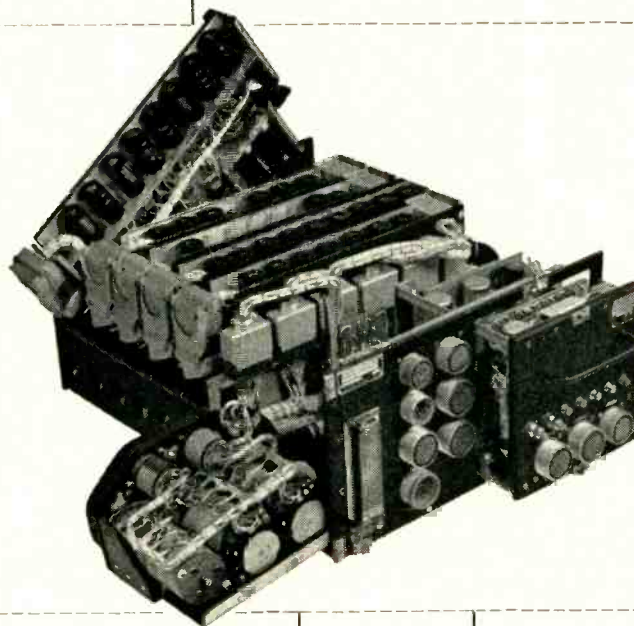
Redesign of an airborne analog computer to perform additional functions called for 20 per cent more parts— with no over-all increase in size, or change in form. At the same time, a high degree of reliability had to be maintained.

Problem:

APPROACH TO RELIABILITY

Advanced radar fire control systems for military aircraft demand the highest degree of reliability under severe restrictions. These include quantity manufacturability, minimum size and weight, protection from shock and heat, serviceability, and exacting performance.

At Hughes, one objective of equipment design engineers is to maintain consistent essential performance of the systems while steadily improving reliability. Following is an example of accomplishment by Hughes engineers in this specialized area:



Solution:

By use of improved components, unique packaging techniques, and thorough environmental testing, Hughes design engineers were able to meet specifications and improve reliability as well. Result was that the new computer operated at mean internal temperatures in excess of 120°C and withstood shocks of 50 g's— as against 85°C and 30 g's for the original unit.

ENGINEERS experienced in the fields of product design, electronics packaging, miniaturization and component reliability will find outlets for their abilities in new advanced packaging and reliability problems.

Relocation of applicant must not cause disruption of urgent military project.

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HUGHES
 RESEARCH
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Culver City,
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Hughes Fusion-Sealed Germanium Diodes



ACTUAL DIMENSIONS
DIODE BODY:
0.265 by 0.130 inches (maximum)
SHUNT CAPACITANCE:
0.5 μ hf (maximum)
AMBIENT OPERATING
TEMPERATURE RANGE:
-78°C to +90°C

Hughes Point-Contact Germanium Diodes are fusion-sealed in a one-piece, gas-tight glass envelope . . . impervious to moisture, fumes or other external contaminating agents. The flexible dumet leads are especially suitable for spot-welding; or they can be iron- or dip-soldered as close as $\frac{1}{4}$ inch to the diode body—without special precautions.

The germanium crystal is permanently bonded to one lead, the cat whisker is welded to the other, and the point of the cat whisker is welded to the crystal. Hughes diodes are highly resistant to shock and vibration. Positive mechanical stability is achieved without risking contamination from fluxes, waxes or impregnants. And—each diode is thoroughly tested to ensure the stability of

its electrical and physical characteristics. All this means: sturdy, highly reliable diodes.

TYPES—The Hughes line of diodes comprises standard RETMA, JAN, and many special types. Special types are produced according to customer specifications and are tested at high or low temperatures . . . for specific recovery time . . . for matching in pairs or quads.

ELECTRICAL SPECIFICATIONS AT 25°C unless otherwise indicated

DESCRIPTION	RETMA or Hughes Type	Clip-in Hughes Type	Peak Inverse Voltage† (volts)	Absolute Maximum Inverse Working Voltage (volts)	Minimum Forward Current @ +1V (mA)	Maximum Inverse Current		Other Characteristics	
						@ -50V (mA)	Other (mA)		
HIGH PEAK	1N55B	HD 2052	190	150	5.0		0.500 @ 150V		
	1N68A	HD 2053	130	100	3.0		0.625 @ 100V		
1 MEG TYPES	1N67A	HD 2054	100	80	4.0	0.050	0.005 @ 5V		
	1N99	HD 2055	100	80	10.0	0.050	0.005 @ 5V		
	1N100	HD 2056	100	80	20.0	0.050	0.005 @ 5V		
500K TYPES	1N89	HD 2057	100	80	3.5	0.100	0.008 @ 5V		
	1N97	HD 2058	100	80	10.0	0.100	0.008 @ 5V		
	1N98	HD 2059	100	80	20.0	0.100	0.008 @ 5V		
	1N116	HD 2060	75	60	5.0	0.100			
	1N117	HD 2061	75	60	10.0	0.100			
GENERAL PURPOSE	1N118	HD 2062	75	60	20.0	0.100			
	1N90	HD 2063	75	60	5.0	0.500			
	1N95	HD 2064	75	60	10.0	0.500			
JAN TYPES	1N96	HD 2065	75	60	20.0	0.500			
	1N126*		75	60	5.0	0.850	0.050 @ 10V	Non-JAN equivalent, HD2070; clip-in, HD2066	
	1N127**		125	100	3.0	0.300	0.025 @ 10V	Non-JAN equivalent, HD2071; clip-in, HD2067	
	1N128***		50	40	3.0		0.010 @ 10V	Non-JAN equivalent, HD2072; clip-in, HD2068	
COMPUTER TYPES	1N198		100	80	5.0	0.250	0.075 @ 10V		
	These values tested 100% at 75°C								
	1N191	HD 2077		§	5.0	400K Ω min. between -10 and -50V @ 55°C§		Back resistance recovers to 50K Ω and 400K Ω (200K Ω for 1N192) in 0.5 μ sec and 3.5 μ sec max., respectively.† 0.2 μ sec recovery time.° 0.2 μ sec recovery time.°	
	1N192	HD 2078		§	5.0	200K Ω min. between -10 and -50V @ 55°C§			
HD2013				50 @ 1V & 1 @ 0.35V	0.120 @ -3V				
HD2014				50 @ 1V & 1 @ 0.35V	0.60 @ -6V				
UHF	HD2016A				UHF MIXER DIODE				
MISCELLANEOUS	HD2051		125	100	4.0	0.050		1N63 equivalent.	

† That voltage at which dynamic resistance is zero when back voltage rises linearly at 90v/sec.

‡ Back Recovery Time is measured with a forward pulse of 30mA, followed by a reverse pulse of 35 volts. Loop resistance of test circuit 2500 Ω max.

° Recovery time is that point at which the diode voltage reaches -1V after the initiation of a 6V back pulse through 20K Ω from an initial 3 mA forward bias. Total shunt capacitance is 20 μ sf.

§ Tested at 55°C. Test voltage is a continuous 60 cps sine wave. Peak Reverse Voltage across the diode is 70V. Peak Forward Voltage not less than +2V or Peak Forward Current not less than 20 mA, whichever occurs first.

* Formerly 1N69A.

** Formerly 1N70A.

*** Formerly 1N81A.

Descriptive Bulletin SP2A is available on request.

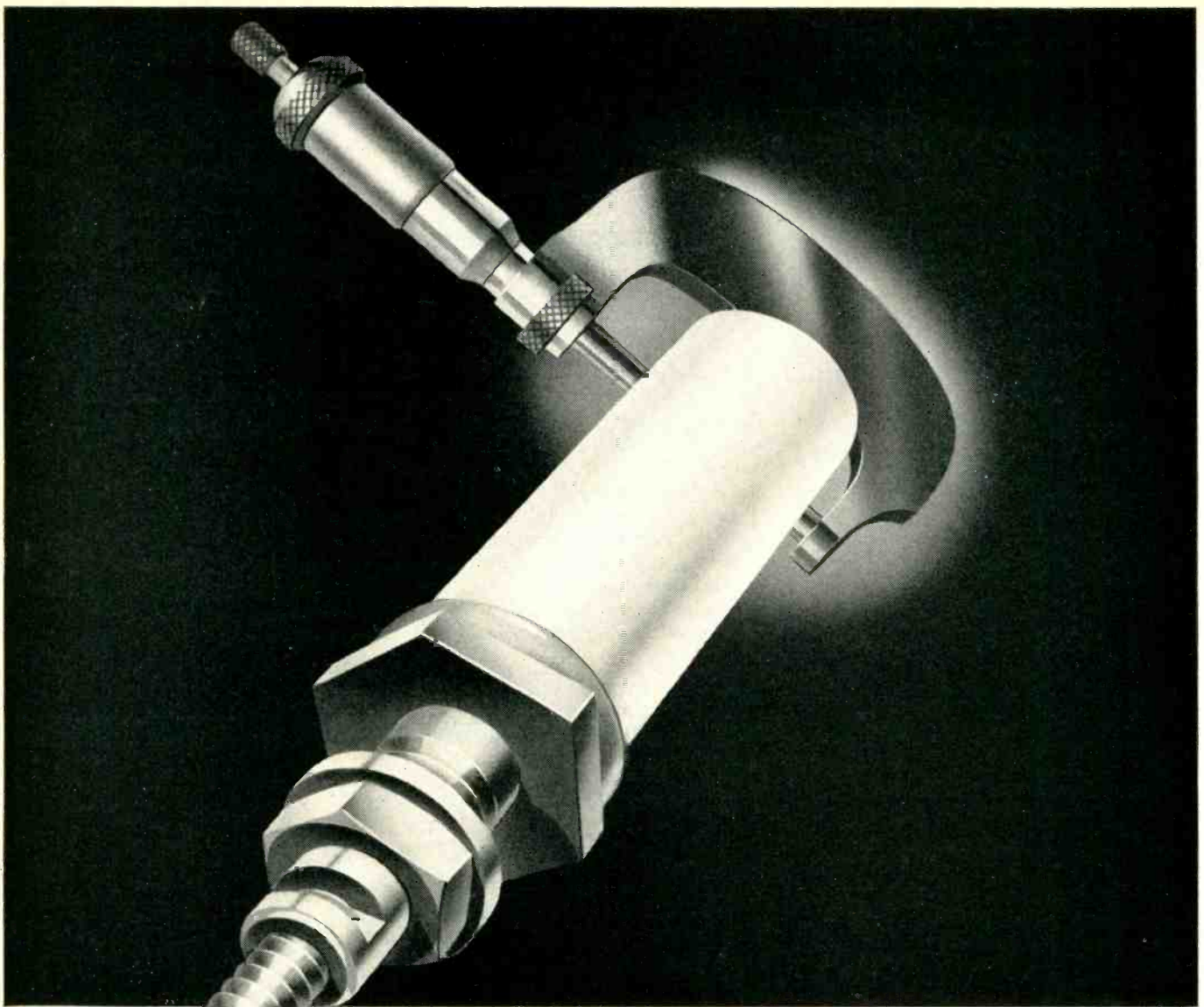
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How to pass a physical exam

CTC's coil forms pass their physical exams in great shape — thanks to precision manufacture.

The basic materials of these forms are certified, then checked again by us, before the forms are made. Each manufacturing detail is quality controlled to the high quality standards that enable us to offer *guaranteed* electronic components, custom or standard.

Forms then get these physical check-ups: *mounting studs* checked for internal and external threads, for general size and electroplating; *form* checked for I.D., O.D. and concentricity; *slug* checked for threads, dimensions, electroplating and checked electrically for Q and permeability; *final assembly* checked for tightness, chips and cracks.

Other CTC components benefiting from CTC precision manufacture include terminal boards, terminals, capacitors, swagers, hardware, insulated terminals and coils. For all specifications and prices, write to Cambridge Thermionic Corporation, 437 Concord

Avenue, Cambridge 38, Massachusetts. West Coast Manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 and 988 Market St., San Francisco, California.

Coil Form Data: Made of grade L-5 silicone impregnated ceramic. Winding diameters from .205" to 1/2". Mounted heights from 1 1/2" to 1 11/16". Certain forms, known as Type C, are also available with silicone fibreglas terminal retaining collars permitting 2 to 4 terminals. These are excellent for bifilar windings and advantageous for single pie windings because they permit terminals to be located above or below winding, thus shortening wiring to circuit elements.

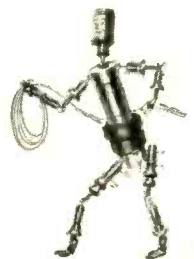


Laboratory Coil Kit. Type X2060 aids in developing prototypes and pilot models. Contains 10 slug tuned coils of L86 size Type C, ranging from 2 Microhenries to 800 Microhenries, each slightly overlapping next coil in scale. Kit contains mounting hardware and lists such information as inductance range, wire size, number of turns, Q value. Coils are color-coded to chart for easy quantity-order.

CTC

CAMBRIDGE THERMIONIC CORPORATION

*makers of guaranteed electronic components,
custom or standard*



Ampex magnetic tape recorders

...lasting quality for every professional use



- Frequency Response — 40 to 15,000 cps.
- Tape Speed — $7\frac{1}{2}$ in/sec.
- Signal-to-Noise — over 55 db.
- Flutter and Wow — under 0.25%.

Ampex machines are built with sustained quality and durability — the prime requirements of the major broadcast networks and recording studios. These perfectionists have chosen Ampex, some as long as six years ago, and their machines are still in use today. For example, one Ampex, after 18,000 hours of heavy duty still maintains performance equal to published specifications for new machines! This is the kind of lasting value that is the Ampex standard of excellence in sound recording.

MODEL 600 • THE NEWEST AMPEX

The Ampex 600 is a portable model that weighs less than 28 pounds. It is an Ampex in design and performance and gives the same class of fidelity, accuracy of timing and reliability as other Ampex recorders. It is the ideal instrument for radio stations, music conservatories, educators, high fidelity enthusiasts and other professional and semi-professional users.

SERIES 300 • THE FINEST AMPEX

The 300 Series comprises the most perfect sound recording machines yet offered by any manufacturer. They are unexcelled for performances deserving the finest recording and reproduction it is possible to make. Superb design and flawless mechanical stability achieve the utmost in program fidelity, operating reliability and timing accuracy.



- Frequency Response — 30 to 15,000 cps.
- Tape Speed — $7\frac{1}{2}$ and 15 in/sec.
- Signal-to-Noise — over 60 db.
- Flutter and Wow — under 0.1%.

SERIES 350 • THE MOST VERSATILE AMPEX

The 350 Series is universally preferred for original and delayed broadcasts, exchanging taped programs, music and drama rehearsals and other performances requiring extensive cueing and editing. Tape editing is remarkably fast with "feather touch" controls mounted within easy reach on a 30°-slanted top-plate. The 350 Series is unusually accessible for installation and servicing, and is available in a variety of tape speeds and mounting styles.



- Frequency Response — 30 to 15,000 cps.
- Tape Speeds — $7\frac{1}{2}$ and 15 ips, or $3\frac{3}{4}$ and $7\frac{1}{2}$ ips.
- Signal-to-Noise — over 60 db.
- Flutter and Wow — under 0.2%.

MODEL 450 • FOR BACKGROUND MUSIC

The Model 450 is a reproducer which provides sustained high fidelity background music anywhere. It is ideal for the finer hotels, restaurants, department stores, funeral parlors, factories and other users of pre-recorded programs. It plays continuously for 8 hours. Starting, stopping, reversing and repeating can be controlled automatically.



- Frequency Response — 50 to 7,500 cps.
- Tape Speed — $3\frac{3}{4}$ in/sec.
- Signal-to-Noise — over 50 db.
- Flutter and Wow — under 0.4%.

SERIES S-3200 • FOR TAPE DUPLICATION

This Series of machines achieves true mass duplication of previously recorded tapes while preserving the superb fidelity of the master recording. Up to 10 exact replicas can be made simultaneously, and up to 2500 hours of program material can be produced in an 8-hour day (or one hour in 10 seconds!). The S-3200 Series duplicates both single and double track masters and 2 track stereophonic tapes, of any standard speed, in one pass either "forward" or "backward."



- Frequency Response — 30 to 15,000 cps.
- Tape Speed — 30 and 60 in/sec.
- Signal-to-Noise — over 45 db.
- Flutter and Wow — under 0.2%.

AMPEX
CORPORATION

WRITE FOR FURTHER INFORMATION AND COMPLETE SPECIFICATIONS TO DEPT. E-1723

934 Charter Street • Redwood City, California

Branch offices: New York, Chicago, Atlanta, San Francisco and College Park, Maryland (Washington D.C. area)

Distributors in principal cities (Listed in Telephone Directory under "Recording Equipment")
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INTERNATIONAL RECTIFIER

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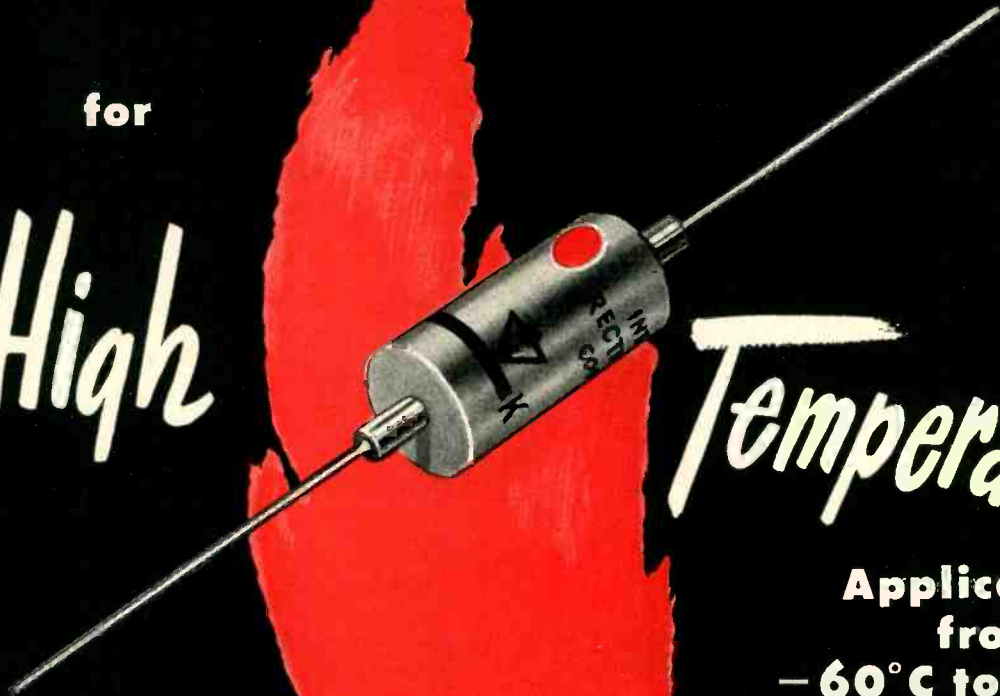
"RED DOT"

Germanium Diodes

for

High

Temperature



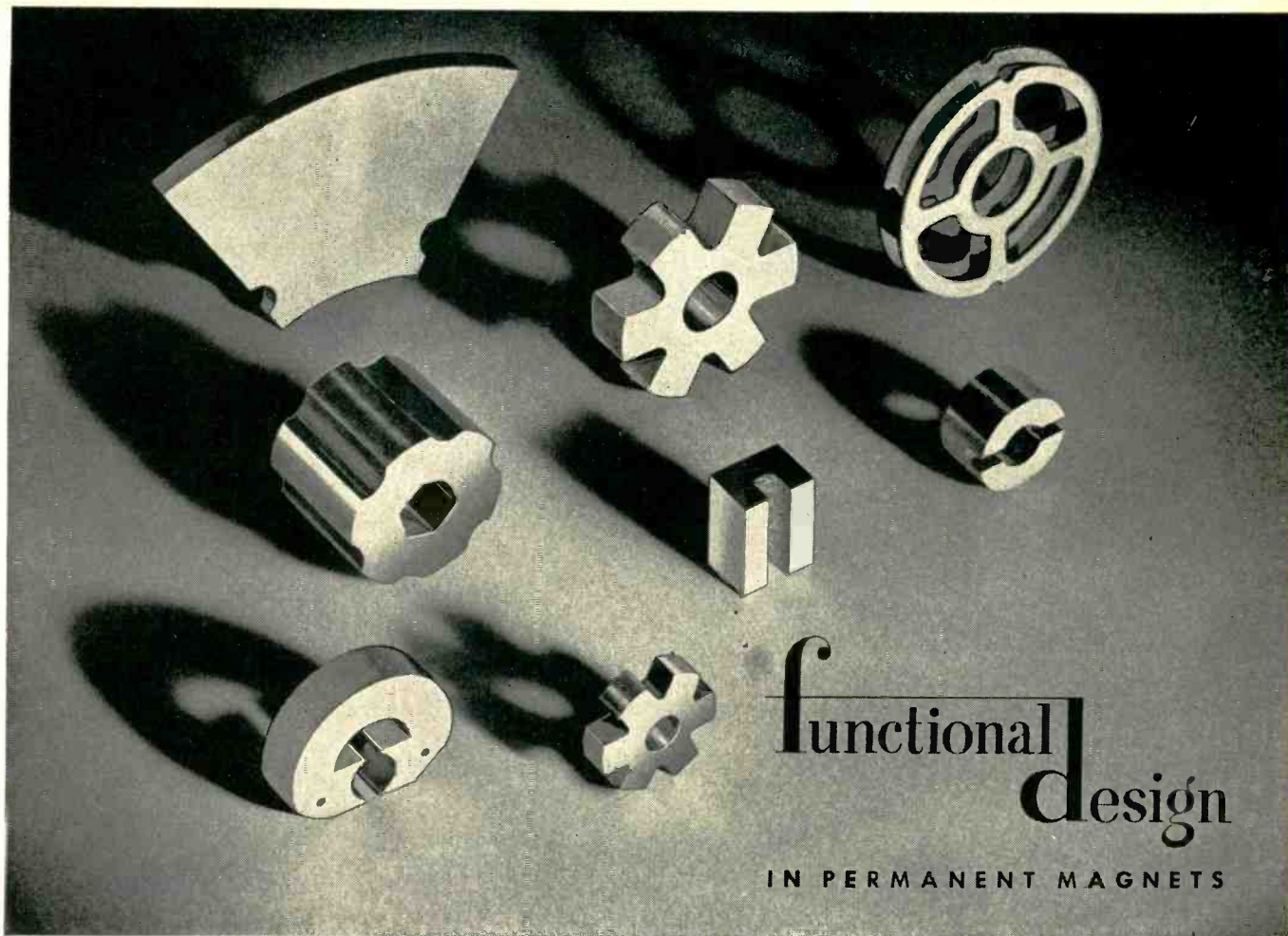
For complete information on "RED DOT" high temperature germanium diodes to meet your particular specifications, write Dept. C for Bulletin ER-191.

**Applications
from
-60°C to +100°C**
AVAILABLE NOW!
INTERNATIONAL RECTIFIER CORPORATION's newly developed "RED DOT" series of germanium diodes with superior forward and reverse characteristics at temperatures to 100°C.

INTERNATIONAL RECTIFIER

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Why SOUND, FUNCTIONAL MAGNET DESIGN

guarantees superior product performance

Magnets must be "tailored" to your product . . . tailored in size, shape, and the material used . . . if greatest efficiency, at the lowest possible cost, is to be expected.

The magnet assemblies shown above are typical of such "tailoring." Those used in test meters, for example, are designed specifically to maintain a magnetic field of uniform high energy, so necessary to the precise operation of such meters.

Others—for holding applications—are designed so that their magnetic circuits provide the

greatest possible tractive power. In applications where the magnet acts on moving parts of an assembly, still different designs may be required.

Our engineers—specialists in permanent magnet design and application—welcome the opportunity to assist you with your designs. For their recommendations—without cost or obligation—write us today. Or return the coupon below for a free copy of the helpful article, "Selecting the Proper Permanent Magnet Material for Your Product."

THE INDIANA STEEL PRODUCTS COMPANY
Valparaiso, Indiana

**World's Largest Manufacturer
of Permanent Magnets**

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MAGNETS**

The Indiana Steel Products Co., Dept. 9A
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Please send me a free copy of "Selecting the Proper Permanent Magnet Material for Your Product."

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NEW




VIDEO TRANSMISSION TEST EQUIPMENT



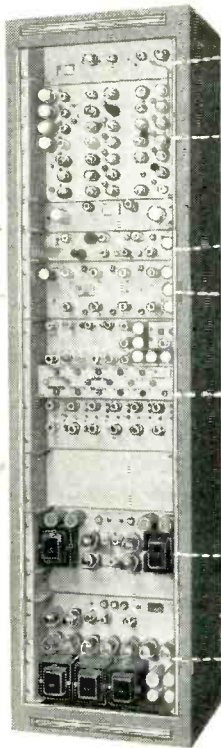
1041-BR STAIR STEP GENERATOR (Variable)
Checks lineary and grey scale output relationship in linear or non-linear system. Built-in color carrier generator may be added to steps. Back porch burst allows lock-in to 3.58 MC color equipment.



1071-AR WINDOW GENERATOR (Variable)
Determines ringing, smears, steps, low frequency tilt, phase shift, mismatched terminations, etc. in TV signals or systems.



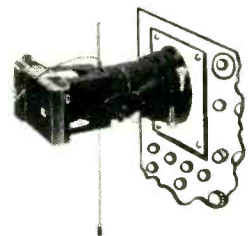
1070-BR MULTI-BURST FREQUENCY GENERATOR (13 freq. selectable from .5 to 6 MC)
Checks wide band coaxial cables, microwave links, individual units, and complete TV systems for frequency response characteristics. Produces six frequencies simultaneously plus white bar reference. Switchable color burst on back porch.



- AUTOMATIC FREQUENCY CONTROL 304AR
- COMPOSITE SYNC GENERATOR 303BR
- STAIR-STEP GENERATOR
- WINDOW GENERATOR
- MULTI-BURST FREQUENCY GENERATOR
- REGULATED POWER SUPPLY 512AR
- REGULATED POWER SUPPLY 613BR

New Telechrome equipment designed to provide test signals for precise checking of video facilities.

This equipment is now in use by major networks, TV stations, and the Bell Telephone System. This type of equipment was recently described by H. Gronberg of NBC before the NARTB Engineering Conference in Chicago. These units are available individually or as an integrated system with 75 ohm or 110 ohm balanced output.



OSCILLOSCOPE CAMERA
MODEL 1521-A (Polaroid Land Type)

for instantaneous 1-to-1 ratio photo-recording of these or other test signals.

MODEL 608-A HI-LO CROSS FILTER
MODEL 524-D OSCILLOSCOPE



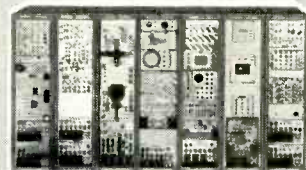
Chromalyzer



Chromascope (Signal Certification)



Phase Slope (Envelope Delay) Curve Tracer



Full facilities Transmits, receives, monitors, analyzes composite color pictures

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



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

New "Airbrasive" cutting method solves many tricky cutting problems

CUTTING BY IMPINGEMENT of carefully graded abrasive particles in a very fine stream propelled by CO₂ or other dry, inert gas — that's the new "AIRBRASIVE" method.

As applied with the S.S.WHITE INDUSTRIAL "AIRBRASIVE" Unit, the method is subject to close control and can be readily adapted for mass production, where relatively small quantities of material are to be removed.

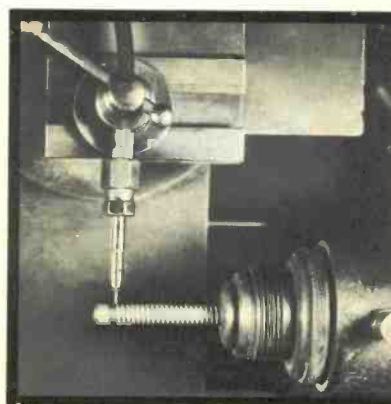
Already, the "AIRBRASIVE" Unit is doing a variety of unusual cutting jobs for industry, many of which could not be done as well — or at all — by previously available methods.

Typical of the cutting operations for which the "AIRBRASIVE" Unit is especially well suited are those illustrated.

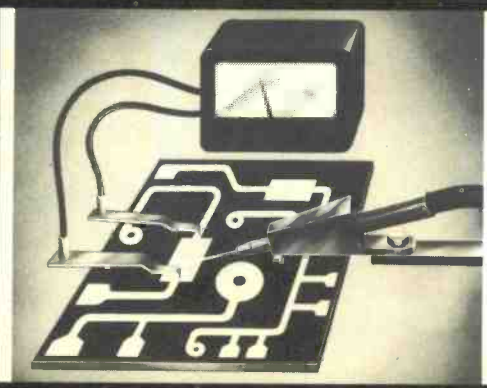
Other applications include:

- Controlled removal of coatings on glass, ceramic and other surfaces.
- Cutting germanium and other hard, brittle materials.
- Etching on glass and metal.
- Producing matte finish on glass and metal.
- Light deburring from inside or outside.

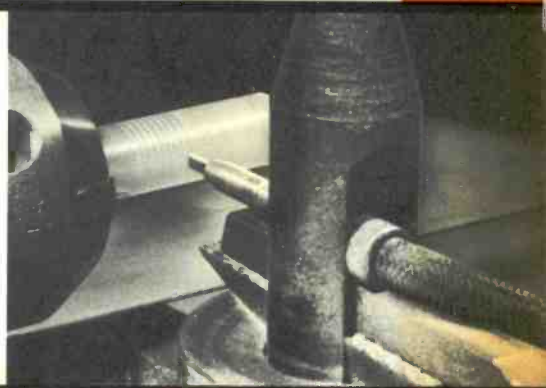
THE *S.S. White* INDUSTRIAL DIVISION
DENTAL MFG. CO.  10 EAST 40TH ST.
NEW YORK 16, N. Y.
WESTERN DISTRICT OFFICE • TIMES BUILDING, LONG BEACH, CALIFORNIA



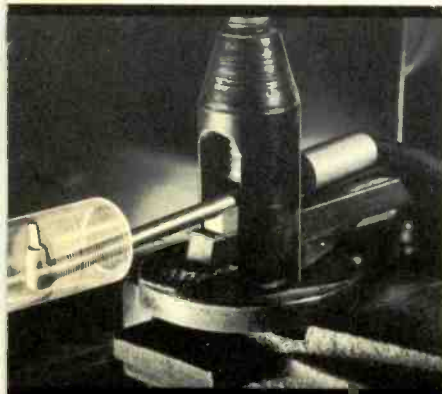
Cutting spiral grooves in carbon resistor with automatic set-up on lathe.



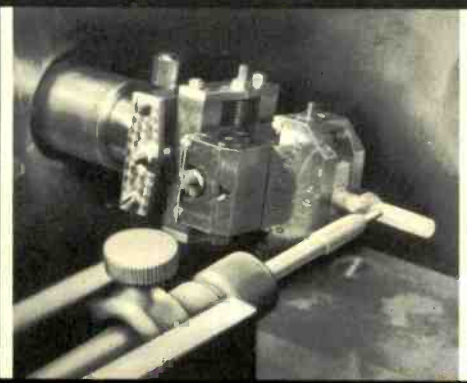
Abrading printed resistors using device that automatically controls resistance value.



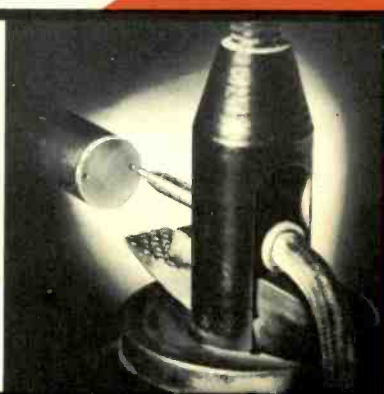
Cutting double thread about .005" deep on ground glass tubing.



Cutting inside thread in glass tubing of 1/2" inside diameter.



Cutting fragile crystals into accurate cylinders with no danger of fracture.



Drilling a contact depression in a quartz disc .030" dia. .015" deep.

**TURN
THE
PAGE**  

for a description of the S.S. White "AIRBRASIVE" Unit and a summary of the advantages offered by the "AIRBRASIVE" method of cutting.

Here's all there is
to operating the

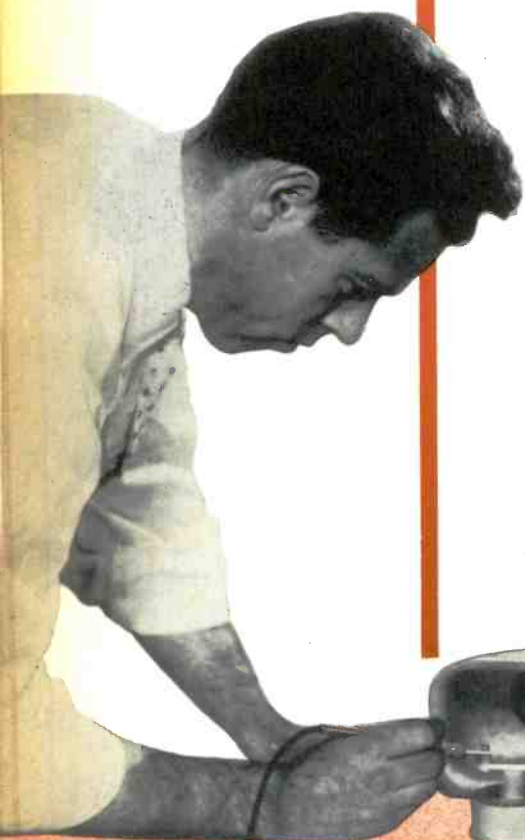
S.S. White

INDUSTRIAL "AIRBRASIVE" UNIT

Contrary to what you might expect, the equipment for applying the versatile "AIRBRASIVE" cutting method is surprisingly simple and correspondingly inexpensive.

The "AIRBRASIVE" Unit measures a compact 12" x 18" x 12". Weighing only 44 pounds, it is readily portable. All you do is plug in its cord to a source of 110 Volt, 60 Cycle A.C. current and connect its tubing to a cylinder of *dry*, inert gas — CO₂, nitrogen or air — never oxygen.

Everything you need is supplied with the unit except the gas cylinder and the dust collecting device. Nozzles of various types are available. The abrasive generally used is aluminum oxide of carefully controlled particle size.



"AIRBRASIVE" CUTTING ADVANTAGES

- There's no heat — no vibration — no shock.
- Pressure on the work is negligible.
- Cutting agent is always sharp.
- Cutting is unaffected by irregularities in surface of work.
- Depth and width of cut are subject to close control.
- High cutting rates are generally possible.

Will "AIRBRASIVE" cutting benefit you?

We'll be glad to help you get the answer. If you're near our New York City or Long Beach, Calif. offices, bring in sample parts for a trial. Or, send us the parts with a statement of your requirements. There's no obligation for this service.

For "AIRBRASIVE" details in print...

write today for a copy of Bulletin 5307. Dept. EB.



THE *S.S. White* INDUSTRIAL DIVISION
DENTAL MFG. CO.

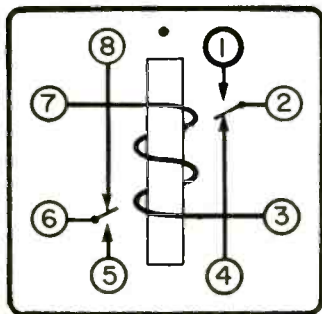


10 East 40th Street, New York 16, N.Y.

WESTERN DISTRICT OFFICE • TIMES BUILDING, LONG BEACH, CALIFORNIA

IRON FIREMAN SENSITIVE RELAYS

Another new Iron Fireman product! These small current-sensitive DPDT relays operate positively where very little power is available, such as in vacuum tube circuits. Yet, their contacts will handle upwards of 200 watts. They are especially designed for dependable performance under adverse conditions of vibration, shock, temperature.



Typical relay circuit diagram

- ★ Exclusive new design
- ★ Resistant to shock and vibration
- ★ Hermetically sealed
- ★ Wide temperature range
- ★ Long life



Model No. MSR-300

Size: $1\frac{1}{8}$ " high; 1" wide

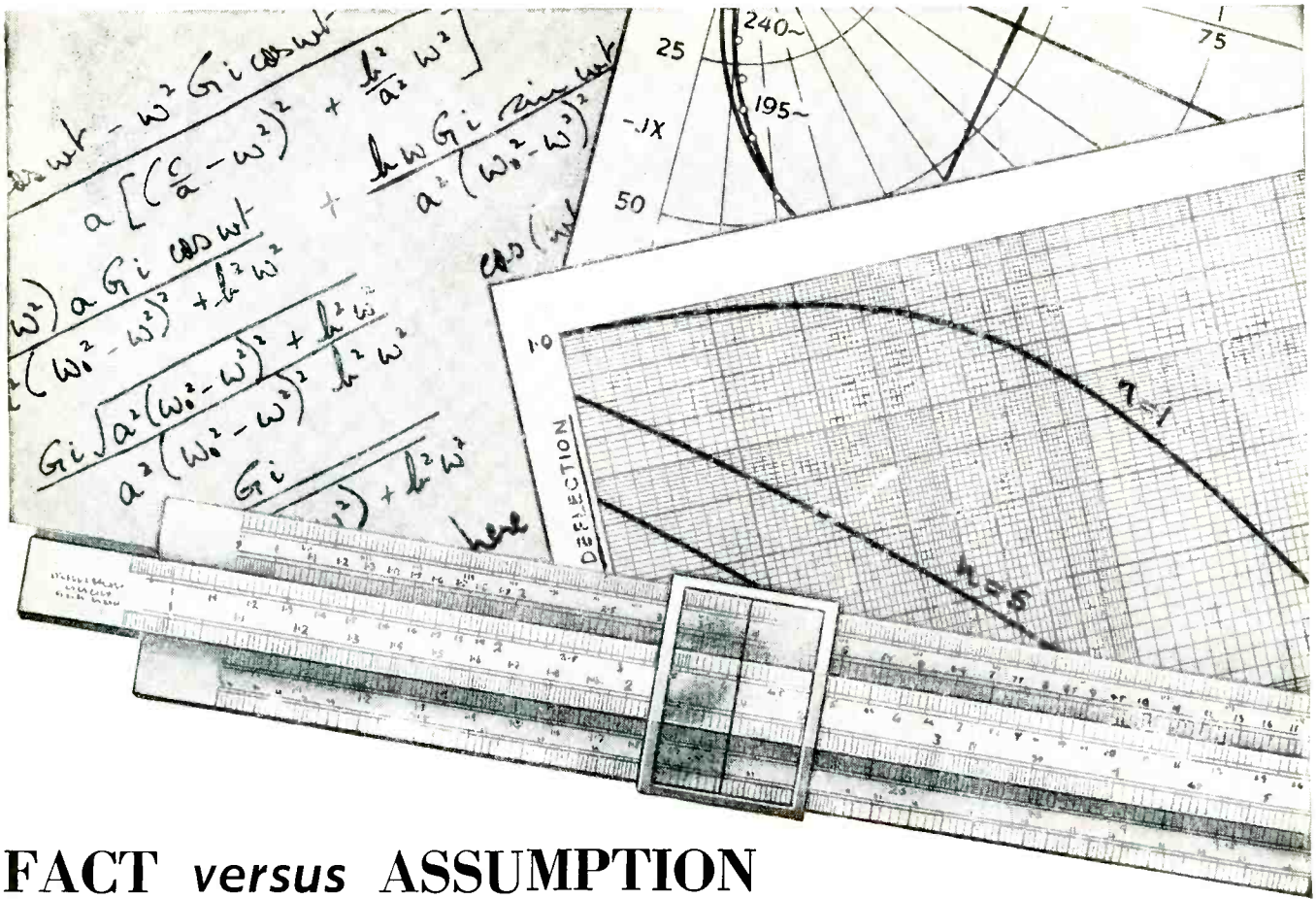
Meets requirements of
MIL-R-57-57-B

For more information on Sensitive Relays as well as Choppers and High-Speed Relays, write to:



Iron Fireman *Electronics*
DIVISION

2800 S. E. 9TH AVENUE, PORTLAND 2, OREGON



FACT versus ASSUMPTION

Vibration effects can be assessed by assumption, estimation and long calculation. Prototypes can be built on those assumptions, but with many anxious moments awaiting operational test results—results which may nullify months of patient effort. It is much simpler, and certainly more economical, to conduct preliminary tests in the laboratory by creating vibrations under controlled conditions—and so obtain the facts. That is the precise function of Goodmans Shakers. They provide vibratory sinusoidal forces at controlled frequency and amplitude, by which specific vibratory conditions over a wide frequency range can be accurately simulated, to assess their effects on materials, structures and components.

Applications include FATIGUE TESTING, ELECTRICAL COMPONENT TESTING, VALVE MICROPHONY TESTING, TORSIONAL VIBRATION TESTING, FLEXURE TESTING OF METALS AND PLASTICS ETC., and MECHANICAL STRUCTURE TESTING.

The range includes models from the 8/600 illustrated, developing a force of ± 300 lbs to the midget model with a force of ± 2 lbs.

GOODMANS

PERMANENT MAGNET SHAKERS

MAIL THIS COUPON

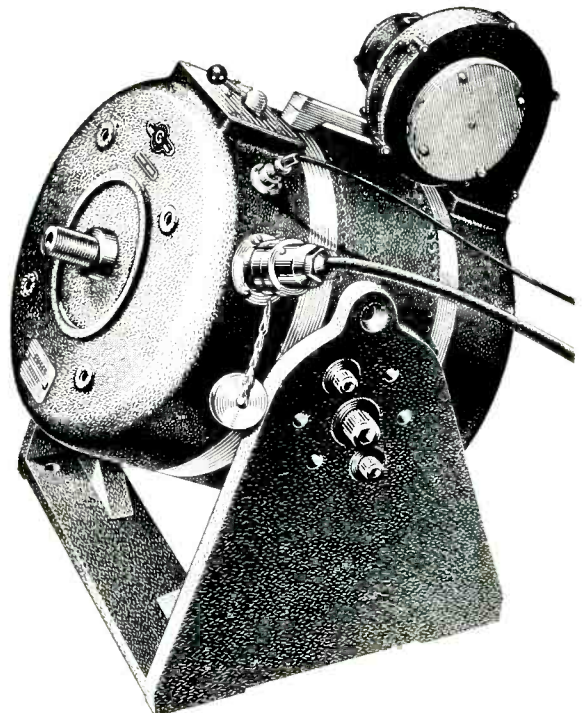
TO GOODMANS INDUSTRIES LIMITED
AXIOM WORKS, WEMBLEY, MIDDX., ENGLAND

Please mail me your catalogue and technical data sheets in connection with your PERMANENT MAGNET Shakers.

Name

Company

CITY ZONE STATE E/U



GOODMANS INDUSTRIES LTD.

AXIOM WORKS • WEMBLEY • MIDDX • ENGLAND

Cables: GOODAXIOM WEMBLEY, MIDDX.

Rectifiers utilized in rugged electric fence chargers



SELENIUM RECTIFIERS
help keep livestock "Home on the Range"



Type 8Y1 (illustrated) for half wave applications; 130 volts RMS and 30 MA DC.

The electric fence chargers manufactured by Northern Signal Co., Saukville, Wis., are subjected to extremes of stifling heat or icy cold, yet they must still deliver a measured shock of strong intensity—.0004 seconds on, one second off . . . And frequently when installed in barns they are exposed to ammoniacal fumes.

An important reason why the chargers are proving so effective under such rigorous conditions is that in each control unit is a "Really Reliable" RRco. selenium rectifier, Type 8Y1, whose size happens to be only a 1/2" cubed!

All Radio Receptor rectifiers, ranging from the smallest ones such as 8Y1, all the way up to the large power stacks required by heavy industry, have an inherent ruggedness that makes them ideal for duty under just such adverse conditions as this.

If you'd like data on some specific problem in rectification, drop us a line without obligation. And make sure to request our new 24 page rectifier bulletin No. 177-E-2.

We also manufacture Germanium Diodes and Transistors.

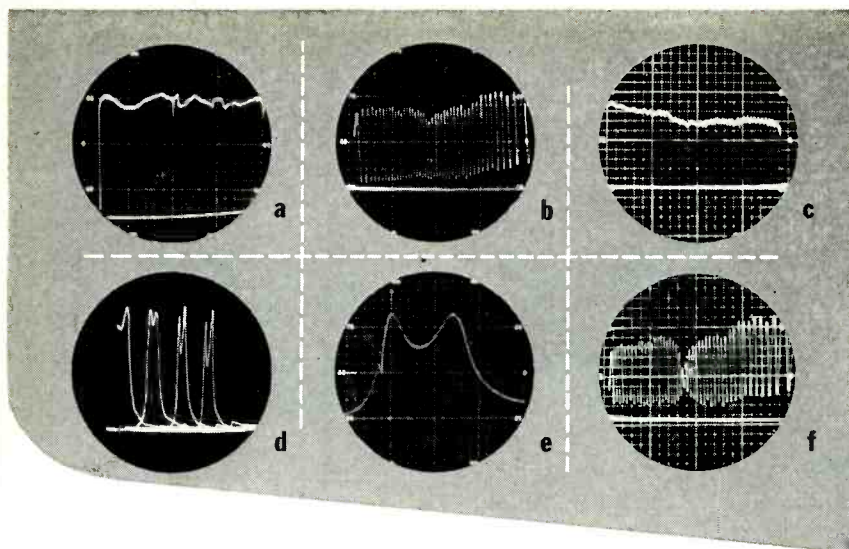
Semi-Conductor Division

RADIO RECEPTOR COMPANY, INC.

In Radio and Electronics Since 1922

SALES OFFICES: 251 WEST 19TH STREET, NEW YORK 11, N. Y.
TELEPHONE: WATKINS 4-3633 • FACTORIES IN BROOKLYN, N. Y.





**470 to 890 MC. CHARACTERISTICS
TAKEN WITH 2144-02 GENERATOR**

- a) Detected output of sweep generator, showing marker at 650 mcs.
- b) VSWR display of unterminated transmission line.
- c) VSWR display of terminated transmission line.
- d) Preselector responses of UHF tuner at channels 14, 20, 30 and 40.
- e) Preselector response of tuner at channel 50, expanded on scope.
- f) Input VSWR display of tuner at channel 50.

**now sweep over 400 mc.
at UHF without tuning**

New Kollsman TYPE 2144 Wide Range Sweep Generator

SPECIFICATIONS

Frequency Range	2144-01	225 to 420 mc.
	2144-02	470 to 890 mc.
	2144-03	850 to 1275 mc.
Minimum Power Output		10 milliwatts
Output Impedance		50 ohms
Maximum Source VSWR		1.25
Amplitude Linearity		± 1 db.
Marker Frequency Calibration		5 mc.
Marker Frequency Accuracy	2144-01	± 1 mc.
	2144-02	± 1.5 mc.
	2144-03	± 2 mc.
Sweep Rate		60 cycle
Tube Complement		6AF4, 6J6, OA2, 6X4
Primary Power		117 volts, 60 cycles, 60 watts

Also Available—Step Attenuator TYPE 2171-01

SPECIFICATIONS

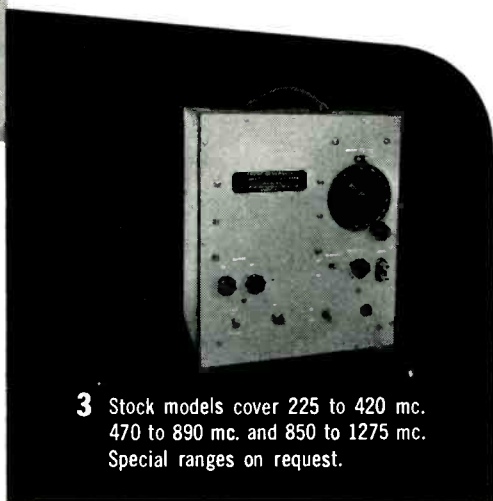
Insertion Loss	Less than ½ db.
Attenuation Steps	0, 3, 6, 9, 12, 15, 20, 30, 40, 50, 60, 70, db.
Frequency Range	DC to 1000 mc.
Maximum VSWR	1.2
Other Attenuation Steps Available	



Write FOR COMPLETE INFORMATION ON
KOLLSMAN TYPE 2144 SWEEP GENERATORS
AND TYPE 2171 ATTENUATORS.



80-06 45th AVE., ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.



3 Stock models cover 225 to 420 mc.
470 to 890 mc. and 850 to 1275 mc.
Special ranges on request.

**THE TYPE 2144 SWEEP GENERATOR
SIMPLIFIES LABORATORY
AND PRODUCTION MEASUREMENTS**

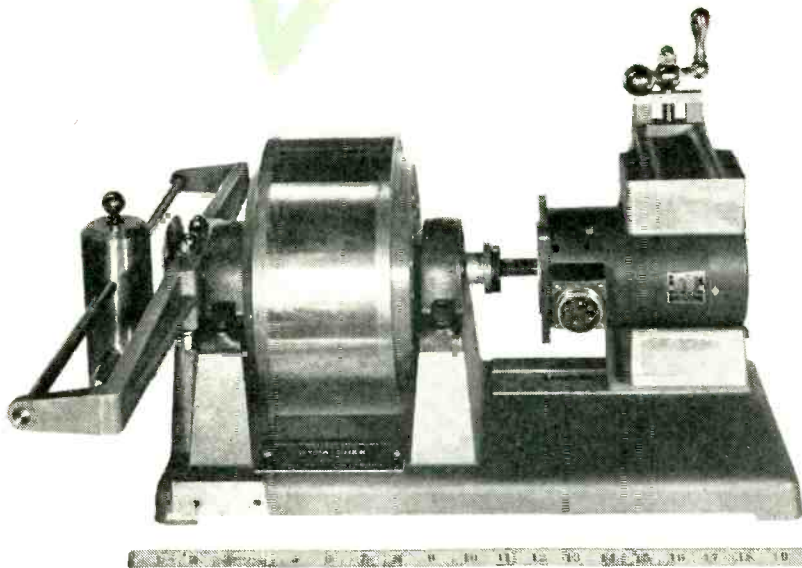
- Instantaneous display of frequency response, impedance or VSWR over 400 mc. without test equipment adjustment.
- Simultaneous observation of desired and spurious receiver responses.
- Display antenna characteristics over entire operating band.

WITH THESE DESIRABLE FEATURES

- 50 ohm output.
- Low source VSWR and amplitude non linearity.
- Passive variable marker for stable, accurate frequency indication, with easily read dial.
- Oscilloscope horizontal sweep signal and base line retrace blanking.
- 60 cycle sweep rate for easy observation.
- Voltage regulation minimizes effect of line voltage variation.
- Uses only standard plug in tubes.

For specialized electronic equipment...

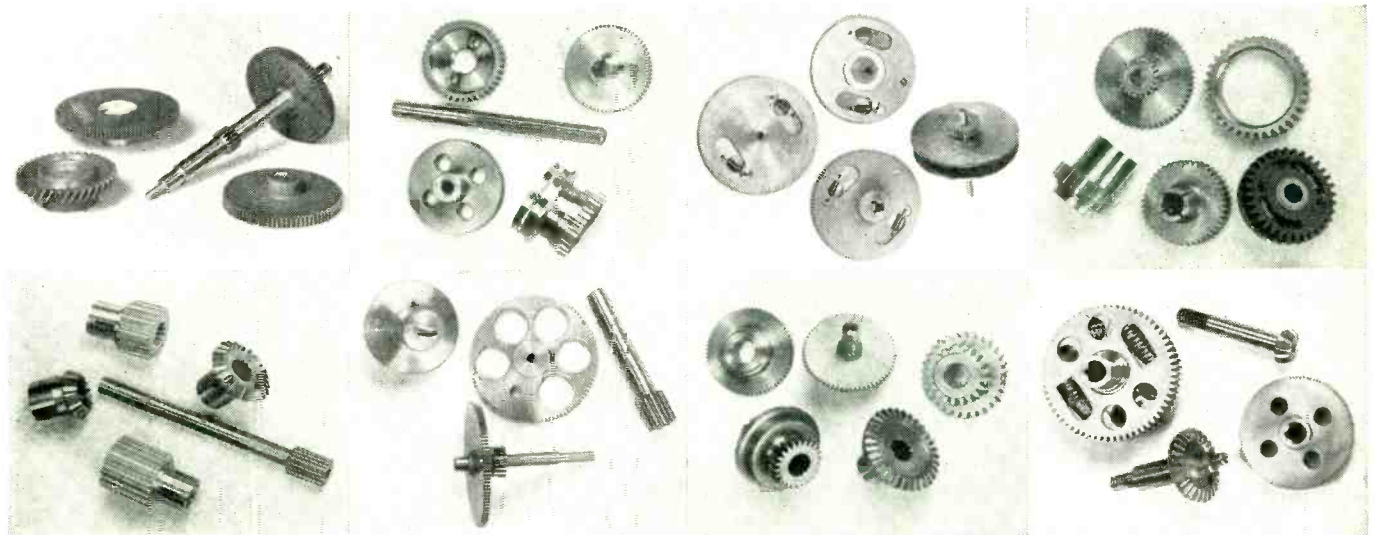
check Western Gear



Dyna-Chek

provides tested and proven accuracy in measuring the output of fractional and integral horsepower motors —

Model DM4 up to 1HP in continuous duty, and Model MDM for 1/10 HP or less. Manufactured by Mission-Western Engineers, Inc.,* Dyna-Chek provides a simple and convenient method of motor testing. Two types of broad range speed measuring equipment available as extra accessories, both supplying a high degree of accuracy. For information, address Mission-Western Engineers, Inc., 132 W. Colorado, Pasadena 1, Calif.



HIGH PRECISION GEARS and precision fine pitch

gearing from 200 to 6 diametral pitch and dimensions from .125" to 10" diameter. Western Gear Works makes available complete engineering and manufacturing facilities for the application of high precision gearing and gear drives in electronics equipment. For assistance without obligation write Executive Offices, Western Gear Works, P.O. Box 182, Lynwood, Calif.

5422

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WESTERN GEAR

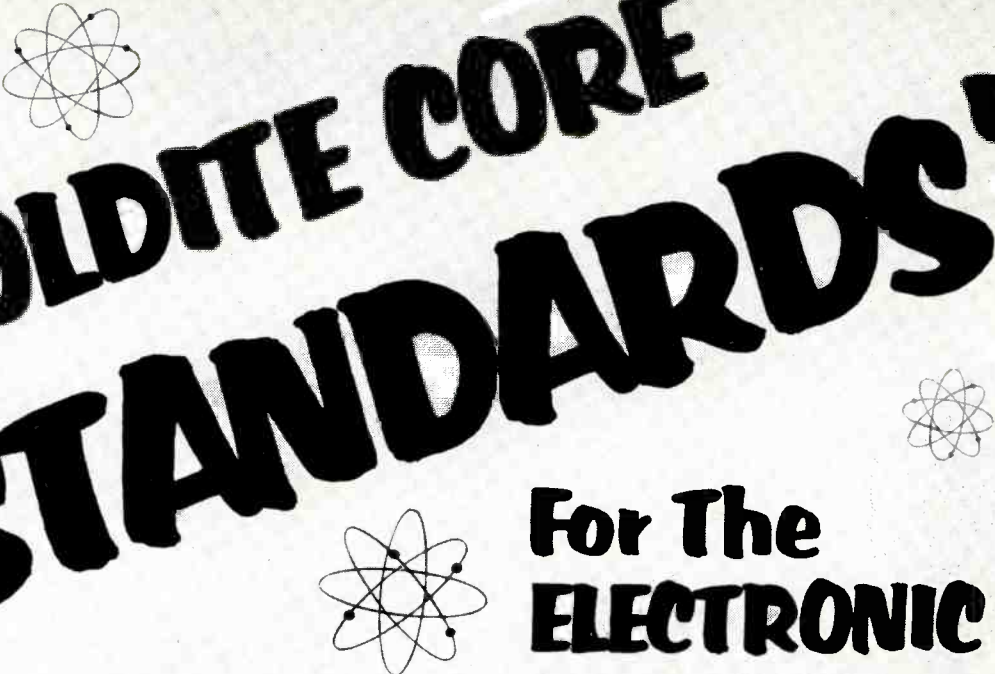
WORKS

PACIFIC-WESTERN PRODUCTS | POWER TRANSMISSION GEARS • MACHINERY •

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* An affiliate of Western Gear Works, since 1888 a leader in the mechanical power transmission field.

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MOLDITE CORE "STANDARDS"

For The ELECTRONIC INDUSTRY

Moldite has taken the initiative in establishing accepted electrical standards long required by the electronic industry. Every coil and set manufacturer, every engineer has designed coils to utilize Moldite "standards".

The reasons are obvious. *Moldite Core Standards Offer . . .*

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MOLDED COIL FORMS
MOLDITE
MAGNETIC IRON CORES**

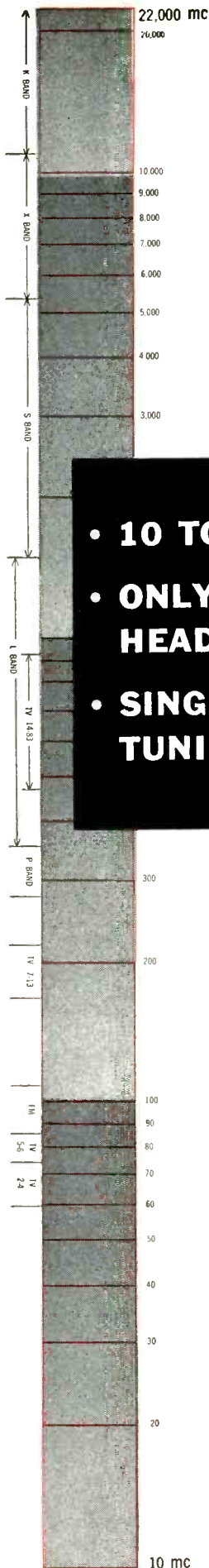
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NEW! PORTABLE DIRECT READING SPECTRUM ANALYZER



- 10 TO 22,000 MCS
- ONLY 3 R. F. HEADS
- SINGLE DIAL TUNING



MODEL TSA

Now, a new Polarad spectrum analyzer only 21 inches high that covers the entire frequency range 10 to 22,000 mcs with but 3 interchangeable R-F tuning heads. The model TSA operates simply—single dial frequency control—with utmost frequency stability. It provides highest accuracy, and reliability for observation and true evaluation of performance over the entire R-F spectrum—saving engineering manhours.

This instrument is designed for maximum utility and versatility in the laboratory and on the production line providing an easy-to-read 5 inch CRT display of the R-F spectrum.

The model TSA Spectrum Analyzer has these exclusive Polarad design and operating features:

- Single frequency control with direct reading dial. No klystron modes to set. Tuning dial accuracy 1%.
- Only three interchangeable R-F tuning units for the entire frequency range 10 to 22,000 mcs.
- Temperature compensation of Klystron Oscillator.
- Swept IF provides 250 kc to 25 mc display independent of R-F frequency setting.
- Internal R-F attenuator.
- Frequency marker for measuring frequency differences from 100 kc to 25 mc.

Write today to your nearest Polarad representative, or directly to the factory for complete information.

Model No.	Equipment
Model TSA.....	Spectrum Display and Power Supply
Model STU-1...	R-F Tuning Unit 10-1,000 mc.
Model STU-2...	R-F Tuning Unit 910-4,560 mc.
Model STU-3...	R-F Tuning Unit 4,370-22,000 mc.

SPECIFICATIONS:

Frequency Range:	10 mc to 22,000 mc
Frequency Accuracy:	1%
Resolution:	20 kc
Frequency Dispersion:	Electronically controlled, continuously adjustable from 50 kc/in. to 7 mc/in.
Input Impedance:	50 ohms
Over-all Gain:	120 db
Attenuation:	RF.....Internal: 120 db continuously variable IF.....60 db continuously variable
Input Power:	400 watts



ELECTRONICS CORPORATION

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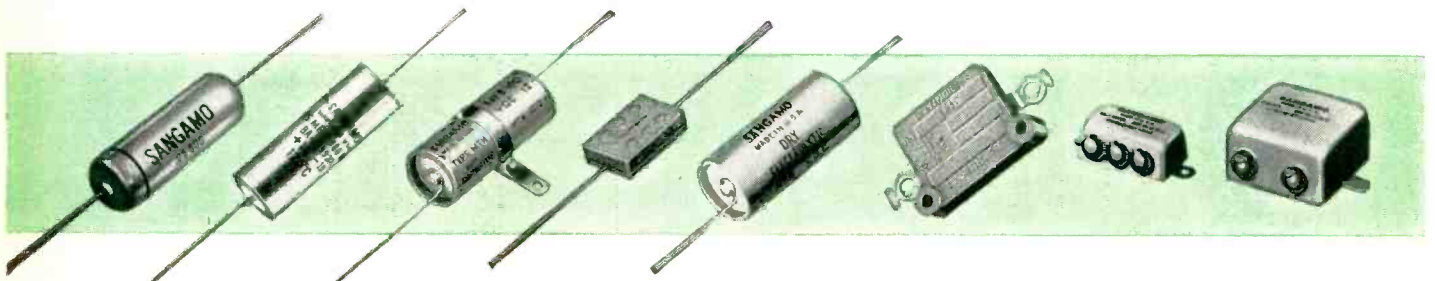
Credentials that Qualify

...that's why **IBM** uses Sangamo

The amazingly complex IBM "702" electronic calculator is hailed as the fastest and most flexible commercial data processing system ever devised. The central Arithmetical and Logical Unit performs calculations and makes decisions at a rate of more than 10,000,000 operations in an hour. Data and instructions for processing are stored in an electrostatic memory bank of cathode ray storage tubes. Output can be in the form of punch cards at the rate of 100 per minute.

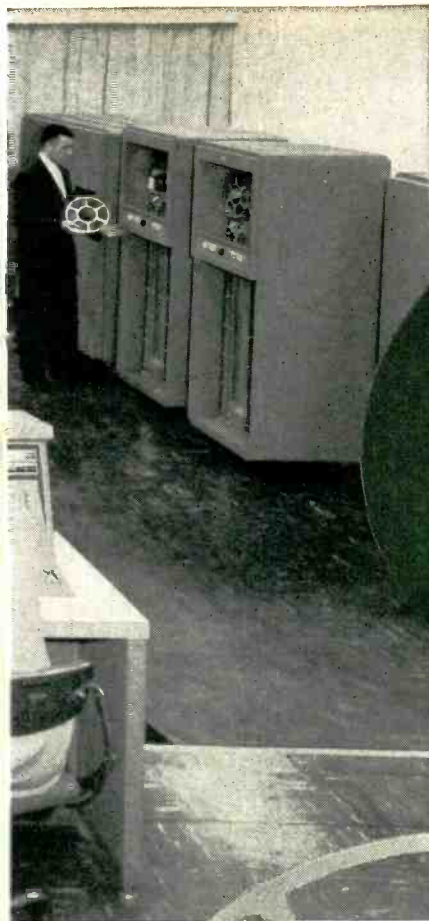
A machine like this needs components that assure maximum performance to meet its exacting demands. That's why several different types of Sangamo Capacitors are used in the 702.

If you need capacitors for demanding electronic applications, Sangamo engineers can help you. You can choose from a complete line of paper, mica, electrolytic and button capacitors for every industrial, electronic, and radio application.



SANGAMO ELECTRIC COMPANY

MARION, ILLINOIS



**SANGAMO
CAPACITORS**

**Longer Life
at High Temperatures**

**Stability
Under All Conditions**

Capacitors in the new 702



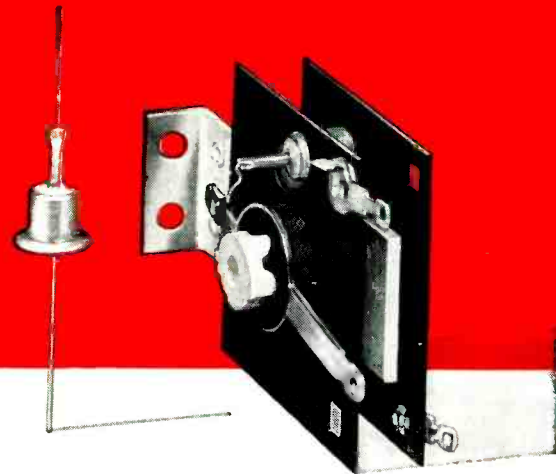
Those who know...  choose Sangamo

G. E.'s LATEST CONTRIBUTION TO



STACKED

**CUSTOM BUILT TO PROVIDE
143 POWER COMBINATIONS!**



- ★ **Smallest unit size yet developed!**
- ★ **Most reliable performance of any rectifier within this category!**
- ★ **Hermetically sealed for lifetime use!**

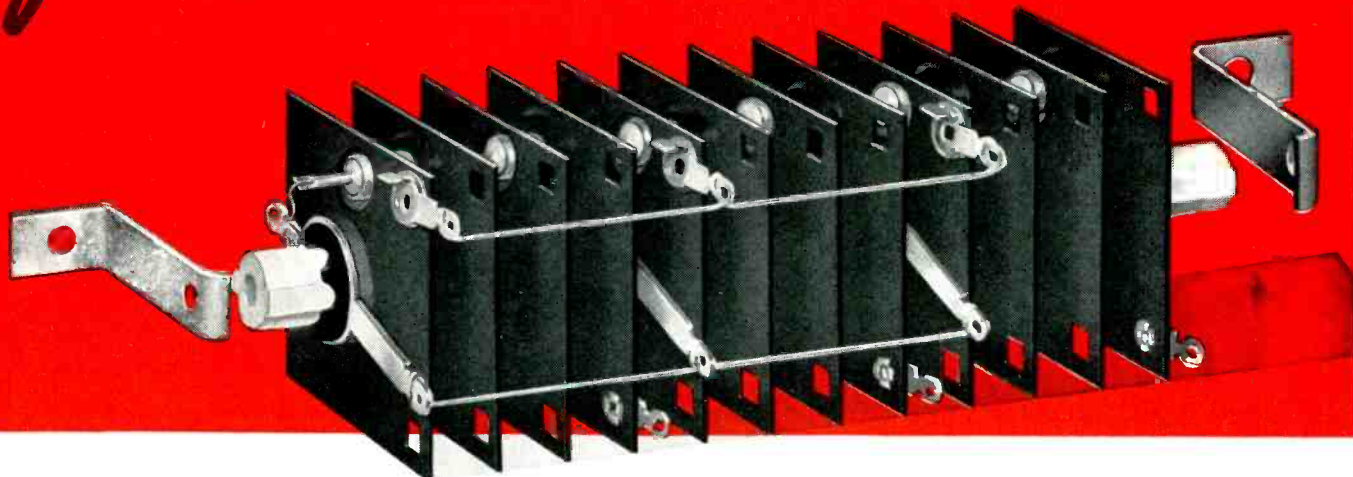
The following germanium rectifier stacks, each occupying a volume of only 1.62" x 2.5" x 6.00", are typical of the 143 standard stacks in G. E.'s new rectifier line.

CIRCUIT	D.C. OUTPUT (55°C Resistive Load)
Half Wave	2 amps @ 280 volts or 3 amps @ 190 volts
Full Wave Center Tap	2 amps @ 280 volts or 3 amps @ 190 volts
Full Wave Bridge	1 amp @ 565 volts or 3 amps @ 210 volts
Three Phase Half Wave	1.12 amps @ 420 volts or 4.5 amps @ 140 volts
Three Phase Bridge	1.3 amps @ 575 volts or 2.6 amps @ 280 volts
Three Phase Star	1.8 amps @ 280 volts or 3.6 amps @ 140 volts



THE PROGRESS OF POWER...

Germanium **RECTIFIERS**



Plus **IMMEDIATE DELIVERY**

General Electric leads the industry again! Announcement of this revolutionary G-E Stacked Germanium Rectifier opens up new avenues of power progress that were heretofore thought impossible to travel. Now, the amazing total of 143 power combinations has been provided with this one product! Your specifications requiring series or parallel stacks in single or polyphase circuits are custom-completed at G-E's factory.

This unit is smaller, weighs less, is more reliable, lasts longer, has better power ratings than any other dry rectifier made *any place by any other company*. AND, G.E. offers you *immediate delivery*.

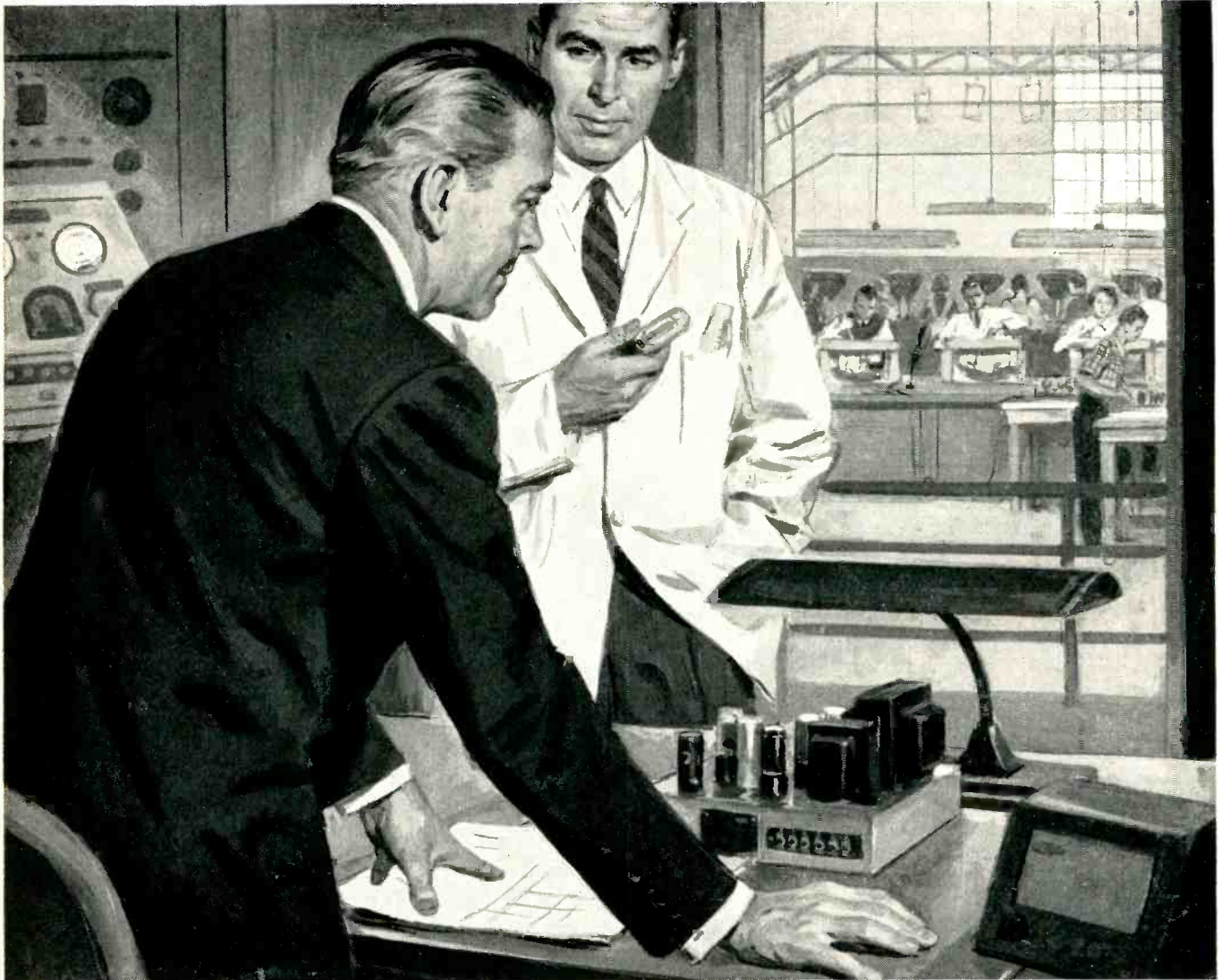
Designed and built to deliver new *power performance*, the G-E Stacked Rectifier is 75% less by volume and weight than any other comparable dry type rectifier. And, rectifier losses are reduced to one-third or less of those encountered with any other type of rectifier. You can count on extreme reliability . . . tested for compliance to 10,000-hour standards. Note also that there are no forming or aging effects.

WRITE US TODAY! GET ALL THE FACTS ON THIS IMPORTANT NEW PRODUCT!
General Electric Company, Section X4894,
Electronics Park, Syracuse, New York



★ ★ **GENERAL**  **ELECTRIC**

TO AVOID LOSSES ON OBSOLETE PARTS



Ship American Airlines AIRFREIGHT

The Most Experienced Air Cargo Service Assures You of Expert Handling

Today, many manufacturers have found they can maintain production with only a fraction of the inventories that were once required. Warehousing costs are reduced; less capital is tied up, and, most important, they can make quicker engineering modifications without obsoleting huge stocks of component parts. They accomplish all this by specifying American Airfreight when they contract for supplies.

They have good reason for specifying American. With more experience and more service to more key industrial centers than any other Airline, American is better able to provide expert handling, prompt forwarding and dependable, on-time deliveries. American Airlines, Cargo Sales Division, 100 Park Ave., New York 17, N. Y.



AMERICAN AIRFREIGHT ALSO LEADS IN

SPEED—American's own terminals and special handling techniques provide prompt forwarding, on-time deliveries.

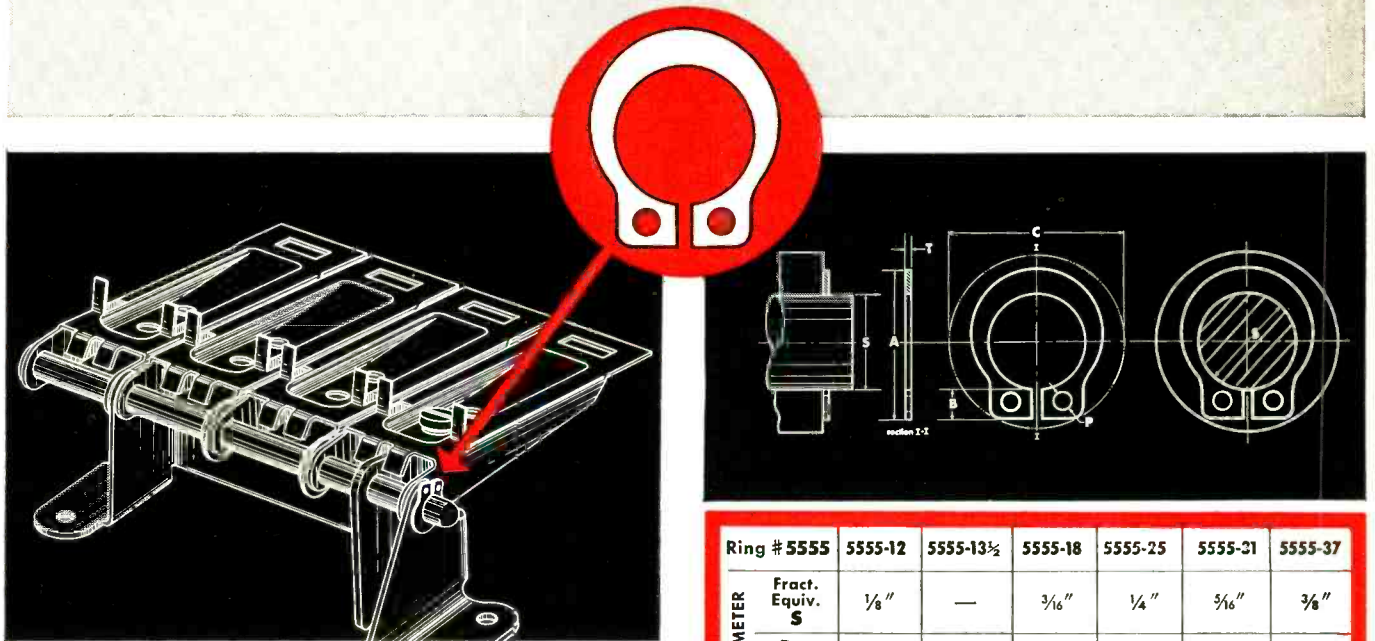
CAPACITY—American has the greatest cargo capacity of any Airline with the right space at the right places.

COVERAGE—American serves more leading industrial centers than any other Airline.

America's Leading Airline

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New Waldes Truarc GRIP Ring requires no groove, holds fast by friction, can be used over and over again



The Waldes Truarc Grip Ring is a new, low cost fastener that provides a positioning shoulder secure against moderate thrusts or vibration. Installed on a straight ungrooved shaft, the Truarc Grip Ring can be assembled and disassembled in either direction with Truarc pliers.

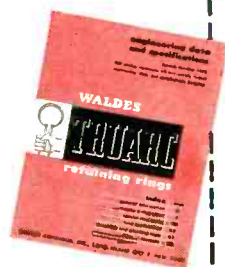
The Grip Ring can be installed tightly against a machine part in order to take up end-play. The basic Truarc design principle assuring complete circularity around periphery of the shaft and the ring's unusually large radial width combine to exert considerable frictional hold against axial displacement. The ring can be used again and again.

Find out what Waldes Truarc Retaining Rings can do for you. Send us your drawings. Waldes Truarc engineers will give your problems individual attention without obligation.

Ring #	5555-12	5555-13½	5555-18	5555-25	5555-31	5555-37	
SHAFT DIAMETER	Fract. Equiv. S	1/8"	—	3/16"	1/4"	5/16"	3/8"
	Dec. Equiv. S	.125	.136	.187	.250	.312	.375
	TOL.	±.002	±.002	±.002	±.002	±.003	±.003
RING DIMENSIONS	Thickness T	.025	.025	.035	.035	.042	.042
	TOL.	±.0015	±.0015	±.002	±.002	±.002	±.002
	Length A	.268	.285	.364	.437	.553	.626
	Lug B	.078	.078	.097	.097	.141	.141
	Hole P	.042	.042	.042	.042	.078	.078
	Min. Ring Clear C	.33	.34	.44	.50	.67	.73
Approx. Ultim. Thrust Load (lbs)	20	20	25	35	50	60	

SEND FOR NEW CATALOG

WALDES
TRUARC
REG. U. S. PAT. OFF.
RETAINING RINGS



WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK
WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,847; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,380; 2,483,382; 2,487,802; 2,487,803; 2,491,306; 2,509,081 AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N. Y. E-096

Please send me sample Grip-Rings (please specify shaft size _____)

Please send me the complete Waldes Truarc catalog.

(PLEASE PRINT)

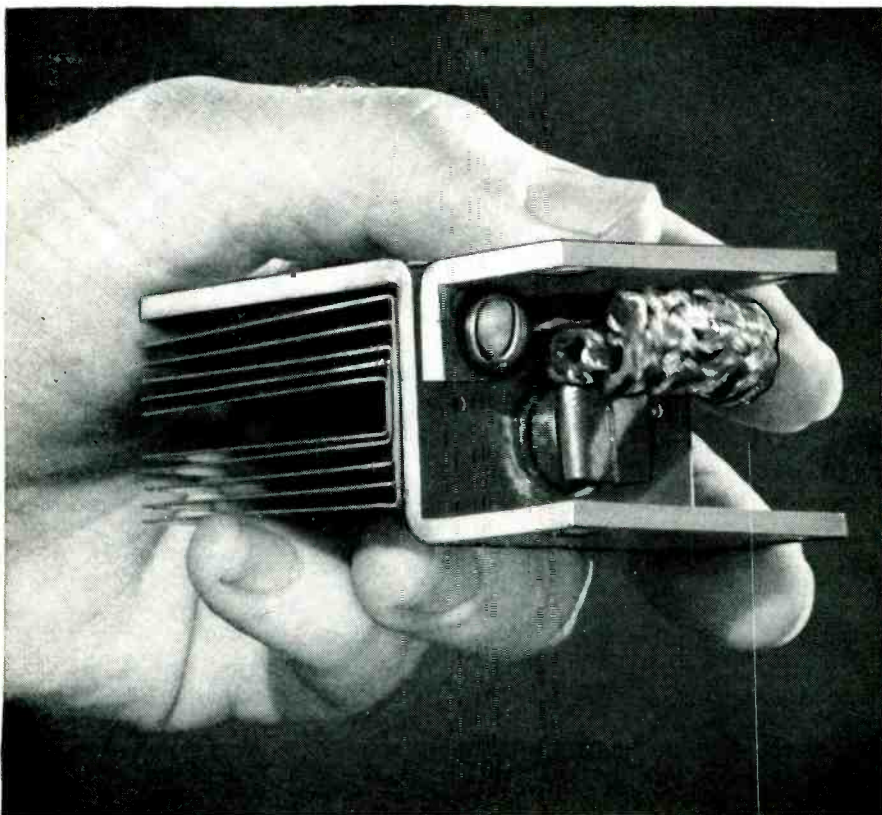
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THIS NEW MIDGET GERMANIUM RECTIFIER HAS AN OUTPUT OF OVER TWO KILOWATTS

Get High Power and Save Space With G-E Germanium Rectifiers

Germanium is a material to stimulate the imagination, so endless are its possible applications. Germanium rectifiers, pioneered by General Electric, offer design engineers tremendous possibilities for product improvement. Combining extreme compactness with the highest efficiency of any metallic rectifier known, G-E germanium cells show practically no aging. D-C power supplies for welders, battery chargers, and electrochemical processes are just a few of the possible applications.

COMPACT—The compactness of germanium rectifiers makes possible real savings in space, volume, and weight. The dime-sized cell, pictured above with its heat exchanger, has a rating of two kilowatts with air cooling at a rate of 1000 fpm. Six of these tiny rectifiers connected in a three-phase bridge will deliver up to

65 volts d-c with a rated capacity of over 14 kw. To do a comparable job with selenium would take six stacks of 30 cells each, or a total of 180 selenium plates.

OTHER RATINGS—Besides the rectifier illustrated above, two other types are available. One is a sealed convection-cooled unit with a half-wave rating of 0.4 amperes d-c output with up to 125 r.m.s. volts a-c input. A second is the plate-mounted convection or fan-cooled rectifier with half-wave ratings of from 4 to 20 amperes d-c output. All assemblies can be used in doubler, center-tap, and full-wave bridge circuits with corresponding increases in ratings.

MORE INFORMATION is available from your nearest G-E Apparatus Sales Office, or write Section 461-32, General Electric, Schenectady 5, N. Y.

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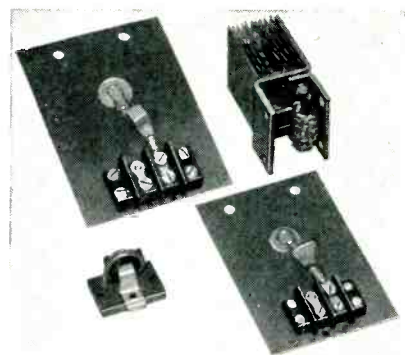
Germanium

The Rectifier of the Future
by C. E. Hamann

Seldom if ever has the rectifier industry experienced such widespread interest in a new development as has occurred with germanium. While much is being written of the capabilities of germanium in the low current area of diodes and transistors, its possibilities in high-power applications are equally amazing.

Perhaps a simple comparison with selenium of the relative current densities will serve to illustrate its fantastic properties as a power rectifier. It is standard industry practice to operate selenium in a 3-phase bridge circuit at a current density of 75 milliamperes per square centimeter of cell area. With an adequate air-cooling system this current density may safely be doubled.

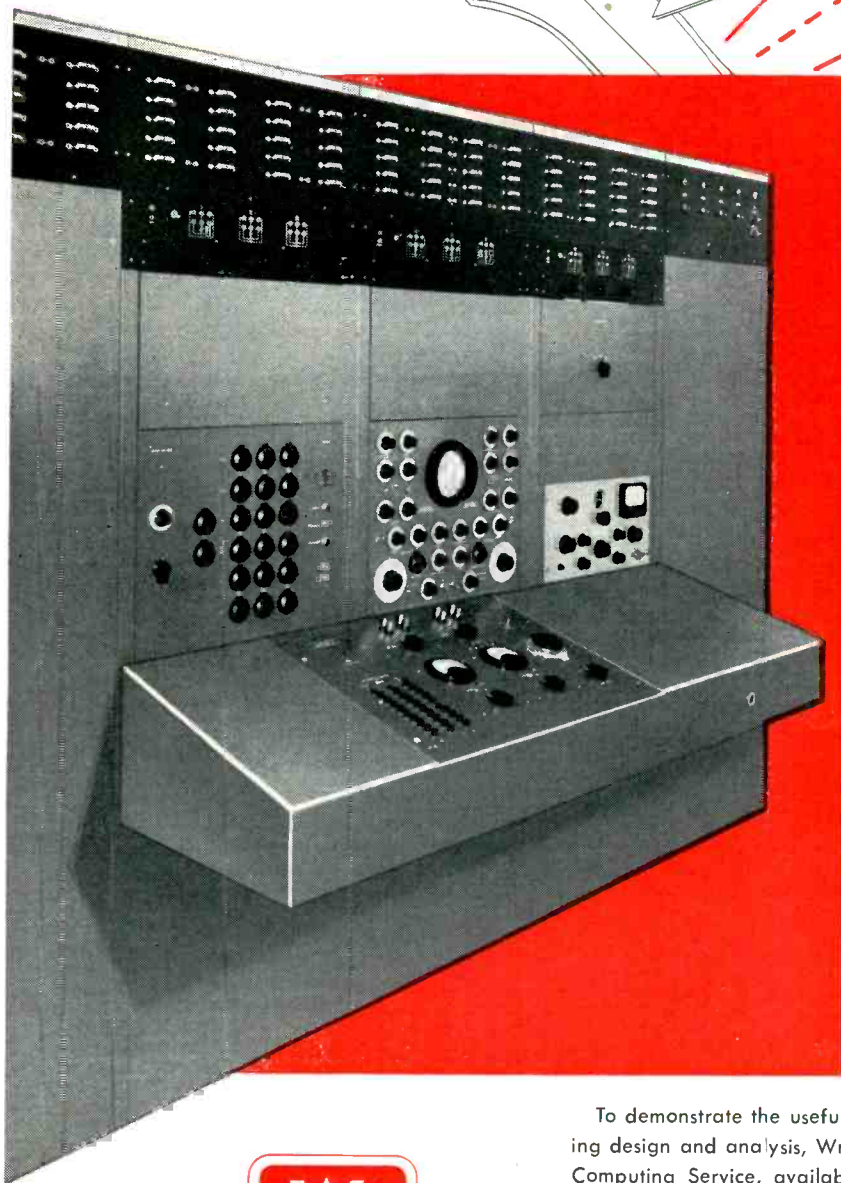
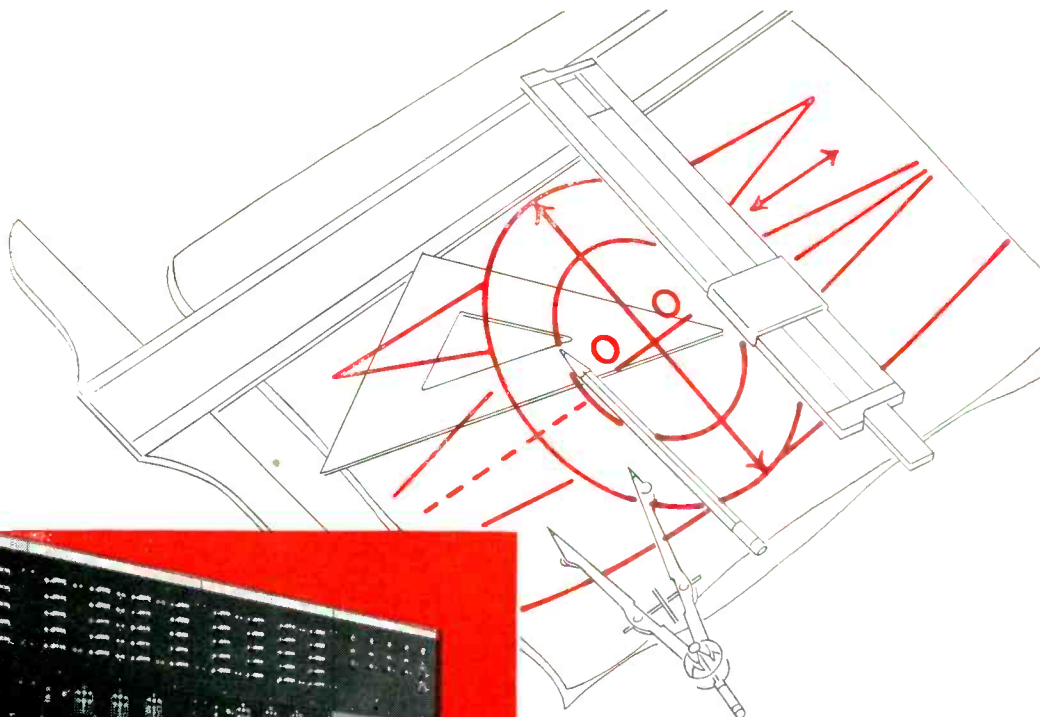
Germanium is presently being operated successfully at a current density of 75 amperes per square centimeter of cell area with every indication that



the top limit of capability has not yet been reached. Considering that germanium is also being operated at r.m.s. voltages per cell more than double that of the best available selenium, it will be seen that its power capabilities are at least 1000 times greater than selenium on a cell area basis.

The reason for this phenomenal ability lies in its inherently high efficiency which in turn means very little heat loss to be dissipated. The cell operating efficiency is in the range of 98 to 99 percent.

C. E. Hamann
General Electric Company



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Time...

REDUCE COSTS

Evaluation of design without actual construction of preliminary models is today an engineering necessity. The MILAC Analog Computer makes this short-cut possible by rapid solution of mathematical-electronic models of new systems or structures. Different approaches and solutions may be tried out more freely, for the cost of construction and test of prototypes for each design change is eliminated. Development costs and engineering man-hours are thus vastly reduced, for the MILAC accurately predicts and rules out faulty designs before final performance tests.

To demonstrate the usefulness of the MILAC Computer in engineering design and analysis, Wm. Miller Instruments maintains an Analog Computing Service, available for solution of either a single design problem or an overall development program.

Detailed information about either the MILAC Computer or the Analog Computing Service will be sent on request.



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A line drawing of a hand pointing towards a vacuum tube component. The tube is shown in a cutaway view, revealing internal structures like a filament and electrodes. The hand is positioned at the top left, with the index finger pointing towards the center of the tube.

**Get Less
Out-Gassing Here**

Vacuum-melting at pressures as low as one millionth part of atmospheric removes gases from metals. Components of electronic tubes, such as thyratrons, made with vacuum-melted metals have a new low level of dissolved and occluded gases. Result: faster pump down time . . . increased tube reliability . . . longer tube life. Write for more facts.

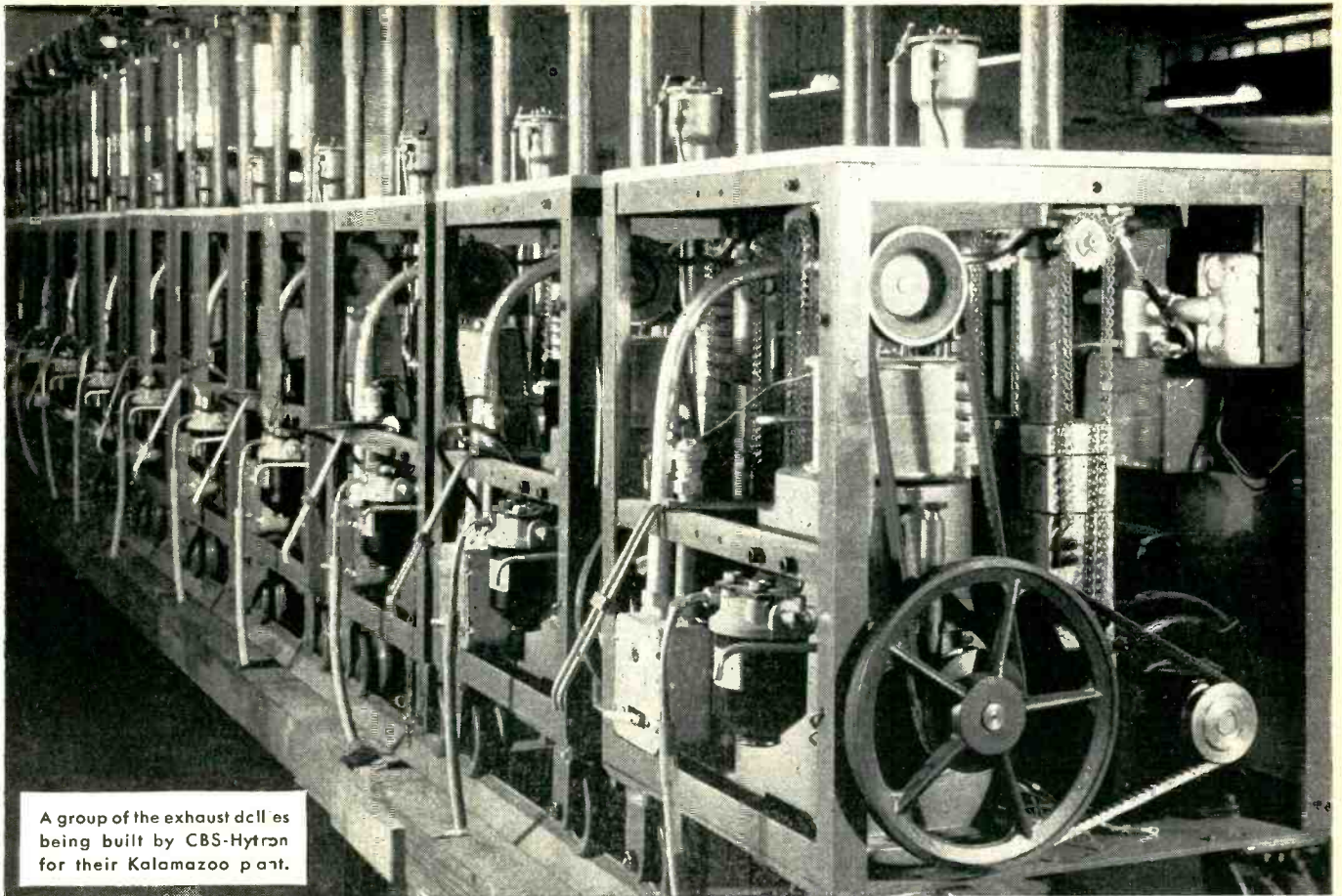
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Vacuum-Melted Metals
Now Available**

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Copper-chromium (.85% Cr.) alloy
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A group of the exhaust cells being built by CBS-Hytron for their Kalamazoo plant.

CBS-HYTRON SELECTS

Vibration-Free, Low Cost Performance of

**NRC
ROTARY
GAS
BALLAST
PUMPS**



Before ordering rotary vacuum pumps for their new Kalamazoo plant, CBS-Hytron ran evaluation tests to find what pump best met their needs. NRC Rotary Gas Ballast Pumps won hands down. Their vibration-free, low cost performance led to the purchase of more than 400 NRC units.

Behind these results is a design story that might well save you money, too. More efficient mechanically and with greater speed at low pressures, NRC Rotary Pumps permit mini-

mum blow back and leakage past pumping members. Result? They pull down *faster* from atmospheric to operating pressures. And since water vapor won't condense in an NRC pump, fast pump down time is *always* maintained and shrinkage reduced.

Easy to service, dependable to operate, users report NRC Gas Ballast Pumps have long life, low operating costs under the most adverse conditions.

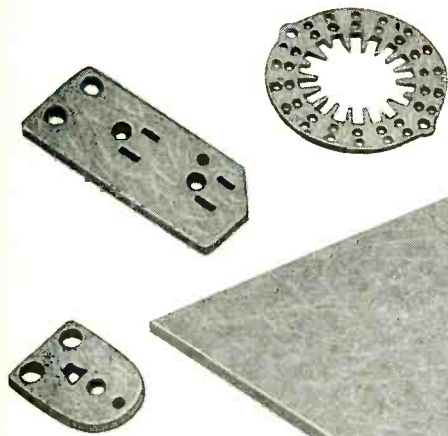


Send today for new Bulletin explaining the Gas Ballast principle plus complete operating and construction data.

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**GREATER ARC
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**A New
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Glass Fibre**

**Insulating Sheet - INSUROK[®]
XT-200**

• If you are looking for an insulating laminate that combines excellent electrical properties with good structural strength, consider this new Richardson laminate. INSUROK XT-200 is an excellent material for pole insulators, cable holders and switches, where arc resistance is important, as well as for motor-generators, transformers, switchgear, electroplating equipment, and various kinds of electrical and electronic heating devices. Moreover, INSUROK XT-200 has very satisfactory fabricating qualities. It is available in sheets 34" x 34", in thicknesses of 1/16", 1/8", and 1/4". The Richardson Company will be glad to supply further information and samples.

Send for Data Sheet XT-200

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- **EXCELLENT STRUCTURAL STRENGTH**
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- **LOW MOISTURE ABSORPTION**
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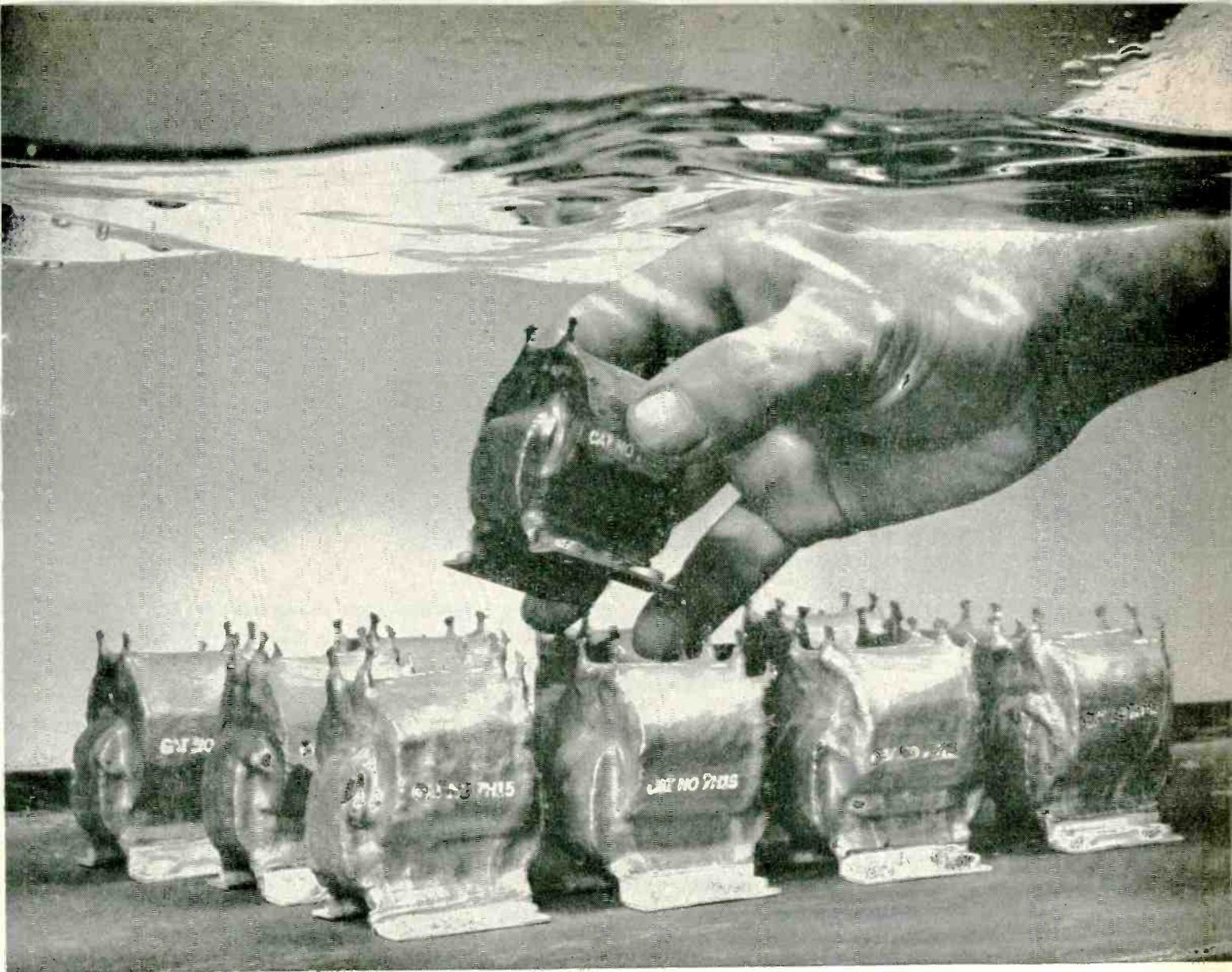
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Westinghouse Fosterite[®] Transformers must pass this 4-hour underwater test

If you're looking for a small, open-type transformer, fully protected against moisture, check the line of Westinghouse Fosterite impregnated transformers. This four-hour underwater test proves the point:

All Fosterite-treated transformers are completely submerged in hot water at 60° Centigrade for two hours, after which they are "thermal-shocked" in cold tap water, and soaked there for an additional two hours. An electrical test is then applied, in which each transformer must show an insulation resistance reading of at least 2000 megohms. Fosterite has to be good!

This is just one of many severe tests to which

Westinghouse specialty transformers are subjected. They assure you of quality that will meet your requirements exactly... quality that stands up under extreme conditions.

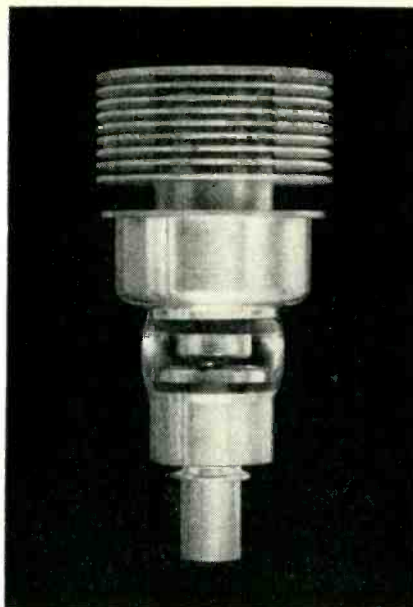
Fosterite impregnated and coated transformers can be made available to meet your most stringent specifications. In addition to moisture protection, Fosterite makes drastic weight reductions possible... as much as 30 to 50%, when compared to enclosed types.

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**Uniformity
Ruggedness
Reliability
make the**



MACHLETT 2C39A

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**New Standard for
Electrical Uniformity**

The ML-2C39A sets the highest standard of electrical uniformity for UHF planar triodes.

Close tolerance parallelism between electrodes prevents uneven heating at high frequencies, minimizes arcing.

Uniquely processed grid, mechanically stable at high temperatures, assures frequency stability over broadest range of operating conditions.

Machined emitter surfaces with extremely uniform oxide deposit assure optimum cathode emission as well as freedom from uneven, grid distorting, heat.

400% More Rugged

Average strength of the ML-2C39A is over 400% greater than *any other* 2C39A, as measured in torque and pry tests.

Unmatched Reliability

Quality in design, materials, and production techniques build superior reliability into the ML-2C39A.

Final inspection includes r-f oscillation in both test oscillators, and prototypes of field equipments, to assure tubes of high power output and long, trouble-free life.

**Electrical Characteristics
of ML-2C39A***

Heater voltage, 6.3 volts	Grid-plate capacitance, 2.0 uuf
Amplification factor, 100	Maximum frequency, 2500 mc/sec
Transconductance, 22,000 umhos	Useful power output, 12-35 watts

**Manufactured to JAN specifications.*

Also made by Machlett to highest quality specifications:
ML-381 for pulsed applications (3500 V peak; 3 microsecond pulse; 1/2% duty cycle) and the ML-322 clipper diode.

**For complete specifications and operating data, write to:
MACHLETT LABORATORIES, INC. • SPRINGDALE, CONN.**



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NOW—Tests Prove FORMULA 800--

*...the Only Adhesive
Preform that will bend
and act as a Conductive
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FORMULA 800 — extracted from epoxy resins. "EPO" can be used in preforms and for conductive or non-conductive small parts welding at 400° F. Wherever you are now using the parts method of bonding, investigate FORMULA 800. It possesses extremely high bonding strength, with no shrinkage, on metals to metals and metals to non-metals.

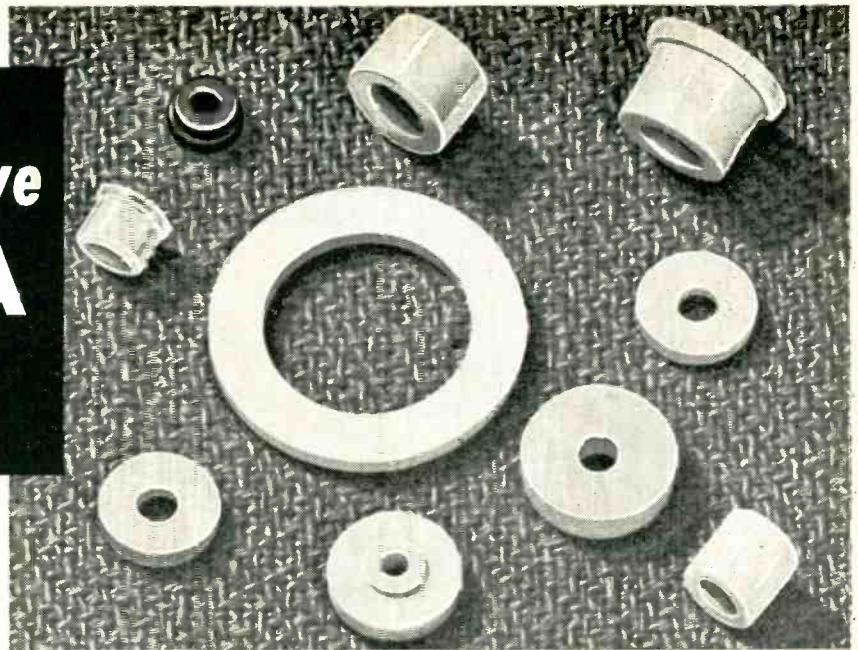
This is a new chemical-resistant material of construction that warrants your consideration when the properties of standard resin cements and coats are not adequate for the service you desire. For an adhesive preform or a small parts resin weld, it will pay you to contact Mansol.

- If you are still making your own preforms, Mansol would like to show you how to save money and eliminate rejects.
- Write to Dept. N for the complete story about preforms, FORMULA 800 and our production facilities. No obligation, of course.

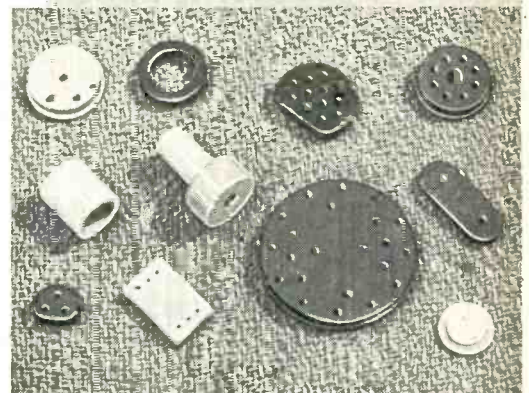


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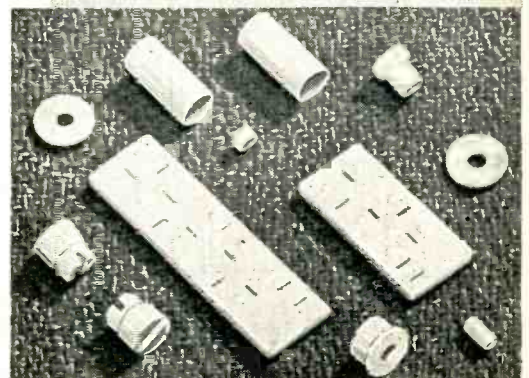
STEATITE PREFORMS — We specialize in small die-pressed ceramic parts held to closest tolerances. All tools and dies are made in our shop to assure quick delivery. For immediate attention to your requirements, contact Mansol today



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POWDERS
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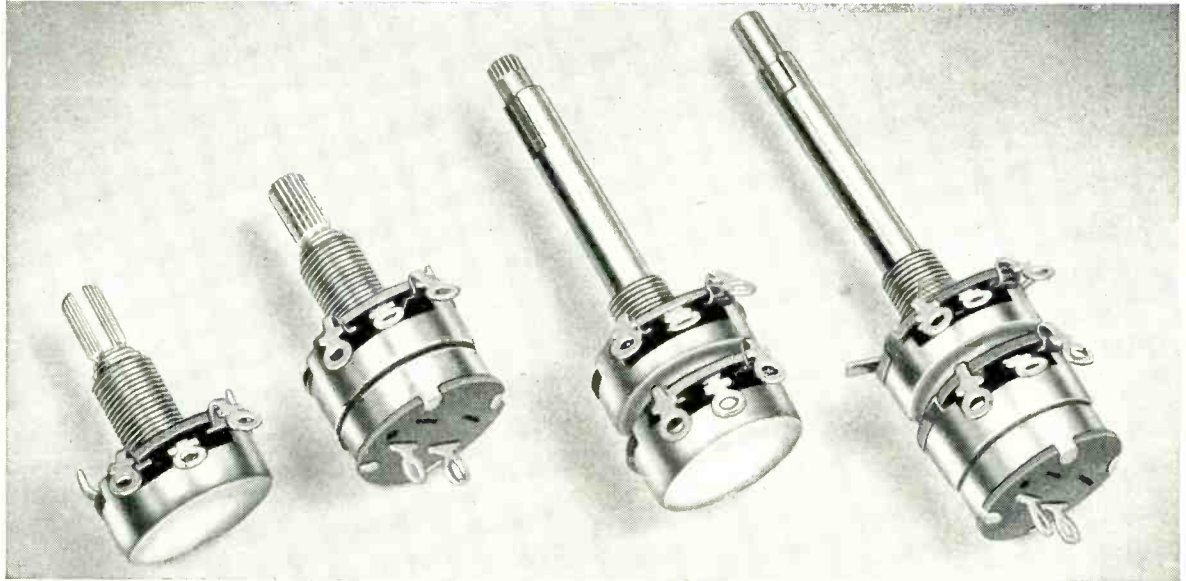


GLASS PREFORMS — The ideal preforms for Iron Sealing and Kovar Sealing, matching the expansion of these metals over their entire working range. They resist mercury attack, have ample mechanical strength, and seal readily. Our Laboratory is prepared to assist you in selecting the proper glass for any metal.





Stable, Low-Noise Carbon Controls in ANY Combination You Want



You don't have to compromise with quality to get the carbon controls your application requires. For Mallory Controls are available in a complete range of constructions, including single, dual concentric and dual tandem types . . . with or without switch.

Their noise level is unusually low, resistance values are unusually stable, and humidity drift is held to 10% . . . thanks to carbon elements with a high degree of surface smoothness and unusual density. Switches are built for long, trouble-free service, with special silver contactors and heavy gauge terminals.

Mallory Controls are built with ample ruggedness to stand any production line handling.

Expect more . . .

Get more

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MALLORY

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

Serving Industry with These Products:

- Electromechanical**—Resistors • Switches • Television Tuners • Vibrators
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They incorporate such mechanical features as welded assembly, vibration-proof clinched terminals, and heavy gauge fastenings.

Write today for the new catalog that describes all Mallory fixed and variable resistors . . . including both carbon and wire-wound types.



CUSTOM-BUILT CONTROLS

The control illustrated is typical of the many special types which Mallory manufactures. Designed for service adjustments in television receivers, it is a tab-mounted, bushingless model with a phenolic shaft . . . for especially economical mounting.

We'll be glad to consult with you on any special adaptations to fit your individual resistor requirements . . . also, to analyze your circuits for opportunities for resistor cost reduction.

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CROSS
TALK

► **WIRING . . .** As predicted, there has been a pronounced upturn in the use of mechanized wiring. Oddly enough, instrument makers are setting the pace, with more of them introducing it in new models than makers of mass-produced radio and television sets. Here, users tell us, are some reasons why:

Mechanized wiring reduces the possibility of expensive errors in the assembly of highly complex and delicate gear. Fixed dressing of leads permits the omission of certain component parts. It reduces the number of adjustments that have to be made on final test and simplifies calibration. Last but not least, it insures ruggedness in the field and reduces maintenance requirements.

► **MEDICINE . . .** Several people have traveled far out of their way recently to ask if we have heard of an electronic device designed to diagnose a wide variety of physical ills. We have indeed heard of such a device, for which very broad claims are made, but do not have sufficient information concerning it for evaluation. Nor do we know of anyone who does have sufficient information, engineer or medic.

A number of electronic devices have proven themselves effective in the hands of experienced diag-

nosticians, the most obvious of them being the fluoroscope, x-ray and electrocardiograph. Therapeutic usefulness is attributed in various degrees to such devices as diathermy and so-called shock-treatment machines. Certainly electronics will contribute heavily to the science of medicine in the future, in research, in diagnosis and perhaps even in therapy. But it should be noted that the devices specifically mentioned here perform highly specialized functions.

Nothing, not even electronics, promises a diagnostic much less a therapeutic cure-all.

► **TRANSISTORS . . .** Transistors are now being made in sufficient variety to make it clear that there may some day be as many different types as there are tubes.

Some effort is already being made within individual plants to avoid producing transistors with only slightly different characteristics. Several industry committees are trying to avoid a future log-jam by early standardization.

We have it on good authority that the basic difficulty at this time is due to inadequate knowledge of proper test procedures. A government bureau is working on the problem and may come up with some answers before the end of the year.

► **NOT BREAD ALONE . . .** Engineers move for money. But that bait is no longer enough; there are many fishermen.

Two phrases currently appearing in the technical help-wanted ads should bring bites. The first angles for "engineers who won't be held back." The second dangles "important engineering freedoms."

► **PLANT CURIOS . . .** In a factory devoted largely to the manufacture of airborne radar antennas the employees have apparently grown so accustomed to using magnesium that this extremely lightweight metal was more or less automatically used to make wedges employed as office doorstops. . .

A luggage manufacturer who makes waterproof cases for electronic equipment tests each one by shoving it under water heated to 160 degrees for several minutes to build up internal air pressure, then checking for leaks with a brush and soapsuds in a manner similar to that used by the corner gas station to find pinholes in innertubes. . . .

Highlight of a safety-poster competition for the children of employees in a western tube plant was one small fry's artistic effort, which pictured many little round red objects falling to the ground. The caption read "Beware of Apple Trees!"



Gravity method of geophysical exploration. Operator, left, is using a portable gravity meter, while jeep driver, right, keeps track of crew's location with odometer

Electronics in the

Increased quantity and quality of petroleum products result from use of electronic equipment for instrumentation, radiolocation, communications and automatic control. Applications are found in geophysical exploration, drilling, pipelining, refining, research and development, and marketing

By **JOHN M. CARROLL** *Associate Editor, ELECTRONICS*

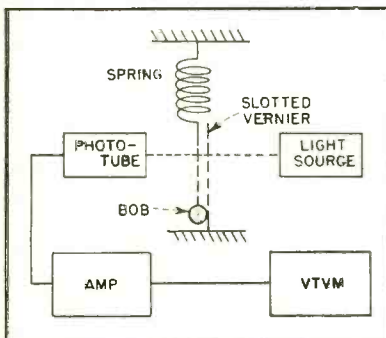


FIG. 1—Schematic of modern gravity meter. Sensitive photoelectric vernier permits measurement of minute changes in the earth's gravitational field

FROM THE DISCOVERY of crude oil to the marketing of refined products, electronics is important in the oil industry.

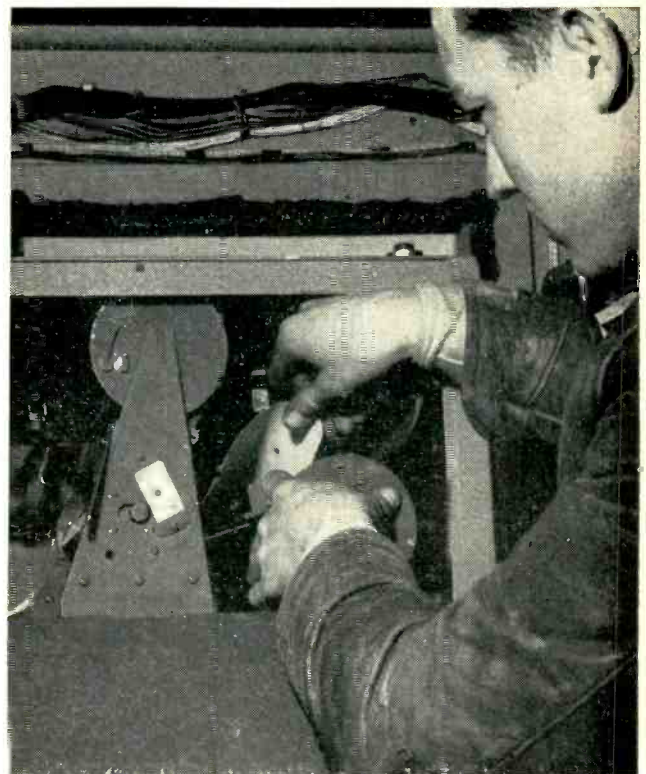
Geophysical instruments and radio navigation equipment make possible the discovery of new oil resources. Well-logging equipment aids in efficient exploitation of oil fields. Microwave and mobile radio both play important roles in pipeline operations, while oil refineries and development laboratories employ many electronic instruments and automatic control devices. In

marketing, electronics enters the picture through use of two-way radio.

The petroleum industry is the fourth largest American industry, with \$40 billion in gross assets and 1,700,000 employees. It is numbered among the growth industries from which great things are expected in the future.

Geophysical Exploration

Location of oil deposits by geophysical exploration involves the study of the physical character-



Seismic crew, left, unpacks portable amplifiers while operator, right, inserts photographic paper leader into recording oscillograph that is fed by the geophone amplifiers

Oil Industry

istics of subsurface formations. Four general methods of geophysical exploration involve (1) study of the earth's gravitational field within the area of interest, (2) study of the earth's magnetic field, (2) seismic study of the elastic properties of subsurface formations, and (4) the study of electrical properties. In 1953, 1,307 wells were geophysically surveyed.

Of these four techniques, the first three comprise the primary methods of petroleum geophysics. As of Dec. 31, 1953, 615 seismic crews, 87 gravity crews and 3 magnetometer crews were known to be in the field in the U. S. Electrical methods are of considerable importance in mineral exploration, but have had limited applications to date in petroleum exploration.

A fifth method of geophysical exploration involves study of the radioactive characteristics within

the area of interest by use of scintillation counters. This method has so far attained more prominence in the field of well-logging than in field exploration.

Gravity, Magnetic, Electrical

The gravity method of field exploration entails taking gravity-meter readings at various points. The modern gravity meter measures the earth's gravitational field by the deflection of a spring-suspended bob. A photoelectric vernier of the type illustrated in Fig. 1 may be employed to read minute variations in spring deflection. A photograph shows the use of a portable gravity meter in the field.

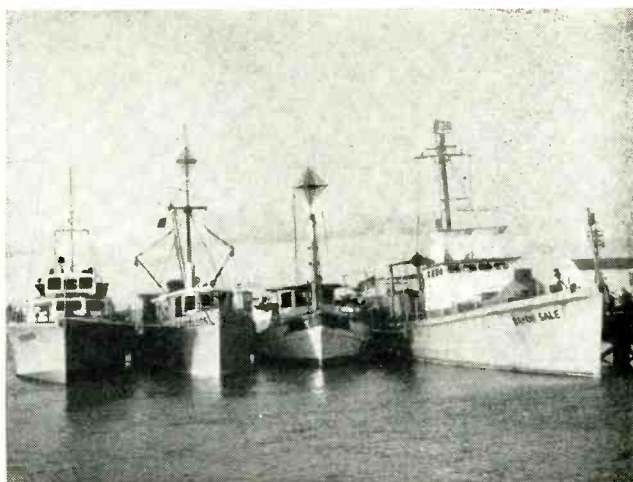
Magnetometric field survey requires taking a number of precise measurements of the earth's magnetic field from point-to-point within the area of interest. The ground magnetometer commonly

used is highly portable and set up like a surveyor's transit.

In areas where it would be difficult or impossible to operate a ground magnetometer crew, or in surveying operations where a rapid reconnaissance is required, the airborne magnetometer (ELECTRONICS, p 143, Oct. 1953) may be employed.

In field surveying it is important that the crews know their location precisely at all times. Survey jeeps are often equipped with odometers (ELECTRONICS, p 94, Nov. 1944) to determine location. In this device the pointer is moved north to south and east to west, and is geared to the jeep's transmission. Over a several mile survey, this instrument is accurate to about 100 ft.

There are two methods of electrical field surveying: the study of the reflection of radio waves set up by a discontinuity in the subsurface rocks; and the telluric



Seismographic operations in the Gulf of Mexico. Radar ship, left, keeps track of other ships in fleet. Target antennas mounted on ships anchored, right, provide positive radar identification

method that involves measurement of earth currents.

Seismic Methods

The seismic method is most widely used in present-day exploration. Electronic seismographs and special radio links were used when a-m broadcasting was in its infancy.

This method involves study of the seismic echoes reflected from geophysical interfaces in subsurface formations, or from geological beds. The seismic waves are generated by exploding a charge of dynamite in a shot hole.

The seismograph, which is generally truck mounted, records three quantities of interest: shock moment, or the exact time that an interruption of electrical current fires the charge of dynamite; the up-hole time or instant the elastic disturbance reaches the top of the shot hole; and the relative times at which echoes are received by pick-up devices called geophones.

Geophones are located on the earth's surface at some distance from the shot hole. The shot instant and up-hole time may be transmitted to the seismograph console by either land line or radio link.

Voice communication is also necessary to coordinate operations between recorder and shooter. This involves distances from a few thousand feet to ten or twelve miles. A seismic crew operating in off-shore waters may make extensive use of ship-to-ship and ship-to-shore radio for coordination.

The geophysical seismograph system consists essentially of three units. First is a detector, some type of geophone that is used to pick up the vibration at the earth surface. In land operations the geophones used are generally of the moving-coil type, while for underwater exploration crystal geophones are often employed. Second unit is an amplifier, while the third is the oscillograph to record the oscillation. The modern truck-mounted seismograph often has 24 channels.

The amplifier is the heart of the seismograph. The range of seismic frequencies is from 5 to 1,000 cps. Most of the useful reflection energy is contained in the band of frequencies extending from 20 to 100 cps. The first requirement of a geophysical amplifier is that it be flat within 3 db down to 5 cps.

All 24 amplifiers used in a truck-mounted seismograph must match with time differences between them of less than one millisecond. In audio work, component differences of 10 to 20 percent from rated values may be used without altering operation, but in seismic work tolerance requirements on the components are 1 to 2 percent. Seismic amplifiers have an overall gain of about 120 decibels, although only a small portion of this gain may actually be used.

The amplifiers are commonly R-C coupled and consist of three or more stages. Important is the input transformer that matches a 500-ohm geophone to the high-impedance grid circuit of the first tube.

Capacitances in the order of 25 to 50 microfarads are required for cathode by-pass to reduce attenuation and phase shift. Bias voltage may also be obtained from flashlight or specially constructed dry cells. In the circuit shown in Fig. 2, both battery and self bias is employed.

Filtering

A certain amount of filtering is usually done in seismic amplifiers. Equipment is usually peaked in the 20 to 80 cps range to take advantage of the predominant frequencies of the reflections and reduce interference. Low frequencies of from 5 to 20 cps may be filtered by a high-pass filter. However, the high-pass characteristics in the transformers, coupling capacitors, cathode capacitors and screen by-passes can accomplish the same result. High frequency interference caused by wind, hole blow or other high-frequency sources may be eliminated by low-pass filters. An automatic-gain-control circuit is incorporated to prevent excessive amplitudes and to balance all traces to the same order of magnitude. The agc should hold the signal nearly constant over an input signal range of at least 1,000 to 1.

Vacuum tubes used in the seismic amplifier shown are of the 12-v miniature type. They are provided with a center-tapped heater that permits operation from either 6.3 or 12.6-v supplies. The transformers used have windings of the hum-bucking type and are hermetically

sealed. The input transformer has a response not more than 1 db down at 2 cps and flat from 10 to 1,500 cps. It is shielded to reduce 60-cps hum pickup approximately 120 db.

Oscillographs used for recording are frequently of the optical type in which a beam of light is deflected across the surface of a photosensitive paper chart. A recent development has been the use of magnetic recording in seismic operations. Many times it is physically impossible or economically impractical to obtain a number of shots from one hole. It is advantageous in such situations to record a seismic record on magnetic tape, enabling the operator to play back the record at a later time under controlled conditions.

Radio Location

Electronic equipment for radio location is particularly important in off-shore exploration and drilling operations. Radio location methods include use of radar, shoran and phase comparison systems including Raydist, Lorac, loran and Decca. Radar is often employed by water-borne seismic crews.

In the Gulf of Mexico, radar is used to determine the position of geophysical survey boats, as a harbor-surveillance device in marine drilling operations and for de-

tecting changes in weather, such as line squalls or hurricanes. In 1953 some 26 radars were licensed to geophysical operators.

Parenthetically, the use of maritime radio and radar by the oil industry is also important. The tanker fleet consists of nearly a thousand ocean-going vessels of 2,000 gross tons or more. The industry has over 2,000 tank barges.

Shoran

The shoran system developed for aircraft guidance and precision bombing is in use in operations involving the airborne magnetometer and in water-borne operations on the continental shelf. Operations are conducted in the microwave band.

The transmitter sends out a short pulse that triggers an auxiliary transmitter. The beacon pulse is received at the base station and the distance to the object carrying it determined by the time delay between the original pulse and the pulse from the beacon. There are 32 shoran transmitters licensed to operate in the United States. These are operated by four companies, two oil companies and two service companies providing either radio surveying or complete geophysical service.

Two service companies now offer radio location service based on

phase comparison methods. Four networks have been licensed covering 275 miles along the Louisiana and Texas coast. Companies are the Hastings Instrument Co. who offer the Raydist service and Seismograph Service Co., offering the Lorac service.

Of the various types of Raydist, the type N system is generally used in geophysical work. This system requires only two narrow-band frequency assignments in the middle or low-frequency bands. The system is unsaturable. Any number of ships or vehicles can obtain position-fixing data simultaneously and continuously. It is illustrated in Fig. 3.

The heterodyne principle is used. The two transmitting stations have a frequency difference of about 400 cps. Position is obtained by comparing the phase of the heterodyne signal received directly at the

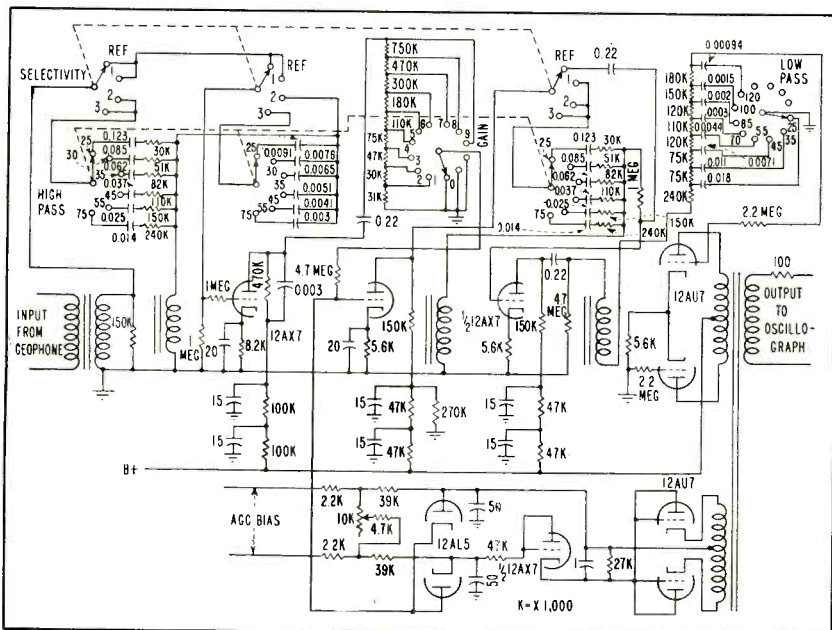


FIG. 2—Schematic diagram of a modern seismic amplifier. Instrument provides an overall gain of 120 db and responds to frequencies from 10 to 100 cps

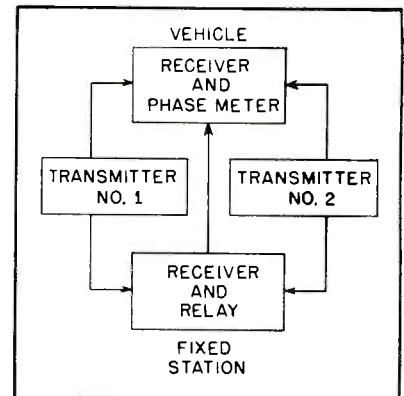


FIG. 3—Functional representation of c-w phase comparison system used for radio location in offshore exploration

vehicle with the phase received at the fixed station and relayed to the vehicle. The system is hyperbolic; the line-of-position pattern is a family of hyperbolas established between pairs of fixed transmitters that are foci of the hyperbolic grid. Frequencies used for this service lie in the band from 1,750 to 1,800 kc and ranges up to about 100 miles from the coast are obtained using transmitters of less than $\frac{1}{2}$ -kw.

An additional use of electronic equipment in radio location is that of radar altimeters in airborne topographical survey work. The final electronic application in exploration is frequently the use of electronic computers to solve field

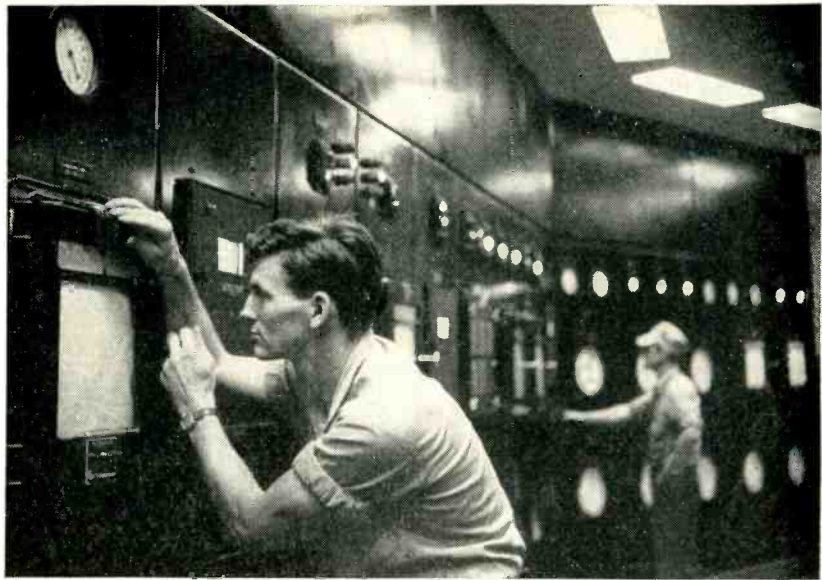
problems. Both digital and analog machines are used.

Well Logging

During the past 20 years electrical well logging has become widely accepted as an important tool in the search for and production of oil and gas. Electrical log is a measurement of the spontaneous potential and the resistivity of earth formations forming the sides of the bore hole to the flow of electric current.

Measurement of these quantities provides a record of the formations traversed by a drill and may give information regarding the fluid content of reservoir rocks. The technique requires direct contact with the mud filling the bore hole by electrodes connected to insulated conductors of the supporting cable. A constant current is made to flow in the surrounding medium and potential differences proportional to the average resistivity are picked up by one or more measuring electrodes in the bore hole and recorded continuously at the surface of the ground, giving a resistivity log.

Where direct contact between electrodes and drilling mud is not possible as in holes drilled with cable tools or holes where nonconductive oil-base mud is used in rotary drilling, the electrical logging method requires the use of



Control panel in fluid catalytic cracking plant. Electronic equipment contributes to automatic operation of giant refineries

scratcher electrodes. For such cases the technique of induction logging has been introduced. An alternating current is made to flow through a coil that is referred to as the transmitter and is supported on an insulated mandrel. The alternating field generates eddy currents that flow in circular paths coaxial with the coil system in the formation surrounding the hole.

These eddy currents create a secondary magnetic field which induces an electromotive force in a second coil or receiver mounted on the nonconductive mandrel a certain distance from the transmitter. The conductivity of the ground determines the secondary field created by the eddy currents and the signal generated in the receiver. The signal is recorded continuously at the surface while the apparatus is moved along the hole. The equipment setup for induction logging is illustrated in Fig. 4.

Seismic velocity measurements made in oil wells can be used as a geophysical tool. Two pickups are spaced one foot apart, thus differences in travel time from the sound source to pickups will vary from 50 to 200 microseconds for the normal range of velocities in earth.

The sonde, or the device which is lowered into the well to depths of 15,000 ft or more, must contain much electronic equipment, including power supply for the sound source, amplifiers and a timing

device to determine differential travel time over the one-foot space between pickups. All of this is contained within a cylinder of maximum diameter of $4\frac{1}{2}$ in. capable of withstanding pressures in excess of 6,500 lb per sq in. and temperatures above 250 F.

Radioactive Logging

The atomic nuclei of certain elements are unstable. They decay and form atoms of lighter but related elements. During the process of disintegration usable energy is released as alpha and beta particles and gamma rays.

Geologists have found a record of gamma radiation intensity from minute quantities of radioactive material along the bore hole a clue to the geophysical structures traversed during drilling. Thus, radioactive well logging has recently come into prominence. Gamma rays originating in rock impinge upon an ionization chamber. The voltage proportional to the current caused by ionization of the gas by gamma rays is delivered to a preamplifier. The signal is then transmitted over an insulated cable to the surface where it is further amplified and recorded by an automatic pen recorder on the panel of the instrument truck.

Gamma-ray logging does not depend upon the electrical induction properties of the bore hole. Unlike

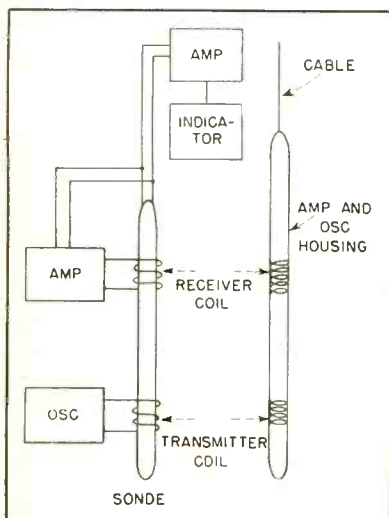
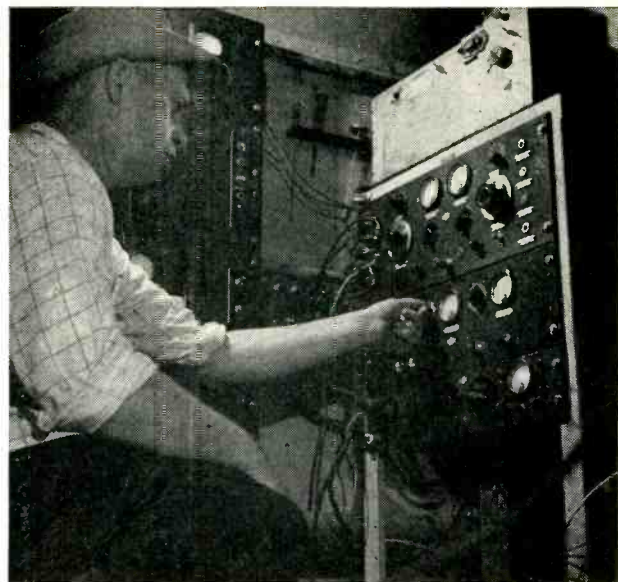
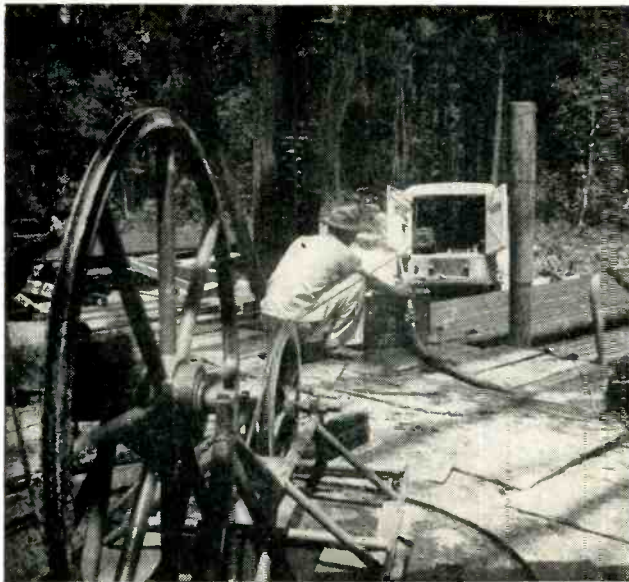


FIG. 4—Sonde used in inductive well logging. Schematic diagram, left, gives electrical characteristics. Drawing, right, is a physical representation of instrument lowered in well hole



Hoist, left, lowers sonde into bore hole while operator, right, monitors instrument panel in truck containing the electronic instrumentation for analyzing results

inductive logging, it is not affected by the presence of metallic casing in the hole, thus a well that has already been cased may be surveyed by the gamma-ray method. Often such surveys reveal that oil-bearing rock has been by-passed in the drilling process.

Neutron Instruments

A second method of radioactive logging is neutron logging. A neutron source and an ionization chamber similar to the one used in the gamma-ray instrument are combined in a single device. Fast neutrons produced by the source collide readily with atomic nuclei in their path. As a result gamma rays may be emitted. These artificially stimulated gamma rays are measured by the ion chamber.

Where hydrogen exists in the formation, neutrons are slowed up near the source. This reduces the number of neutrons available for capture, thus the neutron curve is highly responsive to the presence of hydrogen in the formation and gives an indication of the fluid content of the bore hole.

Other instruments used in well logging include the collar log, the photocalinometer and the dip meter. Once a casing is set and cemented, the electrical collar locator may be used to establish a relationship between the casing collars and the formations through which the well was drilled.

The collar locator consists of a set of springs held in contact with the side of the casing. When a collar is encountered an electrical impulse is generated which is passed through the amplifier to actuate the recording pen and indicate the collar location. The photocalinometer is a magnetic directional surveying instrument that enables the operator to obtain a fast and accurate record of the deviation and direction of deviation of a bore hole from vertical, while the dip meter is used in conjunction with either resistivity or spontaneous potential measurements to obtain information regarding formation slope and its direction.

Pipelining

Pipelines that carry natural gas, crude oil and refined products are in themselves an industry of considerable size. During 1950 oil pipelines accounted for 12.7 percent of all intercity freight traffic, both public and private. By the end of 1953 327,063 miles of oil and gas transmission, field and gathering lines were in operation. The need for communication along these extended right-of-ways has brought about one of the largest applications of electronic equipment in the oil industry, privately owned microwave radio-relay facilities.

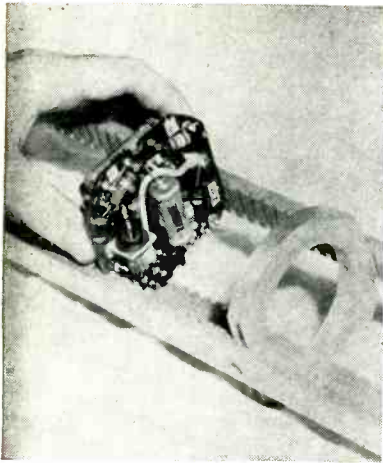
There are at present 20 such systems in operation covering 10,679.2 route miles. The largest system

now in operation is the Transcontinental Natural Gas pipeline which extends for 1,668 miles between Houston, Texas, and Newark, New Jersey. The system alternates between frequencies of 1,905 and 1,855 mc.

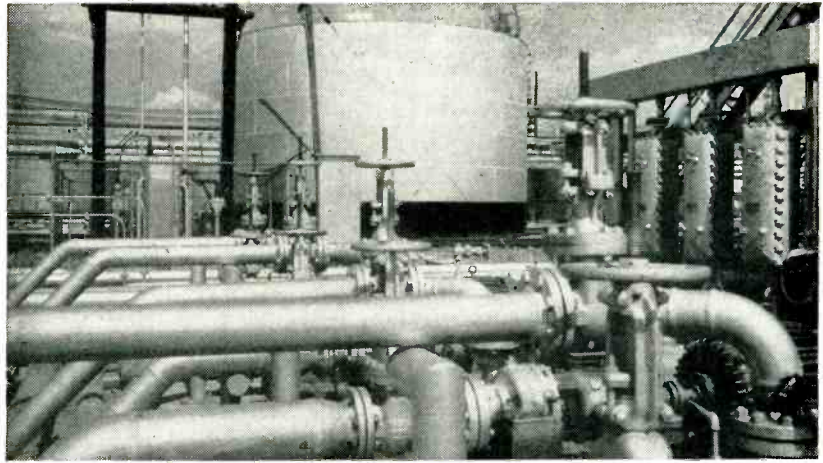
It consists of 47 microwave terminals, 19 compressor stations, one regulator station and two headquarters. The system utilizes pulse-position modulation to achieve eight voice channels. In addition, Transco maintains 161 mobile vhf stations, each equipped with a 50-w f-m transceiver operating on 48.74 mc. Each of the 19 compressor stations has a 250-w f-m transmitter and controls from 5 to 20 mobile stations. These mobile stations located in cars used by maintenance personnel greatly facilitate operation along the pipeline system.

Station Details

Each station provides a 20-watt output and a one-half microsecond pulse is used for signaling. One voice channel between Newark and Linden has recently been devoted to an experimental photofacsimile service. An important trend in pipeline operations has been increasing use of supervisory control and telemetering to run compressor stations unattended. One such setup is installed on the Plantation Pipeline Co.'s north branch line, Bremen, Ga., to Knoxville, Tenn. Two new booster stations will be



Closeup of sonde used in seismic well logging shows construction details



Explosion-proof housings, right, contain relays used in remote control of the refinery pumps in the foreground

operated over microwave from attended stations.

Plantation's 2,000-mc microwave system comprises two terminal stations and five repeaters covering a distance of 156 route miles. Aside from supervisory control and telemetering, the system provides for party-line telephone communication between four pumping stations as well as a service channel with telephone at each radio equipment location and an alarm indication at Bremen for faults throughout the microwave system.

Standby generators at each station are arranged for remote test starting from Bremen weekly with a minimum run of 20 minutes. This is accomplished over the microwave system and an indication of operation provided at Bremen. The supervisory control is centered on a diagram panel at each controlling station. The panel contains three indicators for continuously telemetered pressure—pump suction and pump discharge on outbound lines—and also a recorder for telemetered flow.

Instrumentation is actuated by an electrical strain-gage cell. The voltage from each cell bridge is amplified for actuation of a local pressure indicator with an intermediate output through the pressure telemetering transmitter. Flow measurement is by differential pressure across an orifice on the discharge side of the pump, similarly telemetered through a flow recorder at the controlling station.

For protection of centrifugal pumps in event of roughness an acceleration mechanism responds to

vibration at the frequency of pump speed to close a tripping contact when a predetermined amplitude is attained. Another innovation is the use at each remotely controlled station of two induction type detectors to signal the approach and departure of a line scraper commonly called a pig.

To prevent the pig from lodging where the station suction piping takes off from the main line, the incoming detector installed upstream from this point shuts down the station as the pig passes.

Refined products lines in which several different products may be transmitted sequentially find an additional use for electronic equipment. Radioactive isotopes are injected in small quantities and their passage monitored by radiation detection equipment. This enables operators at the receiving end to tell when a different product begins to flow. The Salt Lake Pipeline Co. pioneered this technique.

Oil Refining

In the refining of petroleum for the manufacture of petrochemicals four variables are of prime importance. These are temperature, pressure, rate of flow and liquid level. Electronic equipment has been devised to measure each of these four variables and feedback control techniques exist such that each one can be brought under automatic process control if so desired. The oil industry has, however, been generally conservative about adopting electronic equipment in process control.

Electronic instrumentation is of

prime importance in the measurement and control of temperature. Here the equipment used is the standard junction thermocouple used in conjunction with appropriate electronic amplifier channels. In many chemical processes in petroleum refining temperature is the variable of greatest importance. The fine control made possible by use of junction thermocouples has made improved varieties of refined products a reality.

Since many refinery operations are conducted in an explosive atmosphere electronic equipment, if used, must be mounted in explosion-proof housings. These housings may be dome-shaped and made from cast iron or cast steel. Where two halves for the housing are fitted together the housing is equipped with a wide flange so that if combustion occurs within the housing the hot gases will have cooled before they reach the explosive atmosphere on the outside.

Such explosion-proof housings are characteristically hard to ventilate. This often has the effect of shortening the lives of electronic components. Safety rules in oil refineries generally require that operations be shut down when any of the explosion-proof housings are to be opened.

Many interesting applications of electronic equipment in refinery operations involve the use of radioactive tracers. A small quantity of radioactive isotope may be introduced into the flow system of the catalytic cracker. Two sets of Geiger tubes spaced 25 to 50 ft apart along the catalyst standpipe

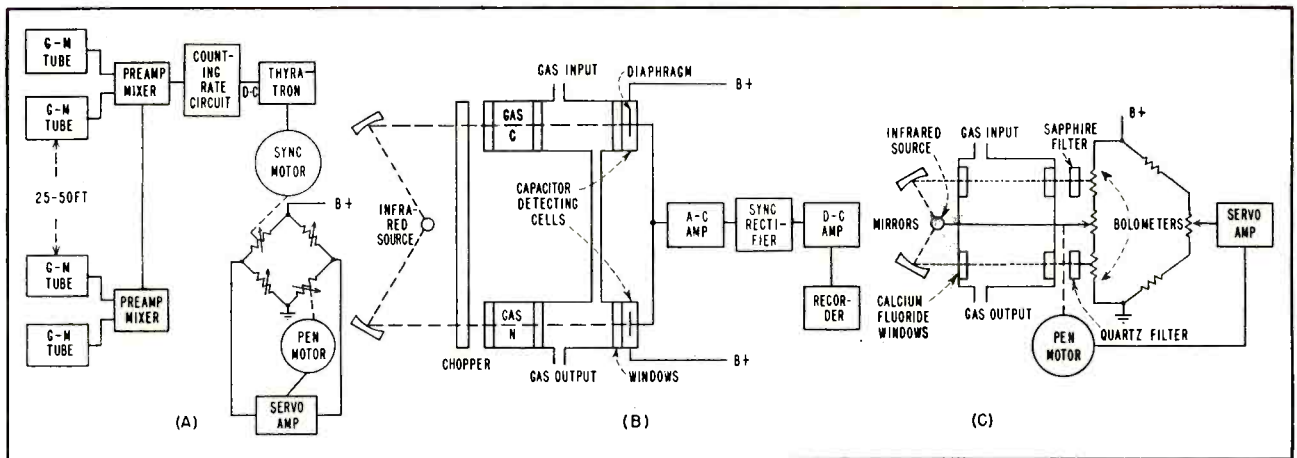


FIG. 5—Process control instrumentation designed for the petrochemical industry. Radioactive flowmeter (A) monitors descent of catalyst in cracking tower, while infrared analyzers (B) and (C) continuously monitor carbon-dioxide content of plant gases

can then determine the time required for a radioactive pellet to pass between them. This time is fed into a computer, which is also fed the density of the catalyst, and the result is a plot of tons per hour of circulation. This system is illustrated diagrammatically in Fig. 5A.

Continuous rapid analysis of plant streams may be had by use of a recording infrared analyzer. See Fig. 5B. Absorption of infrared radiation by gases depends upon their molecular structure. Gases such as nitrogen, oxygen, hydrogen and noble gases which either have homoatomic molecules or are monoatomic show no absorption of infrared radiation, while gases such as carbon dioxide, carbon monoxide, and the hydrocarbons strongly absorb infrared.

This detector for an infrared analyzer can consist of a sealed chamber filled with a pure sample of the gas to be measured and provided with a window to admit infrared radiation, and a sensitive microphone to detect small pressure changes in gas.

Another type of infrared analyzer, Fig. 5C, is the double-beam differential photometer type. Dual infrared beams are transmitted through two sections of the sample cell which is equipped with calcium chloride input windows. The output window of one section of the cell is of sapphire, and the other output window is of quartz. Bolometer elements forming arms of a temperature measuring bridge are mounted behind the two output windows. A high-gain servo amplifier operates

a slide-wire potentiometer to restore bridge unbalance and the shaft motion is passed to a recording pen. If the bridge is balanced against a standard sample of gas containing a known amount of carbon dioxide the carbon dioxide content of an unknown gas may be recorded continuously by recording the bridge unbalance caused by a different degree of absorption of infrared energy passing through the quartz filter.

Tank Farms

Operators of tank farms in which petroleum products are stored find it necessary to know the liquid level in all the various tanks of the field. Measuring liquid level by the dip stick can be a tedious and time-consuming chore in a large tank farm. Likewise, there is a certain hazard from explosive fumes when the tanks are open. Two electronic devices have been developed to measure liquid level in tanks. One (ELECTRONICS, p 156, Apr. 1954) involves placing a sonic transducer at the bottom of the tank and measuring depth by the time it takes to receive an echo from the air-liquid interface.

A second method is the radioactive float gage in which a small quantity of radioactive isotope is placed in a float and radiation detection equipment mounted along the side of the tank to determine the level of the liquid.

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Corp., National Petroleum Council's Committee on the Use of Radio and Radar, American Petroleum Institute, Standard Oil Co. of New Jersey, and the staffs of the McGraw-Hill petroleum publications.

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Color Video Tester

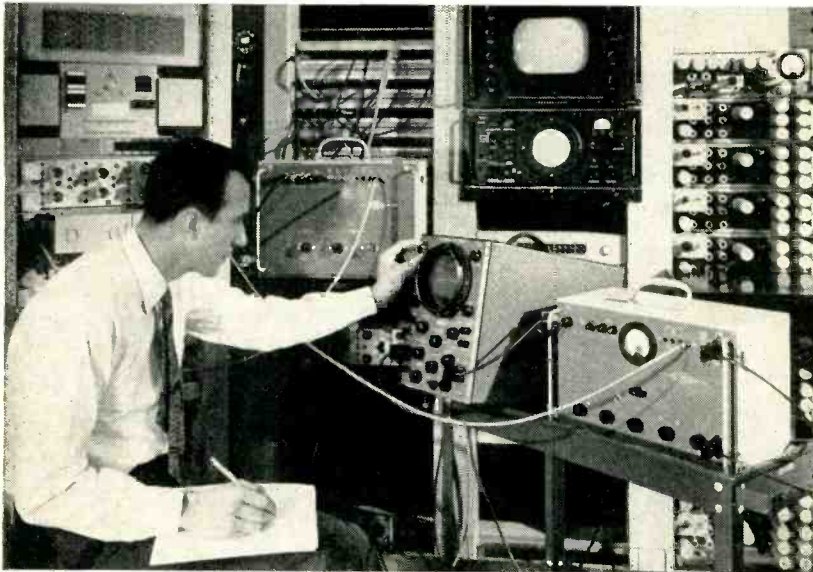


FIG. 2—Schematic diagram of a modern seismic amplifier. Instrument provides an overall gain of 120 db and responds to frequencies from 10 to 100 cps

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studio and distant transmitter may be hundreds of feet or miles apart.

A simplified block diagram of the system is shown in Fig. 1. The transmitter consists of three major parts: a luminance (black-and-white) signal generator, a sync-pulse generator and a constant color carrier generator. The luminance signal generator is a 15.750-kc sine-wave oscillator. Amplitude of this signal can be adjusted to represent a full range of luminance from dark to bright. Sync pulses are derived from the negative peaks of the luminance signal so their positioning on the negative peaks is automatic.

Color Frequency

The color carrier generator is a 3.579545-mc crystal oscillator. Its output represents a constant hue and saturation signal. These three signals are combined at the output of the transmitter. The signal sent into the system under test consists of a constant color carrier signal superimposed on a luminance signal that is continuously varied over the entire range from dark to bright. The effect of the luminance signal is to change the position of the color carrier in the amplitude range of the transmission system. It is this change in position that gives rise to differential phase and gain.

At the receiver, the luminance signal and color carrier are separated by a filter. The luminance signal is applied to a cathode-ray oscilloscope to produce a left-to-right deflection of the beam. Instantaneous amplitude of the luminance signal is shown from dark level (left) to bright level (right).

The received color carrier has been drawn in Fig. 1 to illustrate the presence of differential gain.

COLOR TELEVISION signal transmission circuits must meet stringent linearity requirements. Minimizing differential phase and gain at the color carrier frequency is one important new consideration.

Color Information

In color television, saturation and hue information are added to the luminance information by means of a color carrier.¹ The amplitude of this signal represents color saturation. Large amplitude represents high saturation or a brilliant color. Distortion of color saturation will occur if the gain of the transmission system to the color carrier is different for different amplitudes of the luminance signal.

Such variation is called differential gain. Presence of differential gain in a system used to transmit color television may result in a picture in which some colors appear dim or washed out while others appear oversaturated.

The time or phase relationship of the color carrier signal to a reference synchronizing signal (color burst) determines the hue of the color. Distortions of hue will occur if the transmission system produces a different phase shift in the color

carrier at different amplitudes of the luminance signal. Such variation in phase shift is called differential phase. Presence of differential phase in a system used to transmit color television results in a change in the hue of the colors.

The term differential gain was first proposed by S. Doba. The measurement method suggested here is one of several² that might be used to measure differential phase and gain. It was selected as giving the desired results quickly and accurately.

Practical measurement equipment comprises a portable transmitter and portable receiver. The transmitter generates a simulated color-television signal, which is connected to the input of the system under test. Output signal from the system is examined by the receiver to determine if it has been subjected to differential phase or gain.

Portable Equipment

Transmitter and receiver are physically independent of each other. The only connection between them is the circuit being tested. This independence is necessary since video circuits within a studio-control room complex or between

Checks Distortion

Measurement of differential phase and gain on color television transmission circuits is effected with separate portable transmitter and receiver units. Video equipment adjustment using oscilloscope display prevents distortion of colors at broadcast stations

The color carrier signal is split into two paths. A sharp filter in one path removes any variation present and provides an undistorted color carrier

signal. This signal is used as a reference against which the distorted signal in the other path is compared in the detector. The func-

tion of the detector can be switched for either amplitude or phase comparison.

When differential gain is being

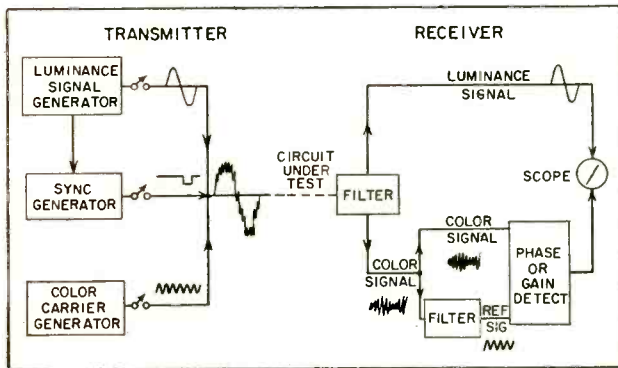


FIG. 1—Complete test system used on color video lines

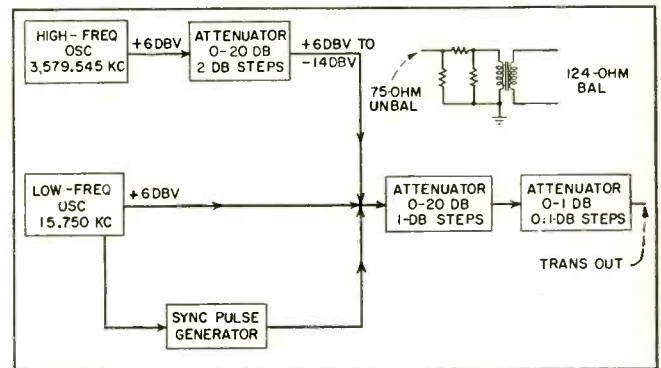


FIG. 2—Detail of sending set shows interconnections and network

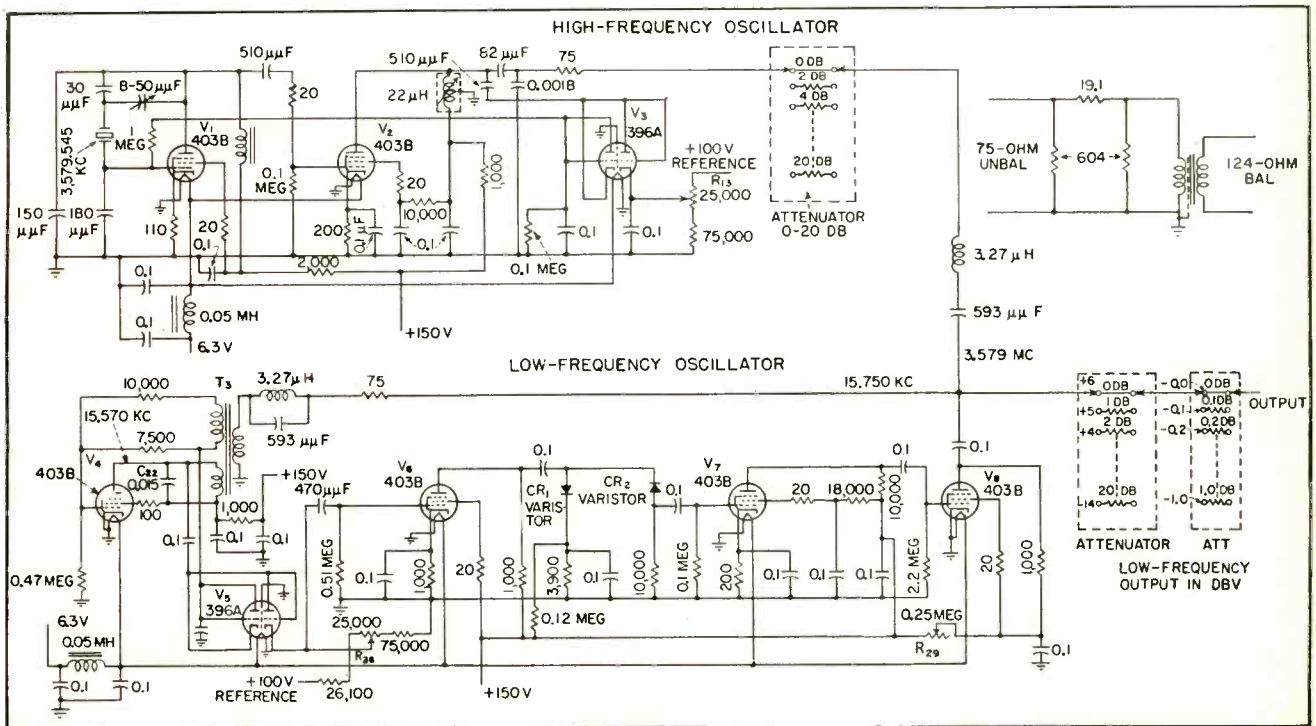


FIG. 3—Circuit diagram of sending set has been simplified by leaving out conventional power supply and plug interconnections. Circuit in upper right adapts unbalanced 75-ohm output to balanced 124-ohm output

measured, the comparison is made on an amplitude basis. The voltage obtained at the output of the detector is proportional to the difference in amplitude between the distorted and reference signals. In a similar manner, when differential phase is being measured, a voltage is obtained at the output that is proportional to the instantaneous difference in phase between the distorted and reference signals.

In either case the output of the detector is applied to the oscilloscope to produce an up-and-down deflection of the beam. The amount by which the beam is deflected vertically is a measure of the amount of differential phase or gain present in the circuit under test. The presentation of the complete measurement is therefore a line on a cathode-ray tube. This might be considered as a graph in which the amplitude of the luminance signal is plotted as a horizontal co-ordinate against differential gain or phase in the vertical co-ordinate. Sensitivity of the measurement is such that the amount of distortion considered just perceptible causes the beam to be deflected vertically one inch. This sensitivity permits measurement and correction for distortions below subjective perceptibility.

Sending Unit

A block diagram of the transmitter unit is shown in Fig. 2 and the complete circuit diagram is given in Fig. 3. The low-frequency

(15.750-kc) oscillator circuit comprises V_1 , T_1 and C_{20} . Tube V_1 and associated components form a peak-to-peak detector circuit that is used to provide avc for the oscillator. This detector circuit is back biased by a positive d-c reference voltage on the second cathode. So long as the peak-to-peak value of the 15.750-kc sine wave at the plate of V_1 does not exceed the d-c reference voltage on the detector, no d-c output is obtained at the first plate of V_1 .

However, when the peak-to-peak value does exceed the reference voltage, a negative d-c voltage is obtained at the first plate of V_1 , which is proportional to the amount of this excess. This voltage is fed back as bias to the grid of the oscillator tube and thus tends to limit the output of the oscillator. Potentiometer R_{30} provides a means of varying the reference voltage to the detector and thereby the output of the oscillator. The reference voltage is supplied by a gas tube. Changes in output are held to less than ± 0.1 db for ± 10 -percent variations in supply voltages. Frequency accuracy is in the order of ± 1 -percent.

Sync Signal

A voltage representing a small portion of the positive peak of the sine wave is obtained at the second cathode of V_1 . This voltage is transmitted to the sync generator that comprises V_2 , V_3 , V_4 , CR_1 , CR_2 and associated components. The sine-wave tips from the low-frequency

generator are amplified and shaped into sync pulses in this circuit. Potentiometer R_{20} provides a means of adjusting the amplitude of the sync pulse output.

The color carrier generator uses a 3.579545-mc crystal oscillator V_{11} , a buffer stage V_{12} and an avc circuit V_{13} , which is similar in its operation to that described for the low-frequency oscillator. Potentiometer R_{13} permits adjusting the output of the oscillator.

Output of the color carrier generator is transmitted through an attenuator before it is combined with the other two signals. This attenuator establishes the ratio between the high and low-frequency amplitudes. The combined output is transmitted through a pair of attenuators.

These attenuators are calibrated in terms of the low-frequency or luminance signal output and cover a range of +6 to -15 dbv in 0.1-db steps. A transformer provides either a balanced 124-ohm output or an unbalanced 75-ohm output.

Receiving Unit

A block schematic of the receiver is shown in Fig. 4. The input filter consists of complementary low and high-pass filters with their inputs connected in parallel. This filter separates the luminance signal from the color carrier signal. The low-frequency luminance signal is obtained at the output of the low-pass section.

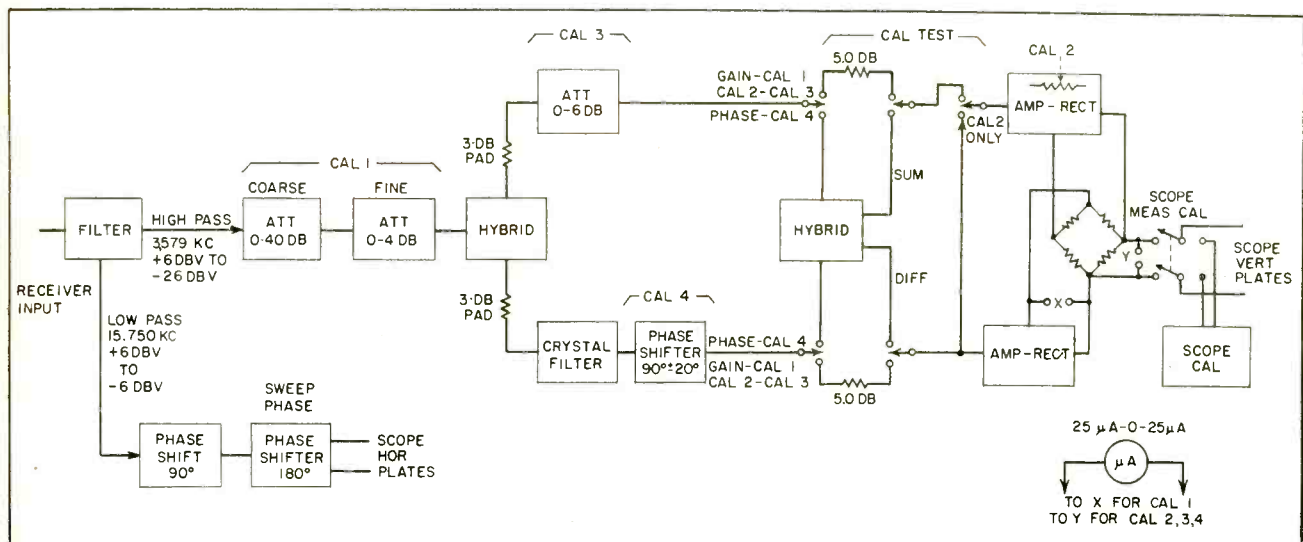


FIG. 4—Interconnections and switching of receiving equipment, shown simplified, include provision for measuring both phase and gain

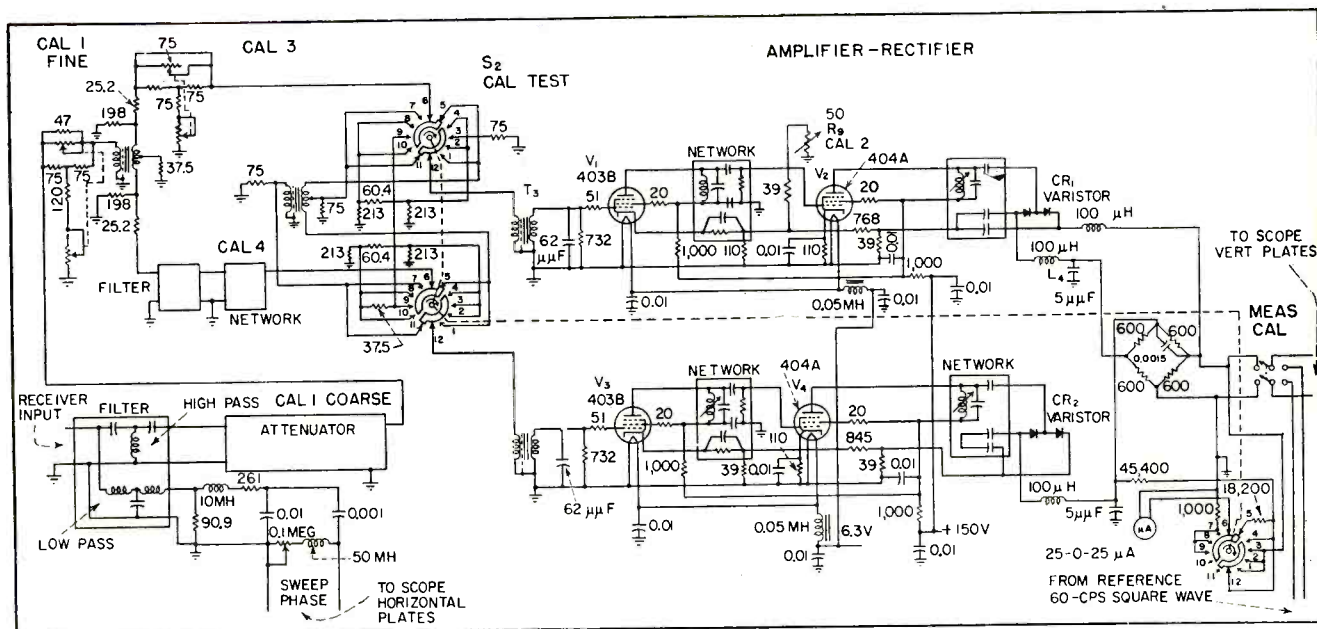


FIG. 5—Power supply and oscilloscope are omitted from the complete circuit of differential phase and gain receiving equipment

The high-frequency color carrier signal is obtained at the output of the high-pass section. A sweep phase control in the luminance signal path adjusts the horizontal sweep so the extreme left-hand end of the oscilloscope trace represents the black level of luminance.

The high-frequency color signal is split into two paths in the first hybrid coil. A sharp crystal filter in one of the paths removes any distortion that might have been produced in the system under test and provides at its output an undistorted reference signal. This signal is used as a reference against which the distorted signal in the other path is compared.

When measuring differential gain, the reference and distorted signals are each connected to the input of the amplifier-rectifier shown in Fig. 5. The rectified outputs are compared in a bridge circuit and a voltage representing their difference is connected to the oscilloscope vertical input. The two amplifier-rectifiers are adjusted to have equal sensitivity by means of R_0 (CAL 2). If at any instant the reference and distorted signals are equal in amplitude, output from the bridge circuit is zero.

Checking Phase

When differential phase is measured, the reference and distorted signals are connected into a pair of

conjugate branches of a hybrid coil. The two outputs from the other pair of conjugate branches represent the vector sum and the vector difference of the two signals. The vector sum is connected to the input of one of the amplifier-rectifiers and the vector difference to the other. The outputs are combined in the same manner as for differential gain. The output from the bridge circuit at any instant is proportional to the phase difference between the reference and distorted signals. Zero output is obtained from the bridge when the two signals are 90 degrees out of phase.

The number 1 position of rotary switch S_2 provides the same circuit arrangement as for gain. The CAL 1 controls are used to adjust input level for the proper value of rectified current from the reference signal amplifier-rectifier as indicated by a reading of 20 μ a on the panel meter.

The second position of S_2 connects the reference signal to the input of both amplifier-rectifiers. The panel meter is connected to the output of the bridge circuit. Adjustment of CAL 2 control for zero output from the bridge then insures equal sensitivity in the two amplifier-rectifiers.

The third position of S_2 provides the same circuit arrangement as for gain except that the meter is connected to the output of the bridge.

The CAL 3 control is then adjusted for equal transmission in the two paths as indicated by a zero reading of the meter.

The fourth position is the same as the phase position except that the meter is connected to the output of the bridge circuit. The CAL 4 control is adjusted in this position to obtain a 90-degree difference in phase shift in the two paths as indicated by a zero reading of the meter.

Each of the two amplifier-rectifier circuits consists of a two-stage 3,579-kc amplifier terminated in a varistor rectifier. Each circuit has approximately 26 db of negative feedback. Since the rectifier circuit is included in the feedback loop, a high degree of linearity and stability is obtained.

This test set provides approximately 50 millivolts to the vertical input of the oscilloscope for 1 db of differential gain or 5 degrees of differential phase. Several oscilloscopes are available that will provide a two-inch vertical deflection for this voltage. A 50-millivolt calibrating signal is available in the receiver for adjusting the vertical sensitivity of the oscilloscope.

REFERENCES

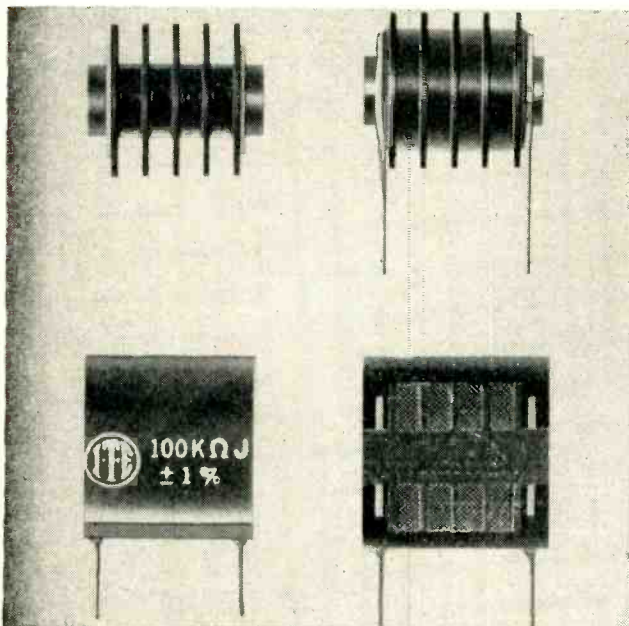
- (1) Donald G. Fink, NTSC Color Television Standards, *ELECTRONICS*, p 138, Dec. 1953.
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Fixed Resistors Show

Part III of a series interpreting recent developments in basic components. Advances in fixed-resistor design emphasize greater stability under adverse environmental conditions. Precision resistors have improved reliability and power resistors provide greater heat dissipation per unit volume

By FRANK ROCKETT

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Construction of ITE precision wire-wound resistors. Bobbin is wound with resistance wire. Entire assembly is then encapsulated in epoxy resin. Cross-section shows internal construction of completed unit



Production-line testing at Daven plant selects resistors within specified tolerance range. Improved fabrication methods have narrowed range of quality variations, producing more accurate resistors at lower cost

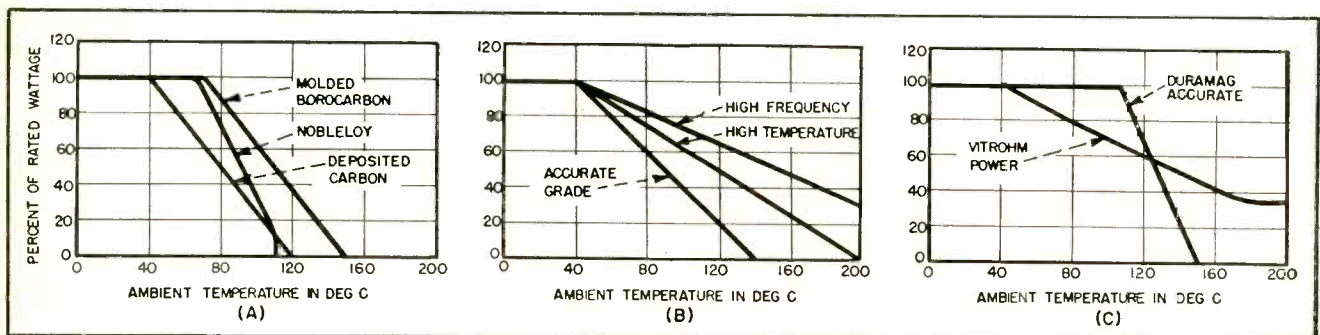


FIG. 1—Derating curves for carbon-film resistors (A), film-on-glass (B) and wire-wound type (C)

Stability Improvements

RESISTORS are probably the most numerous of components in electronic equipment. Composition resistors have been and continue to be the general purpose units. Improved encapsulation protects them from humidity but they are inherently temperature sensitive and noisy.

Boron-Carbon Resistors

For enhanced reliability, pyrolytic carbon-film resistors are being perfected for general use. In one form of film resistor, boron-treated carbon is deposited on a ceramic body to form the resistance element. Initial development by IRC and others indicated that it had a low and positive temperature coefficient and close retrace characteristic suitable for semiprecision low-power units.

A molded phenolic jacket on newer units protects the resistance film from both moisture and vapor and, unlike conventional varnishes, is inert to the film material. These resistance elements have inherently low voltage coefficients of resistance and are manufactured with low contact-resistance terminations. Sprague Electric rates this type resistor for full-load operation to 70 C in contrast to full-load operation to 40 C for earlier types.

The recommended derating for these units is shown by Fig. 1A to be intermediate to that for currently available resistors of representative types. Between -55 C and 105 C their rated temperature coefficient does not exceed 0.01 percent per deg C for units below 20,000 ohms and 0.02 percent per deg C for units above 20,000 ohms.

Depending on resistance and wattage, deposited resistors may consist of a continuous film or of a slightly inductive spiral. For high-voltage operation as in 30-kv supplies for color television receivers, dust precipitators and nuclear elec-

tronic apparatus, a widely spaced spiral is applied to the coated ceramic rod to achieve a long resistance path in small space with relatively low voltage per unit length. A unit 5 inches long and $\frac{3}{4}$ -inch in diameter, including cast plastic housing, rated at 5 watts and 30 kv has a minimum resistance of 1 megohm and a rated temperature coefficient of resistance below -0.05 percent per deg C from 25 C to 100 C.

In a similar construction, a metallic Nobleloy film resistor, also formed on a ceramic base but by a pyrochemic process developed by Continental Carbon, provides a unit with a temperature coefficient rated not to exceed +0.05 percent per deg C for units below 1 megohm or -0.08 percent per deg C for units of 1 megohm or over.

A premium version of this resistor has corresponding coefficients rated as +0.03 and -0.05. The units are protected by a rubberized enamel with the result that in manufacturer's tests, units conditioned for 250 hours at 95 percent relative humidity and 40 C show a maximum resistance change of 3 percent with an average change of 2 percent. Recommended derating begins at about 65 C ambient.

Deposited Carbon

Deposited carbon resistors have been improved during the past few years. Units with temperature coefficients comparable to those described above are made by Radell. When tested for military use for a total elapsed time of 1,000 hours at 40 C and rated voltage applied intermittently 1.5 hours on and 0.5

hour off, their resistance change is no more than 1 percent.

Similar resistors produced as precision units have a rated voltage coefficient less than 0.002 percent per volt, with the average coefficient less than half this value. The rated distributed capacitance is in the order of a micromicrofarad. As a rule of thumb for high-frequency operation, when the product of frequency in megacycles and resistance in megohms is unity, the a-c resistance is about 90 percent of the rated d-c resistance; when the product is ten, the a-c resistance is about 60 percent of the rated resistance.

The temperature coefficient of these units is shown in Fig. 2. As an indication of the effect of applied load on the temperature and hence on the resistance of these units and their heating effect on adjacent components, Fig. 3 shows the rise in surface temperature for units of various rated wattages.

If the unit must withstand humid environment, a hermetic seal is formed by inserting the unit in a ceramic sleeve that has metallized ends. These ends are then silver soldered to the resistor leads. So protected, units are rated to withstand 95-percent relative humidity at 40 C for 250 hours with an average change of 1 percent. The sleeve also provides protection from potting compounds and fungicidal spray, which may attack some conventional coatings.

The details of another construction are shown in Fig. 4. The carbon film is deposited on the ceramic core in a vacuum furnace into which hydrocarbon gas is in-

Previous Articles in Series

Part I: Fixed Capacitors Undergo Miniaturization, p 120, July 1954.

Part II: New Variable Capacitors Extend Tuning Range, p 130, Aug. 1954.

COMPONENT DESIGN TRENDS

- Printed resistors for high-voltage high-resistance applications
- Mixed-metal alloys to provide wide range of temperature coefficients
- Welding of resistance wire to terminal lugs cuts contact noise

produced at a controlled rate. After the end caps and leads are secured in place, the unit is varnished and molded in low-loss thermosetting resin. This size of 0.5-watt unit is available from 100 ohms to 0.5 megohm in tolerances of 1, 2 and 5 percent; the change on life test at 40 C is less than ± 1 percent.

Film-on-Glass

Because of its ability to withstand high temperature, glass is also used as a base for metallic-film resistors. Three variants of this film-on-glass resistor are produced: a high-frequency resistor, an accurate-grade resistor, and a high-temperature resistor. Basically each unit consists of a stable conductive coating fired onto a glass rod or tube.

The resistive coating can be cycled from near absolute zero to red heat without impairing its conductivity. In the complete unit, silver terminals that are fired on provide low-resistance terminations and a silicone coating baked onto the unit provides additional environmental protection.

In the high-frequency resistor, the film is appreciably less than the depth of penetration at vhf. Table

I summarizes ratings of this and the related units. Tolerance is the normal manufacturing value. Stability is the permanent resistance change after 500 hours operation at maximum rating and 40 C ambient. Temperature coefficient is the maximum absolute value. The voltage coefficient of resistance of these units is practically negligible: less than 0.001 percent per volt.

Whereas the high-frequency resistors are rated from 1 to 150 watts depending on size, the accurate-grade resistors are rated from 0.5 to 2 watts depending on style. The high-temperature resistors are rated from 1 to 115 watts based on a 225 C hot spot at 40 C ambient, and are about half the size of equivalent film-type resistors; for example a 25-watt unit is 4 inches long, $\frac{3}{8}$ -inch in diameter, available from 20 to 300,000 ohms.

This example also indicates that their resistances exceed those of conventional wire-wound units of comparable size. Figure 1B shows recommended derating for these units. The temperature coefficient in Table I is for the higher resistance units; for very low resistances, 10 to 100 ohms, the coefficient is positive and increases toward 0.03

percent per deg C as a maximum.

For greater power dissipation, these glass units can be cooled by forced air. This increases the ratings of the high-frequency units for example, four fold, or 50 to 100 fold by liquid cooling, but only continuous-film units should be required to dissipate over 50 watts per square inch. The resistors thus are especially useful where high momentary overloads are expected and as dummy r-f loads.

Another glass resistor, available from 10 to 100,000 ohms at tolerances of 1, 0.5 and 0.25 percent, is produced by Balco Research Laboratories. It consists of a pure metallic spiral film inside a glass tube closed with bonded end caps to form a hermetic barrier rated at over 60 psi.

Wafer Resistors

A subminiature resistor especially designed for use in transistor circuits is now produced by Glenco Corp. rated at 0.1 watt (0.25 watt on special order). This unit, about a quarter of an inch long, is formed by depositing the resistance material on a thin ceramic base, curing and cutting to the desired resistance. It is furnished as cut or with leads, and with protective coating, or it is assembled on a shock-resistant ceramic base with other circuit components connected with leads printed on the base.

Various approaches are being evolved for automatically produced circuits. Success to date indicates that ultimately printed resistors may replace conventional carbon-composition resistors. Experience

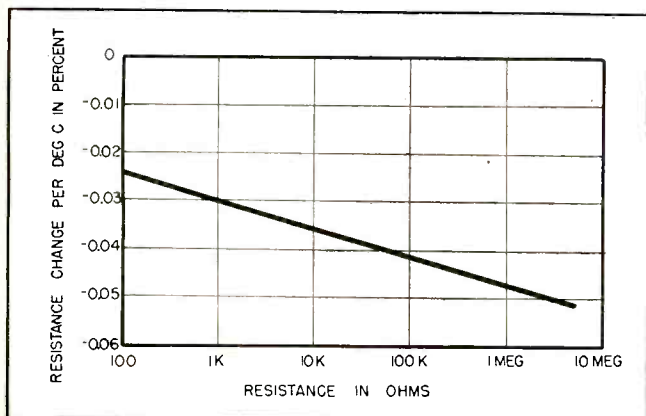


FIG. 2—Temperature coefficient for deposited-carbon resistors. The units for which this data applies are encased in plastic sleeves

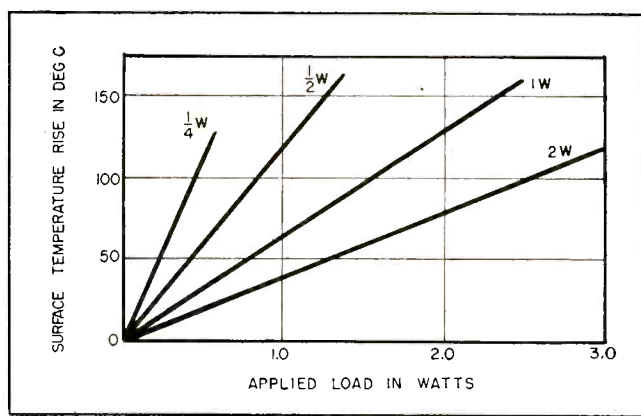


FIG. 3—Rise in surface temperature for four rated wattages of deposited-carbon resistors

at Micro-Circuits Co., for example, has been that tape resistors, although providing a compromise between conventional resistors and printed resistors, do not make full use of the reduction in cost achievable with more mechanized circuit production.

Conductive coatings developed to date make possible the printing of resistors having characteristics similar to those of many conventional resistors and, if not interchangeable with them, are substantially lower in cost and more adaptable to design needs and of greater inherent range in electrical characteristics.

Surge protection for series filament strings and compensation for temperature effects can be provided by printed resistors of high negative temperature coefficient. Among others working in this field, Micro-Circuits Co. is developing resistor paints to provide comparable magnitudes of both positive and negative temperature coefficients. An interesting possibility is a resistor in which most of the resistance change occurs within a relatively narrow temperature range. A resistance above about a thousand ohms is possible with substantial voltage coefficient.

The protection afforded by a fully enclosed printed circuit adapts this style construction especially to high-voltage high-resistance applications in nuclear instruments and television receivers. Fixed voltage dividers, tapped bleeders and decade units to 10^9 megohms may be commercially available in the near future as stock items.

Controlled Temperature Coefficient

Development at International Resistance Co. indicates that thin metal films laid down by vacuum evaporation have electrical properties which may differ from the bulk material. In addition to the effect on resistance of the decreased mean free path in thin films, of the formation of crystals with distorted lattices, and possibly of semiconductor behavior, controlled mixed-metal films make possible the wide range of temperature coefficients shown by the shaded area in Fig. 5.

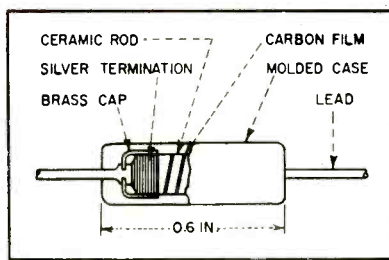


FIG. 4—Cross-section of ceramic-cored deposited-carbon resistor

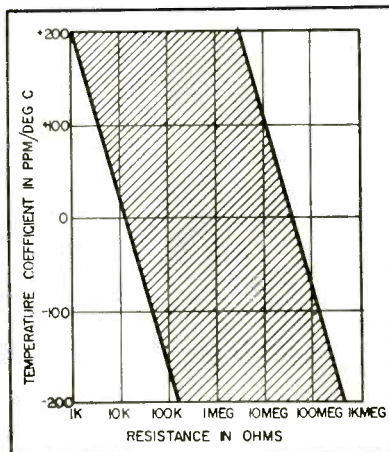


FIG. 5—Resistors having controlled temperature coefficients can be made in the range shown by the shaded area using mixed-metal films

Thus, it is possible to tailor-make resistors to a required temperature coefficient over a broad resistance range. At 100,000 ohms the temperature coefficient can be specified to any value between +200 to -200 parts per million per deg C. Furthermore, the desired value can be obtained within ten percent of the extreme value.

Units with small temperature coefficient, less than 5 ppm per deg C, retain this characteristic over a moderate temperature range. An 11,000-ohm resistor can be formed with an almost nil resistance-temperature characteristic value from 0 C to about 100 C. Units in an organic resin casting show a shelf stability on the order of 0.1 percent; that is, approaching the stability of a wire-wound resistor.

From the success indicated by these results from pilot-production, development is directed toward use at higher frequencies, higher ambient temperatures, and greater power dissipation. It can be expected that, in full-scale production, the cost of evaporated metal resistors will be comparable to boron-carbon units.

Wire-Wound Resistors

Precision wire-wound resistors, commonly manufactured with resistance tolerances to 0.1 percent, are low-wattage units used where their stable characteristics justify their greater expense over composition and deposited resistors. During the past five years the major improvements in this type resistor have been increased accuracy and stability, more constant and closer matched temperature coefficients, use of finer diameter wire, more durable coil protection, higher temperature ratings and smaller overall size.

One of the more troublesome characteristics of precision resistors has been erratic contact resistance between the resistance wire and the resistor terminals. Because of the metallurgical properties of resistance wire and its small size, it is not always possible to solder or weld the wire to its terminals. In Riteohm resistors made by the Ohmite Manufacturing Co. the enameled alloy resistance wire is welded to the terminals to provide stable and permanent electrical connection of low noise level. The resistance wire is noninductively pie-wound on a rigid steatite bobbin.

Resistance element, terminals and bobbin are completely encapsulated by a resin whose temperature coefficient of expansion is chosen to match closely that of other materials in the completed unit. The assembled resistor thus holds the windings firmly in place

Table I—Characteristics of Film-on-Glass Resistors

	High Freq	Accurate	High Power
Tolerance	±2%, 10%, 15%	±1%	±1%, 2%
Stability	3%	0.5%	2%
Temp Coeff	0.03%/°C	0.02%/°C	0.02%/°C

RECENT DESIGN TRENDS

and encapsulation reduce size of wire-wound

hermetic sealing for operation at hot-spot temperatures up to 140 C and at up to 95 percent relative humidity

- Ceramic insulation coating for operation up to 150 C

and repels moisture. It is rated for operation to 125 C.

Accuracy and Stability

The basic characteristics for which precision wire-wound resistors are used are accuracy and stability. As an example of present attainments, Daven calibrates all precision resistors to better than ± 0.1 percent tolerance even though customer requirements may be less stringent. This practice permits close inspection and checking of each manufacturing operation. Resistors that undergo protracted aging and temperature cycling can be supplied to a tolerance of ± 0.02 percent with a stability of ± 0.005 percent.

Part of the improvement in stability is a consequence of refinements in wire production. Wire manufacturers now supply resistance wire that is consistently within ± 20 parts per million per deg C. With winding techniques that avoid causing intermittent shorted turns that may be mistaken as an error in temperature coefficient, it is possible to retain this tolerance in the finished resistor. One precaution is to cushion the windings by a pocket of dry air inside the encapsulation. Where required, temperature coefficients can be matched on a production basis to ± 3 parts per million per deg C by selecting two different alloys for the same resistor. Figure 6 shows temperature characteristics of several common wires.

Improved drawing and enameling techniques by the wire manufacturers make possible the use of 0.0008-inch diameter wire, but such wire must be handled on machines that provide close control of winding tension and requires protection by hermetic sealing in metal cases or by encapsulation. The trend

toward smaller size and higher impedance is focusing development in this direction. Improved, more flexible impregnants now in use are molded completely around the unit.

The ultimate in coil protection is complete hermetic sealing in a metallic case with glass or ceramic bushings around the leads. An advantage of this protection is that several precision resistors or a complete network can be furnished in one case where all parts will be at substantially the same temperature for close tracking as, for example, in the Sealed-Ohm networks produced by The Daven Co. Resistors in such cases operate at hot-spot temperatures up to 140 C with newer enamels applied by wire manufacturers. Probably within the next three years, further development will result in less expensive encapsulation techniques, use of 0.0005-inch wire for higher resistances in smaller sizes and widespread adoption of encapsulated axial-lead type wire-wound resistors.

Higher Temperature

For operation at higher temperatures, resistance wire is coated with ceramic insulation such as Ceron made by Sprague Electric Co. Accurate resistors made with wire so insulated operate up to a hot-spot temperature of 150 C instead of the usual 105 C hot-spot limit. These resistors are enclosed

in a protective casing molded from a mineral-filled thermosetting phenolic under high temperature and pressure. Their power rating at 105 C is as much as five times the rating for conventional resistors at 85 C.

The solid molded matrix is impervious to salt water during immersion with the result that electrolysis failures are avoided with these hermetically sealed resistors. This is accomplished to some extent by molding the lug terminals as an integral part of the winding form. In addition, the resistance wire is terminated on a rigid terminal which is isolated mechanically from the external wiring terminal to avoid damage during installation.

Because of the enhanced ability to withstand high temperature, the usual method of power rating, by determination of the wattage dissipation necessary to produce the maximum safe hot-spot temperature, resulted in unrealistic ratings. Instead, the manufacturer life-tested resistor lots for 500 hours of operation in an ambient of 105 C with the resistors cycled 1.5 hours on and 0.5 hour off at various wattage dissipations. The data plotted in Fig. 7 shows the probability of a given percentage change in resistance due to the thermal cycle as a function of power applied.

For example, if operated at 125 percent of rated power, it is 77 percent probable that the resistors will suffer a 0.2-percent change in resistance. Thus, power rating is based on retrace stability, which is of critical importance in most applications of precision resistors. Resistors are rated in this way to assure a retrace stability of one-quarter the initial resistance tolerance through 150 thermal cycles from -70 C to $+150$ C.

Commonly, precision resistors

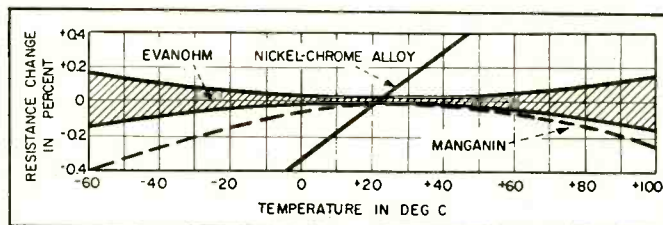


FIG. 6—Temperature characteristics of wires commonly used in resistor manufacture

are fabricated with a hole through the center of the bobbin by which the unit can be mounted on a bolt from the chassis.

For more compact construction, it is desirable to mount resistors by their leads in point-to-point wiring. Radial pigtail-type resistors such as those produced by Cinema Engineering Co. can be mounted by inserting the pigtails through holes in an insulated mounting board. For terminal boards, axial-lead resistors such as Sprague Permaseal units are available. These resistors are wound with Ceron ceramic insulated wire and have axial leads projecting through the molded case. If space is at a premium, Cinema provides an uncased resistor about 0.45 inch long and 0.18 inch across with a maximum resistance of 150,000 ohms rated at 0.3 watt.

The complete encapsulation of wire-wound resistors in epoxy resin has been used for several years by ITE Circuit Breaker Co. Potting in this or other compounds has decreased the cost and weight of hermetically sealed units and simultaneously made possible an increase in maximum resistance for a given overall size. Use of silicone and Teflon insulated resistance wire in conjunction with epoxy resin is expected to result in precision resistors rated to 200 C in the foreseeable future.

A power resistor, like a precision resistor, usually consists of a ceramic core on which are clamped terminals and around which is wound a wire of high-resistance alloy. For both electrical and mechanical stability it is desirable that the junctions between resistance wires and terminals are first mechanically joined and then silver brazed to insure a permanent positive low-resistance bond between wire and terminals. The complete assembly is protected by a glaze such as Vitrohm enamel developed by Ward Leonard. The enamel should be a hard tough moisture and acid-resistant cover possessing high heat conductivity.

Power units are usually fabricated to standard tolerances of ± 5 or 10 percent depending on the type resistor, but are available at increased price to closer tolerances. The power rating of such resistors

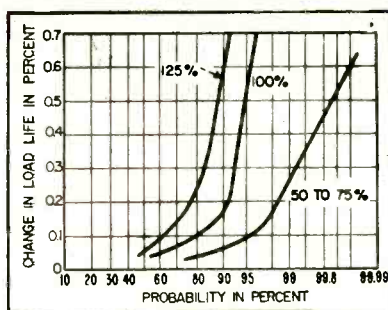


FIG. 7—Probability of resistance change in high-temperature resistors operating at various percentages of load

is usually based on operation in free air at an ambient room temperature of 40 C and a hot-spot temperature of 300 C.

For units not encased in a vitreous enamel, the maximum allowable temperature rise may be 375 C. However, because resistors are seldom mounted in free air, their normal wattage ratings must be reduced to avoid exceeding the maximum allowable temperature rise.

If the normal operating temperature of an equipment is to exceed the ambient temperature of 40 C, resistors must be further derated.

Low-Inductance Windings

The wide variety in which power resistors are available is indicated by the fact that three forms of noninductive resistors are made by Ward Leonard Electric Company. A 24-watt unit, termed Disc-ohm, available in resistance values ranging from 1 ohm to 5,760 ohms with 0.0014-inch wire (1,740 ohms with 0.002-inch wire) consists of a radial winding assembly on a Fiberglas core. The resistance wire is silver brazed to copper terminals.

A more common means to keep both distributed capacitance and inductance to a minimum is the Ayrton-Perry winding consisting of two parallel single-layer windings running in opposite directions. The windings should cross at points exactly 180 degrees apart for maximum cancellation. On an ordinary tubular resistor, uniform wire cross-over is difficult to accomplish. Ward Leonard, therefore, uses a flattened core which both assures that the crossing points are exactly 180 degrees apart and also

provides a better grip for the wire. Because the winding is more uniform, the winding crossover points are at the same potential for minimum capacitance.

The inductance of these units at 1 mc ranges from 0.05 microhenry for a 1-ohm unit to 0.54 microhenry for a 1,000-ohm unit with power ratings of 35 watts. Higher-wattage units have greater distributed inductance. Where both space saving and noninductance are required the Plagohm resistor can be used. This unit is useful where inductance at frequencies up to 1 mc and distributed capacitance up to 5 mc must be negligible. The higher-resistance units consist of a uniform toroidal winding of resistance wire on a Fiberglas core which is then laid out in a flat winding with current flowing in opposite directions in adjacent segments.

Where ventilation and wattage ratings permit resistors to be mounted directly against other metal parts, it is usually necessary to provide additional insulation if the resistor operates substantially above ground potential. In Kool-ohm resistors, the resistance wire is insulated with inorganic material sintered on the wire at temperatures on the order of 1,000 C. This insulation is rated to have a dielectric strength on the order of 350 volts per mil at 400 C and can be operated at red heat.

The use of this insulated resistance wire also facilitates the winding of noninductive Ayrton-Perry windings. With pattern windings relatively large values of inductance with small distributed capacitance can be obtained. Residual inductance of a 40,000-ohm inductively wound unit rated at 5 watts is less than 8 millihenries. Flash voltage to ground is over 10,000 volts at 60 cps under dry conditions. These units are available from 50 to 120-watt ratings. Where a resistor is required to withstand severe thermal shock and salt-water immersion, the unit is protected with a metal-to-glass seal. In special units adapted to glass winding forms and enclosures, with winding ends welded to nickel lead wires, operating temperatures as high as 700 C can be tolerated.

Moving Target Detection

By **R. S. SARGENT**

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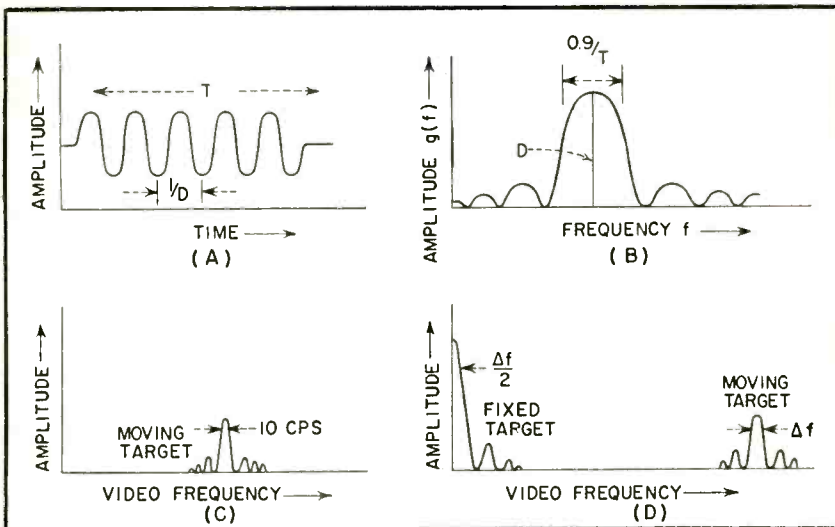


FIG. 1—Stationary c-w radar with nonscanning antenna looks at target. Waveforms show detected video on time scale (A) and corresponding Fourier analysis (B). Also shown are spectrum of target moving through beam (C) and echoes returned to scanning radar (D)

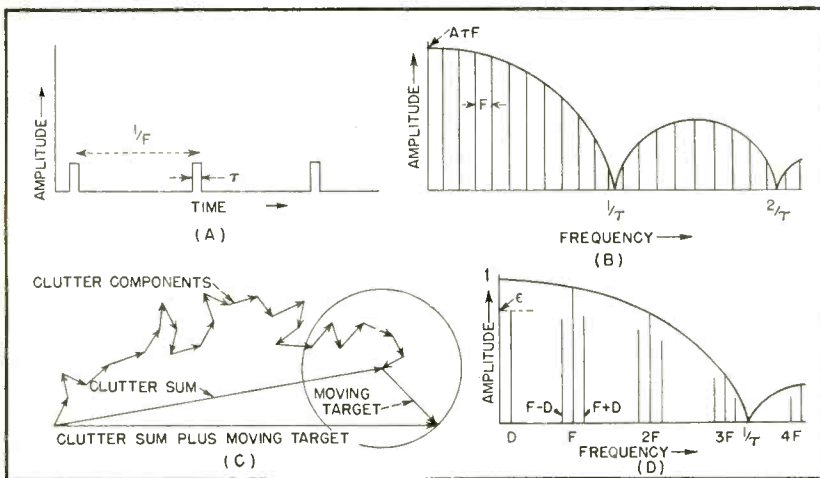


FIG. 2—Ideal echo return of pulse radar (A). Fourier analysis reveals modulation envelope of pulse width (B). Vector diagram (C) shows behavior of ground clutter while (D) illustrates modulation at Doppler frequency

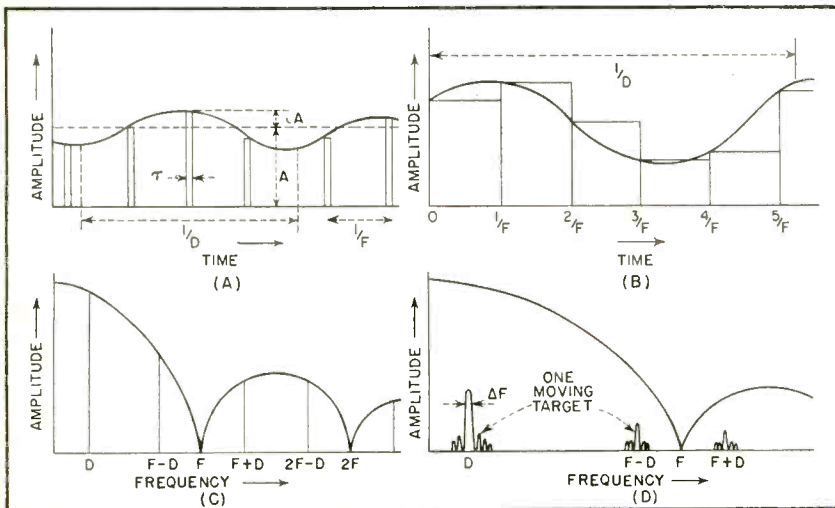


FIG. 3—Spectrum of Doppler modulated pulses (A), effect of boxcar demodulation (B) and cancellation of prf harmonics (C). Waveform (D) is moving target spectrum

PULSE DOPPLER radar is significant primarily because it retains the wide-band, high-information-rate feature of standard pulsed radar and combines with it the ability of continuous-wave radar to distinguish targets by their relative motion. Pulse Doppler radar is any pulsed radar whose method of detection utilizes the Doppler shift in frequency due to radial target motion.

It is distinguished from standard AMTI radar, which delays one sweep and subtracts it from the next, in that the detection system includes relatively narrow-band video filters that detect the Doppler frequency directly.

Basic Theory

Consider a simple stationary c-w radar with a nonscanning antenna looking at fixed targets among which is one moving target. The transmitter sends on a fixed frequency f_0 . All fixed targets return echoes of the same frequency. The moving target, however, returns the frequency shifted by an amount proportional to its radial speed. The amount of this Doppler shift in cps is $D = 2V/\lambda$, in consistent units, or $D = 100V/\lambda$ where V is the radial speed of the moving target in knots and λ the wavelength of the transmitted frequency in centimeters. At X-band, the Doppler shift is about 30 cycles per knot.

If the returned r-f echoes from both fixed and moving targets are beat against the transmitted frequency, the return from fixed targets will come through the detector at approximately zero frequency while the return from the moving target will come through at the

By Pulse Doppler Radar

Method of detection utilizing Doppler frequency shift due to relative motion of target and radar is qualitatively described. Effects of clutter are discussed and functions of boxcar demodulator and coherent oscillator outlined

Doppler frequency, D .

A fundamental limitation on the narrowness of the returned spectrum is imposed by the finite duration of the observed moving target signal. If a moving target stays within the beam for only T seconds, the detected video is as shown in Fig. 1A. A Fourier analysis of this waveform, expressing amplitude as a function of frequency, becomes

$$g(f) = \left(\frac{AT}{2\pi} \right) \left[\frac{\sin \pi T (f - D)}{\pi T (f - D)} \right]$$

This function is shown plotted against frequency in Fig. 1B. The width of the principal peak between half-power points is $\Delta f = 0.9/T$. If a target that returns a pure tone when viewed for a long time is in the beam only for 0.1 second, then $\Delta f = 10$ cps and the video spectrum is as shown in Fig. 1C. Thus the ultimate theoretical limit on frequency resolution is the observation time.

When a stationary c-w radar scans, all targets, fixed and moving, will remain in the beam a finite length of time that depends on the beamwidth and rate of scan. The detected video now resembles the waveform shown in Fig. 1D.

Pulsed System

The original stationary, fixed-beam system is now converted into a pulsed system. Within a certain range, the return from a fixed target is then ideally a series of equal-amplitude pulses, separated by the time interval between pulses, as shown in Fig. 2A.

If F is the pulse repetition frequency, τ the pulse width and A the amplitude, Fourier analysis gives

the amplitude versus frequency spectrum shown in Fig. 2B.

The frequency spectrum consists of an infinite series of harmonics of the repetition frequency, whose envelope is determined by the pulse width. The first zero occurs at $1/\tau$ which in pulsed radars will occur at around 1 mc.

If a moving target is outside the clutter region the detected video will ideally be a series of equal-amplitude pulses at the pulse repetition frequency and the frequency spectrum will comprise harmonics of the prf as in the case of fixed targets.

If the moving target is within the clutter region consisting of echoes sent back by fixed targets, the amplitude of the moving target echo will be modulated by the Doppler frequency. The ground clutter may be regarded as a group of random scatterers out of phase with each other but adding vectorially to give a finite return as depicted in Fig. 2C.

If a moving target is in the midst of the clutter gives a discernible return during one pulse and moves a half wavelength radially during the pulse repetition interval, the r-f energy has to move a full wavelength farther and will arrive at the radar receiver in the same relative phase with the ground clutter that it had on the preceding pulse.

The tip of the vector representing the sum of clutter plus moving target describes a circle as shown in Fig. 2C. When the clutter signal is large compared to the target the resultant clutter-plus-target vector has a sinusoidal modulation. The fundamental modulation frequency is the reciprocal of the time re-

quired for the target to advance a half wavelength. This is the Doppler frequency.

Figure 3A shows the frequency spectrum of a series of equally spaced rectangular pulses amplitude-modulated by a sine wave.

The modulating frequency is D , the pulse repetition frequency F , the percent modulation ϵ and the pulse width τ .

The Fourier analysis gives a d-c component, a component at the modulation frequency D , a component at each multiple of the prf, a component at each multiple of the prf minus the modulation frequency and a component at each multiple of the prf plus the modulation frequency.

The relative amplitudes vary in that each harmonic of the prf has an amplitude modified by the factor $\sin \pi \tau f / \pi \tau f$ where f is the frequency of each harmonic and τ is the pulse width. If the product is an integral number that particular harmonic will vanish. The harmonics will be enclosed in the envelope illustrated in Fig. 2D.

The modulation frequency component and each sideband will have an amplitude ϵ times the ordinate of the envelope at that frequency.

Demodulation

All of these components of pulsed radar have small energy content, as can be seen qualitatively by the fact that the signal is present for only a small fraction of the time. The usual way in which unwanted frequencies are eliminated and amplification accomplished is by a boxcar demodulator—a circuit that measures the amplitude of each signal pulse and stretches it

for the full pulse repetition interval as seen in Fig. 3B.

The pulse width τ is now equal to $1/F$ and at each harmonic of the prf the $\sin \pi\tau f / \pi\tau f$ factor goes to zero (Fig. 3C).

If a moving target remains in the beam a finite length of time T , each of the line spectra from the moving target is broadened into a band $\Delta f = 0.9/T$.

The video-frequency spectrum of the return from one range element containing both fixed and moving targets is shown in Fig. 3D. No spectra from fixed targets will be present.

Moving Radars

If a pulsed radar is installed in an aircraft the spectra of fixed and moving targets is somewhat modified. In Fig. 4A, an aircraft flying in the Z-direction with speed V is a height h above the ground plane. Consider any cone whose apex is at the aircraft, whose axis of symmetry is in the Z-direction and which has a half-angle α . This cone will intersect the ground plane in a hyperbola and a line drawn from each point on the intersection to the aircraft will make the angle α with the velocity vector V . The relative velocity of each point on the hyperbola to the aircraft is $V \cos \alpha$ and the hyperbola is the locus of points having the same relative velocity. For a given V and h a family of hyperbolas can be drawn—one for each value of α . Figure 4B, a plan view looking down on the aircraft, shows how this family of hyperbolas divides the ground into strips, in each of which each point moves with the same speed

relative to the aircraft.

Consider now a radar beam making some angle α with V and illuminating a patch of ground as shown. At a distance from the aircraft, the hyperbolic lines are essentially radial. If the reflecting surface is assumed to be made up of uniformly distributed random scatterers, the power reflected from each strip is then proportional to the power illuminating it, which is a function of the beam shape. Each strip will return its characteristic Doppler frequency which can be considered to be a narrow band of noise centered at the Doppler frequency.

On the assumption that the lines are radial, the difference in relative speed dV between two strips separated by an angle $d\alpha$ can be calculated.

From Fig. 4C, the difference in relative speeds is $dV = V \sin \alpha d\alpha$. Since the Doppler shift at X-band is 30 cycles per knot, the Doppler spread will be $30V \sin \alpha d\alpha$.

This formula fails when the beam is centered at zero. The expression $V \cos \alpha$ can always be used for the relative velocity, however.

Figure 5A, top, shows the r-f frequency spectrum from fixed targets at some small range interval when the radar beam is at some angle with V . The amplitude of the return from each strip is determined by the beam pattern. The beamwidth θ is in radians and is substituted for $d\alpha$ in the expression above.

When the signal is detected each strip will beat with every other strip to produce a spread of Doppler frequencies as wide as the frequency difference between the two outside strips. If dp is the frequency difference between adjacent strips, there will be $(n-1)$ pairs of strips beating together to produce the Doppler frequency dp , $(n-2)$ pairs to produce $2 dp$, $(n-3)$ pairs to produce $3 dp$ and one pair to produce $(n-1) dp$ or $30 V \theta \sin \alpha$. The strongest Doppler

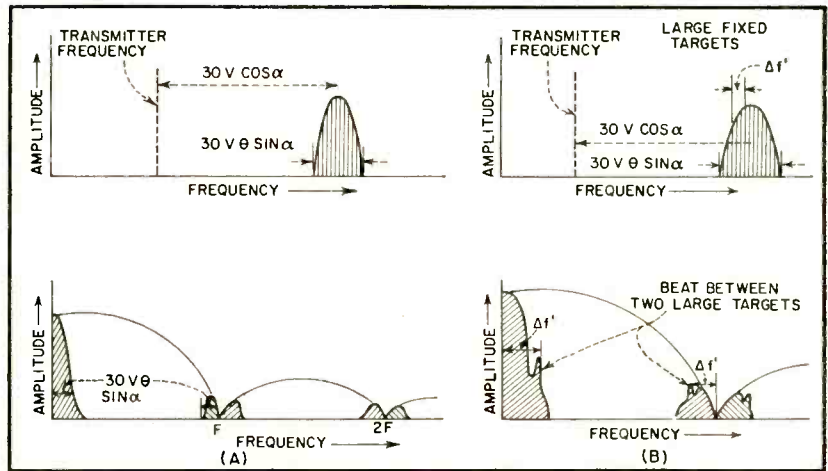


FIG. 5—Airborne radar echoes; r-f and video spectrums (A) denote single large fixed target while (B) shows effect of two such targets

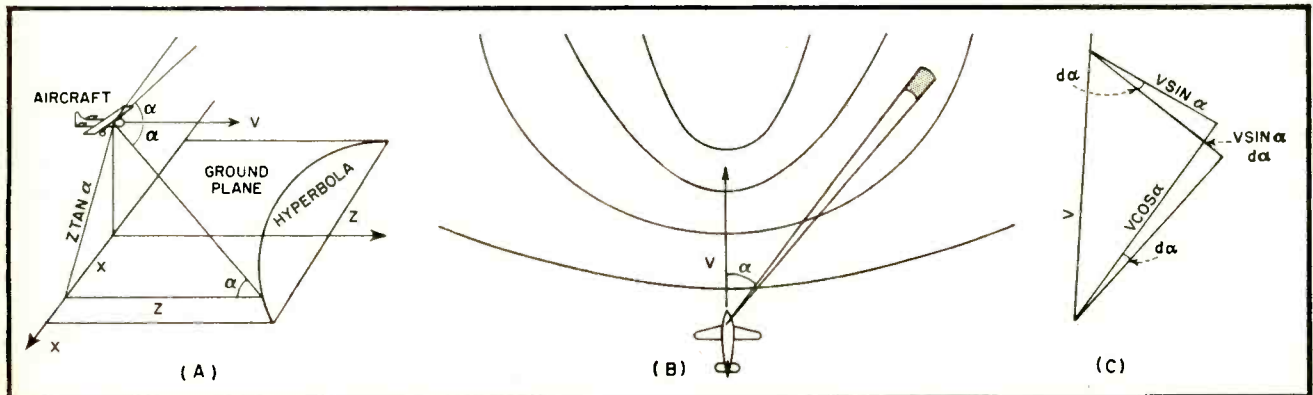


FIG. 4—Motion of aircraft (A) and hyperbolas of constant relative velocity (B). Vector diagram (C) shows relative speeds

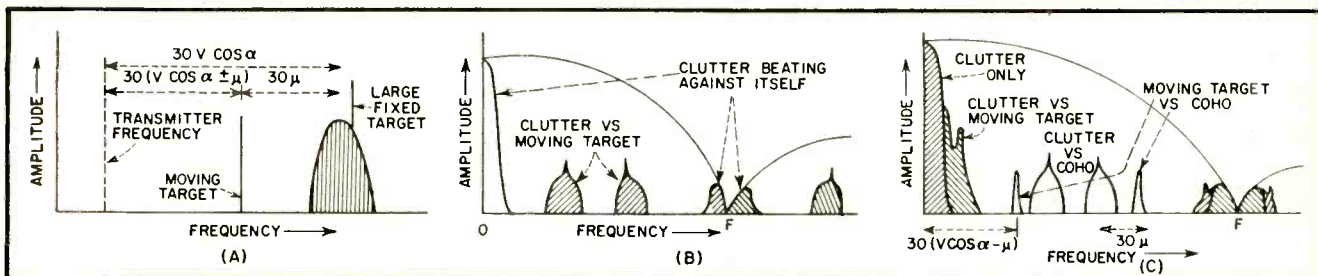


FIG. 6—Radio-frequency (A) and video spectrums (B) illustrate echoes received by airborne radar ranging on moving target. Waveform (C) shows effect of coherent oscillator

frequency will begin at zero and taper off to a small value at $30V_0 \sin \alpha$.

Each one of these Doppler frequencies will amplitude-modulate the received pulses and will have a frequency spectrum consisting of the Doppler component, the components at the multiples of the prf and the sidebands on each side of each multiple of the prf. If the video is boxcar demodulated and the $\sin \pi\tau f / \pi\tau f$ factor thus adjusted so that the zeros fall on the prf multiples, the result will be as shown at the bottom in Fig. 5A.

If one large target is in the beam, the entire video spectrum will be raised in amplitude without altering the shape of the envelope. However, if two large distinct fixed targets are in the beam, the r-f spectrum will resemble the top waveform in Fig. 5B and the video spectrum will be as shown below.

A determination of $\Delta f'$ from the large signal provided by the beat between the two large targets is a measure of the angular separation of the two targets by direct substitution in $\Delta \alpha = \Delta f' / 30V \sin \alpha$ where $\Delta \alpha$ is the angular separation. This azimuth resolution does not depend on the beamwidth but only on aircraft speed, bearing of the antenna, frequency resolution of the system and transmitting frequency.

If three large targets are present, there will be three large spikes, representing the various beat combinations between pairs; if four are present, six, and so on according to $N = n! / 2(n-2)!$ where N is the number of beat combinations and n is the number of large targets.

If a moving target moves into the beam at the gated range with a radial speed such that it is displaced out of the r-f clutter spectrum, the

r-f spectrum will be as illustrated in Fig. 6A.

Moving Targets

If μ is the radial velocity of the moving target with respect to the ground Fig. 6A shows that the displacement of the moving target signal from the center frequency of the ground clutter is 30μ . The sign of μ is positive if the target is approaching the radar-equipped aircraft. In Fig. 6A the target is shown receding. The detected video after range-gating and boxcar demodulation is shown in Fig. 6B.

Coherent System

The final modification involves making the radar coherent by introducing a coherent oscillator (coho) to beat against the returned echo. What is required is an oscillator that is phase-locked to the transmitter pulse and continues to oscillate at a constant frequency during the entire pulse repetition interval.

Phase lock and constant frequency insure that the echo from a target moving with zero relative radial speed will arrive at the transmitter with the same phase relative to the coherent oscillator from one pulse to the next. If it has the same relative phase, the detected video will have no amplitude modulation and will not have the characteristics of a moving target.

If the transmitter and r-f coho frequency are constant and equal and the signal shown in Fig. 6A is present in the receiver the detected video will be as shown in Fig. 6C.

Advantages

The use of the coherent oscillator or coho greatly improves knowledge of the nature of the targets. First,

the spectrum of the ground clutter beating against the coho accurately reproduces the azimuth position of all fixed targets within the beam, within the limits of the frequency resolution of the system. This does not apply to a moving target, which may be displaced completely out of the beam in frequency. All that is known about it is that it is physically somewhere within the beam. However, the number of frequency lines outside the beamwidth clutter spectrum corresponds to the number of swiftly moving targets. The coho therefore provides accurate information about the number and azimuth of large fixed targets and the number of moving targets.

Coherent detection tells whether a target is advancing or receding. The moving target versus clutter video spectrum is the same whether a target is coming or going with respect to the clutter; the moving target versus coho video frequency is different.

Furthermore, the radial speed of a moving target can be detected more accurately with coherent detection since the displacement of a narrow spike of frequency is measured rather than the average displacement of one band of frequencies from another, both a beamwidth wide in frequency.

Many times it is more convenient to beat the coho and signal together at i-f rather than r-f. This is conventionally accomplished by the introduction of a stable local oscillator or stalo, which is centered in frequency and separated from the transmitter frequency by the i-f center frequency.

The writer acknowledges the aid of reports of the Control Systems Laboratory of the University of Illinois, particularly those by C. W. Sherwin.

Frequency Control for Multiple Transmitters

Ultrasonic tone transmitted over wire lines synchronizes carrier frequencies of widely separated transmitters used in low-power educational broadcasting. Technique is potentially applicable to commercial wired-radio systems

LOW-POWER educational radio stations may operate in the standard broadcast band without licensing if they obey FCC regulations that limit the coverage of their transmissions to a radius of several hundred feet.

At Cornell, it was necessary to operate more than one transmitter to reach a widely scattered student body. All the transmitters were required to operate on the same channel without undesirable carrier-frequency difference beats.

Some stations have solved this problem by distributing a modulated r-f signal to several radiation points by coaxial cable. At each point, a linear r-f amplifier is used to boost the signal before radiation. This system, however, is costly when it becomes necessary to feed five or six widely separated transmitters and involves obtaining permission to string cable both on campus and in neighboring residential areas.

However, leased telephone lines are available to connect the remote transmitters to the studio feed. These lines may be utilized for carrier synchronization as well as carrying program material. An ultrasonic tone having an integral submultiple relationship to the desired carrier frequency is sent over the telephone lines to the remote transmitters where it is converted to the carrier frequency. Frequencies on the order of 50 kc are practical for use on lines up to several miles in length, provided a line-carrier system is not in use

over part of the route.

Since the carrier frequency of WVBR is 640 kc, 40 kc was selected as the synchronizing frequency. A frequency multiplication of 16 is required at the transmitter to obtain the 640-kc carrier.

Frequency Multiplier

The 40-kc master frequency is generated by a resistance-stabilized bridged-T Colpitts oscillator. The 40-kc and audio signals are fed to the remote transmitters.

At each transmitter, the audio and master-frequency signals are separated and routed to the appropriate circuits. The most direct way to derive a 640-kc output from the 40-kc master frequency is by

class-C frequency multiplication. To reduce harmonic content in the 640-kc output, it was necessary to use four frequency doublers with double-tuned interstage networks as shown in Fig. 1.

The 40, 80 and 160-kc tuned circuits use ferrite-core variable inductors designed as width controls in television deflection circuits. Small powdered-iron-core variable inductors are used for the 320 and 640-kc tuned circuits.

Controlled Oscillator

Another scheme for generation of the 640-kc carrier is shown in Fig. 2. The local-oscillator frequency is made identical to the 640-kc output of the multiplier by an automatic-frequency-control system using a germanium-diode phase detector and triode reactance tube. Since a moderately high harmonic content can be tolerated in the multiplier output, two pentode frequency quadruplers are sufficient.

The local oscillator that feeds the final amplifier is isolated from the phase detector by a triode buffer so that spurious frequencies in the multiplier output cannot feed through. Use of an electron-coupled local oscillator minimizes the loading effect of the final amplifier on oscillator frequency stability.

The afc-oscillator circuit shown in Fig. 2 provides an r-f carrier of sufficiently low harmonic content and requires only about half the number of tuned circuits needed in the straight multiplier circuit shown in Fig. 1. The multiplier

LOW-POWER BROADCASTING

Radio stations operating between 425 and 1,605 kc, such as the one described in this article, may be operated without a license provided their radiated field is less than 15 microvolts per meter at a distance

$$D = \lambda/2\pi = 157 \times 10^3/f$$

where D is in feet and f in kc.

However, new regulations are being formulated that will place more severe restrictions upon this type of operation. When issued, the new restrictions will apply immediately to all systems beginning operation after that date and existing systems will be required to conform before June 30, 1955

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circuit is, however, basically more stable inasmuch as the afc circuit can get out of synchronization with the master frequency if the local oscillator drifts beyond range of afc action. Both circuits have, nevertheless, proved practical in operation. The multiplier circuit (Fig. 1) appears easier to maintain.

Transmitter Circuit

The schematic of the transmitter is shown in Fig. 3. A 6146 beam power tetrode is used in a plate-modulated class-C r-f amplifier. A 40-kc trap is inserted in series with the modulated d-c supplied to the final amplifier and reduces the amplitude of the 40-kc sidebands in the transmitter output. These result from 40-kc signal that feeds through the modulator. The series-resonant primary of the 40-kc input transformer reduces the amplitude of the 40-kc signal entering the modulator driver.

A panel meter monitors final cathode current, modulator cathode current, modulated plate voltage and phase detector output in the afc-type transmitter. The transmitter is constructed on a 13 x 17 x 3-in. chassis and is contained in a metal cabinet fronted by a 19-in. rack panel 12-in. high.

Performance

Three transmitters have been installed and no audible interaction between them can be observed. Where there is destructive interference of the signals from more than one transmitter, areas of weak signal occur. However, if more than two transmitters cover an area, the field strength pattern is more uniform. The assistance of C. B. Meyer who constructed some of the equipment is acknowledged.

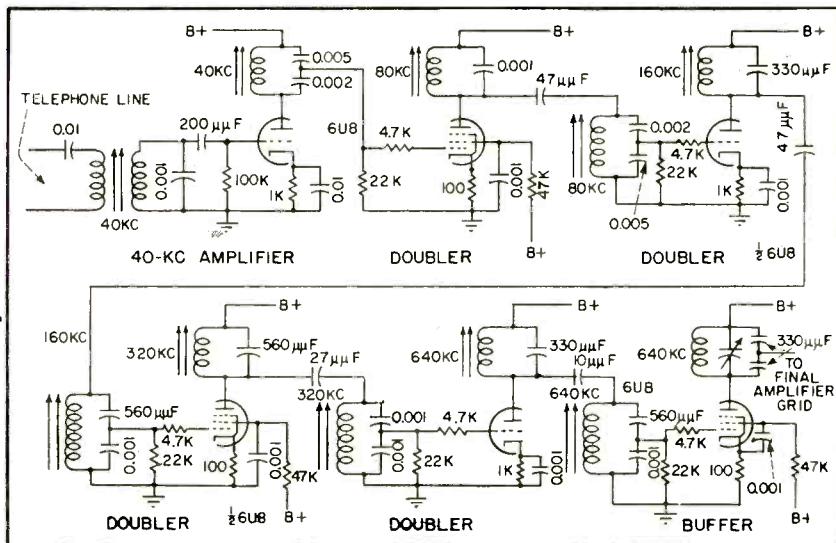


FIG. 1—A series of frequency doublers derives 640-kc r-f carrier from 40-kc tone transmitted over wire lines

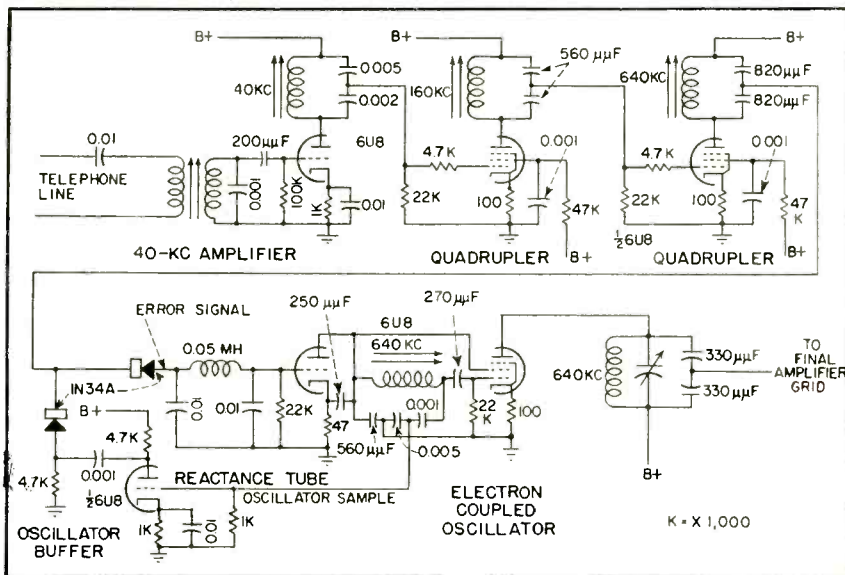


FIG. 2—Alternative arrangement syncs local oscillator frequency with 640-kc signal derived from 40-kc tone

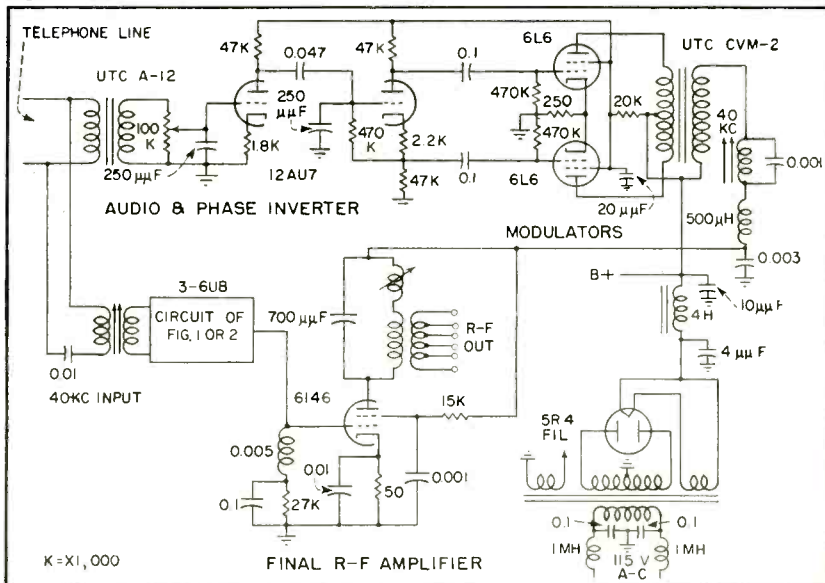


FIG. 3—Booster transmitters use a single 6146 in their final stage and obtain r-f drive from either frequency multiplier or afc local oscillator

Multiplier for

Circuit that takes logarithm of each term, adds them and takes antilogarithm of sum combines high versatility and reasonable accuracy. Applications of equipment include solving nonlinear differential equations and improving response of servo loops

NEED FOR A versatile arbitrary function generator of a dependent variable is strongly felt in feedback control system design. In a control system, the response of which requires improvement, it may be possible to better the performance if appropriate nonlinear functions are added, either in the forward loop or in the feedback path.

In determining the nature of this nonlinear function, a high degree of absolute accuracy is not required. Rather, it is important that one function may easily be modified into another in the attempt to discover an optimum. The design problem then demands a highly versatile computer with only reasonable accuracy, perhaps 5 percent. The arbitrary function generator to be discussed satisfies the needs of the computer designer in that the form of the nonlinearity can be changed by the setting of two knobs.

In many problems it may be necessary to generate products of arbitrary functions of two or more variables. The computer described permits products of the general form

$$[f(x)]^\alpha [g(y)]^\beta [h(z)]^\gamma \quad (1)$$

where $f(x)$, $g(y)$ and $h(z)$ may be the dependent variables of a given problem or may be any independent variables. The constant exponents α , β and γ may be either positive or negative.

The operation of the multiplier is based on the logarithmic function, having the property

$$\alpha \log_a f(x) + \beta \log_a g(y) + \gamma \log_a [h(z)]^\gamma = \log_a \{ [f(x)]^\alpha [g(y)]^\beta [h(z)]^\gamma \} \quad (2)$$

where a is any number greater than unity.

Since summation is easy with

electronic circuits, the logarithms of three voltages can be added simply and the inverse logarithm of the sum results in the product. Hence analog multiplication or division is performed easily by adding voltages.

Multiplying Process

A block diagram of the analog multiplier used for two input voltages is shown in Fig. 1. The signals e_1 and e_2 are rectified and fed to the linear-to-logarithmic converters, which produce the logarithms of the magnitudes of e_1 and e_2 .

After appropriate attenuation or amplification, the signal is fed to the logarithmic-to-linear converter. The sign is restored by the output polarity restorer. As an example of multiplication suppose e_1 is a linear sweep $e_1 = k_1 t$ and e_2 is a sine wave $e_2 = k_2 \sin \omega t$.

Figure 2 shows oscillograms for products of these functions when multiplied and raised to desired powers. The exponent of either function can be changed easily from -5 to $+5$ simply by changing the attenuator setting.

To ascertain the accuracy of the multiplier, the function $y = Ax^n$, $A = 3$ and $n = 0.5$, was set up on the computer. This was accomplished by removing all but one input. From an enlarged copy of Fig. 3A, the points were plotted on log-log. paper as shown in Fig. 3B. From the resulting straight line, the curve was determined to be

$$y = 2.98x^{0.488} \quad (3)$$

Comparison of the exponent yields a discrepancy of 2.4 percent between the two expressions, with the constant multiplier in error by 0.7 percent. From the scatter of the points the error is estimated to be 3 percent. Since judgment is required in reading the oscillogram this last value probably could be improved with practice.

Circuit Details

The linear-to-logarithmic converter¹ converts the all-positive input voltage according to

$$e_0 = -\log_a e_{in} \quad (4)$$

The final circuit of the converter is shown in Fig. 4 where the parallel connected 12AX7 provides the

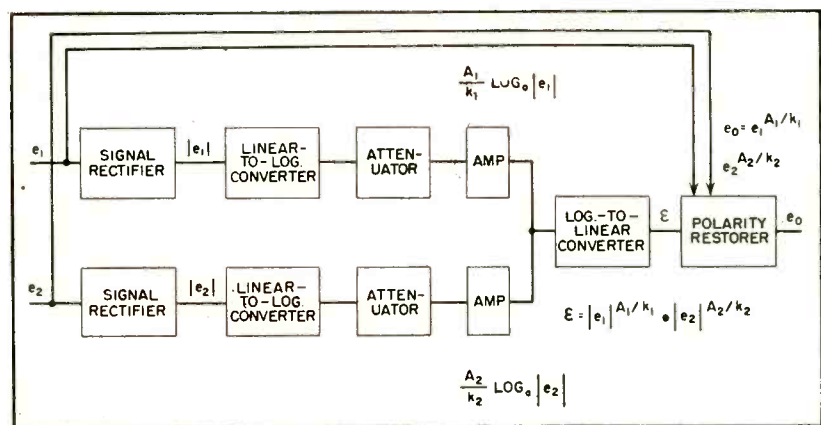


FIG. 1—Functional block diagram illustrates how unit performs analog multiplication using linear-to-log and log-to-linear conversions

Analog Computers

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logarithm characteristic. The 6S4 cathode follower reduces the output impedance of the converter while permitting adjustment of the d-c offset voltage. Many triodes, diodes and rectifiers³ exhibit logarithmic characteristics with a large attenuation and over only a limited range. In this converter, however, use of a high plate voltage permits high-gain conversion that corresponds to a low logarithmic base.

The 270,000-ohm grid-cathode resistor provides a logarithmic characteristic over a wide voltage range, 0.3 to 300 v applied yields +3 to -32 v output. A 350,000-ohm plate-load resistor is used to keep the d-c level at a reasonable value. Good stability, 75 millivolts per hour, and reproducible characteristics are obtained by tube aging.

Since the converter operates on a positive signal only, a signal rectifier must be used before the converter. This input signal rectifier operates much the same as a full-wave rectifier. Hence, for varying voltages in the range -150 to +150 v, the output is positive, ranging from 0 to +105 v.

Circuit Operation

Conformation of the logarithmic-to-linear converter is illustrated in Fig. 5. The basic equations of the circuit are

$$(e_f + e_{in})/2 = e \quad (5)$$

$$(e + \delta) A = e_0 \quad (6)$$

$$-\log_a e_0 + \Delta = e_f \quad (7)$$

Here Δ and δ are the drift of the logarithmic-to-linear converter (referred to its output) and the drift of the amplifier (referred to its input), respectively.

Equations 5, 6 and 7 result in

$$e_0 = \exp_a(e_{in}) \exp_a[(\Delta + 2\delta - 2e_0/A)] \quad (8)$$

This expression demonstrates that the output of the logarithmic-

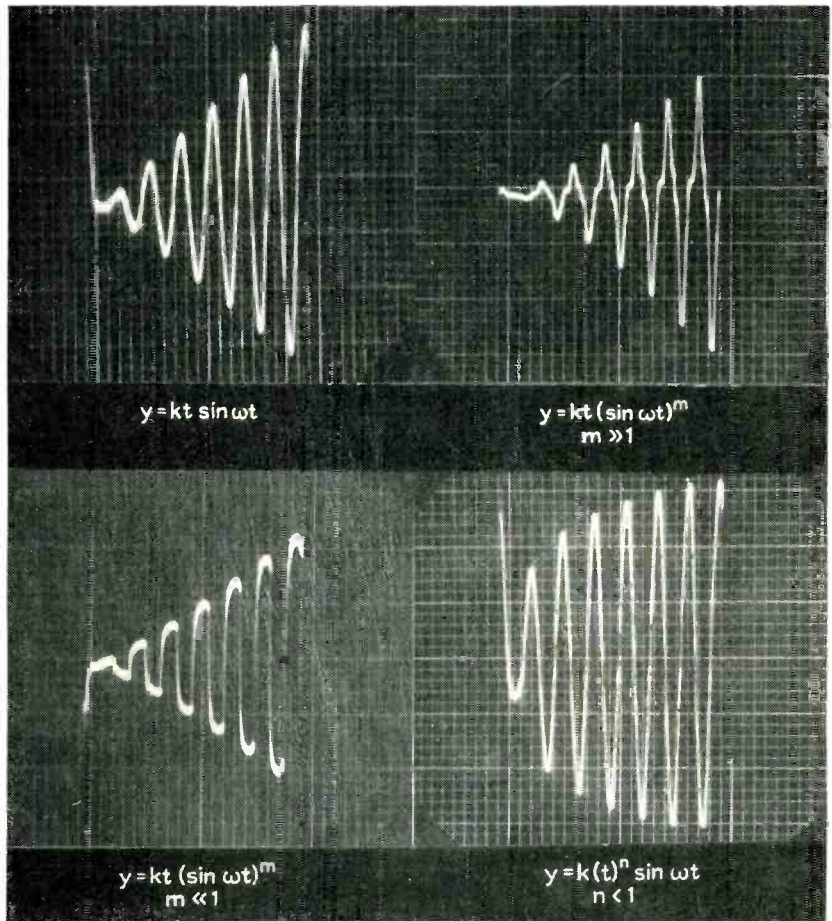


FIG. 2—Functions of form $y = k_1(t)^n k_2(\sin \omega t)^m$ illustrating multiplication of terms and raising to powers

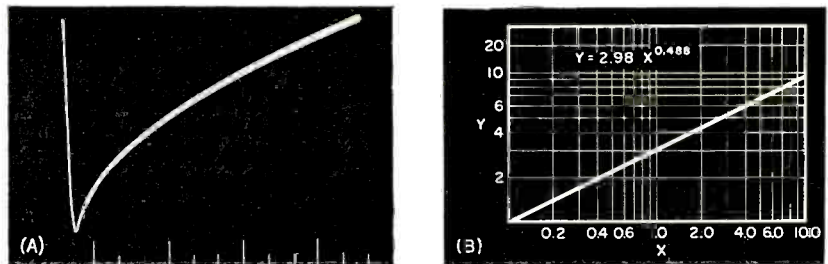


FIG. 3—Checking accuracy of multiplier. Function is set up and output taken. left. Straight line plotted on log-log paper, right, reveals discrepancies

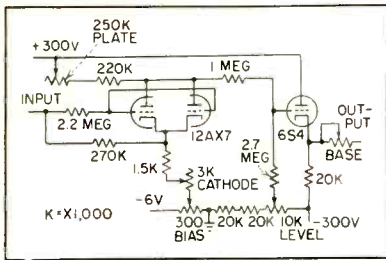


FIG. 4—Circuit of logarithm-taking element of multiplier

to-linear converter is proportional to the product of two factors the first of which is the desired result and the second of which is the combined error. Since the polarity of error is unknown, the most pessimistic case is considered. Expanding the second term is a series

$$e_0 \cong \exp_a(e_{ia}) [1 + (\Delta + 2\delta) \ln a] \times \left[1 + \frac{2}{A} e_0 \ln a \right] \quad (9)$$

From Eq. 9 approximate percent-error expressions resulting from drift and insufficient gain can be obtained

Percent error from drift

$$\Delta E_d \cong 100 (\Delta + 2\delta) \ln a \quad (10)$$

Percent error from lack of gain

$$\Delta E_g \cong 200 e_0 \ln a/A \quad (11)$$

With normal values, $\Delta = 50$ mv, $\delta = 25$ mv, $a = 1.2$, $e_0 = 300$ and $A = 8,000$, substituted in Eq. 10 and 11, the maximum possible errors are

$$E_d = 2.3 \text{ percent and } E_g = 2.1 \text{ percent} \quad (12)$$

However, with appropriate adjustment of the final unit E_d can be reduced considerably and E_g eliminated completely.

Since only positive signals are acceptable to the multiplier, a polarity restoring circuit is needed. The heart of the restorer is a pair of amplifiers; one inverts the input signal, and the other does not.

The sensing part of the inverter allows only one amplifier to operate at a time controlling the polarity of the output. Input signals applied to the sensing input terminals control the sensing circuit such that the correct algebraic sign is restored to the output. If in the multiplication of two voltages both have the same polarity, the output voltage should be positive. If, however, the two input signals have opposite signs, the output voltage should be negative.

The sensing input terminals of the output inverter are connected at points in the circuit where the signals to be multiplied have proper signs and the correct signs of signals passing through the output inverter are restored.

Nonlinear Differential Equation

To demonstrate the operation of the multiplier in a typical analog computation

$$\ddot{X} + c\dot{X} + (\alpha x + \beta x^3) = F \cos \omega t \quad (13)$$

is solved. This equation occurs in several physical problems such as the pendulum with an external periodic force applied, mass subjected to a spring restoring force, saturation effects in iron core inductances and in rotating machinery. Explicit

solutions of simple form are not known. The computer solution is demonstrated in Fig. 6A. Loop analysis yields the analogous electric equation

$$L\ddot{q} + R\dot{q} + \frac{1}{C}q + kq^n = E \cos \omega t \quad (18)$$

Variation of the exponent adjustment permits the choice of any desired n . The classical equation dictates an n of 3, but any $n > 1$ demonstrates similar phenomena.

To demonstrate the resonance hysteresis obtained with this equation consider Fig. 6B, which was obtained with the nonlinear multiplier. When the frequency is increased, the amplitude suddenly jumps down at a certain frequency. When the frequency is decreased,

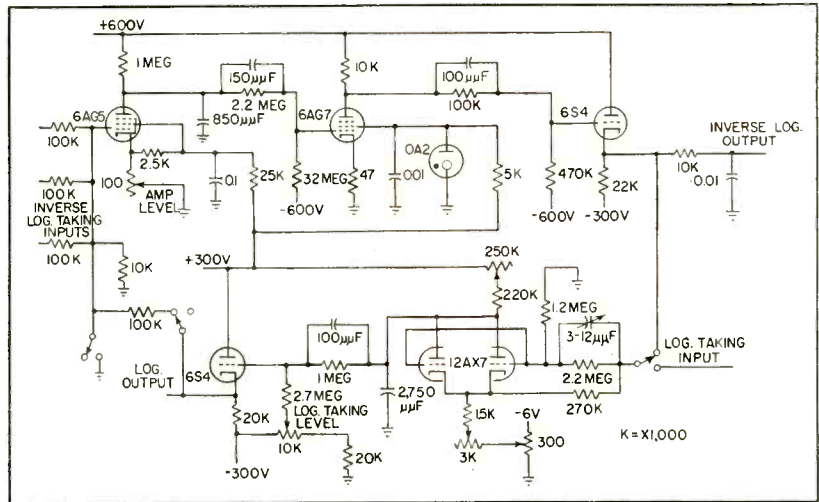


FIG. 5—Circuit of inverse or antilogarithm-taking element of multiplier

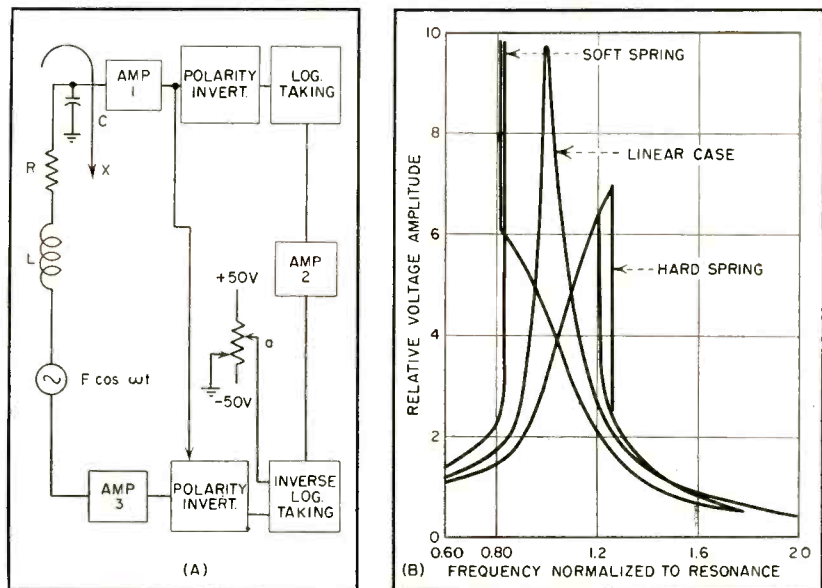


FIG. 6—Setup for solving nonlinear differential equation (A) and resonance hysteresis effects obtained with multiplier (B)

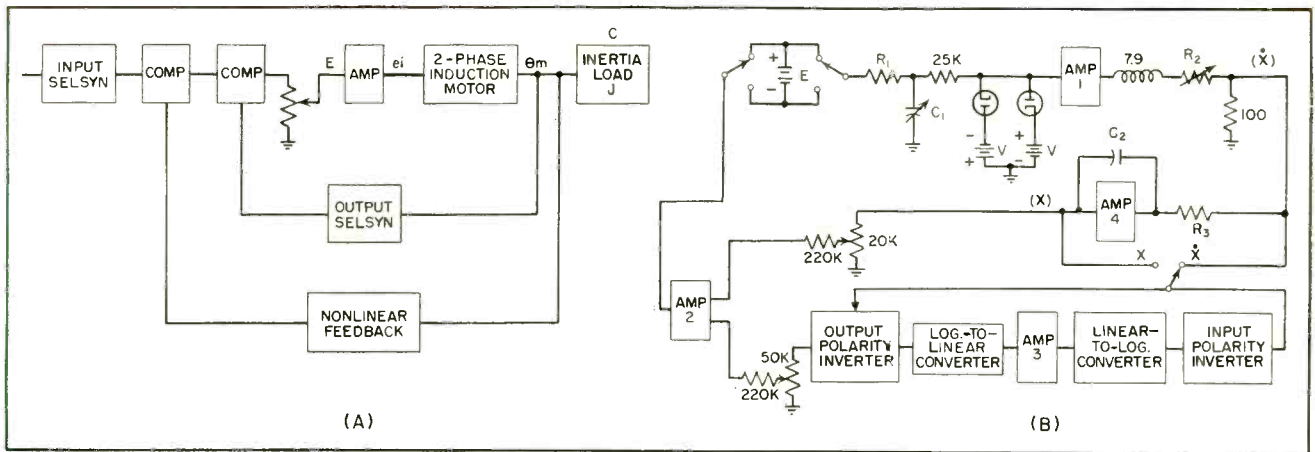


FIG. 7—Simple position servomechanism (A) and analog computer setup for improving response (B)

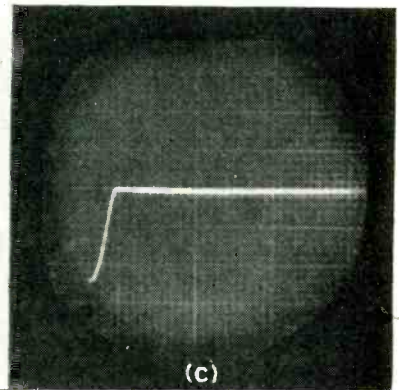
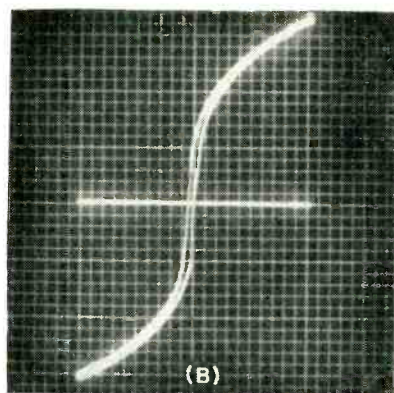
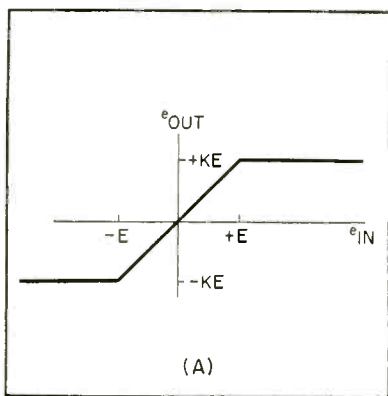


FIG. 8—Saturated amplifier characteristics (A); rate feedback function for improved response (B) and improved response to step function (C)

however, the corresponding jump up occurs at a lower frequency. This nonlinear phenomena has been studied with the aid of the multiplier.

Servomechanism Design

In design of closed-loop systems, a common problem is unavoidable nonlinear operation of certain forward-loop elements. Amplifier saturation, gear-train backlash, brush friction dead space and controller-force saturation are typical examples. By using a large amount of linear feedback, the response can be improved; however, with the use of nonlinear feedback functions a greater range of possibilities is available. The multiplier provides a method for designing the proper function.

Consider the servomechanism shown in Fig. 7A. The system consists of two selsyns, an amplifier, a two-phase induction motor, an inertia load and a nonlinear function generator. The open-loop

transfer function of the control system is

$$C = k \epsilon / p (\tau_a p + 1) (\tau_m p + 1) \quad (19)$$

where τ_a is the amplifier time lag, τ_m the motor time lag, k the gain around the open loop, and $p = d/dt$. Figure 7B shows the electric analogy of the open-loop system.

Writing the circuit equations

$$q = k_1 e / p (\tau_1 p + 1) (\tau_2 p + 1) \quad (20)$$

where $\tau_1 = R_1 C_1$, $\tau_2 = L/R_2$ and $k_1 = A_1/R_2$. Comparison of Eq. 19 and 20 demonstrates the analogy. To provide the necessary position feedback, the voltage across the 100-ohm resistor is integrated obtaining $e_2 = R_2 q / R_3 C_2$. With the multiplier an error function

$$e = q + f(q) + q (dq/dt)$$

can be formed.

If the control system has an amplifier that saturates according to the characteristic given in Fig. 8A, it finds its analogy in Fig. 7B in the two back-biased diodes. Adjusting the gain of amplifier³, the

feedback function can be varied over a large range of exponents. The improved response is obtained with a function

$$g(\dot{x}) = (\dot{x})^{0.35}$$

which is shown in Fig. 8B. Figure 8C shows the final response to a step function when using position plus $\dot{x}^{0.35}$ feedback.

Conclusion

The multiplier is small in size, and relatively easy to adjust. A fixed voltage source provides rapid calibration. Many functions are possible and the form of the function is rapidly changed over a wide range. During service of more than six months, the system was found to be reliable and adequately stable.

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Machine Methods Make

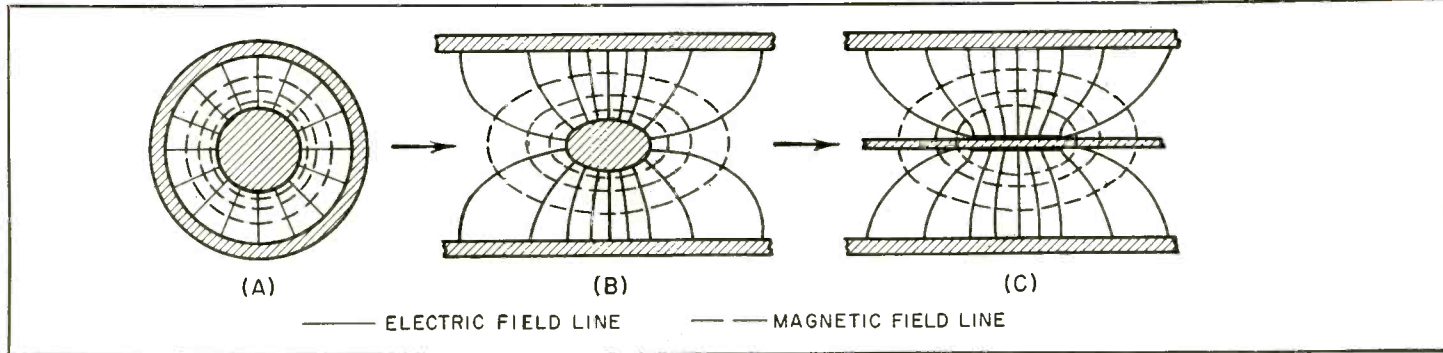
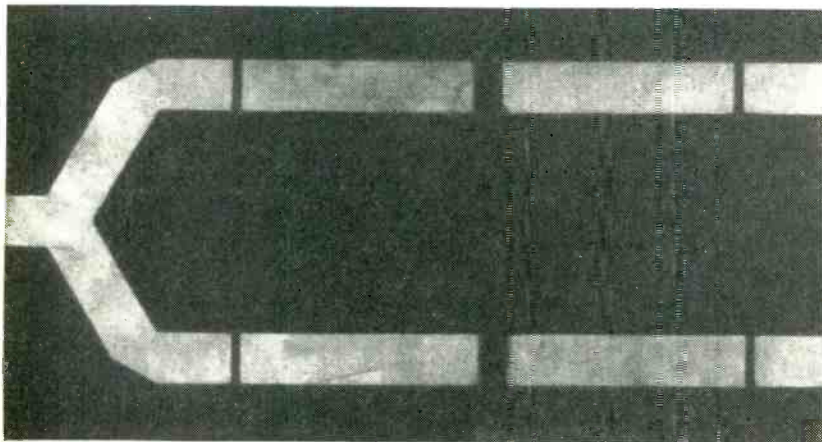
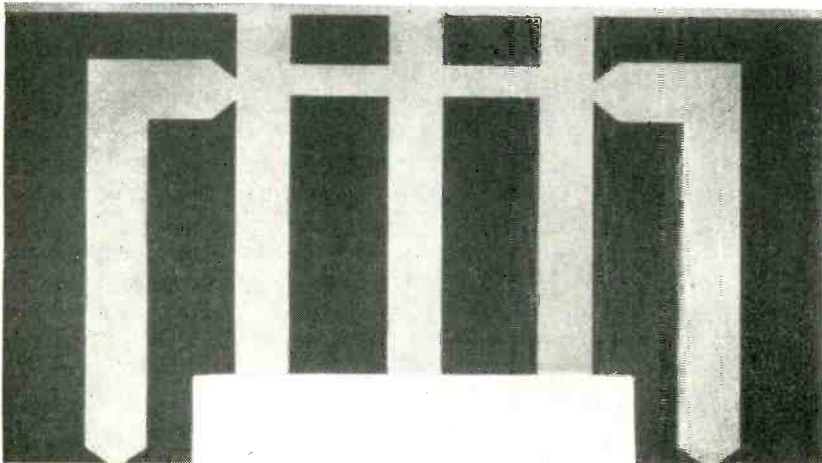


FIG. 1—Diagram shows the evolution of high-Q strip transmission line from coaxial line (A), slab line (B), to final form at (C)

Copper-clad dielectrics allow machine fabrication of microwave components. Practical physical size is only limit on top frequency for transmission line which has been operated up to 10 kmc. Uses include high-Q applications such as filters and resonators



Branching filter with one input and two outputs has 2-db insertion loss



A three-section bandpass filter of quarter-wave elements

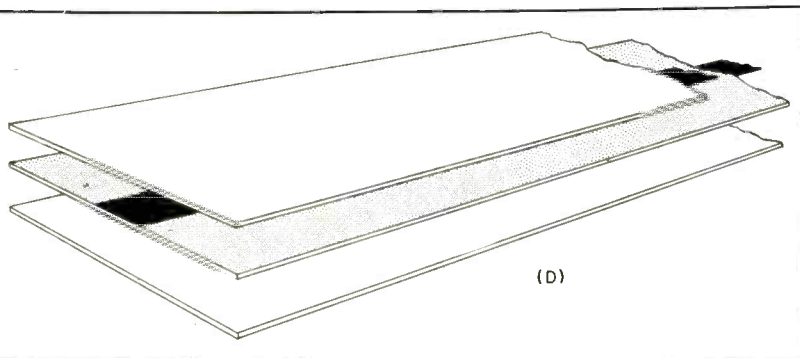
ETCHING of electronic circuits and the printing of components have been confined mostly to those applications involving lumped-constant circuits. More recently the application of these techniques to microwave circuits has begun. Such applications are inherently most successful in the case of planar structures and for this reason have resulted in the exploitation of strip transmission lines.

This type of transmission line, comprising a conducting strip located in fixed relation to a ground plane or planes, has been known for many years. Because it offers no advantages in performance over more conventional types, its use has awaited the advent of these fabrication methods.

Construction

Although strip transmission lines have been described in recent literature^{1,2}, they have been too lossy for applications where a high-Q is desired, such as in filters and resonators. A new type of strip transmission line will be described, which has low losses and consequently is suitable for use in

Strip Transmission Line



and sketch of final form at (D) showing conducting strip in black

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resonant structures. It is the semi-closed symmetrical type wherein the conducting strip is centrally located between two ground planes as shown in Fig. 1.

The essential feature of this line is the splitting of the conducting strip into an upper and lower half so that a supporting dielectric sheet may be placed between. If the two halves of the strip are maintained at the same potential, no electric field (except for fringing effects) exists in the dielectric and dielectric losses are negligible.

In most cases it is sufficient to connect the two halves of the strip

together at the input and output connectors to ensure that they will be at the same potential everywhere. The dielectric sheet supporting the strip may be held in a central location by means of supporting members external to the electric field. Therefore, the losses are essentially the conductor losses and are of the same order of magnitude as the losses in air-filled coaxial line and waveguide.

Modes

The mode of transmission is TEM and since the conductor losses decrease as the physical size

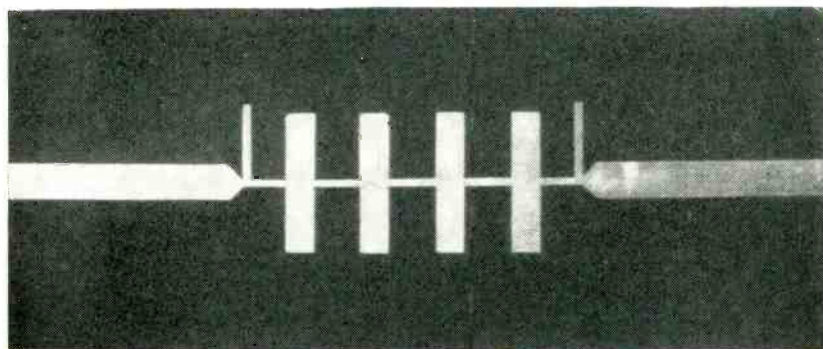
is increased, the largest practical size of the line would be desirable. However, if the plate separation is made too great, higher modes may be propagated. Some of the modes may be prevented by keeping the plate separation less than one-half wavelength at the highest frequency to be used so that for these modes the parallel plane system is a waveguide below cutoff. In addition, the path length around the perimeter of the center strip must be less than a wavelength so that higher modes will not be propagated.

These limitations are similar to those encountered in coaxial line and in most cases are not too severe. Thus the upper-frequency limit for this type of transmission line is chiefly a question of practical size and tolerances. A ground plane spacing of one-quarter inch is reasonable and this has been used up to 10 kmc. There is no low-frequency limit except that the length of resonant elements becomes impractical below about 100 mc.

Characteristic Impedance

This structure may be considered equivalent to a line having a solid center strip of equal thickness. The characteristic impedance of such a transmission line is shown in Fig. 2, where several different strip thicknesses are indicated. These curves are calculated for a solid center strip, but experimental results show that they hold for the dielectric-supported strip with only a 1-percent deviation. These results are true for relatively thin strips and a characteristic impedance in the neighborhood of 50 ohms.

For very thick strips or very narrow strips (high characteristic impedance) the fringing effect would be relatively greater and therefore the effect of the dielectric would be greater. For most practical applications the strip thickness t or more precisely the ratio t/D , where D is the separation between ground planes, may be kept



Low-pass filter with the narrow tabs at either end of the strip-transmission-line-equivalent of m -derived sections to control performance near cutoff

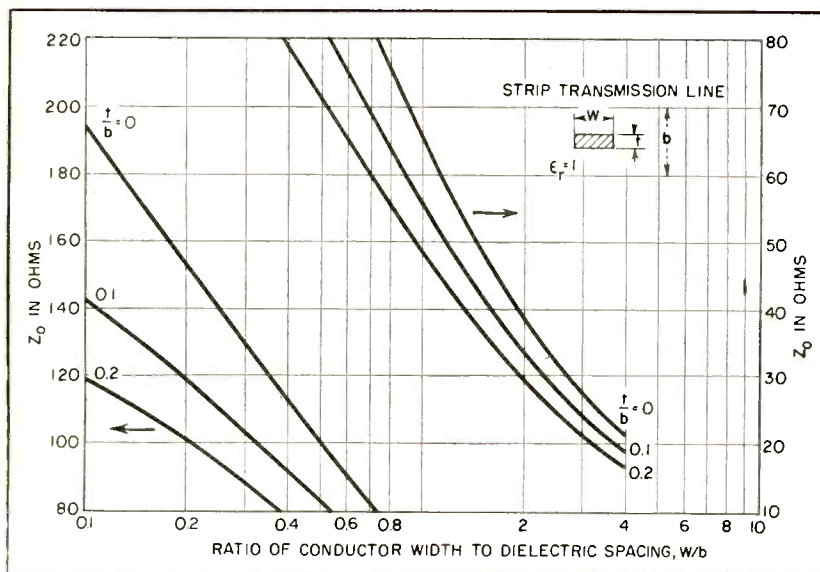


FIG. 2—Characteristic impedance of balanced strip transmission line with several different strip thicknesses

below 0.1. In this case, for characteristic impedances below 100 ohms, the assumption that the center strip is solid is sufficiently accurate.

Attenuation

The attenuation off to the side of the center strip may be considered as the attenuation of the TM_{11} mode in a waveguide below cutoff. Thus the attenuation in a direction perpendicular to the longitudinal direction of the strip is $54/2D$ db per unit length, which is a rather high rate of attenuation. One result of this high attenuation rate is that very sharp bends may be made in the center strip without introducing radiation losses.

Another result is that two transmission paths may be physically close together without having significant interaction. These results permit the design of a complex circuit or system that may be compressed into a small space. The use of resonant lengths of line at frequencies in the vhf region is facilitated by the fact that they may be coiled or bent in the plane of the strip so as to be in a more practical form.

Tolerances

Although the characteristic impedance is not generally of a critical nature, this line has the same sort of logarithmic dimensional dependence possessed by many other transmission systems. In the

neighborhood of 50 ohms the percentage variation in the characteristic impedance is only 0.36 times the percentage variation in the linear dimensions.

The criticalness of centering is of greater importance, but small deviations introduce negligible coupling to undesired radiating modes. The theoretical dependence on centering has not been fully worked out as yet, but a variation of ± 0.020 in. for 0.500-in. ground plane spacing produces no noticeable effects. Therefore, the centering tolerance does not produce any practical difficulties.

The only really important tolerance is on the longitudinal tilt of the center strip, but even in this instance, close tolerances need only be maintained in certain special cases. The effect of tilt is to generate higher, radiating modes resulting in a loss of energy. This loss is not important in many low-Q applications, but for high-Q circuits a tilt of 0.5 degree can reduce the Q by fifty percent. The use of posts to connect the ground planes together in the vicinity of the strip will suppress these modes and with proper spacing, a tilt of 1 degree has no effect.

The planar form of this transmission line as well as the field configuration permit the convenient introduction of various tuning and attenuating devices. These may have either rotary or translational

motion. In either case the control mechanism may pass through or between the ground planes without affecting the field. In this way flap attenuators, variable capacitors, sliding shorts and other similar devices may be included

Because one pair of ground planes suffices for a complete r-f system, several economies and conveniences result. The complete system is embodied in the strip conductor pattern, which may be fabricated in its entirety in the manner of lumped-constant printed circuits. The support structure, tuning mechanisms and vacuum tubes may be mounted on the ground planes.

The assembly of the complete system is simple and noncritical. Due to the absence of intervening walls between the various components there is a saving in size and weight.

Filters

Successful applications of this strip transmission line include various types of filters, the r-f portion of a radar receiver and the r-f portion of a microwave link equipment. Some of these filters are shown in the photographs of center strips fabricated from copper-clad dielectric.

One of these is a low-pass filter comprising series inductive and shunt capacitive sections. The second is a three-element bandpass filter. This uses conductively coupled quarter-wave elements and may be tuned over a broad frequency range. The other is a branching filter with about 2-db insertion loss and more than 60-db isolation between the two output terminals. This filter operates at about 2 kmc and the branches are separated by 68 mc.

The work described is the result of efforts of the Special Devices Section of the Airborne Instruments Laboratory under the guidance of E. G. Fubini and W. E. Fromm. Acknowledgement is also due to S. Cohn for information relative to Fig. 2.

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Rocket-Borne Photometer Measures Sky Light

Spectral and intensity characteristics of sky at different altitudes over eight regions of visible spectrum are sampled. Sensitivity of system is automatically varied to accommodate different signal levels

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MODERN ADVANCES in air transportation have greatly increased interest in the properties of the atmosphere at high altitudes. Such advances have also afforded a means of directly measuring some atmospheric properties which had previously been difficult or impossible to measure from lower altitudes. The instruments to be described were installed in high-altitude sounding rockets at Holloman Research and Development Center, New Mexico to determine the intensity and spectral characteristics of the light of the day sky from the ground to altitudes exceeding 70 miles.¹

Photometric Receiver

Figure 1 is a block diagram of the basic system. All the rocket instrumentation is controlled from a blockhouse situated some distance from the launching tower. The state of the equipment can be determined at any time prior to launching by means of a system of indicator lights and calibrated voltage readings.

The rocket-borne equipment consists of a 1P21 multiplier phototube and a series of narrow-band interference filters. Eight filters are mounted on a motor-driven disk,

which revolves in front of the phototube at 88 rpm. With each revolution of the disk, an intensity measurement of the sky radiation near zenith is taken in each of the eight different regions of the visible spectrum.

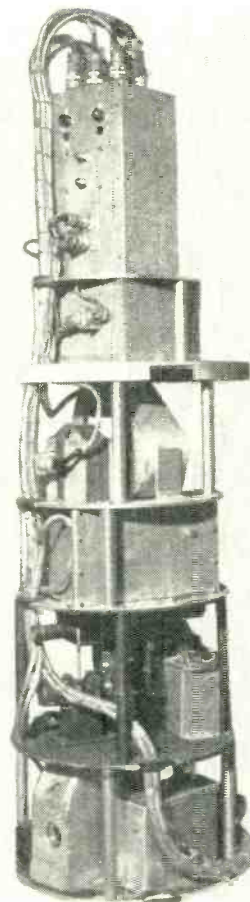
The photometer and associated circuits are designed to meet the rigid requirements of weight, size, ruggedness and dependability which rocket operation imposes.

The equipment has often been recovered in excellent condition and flown again.

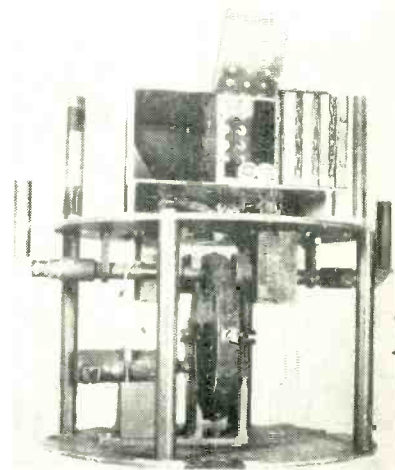
Figure 2 is a schematic diagram of the circuit with six sensitivity ranges. For simplicity the auxiliary controls and calibration circuits have been omitted and only the basic photometer, sensitivity control and output circuits are shown.

Sensitivity

A wide sensitivity range is necessary for accurate measurements due to the great variation of the intensity of sky light with altitude. The method of obtaining the required range is restricted by the fact that the only acceptable input signal to the telemetering system is zero to five volts positive. A variety of sensitivity ranges are easily



Photometer ready for installation in Aerobee rocket. Units are, from top to bottom: missile control box; 28-v battery; 16-mm camera; phototube high-voltage supply; rotating filter disk and entrance optics; 16-mm camera



Light collimator and rotating filter disk; pressurized high-voltage battery box (above) showing method of packing miniature batteries

obtained by varying either the load resistor or the voltage on the dynodes of the phototube. The latter method gives the greatest range without encountering saturation or instability in components.

Figure 3 shows the result of varying all dynode voltages simultaneously by the same amount. This method is satisfactory but imposes massive switching arrangements in the rocket equipment, as each stage must be switched independently.

To eliminate this difficulty, tests were conducted to study the effect of varying the voltage on a single dynode or on only two dynodes while the remaining dynodes were held constant. From the results of these tests, as shown in Fig. 3, it was decided that varying the voltage on dynodes 3 and 4 by the same amount while the other dynodes were held constant was sufficient for our purpose. This considerably simplified the high-voltage switching circuits.

Sensitivity changes must occur at rapid intervals and at appropriate times because of the great vertical speed of the rocket. Also, the change need only cause increased sensitivity because the skylight intensity decreases monotonically with altitude. The control device must be simple and rugged to insure dependable operation during the rocket flight. To meet these requirements, an electronic relay controlled by the photometer output was designed.

Sensitivity switch S_1 , in Fig. 2, is operated by the electronic relay. Sections *B* and *C* control the voltage to the third and fourth dynodes of the phototube. Section *D* changes the 1P21 load resistance. This allows finer adjustment of sensitivity ranges since the supply voltage changes are discrete and determined by the batteries used. Section *E* monitors the sensitivity range by presenting to telemetering a known voltage identifying the switch position at all times during flight.

Both S_1 and S_2 are wafer-type gang switches and are operated by rotary stepping-drive mechanisms. The 1P21 is powered by the batteries through on-off switch S_2 . Section 10 of this switch is used as an on-off monitor by producing a volt-

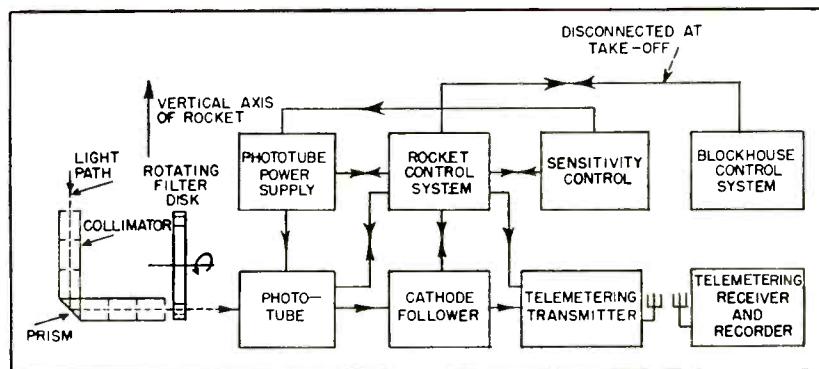


FIG. 1—Block diagram of complete rocket-borne photometer system

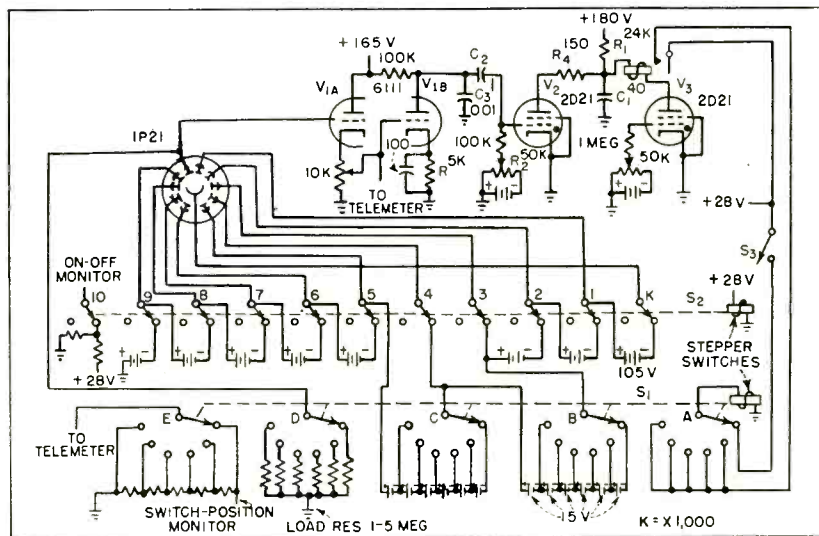


FIG. 2—Simplified schematic of photometer. Switch S_2 is energized through an on-off control switch

age reading at the ground-control center when the switch is on.

Control Circuit

The output of the multiplier phototube, as measured at the telemetering input, is shown in Fig. 4. The shape and amplitude of a given pulse is determined by the optical filter characteristics, speed of the rotating disk and spectral characteristics of the sky light being measured. An attempt was made with the help of neutral filters to obtain constant amplitude for all eight filters, but limitations forced acceptance of a variation of about 30 percent.

The signal must be made to conform to the telemetering input requirement which is zero to five volts across 100,000 ohms. This is accomplished with cathode follower V_{1A} whose cathode resistor is adjusted to give plus five volts output at zero input.

As the multiplier-phototube output increases, the drop across the load drives the cathode-follower grid negative until the tube cuts off. This insures that the telemetering limits are not exceeded. The resulting output is not linear but the curve is known and corrections are made when the data is analyzed.

Amplifier V_{2B} is in parallel with the telemetering input and is self-biased to a value such that a cathode-follower output of five volts, corresponding to zero phototube output, causes zero bias on the amplifier. This applies a minimum voltage to the grid of control thyatron V_2 . Conversely, when the phototube output is maximum, with zero cathode-follower output, the resulting bias on the amplifier is negative driving the thyatron grid in a positive direction.

After establishing the minimum phototube output at which sensitivity is to be increased, the control

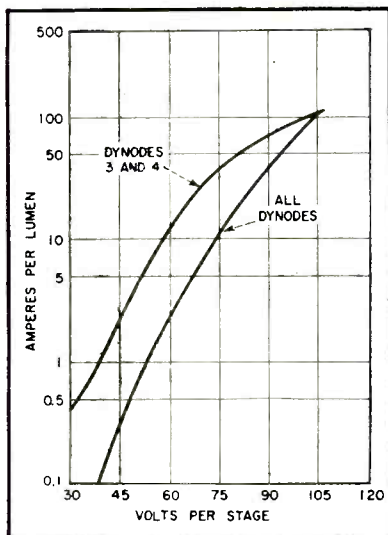


FIG. 3—Photomultiplier sensitivity versus dynode voltages

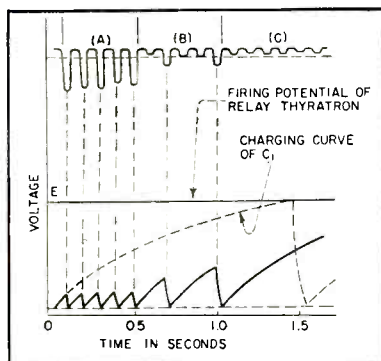


FIG. 4—Photomultiplier tube output (top) and corresponding relay-thyratron plate voltage (below)

thyatron's fixed bias is adjusted so that a phototube output greater than the minimum will drive its grid positive and fire the tube. When the output drops below this minimum value, the thyatron will remain cut off. This action of the circuit is used to control the operation of relay thyatron V_2 .

Firing Point

The fixed bias of the relay thyatron is adjusted so that the tube fires at a plate potential of about 125 volts. Both thyatrons are supplied through an R-C circuit (R_1 and C_1) having a one-second time constant.

If a single pulse from the phototube is greater than the minimum value required to fire the control tube, the plate voltage on the relay tube cannot rise to its firing potential. If the signal is insufficient to fire the control tube, capacitor C_1 will charge to the firing potential

of the relay tube. The plate relay, which is operated by the action of the relay thyatron, activates the rotary sensitivity switch and the voltages on dynodes 3 and 4 are increased by 15 volts each. This raises the phototube output, which in turn drives the control-thyratron grid positive, firing the tube and cutting off the relay tube. If a single step in sensitivity is not sufficient, the relay tube will act as a relaxation oscillator and fire again as C_1 is recharged.

To prevent recycling of the sensitivity switch, the associated relay is powered through section A of S_1 . When this switch has reached the position of maximum sensitivity, the relay circuit is opened and subsequent firing of the relay tube has no effect. The switch can be recycled during preflight operation by means of S_3 , which is located in the blockhouse control unit for the equipment.

As the operation of the sensitivity switch is dependent upon the time constants of the circuit, its range is widely adjustable. In this case the output pulse of the multiplier phototube for a given filter is repeated once per second. The relay tube is adjusted to fire at a 1.5-second rate. Thus if the output from any one filter remains above the desired minimum potential, V_2 will fire rapidly enough to maintain V_2 at cutoff.

Figure 4 shows the thyatron plate voltages and firing characteristics with varying sky-light intensity. Section A of Fig. 4 depicts a high signal which fires the control thyatron on each pulse. In section B, some of the pulses are below the minimum value indicated by the dotted line at 4 volts and will not fire V_2 . This allows C_1 to continue to charge until a strong pulse fires the tube.

Section C shows the signal for all filters less than the minimum value. Thus C_1 charges as shown by the dotted curve. The relay thyatron will fire at the potential E initiating the operation of the sensitivity switch which increases the multiplier-phototube supply voltage and consequently restoring the signal to a value similar to that in section A.

The bias of amplifier V_{1B} is de-

termined by its cathode resistor, giving maximum swing in plate current for the zero to five-volt input. The size of the coupling capacitor C_2 and cathode-bypass capacitor is determined by the square-wave frequency to be passed. In this case the fundamental frequency is about 10 cps therefore the capacitors are large. Capacitor C_3 is an r-f bypass to prevent stray pickup from triggering the control thyatron.

The control thyatron maximum can be adjusted by R_2 to fire on any pulse represented by a signal of from 5.0 to 2.5 volts from the cathode follower. The firing rate of switching thyatron V_3 is adjusted by R_1 .

It was found that the plate-relay resistance and current-limiting resistor R_4 had to be kept below 200 ohms to permit extinction of the tubes when C_1 discharged. The plate relay has a 3,470-turn coil and a resistance of 60 ohms. Chattering of the relay contact arms under vibration was remedied by removing the contacts and replacing them with a miniature Micro Switch.

Power Supply

The phototube operates from a constant and dependable high-voltage source consisting of miniature hearing-aid batteries chosen to conform to size and weight requirements. However, these batteries do not have the current capacity necessary for a stable voltage-divider system as generally used with multiplier phototubes. Therefore, each dynode is supplied separately from a battery as shown in Fig. 2.

The thyatrons are powered from an independent plate supply to insure constancy in the cathode follower characteristics when the thyatrons are firing.

The authors thank their associates in the Atmospheric Visibility Section of the Geophysics Research Directorate for their helpful attitude toward the design of the equipment and the preparation of this manuscript.

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Crystals Reduce

Intermodulation interference caused by stations close in frequency located in same geographical area can be eliminated or reduced by using quartz crystals as radio-frequency filters between antenna and first stage of mobile radio receivers

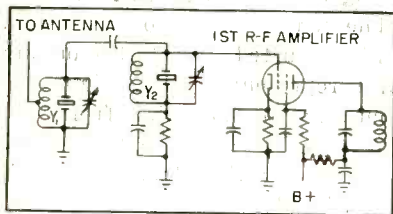


FIG. 1—Simplified circuit of first r-f stage shows crystal filters. Either or both units can be employed

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RAPID GROWTH of mobile communications and the system used of assigning a block of frequencies for a specific class of users have increased the problem of intermodulation interference. These conditions have resulted in a closer study of the mechanism by which intermodulation takes place. This work has stimulated additional study of mechanical or crystal-filter circuits.

With information now available, the receiver intermodulation problem can be disposed of entirely where it results from not more than four signals and for operating frequencies up to 54 mc. Cost increase in the receiver is moderate. For frequencies up to 170 mc, a considerable reduction in intermodulation in the receiver can be accomplished at an equally moderate cost increase.

The intermodulation problem results primarily from the fact that most receivers have a broad pass-band preceding the first grid. In addition, the relationship of grid voltage to plate current in the r-f amplifier is not linear. Radio-frequency amplifier tubes while operating as amplifiers are also detectors, especially during relatively large grid swing.

A common case of intermodulation can be illustrated by a simple numerical example. Consider three

adjacent channels—*A* 41.420, *B* 41.460 and *C* 41.500 mc. Since these frequencies are close, the usual antenna transformer will pass the three signals to the grid of the r-f amplifier tube without discrimination. It is assumed that 41.460 and 41.500 are fairly strong signals—in the order of 1,000 microvolts. The second harmonic of 41.460 will be 82.920 mc. If this beats with the higher-frequency signal, the resulting frequency will be 82.920 minus 41.500 = 41.420 mc, which is a signal exactly one channel lower in frequency than 41.460 mc.

This artificial carrier will have modulation from channels *B* and *C*. It is therefore a potent source of interference and may be in addition a strong carrier as it is usually in the order of only 65 db down from the carriers that produce the intermodulation signal. Likewise, the intermodulation product may fall one channel higher than 41.500 mc, or on a channel *D* (41.540 mc), when it is produced by the second harmonic of the 41.500-mc signal beating with the 41.460-mc signal.

Since the average communications receiver on 40-kc channels has an intermodulation ratio in the range of 60 to 66 db and the average communications receiver used on 20-kc channels has an intermodulation characteristic in the order of 48 to 56 db, the problem

is frequently serious, depending upon geographical location of station or mobile transmitters.

A calculation of received signal strength on the basis of 50-watt stations having 100-foot antenna towers with stations *B* and *C* on the same building results in a condition wherein the intermodulation signal produced on channels *A* and *D* (owing to transmitters *B* and *C* being on the air at the same time) is equivalent to a one-microvolt signal at a radius of 1.5 miles in the case of a mobile and a signal of 5 microvolts for a station receiver with a 100-ft tower.

The condition cited exists in both the 25-to-50 and the 152-to-174 mc range, although it is more frequent in the upper band.

Quartz Filters

In a search for more selective devices without disadvantages of size, expense and loss of cavities, an answer has been found in the use of standard piezoelectric quartz crystals properly applied to the circuit or circuits preceding the first grid. Crystals cause a negligible loss in the input circuit at the desired frequency and are available with proper temperature characteristics. The circuit in Fig. 1 shows that for series resonance of the crystal each coil of the antenna transformer will be loaded

Mobile Interference

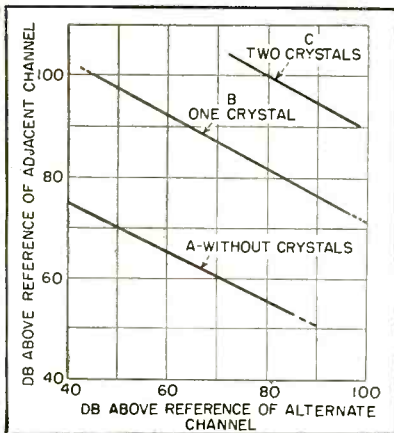


FIG. 2—Intermodulation characteristics of commercial mobile receiver without filter (A), using one crystal (B) and with two crystals (C)

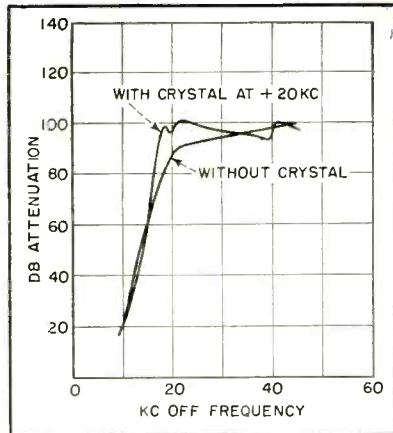


FIG. 3—Typical desensitization curve for receiver tuned to 43-mc channel, showing improvement with crystal in use as radio-frequency filter

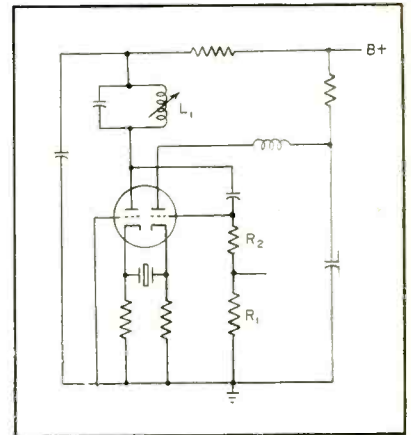


FIG. 4—Series-resonant frequency of crystal is checked by tuning L_1 for maximum grid current in R_2 and measuring frequency

with the equivalent resistance of the crystal (approximately 30 ohms for undesired frequencies), which is an effective short-circuit across each winding of the antenna transformer at the undesired carrier frequency (channels B and C).

Impedances of the coils in the antenna transformer are in the order of 100,000 ohms. Consequently, at crystal resonance, transmission of carrier through this transformer is determined largely by stray coupling and ground currents that can be reduced essentially to zero by proper mechanical design of the antenna transformer. Within a 20-kc channel, crystals will also pass through parallel resonance, at a slightly higher frequency than series resonance. At parallel resonance crystals have an absorption effect that broadens the effective frequency spectrum over which the crystals disable the antenna transformer.

Double Filtering

For severe cases of intermodulation, a crystal is used across each coil of the double-tuned preselector. For the case cited, crystal Y_1 would have its series resonance adjusted to 41.460 mc and crystal Y_2 to 41.500 mc, or vice versa. Standard third-mode crystals are sharp enough to be used on adjacent 20-kc channels in the 25-to-50 mc band

with negligible loss to the desired signal.

The intermodulation characteristic of a standard commercial receiver is shown in Fig. 2. The receiver without crystals in the antenna transformer is represented by curve A. Response with crystal Y_1 added is given at B and the intermodulation characteristic with both crystals Y_1 and Y_2 in curve C. In the 25-to-50 mc band and for adjacent-channel signals the use of crystals Y_1 and Y_2 results in no intermodulation interference for 50-watt transmitters even though the stations are located so close together that break-through occurs on a receiver having a two-signal performance selectivity of 75 db. This means that further reduction of intermodulation would not improve reception conditions. This information is also available from curve C, since the intermodulation ratio for equal values of signal is 93 db.

When the same technique is applied to stations operating in the 150-to-160 mc band, considerable improvement in intermodulation ratios can also be accomplished. Series resistances of the best crystals obtainable at this time, however, are above 100 ohms and the circuit impedance (QX_c) of the input circuit to the first r-f amplifier is appreciably less. With 60-kc

channels, 5th and 7th-mode crystals are sharp enough to avoid loading the input circuit at the desired frequency by the series-resonant crystal on the undesired frequency.

Improving Attenuation

With severe desensitization of either adjacent channel or for any frequency within the pass-band of the antenna transformer, the low resistance of the crystal at series resonance improves the desensitization characteristic of the receiver. Crystal Y_2 is applied to the secondary winding of the antenna transformer shown in the circuit of Fig. 1.

Where a single crystal is used, improvement obtained in desensitization for an adjacent 20-kc channel is 10 to 15 db. Should a further improvement in desensitization be desired, another 10 db can be obtained by placing a series-resonant crystal across the resonant circuit associated with the antenna (Y_1).

A typical desensitization curve is shown in Fig. 3. Only crystal Y_2 was used. The series-resonant frequency of the crystals for this application can be obtained by connecting the crystal in the cathode-type oscillator circuit shown in Fig. 4. Frequency of the oscillator is measured after tuning L_1 for maximum grid current in R_2 .

Magnetic-Tape Pickup

Electron-beam head with perpendicular core structure provides equalized playback response of 0 to 10,000 cps at tape speed of 3 feet per second. Device useful in industrial and other applications requiring low-frequency recording

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RECENTLY PUBLISHED PAPERS on the use of the electron-beam tube for magnetic-tape playback have dealt primarily with longitudinal-type recording systems.^{1,2} The disadvantage of the longitudinal system for certain instrumentation problems is that overall low-frequency response depends upon the wavelength of the recorded signal. The magnitude of the flux intercepted by the pickup core falls rapidly as the wavelength of the recorded signal becomes greater than the physical dimensions of the pickup.³ Hence, even though the electron-beam tube provides a voltage output proportional to flux through the tube, true d-c response can be achieved only when some magnetic recording method other than longitudinal is employed.

The perpendicular-type core structure in combination with the electron-beam tube¹ provides an equalized response range from 0 to 10,000 cps at a tape speed of three feet per second with a signal-to-noise ratio exceeding 40 db. The core was developed with particular attention to problems associated with the use of commercial coated tape. It was found that phase distortion could be minimized by centering the magnetic tape-coating between the faces of the perpendicular-type pole pieces.

Phase Relationships

When the magnetic coating of a recording medium is not centered between the pole faces of a perpendicular-type recording head, an appreciable longitudinal component is

recorded in addition to the desired perpendicular component. This results from the fact that the fringing flux at the trailing edge of the recording gap (at which point the final remanent induction in the tape is determined) is perpendicular to the pole faces and recording medium only in that plane which is equidistant from the two pole faces. The manner in which these two components of magnetization combine in playback to produce phase distortion is illustrated in Fig. 1. Assume recording conditions have been such that the internal inductions representing the perpendicular and longitudinal components are in phase as indicated in Fig. 1A, B, C, D and E. In the case of perpendicular magnetization, internal induction, surface induction and flux through the perpendicular pickup, are in phase regardless of the centering of the tape coating between the pole faces.

For longitudinal magnetization, the internal induction and the flux through the ring-type pickup are in phase. The polarity or direction of the flux through the pickup in relation to that within the tape is of no significance here. However, as indicated in Fig. 1G, surface induction is displaced 90 degrees with respect to the internal induction of the medium. Although due to longitudinal magnetization, the surface induction is directed perpendicular to the medium and will produce a net component in the perpendicular pickup when S_1 is not equal to S_2 . This component of the pickup response is 90 degrees (or 270 degrees) out of

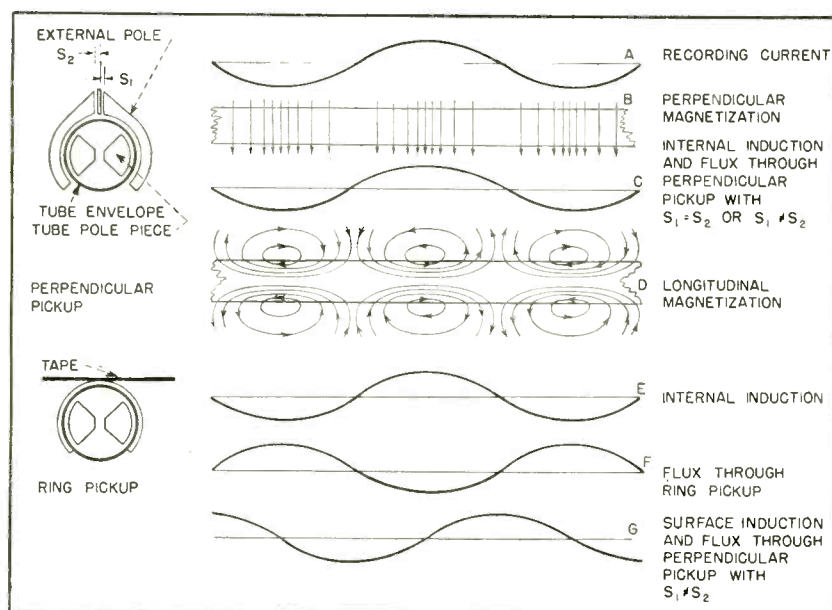
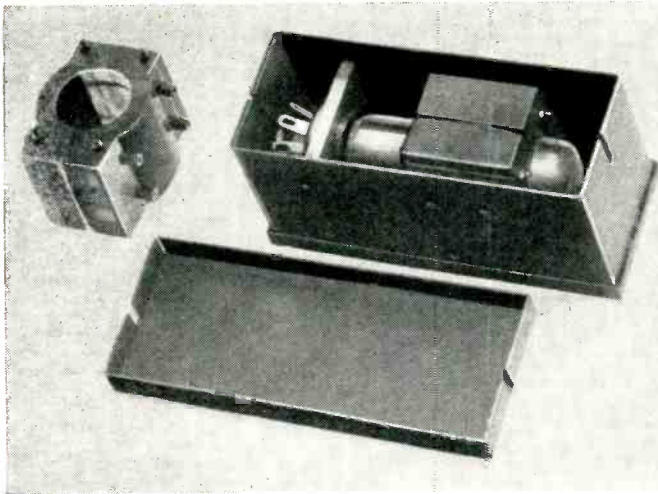
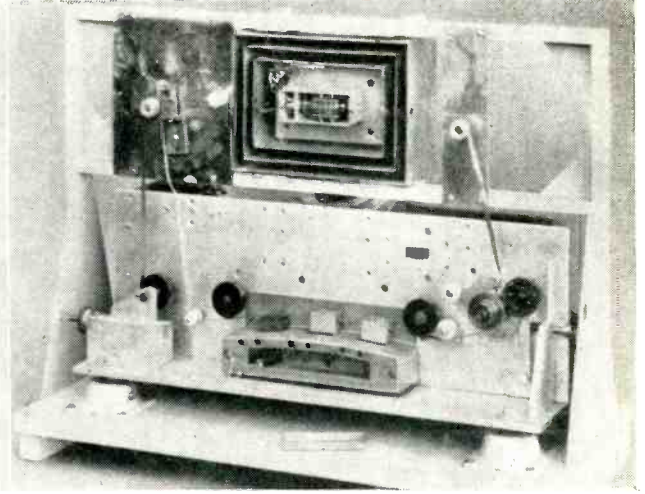


FIG. 1—Phase relations in longitudinal and perpendicular recording

Has D-C Response



Perpendicular-type core and electron-beam pickup with shield



Electron-beam pickup mounted on loop-drive mechanism

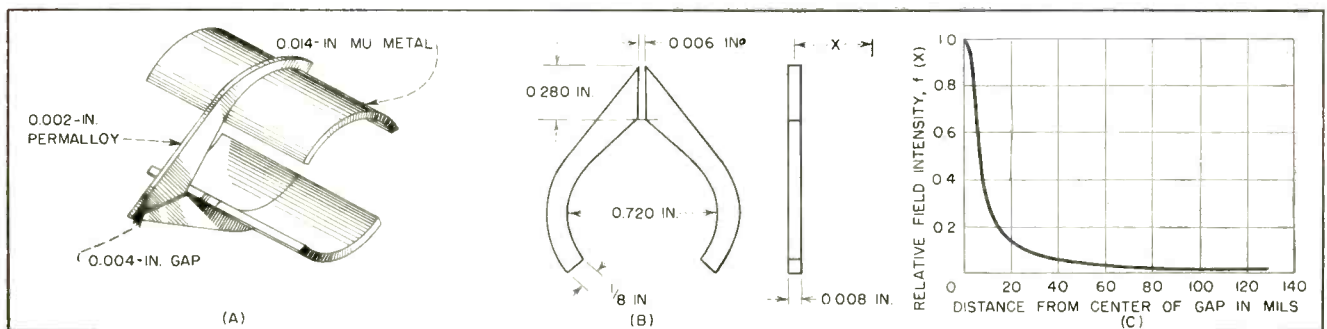


FIG. 2—Magnetic-core structure (A) of electron-beam pickup; typical pole piece (B) and associated field distribution curve (C)

phase with that due to perpendicular magnetization of the medium.

At shorter wavelengths, comparable with the effective pole-piece dimensions, the flux pickup due to longitudinal magnetization becomes significant. It adds substantially to the high-frequency output which would be obtained from perpendicular magnetization alone. However, since the two components are displaced 90 degrees in phase, reproduced complex waveforms will exhibit phase distortion. Thus, the two components may be utilized to provide improved high-frequency response for applications where phase distortion can be tolerated, but for those cases in which phase distortion is to be avoided, the magnetic coating must be centered between the pole faces of perpendicular-type heads.

The external core structure, shown to the left in the photograph, consists of a magnetic core supported in a cast-plastic housing. A groove having a depth slightly greater than one-quarter inch is provided in the top of the housing to permit insertion of standard recording tape. One groove wall is beveled so that tape tension holds the tape against one wall of the groove and the internal pole piece, which is flush with the groove wall.

The form of the magnetic structure is shown more clearly in Fig. 2. Use of a four-mil gap length in combination with the beveled slot was dictated by two considerations:

(1) The thicknesses of the magnetic coating and nonmagnetic backing of plastic tape are approximately 0.6 mil and 1.6 mils. When the tape is operated with the backing

in contact with the beveled side of the slot and the associated pole face, the tape coating is approximately centered in the playback gap; phase distortion in the reproduced signal is then negligible. Alternatively, the tape may be turned over and operated with the coating in contact with the pole face to provide improved high-frequency response for applications in which phase distortion is of no consequence.

(2) To pass through the gap, a conventional splice must be compressed considerably. A satisfactory lap splice may be made by first dipping the tape ends in toluene to remove the tape coating and then cementing the lapped ends.

C-shaped coupling pieces shown in Fig. 2A are cast into the four quarter-sections of the housing.

For some applications the use of

a wider pole piece provides more uniform response and higher output over a restricted low-frequency range. With wider pole faces the ratio of fringing flux to flux induced in the pole faces is decreased to the point at which only that flux induced in the pole faces contributes significantly to the total output of the pickup. For example, with eight-mil pole faces there is a negligible rise in output beyond one-inch recorded wavelength; by comparison, for a two-mil pole face there is a rise of three db over this range and an output which is four to seven db below that obtained with eight-mil poles.

Theoretical Response

The unequalized midrange response of the perpendicular pickup rises gradually and continuously as signal wavelength is increased; the high-frequency cutoff is relatively gradual. By contrast, a longitudinal pickup with the electron-beam tube provides a relatively wide midrange of uniform response; the high-frequency cutoff is much more abrupt. To show more clearly the reasons for these differences and to determine whether the playback gap is the controlling factor, the theoretical response of a perpendicular pickup having the nominal dimensions shown in Fig. 2B was calculated using the general theory developed by Clark and Merrill³.

Instead of initially measuring the longitudinal component of field in-

tensity, the perpendicular component was determined from a graphically-constructed field map for the playback gap. The curve of relative field intensity versus distance from the center of the playback gap, as obtained from the field map, is shown in Fig. 2C.

The total flux induced in the core is

$$\phi \propto \int_0^{\infty} f(x) \cos(2\pi x/\lambda) dx$$

where $f(x)$ is the relative field intensity at distance x from the center of the gap and λ is the wavelength of the recorded signal.

Assuming that tape magnetization at distances greater than 200 mils from the center of the gap contributes negligibly to the total flux, $f(x)$ may be approximated analytically to give

$$\begin{aligned} \phi \propto & \int_0^{200} (1.0 - 0.01x^2) (\cos 2\pi x/\lambda) dx \\ & + \int_{200}^{2000} (0.8e^{-0.10x}) (\cos 2\pi x/\lambda) dx \\ & + \int_{200}^{1000} (0.2e^{-0.03x}) (\cos 2\pi x/\lambda) dx \\ & + \int_{100}^{200} (0.02 - 0.0001x) (\cos 2\pi x/\lambda) dx \end{aligned}$$

The response as calculated from the above formula is shown by the solid-line curve of Fig. 3. The dashed-line curve shows the measured response. Points have been arbitrarily shifted to the left to permit easy comparison of the shapes of the calculated and measured response curves. As measured, the response appeared to approach a minimum of approximately 14 mils instead of 11.5 mils as plotted,

indicating that the actual gap length and pole-face width are somewhat greater than the nominal dimensions. The similarity in the shapes of the calculated and measured curves, however, is evidence that the shape of the response curve is controlled almost entirely by the reproducing core.

For comparison the remaining curve of Fig. 3 shows relative response as calculated from the formula

$$\text{loss} = 20 \log_{10} \frac{\pi l/\lambda}{\sin \pi l/\lambda} \text{ db}$$

This formula, which is generally used for calculating the gap loss associated with ring-type reproducing heads is true only for an ideal rectangular slit or field-distribution curve. The actual field-distribution curve for a typical perpendicular-type gap, as shown in Fig. 2C, is far from rectangular.

Fringing flux, in particular that flux which enters the sides of the pole pieces, contributes substantially to the response at longer signal wavelengths and is responsible for the continuous rise as wavelength is increased. At very long signal wavelengths, flux induced directly

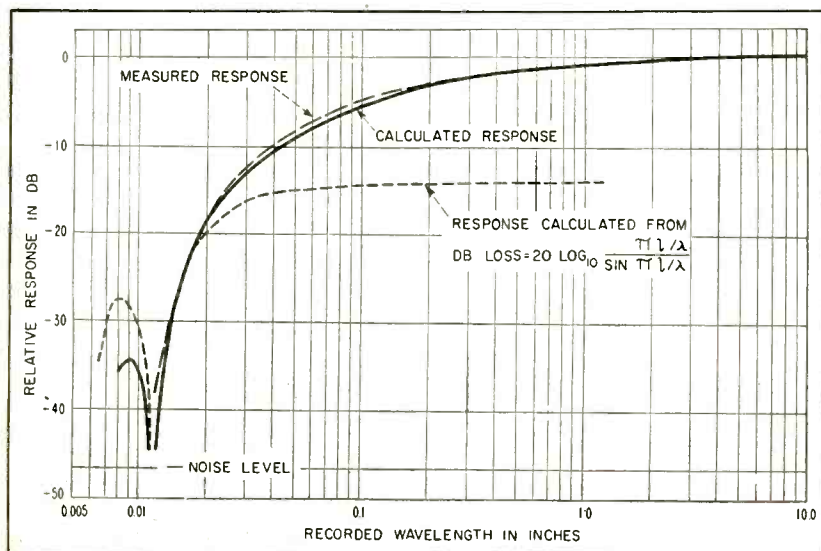


FIG. 3—Measured and calculated response curves for perpendicular pickup core

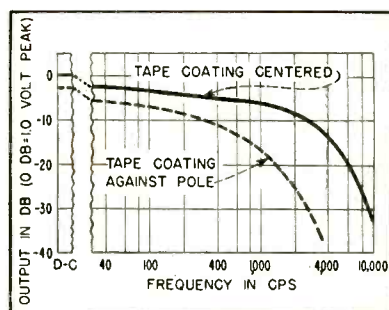


FIG. 4—Unequalized response of pickup with perpendicular core. Curves shown are for a tape speed of 3 ft per sec

in the internal tube pole pieces and the C-shaped coupling pieces of the external core also contributes significantly to the total tube output. The d-c response of the tube and core with pole pieces removed from the external core is 11 db below that obtained with the pole pieces in place; at one-inch recorded wavelength the difference is approximately 29 db.

Performance

The photograph shows the pickup mounted on a loop-drive mecha-

nism. A perpendicular-type recording head is mounted at the upper left. Conventional ring-type erase, record and reproduce heads are located near the lower center of the front panel. For the tests to be discussed, the tape was erased using the conventional erase head. Recordings were made with either the conventional ring recording head or the perpendicular recording head and the continuous-loop recording was reproduced by the electron-beam-tube pickup.

Figure 4 shows the overall un-equalized frequency-response characteristics when using constant recording current, a perpendicular-type recording head and commercial coated tape operating at a speed of

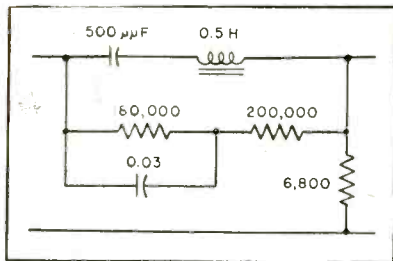


FIG. 5—High-frequency equalizer provides 35-db boost at 10 kilocycles

three feet per second. With the tape coating against one pole face, the d-c tube output is approximately one volt when operating with recording and bias currents adjusted to provide maximum output at a distortion level of three-percent third harmonic as measured at a fundamental-signal wavelength of 0.3 inch.

Equalizer

With the addition of the equalizer of Fig. 5, which provides approximately 35 db of high-frequency emphasis at 10 kc, the response was flat from 0 to 10,000 cps \pm 2 db. Overall signal-to-noise ratios with the pickup tube heated by d-c were 41 db for equalized and 58 db for the unequalized unit. With a-c heating the respective signal-to-noise ratios were 40 db and 48 db. The signal level used as a reference in the figures for the unequalized system is the d-c signal output level of one volt.

Waveforms of the unequalized

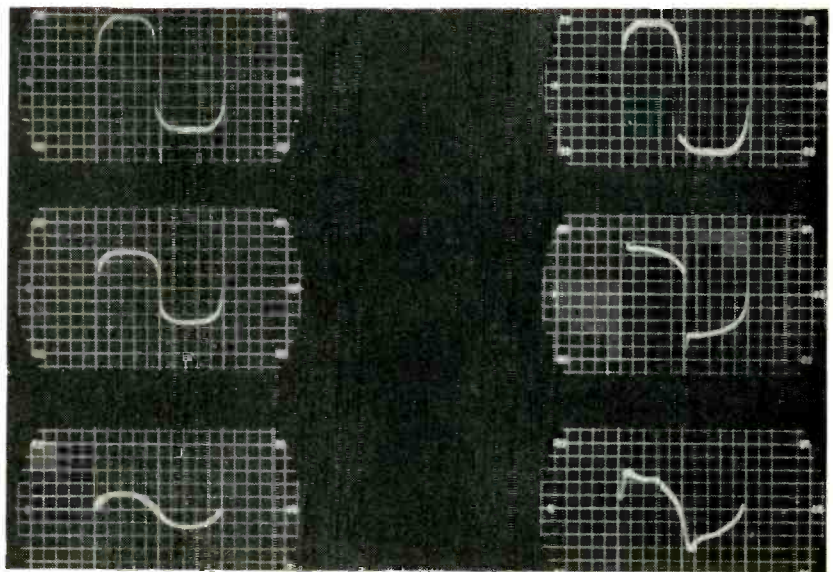


FIG. 6—Unequalized square-wave response for perpendicular-core pickup. The fundamental frequencies are 5, 50 and 500 cps for the top, middle and bottom rows. Waveforms at left were obtained with tape coating centered; those on right, with the tape coating against poles of the pickup

square-wave response of the pickup at fundamental frequencies of 5, 50 and 500 cps are shown in Fig. 6. The left-hand waveforms, which were obtained with the tape coating centered, show no appreciable phase distortion. By comparison, the right-hand waveforms, as obtained with the tape coating against one pole face of the recording and reproducing heads, show a high degree of phase distortion.

Two qualifications concerning the right-hand waveforms should be noted. The actual reproduced waveform at five cps showed a narrow spike at the reversals in polarity; this is not evident in the photographs. The general slope of the waveform at 50 cps may be controlled by offsetting the reproducing pole pieces. With an offset of 1.8 mils, phase distortion is not evident except for the narrow spike at the polarity reversals.

Applications

Prior to the development of the electron-beam tube, longitudinal recording had largely replaced perpendicular recording for two reasons. First, the high-frequency response of the perpendicular pickup is relatively poor because of the large gap required for passage of the tape. Secondly, the conventional perpendicular-type pickup, which employs a pickup coil offers no worthwhile improvement in low-fre-

quency response. With the electron-beam tube, however, use of perpendicular recording makes it possible to attain d-c response. A system utilizing both longitudinal and perpendicular recording is most effective in applications requiring maximum high-frequency response as well as d-c response.

Acknowledgements

This work on core development at Stromberg-Carlson Company and work on tube development at National Union Radio Corporation has been sponsored by the Bureau of Ships of the U. S. Navy under Contract NObsr-57452. Individuals associated with Stromberg-Carlson Company who contributed to the work described in this paper are L. C. Holmes, N. Cole, A. W. LeBeouf, W. B. Latchford and L. L. Merrill.

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Temperature-Compensated Aircraft Fuel Gage

Compensating capacitor immersed in fuel in bottom of each aircraft fuel tank automatically corrects for changing dielectric constant of fuel with temperature, and also compensates for variations in dielectric constant of fuel itself

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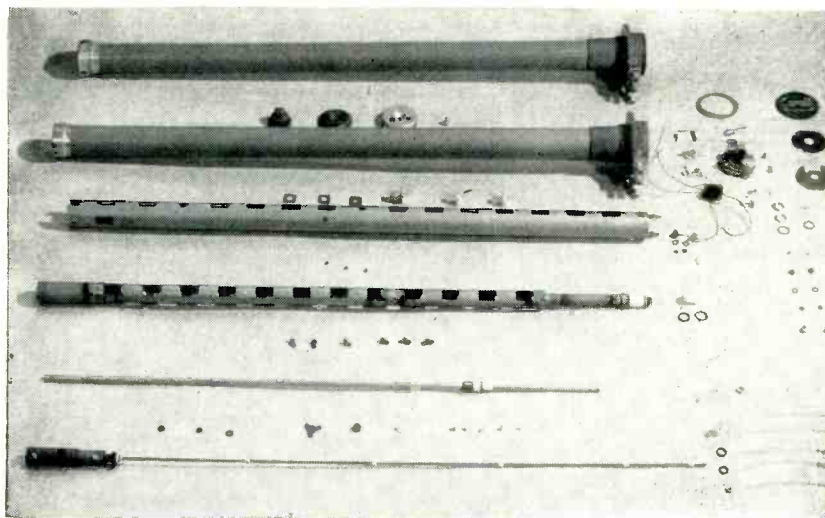
ACCURATE measurement of fuel quantity in an airplane is one of the more difficult instrumentation problems. The most accurate and reliable gages in current use are of the capacitance type. They present a linear dial indication regardless of number or shape of fuel tanks and provide compensation for variations in the dielectric constant of the fuel being measured.

Capacitance gages sense fuel quantity by measuring the change in capacitance caused by fuel rising between two concentric metal tubes mounted in the tanks. The fuel, acting as a dielectric, causes a capacitance change which is measured in a simple servo-rebalance system. The servo is located in the fuel-gage indicator case and rotates a pointer in proportion to the capacitance change.

Liquid hydrocarbons and aircraft fuels in particular make good capacitor-dielectric materials since the dielectric constant K is about 2.0 at room temperature and bulk resistivity is in excess of 10^{15} ohm-cm.

In gaging the fuel it is desirable to indicate weight rather than volume since the energy content of the fuel is proportional to weight. A capacitance gage makes this possible because the dielectric constant of fuel is a function of the specific gravity, p . A plot of K versus p for aircraft gasolines (AN-F-48) and jet fuels (AN-F-58) is shown in

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Probe of fuel gage in progressive order of disassembly

Fig. 1 for a temperature range of -55 C to $+70$ C.

Capacitance is determined by the wetted length of the probe and the difference between the dielectric constant K of the fuel and that of air (or vapor) which is very close to a value of 1.00. The capacitance measured is therefore proportional to $K-1$.

Since the gage is calibrated in pounds the $K-1$ function must correspond to a value of specific gravity p for each value of K

$$\text{thus } K - 1 = Ip \quad (1)$$

or

$$\frac{K - 1}{p} = I \text{ (Capacitance Index)} \quad (2)$$

If Eq. 1 is plotted in Fig 1 for

mean values of K and p the slope of the curve does not fall along a line of best fit for the fuel plotted. Thus, a gage following the simple function of Eq. 1 will have inherent errors when used with fuels having values of K varying from that for which the gage was calibrated. The gage error increases by either a positive or negative amount as the difference between the actual and calibration values of K increases.

Error Elimination

To eliminate these errors, the slope of Eq. 1 must be increased to follow line CD in Fig. 1. If this line were straight the resulting value of the K axis intercept would be less than 1.0, which is not physically

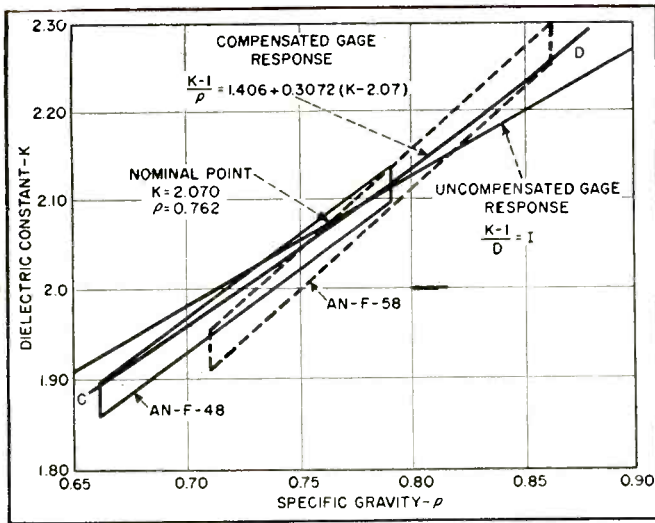


FIG. 1—Variation of dielectric constant with specific gravity. Parallelograms include 95 percent of all data points taken

possible. Since the value of the K intercept must remain at 1.0, the slope must increase along line CD and the gage response line must still pass through the nominal point, it is apparent that the best response line must be nonlinear.

Extensive investigation has produced a line of best fit for both fuels of Fig. 1 having the equation

$$\frac{K-1}{p} = 1.406 + 0.3072(K-2.07) \quad (3)$$

To obtain a gage response following the form of Eq. 3, the value of K must be measured twice since it enters the equation twice. Examination of the equation reveals that the difference between it and Eq. 2 is that the right side has been multiplied by a function of $K-2.07$. The extra K function has the effect of varying the slope of the $(K-1)/p$ relationship as a function of K . Circuitwise this is accomplished by taking a separate measurement of K not affected by level, which is done by locating the extra sensing probe at the lowest part of the deepest tank, and introducing this value into the bridge circuit as an independent input. This correction measurement is known as capacitance-index compensation.

Compensating Circuit

The circuit shown in Fig. 2 illustrates a common way of achieving capacitance-index compensation. The compensation circuit consists of capacitances C_3 and C_4 connected

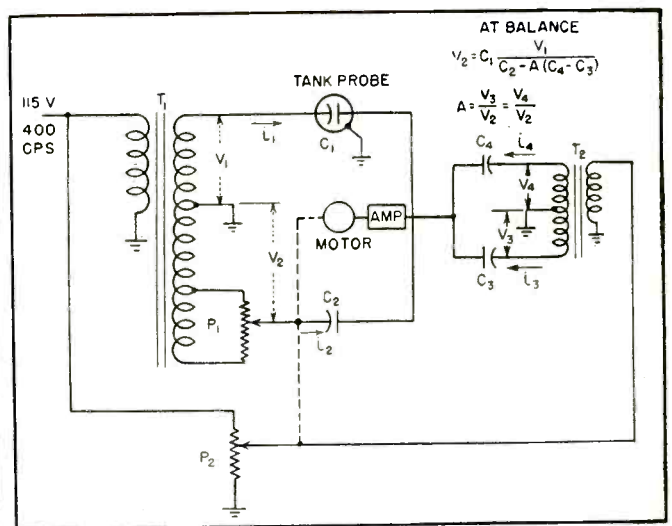


FIG. 2—Capacitance-index compensation achieved by circuit section containing capacitor C_3 normally immersed in fuel

across opposite legs of the center-tapped compensated transformer T_2 . Voltage to T_2 is supplied from potentiometer P_2 which is coupled to the original rebalance potentiometer P_1 . The compensator bridge circuit is arranged so that with C_3 immersed in the fuel of a nominal value of K , it will be equal to the compensator reference C_4 .

Since V_3 equals V_4 , the output of this bridge will be zero regardless of the input voltage when C_3 is immersed in a fuel of nominal dielectric constant. When the dielectric constant of the fuel is other than nominal, a voltage and current output from the compensator bridge circuit will be developed which is in phase opposition to the voltage and current flowing through V_1 winding and C_1 . In other words, the phase of current i_3 will be opposite to the phase of current i_1 . The result of this is a different re-

balance voltage V_2 and thus a different dial indication since i_2 must be equal to the sum of i_1 plus i_3 .

Capacitance index compensation can also be achieved in a slightly different manner. The compensator capacitor is connected in parallel with the reference capacitor on the opposite side of the bridge. A compensation current is thus developed which is proportional to the dielectric constant of the fuel. This compensation current is also in phase opposition to the main sensing current and thus changes the conditions of balance in the circuit.

Example

Assume a fuel having a dielectric constant of 2.25. From Fig. 1, the mean value of specific gravity for this dielectric constant is about 0.852. The dial indication that would be obtained with an uncompensated gage would be 0.890 which would result in an error of 0.038/0.852 or a reading which was 4.45 percent too high. The compensation circuit is thus required in this case to reduce the apparent density by 4.45 percent. This it does by introducing the current i_3 in phase opposition to the current i_2 . The value of i_3 in the compensated circuit will reduce the apparent dielectric constant to a value of 0.855 for a total error of 3 parts in 852 or 0.35 percent from the nominal value. The compensator circuit has thus reduced the error in the fuel gage from approximately 4 percent to less than 1 percent.



Probe at right measures capacitance change as gage at left indicates weight of remaining fuel

Dual-Mode Horn Feed for

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THE GENERAL multiplexing problem relates to the utilization of one or more component parts of a system to convey several channels of intelligence simultaneously and independently. Because of weight and space problems it is usually desirable to multiplex the antenna system in order to use only one radiator for several communication channels. One such system uses the decoupled properties of orthogonally polarized fields in waveguides and space.^{1,2}

The decoupling between cross-polarized fields is of interest because of its frequency independence, and because of the simplicity of the system which results from its use. Even though a cross-polarized mode radiator decouples only two channels, the 40 db or more decoupling that is obtained rather cheaply simplifies the receiver filtering problem considerably. In view of this, a dual-mode cross-polarized square-waveguide-feed horn was investigated and built.

Multimode Transmission

The orthogonal properties of either E-mode or H-mode field structures are adequately described in the literature.³ Examination of these properties leads to the conclusion that it is possible to propagate energy in a waveguide in two or more modes, with each mode independent of the other, ideally with zero crosstalk.

Practically, the use of multimode transmission is limited by the mechanical quality of the waveguide, the type of radiation pattern desired from the end of the guide and by the types of mode launchers and filters required. Only two modes can be used if the horn and parabola are simple. Higher modes, such as the TE_{11} and TM_{11} , can be used in the waveguide but these produce unsatisfactory patterns when used with a system designed

for the lowest mode. The E_0 modes, for example, would produce a cusp-shaped pattern with the zero in the direction of maximum radiation for the lowest mode.

It has been found that two-mode transmission (TE_{10} , TE_{01}) in square-cross-section waveguide, dimensioned below cutoff for all higher modes, was satisfactory. The use of standard drawn tubing for short lengths introduced no appreciable error in mode decoupling. Circular waveguide could also be used for this purpose but slight ellipticities and minor irregularities can cause gradual shifts in polarization which lead to crosstalk between modes.

An important point to consider in the design of a device which propagates orthogonally polarized fields in square waveguide is the cutoff relationship to higher-order modes which cross-couple the fields. A specific case of difficulty caused by higher modes arises when the standard rectangular guide width is used for the side dimensions of the square waveguide. In this case it will generally be found that it is possible to propagate a TE_{11} mode at the high-frequency end of the band when only a TE_{01} or TE_{10} is desired.

Multiplexing Unit

Basically the multiplexing unit considered herein is a device which accepts two signals, converts them into orthogonally polarized waves in square waveguide and then radiates both cross-polarized fields simultaneously.

The methods of exciting the square waveguide involve the use of tapers from rectangular guide to square guide, or coaxial probes or loops directly exciting the square guide.

The structure excited by tapers from rectangular waveguides was investigated and found to have adequate decoupling properties but

poor input vswr's in each waveguide arm.

A better structure which can be used to multiplex two signals is the probe-excited square waveguide shown in Fig. 1. Test results for this are plotted in Fig. 2. In this unit, the probes are 90 deg apart and are tuned by locating their length and position with respect to the short-circuiting plug or the fins. The fins in this device are required to tune the second probe (that nearest the radiating horn) and to reduce the frequency sensitivity, since the second probe could also be tuned with respect to the short-circuit plug although through a long length of line. The probes are not placed in the same transverse plane to avoid direct probe-to-probe coupling.

The coaxial-line-excited multiplexing unit is much simpler and smaller mechanically, and has better input-impedance properties than the waveguide-fed unit. If it is necessary to run waveguide feeds, it is still possible to use this device if short waveguide-to-coaxial-line transducers can be used.

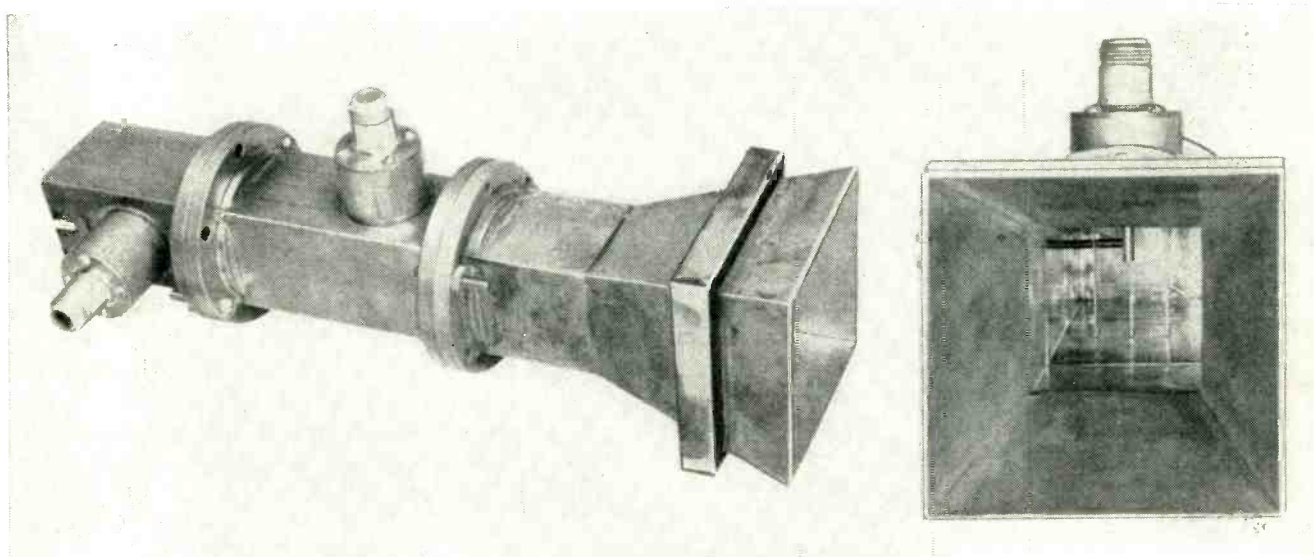
Antenna Systems

The multiplexing-unit horn can be used to illuminate a parabolic reflector either directly or through an auxiliary reflector. Figure 3A shows a square waveguide horn exciting a small primary parabolic reflector which in turn excites the large secondary parabolic reflector. This antenna is compact and easy to support but its disadvantages are that the gain is lower than other types due to spillover past the two parabolas. The side lobes are higher because of the relatively large portion of the aperture that is blocked off, and reflections from the two parabolas are high and difficult to match out without loss in gain.

Figure 3B shows a square-waveguide horn exciting an eccentric

Microwave Multiplexing

Probes 90 degrees apart in square-waveguide horn are energized with identical carrier frequencies in 4.4 to 5.1 kmc band to give two-channel transmission in two modes, with better than 50-db decoupling, for illuminating parabolic reflector of microwave link



Side and front views of horn excited by two probes. The three tuning fins are just behind first probe

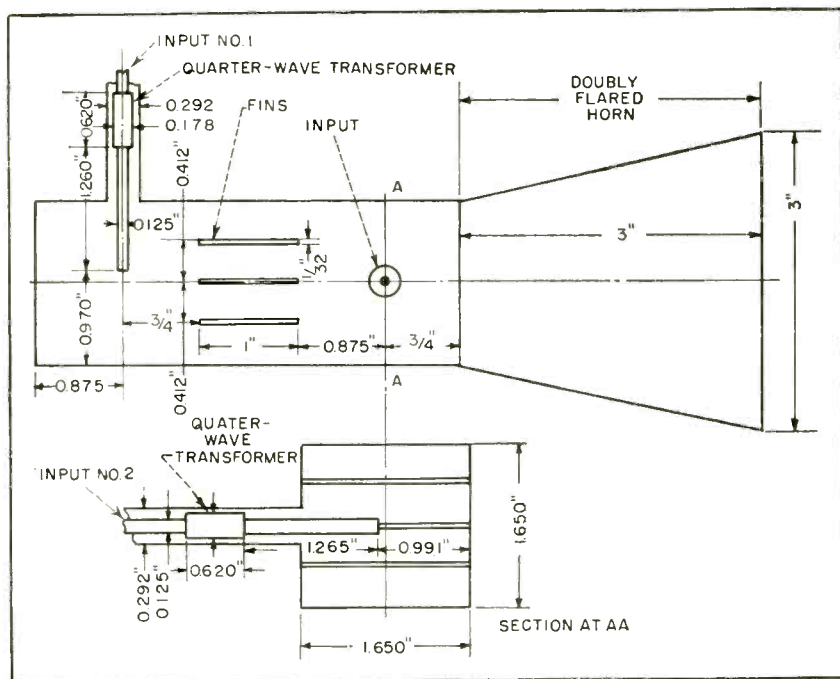


FIG. 1—Internal dimensions of probe-excited multiplexer with tuning fins

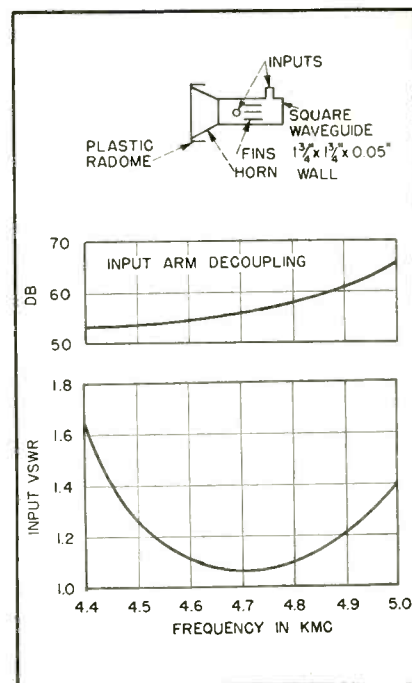


FIG. 2—Multiplexer test results

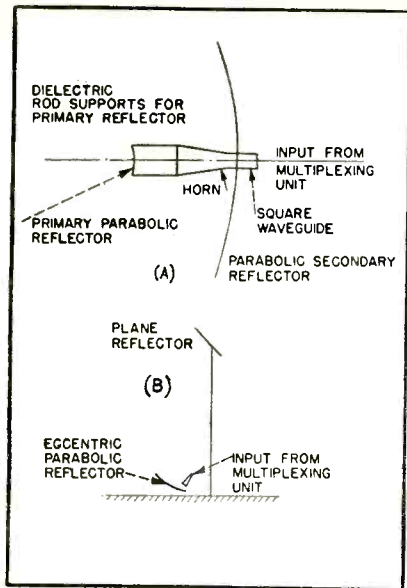


FIG. 3—Two methods of using multiplexer horn in two-channel relay system

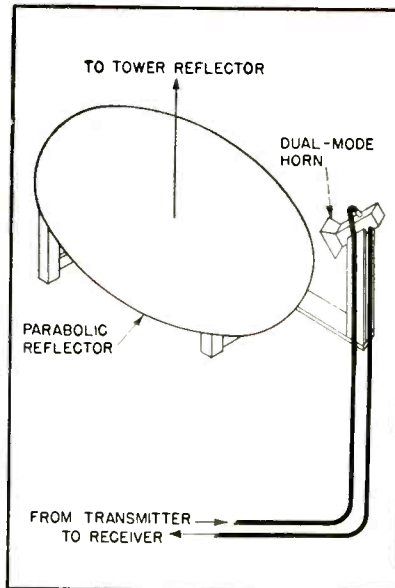


FIG. 4—Details of ground-mounted parabolic reflector used with horn

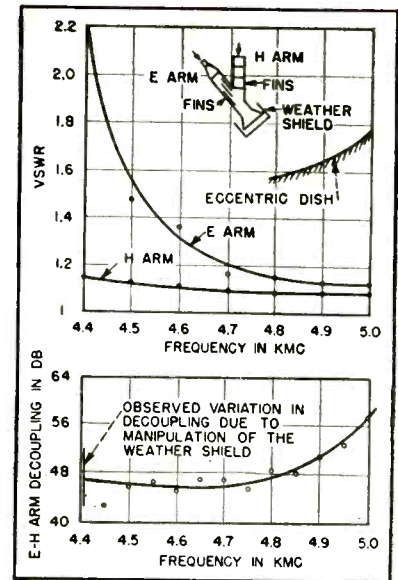


FIG. 5—Test results for mode filter and eccentric dish system

parabolic dish as part of a portable radio-relay link. This antenna is less compact than the one discussed above but its electrical characteristics are superior. The gain is high and the side lobes low because no obstructions are in the aperture, and the reflections from the parabola are very low (swr less than 1.01).

Weatherproofing and water sealing are readily accomplished by boxing the open end of the horn with some low-loss plastic. If necessary, the unit could be pressurized.

For use with radio-relay links, this antenna can be mounted directly on the tower or it can be mounted near the ground if a secondary reflector on top of the tower or mast is used, as shown in Fig. 3B and 4. A long run of transmission line between the transmitter and antenna is undesirable for high-quality links even if an r-f amplifier is used.⁴ The secondary reflector system can be used with any transmitter by mounting the transmitter tube on the multiplexing horn. The distance to the mouth of the horn (the furthest source of reflections) can be made less than one foot so that long-line effects are no longer important. The extra loss (roughly 3 db for towers up to 100 feet high) due to spillover past the secondary reflector is only slightly greater than the loss in the long waveguide.

The transmission region which

is most critical is that propagating the two modes. All metallic surfaces should be smooth and straight, and all unavoidable discontinuities (such as horn flares) should exhibit 90-deg symmetry. Solder joints should be positive, clean and without fillets. Metallic fin edges should be without burrs and probes should be straight and centered in the side walls.

The above requirements are not extraordinary as far as waveguide techniques are concerned, and should not be construed as limiting the use of dual-mode components in antenna systems. Several of these devices were built, observing normal machine-shop practices for fairly precise work and using stock drawn tubing for the dual-mode regions. The results were satisfactory, and indicated that broaching operations were not necessary for the dual-mode sections of tubing.

Results

In general, the decoupling between polarizations on the different units tested ranged from 35 to 55 db and the vswr on the input arms ranged from 1.0 to 2.5. The test results are plotted on Fig. 5 for a unit constructed from 2 in. x 2 in. OD 0.062-in.-wall square waveguide. This unit was waveguide-fed through tapers and exhibited decoupling greater than 40 db, good H-arm input vswr (approximately

1.1 to 1.2) and bad E-arm vswr (greater than 2). The input impedance of the E-arm was generally such that broad-band matching was very difficult.

Tests on the probe-excited square waveguide gave 50 db minimum decoupling and 1.6 maximum vswr over the 4,400-5,000-mc band (Fig. 4). These results, particularly the input vswr, could be improved with proper redesign of the probe circuits. Both inputs had the same properties. One loop-excited unit was tested, and found to have very poor decoupling properties. The probe-fed multiplexing unit thus has better input impedance properties both in magnitude and ease of matching than the waveguide taper-fed unit.

Acknowledgement is due to H. A. Augenblick and A. T. Brown for making some of the measurements described in this paper. The project itself was sponsored by the Bureau of Ships, Navy Department and the Signal Corps Engineering Laboratories.

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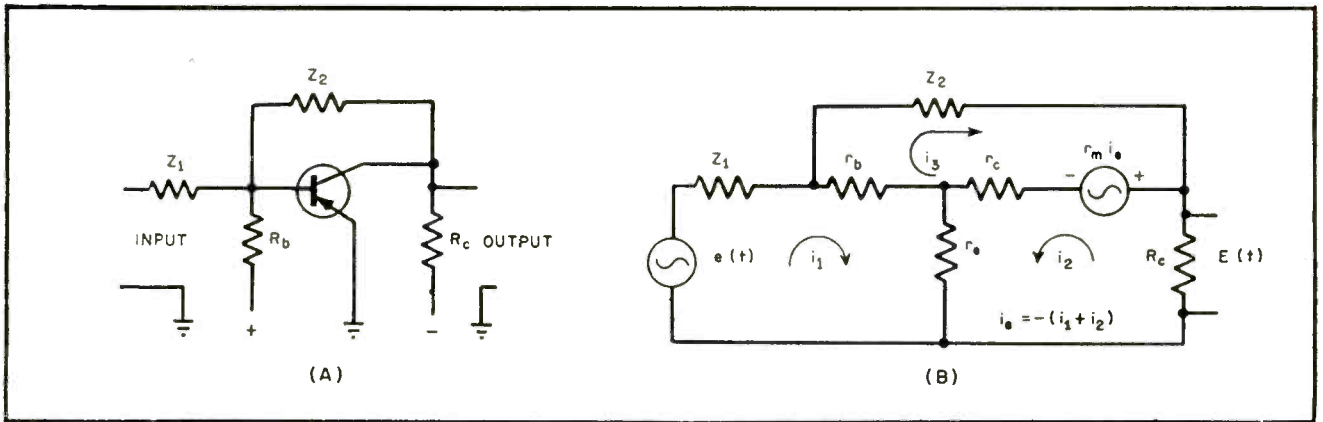


FIG. 1—Transistorized operational amplifier (A) and generalized equivalent circuit (B) assuming that the transistor parameters are resistive at the highest harmonic frequency in the output

Junction Transistor Pulse Forming Circuits

Analysis of integration and differentiation circuits using *npn* junction transistors. Practical circuits are given for saw-tooth generator, square-wave and pulse generator and triangular-wave differentiator

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DESIGN of complex systems involves use of analog elements and a need often arises for operational pulse and sinewave shaping circuits. Where accuracy requirements are not too strict, single-stage amplifiers having finite gain and employing appropriate feedback can be used for this purpose. The Miller integrator, employing capacitive plate-to-grid feedback, is one example of this type of circuit element. Similar results may be obtained using transistors as the active elements in feedback operational amplifiers. This paper shows the analytical approach used

in designing several of these practical transistor operational circuits.

Circuit Analysis

In the following analysis it is assumed that small signal, linear circuit theory applies and that the low-frequency equivalent transistor circuit can be used. The second assumption implies that the transistor parameters are purely resistive at the highest harmonic frequency present in the output waveform. The validity of these assumptions depends on the agreement between calculated and experimental results.

Choice of circuit configuration is

determined by a consideration of the properties required of the amplifier. The active element must have voltage gain and a phase shift of $90 < \phi < 270^\circ$ at low frequencies. Of the three single-stage configurations, only the common-emitter circuit has these properties, assuming no phase-inverting transformer is used.

The circuit diagram for the transistorized operational amplifier is shown in Fig. 1A and the generalized equivalent circuit in Fig. 1B. Elements Z_1 and Z_2 represent the input and feedback impedances usually associated with

this type of circuit. In the usual case, it can be assumed that R_b is much greater than the input impedance of the transistor. The three loop equations for this circuit are

$$\begin{aligned} \bar{e} &= \bar{i}_1 (\bar{Z}_1 + r_b + r_e) + \bar{i}_2 r_c - \bar{i}_3 r_b \\ 0 &= \bar{i}_1 (r_e - r_m) + \bar{i}_2 (r_c + r_e + R_c - r_m) \\ &\quad + \bar{i}_3 r_c \\ 0 &= -\bar{i}_1 (r_b + r_m) + \bar{i}_2 (r_c - r_m) \\ &\quad + \bar{i}_3 (r_b + r_c + \bar{Z}_2) \end{aligned} \quad (1)$$

Methods of the Laplace transformation are useful in treating these circuits. Therefore, the quantities of Eq. 1 have been transformed, term by term, assuming zero initial conditions. The transformed quantities are indicated as such by the use of superbars.

The transformed output voltage \bar{E} is given by $\bar{E} = -\bar{i}_2 R_c$, or, in determinant notation

$$\bar{E} = \frac{-R_c \begin{vmatrix} (\bar{Z}_1 + r_b + r_e) & \bar{e} & -r_b \\ (r_e - r_m) & 0 & r_c \\ -(r_b + r_m) & 0 & (r_b + r_c + \bar{Z}_2) \end{vmatrix}}{\Delta} \quad (2)$$

where Δ is the circuit determinant

$$\begin{vmatrix} (\bar{Z}_1 + r_b + r_e) & r_e & -r_b \\ (r_e - r_m) & (r_c + r_e + R_c - r_m) & r_c \\ -(r_b + r_m) & (r_c - r_m) & (r_b + r_c + Z_2) \end{vmatrix}$$

Therefore, expanding Eq. 2

$$\bar{E} = R_c \bar{e} [A + (r_e - r_m) \bar{Z}_2] / \Delta \quad (3)$$

where $A = (r_b r_c + r_b r_e + r_c r_e - r_b r_m)$. Eq. 3 may be used, with appropriate substitutions, to examine in detail a number of useful transistor operational circuits.

Circuit Applications

To investigate integration of step waveforms, a unit-step input

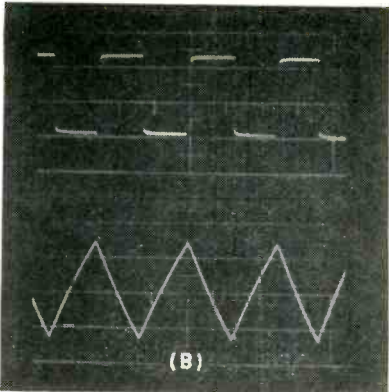
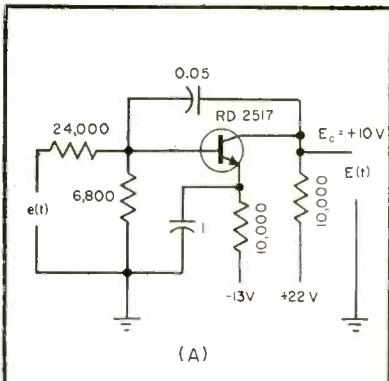


FIG. 3—Transistor circuit (A) integrates square waves with low fundamental frequencies. Waveforms (B) show 1,000-cps square-wave input and corresponding triangular-wave output

is applied to the circuit of Fig. 1A. Impedance Z_1 is resistive and Z_2 is capacitive for the integrator. The substitutions $e = 1/s$, $Z_1 = R$ and $Z_2 = 1/(sC)$ are made in Eq. 3 and an inverse transformation is carried out.¹ The resultant expression is

$$E(t) \cong \frac{-R_c (r_m - r_e)}{CD} \left[1 - \exp \left(- \frac{D}{RA + R_c B} t \right) \right] \quad (4)$$

where $B = A + R (r_b + r_c)$ and $D = [A + R (r_c + r_e - r_m) + R_c (r_b + r_e + R)] / C$. Therefore the output voltage for a positive unit-step input decreases exponentially to a voltage $- [R_c (r_m - r_e)] / (CD)$ with a time constant $(RA + R_c B) / D$.

An expression for the perfection of integration is obtained in the

following way. A theoretically perfect integrator with phase inversion would respond to a step input with an output voltage of constant slope $dE(t)/dt = -k$.

The integrator analyzed in this example yields an exponentially decreasing pulse. At any time τ the deviation σ of the output from linearity is given by

$$\sigma = \frac{\left[\frac{dE(t)}{dt} \right]_{t=0} - \left[\frac{dE(t)}{dt} \right]_{t=\tau}}{\left[\frac{dE(t)}{dt} \right]_{t=0}} \quad (5)$$

Performing the operation indicated on Eq. 4

$$\sigma = 1 - \exp \left(\frac{D}{RA + R_c B} \tau \right) \quad (6)$$

The effect of internal and external circuit parameters on the

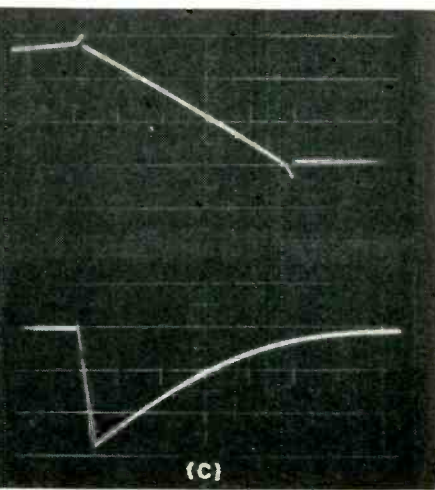
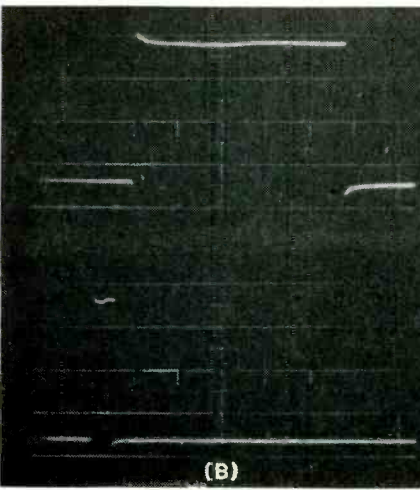
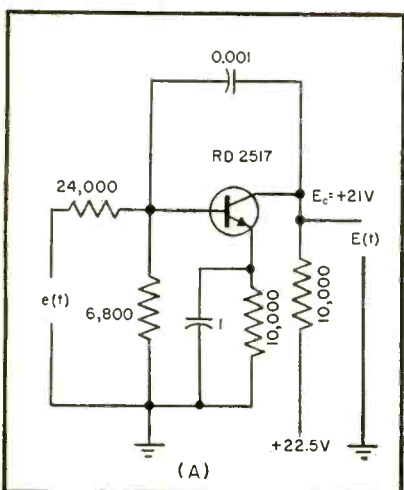


FIG. 2—Integration circuit (A) uses RD 2517 npn transistor. Ten microsecond positive-pulse input (B) produces saw-tooth waveform output (C). Vertical-deflection sensitivity of oscilloscope is 60 volts full scale for both input waveforms and 24 and 20 volts full scale for upper and lower output wave forms

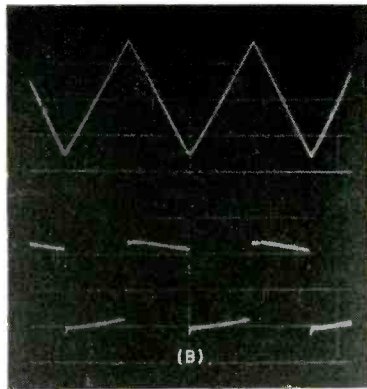
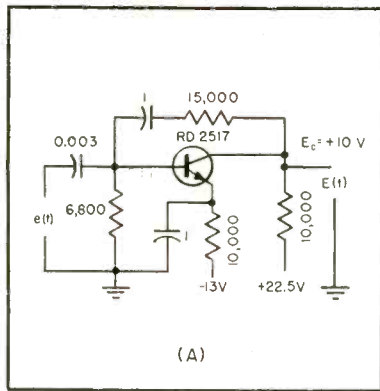


FIG. 4—Transistor differentiation circuit (A); waveforms (B) of 1,000-cps triangular-wave input and square-wave output

output waveshape may be determined by considering the initial slope S_o of the output pulse. Slope S_o is equal to the final voltage attained by the output divided by the time constant of the circuit

$$S_o = -[R_c(r_m - r_e)]/[C(RA + R_cB)] \quad (7)$$

For average transistors, this simplifies to $S_o \cong -\alpha/(RC)$ and the initial slope of the output pulse is determined only by the values of input resistor, feedback capacitor and current gain of the transistor.

Saw-Tooth Generator

As a specific circuit, consider Fig. 2A. This circuit is used for generating saw-tooth pulses from a low duty-cycle train of positive fifty-volt pulses 10 microseconds in width. The output waveform, shown in Fig. 2C has a slope of -1.8 volts per microsecond as compared with a slope of 2 volts per microsecond as calculated from Eq. 7.

The linearity of the output waveshape calculated from Eq. 6 is 3 percent. The collector voltage of $+21$ volts in Fig. 2A indicates a quiescent operating point near cut-off. This allows a full swing of the collector from nearly $+E_{cc}$ to 0 when a positive input pulse is applied and in addition, keeps the average power consumption low.

Negative pulses may be integrated by employing a *pn*p transistor and reversing the bias polarities.

A final consideration in the design of this circuit is the choice of the collector load resistor R_c . The value of R_c has little effect on the

slope of the output saw tooth, but determines to a large extent the recovery time of the circuit since capacitor C discharges through R_c to a voltage E_o after each pulse. The upper-limit value of R_c is therefore determined by the pulse spacing while the lower-limit value is set by the maximum allowable collector dissipation.

Another application of integrators which has been considered experimentally is that of integrating square waves of a relatively low fundamental frequency. For example, the circuit of Fig. 3A is used to integrate square waves having a repetition rate of 1,000 per second. The input and output voltage waveforms are indicated in Fig. 3B.

Differentiation

To investigate differentiation of triangular waveforms, a linearly rising waveform $e(t) = kt$ is applied to the circuit of Fig. 1A. Impedance Z_1 is capacitive and Z_2 is resistive for the differentiator. The substitutions $\bar{e} = k/s^2$, $\bar{Z}_1 = 1/(sC)$ and $\bar{Z}_2 = R$ are made in Eq. 3 and an inverse transformation is carried out. The resultant expression is

$$E(t) = \frac{R_c k [A + R(r_e - r_m)]}{G} \left[1 - \exp\left(-\frac{G}{RA + R_c F} t\right) \right] \quad (8)$$

where $F = A + R(r_b + r_e)$ and $G [A + R(r_e + r_e - r_m) + R_c(r_b + r_e + R)]/C$. Therefore the output voltage for a linearly rising input

approaches a value $E_o = R_c k [A + R(r_e - r_m)]/G$ with a time constant τ whose value is $(RA + R_c F)/G$. This output should be a step function and will approach this value of E_o if τ can be made small. This can be done physically by keeping C small since G is proportional to $1/C$.

The expression for the output step height may be further simplified. If average values of the transistor parameters are considered, assumptions can be made which lead to the approximate expression

$$E_o \cong -k \alpha RC. \quad (9)$$

Thus the output step is negative when the input slope is positive and has an amplitude which depends only on the external parameters R and C , the input slope and the transistor current gain.

As a specific circuit example, consider the diagram of Fig. 4A. This circuit is used for the differentiation of a 1,000-cps triangular wave of 40-volts peak-to-peak amplitude. The measured peak-to-peak square-wave output height is 6.2 volts, while that calculated from Eq. 9 is 6.8 volts. The input and output waveforms are shown in Fig. 4B.

Additional Considerations

The practical integrator and differentiator circuits described were designed to meet the specific requirements of an a-c actuated control system. Because of this, no attempts were made to stabilize the d-c operating point of the transistors against temperature and supply voltage variations. However, such stabilization might be profitably applied in circuits where integration or differentiation of low frequency a-c or d-c voltages is required. Where the d-c output levels are important the initial circuit conditions should be inserted in Eq. 1. In cases where still more accurate operations are to be carried out, the feasibility of multistage-transistor feedback amplifiers should be considered.

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Modified Color Signal

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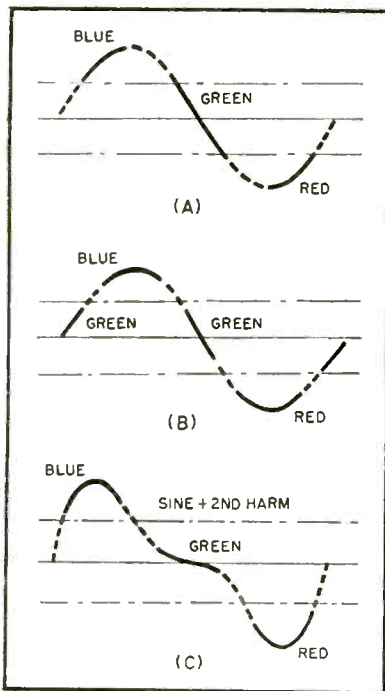


FIG. 1—Sinusoidal color-switching waveform with minimum required blanking time shown by dotted line for a sequence of three (A), sequence of four (B) and sequence of three samples per switching cycle with second-harmonic component added (C)

RECENT APPROVAL of compatible color television standards has focused attention on the problem of the most appropriate color picture tube.

A color television image can be transmitted by sending the three independent variable video signals simultaneously through three separate channels or through a single channel in a periodically recurring time sequence. Sequences can recur at field rate, line rate or dot rate corresponding to the time required to form one picture element.

It is possible to change from a sequential type of transmission into a simultaneous one with the aid of complex storage systems. In the dot-sequential case, passage from the sequential to the simultaneous system can be achieved with the aid of relatively simple circuits consisting of synchronous detectors and adders. The simplicity of this conversion from a dot-sequential to a simultaneous signal has led to the notion that the two types of

transmission are basically identical.

An NTSC color television receiver using a picture tube equipped with three guns is an example of such a combined system. The NTSC signal as it appears at the second detector of the receiver is dot sequential. It is converted into three simultaneous signals which are applied to the three guns of the picture tube.

Single-gun tubes with a color-control electrode require a sequential signal. The question arises whether the unmodified NTSC signal could be applied to the gun of such a tube to produce color pictures. Color distortion is present owing to the fact that although the NTSC signal at the second detector is dot sequential, it never represents a pure primary color at any instant in the cycle, but always a linear combination of the three primaries.

Techniques have been developed whereby the incoming NTSC signal is converted into a different dot sequential signal permitting accurate color reproduction. The inherent advantages of the sequential mode of display are obtained in this way since the same circuit elements and tube fields are used to form all three color images.

Operating Characteristics

In a single-gun tube the beam excites one of the three color phosphors depending on the instantaneous voltage on the color-control electrode, to which a periodic wave is applied. This color-switching wave is analogous to the horizontal and vertical-sweep fields insofar as it is not modulated by picture information. Each color is displayed for a certain voltage range on the control electrode, transitions occurring between these ranges. The

control voltage passes through these transition ranges in changing from one value to another, each value corresponding to one color. The color of the face of the tube may not be uniform if the color-control voltage operates the tube in any of these transition ranges.

In field and line-sequential systems, the transitions must occur during the vertical and horizontal blanking periods, respectively. The control voltage must stay fairly constant during the field or line period in these systems. A stair-step waveform is, therefore, required in both cases. The stairstep would also be desirable in a dot-sequential system but the high switching frequency in such systems renders the use of this waveform uneconomical.

In most single-gun tubes, the color-control electrode has a large capacitance. For reasons of efficiency, this capacitance is resonated by an inductive reactance at the frequencies contained in the switching wave if these frequencies are high. The tuning network must be reasonably simple and, therefore, the number of frequency components in the switching waveform is limited.

Fortunately, the blanking time during color transitions can be made relatively long in dot-sequential systems. It can equal or exceed 50 percent of the switching period. Consequently, it is possible to use a single sine wave as a switching waveform. The long blanking period does not fundamentally affect the operation of the system, but is not desirable due to the resulting loss in brightness.

The addition of one properly phased higher harmonic to the switching wave improves the speed and timing of the transitions. The

for Single-Gun Tubes

Alteration at receiver of the NTSC color signal corrects for color distortion present when unmodified signal is applied to single-gun picture tube. Modulators and demodulators in the receiver are synchronized by waves at subcarrier frequency and its second harmonic

corresponding reduction of the required blanking period and resulting increase in brightness warrant the use of a more complicated switching waveform in many cases.

A tuning network resonating the capacitance of the color-control electrode at two frequencies can be designed using two inductances and one capacitance. A class C driving amplifier will generate a harmonic frequency component of sufficient amplitude.

Dot-Sequential Sampling

Selection of a color in single-gun picture tubes is achieved by deflection of the electron beam by one or more color control electrodes. In the Lawrence tube, deflection occurs in one direction dependent on the voltage on one set of electrodes. For such a tube the beam must pass twice in one switching cycle over the centrally located color stripe. Tubes in which color deflection occurs in two perpendicular directions have been made. In the latter type of tube, the beam can be deflected in a circle exciting each phosphor once in each switching cycle. The single-gun shadow mask tube was an example of this type. The natural switching mode is a sequence of four samples per switching cycle for the tube types mentioned first.

It is, however, possible to blank the beam during one of its passages through the centrally positioned color stripe. Under these conditions, each color is sampled only once per switching cycle. This mode of operation will be referred to as a sequence of three.

In Fig. 1, the sinusoidal color switching waveform is shown for the sequence of three with the minimum required blanking period indicated by the dotted line. The actual

required blanking period will exceed the indicated 50 percent to allow for tube imperfections. In Fig. 1B, the same waveform is shown as used in a sequence of four. In this case, blanking is not required for a perfect tube.

The composite waveform in Fig. 1C improves the performance of a sequence-of-three sampling system considerably. The waveform is obtained by addition of a second-harmonic component having half the amplitude of the fundamental wave. The two peaks and the principal zero crossing occur at instants 120 degrees apart. The passage through the other zero crossing is fast.

This waveform could be used with a blanking period of less than 50 percent without excessive requirements concerning uniform tube construction. The sequence of three is not recommended unless the composite waveform of Fig. 1C can be used.

The video signal at the gun must represent at any instant the color that is being excited. For a symmetrical sequence of three, the required dot-sequential signal is

given by the following expression

$$E_M = -\frac{1}{3} K_R E'_R + -\frac{1}{3} K_G E'_G + \frac{1}{3} K_B E'_B + \left[\frac{1}{3} K_R E'_R - \frac{2}{3} K_G E'_G + -\frac{1}{3} K_B E'_B \right] \sin(\omega t - \theta) + \frac{1}{\sqrt{3}} (K_R E'_R - K_B E'_B) \cos(\omega t - \theta) \quad (1)$$

This signal has the following properties: $E_M = K_R E'_R$ for $\omega t - \theta = 30^\circ$, $E_M = K_B E'_B$ for $\omega t - \theta = 150^\circ$, and $E_M = K_G E'_G$ for $\omega t - \theta = 270^\circ$.

The factors K_R , K_G and K_B are determined by the relative phosphor efficiencies, the transmission characteristics of a possible color-correction filter on the face of the picture tube and the colorimetric properties of the eye.

The received NTSC signal is described by the expression

$$E_N = 0.30 E'_R + 0.59 E'_G + 0.11 E'_B + 0.88[0.70 E'_R - 0.59 E'_G - 0.11 E'_B] \cos \omega t + 0.49[-0.30 E'_R - 0.59 E'_G + 0.89 E'_B] \sin \omega t \quad (2)$$

The similarity of Eq. 1 and 2

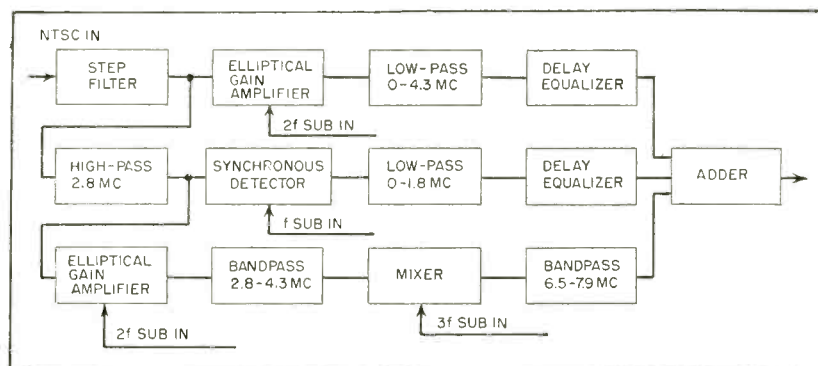


FIG. 2—Block diagram of system for modifying NTSC color signal. Circuit employs elliptical-gain amplifier consisting of tube whose gain is varied at twice the subcarrier frequency

suggests the possibility of a direct conversion of the NTSC signal into the symmetrical dot-sequential signal. This transformation can be achieved in several ways.

In a first attempt, use was made of two conventional circuit elements: a balanced modulator and a synchronous detector. The synchronous detector derives a low-frequency signal from the NTSC chrominance component, which, if added to the NTSC luminance component, forms the low-frequency component of the transformed signal.

The balanced modulator derives a signal from the luminance component of the NTSC signal, which is added to the NTSC chrominance component and the combination forms the subcarrier component of the modified signal. The resulting signal is symmetrical if proper phase relationships and relative amplitudes are observed.

A step filter boosts the chrominance component by approximately 7 percent in order to obtain the correct ratio of high and low-frequency components in the output signal.

The step filter can be made variable to correct for differences in the relative amplitudes of chrominance and luminance components caused by the transmission path. The following values of the gain factors can be computed: $K_R = 1.07$, $K_G = 1.00$, $K_B = 0.68$.

Similar results can be obtained using a novel circuit element called an elliptical-gain amplifier and a synchronous detector. The elliptical-gain amplifier consists of a tube the gain of which is varied at twice the subcarrier frequency rate by applying a wave of this frequency to one of its control grids. The output circuit of the tube suppresses all frequency components above approximately 4.3 megacycles.

The output of this amplifier will contain all frequency components present at the input. In addition, it will also contain a component derived from the original chrominance signal by heterodyning with the second-harmonic reference carrier.

This new component will also be a suppressed-carrier quadrature-type signal. The phase relationship

of the two quadrature components is, however, reversed. The addition of the original quadrature modulated signal to the derived one leads to a new quadrature-modulated signal.

The resultant signal is zero if the incoming chrominance signal is zero. This is the only limitation on the output signal and any signal having this property can be obtained. The symmetrical type of dot-sequential signal has this property if the relative gain factors K_R , K_G and K_B are equal. The reproduced color should be neutral white if a constant signal is applied to the gun.

The phase and amplitude relationships used in the synchronous detector are different from those in the previous case as the required low-frequency component is not the same owing to the difference in gain factors K_R , K_G and K_B . Three degrees of freedom are available in the conversion scheme for the low-frequency signal and these are sufficient to permit the generation of any new low-frequency signal consisting of the sum of three primaries. Two degrees of freedom are represented by the amplitudes of the NTSC luminance component and the detector output, the third by the phase of the reference carrier.

A blanking wave of three times the switching frequency is applied to the picture tube to suppress the beam during the transitions. It is desirable to apply the beam-blanking voltage to an independent control grid of the tube. The results obtained by adding it to the grid driven by the video signal are acceptable. The most noticeable effect associated with this technique is a change of the effective-gamma curve of the tube.

Sequence of Four Video

In a sequence of four, the composite video signal consists of a low-frequency component and two modulated carrier components: one at the switching frequency and one at twice this frequency. Neither of the two carrier signals is quadrature modulated. The signal is described by the following expression

$$E_M = \frac{1}{4} E'_R + \frac{1}{2} E'_G + \frac{1}{4} E'_B$$

$$+ \frac{1}{2} (E'_R - E'_B) \cos(\omega t - \theta) + \left[\frac{1}{4} E'_R + \frac{1}{4} E'_B - \frac{1}{2} E'_G \right] \cos 2(\omega t - \theta) \quad (3)$$

The signal has the following properties

$$\begin{aligned} E_M &= E'_R \text{ for } \omega t - \theta = 0^\circ \\ E_M &= E'_G \text{ for } \omega t - \theta = 90^\circ \\ E_M &= E'_B \text{ for } \omega t - \theta = 180^\circ \\ E_M &= -E'_G \text{ for } \omega t - \theta = 270^\circ \end{aligned}$$

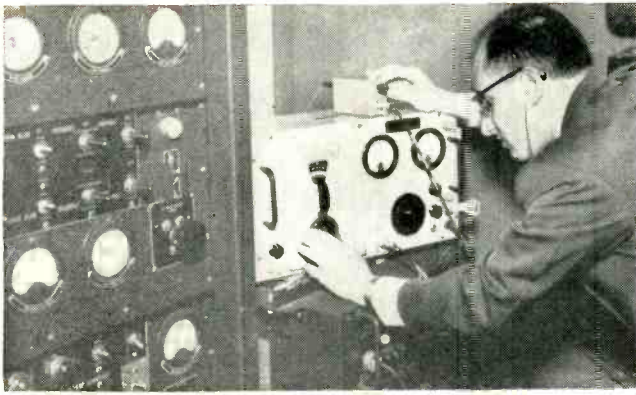
This signal is seen to differ considerably more from the NTSC signal than the previously considered sequence-of-three signal. A more elaborate circuit is needed to obtain the direct conversion of Eq. 2 into Eq. 3.

Two elliptical-gain amplifiers are used instead of one, as shown in Fig. 2. The amplitude of the second-harmonic reference carrier is increased to obtain an operating point such that one quadrature component is completely suppressed. The tube in the elliptical-gain amplifier passes current only in short pulses recurring at twice the subcarrier rate. That quadrature component of the input signal, the peaks of which coincide with the current pulses, is passed while the other quadrature component is almost completely suppressed as the zero crossings of the input wave coincide with the pulses.

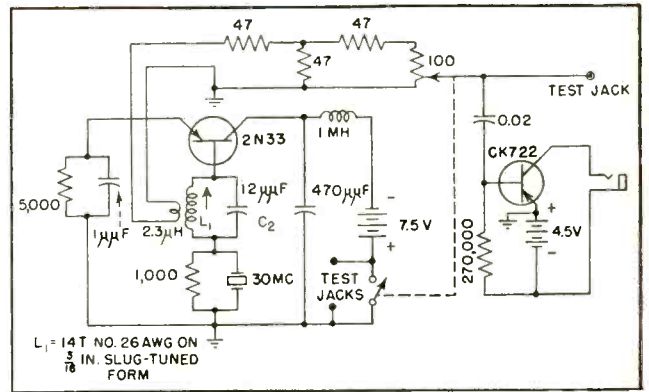
Another way of analyzing the operation of the quadrature suppressor is by considering it to be an elliptical-gain amplifier with equal normal and conversion transconductance. The original and the derived quadrature signal will add for one and cancel for the other quadrature phase.

The components $(E'_R - E'_B) \cos(\omega t - \theta_1)$ and $[\frac{1}{2} E'_R + \frac{1}{2} E'_B - E'_G] \cos(\omega t - \theta_2)$ both occur in the NTSC subcarrier plane. Each of them is selected by a quadrature suppressor and the latter one is heterodyned with a carrier at three times the subcarrier frequency to obtain the carrier component at twice the subcarrier frequency in the output signal.

The low-frequency components are again obtained by adding the output of the synchronous detector to the NTSC luminance component. The phase and gain setting of this arrangement is different from those used in the previous circuits.



Using transistor frequency standard to service military radar in the field. Schematic diagram gives details of oscillator and detector-amplifier stages



Transistorized Oscillator

Pocket-sized crystal-controlled oscillator using two transistors is useful instrument for servicing radar equipment in the field. Unit described operates on 30 mc; similar devices will furnish reference frequencies up to 110 mc

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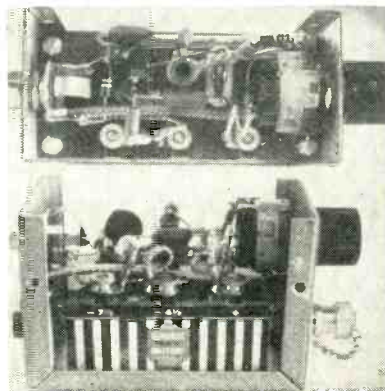
USE OF TRANSISTORS provides a convenient 30-mc crystal-controlled oscillator for servicing radar and communications equipment. Applications include aligning i-f strips, afc units, coherent oscillators and phase detectors. Similar units can oscillate up to 50 mc—or 100 mc with selected transistors.

The model shown uses commercial parts, measures $2 \times 2\frac{3}{4} \times 4$ in. and weighs 12 oz. No attempt at subminiaturization has been made although printed circuits can be employed. Battery size also can be reduced. Current drain is 1.7 ma and output can be maintained constant for 150 hours continuous operation. Transistor life is estimated at 10,000 hours. Maximum power output is 35,000 microvolts to a 50-ohm line.

Circuit

The circuit can supply a 30-mc c-w signal or establish a reference frequency for checking a vfo by

feeding the vfo output into the oscillator and detecting zero beat. The crystal may be either a CR-23 or CR-32, either of which can give 0.005 accuracy at normal operating temperatures. The CR-32 has an accuracy of 0.002 at 75 C and should be carefully selected when used at room temperature. The CR-23 has 700 cps deviation from -55 to +90 C and an effective resistance of 16 ohms.



Top and side views of oscillator

The crystal oscillates in its low-impedance, series-resonant third mode and replaces the usual r-f bypass capacitor. The tank circuit has a medium L/C ratio and is peaked using a grid-dip meter. Oscillation can be determined using a milliammeter in the test jack while adjusting the tuning slug for increasing current flow. The coupling link consists of two widely spaced turns tightly coupled to the output tank.

The detector amplifier uses a CK722 which requires a $4\frac{1}{2}$ -v supply and delivers power to 2,000-ohm headphones. Audio cutoff is about 200 cps. The chassis is of $\frac{1}{8}$ -in. phenolic sheet supported within the case on four rods. The phone and current test jacks must be isolated from chassis ground.

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Pulsed Curve Tracer for

Pulsed voltage sweep technique for determining V - I characteristics in semiconductors decreases thermal effects on measurements. Comparison with curves taken with non-pulsed supply can be used to find cause of rectifier breakdown

SEMICONDUCTOR devices exhibit a pronounced thermal sensitivity that often limits their usefulness. Even when the ambient temperature is constant, the characteristics are affected by the power dissipated within the device.

In p - n junctions the reverse impedance decreases with increasing voltage¹. Similar effects have been predicted and observed in the case of point-contact rectifiers.²⁻⁹

In tracing the voltage-current characteristic across a junction, the current is measured while a known varying voltage is applied. The resulting V - I curve is displayed on an oscilloscope. Thermal effects can be greatly reduced if the voltage is applied for a short time during which the measurements are made. The equipment to be described gives an 80- μ sec pulse every 4.4 milliseconds. The pulses increase linearly with time over a range of 0 to 350 volts. A d-c bias of 0 to 100 volts may be added serially to the pulses, thus allowing investigations up to 450 volts. These excursions are repeated every 144 milliseconds, about 7 per second.

The circuit comprises a pulse generator and a saw-tooth generator which feed their outputs into a gate. The output of the gate, shown in Fig. 1, is a recurring sequence of increasing pulses which are amplified in the final stage.

The short pulses are generated by a one-shot multivibrator of the positive-grid-return type as shown in the circuit diagram of Fig. 2. This multivibrator is driven by a self-triggering multivibrator.

In the saw-tooth generator pentode V_3 feeds a constant current to a capacitance C developing a voltage proportional to time. When this voltage reaches the firing potential of the thyatron V_4 , the capacitor is discharged and another

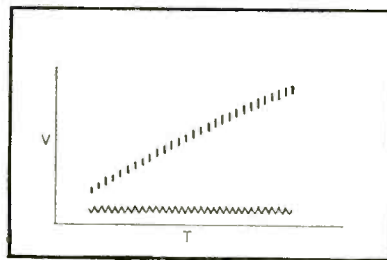


FIG. 1—Gate output is pulsed series of increasing amplitude

charging cycle is started. The resulting saw-tooth wave from the plate of V_3 consists of a potential decreasing by 100 volts in 144 milliseconds.

The gate¹⁰ comprises two cathode followers, V_5 , having a common cathode load. The saw-tooth signal is applied to one grid of V_5 . The pulses are applied to the other grid. Since the cathode of a cathode follower rides with the most positive voltage, the cathodes of V_5 are normally near the potential deter-

mined by the balance adjustment. This adjustment matches the maximum potential of the grid receiving the saw-tooth signal. The balance adjustment establishes the reference level about which the gate operates. When a negative pulse occurs, the cathodes of V_5 drop to a potential approximately equal to the potential of the saw-tooth at this particular time. At the end of the negative pulse the cathodes return to maximum potential, which is the above reference level. The next pulse brings the cathodes to a potential lower than for the previous pulse, since the potential at the other grid has decreased in the meantime. This action is shown in Fig. 3. The pulse height can be adjusted by the cathode potentiometer.

Amplifier

The output of the gate consists of negative pulses the magnitude of which increases from 0 to 80

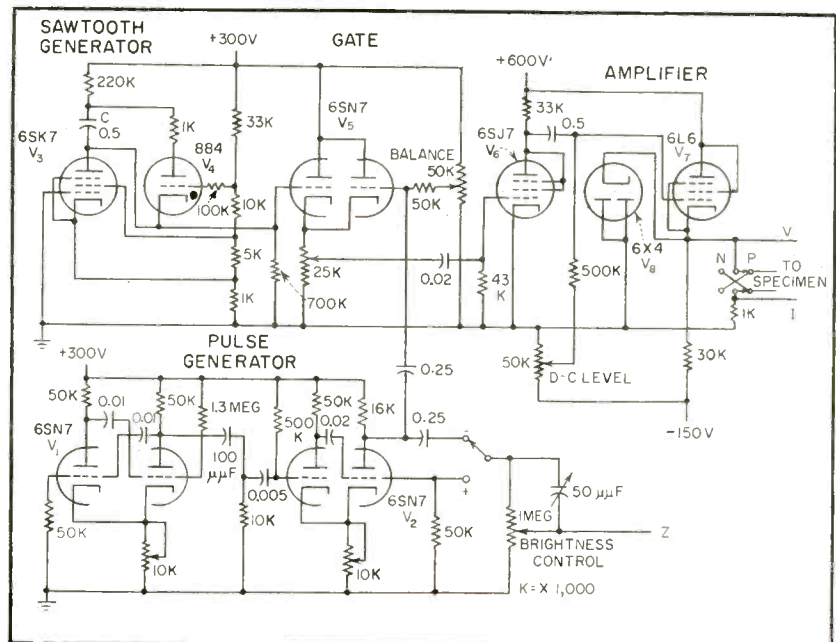


FIG. 2—Signals from saw-tooth generator and pulse generator are combined in cathode-follower gate to produce pulsed voltage for measuring V - I characteristics

Semiconductor Testing

By J. I. PANKOVE

RCA Laboratories
Princeton, N. J.

volts. These pulses are amplified and inverted by V_6 which drives cathode follower V_7 . The pulse magnitude varies from 0 to 350 volts.

These pulses are applied across a 1,000-ohm resistor in series with the rectifier whose V - I characteristics are desired. The current through the rectifier junction is then one milliampere per volt, appearing across the I terminals. The voltage across the specimen is nearly equal to the voltage across the V terminals. This approximation for the voltage is good as long as the resistance of the device is very high compared to 1,000 ohms. A 1-percent error is made for a specimen impedance of 100,000 ohms.

In order that the steady-state voltage across the specimen be zero, the cathode of V_7 is tied through a resistor to -150 volts and through diode V_8 to ground. In the steady state, with a negative bias on the grid, the cathode of V_7 will be clamped to ground by diode V_8 . When the grid of V_7 becomes positive its cathode follows in the same direction and diode V_8 exhibits a high impedance. Hence, the cathode of V_7 can produce positive excursions but always returns to zero potential.

An additional control is available through the d-c grid bias of V_7 . This bias can be adjusted to raise the steady-state potential of the V_7 cathode from 0 to 100 volts. Under the extreme condition, the 0 to 350-volt pulses start at a d-c level of 100 volts, so that the pulsed V - I characteristic covers the range of 100 to 450 volts.

Because the cathodes of V_7 and V_8 experience large excursions in voltage, their filaments are supplied by a separate transformer.

The V and I outputs are used to deflect the beam of an oscil-

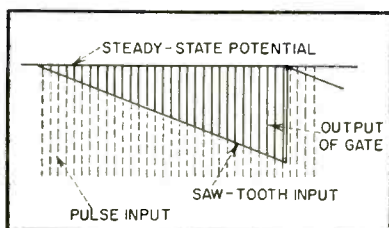


FIG. 3—Combination of waveforms used to produce growing pulse series

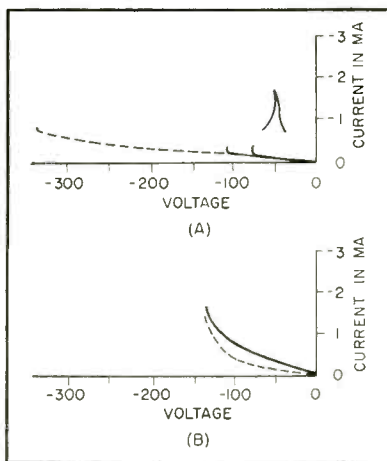


FIG. 4—Curves showing breakdown caused by thermal effects (A) and weakness in rectifying barrier (B)

loscope along the x and y coordinates respectively, the display appearing as a series of dots describing the V - I characteristic. The normal position of the beam, corresponding to the d-c level, exists much longer than the other dots and its brightness hinders observation and photography of the display. To circumvent this difficulty, pulses from the multivibrator are used to intensify the oscilloscope beam at every dot other than the d-c level spot. A trimmer capacitor optimizes the squareness of the pulse.

Applications

Breakdown of a semiconductor may also be due to a weak spot in the rectifying barrier. In this case, the breakdown is not dependent

upon the duty cycle of the applied voltage.

Therefore, if duty cycle affects the breakdown characteristics of the device a thermal phenomenon is taking place. This is shown in Fig. 4A, the reverse characteristic of a point contact on a 15-ohm-cm n -type germanium crystal. The full line, with a thermal hysteresis after a -110 breakdown, was taken with a 60-cps semisinusoidal voltage. The dotted line was displayed on the same oscilloscope with short duty cycle pulses from the apparatus described. The voltage breakdown was -350 volts.

In Fig. 4B, the reverse characteristic of an old 1N46 germanium rectifier shows that the breakdown voltage (-130 volts) is nearly the same under 60-cps display and under pulsed display. However, here the thermal effect manifests itself in the larger reverse current for the longer duty-cycle display.

The author's thanks are due to M. W. Green for some valuable suggestions.

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Saturable Transformers

Ferrite-cored units control flow of information into particular information channel at high switching rates. Gating action is analyzed in relation to core material, design and construction. Applications include magnetic-drum read-out systems for computers

IN INFORMATION-HANDLING systems such as digital computers, vacuum tubes, semiconductor diodes or electromechanical relays have been used to allow or inhibit the flow of information, usually in the form of electrical impulses, in a particular information channel. A saturable magnetic element can also be used as a gate for this application.

As shown in Fig. 1, either a saturable reactor or a saturable transformer may be used to control the voltage developed across a load resistor. For a constant-voltage source, the reactor used would be equivalent to a variable inductor in series with the load. For a constant-current source, the saturable transformer is used and is equivalent to a variable inductor shunted across the load. The work described utilized the transformer mode, since a high-impedance driving source such as the plate circuit of a high- μ triode seemed the simplest approach to conditions likely to be encountered in practical applications.

Impedances considered in the

equivalent circuits for both modes of operation are functions of the permeability μ of the core material. For the reactor mode of operation, a decrease in μ would result in an increase in the output voltage while for the transformer mode, a decrease in μ would cause a decrease in the output.

Core Characteristics

A typical hysteresis loop with a definition of terminology is shown in Fig. 2. Instrument limitations prevent measuring the small flux changes needed to determine reversible permeability of μ_r as the limit of a set of values of μ_Δ . Thus it has become conventional to use the incremental permeability measured at $\Delta B = 20$ gauss as the reversible permeability. This gives a good approximation to the true μ_r when ΔH is small, as it will be in high-permeability materials.

The B - H characteristic for an ideal core material is presented in Fig. 3. Hysteresis losses are nil, retentivity is zero and the saturation level is sharply defined. If control current is zero, a signal pulse

on the transformer primary will produce a certain flux change and the voltage induced across the terminals of the secondary winding will be proportional to the time rate of change of the magnetic flux. If a control current producing a biasing field H_m is applied to the transformer core, a signal pulse on the input winding will produce no further flux change, and no signal will appear at the output terminals.

The hysteresis loop of a typical core material suitable for magnetic gating purposes is illustrated in Fig. 4. Because the signal consists of unipolar pulses rather than an alternating waveform, and because the control field is always applied in the same direction, the states of the core characterizing the two points of operation are the remanence point ($H = 0, B = B_r$) and some point of saturation ($H = H_m, B = B_m$). When the control or bias field is zero, a signal pulse will cause the state of the core to trace out a minor loop with its nose at remanence. The size of the minor loop will depend on the amplitude of the input pulse and the amount of cur-

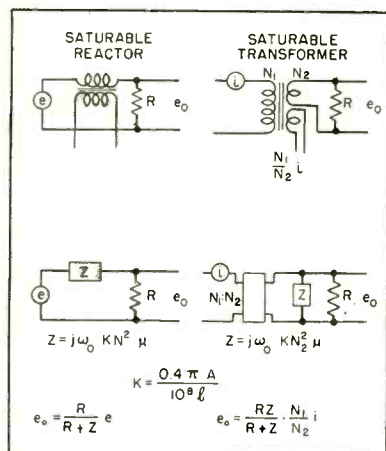


FIG. 1—Equivalent circuits for saturable reactor and saturable transformer

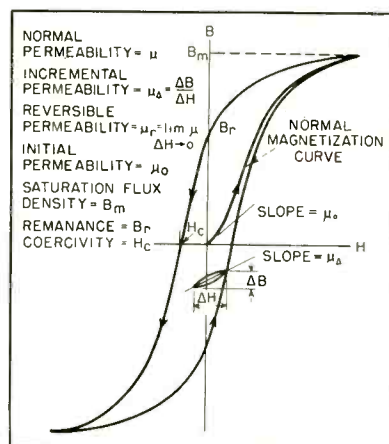


FIG. 2—Typical hysteresis loop with quantities defined

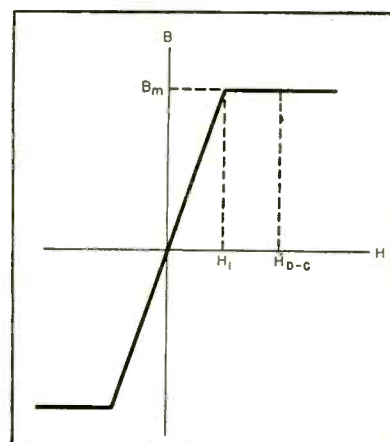


FIG. 3—Characteristic curve for theoretical core material

as Gates

By **BURNHAM MOFFAT**

University of Pittsburgh
Pittsburgh, Pa.

rent allowed to flow in the secondary circuit giving rise to a counter-flux in the core.

When the core is saturated by the control flux, the signal pulse will produce virtually no flux change and therefore no output voltage. The operating ratio is the ratio of the output signal with zero control flux to the signal output voltage when the control flux is applied.

Core Materials

The design objective is to maximize the operating ratio and minimize the transition time required to open or close the gate. It is also desirable to prevent interaction between control flux and signal flux, so that turning the control current on and off will not introduce transients which would cause spurious pulses to appear in the output signal.

High incremental permeability at remanence, a sharp saturation level at low values of magnetizing force and low hysteresis and eddy current losses are desirable characteristics for a core material.

To eliminate eddy current diffi-

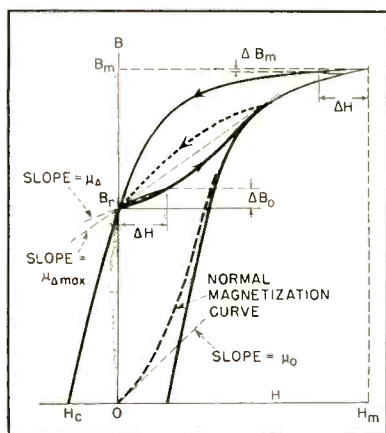
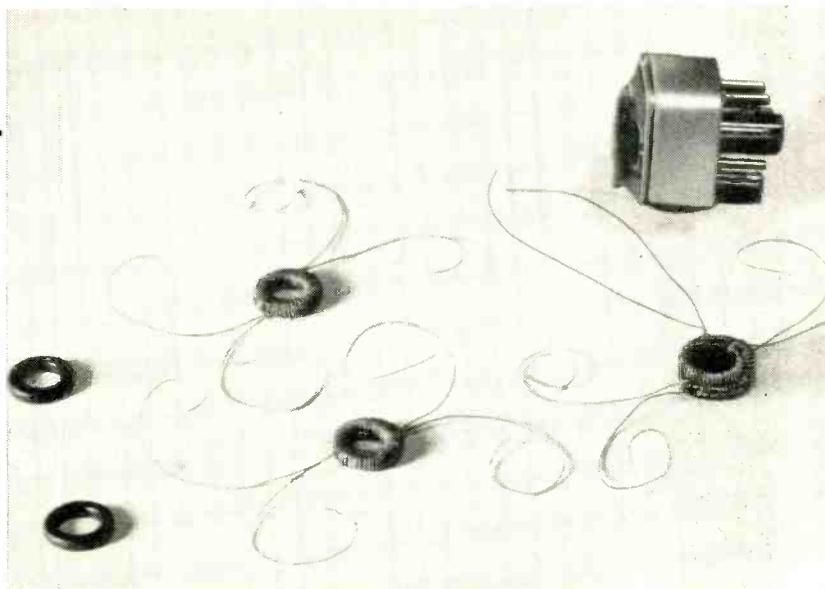


FIG. 4—Curve for typical magnetic-gate core material



Construction of magnetic gates from ferrite cores. Input and output windings are wrapped on each core and control windings are wrapped around both. Final unit is installed on octal tube base

culties, only ferrite core materials were considered. The two commercially available ferrites found to be suitable were Ferramic I and Ferroxcube 101.

Their properties are summarized in Table I. Ferrites chemically constituted to give minimum magnetic anisotropy, and heat treated to keep crystallite size small, should prove most satisfactory as core materials.

Design and Construction

In magnetic amplifiers, a commonly employed technique of preventing pickup of the a-c carrier in the control winding is to use a three-legged core. The same method is applicable to magnetic gates. As is shown in Fig. 5, the control winding is placed on the center leg, and the input and output windings are split, with the respective halves placed on the outer legs of the core and connected in series. The flux produced by the control winding divides and induces equal and opposite voltages in the two halves of the output and input windings, thereby producing zero net-output voltage. The signal flux produced by the two halves of the input winding cancels in the center leg of the core.

With ferrites it is often more convenient to use a pair of small toroidal cores rather than a single three-legged core. The equivalence of the two configurations is given

in Fig. 5C, which shows a double-core arrangement.

An experimental gate was constructed using two toroidal cores of Ferroxcube 101. Each core had a mean diameter of 1.00 cm and a square cross section of 0.056 cm². Each toroid was wound with two single-layer windings of 31 turns each of No. 32 cotton-covered, enamel-coated wire and sprayed with an acrylic plastic.

The two toroids were sandwiched together, with the windings juxtaposed to minimize the capacitance between input and output coils. The input winding of one toroid was placed directly beside the input winding of the second toroid, and the output windings were correspondingly adjacent. The control winding, consisting of 52 turns of No. 28 enamel-coated wire, was wound around the two cores. The unit was wrapped with electrical tape and mounted on an octal-tube base. The photograph shows the component in various stages of construction.

The gate was tested by applying current pulses to the input winding, periodically applying a current to the control winding and observing the degree of suppression of the output pulses obtained for different values of control current. Signal pulse amplitude was 65 milliamperes, pulse duration was 3.5 microseconds and the pulse repetition

frequency was 25 kc.

Gating current was a square wave with a frequency one-eighth the pulse repetition frequency, giving a four-on four-off pulse pattern. The operating ratios obtained for different values of control current are given in Table II.

Typical waveforms are presented in Fig. 6. In this case, the control field was calculated to be 4 oersteds and the operating ratio observed to be about 15 to 1.

Performance

To test the performance of an array of magnetic gates, a four-input single-output channel selector was constructed using six gates. Figure 7 is a schematic diagram of the channel. Adopting the convention that the shaded half of each box represents the half of the flip-flop that is producing a control current, it can be seen that the cross-hatched gates are in a saturated or nontransmitting condition. An input signal on channel 1 is the only one which will appear at the output terminals.

A block diagram of the channel selector test setup is given in Fig. 8 and waveforms are shown in Fig. 9. Each of the four inputs was fed with a different repeated four-digit binary number and the control windings were driven by a two-stage binary scaler with cathode follower outputs.

Figure 9C (top) shows ungated output-voltage waveform. With no control current flowing in the windings of any of the cores, the output voltage waveform consists of a superposition of all four input signals. The gated 16-v output signal is obtained with control current adjusted to produce a biasing field of 3 oersteds in each core. Observed operating ratio is about 8 to 1.

Owing to a small amount of crosstalk, which was apparently unaffected by the control field, practically no improvement in operating ratio was obtained when the control

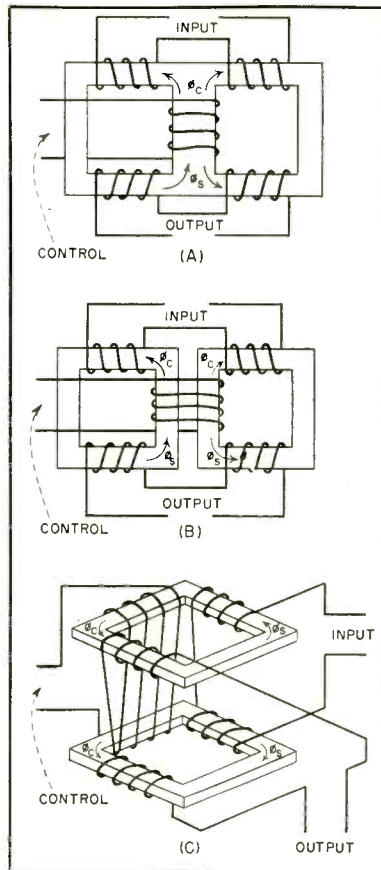


FIG. 5—Three-legged core (A), double core (B) developed from (A) and double-core arrangement (C) used in saturable-transformer gates

field was raised as high as 8 oersteds. Input pulse amplitude was 38 milliamperes, pulse duration was 2.5 microseconds and pulse repetition rate was 100 kc.

A small ringing effect in the output-voltage waveform was damped out by a 1,000-ohm resistor across the output terminals. The ringing effect was caused by the inductance of the output winding resonating with the input capacitance of the oscilloscope. The channel selector was also operated satisfactorily at a pulse repetition frequency of 150 kc, but deficiencies in the performance of the control scalars at this frequency introduced some spurious pulses and degraded the operating ratio.

Table I—Magnetic Characteristics of Materials Used in Gates

Material	μ_0	μ_{max}	B_s	B_r	B_r/B_s	H_c	T_c
Ferramic I	900	1,600	1,510 gauss	725 gauss	0.48	0.24 oersted	70 C
Ferroxcube 101	1,000	2,870	2,245 gauss	1,089 gauss	0.48	0.18 oersted	120 C

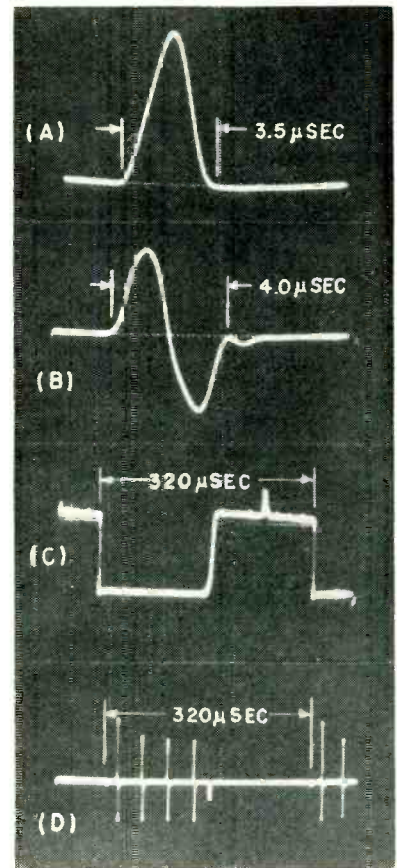


FIG. 6—Input pulse of 65 ma to magnetic gate (A) and typical 18-v output pulse (B). Gating current pulse is shown at (C) with gated output at (D)

The channel selector is a simple but typical application of the magnetic-gate principle. An 8-to-1 operating ratio is adequate for the handling of binary information such as a magnetic drum pulser.

The maximum number of cascaded levels in a channel selector would depend on the permissible attenuation of the signal, and on the minimum usable overall operating ratio. In the experimental channel selector described, the attenuation was about 1.9 db per stage. The number of stages which may be cascaded is roughly proportional to the operating ratio of a single element. With the operating ratio available in the experimental magnetic gates, four or five levels would seem to be the practical limit. With four cascaded levels, sixteen inputs are available; with five levels, thirty-two, and with six levels sixty-four input channels can be controlled.

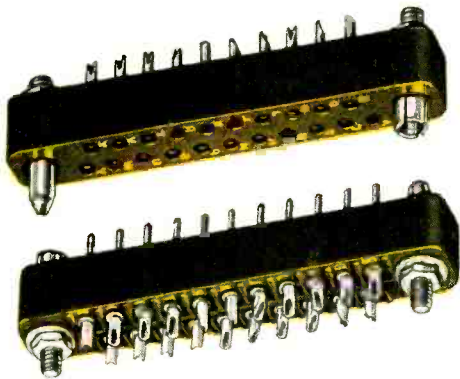
In contrast to switches using square loop materials, there is no difficulty in attaining high-frequen-

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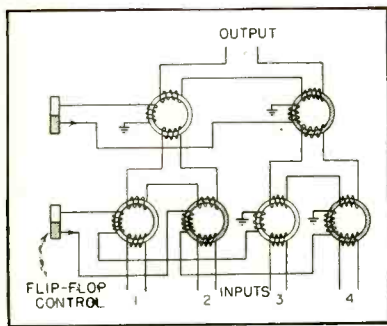


FIG. 7—Four-input single-output channel selector. Shaded cores are in saturated condition

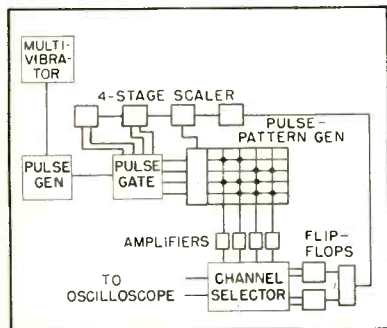


FIG. 8—Test arrangement for four-input single-output channel selector

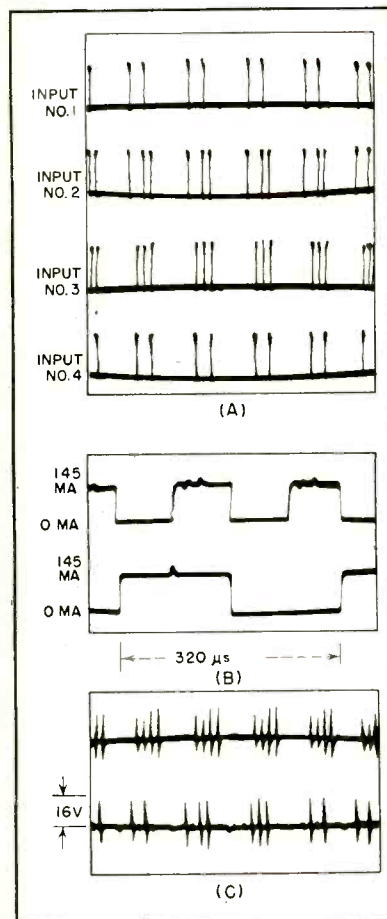


FIG. 9—Four input signals to channel selector (A), gating current waveform (B) and resulting output (C)

cy operation in saturable transformer gates. Since the state of the core traverses only a minor loop, neither hysteresis heating nor switching time creates a problem. The desired frequency response and pulse-shaping characteristics may be obtained by consideration of factors in pulse-transformer design.

The magnetic gate can be compared with the electromechanical relay. In both devices the information circuit is opened or closed by direct-current in the control windings.

The magnetic gate and the relay differ in range of signal frequencies which may be transmitted, insertion loss, operating ratio and switching rate. The closed contacts of a relay form a low-impedance connection that can handle signals of any frequency from d-c to r-f.

Magnetic coupling between input and output precludes the transmission of static voltage levels by the magnetic gate. The insertion loss of a relay is nil, whereas in the magnetic gate it is a definite amount which depends on leakage flux and core losses. The operating ratio of a relay is essentially infinite, whereas for the magnetic gate the operating ratio is finite.

The finite insertion loss and operating ratio of the magnetic gate limit the number of stages which may be cascaded without affecting adversely the quality of the signal. The best relays have a switching speed of the order of one millisecond. The magnetic gate can be switched in less than ten μ sec.

Applications

Use of magnetic gates in the channel-selection system of a magnetic-drum storage unit of a digital computer would result in considerable simplification in circuitry as compared with other high-speed selection systems.

Table II—Operating Ratios with Different Control-Current Values

Control Current in Ma	Calculated Control Field in Oersteds	Observed Operating Ratio
0	0	1:1
48	1	2:1
96	2	7.5:1
192	4	15:1
384	8	25:1

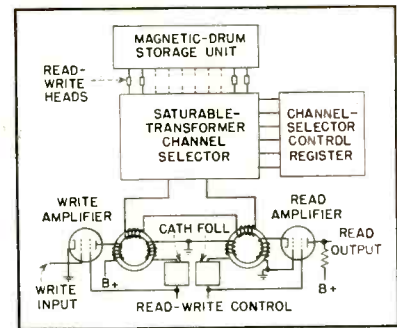


FIG. 10—Application of magnetic gates to magnetic-drum storage system. Only one read and one write amplifier are required

High-speed channel selectors generally employ both a read and a write amplifier for each pickup head. Thus, for an n -channel magnetic drum, $2n$ gating amplifiers would be needed, plus a diode matrix containing $n \log_2 n$ diodes.

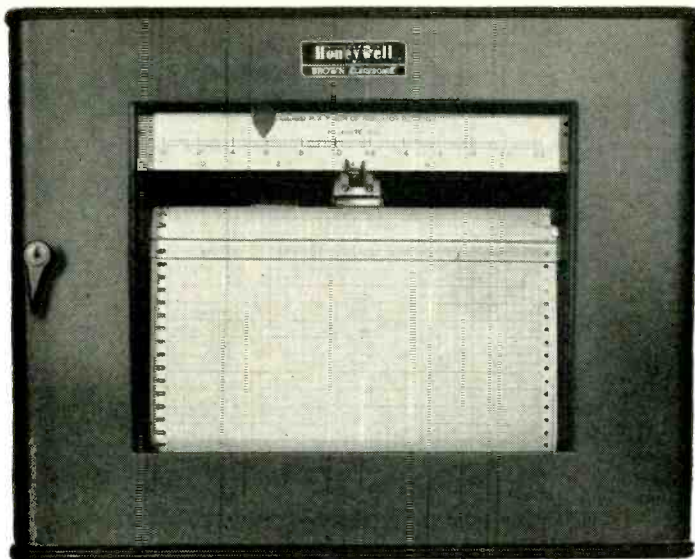
The matrix can be eliminated, and the number of gating amplifiers can be reduced to one read and one write amplifier by the use of a flip-flop controlled relay system but only at a considerable sacrifice in operating speed. The same advantage in the saving of equipment, but with no loss of operating speed, may be realized by using magnetic gates instead of relays.

A proposed channel-selector system is shown in Fig. 10. The additional pair of magnetic gates acts as a switch to connect the channel selector either to the read or to the write amplifier. This isolation is necessary to prevent the write pulse from damaging the read amplifier.

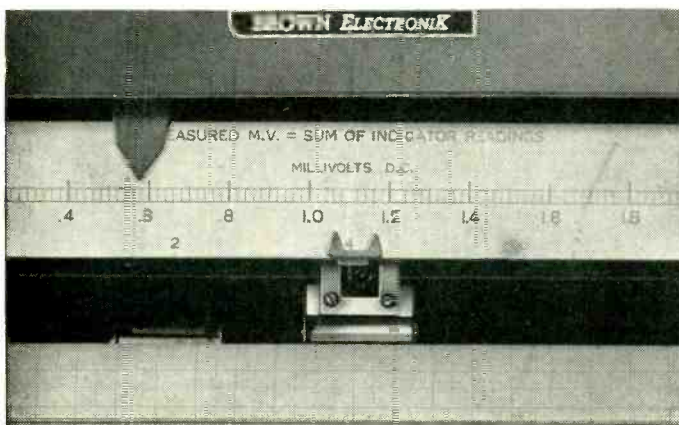
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Accelerator for Food Industry

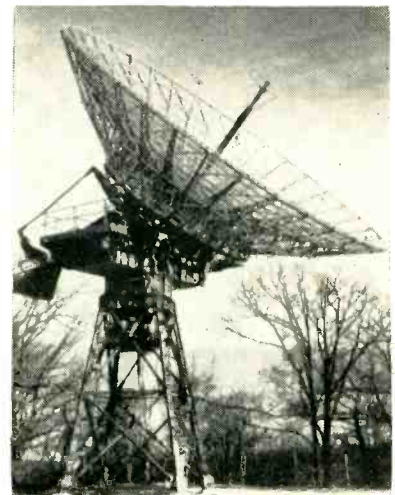
Electron linear accelerator now under construction by Applied Radiation Corp. is expected to be more powerful than comparable devices including resonant-transformer and Van de Graaff machines. At an estimated cost of \$100,000 weighing about a ton and requiring a space 4 by 4 by 9 feet, the new accelerator may provide a means for industry to preserve meats, vegetables and fruit without refrigeration. Electronic radiation destroys bacteria and inhibits enzyme action

Radar Antenna Follows Stars

By W. VIRGIL STINE
*Mechanical Engineer
Evans Signal Laboratory
Fort Monmouth, N. J.*

ON THE SITE where the first radar signals were bounced off the moon, a powerful new radar antenna has been erected for future wave-propagation studies.

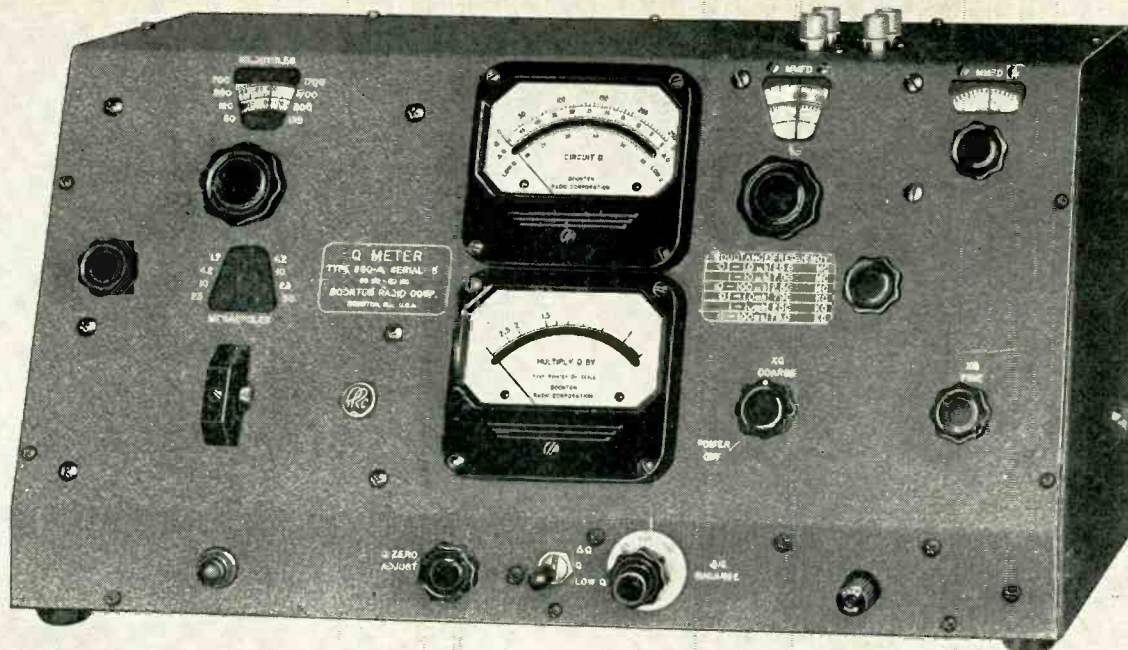
The radar mount is a steel structure weighing sixty-five tons that rotates a parabolic reflector weighing fourteen tons. The parabolic reflector, fifty feet in diameter, is



Fifty-foot diameter radar reflector weighs fourteen tons. Position of antenna is controlled by computer through servo system

positioned by an electronic computer feeding azimuth and elevation co-ordinates to a servosystem, following celestial bodies as the earth rotates. Radio-frequency energy is fed to the antenna through a six-inch coaxial rigid transmission line. The radar, when completed, will be one of the largest and most powerful in existence.

The antenna and mount will withstand winds of 100 miles per hour or a snow load of 30 tons. The reflector surface consists of a rolled expanded metal screen formed to contour over radial curved trusses. An adjustable dipole, 16½-feet long, will feed r-f energy to the reflector. The reflector and dipole are positioned from an adjacent building by the computer and servocontrol



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NEW FEATURES

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- Voltage insertion resistor decreased to 0.02 ohms to minimize effect on measuring circuit. New type low reactance metalized coaxial resistor used.
- All indications on large meters with parallax correction and accuracy of $\pm 1\%$ full scale.
- Range switch controls mask and arrow which indicate correct scale on frequency dial.
- Oscillator rigidly supported by casting which supports turret ball bearings and circuit using long life subminiature triode.

The Q Meter Type 260-A replaces our Type 160-A, one of Boonton Radio's Q Meters which has been standard equipment in laboratories and on production lines for eighteen years. Many improvements have been made during this time, but several of our ideas for a better instrument were too extensive to put into a model already in production. These ideas were carefully tested for use in a new model. The Q Meter Type 260-A includes all past improvements and the extensive changes that we have accumulated.

SPECIFICATIONS:

FREQUENCY COVERAGE: 50 KC to 50 MC Continuously variable in eight ranges.

FREQUENCY ACCURACY: Approximately $\pm 1\%$.

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equipment located there.

The rotating mechanism is located atop a 26-foot tower. The tower is 15-feet square at the base, tapering to 7½ feet at the top. Each leg of the tower consists of two 5 × 5 × ½ in. structural angles laced together.

An 8-inch wide flange structural ring section 17½-feet in diameter is used as a ring section to support the small radial trusses to form the antenna. The base ring is in turn supported by a truss structure with elevation bearings 19½-feet apart.

The elevation bearings are supported on the ends of a reinforced box-girder section, 19-feet long, 7-feet wide and 4-feet deep, which rotates upon an azimuth bearing 100-inches in diameter. An electrical slip ring assembly and an azimuth r-f rotating joint are housed in the center compartment of the girder. Another r-f rotating joint for the elevation rotation is located adjacent to the elevation bearing through which the radio-frequency transmission line passes.

The elevation drive mechanism consists of a ½-horsepower 230-volt d-c servomotor connected through a 1,274,528-to-1 gear reduction. A clutch and brake mechanism, a 2-horsepower slew motor and a

sector gear and pinion make up the balance of the drive system.

Total overall gear reduction from servomotor to antenna movement of over 1,000,000-to-1 results in a very slow speed for the antenna, enabling it to follow celestial bodies. The 2-horsepower motor is used for slew positioning of the antenna and when in use the servomotor is uncoupled by means of a magnetic clutch mechanism. When power to the servo and slew motor is off, a magnetic brake system locks the mechanism.

The azimuth drive mechanism is identical to the elevation drive mechanism except that the angular velocity is twice as fast. The antenna can be moved from a west to an east position and from a zenith to a horizon position in less than fifteen minutes when reorientation is required. The azimuth bearing is 100 inches in diameter with an internal 90-inch pitch-diameter gear cut on the inner race. The tooth spacing error was specified not to exceed 0.001 inch over any three consecutive teeth. The 9-inch pinion on a 5-inch shaft will transmit a maximum torque of 546,000 inch-pounds needed only under the high-wind conditions.

A 32-ring slipping assembly is

provided for power, controls and telephone to the rotating mechanism.

In moving from the zenith to the horizon position 30,000-pound counterweights move out to maintain the centering of the weight on the tower. At the horizon position the bottom edge of the reflector is 12 feet above ground level.

Synchro data boxes, housing four synchros, two each at 1-to-1 gear ratio and two each at 36-to-1 gear ratio, are driven from the elevation axis. Similar synchro data are taken from the azimuth rotation. The synchro information is interconnected with the servocontrol in the adjacent building and at the operator's position.

A small low-power optical telescope with night-lighted cross hairs is located parallel with the axis of the reflector for visually placing the radar on track and for optically checking the computer positioning.

The servosystem used for positioning the antenna is operable from three data systems; the local operator's control, the electronic computer data system which computes azimuth and elevation positions with respect to time or a separate optical telescope transmitting synchro data.

Microsecond-Spike Generator

BY KARL GREIF
Vestal, N. Y.

NEED FOR A simple means to obtain pulses of less than 1-microsecond widths at audio repetition-rates has resulted in the development of a spike generator that operates reliably from 0 to 8,000 pps, is completely free of jitter, relatively insensitive to input amplitude variations and provides a low-impedance output. The input may be either a sine wave or a square wave.

The circuit shown schematically in Fig. 1 appears to be similar to the sawtooth generators used in oscilloscope sweep circuits. Its components are, however, quite different. The small discharge capacitor C is charged through the high-charging resistor R₁ from the B+ supply. The 2D21 gas-discharge

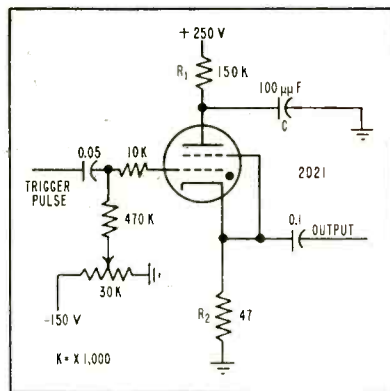


FIG. 1—Thyatron spike generator will operate at trigger rates up to 8,000 pps

tube is cut off by proper biasing with the potentiometer. After capacitor C is fully charged, the cir-

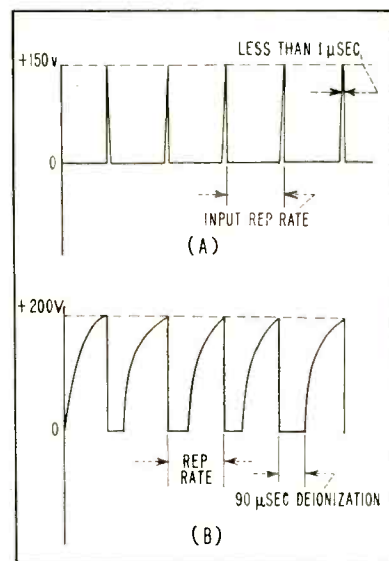


FIG. 2—Output of thyatron spike generator (A) and plate-voltage cycle (B)

cuit is in a standby state.

When the positive half of a sine wave or square wave or a positive

LIQUID-LEVEL GAUGE WEARS 7 LEAGUE BOOTS

Taking inventory was an oil-industry headache until the Shand & Jurs Company of Berkeley, California developed its Electronic Precision Remote-Reading Tank Gauge System...relying on HELIPOT* precision potentiometers for translating critical measurements into voltages which are transmitted to an indicator located miles away.

Tank-gauging starts with a float riding on vertical guides. A perforated metal tape runs up from the float...over a sprocket-wheel...and down to a counterweight.

The sprocket-wheel, through a gear train, drives two HELIPOTS. The shaft of the first... a Model A, 10-turn unit...rotates 3600° as the float moves from the bottom of the tank to the top. The shaft of the other... a Model F, continuous-rotation unit... makes a full turn for each foot the float moves.

The voltage outputs of the two HELIPOTS are conducted to the remote station where either can be fed to the circuit of a Brown Instrument Co. self-balancing Wheatstone bridge.

The voltage of the Model A HELIPOT is read directly in feet... that of the Model F HELIPOT in 1/8" increments. Inventory of any number of tanks can be made quickly... by successively switching the outputs of their HELIPOTS into the circuit of the indicator.

Operating on a tank containing petroleum vapor, the HELIPOTS must be housed in an explosion-proof chamber. To overcome the problem of moisture condensation, the HELIPOTS operate completely immersed in oil...which enters the HELIPOTS themselves through holes in their housings. Condensation is drained periodically from the bottom of the chamber. Identical HELIPOTS, laboratory-tested while similarly immersed, showed negligible wear of coil or slider contact after 2 million revolutions.

Application Data... For complete details on this and other applications, write for Data File No. 901

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ELECTRONICS — September, 1954

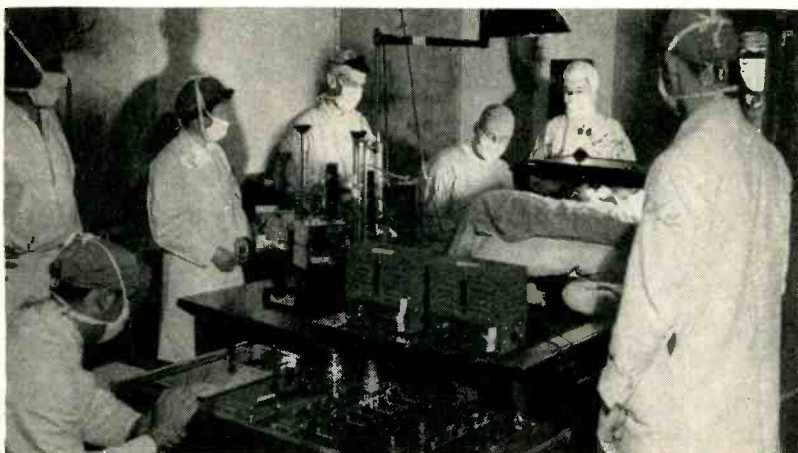


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THE FRONT COVER



ELECTRONIC EQUIPMENT shown above includes two electromanometers and a four-channel direct-writing recorder. Graphs of pressure within the heart, from an artery remote from the heart, an electrocardiogram and one other desired physiological phenomenon can all be recorded simultaneously.

The electromanometer converts pressure into a proportional voltage, which is amplified before recording. The device used to measure variation in pressure level is a condenser microphone with a stiff diaphragm. A fluid-filled catheter probe transmits pressure changes.

Connected as one arm of an alternating-current bridge, variation in the capacitance of the microphone unbalances the detector and causes an upward deflection of the writing stylus of the Sanborn recorder.

The system measures pressures having components at any frequency from zero to 100 cps. Full-scale deflection is obtained at any pressure range from 4 to 400 mm of mercury. The recorder speed can be varied from 0.25 to 50 mm a second.

pulse from another source is applied to the input the tube will ionize. When the tube fires, the circuit consists simply of C , the tube and the small cathode resistance R_c . Since C is small, it discharges rapidly through the tube and resistor impressing a relatively high voltage across the effective load resistor R_L . The charge is completely dissipated, producing a spike of 150-volts amplitude with a width of less than a microsecond.

A capacitor is used to couple this spike out to external equipment. The high resistance of R_L and the bias control prevent continuous ionization. Because of the very low impedance of the circuit and of R_c , an extremely sharp leading and trailing edge is obtained, Fig. 2A.

Even though the capacitor is fully discharged in less than 1 micro-

second, the tube continues in an ionized state for approximately 90 microseconds before the recharging cycle of C through R_c can be again effected. After this deionization period, the capacitor again charges and waits to be discharged again into the load resistor with the next incoming positive triggering signal.

The series grid resistor reduces grid current. Although the constants shown are typical values that work well in the arrangement given here, the components can be varied to meet various special requirements.

The bias control, while providing more flexible usage, can be eliminated in most cases, with the 470,000-ohm resistor tied directly to ground.

In examining the pulse, the oscilloscope sweep speed should be ad-

justed such that 3 or 4 spikes fall across the screen. If close examination fails to reveal the spikes, connect the oscilloscope to the plate of the thyatron. If a picture similar to Fig. 2B is observed, the circuit is operating properly and the spikes are too narrow to be seen on the oscilloscope. If the plate is at zero, the bias should be increased. If the plate remains at full $B+$, the tube is not being triggered.

These are the only three circuit conditions and as such they permit easy adjustment of the circuit.

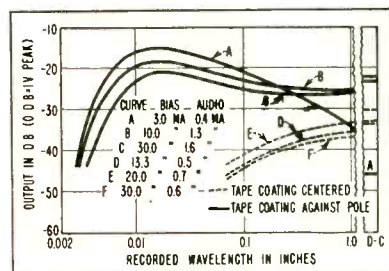
Characteristics of Ring Recording Heads

By J. W. GRATIAN

Research and Development Dept.
Stromberg-Carlson Co.
Rochester, N. Y.

EXISTENCE OF PERPENDICULAR magnetization as well as longitudinal magnetization is known when recordings are made with the ring-type head of conventional magnetic recording systems. The figure shows overall frequency response data for a system utilizing the perpendicular electron-beam pickup, coated tape and a ring recording head having a recording gap length of slightly less than one mil.

In a conventional longitudinal-type system this recording head requires a bias current of two to three milliamperes. Curve A shows relatively low d-c response at this bias value, thus indicating a low degree of perpendicular magnetization within the recording medium. As shown by curves B and C, a bias current in the order of ten times



Response curves for ring recording head, coated tape and crt pickup with perpendicular core having aligned poles

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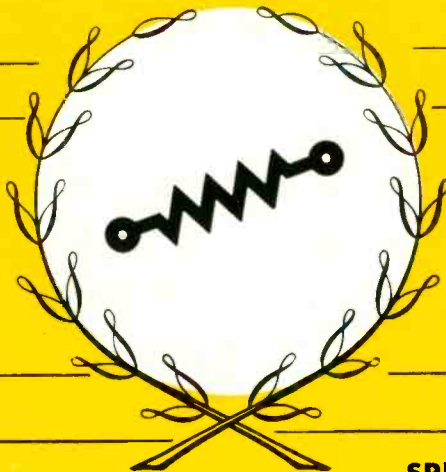
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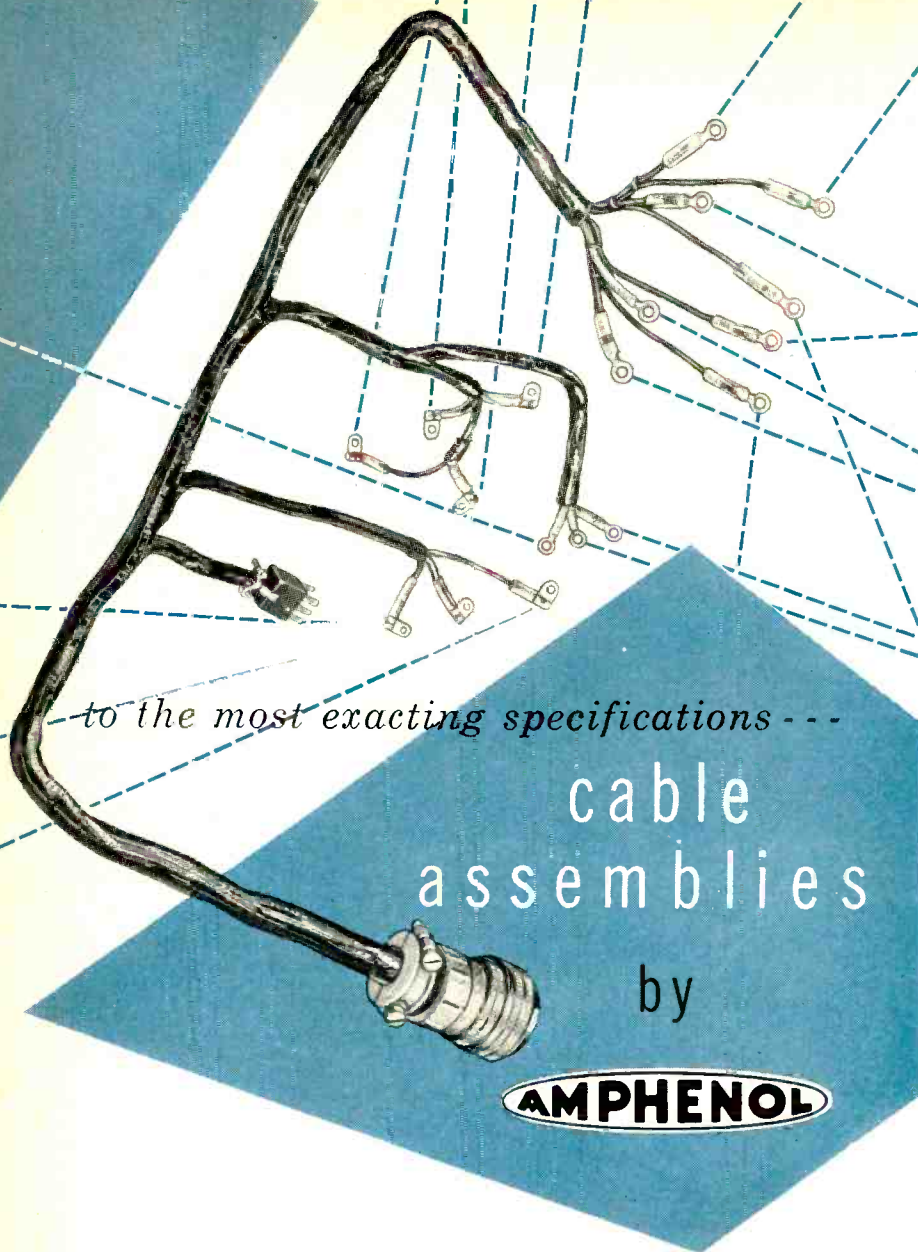
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the conventional range of values is required to provide smoothest response in the perpendicular system.

For the data in the figure, bias currents were chosen arbitrarily and the associated signal levels adjusted to those values that would give 3 percent third harmonic distortion at 0.3-inch signal wavelength on an equalized system.

The low output with the tape centered is surprising; further tests showed that distortion increased slowly with recording level, reaching 6.4 percent at a level approximately 20 db above that shown in the curves for 3 percent distortion.

When offset poles were substituted for aligned poles and the tape was operated with its coating against one pole of the reproducing head, data were similar to those represented in the figure. However, with the tape coating centered, the low-frequency output levels for 3 percent distortion were approximately 20 db higher and the high-frequency response extended to within one octave of that obtained with the tape coating against the pole. Square-wave tests showed a high degree of phase distortion.

This information supplements that given in an article on p 156 in the feature section of this issue.

Hard Tube Operates Magnetic Counters

By L. FLEMING

*Instrumentation Consultant
Falls Church, Va.*

COUNTING EVENTS at rates under about 10 a second is often performed by means of a magnetic counter and a thyratron. A hard-tube circuit works better, however, because it can deliver better-shaped pulses of current to the counter magnet and because it will never fail to return to the nonconducting state after each actuation.

Figure 1 shows a hard-tube circuit that will actuate a counter on receipt of negative input pulses of 0.5 volt or more. It is a one-shot multivibrator. First stage V_1 is designed for high voltage gain; the second stage V_2 for high current output. The best type of counter for use with this circuit is one

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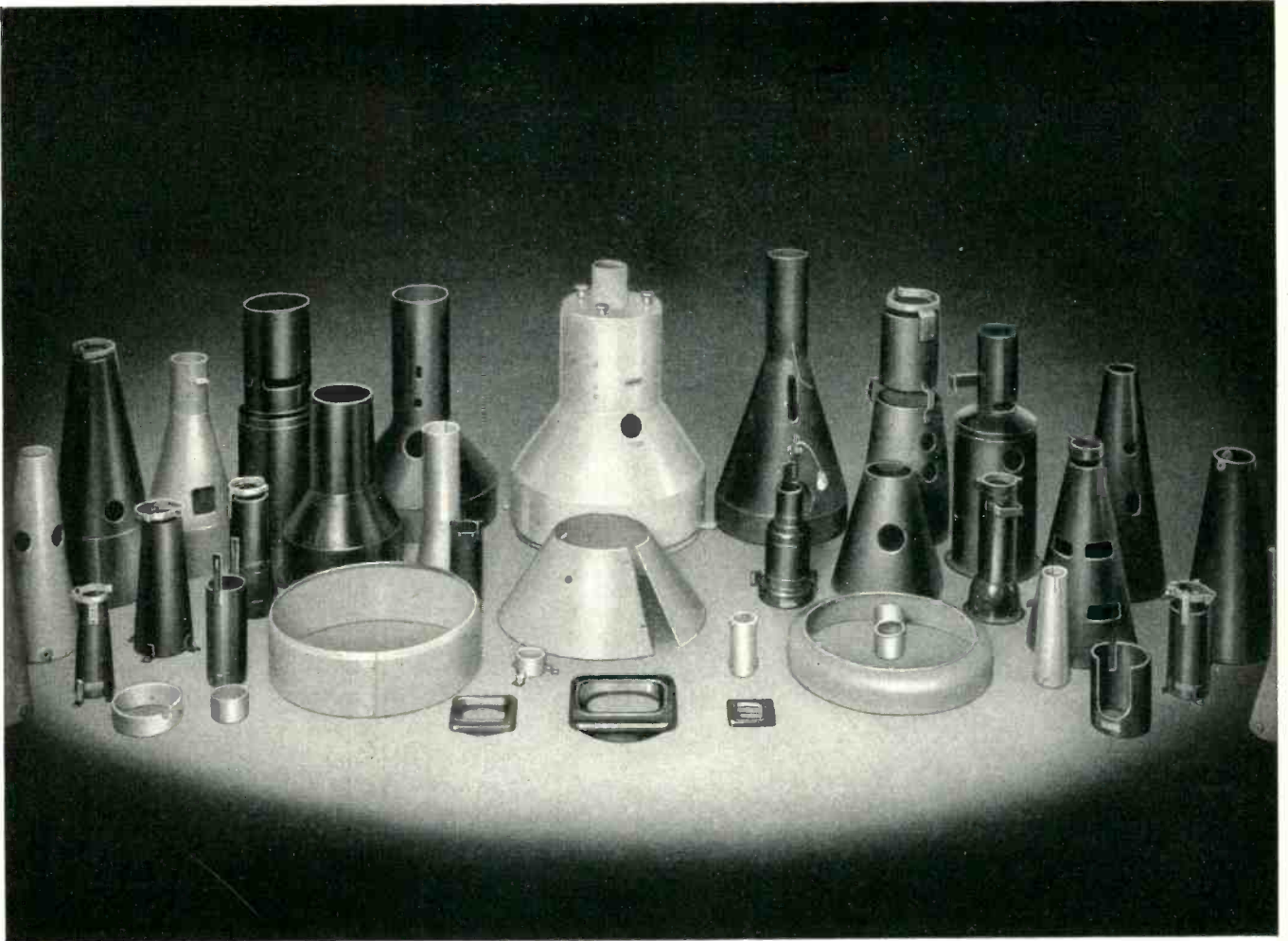
There are highly competent employees engaged in cable assembly work at AMPHENOL. They have had years of experience in this complicated field and work for you with speed and skill. Rigid in-process inspection procedures guard the quality of the assembly from the moment individual components are received until the complete assembly is shipped.

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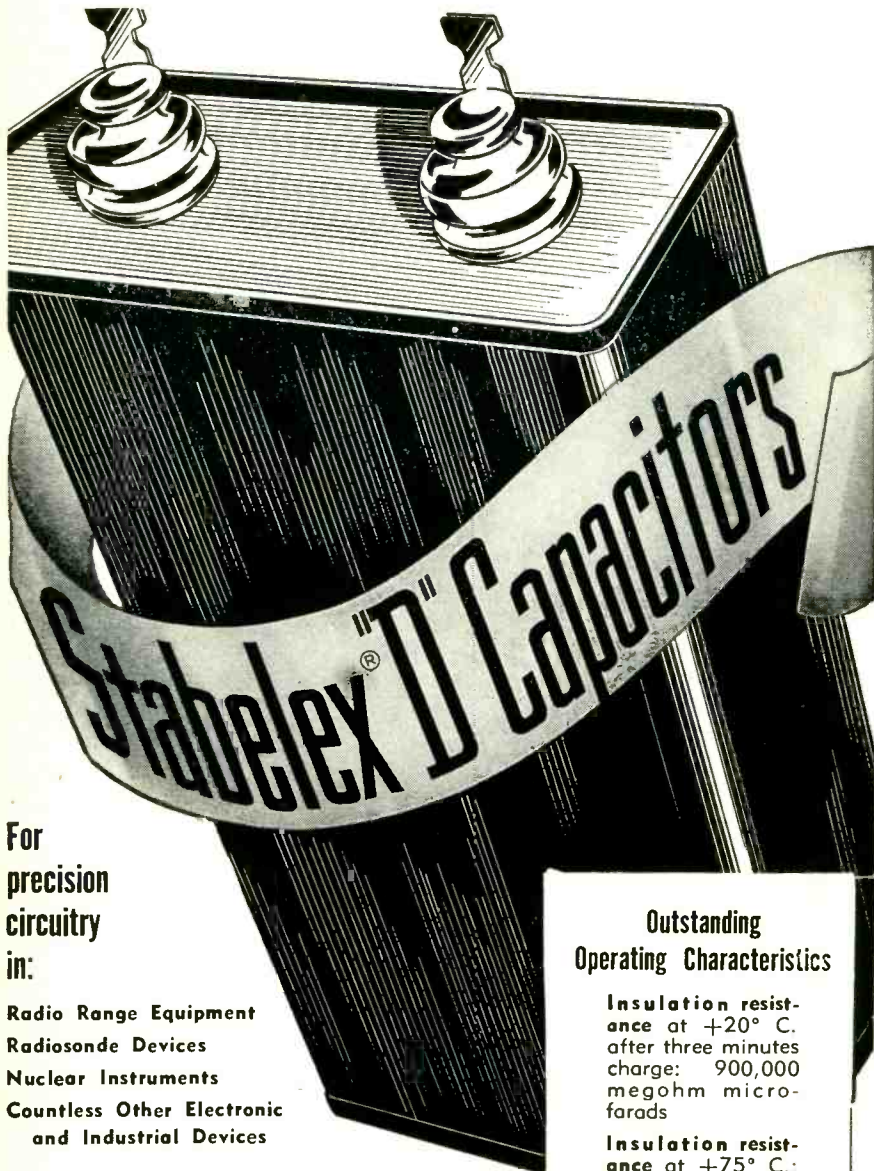
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Change in capacitance from +25° C. to -80° C.: +0.76%

Self time constant of 10 mfd. capacitor: 4800 hours
Q at 50 kilocycles: 10,000

✓ **Power Factor** at 1 kc: 0.00025

rated for 110-volt d-c operation. About 60 ma is required in the coil for positive operation. Tube V_2 delivers 100 ma peak.

Power tube V_2 is normally cut off by means of bias resistors R_2 , R_3 . Some initial adjustment may be required by selecting resistors. About 65-v bias is required. If V_2 is not completely cut off, the circuit will operate free-running. If bias is excessive, sensitivity will suffer and peak power delivered to the counter will be reduced.

The feedback paths between V_1 and V_2 are through coupling capacitor C_1 , and common cathode resistor R_4 .

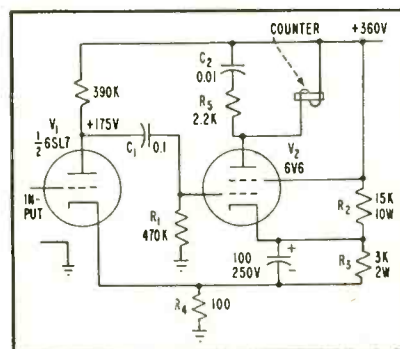


FIG. 1—Trigger circuit supplies pulse for reliable operation of 60-ma 100-v d-c magnetic counter

The shape of the current pulse delivered to the counter coil is approximately square-topped. Current is about 100 ma with a duration of 1/20 second. It may be observed by connecting an oscilloscope across R_4 .

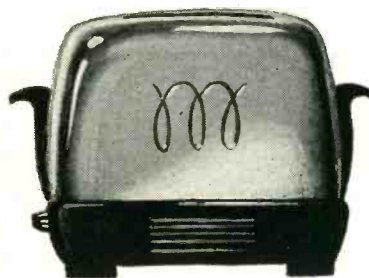
Value of R_1 is determined mainly by the voltage required to cut off V_1 . The 10 volts developed is adequate. Larger values will reduce the output power.

Pulse duration is mainly determined by the interstage time constant $C_1 R_1$. Too-long pulses will impair the maximum time resolution of the circuit-counter combination and too-short pulses will fail to give positive actuation.

A surge-absorption circuit $C_2 R_5$ across the counter coil was found advisable to absorb the high voltage induced in the coil at the instant when V_2 cuts off.

If operation is desired only on signals exceeding a preset threshold level, the biased series-diode circuit of Fig. 2 is added ahead of

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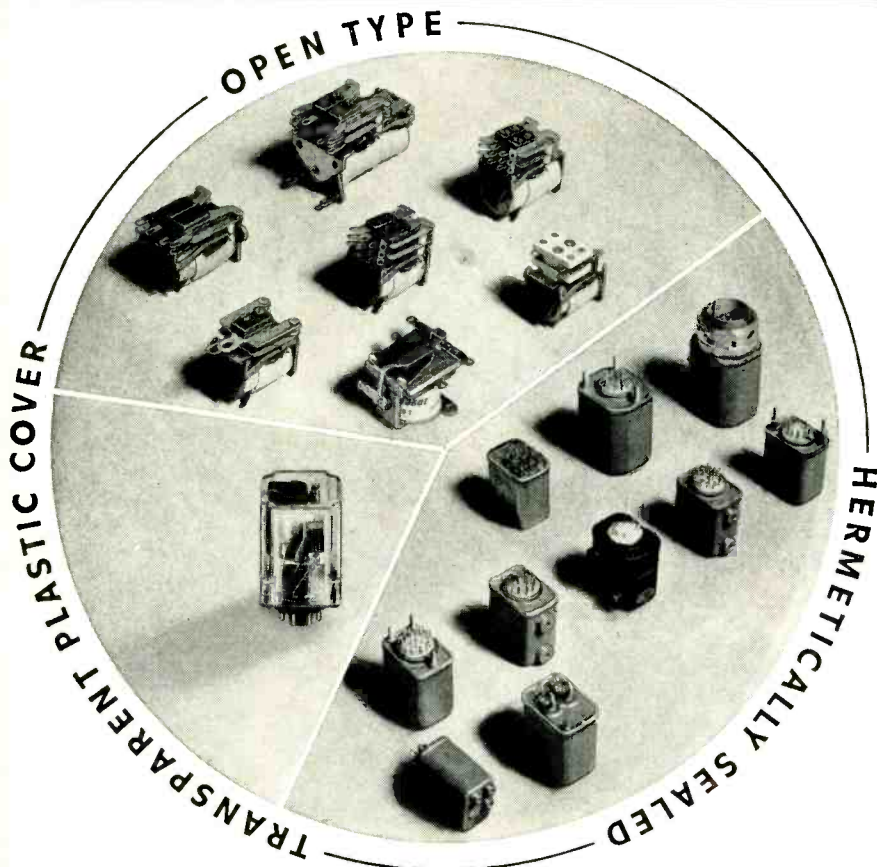
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the input to V_1 . The constants shown allow operation at any level between about 0.5 volt and 10 volts. A series diode is superior to a shunt diode in this application.

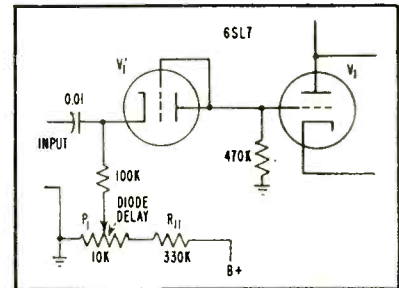


FIG. 2—Biased series-diode circuit can be added ahead of trigger circuit if operation is desired only above preset input level

If triggering is desired on positive pulses instead of negative, the phase may be reversed by means of an interstage audio transformer. To obtain triggering equally on inputs of either polarity, a push-pull transformer or a phase inverter, with a full-wave diode rectifier is appropriate.

Input Requirements

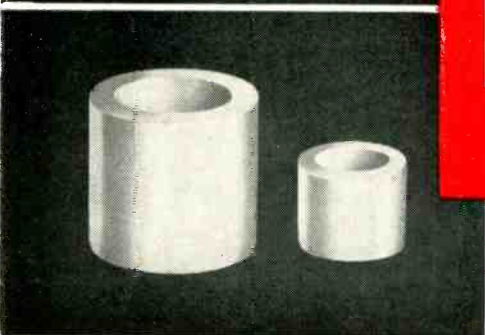
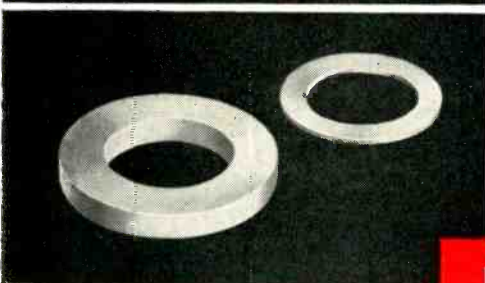
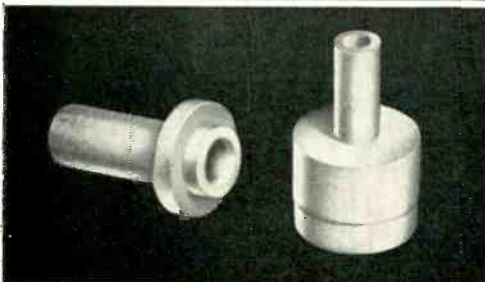
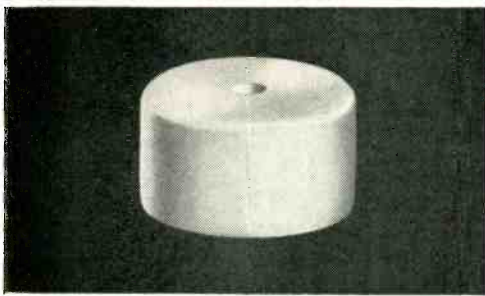
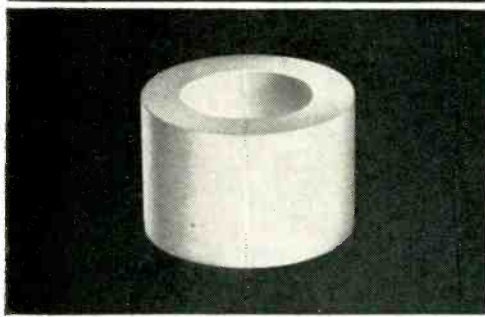
The input signal must last at least 0.1 millisecond for reliable triggering. The signal should not be so large as to produce an excessive charge on coupling capacitor C_1 and the negative triggering pulse should not be followed by a much larger pulse of positive polarity.

Excessive charge on C_1 takes too long to leak off and impairs the time resolution. No such impairment occurs unless the pulse is larger than about 20 volts. No deterioration in operation occurs with the application of audio-frequency sine or square waves to the input.

This circuit is applicable not only to the counting of purely electrical events, but aids in the counting of signals obtained from electrical contacts. Contact bounce and chatter often produce skips and multiple counts when operating a counter directly. With this circuit, most of the restrictions on contact resistance and dwell time are removed and positive reliable counter operation is obtained even from improvised contact arrangement.

(Continued on Page 192)

The tape and parts pictured are typical of R/M Teflon manufacture



gives you the plus of R/M's unmatched skill, experience, facilities

It is difficult to write about Teflon without appearing to exaggerate. For in many different ways this almost magic plastic—the most important derivative of the new wonder chemical fluorocarbon—is making the seemingly impossible possible. Parts made of R/M Teflon have already brought many startling improvements to the electronics and electrical manufacturing fields. And everyone working with it senses that the surface has barely been scratched—that hundreds of applications remain to be revealed.

There undoubtedly are ways in which Teflon can be profitably put to use in your own plant. So we have this suggestion to make to you: consider the properties of Teflon listed below—then get in touch with us if you think that any of them might make a contribution to your operation. We will fabricate parts to your own specifications or supply you with Teflon in the form of rods, sheets, tubes or tape.

Properties

High resistance to acids and gases even at high temperatures • Moisture absorption zero • Unaffected by weather • Excellent heat stability up to 500°F. in continuous operation • As tape, leaves no carbon residue along discharge path • High impact resistance • Nonadhesive • Stretches easily • Tensile strength 1500-2500 psi

**Du Pont's trade-mark for its tetrafluoroethylene resin*



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1 μ v

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MODEL 700

FEATURES

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- High Input Resistance
- Distortion-free Output
- Low Noise Level
- Accurate for 50-70 cps Line Frequencies
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- Immune to 60 cps Stray Magnetic Fields

SPECIFICATIONS—MODEL 700

INPUT VOLTAGE RANGE.....	10 μ v — 100 v DC (Sensitive to 1 μ v)
VOLTAGE RATIOS (DC input to AC RMS output).....	1:100 & 10:1
INVERSION STABILITY (> 100 μ v input).....	1%
CALIBRATOR ACCURACY.....	0.25%
DC INPUT RESISTANCE.....	10 meg for 1:100; 50 meg for 10:1
AC INPUT IMPEDANCE.....	> 200k
INPUT NOISE LEVEL.....	Approx. 3 μ v
AC OUTPUT FREQUENCY.....	Line Frequency
MAX AC OUTPUT LEVEL.....	10 v RMS
TOTAL DISTORTION IN OUTPUT WAVE FORM.....	< 2%
RESPONSE TIME (90% of Final Amplitude).....	0.25 sec
POWER REQUIREMENTS.....	105-125 v; 50-70 cps; 15 watts

BALLANTINE LABORATORIES, INC.

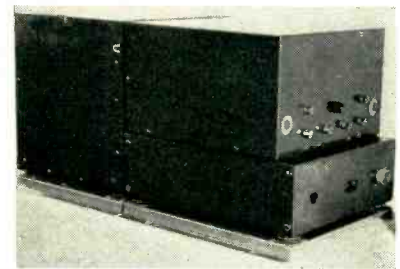
100 FANNY ROAD, BOONTON, NEW JERSEY



Recorder Monitors Test Flight

ELIMINATING the human element from test flights of new aircraft has long been the goal of aircraft designers. Information obtained in test flights must be interpreted keeping in mind the unfortunate fact that no two pilots react the same to any given condition.

One approach toward pinning down flight-test data has been to monitor important engine and aircraft gages and pilot reactions and to telemeter the information so obtained to a ground station. Unfortunately, this technique involves considerable equipment aboard the plane itself. Often the addition of such gear has a misleading effect on the operation of the plane, which may limit the usefulness of the tests.



USAF recorder for recording flight test data during flight

The photograph shows a compact recorder designed to be tucked away in the airplane to keep running records of the necessary functions during flight tests. The resulting records are permanent and easily interpreted after the test is completed.

Flight data recorded include forces applied to the pilot's stick and rudder controls, altitude, rate of roll, vertical accelerations applied to the aircraft and so on. To obtain this information some of the instruments normally contained on the plane's instrument panel are duplicated in the recorder; other data are collected by taking off signals from existing panel instruments.

A block diagram of the complete recording system is shown in Fig. 1. Sensing elements for altitude,

- Photographic Equipment Resistor used in Photo-Flash Circuits



- Bleeder Resistor for . . . Power-Line Capacitors



- Heat Anticipator Resistor for Wall Thermostat



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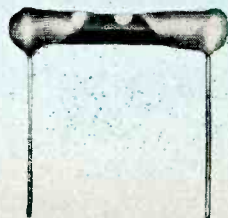
- Resistor for Electric Clock



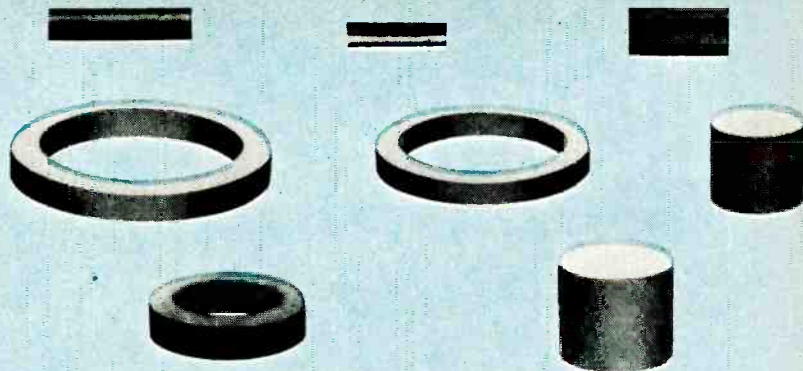
- Strain-Gage Resistor for Detecting Strain in Airplane Wings and Propellers



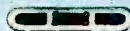
- Voltage Dividers for TV Sets with Special Coating to Prevent Corona Discharge



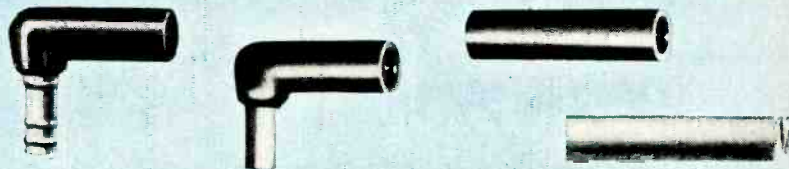
- Resistance Rings, Pins, and Plugs for Lightning Arresters



- Film Resistors for Automatic Light Dimmers



- Special and Standard Case Ignition Noise Suppressors



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MOST ECONOMICAL, HERMETICALLY SEALED



STANDARD



MINIATURE

Provide delays ranging from 2 to 120 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.
- Circuits: SPST only — normally open or normally closed.

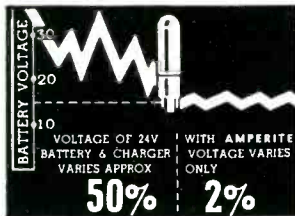
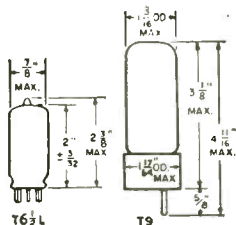
Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from -55° to +70°C. Heaters consume approximately 2 W. and may be operated continuously. The units are most compact, rugged, explosion-proof, long-lived, and — inexpensive!

TYPES: Standard Radio Octal, and 9-Pin Miniature.

PROBLEM? Send for Bulletin No. TR-81

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- Hermetically sealed, light, compact, and most inexpensive.



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Maximum Wattage Dissipation: T6 1/2 L—5W. T9—10W.

Amperite Regulators are the simplest, most effective method for obtaining *automatic regulation* of current or voltage. Hermetically sealed, they are not affected by changes in altitude, ambient temperature (-55° to +90°C), or humidity. Rugged; no moving parts; changed as easily as a radio tube.

Write for 4-page Technical Bulletin No. AB-51

AMPERITE CO. Inc., 561 Broadway, New York 12, N. Y.

In Canada: Atlas Radio Corp., Ltd., 560 King St. W., Toronto 2B

rate of roll, airspeed and yaw are contained in the recorder instrument. Control position and two pilot actions are derived from external sensing devices.

The acceleration channel contains an electronic analog-to-digital conversion system to meet the frequency response required on this channel. The accelerometer signal is amplified, rectified and applied to a comparator that compares the accelerometer signal amplitude with a signal from a 100-step voltage generator. At regular intervals signals are sent from the comparator through a system of counters and matrices to the styli in the recorder, which in turn plot the function digitally.

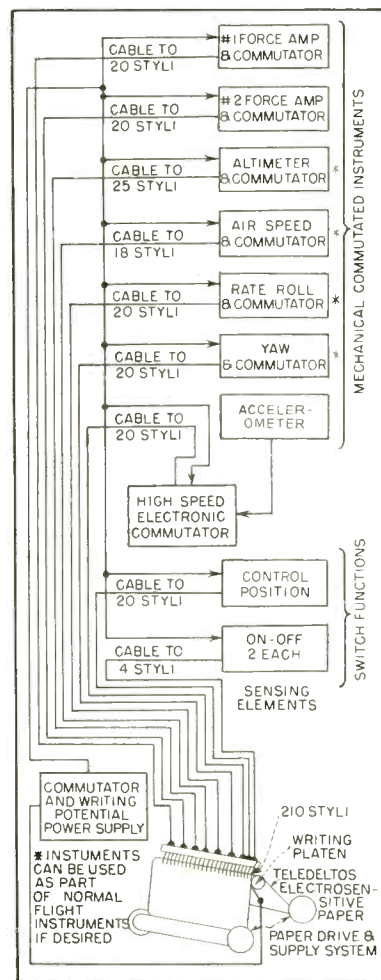
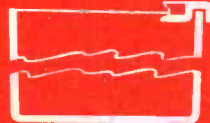
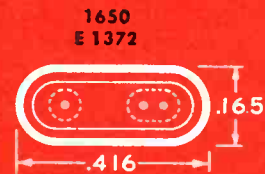
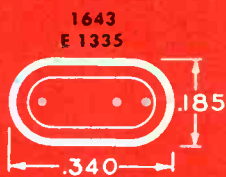


FIG. 1—Block diagram of flight test recorder

By converting the analog-type signals from the sensing elements into decimal digital information in the converter unit, the values of the function from 1 to 100 can be represented with relatively few styli,

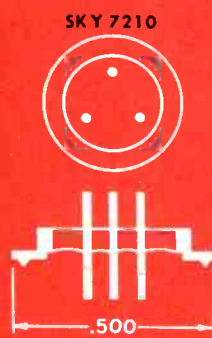
HEADERS & CANS*



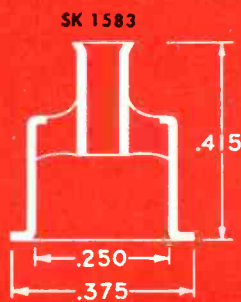
* Measurements given are maximum outside dimensions.

G. H. Q. for Transistor

HEADERS



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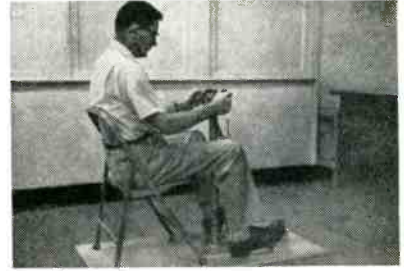
Hermetic headers are equally applicable for other miniaturized electronics "packaging": rectifiers, relays, printed circuit assemblies, etc. Ask for our catalog.



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Newark 7, New Jersey

two sets of ten styli representing tens and units.



Simple mockup "calibrates" pilots' reactions

A simplified diagram of the comparator circuit is shown in Fig. 2A. The output from this circuit, obtained at the point of amplitude comparison, pulses all of the output plates and activates the recorder pens of the two tubes that are positively gated at that instant. The gates are obtained from the counter matrix with one hundredth count triggering the recycling pulse generator.

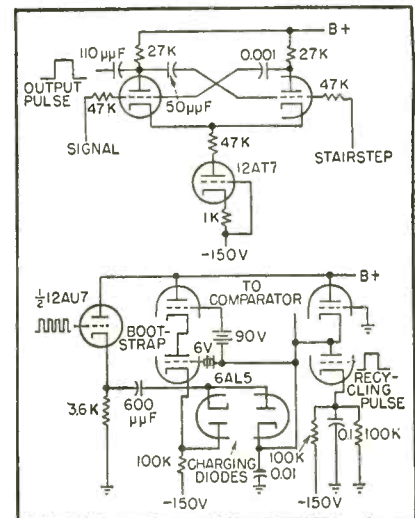
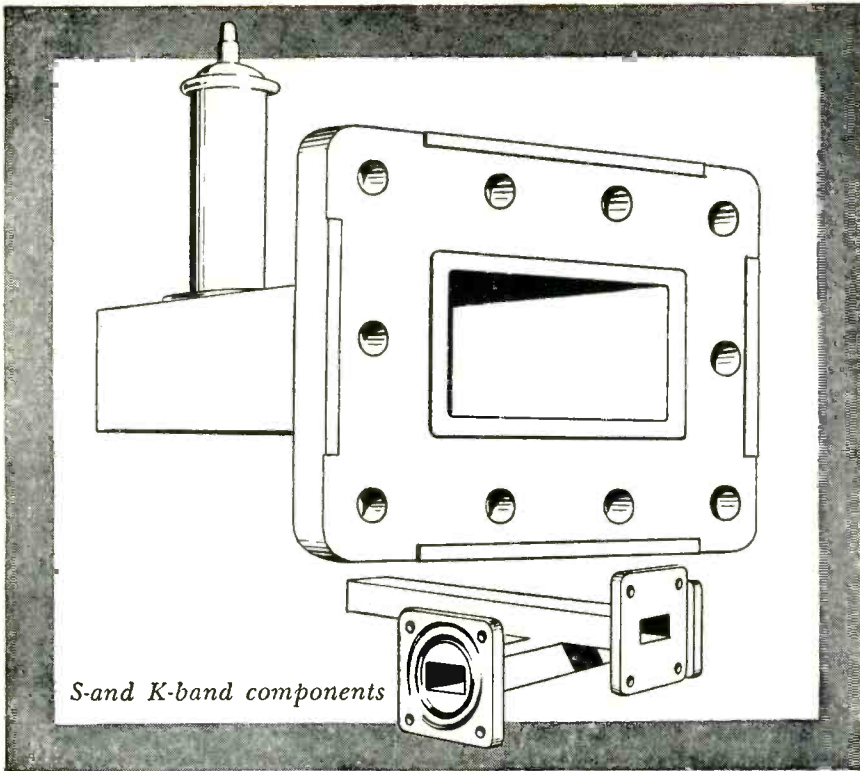


FIG. 2—Simplified circuits of comparator (A) and stair-step generator (B)

The stair-step generator (Fig. 2B) uses a conventional step counter with charging and discharging diodes and a dual cathode-follower bootstrap circuit for linearization. One cathode follower linearizes the charging curve of the collecting capacitor and the other linearizes the first cathode follower. The leading edge of the square-wave output of a free-running multivibrator triggers the stair-step generator. The trailing edge of the same pulse triggers the counter circuit. Thus there is automatically a count for each step and no string-



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can a
wave
guide
get?

Well, alongside some of the stuff we're working with now, the radar plumbing we used during World War II gets to look like air-conditioning duct. What's more, some of our boys here seem to regard anything below S-band as practically pure D.C. Naturally, we're up to our hips as usual in work on military equipment. However, we do occasionally have some extra creative capacity available, so if you have a problem involving something special in wave guide components (real small ones, too) and like that, maybe we can help. Drop us a line.

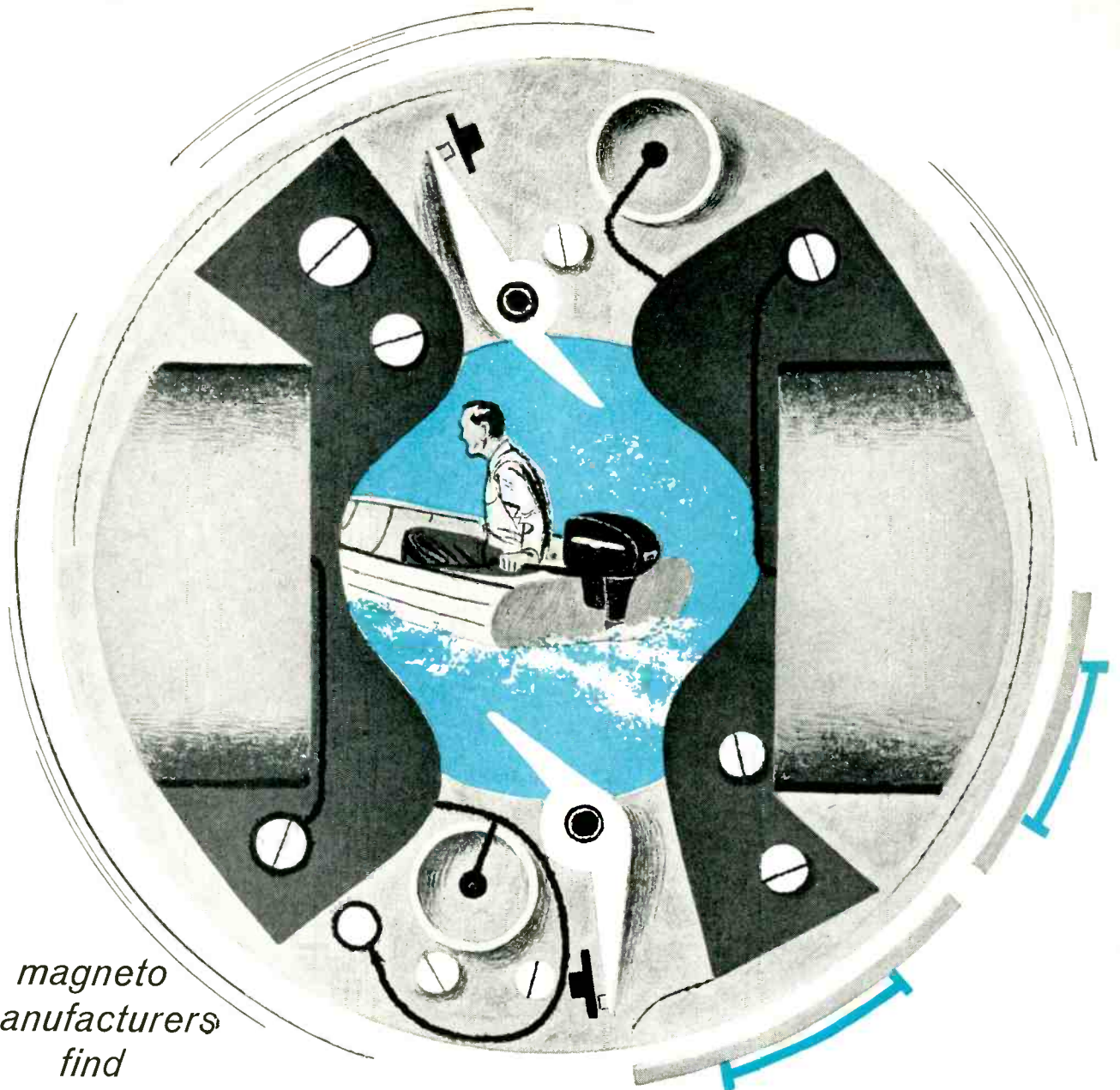


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- ★ Single deck, single pole,
36 or 60 positions
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Here's the answer to complicated range or circuit switching problems in high quality test equipment or experimental apparatus.

A number of these single deck switches may be ganged to provide additional poles. Both switches have a special detent which also provides the non-shorting action. The rotor arm is actually *lifted* as it moves from one contact to the next. This Shallcross design provides more usable contacts in less space than conventional non-shorting switches. Write for prices and drawings. Shallcross Manufacturing Co., 522 Pusey Ave., Collingdale, Penna.

SPECIFICATIONS

Types 10061-S (60 pos.) and 10054-S (36 pos.)
Shaft Extension: 1" beyond spacers
Size: 4 $\frac{1}{8}$ " sq. x 1 $\frac{1}{2}$ " d.
Insulation: Phenolic. Isolated shaft.
Avge. Contact Resistance: 0.006 ohms max.

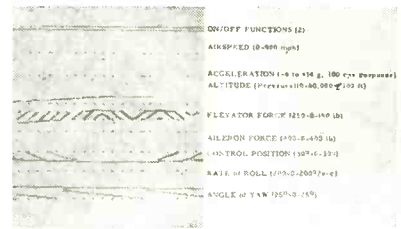
Type	# 10061-S	# 10054-S
Voltage Breakdown:	1500 v.	2500 v.
Current Capacities		
Carrying—	30 amps.	40 amps.
Breaking—	2 amps. at 110 v. a-c	3 amps. at 110 v. a-c

Shallcross

ent requirements are placed on stability of either counter or generator.

The recycling pulse generator is a monostable multivibrator with a sufficiently long time constant to allow the stair-step generator to become discharged. The discharge tube is normally biased off but conducts heavily when under the influence of the recycling pulse. The cathode follower on the discharge circuit insures that the stair-step generator discharges to the same potential on every cycle.

The disabling tube is normally held off but conducts during the recycling period. This, in turn, causes one section of the multivibrator to become cut off and held off, disabling the multivibrator for the duration of the recycling period.



Typical recording of flight data

Sensitivity and stability requirements for the comparator circuit are severe. The circuit must be capable of delivering full output with less than 1.5 volt change



Plastic Research Aid

Lighthouse tube (right) taken from production line reveals secrets of internal structure when filled with plastic and sawed in half (left). Plastic casting technique holds each tiny part in exact position. Tube to be examined is immersed in liquid plastic and seal is cracked. Atmospheric pressure forces liquid into envelope. Plastic hardens in about a day after which a cutting wheel slices it



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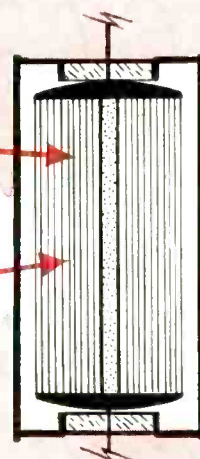
**DuPont trademark for polyester film.*

MIRACLE X IMPREGNATED—completely impregnated in this *high temperature impregnant* to prevent troublesome voids.

SPECIAL TOLERANCES as low as $\pm 1\%$.

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Write for complete catalog covering all types of Good-All long-life capacitors. We invite sample orders for your evaluation. Our engineers are always ready to work with you on any capacitor problem.



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613 Both Ends Insulated



Types 614 and 615

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**JK GLASLINE crystal
sets stability record* of**

**1 PART IN
100,000,000**

**opening new concepts of
stabilized frequency control**

* In test by a leading U. S. Government Laboratory using a G12A 1000 Kc Crystal

NOT A "LABORATORY" CRYSTAL: This record was made by the reproducible type JK G-12A quartz crystal illustrated, using a precision oven, over a two week continuous test period. This stability, corresponding to a rate of change of less than one second in more than three years, challenges existing methods of measurement. Presented here are several crystal units from the ultrastable JK GLASLINE series. Write us for additional information.



JK GLASLINE G-12A

Frequency Range: 540 to 1600 kc
Stability: ± 15 cycles or better, 0 to 50°C

RECOMMENDED for extreme precision frequency applications in the 1 mc region. Also F.C.C. Approved for broadcast use without temperature control.

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for the Critical"*



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Company
Sandwich, Illinois



(step-voltage increment) in the stair-step voltage; any drift will cause corresponding inaccuracy.

To sense and record forces applied by the pilot in maneuvering a test airplane, strain gages are attached to appropriate control mechanisms in the plane. Calibration of the force channels of the equipment is achieved by the mockup shown in the photograph. Before leaving the ground, the pilot flies the broomstick and thus his particular habits are measured. When he takes over control of the plane in flight, signals derived from strain-gage detectors can be calibrated in terms of actual force applied.

Selenium Rectifier Testing Techniques

By EDWARD L. PAGANO

*Development Engineer
Bradley Laboratories, Inc.
New Haven, Conn.*

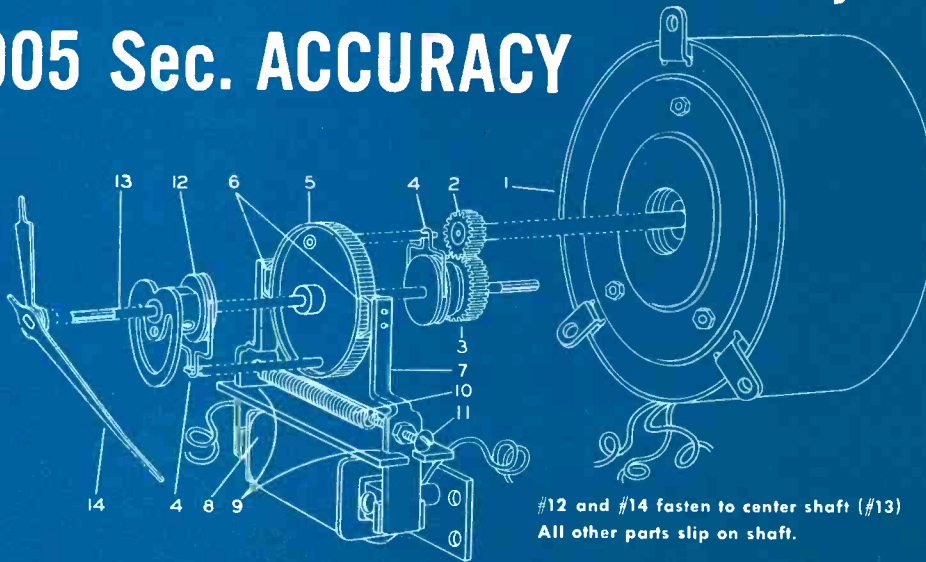
TEST RESULTS are not always a true indication of the life of a selenium rectifier in actual application.

Surveys of testing techniques and various manufacturing processes in which desirable rectifier characteristics are obtained show that it is possible to produce selenium rectifiers that will test exceptionally well on all the conventional preliminary tests, but will not last as long as some rectifiers that do not show up as well.

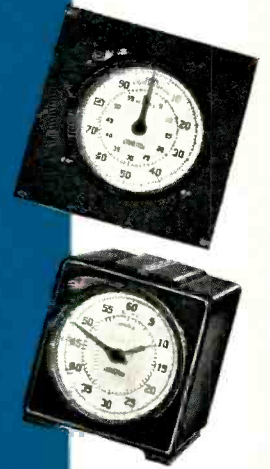
The manufacturer can determine this difference by control of his manufacturing processes and thus knows which rectifier will be better before it is tested. The user of selenium rectifiers does not have this information and must rely on proper initial testing and the reputation of the manufacturer.

The forward resistance of a rectifier can be analogous to the internal resistance of a d-c generator or battery; as forward resistance increases, the output voltage decreases. However, it is important to remember that since a rectifier is a nonlinear device the forward resistance will change as load-current changes. The load current flowing through the forward resistance of the rectifier produces a power loss, decreases output volt-

Facts behind the S-1 Timer's extraordinary .005 Sec. ACCURACY



#12 and #14 fasten to center shaft (#13)
All other parts slip on shaft.



Formula S-1 Expensive high torque, ball bearing motor, low inertia of moving parts, high proportion of precision and ground parts, no thrust bearings as found in ordinary clutches.

- High torque (2 inch-ounce at 100 RPM) industrial grade motor (#1) with no internal gear train so small changes in load due to binds or hand acceleration cause no phase shift between rotor and rotating field... runs continuously to eliminate starting error.

- Precision cut gears (#2, #3). Any eccentricity or inaccuracies in gearing reflect directly in timer reading.

- Slip clutch composed of hardened steel spring (#4) riding a V-grooved graphited (for long wear) collet, applies .6 inch-ounces of torque to aluminum (for low inertia) control disc (#5) with 314 tiny teeth in its periphery.

- To hold control disc (#5) at rest, 2 hardened steel brake shoes (#6), ground to square knife edges, grip periphery of control disc in 4 places... control disc position to under 1/2 of a degree (1/720 second).

- Electro magnet (#8) pulls brake shoes away from control disc through armatures (#7). Air gaps kept to minimum for speed. Precision made fulcrums prevent stickiness or unequal movement of armatures.

- Adjusting screw (#11) adjusts tension of armature spring (#10) so that time between energizing magnet coil and starting of control disc is same as time between de-energizing magnet coil and stopping of control disc. This compensates for starting and stopping errors.

- Second friction clutch (#12) transfers control disc motion to center staff (#13); allows hands to be reset when control disc is held stationary.

"Gentlemen... Let me give you the formula for our astounding final accuracy of .005 sec. obtained with our D-C clutch S-1 Timer."



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Take a Minute Now and Send Us This Coupon

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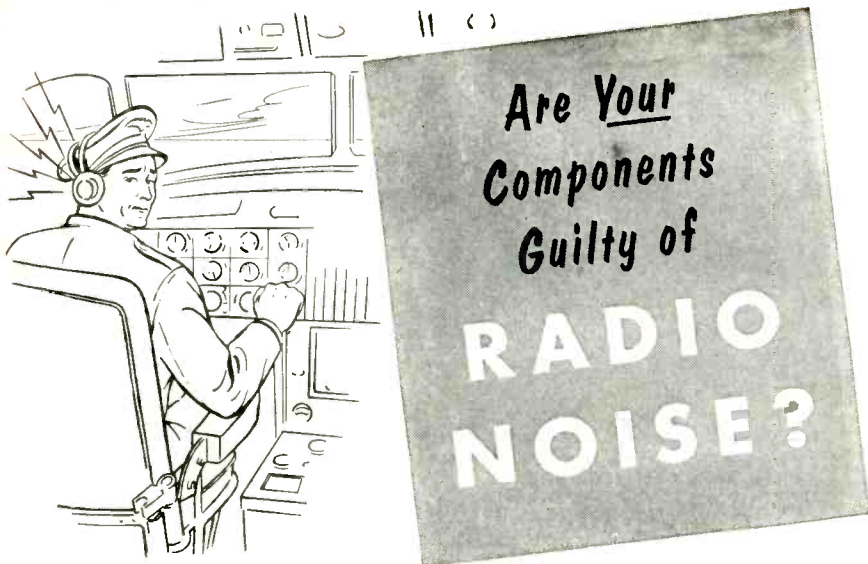
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Firm _____

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and **POTTER** can make the **FILTER** that will confirm that "how"

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Call Potter to engineer, design and produce the filter to solve your radio interference problem.

Write for Bulletin 41 A.

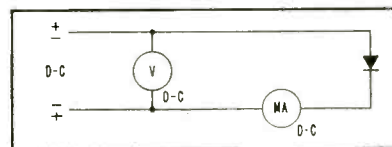
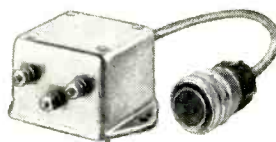


FIG. 1—Test setup for measuring static reverse and forward characteristics

The reverse characteristic has a tendency to form; that is the reverse leakage current begins to decrease after the first cycle of applied voltage; therefore, when testing the reverse characteristics of a rectifier, especially those stored for a period of time, ample time should be allowed for forming.

There are various tests to determine the quality of a rectifier and each of these has its advantages as well as disadvantages. Some of the primary factors to be considered in the selection of the appropriate test are the application of the rectifier, quantity to be used, cost of the rectifier and the accuracy and type of test equipment available.

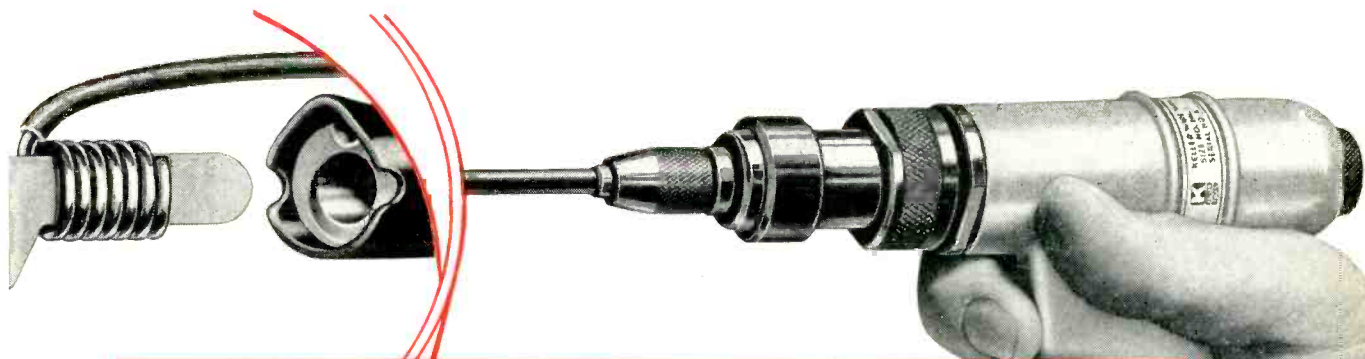
A particular type rectifier, depending upon the circumstances, may have several different tests and each may be perfectly valid. For example, with the common radio and television type rectifier, the serviceman, because of the small quantity involved, would probably be content to test the rectifier with an ohmmeter or in the actual circuit for satisfactory output. However, the radio and television manufacturer, because of the large quantity involved of this same type rectifier would perform, on a sampling basis, more elaborate tests on the forward and reverse



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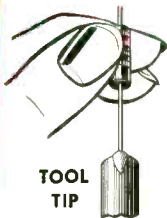
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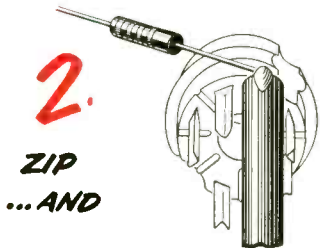
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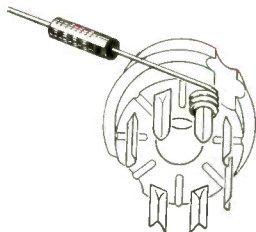
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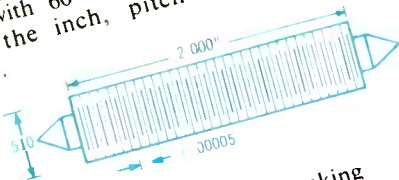
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characteristics as well as output voltage and life.

One of the simplest rectifier tests is the static or d-c test as shown in Fig. 1. A small predetermined d-c voltage is impressed across the rectifier causing current to flow in the forward direction. If this current is above a specified value the rectifier has a forward resistance below the specified maximum allowable. A large predetermined d-c voltage is then impressed across the rectifier in the reverse direction, and if leakage current is below a specified maximum the reverse resistance is above the minimum allowable.

Forward and reverse resistance as measured by the static test is valid only for the particular voltage and current at which it is tested and does not necessarily show the merit of the rectifier under actual operating conditions. The advantage of this type of test is that it is fairly simple to perform but it should serve only as an indication, unless the rectifier is to function as a d-c valve or in a similar application.

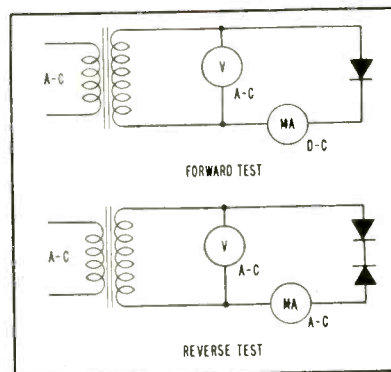


FIG. 2—Basic circuits for making a-c dynamic tests of rectifier characteristic

Since the basic rectifier operates in an a-c circuit, a more realistic test is made under a-c conditions. There are several dynamic tests and one of the simplest is illustrated in Fig. 2. The forward characteristic is measured by impressing a specified a-c voltage across the rectifier and measuring the d-c current flowing, while the reverse characteristic is tested by impressing the rated a-c voltage across two similar rectifiers connected back to back and measuring the a-c flow.

Although this test is relatively



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simple to perform and does not require elaborate test equipment, it has several disadvantages. The forward test depends entirely upon the type of a-c voltmeter used, and the impedance of the transformer. During the forward-conduction period of the rectifier, the voltage waveform has a tendency to be distorted owing to transformer loading and if the resistance of the transformer is high, the distortion will become pronounced and the type of a-c meter used will be important.

Since the input voltage wave will be distorted only during the forward-conduction half cycle, using the same transformer, different results will be obtained with a peak-reading, rms reading or average-reading meter. If a half-wave-rectifier type meter is used, different results will be obtained by simply reversing the loads, because this effectively switches the meter from the distorted half cycle to the undistorted half cycle or vice versa.

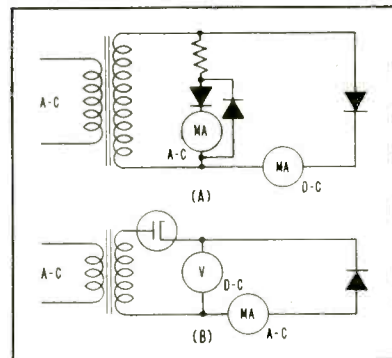


FIG. 3—Dynamic measurement setup that closely duplicates actual operating conditions

The reverse test also has its faults. With the back-to-back circuit, the leakage current is the rms current contributed by both rectifiers. Therefore, the rectifier being tested is directly dependent upon the rectifier that it backs and the indication will be a composite of the two. Under these conditions, depending upon the rectifier it backs, a good rectifier may test bad and vice versa.

With slight variations of the dynamic test circuit, these difficulties can be corrected. Figure 3, illustrates an improved dynamic test that closely duplicates actual operating conditions. The input voltage is adjusted until rated current

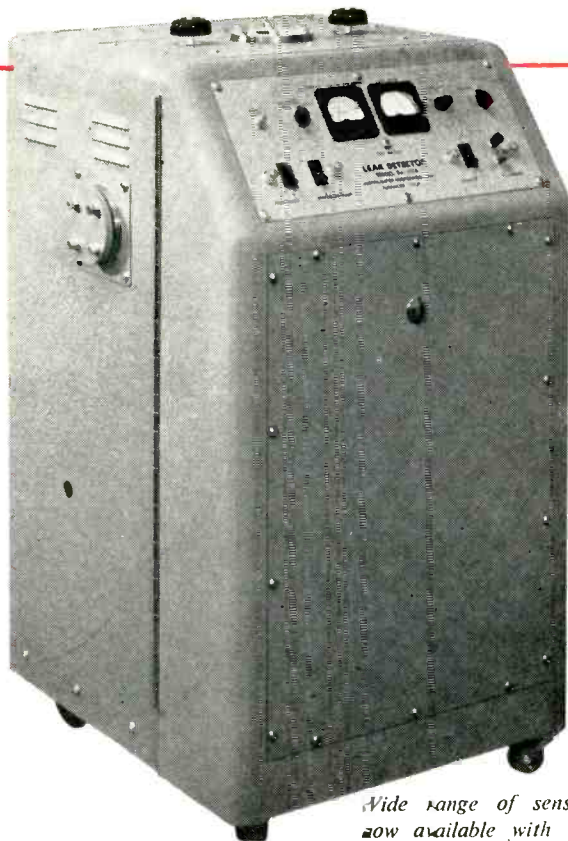
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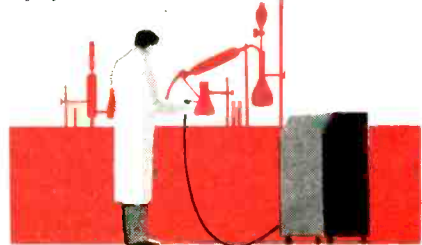
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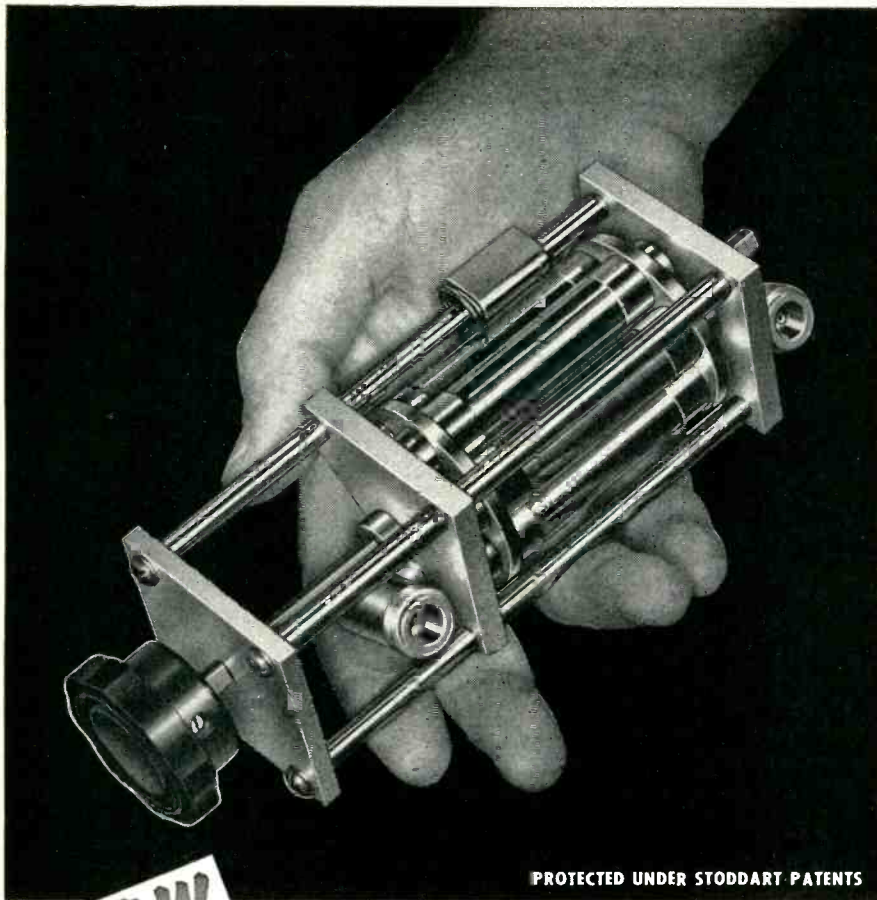
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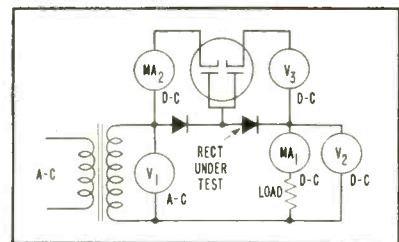


FIG. 4—Circuit for making rapid dynamic forward and reverse characteristic tests on large quantities of rectifiers

flows through the rectifier and the forward voltage drop across the rectifier is indicated by the voltmeter. To measure the forward voltage drop, the voltmeter must indicate only during the half wave in which the rectifier is conducting in the forward direction. This can be accomplished by calibrating a half-wave-rectifier type a-c meter for half-wave d-c as shown in Fig. 3A. This method reduces the importance of the transformer resistance and insures identical results regardless of the voltmeter used, providing it is a properly calibrated half-wave-rectifier type.

An alternate method is to use a series arrangement of a low-resistance half-wave-rectifier tube and a high resistance d-c voltmeter as shown in Fig. 3B.

The reverse test measures each rectifier on an individual basis and is therefore an improvement over the back-to-back test. A half-wave d-c voltage, similar to that encountered under actual operating conditions, is impressed across the rectifier being tested and the reverse leakage current is measured. The voltmeter indicates the average of the half wave impressed across the rectifiers; therefore the peak inverse voltage is equal to this average value divided by 0.318.

If a large quantity of the same type rectifier is being used, it may be desirable to test the forward and reverse characteristics simultaneously. Figure 4 illustrates a circuit arrangement used for this purpose. The input voltage is adjusted until rated input voltage is indicated by V_1 , and the load resistor is then reduced until rated current flows through MA_1 . Output voltage is indicated by V_2 , while V_3 indicates the forward voltage drop and MA_2 the reverse leakage current. This circuit is simple,

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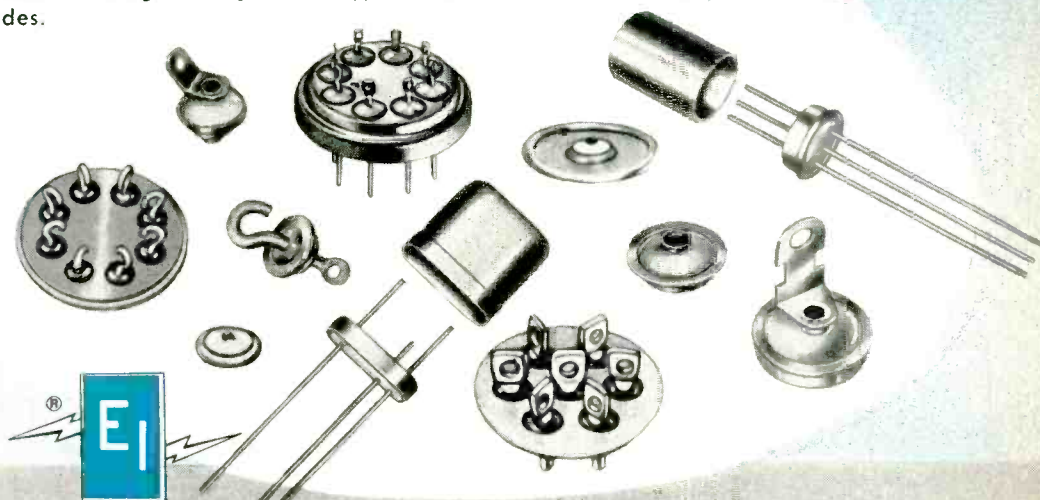
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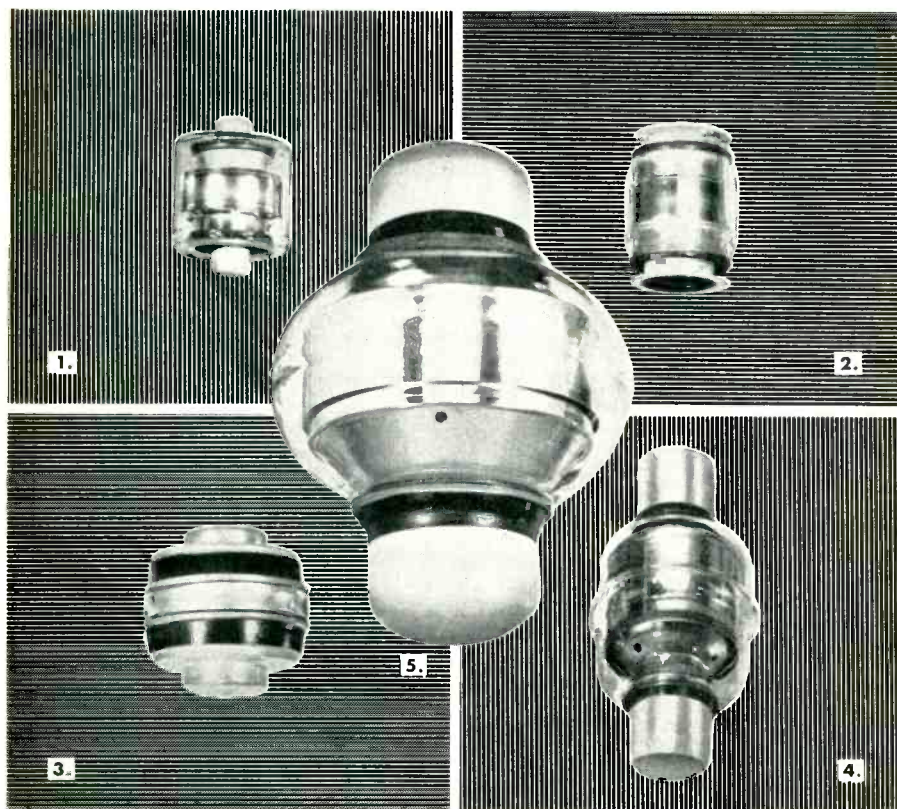
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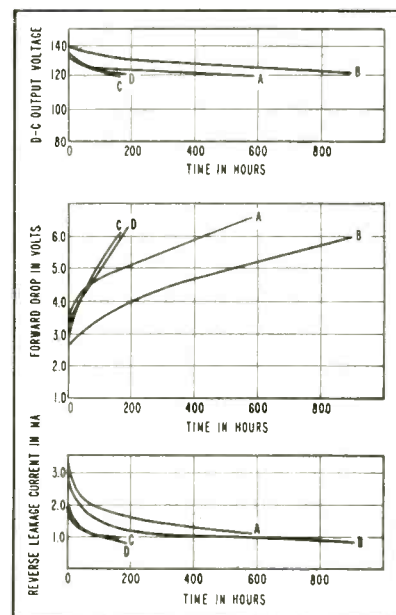


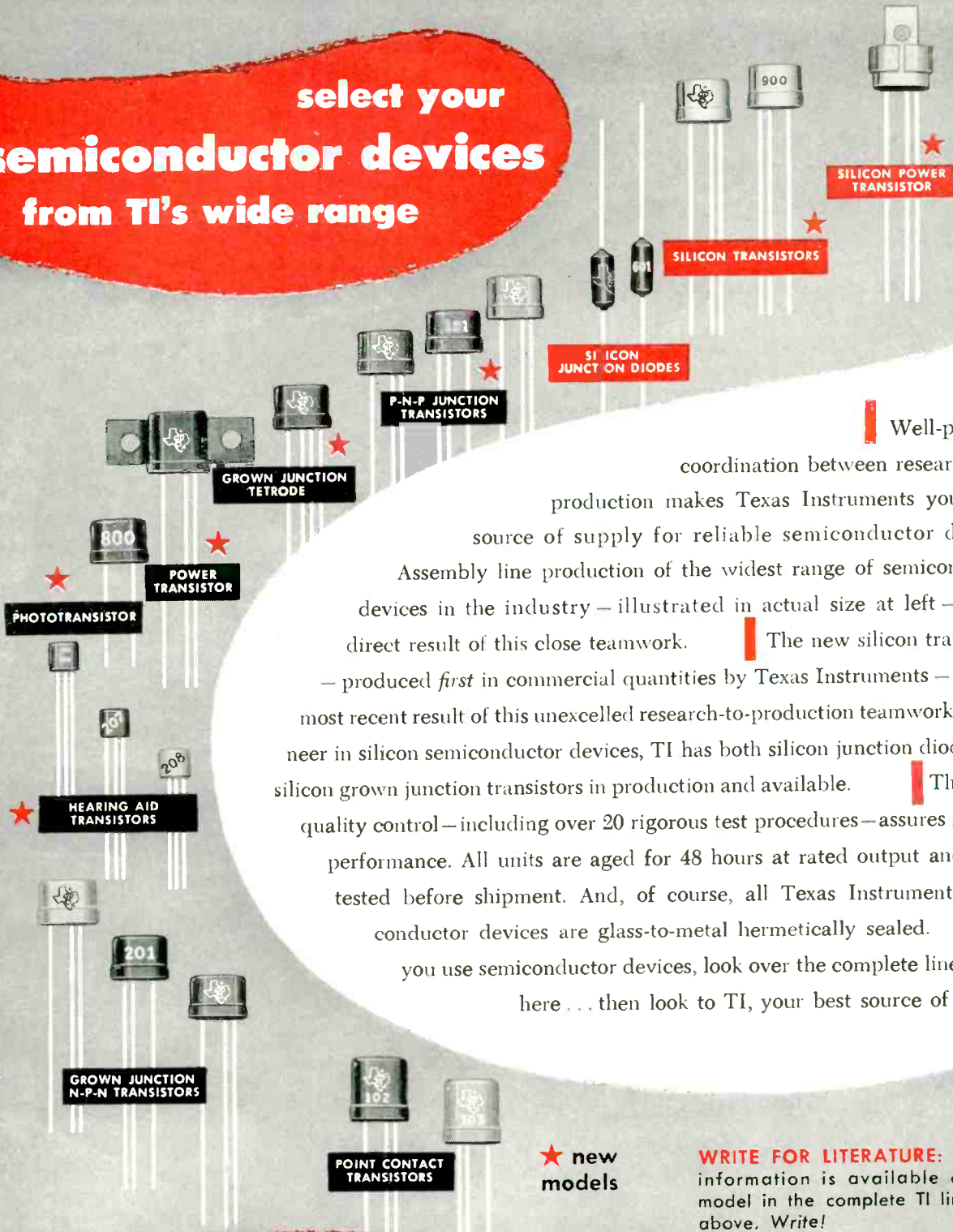
FIG. 5—Curves for accelerated life tests on four 75-ma selenium rectifiers made by different manufacturing techniques show length of life determined by forward and reverse characteristics

compact and will test the characteristics of the rectifier under actual operating conditions with rated input voltage and rated current.

There are several tests that may be used to determine the quality of a rectifier, and although all the tests are based upon measuring the forward and reverse characteristics, the real criterion for quality is the change in forward and reverse characteristics during the life of the rectifier.

The curves of Fig. 5 emphasize the fact that initial conditions do not necessarily disclose the absolute quality of the rectifier. These curves are the results of extensive accelerated life tests on 75-ma rectifiers of the radio-television type produced by different manufacturing techniques. Rectifiers *C* and *D* exhibit low initial forward voltage drop and low initial reverse leakage. However, their life is seriously curtailed due to the rapid increase of forward voltage drop. Although rectifiers *A* and *B* have a larger initial reverse leakage current than either *C* or *D*, the rate of decrease is rapid and the rectifiers have a longer useful life. Life is usually defined as the time required for the output voltage to decrease to 90 percent of its initial value. This time is definitely determined by a combination of the inherent quality

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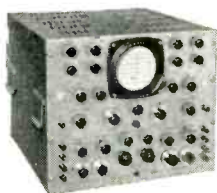
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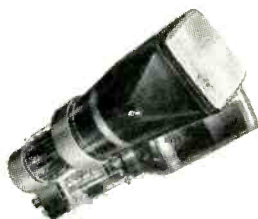
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of both the forward and reverse characteristics.

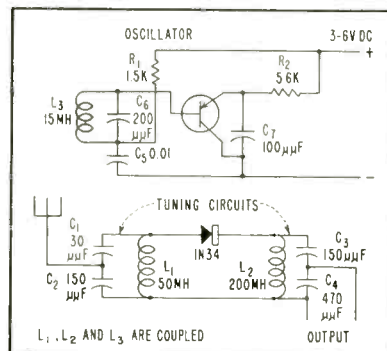
Transistor Converter

BY LEO J. HRUSKA

Engineer
The Glenn R. Martin Co.
Baltimore, Md.

THE PROTOTYPE model of the converter described here was made for operation at 3.5 mc. However, with the newer transistors, it is feasible to make similar converters that will operate at frequencies up to and including 50 mc.

The circuit, shown below is a simple crystal mixer-oscillator circuit. Coil L_1 in conjunction with C_1 and C_2 tunes broadly to the signal frequency centered at approximately 3.75 mc. This comprises the input circuit. Coil L_2 with C_3 and C_4 tune in similar manner to the center of the broadcast band, about 1 mc. Both tank circuits are tapped down by the capacitance split C_1 , C_2 for antenna match, and C_3 , C_4 for receiver match.



Transistorized short-wave tuner. Coil L_3 is placed between L_1 and L_2 and is inductively coupled to both

The oscillator is built around a point-contact type transistor with the tuned impedance in the base circuit and feedback between emitter and collector. This circuit has been found to oscillate on as low as three volts. Current drain at six volts is about 1.75 ma.

Inductive injection is used in the detector-mixer circuit. By locating oscillator coil L_3 adjacent to and between the input and output coils and phasing the connections so that the flow is additive, a beat-frequency signal is passed thru the diode. The difference frequency is used in this converter.

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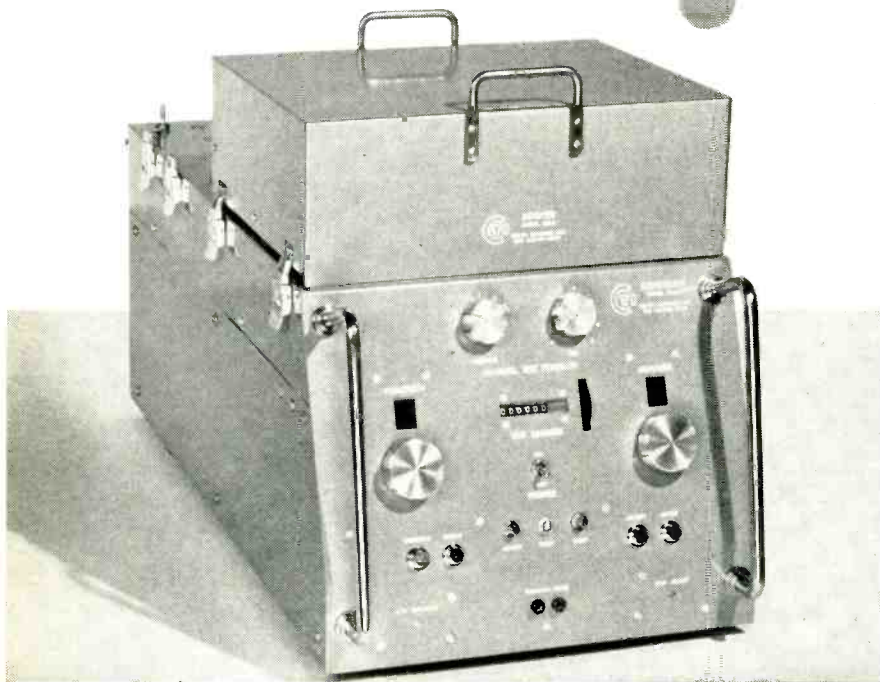
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connection between the oscillator and mixer circuits permits either pole of the battery to be grounded.

PERTINENT PATENTS

By NORMAN L. CHALFIN
*Hughes Aircraft Co.
Calver City, Calif.*

AUTOMATIC CONTROL devices depend upon reliable methods of sensing. Interest in this field is reflected by a number of patents described below.

Unbalance Detector

A Balancing Machine is the subject of U. S. patent 2,651,937 awarded F. A. Martin and S. J. Jeffery of St. Catherines, Ontario, Canada, assignors to the General Motors Company of Detroit, Michigan.

The Balancing Machine is designed to indicate the amount, location and angular position of an unbalance in high-speed rotating masses such as armatures, gyroscopes and the like.

The device to be balanced is placed in a special carriage suspension arrangement, like that shown in Fig. 1 and driven by some ex-

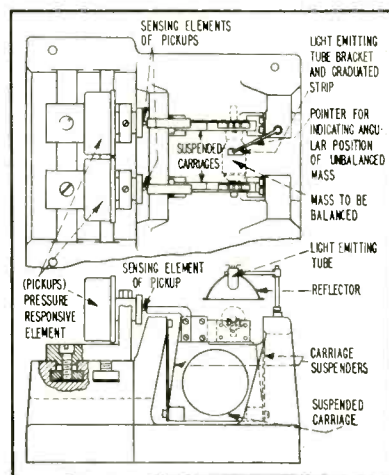


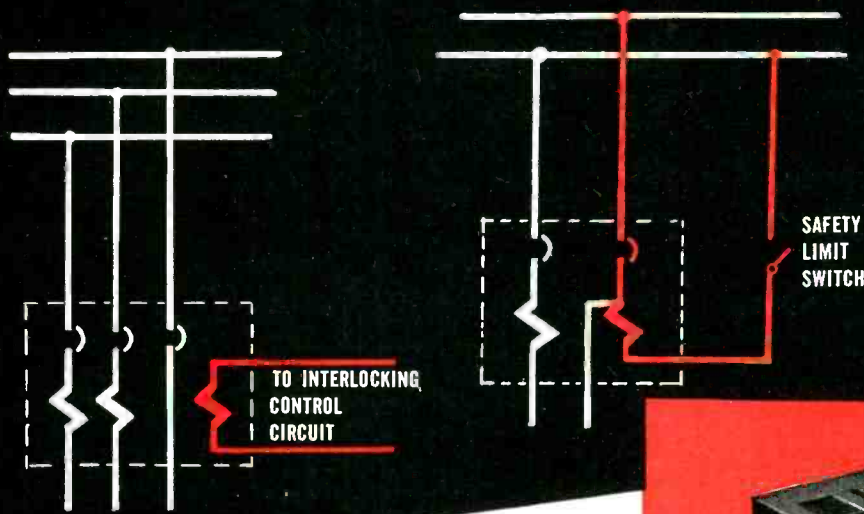
FIG. 1—Balancing machine

ternal means such as air or a motor and drive belt to the part. Pressure-sensing devices are in contact with the carriage to detect the variations in pressure that occur when there is unbalance of the rotating mass in the suspended carriage.

The signal resulting from the vibration is picked up by the sensing devices and amplified in the

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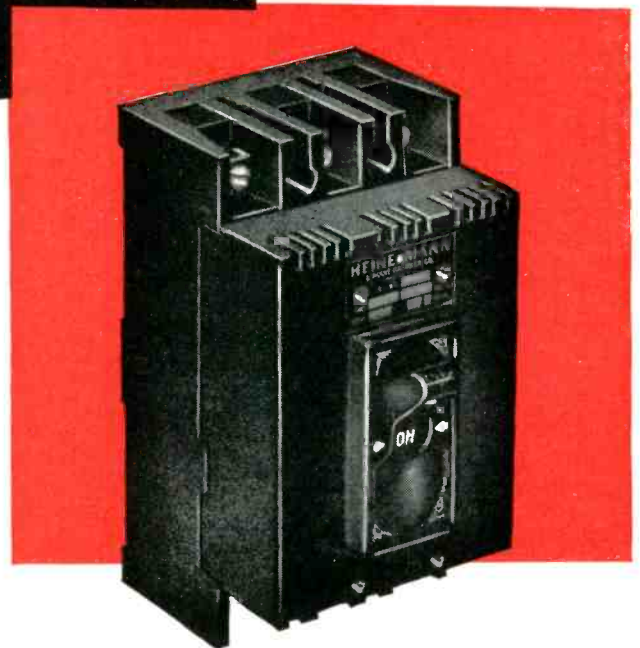


Design engineers looking for a simple and low cost means of interlocking control circuits often find their answer in Heinemann circuit breakers. Operating on basically a solenoid principle, these circuit breakers permit a choice of circuit arrangements in single pole units or any combination of circuits in multiple-pole breakers. One or two coils of the circuit breaker can provide overload protection while another coil interlocks with a separate control circuit.

The separate control circuit may be energized by a "stop" pushbutton, pressure switch, thermostat or other high-low limit control. Or, the interlocking coil of the circuit breaker may be used for overload protection, tripping the circuit breaker and opening the main power supply when an overload occurs in the interlocked circuit. Thus, a single Heinemann circuit breaker can serve three functions: (1) As the power switch, (2) as overload protection, and (3) as the means of control interlock.

By combining several functions in a single Heinemann circuit breaker, many manufacturers have achieved highly desirable design simplification and better protection for their products . . . at substantially reduced overall costs.

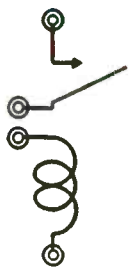
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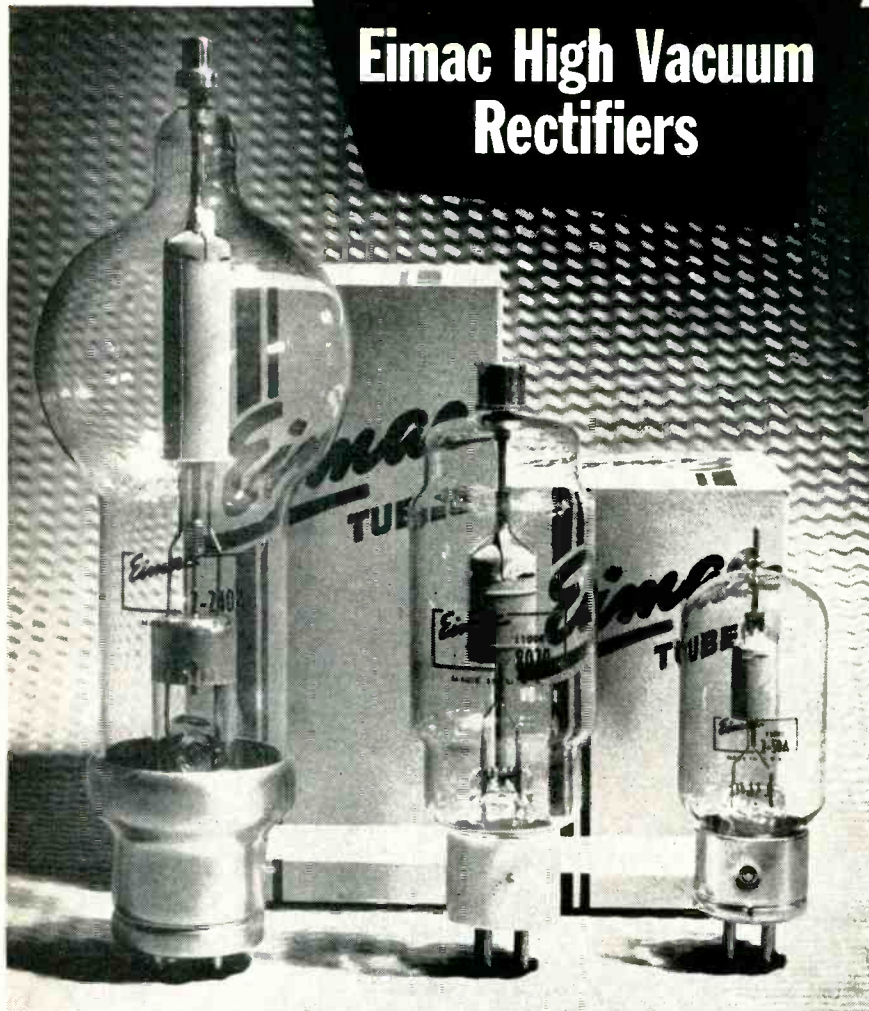
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2-50A	75	30	30,000	5.0	4.0
8020	100	60	40,000	5.0	6.5
2-150D	250	90	30,000	5.0	13.0
250R	250	150	60,000	5.0	10.5
253	350	100	15,000	5.0	10.0
2-240A	500	150	40,000	7.5	12.0
2-2000A	750	1200	75,000	10.0	25.0

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amplifier-indicator circuit shown in Fig. 2. The circuit comprises a straightforward push-pull amplifier and a metering arrangement to indicate the amplitude of the unbalance signal. A portion of the signal also drives a sawtooth generator. The signal generated is amplified and applied to a stro-

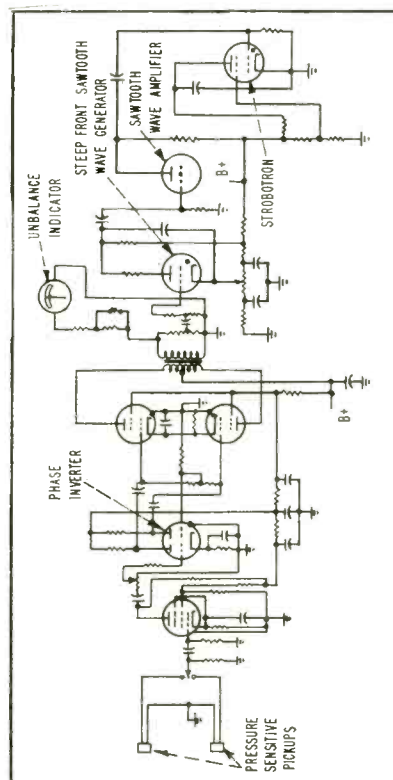


FIG. 2—Unbalance indication is illuminated by stroboscopic flash

botron. On the mechanical assembly a pointer is provided. A graduated strip is attached to the armature or other unit under test. When the unbalance voltage fires the strobotron, stroboscopic flashes occur coincident with the angular position of the armature at the instant of firing.

The pointer then stands still at some position on the graduated strip.

By this means an accurate indication is made of the degree of unbalance (amplitude of the meter indication) and the position of the unbalance (flashing of the strobotron).

Liquid Level Control

Apparatus for Measuring Liquid Level is the subject of patent 2,651,940 issued to K. H. Kline, Oak

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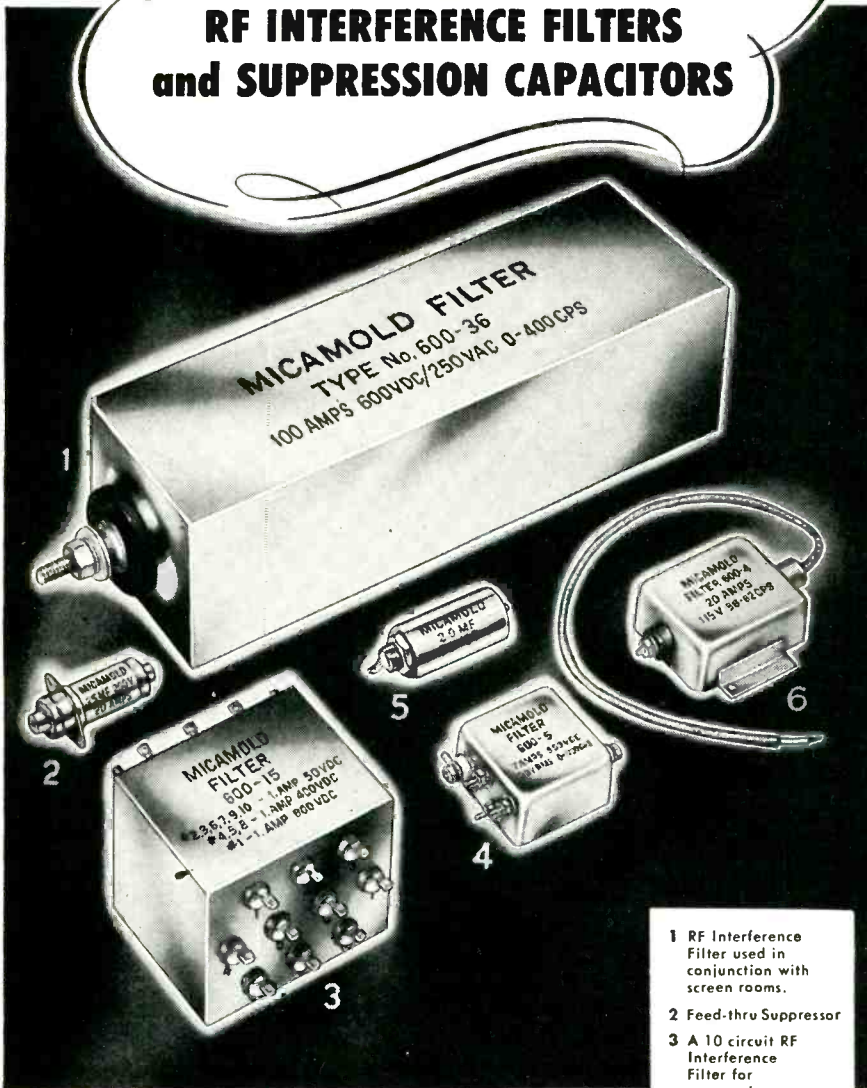
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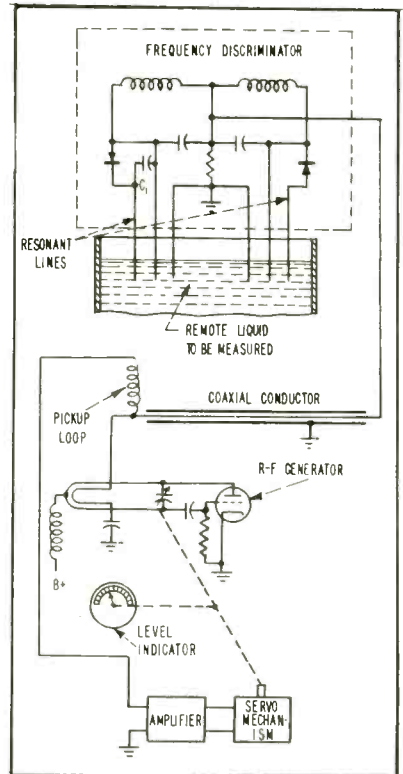


FIG. 3—Capacitors in liquid show unbalance

this invention is shown in Fig. 3. An r-f generator in the form of a triode oscillator generates a predetermined frequency f_0 that is applied to a novel discriminator circuit. The discriminator circuit is a double-tuned type and the resonant circuits comprise coaxial or other resonant lines inserted into the liquid, the level of which is to be measured.

The liquid and its container are remotely located. Lines are coupled

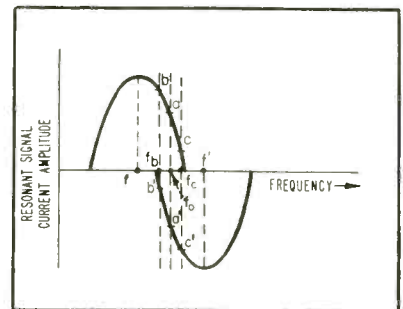


FIG. 4—Discriminator characteristic

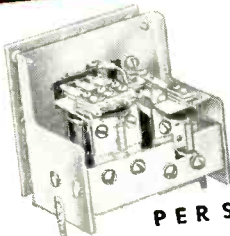
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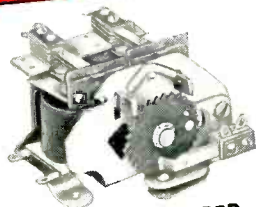
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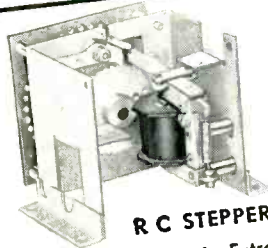
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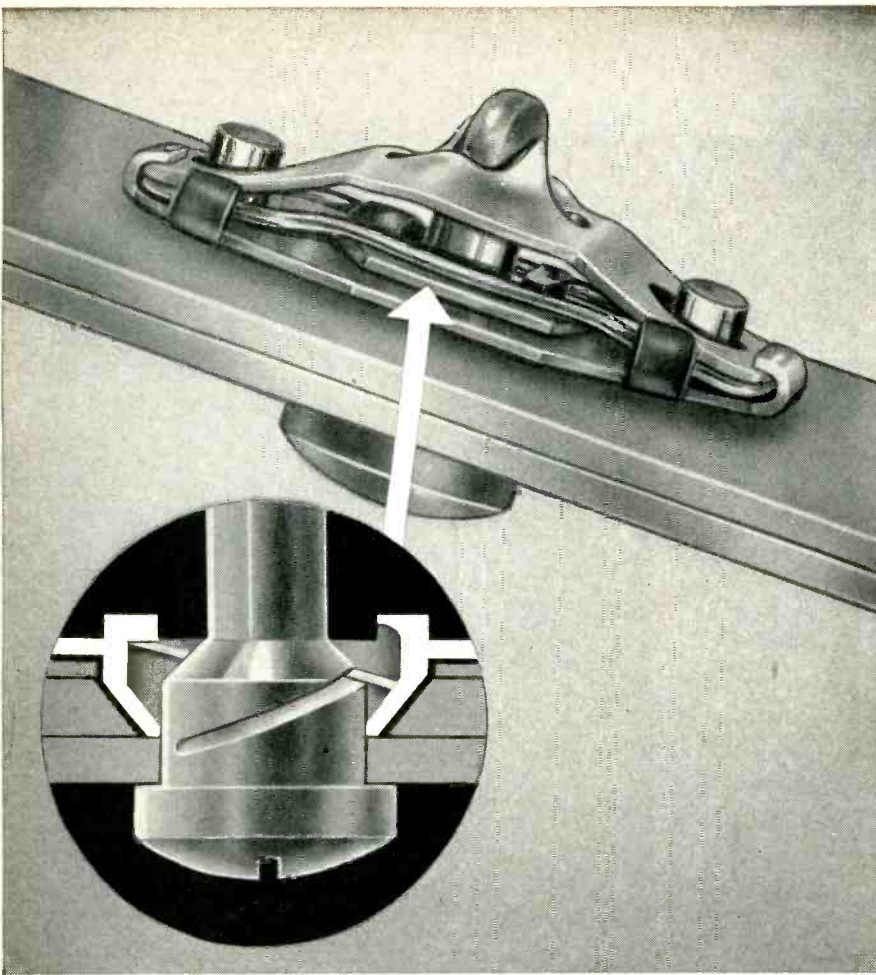
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to the r-f generator by coaxial cables.

Each of the resonant lines is resonant at a particular frequency.

Figure 4 shows the relationship of the frequencies utilized in the operation of this invention.

The lines resonate at f and f_1 respectively. At a mean frequency between them f_0 the discriminator will develop an error voltage of zero. At f_0 or f_0 an error voltage will be developed having one polarity or its opposite.

This voltage is applied to a servomechanism to operate a control device coupled to the frequency-controlling element of the r-f generator so it generates a frequency such that zero discriminator output voltage is maintained.

As the level of the liquid changes in the liquid container the resonant frequency of the lines inserted in the liquid changes. The servomechanism control in adjusting the frequency controlling element of the r-f generator also rotates an indicator calibrated to indicate the level of the liquid.

In an alternative use of the system, the servomechanism is connected to a valve and pump control, which in response to the error voltages permits additional liquid to flow into the container, or drain out of the container as required to maintain a predetermined level of liquid. The r-f generator frequency-controlling element is manually set to some predetermined frequency corresponding to a desired liquid level.

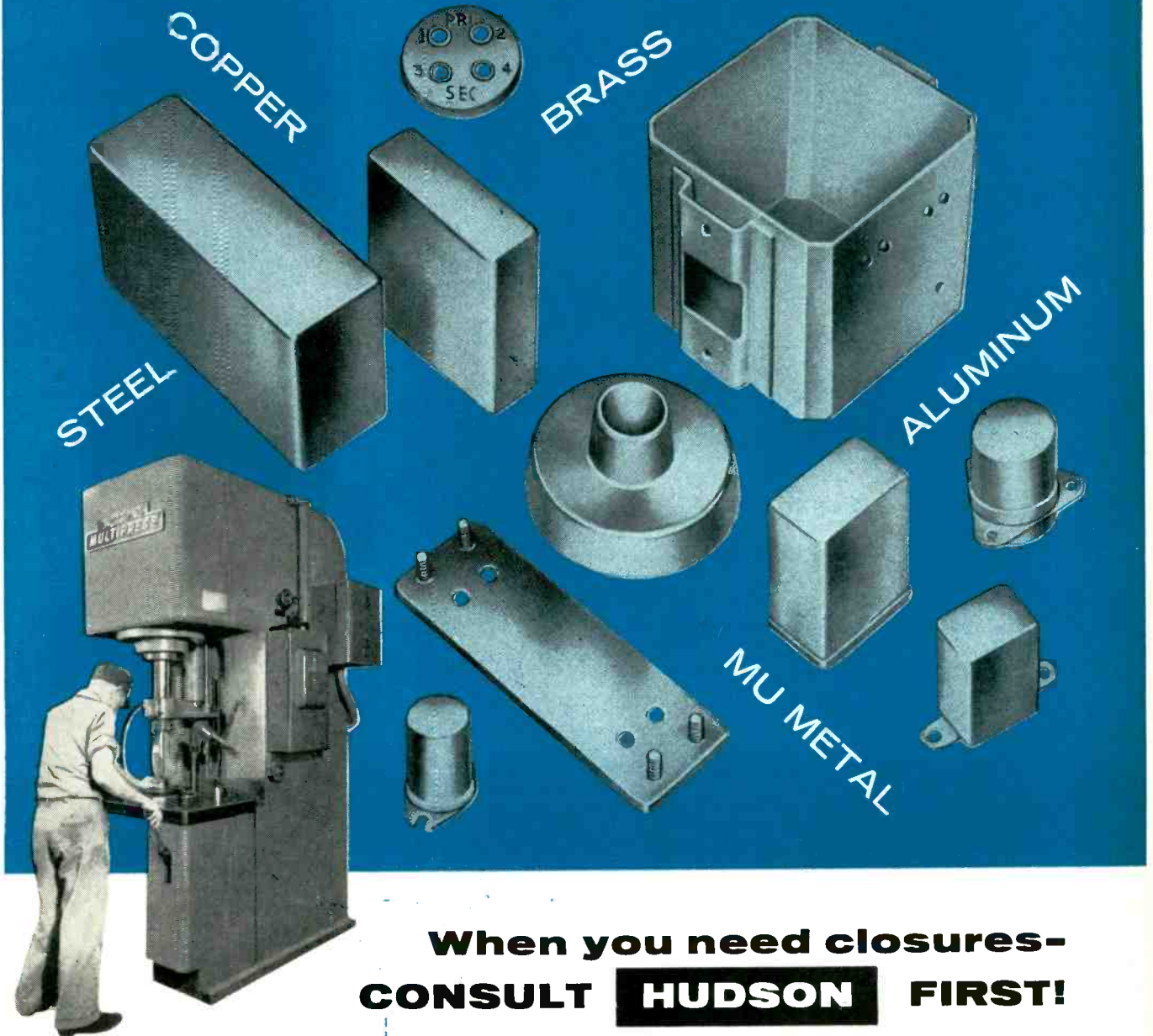
Nonlinear Winder

In patent 2,653,772 issued to B. B. Scott of Schenectady, New York, assigned to the General Electric Company, an electronically controlled Winding Machine is described.

For winding variable wire-wound resistors that have nonlinear characteristics this inventor has devised a control system for the machine that automatically varies the spacing between wire turns to correspond to some predetermined resistance characteristic, such as logarithmic, sine or cosine.

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to have the desired characteristic, forms one leg of a resistance bridge. The resistance being wound forms an adjacent leg. Any difference between them produces an unbalance voltage across appropriate diagonals of the bridge. The resulting d-c unbalance voltage is interrupted by a vibrator and amplified. The resultant output is both connected to an oscillograph and a servocontrol circuit. An additional circuit is responsive to positive signals developed for too close spacing.

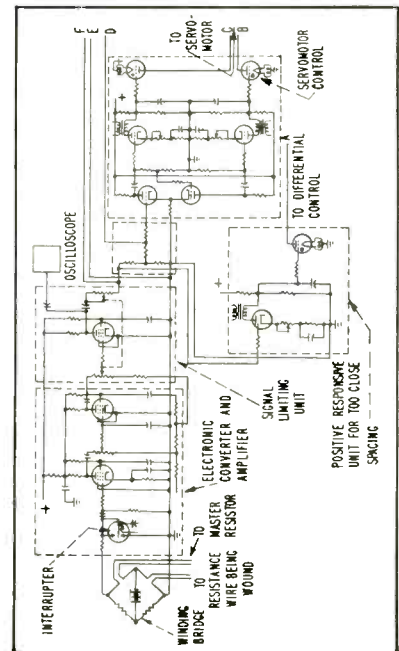


FIG. 5—Winding bridge and servomotor connects to Fig. 6

The circuit arrangement of the winding control is shown in Fig. 5. The electronic converter and amplifier unit is a straightforward d-c interrupted amplifier arrangement where an a-c amplifier is provided for the interrupted d-c bridge unbalance voltage. This is followed by a limiting amplifier that has a gain limit of some predetermined value. These units comprise the control signal generator of the winding circuit.

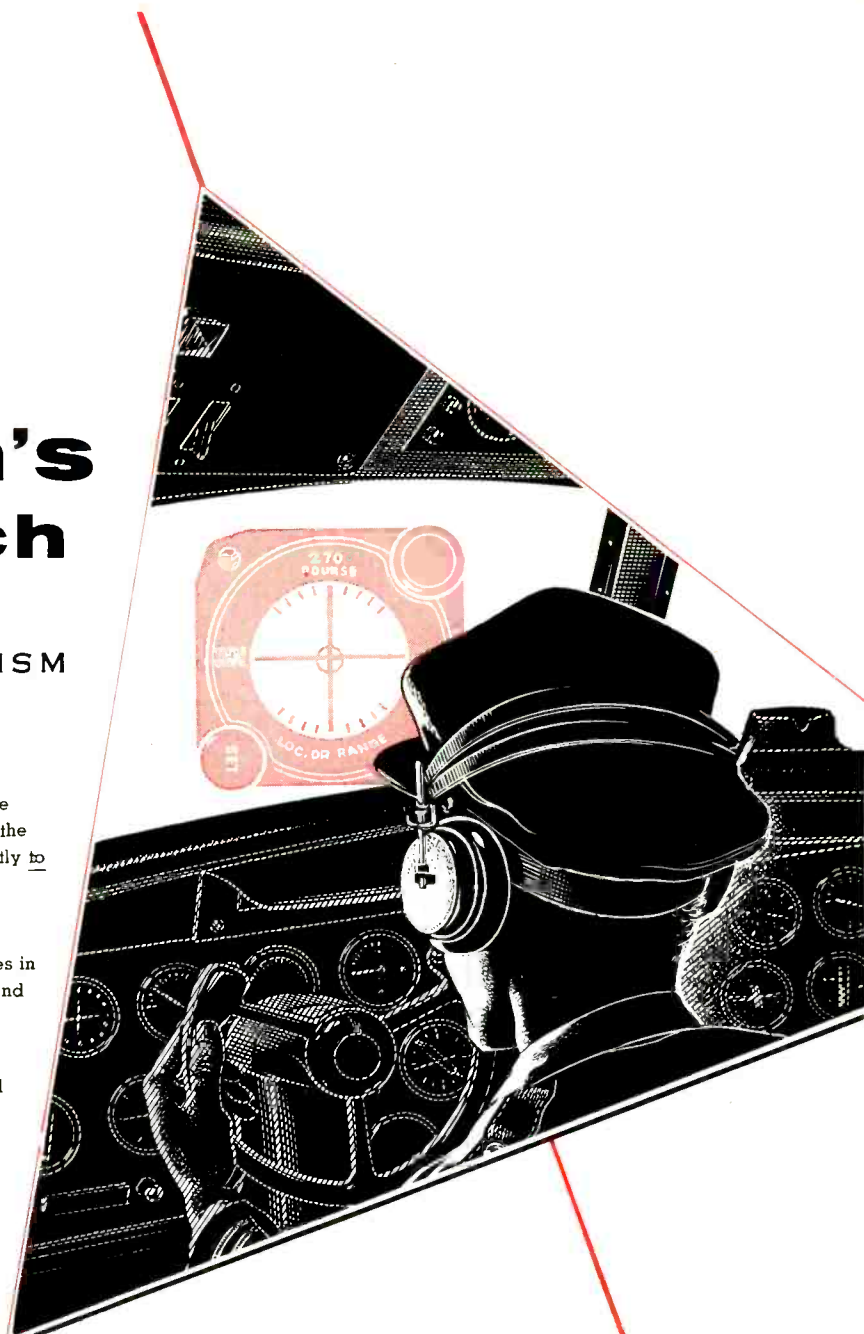
The output of the control signal circuit is interrupted by a shorting cam arrangement for 180 deg of each winding turn. While closed, the control circuits adjust the turn spacing and winding rate according to the most recent signal information, while during the open interval the control signal generator circuit

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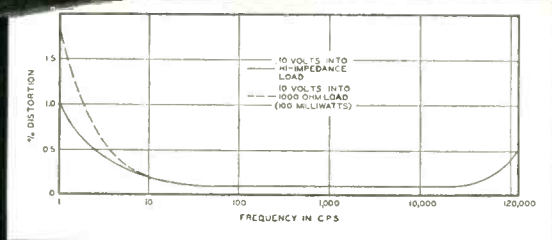
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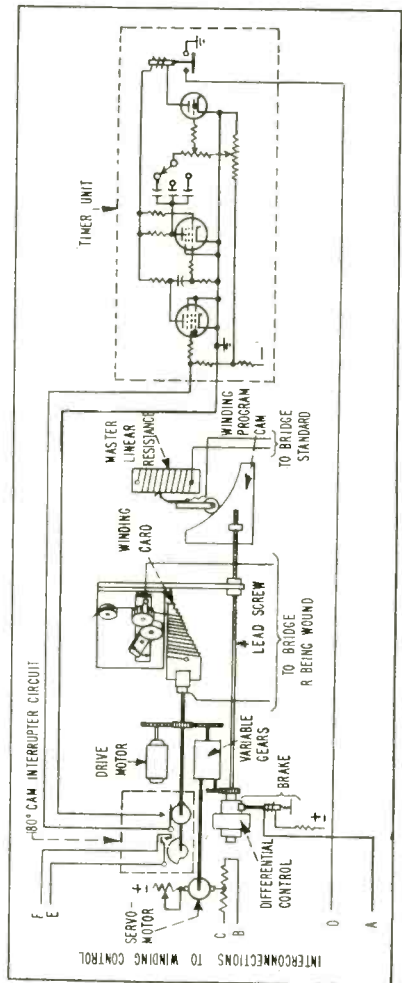


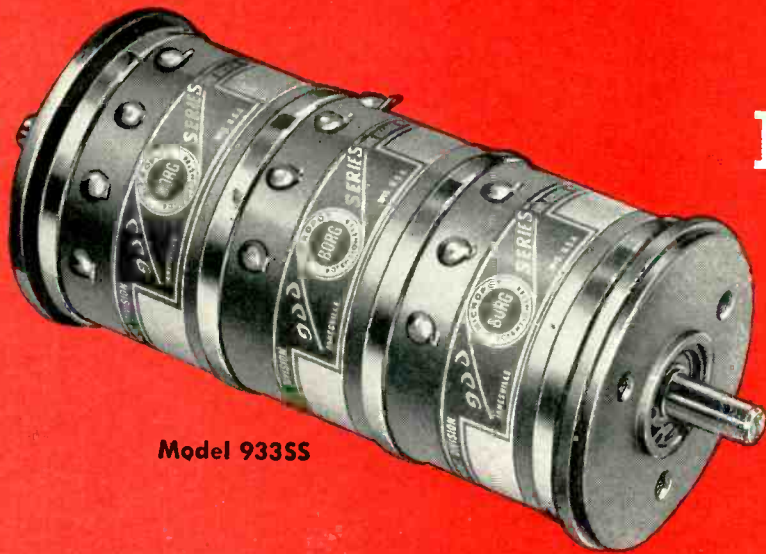
FIG. 6—Leads from Fig. 5 connect at left

as shown in Fig. 6. The inventor claims typical machines built to the specification of this invention have wound enameled nickel-chromium-iron alloy wire of 0.00225-in. diameter at speeds of 330 rpm. It is claimed that wire of 0.0015 in. diameter has been positioned accurately on a card to within 0.0001 inch. The incremental corrections can be accomplished within a 90-deg rotation of the winding card.

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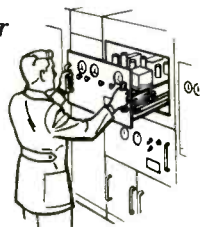
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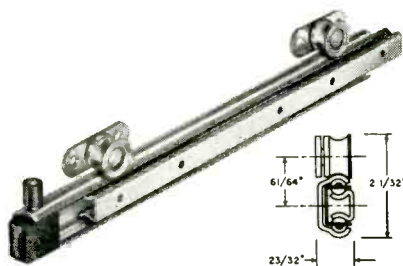
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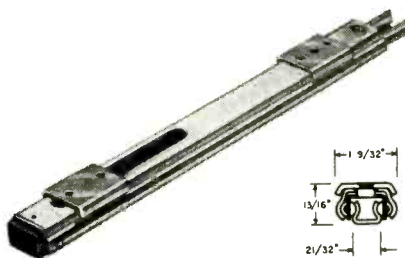


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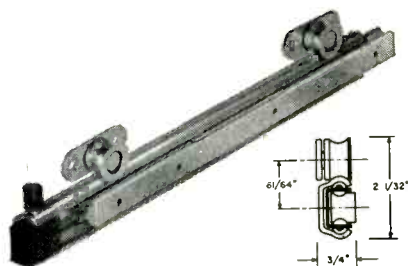
No. 306R Slide

Two-section slide with rollers for moving unit. Ball bearing action. Full travel possible. Load capacity: 50 lbs. per pair mounted vertically.



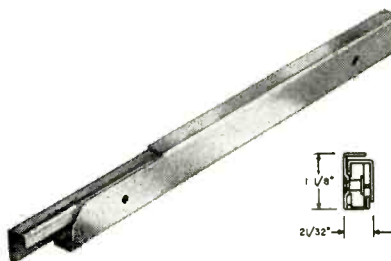
No. 308 Slide

Two-section underneath mounting slide. Ball bearing action. Glide brackets permit full travel, easy chassis removal. Load: 30 lbs. per pr.



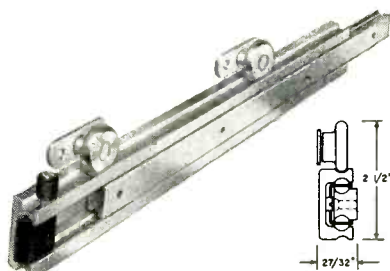
No. 313R Slide

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The inventor categorizes cryptographic systems into those in which the elements of the intelligence are transposed and those in which there is a substitution of another element of intelligence or a character for each element of the desired intelligence.

It is the first of these techniques that is employed in this invention. A block diagram of the arrangement is shown in Fig. 7. Here the

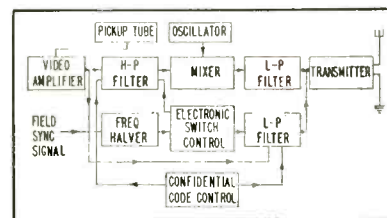


FIG. 7—Block diagram of coded transmitter

inventor proposes to transpose the elements of a video signal into a band of frequencies outside their nominal range so that a local heterodyne signal is required to recover the intelligence.

By a prearranged code between the television transmission agency and the receiver the transposition band and consequently the heterodyne frequency required at the receiver may be changed. The block diagram of Fig. 8 illustrates the receiver system employed in the television secrecy system.

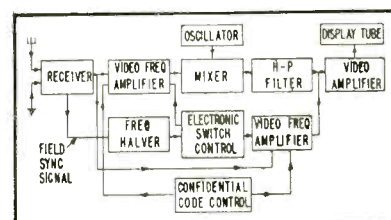


FIG. 8—Coded receiver unscrambles video signals

Assuming, for example, a bandwidth of 7.5 mc and intelligence signals in that band, a bandpass filter system incorporating a high-pass and a low-pass filter centering at 3.5 mc is used to separate into individual channels all frequencies above and below the center frequency, respectively. An electronic switch synchronized to the line-



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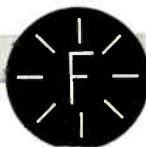


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scanning frequency may be employed alternately to energize each of the channels while a local oscillator heterodynes each channel as it is switched. The circuit of the bandpass filters and electronic switch is shown in Fig. 9.

In Fig. 10 there is shown a variation of the switching system of the invention where a mechanical programming cam and lever arrangement

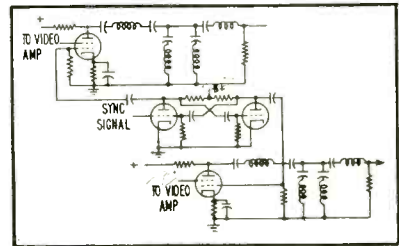


FIG. 9—Bandpass filters and electronic switch

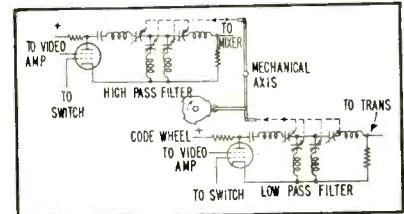


FIG. 10—Mechanical device shifts cutoff frequencies

ment are employed to tune the filters so as to shift the respective cutoff frequencies in accordance with the positions of the cam wheel. In such a circuit the code is not tied to the line or frame-scanning frequencies. Similar circuits and mechanical devices can be incorporated in the receiver to recover the intelligence.

Equipment such as described in this patent are useful in the proposed pay-as-you-go type of television broadcasting.

Spectrometer Control

In patent 2,640,935 recently awarded Stanford B. Spracklen, of Oak Ridge, Tenn., and assigned to the United States of America as represented by the U. S. Atomic Energy Commission, there is described a Mass Spectrometer Control.

A mass spectrometer is an apparatus for sorting ions that have different mass-to-charge ratios. It is used in the qualitative and quantitative analysis of the elements contained in mixtures, compounds,

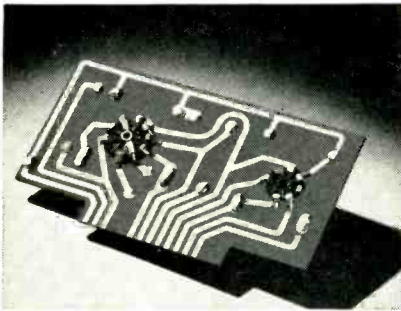
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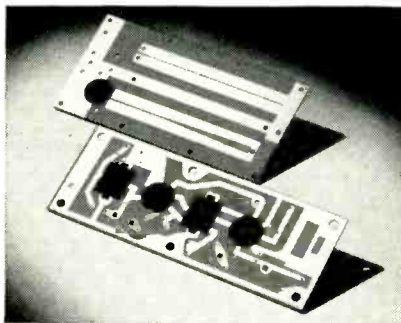
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Any metal clad is no better than its base and the care taken in laminating. With the cost of material high, compared to labor and inspection, the purchase of a uniform metal clad material, like this C-D-F grade, becomes vital.



COPPER CLAD
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Similar to grade XXXP-26 in electrical and moisture resistance properties, but not quite as strong mechanically. Equal cold flow and punching characteristics. Natural brown.

COPPER CLAD GRADES GB-112S AND GB-261S

These silicone grades use a glass fabric laminate with a copper foil surface on one or both sides. Recommended where high heat resistance and low dielectric loss properties are required. For certain tuners and inductances the

low dielectric loss factor of this grade makes its higher cost acceptable. A continuous filament (Grade GB-112S) is used for thicknesses $\frac{1}{32}$ to $\frac{1}{16}$ ". A staple filament (Grade GB-261S) is used for thicknesses over $\frac{1}{16}$ ".

COPPER CLAD GRADE GB-116T

A glass base laminate using duPont's tetrafluoroethylene resin, Teflon, for outstanding resistance to high heat with extremely low dielectric loss properties. A fine weave continuous filament glass fabric cloth is used for superior mechanical strength and good machining qualities. In spite of its high cost, this C-D-F grade has demonstrated that it can save money and do a job that no other single material can in microstrip high-voltage, high-frequency circuit elements. Remember, C-D-F is a major supplier of sheets, tapes, rods, tubes of Teflon, has valuable experience in its manufacture and fabrication. Write for samples.

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BONDING STRENGTH—FOIL TO LAMINATE	
MATERIAL	Average or Typical Value Lbs. pull per 1" width of foil to separate
XXXP-24 or XXXP-26 plus 0.0014" copper	5 to 8
XXXP-24 or XXXP-26 plus 0.0028" copper	7 to 9
GB-116T plus 0.0014" copper	5 to 12
GB-112S plus 0.0014" copper	6 to 8
GB-261S plus 0.0014" copper	7 to 10

These values are based on tests at prevailing room temperature (20-30°C.)

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mixtures of compounds and particularly for the determination of the isotopic ratios that exist in most elements.

Most control devices in the prior art provided for the control of mass spectrometers were designed for the laboratory use of such instruments. When used for automatic production control these have proved inadequate. For the production control use relatively constant sensitivity is required. This can only be maintained if the mass spectrometer is operated below a certain pressure in the chamber of the spectrometer.

The control circuit of this invention provides means for automatically preventing the operation of the mass spectrometer at higher than some predetermined pressure until a manual reset is made.

The circuit of Fig. 11 shows the invention as applied to a mass spec-

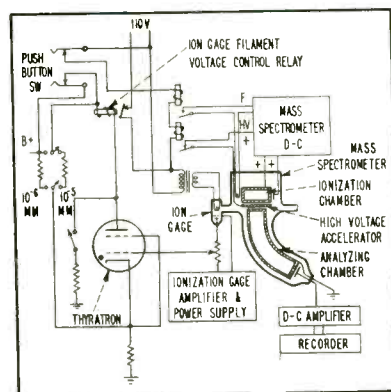


FIG. 11—Mass spectrometer control for automatic production

trometer. The control circuit includes a thyatron that is under the control of the voltage drop across a variable resistor R_1 . The drop across it develops when the pressure in the mass spectrometer, as represented by a current through an ion gage changes. Resistor R_1 is the plate load, so to speak, of the ion gage. A relay in the thyatron plate circuit is rendered operative when the thyatron conducts to open the primary of a filament transformer and the spectrometer high-voltage supply. Ranges in the order of 10^{-6} to 10^{-5} millimeters of mercury are possible as the control areas of the circuit of this invention. Adjustment is possible through thyatron screen control and the setting of R_1 .

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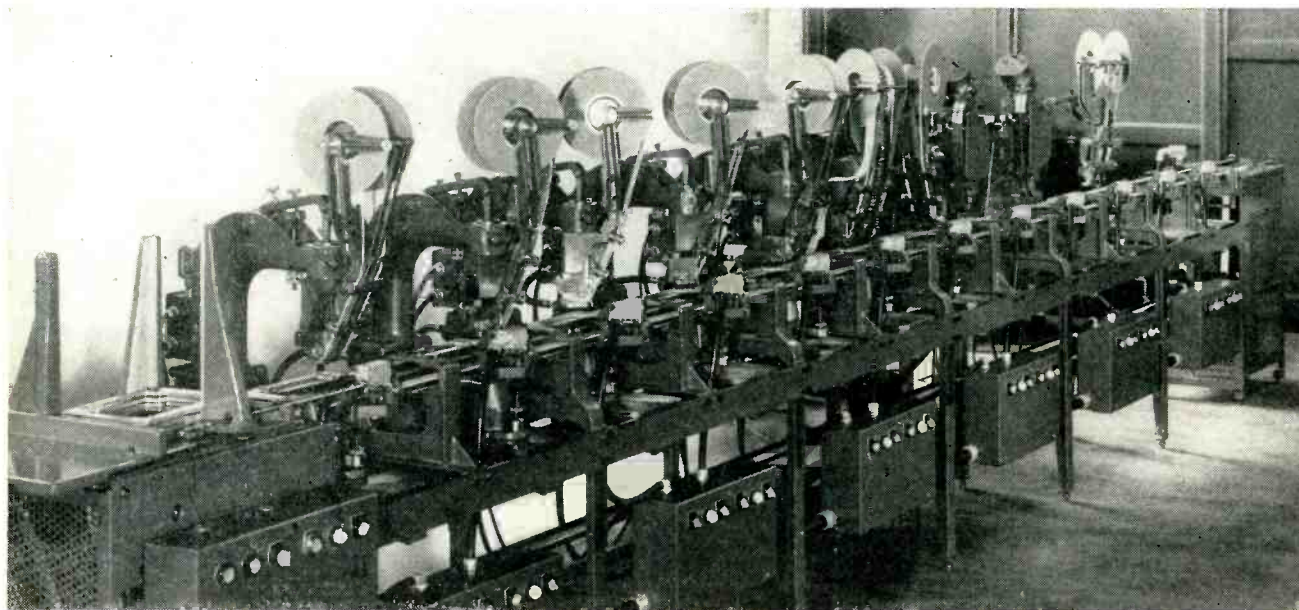
Edited by JOHN MARKUS

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Machine Inserts Components in Printed Wiring Boards



Machine setup for inserting components accurately in holes of printed wiring boards. Reels above inserting stations contain components belted together with adhesive tape. Pallets with wiring boards are loaded into vertical rack at left

AN EXPERIMENTAL conveyor-type machine automatically inserts resistors, capacitors, jumper wires and eyelet-type terminals in printed circuit wiring boards at the rate of 9,600 boards in an 8-hour day. This automatic assembly machine, developed in the Beverly, Mass. Research Division of United Shoe Machinery Corp., is readily adjustable to provide for changes in circuitry and components.

In its present state of development, printed wiring boards up to 5 x 8 in. are loaded by hand onto pallets or frames and stacked at the input end of the machine. From

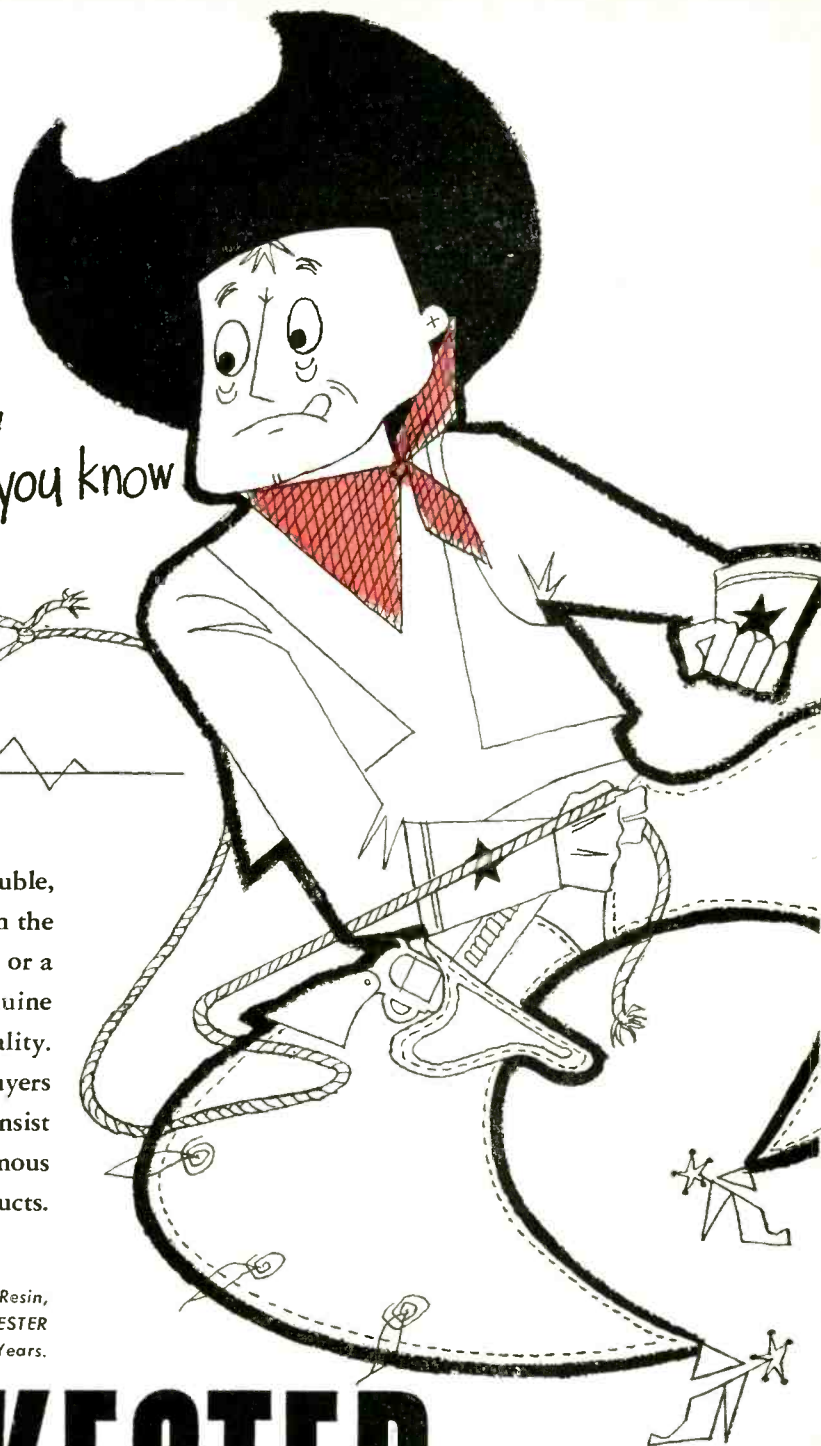
here a conveyor picks up the pallets one by one and moves them past the inserting stations. At each of these stations, a pallet is stopped and one component automatically inserted in any desired location on the board.

As it now stands, the experimental machine will insert only resistors, tubular and disk ceramic capacitors, jumper wires and eyelets. The complete system for automatic assembly of electronic equipment will include means for automatic placement of printed wiring boards in the pallets, additional inserting heads for tube sockets,

coils and other components, stations for dip soldering, testing and pallet unloading, and provision for automatic return of pallets to the loading station.

A unique method of belting pigtail components is used to achieve optimum feeding conditions. One machine has already been built for belting resistors, the basic design of which may be readily extended to other axial-lead components. The resistors are fed automatically through a lead-straightening position, then to taping stations where self-adhesive tape is folded over the ends of the leads to form a

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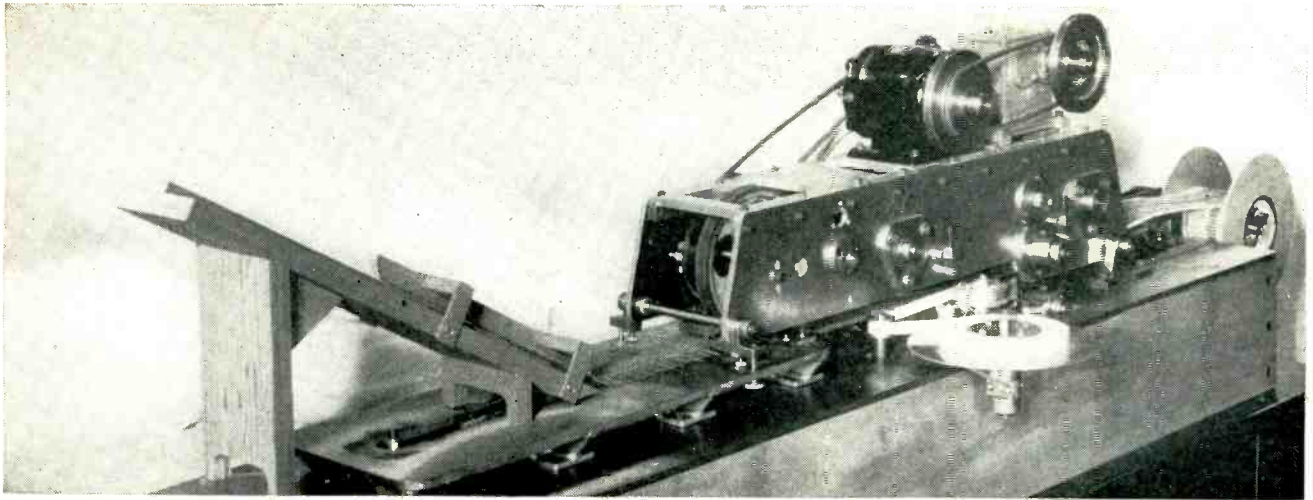


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Machine for applying adhesive tape over ends of axial-lead resistors after first straightening the leads. Loose resistors are loaded into chute at left, and belted units are reeled at right

resistor belt that is wound on a reel.

At the conveyor, belted components are fed from reels into the inserting heads. These automatically cut and form the wire leads and insert them through the pre-punched holes in the printed wiring boards. At the same station the lead ends protruding through the board are automatically clinched to hold each component in place until the board is dip soldered.

Surplus lead length is thus chopped automatically, leaving the cut ends sticking to the belt so they are pulled right through the machine for convenient disposal. To avoid damage to the bodies of components, they are handled by their leads throughout the belting, inserting and clinching operations.

Safeguards built into the assembly machine include provisions to stop the machine when a station is empty, when a component is

missing or not correctly inserted, or when an inserting head does not complete its cycle. Positioning is checked by using a split anvil for clinching the leads underneath, with the anvil parts insulated and connected to a continuity checking circuit. This checks continuity from each inserting head (which grips the lead near the resistor body) to the corresponding anvil under the board to make sure each lead is properly inserted.

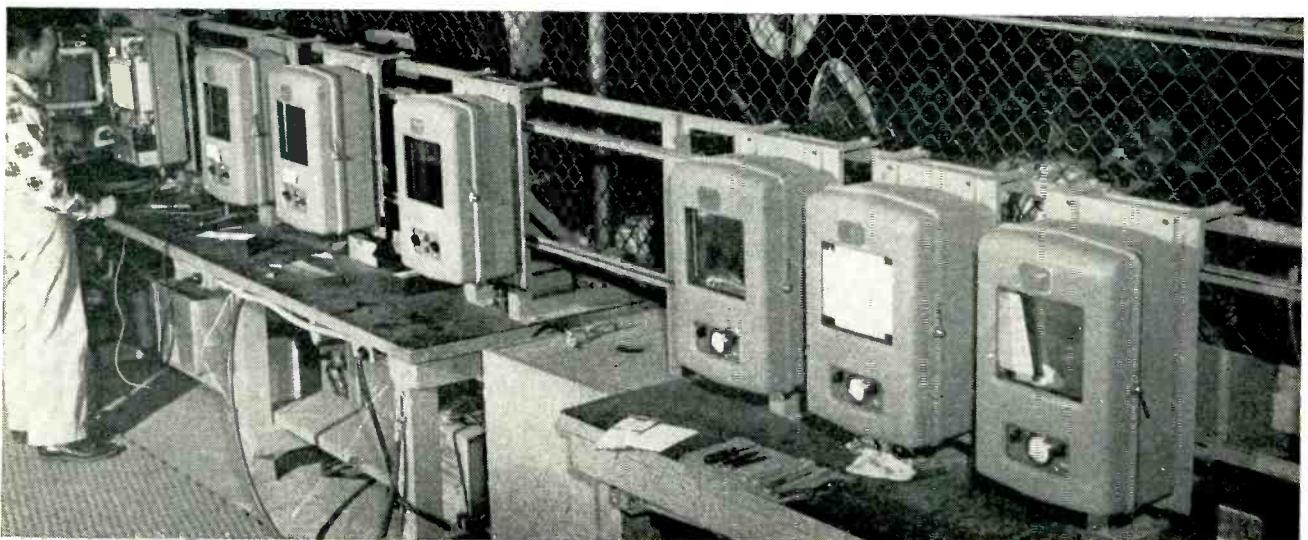
Pallets on Rails Speed Assembly of Ultrasonic Depth Recorders

FOR FINAL assembly and test of depth recorders in the North Hollywood, Calif. plant of Bendix Aviation Corp., the cast metal housings of the recorders are hung on metal pallets equipped with rollers that

run on rails bolted to vertical supports at the rear of the work bench. The units are moved along the rails by hand one by one as work is completed at each position.

Metal pegs on the vertical pallets,

inserted at a slight upward angle, are positioned so that the mounting straps for a housing fit over the pegs. When all work on a unit is completed, the unit is lifted off these pegs and transferred to the



Method of using pallets on rail line for assembling ultrasonic depth recorders

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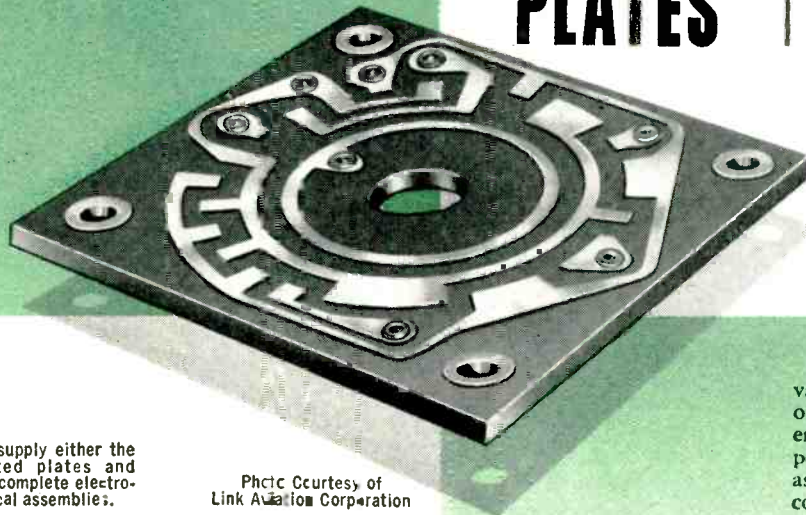
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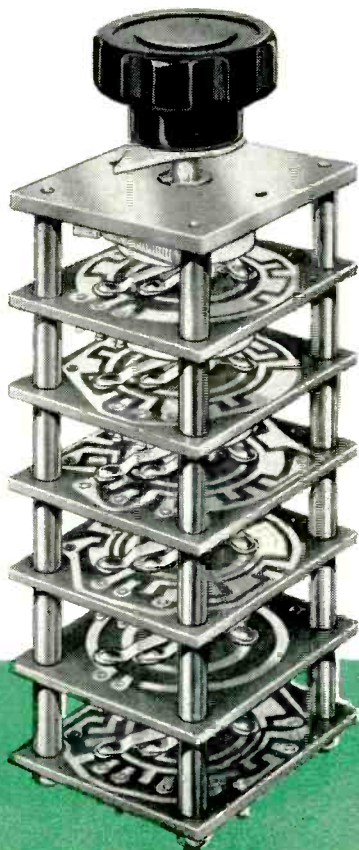
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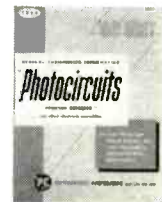
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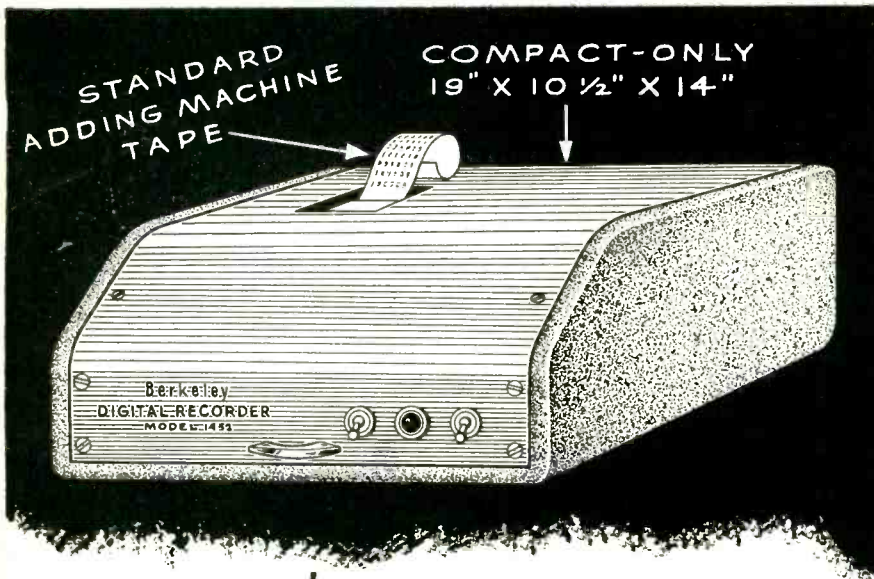
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* Older BERKELEY models may be adapted for use with the Model 1452.

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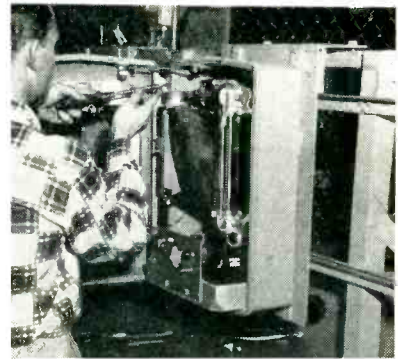
Recording capacity	6 digits standard, 8 or 10 on special order
Max. cycling rate	1 printout every 0.85 sec. for 6 digits
Power requirements	100-130 v., 50/60 cycles, 125 watts (approx.)
Input requirements	Direct connection to basic counting unit
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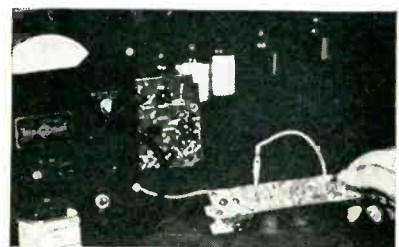
Details of pallet riding on rails, and method of hanging recorder housing on pegs set into pallet

shipping department, after which the pallet is lifted off the rail and returned to the beginning of the line.

This type of mechanized line has proved ideal for job lot assembly because it places the equipment at the most convenient working level for an operator standing at the bench. The front of the bench is always free to hold tubes and test equipment. The pallets can easily be lifted up and stored to permit complete use of the bench for other work when desired.

Printed-Circuit Flux Reduces Panel Leakage

A FLUXCOAT material applied centrifugally or by dip or spray to printed circuits immediately after the etching process dries rapidly to a non-tacky film. This serves to insulate the board and protect the copper or silver circuit from oxidation, yet allow a smooth, even tinning operation. The insulating residue does not have to be removed after tinning. Insulation measurements taken after dip-tinning showed readings of 50,000 megohms across the board at 350 F, and finished equipment showed no traces of hum due to electrical leak-



Measuring surface conductivity of etched wiring panel after tinning conductors by dipping in molten solder

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The Governor of Florida and his Council for Industry & Commerce cordially invite you to investigate the special opportunities Florida offers Industry

you'll always do better in Florida

age across the phenolic boards used as a base.

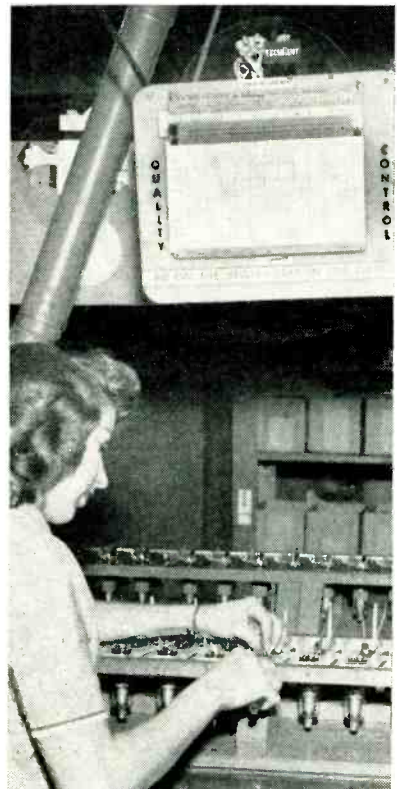
The new insulating rosin coating, known as Lonco Fluxcote 21-XR, is made by London Chemical Co., Chicago, and is being tested in the Chicago plant of Hallicrafters Co.

Scoreboard Boosts Quality on Production Line

A PERSONAL eye-catching yellow plastic scoreboard at each position on Motorola radio and tv receiver lines has boosted quality by singling out individuals who are doing the best work and giving them recognition among their associates on the line.

The competitive rating of employees is the focal point of the program. The idea is to detect errors or rejects in the radio and tv sets while they are still in the production stage by making people conscious of their jobs.

Hooked to the front of the plastic slate is the quality control chart, divided into sections showing the errors made for each hour



High-voltage power pack assembly line for television receivers, showing quality control board suspended from overhead fluorescent lamps by straps

now!

BENDIX-SCINFLEX

waterproof

plugs

*for use with
multi-conductor
cables*



These new Bendix*-Scinflex *waterproof* plugs are a modification of our standard AN type "E" (environment resistant) connector. They are designed to meet all "E" performance requirements when used with multi-conductor cables. Each plug includes a modified AN3057B cable clamp which provides inward radial compression on multi-conductor cables. This unique feature completely eliminates cable strain—a common source of circuit trouble.

In addition, there are gaskets at all mating surfaces and an accessory sleeve is available to accommodate an extreme range of cable sizes. A folder describing this new waterproof plug—and the various sizes in which it is manufactured—may be obtained by writing our Sales Department.

*REG. TRADE-MARK

THESE BUILT-IN FEATURES ASSURE TOP PROTECTION AGAINST CIRCUIT FAILURE:

Shock and Vibration Resistant • Die Cast Aluminum Shell
• Cadmium Plate—Olive Drab Finish • Moisture-Proof,
Pressurized • High Arc Resistance, High Dielectric
Strength • Silver-Plated Contacts • Resilient Inserts

SCINTILLA DIVISION



SIDNEY, NEW YORK

Export Sales: Bendix International Division
205 East 42nd St., New York 17, N. Y.

Factory Branch Offices: 117 E. Providencia Avenue, Burbank, California • Brouwer Building, 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • Stephenson Building, 6560 Cass Avenue, Detroit 2, Michigan • 512 West Avenue, Jenkintown, Pennsylvania • 8401 Cedar Springs Rd., Dallas 19, Texas • American Building, 4 South Main Street, Dayton 2, Ohio



MEECO
Instruments



SWEEPMASTER Sweep Frequency Generators give you these outstanding advantages . . .

- Frequency Marker with an accuracy independent of Sweep Width. Inserted after external detection, it eliminates erroneous interpretation—eliminates possibility of undesirable transient distortion or limiting actions. The Marker is adjustable in amplitude and after adjustment remains independent of other controls.
- An attenuator whose performance is free of Frequency, assuring you that the Output Envelope is the same as that indicated by the Internal Monitor.
- A simple switching operation to permit examination of either Envelope of the Swept Frequency Signal.
- Durable, compact, lightweight Output and Detector Probes, either of which can be detached easily and replaced by cables having standard connectors.

SPECIFICATIONS

MODEL	CENTER FREQUENCY	RF OUTPUT 50 ohm * TERMINATION	SWEEPWIDTH CONTINUOUS ADJUSTMENT	FREQUENCY MARKER
SM I	100 KC to 11 MC	1 volt RMS	150 KC to 14 MC	100 KC to 11 MC
SM II	500 KC to 50 MC	0.2 volt RMS	150 KC to 20 MC	500 KC to 50 MC
SM III	500 KC to 75 MC	0.1 volt RMS	150 KC to 20 MC	500 KC to 75 MC

FLATNESS: Less than 1 DB variation over maximum sweepwidth range.

FREQUENCY MARKER: Engraved calibration accurate to $\pm 2\%$.

* 75 ohm available when specified

HORIZONTAL DEFLECTION: A 60 cps sine wave for application to horizontal input of oscilloscope is supplied.

continuously or blanked out for $\frac{1}{2}$ of each 60 cycle period.

BLANKING: The RF signal may be operated

EXTERNAL DETECTOR: Blocking capacitor of 400 volt breakdown capacity.

Write for complete information

MANUFACTURERS ENGINEERING & EQUIPMENT CORP.
15 Sunset Lane • Hatboro, Pa.

that the whole line operates. The group leader marks the quality chart each hour. He also counts the individual's errors and scores them according to his or her quality performance.

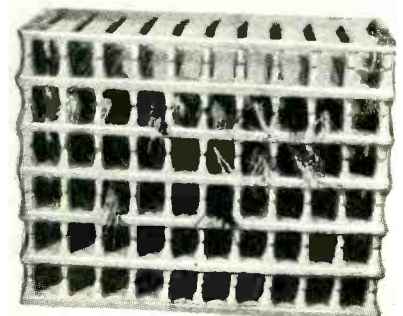
The ratings, classified as excellent, good, fair and poor, are marked on a plastic wheel which is fastened to the back of the yellow slate. The wheel is spun to the position showing the operator's current rating. In each instance, "Professor Sharin," Motorola's mythical symbol for its profit-sharing fund, is the central figure in the decal marking. He holds a colored card with the rating lettered on it.

Directly under the quality index chart is the job classification. The jobs which compete for quality performance fit into four categories—trainee, operator, key operator and group leader.

Though the plastic scoreboards have scarcely made their debut, employees have already sliced the error problem in half. Many are quite curious to see just which rating sign Prof. Sharin has hanging above their next-door neighbors' heads.

Plastic Trays Modernize Assembly Benches

CUSTOM-MOLDED plastic bins and trays for small parts and hardware reduce bench space requirements and at the same time improve reliability of electronic assemblies by minimizing handling losses. These new bench-modernizing tools are available in both stock and custom designs from Product Engineering Laboratories Co., Inc., Newark, N. J. Materials used in molding include Boltaron 6100 and Boltaron



Stacking and locking trays for cut wires



ALSiMAG[®]

offers you these advantages for

Die Pressed Ceramics

FOUR
LARGE MODERN
PLANTS INSURE
QUICK
DELIVERIES!

Capacity: Whether you require a few hundred or several million parts, the right size and type of equipment is available. Ample kilns available plus many special kilns, including controlled atmosphere kilns, provide firing capacity at optimum temperature.

Volume: Batteries of presses include several rotaries, each capable of producing up to 1,800,000 parts a day of small, simple designs. These are backed by vast volume resources for raw material preparation, firing and machining both before and after firing.

Low Cost: The right equipment for every job means that your work is produced at the most favorable cost.

Variety of Materials: In ALSiMag you have the widest choice of materials so that you can most readily match the material to your requirements. Latest property chart sent on request.

Versatility: More than fifty years of specialized experience has made it possible to produce ALSiMag parts that meet "impossible" requirements.

Engineering Assistance: If you will send details of your requirements, our engineers will submit suggestions on material and design to assist you in finding the most efficient and economical solution to your requirement.

53RD YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE

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PITTSBURGH: 911 Plaza Bldg., Atlantic 1-2075

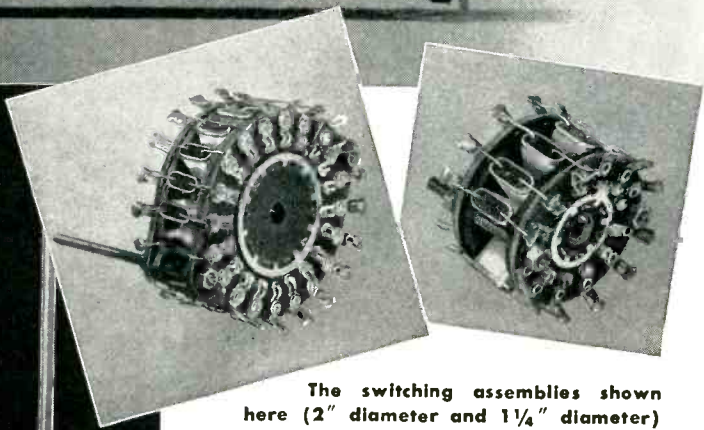
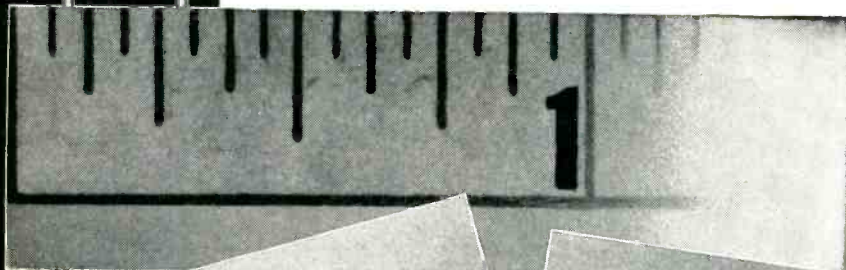
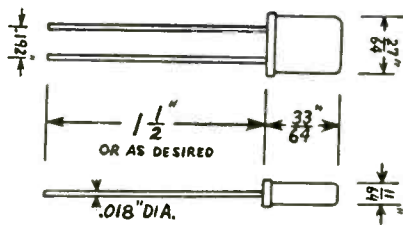
**A NEW
SUB-MINIATURE
PRECISION
QUARTZ CRYSTAL
THAT
USES
ONLY 1/5th
THE
SPACE
FORMERLY
REQUIRED**

The McCoy M-20 "McMite" has a frequency range of 5.0 mc. to 110 mc. It's a sub-miniature hermetically sealed unit, adaptable to multi-channel design for communications and frequency control equipment. Can be plugged into a sub-miniature tube socket, wired into miniature selector switch assembly or can be soldered to a printed circuit terminal board. Meets Military Specification requirements for fundamental operation above 5 mc. and overtone operation above 15 mc. The "McMite" does not sacrifice stability or dependability but meets same characteristics and performance requirements as larger crystal units used by the Military.

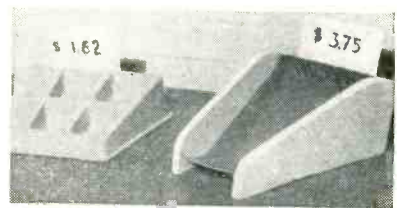
Send for **FREE** catalog today on the McCoy line of high quality, precision made quartz crystals.

McCoy ELECTRONICS CO.
MT. HOLLY SPRINGS PENNSYLVANIA

McCoy M-20 "McMite"



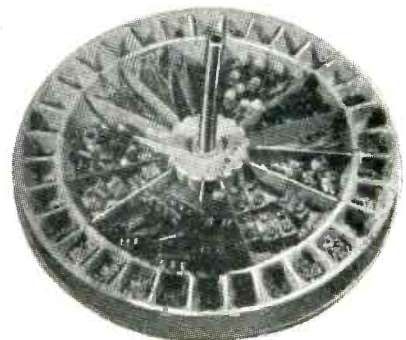
The switching assemblies shown here (2" diameter and 1 1/4" diameter) are illustrative of the space saving qualities of our M-20 "McMite" crystals.



Cost comparison of new molded plastic tray (left) and shop-improvised wood and metal rack

PVC made by Bolta Corp., Royalite made by U. S. Rubber Co., and Rigid Vinylite made by Bakelite Division.

Experience with the new Pelco trays in a number of electronic plants has shown that they make workers have more respect for delicate parts stored therein. With old wood or galvanized trays that quickly acquired a coating of dirt and grease, the psychological effect

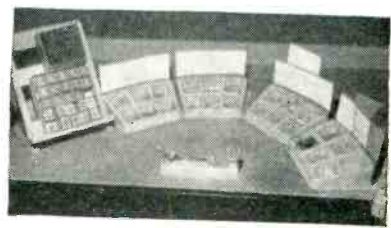


Rotary bin for small parts

was often much like that of delivering diamonds in a coal scuttle. The new trays have a glossy smooth surface with no finish to chip or peel and no sharp corners, permitting absolute cleaning to eliminate sources of contamination.

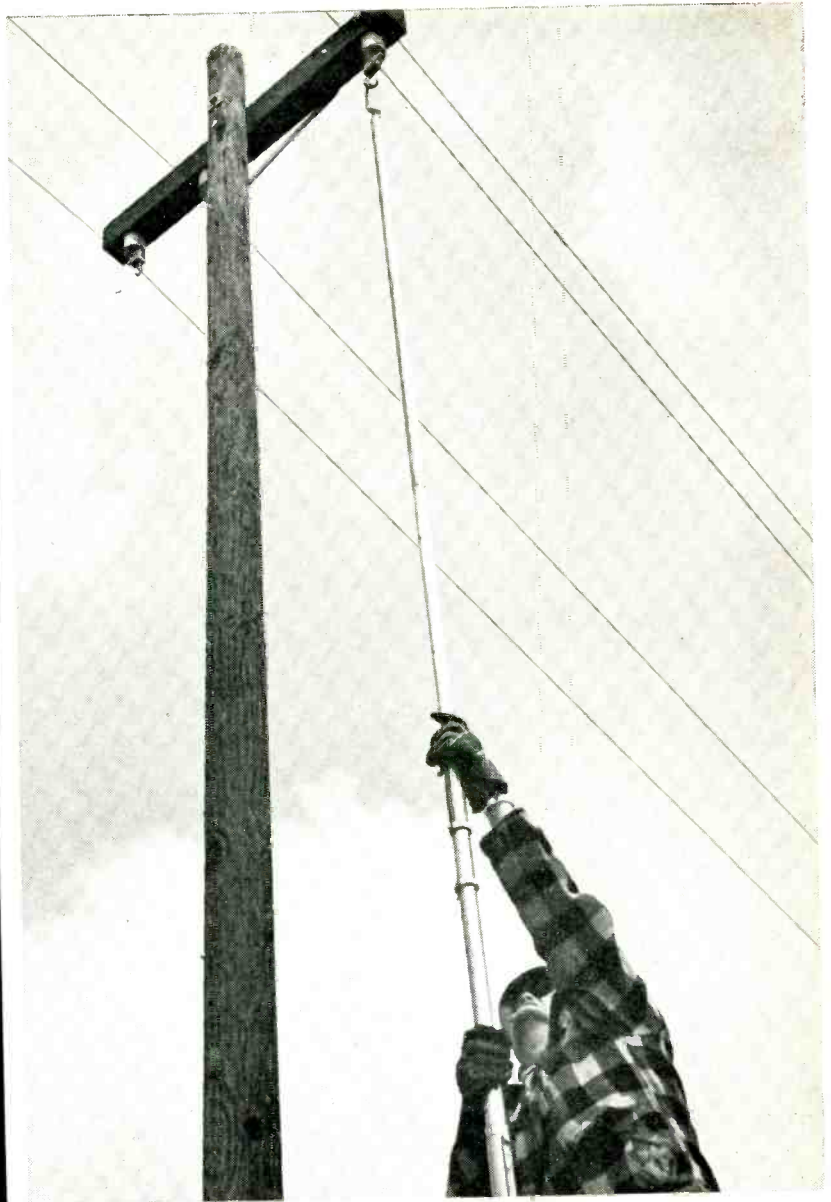
Ten-position trays for cut wires stack and interlock to produce as many compartments as are desired for wiring positions. These are equipped with slanting-rod wire snubbers for one-wire extraction.

A lazy-Susan rotary bin mounted



Typical assembly bench arrangement using combination of plastic and wood racks, with subassembly jig in foreground fastened to bench

The
pole
that
need
not
be
climbed



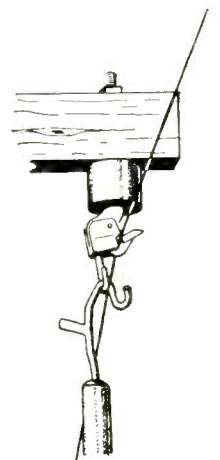
Fastening wires with new tool.

Since telephony began, there has been just one way to install telephone wires on poles: have a trained man climb up and fasten them there. Now Bell Laboratories engineers have developed a special pole line for rural areas. The entire line can be erected without climbing a pole.

The whole job is done from the ground. Light-weight poles are quickly and easily

erected. Newly created tools enable men to fasten wires to crossarms 10 to 25 feet over their heads.

This inexpensive line promises more service in sparsely populated places. From original design to testing, it exemplifies a Bell Telephone Laboratories team operation in widening telephone service and keeping costs down.



Key to the new "climbless" pole is this insulator. Ground crews use long-handled tools to place the wire in position and then lock it fast.

Bell Telephone Laboratories



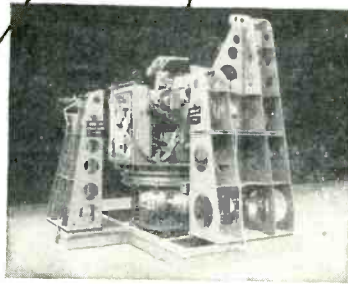
IMPROVING TELEPHONE SERVICE FOR AMERICA PROVIDES CAREERS FOR CREATIVE MEN IN SCIENTIFIC AND TECHNICAL FIELDS



SERVO ANALYSIS NETWORK



ANGULAR POSITION TRANSMITTER



GUN DIRECTOR—being optically aligned.



POTENTIOMETERS—precision linear and non-linear



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DRAWING BOARD
to
FINISHED PRODUCT
under one roof!

Serving the Armed Forces and Industry in the research, development, design and manufacture of electronic, electrical, electromechanical and mechanical devices—DAYSTROM INSTRUMENT has a full range of up-to-date equipment for production from raw materials to finished assemblies and systems. Under one roof their 350,000 sq. ft. plant has facilities available to meet every need for internal, external, surface and centerless grinding; low to high precision turning; jig boring and milling; welding, heat treating and finishing; spur and helical gear shaping; hobbing and shaving; straight and spiral bevel gearing; test and inspection, facilities and know-how for the entire range of production.

Division of Daystrom, Incorporated

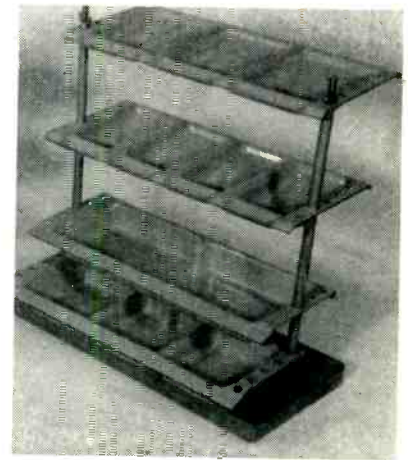
DAYSTROM INSTRUMENT

ARCHBALD, PENNSYLVANIA

AFFILIATES:

American Type Founders, Elizabeth, N. J.
Daystrom Furniture Div., Olean, N. Y.

Daystrom Electric Corporation
Poughkeepsie, N. Y.



Method of using pipe sections on vertical rods to space trays. Five punched holes in each end of each tray permit staggered mounting



Spring-clip supports for trays

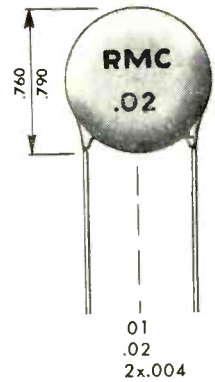
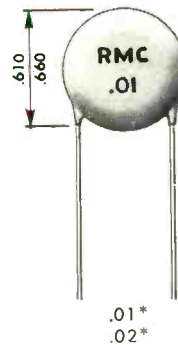
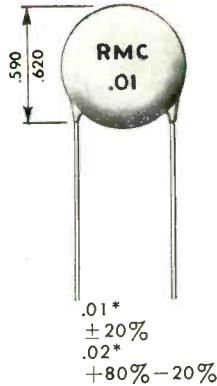
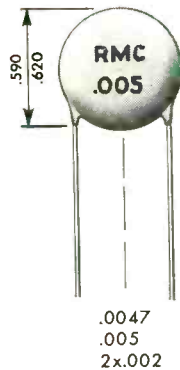
on a pipe stand has 32 scoop-shaped cups on its outer circumference for hardware. The inner circle has slots for removable partitions that give up to 16 additional larger compartments for components.

Two types of mountings are used for stacking dispenser trays with varying clearances between trays. Both use wood bases with vertical rods. In one, the trays have five punched holes at each end for threading onto the vertical rods, and pipe sections are used as spacers between trays. Wing nuts on the threaded upper ends of the rods lock the entire assembly together. By using different tray holes, a staggered arrangement is achieved that gives easy access to each tray.

Another arrangement, having still greater flexibility because it can be adjusted without taking anything apart, uses plain vertical rods

UNEXCELLED FOR BY-PASS OR FILTERING APPLICATIONS

RMC HEAVY DUTY DISCAPS®



SPECIFICATIONS

GUARANTEED MINIMUM VALUE

POWER FACTOR: 1.5% Max. @ 1 KC (initial)

POWER FACTOR: 2.5% Max. @ 1 KC (after humidity)

WORKING VOLTAGE: 1000 V.D.C.

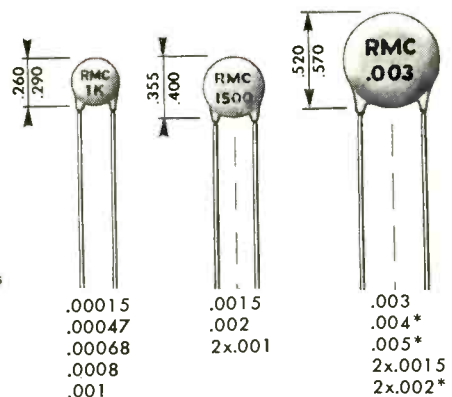
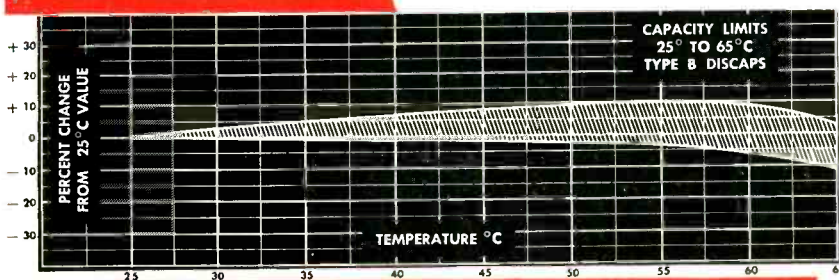
TEST VOLTAGE (FLASH): 2000 V.D.C.

LEADS: No. 22 finned copper (.026 dia.)

INSULATION: Durez phenolic—vacuum waxed

INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms

AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms



TYPE B

1000 V.D.C.W. By-Pass Series

*Rated 600 V.D.C.W. Flash test 1200 V.D.C

DISCAP
CERAMIC
CAPACITORS

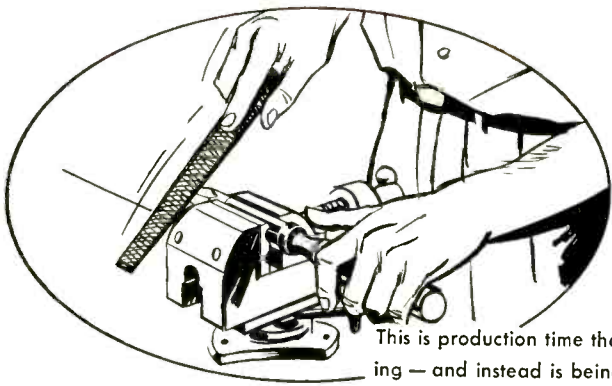


RADIO MATERIALS CORPORATION

GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.

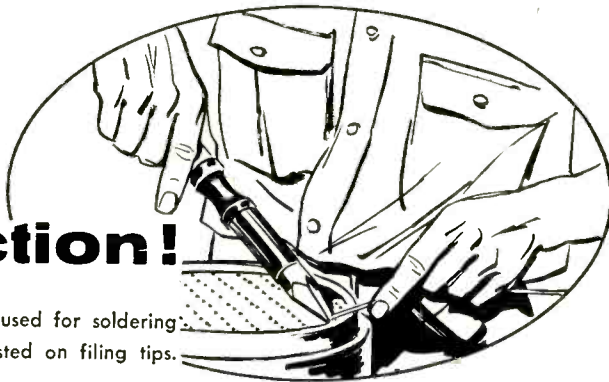
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

DISTRIBUTORS: Contact Jobbers Sales Co., P. O. Box 695, Fairlawn, N. J.



This Is Waste!

This is production time that should be used for soldering — and instead is being used to file soldering tips. Plain copper tips need constant filing.



This Is Production!

Time is being used for soldering — not wasted on filing tips.

Big difference is use of Stanley Armor Clad Soldering Tips. Armor Clads don't need filing — *all* production time can be used for soldering. More! Whereas ordinary tips are usually finished after soldering 3000 joints, Stanley Armor Clads are only

getting "warmed up." They last from 3 to 10 times longer.

You'll get better work, too, from Stanley's uniform tip length and unvarying heat. 41 sizes and shapes — screw or plug type — to fit all kinds of electric soldering irons.



Fast! Dependable! Economical!

Stanley Plug Type Electric Soldering Iron

An easy-to-handle lightweight. Has new, replaceable heating element — cool, comfortable, hardwood handle. Six models to choose from.

Call your industrial supply distributor for Stanley Armor Clad Tips and Soldering Irons, or write Stanley Tools, 108 Elm Street, New Britain,

Conn. Your name and address plus "Armor Clads" on a postcard will bring you a 36-page booklet, "Expert Soldering" by return mail. We'll include a folder showing the complete line of Stanley Armor Clad Soldering Tips and Electric Soldering Irons. Act now!

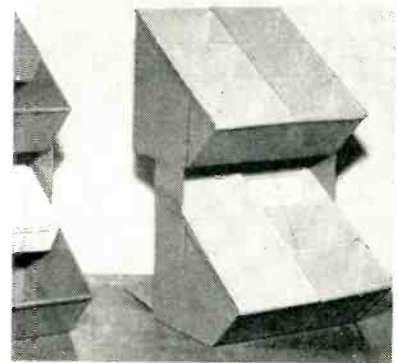
THE TOOL BOX OF THE WORLD



Tools

A Division of The Stanley Works

HARDWARE • ELECTRIC TOOLS • STEEL STRAPPING • STEEL



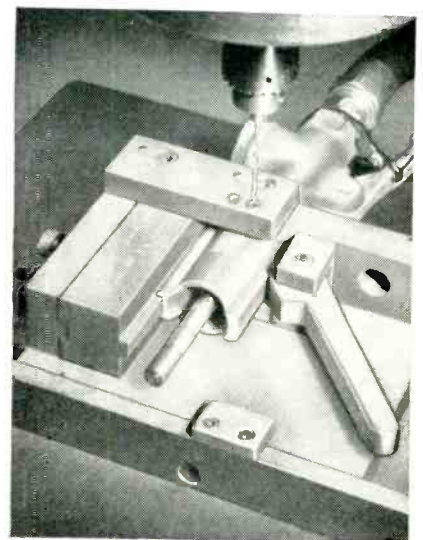
Use of molded plastic inserts in standard metal parts rack. Old metal inserts are in rack at left

without spacers. At each end of each tray is a wire rod on which a spring clip can be slid back and forth. Detents in the tray ends permit positioning this clip quickly in any of five positions, corresponding to the punched holes in the other type of tray. When these clips are squeezed together the trays may be slid up or down on the rods easily. When the clips are released, they lock in position on the rods.

Drilling Jig for Potentiometer Rotors

A SPECIAL JIG developed by Helipot Corp., South Pasadena, California, is used in the manufacture of rotors for standard 10-turn precision potentiometers. The jig serves as a guide for drilling the two holes necessary for attaching the saddle strap of the slip ring contact spring.

The rotor is first locked into position on the jig. Sliding the carriage to the left registers the rotor for

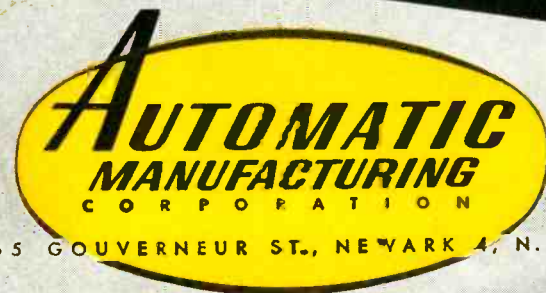


Rotor drilling jig

Superior Design
+ Mass Production
= Low Cost

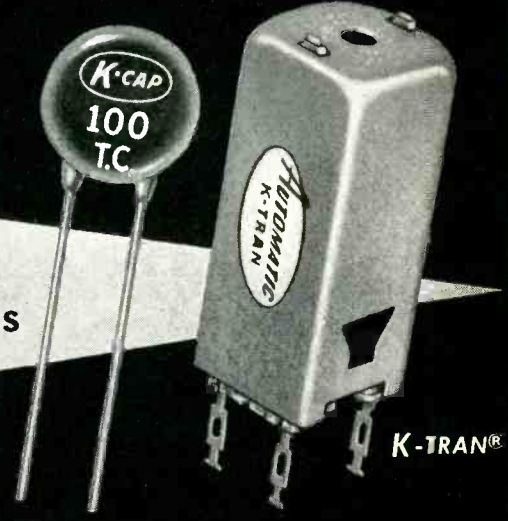
**TV TUNERS,
YOKES and
FLYBACKS**

BY
AUTOMATIC



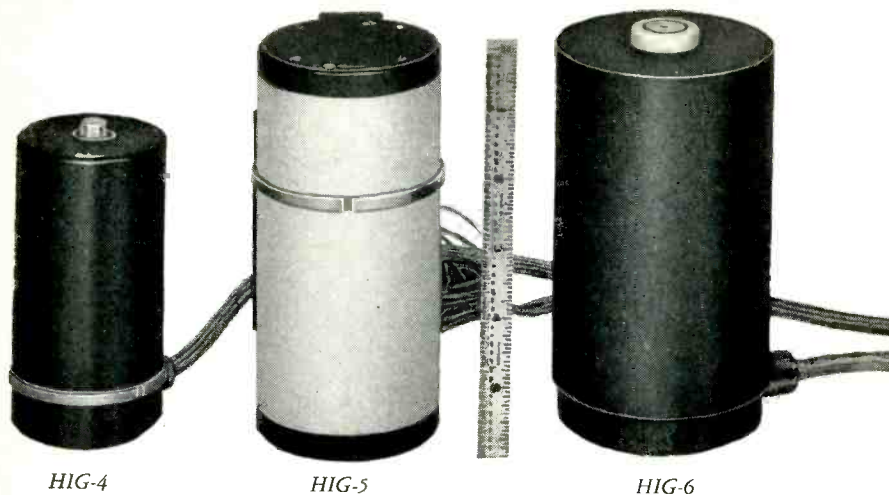
MASS PRODUCERS OF
ELECTRONIC COMPONENTS

65 GOVERNEUR ST., NEWARK 4, N. J.



K-CAP®

K-TRAN®



HIG-4

HIG-5

HIG-6

Small... rugged... the world's most sensitive!

NOW—A HONEYWELL HIG GYRO "FAMILY"

To meet your floated gyro needs, Honeywell has developed two new Hermetic Integrating Gyros, the HIG-4 and the HIG-6. These, together with the already famous HIG-5, make up the new Honeywell HIG "family!"

This is a *versatile* line-up, as indicated by the specifications below. It gives you a wide range of floated gyro accuracies, in a variety of weights and sizes. Honeywell HIGs can be used as rate gyros, platform gyros, directional gyros, free gyros, or precessible gyros.

For full details on the HIG "family" and on our full gyro line, write Honeywell Aero Division, Dept. EL-9-163, Minneapolis 13, Minnesota.

Specifications of new Honeywell HIG "family"

	HIG-4	HIG-5	HIG-6
Angular Momentum	10 ⁴	10 ⁵	10 ⁶
Threshold	1° per hr	.2° per hr	.01° per hr
Trimmed Drift Rate	5° per hr	1° per hr	.05° per hr
Maximum Precession Rate	5 radians/sec	1 radian/sec	.1 radian/sec
Characteristic Time Constant	3.5 millisecc	2.8 millisecc	3.1 millisecc
Damping Ratio—			
Output Axis/Input Axis	1 to 1	1 to 1	2.1 to 1
Torque Generator Scale Factor	1 or 10 dyne-cm/ma ²	2.5 or 35 dyne-cm/ma ²	.025 or 1 dyne-cm/ma ²
Signal Generator Scale Factor	25 volts/radian at 100ma 400 cps	34 volts/radian at 100ma 400 cps	25 volts/radian at 50ma 400 cps
Spin Motor Excitation	10 volts, 2 phase	10 volts, 3 phase	115 volts, 3 phase
Weight	1.5 lbs.	2.75 lbs.	4.5 lbs.

MINNEAPOLIS
Honeywell
Aeronautical Division

112 OFFICES ACROSS THE NATION



drilling the right-hand hole. The drill is then withdrawn and the carriage slid to the right to locate the rotor for the second hole. Compressed air from a hose removes all chips and curls.

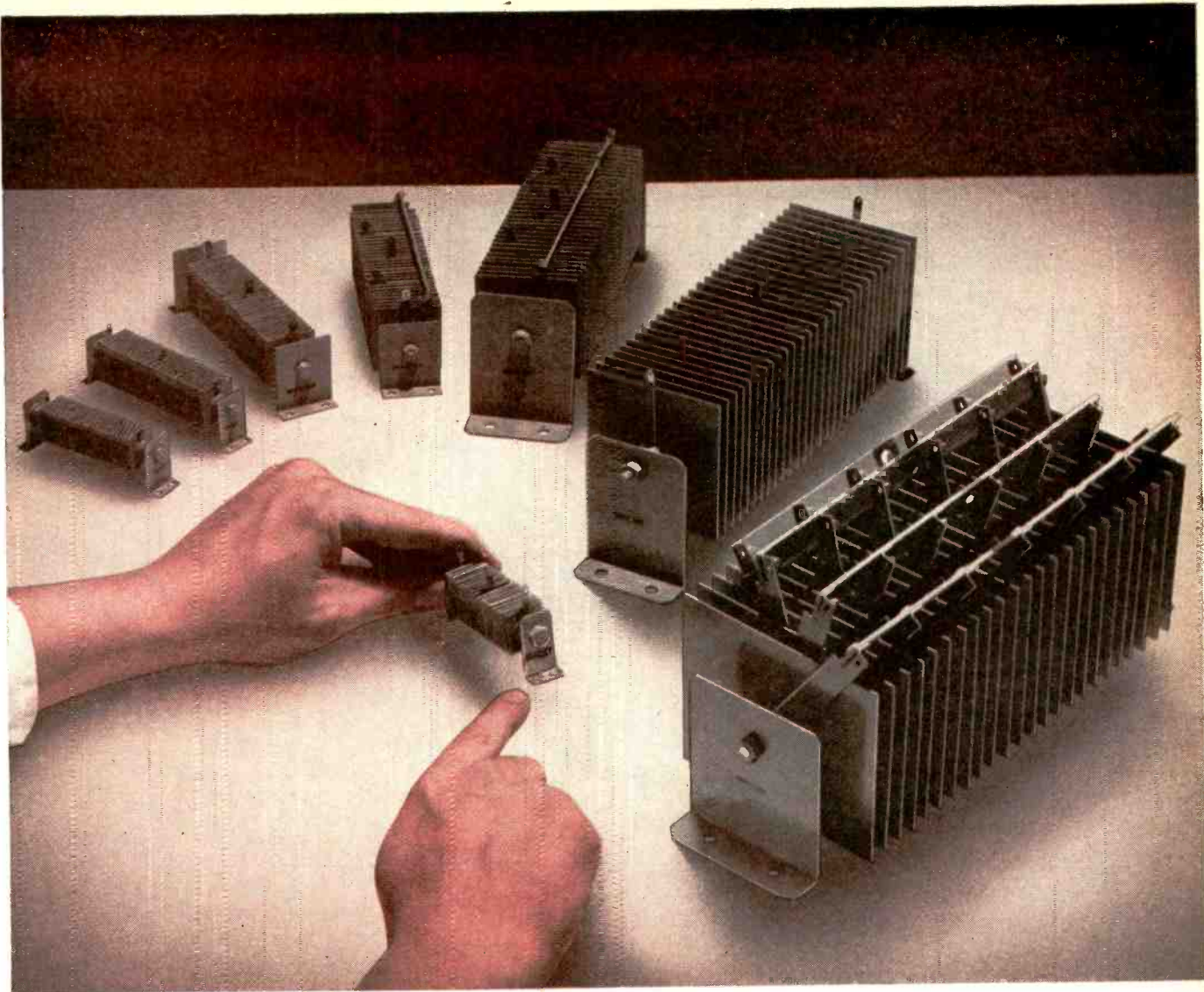
Plastic Windows Improve Wire Strippers

WITH CONVENTIONAL solid metal guards on motor-driven wire strippers, a safety hazard existed because operators continually used the machine with guard open so they could see the wire ends being twisted. The problem was solved in Bendix Pacific Division's plant in North Hollywood, California by bolting a transparent plastic guard permanently in position.

Mounting of the wire strippers on a slanting wood platform served to increase output and reduce worker fatigue because it permitted performing the operation while the hands of the worker were in a normal relaxed position. The standard model of Speedcraft insulated wire stripper, made by The Wire Stripper Co., Cleveland, Ohio,



Mounting wire stripper at forward angle as shown greatly reduced worker fatigue. Ruler mounted behind twisting head makes length setup easier



STACKS OF STABILITY

Bradley rectifiers invariably exceed performance requirements, but this quality bonus does not carry a premium price. Our exclusive vacuum process not only assures stability and long life; it also

assures low cost. We would like to prove it by quoting now on your rectifier needs. Please fill out the form below — no obligation, of course. You will get quick action.

VACUUM PROCESSED—for performance as rated

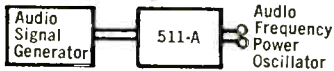
BRADLEY LABORATORIES, INC., 168E COLUMBUS AVENUE, NEW HAVEN 11, CONNECTICUT



DC Output: Volts Min. _____ Amperes Max. _____ Circuit _____	FINISH REQUIRED: _____
AC Input: Volts Max. _____ Phase _____	QUANTITY: _____
LOAD: Res. _____ Ind. _____ Cap. _____ Battery _____	NAME _____
DUTY: Continuous _____ Intermittent _____ On _____ Off _____	ADDRESS _____
COOLING: Convection _____ Forced _____ Ft. Per Min. _____	_____
Max. Ambient Temp. _____ °C	_____



TYPE 511 - A POWER AMPLIFIER



- PHASE SHIFT COMPENSATION
- NEGLIGIBLE DISTORTION
- HIGH VOLTAGE OUTPUT LEVEL

... a general purpose laboratory power amplifier featuring low distortion, low noise and excellent phase characteristics throughout the frequency range from 50 cps. to 50 kc. A choice of four outputs available to match various loads (5, 25, 200 or 1200 ohms). The 511A Power Amplifier is especially useful as a test driving source for tachometers, synchros, small motors, choppers, electro-mechanical devices and, with an audio frequency signal generator, as a power oscillator.

At rated frequencies and gain settings the overall phase shift is small. A special feature is the phase compensation circuit which permits the overall phase shift to be maintained at a constant value with varying gain. Harmonic distortion and intermodulation distortion are low. Output voltage up to 120 volts into a 1200 ohm load. Operates into loads varying from pure resistance to pure reactance.

The flexible system of phase shift control makes the 511-A Power Amplifier ideal for use in conjunction with phase measuring equipment as a power source in the investigation of phase characteristics of transmission lines, transformers, filters or equalizing networks, saturable reactors, magnetic amplifiers, and in acoustical measurements.

SPECIFICATIONS:

Output Characteristics and Gain (for 0.5% max. allowable harmonic distortion):

OUTPUT SELECTOR (Front Panel Control)	E _{out} Max.	Voltage Gain	Optimum Load	P _{out} Max.
Position 1	8 volts	1.4	5 ohms	12.8 W
Position 2	18 volts	2.8	25 ohms	13.0 W
Position 3	55 volts	8.0	200 ohms	15.1 W
Position 4	120 volts	21.0	1200 ohms	12.0 W

INPUT IMPEDANCE: 100 K ohms shunted by approximately 10 uF.

FREQUENCY RESPONSE: At 10 watts or less output, essentially flat from 50 cps to 30 kc, down 0.5 db at 50 kc. At 10 to 16 watts, essentially flat from 50 cps to 30 kc, down 1.0 db at 50 kc.

HARMONIC DISTORTION: At 10 watts or less output, less than 0.5% total harmonic distortion (rms). At 10 to 16 watts output, less than 1.0% total harmonic distortion (rms).

PHASE SHIFT: 1.0° ± 1.5° from 50 cps to 10 kc.

Phase shift may be compensated at any single frequency to remain constant for all gain settings. Phase shift may also be made zero for a single frequency and a single gain setting.

INTERMODULATION DISTORTION (rms): Less than 0.5% from 50 cps to 15 kc for difference frequency of 150 cycles.

OUTPUT REGULATION: ±5% of rated output voltage from optimum load to open circuit on all ranges.

HUM AND NOISE: Less than 15 mv. with input shorted.

TECHNOLOGY INSTRUMENT CORP.

533 MAIN ST., ACTON, MASS., ACTon 3-7711



Method of mounting transparent plastic guard on stripper. Wire stripping is one of many electronic production operations that is being performed efficiently by handicapped workers in this plant

is employed. With the stripper projecting over the edge of the bench, it was no longer necessary to drill a hole through the bench from the motor switch to the foot pedal used by the operator for starting and stopping the stripper.

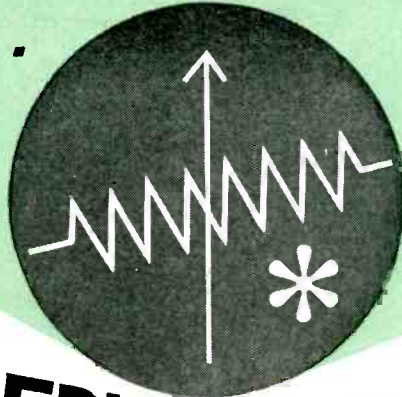
Economic Inspection of Soldered Connections

WITH RESPECT to loose soldered connections in military electronic equipment and in telephone dial exchange equipment, the quality control organization at the Hawthorne plant of Western Electric Co. has set a bogey of not more than one loose connection per 10,000 connections. The degree to which this has been attained is shown on the accompanying chart.

Production problems, quality control, inspection methods and operator training programs related to soldered connections were discussed by C. S. Barrett of this plant at the Conference on Reliability of Electrical Connections in Chicago, April 16, 1954. The following material was abstracted from his paper.

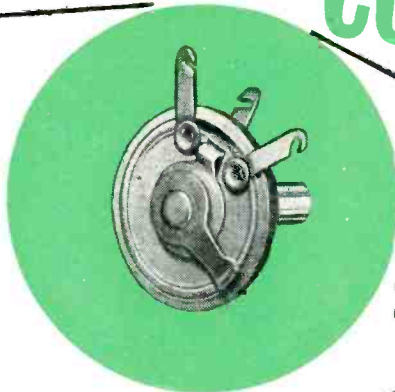
In the audit inspection of the product, defects are assessed

From "The House of Resistors" **
come . . .



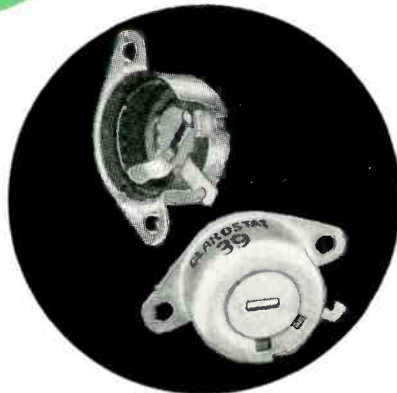
COST-REDUCING CONTROLS

So you must get cost down in designing that assembly? That's just the time to enlist Clarostat's cost-saving talents and facilities. The same superlative engineering and production skill that accounts for the finest quality in controls and resistors, is also available for designing and fabricating cost-reducing components. Three typical examples are presented herewith. These are *standard* items, promptly available in any quantities, at marked savings. And for any extraordinary requirements, *special* controls and resistors can be developed, tooled-up and produced.



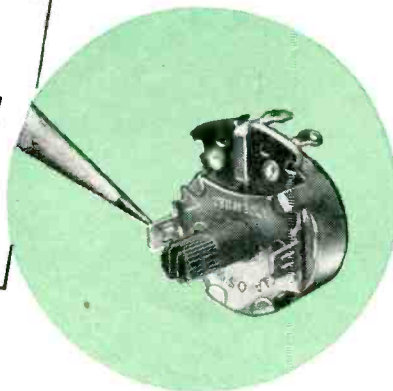
The original "Humdinger" Series MH. Compact, rugged, wire-wound control. Virtually millions in use. Fibre base holds resistance winding. Movable arm and shaft. 1-watt. 2 to 1000 ohms.

Latest "Humdinger" Series 39. Metal-case mounted with rivets or screws. Mounting surface serves as cover. Semi-fixed setting by screwdriver slipped into rotor slot — no shaft 2-watt 4 to 5000 ohms.



Twist-Tab Mounted Series 47. Eliminates usual bushing, lockwasher, nut. Composition-element control. Metal or plastic shaft. Plastic shaft has rear slotted protrusion, therefore adjustable from front or rear.

It's easy
to do business with **CLAROSTAT!**
Agents in all principal cities. ★ Wire Western Union — we have a direct wire. ★ Telephone Dover 975 — we have added trunk lines to render service. ★ Teletype — our TWX number is Dover 275-U.

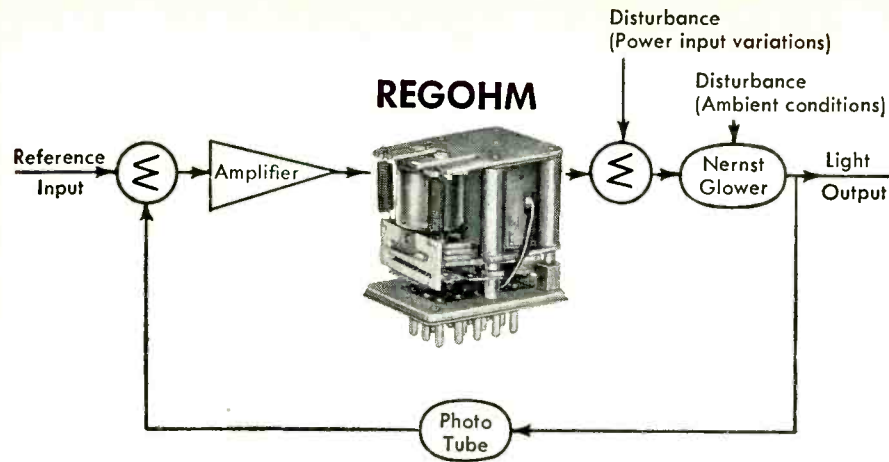


**Trade Mark



CONTROLS and RESISTORS

CLAROSTAT MFG. CO., INC., DOVER, NEW HAMPSHIRE
In Canada: CANADIAN MARCONI CO., Ltd., Toronto, Ont.



Regohm keeps radiation energy constant for new infrared spectrometers

Since infrared analysis must be able to record changes as slight as 1 part in a million of a chemical substance, the energy source must be kept constant. The above block diagram shows how Regohm does this for a Perkin-Elmer Infrared Spectrometer.

In most applications, Regohm directly senses what it controls. Here, however, Regohm serves as a power amplifier. A photo tube acts as the sensing device. Its output is electronically amplified, using a balanced DC amplifier to raise the power level of signal and eliminate the effects of drift.

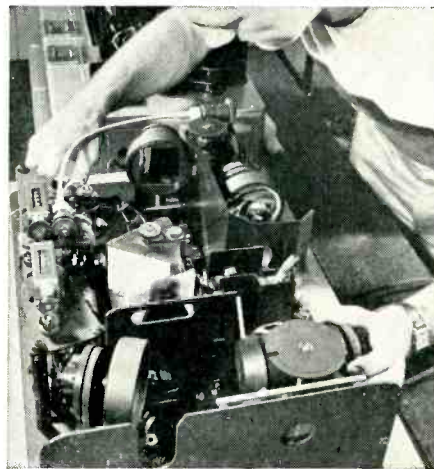
The photo tube is constantly sensitive to changes from the Nernst glower by delivering current output proportional to changes in radiation. Output from the Reference Balanced Amplifier changes above and below fixed voltage.

Reacting to milliwatt output changes in the amplifier, Regohm produces large changes in power input to the Nernst glower. Hence, the Regohm circuit adjusts for all variations in source intensity, counteracting disturbance from power input changes and ambient temperature conditions. Regohm's dashpot stabilizes the control system.

Electric Regulator takes pride in the fact that high performance alone was the reason for P-E's choice of Regohm for equipment that is the "Cadillac" in its field.

7 Reasons why Regohm can simplify your control problem

- 1. Regohm is small in size**—It is compact, lightweight, position-free.
- 2. Regohm is a high-gain power amplifier**—Milliwatt variations in signal energy control energy changes millions of times greater.
- 3. Regohm's isolated signal and control circuits**



Assembling a Perkin-Elmer Infrared Spectrometer

eliminate impedance matching problems—Signal coils may have ratings from 0.01 to 350 amperes. Control resistance range unlimited.

4. Regohm will correct system instability—A reliable, sturdy dashpot aids system damping.

5. Regohm's effect can be calculated in advance—Its response is independent of rest of servo system.

6. Regohm assures continuous control—In "closed loop" systems a high-speed averaging effect occurs.

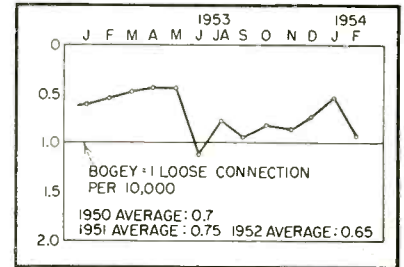
7. Regohm has long life—Plug-in feature simplifies replacement when necessary.

Regohm can be applied to your control system or regulation problem. Our engineering and research facilities are always at your service. Write for Bulletin 505.00, analyzing Regohm's characteristics and applications. Address Dept. E., Electric Regulator Corporation, Norwalk, Conn.

penalties in accordance with a four-fold classification, the demerit values depending on the seriousness of the defects. Loose connections are assessed the maximum-seriousness weight value.

Training Procedures

The first consideration in achieving good soldered connections is the selection of qualified people for wireman jobs. Tests determine an applicant's ability to learn and his



Quality control record for soldered connections

capabilities with respect to such factors as hand, eye and arm coordination and finger dexterity. Embryo wiremen are placed in an instruction group for a maximum of 20 weeks. Carefully chosen from supervisory ranks, the instructor is temporarily transferred to the Training Department. Trainees are paid on a day-work basis.

A performance chart is kept for each trainee, and individuals who do not make satisfactory and progressive advancement are placed in some other field of work. Individuals may and can complete the training and take their place in the production unit before 20 weeks have elapsed if they show above-average ability and accomplishment.

After training, new wiremen are placed on the simpler wiring jobs. Candidates for the advanced wiring jobs come from the group of employees engaged in doing the simpler wiring. Before being placed on the advanced job they are given a second period of training covering a maximum of 10 weeks.

100-Percent Inspection

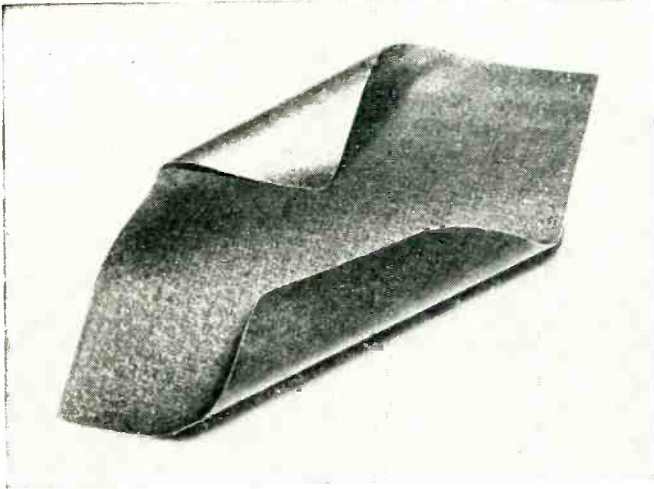
Although all manufacturing departments recognize the importance of operator training and the necessity for a high level of quality for soldered connections, there have been relatively few groups of oper-

REGOHM

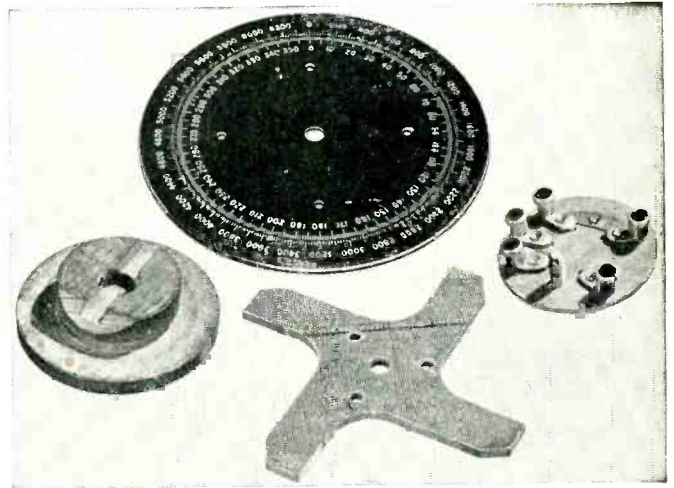


CONTROL COMPONENT IN: Servo systems • battery chargers • airborne controls • portable and stationary generators • marine radar • inverters • locomotive braking systems • mobile telephones • guided missiles • signal and alarm systems • telephone central station equipment • magnetic clutches • railroad communication systems • magnetic amplifiers.

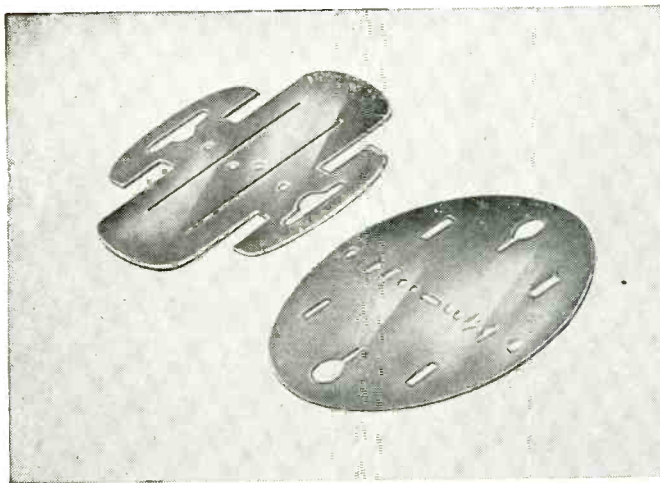
Do you have any of these problems?



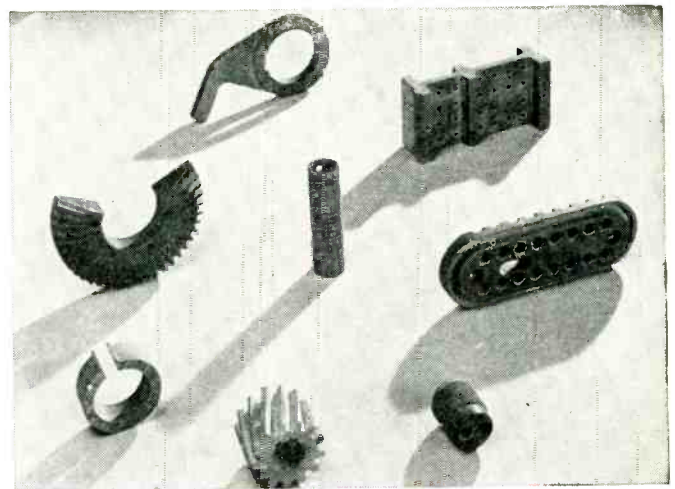
1. Looking for a thin, flexible insulating material that will not break down under extremely high temperatures? ISOMICA® Flexible Plate, Class B and Class H, built-up from continuous mica sheets, gives superior electrical and thermal insulation for coil windings and similar applications.



2. Need a material with special mechanical, thermal and insulating properties? LAMICOID®—a laminated plastic made with various fillers—gives you the properties you need for antenna parts, coil forms, tube sockets, switch gear and relay parts, panels, motor and transformer parts, and dozens of other uses.



3. Need accurately punched mica stampings for filament, grid and plate supports? MICO produces mica stampings to extremely fine tolerances. Whenever you need precision-fabricated mica of the highest quality, call on MICO. We have 60 years of experience in this field.



4. Looking for precision-made fabricated parts? Let us solve your problems with parts fabricated from LAMICOID®—a thermo-setting plastic—strong as metal, lighter than wood. We are fully equipped with the latest machinery and can provide you with the best possible service.

Whatever electrical insulation material you need—Class A to Class H—MICO makes it best. We manufacture it, cut it to size, or fabricate it to your specification. Send us your blueprints or problems today.



MICA *Insulator* **COMPANY**

Schenectady 1, New York

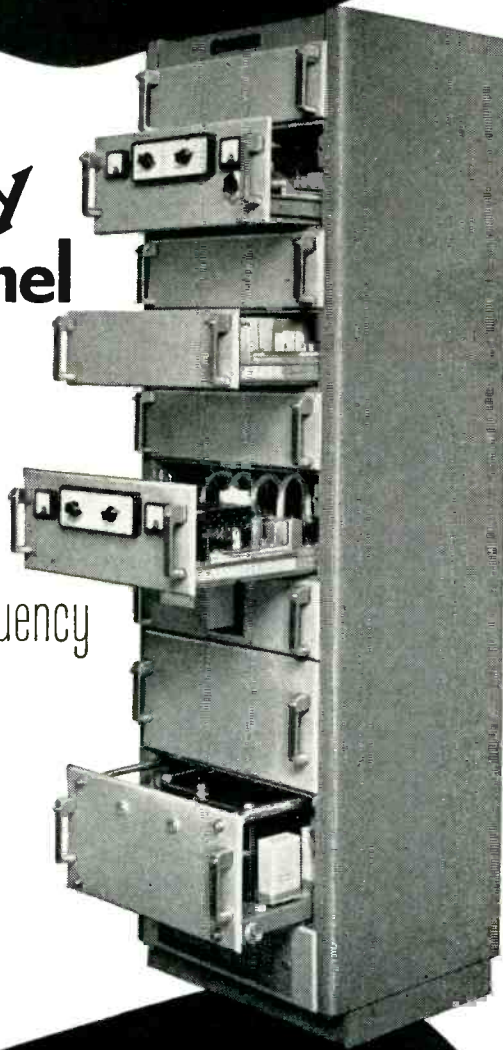
Offices in Principal Cities
In Canada—Micanite Canada Ltd., Granby, Quebec

LAMICOID® (Laminated Plastic) • MICANITE® (Built-up Mica) • EMPIK® (Varnished Fabrics and Paper) • FABRICATED MICA • ISOMICA®

NO EXTERNAL CHANNELLING EQUIPMENT !

**Standard
six channel**

Very **H**igh **F**requency
radio link
type
FP11



complete in one cabinet

Six Telephone or Teleprinter Channels, plus Independent Order Wire Circuit. Full Supervisory and Control Facilities. Alternative Radio Frequency Bands.

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Registered Office: Connaught House, Aldwych, London, W.C.2

RADIO DIVISION • New Southgate • London • N.11 • England



ators which have produced this level of quality consistently. Most operating departments meet their bogey by inspecting the output 100 percent and correcting the defects found in inspection.

Experience has shown that 100-percent inspection will not guarantee removal of all defects. This is especially true in an inspection of the type involved for loose soldered connections, where the inspector has to examine visually thousands of good connections with very little probability of finding a single defect. Very good inspectors are not 100-percent efficient in detecting loose soldered connections. Furthermore, repeated inspection of soldered connections in wired equipments can be detrimental. Several years ago, a shop got into soldering difficulties and in an honest effort to improve the quality repeated the 100-percent inspection several times. Most of the poor joints were located and corrected, but it was almost like burning down the barn to get rid of the rats—so many broken wires began to develop as a result of the overzealous inspection that it was necessary to rip off the cables and rewire the equipments.

Sampling Inspection

Although sampling for soldering has not been introduced generally, one sampling layout has been issued. Soldering defects other than loose connections are inspected on a regular lot-by-lot AOQL sampling plan, while sampling for loose connections is on a continuous sampling plan developed around H. F. Dodge's Bell Telephone System Monograph 1834, CSP 1. The values of $f = 25$ percent and $AOQL = 0.01$ percent were used. The plan provides that 25 percent of the soldered connections of each equipment unit be inspected for loose connections. If a defect is found in the course of sampling, 100-percent inspection is initiated and continued until 6,000 consecutive good connections have been inspected, after which 25-percent sampling is again resumed. Assuming that all defects are found and removed in all portions of the product inspected, this plan will

NOW! the new

**Eliminates extra
manpower
requirements**

*Gray
Telop III*

opaque and transparency projector



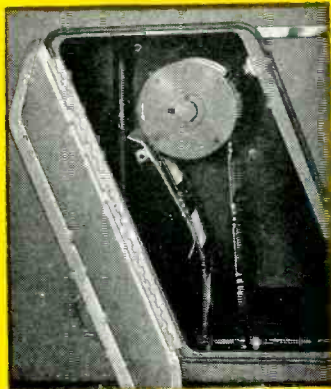
**REMOTE OR LOCAL CONTROL
CHECK THESE NEW FEATURES**

- Completely automatic . . . utilizing features contained in the now famous Telop and Telojector . . . Slides change by push button control.
- Sequence of up to 50 slides can be handled at one loading . . . additional pre-loaded slide holders easily inserted in unit.
- Remote control of lap dissolves . . . superposition of two slides . . . and slide changes.
- Shutter type dimming permits fades without variation of color temperature . . . opaque copy cooled by heat filters and adequate blowers . . . assembly movable on base which permits easy focus of image.

**SCREEN OUT HIGH PRODUCTION
COSTS FOR LOCAL SPONSORS**

Telop III by the elimination of extra manpower assures the production and projection of low-cost commercials that local sponsors can afford. It can be used with any TV camera including the new Vidicon camera. Telop III projects on single optical axis opaque cards, photographs, art work, transparent 3 1/4" x 4" glass slides, strip material, and 2" x 2" transparencies when Telojector is used with optical channel provided. Telop III eliminates costly film strips and expensive live talent.

WRITE FOR: Illustrated bulletin describing Telop III specifications. Your request will receive prompt response.



Telop III . . . interior view of automatic slide holder which accommodates 4" x 5" opaque slides . . . One lens . . . no registration problem . . . no keystoring.

GRAY RESEARCH

AND DEVELOPMENT CO., Inc., Hilliard St., Manchester, Conn.
Division of the GRAY MANUFACTURING COMPANY
Originators of the Gray Telephone Pay Station and the
Gray Audograph and PhonAudograph.

new approach to THERMAL RELAY DESIGN

G-V TIME DELAY RELAYS

- Hermetically Sealed
- Still Adjustable
- Amazingly Rugged
- Thoroughly Dependable



G-V ENGINEERING OFFERS A NEW APPROACH TO THERMAL RELAY DESIGN

- Stainless steel mechanism welded into a single integral structure and supported at both ends for unequalled resistance to vibration and shock
- Heater built inside expanding member for maximum efficiency and protection
- Rolling contact action for positive operation
- Easy adjustability where desired
- Precise operation never before available in thermal relays
- Time ranges: 3 seconds to 5 minutes
- Hermetically sealed in metal shell
- Heater voltages up to 230 volts
- Fully temperature compensated
- Suitable for military and industrial use
- Unequalled for ruggedness and precision

U. S. and Foreign Patents Pending

G-V
CONTROLS INC.

The stainless steel structure of G-V Thermal Relays, encased in a metal shell, delivers dependable, trouble-free performance under the most severe operating conditions . . . proved in commercial and military service for three years.

Thermal Relays are the simplest, smallest, lightest, most economical means of introducing a substantial delay into an electrical circuit.

G-V Relays offer performance never before available.

Why not find out by writing today how they can help you. G-V Controls are Thermal Relay specialists. They originated the 7-pin miniature and now make more of these than all other producers combined.

Only G-V offers complete technical data and helpful engineering cooperation on THERMAL TIME DELAY RELAYS

Write for bulletin and help with your particular problems.

24 Hollywood Plaza
East Orange, New Jersey

Greatly expanded production facilities assure prompt deliveries.

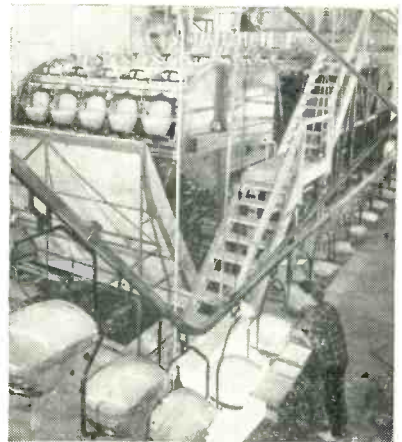
assure a maximum average outgoing quality of one defect in 10,000.

In addition to the regular fractional sample inspection, the layout provides for another inspection of 600 connections from each soldering operator each day. The purpose of this inspection is to furnish additional inspection control and provide a complete pattern of the quality of each soldering operator's work. If a loose connection is found in this inspection the sample is extended to another 1,800 additional connections with no additional defects allowed. All defects are returned to the operators for repair. Frequently only a small portion of the operators and/or machines are principally responsible for most of the defects. Operator sampling is an efficient means for reducing the defects to an economic level.

Screen-Settling Conveyor for 27-Inch Picture Tubes

A NEW MACHINE 47 feet long and capable of handling up to 210 27-inch picture tubes at a time is being used in Raytheon's Quincy, Mass. plant for applying screen phosphors automatically. Operators merely load empty bulbs five in a row and take them off after one trip around the huge endless conveyor.

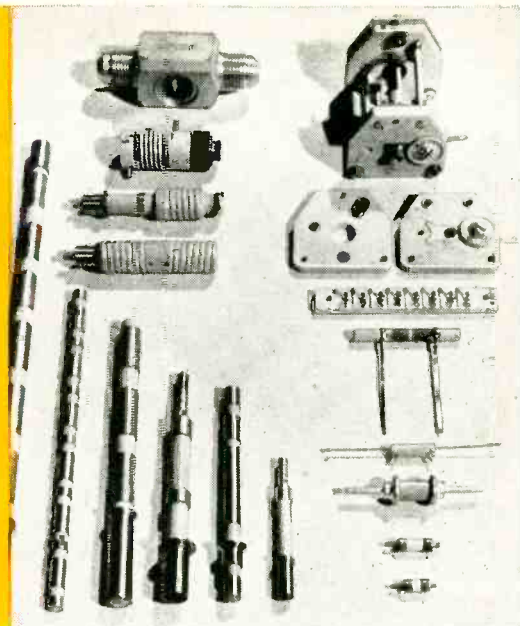
Each bulb is automatically filled with chemicals. As the bulbs move smoothly and steadily across the



Automatic screen-applying machine for 27-inch picture tubes. Man at right rear unloads finished tubes for transfer to overhead conveyor which brings them past fluorescent-lamp inspection position in foreground

ceramics and metal

are permanently
and accurately combined



The metal bands on the rotor shafts shown at the left, above, are concentric with the shaft to within 0.001 in.

Stupakoff

assemblies

Your production procedure is simplified when you use high-precision Stupakoff ceramic-to-metal assemblies. Extensive experience in the field of electrical and electronic ceramics, thorough familiarity with methods of metallizing, and the use of modern precision manufacturing methods insure the high quality and uniformity of Stupakoff Assemblies.

Among the assemblies made by Stupakoff are: rotor shafts, strain and spreader insulators, stand-offs and trimmers. Ceramic bodies are specially formulated for the intended service; metals used include silver, copper, brass, stainless steel and monel. Stupakoff's broad experience in this field insures the selection of a method of assembly best suited to meet service conditions.

A few types of Stupakoff Ceramic-to-Metal Assemblies are illustrated in the photographs on this page.

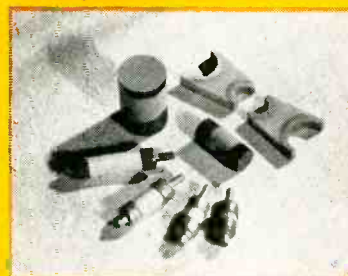
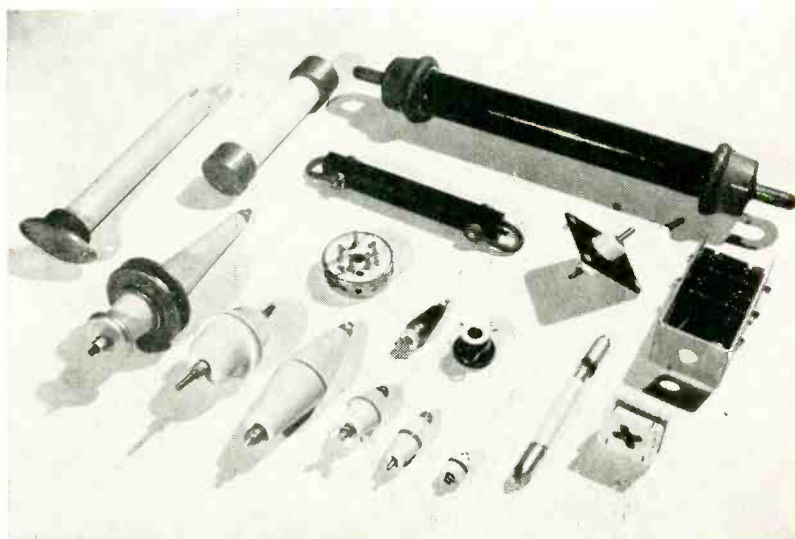
STUPAKOFF CERAMIC & MANUFACTURING COMPANY

LATROBE, PENNSYLVANIA

DIVISION OF THE CARBORUNDUM COMPANY

Small metallized ceramic parts are accurately made and dependably uniform.

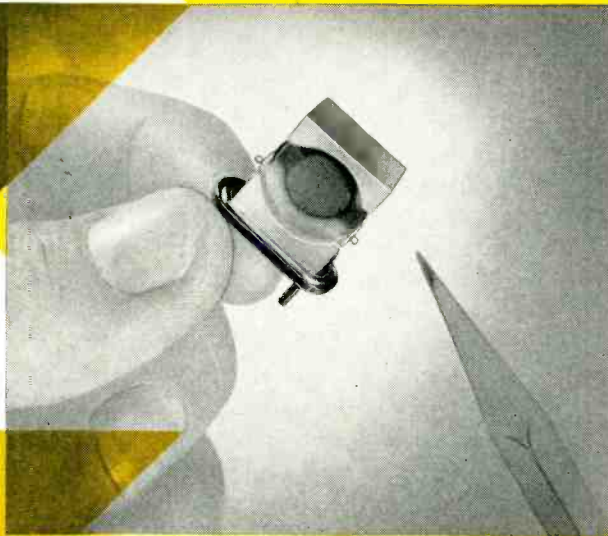
Some of the larger types of Stupakoff metallized ceramic parts.



NEW, SHOCK-PROOF 1 MC CRYSTAL UNIT PERFECTED

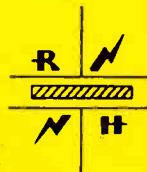
Reeves-Hoffman has perfected a 1 mc Crystal Unit, shock-mounted in an HC-6 holder, and built to meet all requirements for MIL types: CR-18, 19, 27, 28, 35, 36 and 48/ μ . The secret of the crystal's exceptional stability lies in the revolutionary, new nylon nest which firmly secures the AT cut crystal from shock, permitting Reeves to go down to 500 kc in an HC-6 holder while keeping frequency deviation at a minimum.

This radically different nylon mount proves once again Reeves-Hoffman offers superior quality in all types of crystal units... especially in the low frequency range.



Write today for further information and prices.

REEVES-
HOFFMAN
CORPORATION



A subsidiary of Claude Neon, Inc.

CHERRY AND NORTH STREETS

CARLISLE 2, PENNSYLVANIA

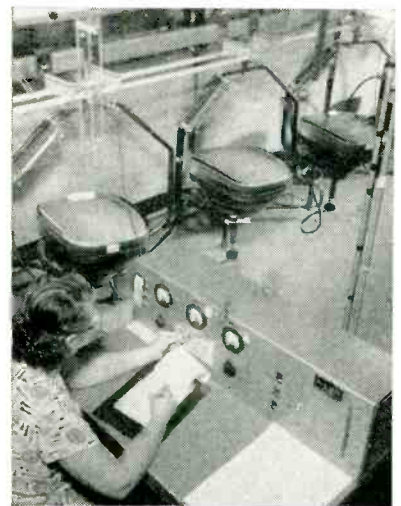
LICENSED UNDER PATENTS OF THE BELL SYSTEM

top of the machine, the phosphors settle on to the face. The liquid is automatically poured out of each bulb as the bulbs move around the end of the machine. All bulb holders are adjustable to accommodate the various tube sizes which might be produced—primarily 21-inch, 24-inch and 27-inch.

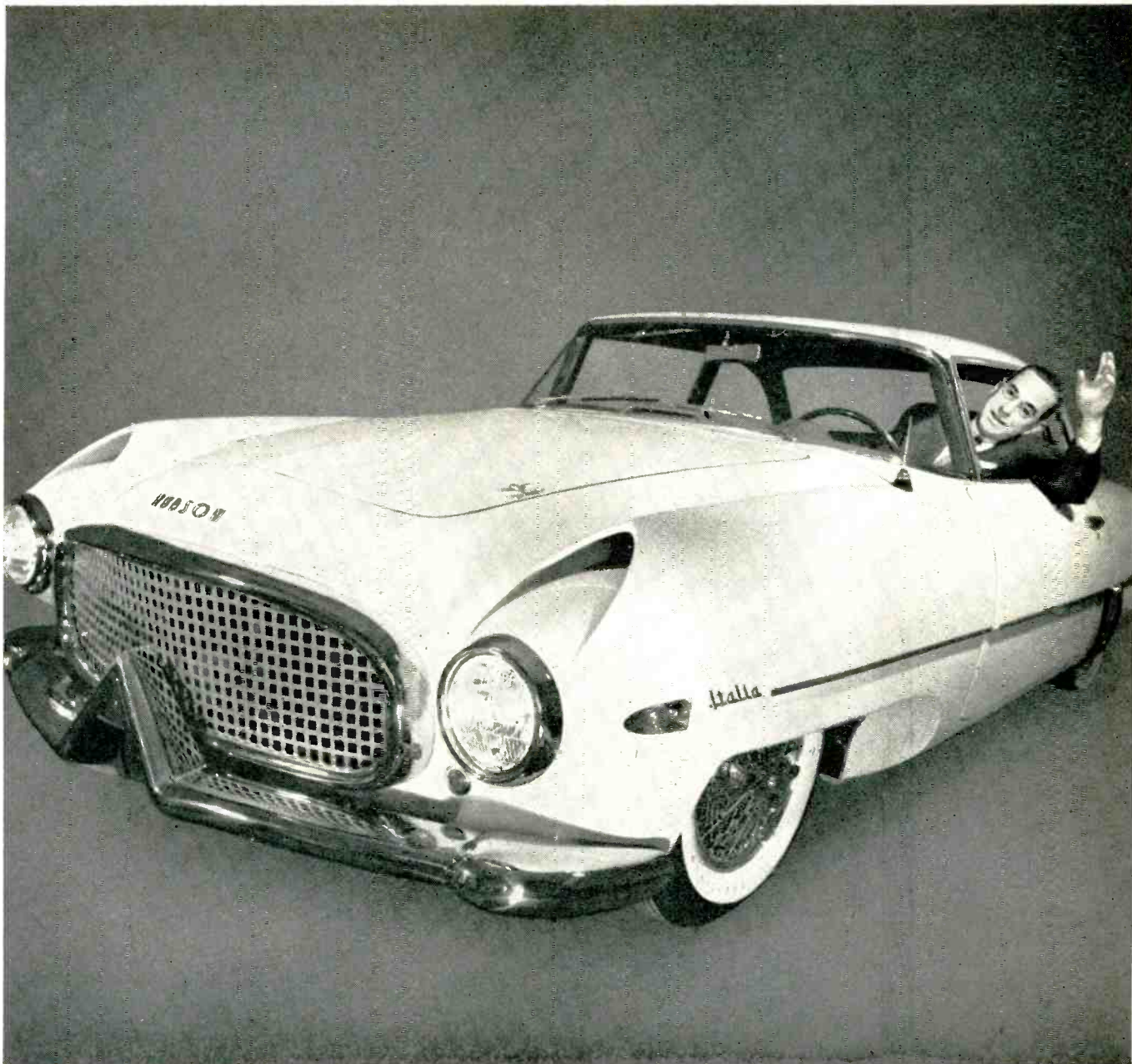
In the underpart of the machine the bulbs are automatically dried by suitable air blasts. They are then unloaded and set into an overhead conveyor which runs slowly through an inspection table where the inspector checks for all types of screen blemishes. These are illuminated by the light from the fluorescent bulbs underneath the inspection table. Unsatisfactory bulbs are marked. At a later point on the conveyor, these bulbs are removed and put through a washing process, after which they go back to the settling machine for another screen. The procedure is mechanized in such a manner that screen rejects can be reprocessed as easily as for a new bulb.

Testing Picture Tubes On Conveyor Line

A TEST SET located alongside the overhead picture-tube conveyor line in Raytheon's Quincy, Mass. plant gives a complete electrical test in the 20-second period that is available for this purpose. By manipu-



Setup for testing picture tubes as they move past on conveyor. Operator notes readings of meters as she pushes each of the four test buttons in turn with her left hand as shown



Taking the wheel of Hudson Motor Car Co.'s "Italia," N. K. VanDerzee, V.P. in Charge of Sales, explains:

How a new Hudson avoids traffic problems!

"Here is the new *Italia*—a look into the future and the latest member of the Hudson family which includes the Hornet, the Wasp, and the Jet," says N. K. VanDerzee.

"But new design naturally creates new traffic problems—in the factory. It's a big job to prevent parts shortages from stalling assembly lines. Air Express is a tremendous help.

"As our Traffic Department puts it: One phone call, and it's a load off our minds. Air Express delivers in a matter of hours. This dependable speed gives us the safety margin we need to keep production rolling. We handle about 2,500 lbs. a month by Air Express. Naturally, we're thinking about speed. But

our records show that most of our Air Express shipments also *cost less* than they would by any other air service!

"Add to this the country-wide coverage and Air Express' ability to pinpoint shipments in transit, and you have some idea of why our Traffic Department turns to Air Express for our most urgent traffic.

"We in Sales are proud of our reputation for on-time deliveries of new cars. In large part, we owe that reputation to our Traffic Department—and Air Express."

It pays to express yourself clearly. Say Air Express! Division of Railway Express Agency.



Air Express

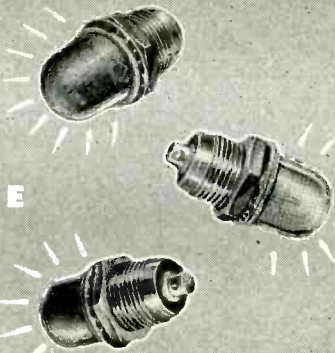


GETS THERE FIRST via U.S. Scheduled Airlines

dependable subminiature indicator lights

WITH W-I-D-E ANGLE
VISIBILITY

Light "piped" throughout entire periphery of long plastic lens assures easy visibility of signal from all sides.



- ✓ Smaller, truly subminiature size
- ✓ Fully illuminated lens is clearly visible from any angle
- ✓ For either standard or edge-lit panels
- ✓ Designed to meet critical aviation performance standards

Larger illuminated area... smaller physical size

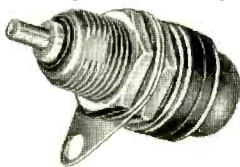
Smaller than most subminiature lamps, yet with uniformly bright wide-angle visibility, Hetherington L6000 Series make ideal indicator or warning lights for critical military as well as many commercial applications. Using AN-3140 lamps fitted into a heavy plastic lens $\frac{7}{64}$ " long, these rugged lights are $1\frac{1}{32}$ " overall, and mount in a $\frac{13}{32}$ " hole. Details in Bulletin L2.

"Standard" Hetherington Lights Fill Most "Special" Requirements



EDGE-LIT PANEL MOUNTING Series L2000

... for MIL-P-7788 panels. Sturdily constructed of nickel-plated brass with integral molded-in terminal and snug-fitting plastic lens that will not vibrate loose. Easy to mount. Write for Hetherington Bulletin L1.



REGULAR PANEL MOUNTING Series L1000

Combines exceptionally small size and light weight with durable vibration-resistant construction. Sealed against moisture. Terminal is molded into the assembly. Ask for Bulletin L1.



"PUSH-TO-TEST" INDICATORS Series L3000

Ideal for many military as well as industrial uses. Bulb is lit by pressing spring-mounted lens button. Supplied with or without silicone boot for moisture protection. Send for Hetherington Bulletin L1.



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 Hetherington Catalog.

HETHERINGTON

SHARON HILL, PA.

West Coast Division: 8568 W. Washington Blvd.
Culver City, California

Indicator lights • Switch-indicator light combinations • Push-button, snap action, and toggle switches • "Hi-G" Relays • Aircraft and Electrical Equipment Assemblies.

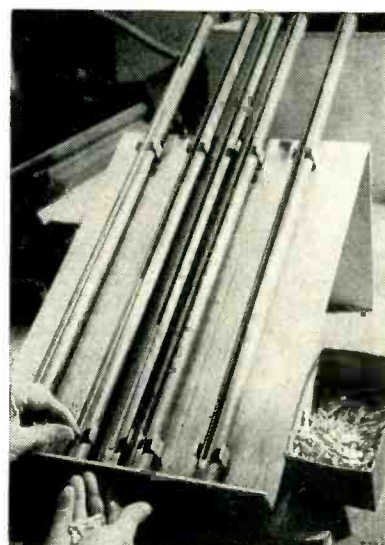
lating pushbuttons while watching meters the operator checks in turn for gas, cathode emission, control grid cutoff voltage and short-circuits.

Socket and second anode leads run from the picture tube to brushes mounted on the frame of the conveyor unit. As the picture tube approaches the test set, these brushes make contact with copper busbars that are connected to the test set. Provision is made for energizing the filament with longer busbars to heat up the tube before it is tested. Transparent plastic sheets mounted alongside the copper conductor strips provide added insulation for the second anode voltage. A small fluorescent lamp attached to each conveyor unit serves as a safety warning by glowing when the tube reaches the high-voltage busbar for the actual test.

Inserting T-Shaped Lugs in Phenolic Boards

INSERTION and fastening of T-shaped soldering lugs in phenolic boards can be done rapidly and accurately by means of a special machine designed and built by engineers at the Lenkurt Electric Co., San Carlos, Calif.

After the boards are sawed to desired sizes, they are punched with T-shaped holes for the lugs. Necessary markings on the boards are



Loading lugs into magazines held by spring clips on sheet metal fixture. Curved metal stud projecting up into each magazine at bottom leaves starting space for insertion of lug



HOW ARE YOUR COMMUNICATIONS ?

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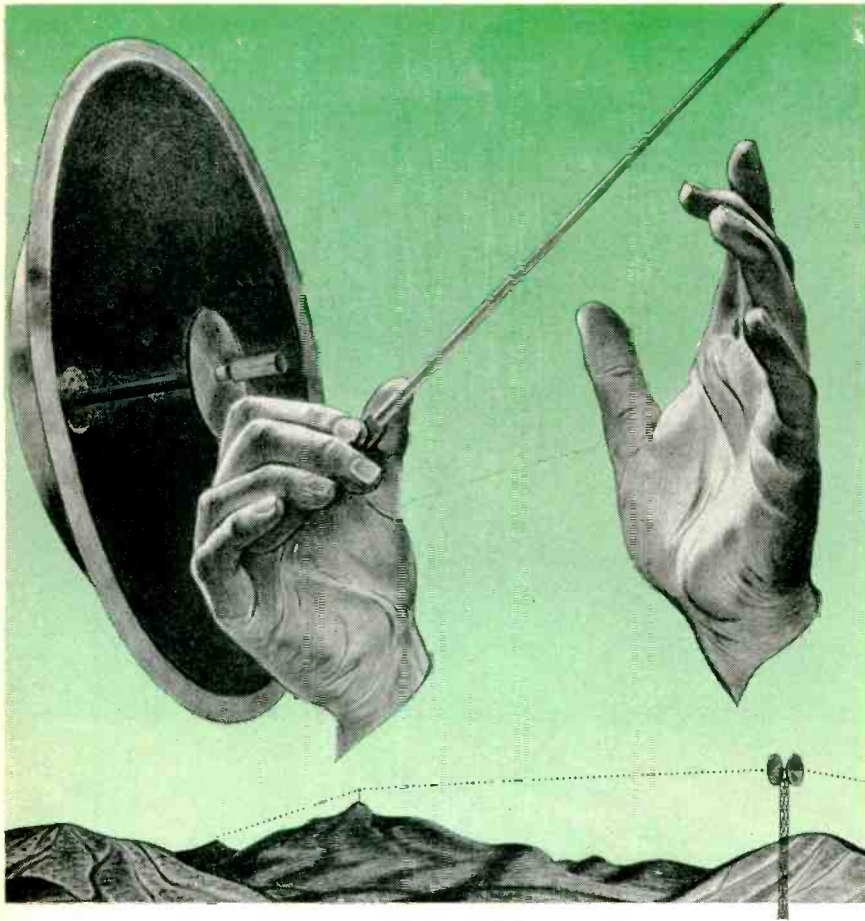
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IN RELAY KLYSTRONS, *Quality counts most...*

For performance that measures up to the exacting demands of high frequency relay systems, there can be no compromise with quality. System designers and equipment buyers know that high performance, high frequency systems depend upon klystrons having sufficient power to override noise, excellent frequency stability and long life. Varian klystrons are **designed** and **built** to meet these exacting demands.

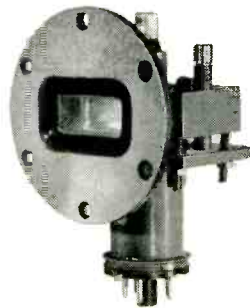
VARIAN MEANS PROVED PERFORMANCE...

In the 6000 to 8000 megacycle band, Varian X-26 klystrons outperform all others. Here are five reasons why leading system designers insist on these klystrons for top performance in relay applications:

- **Greater Power** — X-26 high power klystrons are conservatively rated. They will deliver **more** than rated power **without** failure.
- **Greater Frequency Stability** — X-26 klystrons have negligible short term drift — long term drift is less than 5 megacycles.
- **Greater Uniformity** — Varian mass production techniques assure uniformity — every klystron is as reliable as a nut and bolt.
- **Longer Life** — X-26 klystrons can be operated at full power for thousands of hours, at low power for years.
- **Less Distortion, Less Noise** — FM distortion and inherent noise are negligible — 60 db below a 1-megacycle deviation.

IN EVERY KLYSTRON APPLICATION, VARIAN GIVES YOU:

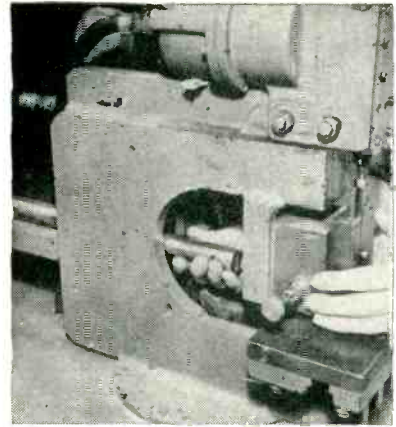
- Advanced Design
- Operating Economy
- Proved Performance
- Structural integrity



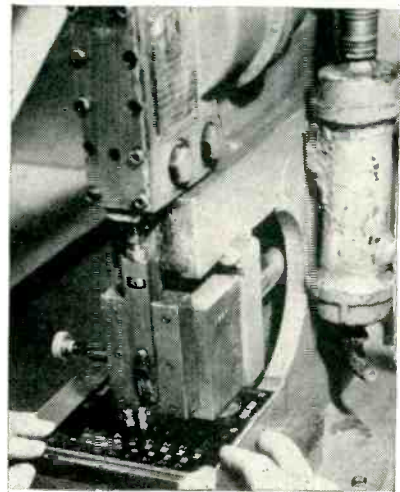


IN KLYSTRONS, THE MARK OF LEADERSHIP IS
VARIAN associates
 PALO ALTO 1, CALIFORNIA

Representatives in all principal cities



Loading filled magazine into press. Magazine is solid rod having milled slot running its entire length



Driving lugs into panel with air-actuated press controlled by foot treadle

applied by engraving or hot stamping. The lugs are stamped from $\frac{1}{8}$ -inch brass ribbon.

The lugs are loaded manually one by one into a magazine that will hold 375 in one filling, using a fixture that facilitates loading from the bottom. The magazine is then put into a feeding tube. The next step is connecting the loaded tube to the air supply for the machine's driving head. The air equipment utilized with the machine is manufactured by the Keller Tool Co., Grand Haven, Mich.

The lugs are driven into a phenolic board as the machine operator actuates a foot treadle. A pilot button on the table surface of the machine is used in positioning the board. As the operator moves the board along the surface, the button protrudes into a hole opening and the operator knows the board is positioned properly for insertion of

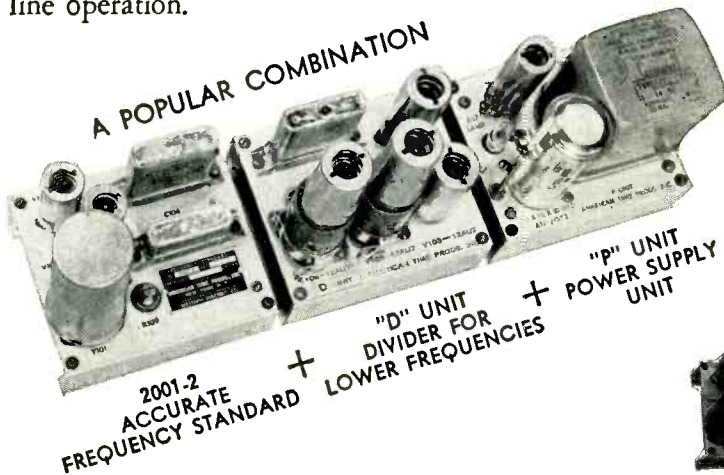
FREQUENCY STANDARDS

Modular system

DESIGNED AS A

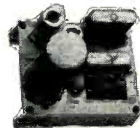
The Type 2001-2 series provides frequencies from 30 to 30,000 cycles with an accuracy of .001% (at room temperatures) in units suitable for integration with instruments of your own design — or for panel rack mounting with your own power sources — or for line operation.

WHICH WILL MEET YOUR
CUSTOM NEEDS
FROM A COMBINATION OF
STOCK UNITS



TYPICAL COMBINATIONS

2001-2	2001-2 + M
2001-2 + L	2001-2 + M + P
2001-2 + L + P	2001-2 + L + P + R
2001-2 + H	2001-2 + H + P + R
2001-2 + H + P	2001-2 + M + P + R



TYPE "2001-2"
FREQUENCY STANDARD
Frequencies, 200 to 3,000 cycles. Output, approximate sine wave at 5 volts.

ACCESSORY UNITS



"L" UNIT.
DIVIDER, (MULTI-VIBRATOR TYPE)
Provides frequencies from 30 to 200, controlled by the 2001-2 unit. Output, approx. 5V. Approx. sine wave.



"M" UNIT
AMPLIFIER
Provides 2 watts at 6 and 110 volts.



"D" UNIT.
DIVIDER, (COUNTER TYPE)
Provides 40 to 200 cycles controlled by the 2001-2 unit. (fail safe)



"P" UNIT
POWER SUPPLY
Provides power for combinations of units illustrated, if other sources are inconvenient or not available.



"H" UNIT
MULTIPLIER
Provides frequencies from 3,000 to 30,000 cycles, controlled by the 2001-2 unit. Output, approximately 5 volts.



"R" UNIT
PANEL MOUNTING
Accommodates up to three units. Standard size is 8 3/4 inches high, 19 inches long.

For details, please request our "Type 2001-2" Booklet.

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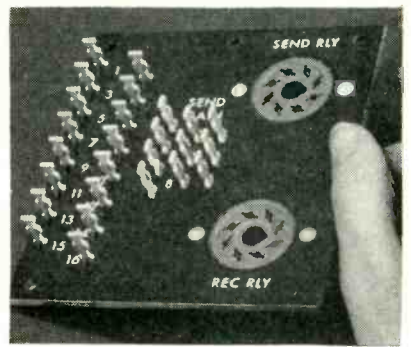
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TO SPECIFICATIONS

"Chester"
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For Dependable Wiring,
Connect It with Chester!



CHESTER CABLE CORP.
CHESTER, NEW YORK



Appearance of lugs in panel

a lug. This enables the operation to be done rapidly and assures perfect alignment of the lugs.

An average-size terminal board can be stamped with 26 lugs in a matter of seconds.

Quantity Reproduction of Photo-Oscillograms

By DANIEL NAIDAMAST
New York, N. Y.

THE REPRODUCTION of photographs of oscilloscope patterns for inclusion in manuals and reports has often been a source of expense and delay. A technique which permits rapid and inexpensive reproduction by small companies, using their own facilities, is described below.

The use of the Land-Polaroid camera for oscillographic work (as modified and sold by the Fairchild Camera and Instrument Co.) greatly simplifies photographic recording. The reason is that dark-room facilities for the two-step negative-positive process are no longer required. However, a useful negative is not available, and the positive print must be used for additional copies. Resolution obtained by the Land-Polaroid process may not compare hypercritically with that obtained using a conventional camera and film, but photographs of patterns, using a steady, well-synchronized sweep, are excellent in detail and clarity. Such prints are easily usable for calibration and also, to a considerable extent, for analysis.

The inclusion of these prints, or copies of them, in progress reports and instruction manuals requires that there be little sacrifice in definition and that the expense be moderate. Where government or military work is concerned, the

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Part No.	Material	Length
EE 5001-P	PY 12A (IRN-8)	3/8"
EE 5002-P	PY 1A (Carbonyl E)	3/8"
EE 5003-P	PY 1A (Carbonyl E)	1/2"
EE 5004-P	PY 14A (Carbonyl TH)	3/8"
EE 5005-P	PY 14A (Carbonyl TH)	1/2"



PYROFERRIC THREADED CORES
Material: PY 1A (Carbonyl E)

Part No.	Diameter	Length	Thread	Adjusting Slot
EE 5101-P	.248-.250	3/8"	28 T.P.I. Shallow	Hex Hole .103-.105
EE 5102-P	.237-.239	3/8"	32 T.P.I. Shallow	Hex Hole .103-.105
EE 5103-P	.180-.182	5/16"	32 T.P.I. Shallow	Screwdriver slots both ends

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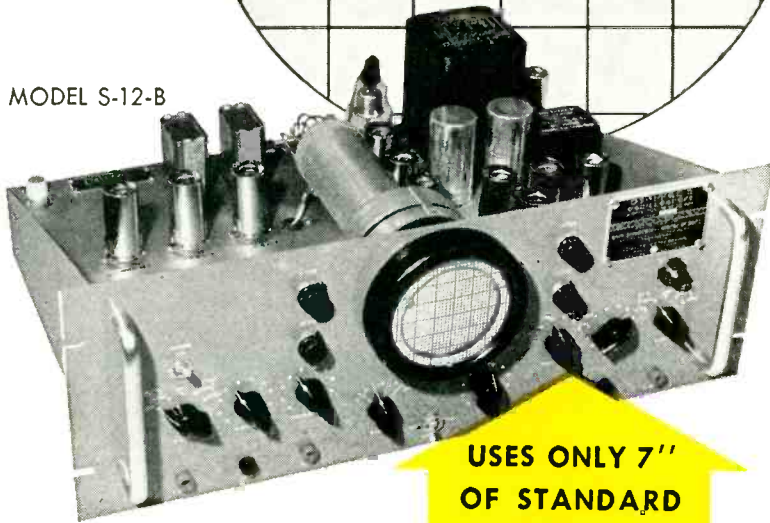
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JANized RAKSCOPE

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Waterman

MODEL S-12-B



USES ONLY 7"
OF STANDARD
RELAY RACK

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The S-12-B RAKSCOPE is a rack mounted, JANized (Gov't Model No. OS-11) version of the famous WATERMAN S-11-A POCKETSCOPE, with the addition of a triggered sweep and a special calibrating circuit for rapid frequency comparisons. The entire oscilloscope is built to occupy but seven inches when mounted in a standard relay rack. The vertical and horizontal amplifiers are identical, having sensitivities of 0.05 Volt rms/inch and frequency responses which are flat within -2 db from DC to 200 KC. These features permit observation of low frequency phenomena without undesirable trace bounce. The sweep rate is continuously variable from 5 cycles to 50 KC in either the triggered or repetitive mode with synchronization polarity optional. The return trace is blanked. Because provisions are made for applying input signals from the rear, as well as the front, the S-12-B is the ideal combination, systems monitor and trouble-shooting oscilloscope. Investigate the multiple applications of this instrument as an integral part of your "rack mounted" projects.

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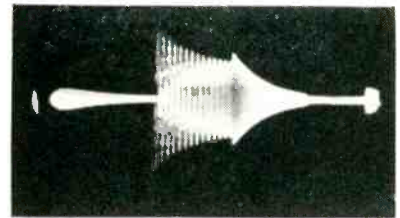
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- S-6-A BROADBAND PULSESCOPE
- S-11-A INDUSTRIAL POKETSCOPE®
- S-12-B JANized RAKSCOPE®
- S-14-A HIGH GAIN POKETSCOPE
- S-14-B WIDE BAND POKETSCOPE
- S-15-A TWIN TUBE POKETSCOPE
- RAYONIC® Cathode Ray Tubes
and Other Associated Equipment

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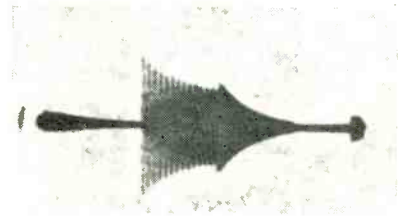
WATERMAN PRODUCTS

facilities must also meet security requirements concerning location and personnel. The best location, of course, is within the plant. The necessary equipment includes an Ozalid or similar reproducing machine, a 10 × 12-inch photographic contact printer, three 11 × 14-inch trays, a rotary print dryer, a press and a Fairchild (Land-Polaroid) camera.

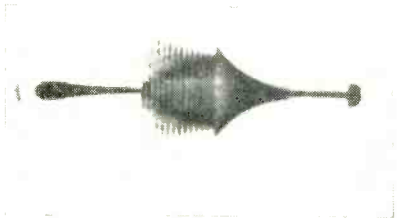
Most companies today have the



Original Land-Polaroid photograph of waveform on oscilloscope screen



Reflex paper negative made from photograph



Ozalid process blue-on-white print made from reflex negative

first item, as it is a valuable short-order printer; many plants have, in addition, the desk-size 8½ × 11-inch reproducer. The contact printer, dryer and press represent an additional outlay of less than \$100. They require about 30 square feet of floor space that is sufficiently dim so as not to fog the photographic paper to be used as negative material.

This paper is known as a reflex paper, manufactured by the Eastman Kodak Co. (Kodagraph Contact, Standard, extra thin for Wratten safelight No. 1A) and is available in a very thin stock. It is reflex-type in that it is sensitive to reflected light, while not fogging when light is passed through it. It

Lockheed Missile Systems Division

Lockheed Aircraft Corporation : Van Nuys, California

An Invitation to Physicists and Engineers:

Missile systems research and development is not confined to any one field of science or engineering. Broad interests and exceptional abilities are required by the participants. Typical areas include systems analysis, electronics, aerodynamics, thermodynamics, computers, servomechanisms, propulsion, materials research, design and fabrication.

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delivered from stock

Accuracy: 10 ohms and above: $\pm 0.1\%$
 1 ohm: $\pm 0.25\%$
 0.1 ohm: $\pm 1\%$
 0.01 ohm: $\pm 5\%$

Temp. Coeff.: $\pm 0.002\%$ per degree C.
 Maximum Load: $\frac{1}{2}$ -watt per step
 Frequency Limit: Non-inductive to 20KC

DECADE RESISTANCE BOXES

Type	Dials	Ohm Steps	Total Resistance—Ohms	Price
817	3	0.01	11.1	\$60.00
818	3	0.1	111	51.00
820	3	1	1,110	56.00
821	3	10	11,100	60.00
822	3	100	111,000	63.00
823	3	1,000	1,110,000	77.00
824	3	10,000	11,100,000	120.00
817-A	4	0.01	111.1	75.00
819	4	0.1	1,111	71.00
825	4	1	11,110	77.00
826	4	10	111,100	79.00
827	4	100	1,111,000	92.00
828	4	1,000	11,110,000	139.00
8285	5	0.1	11,111	94.00
829	5	1	111,110	101.00
830	5	10	1,111,100	113.00
831	5	100	11,111,000	155.00
817-C	6	0.01	11,111.1	105.00
8315	6	0.1	111,111	109.00
832	6	1	1,111,110	121.00
833	6	10	11,111,100	169.00



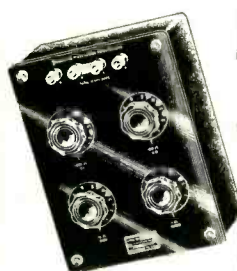
UNMOUNTED DECADE RESISTANCES

Type	Dials	Ohm Steps	Total Resistance—Ohms	Price
435	1	0.1	1	\$12.00
436	1	1	10	13.25
437	1	10	100	13.25
438	1	100	1,000	15.00
439	1	1,000	10,000	16.00
440	1	10,000	100,000	18.50
441	1	100,000	1,000,000	32.50
442	1	1,000,000	10,000,000	60.00



DECADE VOLTAGE DIVIDERS (Potentiometers)

Type	Dials	Ohm Steps	Total Resistance—Ohms	Price
845	3	1	1,000	98.00
837	4	0.1	1,000	126.00
835	4	1	10,000	132.00
836	4	10	100,000	146.00



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Shallcross

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is an excellent photostat paper. The developing process is identical to that used for conventional printing except that a light-tight darkroom is not essential.

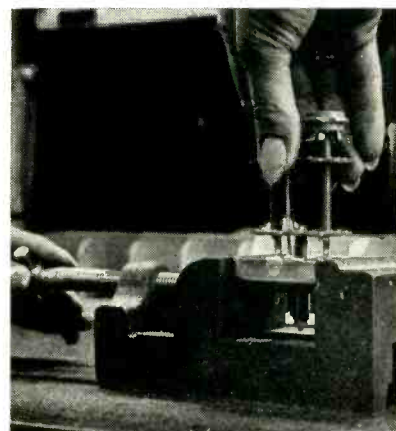
A reflex negative is made by placing a sheet of the paper on the printer, sensitive surface up; the photograph to be copied is placed face down against it and the exposure made by passing light through the paper.

The result after developing and drying is a thin paper negative. Captions or textual matter may be typed, pencilled or inked on the reverse side of the paper, with carbon backing for better reproduction. The final negative is then printed in the Ozalid machine in any desired quantity, and may be filed away for future use.

The accompanying illustration shows the three steps in the process—the original Fairchild camera photograph, the negative in reverse and the final blue-on-white Ozalid print. There is little loss in detail or clarity. This technique has been found excellent as regards speed, time and cost, and the results are of the desired professional quality.

Nine Assembly Jigs

NEW JIGS to speed and simplify fabrication and assembly operations are continually being devised at Hewlett-Packard, Palo Alto, Calif. Its products are continuously in a stage of development for the rapidly changing needs of the electronic industry, hence production



This standard drill vise is used for a number of assembly jobs, to hold resistor cards, decade dividers and in this case a discriminator unit



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FOR OUTSTANDING PERFORMANCE
AND APPLICATION**

TORKRITE TUBING
in foreground, enlarged to show detail.

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**TORKRITE
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ADVANTAGES**

Torkrite affords unmatched recycling ability. After a maximum diameter core has been recycled in a given form a reasonable number of times, a minimum diameter core can be inserted and measured at 1" oz. approximately.

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Improved new Torkrite is now available in various diameter tubes. Lengths from 3/4" to 3-1/8", are made to fit 8-32, 10-32, 1/4-28 and 5/16-24 cores.



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Grade EE	Improved general purpose
Grade EEX	Superior electrical and moisture absorption properties
Grade EEE	Critical electrical and high voltage application
Grade XAX	Special grade for government phenolic specifications
Grade SLF	Special for very thin wall tubing having less than .010 wall

High performance factors, uniformity and inherent ability to hold to close tolerances, make Clevelite outstanding for Coil Forms, Collars, Bushings, Spacers and Cores.

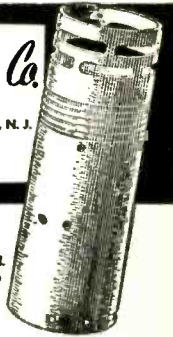
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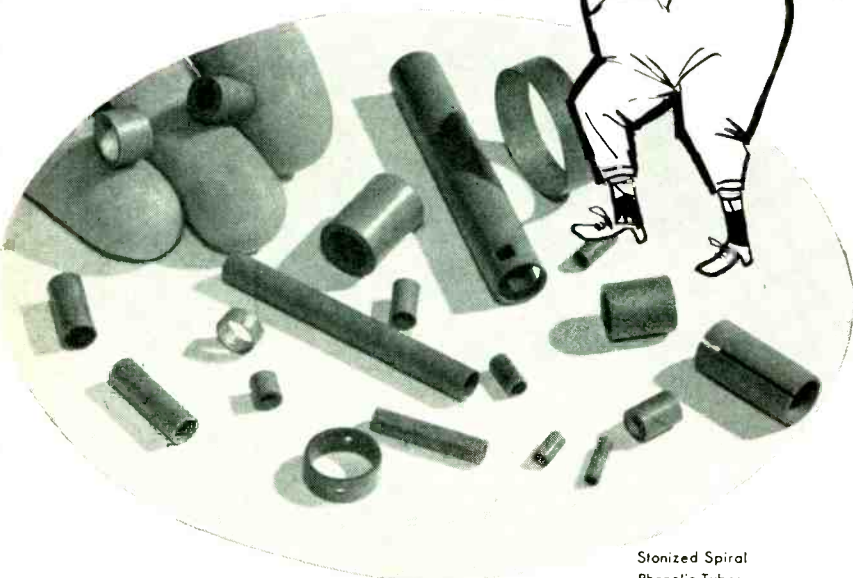
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Stone's pioneering experience in spiral wound small diameter paper tube manufacture is assurance that our phenolic impregnated tube—"Stonized"—will meet your most rigid specifications.

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These are specific *grades of Stonized* tubes, but others may be tailored to your exact requirements.

Let us have one of our conveniently located representatives call on you, or write directly to us.

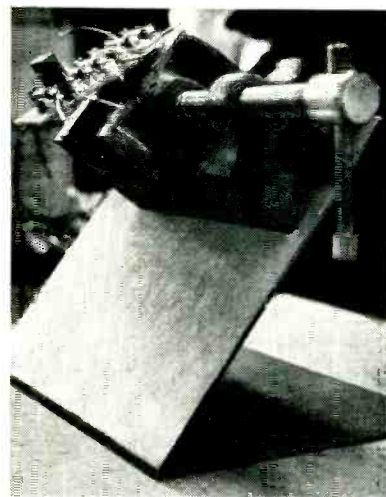
Stone

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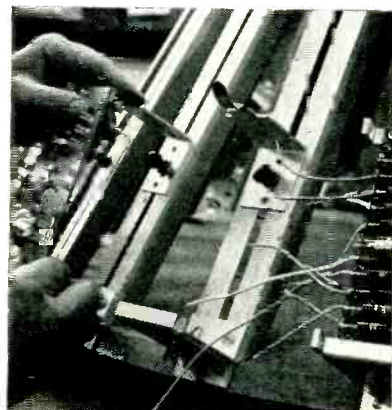
900-922 Franklin Street, N.E., Washington 17, D. C.



Standard drill vise mounted on a slanting sheet metal panel to hold resistor cards at a convenient angle and level for the worker



Lazy Susan jig holds resistor cards for soldering and assembly. Use of this setup cut by 40 percent the time required when individual jigs were used. Operator spins the jig to do the same operation on each card in turn, then repeats for the next operation



Close-up shows adjustable spring clamp holders on Lazy-Susan jig. Use of the multiple jig saves time and has incentive value—the worker gets satisfaction out of seeing a number of completed units. Units come off the jig all at once after the last operation on each of them

(Continued on p 272)



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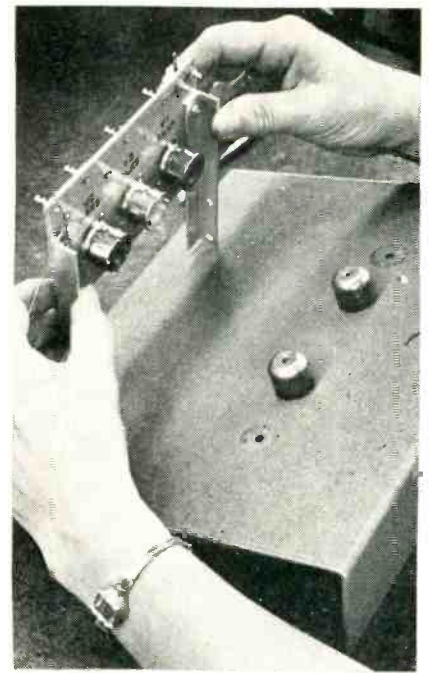
Direct, accurate measurements of signal components—15 to 500 kc



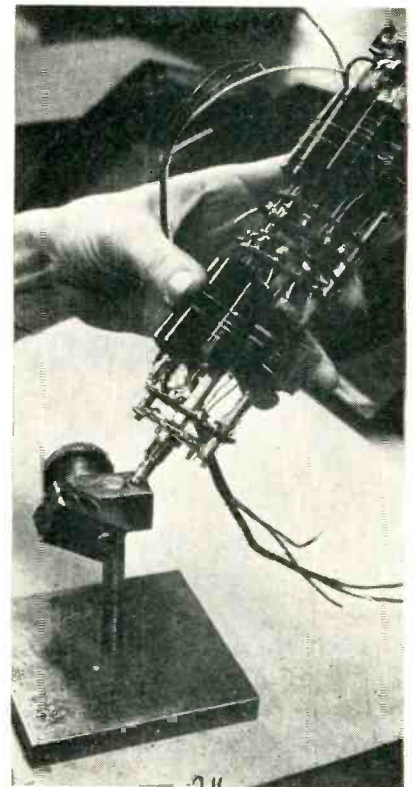
Model 121 Wave Analyzer

This new Sierra Wave Analyzer is designed to give you maximum operating ease, high accuracy and broad applicability in analyzing complex wave forms between 15 and 500 kc. The instrument is particularly useful for carrier system frequency analysis and induction studies, for determining filter transmission characteristics, or for measuring distortion and intermodulation components of rf signal sources and transmitters.

The Model 121 makes possible direct measurement of signal components throughout its range, and eliminates complex expensive setups with conventional receivers and signal generators. Input level range is +42 to -70 dbm at 600 ohms impedance. Measuring accuracy is ± 2 db; selectivity is such that response is 45 db down at 1 kc off resonance. Input bridging impedance is 10,000 ohms in the pass band.



A single-purpose jig mounts two studs for quick positioning of a subassembly for a high-frequency oscillator circuit. Shielded tube socket bases in the assembly are used as holding fixtures. Note that studs were previously mounted farther apart for a larger assembly



This turret switch fabrication jig at a soldering station is adjustable two ways, vertically and radially and has three different sizes of holes to hold different switches

(Continued on p 274)



**Model 122
LINE-BRIDGING
TRANSFORMER**

The Sierra 122 Line-Bridging Transformer instantly converts Model 121 Wave Analyzer from single-ended to balanced input. The transformer is a broad band ferrite core unit operating flat within 0.5 db from 15 to 500 kc. It is compensated so that Analyzer readings are corrected for the transformer's small insertion loss. Offered in three impedances: Model 122A, 135 ohms; 122B, 500 ohms; 122C, 600 ohms.

For complete information see your local Sierra sales representative or request Bulletin 103A



Sierra Electronic Corporation

San Carlos 2, California, U. S. A.

Sales representatives in major cities

Manufacturers of Carrier Frequency Voltmeters, Wave Analyzers, Line Fault Analyzers, Directional Couplers, Wide-Band RF Transformers, Custom Radio Transmitters.



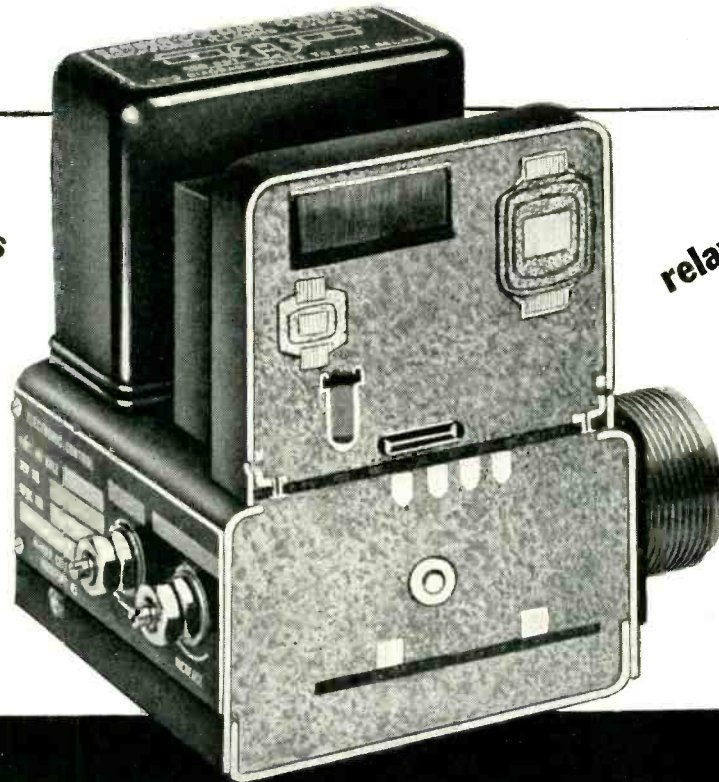
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2769

What's inside this Aircraft Temperature Control?...



resistors
transformers
potentiometers
capacitors



relays
sub-miniature vacuum tubes
radio noise filter

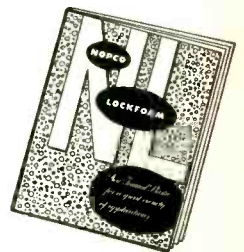
BARBER-COLMAN protects these from shock, vibration, humidity with NOPCO® LOCKFOAM

Barber-Colman Company, Rockford, Ill., is well known for its varied line of aircraft temperature and positioning control systems, actuators, air valves, and other accessory equipment. In designing the electronic temperature control shown here, they required a potting material to protect the fragile components and the connecting wiring. It was necessary that the material be both light and strong, have good electrical insulation properties, and be impervious to salt spray and humidity. Curing temperature was not to exceed 250° F., and after curing had to withstand ambient temperatures up to 220° F.

Their search for the right material ended when they tried one of the 50 different formulations of Nopco Lockfoam. "By using Nopco Lockfoam as the potting material," states Barber-Colman, "we were able to meet environmental operating requirements with an economy in manufacturing and assembly time."

These properties of Nopco Lockfoam are finding new applications almost daily—and they are by no means limited to electronics or aviation. Since Nopco Lockfoam is poured-in-place, it exactly fills the configurations you wish to fill. It is consistent and reproducible.

One of the many formulations of Nopco Lockfoam may be the means of improving some product of yours, or even of bringing into being a product that so far exists only on your drafting board. Send for the free informative booklet today.



Plastics Division

NOPCO
CHEMICAL COMPANY



Harrison, New Jersey

4858 Valley Blvd., Los Angeles 32, Calif.

INTRODUCING A NEW

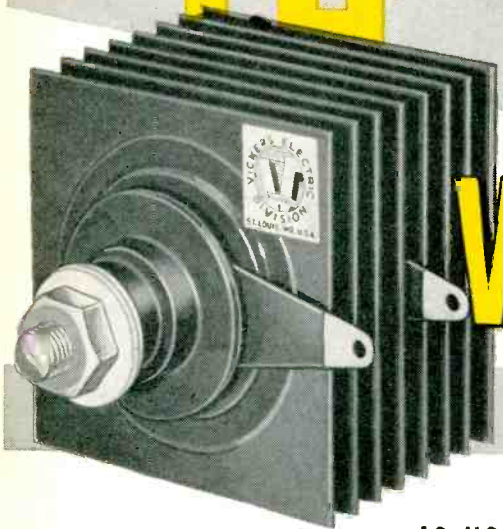
HIGH VOLTAGE

40

Selenium Rectifier

by

Vickers



a combination of outstanding features

that results in

MORE WATTS

PER DOLLAR

INITIAL COST

LOWER

ANNUAL COST

WRITE TODAY

for complete

information

40-VOLT Inverse Cell Rating Combined with:

LOW LEAKAGE...

only 2 milliamperes per square inch average ... one-half that of conventional rectifiers.

LOW INVERSE LOSS...

heating as a result of low inverse loss at high voltage averages less than 5°C—one-half that of conventional rectifiers.

HIGH DIELECTRIC QUALITY...

withstand surges up to twice rated voltage.

PLUS the advantages of

HIGH AMBIENT

Operate in ambient temperatures up to 125°C. No derating for 50°C.

Operate at temperatures that would destroy ordinary rectifiers—withstand accidental temperature excesses due to overload or cooling malfunction.

LONG LIFE

Newly developed inorganic barrier is inherently stable. Inverse characteristics actually improve with use. Life test now past 25,000-hour mark.

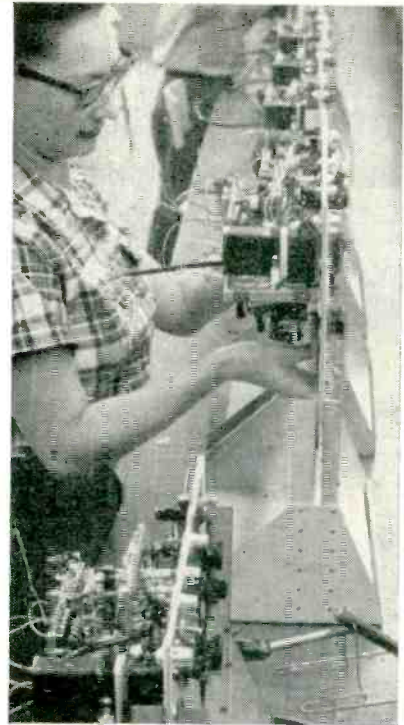


VICKERS ELECTRIC DIVISION

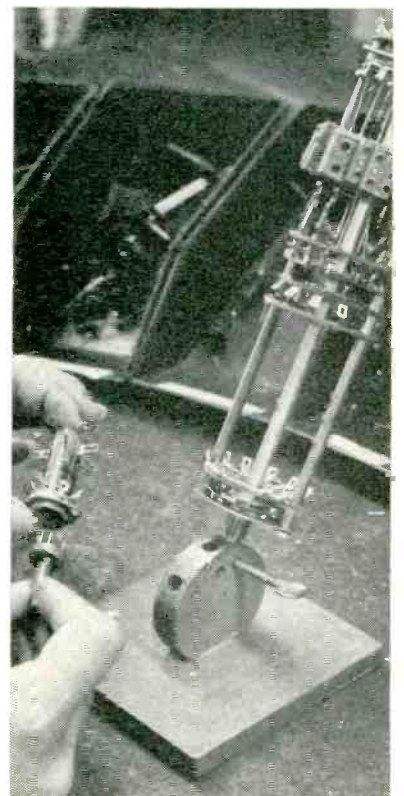
VICKERS Inc.

A UNIT OF THE SPERRY CORPORATION

1801 Locust St. • St. Louis, Missouri



Panel jigs here hold subassemblies for pulse generators. Panel rests in groove on stop bolt in one set of a series of holes, making the jig adjustable vertically. The back supports of the jigs are covered with a vinyl tape to protect the painted surface of the panels



Simple metal jig for switch fabrication offers only three steps of radial adjustment. The worker holds a fitting which enables this jig to serve also for tube socket turret fabrication

(Continued on p 276)

A COMPLETE LINE of calibrated random NOISE SOURCES

- FREQUENCY RANGE FROM 5 to 26,500 mc.
- MEASURE NOISE FIGURE AND RECEIVER GAIN

Microwave Mega-Nodes NOW AVAILABLE WITH NEW GAS TUBES... INDEPENDENT OF OPERATING TEMPERATURE NOISE sources provided in 8 waveguide sizes



In addition to the fluorescent tubes, new type gas tubes are also available. These new gas tubes eliminate the necessity of correcting for temperature variations.

MICROWAVE MEGA-NODE SPECIFICATIONS

Waveguide Sizes	Frequency (mcs.)
RG-69/U	1,200—1,400
RG-48/U	2,600—3,900
RG-49/U	3,950—5,850
RG-50/U	5,850—8,200
RG-51/U	7,050—10,000
RG-52/U	8,200—12,400
RG-91/U	12,400—18,000
RG-53/U	18,000—26,500

NOISE OUTPUT (all guides): 15.8 db.

ACCURACY: To ± 0.25 db.

EQUIPMENT SUPPLIED: Power supply, fittings, power cables, instruction manual.

PRICE:

Single waveguides (with either gas tube) RG-48/U, RG-49/U, RG-50/U, RG-51/U or RG-52/U

\$195.00

Power Supply for any of above (for use with waveguides using fluorescent tubes).....\$100.00

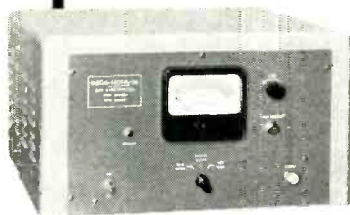
Power Supply for any of above and RG-69/U guide (for use with new gas tube).....\$150.00

RG-69/U (L-Band) waveguide (with either gas tube).....\$400.00

Power Supply (for use with fluorescent tube) for RG-69/U guide.....\$120.00

Set consisting of standard power supply and one each of the following waveguides: RG-48/U, RG-49/U, RG-52/U.....\$600.00

Prices are f.o.b. factory



MEGA-NODE SR. SPECIFICATIONS:

FREQUENCY RANGE: 10 mc to 3000 mc.

OUTPUT IMPEDANCE: 50 ohms unbalanced into Type N Connector.

NOISE FIGURE RANGE: 0 to 20 db.

METER CALIBRATION: Linear in DB Noise Figure.
Logarithmic in DC. MA.

PRICE: \$995.00 f.o.b. factory.

MEGA-NODE SPECIFICATIONS:

FREQUENCY RANGE: 5 to 220 mc.

OUTPUT IMPEDANCES:

Unbalanced: 50, 75, 150, 300, Infinity

Balanced: 100, 150, 300, 600, Infinity

PRICE: \$295.00 f.o.b. factory.

NOISE FIGURE RANGE:

0 to 16 db at 50 ohms

0 to 23.8 db at 300 ohms

METER CALIBRATION:

Linear in DB Noise Figure

Logarithmic in DC. MA.

Write for
NEW CATALOG

KAY ELECTRIC COMPANY

14 Maple Avenue Pine Brook, N. J.

CAldwell 6-4000

PRECISION TEST AND MEASURING INSTRUMENTS FOR LABORATORY, PRODUCTION AND FIELD

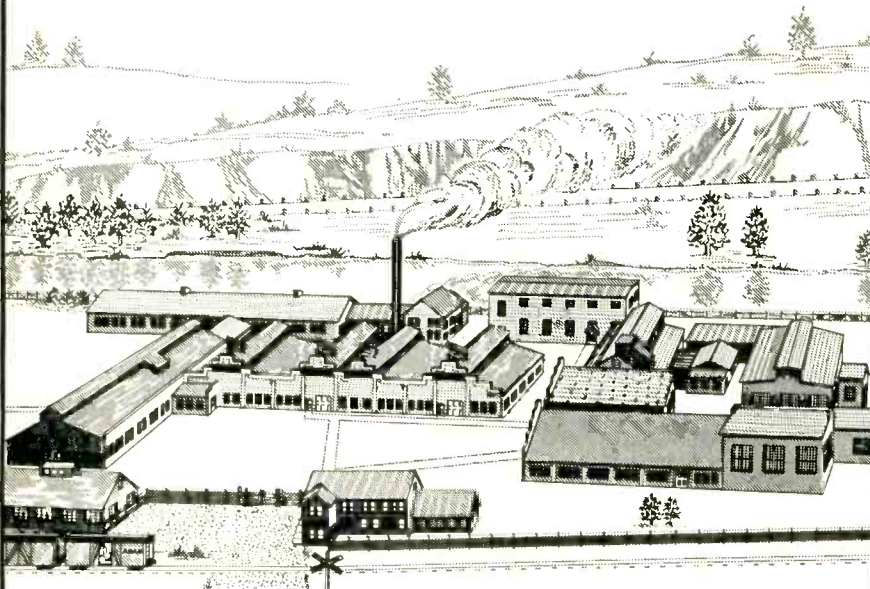


What Will They Think of Next?

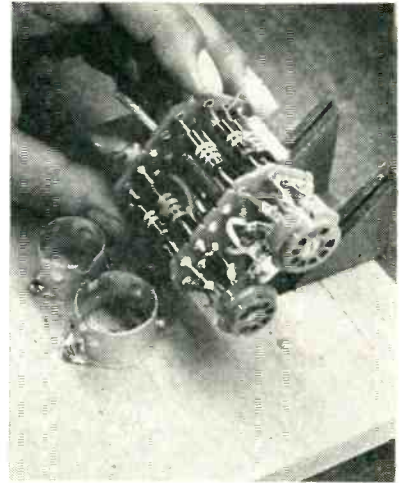
Vienna, Austria, July 28 (AP)—A Czech grocery clerk has escaped from Communist Czechoslovakia by swimming three miles under water in a submarine suit fashioned from a picture of a U. S. Navy frogman, American officials said today.

**DUMONT ENGINEERS
EXPERIMENTING and PLANNING
AHEAD ...**

Dumont Engineers have developed and produced many capacitors that have been a big factor in solving the problems of countless manufacturers throughout the industry — not only for their immediate needs but for to-morrow's new era. When it comes to thinking ahead, you can be sure Dumont engineers and facilities will be in the best position to supply capacitors to meet these new problems too! Your inquiries are invited.



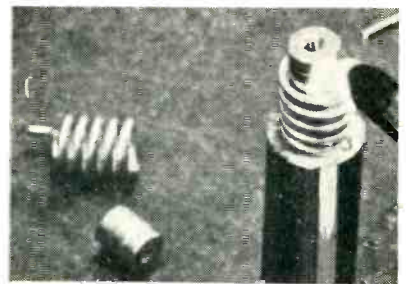
DUMONT-AIRPLANE & MARINE INSTRUMENTS, Inc.
 OFFICE 15 William Street New York 5, N. Y.
 FACTORY Clearfield Pennsylvania



Two-position jig holds discriminator unit for soldering. Bakelite wafers in unit rest in grooves at back of jig for one work position. Unit is then upended and sockets slipped into tube shield cans for further assembly work



This jig lines up coils and terminations to be soldered together before plastic molding. A Wyse arc-melt soldering unit (Wyse Labs. Dayton, Ohio) is used, with one graphite electrode and one clip attached to the metal jig



Closeup of coil terminal soldering with graphite electrode

runs are often relatively short. For the shortest runs, the company has found that a simple vise suits its needs well. Sometimes it is satisfactory even on long runs, especially when adapted for the job — by the addition of a slanted panel, for instance. Some components are handled in

he's working for you



THIS FELLOW IS TRAINED IN YOUR BUSINESS. His main duty is to travel the country — and world — penetrating the plants, laboratories and management councils . . . reporting back to you every significant innovation in technology, selling tactics, management strategy. He functions as your all-seeing, all-hearing, all-reporting business communications system.

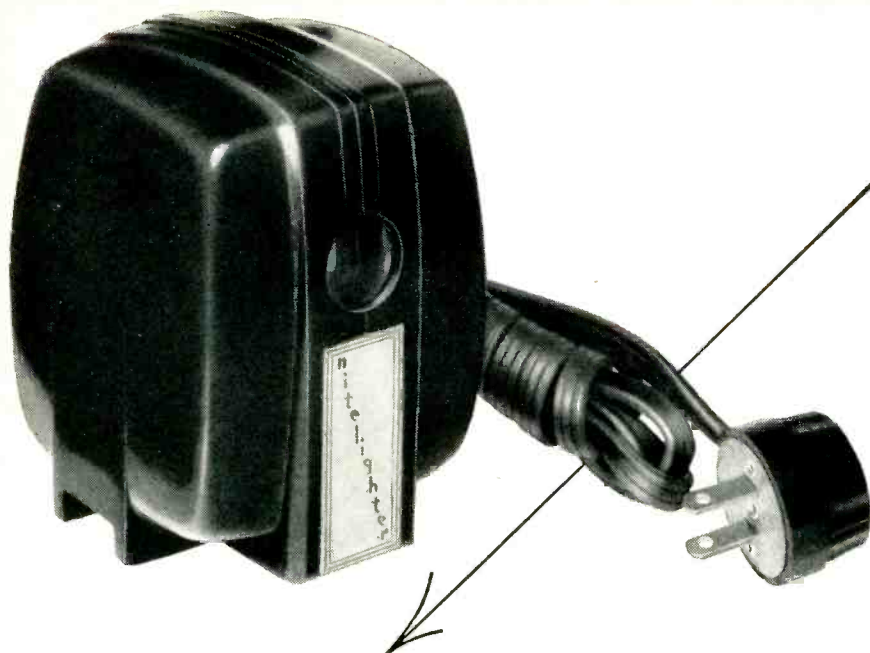
THE MAN WE MEAN IS A COMPOSITE of the editorial staff of this magazine. For, obviously, no one individual could ever accomplish such a vast business news job. It's the result of many qualified men of diversified and specialized talents.

AND, THERE'S ANOTHER SIDE TO THIS "COMPOSITE MAN," another complete news service which complements the editorial section of this magazine — the advertising pages. It's been said that in a business publication the editorial pages tell "how they do it" — "they" being all the industry's front line of innovators and improvers — and the advertising pages tell "with what." Each issue unfolds an industrial exposition before you — giving a ready panorama of up-to-date tools, materials, equipment.

SUCH A "MAN" IS ON YOUR PAYROLL. Be sure to "listen" regularly and carefully to the practical business information he gathers.



McGRAW-HILL PUBLICATIONS



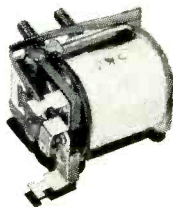
... So you'll
NEVER COME HOME TO DARKNESS

We can't resist the opportunity to plug one of our old stand-bys (perhaps too long forgotten), and at the same time give a boost to a product of our affiliate, The Fisher-Pierce Co.

Fisher-Pierce, now well-established and in its eighth year in the photoelectric street lighting control business, recently decided they should have a consumer product as well. The result was just what you might expect: an inexpensive (\$15.95 retail) little light control for home use.

F-P calls it the NITELIGHTER,* since it turns on a light at dark, when daylight ceases to energize its phototube. Its special plug goes in the AC wall outlet and takes the plug from your favorite lamp. For you who don't like to come home to darkness, want to make burglars think you're home when you're not, or have some other use for a daylight-sensitive light switch — the NITELIGHTER could be the answer. (In case you don't really need a NITELIGHTER, they're fun to just fool around with.)

The "old stand-by" is one of our Series 41 relays, originally designed as a "streamlined" version of our "4", for people who didn't need all the fancy features of the "4" and who were spending their own money. This particular 41 does very well in its intended applications, however, and switches up to 300 watt lamp loads on 0.15 watt coil signals in the NITELIGHTER. Relay mechanical life equals at least twice the lifespan of a NITELIGHTER owner. The 41 should be considered when high sensitivity, high speed, 5 ampere contact ratings and nominal cost are what you need.



* IF YOU WANT TO BUY
 (OR SELL) THESE, WRITE
 THE FISHER-PIERCE CO.
 CARE OF US.

SIGMA

SIGMA INSTRUMENTS, INC.
 62 PEARL STREET, SO. BRAintree, BOSTON 85, MASS.

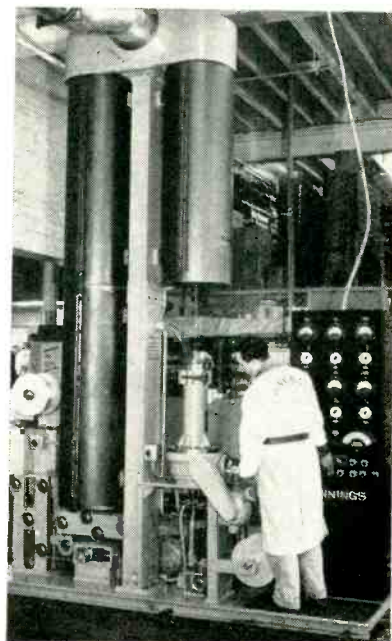
sufficient quantity to justify the building of jigs that do only one job. However, most components are subject to minor changes, even if they stay relatively stable in form. For these the jigs are flexible, fitted with screws or pegs so that the components or assemblies they hold may vary in size and may be worked on from varying angles. Examples of all types are shown in the accompanying illustrations.

Teflon Extruder for Wire

AUTOMATIC equipment for extruding Teflon (tetrafluorethylene resin) around stranded or solid wire in sizes ranging from No. 12 to No. 26 Awg has been developed by Jennings Engineering Inc., Philadelphia, Pa. Dies and wire guide components must be changed to accommodate different wire sizes. Speed and heat flexibility are adequate for this range of sizes.

The machine is now being used both by wire processors and by electronic equipment manufacturers that would normally buy their own insulated wire.

For any particular wire, the thickness of a coating can be varied with any one die by adjusting the ratio between wire speed and extruding speed and by adjusting the heaters. Greater variations in



Machine setup for applying Teflon insulation to bare wire

Is the wire in your product aiding or hindering production?

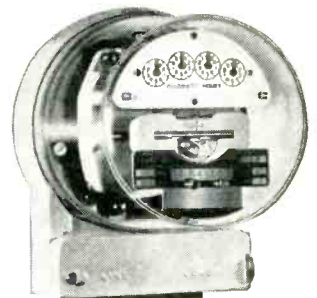
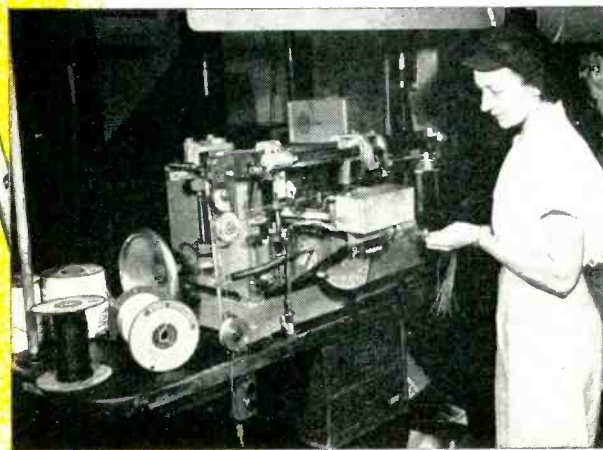
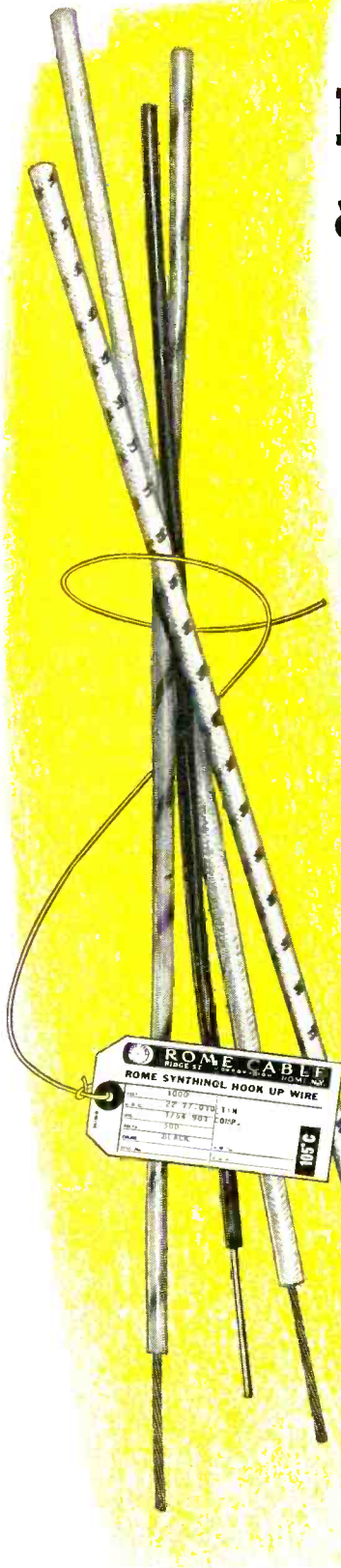
Even little points of product superiority can make a big difference in your over-all production costs.

Sangamo Electric Company, of Springfield, Illinois, for example, found that in wiring up their meters and time switches with Rome Synthinol 901 thermoplastic hook-up wire, they were able to speed up production because of the "tight lay" of the stranding and the perfect anneal of the conductor. Compact connections were possible in less time.

In addition, Rome Synthinol 901 provides high resistance to moisture, flame, acids, oils and solvents, plus extreme resistance to

heat deformation, shrinkage and cracking, as well as improved solderability. Such attention to quality is basic policy with Rome Cable. Whether you need a special hook-up wire or a complex multi-conductor cable, Rome has the engineering skill and production facilities to give you exactly what you want.

Rome Synthinol 901 hook-up wire carries Underwriters' Laboratories Appliance Wiring Material Labels and is approved for use in appliances where exposed to air at temperatures up to 105° C. Available as solid or stranded in a wide range of permanently clear colors.



Here operator is stripping Rome Synthinol 901 wire to make leads for the potential coil in Sangamo Electric's Type "J" meter. The special thermo-plastic compound assures dependable service life under severe operating conditions.

It Costs Less to Buy the Best



ROME CABLE
Corporation
 ROME • NEW YORK
and
 TORRANCE • CALIFORNIA

ROME CABLE CORPORATION, Dept. EL-9, Rome, N. Y.
 Please send me information on Rome Synthinol 901.
 Name Title
 Company
 Address
 City Zone State

Career Opportunities

for

- MECHANICAL ENGINEERS
- ELECTRONICS ENGINEERS
- ELECTRICAL ENGINEERS
- PHYSICISTS
- AERODYNAMICISTS
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- TECHNICAL WRITERS

➤ Sandia Corporation, a subsidiary of the Western Electric Company, offers outstanding opportunities to graduates with Bachelor's or advanced degrees, with or without applicable experience, in the above fields.

➤ Engineers and scientists at Sandia Laboratory, an atomic weapons installation, work as a team at the basic task of applying to military uses certain of the fundamental processes developed by nuclear physicists. This task requires applied research as well as straightforward development and production engineering.

➤ The place of an engineer or scientist on the Sandia team is determined initially by his training, experience, and talents . . . and, in a field where ingenuity and resourcefulness are paramount, he is afforded every opportunity for professional growth and improvement.

➤ Sandia engineers and scientists design and develop complex components and systems that must function properly under environmental conditions that are much more severe than those specified for industrial purposes. They design and develop electronic equipment to collect and analyze test data; they build instruments to measure weapons effects. As part of their work, they are engaged in liaison with the best production and design agencies in the country, and consult with many of the best minds in all fields of science.

➤ Sandia Laboratory, operated by Sandia Corporation under contract with the Atomic Energy Commission, is located in Albuquerque — a modern, mile-high city of 150,000 in the heart of the healthful Southwest. Albuquerque offers a unique combination of metropolitan facilities plus scenic, historic and recreational attractions; and a climate that is sunny, mild, and dry the year around. New residents have little difficulty in obtaining adequate housing.

➤ Liberal employee benefits include paid vacations, sickness benefits, group life insurance, and a contributory retirement plan. Working conditions are excellent, and salaries are commensurate with qualifications.

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DIVISION C

SANDIA

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SANDIA BASE • ALBUQUERQUE, NEW MEXICO

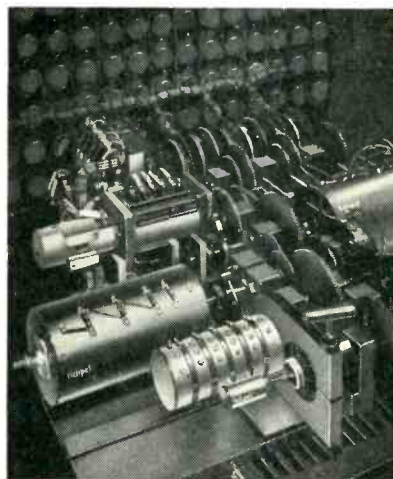
thickness are obtained by changing dies.

Spaghetti tubing and certain sizes of beading can also be run through for addition of Teflon insulation. Even tape can be handled.

Once the correct dies have been installed, operation is entirely by pushbutton control. The bare-wire supply wheel is at the front of the machine near the floor, and the takeup wheel is higher at the rear. The sintering oven and vaporizing oven are mounted vertically and extend up approximately 14 feet. The ovens require venting with a 12-inch circular furnace pipe.

Linearity Tester for Precision Potentiometers

AN ULTRASENSITIVE recording linearity tester in use at Helipot Corp., South Pasadena, California, equates potentiometers under test against



Linearity test setup, with master pot at right and pots under test at left foreground. Trim pots are on panel at rear

the master precision potentiometer. Trim potentiometers in the tester are preset to insert voltage in series with the master pot at 360 points.

The master potentiometer is linear within 0.01 percent, having been checked against a Leeds and Northrop voltage divider which is accurate within 0.001 percent. Through the inclusion of the trim pots in the master circuit, the tester is made accurate within 0.003 percent. Intricate gear-trains drive the sliders of the potentiometers under test—whether they be single-turn models or 3, 10, 15, 25 or 40-turn units—in phase with a 40-turn master potentiometer.



It's always a good spring

WHEN YOU USE BRIDGEPORT PHOSPHOR BRONZE ♦

In any season, electrical parts made from Bridgeport Phosphor Bronze (Alloys 35 and 36) retain their resiliency and high flexural strength, year after year. They also resist corrosion and wear due to the inherent characteristics of these Bridgeport Alloys, and their excellent electrical properties help improve the operating efficiency of the parts.

To use the advantages of Bridgeport Phosphor Bronze for your parts, and for prompt service on your metal needs, call your nearest Bridgeport Sales Office.

♦ One of the many Bridgeport Metals with High I.Q. (Inner Quality) for economical fabrication and improved products.

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NEW PRODUCTS

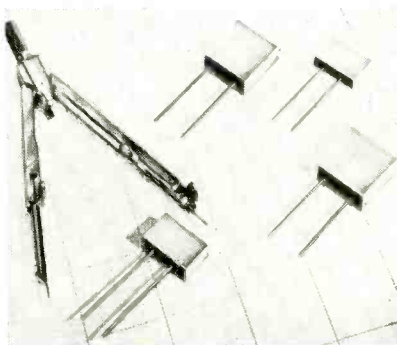
Edited by WILLIAM P. O'BRIEN

60 New Products and 41 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

MICA CAPACITOR

is tiny encapsulated unit

CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J., has developed a new style of midget mica capacitor in the form of an encapsulated unit. The capacitor section is separately processed in its entirety and then inserted and sealed into a premolded case. The Super Micadon will house 5 to 6 times the capacitance now possible in CM-20 and CM-30 cases. Two sizes are available. Type 5A is 51/64 in. × 15/32 in. × 7/32 in., type 1A is 53/64 in. square × 9/32 in. In a 4,000-hour life test at twice rated



voltage) 76 percent of conventional capacitors failed, compared to only 4 percent failure for the Super

OTHER DEPARTMENTS

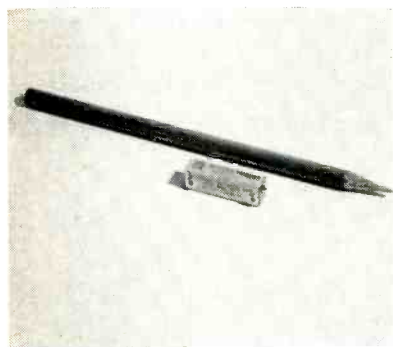
featured in this issue:

	Page
Electrons At Work	180
Production Techniques	232
Plants and People	340
New Books	394
Backtalk	404

Micadons. In rigorous humidity tests the new capacitors revealed a moisture resistance of nearly 20 times conventional types, while insulation resistance ranged from 10 times higher at room temperature to 35 times higher at + 120 C. They are designed with flat, clinched wire leads giving improved voltage breakdown safety and enabling overall inductance to be reduced by 30 percent over ordinary types.

TRIMMER POTS

have rugged construction



TECHNOLOGY INSTRUMENT CORP., Acton, Mass. Now infinite resolution is available in miniature trimmer potentiometers with a wide range of total resistance values. The type RFT Metfilm trimmer embodies a unique deposited metal resistance element. A 90-deg turn of the drive screw results in an approximate voltage change of 1 percent of the applied voltage. The diminutive size of the type RFT

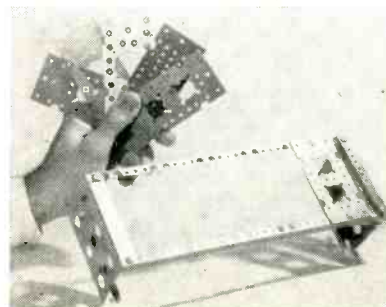
makes it ideal for trimming adjustments in computers, analyzers, telemeter and airborne electronic equipment of high component density. They are available in standard resistance values ranging from 50 to 25,000 ohms ± 10 percent. Power dissipation is rated at 0.5 w at 40 C, 0.25 w at 125 C, derated to 0 at 100 C. The operating ambient temperature range is from -55 C to + 100 C. The deposited metal resistance element has a nominal temperature coefficient of 0.00025 per deg C.

BREADBOARD CHASSIS

for circuit development

ALLEN B. DUMONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J., has available a universal circuit breadboard chassis. The breadboard and its component parts greatly reduce circuit construction time and accommodate a complete

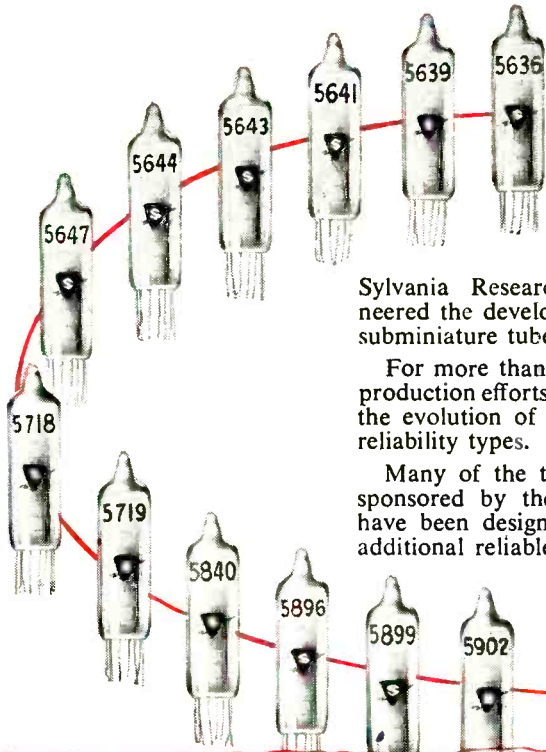
variety of components without the need for a single power tool. It promotes neat wiring both above and below the chassis, facilitates rapid modifications on circuit components, simplifies circuit layout and provides prototype wiring for



FOR YOUR EQUIPMENT-

Specify Types

from the Finest—most Complete Line of Premium Subminiature Tubes



Sylvania Research and Engineering pioneered the development of the cathode-type subminiature tube.

For more than a decade, engineering and production efforts have been directed towards the evolution of this premium line of high reliability types.

Many of the types listed were originally sponsored by the Armed Services. Others have been designed by Sylvania to furnish additional reliable types required for newer

applications. Beyond this, there are other types not listed above which are presently undergoing active development.

Outstanding Design Features

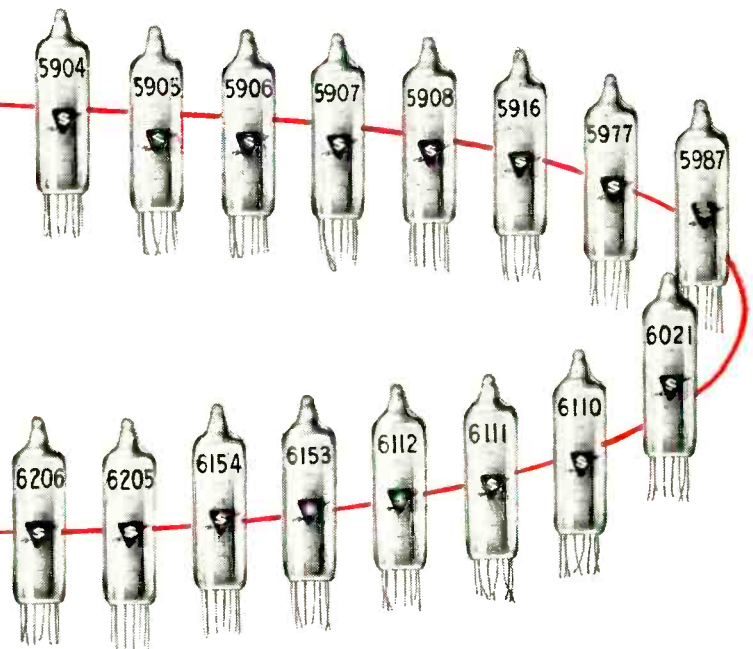
- Low inoperative failure rate
- Stable characteristics
- Long life
- Fatigue and impact resistant
- Vibration resistant
- High temperature operation

all originated by Sylvania

5636 Pentode Mixer	†5907 Semi-remote Cut-off Pentode
5639 Video Output Pentode	†5908 Pentode Mixer
5641 Rectifier	*5916 Pentode Mixer
5643 Thyatron	5977 Low Mu Triode
†5644 Voltage Regulator	5987 Power Control Triode
5647 T-1 Detector	6021 Medium Mu Double Triode
5718 Medium Mu Triode	6110 Double Diode Detector
5719 High Mu Triode	6111 Low Mu Double Triode
5840 Sharp Cut-off Pentode	6112 High Mu Double Triode
5896 Double Diode Detector	6153 Sharp Cut-off Pentode
5899 Semi-remote Cut-off Pentode	Low Cgp (Separate suppressor)
5902 Audio Power Pentode	6154 Remote Cut-off Pentode
*5903 Double Diode Detector	Low Cgp (Separate suppressor)
†5904 Medium Mu Triode	6205 Sharp Cut-off Pentode (Separate suppressor)
†5905 Sharp Cut-off Pentode	6206 Semi-remote Cut-off Pentode (Separate suppressor)
†5906 Sharp Cut-off Pentode	

†6308 Voltage Reference Tube.

*26-volt heater †26 volts all elements ‡Cold Cathode Type
All other types are 6.3 volt heaters.



For complete data sheets and specifications concerning any of the above tube types and for application information, see your Sylvania Sales Engineer or write to: Sylvania Electric Products Inc., Dept. 4R-1609, 1740 Broadway, New York 19, N. Y.

SYLVANIA

LIGHTING • RADIO
ELECTRONICS
TELEVISION



In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., St. Catherine St. Montreal, P. Q.

the design of printed circuits. The universal breadboard consists of a chassis frame and an assortment of phenolic subchassis which can be mounted with speed and convenience. The cadmium plated

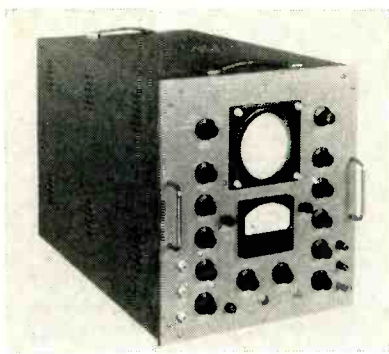
chassis frame is 4 in. wide, 12 in. long and 3 in. high, mounted together with 6-32 self-tapping screws. End brackets of the frame have a series of 1/8-in. holes to accommodate regular and miniature

potentiometers, fuses and switches. Chassis frames may be tiered, mounted side-by-side, or end-to-end by means of self-tapping screws to accommodate construction of large circuits.

SYNCHROSCOPE

has five major improvements

T. L. G. ELECTRIC CORP., 31 W. 27th St., New York 1, N. Y. Model C-04 synchroscope represents a significant redesign of the P-5 synchroscope. New circuits have resulted in five major improvements: much faster writing rate (0.05 μ sec per in.), much higher vertical channel frequency response (600 mc without resonance or distortion) much greater stability (drift is less than 0.4 percent per month), greatly in-



creased calibration accuracy (distortionless comparison to d-c without removing pattern from screen, against 0.5 percent hand-calibrated Weston meter), and a new stiffer and faster trigger output (directly firing any hydrogen thyratron up to the 5C22). Shielding and geometry of the input circuit permit use of the model C-04 in close proximity to the 40-megawatt pulsers. Characteristics of the C-04 meet or exceed the most recent SCEL memorandum on synchroscope improvement for radar pulse observation.

TIME DELAY RELAYS

for airborne applications



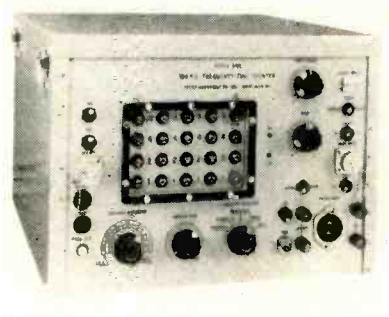
ELECTRONIC SPECIALTY Co., 3456 Glendale Blvd., Los Angeles 39, Calif., has introduced a new line of time delays relays designed for airborne applications where an accurate, reliable and vibration resistant time delay or time pulse is required. They utilize a very rugged and reliable relay in conjunction with a resistor-capacitor circuit. Dimensions are 1 5/8 in. \times 1 7/16 in. \times 2 1/4 in. and weight is 6 1/2 oz. The relays are contained in her-

metically sealed enclosures filled with inert gas and operate over the range of 18 to 30 v d-c. They feature quick recycling time, long life (500,000 cycles minimum), 5-ampere resistive load contact rating, and they meet applicable Air Force environmental requirements. They are available with factory set timing period from 15 to 500 milliseconds, with normally closed or normally open contacts, one to four pole, single throw or double throw, and various bases, including miniature tube plug-in and solder terminals.

COUNTER

measures frequency and time

POTTER INSTRUMENT Co., INC., 115 Cutter Mill Road, Great Neck, N. Y. Model 3149 is a general-purpose instrument for making direct frequency and time measurements under field conditions with laboratory type accuracy and complete reliability. Gold-plated switch contacts and JAN components are used throughout. Direct measurement of frequency up to 150 kc is provided by means of 5 electronic counter decades that count the cycles of the unknown for an exact crystal-controlled interval of time.



Low frequencies are measured by counting time-base pulses occurring during 1 or 10 cycles of the un-

known. Time intervals may be measured to the nearest 0.00001 second. The instrument also serves as a secondary frequency standard and as a totalizing counter.

PRECISION RESISTORS

in grouped type

OHMITE MFG. Co., 3664 Howard St., Skokie, Ill., has announced a new grouped model of the Riteohm encapsulated precision resistors. The units are made up from 2 to 6 individual, lug-type Riteohm resistors, arranged end-to-end in a one-piece, molded resin body. A special resin

The security of experience. Pyramid has more experienced personnel in years of actual designing and manufacturing of capacitors than any other manufacturer.

The advantage of leadership. Pyramid supplies capacitors to all leading TV set manufacturers, and to ALL Branches of Government. Being so close to initial product developments, the design engineer, purchasing agent and production man benefit by new developments in the Pyramid line.

The control of specially designed facilities.

Pyramid is the only manufacturer of capacitors whose plants were planned and built specifically for the entire manufacturing process of capacitors from drawing board conception through reception of raw materials, fabrication, packaging and shipment.

what is available from **Pyramid**

commercial
MIL-SPEC
capacitors

The guarantee of one standard. All Pyramid capacitors are one quality, made of the same quality materials demanded by rigid military specifications. Pyramid capacitors have a low leakage factor due to the non-hygroscopic insulating material used on all production. Pyramid delivers the best at no premium.

A complete line of capacitors—full ranges in all ratings and types.

ELECTROLYTICS



Type TD, TDL



Type CDB



Type MC



Type TM



Type DO

PAPER



Type 85LPT



Type PG
"Glassed"



Type CT



Type PTIM,
CP 25



"IMP" Molded



Type PDM,
CP 53



Type PEM,
CP 67, CP 69



Type PKM,
CP61 to CP65

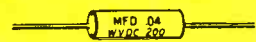


Type PLMF,
CP70



Type PJ,
CP70

METALLIZED PAPER



Type MT



Type MPD



Type MPT



Type MBE

PYRAMID ELECTRIC COMPANY 1448 HUDSON BOULEVARD • NORTH BERGEN, N. J., U.S.A.



(Potentiometer is shown in actual size)

Another **NEW**
Fairchild Precision Potentiometer

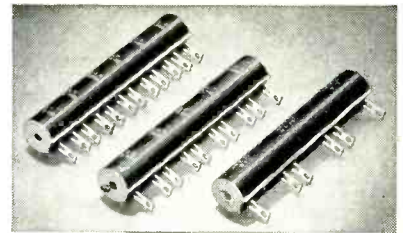
**The
 FilmPot
 TYPE
 771**

This metallic film potentiometer offers infinite resolution, high temperature operation (225° C.), high wattage dissipation, and 100 to 200,000 ohms resistance range in a case only $\frac{3}{8}$ " in diameter and $\frac{1}{2}$ " long. The infinite resolution of a metallic film resistance element in servo applications limits hunting and oscillating. Available with servo flange or threaded bushing mounting. Gold-plated terminals. Now manufactured to target specifications for engineering evaluation; sample orders are accepted in standard resistance values only.

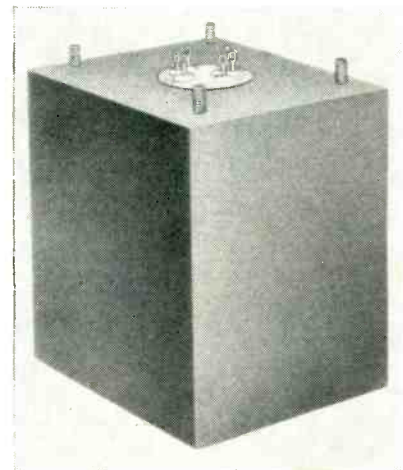
Another reason why
**Fairchild can supply ALL your
 precision potentiometer needs**

Fairchild makes a complete line of precision potentiometers to fill all your needs—linear and nonlinear potentiometers, singly or in ganged combinations . . . single-turn and helical . . . with servo or threaded bushing mounts . . . and with resistance elements to meet your requirements.

Fairchild guarantees accuracy of $\pm 1\%$ or better in nonlinear types and $\pm 0.5\%$ or better in linear types. Highly accurate production methods and close mechanical tolerances, plus thorough type-testing and quality control, provide high resolution, long life, low torque and low electrical noise level in every Fairchild potentiometer. For more information, or for help in meeting your potentiometer problems, call on Fairchild Camera and Instrument Corp., Potentiometer Division, 225 Park Avenue, Hicksville, L. I., N. Y., Department 140-51A1.



completely encloses the individual resistors and gives maximum protection against mechanical damage and ambient conditions. The coefficient of expansion of the resin closely matches that of the other materials of the unit. The grouped Riteohms are available in lengths up to approximately 3 in. The individual resistor units in the group can be obtained in wattage sizes of $\frac{1}{4}$, $\frac{1}{2}$ and 1 w (125 C ambient), and in resistance values up to a maximum of 1,950,000 ohms. Tolerances as close as ± 0.1 percent are available. Descriptive bulletin No. 145 gives full details.



MAGNETIC AMPLIFIER
 features 1-cycle response

POLYTECHNIC RESEARCH & DEVELOPMENT Co., INC., 202 Tillary St., Brooklyn 1, N. Y. The R6G10W1 magnetic amplifier is ideally suited, without need of a preamplifier, for many medium performance indicating or position type servomechanisms. Though the addition of a simple preamplifier, it may be employed in the most accurate and demanding type of control systems. Design of the unit for 1-cycle response assures the widest possible bandwidth consistent with the use of 60 cps as the power supply frequency and thus reduces many of

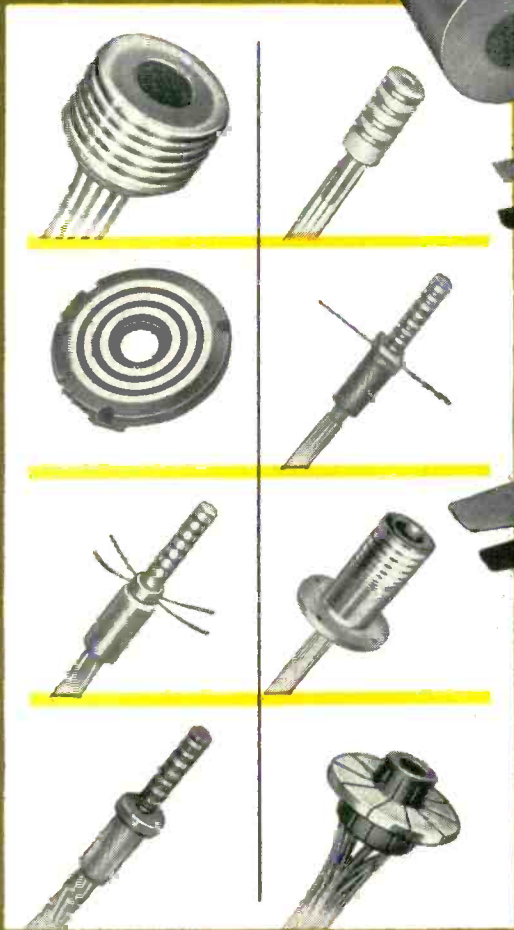
**INSTRUMENT CORPORATION
OF AMERICA**

slip ring & commutator assemblies

**One-piece construction*
assures high accuracy and
super-dependability to the
most rigid specifications.**

*Proven for
performance in
precision instruments
and equipment including
SYNCHROS, GYROS, RADAR,
FIRE CONTROL, TEST TABLES
and other CRITICAL APPLICATIONS*

Specify Instrument Corporation of America Slip Ring and Commutator Assemblies for closer tolerances, absolute uniformity and the ultimate in miniaturization. Wherever extreme dimensional precision, accurate concentricity and high dielectric qualities, are required, Instrument Corporation of America assemblies are specified with confidence. One-piece, unitized construction eliminates dimensional variation due to accumulated errors, provides jewel-like finish, uniform ring hardness and reduced weight. Engineering "know-how" resulting from years of specialization and continuous collaboration with leading manufacturers all over the world is at your immediate service.



**TYPICAL
SPECIFICATIONS**

- SIZES: .035" to 24" Diameter, Cylindrical or Flat
- CROSS-SECTIONS: Ring Thickness .005" to .060" or More
- FINISH: 4 Micro-Inches or Better
- BREAKDOWN: 1000 V or More Hi-Pot Inter-Circuit
- RING HARDNESS: 75 to 90 Brinell
- SURFACE PROTECTION: Palladium and Rhodium or Gold Prevent Tarnish, Minimize Wear & Noise

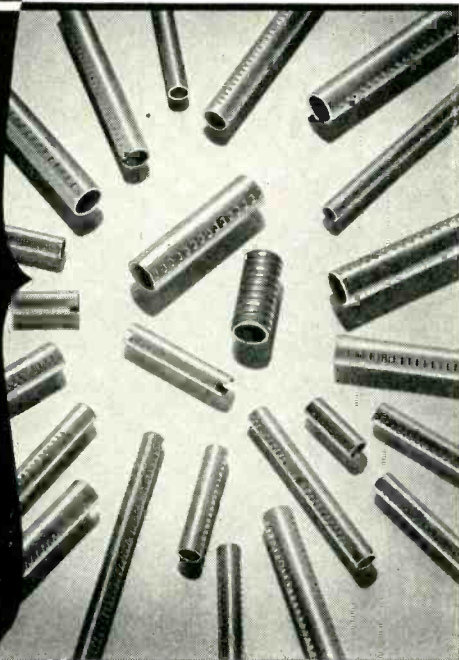
**INSTRUMENT CORPORATION OF AMERICA
BLACKSBURG · VIRGINIA**

ELECTRO DEPOSITION PROCESS AVAILABLE UNDER EXCLUSIVE LICENSE AGREEMENT WITH ELECTIC TEC CORP.

RESINITE

EMBOSSED COIL FORMS

*...can
increase
efficiency
of your
iron core
insertion
production
by 20%*



Special embossed construction eliminates torque control problems and stripping . . . prevents breakage or freezing of cores due to cross threading or improper starts.

Custom fabrication to your exact specification assures correct dimensions to within the most critical tolerances, plus uniformity throughout.

Threads are positioned in accordance with your requirement —full thread, each end, one end, center only.

We will furnish—without charge—a pilot production run of custom-made embossed forms to fit your particular application. We will also send a winding mandrel made to the specifications you supply.

Contact us now for full details about this special offer. Request technical bulletin, *Use of Threaded Tubes, Threaded Iron Cores VS. Torque Control.*

**RESINITE
CORPORATION**

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of.

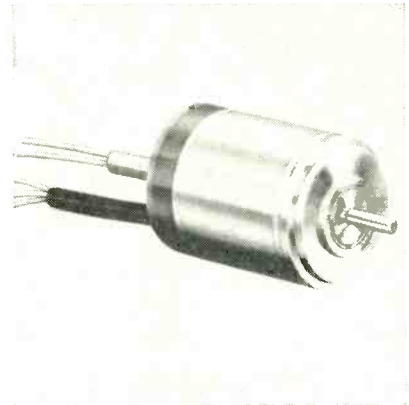
PRECISION PAPER TUBE COMPANY

2035E W. CHARLESTON ST. • CHICAGO 47, ILLINOIS

NEW PRODUCTS

(continued)

the stabilization problems formerly encountered when incorporating magnetic amplifiers in servomechanisms. The type R6G10W1 delivers 10 w reversible phase output for reversible phase a-c or reversible polarity d-c input.



SYNCHROS feature high accuracy

CLIFTON PRECISION PRODUCTS Co., INC., Marple at Broadway, Clifton Heights, Pa., has developed a new series of size 10 synchros. These units feature accuracies available before only in much larger units. Maximum diameter is 0.937 in. and maximum overall length is 1.281 in. Weight is 1.8 oz. The synchros are available with 12-in. leads, with radial terminals or with axial terminals. Cast stator and clamped bearing race construction insure lifetime alignment and accuracy. Dielectric insulation between the windings and case is rated in excess of 550 v a-c. The units are available in the following types: signal generators, repeaters, control transformers, high impedance control transformers, control differentials, resolvers and sine-cosine generators.



D-C POWER SUPPLIES are voltage regulated

ASSOCIATED SPECIALTIES Co., 1751 Main St., Orefield, Pa. Model I electronically regulated constant

Bomac

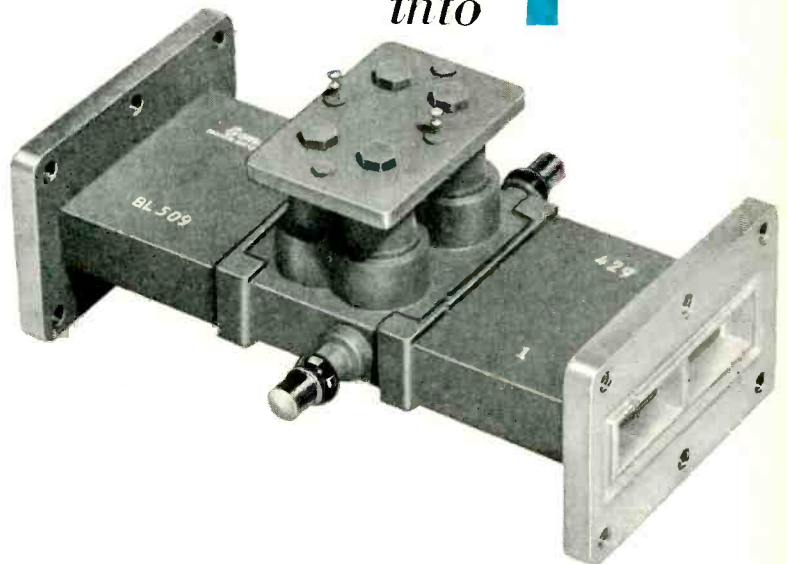
combines **4** COMPONENTS
into **1**

A complete **Duplexer**
NOW in One Compact Unit

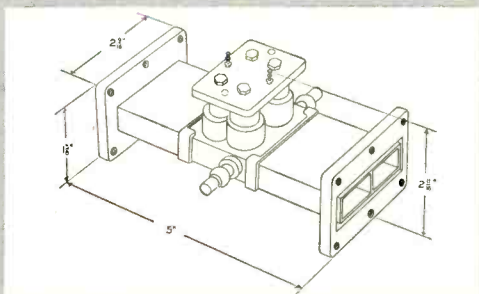
For the first time, Bomac offers to the electronic industry a complete duplexer as a single component . . . the **BL-509**.

Combining (1) a Bomac TR tube having (2) integral shutters, with (3,4) two hybrid junctions, the BL-509 eliminates the necessity of specifying these components separately. Light weight and compact, it also assures superior electrical performance and mechanical strength.

This duplexer may be fabricated to customer's configurations.



DIMENSIONS



RATINGS

Shutter Holding Current	0.060 amp
Shutter Operating Current	0.280 amp
Shutter Operating Voltage	28 V.
Ignitor Current	100-200 μ Adc
Ignitor Interaction, 100 μ Adc (max.)	0.1 db
Voltage Drop, 100 μ Adc	200-375 Vdc

CHARACTERISTICS

Duplexer Loss (max.)	1.2 db
Arc Loss (max., at 4 KW)	0.6 db
Spike Leakage (at 40 KW)	0.1 erg
Flat Leakage (at 40 KW)	20 MW
Bandwidth	8490-9578 MC
Center Frequency	3000 MC
Recovery Time (at 200 KW)	7 μ sec.
Shutter Attenuation (min.)	40 db
Isolation	20 db min. at center, 15 db min. at ends

We invite your inquiries regarding

- ENGINEERING
- DEVELOPMENT
- PRODUCTION

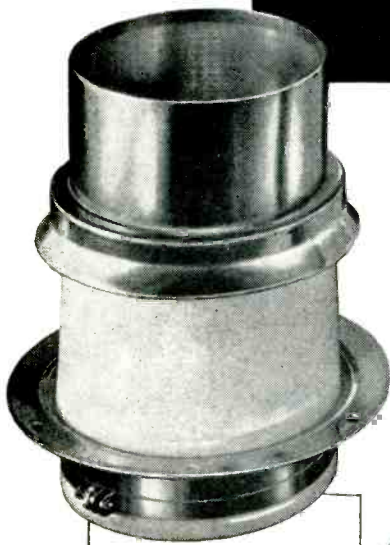
Bomac Laboratories, Inc.

BEVERLY, MASSACHUSETTS

GAS SWITCHING TUBES · DIODES · HYDROGEN THYRATRONS · DUPLEXERS · MAGNETRONS
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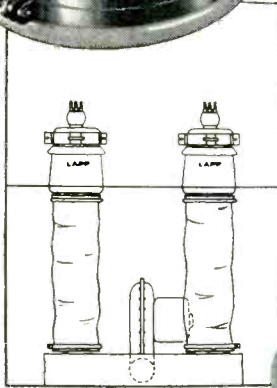
Catalog on request.
Write (on your company letterhead)
Dept. E-9 BOMAC
Laboratories, Inc.
Beverly, Mass.

Lapp



TUBE SUPPORTS

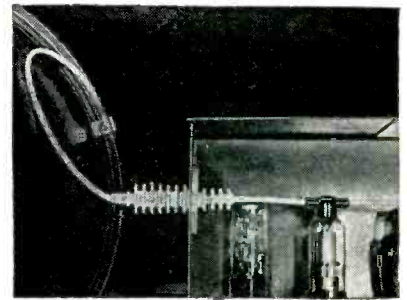
for forced-air-cooled
power tubes



• No longer is it necessary for equipment manufacturers to design supports for forced-air-cooled tubes. After producing many such special designs, Lapp has engineered and built a complete series of insulating supports for air-cooled tubes. Use of these supports facilitates design of transmitter and other high-power circuits. Simple, compact, efficient and attractive in appearance, they make for economical production, easy interchangeability, and availability of replacement units. Write for Bulletin 301, with complete description and specification data. Lapp Insulator Co., Inc., Radio Specialties Division, 229 Sumner St., Le Roy, N. Y.

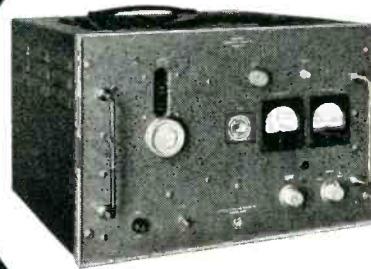
Lapp

voltage power supplies have a d-c output voltage continuously variable from 200 to 325 v for load currents of 0 to 100 ma. Ripple output is less than 10 mv rms. Both positive and negative sides of the output are isolated from ground. Either side may be grounded or the output may be left floating. An isolated a-c voltage of 6.3 v at 3 amperes is available at the output terminal connections. All input and output connections are made to a single terminal strip conveniently located on the rear of the chassis. Weight of the unit is about 20 lb. Price is \$56.



CONNECTOR CABLES are integrally molded

ALDEN PRODUCTS Co., 117 North Main St., Brockton 64, Mass., has developed a new cabling technique making it possible to mold several cable connector components into one integral unit by molding the connectors right onto the wire insulation. The cost is low, space is saved and the problems of strain relief, wire insulation pull back, wire fatigue under vibration and h-v arc over at wire holes are eliminated. Very compact designs are possible because of a homogeneous body of insulation molded right around the contacts and leads. A minimum of material is required by eliminating the need for long leakage paths at the wire joints. The h-v potential sources are sealed into the insulating jacket greatly reducing the problems of corona suppression and shielding. Developed for color tv, these integrally molded cables have a wide field of application in other areas, such as h-v power supplies, h-v rectifier circuits in such equipment as radar, transmitters and x-ray. Illustrated is an integrated cable tailored to



Ultra-stable Microwave Oscillator

LFE Model 804 X-band Microwave Oscillator holds frequency to 1 part in 100,000,000, giving you *real* stability. It is the oscillator you need for VSWR or Q measurements, general narrow band design work, or any application where a high degree of stability is required.

This same stability is available in C-band as well as X-band oscillators and in other microwave frequencies to meet your specifications.

SPECIFICATIONS: (Model 804)

Frequency Coverage

8,500 — 10,000 Mc-X-Band

Dial Calibration

Calibrated directly in frequency —
1 Mc per division

Frequency Stability

Short Term Deviation — less than one part in 10^8
Long Term Drift — negligible after complete warm-up

Modulation

Can be modulated 25% when stabilized; 100% modulation possible when stabilization is removed

Power Output

80 — 100 milliwatts
Output flange — UG 40/U

Power Consumption

160 watts

Size

$12\frac{1}{2}$ " x 19" front panel, $19\frac{1}{4}$ " deep, cabinet or rack mounting

Weight

100 lbs.



LABORATORY for ELECTRONICS, INC.

75 Pitts Street

Boston 14, Mass.

PRECISION ELECTRONIC EQUIPMENT • OSCILLOSCOPES • NUMAR CHEMICAL SPECTROMETER • COMPUTERS • SOLID DELAY LINES

5 idea starters for product improvement in Metallized Glass

In each of the components shown here, the unique properties of metallized glass have helped solve a design problem and make a better product.

A basic idea starter is the Metallized Glass Enclosure Tube. You see six of the many available sizes at the right.

You can use these tubes to hermetically enclose many kinds of components. Such enclosure gives the components performance characteristics they otherwise do not have.

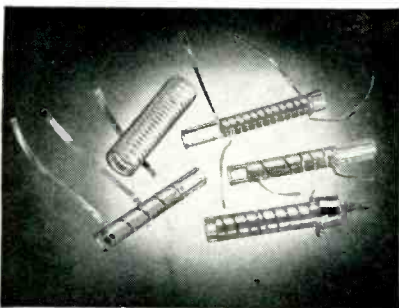
Corning's metallizing process makes possible a true hermetically sealed enclosure. Components encased in metallized glass enclosures are impervious to moisture, moulds, and atmospheric changes. Assemblies complete with end caps are capable of withstanding severe temperature changes. Glass has excellent electrical characteristics, and its transparency permits visual inspection. Bond strength for metallizing used on enclosure tubes has been measured at 1500 to 2000 pounds per square inch.

These characteristics can perhaps broaden your use of some product, ex-

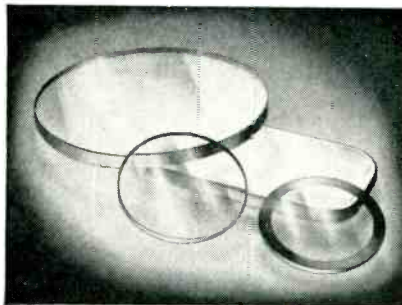


pand its performance limits, or reduce servicing and minimize breakdown possibilities.

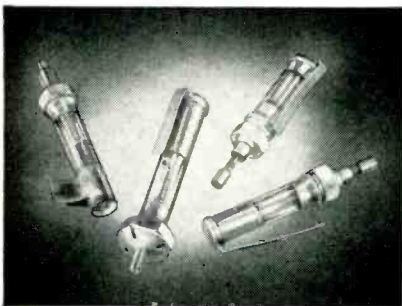
Illustrated below are other applications of Corning's metallizing process. If none of them exactly meets your needs—or, if metallized glass characteristics suggest solutions to other problems, write us your requirements. Chances are, we'll be able to help you. There is no obligation.



CORNING METALLIZED GLASS INDUCTANCES are made with a precision that guarantees duplication within close limits. When used in either FM or TV circuits, you can be sure that they will contribute negligible drift even under unusual temperature changes.



METALLIZED GLASS INSTRUMENT WINDOWS are made of both tempered and untempered glass with metallized bands on the edges. They can be easily soldered into a bezel to form a hermetic seal. Available in sizes and shapes to meet your needs.



MIDGET TRIMMER CAPACITORS are available in standard types from 0.5 to 12.0 mmfds., or they can be designed to your requirements. Temperature coefficient for brass core units is approx. 200 ppm/deg. C.; for invar core units, approx. 50 ppm/deg. C.



METALLIZED BUSHINGS AND STANDOFF INSULATORS for high voltage applications. Bushings can provide hermetically sealed insulators for high voltage transformer and capacitor terminals. Standoff insulators are made of tempered low loss glass. Both can be furnished in special sizes.

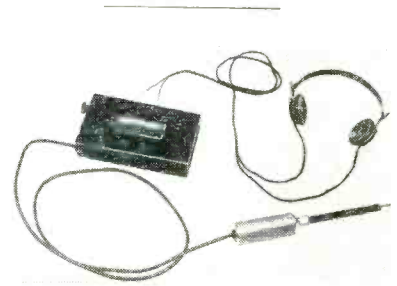


CORNING GLASS WORKS, CORNING, N. Y.

New Products Division

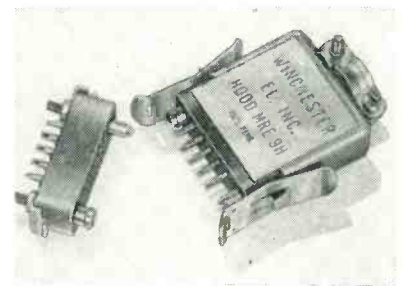
Corning means research in Glass

customers' specifications for 20,000-v anode power supply—made up from "in line" tube cap, h-v disconnect and anode clip.



SOUND PROBE weighs less than 5 lb

THE GEL-ME Co., P. O. Box 293, Bloomington, Ill., announces the electronic sound probe, a scientific instrument that changes vibrations into electrical energy, multiplies sound volume and transmits directly into earphones. The compact tool enables users correctly to diagnose and locate trouble spots in any mechanically operating piece of equipment. The instrument comes complete with tubes and batteries. A four-page folder now available points out the unit's many applications.



VIBRATION LOCK for electrical connectors

WINCHESTER ELECTRONICS, INC., Glenbrook, Conn., has designed a new vibration lock that locks automatically by simply engaging the mating connector parts. Simplicity of operation is the outstanding design feature and time-consuming, troublesome lock screws have been eliminated. Quick unlocking action is achieved merely by depressing the extended lever arms and requires no additional handling operation than is normally encountered when disengaging the plug and receptacle connectors. Spring-action

FREED MAGNETIC AMPLIFIERS

Series MAHS

Designed for

Aircraft and Guided Missile Control Systems

DRIFT-FREE & RELIABLE AT 200° C

The MAHS series of FREED MAGNETIC AMPLIFIERS is characterized by:

- Reliable operation in ambient temperatures up to 200°.
- Fast response—2 cycles of power frequency delay for 100% response to step input signal.
- Phase reversible A.C. output with ZERO DRIFT OF NULL POINT.

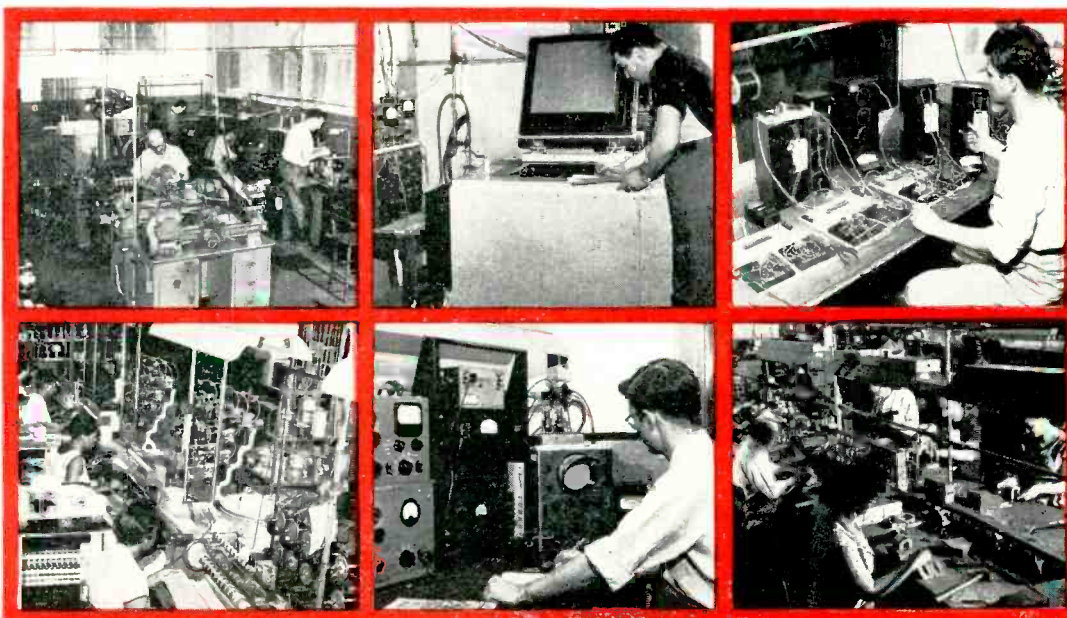
The MAHS series includes the units described below. Engineering and development facilities are available for the design and development of Magnetic Amplifiers having special performance characteristics.

HIGH TEMPERATURE MAGNETIC AMPLIFIERS — DRIFT-FREE

1 ϕ Supply Voltage and Frequency	Full Power Output	Max. Voltage Output	Signal Req. for full output	Max. Power Gain	Mfr. and Type No.	Typical Motor Load Stall Torque	No Load Speed	FREED Type No.
115V., 60	15 watts	115V. AC phase reversible	.4V. AC (10,000 ohms input impedance)	1.5×10^7	Diehl FPE 25-11	5.5 in-oz	3500 RPM	MAHS-1
115V., 400	2.7	26V. AC phase reversible	.4V. AC (10,000 ohms input impedance)	2.6×10^6	Kearfott R 118	.32	7200	MAHS-2
115V., 400	5	57.5V. AC phase reversible	.4V. AC (10,000 ohms input impedance)	5×10^6	Kearfott R 110-2	1.5	5300	MAHS-3
115V., 400	10	57.5V. AC phase reversible	.4V. AC (10,000 ohms input impedance)	1×10^7	Kearfott R 111-2	2.4	5300	MAHS-4

SEND FOR LATEST DETAILED BULLETINS AND CATALOGS

FREED RESEARCH, Engineering and Production Facilities Combine to Produce Transformers and Instruments of Top Performance.



FREED TRANSFORMER CO., INC.

1722 WEIRFIELD ST., BROOKLYN (RIDGEWOOD) 27, N. Y.

Freed Magnetic Amplifiers, Saturable Transformers and Reactors are designed for efficient operation and long life. They can be used wherever reliable, rugged and maintenance free systems are required.

The types of amplifiers listed are designed to control AC servomotors.

Development facilities are available for the design of magnetic amplifiers to meet specific requirements.

All standard units are hermetically sealed and meet MIL-T-27 Specifications.

SATURABLE TRANSFORMERS — Controlled with dual triode; plate supply can be either DC or AC; no rectifiers; AC or DC control signals.

PUSH-PULL MAGNETIC AMPLIFIERS — AC or DC control signals; high gain; may be used with magnetic or vacuum tube preamplifiers if needed.

FAST-RESPONSE MAGNETIC AMPLIFIERS — High gain; half-cycle per stage response time; AC or DC control signals; RC feedback networks for control system stabilization can be used directly; preamplifier not needed.

HIGH TEMPERATURE MAGNETIC AMPLIFIERS — Designed to operate in ambient temperatures as high as 200°C; AC or DC control signals.

DRIFT-FREE MAGNETIC AMPLIFIERS — For rigid drift-free requirements of control systems; designed to meet specific requirements.

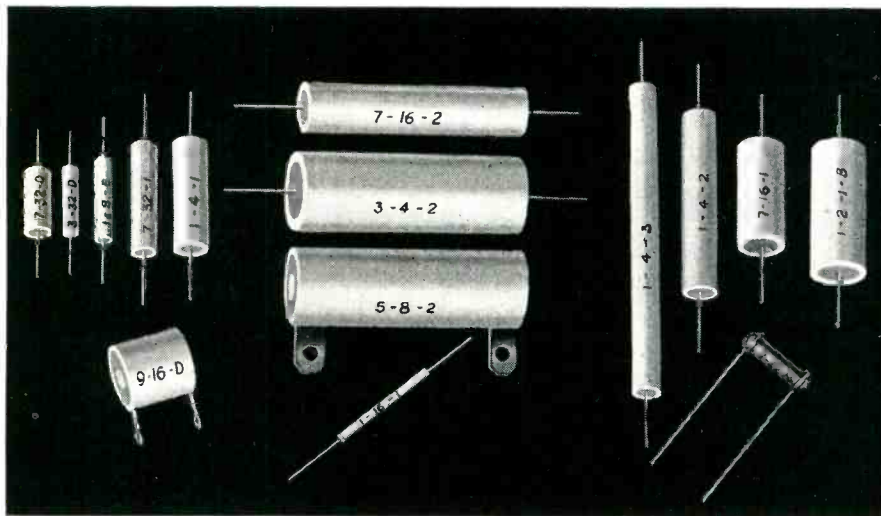
OTHER FREED PRODUCTS TRANSFORMERS

- High Fidelity
- High Level Pulse
- High Q Toroids
- Power
- Slug-Tuned
- Hermetically Sealed
- Step-down
- Miniature Transistor
- High Q Reactors
- High Temperature
- Miniature Audio
- Charging Reactors
- Sub-miniature
- Precision Reactors
- Precision Filters

INSTRUMENTS

- Comparison and Limit Bridges
- Low frequency "Q" Indicators
- Incremental Inductance Bridges
- Universal Bridges
- Null Detectors and V.T. Voltmeters
- Power Supplies
- A.C. Bridges and Accessories
- Differential Voltmeters
- Harmonic Distortion Meters
- Wide Band Amplifiers
- Decade Amplifiers
- Decade Inductors
- Decade Capacitors
- Megohmmeters
- Filters
- Magnetic Voltage Regulators

NEW UNIQUE Bobbinless NON-INDUCTIVE PRECISION WIRE TYPE Resistors



LOWER COST • SMALLER SIZE

A new, entirely different method of making precision wire resistors. NEW, EXCLUSIVE techniques and patented* designs permit these unique features:

- ▶ Lower cost; smaller size per given resistance value
- ▶ Bobbins eliminated
- ▶ Winding strains eliminated
- ▶ Much closer tolerance control
- ▶ No artificial aging required
- ▶ Combines absolute minimum inductance and capacitance effect
- ▶ Sealed-in ceramic tube seals-out moisture
- ▶ Identical performance as costlier, larger resistors

Wide variety of sizes, shapes and resistances available. Ideal for many applications, including computers, meters, test instruments and other electronic devices requiring absolute accuracy and stability combined with lower cost. Write for full details TODAY.

*Pat Pending

M O N S O N

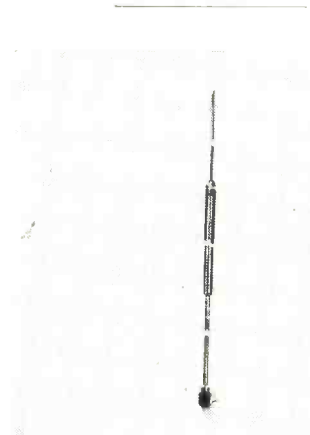
MANUFACTURING CORPORATION

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NEW PRODUCTS

(continued)

lever arms provide secure locking in excess of 50-g shock impact and 10-g vibration acceleration. An important feature is that the locking mechanism is easily assembled to MRE connectors now in field service.



VHF COAXIAL DIPOLE of all brass construction

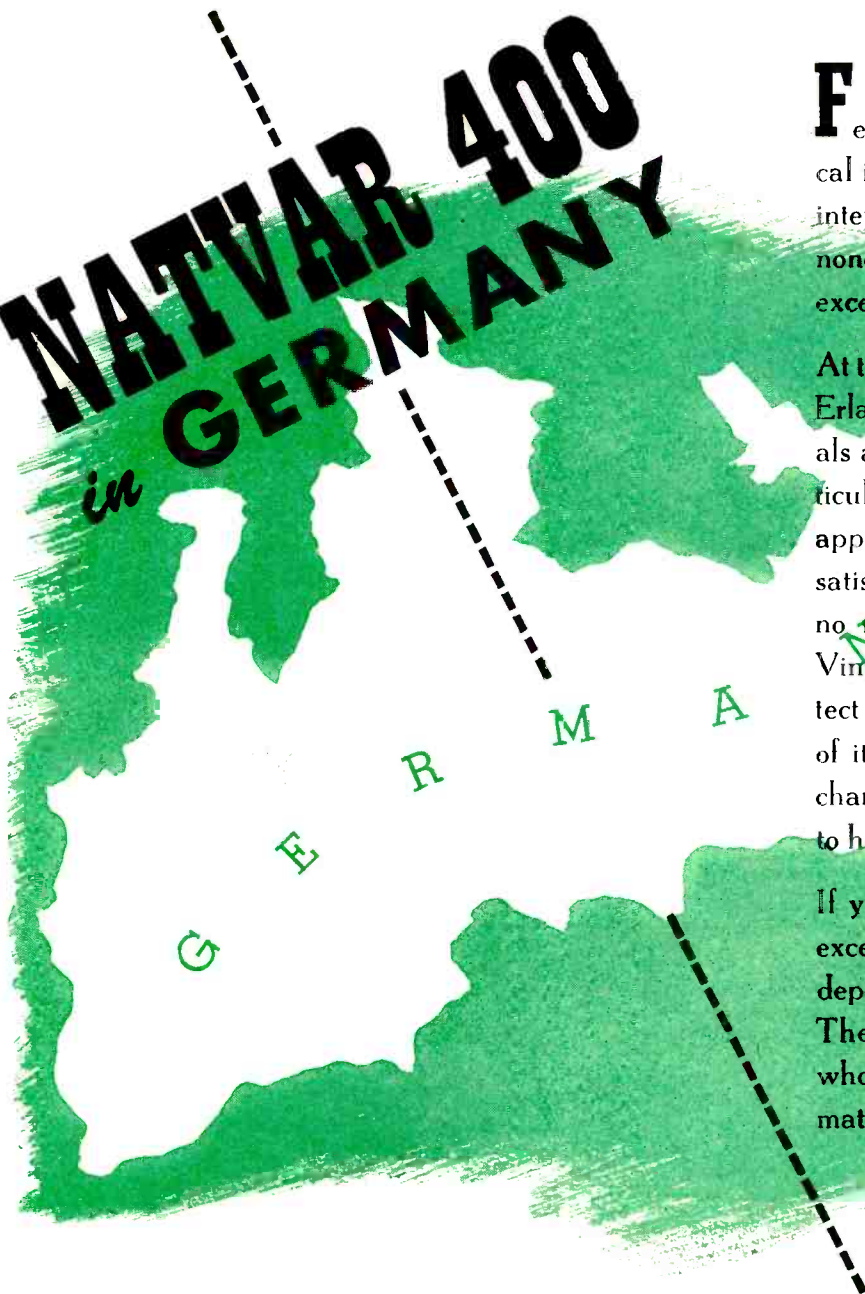
OMEGA LABORATORIES, P. O. Box 33, Arlington 74, Mass. Model OXA-146-W vhf coaxial dipole features all brass construction, is sealed against corrosion and cut to specified frequency. It also features power inputs to 750 w. Input impedance is 51 or 72 ohms, and standing wave ratio, 1.15. The unit was designed for use by amateurs, civil air patrol-civil defense, and communication services who desire an omnidirectional antenna that will stand up under the most rugged service. Price is \$19.95 net.



TINY TRANSFORMERS weigh only 1.5 oz

TORWICO ELECTRONICS, INC., 961 Frelinghuysen Ave., Newark 5, N. J., has in production a line of miniature transformers with outputs of 3 v-a and 6 v-a. Typical is the TW-6 unit illustrated. This is

NATVAR 400 in GERMANY



Few, if any, are the names in the electrical industry that are more *widely* known internationally than Siemens. Certainly none are more *favorably* known for the excellence of their products.

At the Siemens-Reiniger-Werke A. G. in Erlangen, Germany, construction materials are carefully tested and selected, particularly for such equipment as X-Ray apparatus which is expected to operate satisfactorily for many years with little or no maintenance. Natvar 400 Extruded Vinyl Tubing is used to insulate and protect leads of X-Ray transformers because of its uniformly good electrical and mechanical characteristics and its resistance to heat and oil.

If you need insulating materials with exceptionally good properties, you can depend on Natvar flexible insulations. They are available either from your wholesaler or direct, and are the same no matter when or where purchased.

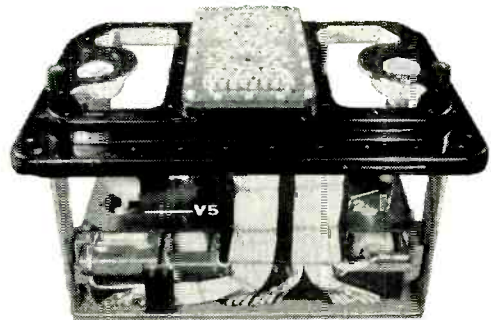


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- Varnished—Silicone coated Fiberglas
- Varnished papers—rope and kraft
- Slot cell combinations, Aboglas®
- Vinyl coated—varnished—lacquered tubing and sleeving
- Extruded vinyl tubing and tape
- Styroflex® flexible polystyrene tape
- Extruded identification markers

Ask for Catalog No. 23

Interior view of a 125 kv transformer used in X-Ray equipment manufactured by Siemens-Reiniger-Werke A. G. It is an oil immersed type and operates from a 580 volt AC power source. Primary leads are insulated and protected with Natvar 400 Extruded Vinyl Tubing which retains its excellent electrical and mechanical properties in spite of heat and oil.



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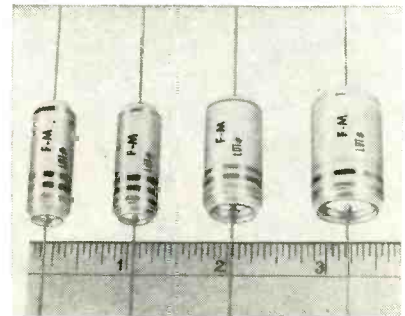
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NEW PRODUCTS

(continued)

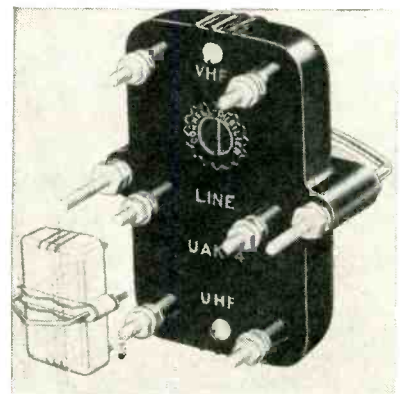
only 1 in. o.d. \times $\frac{3}{4}$ in. high and weighs 1.5 oz. Electrical ratings are: input, 115 v, 400 cycles; power output, 6 v-a; regulation, 10 percent; heat rise 40 C, class A. It is hermetically sealed in a metal case to MIL-T-27 requirements.



COILS

are hermetically sealed

THE FUGLE-MILLER LABORATORIES, 398 Main St., Metuchen, N. J., announces production of a new series of hermetically-sealed coils for electronic and electrical applications. The coils are offered in a wide range of electrical and mechanical characteristics. Features include: hermetic sealing to provide absolute protection against the effects of moisture; true glass-to-metal sealing techniques; insulated metal case; and specifications exceeding the most rigid requirements.



FILTER NETWORK for tv antennas

CORNELL-DUBILIER ELECTRIC CORP., 333 Hamilton Blvd., South Plainfield, N. J., announces the model UAK-4 filter, network for tv antenna installations. It is not just a printed circuit but a truly engineered filter network with coils

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Year	Error Spread	Weight	Cost
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1934	6°	10 oz.	\$65.00
1941	2½°	5 oz.	\$20.00
1944	20'	5 oz.	\$35.00
1954	10'	1¾oz.	\$25.00
Coming	5'	5 oz.	?
Coming	15'	1¼oz.	?

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ACTUAL SIZE

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PRECISION PRODUCTS CO.

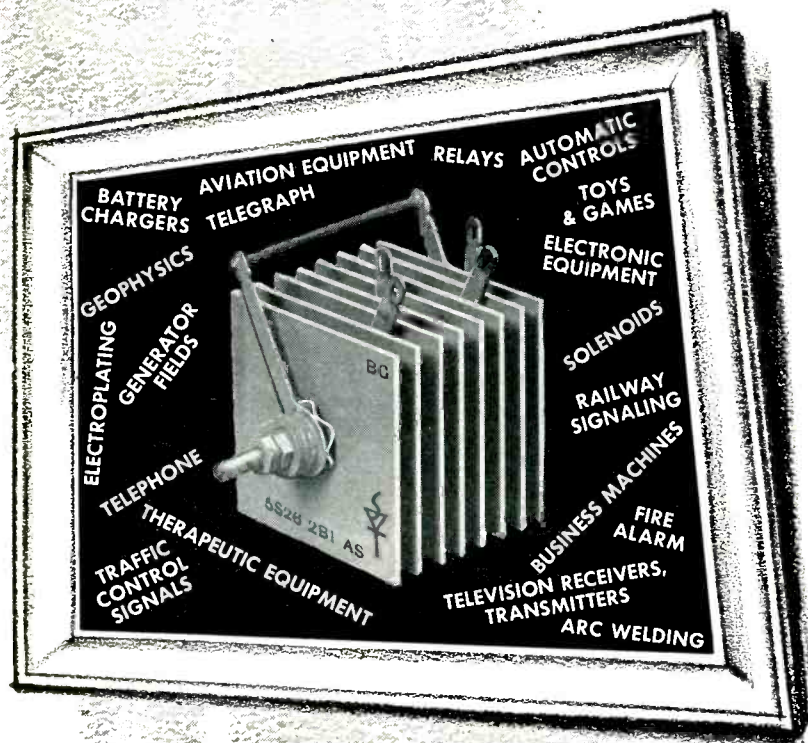
DIFFERENTIAL
TYPE CD-10-AS-2
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PRECISION PRODUCTS CO.

RESOLVER
TYPE CS-10-AS-1
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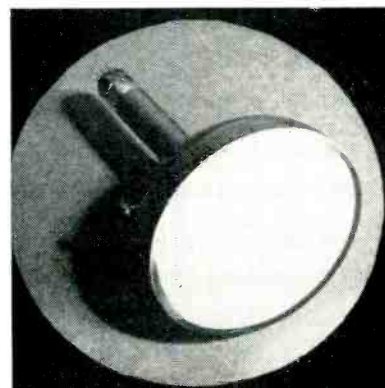
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and capacitors, no resistors, and functioning truly as a low-loss filter. Other features include sealed polystyrene case with molded standoffs, maximum signal rejection ratio insuring minimum signal interaction, easy installation, positive gripping to fit almost any mast, and no ghosts or images because there is a minimum reflection loss. It is ideal for segregating vhf and uhf at the set and is guaranteed to work with uhf.



MINIATURE C-R TUBE for daylight use

NATIONAL UNION RADIO CORP., 405 Lexington Ave., New York, 17, N. Y., announces a new c-r tube with a 5-in. face, a heater power consumption of only 1.26 w and an overall length of only 7½ in. It has special features that make it easily read in bright daylight. The tube, with a standard 9-pin miniature base, uses magnetic focus and deflection and produces beam currents of 0.5 to 1.0 ma under normal operation. It can be designed into airborne or small, compact equipment or can be used where strong, surrounding light levels are encountered.

PULSE GENERATOR is a rotary type unit

SARGROVE ELECTRONICS LTD., Alexandra Road, Hounslow, Middlesex, England, has developed a rotary pulse generator, which generates a train of pulses directly proportional to the linear motion of material being rolled out by a rolling mill. The pulse generator, originally developed to give a highly accurate remote indication of the velocity of

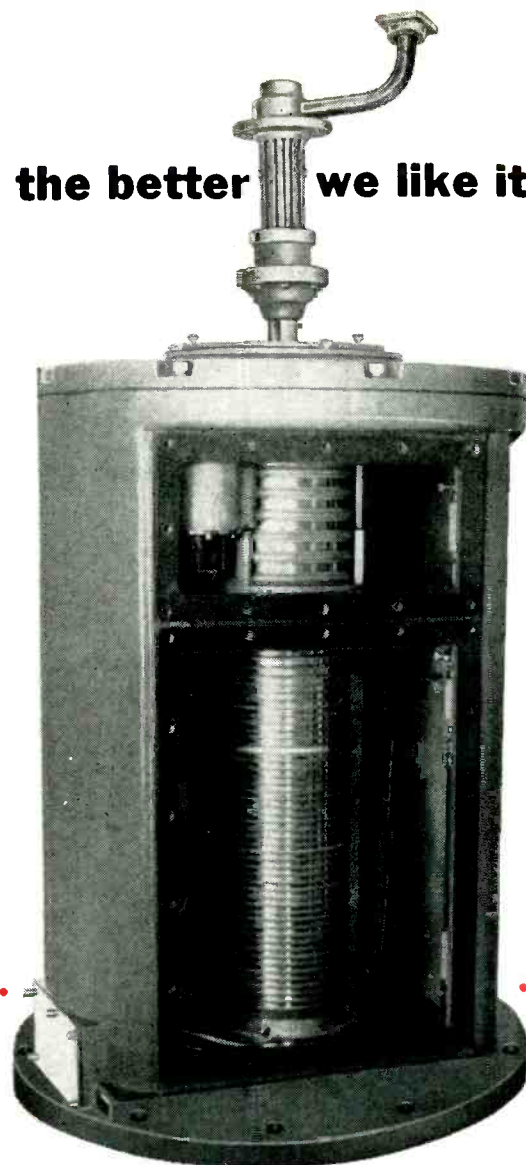
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We shall be glad to confer with you on the design and manufacture of prototypes and production runs. Our exceptional testing facilities are at your disposal.



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heavy machinery in steel rolling mills, can be used for a number of different purposes. For example, it will measure the linear motion of rolled material with sufficient accuracy to enable the material to be guillotined to an accuracy of 0.1 percent. It can also be used to feed information into high-speed counting or batching machines, and can be geared to a radar antenna or searchlight beam to give a direct angular positional indication of the beacon bearing by means of the pulses it generates.



POWER TRIODE is low-mu regulator tube

CHATHAM ELECTRONICS CORP., Livingston, N. J. Type 6337 power triode features high plate dissipation and high perveance, plate current held within ± 10 percent and absence of plate current drift. Compact in design, the new tube is capable of withstanding 500 g. A hard glass envelope and a button stem that strengthens the mount, provide high immunity to extreme shock and vibration. Wide interlead spacing practically eliminates electrolysis. These and other features make the tube highly dependable in critical regulating circuits.

TUBE GRAPH BOOK with price list available

SCHNURR-SCHULTZ-WEBER, Consultant Engineers, 7251 Teal Ave., St. Louis 14, Mo. "Vacuum Tube Characteristics and Design Sheets" is a 42-page book containing design data on 36 tube types and a 9-page



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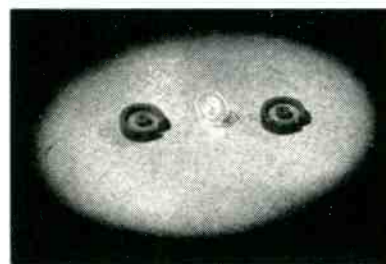
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explanation of the use of the design curves with numerical examples. It features large scale, easy-to-work-with plate characteristic curves on 8½ × 11-in. sheets. Punched holes, for insertion in a data book or laboratory report, permit the curves to be removed from the book and retained as a permanent record of circuit design. In addition each sheet includes: absolute maximum ratings according to the military specifications for electron tubes, MIL-E-1B; absolute maximum plate dissipation hyperbola; and a tube schematic. All information pertinent to the design and breadboarding of a circuit utilizing a particular tube is given on a single uncluttered sheet. In addition to the 42-page book, single sheets are also available for 45 tube types, 6 of which are widely used subminiatures.

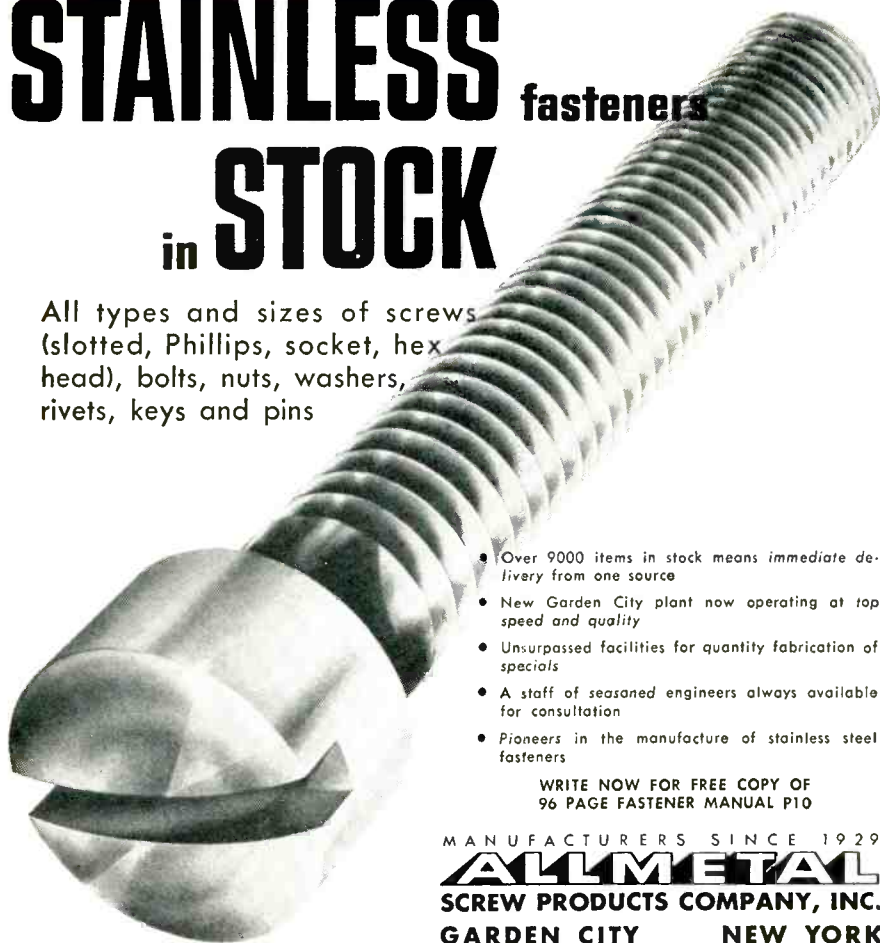


FERRITE POT CORE
is miniature size

SPRAGUE ELECTRIC Co., North Adams, Mass. A miniature pot core made of Ferroxcube type 3C ferrite material permits construction of very small coil assemblies having moderate inductance values with a relatively high Q. The windings are of coil assemblies made of this pot core, and are entirely surrounded by high permeability material so that shielding is excellent and stray fields are minimized. Assemblies of this pot core may be placed close together and even stacked in some applications with negligible coupling between adjacent coils. A nylon bobbin, part A508-72, is also available from Ferroxcube Corp. of America, Saugerties, N. Y., for use in assemblies of the new pot core. (The bobbin is illustrated between two halves of the pot core structures.) The new Ferroxcube pot core finds wide ap-

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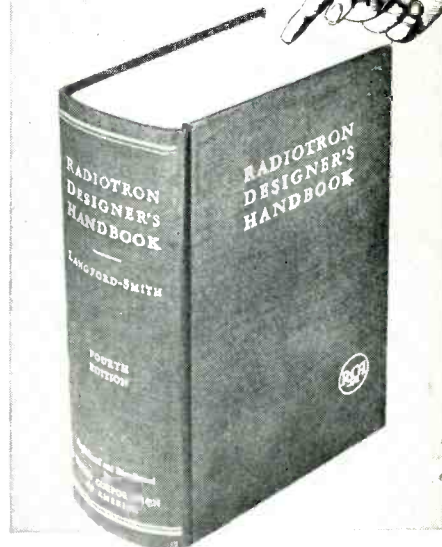
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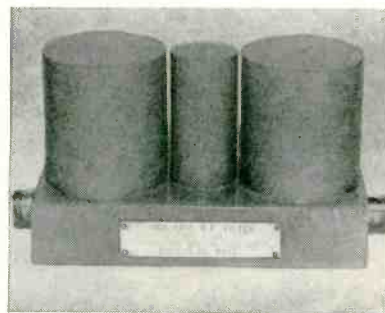
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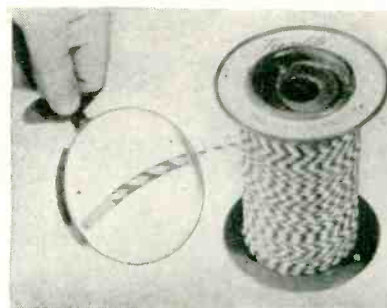
ELECTRON TUBES HARRISON, N. J.

plication in blocking oscillator transformers, pulse transformers, filters, delay lines and oscillator inductances.



FILTERS for use in 52-ohm circuits

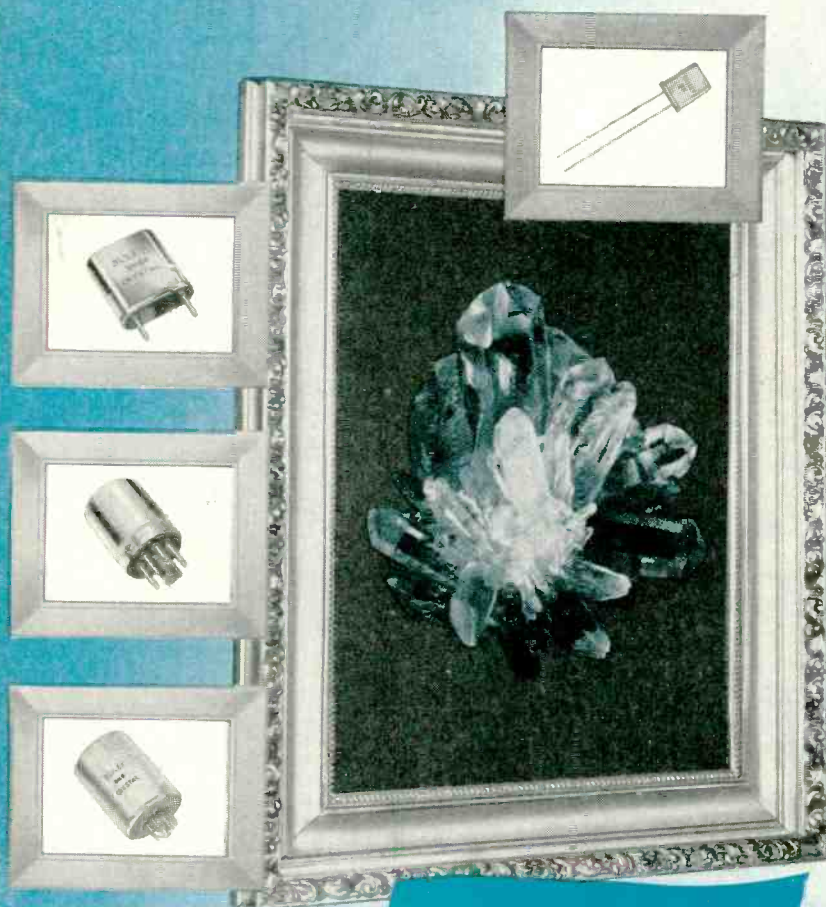
SCIENTIFIC SPECIALTIES CORP., Snow and Union Sts., Boston 35, Mass., has available symmetrical high-pass ladder type filters with transmission line sections for use in unbalanced transmission systems. The filters are noted for their low loss in the passband and high attenuation in the stop band. They can be used in the antenna transmission lines of h-f receivers or transmitters to permit power transmission at certain frequencies and stop power transmission at other frequencies. The filters are designed for use in 52-ohm circuits but other impedances can be supplied. Insertion loss at frequencies near the cutoff is less than 3 db. At lower frequencies the insertion loss is less than 0.5 db.



TEFLON WIRE is spirally striped

TENSOLITE INSULATED WIRE CO., INC., 196 Main St., Tarrytown, N. Y., is now offering production quantities of spirally striped Tensolon high temperature Teflon insulated hook wires for color coding and

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TECHNICAL LITERATURE AVAILABLE:

Bulletin No. 47—Crystals, Ovens, Frequency Standards, MIL-type Specification Index

Bulletin No. 45-A—Solid Ultrasonic Delay Lines

Bulletin No. 46-A—"Banana BX" Crystals

Bulletin No. 44-B—Amateur, Standard Frequency, Sail-To-Shore, and TV Service Crystals

circuit identification. Spiral striping conforms to commercial (GEN-104) and military (MIL-W-76A) specifications for color coding. There are 819 different striped combinations possible using black, brown, red, orange, yellow, green, blue, purple and grey inks on neutral or white insulation. Finished wire is supplied in conductor sizes from No. 26 to No. 10 Awg. The Teflon insulation has a nominal wall thickness of 0.010 in. to meet the requirements of MIL-W-16878A specification for type E wire rated for operation at 600 v up to 250 C continuous temperature.

RESISTORS are flat, card wound

THE DAVEN Co., 191 Central Ave., Newark 4, N. J., announces availability of their flat, card wound resistors. For many precision wire-wound resistor applications, where space is at a premium, these resistor cards provide a workable, economical solution in place of the usual spool or bobbin type. The cards are 1/8 in. thick and 3/8 in. wide. Length is determined by the number of individual resistance sections required for a particular application. Normal power rating is 0.6 w. Up to 5,000 ohms per section may be obtained. Accuracies to 0.1 percent are available. Cards can be impregnated to withstand severe military or industrial environmental tests.



TRANSFORMERS and filter reactors

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NEW "ULTRA-VIDEO VOLTMETER"



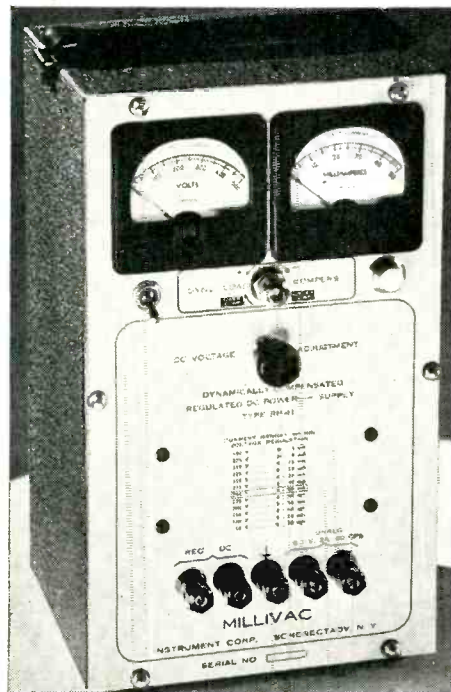
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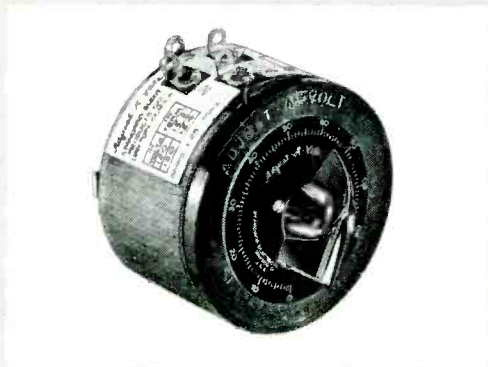
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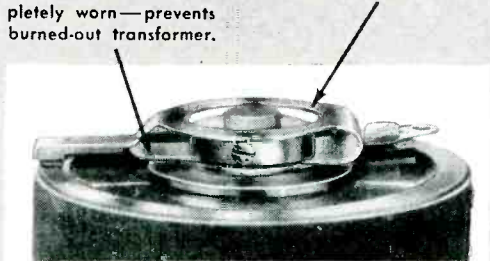
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This highly efficient, compact, toroidally-wound control unit smoothly delivers any desired voltage from zero to line voltage or above. Sturdily built to give years of service, Type 100BU features LoRes alloy plated brush track and exclusive brush-holder design.

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Specially designed stop prevents brush holder from engaging winding when brush is completely worn—prevents burned-out transformer.

Extra long brush spring gives free action—uniform pressure from full-brush to no-brush.



Write for 18 page Adjust-A-Volt Catalog and full data on Type 100BU, or contact your local distributor.

STANDARD ELECTRICAL PRODUCTS COMPANY

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18, Ill., has made available a full line of stock 400-cycle power and filament transformers and filter reactors. All of these units were designed to meet MIL-T-27, class B specifications for high temperature operation. They are housed in seamless drawn steel, hermetically sealed cases, with stud-type terminals. Detailed specifications and prices are given in bulletin 32.



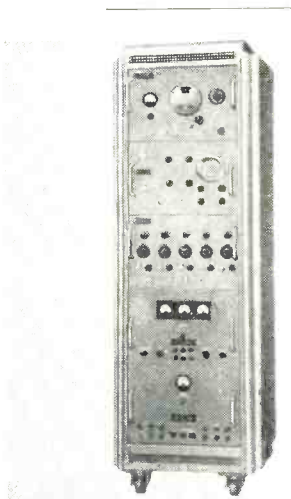
DISTORTION METER has 0.1-percent accuracy

FREED TRANSFORMER CO., INC., 1715 Weirfield St., Brooklyn 27, N. Y. Model 1410 distortion meter has a frequency range from 20 kc to 1 mc in 10 overlapping ranges. Distortion range is from 0.1 percent to 30 percent. Input level range allows signal levels from 0.2 v to 1,000 v to be measured directly. An accuracy of 0.1 percent is obtained at signal levels as low as 0.2 v. Other features include an easy-to-read 4-in. meter used as distortion indicator and monitor, the meter being protected against overload. Residual signal is measured by high gain vtvm with flat response up to 3 mc. The unit has a low-impedance, distortionless preamplifier with monitoring circuit. A null T network assures complete attenuation of fundamental.

MASS SPECTROMETER is sensitive and portable

CONSOLIDATED ENGINEERING CORP., 300 N. Sierra Madre Villa, Pasadena 8, Calif., has developed a new mobile, process monitoring and control type mass spectrometer, model 21-620. It utilizes a cycloidal-fo-

cusing principle. The unit will furnish the petroleum, chemical and petrochemical industries with a highly-sensitive portable tool for making high-speed and accurate analyses of gaseous and light liquid mixtures.



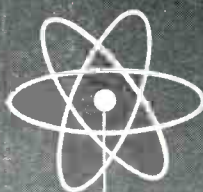
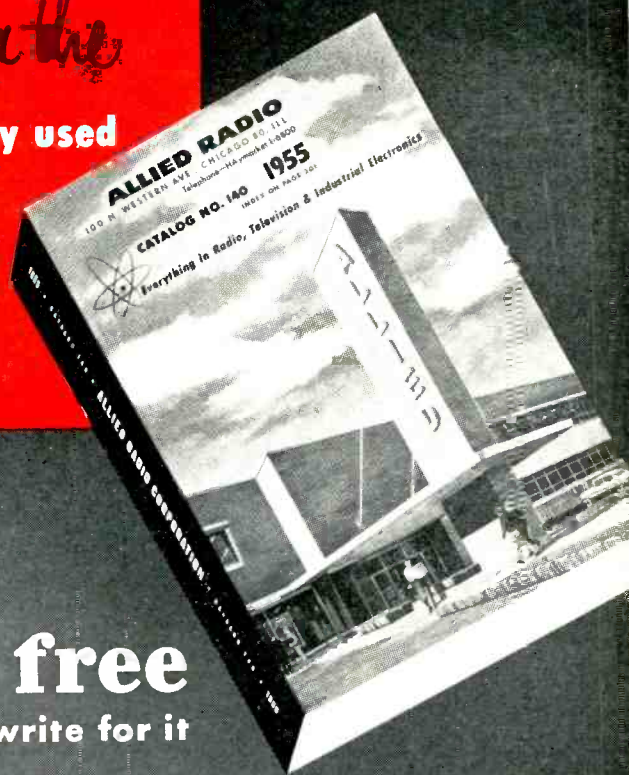
SIGNAL GENERATOR for microwave checking

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N. Y. Model B signal generator has been designed to check equipment requiring multiple pulse modulated microwave frequency energy whose widths and delays can be accurately controlled. It consists of 4 interchangeable r-f heads providing continuous coverage from 950 to 10,750 mc, with single dial, direct reading tuning controls. A direct reading r-f attenuator is provided in each r-f head. The modulator portion furnishes five independently adjustable pulse channels, each capable of being adjustable in time and width as well as supplying pulse time modulation. A high speed oscilloscope is incorporated in the unit to monitor accurately pulse adjustments. All power supplies are operated from a line voltage regulator to insure utmost stability of operation.

CORE TESTER delivers a pulse program

RESE ENGINEERING INC., 301 Walnut St., Philadelphia 6, Pa. Model MPT-1 magnetic core pulse analyzer was designed for testing ferrite cores for high-speed memories

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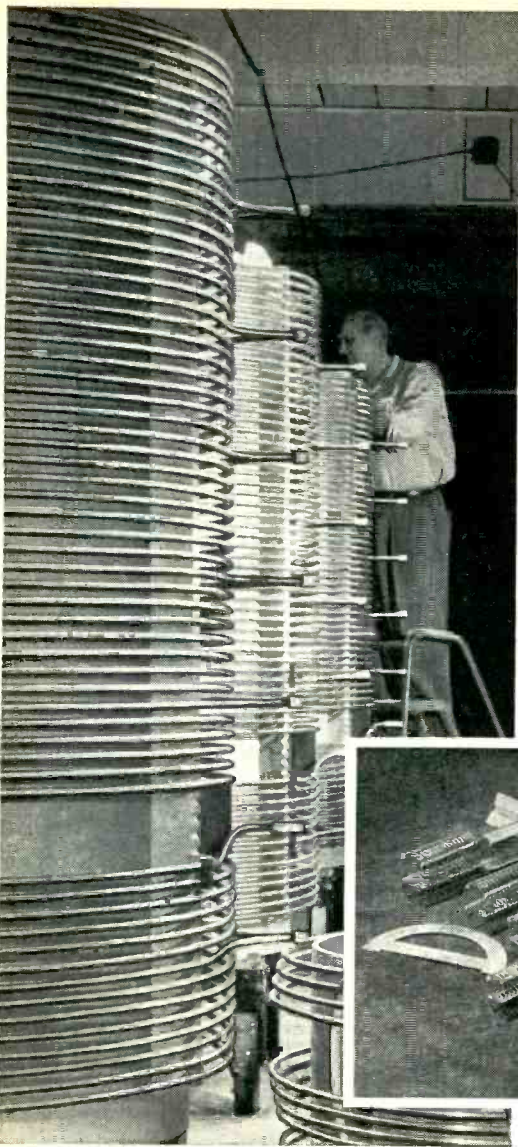
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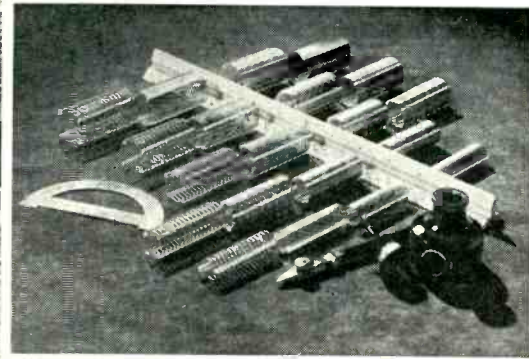


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When you need coils . . . whether it be just a few for research and development or huge quantities for volume production . . . you'll find your needs right up B&W's alley. Regardless of size or type . . . from 6' x 48" variometer type loading coils down to half-inch miniductors, both shown above.

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in digital computers. It can also be used for pulse evaluation of any magnetic materials. Cores are tested by being submitted to a program of pulses to simulate the conditions of actual computer operation, and observing the output of the core on a suitable oscilloscope. An 8-step program is available which will give any combination of positive, 1/2 positive, negative or 1/2 negative pulses, as selected by 16 toggle switches on the front panel. The program is repeated continuously and the prf of the individual pulses is variable from 1 kc to 10 kc.



AIRCRAFT BATTERY ELIMINATOR

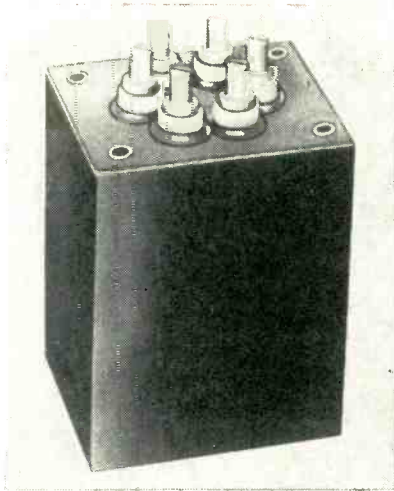
for testing communication equipment

OPAD-GREEN Co., 71 Warren St., New York 7, N. Y. Model K101F aircraft battery eliminator, for testing and operating aircraft electrical and communication equipments, operates on 115 v a-c, 60 cycles single phase and provides a continuously variable output from 0 to 28 v d-c. Maximum continuous load current rating is 20 amperes, and overload capacity is 400 percent for 1/2 minute and 200 percent for 2 minutes. Ripple does not exceed 1 percent at maximum ratings. Bulletin No. 150 giving electrical and mechanical specifications is available.

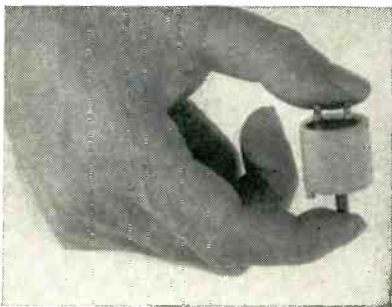
MAGNETIC AMPLIFIERS

available in three types

FREED TRANSFORMER Co., INC., 1715 Weirfield St., Brooklyn 27, N. Y., has developed three types of magnetic amplifiers to meet best known



requirements: (1) high-temperature magnetic amplifiers to operate reliably in ambient temperatures as high as 200 C, with a time constant as low as 0.003 sec; (2) half-cycle response units for closed-loop systems which require high gain and fast response, for operation in ambient temperatures from -55C to +70C; and (3) full-wave magnetic amplifiers using self-saturating or external feedback circuitry to operate in ambient temperatures from -55C to +40C. All are built to the most rigid specifications and feature highest quality with efficient operation and long life.



TINY INDUCTORS from 2.2 to 220 mh

MICO INSTRUMENT Co., 80 Trowbridge St., Cambridge 38, Mass. Type SL1 miniature inductors are particularly suited for use as inductor elements in tuned circuits and filter networks in receiving, telemetering and navigation systems, computers or laboratory measuring equipment. They are designed for use in any application where a compact, stable and durable inductor having high Q is required to operate in the frequency range

THESE EXTREMES —or anything in between!

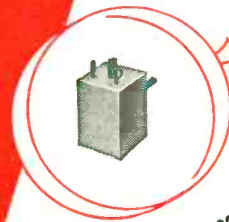
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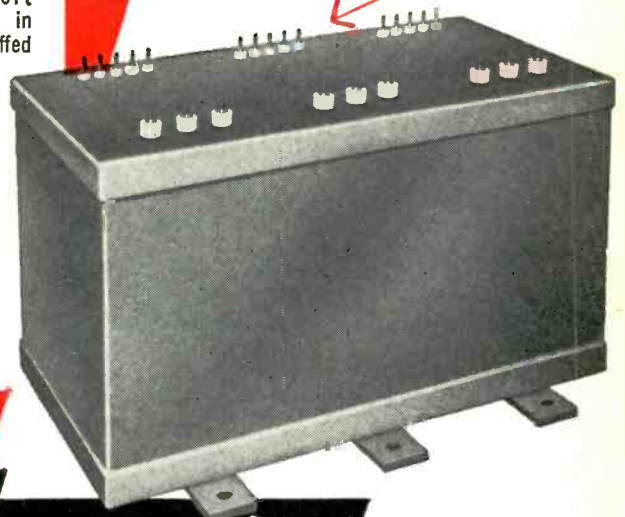
- 1** Complete MIL-T-27 tests for qualification approval can be made in our own laboratory—often saves weeks on contract completion.
- 2** Samples and short runs are handled in our model shop, staffed and equipped for high speed, economical service on small quantities.
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You can depend on LANGEVIN for every transformer requirement, large or small, including pulse transformers, charging reactors, saturable reactors, high cycle transformers and units built to the most rigorous specifications. Highly specialized facilities permit fast handling of short or long runs with maximum economy and rigid quality control. For prompt quotations or engineering collaboration, call or write today without obligation.



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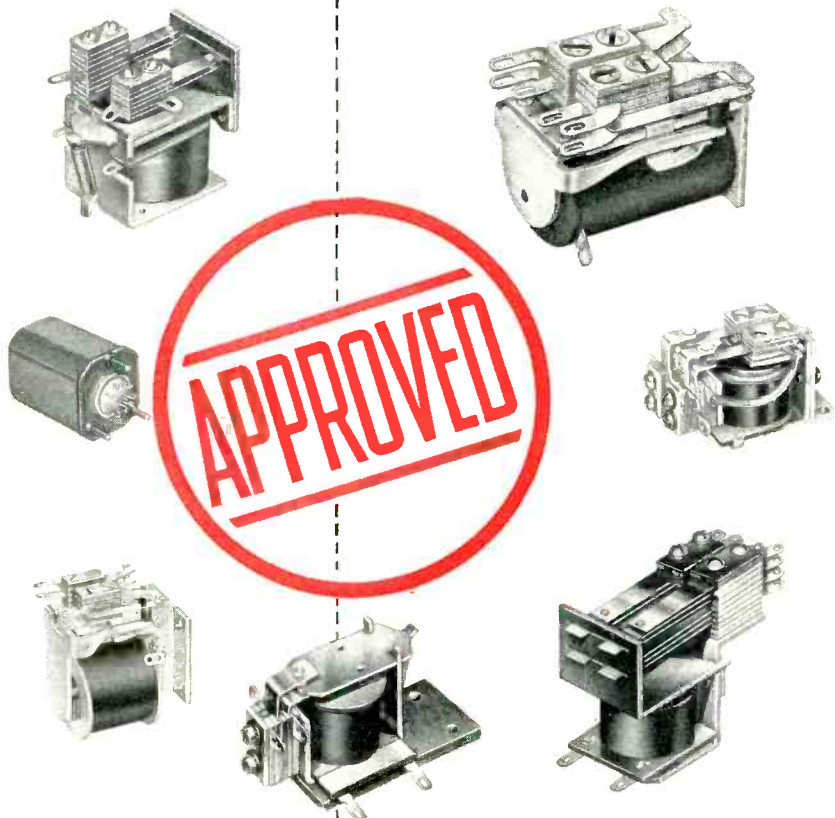
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COMAR RELAYS...

NEW PRODUCTS

(continued)

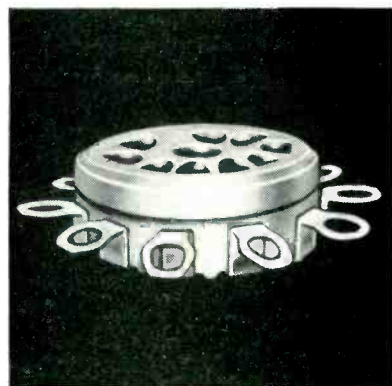
of 5 to 500 kc. Chief features, specifications and ordering data are included in a recent bulletin.



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Comar relays have consistently been "approved" by leading designers and manufacturers because of their superior performance, dependable operation. Comar relays are custom-engineered to exact specifications, job-tested and job-proved for top efficiency, quality constructed for utmost reliability. If you use relays, it will pay you to contact Comar. Our experienced engineering staff, plus huge manufacturing and sealing facilities, will save you time and money. Send for catalog.



TUBE SOCKET for printed-circuit use

MYCALEX TUBE SOCKET CORP., Clifton Blvd., Clifton, N. J. The socket shown, for general use in printed circuitry, is made of Mycalex 410 glass-bonded mica, which affords the following advantages over phenolics: loss factor of 0.014 at 1 mc; power factor of 0.0015 at 1 mc; high dielectric strength; no carbonization; no cold flow; a high thermal shock resistance that prevents damage in soldering; precision dimensional accuracy and permanent dimensional stability. Connections can be made to both top and bottom of this socket. The specially designed contact permits a positive mechanical attachment in conjunction with a soldered connection. This feature is vital to assure immunity to shock and vibration and also to prevent loosening of connections under the stress of inserting and extracting tubes.

MINIATURE RESISTOR designed for h-f use

INTERNATIONAL RESISTANCE Co., 401 N. Broad St., Philadelphia 8, Pa. Type HFR is a 1-w h-f miniature resistor constructed of special, solid ceramic rods to which a thin resistive film is permanently bonded. It exceeds specification MIL-R-10683A. The resistor is recommended for use in circuits requiring excellent frequency response over a wide band of frequencies, h-f circuits, and any



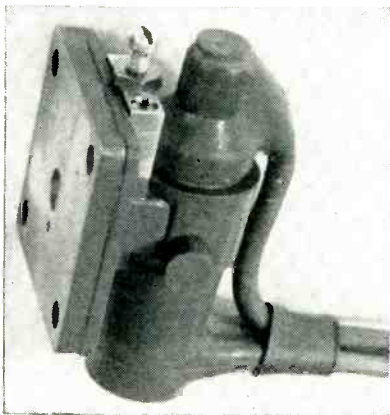
3349 ADDISON STREET
CHICAGO 18, ILLINOIS

RELAYS • SOLENOIDS • COILS • TRANSFORMERS • SWITCHES • HERMETIC SEALING

application where low shunt capacity is desirable. Standard tolerance is ± 20 percent, with ± 10 percent and ± 5 percent available. Body length is 9/16 in.; body diameter (over caps), 3/32 in.; lead length 1 1/2 in. and lead diameter, 0.025 in.

RECORDING EQUALIZER offers a choice of 5 curves

FAIRCHILD RECORDING EQUIPMENT Co., 154th St. and 7th Ave., White-stone, N. Y., has announced a new universal recording equalizer, model 639, to the recording industry. Readily adaptable to any recording system, this unit offers the recording engineer a choice of 5 curves to modify the frequency characteristics of the recording system. The 5 positions permit the rapid selection of flat, intermediate, AES, L-P and NARTB recording curves. Two units are available. Model 639A has an insertion loss of 24 db, while model 639B includes a booster amplifier for an overall gain of 16 db. Both units are for insertion in a 600-ohm system.



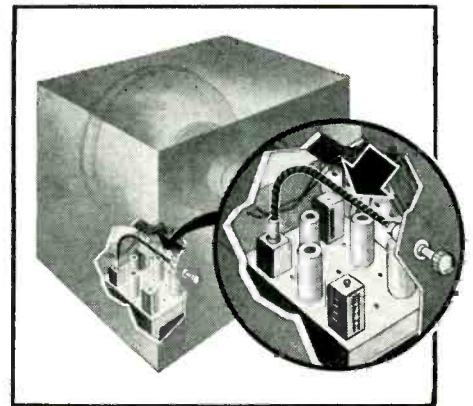
KLYSTRON for airborne applications

VARIAN ASSOCIATES, 990 Varian St., San Carlos, Calif., announces a new K_u -Band reflex klystron. The VA-94 klystron is a compact, rugged, low-voltage oscillator type tube especially designed for missile and radar applications in the frequency range of 16 to 17 kmc. At 300-v beam potential it provides a minimum of 20 mw power output and 55-mc bandwidth, assuring ample

COST-SAVING IDEAS  FOR DESIGN ENGINEERS

TRUE-BLUE HUES FOR COLOR TV... THANKS TO S.S. WHITE FLEXIBLE SHAFTS

One of the problems encountered in designing this color TV set was that of providing a method of regulating the hue control from a knob mounted on the rear of the set. As with many such problems, an S.S. White remote control flexible shaft was the simple, low-cost, easy-to-install answer. Despite the 90° turn, the shaft provides the sensitivity needed to make extremely delicate adjustments.



SIMPLIFY AND SAVE WITH FLEXIBLE SHAFTS

S.S. White flexible shafts are *one-piece* mechanical elements which are easy to install, need no alignment and which readily meet almost every space, operating or other service condition. Their many cost-saving features make them the logical choice both for transmitting rotary power as well as providing remote control. It will pay you to consider their use. S.S. White engineers stand ready to cooperate with you in working out details on any application.

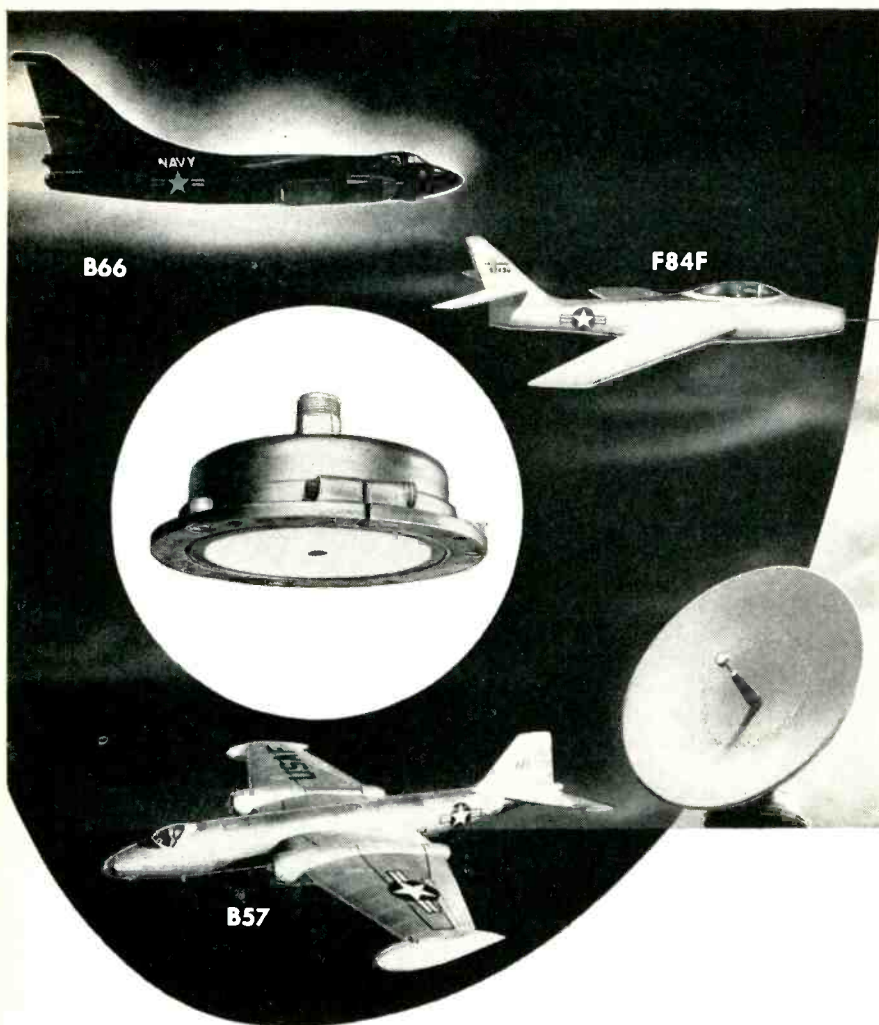
BULLETIN 5306 has basic information and data on flexible shaft application and selection. Send for a free copy. Address Dept. E



R-5

THE *S.S. White* INDUSTRIAL DIVISION
DENTAL MFG. CO.  10 East 40th Street
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ANTENNA PRODUCTION

ADVANCED—*from the ground up*

At whatever point Gabriel takes over your antenna problem — prototype, blueprint, or just basic idea — the result is improved performance.

When Gabriel product-engineered the pressurized radome of the flush-mounted aircraft antenna shown, a major obstacle to large scale production was cleared. Result — Gabriel mass production for F84F, B57, B66 and other aircraft with improved dependability, uniformity, and economy.

To improve MTI radar, Gabriel started from the ground up... developed for production the SCR 584 shown, a 10-foot parabolic antenna with circularly-polarized conical scanning feed, crossover level at -3 db.

These are typical Gabriel solutions to government and industry's problems of airborne, shipborne, and ground-based antennas. The Electronics Division's engineering and production facilities are supplemented by the specialized research facilities of the famous Gabriel Laboratories.

For a thorough description of these integrated facilities for antenna research, development, and production, write for our new 24-page "Facilities Report". Or ask for a Gabriel antenna specialist to call.

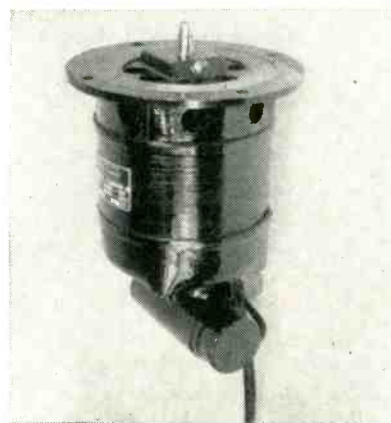
GABRIEL ELECTRONICS DIVISION

Formerly Workshop Associates Division

THE GABRIEL COMPANY, 230 Endicott Street, Norwood, Mass.



performance in mixer and test set applications. Features include the convenience of waveguide output, matched load operation, miniature size (2 in. × 1½ in. × 1½ in.), minimum weight (4 oz), and molded silicone rubber leads for high altitude and high temperature service. A small screw tuner provides convenient frequency-adjustment at a slow tuning rate. Microphonics are negligible, even under high-amplitude 10-g vibration or 150-g impact conditions.

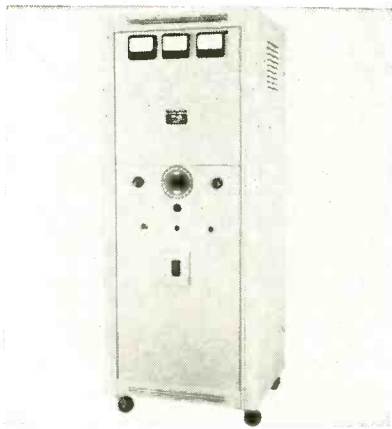


SYNCHRONOUS MOTOR with squirrel-cage rotor

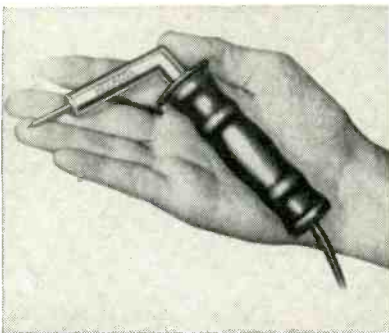
HOLTZER-CABOT MOTOR DIV., National Pneumatic Co., Inc., has developed the RBH-5425 synchronous motor that is suitable for wide variation of voltage and ambient temperature. It is rated at ½ h-p, 115 v, 60 cycles, 1,800 rpm, ball-bearing, flange-mounted, designed for vertical operation shaft up, but may be mounted in any position. It is approximately 5½ in. in diameter. This motor is of the reluctance type, with squirrel-cage rotor having no brushes or slip rings.

GENERATOR covers 50-6,000 cycles

COMMUNICATION MEASUREMENTS LABORATORY, INC., 350 Leland Ave., Plainfield, N. J Model 1425 electronic generator delivers 900 v-a power output from 80 to 135 v or 160 to 270 v. Four frequency ranges covering from 50 to 6,000 cycles are provided. The distortion is less than 5 percent at full load. Voltage regulation (no load to full



load) is within 2 percent. It is useful as a power source in testing airborne equipment, servo systems and other equipment operating at standard or special power supply frequencies.

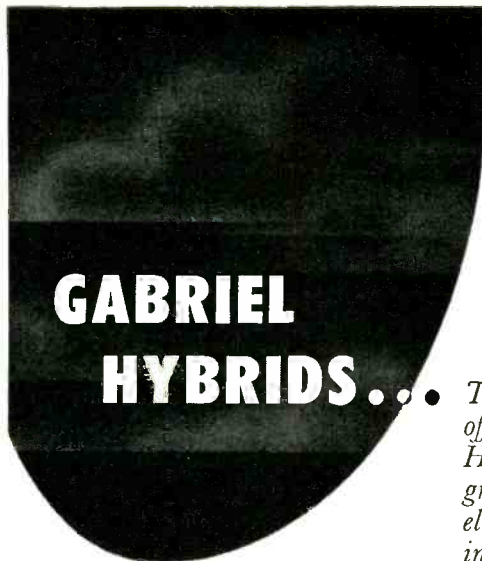


SOLDERING IRON with hatchet design

HEXACON ELECTRIC Co., 130 W. Clay Ave., Roselle Park, N. J., announces a new very small hatchet soldering iron weighing but 3 oz. Perfect balance due to hatchet design makes the iron effortless to hold and thus gives more accurate control of soldering, resulting in better soldered joints. It is recommended for fast soldering of instruments, small electronic equipment and subassemblies. The iron operates identically on d-c or a-c, any cycle. It is available in 110 or 220 v.

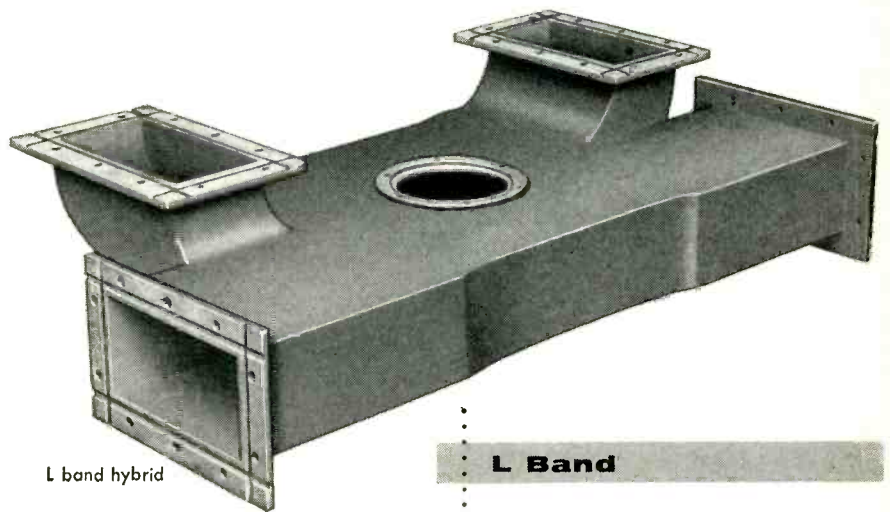
FLAP ATTENUATOR with positive lock

TRANSLINE ASSOCIATES, 57 State St., Newark, N. J. A new flap attenuator provides a simple and convenient method of adjusting power levels and isolating oscilla-



GABRIEL HYBRIDS...

The Gabriel Laboratories now offer a complete line of hybrids. High-precision casting with integral flanges assure exceptional electrical performance and easy installation.



L band hybrid

L Band

- Coupling** : (power division) less than 0.5 db
- Isolation** : 30 db
- VSWR** : 1.1 over 100 mc range
- Material** : aluminum

X Band *

- Frequency** : 8200 - 9700 mc
- Coupling** : (power division) 0.25 db
- Isolation** : in excess of 35 db
- Input VSWR** : less than 1.07
- Material** : Beryllium copper or aluminum

- * **X Band** hybrids feature
 - (1) the new "top wall" construction,
 - (2) extremely low cost, and
 - (3) immediate delivery.

For more information about these hybrids or other waveguide components from our complete line, write, or phone NEedham 3-0005.



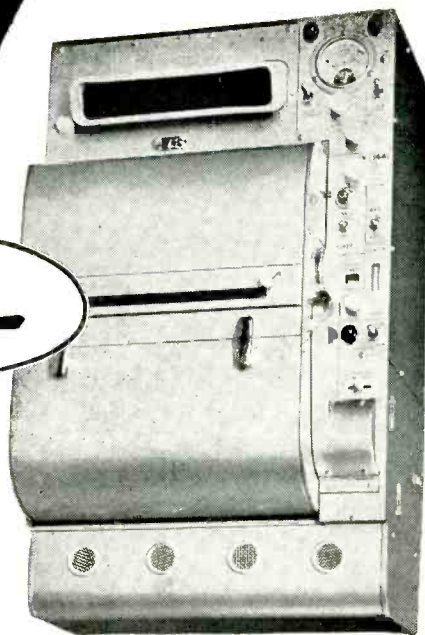
The Gabriel Laboratories

DIVISION OF THE GABRIEL COMPANY 135 Crescent Street, Needham Heights, Mass.

NEW!
Revolutionary

Heiland

**Model 700C
Multi-Channel
Oscillograph**



MODEL 708C

...for Dynamic Data Recording

The complex phases of modern testing programs demand that test instruments be advanced far beyond today's requirements.

Heiland has continued to meet the challenge by progressive improvements in their products, and now take pleasure in announcing their most recent contribution—the 700C.

Heiland's New 700C Oscillograph is available in two models: The 708C which records up to 36 channels on 8 inch recording media; The 712C which provides up to 60 channels using 12 inch media. Record speeds as high as 144 inches per second or as low as .030 inches per second are made readily available through rapid change gears. In addition, any one of four separate record speeds with automatic recording intensity control may be selected from the operating panel even while a record is in progress. This permits "jump speeds" having 2:1, 4:1 and 8:1 ranges which has long been a standard Heiland feature. Remote operation of the jump speed, which was previously installed on special order, is now standard. A new optical system provides more than adequate recording intensity for the highest writing speeds. Provision is made for operation of the same instrument from 28 Volt DC, 115 Volt 60 cps, or 115 Volt 400 cps power.

The 700C accommodates Heiland's New Sub-Miniature Galvanometers and temperature controlled magnet assemblies.

The New Sub-Miniature Galvanometers are exceptionally stable yet offer the highest in sensitivity. A partial galvanometer listing is as follows:

Type	Frequency Response	Milliamperes per inch
M40-350	0-24 cps	.00424
M100-350	0-60 cps	.00551
M400-120	0-240 cps	.0678
M3300	0-1980 cps	25.4
M5000	0-3000 cps	33.9

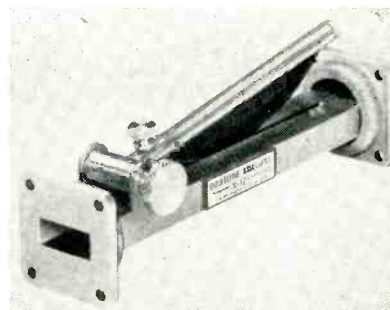
See these and other Heiland instruments at

**Booths 332 and 334
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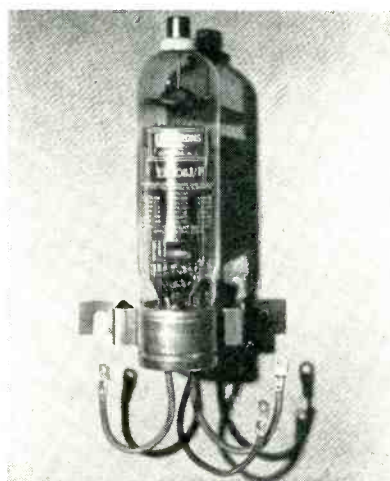


Heiland Research Corporation

130 EAST FIFTH AVE.
DENVER, COLORADO



tors from the pulling effects of variable loads. With a fully inserted flap it may be employed as a load. The unit operates over the X-band spectrum from 8,200 mc to 12,400 mc. For attenuation values less than 20 db, maximum vswr is less than 1.15. A simple screw mechanism positively varies the attenuation continuously from 0 to over 30 db. An auxiliary locking device, when used, offers insurance against variations in attenuation due to vibration or shock.



**THYRATRON TUBE
is temperature-stable**

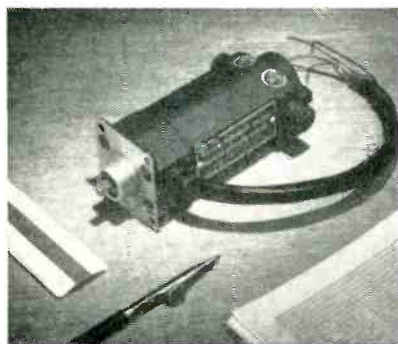
ELECTRONS, INC., 127 Sussex Ave., Newark 3, N. J., has available the type ELC6J/F temperature-stable thyatron tube. This Xenon gas-filled, grid-controlled rectifier tube is especially manufactured for panel mounting. Flexible lead connections eliminate the conventional socket and thereby assure reliable, trouble-free contacts between tube and circuit. Pertinent maximum ratings are: anode average current, 6.4 amperes d-c; oscillograph peak current, 77 amperes; peak inverse voltage, 1,250 v; peak forward voltage, 1,000 v; average tube drop, 9

v; and critical grid voltage at pfb is -4.6 ± 1.6 v.



FLYBACK TESTER is a versatile unit

TELE TEST, INC., 30-01 Linden Place, Flushing, L. I., N. Y., has available a flyback tester that tells exactly what condition any flyback is in. It tests good flybacks as well as bad. The tester checks continuity, yokes, width coils and linearity coils for shorted turns. The instrument checks the flyback under the full operating voltage. Many other testers need a known good reference flyback of the exact type being tested. Users of the new flyback tester have been able to reduce their inventories of unneeded flybacks almost down to the zero level. The portable, compact instrument sells for \$44.95.



ACTUATOR MOTOR for intermittent duty

DALMOTOR Co., 1329 Clay St., Santa Clara, Calif. The SR-43 compact motor for intermittent duty suggests itself for such applications as low or high-speed, linear or ro-

IMPORTANT NEWS

For the Electrical and Electronic Industries

... a New HARDENABLE SILVER ALLOY



Important Properties of SILVER-MAG-NICKEL

- ✓ Oxidation Hardenable
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- ✓ Tensile Strengths to 70,000 psi.
- ✓ Corrosion Resistance Like Fine Silver
- ✓ Hardness Unaffected by Silver Brazing

SILVER-MAG-NICKEL is its name. As you receive it, it is soft and ductile, like fine silver. Fabricate your most intricate parts, then oxidation harden them and this new alloy will hold its temper permanently. This hardness is not disturbed even when subsequent elevated temperatures are encountered.

SILVER-MAG-NICKEL has excellent thermal and electrical conductivity. Its corrosion resistance is equal to that of fine silver. It is available in wire and strip in thicknesses down to .002".

Have you an application where SILVER-MAG-NICKEL can be used to advantage? See the list of properties to the left. Write giving full details of your potential application. Our engineers will be glad to discuss these properties with you.



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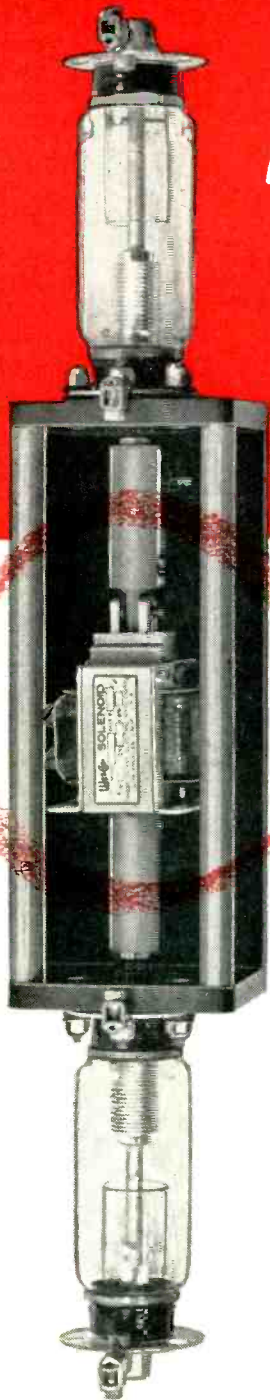
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*Large Electronic
manufacturer specifies*

WesCo solenoids

**to actuate
relays and
switches!**



WesCo trademarked solenoids are now being used by Jennings Radio Manufacturing Corp. of San Jose, Calif. The AC solenoid shown here helps the Jennings Type R 1 vacuum relay and similar units switch RF, DC, and 60 cycle power circuits at continuous ratings as high as 85 KV and 100 amperes rms.

Jennings Radio manufactures a wide range of lightweight high voltage vacuum switches and overload relays. Almost all specify accurate, dependable WesCo solenoids.

Write today on your company letterhead for WesCo's informative new AC catalog. Engineering and design drawings, solenoid performance charts, temperature and work curves, and other features help you select the right solenoid for your application. Send for yours now.

NOTICE:

If you specify DC aircraft solenoids for your company, you will find the WesCo DC solenoid catalog helpful. The pages are filled with easy to read information to help you choose the right solenoid. Sent only to requests on company letterhead.

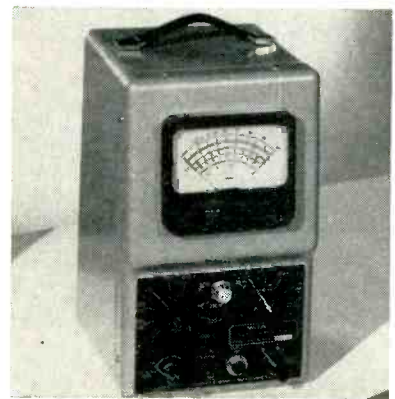


THE TRADEMARK ON OVER 5,000,000 SOLENOIDS SINCE 1927

WEST COAST ELECTRICAL MFG. CORP.

233 W. 116th PLACE, AC DIV. 107 • LOS ANGELES 3, CALIF. • PL. 5-1138

tary-actuator mechanisms. It incorporates an automatic clutch brake which applies 2 oz in. of brake torque to the load, and disengages the armature automatically when power is removed. Totally enclosed, the unit turns up 20,000 rpm at 1½ oz in. torque with 3.8 amperes of 28-v d-c power. The locked-rotor torque is 10½ oz in. Rotation is reversible and various shaft arrangements including plain shafts, splines, keyways and gears to specification can be provided. Electrical connections are by integral shielded leads which can be of various lengths as specified.



**VTVM'S
for a-c and d-c use**

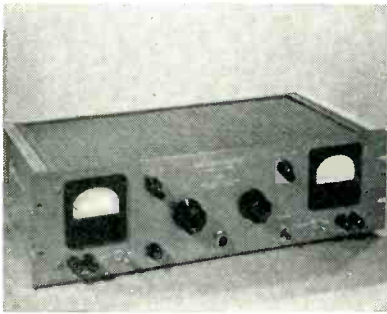
MILLIVAC INSTRUMENT CORP., 444 Second St., Schenectady 6, N. Y. A new series of sensitive electronic volt and ampere meters for a-c and d-c has been thoroughly redesigned, both externally and internally. They include the MV-17B d-c millivoltmeter (now MV-17C) having 0 to 1-mv sensitivity, the MV-11B d-c micromicroammeter and several a-c voltmeters. Their new housings are streamlined in appearance while an improved retunable d-c modulator and redesigned amplifiers assure higher accuracy and stability in these new instruments.

**MIDGET RESISTOR
measures only ¼ in. long**

I-T-E CIRCUIT BREAKER CO., 19th and Hamilton Sts., Philadelphia 30, Pa. A tiny, wire-wound resistor has been developed to meet the needs of the industry's subminiaturizing program. Built to cus-



tomers' specifications, this hermetically sealed resistor is available in standard sizes down to $\frac{1}{4}$ in. \times $\frac{1}{4}$ in. The resistors are designed to operate precisely in ambient temperatures ranging from -55 C to $+55$ C. They feature: (1) low temperature coefficient of ± 20 ppm per deg C and (2) high stability. Resistance change with time is less than one-third the tolerance.



REGULATED SUPPLY for use with transistors

DRESSEN-BARNES CORP., 250 N. Vinedo Ave., Pasadena 8, Calif., has developed closely regulated d-c tube type power supplies for powering transistors. The new models embody two basic types. Model T-100-B is a meter-equipped regulated dual voltage power supply with two duplicate outputs. Each of these outputs has 3 ranges: positive or negative 0-1 v, 0-10 v and 0-100 v. Adjustment of the 3 ranges is made by decade switches and potentiometers. Maximum d-c current output is 100 ma. Model T-100-D has no meters. It provides the same output ranges as the T-100-B, but adjustment is by direct-reading decade switches in steps of 0.1 v, with 0.1-percent accuracy. Regulation of the units is 0.05 percent from no load to full load. The d-c internal impedance is 0.6 ohm, 0.1 ohm at 120 cycles,



Presenting the only BROADCAST MICROPHONE with "all three"—!

- Small size, slim design!
- Smooth, extended frequency response!
- World-famous, patented, Uniphase system!

THE SHURE
Concert-Line

UNIDIRECTIONAL MICROPHONE

Out of the Shure Laboratories has come a slim, small Broadcast microphone so remarkable in its over-all performance that we have given it a special name—the "Concert-Line."

The "333" is the only small, slim Broadcast microphone in the world with the world-famous, patented, Uniphase system!

The small, slim "333" provides the fine quality formerly found only in the conventional-type, large size Broadcast microphones. The Concert-Line "333" is truly an important advancement in microphone development and design.

The Unidirectional "333" is AVAILABLE NOW—in limited quantities—for the most discriminating users.

The Mark of Quality — SHURE



"333"

Model "333"
Concert-Line
Microphone
List Price
\$250.00

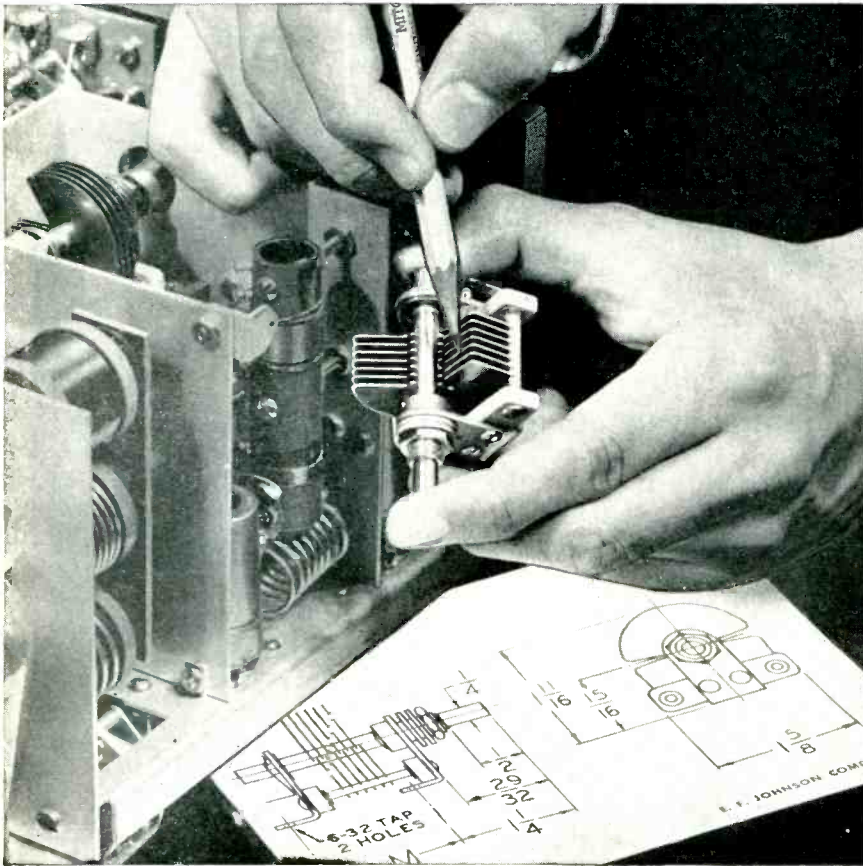
SHURE BROTHERS, Inc.
Manufacturers of
Microphones and
Acoustic Devices
225 West Huron Street
Chicago 10, Illinois
Cable Address: SHUREMICRO

IMPROVED DESIGN FOR RUGGED DUTY CAPACITORS

NEW PRODUCTS

(continued)

0.4 ohm at 50 kc. Input regulation is 0.1-percent change per ± 10 -percent variation in line voltage. Ripple is 1 mv maximum.



Johnson gang-tuned Mobile Transmitter using Type "R" capacitors

JOHNSON TYPE "R" AIR VARIABLES

Designed for strength and reliability, this Johnson version of a popular standardized capacitor is ideal for equipment subject to rough usage. Featuring sturdy construction, thicker than usual steatite stator support insulators, heavy brass end frames and rugged rotor bearing design, Type "R" air variables insure peak performance even under conditions of extreme vibration.

Accurately aligned, soldered brass plates .023" thick • All metal parts heavily nickel plated • Double-bearing construction with $\frac{1}{4}$ " shafts extended at rear for ganging two or more units • Plate spacing .024" - 1200 volts peak rating • Rotor contacts silver plated beryllium copper for smooth high frequency operation.

Especially suited to mobile and aircraft application, Johnson "R" variables are the perfect choice for any design requiring rugged strength and resistance to vibration. For complete information write for data sheet #723 today! For information on all Johnson components write for your copy of Catalog #975.

Cat. No.	Type No.	Cap. per Sec.		"M" Dimension	Net Price
		Max.	Min.		
149-1	20R12	20	5	1 7/32"	\$2.05
149-2	35R12	35	6	1 7/32"	2.10
149-3	50R12	50	6.5	1 7/32"	2.15
149-4	75R12	80	8	1 7/32"	2.30
149-5	100R12	102	8.5	1 13/32"	2.45
149-6	140R12	140	9.5	1 19/32"	2.65

Johnson Type "R" capacitors are available in maximum capacities to 320 mmfd. with .036", .050", .071", or .095" plate spacings as well as special platings and shaft lengths in production quantities. Also available without mounting feet for panel mounting applications.



E. F. JOHNSON COMPANY

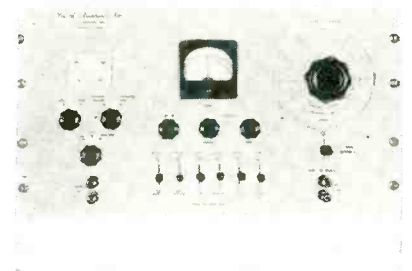
2330 SECOND AVENUE SOUTHWEST • WASECA, MINNESOTA

CAPACITORS • INDUCTORS • SOCKETS • INSULATORS • PLUGS • JACKS • KNOBS • DIALS • PILOT LIGHTS



TUNING CAPACITORS for tv and other h-f use

THE HERMASEAL CO., Elkhart, Ind., has introduced new high-frequency tuning capacitors for tv and other h-f apparatus. The present miniature model is being produced in a range of 0.4 to 0.8 μ f. Of a balanced dielectric construction, the capacitors consist of a metallized glass rotor fitting to close tolerance within a metallized glass stator. Made of precision-bore glass tubing, rotor and stator are directly soldered to standard brass fittings for conventional chassis mounting. Minimum Q is 500 at 50 mc. Tolerance is still within prescribed limits after 100,000 revolutions.



TRANSISTOR TEST SET designed for lab use

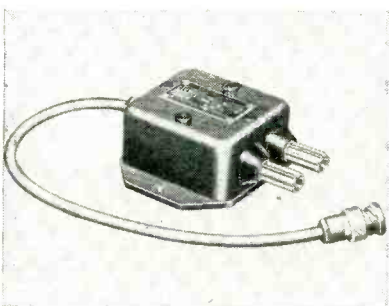
BAIRD ASSOCIATES, INC., 33 University Rd., Cambridge 38, Mass. Model GP1 transistor test set features dependable, direct measurement of transistor characteristics at any frequency from 100 cps to 1 mc. Designed as a versatile laboratory instrument, its speed and simplicity of operation adapt it for

routine production testing. It tests *npn* and *ppn* type transistors in either grounded base or grounded emitter configuration. The test set is used in conjunction with an external oscillator and vtvm. Provision is made for measuring phase angle as well as magnitude of the hybrid coefficients, thus permitting accurate design of a-f, i-f and r-f circuits.



TOROID COILS for resonating L-C circuits

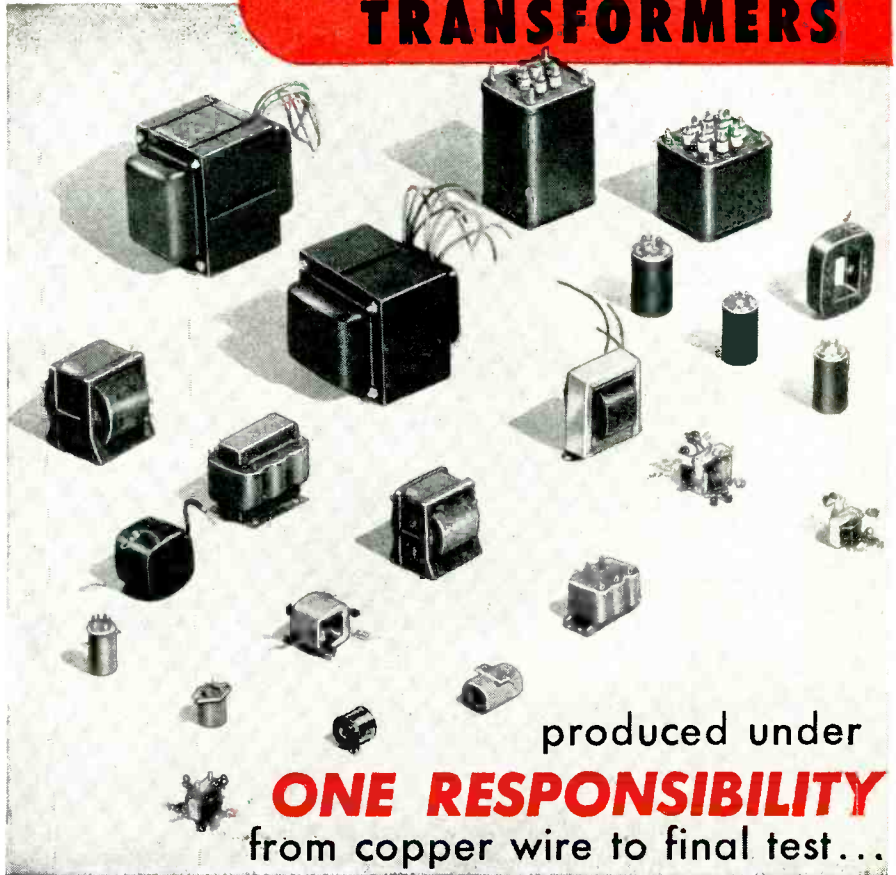
HYCOR Co., INC., 11423 Vanowen St., North Hollywood, Calif. The PR adjustable toroid coils offer a simple and economical means of resonating L-C circuits. The termination of the winding is left free for the addition or removal of turns. Coils are factory adjusted to within ± 5 percent of nominal inductance values and are economically priced due to the elimination of critical adjustment and impregnation. A catalog sheet is available.



COUPLING UNIT measures $1\frac{1}{4}$ in. \times $2\frac{1}{2}$ in. \times $3\frac{3}{4}$ in.

BOONTON RADIO CORP., Boonton, N. J. Type 564-A coupling unit

CUSTOM-ENGINEERED TRANSFORMERS



produced under
ONE RESPONSIBILITY
from copper wire to final test...

- Wheeler transformers are custom-engineered to meet your specific requirements. Your needs come first with us.
- Wheeler makes its own magnet wire . . . from the copper rod to the finished, insulated and tested product . . . with quality under our control every step of the way.
- Wheeler uses the most modern winding techniques and equipment.
- Wheeler's facilities for the production of intricate coils and assemblies are unexcelled.
- Wheeler affords fullest protection to its transformers with latest techniques in wax and varnish impregnation and FOSTERITE® encapsulation.
- Wheeler transformers are subject to specially devised engineering and test procedures throughout manufacture, and must individually undergo a final comprehensive test before shipment.

To learn what these advantages can mean to you, write:

THE WHEELER INSULATED WIRE COMPANY, INC.

Division of The Sperry Corp.
1101 East Aurora St., Waterbury 20, Conn.



WHEELER

MAGNET WIRE

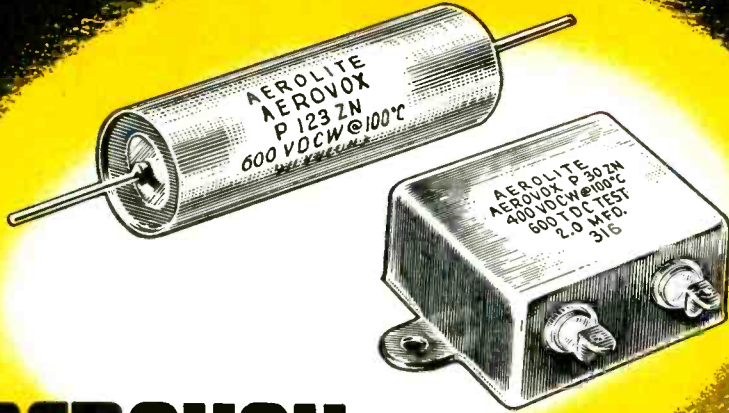
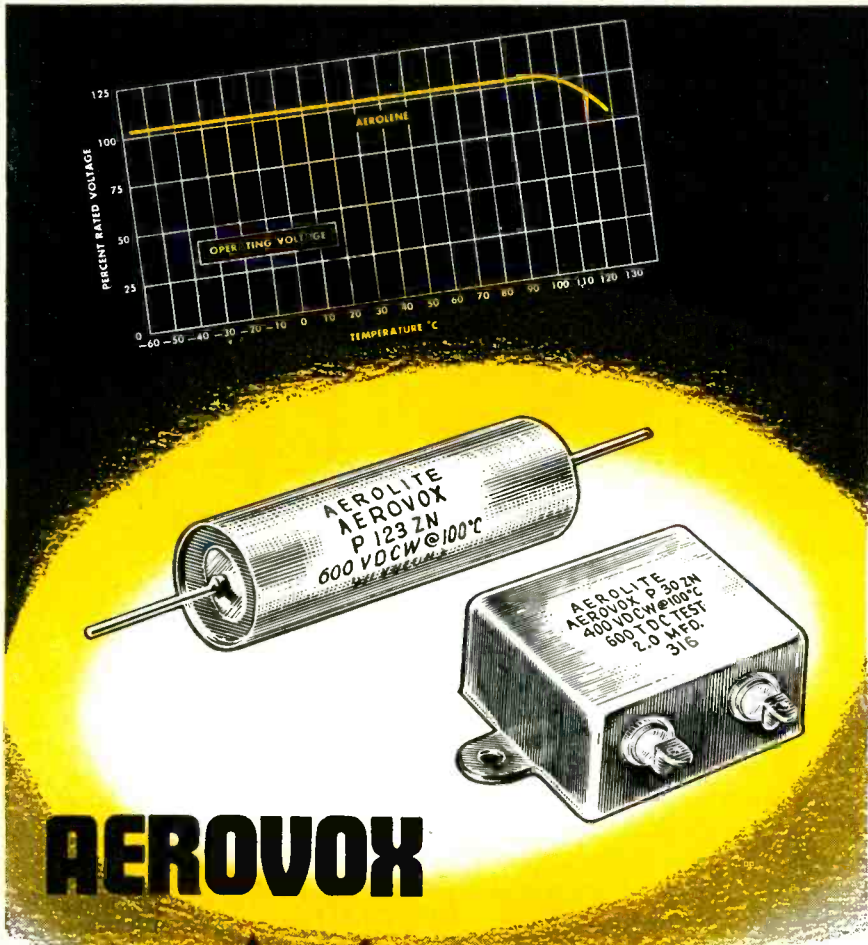
COILS

COMMUNICATIONS EQUIPMENT

TRANSFORMERS

WHEELER MAKES THESE PRODUCTS A *Specialty*

®The WESTINGHOUSE encapsulating material that gives a high degree of protection to small transformers. Applied by Wheeler under license.



AEROVOX

high-temperature

metallized-paper CAPACITORS

FUNCTION FITTED Aerolene* does it! This Aerovox-exclusive solid impregnant accounts for the higher temperature ratings and longer life of Aerovox metallized-paper capacitors. The accompanying curve (Operating Voltage vs. Temperature) tells the story. Further gains from permanently-imbedded sections in solid Aerolene impregnant are: maximum immunity to vibration and rough handling. And of course minimum size and maximum convenience. Install them—forget them!

Available in a wide variety of case styles including modified molded tubular, and all types of metal-cased hermetically-sealed construction with capacitance ratings from .0005 mfd. to 100. mfd. at voltages up to 600 VDC.

Get the FACTS!

Ask for literature on Aerovox metallized-paper capacitors in both standard and special types. Our metallized-paper specialists will gladly collaborate on your extra-compact-capacitor needs.

*Trade Mark



AEROVOX CORPORATION

NEW BEDFORD, MASS.

Hi-Q
DIVISION
OLEAN, N. Y.

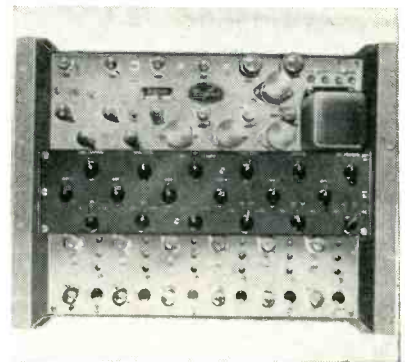
ACME
ELECTRONICS, INC.
MONROVIA, CALIF.

CINEMA
ENGINEERING CO.
BURBANK, CALIF.

In Canada: **AEROVOX CANADA LTD.**, Hamilton, Ont.

Export: Ad. Auriema, Inc., 89 Broad St., New York, N. Y. Cable: Auriema, N. Y.

permits the coupling of an external oscillator into the new type 260-A Q meter for Q measurements in the audio and supersonic frequency ranges. The new unit, measuring 1½ in. × 2½ in. × 3¾ in. provides binding posts for connection of the external oscillator and a coax cable with BNC connector for convenient connection to the Q meter. Physical mounting is by means of a drilled mounting flange which is provided. Input impedance is 500 ohms; output impedance, 0.3 ohm; frequency range, 1 kc to 50 kc; and input voltage requirements, variable up to 22 v.



SIGNAL GENERATOR tests television systems

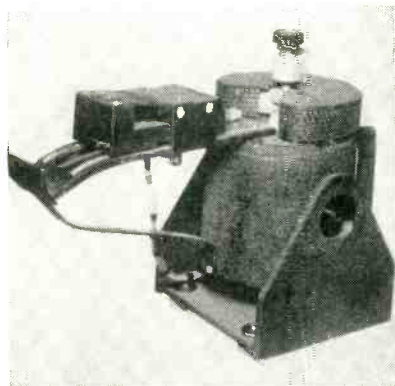
WICKES ENGINEERING AND CONSTRUCTION Co., 12th St. and Ferry Ave., Camden 4, N. J. Model MBG-1 is a multiburst video test signal generator for quick and accurate frequency response checks of individual units or complete color or monochrome tv systems. It generates discrete bursts of frequencies from 0.5 mc to 6.0 mc, and offers a choice of 13 frequencies in 6 overlapping ranges. Any 6 frequencies are obtainable simultaneously. It features an adjustable burst width and amplitude, a built-in filament supply, and will simulate composite color or monochrome video signal. Brackets are supplied for bath tub and internal-rail standard rack mounting.

POWER SUPPLY for varied laboratory uses

SPECIALIZED INSTRUMENTS CORP., 535 O'Neill Ave., Belmont, Calif. Suitable for a wide variety of lab-



oratory power-supply applications, the new Duostat includes, in a single unit, facilities for both constant-current and constant-voltage operation. Energized from a standard 115-v 50/60-cps power outlet, the Duostat is capable of providing currents ranging from 5 to 50 ma, automatically regulated to ± 2 percent at voltages ranging from 100 to 500 v. In its constant-voltage mode of operation, the unit is self-regulated to ± 1 percent from 160 to 500 v, and over a load-current range of 0 to 50 ma. Output is relatively unaffected by line-voltage changes between 105 and 125 v. The unit weighs 11½ lb.



VIBRATION EXCITER tests miniature tubes

THE MB MFG. Co., New Haven, Conn., has announced a small, new shaker that vibrates at frequencies up to 10,000 cps for production vibration testing of subminiature electron tubes. This electromagnetic equipment provides for rigidly clamping tubes in the vibrating armature. It also includes a flat-top table for use in calibrating small vibration pickups and accelerometers. Testing tubes with this shaker provides data on a tube's vibratory response and its ability

WIDE-RANGE FREQUENCY METER 85-1000 MEGACYCLES

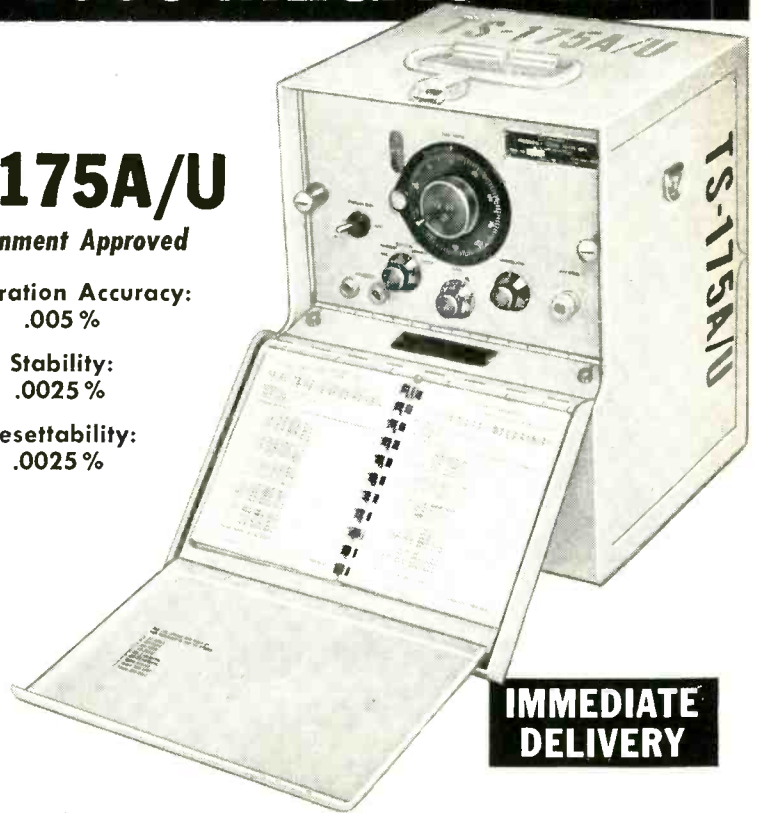
TS-175A/U

Government Approved

Calibration Accuracy:
.005 %

Stability:
.0025 %

Resettability:
.0025 %



**IMMEDIATE
DELIVERY**

A VERSATILE PRECISION MEASURING INSTRUMENT

Recommended Applications:

- Precise Measurements of Frequencies
- Production Testing
- Alignment of Transmitters and Receivers
- Laboratory Testing
- Portable Field Testing
- A Secondary Frequency Standard
- Signal Generator Calibration
- U.H.F. and V.H.F. Television Alignment

Calibration: Each instrument is individually calibrated, without interpolation, at 50 Kilocycle intervals throughout its range.

Frequency Range: The unit covers the calibrated range of 85 to 1000 megacycles. The fundamental of the precision variable frequency oscillator is 85 to 200 megacycles.

Sensitivity: The Frequency meter can detect a radio frequency signal of 20 microvolts with an audio power output up to 50 milliwatts depending on the frequency.

Internal Modulation: When desired, amplitude modulation of 1000 cycles in frequency can be employed. The modulation percentage is approximately 30%.

Radio Frequency Output: The output voltage from a 50 ohm source, varies from 300 to 100,000 microvolts, within the range of 85 to 1000 megacycles.

Secondary Frequency Standard: A 5000 Kc. oscillator incorporating a CR-18/U crystal can be used as a secondary frequency standard with harmonics of 5 megacycles up to 200 megacycles.

Territories for representation available.

We offer a complete automatic recalibration service on all frequency meters.

COLORTONE
ELECTRONICS, Incorporated
238 William Street, New York, N. Y. • COrtlandt 7-5160
Executive Offices: 400 Duffy Ave., Hicksville, Long Island

New Multiple Function MICROWAVE VSWR AMPLIFIER



MODEL 2000

FEATURES:

Crystal current and power monitoring
Two channel input
VSWR to 60 db
Set-up signal sources

for faster, more accurate readings... easier operation

WAVELINE, precision leader in the manufacture of microwave test equipment, now offers you the ultimate in advance-design VSWR AMPLIFIERS.

This NEW Standing Wave Amplifier is the culmination of extensive research and testing... directed at developing new concepts of instrument function and design for microwave test equipment.

Exclusive combinations of features make WAVELINE microwave instruments the most valuable test equipment available today!

Technical data on microwave instruments covering the range 1,000 to 40,000 MCS available on request.

SPECIFICATIONS

New MODEL 2000 Standing Wave Amplifier

Crystal Current Measurement — a feature is incorporated making the meter available for monitoring crystal current and power.

Two Channel Input — provides in one instrument:

1. By alternate use of two channels a pulsed oscillator in combination with a calibrated attenuator provides a substitute for a costly signal generator.

2. Monitoring crystal current and measuring VSWR.

3. Both channels measure VSWR.

4. Monitoring power with bolometer and measuring VSWR.

5. Monitoring power at two points.

Sensitivity — Full scale deflection; minimum 0.3 microvolts; maximum 0.3 volts.

Selectivity — Overall Q of approx. 20.

Calibration — Calibrated for use with a square law detector. 60 db over-all range in 6 steps. Accuracy ± 0.1 db per 10 db.

Detector — Crystal rectifier or bolometer with 8.75 Ma. or 4.0 Ma. bolometer bias for standard 200 ohm bolometer, barretter or 1/100 amp instrument fuse.

Modulation Requirements — For VSWR measurement the RF source must be modulated at 1000 CPS ± 20 CPS. Plug in units for frequencies 250 to 2500 CPS available.

Price — \$200. F.O.B. Caldwell, N. J.

Sales Engineers in All Principal Cities

CONTI

WAVELINE INC.

CALDWELL, NEW JERSEY

NEW PRODUCTS

(continued)

to withstand severe vibration in service.



TRANSFORMER for transistorized circuits

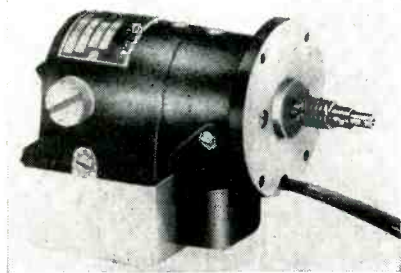
TELEX, INC., Telex Park, St. Paul 1, Minn., has announced a transistor transformer with a wide variety of industrial applications. The tiny unit has been made available for commercial transistorized circuitry use in audio amplifiers, hearing aids and control circuits. Measuring $\frac{1}{8}$ in. \times $\frac{1}{8}$ in. \times $\frac{3}{8}$ in., it comes in three models—No. 8641 transistor input, No. 8642 transistor interstage and No. 8643 transistor output. Units are packaged in a clear Lucite box for easy identification, and each box contains an insert label giving complete specifications on the transformer.



ELECTRONIC COUNTER will operate on 100-120 v

POST ELECTRONIC PRODUCTS DIV., Post Machinery Co., Beverly, Mass. Model F-1 serves many counting operations. It is designed to count

continually at a speed of 2 to 3 per second. Any Post photohead can be used, and line voltages from 100 to 120 will operate the model F-1. The counter can be located as far away as 100 ft from the photohead. The photohead can be used in highly confined areas and the counter can be located as far away as 100 ft from the photohead. The photohead can be used in highly confined areas and the counter can be mounted in plain view somewhere on the production machine. Standard Model F-1 counter is provided with an 8-ft length of cord from counter to photohead. Longer cords can be provided on request.



SHUNT WOUND MOTOR designed for military use

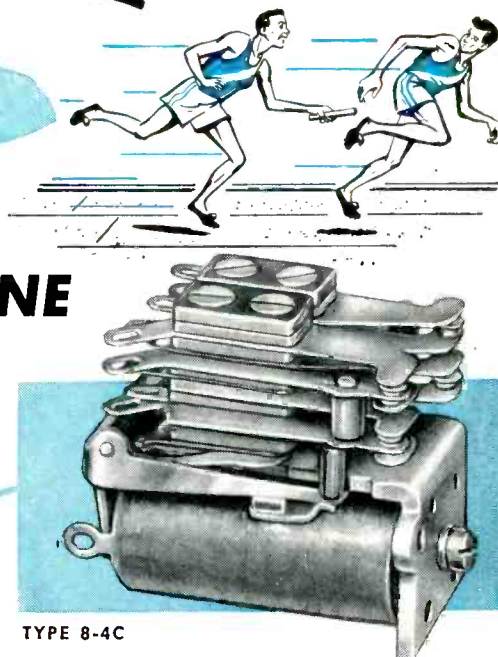
ELECTRO ENGINEERING PRODUCTS Co., 609 W. Lake St., Chicago, Ill., has announced a new shunt wound d-c motor designed for military use. Operating on 28 v, the motor is rated at 0.02 hp at 12,000 rpm. It is furnished complete with noise filter and high-altitude brushes. Constructed as part of AN/ARA-8, the motor employs precision ball bearings and stainless steel shafts for extra-heavy duty. All parts are finished in accordance with rigid military specifications.

INDUSTRIAL X-RAY is a portable unit

BALTEAU ELECTRIC CORP., Stamford, Conn., is manufacturing a new line of portable industrial x-ray equipment. Designed "Baltograph", the equipment features maximum penetration for minimum weight. The self-contained x-ray head of the model rated at 195 kv, 5 ma weighs only 153 lb and measures 26½ in. × 14 in. × 8¼ in. The head

THE RELAY IS ON TO *Leach*

NEW TELEPHONE TYPE RELAYS



TYPE 8-4C

Functional communication equipment components with design emphasis on high performance and simplicity are worthwhile factors to consider when faced with weight, size and reliability restrictions imposed by high precision equipment control problems.

Yes... *THE Relay Is On To Leach*... Design Engineers are making these new, compact, versatile, special purpose miniature relays standard in communication equipment and many other commercial applications.

These relays are designed to insure positive, long-life operation, have extremely low friction loss and withstand extreme vibration at minimum power consumption.

Other applications include computers and other types of instrumentation, electronic control circuits, plate circuits, remote controls, etc.

OPERATING CHARACTERISTICS

CONTACTS:

Palladium, standard.
Various contact arrangements up to a maximum of 4PDT, 6PST, or 2D (Make-Before-Break) can be obtained by combinations of basis types.

RATINGS:

3 Amps. @ 32 VDC, resistive.
3 Amps. @ 115 VAC, non-inductive.
Type number 8—followed by contact designation.

COILS:

DC only—up to 8,000 ohms.
Nominal, 2.9 Watts.
Maximum, 3.85 Watts.
Maximum sensitivity, 90 mw for SPDT; 750 mw for 4 PDT.
Typical Coil: 235 Ohms. ± 10% for 26.5 VDC.

INSULATORS:

XXX Phenolic, standard.

VIBRATION:

10 G to 55 CPS.

SHOCK:

25 G.

WEIGHT:

2.25 ounces.

DIMENSIONS:

Length 1⅞" height 1⅝"
width 1⅝"

Specify Contact Arrangement and Coil Characteristics
Also available Hermetically Sealed in miniature 9 or 14 pin plug-in, or solder terminal types.

Write for new 44 page 2-color loose leaf catalog.
Illustrates and gives full details of complete line.

COMPARE PERFORMANCE

SWITCH TO LEACH

Specialists in Electronics and Electro-Mechanics

LEACH RELAY CO.

DIVISION OF *Leach* CORPORATION

5915 AVALON BOULEVARD, LOS ANGELES 3, CALIFORNIA
Representatives in Principal Cities of U. S. and Canada.

ANOTHER PROBLEM SOLVED by *Tubular Rivet*

RE: A COST REDUCTION AND QUALITY PROBLEM

problem

Trombone TV Antennas --
Production required 4,000 per day
necessitating two shifts of 12
operators each when using bolts, spring
washers and nuts, which were unsatis-
factory due to cost and trouble with
loosening assemblies.

solution

Assembly redesigned for use of Tubu-
lar Rivets.
Above production maintained using two
operators and one Automatic Feed
Machine.

P.S.

SAVING - \$400.00 per day with improved
product owing to elimination of
loosening nuts. What's your problem?
No obligation, naturally. Contact
TUBULAR RIVET, Dept. E.

Tubular Rivet

STUD COMPANY

WOLLASTON 70, MASSACHUSETTS

BRANCH OFFICES: Buffalo, Chicago, Dallas, Detroit, Indianapolis,
Los Angeles, Nashville, New York City, Philadelphia, San Francisco, St. Louis

houses both x-ray tube and h-v transformers of radical new design. All models operate directly from 110 v or 220 v, 60-cycle lines and do not require cooling pumps or special accessories.

SOLDERING ALLOY for low-temperature use

HOWE INTERNATIONAL, 431 Dan-
forth Ave., Jersey City 5, N. J., an-
nounces a new soldering alloy, de-
veloped especially for electronic
applications, production and serv-
ice. Known as Howalloy No. 425,
the new alloy is applicable through
any application of heat generating
425 F. It possesses the same flow
and capillary characteristics of the
silver brazing alloys, and is entirely
free of zinc and lead. It has excel-
lent corrosion resistance, and ap-
plies easily to copper, stainless,
brass, and other materials regu-
larly used in electronic work. When
used with No. 425 flux, it is inval-
uable in eliminating the usual prob-
lems encountered in joining various
metals, including copper, nickel,
Invar, resistance wire, Alnico and
chrome-plated surfaces. Complete
information, with new descriptive
folder, may be obtained directly
from the manufacturer.



TORQUE SCREWDRIVER for precision assembly

RICHMONT INC., 922 So. Myrtle
Ave., Monrovia, Calif. The new
Livermont Roto-Torq model PM-5
was developed for use in electronics
assembly, where tiny screws, nuts
and bolts require extremely low
torque combined with absolute
torque accuracy. A feather-weight
tool, it tips the scales at slightly
over 3 oz, with standard bit in-
cluded. It comes equipped with
magnetic bit holder and can be
used with screwdriver bit or hex

sockets of various sizes. Torque capacities are 4 in. oz. to 80 in. oz. Length is 5½ in. (without bit). Weight is 3½ oz.

Literature

Laboratory and Maintenance Instruments. The Clough-Brengle Co., 6014 Broadway, Chicago 40, Ill. Form 143 covers 12 models of laboratory and maintenance instruments for the radio and allied communications fields. Included are illustrated descriptions of a beat frequency oscillator, audio-frequency generators, a transmission measuring set, a standard signal generator, a band-spread oscillator, an i-f sweep generator, an extended range audio oscillator, a standard r-f signal generator and a capacitance-resistance-inductance bridge.

Ultrasonic Soldering Iron. Alcar Instruments, Inc., Fair Lawn, N. J. A single-page bulletin illustrates and describes the model AA1 Ultra Gen, a source of low frequency, 18-ke ultrasonic energy for use as a driver for magnetostrictive transducers, such as those used in soldering and mixing. Prices are included for the ultrasonic soldering iron complete, the Ultra Gen (only) and the soldering gun-transducer (only).

Ballistocardiograph. Industrial Development Laboratories Inc., 19 Pollock Ave., Jersey City 5, N. J., has available a single-page reprint dealing with the Arbeit Ballistocardiograph that records the displacement, velocity and acceleration component of the body motion due to cardiac systole. The unit described covers the frequency range of internally impressed forces up to 20 cps; and requires no adjustments of filters, ambient vibrations being electronically eliminated.

Meterless Resistance Bridge. Industrial Development Laboratories Inc., 17 Pollock Ave., Jersey City 5, N. J. A recent catalog sheet illustrates and describes the model R-10 Signa-Glow, a resistance bridge that uses no bat-

NO GUESSWORK

7 3 4

NO CHANCE FOR ERROR

with a
DIRECT READING

HYCON DIGITAL VTVM

MODEL 615

ILLUMINATED DECIMAL POINT
AND POLARITY SIGN



\$374.50

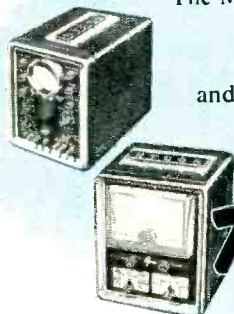
The Model 615 VTVM is a precision instrument — functional in design . . . professional in appearance.

The direct-reading digital display eliminates most interpolation error — shortens costly "learning curve" in factory and assembly line inspection.

Other features — never before offered in an instrument of comparable price — include 1% accuracy (DC and ohms), and 1 millivolt sensitivity. Inspect the Model 615 at your Electronic Parts Jobber's. You'll agree the new standard is Hycon . . . "where accuracy counts."

- 12 RANGES: AC, DC, OHMS • AC FREQUENCY RESPONSE TO 250 MC (with auxiliary probes) • OVERLOAD PROTECTION
- LIGHTWEIGHT, STURDY STEEL CASE • PROVISIONS FOR BENCH STACKING

The Model 615 VTVM is one of a matching set of precision test instruments, which includes the Model 617 Oscilloscope (designed for color TV) and the Model 614 Standard VTVM.



Service facilities in your area.

Hycon Mfg. Company

2961 EAST COLORADO STREET PASADENA 8, CALIFORNIA

"Where Accuracy Counts"

TIME flies...



6700 Series Timing Motor

HAYDON* 400 cycle synchronous timing motors and timing devices . . . MEASURE IT!

Where controlled time measure is vital, HAYDON instruments can be relied upon to meter with accuracy and dependability — even under variable conditions. Flight-proved 400 cycle synchronous timing motors and devices for military use are: The 6700 Series hysteresis type motor. Needs no RF filter! Essentially 2-phase, it has a capacitor for self-starting on single phase. The 7008 Series Elapsed Time Indicator. And, the 5103 Series Time Delay Relay. Also d-c motors: Calibrated and uncalibrated (9200 Series); with RF interference filter (9250-F Series).

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A SUBSIDIARY OF GENERAL TIME CORP.

HEADQUARTERS FOR
TIMING

HAYDON Manufacturing Company, Inc.

2433 ELM STREET, TORRINGTON, CONNECTICUT

series, and effectively measures, at line frequency, resistance to 50 megohms. The meterless bridge discussed features a Dual-Null indicator. Specifications and information on operation are included.

Precision Power Supplies. Lambda Electronics Corp., 103-02 Northern Blvd., Corona 68, N. Y., has available a mailing piece dealing with a line of heavy-duty, precision regulated power supplies. It contains illustrations, special features, technical specifications and prices.

All-Plastic Tank Unit. Avien, 58-15 Northern Blvd., Woodside, N. Y., has issued a catalog sheet illustrating and describing a new all-plastic tank unit that features low cost, fewer parts, smaller size, greater accuracy, simplified maintenance and overhaul, less weight and greater reliability. The gaging unit discussed, with only two tubes, performs all the sensing functions of fuel gaging and management which formerly required 3, 4 and 5-tube structures. The electronically actuated gage described gives greater structural resistance to fatigue and meets MIL-G-7818 vibration requirements in all lengths.

Aperiodic Coupling Units. Motorola Communications & Electronics, Inc., 4501 W. Augusta Blvd., Chicago 51, Ill., has published brochure E-108 on aperiodic coupling units, coupling capacitors and potential devices. The 8-page booklet, of particular interest to power utility engineers, describes improved equipment developed by the company for wide-band coupling of carrier current signals to high-voltage transmission lines. Included in the brochure are circuits of the aperiodic coupling network high-pass filter and the potential device, insertion loss characteristics, photographs and drawings showing dimensions and construction. Specifications are given in detail.

Instrument Generator. Dalmotor Co., 1329 Clay St., Santa Clara, Calif. A 9-oz, p-m, continuous-duty generator recommended as a

precision voltage source is described in a new leaflet, Form GPM-44A. Part of a series, the leaflet illustrates the unit, provides dimensioned outlines and tabulates physical and electrical characteristics. Operating parameters of phase voltage versus load-per-phase are presented graphically for operating speeds of 1,200, 2,100 and 4,500 rpm giving frequencies of 20, 35 and 75 cps.

Encapsulated Precision Resistors. Ohmite Mfg. Co., 3668 Howard St., Skokie, Ill., has published a 2-page bulletin, No. 145, giving specifications and features of type 85 Riteohms with axial leads and type 86 with lug terminals. These are precision, wire-wound resistors in $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, 1 and 1-w sizes that are encapsulated in a special resin and have the resistance wire welded to the terminals. The bulletin shows both individual units and grouped units (several individual units in the same molded resin body), and gives resistance values, wattages, voltage ratings and dimensional drawings of the new resistors.

Photo-Record Processor. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif. The test engineer's dilemma—how to develop and dry large quantities of test data on rolled sensitized paper—is solved by the type 23-109 oscillogram processor described and illustrated in bulletin 1537A-DM. The self-contained instrument discussed is built for operation at the actual testing site, is capable of processing records as rapidly as 15 ft per minute, requires no external water supply and can be used in daylight or in a normally illuminated room.

Beryllium Copper Strip. Penn Precision Products, Inc., 501 Crescent Ave., Reading, Pa. The 4-page bulletin 2, "Introducing Penn-temp Beryllium Copper Strip," presents information on a new type of mill-hardened beryllium copper strip that requires no heat treatment. It describes material supplied with thickness and flat-



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ness tolerances not previously available. The bulletin includes discussion of temper selection together with tables covering sizes and properties.

Vibration and Shock Mountings. Robinson Aviation, Inc., Teterboro, N. J. How to stop vibration, eliminate shock, reduce noise and cut down on the wear and tear of industrial machinery, is the subject of booklet 850. The booklet describes a new concept of vibration and shock control based on the employment of resilient, primary load-carrying cushions of knitted metal wire (Met-L-Flex). Examples of typical industrial mounts and mounting systems are illustrated and engineering data are given. Applications range from delicate precision equipment to massive machinery.

Frequency Recorder. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Instrumentation data sheet 9.1-8a describes the Elektronik frequency recorder with a new pulse-type measuring circuit. Having a calibrated accuracy of ± 0.01 cps the instrument discussed is sensitive to frequency deviations as small as 0.005 cps. Available for both 50 and 60-cycle systems, it incorporates the high speed of response and accuracy inherent with electronic potentiometers and continuous-balance measuring systems.

Molded Mica Capacitor. Arco Electronics Inc., 103 Lafayette St., New York 13, N. Y. A single-page bulletin describes the CM-42 molded mica capacitor that can be wired indirectly without need of additional mounting facilities. Dimensions and capacitance ranges are included.

Closed Circuit Television. Radio Corp. of America, Camden, N. J. An informative brochure describes and illustrates 20 basic applications of the company's "TV Eye" closed-circuit tv equipment. It details the equipment's specifications and describes its application in production, control, remote observation, training and instruction, process control, surveillance,

property protection, dangerous viewing, materials handling and work coordination. Ask for form 3R2335.

Accessories Catalog. Javex, Redlands, Calif. Catalog 254 displays 35 advance design electronic accessories. It covers tv installation practices, types of accessories available for a multiplicity of installations, giving sizes, prices, colors and ratings. Special services are also listed.

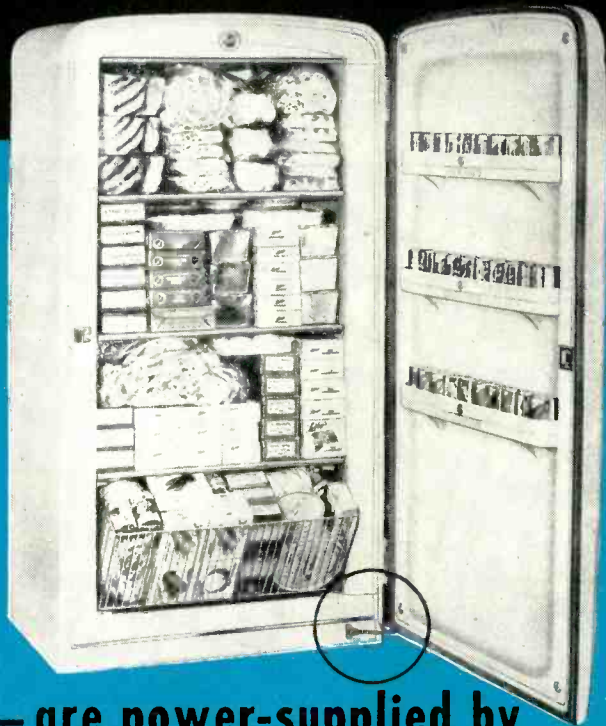
Microwave Duplexers. Airtron, Inc., 1103 West Elizabeth Ave., Linden, N. J. A 6-page technical bulletin, "Branching and Balancing Duplexers", covers design theory and applications of microwave duplexers. Listed as technical bulletin T-2200, it offers an analysis of the operational and electrical characteristics of various practical duplexer designs. This enables the microwave engineer or equipment manufacturer to evaluate the type best suited to his particular transmitter-receiver application.

Dag Dispersions for Industry. Acheson Colloids Co., Division of Acheson Industries, Inc., Port Huron, Mich., has issued a 4-page booklet containing a list of 40 dispersions of colloidal, graphite, molybdenum disulfide, vermiculite and zinc oxide. Typical applications, densities, carriers and other important data are given. Recent additions to the list are dispersions which offer the advantages of the valuable new epoxy resins as bases for dag colloidal graphite and molybdenum disulfide dry-film coatings.

Switches for Industry. Micro Switch, a division of Minneapolis-Honeywell Regulator Co., Freeport, Ill. The 20-page catalog 101 covers 22 families of switches, describing 258 different switches, actuators and enclosures. Dimensionalized photos, complete characteristics, electrical ratings and technical data are intended to aid the design or plant engineer in the selection of the right switches for his particular applications. The catalog illustrates a good cross-section of the company's thousands of precision, snap-action switches

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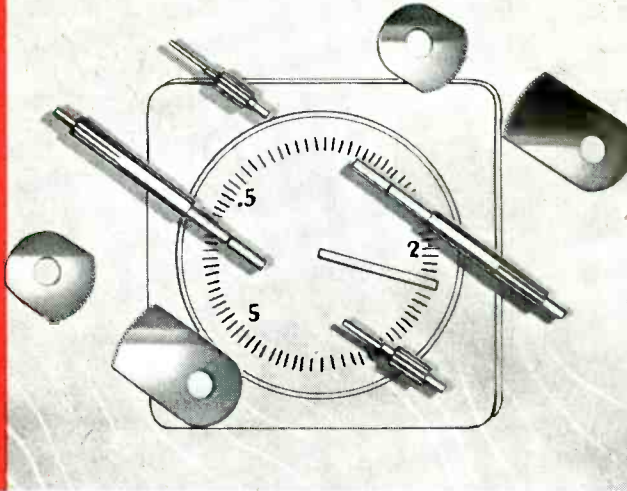
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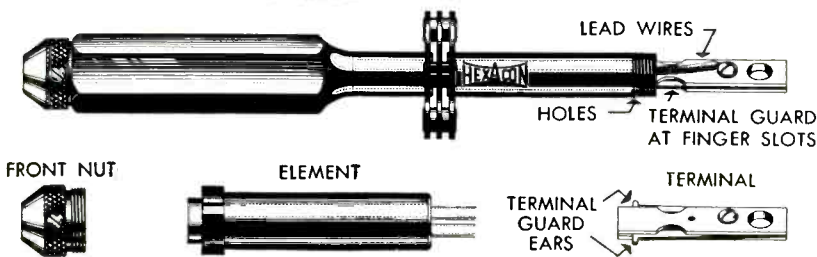
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designed for a-c or d-c industrial and commercial applications.

Pillow Speakers. Telex, Inc., Telex Park, St. Paul, Minn., has issued a 2-color catalog sheet on its dynamic and magnetic pillow speakers. The dynamic speaker described features a wide frequency range and excellent tone control, while the magnetic type is a lightweight plastic unit. Specifications and advantages of both are listed in the sheet, and it explains their many uses in hospitals, homes, hotels and commercial transportation vehicles.

Amplifier Pentode. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y. A recent mailing piece describes the type 6BZ6 amplifier pentode which is specifically designed for operation as an automatic-gain-controlled i-f amplifier in tv receivers. Chief features and electrical data are given.

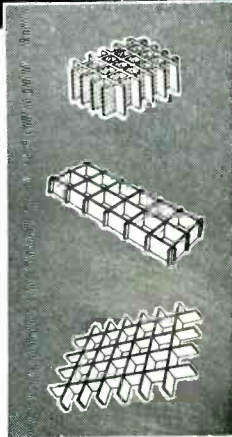
Transformer Catalog. United Transformer Co., 150 Varick St., New York 13, N. Y. The 26-page catalog A presents a complete line of transformers for broadcast, amateur, laboratory and replacement purposes. Each of the lines described is distinguished by individual characteristics ideally suiting the items to the specific application intended. An index and price list are included.

Television Transmitters. Allen B. DuMont Laboratories, Inc., Clifton, N. J., has available bulletins TR-633 and TR-634 dealing with the 25-kw and 50-kw television transmitters respectively. The former illustrates and describes the series 9000 designed to operate between channels 2 to 6; the latter, the series 12000 for channels 7 to 13. Chief features, specifications and diagrams are included.

TV Transformer Replacements. Chicago Standard Transformer Corp., Addison and Elston Sts., Chicago 18, Ill., has published catalog bulletins announcing the addition of 38 new tv transformer replacements. The Stancor replacements described include: 23 power

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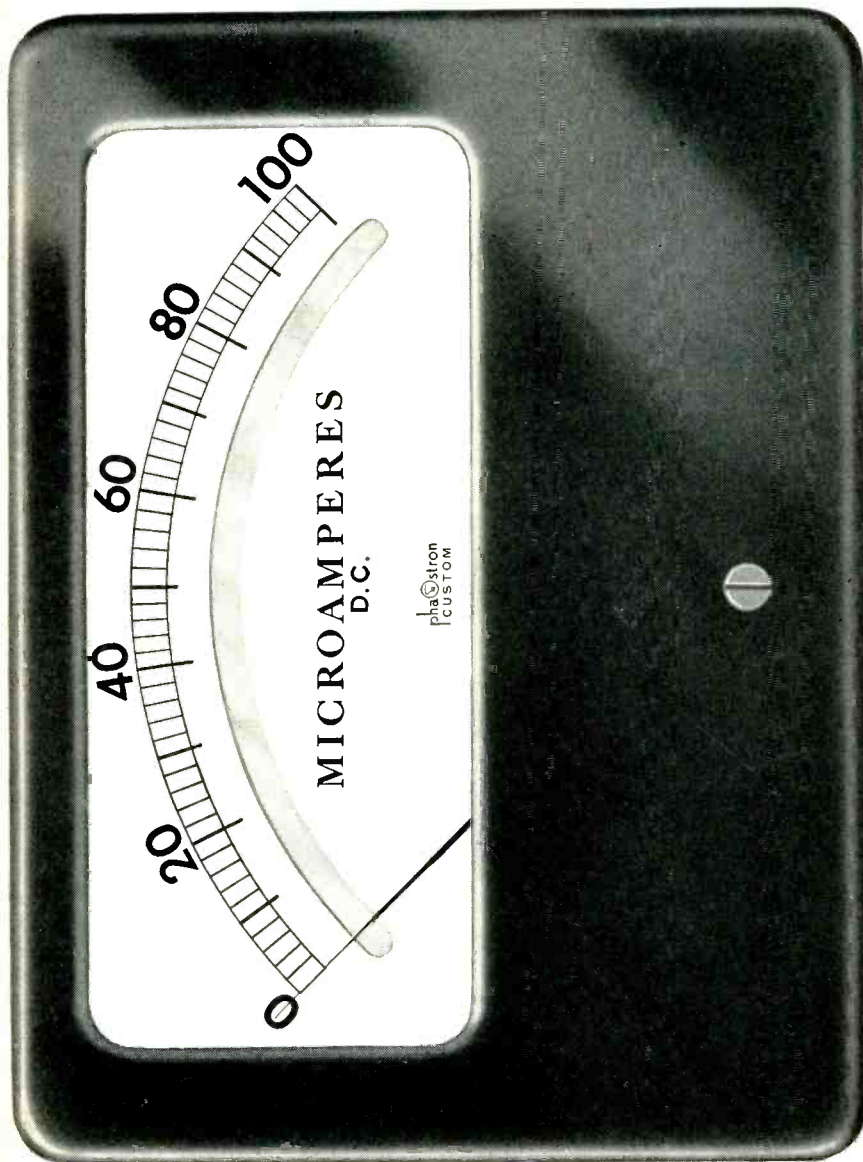
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transformers; 8 vertical output transformers; 5 width and linearity controls; 1 deflection yoke and 1 filter choke.

Photoelectric Cells and Power Rectifiers. Standard Telephones and Cables Ltd., Warwick Road, Boreham Wood, Herts., England. A 4-page catalog folder covers a line of germanium junction photoelectric cells and power rectifiers. Full descriptions, dimensional diagrams and specifications are included.

TV Studio Cuing System. Allen B. DuMont Laboratories, Inc., 1500 Main Ave., Clifton, N. J. Bulletin TR-637 illustrates and describes the type No. 5409-A tv studio cuing system. Technical features, specifications and a line drawing are given. The Tele-Q described is a small, controllable-speed viewer which is attached to the image orthicon camera just below the line-of-sight of the lenses, providing a moving, highly visible printed text for cuing or direct reading.

Resistance Strips and Concentric Disk Resistors. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Catalog data bulletin T-1 covers resistance strips and concentric disk resistors. It gives 4 pages of comprehensive data on construction, tolerances, resistance values, power and voltage ratings, dimensions, machining technique, temperature coefficient and voltage coefficient. Charts and graphs are included.

Capacitor Catalog. Gudeman Co., 340 W. Huron St., Chicago 10, Ill. A new 20-page catalog No. X-100, illustrating and fully describing a complete line of miniature, hermetically sealed, high-temperature (-55 C to +125 C) tubular paper capacitors is now available. Included are dimensional drawings, electrical characteristics, engineering data and tables of voltages, capacitance values and tolerances.

Germanium Diodes. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif., has available a new, 4-page bulletin GD-1A,

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Describes pulse circuits operating in the millimicrosecond time range, covering both basic principles and latest developments. Devotes primary attention to systems of large bandwidth and discusses basic theories, transmission lines, transformers and a novel pulse inverter; pulse generators, amplifiers, cathode-ray oscilloscopes, etc. Explains important nuclear physics applications. By Ian D. Lewis and Frank H. Wells, Atomic Energy Research Establishment, Harwell, England. 250 pp., \$7.50



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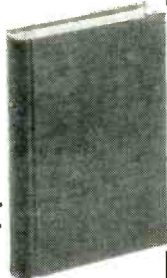
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An organized treatment emphasizing engineering and scientific applications. Describes mechanical, electromechanical, electrical, and electronic analog components and how they may be combined into mathematical machines for solving many types of equations. Covers such recent advances as schemes for multiplication of variables and the uses of high-gain feedback amplifiers. By Walter W. Soroka, Professor of Engineering Design, U. of California. 400 pp., \$7.50

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A practical approach to better acoustics—for improved noise control, high fidelity music reproduction, and other applications. Uses the background of electrical engineers and communication physicists to solve a wide variety of acoustical problems. Discusses effects of sound in many aspects. By Leo L. Beranek, Technical Dir., Acoustics Lab., M.I.T. 467 pages, 312 illus., \$9.00



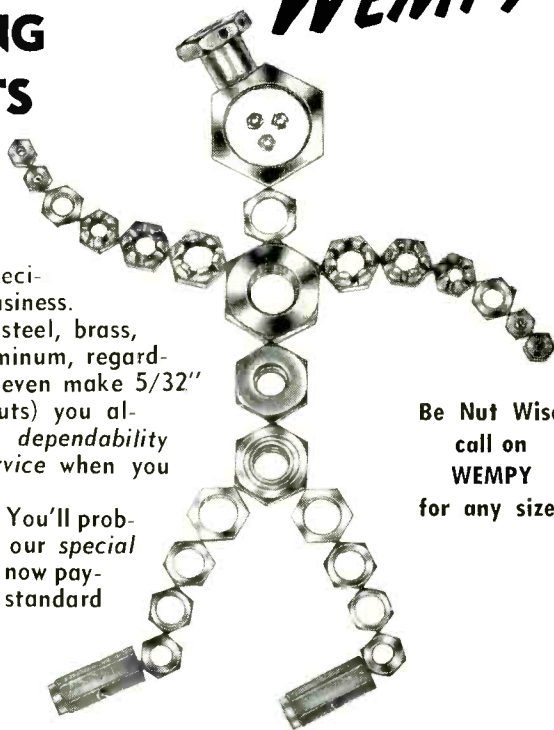
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Gives hundreds of facts, formulas, and numerical examples to provide a thorough understanding of modern and classical wave-propagation concepts. Intensive treatment in 2 volumes explains and shows application of every frequency—from those of about 30 meg. per sec., to the highest radio frequencies in practical use. By August Hund, McGraw-Hill Radio Communications Series, 2 vols. (not sold separately). 1382 pp., 97 tables, 394 illus., \$20.00 (available on terms)

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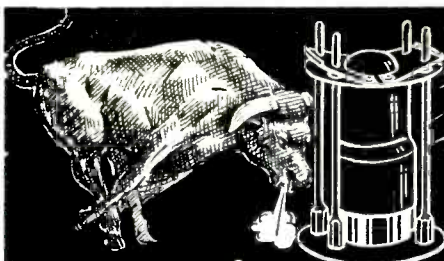
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And remember this: You'll probably pay no more for our *special fasteners* than you are now paying for ready-made standard nuts.

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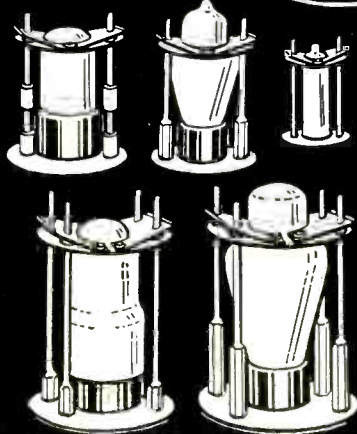
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VACUUM TUBE RETAINERS

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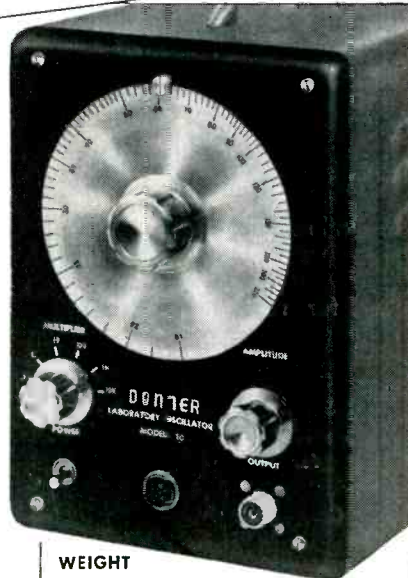
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FREQUENCY RANGE

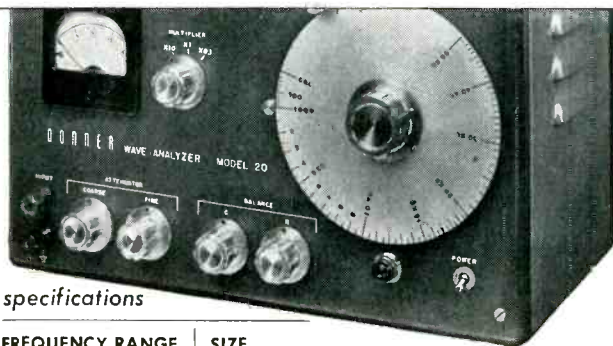
2 cps to 2 mcs in six overlapping decade ranges.

FREQUENCY RESPONSEConstant output ± 1 db.**OUTPUT**Over 20 volts r. m. s.
Neither reactive nor resistive loading will cause distortion of the output waveform.**OUTPUT IMPEDANCE**
2500 ohms**DISTORTION**
Less than 1% at full output**FREQUENCY STABILITY**

Drift less than 2% including warmup. No zero setting required. Line voltage variations of 10% change frequency less than 0.1%.

**WEIGHT**

15.5 pounds

SIZEPanel 7 $\frac{3}{8}$ " x 10 $\frac{3}{8}$ ", depth 8 $\frac{1}{8}$ "specifications**FREQUENCY RANGE**

50 cps to 50,000 cps

SIZEPanel 9 $\frac{1}{4}$ " x 14 $\frac{3}{4}$ ",
depth 9 $\frac{1}{8}$ "**FREQUENCY CALIBRATION**

Calibration accuracy is 3%, with the calibration covering a 250° sweep of the six-inch, planetary driven dial.

INPUT VOLTAGE RANGE

50 millivolts to 500 volts r.m.s., superimposed on DC potentials up to 600 volts. A coarse attenuator with 20 db steps and a continuous fine attenuator are provided to set the meter to 100% for the fundamental component.

POWER SUPPLYVR-Tube regulation of high voltage, amperite regulation of the local oscillator heater current, and temperature compensation of the frequency determining elements permit normal operation with line voltage variation up to $\pm 10\%$.**INPUT IMPEDANCE**
200,000 ohms**WEIGHT**
17.5 pounds.

Wave Analyzer

MODEL 20

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listing ratings and specifications on its germanium diodes. Included is a complete replacement guide of international germanium diodes for replacing RETMA type diodes, and ratings and characteristics for new Red Dot germanium diodes for 100 C applications.

Television Camera Equipment.

Allen B. DuMont Laboratories, Inc., Clifton, N. J. Bulletin TR-605 illustrates and describes the type 5400-A tv Porta Dolly and type 5401-A Porta Tripod. With the units described, a full range of easy and convenient height adjustments is available from a full 56-in. elevation for awkward, hard-to-get, high-angle shots down to a low-level mounting for dug-out shots. Features and specifications are included.

Traveling-Wave Tube Amplifiers.

Hewlett-Packard Co., 2997D Page Mill Road, Palo Alto, Calif., has available a 4-page loose-leaf perforated folder illustrating and describing the 490/491A traveling-wave tube amplifiers that feature broad-band high-gain, low-noise amplification for S band. Complete technical specifications are given.

Radiation Measuring Equipment.

Nuclear Instrument & Chemical Corp., 229 W. Erie St., Chicago 10, Ill., has recently printed a new 40-page, 2-color catalog. It describes the company's line of radiation measuring equipment including scalars, count rate meters, Geiger proportional and scintillation counters, along with complete radioisotope laboratories.

Temperature Indicator.

Beckman & Whitley, Inc., 913 E. San Carlos Ave., San Carlos, Calif. A new leaflet describes a sensitive, rapid-responding temperature indicating instrument available in several types, each with either a span of 130 F in six overlapping ranges, or a single span of 30 F. The basic thermistor-type instrument is illustrated and described, including specification data on accuracy, battery life, response time and cable length. The literature also includes data on a portable aspirated-type psychrometer for wet and dry-bulb temperature

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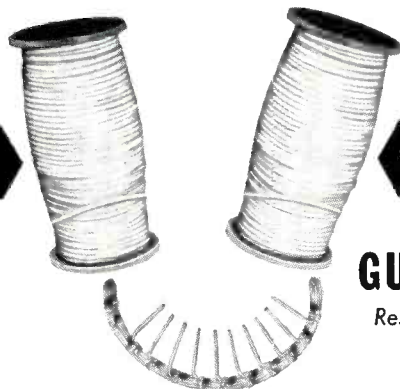
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Easy on Hands
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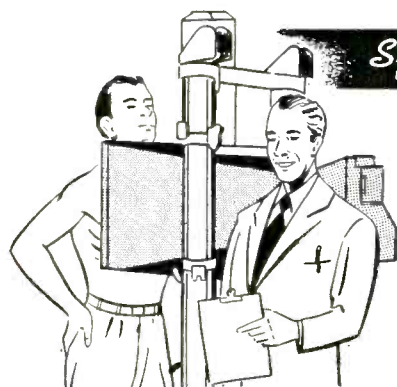
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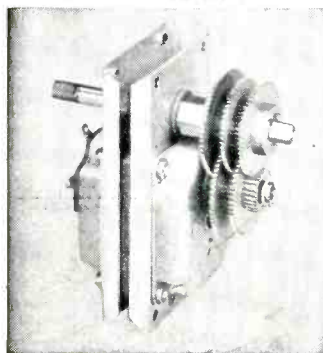
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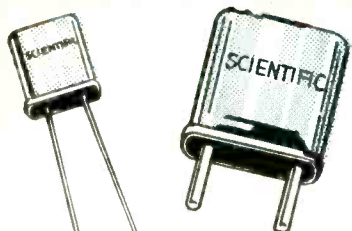
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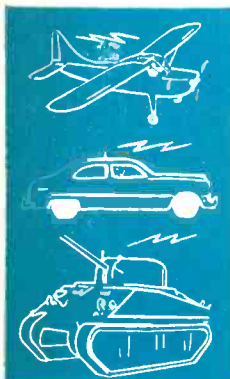
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measurements, or dry-bulb free-air temperature measurements. Also listed is an aircraft type accessory shield, which permits mounting thermistor units on wing-tips for meteorological inversion temperature measurements and similar studies. Ask for Form 196.

Electronic Regulator. Reliance Electric & Engineering Co., 1088 Ivanhoe Rd., Cleveland 10, Ohio, has issued a two-page bulletin describing and illustrating the VSR—a new electronic regulator for speed, voltage and current regulation for industrial electric motor drives. With illustrations and a diagram, the bulletin explains the function of the regulator in controlling motor or generator field excitation in response to the input signal from the quantity being regulated. Also featured in the bulletin are the company's Sealpak units, an innovation providing the advantages of electronics together with the ruggedness required for industrial application.

External Fluxes for Industry. Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J. A 4-page folder discusses fluxes for the electrical and electronics industry that are compounded of the highest quality water white rosin and a suitable solvent. Activated and nonactivated rosin fluxes and their specific thinners are listed. Other information about the company's fluxes is included.

Transistors. Federated Semi-Conductor Co., 66 Dey St., New York 7, N. Y., has available literature describing a line of hermetically sealed *npn* grown junction transistors. Specification and price sheets cover four types of triodes and three types of tetrodes. Recommended applications for each are included.

Beryllium Copper Tubing. Superior Tube Co., Germantown Ave., Norristown, Pa. Properties, applications and advantages of seamless and Weldrawn beryllium copper tubing are presented completely in data memorandum No. 7-2. The alloy described, which

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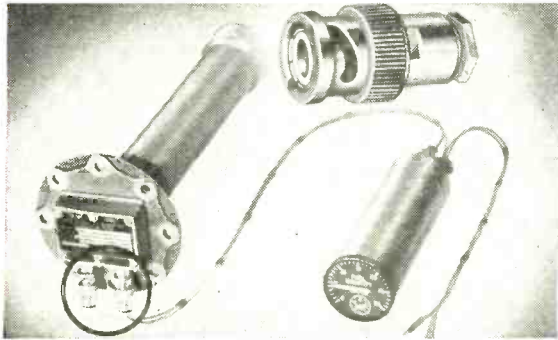
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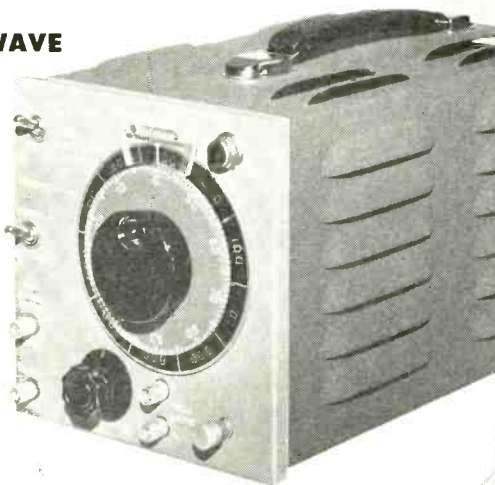
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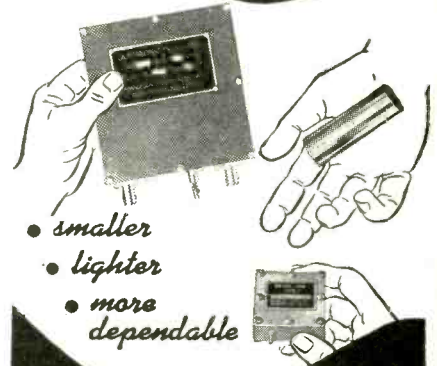
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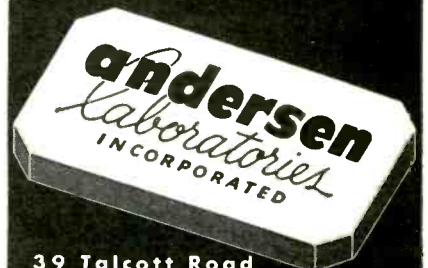


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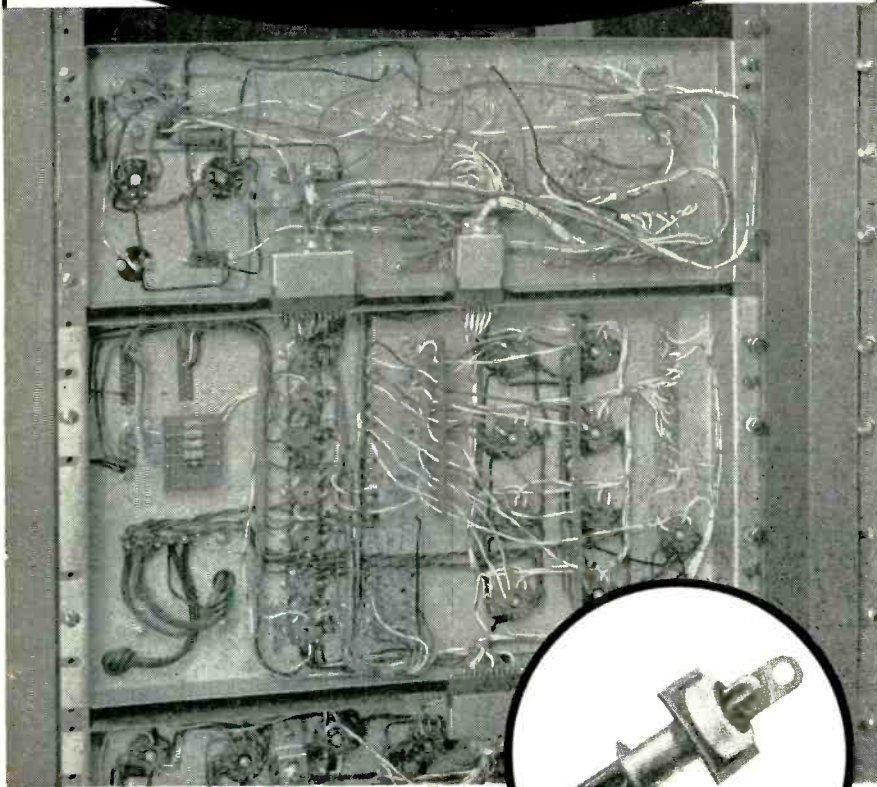
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Airborne Power Supplies. The Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif., announces a new bulletin No. A453 dealing with their airborne transformer-rectifiers and power supplies. The transformer-rectifiers described are rated at 28 v with current ratings up to 200 amperes and the complete power supply units are for airborne-radar applications.

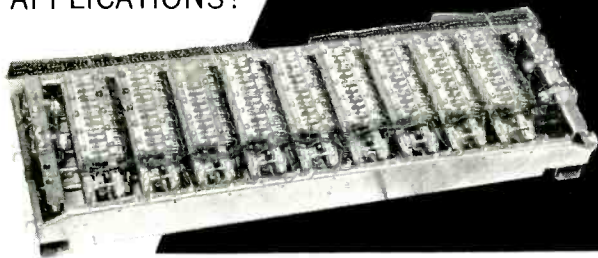
Mobile System. Allen B. DuMont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J., has published a single-page illustrated bulletin covering the type MCA-401-A complete mobile system designed for use in the uhf 450 to 470-mc band. The system described offers the inherent advantages of minimum electrical noise, availability of several channels, plus a design that incorporates unparalleled ruggedness and performance.

Titanate Ceramics for Capacitors. American Lava Corp., Chattanooga 5, has issued bulletin 542 entitled "Titanate Ceramics for Capacitors." The bulletin outlines the physical properties of AlSiMag dielectric compositions, and explains the applications of the two classes of AlSiMag ceramic dielectrics. Several easy-to-read charts are included.

Relay Symposium Papers. Potter & Brumfield, Princeton, Ind., has released a new volume of relay symposium papers. Like its 1953 predecessor all papers are presented exactly as given at the symposium—no attempt has been made to edit or arrange them in any specific sequence. The new volume is available without charge to engineering, manufacturing, purchasing, teaching and student personnel.

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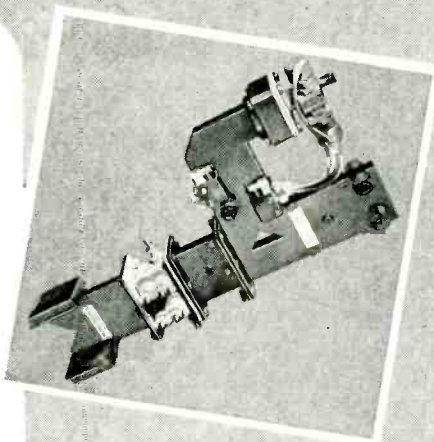
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Government names electronic engineers, sets up new consulting groups . . . Manufacturers announce plant expansion plans . . . Engineers and executives are promoted . . .

OTHER DEPARTMENTS

featured in this issue:

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Defense Department Names Shockley

WILLIAM SHOCKLEY, research physicist of the Bell Telephone Laboratories, has been appointed director of research for the Weapons Systems Evaluation Group of the Defense Department.

In this position, he also serves as deputy to the director, Lieutenant General Geoffrey Keyes, and as chief scientific officer of the group.

Primary function of the WSEG is to respond to calls for service and assistance from the Joint Chiefs of Staff and the Assistant Secretary of Defense (Research and Development) for analytical studies and evaluations of the comparative effectiveness and costs of present and future weapons systems.

Dr. Shockley is on leave of absence from his position as director of the transistor physics department of Bell. He joined Bell in 1936.

The point contact transistor, first announced in 1948, was invented by J. Bardeen and W. H. Brattain while working under Shockley's supervision. The junction transistor, used in hearing aids, was invented by him. He has also invented the unipolar and several other types of transistors. The recently announced Bell "Solar Battery" was developed in part in Dr. Shockley's department.

For his contributions to the transistor, Dr. Shockley received a "Citation of Honor" from the Air Force Association, the Morris Liebmann Prize from the Institute of Radio Engineers, and the Oliver E. Buckley Prize from the American Physical Society.



Manufacturers Confer With Navy On Tubes

GOVERNMENT and electronic industry officials gathered at the Navy's Electronic Supply Office (ESO) in Great Lakes, Ill. to confer in regard to structuring a new code for electron tubes to be used in determining military requirements for raw material and finished product. They are, left to right, H. A. Kent and W. S. Sims of Continental Electric; G. Rivers of RCA; R. J. Higgins of Eitel-McCullough; A. Guthrie of ESO; G. F. Wunderlich of Eitel-

McCullough; S. Gertzis of Amperex Electronic; C. Anderson of Chatham Electric; H. M. Schwalbach of ESO; W. F. Sandberg of Amperex Electronic; L. G. Kleinlein, D. Persinger, S. Osterlund, Chairman, and M. Shuck of ESO; M. Deitchman and R. S. Facer of Army Signal Corps; J. Prichard of EPRA; H. A. McGettigan, E. N. Kather and P. R. Keeler of Raytheon; W. J. Walker of GE and J. E. Cunningham of CBS-Hytron.



E. Finley Carter Joins Stanford Research

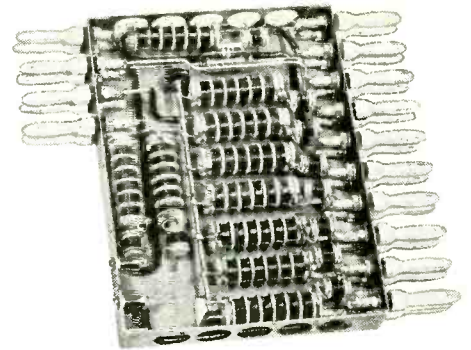
E. FINLEY CARTER, vice-president and technical director of Sylvania, has joined Stanford Research Institute as manager of research operations, effective October 1.

He will supervise the three research divisions carrying SRI's main programs and projects—physical sciences, engineering and

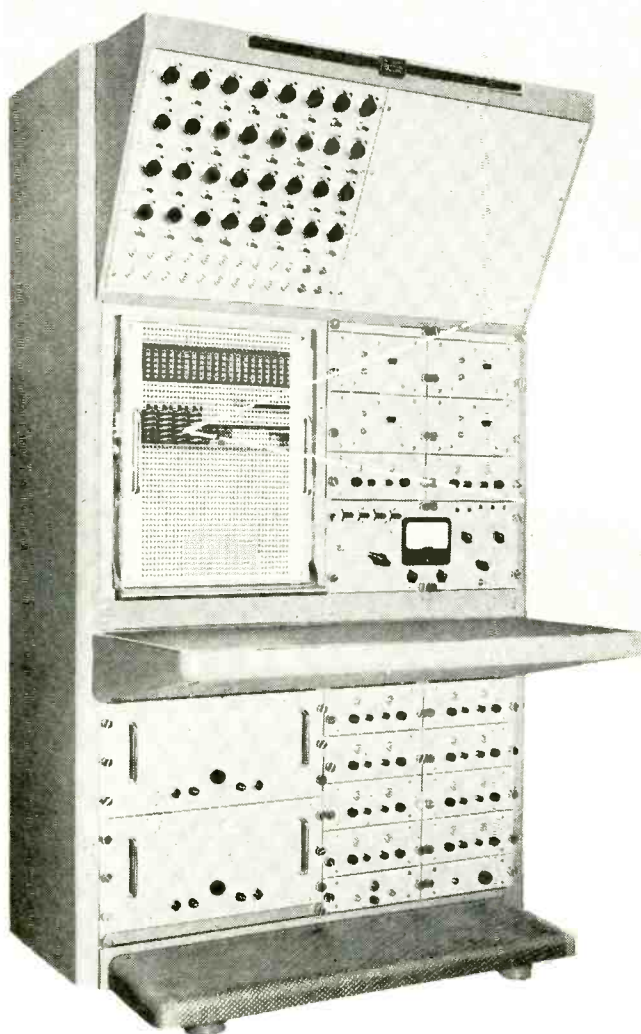
Electronic Associates Specifies

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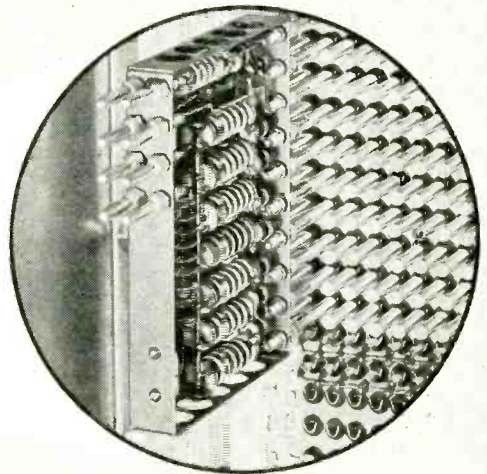


The EPR SS-5L Low Capacity Precision Resistor selected by Electronic Associates for use in their Analog Computer 16-31R. Only EPR SS-5L Low Capacity Resistors were found to have a distributed capacitance of less than 2.0 mmf. Each plug-in network contains a series of these resistors and each resistor is matched to within .05%. EPR techniques in winding and artificially aging guarantees stability of the network over a wide temperature range. Such accuracy and long term stability are the reason Electronic Associates relies on EPR.



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EPR makes a wide variety of encapsulated, sub-miniature, high-temperature and standard type precision wire-wound resistors.



The General Purpose Analog Computer 16-31R developed by Electronic Associates, Inc. of Long Branch, N. J., presents important advances in this field. In addition to high accuracy, versatility and dependability—it provides ruggedized construction . . . a new high-gain low-drift contact stabilized d-c amplifier with outstanding accuracy, gain frequency response and output power characteristics. By the addition of standard operational groups such as amplifiers, servo-multipliers, resolvers, etc., it may be expanded to more complex systems. Its success is due to the right combination of imagination, engineering talent and superior components. We of Eastern Precision Resistor Corp., are proud to have contributed.

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economics research.

Carter will retain an association with Sylvania, assisting in contacts with the Department of Defense and consulting on major research and development contracts.

Carter joined Sylvania in 1932 as a consulting engineer, later became radio-division engineer, then assistant chief engineer.

In 1941 he was appointed director of Sylvania's new industrial relations department. He was subsequently elected a vice-president of the company.

Podolsky Heads Group On Mil Parts Specs

LEON PODOLSKY, technical assistant to the president of Sprague Electric, has been appointed chairman of a new group to review all military electronic component part specifications with a view toward improving the performance of these components in the light of equipment requirements for new, very high reliability applications.

Podolsky was requested to undertake chairmanship of this Ad Hoc Group by M. Barry Carlton of the office of the assistant secretary of defense for applications engineering.

The other members of the committee will be P. S. Darnell of the Bell Telephone Laboratories, J. T. Brothers of Philco and one representative each of the Air Force, Army, Navy and the Armed Services Electro Standards Agency.

Podolsky previously headed similar military task force engineering committees during World War II.

The need for the present program arises in the very large numbers of electronic components which appear in modern electronic systems, such as guided missiles, radar warning nets, and navigation systems, where there are many thousands of components in comparison to a few dozen which appeared in World War II electronic systems. The committee will determine what revisions are required in military component specifications to insure meeting existing equipment requirements for high reliability operation.

Association Honors Ten Past Chairmen



THE Northern Council of the West Coast Electronics Manufacturers Association presented commemorative plaques to its ten past chairmen. Those honored with the year of office are left to right, first row:

1944, Jack Kaufman, president of Lewis and Kaufman, Los Gatos; 1945, Clayton Bane, owner of Clayton F. Bane Advertising, San Francisco; 1946, Ralph Shermund, vice-president and production manager of Specialized Instruments, Belmont; 1948, William R. Hewlett, vice-president of Hewlett-Packard.

Second row: 1950, O. H. Brown, director of field engineering of Eitel-McCullough, San Bruno; 1951, Paul F. Byrne, vice-president and chief engineer of Sierra Electronic Corporation, San Carlos; 1947, W. W. Wahlgren, partner and technical

director of Electro Engineering Works, Oakland; 1949, W. Noel Eldred, sales manager of Hewlett-Packard Company; 1952, Noel E. Porter, production manager of Hewlett-Packard Company; 1953, N. Moore, president of Litton Industries, San Carlos, (not shown).

The Northern Council of WCE MA comprises 45 electronic companies in Northern California, Oregon and Washington.

Present officers of the Northern Council are James J. Halloran, chairman, partner and chief engineer of Electro Engineering Works; H. Myrl Stearns, vice-chairman, executive vice-president and general manager of Varian Associates, Palo Alto and Winfield Wagner, secretary-treasurer, field engineer at Eitel-McCullough.

NBC Expands for Color Television

THE National Broadcasting Company is developing additional studio facilities which will permit, by next Fall, the production of 12 to 15 hours of live color programs weekly. This will enable, at capacity, the scheduling of more than 500 hours of color programming throughout the season.

The network's color programs are being broadcast over 31 affiliated stations across the United States. By October, with further progress in the color-conversion of network lines, 64 stations will be broadcast in color, making colorcasts

available in areas comprising 78 per cent of the nation's television homes.

By September, NBC will have expended \$15 million in research funds earmarked for making a commercial broadcasting reality of the compatible color system. This figure is in addition to the \$25 million already spent by RCA in the development of color.

Rapid expansion of NBC color-casting facilities is now under way in New York and Hollywood. In New York, the Brooklyn studios acquired from Warner Brothers will

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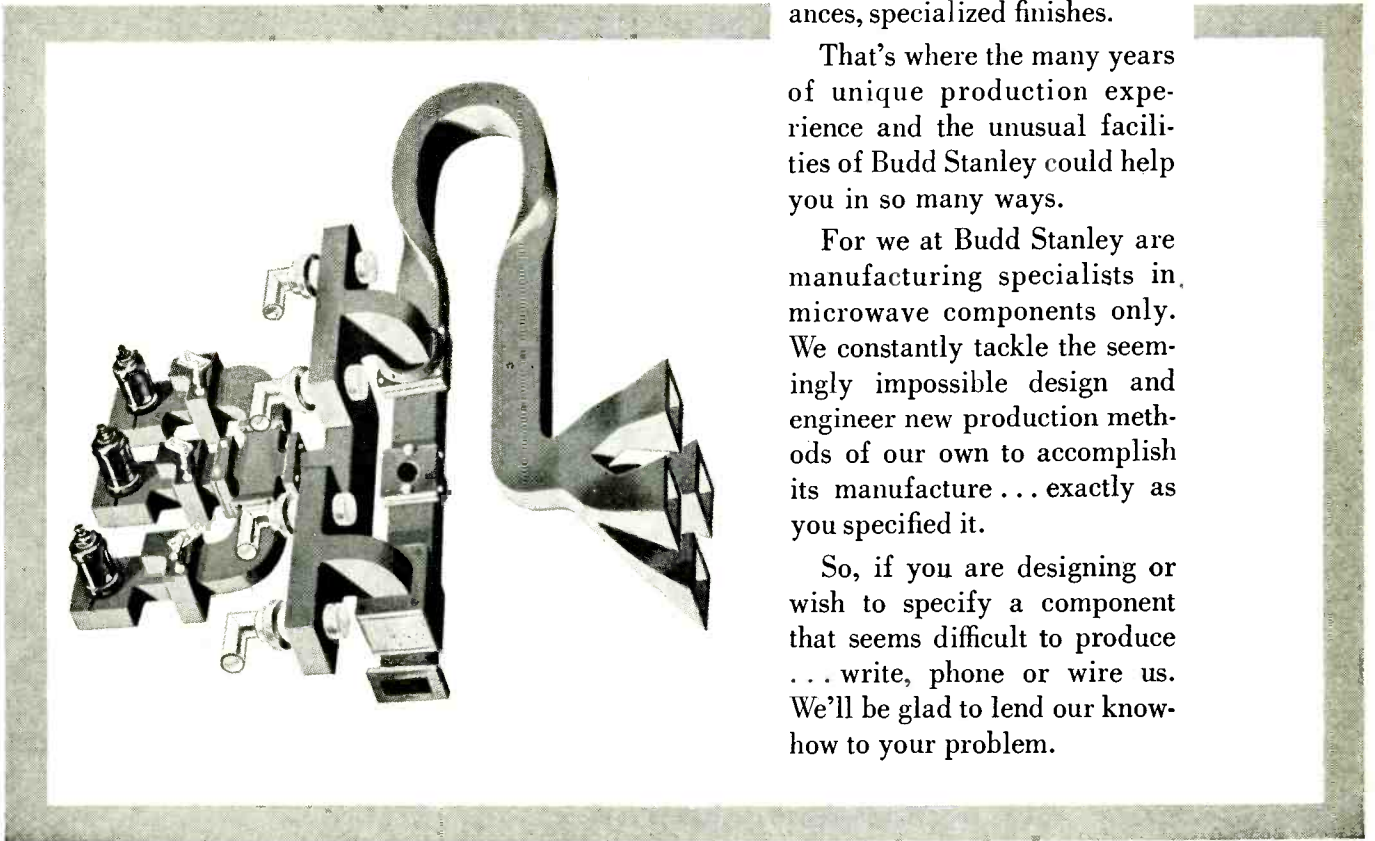
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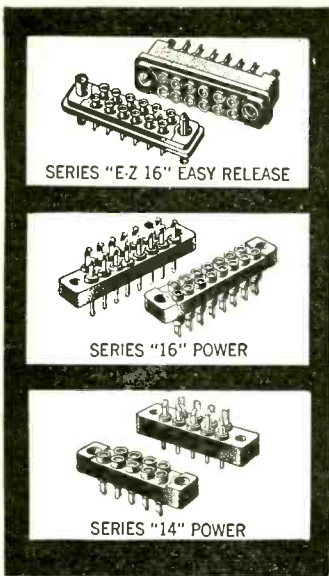
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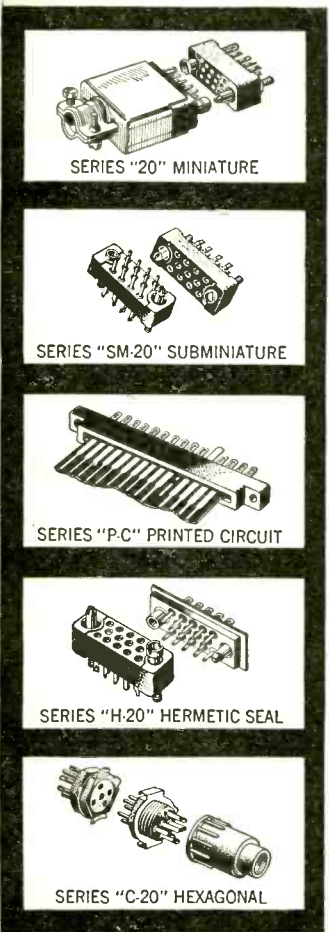
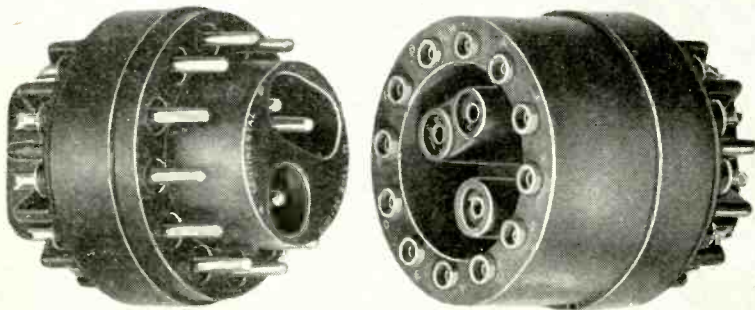


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For complete illustrated engineering literature, and assistance on special or unusual connector problems, write Dept. EHV9, DeJur Amsco Corporation, 45-01 Northern Blvd., Long Island City 1, New York.

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be fully equipped for color by September and will carry a large part of the color production load. In Hollywood, a new color studio is being built and equipped at a cost of \$3,600,000 and will be ready by Jan. 1, providing an added color production capacity.

Existing color studio facilities in New York are the Colonial Theater and Studio 3-H in Radio City.

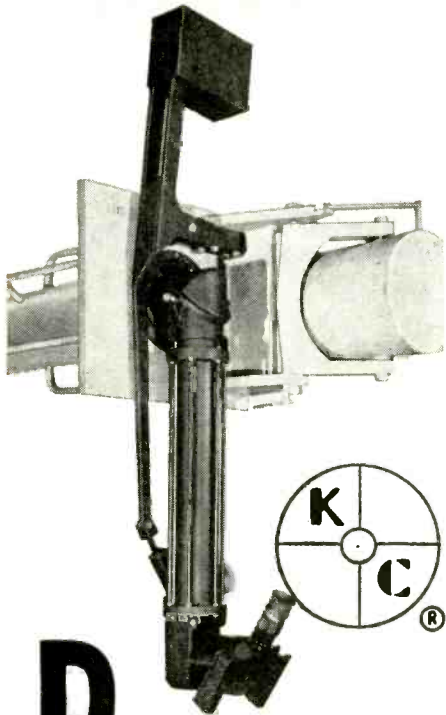


Sylvania Dedicates Plant, Elects Officer

SYLVANIA dedicated its new 422,000 sq ft tv-set assembly plant in Batavia, N. Y., largest of its plants, under one roof.

The Batavia plant on which construction began in the summer of 1953, commenced operations last March. The manufacture of production model receivers gradually was transferred to Batavia from the company's plant in Buffalo. Now all commercial tv sets are being produced there. The plant now employs approximately 1,200 persons. Television engineering, including development work on color television sets and the production of prototype models, is being carried on in Buffalo. In the new plant four reciprocating lifts carry material from the second to the first floor. A continuous lift device carries incoming goods to the second floor. In the process-test area, television chassis are placed on a moving slat conveyor so that electrical tests can be made while each chassis is moving toward the next operation.

Arthur L. B. Richardson has been elected secretary and general counsel of Sylvania, succeeding



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If you have a problem calling for a periscope or for any precision optical system, check with us. For nearly half a century Kollmorgen has designed, developed and manufactured precision optical products including Industrial and Naval Periscopes, Fire Control Devices, Projection Lenses and Navigational Instruments for Industry and for the Armed Services.

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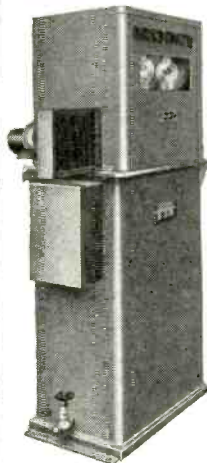
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Askarel Immersed Filter Reactor 50,000 Volt Test

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MAGNATRAN INCORPORATED

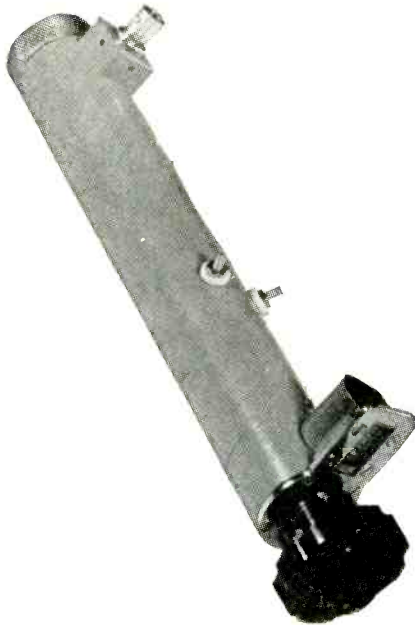
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Amerac's new . . .

ROCKET TUBE CAVITY OSCILLATOR

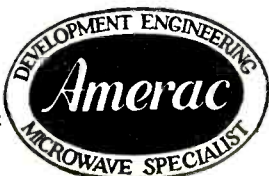


The #192A Rocket Tube Cavity Oscillator is a coaxial line cavity, employing the Sylvania UHF Planar Triode which provides a stable R.F. signal source in both a CW and a pulse model. This cavity enjoys a stability possible only with a triode. The oscillator can be supplied at frequencies from 1000 to 4000 MC with a 400 MC/S tuning range. The 192A was designed with emphasis on minification. It features a single control for tuning and utilizes fixed feedback. Cavity can be furnished with a regulated supply and frequency calibration curves.

SPECIFICATIONS

(for a typical pulse operation)

Heater volts	6.3 V AC
Heater current	400 M.A.
Peak plate volts	1700-2000
Pulse repetition frequency	1000
Pulse width	1 u sec.
Frequency of operation	3600 MC/S
Peak out power	200 watts
No selection of tubes required	
Over-all length	8 inches
Diameter of body	1-5/16 inches
Root counter for calibration	
Output	BNC or type N jack
Net weight	1 lb. 3 oz.



Amerac Incorporated

116 TOPSFIELD ROAD
WENHAM, MASSACHUSETTS



A. L. B. Richardson

John S. Learoyd who retires.

Richardson has been general counsel for the company since 1953. He joined Sylvania in 1945 as patent attorney, and in the same year was appointed manager of the patent law department. In 1950, he was named general attorney for the company and in 1953 was elected general counsel.

Previous to his Sylvania affiliation, Richardson was an attorney for a Chicago law firm. Prior to this, he had been assistant patent attorney in GE's patent department. He joined GE as an electrical engineer in 1934.



Palley Joins Temco Aircraft

I. NEVIN PALLEY, formerly chief of missile design for Chance Vought Aircraft, has joined Temco Aircraft Corp. of Dallas, Texas in the newly created post of vice-president of engineering.

Palley will have complete respon-

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Reply, giving resume of education and experience, with salary expected to:

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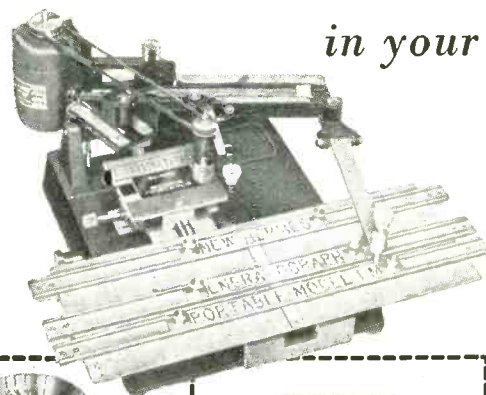


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20 G UP TO 2000 CPS**



ACTUAL SIZE

Limited quantity of model shop samples available — submit your specifications and requirements with your inquiry.



PHOTO
Martin Matador, courtesy
The Glenn L. Martin Company

DIMENSIONS:

$1\frac{3}{32}$ " diam. x $1\frac{3}{4}$ " long

WEIGHT:

less than 1 oz.

OPERATING POWER:

100 MW Max.

CONTACTS:

spdt—2 amp. at 24 V DC
Resistive load

VIBRATION RESISTANCE:

20 G up to 2000 CPS
(cycles per sec.)

RELAYS
Wheelock **SIGNAL**
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WRITE THEIR OWN

APPLICATION

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products would be well able to support such extraordinary self-representation. The unique characteristics of VECO SEMICONDUCTOR DEVICES present a challenge to equipment designers to take advantage of countless new possibilities for the MEASUREMENT and CONTROL of THERMAL, ELECTRICAL, and PHYSICAL ENERGY.

The electrical resistance of VECO THERMISTORS varies extensively with minute thermal changes. They are made in the forms of rods, discs, washers, and beads, and stocked in a wide range of temperature vs. resistance characteristics—can also be produced in quantity to your requirements.

A request on business stationery will bring you the VECO THERMISTOR DATA BOOK.

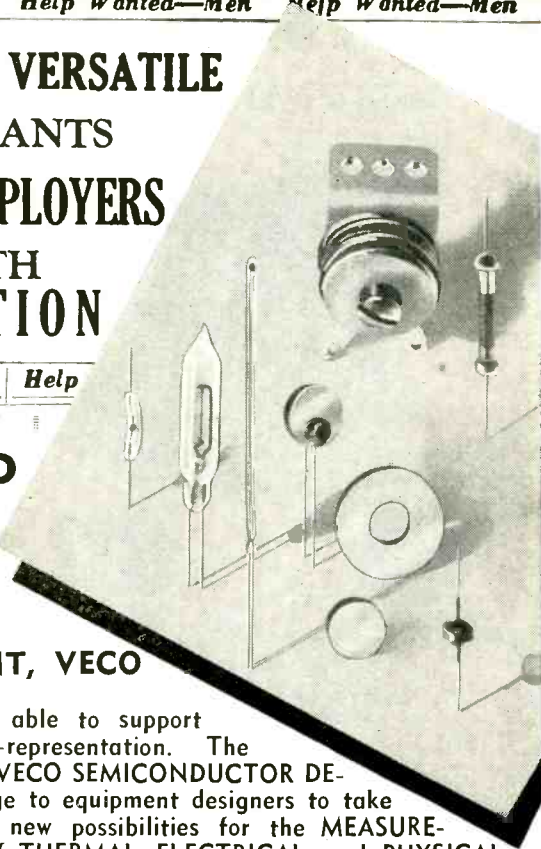
VECO VARISTORS react instantaneously to current or voltage changes, and have innumerable uses such as arc suppressing and regulating source voltages. They are electrically stable, do not polarize and, in proper use, do not age.

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PLANTS AND PEOPLE

(continued)

sibility for all Temco engineering and electronic activities. Reporting to him will be H. G. Erickson who will continue as chief engineer and G. B. Spaulding who will continue as superintendent of electronics.

Palley was recently appointed a member of the Technical Advisory Panel on Aeronautics for the Assistant Secretary of Defense for Research and Development.

Palley left Curtiss-Wright to join Chance Vought Aircraft in 1941 and six months later was made head of the preliminary-design group.

Starting with a group of thirty engineers he directed the Regulus missile project from its inception to the point where he was directing 600 engineers and the Regulus became a successful operational missile.

At Temco, Palley will direct advanced projects both in the piloted aircraft and missile fields.

Emerson Research Names Engineers

RAYMOND E. WILSON has been appointed principal physicist at the Emerson Research Laboratories in Washington, D. C., a division of Emerson Radio. Dr. Wilson transferred from the National Bureau of Standards where he served as chief of the temperature measurements section and assistant chief of the heat and power division. Prior to specializing in the field of temperature measurements, he was engaged in underwater ordnance work for the U. S. Navy.

Sydney Rattner has joined the staff of Emerson Research as a principal electronic engineer. Prior to joining Emerson, Rattner was a member of the Diamond Ordnance Fuze Laboratories where he served as an assistant branch chief of the guided missile fuze laboratory. This laboratory was formerly the ordnance electronics division of the National Bureau of Standards.

Norman A. Kahn has been appointed as a principal mechanical engineer at the Laboratories. Kahn was formerly assistant mechanics branch chief of the guided missile fuze laboratory of the Diamond Ordnance Fuze Laboratories. He has specialized in the development

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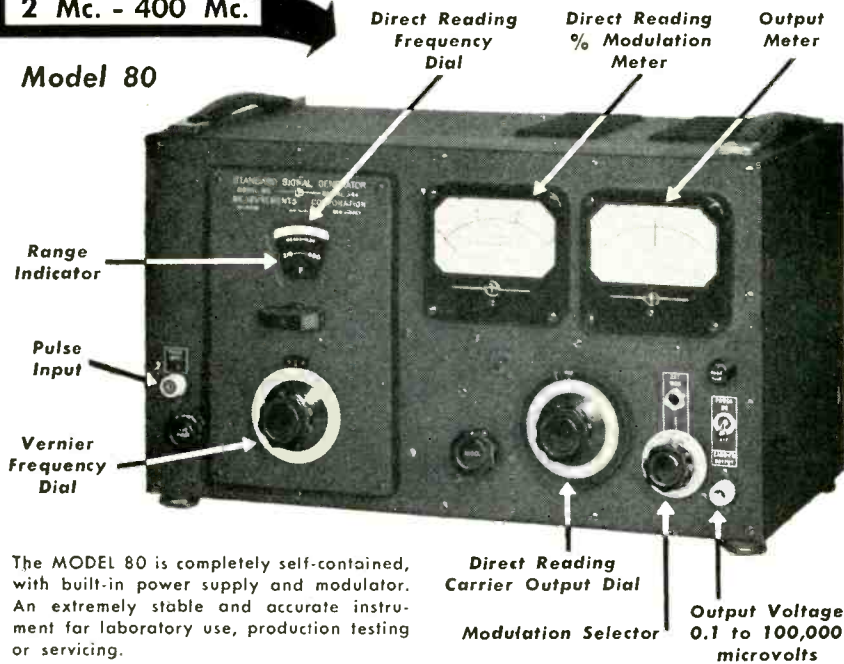
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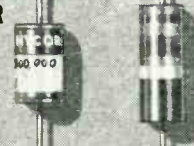
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**NEWLY DEVELOPED
SUB MINIATURE TYPE 10**

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RESISTOR



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1 WATT
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RESISTOR

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PRECISION WIRE-WOUND

RESISTORS

The new Hycor "H" Series Precision Resistors incorporate unique design features that make it possible for the resistors to meet performance requirements far beyond those required by military specification.

The "H" Series Precision Resistors are encapsulated in a tough plastic compound. The result is a solid, homogeneous unit with unparalleled ruggedness, impervious to the effects of moisture, thermal shock and mechanical shock. The plastic is filled with heat conducting mineral which dissipates the heat and equalizes the "hot spots" in the resistor winding. The sealed-in terminal connections are welded.

SPECIFICATIONS...

MILITARY SPECIFICATIONS: Performance characteristics satisfy all requirements of MIL-R-93A and JAN-R-93.

TEMPERATURE COEFFICIENT: $\pm 0.0022\%$ per deg.C.

OPERATING TEMPERATURE: $-65^{\circ}\text{C. to } +125^{\circ}\text{C.}$

RESISTANCE ACCURACY: Standard resistance tolerances are 1%, 0.5%, 0.25% and 0.1%.

Type 10 (illustrated):

1/4" dia x 1/2" long;

Resistance range: 1.0 ohm - 0.35 meg.

Send for Bulletin H for complete description on other physical sizes and wattage ranges.

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Here's another advance in the Bendix Red Bank "Reliable" Vacuum Tube program. Featuring a hard glass bulb and stem with gold-plated pins . . . plus a conservative design center of cathode temperature . . . the Bendix Red Bank RETMA 6094 can operate at temperatures up to 300° C. compared to an average of only 175° C. for soft glass bulbs. Thus, this new tube ideally meets aircraft, military and industrial applications where freedom from early failure, long service life, and uniform performance are essential.

The Bendix 6094 uses pressed ceramic spacers, instead of mica, for element separation. In other tubes, deterioration of mica in contact with the hot cathode causes loss of emission which is greatly accelerated under shock and vibration. Ceramic eliminates this problem and greatly reduces damage caused by fatigue failure of parts.

For complete details on our special-purpose tubes, write today.

ELECTRICAL RATINGS*

Heater voltage (AC or DC)**	6.3 volts
Heater current	0.6 amps.
Plate voltage (maximum DC)	275 volts
Screen voltage (maximum DC)	275 volts
Peak plate voltage (max. instantaneous)	550 volts
Plate dissipation (absolute max.)	12.5 watts
Screen dissipation (absolute max.)	2.0 watts
Cathode current (max. instantaneous peak value)	100.0 ma
Heater-cathode voltage (max.)	±450 volts
Grid resistance (max.)	0.1 megohm
Grid voltage (max.)	+5.0 volts
(min.)	-200.0 volts
Cathode warm-up time (Plate and heater voltage may be applied simultaneously.)	45 seconds

*To obtain greatest life expectancy from tube, avoid designs where the tube is subjected to all maximum ratings simultaneously.

**Voltage should not fluctuate more than ±5%.

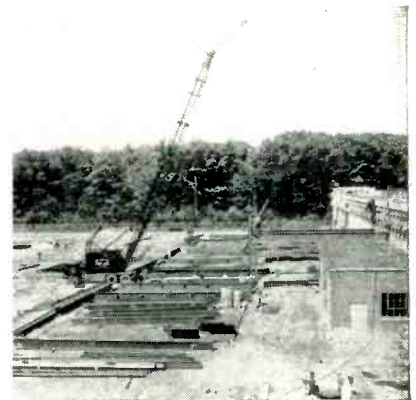
MECHANICAL DATA

Base	9 pin miniature hard glass— gold plated tungsten pins
Bulb	Hard glass—16½"
Max. over-all length	2¾"
Max. seated height	2¾"
Max. diameter	¾"
Mounting position	any
Max. altitude	80,000 feet
Max. bulb temperature	300°C.
Max. impact shock	500g
Max. vibrational acceleration	50g
(100-hour shock excited fatigue test, sample basis.)	

of electromechanical devices for guided missiles, rockets, fire control systems and underwater ordnance equipment.

James Bonelli has been appointed manager of the materials division of Emerson Radio.

Bonelli has an electronics background extending back to 1938 when he entered the industry as an engineer. In subsequent years, he was plant manager for two major electronics manufacturing companies.



Carboloy Plant Construction Underway

CONSTRUCTION starts as first steel beams swing into place for the million-dollar plant addition at Carboloy department of General Electric Company in Detroit. The structure, to be completed this fall, will add 36,000 sq ft of floor space to the department's metals building. It will accommodate new engineering and manufacturing equipment and allow the rearrangement of other facilities to make 16,000 sq ft of vacated space available for advanced-engineering activities, including pilot plant and laboratories

B.B.C. Engineers Tour Du Mont's Tele-Centre

AS ONE of the stops in a two-week tour of American television facilities, a group of executives for the British Broadcasting Corporation recently inspected the Du Mont Television Network's Tele-Centre.

The proposed studio control room layout for the B.B.C.'s soon due TV studios in White City, London, are

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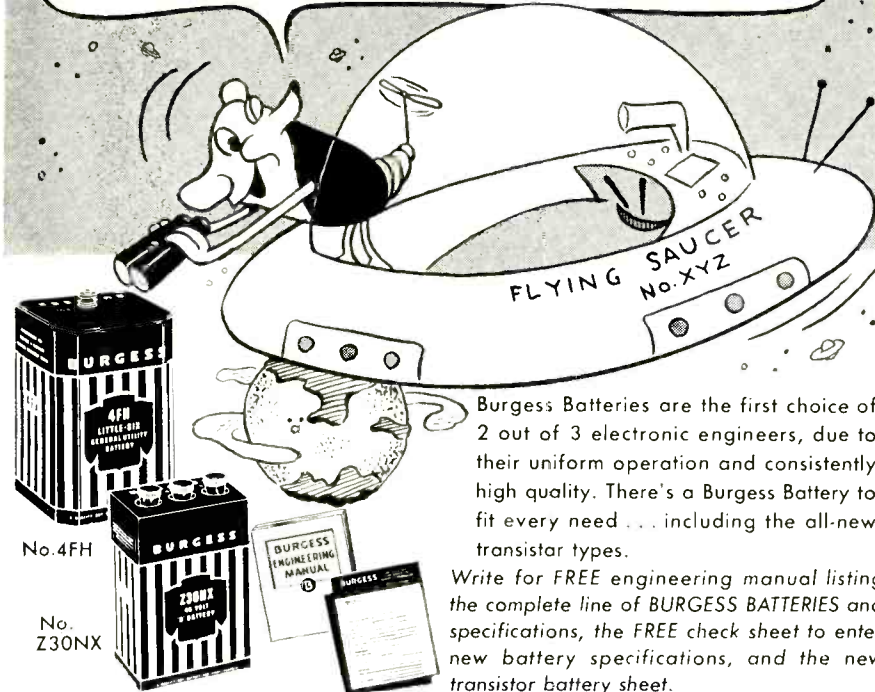
The model 12GLX-M, 1KW Beacon Transmitter illustrated, operates on a single frequency in the range 200-415 Kcs. Oscillator coil can be supplied crystal-controlled or self-excited. Tone oscillator provides 30% high level modulation for identification when keyed with Aerocom's model AK-3B automatic keyer. The unit can also be voice modulated. Power supply . . . any stable voltage in the range 200-240 volts, 50/60 cycles, single phase. Overall dimensions in CM, 56W x 62D x 177H. Net weight 286 kilos.



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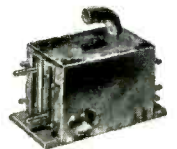
We have the Engineers, Plants, Equipment and Know-How to produce **SPECIAL PURPOSE DEVICES** and **COMPONENTS AT LOW COST**.

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Carrier Amplifier



Excellent gain and zero stability together with remarkable linearity make Consolidated's new 20 kc Carrier Amplifier the most outstanding instrument ever offered for the measurement and recording of high-frequency transient data. Operating on the suppressed carrier principle, the 1-127 is designed for resistance or reluctance bridge-type transducers, and has sufficient output to drive the CEC 7-326 galvanometer to a full-scale trace deflection of plus or minus 1.5 inches throughout its full frequency range of 0 to 3000 cps.

Designed for stacking as well as rackmounting, this 4-channel precision instrument offers performance never before available. It may be operated with several hundred feet of input cable. Carrier voltage is continuously adjustable. Strain gage transducers from 60 to 1000 ohms are accommodated. Rugged construction and careful design permit operation under wide variation of ambient conditions. For full information, write for CEC Bulletin 1550-X2.



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CORPORATION

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**ANALYTICAL INSTRUMENTS
FOR SCIENCE AND INDUSTRY**

to be patterned after the Tele-Centre's split arrangement.

The B.B.C. group included: R. H. Howell, chief of building construction and maintenance; H. W. Baker, supervising engineer of the B.B.C.'s television studios; S. W. Watson, head of television design engineering; R. H. Mannons, head of television planning and installation and Reginald Patrick, chief engineer for the B.B.C.'s New York office.



ElectroData Names Bradburn President

JAMES R. BRADBURN has been elected president of ElectroData Corporation, electronic computer affiliate of Consolidated Engineering.

Bradburn, who was named executive vice president of the computer firm in February, 1954, succeeds P. S. Fogg as president. Fogg will continue as chairman of the board.

Bradburn joined Consolidated in 1945 as treasurer and assistant to the president. In 1946, he became director of sales and vice-president in charge of commercial engineering. He subsequently served as vice-president and director of engineering. In December, 1953, he was named vice-president and director of Consolidated's computer division.

Dixon To Head Clevite Research

JOHN W. DIXON, executive vice-president of Clevite Corp. since

Star Performers

EPCO "QUALITY-PLUS"
TRANSFORMERS

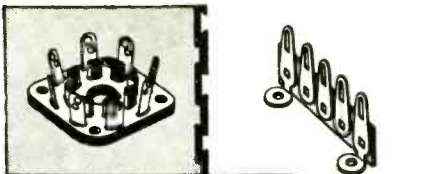
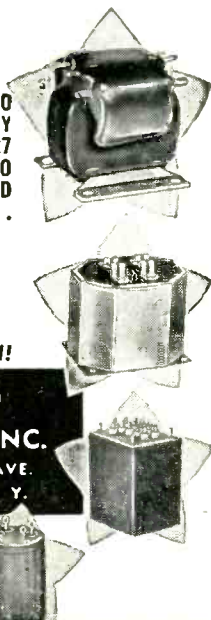
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Precision engineered electronic components and connecting devices for all your needs.

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Write for samples and information Dent. E-9

INDUSTRIAL HARDWARE
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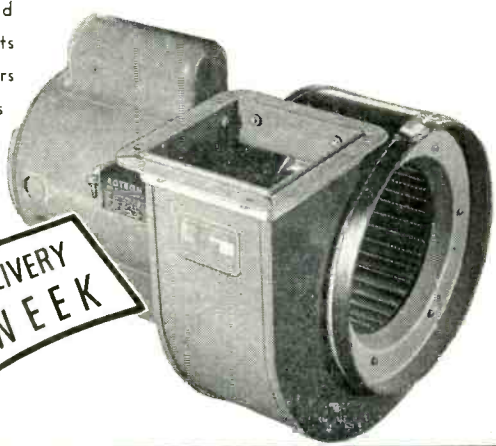
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YOU CANNOT AFFORD TO MISS
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MODEL "U" UTILITY blowers are specially designed for electronic, instrument and light industrial applications. They are compact and move large volumes of air in relation to their size and weight. Handy mounting arrangements as well as integral ducting connectors are a designer's delight. The blowers are driven by the new General Electric, nylon-insulated, all-angle, sleeve bearing, NEMA, motors and are . . .

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- VERSATILE
- MANY FEATURES YOU HAVE NEVER BEFORE FOUND IN A BLOWER
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115-230 VOLT
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NORMAL DELIVERY
ONE WEEK



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Schoonmaker Lane Woodstock, N. Y.

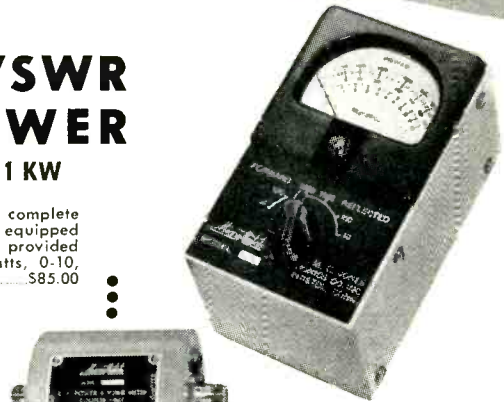
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0.5 to 225 MCS 0 to 1 KW

MODEL 263 Laboratory type complete coupler and indicator. Coupler equipped with N connectors. Indicator provided with 3 scales calibrated in watts, 0-10, 100, 1000 \$85.00

MicroMatch

Compact, sensitive and accurate, the MicroMatch 260 Series monitors both incident and reflected power without the necessity of removing the coupler or reversing its connections. Three models of this equipment are available.



MODEL 261 Coupler (only) similar to Model 263 coupler but with 83-1R Connectors, complete instructions to build #262 Indicator included \$22.50

MODEL 262 Indicator (only), provides relative power measurements when used with #261 coupler. \$14.50



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Voltage Regulation

IS A VICTOREEN SPECIALTY

Whenever electronic designs involve a voltage regulating problem, call upon Victoreen for the proper voltage regulator to give maximum performance and long life.

Here are a few of the Victoreen voltage regulators which can be manufactured in quality quantities at economical costs.



Victoreen Very High Voltage Regulators are sturdily designed for regulation of potentials of 18,000, 20,000, 30,000 volts.



Victoreen subminiature voltage regulators are only $\frac{3}{8}$ " diameter x $1\frac{1}{8}$ " long plus leads. Available in ratings for regulating potentials of 400 to 2500 volts.



This Victoreen glass enveloped regulator can be produced in quantities of uniform high quality for applications requiring potential regulation from 500 to 5000 volts.



The VXR 6000 series regulator is typical of Victoreen metal case designs for potential regulation from 6000 to 15,000 volts.

Our engineering department is available to help solve your voltage regulation problems.



The Victoreen Instrument Co.

COMPONENTS DIVISION: 3810 Perkins Ave. • Cleveland 14, O.

PLANTS AND PEOPLE

(continued)

1951, has been named to coordinate the activities of the firm's new research center with those of the other units in the corporation.

In the newly-created post of vice-president in charge of coordination of research and new product development, Dixon will devote his full time to the activities of the center.

The research center, which is scheduled for its official opening this fall, brings together some 300 scientists, technicians, and administrative assistants whose work was previously conducted in a number of separate places.

Included in the center are two self-contained units, each with its own management: The Brush Laboratories Company, the corporation's basic research group, and Clevite-Brush Development Company, its product development unit.

The Brush Laboratories Company, headed by C. Baldwin Sawyer, president, is principally concerned with fundamental research, much of it toward developing new materials and evolving the basic technology related to their use.

Clevite-Brush Development Company, with A. L. W. Williams as president, is directly concerned with the development or improvement of products which can be produced and marketed by Clevite operating units.



Ford Instrument Names Slawson

KENNETH SLAWSON has been named vice-president of Sperry's Ford Instrument. He will continue to assist president and general manager R. F. Jahn in the general management of the company.

Slawson joined the company in

Over 85% of the torque wrenches used in industry are

Sturtevant

TORQUE WRENCHES
Lead by Sight, Sound or Feel.

- Permanently Accurate
- Practically Indestructible
- Faster—Easier to use
- Automatic Release
- All Capacities

in inch grams...inch ounces...inch pounds...foot pounds
(All sizes from 0-6000 ft. lbs.)

Every manufacturer, design and production man should have this valuable data. Sent upon request.

PA **Sturtevant Co**
ADDISON QUALITY ILLINOIS

UNIVERSAL meets exacting DESIGN REQUIREMENTS in TOROIDAL COILS

Wire	Material	Temp
Size	Resistance	Inductance

Our specially designed machines now wind Toroidal Coils quicker and with more accuracy than other standard methods. Universal Toroidal Coils in any size wire to your specifications—are economical in materials and possess the smallest external leakage field of all other shapes.

Universal Toroids wound to Mil-T-27 specs.
Wire sizes #42 (.00249 mils) to #10 (.1019 mils).
Excellent Delivery in small or large quantity.

Engineering Service Available.
"ACCURACY IS A UNIVERSAL WORD"

UNIVERSAL MANUFACTURING COMPANY, INC.

Michigan & Monroe Aves., Kenilworth, N. J.

for the ELECTRONIC INDUSTRIES

Quality

Ribbons STRIPS

**MOLYBDENUM
TUNGSTEN
TANTALUM
FORMED PIECES**

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Your Special Metals Rolled to Thin Sizes & Close Tolerances

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YOUR INQUIRIES WILL RECEIVE PROMPT ATTENTION

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WOrth 2-2044 and COrtlandt 7-0470

READ-RECORD HEADS

OPTIMUM
READ-BACK SIGNAL
LOW NOISE FACTOR
HIGH FREQUENCY OPERATION

Librascope read-record heads are designed for recording and reading on magnetic drums or other magnetic storage systems and consist of a center-tapped coil wound on a toroidal core and molded into a temperature-stable epoxy resin package 3/4" long. Optimum read-back signal at high frequencies is made possible by sintered ferrite core, a winding with low distributed capacity and with back gap eliminated. Positioning dowel hole permits precise mounting. All heads subjected to 1200 volt RMS high potential test. Write for catalog.

SPECIFICATIONS:

- Crosstalk limited to minus 60 Db for adjacent heads. Resonant frequency above 500 KC
- Track width: .090 in.
- Gap width: .0015 in.

Computers and Controls

LIBRASCOPE

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION
1607 FLOWER ST., GLENDALE, CALIF.

LIBRASCOPE, INCORPORATED



Volkert—Behind This Mask and Ahead of the Field in Color TV Stampings

Volkert is now forming curved-type, 205-sq. in. shadow masks—key component in the new CBS-Colortron picture tube used by several leading set manufacturers in their first “big-screen” color television receivers. The curved screen-mask construction originated by CBS-Hytron opens the door to even larger, superior-performing color tubes. The irregular-shaped contour of this size mask, which gave a maximum useful screen area, presented numerous production problems. But Volkert designed and built tooling weighing nearly half a ton to form these delicate masks accurately and economically in a special, wide-capacity press. It’s just another example of Volkert leadership in stampings for electronics.

John Volkert Metal Stampings, Inc.
222-34 96th Avenue, Queens Village 29, L. I., N. Y.

Volkert for design...
tooling...
production
and assembly of
precision stampings

Have you seen the color movie “Stampings for Electronics”? Volkert’s new 20-minute, full-color film shows what it takes to turn out two million precision metal parts each day. Write today to arrange for your free group-showing.

1928. When Sperry acquired E. G. Staude Manufacturing in 1946, he was appointed manager. He continued at E. G. Staude until he rejoined Ford Instrument this year as assistant to the president.

Convair Plans Computer Expansion

CONVAIR division of General Dynamics Corp. will build a reinforced concrete “data reduction building” soon at its San Diego, Calif. plant. The preliminary cost estimate is \$100,000, for the building to be constructed on Convair-owned land.

The building will house several million dollars worth of electronic computing devices, and will be built near the \$1.2 million engineering research building.

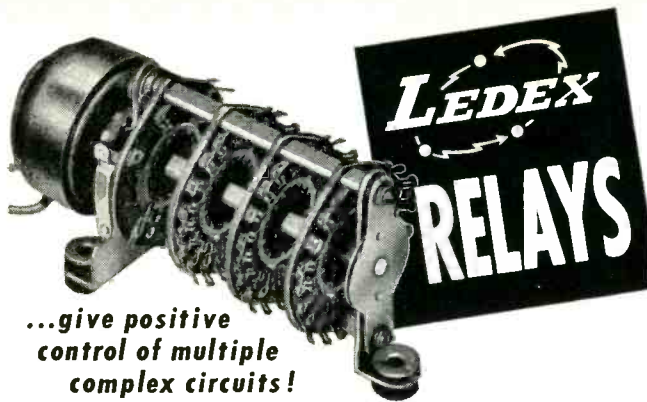
Pacific Northwest Group Elects Officers

G. L. OSBORNE, president of Osborne Electric, was elected president of the Northwest Association of Electronic Manufacturers. M. J. Murdock, general manager of Tektronix, and Leonard Larson, sales manager of Iron Fireman’s electronics division, were elected vice-president and secretary-treasurer, respectively. Ray Morrow, president of Morrow Radio, was elected director at large. Last year’s president of NAEM, Douglas Strain, president of Electromeasurements, is the other director for the coming year.



Maxson Appoints General Slaughter

BRIG. GENERAL Willis R. Slaughter, U. S. Army Retired, has joined W.



...give positive control of multiple complex circuits!

The versatility of Ledex Relays makes it possible to produce special switching combinations for specific applications. Stepping or selective controls are available depending upon the requirements. A wide range of operating voltages can be used by selecting the proper Ledex coil wire size.

HERE'S HOW A LEDEX RELAY OPERATES . . .

A LEDEX ROTARY SOLENOID provides the mechanical power to drive the gang of rotary, wafer type switches. **SELECTIVE CONTROL** —The commutating switch of the Ledex in combination with the control wafer switch makes it possible to select the multiple circuits to be connected by a single manually operated switch. **RATCHETS** are used to transmit the oscillating action of the Rotary Solenoid to the Relay rotor shaft. **CIRCUIT WAFERS** are produced in combinations of 8, 10, 12, 18 and 24 positions. All wafer sections are versatile in application. For example the 12 position wafer switch may be designed to utilize almost any of the factors of 12 such as 1P-12T, 2P-6T, 3P-4T, or 4P-3T. The clips and rotors of the wafer switches are of silver alloy. For most applications the switch insulation is of wax-impregnated bakelite. Ledex Relays are available with foot, flange or panel mountings.

The Engineering staff of G. H. Leland, Inc., will assist you in developing solenoid operated Relays best suited to your products!

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G. H. LELAND, INC.

123 WEBSTER ST., DAYTON 2, OHIO



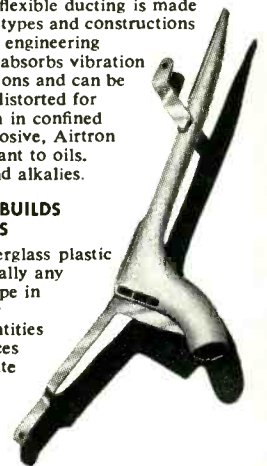
Lightweight Arrowhead FLEXIBLE DUCTING

ABILITY TO WITHSTAND extreme vibration and flexing conditions have definitely proved the superiority of Arrowhead's Airtron flexible ducting for electronic equipment cooling. This Fiberglass ducting retains its resilient flexibility in all temperatures from -125° F. to +700° F.

Arrowhead's flexible ducting is made in 130 standard types and constructions to serve various engineering applications. It absorbs vibration and torque motions and can be compressed or distorted for easy installation in confined areas. Non-corrosive, Airtron ducting is resistant to oils, vapors, acids and alkalis.

ARROWHEAD BUILDS SPECIAL DUCTS

Laminated Fiberglass plastic ducts in practically any conceivable shape in experimental or production quantities to close tolerances without elaborate or expensive tooling.



WRITE FOR COMPLETE DATA

showing types and applications. Comparative charts show characteristics, temperature ranges, weights, pressure ranges, etc.



DC-7 NEVER BEFORE such Magnificence . . . such Power
such Performance!

and NEVER BEFORE has the A. W. HAYDON COMPANY been so proud of its contribution . . .

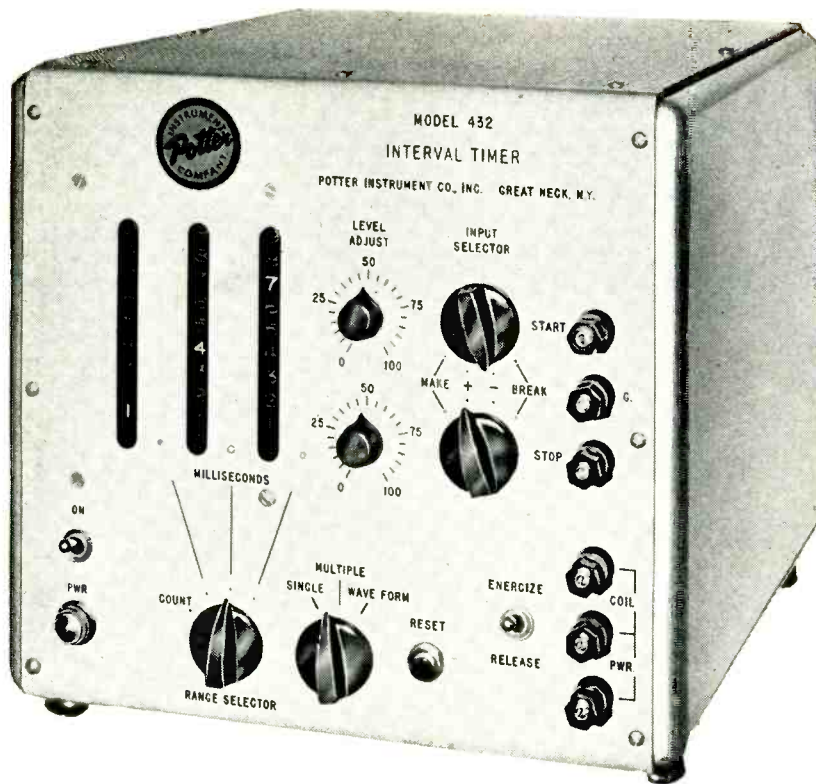
DOUGLAS DC-7, the ultimate in comfortable and safe air travel. Swift, luxurious, dependable — the new DOUGLAS DC-7 justly deserves the accolades it is receiving.

In the never-ending conquest of the vast barriers of space and time, Douglas goes ever forward meeting every challenge that men and machines must face. The newest — and brightest — star in the aviation firmament, the Douglas DC-7, is truly a miracle of the mastery of men over machines . . . and in this great work sixteen A. W. Haydon timing devices play an important part. We at A. W. Haydon take pride in our contribution toward bringing a mass of metal and machinery into integrated performance which meets Douglas' high standards. Integrated performance is born of a multitude of small component parts, working in perfect mechanical and electrical coordination. The A. W. Haydon precision timing instruments are a vital part of this vast network.

A. W. Haydon Time Delay Relay is a very important component of the automatic prop feathering system.
A. W. Haydon Time Delay Relay times duration of prop feathering.
A. W. Haydon Repeat Cycle Timer is a vital part of the prop deicing equipment.
A. W. Haydon D.C. Timing Motors are used in the cabin pressurization systems.

The A. W. HAYDON COMPANY
235 NORTH ELM STREET
WATERBURY 20, CONNECTICUT
Design and Manufacture of Electro-Mechanical Timing Devices

when timing poses a problem — consult
(Catalog sent on request)



Here's a low-cost solution to your high-precision timing problems

The New Potter Model 432 Interval Timer is a general-purpose instrument for timing relays, camera shutters, high-speed machine operations, and for calibrating electrical and mechanical timing devices. It is simple to operate—even an unskilled operator can make interval measurements to within 0.00001 second.

Versatile Input Circuits permit measurement of time between any combination of voltage changes, contact opening, or contact closure, thus accommodating a wide variety of timing problems.

Timing Is Achieved by Electronically Counting the number of pulses produced by a high-frequency crystal-controlled time-base oscillator during the unknown interval. Three time-base frequencies (1, 10, and 100 kc) are provided for making measurements in increments of 0.01, 0.1, and 1 millisecond. Results are displayed directly in milliseconds with an illuminated decimal point—misinterpretation of readings is virtually impossible.

Maximum Timing Range of the 432 is 1 second; this can be extended to 1,000,000 seconds by addition of a mechanical register (available as an optional feature). The 432 also serves as a totalizing counter (can be used to count relay contact bounces) and as a secondary frequency standard with outputs of 100 kc, 10 kc, 1 kc, 100 cps, 10 cps, and 1 cps for general laboratory use.

Descriptive Literature Is Yours for the asking. Write today and see how this compact, low-cost instrument can solve your timing problems with greater accuracy and convenience.

Potter POTTER INSTRUMENT COMPANY, INC.
115 Cutter Mill Road, Great Neck, N. Y.

L. Maxson Corp. as plans and programs advisor. Former Commanding General of the Ordnance Training Command at Aberdeen Proving Ground, General Slaughter will serve Maxson as a technical advisor in systems applications of its products and in long-range planning and evaluation of military projects.

General Slaughter retired from the Army after 41 years of active service, having spent the major portion of his military career in Army Ordnance. His most recent duty included an assignment as Deputy Commanding General of the Aberdeen Proving Ground where the Army's newest weapons and vehicles are studied and tested.

Boeing Builds Wooden Electronics Plant

SINCE large amounts of steel would make accurate testing impossible, Boeing Airplane built a new electronics building at Seattle, principally of wood, with glue-laminated girders and columns.

A small portion of the building is two stories high, thus qualifying the project as one of the few multiple-story structures yet constructed of laminated timber.

The building has 58,000 sq ft of floor space.



Schneider Named By National Union

GERHARD G. SCHNEIDER, who joined National Union Electric in 1934 as a designer and tool maker, has been elected vice-president in charge of production for the firm.

He was originally employed by

JELLIFF

ALLOY 800 RESISTANCE WIRE

for miniaturized precision-instrument components

the ideal resistance wire for

fixed and variable resistors of high ohmage — resistance boxes and bridges — voltmeter and wattmeter multipliers — and other miniature wire-wound units.

Where space is at a premium and performance is a "must" — these outstanding qualities of Jelliff Alloy 800 will assure that your products conform to the tightest specs.

High resistivity, 800 ohms/cm — Low Temperature Coefficient, ± 20 ppm per $^{\circ}\text{C}$ — Non-Magnetic — Highly Stable Electrically and Mechanically — Diameters from 0.0009" to 0.0056" — Bare, enameled or oxidized, or insulated with silk, Nylon or cotton — Solders and Winds easily.

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MANUFACTURING CORP. SOUTHPORT, CONN.

NEW MULTIMETER KIT
\$26.50

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Heathkit TEST EQUIPMENT

BUILD YOUR OWN — INCREASE KNOWLEDGE — SAVE MONEY — BUY DIRECT FROM MANUFACTURER . . . Top quality instruments in kit form; featuring latest design and circuit developments. Completely detailed step-by-step construction manual — clear pictorials — complete schematics. All sheet metal work punched, formed and finished. Low kit prices include tubes, chassis, cabinet and all necessary constructional components.

Kits for the school — service shop — industrial laboratory — hobbyist, etc.

Write for free catalog for further information.

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A. C. Household ELECTRICITY
Anywhere... IN YOUR OWN CAR!

BE PREPARED FOR ANY EMERGENCY WITH **ATR** INVERTERS!

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Ideal for Emergency Lighting and Power Applications for Civil Defense, Red Cross, Rescue Work, etc. Simply Using Extension Cords.

EASY TO INSTALL
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Also... **DICTATE REPORTS ACCURATELY-PROMPTLY!**
make your car, boat or plane a "rolling office" WITH **ATR** INVERTERS

for changing your storage battery current to A. C. Household ELECTRICITY *Anywhere* in your own car!

LIST PRICE **\$2250** AND UP

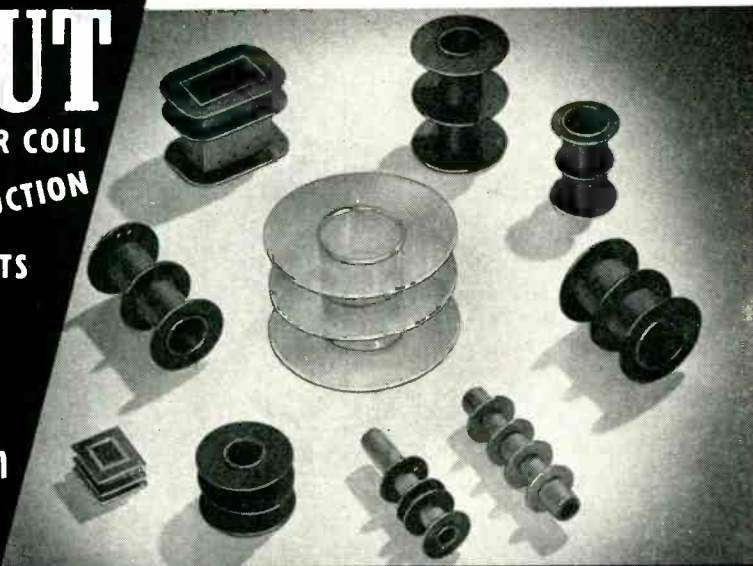
ATR INVERTERS especially designed for operating standard 110 volt A. C.

- TAPE RECORDERS • DICTATING MACHINES
- WIRE RECORDERS • ELECTRIC RAZORS

See your jobber or write factory today for complete information

ATR AMERICAN TELEVISION & RADIO CO.
Quality Products Since 1931
SAINT PAUL 1, MINNESOTA — U. S. A.

CUT
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COSTS
with
PRECISION COIL BOBBINS

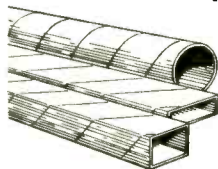


Our special machinery and high production methods work in combination with rigid quality control to provide you with the finest in coil bobbins at lowest possible cost.

Your specifications are met to the most critical tolerances. Workmanship is precise and carefully inspected. You can order in quantity, in any size or shape, flanges of all types, and be sure of uniformity throughout. Only fine dielectric materials are used—kraft, fish paper, acetate, phenol impregnated or combinations.

With Precision Bobbins you eliminate rejects, waste, loss of time—get better coils at less cost. Prove it to yourself! Send specifications for samples. Ask for literature.

PRECISION LOW COST PAPER TUBES



Order in any length, size, shape, I.D. or O.D. and in any quantity. Precision Paper Tubes are crush resistant and light weight, with excellent dimensional stability. They are fabricated to the same high standards governing Precision Bobbins.

Send for samples and Arbor List of over 2000 sizes

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National Union to conduct research in the design, development and construction of automatic machinery, manufacturing equipment and devices for the improvement of quality in mass production of radio receiving tubes.

He worked his way up in the company as an equipment engineer, machine shop foreman, plant superintendent, production manager and a member of the operations committee.

Schneider holds a number of patents, including those for automatic grid-winding machines, electronic tube-base making machines, heater-folding machines, tube-sealing machines, a spray-coating mechanism, heater-inserting machines, tube-removing mechanisms, a pin feeding mechanism and a piece handling machine.

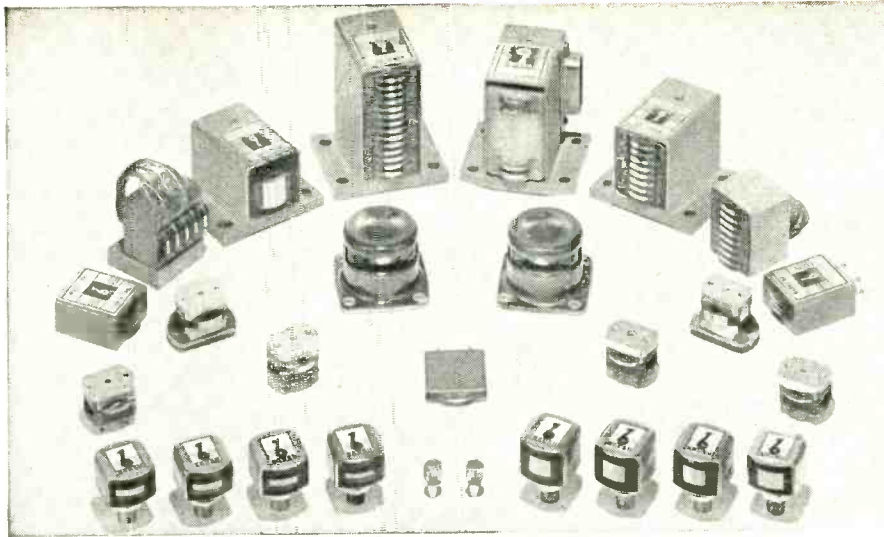


Korean Distributor Promotes Ballentine

EDWIN C. BALLENTINE has been promoted to director of engineering for Korcad, RCA Distributors for Korea in Seoul. In this capacity he will be responsible for all engineering activities and policies of the new company, headed by J. B. Miller, president and G. B. Morgulis, vice-president. Ballentine is also serving as consulting engineer to several associated companies in Korea. Extensive new radio broadcasting facilities were recently purchased by the ROK Government, according to Ballentine.

Jordan Leaves Hughes Aircraft

WILLIAM C. JORDAN, executive vice-president of Hughes Aircraft Co.,



FOR ALL YOUR REQUIREMENTS IN MAGNETIC HEADS

• The performance of magnetic recording equipment depends on the quality of the magnetic head—which records, reproduces or erases. Brush offers a complete line of heads, outstanding for precision alignment

and balanced magnetic construction. For assistance in application, call on Brush's unequalled experience in this field. Write Brush Electronics Company, Department K-9B, 3405 Perkins Avenue, Cleveland 14, Ohio.

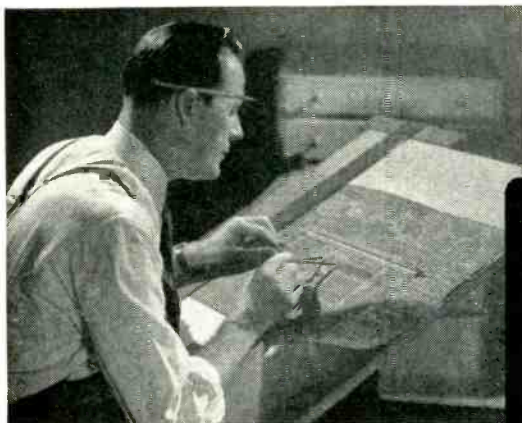
BRUSH ELECTRONICS

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZO-ELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT
ULTRASONIC EQUIPMENT



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formerly
The Brush Development Co.
Brush Electronics Company
is an operating unit of
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No. 1 of a Series

MEYERCORD
Nameplate **DECALS**
Help You DESIGN
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Here's a way to shave production costs starting in the blueprint stage . . . a complete and continuous service to you and everyone in your organization concerned with product development and merchandising.

Meyercord Nameplate Decals identify your product and instruct consumers in its use. We produce Meyercord Nameplate Decals for *any* commercial surface . . . for *any* temperature condition . . . for *any* production run, short or long. And we take over the design problem.

Your Meyercord representative will show how our decals surpass in ease and speed of application . . . with low unit cost. He'll show you how to cut time, labor, and material costs . . . and he'll place our laboratory at your service . . . without obligation.

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Send today, on your company letterhead, for this valuable full-color guide to every industrial problem in marking, identification, instruction, and information.

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Type
531

**SAVES
ENGINEERING
TIME**



The Type 531 Oscilloscope saves engineering time two ways. It provides you with an extremely wide range of facilities. It eliminates the need to hunt up another oscilloscope when your requirements change—say from "high-gain" to "wide-band", or to "dual-trace".

Plug-in preamplifiers are used for maximum flexibility in signal handling. Sweep-speed range is 600 million to one—the widest you can get in a single oscilloscope. Accelerating potential is high enough to permit photographing a single sweep . . . even at the fastest sweep speed.

Direct-Reading in Time and Amplitude. You can read time and amplitude with accuracies comparable to indicating meters.

Sweep Range—0.02 μ sec/cm to 12 sec/cm.
10KV Accelerating Potential
Versatile Triggering Circuitry
Price—\$995 plus price of desired plug-in units

PLUG-IN UNITS

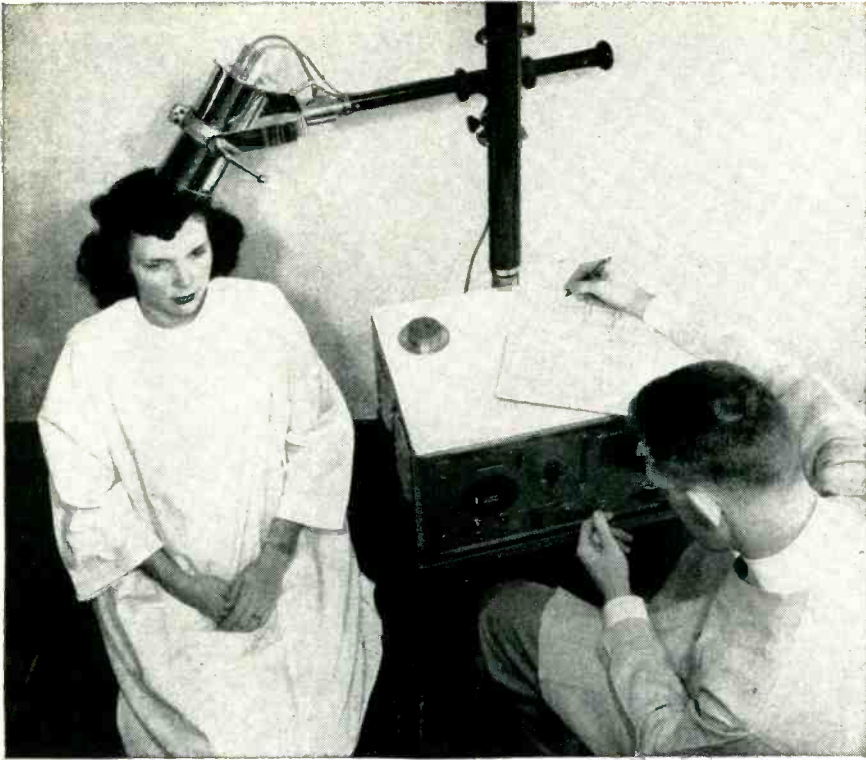
TYPE 53A—DC to 10 mc, 0.05 v/cm to 50 v/cm \$85
TYPE 53B—Same as 53A with additional ac-sensitivity to 5 mv/cm \$125
TYPE 53C—Dual-trace unit. Two identical amplifier channels, dc to 8.5 mc, 0.05 v/cm to 50 v/cm. Electronic switching triggered by oscilloscope sweep, or free-running at about 100 kc \$275
TYPE 53D—Differential input. DC to 350 kc at 1 mv/cm—passband increasing to 2 mc at 50 mv/cm. Full range—1 mv/cm to 125 v/cm \$145
Prices f.o.b. Portland (Beaverton) Oregon

See the Type 531 at the
INTERNATIONAL INSTRUMENT EXPOSITION
Philadelphia—and at the **NATIONAL**
ELECTRONIC CONFERENCE, Chicago.



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WHERE PRECISE MEASUREMENT
OF TIME IS ESSENTIAL . . .

Specify **Cramer** RUNNING TIME METERS

"The Cramer running time meter plays an extremely important part in our equipment . . .," reports R-C Scientific Instrument Company, Inc., Playa Del Rey, California, manufacturers of high-quality radiation detection instruments.

"The Scintiscaler shown here is designed for alpha, beta or gamma counting interchangeably. The quoted accuracy of our apparatus is based on a statistical formula for computing the probable error in sampling a series of pulses randomly spaced in time. Since no allowance is made in this formula for the running time meter, it must be extremely accurate. We've used Cramer devices on all our scalers for the past five years with no failures."

Regardless of application or type of timing device needed, it will pay you to consult the R. W. Cramer Company, specialists in time control. An experienced engineering staff is available to help you solve your timing problems.



Running time meter with reset feature for flush panel mounting. Complete line of time control equipment available to fit every installation requirement.



SPECIALISTS IN TIME CONTROL

The R. W. CRAMER CO. *Inc.*

BOX 3, CENTERBROOK, CONNECTICUT

has resigned. Pending appointment of his successor, the executive committee of the company will assume the responsibilities of general management. The executive committee is composed of Howard Hughes, president; R. J. Shank, vice-president and director of research and development—radar; Nathan I. Hall, vice-president and director of research and development—missile division; Raymond B. Parkhurst, vice-president and plant manager—electronic manufacturing and W. W. Wooldridge, vice-president and plant manager—missile manufacturing.

Jordan served as executive vice-president since October 15, 1953, after agreeing to accept the post on a temporary basis.



Johnson Elected By Cornell-Dubilier

LESLIE A. JOHNSON was elected a vice-president of Cornell-Dubilier and appointed manager of the firm's new Sanford, N. C. plant.

Johnson has been associated with Cornell-Dubilier since 1939. Prior to that date, he was employed by Rohm and Haas Chemical Co. He was assistant manager of the firm's New Bedford plant from 1941 to 1945. From 1947 to 1953 he was manager of the Worcester plant, which produces capacitors for military use.

Remler Forms Research Division

REMLER COMPANY, electronics manufacturer of San Francisco, has set up a new research unit to be known as the Gray Scientific Division.

The new unit will be active in re-

DANO COILS

Serve Modern Industry

Behind the scenes come Dano Coils—made to exact customer specifications to perform an exact electrical function . . .

- Molded Coils
- Form Wound
- Paper Section
- Acetate Bobbin
- Bakelite Bobbin
- Cotton Interweave
- Coils for High Temperature Application

Also, Transformers
Made to Order

The **DANO** Electric Co.
MAIN ST., WINSTED, CONN.

PRECISION ANALOG COMPUTERS... rapidly and accurately solve complex engineering problems!

Time Saving • Money Saving



Electronic Associates Computation Center near Princeton, N. J.

At the EA Computation Center you may solve complex problems in Applications Engineering, Simulation, and Engineering Design by renting EA Analog Computation Equipment by the hour, week, or month.

Scientists, engineers, and mathematicians experienced in the use of analog computers are available to assist in problem solution.

PRECISION ANALOG COMPUTATION EQUIPMENT IS ALSO AVAILABLE FOR PURCHASE.

Throughout the design of this computing equipment the objective was to produce the most accurate, versatile and dependable equipment possible at a reasonable price. In achieving this end, many of the latest advances in the art have been incorporated which contribute to the superiority of this equipment.



EA Precision Analog Computer, Type 16-31R

If you state your interest, we will be glad to send you applicable data. Write to Dept. EL.

PRECISION ANALOG COMPUTING EQUIPMENT FOR SOLVING PROBLEMS IN DYNAMICS

ELECTRONIC ASSOCIATES

LONG BRANCH • NEW JERSEY

new
laboratory kit
saves design-in time

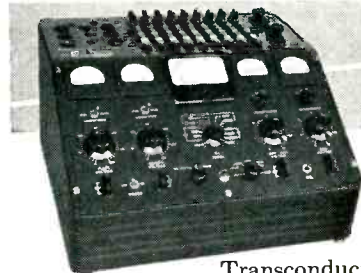
ACTUAL SIZE!

MICRODOT®
World's smallest COAX connectors, cables and assemblies

The unique flexibility of Microdot Kit #553 provides scores of coax assembly combinations. Save valuable time in "try-out," pre-production and design-in... keep products design competitive with Microdot advantages. Order Kit #553 today.

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1826 FREMONT ST.
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NEW TRANSCONDUCTANCE ANALYZER & CIRCUIT SIMULATOR



MODEL 901

SPECIFICATIONS

Transconductance Range: 0-100, 0-500, 0-1000, 0-5000, 0-10,000 and 0-50,000 micromhos. Range of Current Measurements: Plate & Screen: 0-100 μ a, 0-10 ma, 0-100 ma, 0-200 ma; Grid & Suppressor: 100-0-100 μ a, 1-0-1 ma, 10-0-10 ma. Available D. C. Voltages: Plate & Screen: 0 to 300 V; Grid & Suppressor: 0 to 3 V, 0 to 15 V, or 0 to 150 V pos. or neg.

This direct-reading vacuum tube transconductance meter measures transconductance under all operating conditions and reproduces all kinds of static or dynamic tube characteristics. It has means for connecting components to simulate the circuitry in which the tube will operate. Push button switching applies voltages to each tube element.



SQUARE WAVE GENERATOR

Combined Voltage Calibrator and Source of Square Waves

This precision instrument provides square waves suitable for testing the transient and frequency response of wide band amplifiers, and for accurately measuring their amplitude. A wide range of output levels is available. Attenuator settings do not affect the output wave shape.

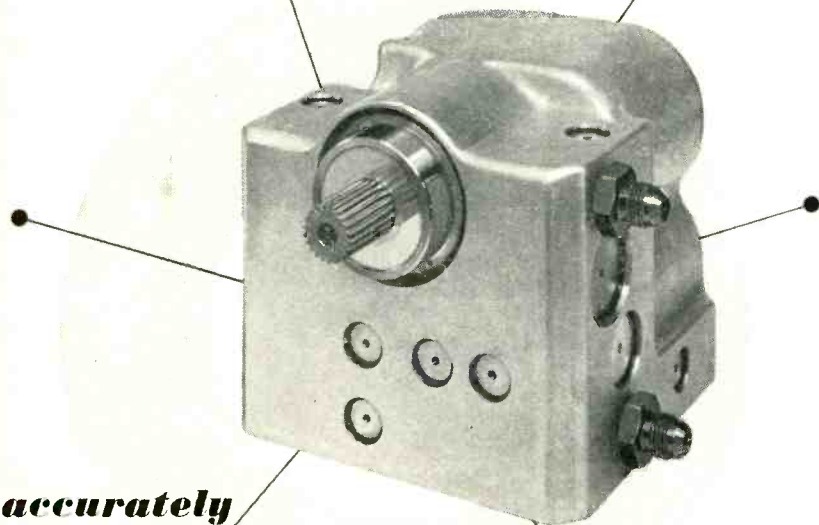
MODEL 183

SPECIFICATIONS — Frequency Range: 10 cps to 1 mc continuously variable over decade steps; Rise time: 0.02 μ sec for 100 ohms output, 0.05 μ sec for 1200 ohms output; Max. output: 10 volts p-p across 100 ohms, 100 volts p-p across 1200 ohms.

Write for specifications and catalog on our complete line of measuring equipment.

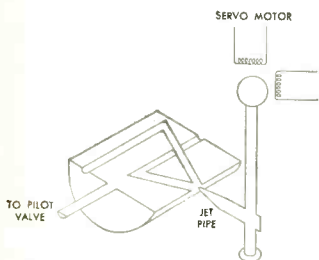
NEW LONDON INSTRUMENT Company
P. O. BOX 189 E
NEW LONDON, CONN.

KEARFOTT-ASKANIA ELECTRO JET



*accurately
positions heavy duty equipment
by means of
minute electrical signals*

This Electro-Hydraulic Servo System is ideally suited for industrial controls to maintain flows, ratios, levels, pressures, speeds and for machine tool positioning. It is a $5\frac{1}{4}$ " cube self-contained unit and weighs but 12 pounds.



The Kearfott Electro Jet utilized the Askania jet pipe principle, characterized by high frequency response, rugged construction and highly accurate shaft positioning. Rated output is 200 inch pounds torque through ± 60 degrees. Maximum torque rating is 333 inch pounds. Frequency response is flat (within 3 db) up to 25 cycles. Resolution of the output piston positions is one part in 500 or better.

Write today for full information about the Kearfott Electro Jet. It may help in the solution of your control problem.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, 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 components of interest to you.



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Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

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Winfield W. Salisbury

search and development work for industry and the armed services in the fields of radio, radar and electronic physics.

Gray Scientific will be directed by Winfield W. Salisbury, recently director of accelerator research at California Research and Development.



Littelfuse Names Blake New President

THOMAS M. BLAKE has been appointed president of Littelfuse of Des Plaines, Ill.

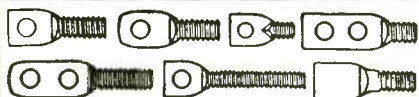
Blake, for the past eight years, has been executive vice-president of the company.

In his new position, he will take over the responsibilities formerly handled by E. V. Sundt, who will continue as a technical consultant to the company and chairman of the board of directors.

Blake joined Littelfuse when it was incorporated in 1938. For the

SINCE 1920
QUALITY
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PRODUCTS

SPADE BOLTS



Specialists in designing and manufacturing All-Purpose Fasteners and Mounting Lugs. Tooled to produce over 1,000 sizes and styles of Spade Bolts in any finish, material or quantity.

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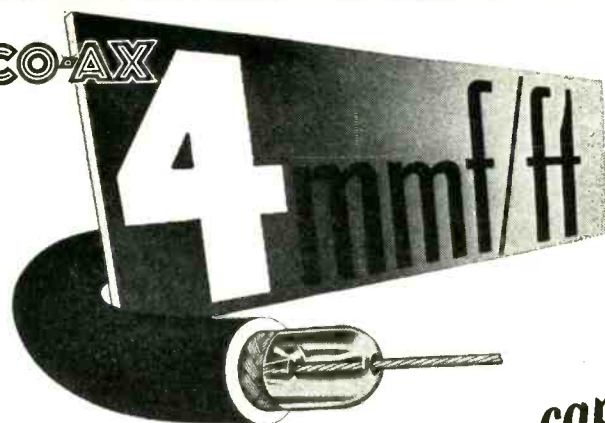
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- TOOLS AND DIES
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- WIRE SPECIALTIES
- REPLACEMENT TIPS for Electric Soldering Irons

Send samples or specifications for quotations. Descriptive bulletin on request.

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capacitance & attenuation

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SPOT DELIVERIES FOR U.S.
BILLED IN DOLLARS—
SETTLEMENT BY YOUR CHECK
CABLE OR AIRMAIL TODAY

TYPE	μF/ft	IMPED.Ω	O.D.
C1	7.3	150	.36'
C11	6.3	173	.36'
C2	6.3	171	.44'
C22	5.5	184	.44'
C3	5.4	197	.64'
C33	4.8	220	.64'
C4	4.6	229	1.03'
C44	4.1	252	1.03'



NEW 'MX and SM' SUBMINIATURE CONNECTORS
Constant 50Ω-63Ω-70Ω impedances

TRANSRADIO LTD. 138A Cromwell Rd. London SW7 ENGLAND CABLES: TRANSRAD, LONDON

BE SAFE WITH

Q-max A-27

LOW-LOSS LACQUER & CEMENT

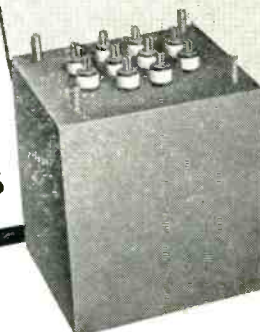
- Q-Max is widely accepted as the standard for R-F circuit components because it is chemically engineered for this sole purpose.
- Q-Max provides a clear, practically loss-free covering, penetrates deeply, seals out moisture, imparts rigidity and promotes electrical stability.
- Q-Max is easy to apply, dries quickly and adheres to practically all materials. It is useful over a wide temperature range and serves as a mild flux on tinned surfaces.
- Q-Max is an ideal impregnant for "high" Q coils. Coil "Q" remains nearly constant from wet application to dry finish. In 1, 5 and 55 gallon containers.

Communication
Products Company, Inc.

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(MONMOUTH COUNTY)
Telephone: FReehold 8-1880



For . . .
IMPROVED CIRCUIT PERFORMANCE,
LIFE AND RELIABILITY . . . specify
ATLAS MAGNETIC AMPLIFIERS



RG-60-D SERIES (RG-60-D-6, 27 and 115) with the following respective specifications — maximum DC output current of 4.5 A, 1.2 A and 225 MA; and Regulated output voltages of 6.0, 27 and 115 V DC.

Physical specifications — size: 4 $\frac{1}{16}$ " x 3 $\frac{1}{16}$ " x 4 $\frac{1}{2}$ " high; hermetically sealed LB case; four 8-32 x $\frac{3}{8}$ " mounting studs; weight: 2 pounds, 3 ounces.

MD SERIES Servo Motor amplifiers specifications — MD-60-115-5: Supply voltage, 115 V, 60 cycles; output, 0-57 V RMS at 10 watts to control phase. Size, 2 $\frac{1}{2}$ " x 2 $\frac{1}{2}$ " x 3 $\frac{3}{8}$ "; weight, 1 lb., 9 oz. MD-400-115-5: Supply voltage, 115 V, 400 cycles; output, 0-57 V RMS at 10 watts; to control phase. Size, 2 $\frac{3}{16}$ " x 2 $\frac{1}{16}$ " x 2 $\frac{1}{2}$ ", weight 14 oz.

Write for Technical Bulletins MA-1, 2.

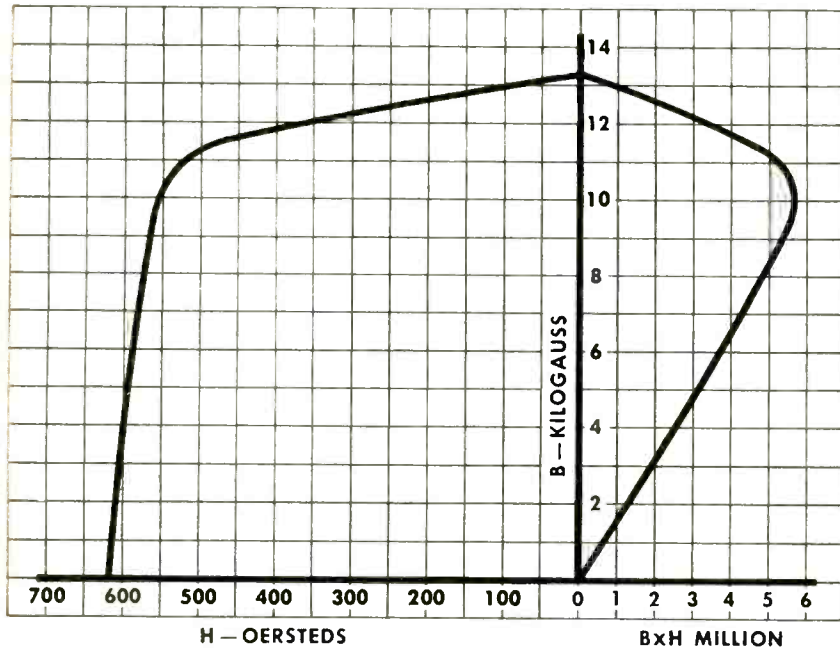
ATLAS

ATLAS ENGINEERING CO., Inc.
3 EDGEWOOD ST., ROXBURY, MASS.

ALNICO 5Cb* has 5.70 million energy product nominal

A new permanent magnet alloy—with the highest energy product of any Alnico—has been developed by Thomas & Skinner research engineers. With an energy product of 5.70×10^6 Bd Hd nominal, the new alloy—5Cb—has a residual flux density of 13,300 and a coercive force of 650.

Composition of new Alnico 5Cb includes aluminum, cobalt, copper and iron (like other Alnico grades)—plus T&S-added columbium. It is the addition of this relatively rare element that gives Alnico 5Cb the stability necessary to provide consistently high magnetic values.



Graph shows typical demagnetization and energy product curve of new T&S Alnico 5Cb. This new alloy offers an energy product of 5.70 million nominal, and through the addition of columbium has greater stability with consistently high magnetic values.

Applicable to all designs now utilizing the magnetic properties of any Alnico grade, Alnico 5Cb adds the advantage of increased gap flux density. Immediate benefit to present meter and motor applications, for example, is corresponding increase in torque.

Whatever your design problem—microphones, meters, klystrons, radar, magnetic pickups, speakers—the answer may be the new

T&S Alnico 5Cb. For detailed information, write today for Bulletin 1253.

Specialists in Magnetic Materials



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*PAT. PEND.

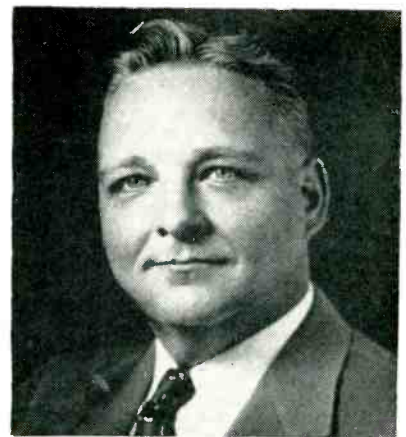
preceding nine years, he was associated with the General Outdoor Advertising.

Communications Group Elects R. C. Fuller

R. C. FULLER, general manager of Bendix Aviation's Pacific division, has been elected president of the Armed Forces Communications Association, Southern California Chapter.

Other new officers are C. A. La Har of RCA, vice-president, and Lester R. Daniels of Audio Products, secretary-treasurer.

The AFCA, formed in 1946, is composed of industry representatives and retired and active service communications officers, and is dedicated to "defense and security of the country and toward cooperation with armed forces communications."



Donald H. Allen

Gudeman Opens California Plant

THE GUDEMAN COMPANY of California opened new laboratory and production facilities for the design and production of its products in Los Angeles. The new plant is under the direction of Donald H. Allen, formerly vice-president and general manager of PCA Electronics.

RCA Victor Names Division Engineers

JOHN L. FRANKE has been appointed chief engineer of the engineering department of RCA Vic-

AIRCRAFT SERVO COMPONENT



Condensed Data

Range: 0-14.7 psi, absolute
Resistance: 7500 ohms
Maximum voltage: 75 volts
Resolution: 1/3%
Accuracy: 2% of full scale

Typical Applications

Servos—Vary servo loop gain as a function of altitude.
Computers—Voltage divider, P total/P static.
Fire Control—Air density measurements.
Telemetering—Pressure transducer.
Recording—Pressure transducer.

Write for Bulletin No. 71-5 for further details

Price: \$225.00
Short delivery

The Type 71-5 Baroresistor is a pressure actuated potentiometer designed for operational use in aircraft. It features:

HERMETICALLY SEALED MECHANISM

The potentiometer winding and operating parts are hermetically sealed in a vacuum. Pressure is applied inside the bellows only. Therefore, the Type 71-5 Baroresistor is not affected by dust, fungi, or moisture.

RUGGEDIZED CONSTRUCTION

A special high force mechanism was developed for the Trans-Sonics Baroresistor to avoid the necessity for employing micro force potentiometer elements. Shock of 30g in any direction will not cause electrical discontinuity.

MACHINE CALIBRATION

Each instrument is calibrated by machine and its performance is automatically recorded as a graph of resistance versus pressure. Every turn of the winding is inspected. All electrical characteristics are automatically checked in an eleven stage inspection cycle.

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Seattle, Wash.
Telephone: Main 7005

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Precision Parts to meet your Production and Engineering needs. From .002" dia. to .125" dia. Radio tube parts—Stampings—Drawings. Modern facilities, high-production equipment.

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ULTRA-HIGH PRECISION POLYSTYRENE CAPACITORS

as low as 0.1%
tolerance in most values

CAPACITANCE AVAILABLE—0.05 to 10.0 MFD.
VOLTAGE AVAILABLE—100 to 400 VDC
INSULATION RESISTANCE—10⁸ MEG./MFD.
TEMP. COEFF.—100 P.P.M. per °C (—20° to 140°F)
DIELECTRIC ABSORB.—.015%
DISSIPATION—.0002

Special Values to
Close Tolerances—Our Specialty

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239 W. Orange Grove Avenue, Burbank, Calif.



1 MFD. 2" x 2" x 1"



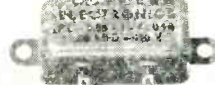
0.5 MFD. 1 3/4" x 1 1/4" x 1 1/8"



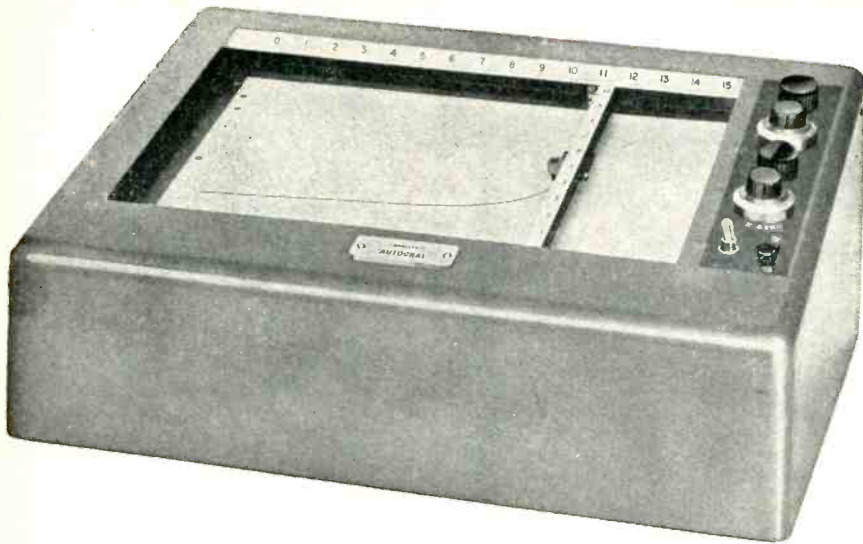
0.25 MFD. 1 3/8" x 1 1/4" x 7/8"



0.1 MFD. 1 3/8" x 1" x 7/8"



0.05 MFD. 1 3/8" x 7/8" x 1 1/16"



*A new, large size,
flat bed,
versatile
2-axis recorder...*

AUTOGRAF^{trademark} MODEL 2



Curves are available for observation and labeling while they are being drawn.

The versatility and labor-saving convenience of the original portable Autograf have now been built into an instrument which handles standard 11" x 16½" graph papers. Model 2 has the same scales and ranges as Model 1 (0-5 millivolts to 0-100 volts each axis); same speed (full scale X and Y in one second); same input impedance (200,000 ohms per volt). In addition, depressed zero available each axis, larger recording area (twice as big), flat bed, easy-reading design.

THE AUTOGRAF MODEL 1

general purpose 8½" x 11" X-Y recorder — is doing duty in hundreds of laboratory applications: chemical, electrical, electronic, wind tunnel, computer... And on production lines: measuring motors, filters, tubes, transistors, airfoils, amplifiers, rectifiers, magnetic circuits and materials, nuclear devices, etc. . . .



**AUTOGRAF
CURVE FOLLOWER**
plots or reads out Y vs. X. Either Model 1 or Model 2 can be furnished as a recorder/curve follower.

**AUTOGRAF
POINT PLOTTER**
Models 1 and 2 may be fitted for point plotting from keyboard or other digital sources.

A new high accuracy, easy-to-read, multi-range servo-voltmeter with fast response. Scales 0-3 millivolts to 0-300 volts. Zero left or zero center. Designed for indication, control, or analog to digital conversion.

Bulletins describing these instruments are available, and we will be glad to send you the ones you want. Write...

**BOTH AUTOGRAF
MODELS ARE OUTSTANDING
FOR THEIR VERSATILITY**

**NEW MODEL 20 SERIES
DC VOLTMETER**

F. L. MOSELEY CO., 409 NORTH FAIR OAKS AVENUE, PASADENA 3, CALIFORNIA

tor's radio and Victrola division.

Alexander D. Burt was named manager of record changer engineering and Paul R. Bennett was appointed manager of radio and phonograph engineering, both reporting to Franke. Thomas S. Weeks has been appointed general plant manager for the division.

Franke previously served as manager of radio and phonograph engineering. He has been with RCA Victor since 1930, when he started as a draftsman.

Burt joined RCA in 1930 as a loudspeaker engineer. Since 1946 he has supervised record changer engineering activities for the home instrument division.

Bennett has served as chief engineer of RCA Victor's plant in Buenos Aires, Argentina. In 1943 he was transferred to the engineering section in Camden and in 1951 was named manager of its electrical and export group, the position he leaves to assume his new duties.

Weeks, who started with RCA as an assembly line operator in 1933, was manager of the company's tv set plant in Bloomington, Ind. prior to his new appointment. G. L. Leinenweber has been named to succeed Weeks as Bloomington plant manager. He was previously assistant to the home instrument division general plant manager.

ESC Moves To New Plant

ESC CORP., manufacturers of delay lines, transformers and networks, has moved to a new and enlarged plant in Palisades Park, N. J.

The Newton Company Buys American Tool

THE Newton Company of Manchester, Conn. has purchased the machinery and equipment of American Tool Works of Hartford. These facilities will be removed to the purchaser's plant in Manchester. Many of the former employees of American have been employed on the newly acquired facilities. The new addition complements Newton's engineering, research and development activities with facilities for

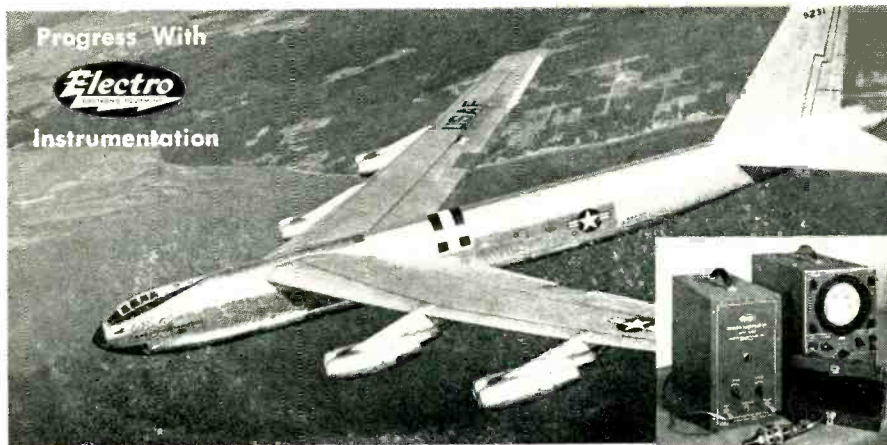
you could print your own money...

But those who've tried it report that the results are never worth the effort and trouble.

That's how it is with coils, too. Why make your own—when in most cases we at Coto-Coil can make them for you faster, better and at less cost? We've had nearly 40 years of coil design and manufacturing experience. We know the best types of materials for each type of coil. We use automatic production equipment, the most modern testing devices.

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Progress With
Electro
Instrumentation

USED BY **BOEING** TO HELP BUILD THE B-52

Extremely fine tolerances required in the production of these more than 600 m.p.h. Stratofortresses are made possible with the Electro Dynamic Micrometer. It accurately measures, without contact or "loading" axial or radial displacement to .0001". Also views the amplitude of dynamic movement of any metal body at any speed. Measurements are independent of acceleration or frequency of displacement. The sensing unit is calibrated for direct reading.

- Measures radial expansion due to high speeds • Bearing slap in motors
- Travel, bounce of relay contacts • Eccentricity of commutators, slip rings
- Shaft whip • Vibration in motors, turbo compressors, heat exchangers.

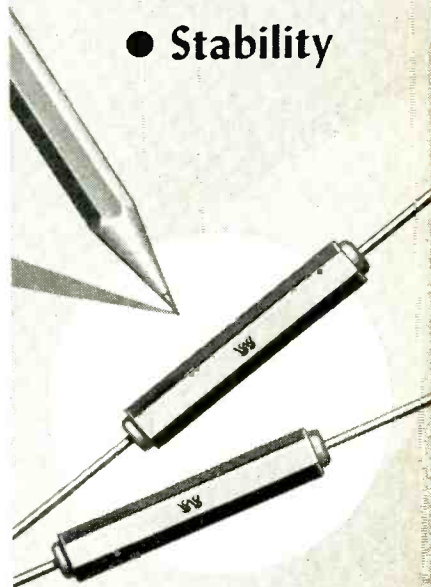


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Canada: Atlas Radio Corp., Ltd., Toronto, Ont.

ELECTRO DYNAMIC
MICROMETER
Model 3600-A

- Low noise level
- Precision
- Stability



Silwhite 65X MOLDED RESISTORS

- RATING**—1 watt.
- TEMPERATURE COEFFICIENT**—From approx. +0.1%/°F for 5000 ohm values to approx. -0.2%/°F for 10 megohm values.
- VOLTAGE COEFFICIENT**—Rated at less than 0.02%/Volt.
- UPPER TEMP. LIMIT**—170°F for continuous operation.
- NOISE LEVEL**—Low noise level inherent, but at extra cost we can test and guarantee standard range resistors with "less noise than corresponds to a resistance change of 1 part in 1,000,000 for the complete audio frequency range."
- VALUES**
- Standard Range — 1000 ohms to 9 megohms.
 - Extra High Value Range — Up to 10,000,000 megohms.

BULLETIN 4906
has full details. Send for a
copy. Attention Dept. R



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MICROPHONE CORD

with newly-developed

TEXTILE SHIELD for

longer service life, improved flexibility



This is a completely new cable design in which a close semi-conducting textile wrap and a stranded flexible drain wire replace the conventional braided copper shield. Conductors are cadmium copper for improved flex life. This new construction is not subject to damage by twisting or by the pressure of heavy equipment rolling over it. The shield will not break as a result of continued flexing.

Additional Features

- Super Flexible
 - Light weight
 - Long Flex Life
 - Excellent Electrical Characteristics
 - Tough, abrasion-resistant brown neoprene jacket

This improved construction is the result of years of development work by Whitney Blake laboratory to find the best answer to the needs of the broadcasting companies and equipment manufacturers. The semi-conducting textile shield construction has already been used successfully for over a year on nationally famous dictating machine microphones where extreme flexibility, long flex life and freedom from noise are cord essentials.



Available in 2 conductor, #18 A.W.G. and 3 conductor, #20 A.W.G. Order some and take advantage of the newest development in microphone cords.

Well Built Wires Since 1899



WHITNEY BLAKE COMPANY

New Haven 14, Connecticut

the production of special tools and precision components.

Among the former officers and management of the American Tool joining Newton are John Sundkvist, founder, who will act as a consultant. Norman Nelson will continue as sales manager and Edward Wild will continue as superintendent of the production department.



J. J. Bachner

Chicago Molded Elects Officers

EDWARD F. BACHNER, SR., has been named to the newly created post of chairman of the board of Chicago Molded Products. Marcel F. Bachner, formerly vice-president and treasurer, has been elected president and treasurer. John J. Bachner has been upped to executive vice-president and general manager. All other officers were re-elected.

Gams Named By T. L. G. Electric

THEODORE C. GAMS, consulting electrical engineer, has been retained by T. L. G. Electric to organize and direct its new custom engineering department. The new division will specialize in short-run, one-of-a-kind and developmental production of electronic test and processing equipment.

Gams has been a consulting engineer for many years. He taught electrical engineering and electronic design in both the graduate and undergraduate schools at the

for Radar • Communications • Laboratory • Computers



SERIES M200 Miniature i. f. Amplifiers

Here's a brand new way to design i. f. strips! Simply reach for your purchase order pad, specify the characteristics you desire, and mail to Instruments for Industries, Inc. Standard models are available from stock, special designs get prompt attention from our engineering and production staff.

I. F. I.'s fast, convenient service on i. f. strips and other types of broad-band amplifiers has saved valuable design and production time for many leading companies. For complete details write: Instruments for Industries, Inc., 125 Old Country Road, Mineola, N. Y.



Specifications of Standard Units

	M260	M230
Band center frequency	60 mc	30 mc
Band width	10 mc	2 mc
Voltage gain	110 db	120 db
Output power	up to 0.02 watts	up to 0.1 watts
Input impedance	50 ohms	50 ohms
Input V. S. W. R.	less than 1.2:1 over pass band	less than 1.2:1 over pass band

Note: M230 model available with 1.5 db noise figure

- 8 — 6AK5's mounted on flat chassis, 1 1/2" x 15"
- Standard BNC cable connectors used for r-f terminals

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DC - AC CHOPPERS

0-500 cycles
DEPENDABLE



DC-AC CHOPPER
TYPE 36

DC-AC CHOPPER
TYPE 36

COIL & VOLTS
10-500 CPS
STEVENS-ARNOLD, INC.
BOSTON, MASS.

All military specifications met. Liberal factors of safety to meet emergency conditions.

1. Production sampled daily and life tested to check 1,000 hour rating.
2. Every Chopper given not only one but two tests over the full range of military temperatures before shipment.
3. Only gold contacts used for superior operation in the vital 0-1 1/2 volt d-c range.
4. Liberal safety factors to meet emergency conditions.
 - a. 0-500 cps.
 - b. Input voltage $\pm 30\%$

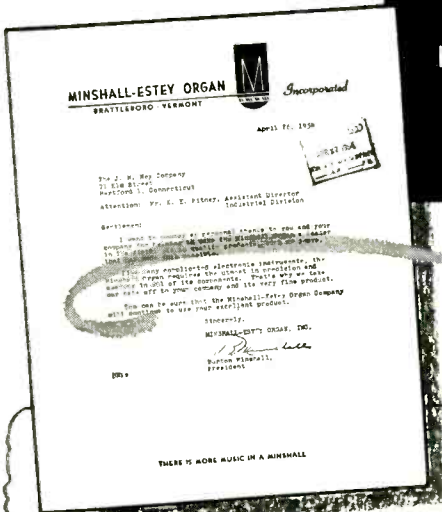
WRITE FOR THESE CATALOGS
No. 371, 0-500 CPS.
No. 370, 60 CPS.

STEVENS ARNOLD INCORPORATED

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With ideal physical and electrical properties, resistance to tarnish and most corrosive atmospheres, Ney Precious Metals, fabricated into slip rings, brushes, wipers, and contacts, have again demonstrated their superiority for use in precision electrical and electronic apparatus. Improve the accuracy and prolong the life of your instrument by using Ney Precious Metal Alloys. Write today to... Engineering Department.

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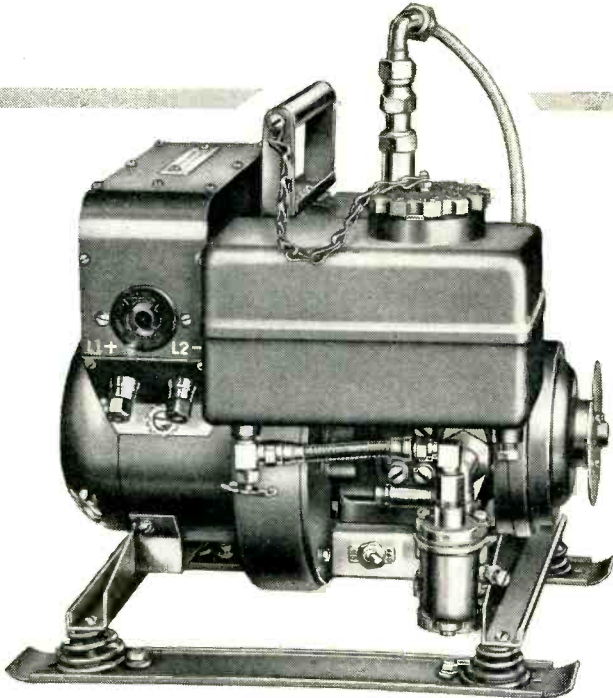
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HOMELITE

Gasoline-Engine-Driven Generators

designed and built to meet
toughest specifications



Another Typical Homelite Example

This is the first generator of this size procured to meet the requirements of MIL-G-10286A(CE) and the requirements of the reference engine specification MIL-E-11275A (CE). Only 22 pounds complete, it has a military rating of .15 KW, 120 V., 60 cycle, 1 Phase, 1.0 P.F. reconnectable to 120 V. DC. One gallon of fuel will operate this generator more than 11 hours *at full load*.

What's your problem? If it involves meeting MIL specifications for lightweight generators, get in touch with Homelite.

With more than thirty years' experience in designing and building hundreds of thousands of lightweight, dependable gasoline-engine-driven units, Homelite's engineering and manufacturing facilities are in a position to find the best solution to your toughest problem. quickest.

Write and you will receive prompt, competent and confidential service.

Homelite builds generators in sizes from .15 KW up to 5 KW in all voltages and frequencies . . . with either gasoline engine or electric motor drive.

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Carryable Pumps
Generators • Blowers
Chain Saws

PERFORMANCE • DEPENDABILITY
HOMELITE
CORPORATION
SERVICE

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Canadian Distributors: Terry Machinery Co., Ltd., Toronto, Montreal, Vancouver, Ottawa

Polytechnic Institute of Brooklyn for seven years, from 1945-52.

His most recent major consulting activity was the organization of the custom engineering department of Douglas Laboratories, suppliers of test and processing equipment, which he directed from 1952 to 1954.

Gams has also served as chief engineer of Allied Laboratory Instruments and as director of the School of Industrial Technology.

In his new post, he will have the title of director of engineering operations.

Canada Names Arthur Levin

AT THE request of the Canadian Government Arthur Levin, director and chief engineer of Cossor (Canada), will assist the Government in special work for the armed services for a few months.

Resistor Firm Organized By Monson

MONSON MANUFACTURING in Chicago was recently formed to manufacture resistors. The firm plans to also make a line of capacitors and other electronic components.

Harry Monson is president and general manager of the new firm. He is also president of Monson Corp., manufacturers' representative. He was formerly vice-president and sales manager of Ampro Corp., now a division of General Precision Equipment.

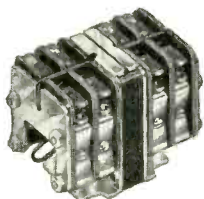
Hal F. Fruth is vice-president in



Harry Monson

RELAYS

POWER AND SENSITIVE TYPES



COILS • SOLENOIDS



WOUND
TO YOUR
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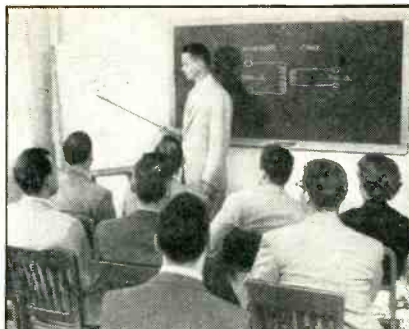
LIGHT
AND MINIATURE
TYPES



Send us your prints and specifications for prompt quotations. Literature available on request.

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MICROWAVE DEVELOPMENTS

Wheeler Laboratories is an engineering organization offering consulting, research, and development services in the fields of radio and radar.

At present, Wheeler Laboratories comprises a staff of twenty engineers under the personal direction of Harold A. Wheeler, with supporting facilities including a group of designers and a model shop.

Our engineers are kept abreast of current progress in our laboratories by monthly technical staff meetings which are addressed by Mr. Wheeler or one of the staff engineers as shown above. These discussions provide a valuable education in the theoretical development and practical application of microwave techniques to our specialized design problems.

A brief summary of our work will be sent on request, and comprehensive engineering reports on some of our developments are available. Inquiries are welcomed regarding your particular problems in microwave design and development.

Wheeler Laboratories, Inc.

122 Cutter Mill Road, Great Neck, N. Y.
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ENGRAVER**

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Kanthal DR resistance wire
SAVES YOU UP TO 50% Because...

... it is lighter in weight (more feet per pound), and the per pound price is low. Total savings approximately 50%.

... Kanthal DR improves the performance of resistors and precision equipment. Its electrical resistivity is high — 812 ohms per circular mil foot — its temperature coefficient is low ($\pm 0.00002^\circ\text{C}$ between -50° and $+150^\circ\text{C}$), and it has a low thermal EMF to copper.

Available in fine gages and all types of insulation.

WRITE FOR FURTHER INFORMATION AND PRICES TODAY

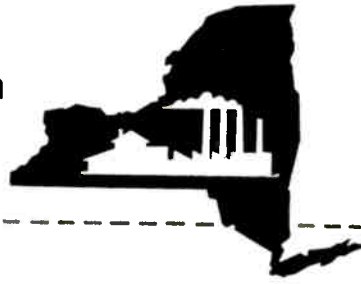


THE KANTHAL CORPORATION

13 AMELIA PLACE, STAMFORD, CONNECTICUT



plant-location news



Market data can make the difference...

Only the most detailed, up-to-the-minute information can show if a new plant site is near your *best* potential markets . . . whether these market areas will change in size or character . . . or if new and bigger markets for your products can be developed in a particular locality.

But how can you be sure that your market data is current and complete? That it will answer most plant-location problems? If you're planning to establish a new plant in relation to your market, here's one way you can get all the facts needed to make the right decision on location. Just contact the Industrial Location Service of New York State.

Facts are our forte . . .

ILS market data covers a lot of ground. One of the big reasons for this is that we're associated with the state government. We are constantly dealing with facts and figures on incomes, consumption, and population shifts. And detailed market data like that can make a big difference in choosing the right plant site!

Detail is our dish, too . . .

Another thing that makes our service unique is the *extent* of our records. Over the years we've been able to chart trends in expenditures, retail inventories, and family composition, among other things—for every area in the

state. A lot of companies have found these figures mighty helpful in spotting just the markets they want to hit.

Doesn't matter whether yours is an industrial or consumer product, either. In most instances figures can be provided representing present industrial consumption of specific products within a given radius of suggested New York State locations. Or on the size and number of companies to which you'll be selling. All this information is free and strictly confidential.

Other free plant-site services

Markets won't be your only concern when you're looking for a new plant location. But no matter what factors are involved, ILS can be of help.

Reports are available on transportation, buildings and sites, raw materials, labor, water and local laws and regulations—to mention just a few. All of these surveys are tailored to meet your requirements, and are sent to you without any cost or obligation in full confidence.

Our booklet called "Industrial Location Services" shows how you can put this valuable plant-location data to work. To get your free copy, just drop me a card, care of the New York State Department of Commerce, Room 875, 112 State Street, Albany 7, New York.

Ronald B. Peterson

Director, Industrial Location Service

charge of research. He holds 67 patents granted or pending on electronic components and processes. Dr. Fruth formerly headed research departments at Raytheon and P. R. Mallory and was assistant research director at Western Electric and Motorola.

Axel Monson, secretary-treasurer, organized, developed and headed Ampco Corp. for many years until it was purchased by General Precision Equipment.

Otis Boykin, chief engineer, holds a number of patents on electronic components. He is also a research consultant in the electronic and chemical fields.

Harry Miller, production engineer, was formerly production engineer at Zenith, Motorola and Communication Coil Co. He is also a consultant in production and electronic equipment design.

Philharmonic Adds Two V-P's

PHILHARMONIC RADIO & TV CORP. has promoted Eli Saltz to vice-president in charge of manufacturing and Mike J. Morris to vice-president in charge of engineering. No changes will be made in either's duties since both men were heads of their respective departments. Both have been with Philharmonic for the past four years.



Astatic Names G. L. Werner

G. LEONARD WERNER, formerly sales manager of Mark Simpson Mfg., has been appointed general sales manager of The Astatic Corp.

While with Simpson, Werner also

"Happy Cappy"

co-operates
to build a good name,
a steady market for your products

VITRAMON CAPACITORS

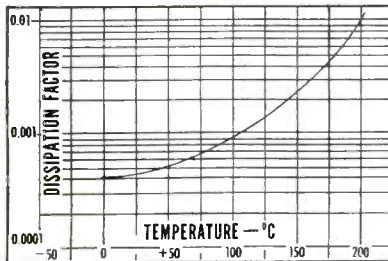
by operating at higher efficiency
teamed with other quality components, give

LOW LOSS

to your circuit systems



The excellent dissipation factor of the dielectric, and its thorough bonding to high-conductivity silver electrodes, assure a very low loss factor. As shown in the adjacent curve, the dissipation factor at 25 C and 1 mc is equivalent to a Q of 3000.



Temperature Characteristic

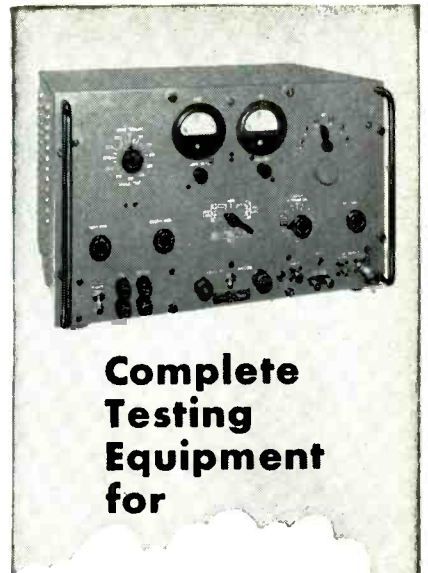
Vitramon Capacitors are tough and tiny. Their fine-silver electrodes are buried in a monolithic block of fused porcelain dielectric. This structure assures optimum electrical qualities in all capacities, 0.5 through 2000 μf .

Write today for complete data.

Vitramon

INCORPORATED

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Complete
Testing
Equipment
for

OMNI and LOCALIZER RECEIVERS

A.R.C. Type H-14 Signal Generator



For a quick and accurate check by pilot before take-off, or for maintenance on the bench, this is the favored and dependable instrument. Checks up to 24 omni courses, omni course sensitivity, to-from and flag-alarm operation, and left-center-right on localizer. For ramp check, RF output 1 volt into 52 ohm line; for bench checks, 0-10,000 microvolts.

The H-16 Standard Course Checker is a companion instrument to the H-14. It makes possible a precise check on the course-accuracy of the H-14 or of any other omni signal generator. Just as a frequency meter is necessary in connection with a variable frequency signal generator, the H-16 Standard Course Checker is required in connection with a VOR signal generator for a precise measurement of phase accuracy.

These instruments sold only direct from factory.



Write for detailed literature



Dependable Airborne
Electronic Equipment
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Aircraft Radio Corporation
BOONTON NEW JERSEY

Metallurgists & Specialists in Small Wire

Serving Industry—FOR OVER 53 YEARS



BASE METAL WIRES
Very small diameter—for filaments, thermo-couples, resistance units.

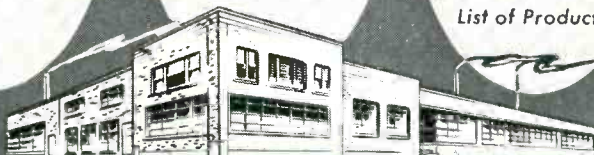
PRECIOUS METAL WIRES
Produced in Platinum, Gold, alloys and pure metals—small diameter... Platinum alloy resistance wires.

COATED WIRES
Comprising an extensive range of electroplated grid wires... Enamel insulated wires for precision resistors and potentiometers.

... Write for latest
List of Products.



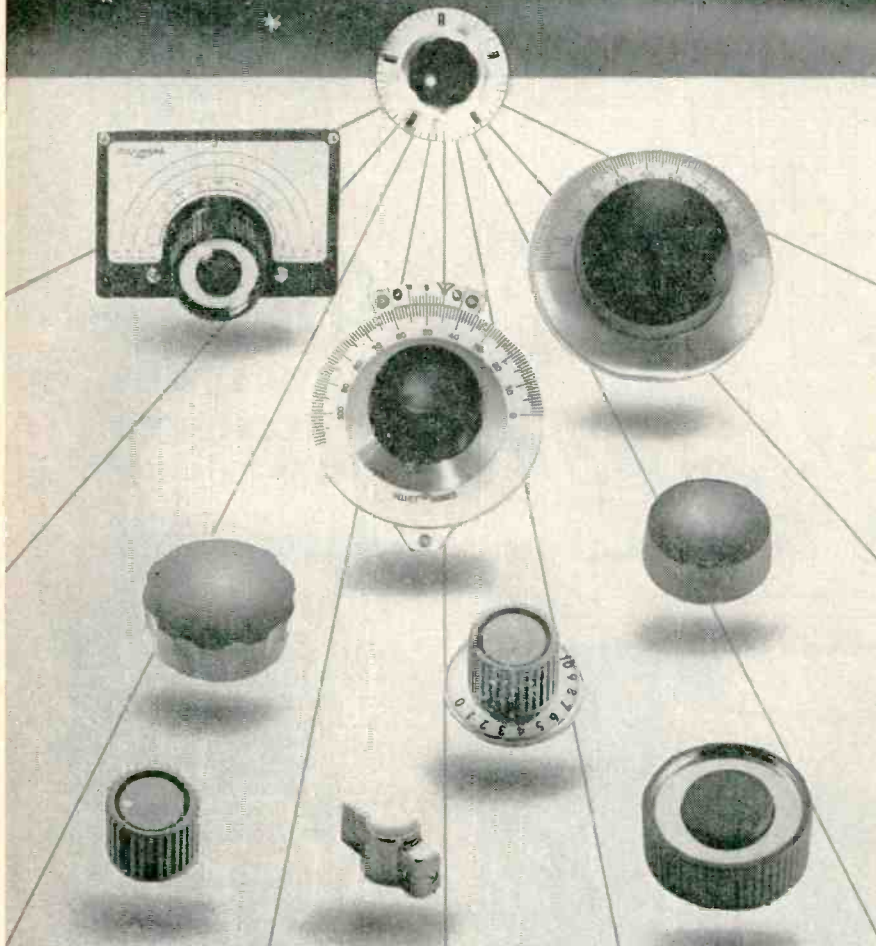
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NATIONAL dials feature smooth, velvety action, easily-read scales and quality construction. Many dials, like the N and ACN dials shown, can be specially calibrated or supplied with blank scales for commercial applications.

NATIONAL knobs — distinguished by their clean, functional, chrome and plastic styling and sturdy construction — are the most popular of their type ever produced. All fit 1/4" shafts. For commercial applications, they can be supplied in special colors and with special calibrations.

Write for new NATIONAL catalog of dials and knobs to Dept. E-954



National

NATIONAL COMPANY, INC., 61 SHERMAN ST., MALDEN 48, MASS.

held the positions of chief engineer and director of sales engineering. He originated and designed the company's products and was directly concerned with production, sales promotion and advertising. His wide scope of duties also included liaison and sales engineering work with government agencies.

Werner entered the radio business in 1930 and for a number of years manufactured sound and intercom equipment and other electronic devices.

Granco Doubles Production Capacity

GRANCO PRODUCTS, makers of uhf tuners, has opened its new plant annex in Long Island City, N. Y. The single-story structure is equipped with new machinery, assembly lines and test positions to provide for more than twice the previous production capacity. In the new and old buildings over 300 workers can be accommodated on a one-shift basis and production capacity has more than doubled.

Burnell Opens West Coast Division

A PLANT has been opened in California by Burnell and Company of Yonkers, New York, designers and manufacturers of electronic parts.

The new firm, a wholly-owned subsidiary, is known as Burnell and Company, Pacific division, and will maintain office and factory operations in South Pasadena, California.

Frank W. Edmonds has been named president of the Pacific division. Edmonds was formerly chief



Frank W. Edmonds

Electronic Counter

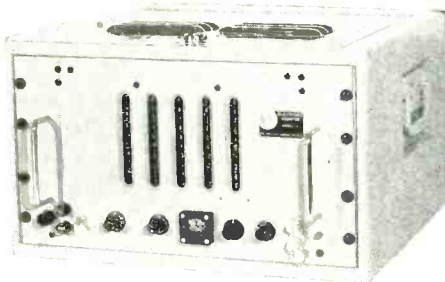


MODEL 111

- All Digital Operation for High Reliability.
No frequency adjustments are made. The counting interval is generated by digital division of the crystal standard frequency.
- Internal Self Checking Features.
- Input Level Metering Circuit.
- Military Quality Premium Components Throughout.
- Rugged Construction for Field Use.

SPECIFICATIONS

Frequency Range	Sinewave 10 to 100,000 cps. Pulse 0 to 100,000 counts/sec.
Accuracy	± 1 Count
Counter Capacity	99,999.
Input	Sinewave 0.1 to 100 v peak-peak. Positive pulses 0.1 to 100 v peak.
Input Voltage	0.1 Volt Minimum Peak-Peak
Input Impedance	1 Megohm Shunted by 50 mmfd.
Counting Interval	1 or 10 Seconds.
Interval Accuracy	± 0.0005 Percent.
Count Display Time	1, 2, 5, 10 Seconds or Manual Reset
Power Input	3 Amperes, 105-125 Volt, 55-65 CPS.
Ambient Temp.	-20° - 150° F.
Cabinet Size	22" Wide X 12 1/2" High X 17" Deep
Weight	120 Pounds.



Price:

\$2250

F.O.B. Los Angeles

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Electronic Engineering Company of California

180 SOUTH ALVARADO STREET...LOS ANGELES, 57, CALIFORNIA

Beat THE Heat (AN OLD CORNISH CUSTOM)

with

TEF-COR

HOOK-UP WIRE



scores another triumph with this tough, super-flexible product that has proven itself under fire.

Heat-resistant to 500° F.

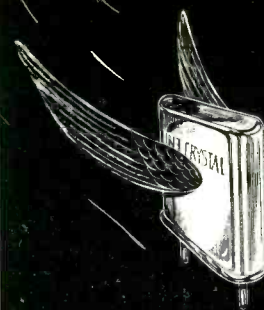
This new super-heat wire, insulated with "TEFLON," is ideal for guided missile, jet and low-tension aircraft applications, transformer and coil leads. Sizes from AWG10 through 28. Also supplied with silver coated copper shields, and to individual customer requirements. Write for further information.

- ♦ Cold-resistant to -67° F
- ♦ High dielectric properties
- ♦ Does not support combustion
- ♦ Impervious to known solvents
- ♦ Perfect concentricity
- ♦ Tough, homogeneous, uniform

Companion to the famous "NOFLAME-COR"

"MADE BY ENGINEERS FOR ENGINEERS"

CORNISH WIRE CO., INC.
50 Church St., New York 7, N. Y.



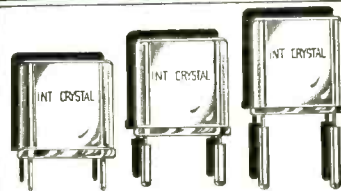
ONE DAY SERVICE

ON

QUARTZ CRYSTALS

throughout the range of frequencies from 1500 kilocycles to 50 megacycles. Fundamental Crystals - 1500 KC - 15000 KC. Overtone Crystals - 15 MC - 50 MC.

All orders of less than five units of any one frequency in the range 1500 KC - 50 MC - will be mailed within 24 hours from the time received.



F-605

Pin dia. .050
Pin lgth. .238

F-609

Pin dia. .095
Pin lgth. .445

F-612

Pin dia. .125
Pin lgth. .620

Pin spacing on each of above is .486

WHEN ORDERING SPECIFY:

- (1) Frequency
- (2) Holder Type*
- (3) Circuit Data (32 mmf load, series resonance, etc.)
- (4) End Use (Equipment type & manufacturer, development, etc.)

*Adaptors can be supplied for 3/4" pin spacing.

Calibration

All fundamental crystals are calibrated into 32 mmf unless otherwise specified. All overtone crystals are calibrated for series resonance, unless otherwise specified.

All units are calibrated to .0025% or better of their nominal frequency at 25° C.

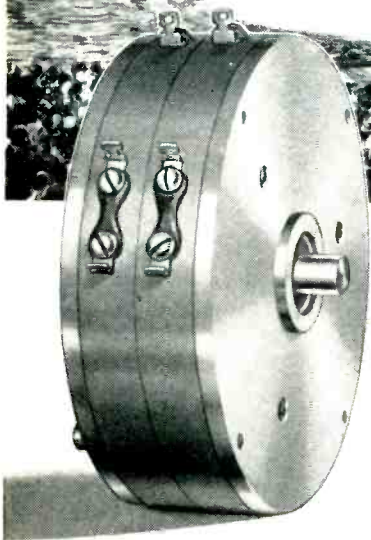
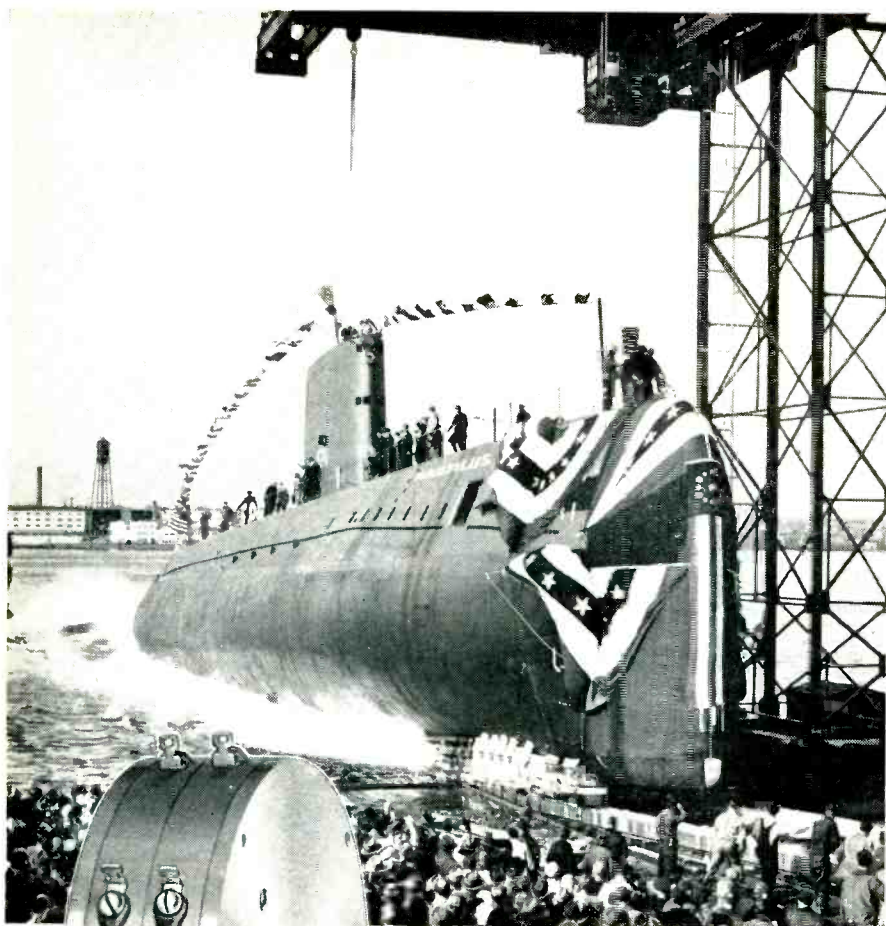
For further information write, wire or call:

International
CRYSTAL Mfg. Co., Inc.

18 N. Lee

OKLAHOMA CITY, OKLA.

Phone FO 5-1165

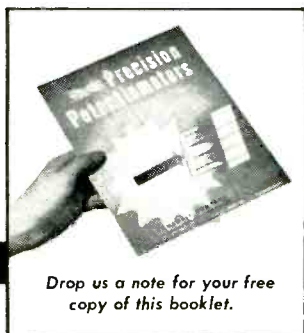


Another example
of accuracy with
GAMEWELL
Precision
Potentiometers

Naturally, we can not divulge the exact operation of the Gamewell 2-gang Precision Potentiometer used in the "Nautilus".

This use of Gamewell's experience in designing precision potentiometers to meet specific needs does suggest that when you have a problem, the chances are that Gamewell can help you solve it.

Send us information about your project and we will go to work with your engineers.



THE GAMEWELL COMPANY
Newton Upper Falls 64, Mass.



PRECISION POTENTIOMETERS

Manufacturers of Precision Electrical Equipment Since 1855

engineer of the transformer division of Langevin Mfg., general manager of Radio Development and Research Corp. and chief engineer of the transformer division of Federal Telephone and Radio.

The Pacific Division, according to Edmonds, will stock the firm's complete line of products. It will engage in limited production of some of these products and plans to gradually expand productive facilities to full production of all types of Burnell coils and filters.

Dearborn Glass Expands Plant

DEARBORN GLASS COMPANY, specialists in glass processing, has transferred all Chicago operations to their new plant and office building in Bedford Park, Ill.

The new building provides 100,000 sq ft of floor space and is located on a 22 acre plot. This is the first phase in an overall expansion program. Plans are now underway which will eventually triple present facilities.

Moloney Electric Promotes Engineers

MOLONEY ELECTRIC COMPANY, transformer manufacturer in St. Louis, Mo., recently made the following appointments: Howard D. Tindall, formerly section engineer of the distribution and specialty transformer divisions has been named assistant chief engineer and vice-president. He joined the firm in 1940 as a design and development engineer.

Edward F. Classen and D. E. Spackler were appointed vice-presidents of the company. Classen was previously with Emerson Electric



Howard D. Tindall

POWER SUPPLIES REGULATED & VARIABLE



Over 30 standard models, plus an infinite number of custom variations, make the MOHAWK line the most complete available in the industry.

Illustrated above is the model MRPS-20-300.

FEATURES:

- 0-300 V.D.C. @ 150 Ma.
- 0-150 V.D.C. Bias @ 5 Ma.
- 6.3 V.A.C. C.T. @ 8 Amps.
- Regulation better than 0.5%
- Ripple—Less than 5 Mv.
- Fully metered—3½" motors.

NET PRICE \$149.00

It will pay you to investigate our complete line—Write for catalog.

**MOHAWK ELECTRONIC
RESEARCH LABS, Inc.**



Box 126-A, RD 4, Amsterdam, New York



Get This Informative Free Booklet on New Uses for Straits Tin

New, 20-page booklet tells important story of Straits Tin and its many new uses today. Fully illustrated. Includes sections on new tin alloys, new tin solders, new tin chemicals. Covers tin resources and supply, Malayan mining. Booklet is factual, informative — could well prove profitable to you. Mail coupon below today.

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Dept. N, 1028 Connecticut Ave.
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Please send me a copy of your free booklet on new uses for Straits Tin.

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GLASS • PAPER
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*in such products as
Resistors, capacitors,
valves, tubes, labels,
sleeves, spark plugs, car-
tons, etc., etc.*

**THESE PRODUCTS
AND MANY OTHERS
OF ALMOST ANY
MATERIAL AND SHAPE
CAN BE IMPRINTED**

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REJAFIX MARKING MACHINE

Why not send us samples of your products? They will be test-printed and returned to you for your examination!

- REJAFIX HAND-OPERATED MODELS FOR SMALL RUNS. FULLY AUTOMATIC MODELS FOR MASS PRODUCTION.

EST. 1922

POPPER & SONS INC. 300 FOURTH AVENUE
NEW YORK 10, N. Y.

UHF ATTENUATORS

UHF ATTENUATORS, MODELS AT-50, AT-60

50 ohm resistive T-networks of concentric line construction.

FREQUENCY RANGE: AT-50: DC to 4000 MC.
AT-60: DC to 3000 MC.

VSWR: Better than 1.1 at all frequencies.

ACCURACY: ± ½ DB.

RATED POWER: AT-50: 1W continuous • 1KW peak
AT-60: 2W continuous • 2KW peak

ATTENUATION: Standard: 3, 6, 10, 20, 40 or 60 DB.

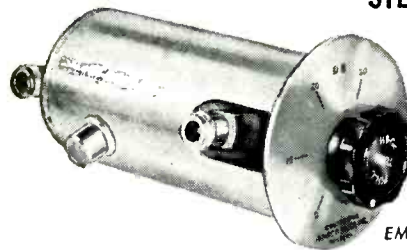
AT-50



AT-60

SPECIAL VALUES UPON REQUEST

STEP ATTENUATOR MODEL AT-101



Uses AT-50 pads in multiple step coaxial turret arrangement.

AT-101A, ATTENUATION:
0, 10, 20, 30, 40, 50 DB.

AT-101B, ATTENUATION:
0, 20, 40, 60 DB.

*EMPIRE DEVICES' expert engineering staff
is available
to give careful attention to your inquiries.*

edp

EMPIRE DEVICES PRODUCTS CORPORATION

38-15 BELL BOULEVARD • BAYSIDE 61, NEW YORK

MANUFACTURERS OF

FIELD INTENSITY METERS • DISTORTION ANALYZERS • IMPULSE GENERATORS • COAXIAL ATTENUATORS • CRYSTAL MIXERS

UHF

... Ultra High Frequencies



**RADIO INTERFERENCE
and FIELD INTENSITY*
measuring equipment**

Stoddart NM-50A • 375mc to 1000mc

Commercial Equivalent of AN/URM-17

ULTRA-HIGH FREQUENCY OPERATION... Frequencies covered include UHF and color television assignments and Citizen's Band. Used by TV transmitter engineers for plotting antenna patterns, adjusting transmitters and measuring spurious radiation.

RECEIVING APPLICATIONS... Excellent for measuring local oscillator radiation, interference location, field intensity measurements for fringe reception conditions and antenna adjustment and design.

SLIDE-BACK CIRCUIT... This circuit enables the meter to measure the effect of the peak value of an interfering pulse, taking into account the shaping due to bandwidth.

QUASI-PEAK FUNCTION... An aid in measuring pulse-type interference, the Quasi-Peak function is just one of the many features of this specially designed, rugged unit, representing the ultimate in UHF radio interference-field intensity equipment.

ACCURATE CALIBRATION... Competent engineers "hand calibrate" each NM-50A unit. This data is presented in simplified chart form for easy reference.

SENSITIVITY... Published sensitivity figures are based on the use of the NM-50A with a simple dipole antenna or RF probe. However, the sensitivity of this fine instrument is limited only by the antenna used. The sensitivity of the NM-50A is better than ten microvolts across the 50 ohm input.

Stoddart RI-FI* Meters cover the frequency range 14kc to 1000mc

VLF

NM-10A, 14kc to 250kc
Commercial Equivalent of
AN/URM-6B. Very low frequen-
cies.

HF

NM-20B, 150kc to 25mc
Commercial Equivalent of
AN/PRM-1A. Self-contained
batteries. A.C. supply optional.
Includes standard broadcast
band, radio range, WWV, and
communications frequencies.
Has BFO.

VHF

NM-30A, 20mc to 400mc
Commercial Equivalent of
AN/URM-47. Frequency range
includes FM and TV bands.

STODDART AIRCRAFT RADIO Co., Inc.
6644-A Santa Monica Blvd., Hollywood 38, California • Hollywood 4-9294

and McDonnell Aircraft before joining Moloney in 1950. Spackler joined the firm in 1950 as a member of the sales department.

Honeywell Names New Marine Head

JERRE V. MANNING has been appointed general manager of the marine equipment division of Minneapolis-Honeywell.

The division, with headquarters in Seattle, Wash., produces the Sea Scanar, an ultrasonic underwater scanning device used for fish-finding, salvage operations and navigation.

Manning, who succeeds Walter Munson, resigned, has been divisional manager in Chicago for the firm's Micro Switch division. He joined the company in 1940.

Automatic Control Elects Officers

NEW OFFICERS for the Automatic Control Company in St. Paul, Minnesota, manufacturing engineers of control systems, have been elected. L. H. Mogck, treasurer, has been named president and treasurer; J. S. Williams retains his position as vice-president and R. A. Sandberg, production manager, becomes secretary.

Du Mont Names Keeton Arnett

KEETON ARNETT has been named vice-president, administration, of Du Mont Laboratories.

Arnett has served as general assistant to the president since 1951.

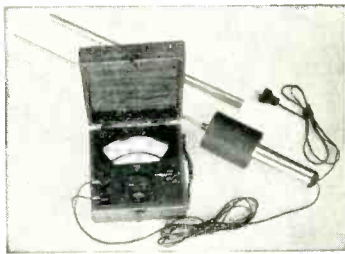
Union Carbide Appoints Kinzel

AUGUSTUS B. KINZEL has been appointed director of research for Union Carbide and Carbon Corp.

In his new capacity he will be responsible for the administration and co-ordination of the research activities of all divisions of Union Carbide. These activities are carried on in seven major laboratories.

Dr. Kinzel has been actively engaged in research work with Union

RAWSON-LUSH Rotating Coil GAUSSMETER



Tiny coil (approx. 3 mm diameter) rotates in the field to be measured. The voltage generated is rectified in a synchronous rectifier and used to deflect a Rawson high sensitivity voltmeter with scale calibrated in kilogausses.

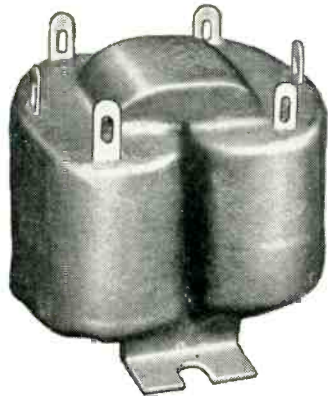
Features

- (1) Simple operating principles, simple to use and maintain.
- (2) Compact and portable, just one meter and the long probe unit.
- (3) Ranges 0.4—1.2—4—12—40—120 kilogausses, all in one instrument.
- (4) Practically point measurement of magnetic field.
- (5) Can be inserted in any gap larger than 1/4" and will reach center of 3/7" diameter gap. Coil protected by stationary outer tubing.
- (6) Measures direction of field as well as intensity.
- (7) Guaranteed accuracy 1 per cent or better.
- (8) Low Price \$350.00 complete with meter.

**RAWSON ELECTRICAL
INSTRUMENT COMPANY**

111 Potter St. Cambridge, Mass.

PLASTIC ENCAPSULATED TRANSFORMERS



To meet the need for transformers finished in any one of several tested plastic formulations, Acme Electric have complete production facilities as well as experienced personnel and supervisory engineers to produce this class of equipment.

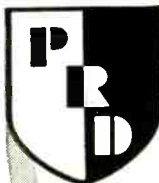
*We invite your
inquiries with
specifications.*

ACME ELECTRIC CORPORATION

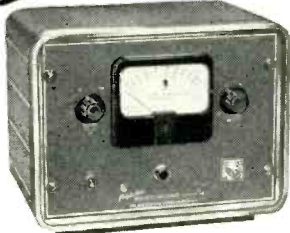
447 WATER ST. • CUBA, N. Y.

West Coast Engineering Laboratories:
1375 W. Jefferson Blvd., Los Angeles, California
In Canada: Acme Electric Corp. Ltd.
50 Northline Road, Toronto, Ontario

Acme Electric
TRANSFORMERS



TYPE 904 VHF-UHF NOISE GENERATOR



FREQUENCY RANGE
(mc/sec): 10 to 1000
NOISE FACTOR RANGE
(db): 20
CHARACTERISTIC IMPEDANCE:
50 ohms (unbalanced)

This calibrated broadband noise source permits direct measurements of noise factors as high as 20 db for r-f amplifiers and receivers operating in the range from 10 to 1000 mc/s. Equipment is housed in an attractive metal cabinet.

Write for Catalog

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RESEARCH & DEVELOPMENT CO., Inc.
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Can Profit Through MALCO'S Low Cost, Quantity Production

We manufacture a complete line of standard and custom-made solder and solderless lugs, terminals, corona rings, and small stampings for radio, television and industrial electrical/electronic use.

Precision tooling and rigid quality control insures tolerances to your most critical specifications. High production techniques, plus stocks of over 1000 different parts permit prompt delivery at lowest possible unit cost.

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Carbide since 1926 when he joined Electro Metallurgical Company as a research metallurgist. He became chief metallurgist of the Laboratories in 1931 and a vice-president of Electro Metallurgical in 1944.



L. E. Packard

Technology Instrument Promotes Officers

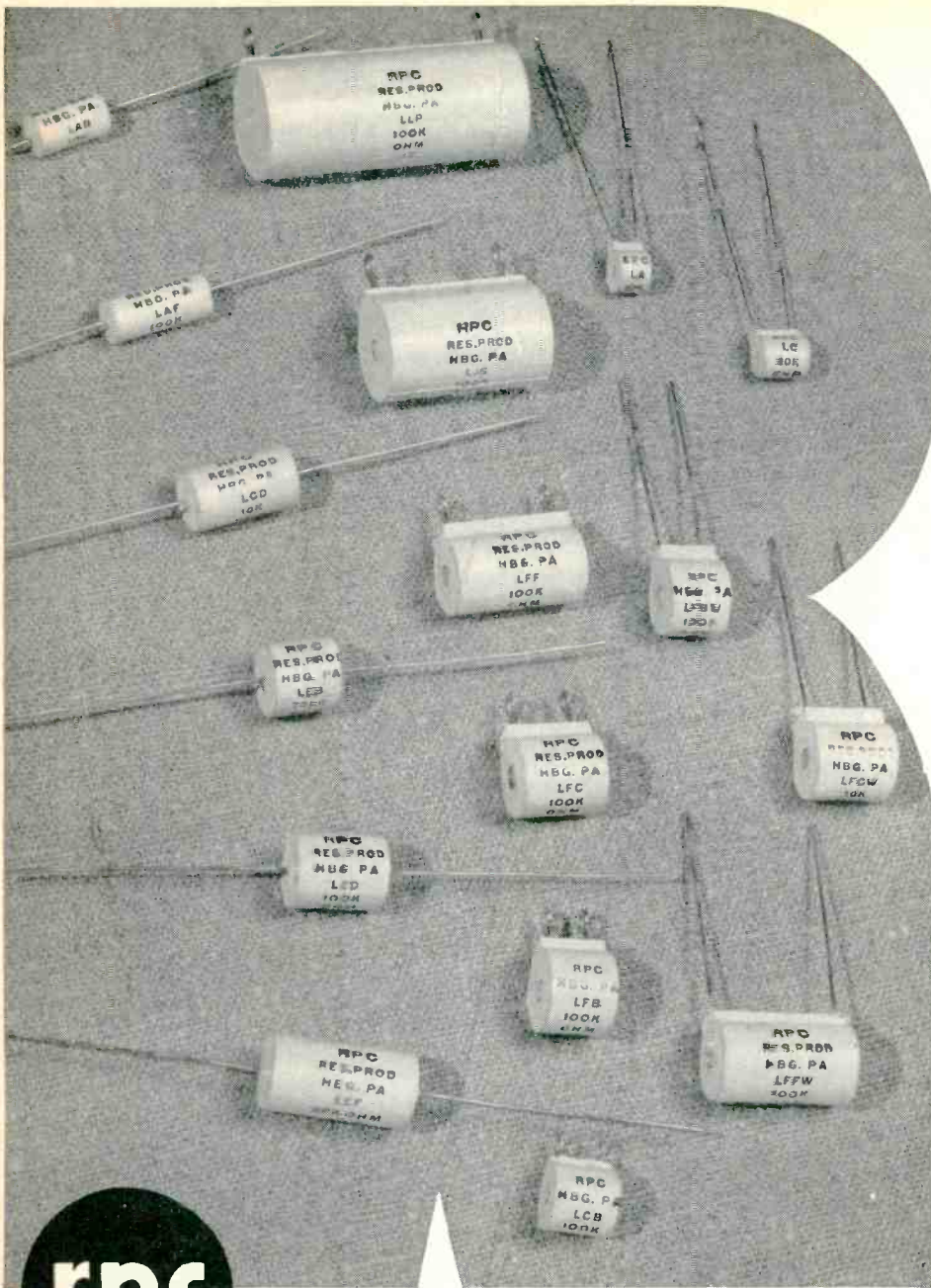
L. E. PACKARD is now chairman of the board of directors of Technology Instrument of Acton, Mass., with R. W. Searle serving as president and treasurer of the corporation. F. P. Perier has been named general manager and W. W. Graustein is chief engineer. Both Perier and Graustein are newly appointed to the TIC board of directors.

Eitel-McCullough Names Engineers

BYRON BALLOU and William McAulay have recently been added to the field engineering staff at the San Bruno, California, plant of



Byron Ballou



rpc

Encapsulated Precision Wire Wound Resistors Defy Shock, Vibration and Extreme Changes

Completely sealed in epoxy resin and wound on steatite bobbins, RPC has engineered Type L Resistors that are protected against extreme humidity, temperature and altitude conditions, mechanical damage, while maintaining dimensional stability.

Type L Resistors, in many tests, have withstood 30 humidity cycles of MIL-R-93A moisture resistance tests without deterioration. They fully meet the requirements of U.S. Govt. Specifications MIL-R-93A. Not affected by extremes in humidity, altitudes, and corrosive influences; protected against outside elements.

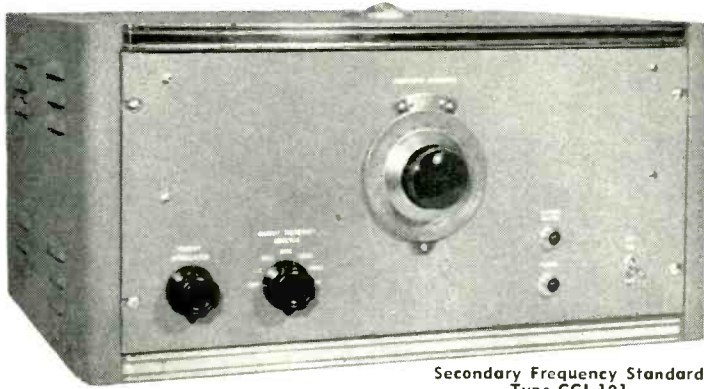
RPC can supply Type L on short notice with lug type terminals or wire leads; in a *complete* line of standard, midget and sub-miniature sizes. Wide range of performance! Write for catalog or additional details.

Sales representatives in all principal cities of the U.S.

RESISTANCE PRODUCTS CO.
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Makers of Resistors — High Megohm, High Voltage, High Frequency, Precision Wire Wound

PROVEN PERFORMANCE!



Secondary Frequency Standard
Type CCI-101

Seven Years *PROVEN* Performance

Compare these outstanding features:

- Stability 1 part/10 million over period of hours
- Standard oscillator variable 40 PPM with dial calibrated in parts per million and directly readable to 0.1 part per million
- Resetability to within 0.1 PPM
- 1 KC Harmonic to 15 Mc
- 10 KC Harmonics to 100 Mc
- 50 KC Harmonics to 150 Mc
- 100 and 250 KC Harmonics to beyond 250 Mc
- Low output impedance
- Low cost

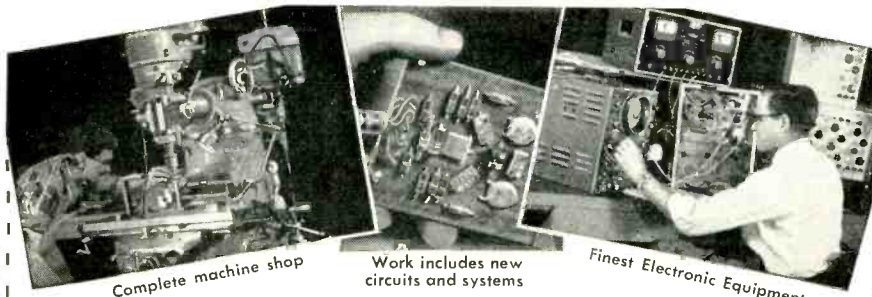
First Time Available! A sliding secondary frequency standard with direct reading in parts per million up to 40 PPM.

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Complete machine shop

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Men qualified to handle high level assignments in electronics are offered a challenging opportunity in Boston, under ideal working conditions divorced from production. The laboratory provides stimulating projects, an atmosphere of scientific progress and provides assistance towards your personal advancement or professional recognition. You will work with a top level technical staff possessing the finest facilities. Administrative positions are open to men qualified to guide the efforts of others.

MICROWAVE ENGINEERS

Senior engineers to handle design and development projects and provide technical direction of other top-level engineers working on microwave circuits and microwave plumbing in the development of military airborne electronic equipment. Should have 5 years' experience in such work and at least a BS degree.

RADAR SYSTEMS AND CIRCUIT ENGINEER

To assume responsibility for electronic circuit design for major elements of complex airborne electronic equipment. Should have a BS degree and about 5 years' experience.

Sylvania provides financial support for advanced education as well as a liberal insurance, pension and medical program. Investigate a career with Sylvania.

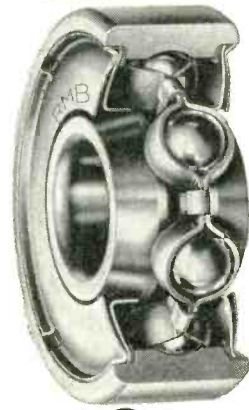
INTERVIEWS BY APPOINTMENT

Don Bradley, Personnel Manager, Boston Engineering Lab. Dept. B

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from 0.1969" O.D.

Smallest Sealed Retainer Type Radial Ball Bearing

An RMB First

This is a miniature bearing! It looks like a big bearing, doesn't it? That's because it has all the features of a big bearing, such as—

- Deep groove races
- Balanced two-piece or snap-type ball retainer
- Non-rubbing capillary oil seal
- Removable and replaceable dust shield
- Precision tolerances

RMB Type RF Filmoseal bearings (illustrated) are available in sizes from 0.1969" O.D.

Type RF now available in R2 size (ABEC-1, 3, 5)
(1/8" bore—3/8" O.D.)

Bring your Miniature Bearing Problems to RMB

A complete line of over 250 miniature and instrument bearings including radial and roller types available for prompt delivery. Experimental quantities from stock.

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Constant Current or Constant Voltage DUAL PURPOSE REGULATED DC POWER SUPPLY



Model PS-110

Continuously variable thru zero from full output of either polarity to full output of opposite polarity

- Constant current to 50 ma, 100 volts max.
- Constant voltage to 200 volts, 50 ma max.
- Wide range selection permits fine control to zero
- Provisions for modulation by external signal
- Voltage regulation $\frac{1}{4}\%$ or 0.3 volts, no load to full load
- Current regulation $\frac{1}{4}\%$ or $0.2\mu a$, all scales, except $\frac{1}{2}\%$ for 50 ma and 100 ma scales, max. voltage to short circuit



TELETRONICS LABORATORY, INC. 54 KINKEL STREET
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William McAulay

Eitel-McCullough.

Ballou has been with Eimac for the past ten years. He was previously employed by Globe Wireless and the University of California radiation laboratory.

McAulay came to Eimac from NBC where he was a station engineer and transmitting engineer.

Winder Aircraft Expands Facilities

WINDER AIRCRAFT of Winder, Georgia, is expanding in the electronic and guided weapons field.

The firm is acquiring specialized electronic research and test equipment, and hiring engineers and technicians for work in electronics.

Sterling Names Chief Engineer

FRAZIER O. STRATTON has been named chief engineer of Sterling Engineering in Laconia, N. H.

Prior to joining Sterling in 1953 as assistant sales manager, Stratton was associated for seven years with C. P. Clare as sales engineer. He also served as a staff engineer in the sales department of Automatic Electric following five years as chief engineer of the New York Stock Exchange. From 1939 to 1942 he was general manager of service with Thomas A. Edison.

Atkinson Opens Tape Plant

ATKINSON LABORATORY, of Hollywood, Calif., color film processing specialists, opened a subsidiary plant for the manufacture of magnetic sound recording tape in Bev-



MILLI-MICROSECOND PULSE GENERATOR

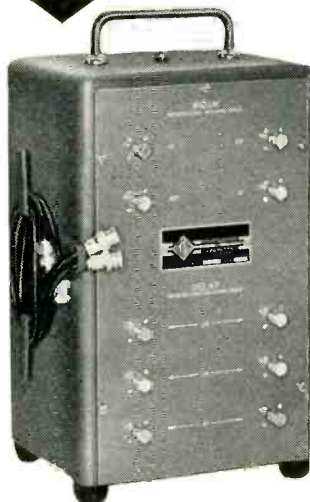
Model PG-215

WIDTH AND DELAY UNIT

Model PGA-220

- Practically ideal rectangular pulses 60 or 120 per second recurrence rates.
- Rise and decay times down to 1.2 $m\mu s$ minimum width 1.2 $m\mu s$ max unlimited.

- Amplitude 0 to 35 volt with 93Ω load may be read directly on DC voltmeter.
- Sync output isolated from main pulse with provisions for main pulse delay.



The Model PG-215 Pulse Generator is a mercury-relay plus pulse-forming-line type of generator producing rectangular waveforms having rise, duration, and decay times in the millimicrosecond range. It also furnishes a trigger signal, advanced in time with respect to the main pulse, for synchronizing associated equipment. All of the time parameters are determined by sections of standard coaxial cable supplied by the user or contained in the Model PGA-220 Width and Delay Unit available as a separate accessory.



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erly Hills. The plant is now in full production.

Tech-Master Moves To Brooklyn

TECH-MASTER of New York City has moved to new larger quarters in Brooklyn, New York. The company manufactures television kits, custom-built chassis and high fidelity sound equipment.

B & R Electronics Acquires Tele-Tone Name

B & R ELECTRONICS CO of New York City, manufacturers of radios and phonographs, has purchased the name, trademark and patents of Tele-Tone. A complete new line, including radios, portable phonographs, combinations and high-fidelity units will be made under the new label.

The addition of Tele-Tone will not effect B & R's present manufacturing program under its other trade names.

Oak Manufacturing Plans Expansion

OAK MANUFACTURING of Chicago, makers of radio and tv parts, plans an expansion of facilities and personnel at its advance development laboratory in Rockville Center, New York.

The development group there is headed by Rudolf Selbmann, engineering manager; Walter Piwinski, senior project engineer and Morris Tucci, chief mechanical engineer, all under the home office direction of R. E. Wood, chief electrical engineer.

Buxton Industries Expand

BUXTON INDUSTRIES of Pasadena, Calif., tv antenna manufacturer, has moved into a new plant in Pasadena that more than triples the previous plant's area.

Midwest Research Appoints Levy

SHELDON L. LEVY, formerly a mathematics professor at Brown University, has been named manager

WIDE-BAND ELECTRONIC SWITCH

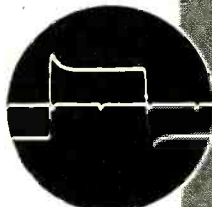
DC to 15 MC

Dual Trace

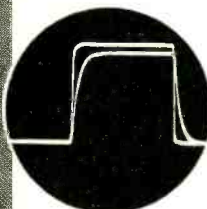
Oscilloscope Presentations



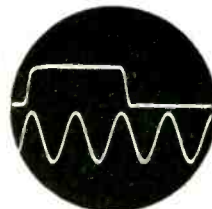
Model ES-180



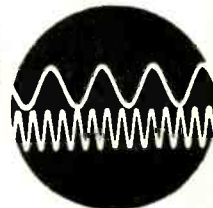
Overshoot, Rise-Time Duration Measurements



Accurate Shape, Time, Amplitude Comparisons



Simultaneous Display of Related Waveforms



Simultaneous Display of Non-Sync. Signals

- Signals displayed on alternate sweeps, switched at sweep-end, rate to 100 kc
- Amplifier rise-time .023 microseconds, megohm input, 93 ohms load impedance
- Unity-gain, feedback, regulated power supplies for linearity and stability
- Index trace calibrated in volts and % amplitude eliminates parallax errors
- Time-signal input allows accurate and rapid measurement of pulse parameters



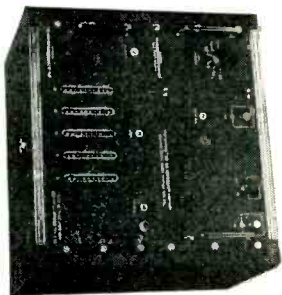
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PRECISION PHASE MEASUREMENT + 0 CPS TO 500 MEGACYCLES

PHASE ANGLE COUNTER



+ 0 CPS to 1000 CPS
with
 ± 1 Count per 100,000 Accuracy
Contains revolutionary new advance iron circuit to insure accuracy and to stand frequency range down to + 0 CPS.

TYPE 1011-2-6

PRICE \$918.00

H-F PHASE & VECTOR VOLTAGE METER—TYPE 213

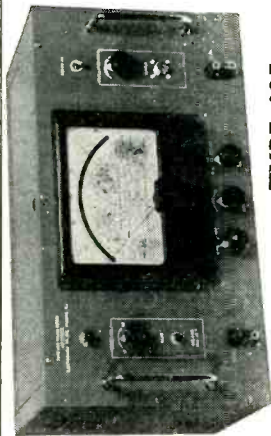
Frequency range: 15 KC TO 500 MEGACYCLES. It measures phase angle between two voltages, vector difference of two voltages, and others. It is based on a new differential rectifier circuit developed exclusively by this company. Price—\$228.00.

PHASE METER

- 8 CPS to 100 KC with 0.5° relative accuracy.
- No ambiguity for measuring 0 degrees.
- Meter Reading independent of signal amplitude.

TYPE 405

PRICE \$485.

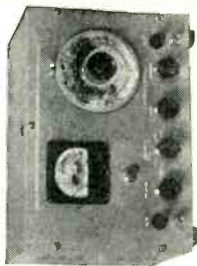


PRECISION PHASE DETECTOR

TYPE 205

- 100 KC to 15 MEGACYCLES.
- MEASURES TIME DELAY, ENVELOPE DELAY WITH 1% ACCURACY.
- MEASURES PHASE ANGLE, WITH 0.1° ACCURACY.

PRICE \$445.



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PLANTS AND PEOPLE

(continued)

of the applied physics division at the Midwest Research Institute.

Dr. Levy succeeds Dr. R. R. Hancock who has taken a position with the Great Lakes Pipeline Company.

Link Radio of New York Is Organized

A NEW company, Link Radio Corp., in New York City, has taken over complete rights and title to all of the assets of the former Link Radio Corp.

Murray Platt, president of the new company, announced that the concern is now in a strong financial position and that production lines are in full swing for all types of past and present Link equipment.

The new Link Radio Corp. is owned and operated exclusively by Platt. Key executives working with him are: James B. Ferguson, chief engineer; Paul H. Bellingham and Robert W. Fisher, both assistant chief engineers and district managers; and Ignatius R. Barbitta, central district manager.

Franklin Electric Enlarges Plant

FRANKLIN ELECTRIC, manufacturers of electric motors, placed contracts for the construction of an addition to their main plant in Bluffton, Ind., doubling its size to provide for employment of up to 1,000 workers.

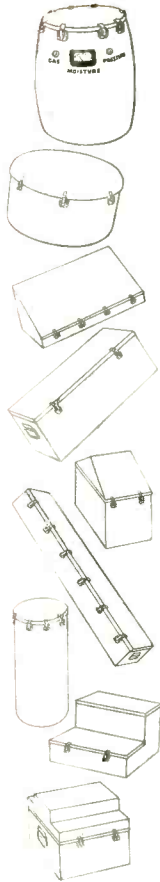
Federal Labs Names Dodington

S. H. DODINGTON has been named laboratory head in charge of the radio navigation and radio equipments of Federal Telecommunication Labs.

Dodington, who joined FTL in 1941, has long been associated with the development of airborne navigation systems and has been granted over twenty patents for his contributions to the field.

Canadian Reps Elect Officers

FRED HARRIS was elected chairman of CESR (Canadian Electronic



TRANSIT CASES

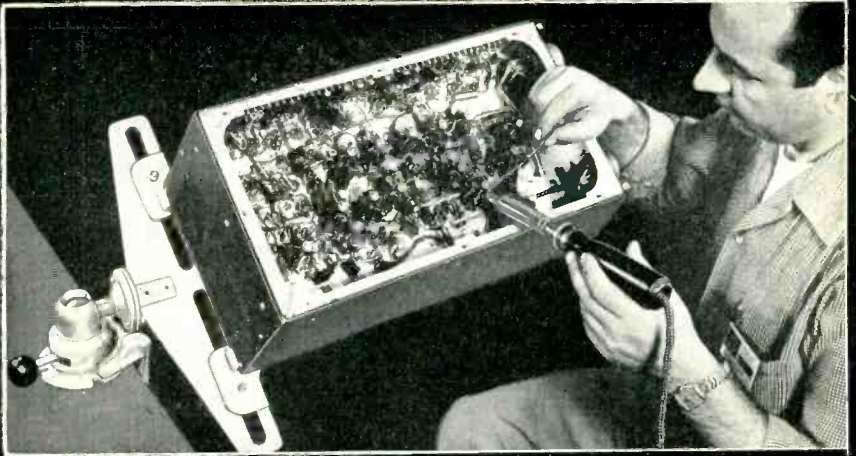
**Stronger, Lighter
Versatile . . .**

Absolute protection for delicate Electronic Instruments, Machine Tools, Dies, Jigs, Arms, Charts, Maps, Records, Film, etc. — against SUBMERSION, SHOCK, CORROSION, OXIDATION, DEHYDRATION, ROT, FUNGUS, HUMIDITY. Contents ready for instant use when case is opened . . . No gummy substances to remove. Withstands temps. —85°F to 210°F.

Exclusive Feature! Preservation Gas installation optional in all cases. Write or phone for complete data.

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LOOK! NO HANDS!

Wilton's PowRarm Work Positioners leave both hands free, and make work pieces easily accessible from any angle. This permits workers to spend less time getting a job ready, and more time in actual productive labor. PowRarms are more versatile than custom built fixtures, cost much less, and are available immediately for either stationary or conveyor installations.

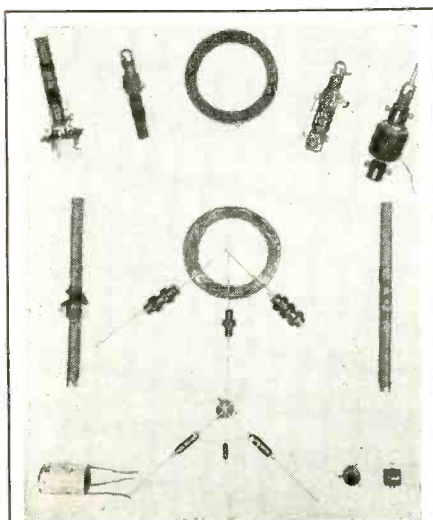
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WILTON TOOL CANADA LTD. GUELPH, ONTARIO, CANADA



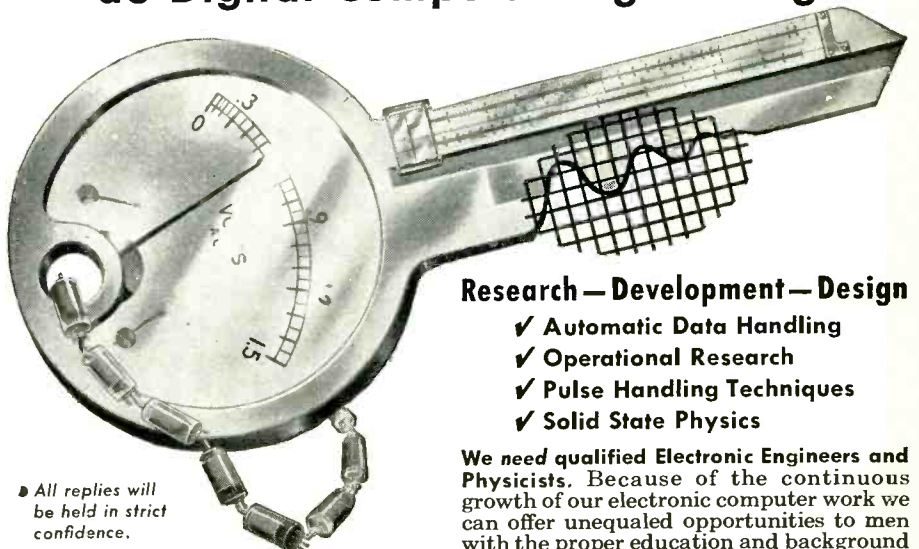
Coils of Special Order to the Customer's prints are wound at Moran Electronic Components Inc. to a high quality at reasonable cost — with best possible delivery.

Moran Electronic Components Inc. offers a standard line of most used Chokes of the Solenoid and Universal Pie types, ranging in Inductance from .47 Micro-Henry to 25 Milli-Henry.

Complete Data available on request.

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UNLIMITED OPPORTUNITIES for . . . Electrical Engineers and Physicists to do Digital Computer Engineering



Research — Development — Design

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We need qualified Electronic Engineers and Physicists. Because of the continuous growth of our electronic computer work we can offer unequalled opportunities to men with the proper education and background in the Electronics field . . . permanent positions, financial security, professional development.

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(DUAL RANGE)

MODEL 611—0-15 and 0-60 Watts

MODEL 612—0-20 and 0-80 Watts

IMPEDANCE—51½ Ohms

Models 611 and 612 are popular instruments in research and design laboratories, vacuum tube plants, transmitter manufacturing plants, and in fixed and mobile communication services.

They are ruggedly built for portable use, and are as simple to use as a D.C. voltmeter. The power absorbing load resistor is non-radiating, thus preventing transmission of unwanted signals which interfere with message traffic in communication services.

Frequency range: 30 to 500 MC (30 to 1,000 MC by special calibration)

Impedance: 51.5 OHMS—VSWR less than 1.1

Accuracy: Within 5% of full scale

Input connector: Female "N" which mates with UG-21 or UG-21B. Adapter UG-146/U is supplied to mate with VHF plug, PL259.

Special Scale Model "61s" are available as low as ½ watt full scale, and other models as high as 5 KW full scale.

Catalog Furnished on Request



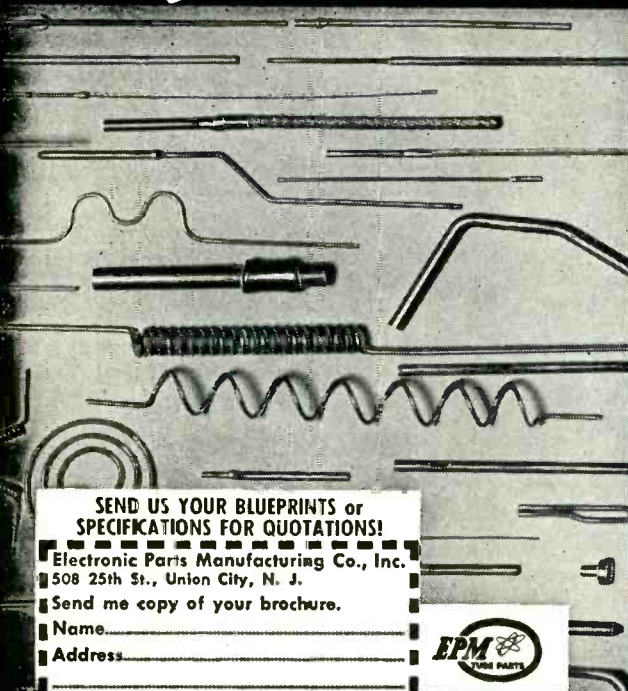
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improve your products with **QUALITY COMPONENTS**



quality
hand-wound
COILS
of Tungsten
and Molybdenum

quality
"precision"
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NICKEL
NICKEL-CLAD COPPER
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TUBE
COMPONENTS**
to customers'
specifications

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Electronic Parts Manufacturing Co., Inc.
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Send me copy of your brochure.

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Address _____



ELECTRONIC PARTS MANUFACTURING CO., Inc.
508 25th St., Union City, N. J.

Sales Representatives) for the ensuing year. Other officers elected were C. G. Pointon and Chas. L. Thompson, vice-presidents and A. T. R. Armstrong, secretary-treasurer.

Parker Pen Renovates Electronics Lab

PARKER PEN Co. has completed the modernization of its 6,000 sq ft research and development department. Its electronics laboratory has been enlarged and has a screen room for radiating equipment where work with dielectric and induction heating equipment can be performed.

Carboloy Names Manufacturing Head

PETER J. JENSEN has been named manager of manufacturing at Carboloy department of GE.

He has been manager of Carboloy's Michigan sales district since 1948.

In 1946 he served as executive engineer in the Carboloy engineering and research department until he was named Michigan district sales manager.

He joined the firm as a tool engineer in 1937, after a year in Schenectady on GE's test course.

John A. Muldoon succeeds Jensen as manager of the Michigan sales district. He was previously manufacturing manager.

Elco Moves To New Plant

ELCO CORP., manufacturer of tube-sockets, shields and connectors, has moved to a new plant in Philadelphia.

All facilities existing in two other plants in Philadelphia are consolidated in the new facility.

The new plant covers 50,000 sq ft of floor space and is located on a 3 acre site.

Computer Research Becomes NCR Division

THE Computer Research Corp. of California has become the electronics division of National Cash



STOP RF LEAKAGE ON THE DRAWING BOARD

... WHEN YOU DESIGN METEX ELECTRONIC WEATHERSTRIPPING INTO YOUR EQUIPMENT YOU GET ITS POSITIVE SHIELDING EFFECTIVENESS — AT MAXIMUM OVERALL ECONOMY

Plan now to take full advantage of *Metex Electronic Weatherstripping's* unusual effectiveness in shielding all types of electronic equipment. Because it is made of knitted wire mesh, *Metex Electronic Weatherstripping* is both conductive and resilient. It assures positive metal-to-metal contact between all mating surfaces. And being resilient it accommodates itself positively to surface inequalities.

In reality, *Metex Electronic Weatherstripping* can do more for you than just shield RF leakage. It can cut the cost of machining mating surfaces to close tolerances. It can eliminate the need for extra fasteners and many other costly means of making joints RF tight.

Applications in which *Metex Electronic Weatherstripping* has already proved its effectiveness include pulse modulator shields, wave-guide choke-flange gaskets, local oscillators on TV sets, dielectric heaters, etc.



For detailed information on METEX ELECTRONIC PRODUCTS, write for FREE copy of "Metex Electronic Weatherstrips" or outline your SPECIFIC shielding problem — it will receive our immediate attention.

**METAL
TEXTILE
CORPORATION**

ROSELLE NEW JERSEY

Register. NCR purchased the controlling interest in Computer Research in March, 1953 and made the company a wholly owned subsidiary with the purchase of the remaining stock early this year. As an NCR division, it will manufacture electronic computers for business applications, in addition to its present line of computers. The division has a staff of over 350 people.

White Industries Plans Expansion

WHITE INDUSTRIES intends to more than double its present manufacturing facilities under a new expansion program.

Under the newly organized aircraft division an electronics products department, electro-mechanical products department and a mechanical products department will be formed. New machinery and personnel will be added to the present staff and equipment.

American Car Changes Name, Acquires W-K-M

AMERICAN CAR and Foundry, parent company of Avion Instrument and ACF Electronics, has changed its name to ACF Industries. The name was adopted as being more descriptive of the company's present business and future objectives.

The company acquired for cash the entire assets of W-K-M company of Houston, Texas, which will in the future be known as W-K-M Manufacturing Company and will operate as a wholly owned subsidiary of ACF. The firm makes high pressure steel valves.

IBM Subsidiary Elects President

ARTHUR K. WATSON has been elected president of the IBM World Trade Corp., an IBM subsidiary. He was formerly vice-president and general manager and succeeds Harrison K. Chauncey, who was elected vice-chairman of the board.

Three vice-presidents of the corporation, John E. Brent, Charles K. Campbell and Thomas A. Kirk-

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KINESCOPE RECORDING

with
Guaranteed Results!
OR YOUR MONEY BACK

**NOW, A DUAL-PURPOSE
AURICON
"SUPER 1200" CAMERA
with TeleVision-Transcription
"TV-T" Shutter...**

...designed for Kinescope Recording...and also shoots regular Live Action 16 mm Sound-On-Film Talking Pictures with no Camera modification! The "Super 1200" Camera with "TV-T" Shutter (Pat. Appl'd. for 1949) can Kinescope Record a 30 minute continuous show using 1200 foot film magazines. Write today for information and prices.

USE AURICON "TV-T" KINESCOPES FOR:

- ★ DELAYED RE-BROADCASTING
- ★ SPONSOR PRESENTATIONS
- ★ COMPETITION CHECKS
- ★ PILOT KINESCOPES
- ★ SHOW-CASE FILMS
- ★ "HOT KINES"
- ★ AIR CHECKS

Auricon 16 mm Sound-On-Film Cameras are sold with a 30-day money-back guarantee. You must be satisfied!

Auricon 50 ft. Kinescope "TV-T" Demonstration Films are available on loan to TV Stations and Film Producers. Please request on your letterhead.



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MANUFACTURERS OF SOUND-ON-FILM RECORDING EQUIPMENT SINCE 1931

New Vectron VFS 250**Variable Frequency
Power Supply****FOR TESTING:**

Airborne Electronic Equipment
Airborne Electrical Systems
Servo Amplifiers and Equipment
Synchro and Selsyn Systems
Transformers and Inductors
Export and Foreign Equipment

FOR POWERING:

Vibration Shakers
Choppers and Vibrators
Magnetic Amplifiers

FOR CONTROLLING:

Synchronous Motors
Processing Equipment

- Full negative feedback networks for instantaneous voltage control.
- Built-in two range stabilized frequency generator.
- Grounded output with polarized receptacle for maximum safety.
- Full accessibility to all tubes and components.
- Compact, semi-portable package for bench use.

Output Power 250VA continuous
at 100 to 130V 300VA intermittent
Output Frequency 45-2,000 cycles
Output Voltage 0-130 Volts
Output Regulation $\pm 1\%$ to 1,000 cycles
zero to full load $\pm 2\%$ to 2,000 cycles
Line Regulation $\pm 1\%$ maximum change
at 250VA for 105-125V input

Flexible, can be supplied with limited frequency ranges 45-75 cycles and/or 320-480 cycles, with stabilized single frequency tuning fork or single range to cover entire frequency spread as required. An external frequency source may be used. Can be furnished with complete frequency programming equipment built in for fixed or variable cycle. Metering of output voltage, current and/or frequency can be included.



For detailed information, see your Vectron Commercial Test Equipment Representative or write direct for "Advance Bulletin" VFS 250.

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Precision Electronic Components
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land were elected to the board of directors of the corporation. Thomas J. Watson, Sr., chairman of the board, continues as chief executive officer.

**General Precision
Names Cunningham**

JAMES M. CUNNINGHAM has been named western regional sales manager for General Precision Laboratory.

He has a background as a design engineer and systems engineer with West Coast firms.

**Schonfeld Promoted
By Avien**

SAUL N. SCHONFELD has been appointed chief application engineer for Avien, manufacturers of aircraft fuel management equipment and other aeronautical instruments.

Prior to joining Avien, Schonfeld was with Simmonds Aerocessories for 8 years, most recently as manager of the company's application engineering department.

He succeeds Frank DeNardo who has been appointed regional engineering representative for Cal-Avien in Culver City, Calif.

**General Manager Appoint
For IRC Subsidiary**

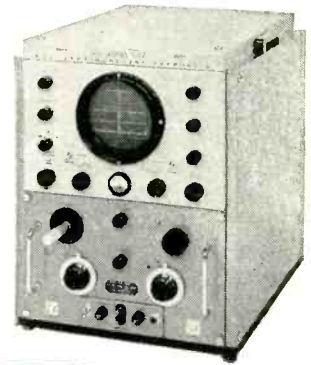
CLARENCE HARDING has been appointed general manager of Ircal Industries, California subsidiary of International Resistance. Edward A. Stevens, vice-president & treasurer of IRC was recently named president of the Los Angeles concern.

Harding has been assistant treasurer & controller at IRC for the past nine years, and will, in his new position, be responsible for all operations of Ircal Industries.

Batelle Institute Expands

BATELLE INSTITUTE of Columbus, Ohio, has bought 397 acres of land for new experimental projects in engineering and agriculture.

The present staff of 2150 people

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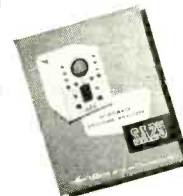
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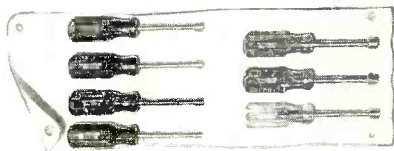
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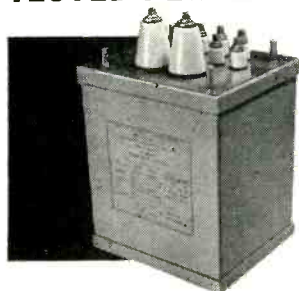
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See page 21

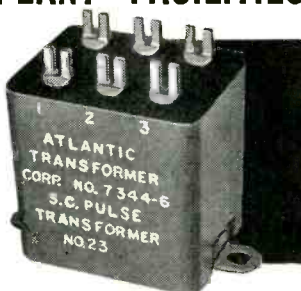
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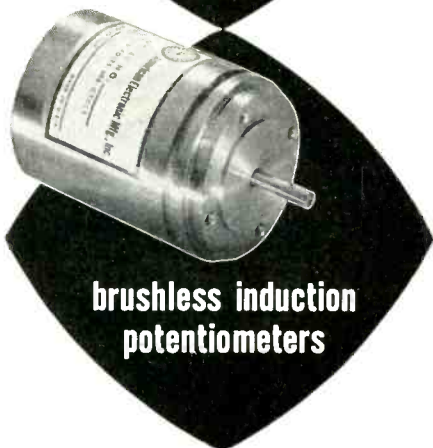
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at Batelle is double that employed in 1945. Approximately \$13.5 million dollars was used in research in 1953.

McDonald Joins Cinema Engineering

JOSEPH McDONALD has joined the mechanical engineering staff of Cinema Engineering at its Burbank, Calif., plant. He will work with Charles Broneer, supervisor.

He has been with the P. R. Malloy resistor division plant at Frankfort, Ind., as a draftsman and designer and more recently in a similar capacity with Lockheed Aircraft and Hydro-Aire Corp.

New TV Station and Plant Planned In Philippines

STEWART LABORATORIES plans to set up a new television station and a new tv plant in the Philippines. The station will have a 30 kw transmitter with a 500 ft. tower. The plant, to employ 250, is to assemble 15,600 television sets and 36,500 picture tubes annually.

It is hoped that the factory will be able to supply television sets and tubes for sale not only in the Philippines but also in Japan, Thailand, Indonesia and other far eastern countries. A relay station in Cebu to cover practically the whole island group between Mindanao and Luzon is planned. The projected station, DZBB-TV, will be equipped with mobile units and field cameras.

U. S. Relay Forms Projects Laboratory

U. S. RELAY of Los Angeles has set up a Shelf Projects Laboratory for the development and testing of higher efficiency relays for guided missiles and aircraft of the future.

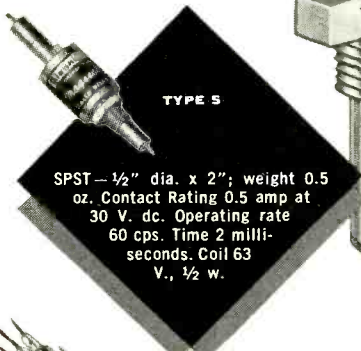
The organization, through electronic engineer Harold Fox, U. S. Relay chief engineer Paul Chamberlin and assistant chief engineer John Schuessler, has perfected a new sub-miniature relay said to be about half the size and weight of the smallest now in use. The relay

New! Mag-Seal

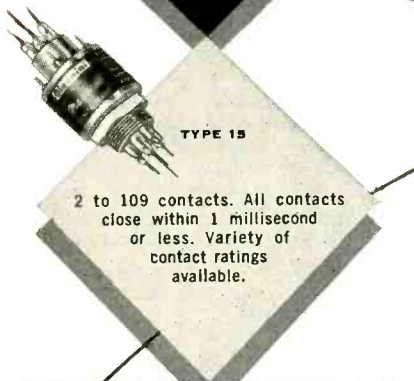
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Cook Division Moves To Larger Plant

THE ELECTRONIC SYSTEMS division of Cook Electric has moved to a larger plant in Chicago.

Formed several months ago, the division outgrew initial plant facilities. The new, two-story location provides doubled working area and modern facilities for electronic development and production. The division is headed by Edward J. O'Brien.

National Union Radio Changes Its Name

THE NATIONAL UNION Electric Corporation is the new official name of the National Union Radio Corp. The change in names was made to reflect the expanded activity of the company.

Azilda Nielsen Named President of Best

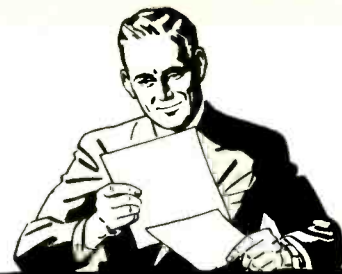
AZILDA NIELSEN has been elected president of Best Manufacturing of Irvington, N. J. and its associate companies, Sampson Electric Products of Clinton, N. C. and Fidelity Products of South Orange, N. J.

Mrs. Nielsen succeeds her late husband, E. W. Nielsen as president of the firm which manufactures radio and tv components and sound reproducing equipment.

Holland Joins Stromberg-Carlson

JOHN J. HOLLAND, formerly electronic equipment contracting officer for the U. S. Army Signal Corps at Fort Monmouth, N. J., has joined Stromberg-Carlson's radio-tv division as head of quality control and inspection. His duties will encompass both commercial and military production. Holland's background is in the field of electronics engineering.

He was also with the Signal Corps in Philadelphia.



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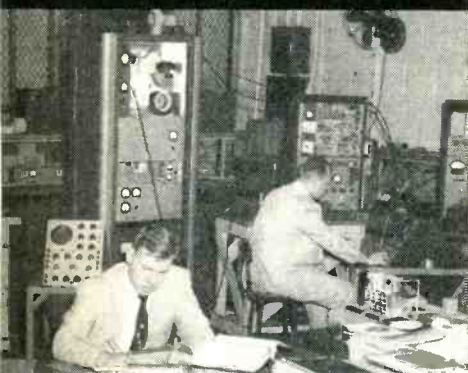
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NEW BOOKS

Vector and Tensor Analysis

By G. E. HAY, *Dover Publications, Inc., New York, N. Y., 1953, 194 pages, \$1.50 paper bound, \$2.75 in cloth.*

For some reason or other, this reviewer has always had a fascination for vector analysis. The probable reason for this feeling is the fact that he once roomed with the mathematician Schelkunoff who had a theory that vector analysis ought to be taught in the lower grades and not postponed until after the student had digested virtually everything else in the way of mathematics. At any rate, this fascination has impelled the perusal of many books on the subject with the result that, sooner or later, an impasse or hurdle was reached beyond which this reader could not go.

Professor Hay's book seems to let the unskilled go further than most before the hurdle appears and this may be because of the choice of examples of usage of the fundamental operations, especially those applying to geometrical problems. At any rate the book is a useful addition to the library on the subject.

The paperbound edition is easy to handle for it is light in weight and while publishers in general do not look with favor on such unorthodox (and unprofitable) presentations there is much to recommend them to the student or engineer. It is regrettable that not enough purchasers exist for highly technical books for all of them to appear in light-weight, coat-pocket, low-cost format.

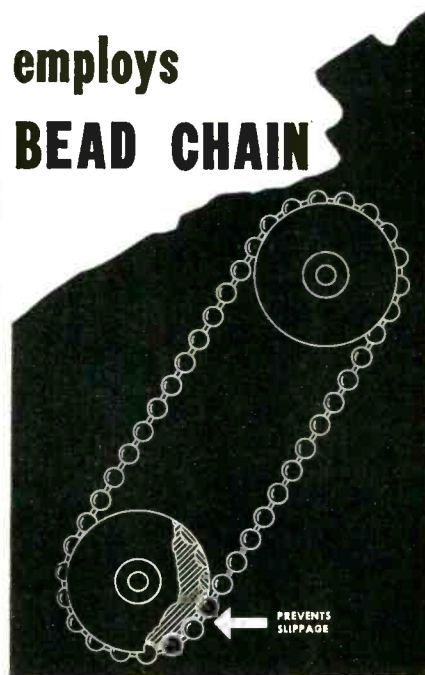
Having proved, by very few moves, that the three medians of a triangle meet in a single point which trisects each of them, one is inclined to believe that Schelkunoff was right: vector analysis is easier than geometry and ought to be taught first.—K.H.

Relaxation Methods

By D. N. DEG. ALLEN. *McGraw-Hill Book Company, 257 pages, 1954, \$7.50*

THIS is a fascinating book for the engineer. It is not, as this reviewer

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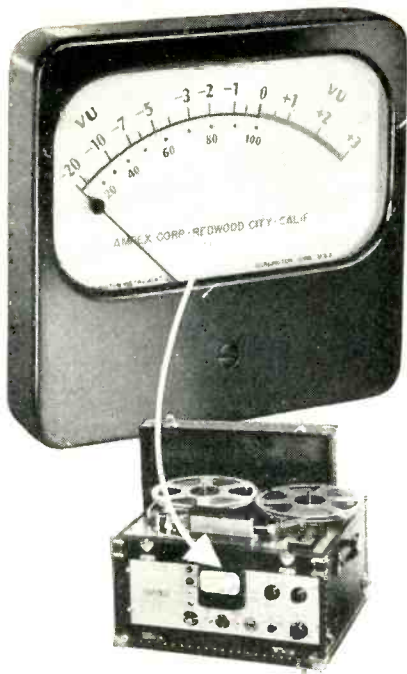
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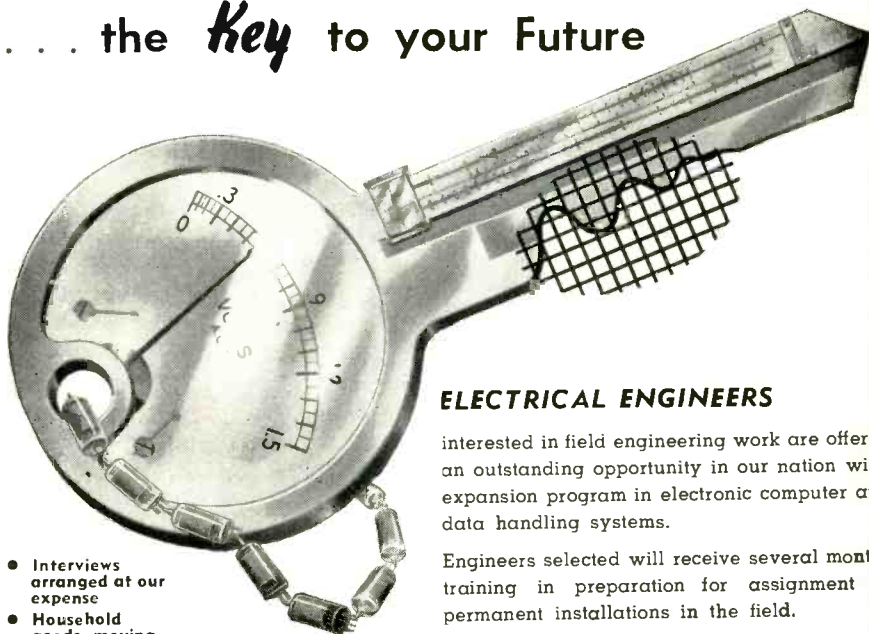
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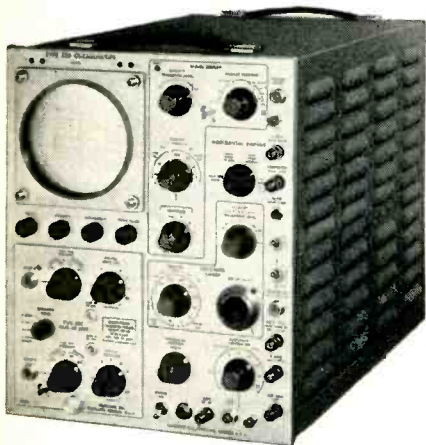
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first surmised, devoted to flip-flop circuits and the consequences of the van der Pol equation. Nor does it have anything to do with serenity and the good life. It is in fact an ordered technique for applying the method of successive approximations to mathematical and physical problems of almost any complexity and analytic difficulty. Now every engineer knows of the method of successive approximations and has probably solved at least one problem by its use, but this is a systemization of the method which allows one to readily obtain numerical solutions of the problem of heat flow in 3 dimensions.

The method is of course based on the fundamental truth, which any digital computer knows, that all of the mathematical processes are in reality sophisticated forms of addition and subtraction. To become adept in "relaxation methods" one must learn to think more or less like a digital differential analyzer.

The technique in its simplest mode is to organize the controlling equations in a particular form and then to vary each independent variable separately (or in groups) until the stated equations are solved. While a naive application of this might well take a lifetime for some problems, Sir Richard Southwell and his fellow relaxers have developed a technique and philosophy of the method which make the solution of many difficult problems seem ridiculously simple.

There are two especially interesting details brought out in the discussion. The first is that the individual practicing the method is not only free to, but is encouraged to, break any or all rules when it seems advantageous. The second, which was a godsend to this novice relaxer, is that the ability to keep a check book accurately is not a requisite, since the system is self-checking.

In this "first book of its kind to show the reader how to use the techniques of relaxation", Chapters 1 and 2 are used to establish the fundamental method of relaxing and to make the reader cognizant of certain techniques for shortening the actual computational process.

In Chapter 3 the method is applied to both two-and three-dimen-

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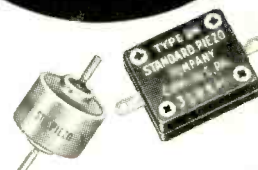
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sional frames, both pin-jointed and stiff-jointed, to which external forces are applied. It is here that the reason for choosing the name for the method becomes evident. The frame is first assumed in equilibrium and the external force or load applied. It is seen that the "operations table" represents the mechanical process of "the systematic relaxation of (local) constraints" until all the members are again in equilibrium—in new locations which are given by the calculated displacements.

Chapter 4 applies the method to obtaining particular solutions of ordinary differential equations. The particular problem chosen for study is that of the deflection of a beam under stress. Here the trick of using finite-difference approximations to derivatives is introduced with its resulting inaccuracy. It is shown, however, that this inaccuracy can be reduced to any degree desired. If more accuracy is required, the unit finite difference must be made smaller. This results in more equations and so more computation and tedium in solving them. It is shown by a numerical example that finally the answer will not be changed by decreasing the size of the finite difference, so that here, as in the case of automatic computers, accuracy can be exchanged for time and complexity.

Applications to Laplace and Poisson Equations

The next six chapters (5-10) contain the relaxational approach to the solution of Laplace's and Poisson's equations. Here the power of the method in obtaining numerical solutions at particular points (which can be as closely spaced as you wish) becomes evident. Complex problems which can be solved analytically only with considerable difficulty here become simply tedious. (To relieve this the author advises "it is virtually essential that a calculating machine be available".) The quasi-pole-potential generalized form of Poisson's equation proves to be just as amenable to the method as the more simple forms which are generally solved in analysis. In fact, the fourth-order biharmonic equation (useful in the bending and exten-

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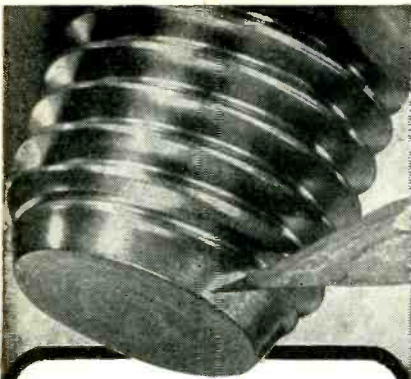
sion of flat elastic plates) and simultaneous partial differential equations of the second order only increase the tedium without introducing any marked perplexity.

Chapters 11 and 12 apply the method to Eigenvalue problems arising from the study of vibrational questions, first for a finite and then for an infinite number of degrees of freedom in two dimensions. Three problems in particular which are solved are: the vibration of a rectangular membrane with fixed edges; the critical thrust in a strut with clamped ends; electromagnetic vibrations in a wave guide. It is indicated how the method could be readily extended to solve problems which "are not capable of exact analytical solution; from a relaxational point of view, the greater difficulty, if any, lies only in additional computation". Chapter 13 extends the method to multiply connected regions such as the extensional problem for a flat plate containing holes and the stressing problem for an axially symmetric solid with cavities.

Problems of two-dimensional flow, where the boundaries may be unknown, are considered in Chapters 14 and 15. The percolation of a fluid through a porous material, the irrotational flow of an incompressible fluid, the heat-conduction equation and the stressing of a uniform cylinder in torsion sufficiently so that part of the material is stressed to its elastic limit are some of the problems tackled.

The final chapter gives an introduction to the use of Relaxation Methods to three-dimensional problems. The method itself is so powerful that it can be stated: "The major difficulty . . . was that involved in finding a satisfactory technique of recording on paper a calculation which in reality should take place on a three-dimensional lattice". A suggested successful technique is to record the relaxational computations on an isometric projection of the lattice. The final touch in the book is to show how three-dimensional problems with irregular boundaries may be handled.

The book is well organized and well written. The problems are



TOUGHER!

Allen

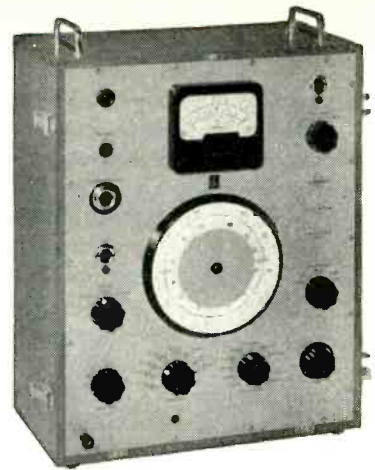
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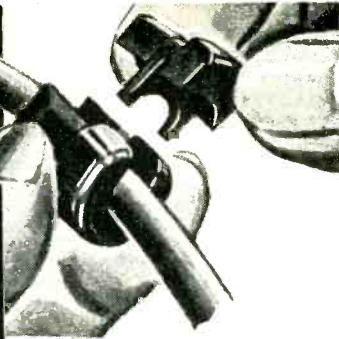
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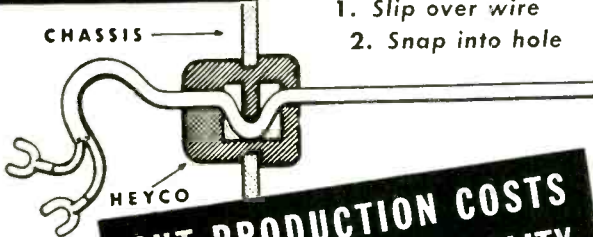


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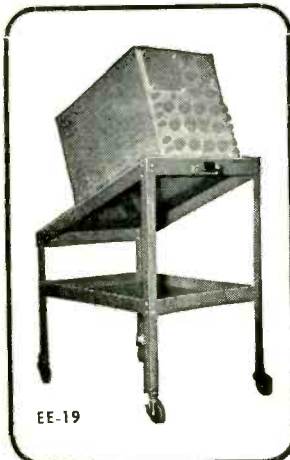


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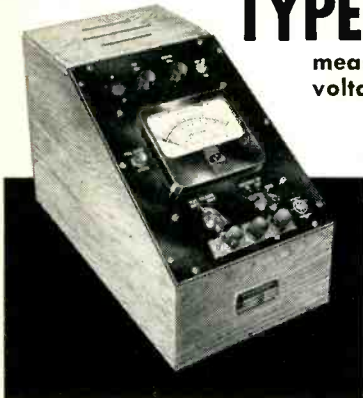


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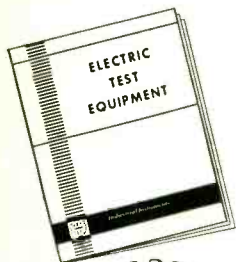


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carefully graded to introduce the newcomer to the field and to carry him along as if the subject had scarcely any difficulties. The format is good; the bibliography and index seem reasonable.

My one complaint is the author's statement: ". . . in particular, no mention is made of the solution of non-linear equations", without stating whether the method has some fatal flaw in this connection. My own guess would be that this should be a powerful tool with which to attack some of the stickier non-linear problems. I should suspect that there is some exciting mathematical research in this direction.

This book should be a stimulation to the introduction and increase of the use of the powerful relaxation methods in this country and should be studied by every engineer who is required to get particular solutions of problems which do not lend themselves well to easy analytic solutions. It furthermore will probably prove enlightening to many concerning the processes of the modern computing machines.—KNOX MCILWAIN, *Hazeltine Electronics Corp.*

THUMBNAIL REVIEWS

Symposium on Light Microscopy. American Society for Testing Materials, Philadelphia, Pa., 132 pages, 1954, \$2.50. Useful articles for any research engineer employing the microscope as a tool. Titles are: *The Methods of Microscopy*, by Clyde W. Mason; *Apparatus for Microscopy*, by H. W. Zieler; *Some Applications of Light Microscopy in the Study of Textile Materials*, by V. W. Tripp; *Polarized Light Microscopy and Supplementary Techniques* by W. C. McCrone; *Applications of Light Microscopy in Concrete Research*, by Katharine Mather; *The Microscopical Examination of Metallic Specimens*, by J. R. Vilella; *Resinography, the Microscopy of Resins and Their Plastics*, by T. G. Rochow; *Methods of Particle-Size Analysis*, by R. P. Loveland.

Radio Amateur's Handbook. ARRL, West Hartford, Conn., 800 pages, 1954, \$3.00. An up-to-date revision of this famous handbook, annually awaited. Contains material on semiconductors, color television and other new topics.

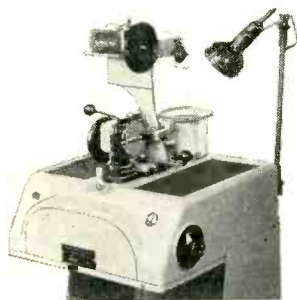
Highlights of Color Television. By John R. Locke, Jr., General Electric Co., Syracuse. John F. Rider Publisher, Inc., New York, 1954, 44 pages, \$.99. Concise summary of technical



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ELECTRONICS — September, 1954

NEW BOOKS

(continued)

aspects of the present FCC-approved compatible electronic television system, for those already familiar with monochrome television principles.

Wireless and Electrical Trader Year Book 1954. Trader Publishing Co., Ltd., Dorset House, Stamford St., London, S. E. 1, England, 25th edition, 296 pages, 1954, 10s 6d. Data on 250 current tv receivers, tube and cathode-ray tube base connections, etc. Useful to anyone connected with sales or service or interested in contacting British sources of supply.

Applied Electronics Annual 1953/54. British-Continental Trade Press Ltd., 222 Strand, London W. C. 2, England, 258 pages, 1954, £ 1. Articles on electronics in fishing, textiles and printing, plus directory of manufacturers of electronic apparatus, components and a British Who's Who of the executives of many electronic firms throughout the world.

Economic Almanac 1953-1954, Edited by Frederick W. Jones and Anita R. Beckerman, NICB, Thomas Y. Crowell Co., 432 Fourth Ave., New York 16, N. Y., 671 pages, 1954, \$3.95. Handbook of useful facts about business, labor and government in United States and other areas.

Basic Radio, a Practical Training Manual. Howard W. Sams & Co., Inc., Indianapolis 5, Ind., 240 pages, 1953. Simple, well-planned manual for training technicians in all phases of the electronics industry from lecture and classroom notes used at Coyne Electrical School. Thirty-six lessons, questions and problems.

Auto Radio Service Data Manual, Vol. 2 and Vol. 3. Compiled and published by Howard W. Sams & Co., Indianapolis, Ind., 1953, \$3.00 each. Circuit diagrams and servicing data on recent models of auto radios, creatively presented for maximum usefulness to practicing servicemen.

Audio Amplifiers & Associated Equipment, Vol. 4. Compiled and published by Howard W. Sams & Co., Indianapolis, Ind., 1953, \$3.95. Circuit diagrams and service data on audio amplifiers, a-m and f-m tuners, pre-amplifiers and associated equipment of interest to high-fidelity enthusiasts.

Human Behavior in Industry. By W. W. Finlay, A. Q. Sartian and W. M. Tate. McGraw-Hill Book Co., New York, 1954, 247 pages, \$4.00. Written to assist project engineers, chief engineers and other executive engineers in meeting and solving personnel and human relations problems. Chapter topics include: delegation of authority and responsibility; dealing with engineering unions; use of incentives; selection and evaluation of employees; improving attitudes and morale; gaining interest and cooperation; handling disciplinary problems; improving management-employee communication.

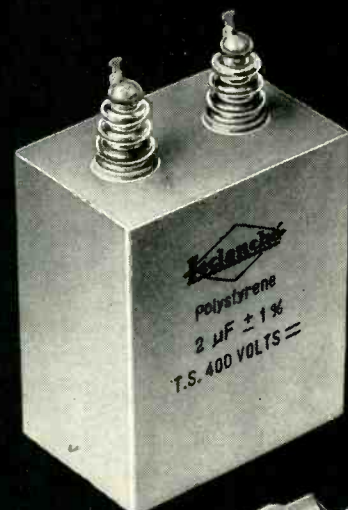
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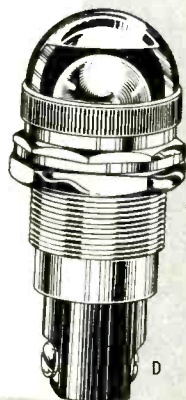
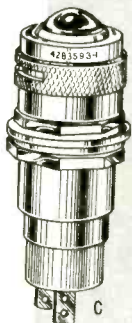
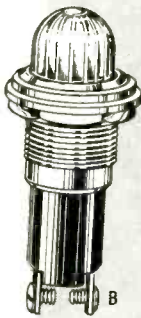
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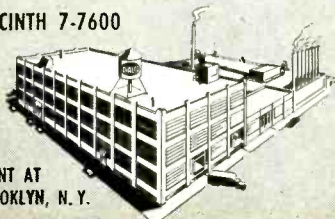


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NEW BOOKS

(continued)

cago, 11, Ill., 100 pages, 1954, \$1.75. How to use saws, jointers, shapers, routers and belt sanders without getting hurt. For the woodworking or carpenter shop.

1953 Supplements, ASTM Standards. ASTM, 1916 Race St., Philadelphia 3, Pa., seven parts listed below, \$3.50 each part or \$24.50 for complete set. Part 1, Ferrous Metals, 380 pages; Part 2, Non-ferrous Metals, 288 pages; Part 3, Cement, Concrete, Ceramic, Thermal Insulation, Road Materials, Waterproofing, Soils, 400 pages; Part 4, Paint, Naval Stores, Wood, Fire Tests, Sandwich Constructions, Building Constructions, Wax Polishes, 174 pages; Part 5, Fuels, Petroleum, Aromatic Hydrocarbons, Engine Antifreezes; 348 pages; Part 6, Rubber, Plastics, Electrical Insulation, 208 pages; Part 7, Textiles, Soap, Water, Paper, Adhesives, Shipping Containers, 308 pages.

Temperature Measurement with Rayotubes. By Paul H. Dike, Leeds & Northrup Co., Philadelphia 30, Pa., 1953, 48 pages, \$1.00. A monograph on the theory, design and use of Rayotubes including actual temperature measurement, standardization and calibration. Rayotube is the trade name for "total" radiation pyrometers produced by L&N.

TIC Potentiometer Handbook. Technology Instrument Co., 531 Main St., Acton, Mass., 207 pages, 1954, \$2.00, including periodic release of new material. Design, construction, performance, mounting and ganging, bibliography and catalog.

Professional Income of Engineers—1953. Engineers Joint Council, 29 West 39 St., New York 18, N. Y., 32 pages, 1954, \$2.00. Income of about 72,000 engineers in industry, government and education in relation to year of receiving first degree in engineering.

Discrete Sources of Extra-Terrestrial Radio Noise. Special Report Nr. 3, URSI, (International Scientific Radio Union) 42 Rue des Minimes, Brussels, Belgium, 1954, 56 pages, \$1.15. A brief account of well established experimental data and techniques as of the 1952 General Assembly URSI.

Radiation Biology. Edited by Alexander Hollaender, Oak Ridge National Laboratory; Volume 1 of a three-volume work, in two parts, McGraw-Hill Book Co., 1954, \$17.50. An exhaustive treatise on the biological effects of radiation from the physical, chemical and biological points of view.

Psychology of Industrial Relations. By C. H. Lawshe, Professor of Psychology, Purdue University, McGraw-Hill Book Co., New York, N. Y., 1953, 350 pages, \$5.50. Written for industrial people in supervisory and managerial ranks as a day-to-day practical aid for meeting and handling personnel problems. Coverage includes human behavior, employment placement, training and supervision, handling of complaints, establishing wage rates, dealing with unions and aiding production by making work easier.



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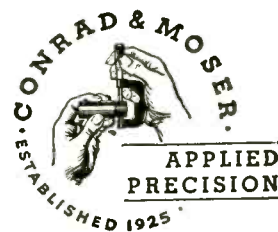
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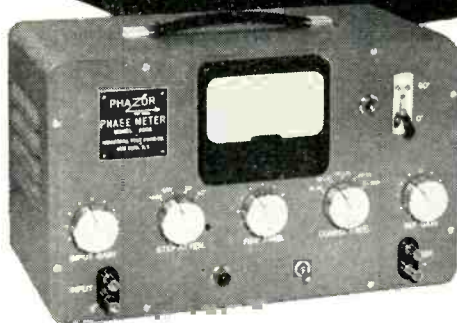


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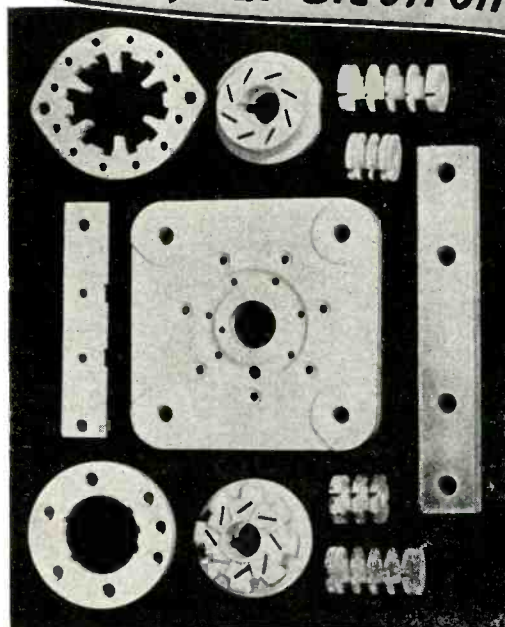
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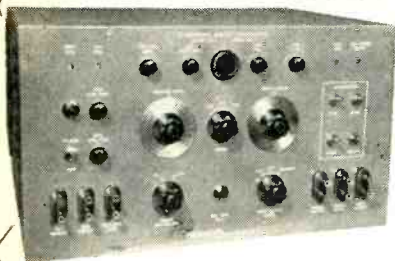
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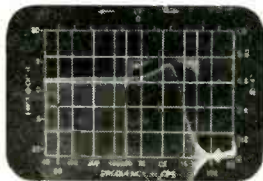
MODEL

SG-1

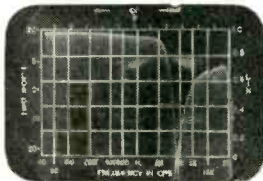
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BACKTALK

Engineering Personalities

DEAR SIRS:

THE RELATIONSHIP between gene-chromosome pattern and functional dominance in personality, and between personality and trait, is well enough known to provide adequate criteria against which to rate the list of personality traits set out in *Cross Talk* (ELECTRONICS, July 1954) and applied to engineers.

The constellation of aptitude weights personality into three major categories of functional dominance. (W. H. Sheldon, "The Varieties of Human Physique", Harper & Brothers Publishers; James F. Bender, "The Technique of Executive Leadership," McGraw-Hill Book Company, Inc.). Two of these categories can be indicated by the general psychological terms introvert and extrovert.

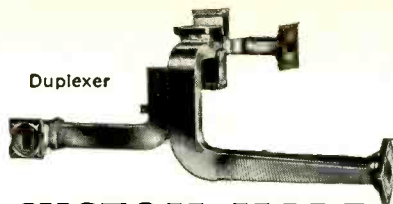
Neither of these personality-patterns corresponds to the aptitude pattern generally taken to identify the engineer. The third category, described in the technical term mesomorph-somatotonia, is found to be populated with persons who do gravitate toward the functions of engineering.

In true or false annotation, the four points all score false. . . .

Dogmatism, hostility, secretiveness, and inability to delegate are all observable factors in human relations. To present what appear to be features of functional disturbance as characteristics of personality, and descriptive of engineers, requires rather more justification than seems to be readily available.

In my experience, the firm where hostility and rebellions spot the margins of cold and warm fronts down the line of executive functions will be host to the impossible demands associated with high labor turnover, and ensuing from techniques applied by any one of several parties in the contract.

Dividend-producing firms of happy atmosphere will be found to comprise a dynamic balance of functional dominants, demonstrating the company of characteristic aptitudes. Administration and its function of recording, communica-



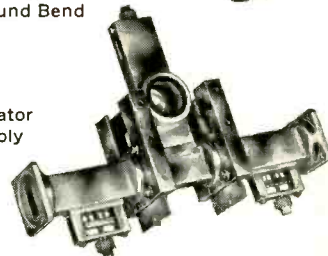
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BACK TALK

(continued)

ting, inspecting and sensing, will be populated with persons having high talent for accurate observation and low coefficient of imaginative activity. Production personnel will feature ability to balance out, or govern, applications of energy—in policy, direction, skill, and development. Distribution will engage the talent for persuading and response to consumer-potential associated with the roly-poly endomorph.

In this general panorama, the scientists gravitate toward energy-costing in the laboratory or money-costing in administration. The engineer moves toward the cybernetics of production, at various levels. And the promoter-salesman joins his talent to this dynamic community to spread the good news of a better way of life.

Case History

The following case history throws some interesting light on the general situation. Mr. A employs 25 persons in the manufacture of a major household appliance. With expansion in mind, he engaged me to conduct a survey and introduced me to Mr. B, general manager, with whom I would be working. Both Mr. A and Mr. B confided to me that Mr. C, chief engineer and works manager, was a source of concern because of his uncooperative attitude. Dr. Pearse's evaluation represented management's description of Mr. C, to a T.

My findings, however, showed Mr. C to be superbly competent in his field, admired by his men, in love with his work, extremely capable in customer-relations (he supervised field installations), well-poised in personality. He responded warmly to suggestion and improvement.

In due time, the situation clarified. Both Mr. A and Mr. B typed out as dominant introverts. The breakdown in communication, which they imputed to Mr. C, was traceable unerringly to themselves.

The reason was not their dominant pattern, by any means. Both were talented in directions appropriate to their dominance. But of all possible management techniques, Mr. B had instituted a

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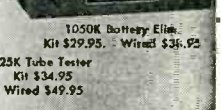
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BACK TALK

(continued)

course which set the conditions for flaring temper and frustration as surely as looking into a gas tank with a lighted match. . . .

RALPH E. SPENCER
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Engineers and Executives

DEAR SIRs:

I DISAGREE with Dr. Pearse (*Cross Talk*, p119, July 1954). He describes a pattern of behavior which may apply to any intellectual group.

An engineer is a special creature of this earth, deeply concerned with accuracy. He has an intense passion for test and measurement. He recognizes the inconclusiveness of theory. His evaluations are made with a blend of the empirical and mathematical method.

Dr. Pearse is interested in developing executives. All executives are not engineers. This is simple proof that the executive may differ from the engineer.

Can a good executive be made from an engineer? Certainly; but first, something must happen to his inner self, to his mental attitude.

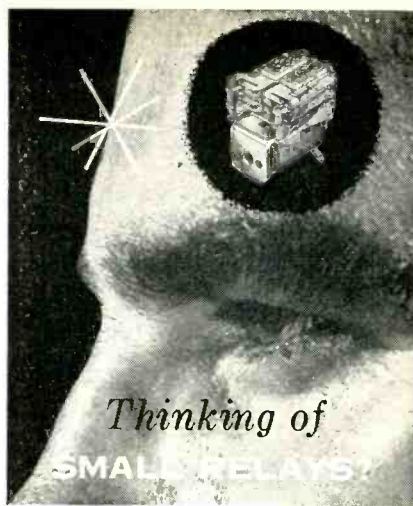
The executive is concerned with broad policy, with overall results. He does not waste his time on the fine detail and restrictive accuracies which occupy the staff engineer.

The executive must always be making assessments of intangibles. He needs an understanding of statistical analysis and probability. He must know how to evaluate the limitations of men and machines, without confusing one with the other. He should be ready to admit errors of judgment and seek corrective measures. Above all, he must have a strong emotional stability, to withstand with serene composure the stress of adversity.

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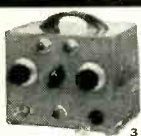
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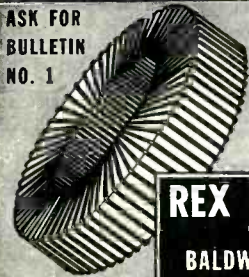
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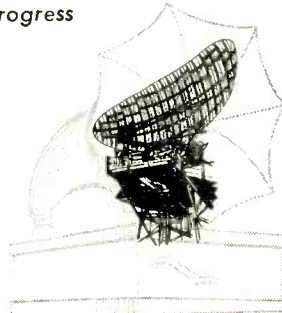
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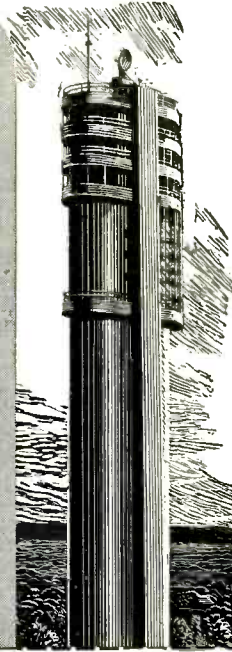
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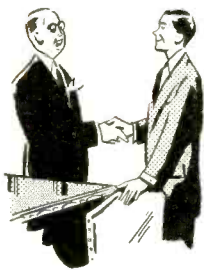
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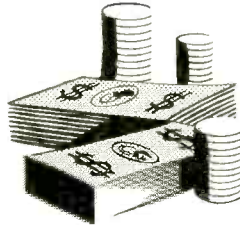
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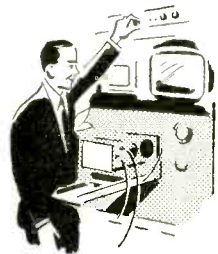
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RCA offers all These...and more!

RCA offers career opportunities for qualified **ELECTRICAL** and **MECHANICAL ENGINEERS** . . . **PHYSICISTS** . . . **METALLURGISTS** . . . **PHYSICAL CHEMISTS** . . . **CERAMISTS** . . . **GLASS TECHNOLOGISTS**.

Positions now open in Systems, Analysis, Development, Design and Application Engineering. Your choice of long range work in commercial or military fields.

At RCA you'll work in an atmosphere conducive to creative work — laboratory facilities unsur-

passed in the electronics industry . . . constant association with leading scientists and engineers.

Delightful suburban living easily available. Modern retirement program . . . liberal tuition refund plan for advanced study at recognized universities . . . modern company paid benefits for you and your family.

Individual accomplishments readily recognized. Ample opportunity for increased income and professional advancement.

Join the team at RCA and grow with the world leader in electronics.

Personal interviews arranged in your city.

Please send a complete resume of your education and experience to:

MR. JOHN R. WELD

Employment Manager, Dept. 300 I
Radio Corporation of America
30 Rockefeller Plaza, New York 20, N.Y.



RADIO CORPORATION of AMERICA

Tmks. ®

**SYSTEMS—ANALYSIS—DEVELOPMENT—
DESIGN—APPLICATION ENGINEERING**
in the following fields:

AVIATION ELECTRONICS (FIRE CONTROL, PRECISION NAVIGATION, COMMUNICATIONS)—
Radar—Analog Computers—Digital Computers—Servo-Mechanisms—Shock & Vibration—Circuitry—Heat Transfer—Remote Controls—Sub-Miniaturization—Automatic Flight—Transistorization—Automation

RADAR—Circuitry—Antenna Design—Servo Systems—Information Display Systems—Gear Trains — Stable Elements — Intricate Mechanisms

COMPUTERS—Digital and Analog—Systems Planning — Storage Technique — Circuitry — Servo-Mechanisms—Assembly Design—High Speed Intricate Mechanisms

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COMPONENT PARTS (COLOR & MONOCHROME TV) —HV Transformers—Coils—Deflection Yokes

SEMI-CONDUCTORS—Transistors—Diodes

ELECTRON TUBE DEVELOPMENT — Receiving — Transmitting—Cathode-Ray—Phototubes and Magnetrons—Power Tubes—Camera Tubes

ELECTRONIC EQUIPMENT FIELD ENGINEERS — Specialists for domestic and overseas assignment on military electronic Communications Navigational Aids, and Guided Missiles.

Electronic Engineers Your Move



The men we seek are experts in their specialized fields; capable of filling responsible engineering positions with MELPAR, a leader in research and development. Perhaps one of these men may be you. We invite you to learn about our long-range military and industrial programs.

If you are experienced in one or more of the fields listed, write us about yourself, and let us tell you during a personal interview about our past record of success and how you can successfully fit into our future plans.

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- Experience in design of digital electronic equipment operating from and into magnetic tape. Manipulation of digital data, logical circuits, shift registers, magnetic core devices.



Technical Personnel Representative

melpar, inc.

A Subsidiary of the Westinghouse Air Brake Co.

452 Swann Ave., Dept. E-9, Alexandria, Virginia
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Department Y-1



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Phone: York 5521

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**A Growing Company
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High Starting Salaries
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MR. D. M. HALLIDAY

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A Division of
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Mechanical design of missile-borne and vehicular electronics equipment.

Analysis and laboratory work involving development of new types of airborne and ground radiators and waveguide components.

VHF and microwave antenna waveguide circuitry.

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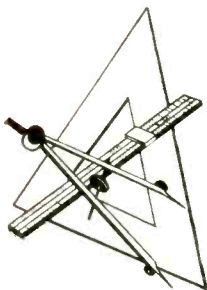
Desire men with B.S. degree or above. Salary commensurate with education and experience. Free health, accident and life insurance. Free hospitalization. Profit Sharing. Paid holidays. Sick leave. Vacations. Ideal working conditions. Plenty of housing, reasonably priced. Excellent schools. Exceptionally mild and dry winter climate.

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Motorola Research Laboratory
3102 North 56th Street
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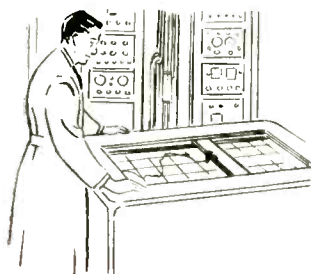


DESIGN AND DEVELOPMENT engineering opportunities are available for capable and imaginative men and women in the field of airships, aircraft and aircraft components.

RESEARCH AND DEVELOPMENT projects — missiles, electric and electronics systems, servomechanisms, new special devices, fiber resin laminates — all present an urgent need for engineers with fresh talent, aptitude and ambition.

POSITIONS ARE OPEN at several levels in various fields with salaries based on education, ability and experience.

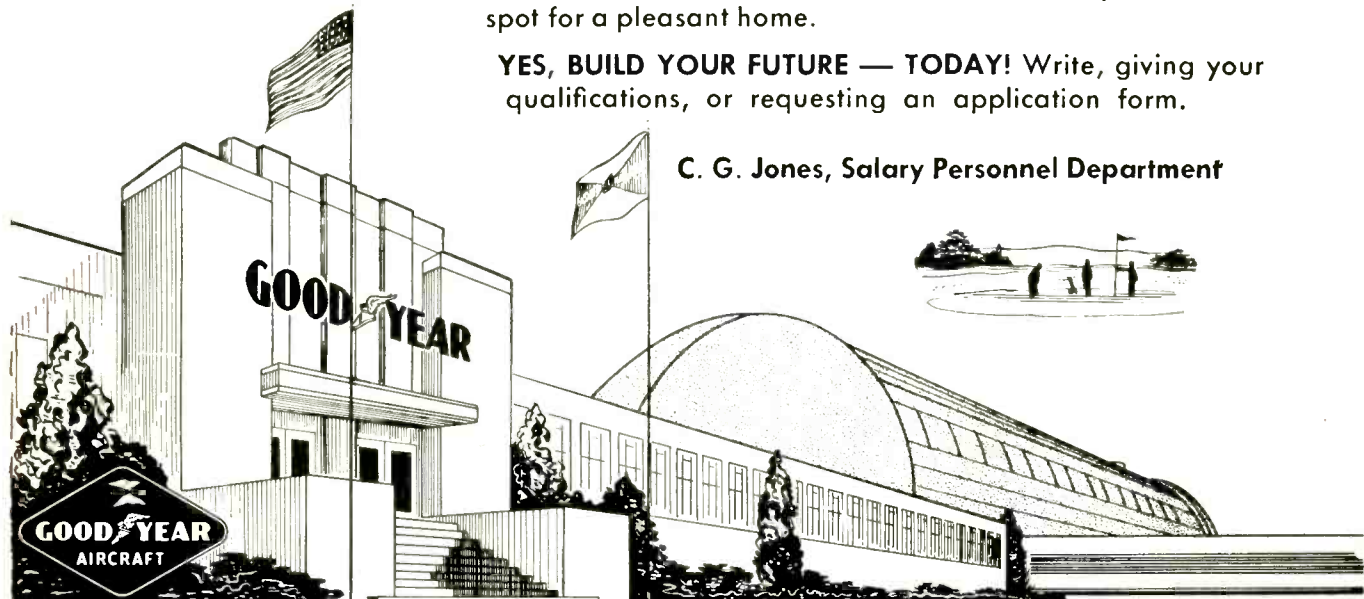
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| Mechanical engineers | Electrical engineers |
| Aeronautical engineers | Technical editors |
| Welding engineers | Technical illustrators |



AKRON, THE HOME OF GOODYEAR AIRCRAFT, is located in the lake region of northeastern Ohio. Cosmopolitan living, year-round sports and recreation, cultural and educational advantages make this thriving city an ideal spot for a pleasant home.

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C. G. Jones, Salary Personnel Department



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**the
SYSTEMS
ENGINEER
at RCA**

Systems engineers conduct studies to determine operational requirements . . . create and synthesize military equipment concepts . . . guide development of new integral elements . . . conduct evaluation programs to determine operational effectiveness.

You may qualify! Professional *ability* to create and analyze over-all complex systems and *experience* in electronic or electro-mechanical systems engineering required.

There are several opportunities now in:

AVIATION ELECTRONICS
INFORMATION HANDLING
COMPUTERS • RADAR
COMMUNICATIONS
MISSILE GUIDANCE

Send a complete resume of your education and experience to:

Mr. John R. Weld, Employment Manager
Dept. B-4541, Radio Corporation of America
Camden 2, New Jersey



Tmks. ®

RADIO CORPORATION OF AMERICA



ENGINEERS

**Have you developed a
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If A year or two of practical experience has given you the youthful maturity that demands more than just a job, you may be interested in our "career opportunities" in color TV, crystal products and electronic tubes.

Submit resume or address request for personal interview to D. Bellat, Personnel Director.

TUNG-SOL ELECTRIC INC.

200 Bloomfield Avenue
Bloomfield, N. J.

**RESPONSIBLE
POSITIONS
FOR
ENGINEERS
PHYSICISTS**

SERVOMECHANISM AND CONTROL DEVICES

Applicants must have Bachelor, Masters or Ph.D degrees and a minimum of two years' experience in experimental research, design and development of control equipment and instruments.

Positions are of immediate and permanent importance to our operations. Southwestern location in medium sized community. Excellent employee benefits. Reply by letter giving age, experience and other qualifications.

**Employee Relations Manager
Research and Development Department
PHILLIPS PETROLEUM COMPANY
Bartlesville, Oklahoma**



An Opportunity

is offered for intelligent, imaginative engineers and scientists to join the staff of a progressive and self-sustaining, university-affiliated research and development laboratory. We are desirous of expanding our permanent staff in such fields as electronic instrumentation, missile guidance, microwave applications, design of special-purpose electronic computers, and in various other applied research fields of electronics and physics.

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**CORNELL AERONAUTICAL
LABORATORY, INC.**



BUFFALO 21, NEW YORK

ENGINEERS

**Have You Considered
What a Career at
General Precision Laboratory
Can Mean to You?**

Electronics, systems, computer, field and related engineers will find few opportunities which can match the advantages at General Precision.

It's a growing research laboratory, subsidiary of the large and diversified General Precision Equipment Corporation. Work is on a variety of interesting long-range projects, and men with initiative and ability are given prompt recognition for their achievements.

Living and working conditions are of the best. The modern laboratory is located in New York's Westchester County, known throughout the country for its beautiful surroundings and high standard of living . . . and only one hour from metropolitan New York city with its wealth of cultural and educational activities.

If you're interested in a permanent, satisfying career, send your resume to Mr. Hollis F. Ware, Personnel Director. Expenses will be paid for qualified applicants who come for interviews.

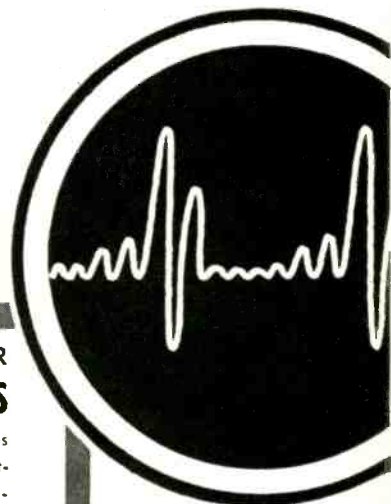
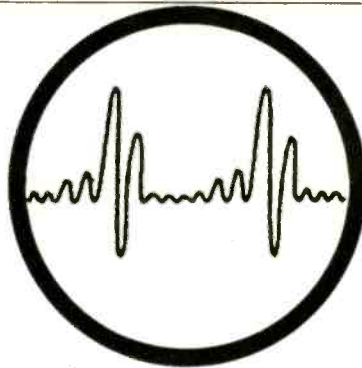
GENERAL PRECISION LABORATORY INCORPORATED

*A subsidiary of
General Precision Equipment Corporation*

63 Bedford Road

Pleasantville

New York



SPECIAL OPPORTUNITIES FOR ELECTRONIC ENGINEERS

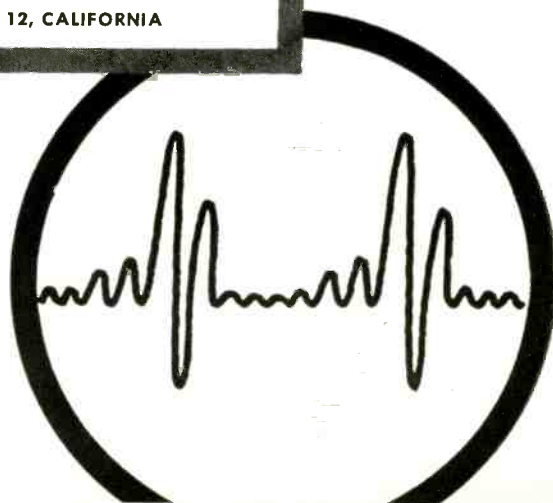
Convair in beautiful, sunny San Diego invites you to join an "engineers" engineering department. Interesting, challenging, essential long-range projects in missiles, engineering research and electronics development. Positions open in these specialized fields:

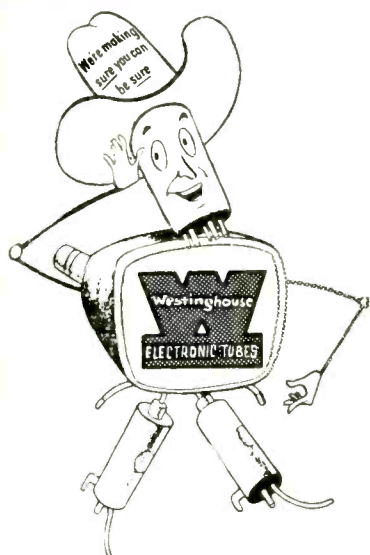
Microwave Antennae	Dynamics Testing
Microwave Components	Telemetering
Electronic Packaging	Servomechanisms
Mathematical Physics	Electron Tubes
Electronic Components	Radome Design
Electronic Systems	Digital Computers
Applied Mathematics	Test Equipment
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Division of General Dynamics
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SAN DIEGO 12, CALIFORNIA





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A pleasant life in Elmira, N. Y. . . . amid New York State's resort lakeland! Good housing, excellent schools, hunting, fishing, sailing, etc. . . . An opportunity for Professional Progress . . . stock-purchase and pension plans . . . tuition-refund program, etc.

TUBE DESIGNERS . . . Any of these fields: Micro-wave tubes, receiving tubes, solid-state devices, image orthicon, traveling wave tubes.

APPLICATION ENGRS Circuit experience in one of these fields helpful: Radio, TV, VHF, semi-conductors, and sweep circuits.

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1. For black-&-white and color TV manufacturing. Knowledge of photo-sensitized screens, silk screens or printed screens desirable.
2. For power-tube operations, including magnetrons, micro-waves and semi-conductors.
3. For quality-control. Elec'l Engineering background preferred.

WESTINGHOUSE will pay expenses of Engineers invited to Elmira for interview. Send resume:

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P. O. BOX 284,

ELMIRA, N. Y.

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Electronics Engineers and Applied Physicists

For a long-range research and development program in air armament. Interested in both senior and junior men for work on:

- Infrared systems and components.
- Simulators and computers.
- Ordnance and ordnance test equipment.
- Instrumentation for aircraft and missile test ranges. (Locate in Chicago or Florida.)

Complete, modern laboratory and shop facilities. Professional atmosphere on a university campus, with salaries equivalent to industry. Liberal vacation and other benefits. U. S. citizenship required. Send brief resume with request for application form to:

Scientific Personnel Office

CHICAGO MIDWAY LABORATORIES
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RECEIVER ENGINEERS With Experience in VHF and UHF Frequencies

Career Opportunities
With Old Established
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THE ALLEN D. GARDWELL ELECTRONICS PRODUCTIONS CORPORATION
Plainville, Connecticut



Electronic Engineering Company of California

The Electronic Engineering Company of California is an independent firm engaged in the design, development and fabrication of electronic equipment for private industry and the Armed Forces. Founded and managed by electronic engineers, the Electronic Engineering Company offers a broad background of experience, highly trained personnel, excellent facilities plus a well integrated, expanding organization.

The Electronic Engineering Company has openings for engineers with experience and background in industrial and military electronics.

Please send resume of experience and education with salary requirements to:

Electronic Engineering Company of California
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LOS ANGELES - 57 - CALIFORNIA

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Project Responsibility for the Mechanical Design and Development of Air Data Sensing Instruments.

SERVOMECHANISMS INC.
POST & STEWART AVE'S
WESTBURY, L. I.

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Experienced physicist or electronics engineer with Ph.D. degree for development work on electronic tubes. Minimum of five to ten years experience in this field is prerequisite. Send complete resume or apply in person to:

Research Division
NATIONAL UNION ELECTRIC CORP.
350 Scotland Rd. Orange, N. J.

REPRESENTATIVES WANTED

Manufacturer of electronic test equipment for military and commercial applications needs technically qualified representatives. Write giving qualifications, lines handled, territory covered.

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If you have design
experience in

**MAGNETIC
AMPLIFIERS
CRYSTAL and
L-C FILTERS
MINIATURE
TRANSFORMERS
PLASTIC
ENCAPSULATION
TECHNIQUES**

(or if you are an engineer
desiring experience in these
fields)

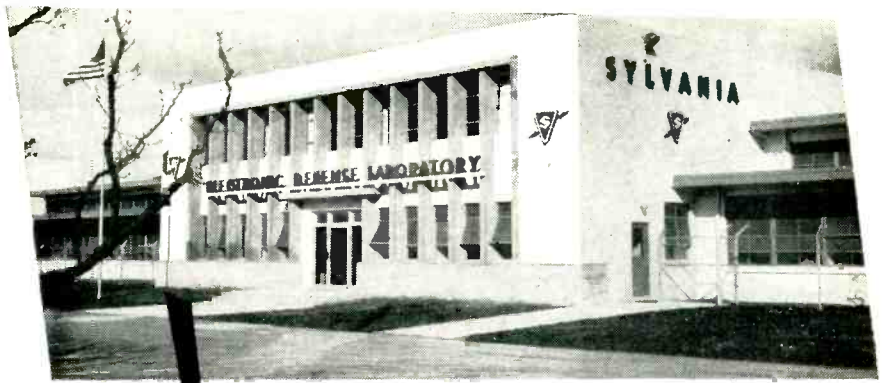
. . . you owe yourself an investi-
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offered by Communication Acces-
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Missouri . . . located in South
Suburban Kansas City, where you
and your family can enjoy ad-
vantages of:

1. Management-owned expanding organization.
2. Rural atmosphere — 25 minutes to metropolitan Kansas City.
3. Newly developed housing facilities, schools and shopping centers.

*For confidential negotiations,
address inquiries to
W. S. Bonebright, V. P.,*

**COMMUNICATION
ACCESSORIES
COMPANY**

Hickman Mills, Missouri



**SYLVANIA'S
CALIFORNIA RESEARCH LABORATORY**

(San Francisco Bay Area—Near Palo Alto)

*Needs a few top flight Research Scientists
and Development Engineers for a long
range program in circuit research and
development and systems analysis.*

We have specific openings for:

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Candidate selected will provide direction of a staff of first rate scientists and engineers in the analysis and synthesis of systems. Must have strong physics, engineering or mathematics training at the graduate level and extensive systems experience.

**ENGINEERING SPECIALISTS AND SENIOR ENGINEERS
SYSTEMS DEVELOPMENT (7)**

To work with competent staff of development engineers in the design and test of complex circuits and systems. Engineering degree and substantial related experience essential. Opportunity to advance to supervisory or specialist positions.

HEAD OF TRANSMITTER DEVELOPMENT

To direct versatile group of engineers in the development and test of transmitters. Technical degree and heavy related experience, preferably in microwaves, essential.

**SENIOR TRANSMITTER AND RECEIVER
DEVELOPMENT ENGINEERS (6)**

To develop and test transmitters and receivers. Technical degree and related experience at the senior level, preferably in microwaves and pulse techniques, essential.

*Sylvania offers the finest facilities and
equipment available. We also provide
financial support for advanced education,
as well as a liberal insurance, pension
and medical program.*

*This Sylvania laboratory is located 5 miles
from Palo Alto in the San Francisco Bay
area, close to excellent schools and
universities, unexcelled living conditions,
ideal climate and ample housing.*

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Please send
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Defense
Laboratory
Box 205
Mountain View,
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ELECTRONIC DEFENSE LABORATORY

A Division of
SYLVANIA
ELECTRIC PRODUCTS INC.





Engineering Careers with a *FUTURE . . .*

• Positions are available in our organization at all levels for qualified personnel in the following fields:

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Commercial
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Monochrome
Color | • MILITARY COMMUNICATIONS

• COMMERCIAL RADIO

• RADAR |
|---|--|

Our rapidly expanding interests in these and other fields opens many opportunities for experienced electrical engineers as well as recent graduates.

Chicago location offers excellent opportunities for further study and graduate work in the electronics field.

Personal interviews will be arranged at the convenience of qualified applicants

We suggest you write Mr. Walter Wecker, Personnel Department to get more information on career opportunities, advanced educational plans, and other advantages.

Admiral Corporation

3800 W. Cortland St.
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ELECTRONIC ENGINEERS & PHYSICISTS

OUR STEADILY EXPANDING LABORATORY OPERATIONS ASSURE PERMANENT POSITIONS AND UNEXCELLED OPPORTUNITY FOR PROFESSIONAL GROWTH IN

RESEARCH-DEVELOPMENT-DESIGN

- ELECTRONIC COUNTERMEASURES
- RADAR SYSTEMS
- MICROWAVE COMPONENTS
- AIRBORNE ANTENNAS
- MISSILE GUIDANCE CONTROL SYSTEMS
- SOLID STATE PHYSICS
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FORT WAYNE, IND.

THE EMPLOYMENT DEPT.

DEVELOPMENT & FIELD SYSTEMS ENGINEERS

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- RADIO COMMUNICATIONS
- RADAR
- MICROWAVE
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- TELETYPE

With a progressive, expanding, well established corporation. Interviews will be arranged for qualified applicants. Send complete biographical resume, experience and education to

Mr. J. E. Richardson
Personnel Director
MARYLAND ELECTRONIC MFG. CORP.
5009 Calvert Road
College Park 9, Maryland

ENGINEERS

**SYSTEMS
RADAR
SERVO
COMPUTER**

BACKGROUND: Responsible positions open for top level development and project engineers with practical and research experience in:

**Advanced Electronic Circuits and Systems
Microwave Radar
Microwave Receivers and Transmitters**



Requirements emphasize advanced analytical and/or management experience on highly complex electronic and electro-mechanical systems.

Kindly send resume and salary requirements to

The W.L. MAXSON Corp.
460 W. 34th St., NEW YORK 1, N.Y.

Electronic Filter Design ENGINEER

Excellent salary and opportunity offered by expanding, nationally known manufacturer of coils and filters. Location: Metropolitan Area, N.Y.C. Necessary qualifications: thorough knowledge of filter design theory.

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330 W. 42 St., New York 36, N. Y.

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Interesting Assignments In
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of
**SERVOS
GYROSCOPES
SCANNING DEVICES
ELECTRONIC DEVICES**

Experience required in development of delicate electromechanical, electro-optical or electronic systems.

AEROJET-GENERAL CORPORATION
SUBSIDIARY OF

The General Tire & Rubber Co.
6352 N. IRWINDALE AVENUE
AZUSA, CALIFORNIA

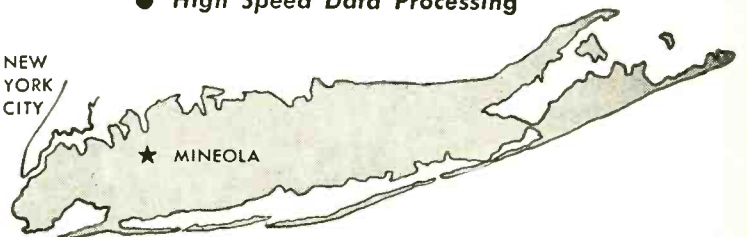
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initiative

PAYS OFF

Have you reached a blank wall?
Have your ideas been stymied?
AIRBORNE INSTRUMENTS LABORATORY INC. has challenging design and development problems, and is increasing its research staff. Men with BS, MS & PhD Degrees are being sought for creative work in the following fields:

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- Navigation and Communication Devices
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- Transistor Development
- Servo Mechanisms
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YORK
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Ideally situated on Long Island for suburban living with access to graduate study . . . and still close enough to reach New York City in less than an hour . . . AIRBORNE INSTRUMENTS LABORATORY INC. might prove to be "the spot you are looking for". Employee benefits include paid vacations and holidays, insurance, pension and hospital plans, tuition refunds, etc.

Pioneer 2-0600

Howard Gresens,
Personnel Manager



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INSTRUMENTS
LABORATORY** INC.

160 OLD COUNTRY ROAD, MINEOLA, L. I., N. Y.

ENGINEERS & TECHNICIANS

Insure your future in

COLOR TELEVISION

with
CBS-COLUMBIA

Positions, offering opportunity & stability, are open to men experienced in the Design & Development of TV Receivers.

AS FOLLOWS:

VIDEO CIRCUITS COMPONENT DESIGN
SYNCHRONIZED CIRCUITS

You will work with a staff of engineers who are leaders in the Television field and will have at your disposal the most modern electronic equipment.

Only men with proven record of resourcefulness & technical accomplishment will be considered.

- Remuneration high—Complete employee benefit program

To help us get better acquainted write us all about yourself. Interviews with out-of-town applicants arranged.

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CBS-COLUMBIA

(Division of Columbia Broadcasting System)

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Long Island City 1, New York

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Qualified Electronic and Electro-Mechanical engineers find happy association with a Western electronics pioneer and leader.

design
development
production

Commercial and military projects. Radar, DME, Communications, Noise, Test Equipment including color T.V. —Many others with real interest & challenge. Relocation expenses—excellent working conditions—Central location. Scheduled reviews & advances. Fine insurance plan. Move should not disturb urgent military projects.

Send complete resume, income history & requirements to engineering employment mgr.

Hoffman LABORATORIES, INC.

(A SUBSIDIARY OF HOFFMAN RADIO CORP.)

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LOS ANGELES 7, CALIF.

**CONTROL
INSTRUMENT
CO., INC.**

subsidiary of

**Burroughs
CORPORATION**

ELECTRONIC DEVELOPMENT ENGINEERS

This is an outstanding opportunity to join a constantly expanding organization which pays top salaries, and where the accent is on development work leading to large-scale future production. Your future here will be closely related to your abilities and achievements.

Important positions for EE's with over 5 years' experience in one or more of these fields:

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| (1) DIGITAL COMPUTERS | (5) INFRA RED |
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| (3) FIRE CONTROL | (7) GYROS |
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Send Complete Resume

33 35th Street

STerling 8-0658,

B'klyn, N. Y.

Ext. 177

When you WANT or OFFER

- EMPLOYMENT
- EQUIPMENT
(Used, or Surplus New)
- PRODUCTS
to manufacture
- CAPITAL
- INDUSTRIAL PROPERTY

USE THE SEARCHLIGHT SECTION

RATES

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The advertising rate is \$16.10 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

AN ADVERTISING INCH is measured 7/8 inch vertically on one column, 3 columns—30 inches—to a page.

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\$1.80 a line, minimum 3 lines. To figure advance payment count 5 average words as a line

POSITION WANTED undisplayed advertising rate is one-half of above rate, payable in advance.

BOX NUMBERS count 1 line additional.

DISCOUNT 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

EQUIPMENT WANTED OR FOR SALE Advertisements acceptable only in Displayed Style.

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Classified Section closes

Sept. 3, 1954 for the October issue.

**"SEARCHLIGHT"
is LOW-COST
NATIONAL**

CLASSIFIED ADVERTISING

Classified Advertising Division

McGraw-Hill Publishing Co., Inc.

330 W. 42nd St., New York 36, N. Y.

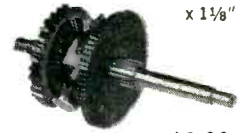
BIG WAR TERMINATION INVENTORY CLEARANCE SALE

DIFFERENTIAL GEAR SYSTEMS

AT GREATLY REDUCED PRICES

SPIDER DIFFERENTIAL

1 1/8" spur gear, 72 teeth. 1" gear, 31 teeth. Size: 2 3/8" long x 1 1/8" dia.



\$2.00 ea.

FOUR GEAR SPIDER DIFFERENTIAL

2"-96 teeth-48 pitch gear; 4" of 48 pitch, 12 teeth pinon wire. Size: 8 1/2" long x 4 3/8" wide x 2" high.



\$3.00 ea.

FRICTION DIFFERENTIAL

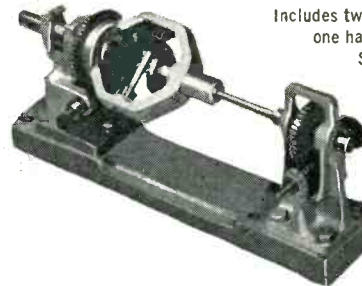
with two 5"-170 teeth spur gears. Size: 3 3/8" long x 5" wide x 5 1/2" high.



\$12.50 ea.

THREE GEAR SPIDER DIFFERENTIAL

Includes two worm gears, 24 pitch... one has 50 teeth, other 40 teeth. Shaft 1/2". Size: 11 1/4" long x 3 1/4" wide x 5 1/2" high.



\$12.50 ea.

SPIDER DIFFERENTIAL

Three spur gears. Size: 7 1/2" long x 1 3/4" wide x 2 3/4" high.



\$5.00 ea.

SIMPLE DIFFERENTIAL

1:1 reverse ratio, 60 teeth on large gear; 1/4" shaft. Size: 3" long with 1-15/16" dia.



\$3.95 ea.

SAVE UP TO 85%

EQUIPMENT FULLY GUARANTEED IMMEDIATE DELIVERY

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Pasadena 8, California
RYan 1-7393

WRITE OR WIRE FOR INFORMATION ON OUR COMPLETE LINE OF SURPLUS ELECTRONIC COMPONENTS. ALL PRICES NET F. O. B. PASADENA, CALIFORNIA.

SPIDER DIFFERENTIAL

Size: 6 1/2" long x 1 3/4" wide w/lt 3/16" shaft.



\$2.50 ea.

GEAR DRIVE SPIDER DIFFERENTIAL

System includes seven gears and spider. Size: 5 1/4" long x 3 1/2" wide x 3" high.



\$5.00 ea.

SIMPLE DIFFERENTIAL

1:1 reverse ratio. Size: 2 1/2" long x 29/32" dia. Shaft 1/8" dia.



\$3.50 ea.

DUAL SIMPLE DIFFERENTIAL

1:1 reverse ratio on both. Size: 3 1/4" long x 1-7/16" dia. Shaft size: 1/8" and 5/32".



\$7.50 ea.

SIMPLE DIFFERENTIAL

1:1 reverse ratio. Size: 6 3/4" long x 2 3/4" dia. Shaft size: 11/32".



\$7.50 ea.

SIMPLE DIFFERENTIAL

Size: 5 1/2" long x 2 1/4" dia. Shaft size: 3/8" on one end and 11/32" on other end. Hub is 1-3/32" dia. on each end.



\$7.50 ea.

SPIDER DIFFERENTIAL



Size: 2 3/8" long x 1-3/16" dia. Shaft size: 1/8".

\$2.50 ea.

PRECISION PLANETARY DIFFERENTIAL

1:1 reverse ratio, ring gear 3" dia., 120 teeth. Overall length 5 1/4". shaft dia. 11/32", 1/8" key on one end.



\$7.50 ea.

COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS

10 CM.—RG48/U Waveguide

10 CM ECHO BOX: Tunable from 3200-3333 Mc. For checking out radar transmitters, for spectrum analysis, etc. Complete with pickup antenna and coupling devices. \$27.50

10 CM ANTENNA ASSEMBLY: 3000-3300 Mc. Parabolic Dish, 20 inch Diam. Fed from dipole. Rotation: 360 Deg. Azimuth at speeds of 20 and 10 RPM. 1 ft. 20 deg. above and below horizontal. Motor-Driven by 2-28V motors, 4.5 A Total Drain. Azimuth info. is fed to seism mechanism, and elevation data is obtained from Azimuth potentiometer. Net weight 65 lbs. \$78.50

POWER SPLITTER for use with type 726 or any 10 CM Shepherd Klystron. Energy is fed from Klystron antenna through dual pick-up system to 2 type "N" output connectors. \$22.50 EACH

DIRECTIONAL COUPLER. Broadband type "N" Coupling, 20 db, with std flanges, Navy #CABV474-AN-2 \$32.50

LHTR. LIGHTHOUSE ASSEMBLY. Parts of LH39 APG 5 & APG 15, Receiver and Trans. Cavities w/assoc. Tr. Cavity and Type N CPLG. To Recvr. Uses 2C40, 2C43, 1B27. Tunable approx. 2400-2700 MGS. Silver Plated. \$22.50

BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfr. Bernard Rice, each \$27.50

MAGNETRON TO WAVEGUIDE Coupler with 723-A Duplexer Cavity, gold plated. \$45.00

721A TR BOX complete with tube and tuning plungers \$12.50

McNALLY KLYSTRON CAVITIES for 707B or 2K28 2700-2900 Mc. \$4.00

WAVEGUIDE to 3/4" Rigid Coax "Doorknob" Attenuator. Coupling Flange Silver Plated Broad Band. \$32.50

AS14A AP-10 CM Pick up Dipole with "N" Cables \$4.50

HOLMDELL-T0 TYPE "N" Male Adapters. W. E. #167284 \$2.75

I.F. AMP. STRIP: 30 MC, 30 db gain, 4 MC Bandwidth, uses 6AC7—less tubes. \$22.50

BEACON ANTENNA, AS31/APN-7 in Lucite Ball. Type "N" feed. \$22.50

ANTENNA, AT49A/APR: Broadband Conical, 300-3300 MC Type "N" Feed. \$12.50

"E" PLANE BENDS, 90 deg. less flanges. \$7.50

3 CM.—RG 52/U Waveguide

FLEX. WAVEGUIDE SECTION, 1 ft. long. With UG-40/UG-39 flanges. Attenuation is less than 0.1 db at 9375 Mc, and VSWR is less than 1.02. Rubber covered. \$7.50

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. \$85.00

Cross-Guide Directional Coupler, UG-40 output flange. Main Guide is 6" Long, with 90 Deg. "E" Plane Bend at one end, and is fitted with Std. UG 39/UG 40 flanges. Coupling figure: 30 db Nominal. \$22.50

VSWR Measuring Section: Consisting of 6" straight section, with 2 pick-up. Type "N" Output Jacks, mounted 1/2 Wave apart. \$7.50

RG52/U Waveguide in 5' lengths, fitted with UG 39 flanges to UG40. Silver plated. per length \$5.00

Rotating Joints supplied either with or without deck mountings. With UG40 flanges. each, \$17.50

Bulkhead Feed-thru Assembly. \$15.00

Pressure Gauge Section with 15 lb. gauge. \$10.00

Directional Coupler, UG-40/U Take off 20db. \$17.50

MAGNET AND STABILIZER CAVITY For 2141 Magnetron. \$24.50

Rotary joint choke to choke with deck mounting. \$17.50

90 degree elbows. "E" plane 2 1/4" radius. \$12.50

Microwave Receiver, 3 CM. Sensitivity: 10-13u Watts. Complete with L.O. and AFC Mixer and Waveguide Input Circuits, 6 LF. Stages give approximately 120 DB. gain at a bandwidth of 1.7 MC. 1/4" to Bandwidth: 2 MC. Uses latest type AFC circuit. Complete with all tubes, including 723A/B Local Oscillator. \$175.00

ADAPTER, waveguide to type "N". UG 81-U, p/o TS 12, TS-13, Etc. \$14.50

ADAPTER, UG-183/U round cover to special bit. Flange for TS-45, etc. \$2.50 ea.

3CM Motor-Driven Echo Box



Cavity Q is 30,000. Tuning range 80 mc. Motor operates from 24 VDC. Type "N" INPUT \$32.50

1 1/4" x 5/8" WAVEGUIDE

VSWR SECTION, 6" L, with 2-type "N" pickups. \$7.50

GG 98B/APQ 13 12" Flex. Sect. 1 1/4" x 5/8" OD. \$7.50

X Band Wave Gd 1 1/4" x 5/8" O.D. 1/16" wall-aluminum. \$7.50

Stg Tuner Attenuator W. E. guide, gold plated. \$6.50

Bi-Directional Coupler, Type "N" Takeoff 25 db. coupling. \$22.50

Bi-Directional Coupler, UG-52. Takeoff. 25 db. coupling. \$17.50

Waveguide-to-Type "N" Adapter, Broadband. \$17.50

JAN WAVEGUIDE FLANGES

UG 39/U \$1.10 UG 51/U \$1.65
UG 40/U \$1.25 UG 52/U \$1.40
UG 40A/U \$1.65 UG 52A/U \$3.40

CATHODE RAY TUBES

3FP7* \$1.50 5FP7* \$1.50
3EP1* \$2.50 *Mfrs. Quantity

MAGNETRONS

Type	Freq. Range (MC)	Peak Power Out (KW)	Duty Ratio	Price
2J21A	3345-9405	50		\$8.75
2J22	3267-3323	265		7.50
2J26	2992-3019	275	.002	7.49
2J27	2965-2992	275	.002	19.95
2J29	2914-2939	275	.002	44.95
2J31	2820-2860	285	.002	24.50
2J32	2780-2820	285	.002	28.50
2J38	3249-3263	5		16.50
2J39*	3267-3333	5	8.7	24.50
2J48	9310-9320	50	.001	24.50
2J49	9000-9160	50	.001	59.50
2J56*	9215-9275	50	.001	132.50
2J61†	3000-3100	35	.002	34.50
2J62†	2914-3210	35	.002	34.50
3J31	22-27KMC	50	.001	85.00
4J34	2740-2780	900		125.00
4J38	3550-3600	750	.001	169.45
4J42†	670-730	30	.003	169.50
5J23	1044-1056	475	.001	49.00
7008	698-700	40	.002	22.50
700D	710-720	40	.002	39.75
7065Y	3038-3069	200	.001	32.50
706CY	2976-3007	200	.001	32.50
725-A	9345-9405	50	.001	7.50
QK259†	2700-2900	800	.001	249.50
QK60†	2840-3005	100	CW	85.00
QK61†	2975-3170	100	CW	85.00
QK62†	3135-3350	100	CW	85.00

*—Packaged with magnet.
†—Tunable over indicated range.

THERMISTORS

D-164699 Bead Type DCR: 1525-2550 Ohms @ 75 Deg. F. Coefficient: 2% Per. Deg. Fabr. Max. Current 25 MA AC/DC. \$2.50

D-167332 Bead Type DCR is 1525-2550 Ohms. Rated 25 MA at .825-1.175 VDC. \$1.35

D-167613 Disk Type DCR: 355 Ohms @ 75 Deg. F.P.M. 2.5%, 1 Watt. \$1.35

D-166228 Disk Type 7120 Ohms @ 60°F. 4220 Ohms @ 80°F. 2500 Ohms @ 100°F., 1640 Ohms @ 120°F. \$1.35

VARISTORS

D-167208 \$1.35 D-171812 \$1.63
D-171858 \$1.42 D-172155 \$1.50
D-168687 \$1.35 D-167176 \$1.25

400 CYCLE TRANSFORMERS

Stock	Rating	Price
KS9608	1233VCT/.35MA, 1140VCT/.07A	\$5.79
M52-7102	6.3V/2.5A	1.45
M-7472426	1450V/1.0MA, 2.5V/.75A, 6.4V/3.9A, 5V/2A, 6.5V/3A, P/O 1D-39/APG-13	4.95
352-7039	640VCT @ 380MA, 6.3V/.9A, 6.3V6A 5V/V	5.49
702724	9800/8600 @ 32MA	8.95
KS9584	5000V/290MA, 5V/10A	22.50
KS9607	734VCT/.177A, 1740VCT/.177A	6.79
352-7273	700VCT/350MA, 6.3V0.9A, 6.3V 25A. 6.3V/.08A, 5V/CA	6.95
352-7070	222.5V/2.5A (2KV TEST) 6.3V/2.25A, 1200/100/750V @ .05A	7.45
352-7196	1140/1.25MA, 2.5V/1.75A, 2.5V/1.75A —5KV Test	3.95
352-7176	320VCT/50MA, 4.5V/3A, 6.3VCT/20A, 2x6.3VCT/6A	4.75
RA6400-1	2.5/1.75A, 6.3V/2A—5KV Test	2.39
901692	13VA	2.45
901699-501	2.77V @ 4.25A	3.45
901698-501	900V75MA, 100V/.04A	4.29
UX8855C	900VCT/.067A, 5V/3A	3.79
RA6405-1	800VCT/65MA, 5VCT/3A	3.69
T-48852	700VCT/806MASV/3A, 6V/1.75A	4.25
352-7098	2500V/50MA, 300 VCT 135MA	5.95
KS 9336	1100V/50MA TAPPED 625V 2.5V/5A	3.95
M-7474319	6.3V/2.7A, 6.3V/.66A, 6.3VCT/21A 27V/4.3A, 6.3/2.9A, 1.25V/.02A	4.25
KS9884	650VCT/50MA, 6.3VCT/2A, 5VCT/2A	3.75
52C080	400VCT/35MA, 6.4V/2.5A, 6.4V/15A	3.85
3232	1150-0-1150V	2.75
80G198	6VCT/.00006 KVA	1.75
302433A	6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5/3.5A	4.85
KS 9445	592VCT/118MA, 6.3V/8.1A, 5V/2A	5.39
KS 9685	6.4/7.5A, 6.4V/3.8A, 6.4/2.5A	4.79
70G30G1	600VCT/36MA	2.65
M-7474318	2100V/.027A	4.95
352-7069	2-2.5V Wdgs at 2.5A, Each Lo-Cap., 22Kv Test	5.95
352-7096	2.5V/79A, 6.4V/3A, 6.5V/6A, 6.5V/1.2A, D/O BC800	4.95
352-7099	360VCT/20MA, 1500V/1MA, 2.5V/1.75A, 6.3V/2.5A, 6.3V/6A, P/O BC-929	6.45
D163253	5200V/.002A, 2.5V/5A	5.35
M-7473957	2.5V/20A, 12KV Test	4.85
352-7179	250V/100MA, 6.5V/12ACT 5V/2A	3.45

TEST EQUIPMENT

TSX-45E ANALYZER

3 cm. Spectra Analyzer, similar to TS 148, but with greater resolution. Freq. range: 8500-9600 MC. Features: Absorption wavemeter, waveguide-Beyond-cutoff attenuator, 20 mc I.F. Strip, 120 db gain. Operates from 115V/220 V, 50-1200 CPS. Price On Request

TS 100 SYNCHROSCOPE

Precision range calibrator, with both circular and linear sweeps. Accuracy .0002. Circular sweep is 12.361 Usec per scan. Triggered linear sweeps of 0.8/30/350 msec. Variable delay up to 620 Usec. Operates from 115 v. 50-400 cy. Used, exc. \$165

BOONTOWN 102F. Sig Gen. 2700-3400 mc. Uses 2C40. Commercial equal to TS 155/UP. Used, exc. \$350

IE-19 Test Set. For checking out SCR 522 and other VHF equipment. Contains field strength meter, sig. gen. battery box, etc. Range: 100-156 mc. Used, exc. (Price on request)

PULSE NETWORKS

15A—1-400-50; 15 KV, "A" CKT, 1 microsec. 400 PPS, 50 ohms imp. \$22.50

G.E. #3E (3-84-810) (8-2-24-405) 50P4T; 3 KV "E" CKT Dual Unit; Unit 1, 3 sections, 0.84 Microsec. 810 PPS, 50 ohms imp; Unit 2, 8 Sections, 2.24 microsec. 405 PPS 50 ohms imp. \$6.50

7-5E3-1-200-67P, 7.5 KV "E" Circuit, 1 microsec. 200 PPS, 67 ohms impedance, 3 sections. \$7.50

7-5E4-16-60, 87P, 7.5 KV "E" Circuit, 4 sections, 16 microsec. 60 PPS, 67 ohms impedance. \$15.00

7-5E3-3-200-67P, 7.5 KV, "E" Circuit, 3 microsec. 200 PPS, ohms imp, 3 sections. \$12.50

H-616 10KV, 2.2 usec., 375 PPS, 50 ohms imp. \$27.50

H-615 10KV, 0.85 usec., 750 PPS, 50 ohms imp. \$27.50

KS8865 CHARGING CHOKE: 115-150 OH @ 100 MA, 32 —40H @ .08A, 21 KV Test. \$37.50

G.E. 25E5-1-350-50 P2T, "E" CKT, 1 Microsec. Pulse @ 350 PPS, 50 OHMS IMPEDANCE. \$69.50

KS9623 CHARGING CHOKE: 16H @ 75 MA, 380 OHMS DCR, 900V Test. \$14.95

G.E. 6E3-5-2000 50 P2T; 6 KV, "E" Circuit 0.5 usec @ /2000 PPS/50 ohms/2 sections. \$7.50

PULSE TRANSFORMERS

K35145—Pulse Inversion; PRI: 5 KV PK. Pulse Negative. Sec: Pos. Pulse, 4 KV; 1 usec. and .001 DUTY RATIO. \$6.50

54J318-1 3 wdgs. Ratio: 1:1:1, 1.10 uh/wdg. 2.5 ohms DCR. \$3.50

Westinghouse 4P37; Primary: 50 ohms imp, 750 v. Sec. 15 kv, 1000 ohms imp. Bifilar filament trans. built-in, delivers 12.6 c at 2.5 amp. (pri. 15 v. 400 cy.) \$37.50

RAYTHEON WX 4298E; Primary 4KV, 1.0 USEC. SEC: 16KV-16 AMP DUTY RATIO: .001 400 CYCLE FIL TRANS. "BUILT-IN" \$42.50

WECO: KS 9948; Primary 700 ohms; Sec: 50 ohms. Plate Voltage: 18KV. Part of APQ-13. \$12.50



GE #K-2449A

Primary: 9.33 KV, 50 ohms imp.
Secondary: 28 KV, 450 ohms
Pulse length: 1.75 usec @ 635/120 PPS. Pk Power Out: 1.740 KW
Bifilar: 1.5 amps. (as shown). \$62.50

GE #K2748-A, 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40/100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar rated at 1.3 Amp. Fitted with magnetron well. \$39.50

K-2745 Primary: 3.1/2.8 KV, 50 ohms Z. Secondary: 14/12.6 KV, 1025 ohms Z. Pulse Length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Bifilar: 1.3 Amp. Has "built-in" magnetron well. \$42.50

K-2461-A, Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV, 1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/150 KW. Bifilar: 1.3 Amp. Fitted with magnetron well. \$39.75

UTAH X-151T-1: Dual Transformer, 2 Wdgs. per section 1:1 Ratio per sec 13 MH inductance 50 ohms DCR. \$5.00

UTAH X-150T-1: Two sections, 3 Wdgs. per section, 1:1:1 Ratio, 3 MH, 6 ohms DCR per Wdg. \$5.00

66G71: Ratio: 4:1 Pri. 200V. Sec. 53V, 1.0 usec. Pulse @ 2000 PPS, 0.016 KVA. \$4.50

TR1049 Ratio 2:1 Pri. 220 MH, 50 Ohms, sec. 0.75 H. DCR 100 Ohms. \$6.75

K-904695-501: Ratio 1:1. Pri. Imp. 40 Ohm. Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise. \$8.95

RAY UX 7896—Pulse Output Pri, 5v sec. 4iv. \$7.50

RAY UX 8442—Pulse Inversion—40v + 40v. \$7.50

PHILCO 352-7250, 352-7251, 352-7287

RAYTHEON: UX8693, UX5986, UX-7307 \$5 ea.

W.E.; D-166310, D-166636, KS9800, D-163247. \$5 ea.

UTAH #2922, with Cracked Beads, but will operate at full rated capacity. \$5.00

UX 8693 (SCS #229627-54); 3 Wdgs. 32 turns #18 wire. DCR is: 362/372/4 ohms. Total voltage 2500 vdc. \$5.00

D-166173: Input: 50 ohms Z. Output: 900 ohms 3 Wdgs. Freq. range: 10 kc-2mc. P/O AN/APQ-13. \$12.50

K-2450: Pulse-Inversion auto-transformer; primary 13 kv, 4 usec. Output: 14 kv @ 100 kv peak. \$34.50

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp.) Duty Ratio: .001 max. Pulse duration: 5, 1.0, 2.0 microsec. Input voltage: 115 v, 400 to 2400 cps. Uses: 1-71B, 4-89-1, 3-72's, 1-73. New. \$155.00

ASD Modulator Units, mfd. by Sperry. Hard tube pulser delivers Pk. pulse of 144 kw. Similar to Mod 3 unit. Brand new, less tubes. \$85.00

Airborne RF head, model A1A, delivers 50 Kw peak output at 9000 mc. at .001 duty. Complete with pulser unit and all tubes. \$185.00

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. 25% DEPOSIT WITH ORDER. BALANCE C.O.D. RATED CONCERNS SEND P. O.

131 Liberty St., New York 7, N. Y. Dept. E-9 Chas. Rosen Phone: DIgby 9-4124

DYNAMOTORS

TYPE	INPUT		OUTPUT		Price
	VOLTS	AMPS	VOLTS	AMPS	
35X-089	19	3.8	405	.095	\$4.35
POX-15	14	2.8	220	.08	8.95
DA-7A	28	27	1100	.400	15.00
DM32A	28	7	540	.250	3.95
BD AR 93	28	3.25	375	.150	7.50
213M	27	1.75	285	.075	3.95
B-19	12	9.4	275	.150	6.95
DA-3A*	28	10	300	.260	6.95
			150	.010	
			14.5	5.	
PE 75 CM	28	19	1000	.350	22.50
BD 69†	14	2.8	220	.08	8.95
DA-C-31A	18	1.2	450	.06	4.49
DM 25†	12	2.3	250†	.05	6.95

† Less Filter. * Replacement for PE 73.
 † Used, Excellent.
 PE 94-C, Brand New..... 6.95

INVERTERS
 800-1B Input 24 vdc, 62 A. Output: 115 V, 800 cy, 7A, 1 phase. Used, excellent. \$18.75
 PE-218H: Input: 25/28 vdc, 92 amp. Output: 115V, 350/500 cy 1500 Volt-ampere. NEW \$37.50
 PE-90B: Input: 28 vdc, 36 amps. Output: 80 v 800 cy, 500 volt-amps. Dim. 13 x 5 1/2 x 10 1/2 \$22.50 New

"SEA-DOG" CONVERTER

Designed for Buships, this rugged, compact dynamotor is rated as follows:

INPUT: 115 VDC—6 AMPS
 OUTPUT: 13 VDC at 40 AMPS
 —OR—26 VDC at 20 AMPS

Brand New, with Switchbox and Spare Parts. **\$89.50**

POWER TRANSFORMERS

COMBINATION—115V/60~INPUT

CT 133 150-C-150V/65MA, 6.3V/2.5A, 6.3V/0.6A	\$1.79
CT 005 350-C-350V/125MA, 5VCT/3A	8.10
CT-048 350-0-350V/90MA, 5V/3A, 2.5VCT/10A, 6.3V/3.5A	5.68
CT-003 350-0-350V/70MA, 5VCT/3A, 2.5VCT/9A	5.10
CT-007 400-0-400V/110MA, 5VCT/3A, 5VCT/15A, 2.5VCT/3.5A	5.35
CT-312 250-0-250V/90MA, 5VCT/3A, 6.3VCT/2.8A	3.25

PLATE—115V/60~INPUT

PT 634 125V/45MA	\$1.15
PT 159 900-0-900 VAC (750VDC) or 800-0-800 VAC (650VDC) at 225MA DC	10.35
PT 167 1400-0-1400 VAC (300MADC) or 1175-0-1175 VAC (1000VDC) at 300MADC	25.50
PT 371 210-0-210V at 2.12Amp	9.45
PT 133 3140/1570V, 2.36KVA	105.00
PT 601 22,000V/23 MA, 5.35 KVA, "Lo-Cap" Donut	135.00
PT 521 7500V/.06A, Half-Wave	85.00
PT #13 2500V/12 MA H'SLD	4.95
PT 12A 280VCT/1.2A	3.95
PT-38-2 37.5/40V at 750 MA	2.15

THIS MONTH'S SPECIALS

PRESSURE SWITCH. For Art-13, CR2927-B-100, SPST, N.O. 18 AMP at 24 VDC up to 40. 900 ft. Trips at 9.72" mercury; resets at 12.10" Merc. Collins 260N457 (As Shown).....\$6.49

S-501 ARC-3 Push-Button Assy. SCS# 829824-83.1..... \$1.19

C-30 ARC-5 Control Box..... 1.50

SA4A/APA-1 Motor-driven Yagi Antenna Switch-24 VDC, DPDT..... 14.50

CHROMALUX Stand-by Heaters 115VAC-DC, 150 W, Screen Base Std. Socket MOD, XFMR Screen For SCR 274-SCS# 220047-3.2..... 1.19

MOD, XFMR Plate, Symbol T-104/ARC-3..... 2.15

AN-154-A Antenna For RC145, 148, etc. Consists of 3 Vert. Dipoles Working against a screen reflector. Range 150,000 MC..... 27.50

C.F.I. UNITS For Art-13, less tubes and crystals..... 12.50

SERVO-AMPLIFIER: 2CV3A1, Less Tubes..... 122.50

MK-12 Presurizing limit for APS-2, etc..... 27.50

TRANSTAT: Type TH 45BC, Input: 230-130V 2Ph., 60 Cy. Out: 0-260V, 11.7A 45Amp..... 165.00

INTERLOCK, Cory Type B986, Safety Type with Lock and Key, Contacts Rated at 20 Amp, DPST..... 2.85

TRANSTAT: Input: 130V/230V, AC 65Cy. Out: 0-260V/6.5A/1.69KVA Amertran TH 6 1/2 B. Used, Exc..... 15.00

POWER SUPPLY: PP 104/APT-5, for T-85/APT-5 Jammer..... 19.50

SPEAKER-TWEETER Used on Beachmaster Amplifier. Has 2" Voice Coil and Diaphragm. Response to 20,000 Cycles. Will Handle up to 50 Watts. Complete with Spare Cone..... 9.95

ANTENNA-AS-33APT-2, for Jammer Transmitter..... 8.50

CRYSTAL S: Type N45, Western Electric..... 75

VIBROPACK, Input 12VDC/0.58 Amp, Out: 2X4.3V/50MA, 2X45VDC/0.5MA, 2X85-VDC/5MA. New. Complete with Spare Vibrator, Well-Shielded and Portable..... 4.75

Send M.O. or Check Shipping Chgs. C.O.D.
COMMUNICATIONS EQUIPMENT CO.
 131 Liberty St Dept. E9 New York City 7, N. Y.

GUARANTEED COMPONENTS

All Fresh Termination Stock!
 Sold on a Money Back Guarantee!

OIL FILLED

1 mfd @ 600v	\$.59
2 mfd @ 600v	.79
3 mfd @ 600v	1.15
4 mfd @ 600v	1.45
5 mfd @ 600v	1.69
6 mfd @ 600v	1.85
8 mfd @ 600v	1.69
10 mfd @ 600v	2.75
1 mfd @ 1000v	.99
4 mfd @ 1000v	1.89
8 mfd @ 1000v	3.10
.5 mfd @ 1500v	.69
1 mfd @ 1500v	.99
4 mfd @ 1500v	2.25
5 mfd @ 1500v	2.45
8 mfd @ 1500v	3.95
10 mfd @ 1500v	4.95
.1 mfd @ 2000v	.99
.25 mfd @ 2000v	1.19
1 mfd @ 2000v	1.79
2 mfd @ 2000v	2.65
4 mfd @ 2000v	2.95
2x.25 mfd @ 2000v	1.39
.1 mfd @ 3000v	1.39
.25 mfd @ 3000v	1.59
5 mfd @ 3000v	1.79
.25 mfd @ 4000v	1.99
2 mfd @ 4000v	8.95
.1 mfd @ 5000v	1.70
.25 mfd @ 6000v	1.49
2x.1 mfd @ 6000v	2.49
2x.1 mfd @ 7000v	1.69
.1 mfd @ 7500v	2.49
.5 mfd @ 7500v	6.95
2x.4 mfd @ 7500v	6.95
2x.5 mfd @ 9000v	17.50
.1 mfd @ 25,000v	44.50

BATHTUBS

.95 mfd @ 400v	.28
5 mfd @ 400v	.35
1 mfd @ 400v	.46
2x.1 mfd @ 400v	.33
2x.25 mfd @ 400v	.35
3x.1 mfd @ 400v	.39
3x.25 mfd @ 400v	.39
.01 mfd @ 600v	.29
.1 mfd @ 600v	.35
.05 mfd @ 600v	.29
5 mfd @ 600v	.49
.25 mfd @ 600v	.39
2x.1 mfd @ 600v	.35
2x.05 mfd @ 600v	.35
2x.25 mfd @ 600v	.49
3x.1 mfd @ 600v	.32
2 mfd @ 600v	.55
2 mfd @ 600v Bot. Term.	.85
2 mfd @ 600v Side Term.	.89
2x1 mfd @ 600v	.49
.1 mfd @ 1000v	.44
.25 mfd @ 1000v	.49
2x.1 mfd @ 1000v	.39
2x.02 mfd @ 1500v	.34

AC UNITS

5 mfd @ 220v 60cy	1.69
3 mfd @ 230v 60cy	1.69
1.75 mfd @ 330v 60cy	.79
7.5 mfd @ 330v 60cy	1.85
10 mfd @ 330v 60cy	2.50
15 mfd @ 330v 60cy	4.50
8 mfd @ 440v 60cy	3.00
8 mfd @ 660v 60cy	4.25

PILLAR TYPE MICA

.09 mfd @ 1500v	7.95
.03 mfd @ 2000v	9.95
.0008 mfd @ 30,000v	59.50

UPRIGHT MICA

.002 mfd @ 6000v	2.45
.004 mfd @ 5000v	2.25
.008 mfd @ 300v	1.75

POSTAGE STAMP MICAS

33 mmf @ 300v 2%	7.00/C
120 mmf @ 200v 5%	8.00/C
2700 mmf @ 500v 5%	30.00/C
320 mmf @ 400v 2%	8.00/C
2000 mmf @ 200v 5%	22.50/C

CERAMICONS

10 mmf @ 500v	6.25/C
27 mmf @ 500v	8.00/C

CONNECTORS

AN 3102-28-2P	1.65
28-15S	3.17
22-4P	1.39
28-16P	2.80
14S-2S	1.67
18-1S	1.22
18-16S	.65
AN3106-18-8S	1.57
18-16P	1.04
28-14S	2.57
22-10P	1.44
28-16S	3.06
UG19/v	1.32
UG21/v	.61

Other Components Not Listed
 Write for Our Brochure

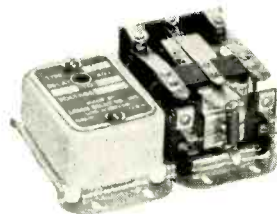
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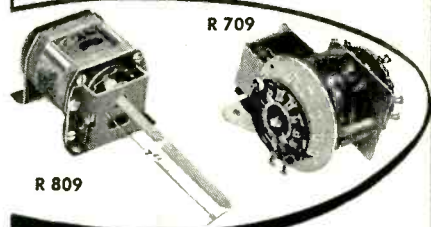
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Voltage Regulators and Cutouts	

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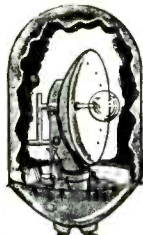
Navy type CA10-21444. Input: 105 to 130VDC. Output: either 26VDC at 20 amps, or 13VDC at 40 amps. Radio filtered and complete with line switch. New. \$89.50
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Type SO-1 (10CM) assembly with reflector, waveguide nozzle and drive motor. New. \$279.50
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Used in B29 planes for Central Station First Control Systems B2, B3 and B4. Used to drive Amplidyne 5AM31N9A and Control Motor 5BA50L2A listed in 1st column. New less tubes. \$29.50

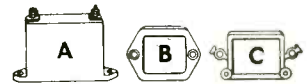
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1B24.....	3.9	3CP1.....	1.97
2A62.....	12.5	7BP7.....	2.75
2Y51.....	1.75	861.....	9.56
3B22.....	1.6	C6J.....	4.00

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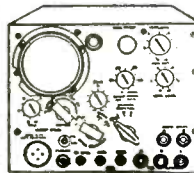
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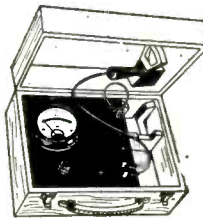


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A combined Panoramic Adapter and Oscilloscope. Has 3 coax input connectors for feeding in from receivers having I.F. of 455kc, 5.2 mc or 30mc. Designed also to be used as regular oscilloscope for testing other equipment. Has both vertical and horizontal push-pull amplifier inputs, etc. Complete with 21 tubes including 3" CR scope tube. For operation on 115V, 400 Cy. Price. \$99.50
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 AN/APA-10 TECH. MANUAL, 80 pages. Postpaid in U.S.A. \$1.00



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Used to calibrate field strength of magnets from .00 to 4000 gauss and indicate polarity. Probe has gap of 1 1/4". Beautifully built in hardwood case with hinged cover. Instructions for operation on under side of cover. Size 12 1/2 x 9 x 6 in. Ideal for lab and school use. New. An exceptional value. \$24.50

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Step by step type for use with potentiometer in D.C. Selsyn Control Systems. Bendix Type CAL14810 (MK1 Mod 0). 70 Volts DC input. \$4.95

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2 KkVA O'Keefe and Merritt. 115DC to 120AC, 50 cy., 1 Ph. Export Crated. New. \$125.00

MOTOR GENERATOR, TYPE CGU-2 Unit of U. S. Navy TCK-7 Transmitter Generator: 1800V. D.C. 0.4 A. 500V. D.C. 0.35A, 115V. D.C. 1.5A, 12 V. D.C. 2A. 3480 R.P.M. Self excited. Brand new including spare armature. \$95.00
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Complete self contained, dual 100/1000 kc crystal, multi-brator and harmonic amplifier. Calibrates with WWV and provides 1000, 100, and 10 kc check points from 100 to 45,000 kc. 115V, 60 cycles. New with instructions. \$23.95



Radar Repeater Adapters NAVY TYPE CBM-50AFO

A repeater unit for video signals and trigger pulses designed to work in conjunction with standard Navy radar equipments wherein provision is made for operation of remote P.P.I. sets. This adapter provides four video and trigger pulse lines for operating one or more remote P.P.I. control installations. 115 Volts, 60 cycles A.C. Dimensions are 3 1/2 x 21 x 15 in. New \$97.50

HIGH POT TRANSFORMER

Westinghouse, Pri: 115, 60 cy. Sec: 15, 000V C.T., @ .060 A.C.T. ungrounded. Excellent for high-potting tests. Size OA 12H x 8 1/2W x 9 1/4D. Weight 67 lbs. Fully enclosed steel case. Price. \$29.50

30-10,000 CYCLE MODULATION TRANSFORMER.

For RCA, Type 250-K Broadcast Transmitter (MI-7242) P to P Primary Imp. 15,000 ohms. Secondary Load 5,000 ohms. Size 11 1/4 x 9 1/2 x 13". Wt. 143 lbs. New. \$49.50

60 CYCLE TRANSFORMERS

G. E. Step-Down, 6KVA. Pri: 230/460. Sec: 115/125, 60 cy. Size: 20" x 11" x 9 1/2". Weight 225 lbs. Navy grey finish, integral junction box and mounting brackets. \$69.50
 Plate Trans. Raytheon, U-5815. Pri: 440/220, 60 cy. 3 phase. Sec: each phase 1310V @ 0.67A test 6000V. \$58.50
 Plate Trans. Pri: 115V., 60 cy., 1 Ph. Sec: 1470V. C.T. @ 1.2A tested at 5500V. RMS. Raytheon. Size 12 1/4 x 10 x 10 in. Shipping wt: 150 lbs. New. Price. \$27.50

ALTITUDE INDICATOR

Type ID-14A/APN-1. Brand New in original cartons. Special. \$29.95

SPECIALS

ATTENUATOR. Daven Type T-800 Circuit: TFE. Imp. 50,000., 0.5 D.B. per step. New. \$2.75
 CRT Shields for 3" Tube. \$2.75
 FIRE DETECTOR. Designed for use on aircraft, tanks, armored vehicles. Heating of outside casing as by fire causes inside snap blade switch to close. Good Experimenters item. \$3 for \$1.00
 JACK BOX. BC-1366M. Band New \$6.65
 JACK PLUG ASSEMBLY. 7870. New. \$1.00
 PARABOLOIDS. 17 1/2" dia. spun magnesium, 4" deep, 1 1/2 x 1 1/2" opening at apex. Per pair. \$12.50
 SAWTOOTH POTENTIOMETER. Continuous winding, 2 rotating and 2 take-off brushes. G225X95. \$2.75
 SOLENOID. 24V DC, 2 lb. pull, 3/4" stroke. New. \$1.45
 SWEEP GENERATOR CAPACITOR. 5/10 mfd., split stator coax type. High speed ball bearings. \$1.95

HIGH VOLTAGE OIL CAPACITORS

Mfd.	Volts	Price
.001	50 KV	\$22.50
.01	5 KV	1.29
.02	8 KV	2.65
.02	20 KV	9.75
.025	50 KV	26.50
.05-.05	50 KV	34.50
.1	3 KV	9.5
.1-1	4.5 KV	3.50
.135	7.5 KV	6.95
.2	50 KV	39.50
.25	15 KV	15.50
.25	20 KV	17.50
.25	50 KV	44.50
1	7.5 KV	6.95
1.	15 KV	39.75
2.	5.5 KV	9.50
2.	6 KV	12.50



SPECIAL \$6.95

9 CONDUCTOR CABLE



Army spec. CO-215 Weatherproof 9 Cond. No. 20 AWG stranded tinned copper, plastic ins., color coded, double vinyl jackets with tinned copper braid between. Dia. 9/16" made by G.E. Available 1000, 1500, 2000 ft. reels. Price \$12 ft. Sample 100 ft. Coil. \$15.00

TERMS: Rated Concerns Net 30, FOB Bronxville, New York. All Merchandise Guaranteed. Prices Subject to Change.

PHONE: DEERFIELD 7-0044

ELECTRONICRAFT INC.

Cable Address: Electcraft, N.Y.

27 MILBURN ST. BRONXVILLE 8, N. Y.

SEARCHLIGHT SECTION

WANTED

ARC-1, 3, ART-13, BC-342, 348, APS10, 15, TS-13, 35, 146, 147, 148, 174, 175, 263 ETC. All SCR, BC, AN, TS. ALL TUBES.

AN/TPS-3—AN/TPQ-3

Early warning and mortar tracking radar. This equipment is completely portable and can be set up for field use very quickly. 600 mc freq. 7" PPI 5'A scope. Range 20-120 miles. Very accurate ranging. POR.

AN/APS-2—AN/APS-15

10 and 3CM nav. and bombing radar. Has 5" PPI and 3'A scope.

AN/CPN-6

3 cm. High Pwr. Airport Radar Beacon. Output approx. 40 kw. Complete installation available. POR.

VE-VF-VG-VC-VD

We can supply many remote PPI indicators for use with various ground and marine radars. These sets are driven by synch-video-synchro pulses from the main radar. POR.

AN/ASQ-1 and 1A MAGNETOMETERS

This is an airborne magnetometer used to measure the magnetic flux of the earth and to locate submarines and other metallic objects by their distortion of the magnetic field. Complete sets available. P.O.R.

SA-SF-SG-SJ-SL-SO-SP-SQ NAVY AND MARINE RADARS

We can supply many types of Navy Radar sets for all uses. We can deliver complete installations of the above and also of the MK series fire control sets in many input voltages. Write for quotations.

AN/TPQ-2 K-BAND GROUND RADAR

Very late model set. Freq. 23,000mc. Used to plot trajectory of artillery and mortar shells and to enable counter battery fire with accuracy. It can also be used to measure height of cloud cover for weather forecasting. Mfg. WESTERN ELECTRIC. POR.

RADALAB

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Richmond Hill 18, New York
Phone Virginia 9-8181-2.3

Prices FOB NYC. Rated firms open account. Prices subject to change without notice.

CABLE: Radalab, NY
TELETYPE: NY-4-4361

COUNTERMEASURES

We specialize in and can supply search and jamming equip. to cover 30mc-10,000mc for Air Ground and Marine use. We can deliver complete installations of the following and many others. Write

SEARCH-DETECTION

AN/APR-4 38-400mc
AN/APR-2 300-1000mc
AN/APR-5 1000-3100mc
AN/APR-6 3000-1000mc

DIRECTION FINDING

AN/APA-17 300-500mc
AN/APA-24

INDICATING

AN/APA-10 Pan-adaptor
AN/APA-11 Pulse analyzer
AN/APA-38 Pan-adaptor

RECORDING

AN/APA-23 Signal & time rec.

JAMMING

AN/APT-1, 2, 3, 4, 5, 10
AN/APQ-1, 2, 3, 9
AN/APQ-1-20
Misc. Equip.
TDY, MRQ, SPT, SPQ, TPQ-1

AN/APN-3 SHORAN EQUIPMENT

This equip. is used for navigation and surveying. Operates in conjunction with AN/CPN-2 ground beacons. Operating freq. is 290mc. Accuracy is plus or minus 10 feet up to its range of 300 miles. Spares available. AN/CPN-2 ground beacons available. POR

AN/GSQ-1A

Speech scrambler for use on any comm. channel to insure privacy. We can supply complete installations of this equipment 28v DC input. Very compact. POR

SCR-508-528-608

10 channel freq.-modulated mobile military radio set. 20-27.9mc. Output 25 watt transmitter is crystal controlled. Receiver is tuneable. Input 12 or 24v DC.

SCR-291A

Automatic ground direction finder covering 1.5mc-30mc. Provides instant bearings on a C.R. indicator of any signal in its range. This equipment is transportable and can be set up quickly. 110v 60 cyc. POR

SCR-300A

Walkie talkie FM. covering 40-48 mc in 41 channels. This is the standard set of most of the nations of the world. Provides reliable communications up to 10 miles. 6, 12 volt vibrapacks RC-291G.P. and spares also available. POR

FIELD RADIO AND COMMUNICATIONS

SCR-284 Field Radio
SCR-536 Handi-Talkie
SCR-694-C Field Radio
SCR-506 Mobile Radio
SCR-808 Mobile Radio
SCR-188, 193 Mobile Radio
SCR-206 Direction Finder
AS-81-GR Direction Finder

AIRBORNE COMMUNICATIONS

RA-1B, ART-13, ARN-6, ARN-7, RTA-1B, ARC-1, 3, APN-9, DY-17, CRN-2 glide path ground station.

TEST SETS

LAF, LAG, TS-35A/AP, TS-62, TS-102, TS-125, RF-3/AP.

Spare parts for many equipments available. WRITE

SPECIALISTS JAN,RUGGEDIZED TUBES SPECIAL PURPOSE

1B24..... 6.75	3B28..... 3.75	F123A..... 6.25	FY..... 5.719..... 4.50	6097..... 1.50
1B24A..... 24.50	3B29..... 0.75	152TH..... 25.00	800..... 3.00	5725..... 3.00
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1B35A..... 7.50	3HP14..... 6.00	249C..... 7.00	837..... .90	5744WA..... 5.00
1B42..... 7.00	4D22..... 20.50	250TL..... 17.50	863..... .75	6110..... 11.00
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		316A..... .55	CK1090..... 6.00	
		TR337..... 10.00	1620..... 4.20	
		412A..... 5.00	1636..... 2.50	
		416A..... 75.00	1654..... 4.00	
		416B..... 75.00	2050..... 3.00	
		434A..... 9.00	5635..... 9.00	
		464A..... 6.00	5636..... 5.50	
		472A..... 2.00	5641..... 7.50	
		537..... 3.25	5643..... 8.00	
		706A/B/C/D..... 7.50	5644..... 11.50	
		701A..... 3.75	5645..... 7.00	
		702A..... 1.50	5646..... 7.00	
		CK705..... .80	5654..... 1.45	
		706B..... 15.00	5651..... 1.75	
		707A..... 15.00	5651WA..... 2.50	
		707A..... 4.00	5670..... 3.00	
		708A..... 2.00	5672..... 1.25	
		709A..... 1.75	5676..... 1.00	
		713A..... .75	5678..... 1.15	
		CK716..... 17.50	5686..... 2.00	
		CK721..... 7.50	5691..... 1.75	
		CK722..... 4.40	5692..... 7.75	
		728A..... 1.25	5693..... 5.00	
		728AV..... 4.00	5696..... 6.12	
		BY..... 3.50	5664..... 1.35	
		CV..... 10.00	5702WA..... 5.00	
		DY..... 5.703	5987..... 3.50	
		EY..... 5718..... 4.50	6005..... 2.50	
			6021..... 5.00	
			6073..... 3.25	
			6074..... 3.75	
			6080..... 3.50	
			6080WA..... 5.00	
			6082..... 5.00	
			6085..... 1.25	
			6096..... 1.50	
			6112..... 8.75	
			6113..... 1.25	
			6136..... 1.75	
			6146..... 4.65	
			6201..... 3.75	
			6215..... 3.25	
			1N21..... 1.75	
			1N21A..... 1.80	
			1N21B..... 1.90	
			1N23..... 2.25	
			1N23B..... 1.75	
			1N34A..... .75	
			1N35..... 2.10	
			1N38A..... .95	
			1N39..... 3.50	
			1N44..... 1.10	
			1N45..... 1.20	
			1N54..... .75	
			1N55A..... 2.00	
			1N63..... 1.80	
			1N69..... .80	
			1N70..... 2.40	
			1N72..... .85	
			1N91..... 1.50	
			1N92..... 2.50	
			1N93..... 3.50	
			1N152..... 3.50	
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SPECIAL 2K33A 47.50

SPECIAL CK5651WA 2.50

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HANOVER ELECTRONICS 125 CEDAR ST. NEW YORK 6, N. Y. RECTOR 2-1296

New Sola Const. Volt. Transformers
Input 95-125VAC, Output 118 VAC 60 cycle
165VA, \$24.95, 225VA \$32.95, 310VA \$42.50,
500VA (115V out) \$47.50, 6.3VAC @2.7A, \$6.95,
Raytheon 120VA (115V out) \$19.95
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RELAY SPECIALISTS
AUTHORIZED FACTORY DISTRIBUTORS
STRUTHERS-DUNN POTTER & BRUMFIELD
GUARDIAN STEPPERS—ACRO COIN SWITCHES
MIDGET RELAY—1 1/4" Long
DPNO + SPDT—6/12 or 24 v. coil \$15.00/doz.
6 Pole D.T. # BN 18D 39 110 v. DC coil \$6.95
RADIO DEVELOPMENT & SALES CO.
323 ATLANTIC AVE. ULSTER 5-0488 BKLYN. I. N. Y.

TELEPHONE RELAYS



Large Stock of
CLARE, TYPES C D & E
COOKE, AUTOMATIC—ELECTRIC
ALL TYPES OF COILS and PILE-UPS
Send Us Your Specs. for Our Quots

CLARETYPE G HALF SIZE SENSITIVE TELEPHONE RELAYS

Coil	Contacts	Operates at	Price*
1) 6500 ohms	2A	5 MA	\$2.50 ea.
2) 5800 ohms	3A	4 MA	2.50 ea.
3) 5800 ohms	2B-1C	5 MA	2.50 ea.
4) 4850 ohms	1C	4 MA	2.50 ea.
5) 3600 ohms	1C	6 MA	2.00 ea.
6) 4850 ohms	1A	5 MA	2.00 ea.
7) 3300 ohms	1A	ACTUATOR Micro-Switch	1.50 ea.

All above Relays may be used for continuous duty operation on 110V. D.C.

OTHER TYPE G TELEPHONE RELAYS

1) 1300 ohms	1A-1C	24 or 48V	\$2.50 ea.
2) 400 ohms	1A	24V	1.65 ea.
3) 500 ohms	1D	24V	1.65 ea.
4) 200 ohms	1A	24V	1.50 ea.

CLARE TYPE C STANDARD SIZE D.C. TELEPHONE RELAYS

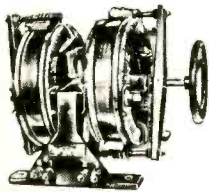
Coil	Contacts	Operates at	Price.
1) 1300 ohm	1B	24 to 85V.	\$2.25 ea.
2) 1300 ohm	2A-1B	24 to 85V.	2.75 ea.
3) 1300 ohm	2C-1A	24 to 85V.	3.00 ea.
4) 1300 ohm	4C-2A	30 to 85V.	4.00 ea.
5) 1300 ohm	2A-1B-1C-1D	30 to 85V.	3.00 ea.
6) 1300 ohm	6C	30 to 85V.	4.50 ea.
7) 2000 ohm	2C-1A	24 to 110V.	3.00 ea.
8) 2000 ohm	4C-2A	30 to 110V.	4.00 ea.
9) 2000 ohm	6C	30 to 110V.	4.50 ea.
10) 2000 ohm	8A	36 to 110V.	3.50 ea.
11) 3000 ohm	3A	24 to 150V.	2.75 ea.
12) 3600 ohm	2C-1A	24 to 150V.	3.00 ea.
13) 110V. AC	2C-1A	110V. AC 60cy	3.50 ea.

CONTACT SYMBOLS
A=Norm. Open B=Norm. Closed C=S.P.D.T.
D=Make Before Break

Chase Electronic Supply Co.
105-07 225 St.
Queens Village, N. Y.
HOllis 4-5033

HERSHEL RADIO CO. BIGGEST BUYS!

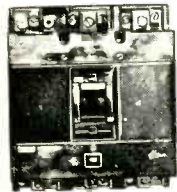
TRANSTAT 100 AMP



ONLY
\$149.

Pri. 115 VAC 60 cy
11.5 KVA Sec. 0-115 VAC 60 cy 100 Amp Max. MFD. Amertron.

CIRCUIT BREAKER



100 AMP
\$19.95

3 Pole 250 VAC. 100 Amp
15,000 Amp interrupting capacity. "Wesco".

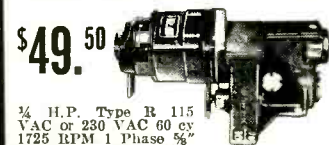
PULSE TRANSFORMER



\$62.50

G.E. Type K2746A
Dia. 9216934 Used
with Cy-153/
TPL-1.

GEAR REDUCTION MOTOR



\$49.50

1/4 H.P. Type R 115 VAC or 230 VAC 60 cy
1725 RPM 1 Phase 3/4" Shaft used with MX-186/TPL-1

SIGNAL GENERATOR I-122



ONLY
\$49.50

RF Signal 15 to 25 MC and 90 MC to 125 MC modulated at 400 cy or 625 cy 110 VAC 60 cy with carrying case.

OIL COND. PAPER CAN

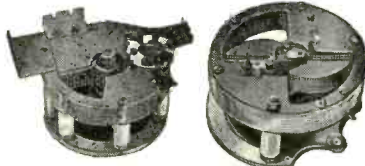
MFD	VDC	Price	MFD	VDC	Price
.05	3000	\$1.95	250	10	\$.39
.05	7500	2.29	500	12	.49
.1	4000	1.29	1000	3	.69
.1	7500	2.49	1000	15	.85
.5	2500	1.75	1000	25	1.29
2x.5	8000	1.49	1200	10	.95
1	3000	2.49	1600	15	1.29
1	3600	2.95	24000	3	1.49
1	5000	4.95	177	110 VAC	1.45
2	1000	.95			
2	3000	4.95			
4	1000	1.95			
6	600	1.29			
7	600	1.39			
8	600	1.75			
8	1000	2.49			
10	600	2.49			
10	1500	4.95			
Dual					
14	1000				
2x4	600	3.95			

POWER UNIT ARMATURE

For PE 85 Athure. Brand New MFD. Leece Neville.

\$17.50

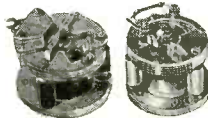
BUTTERFLY CONDENSERS



TYPE A 106 to 330 MC
Can Use 95S Type Tube

TYPE B 135 to 485 MC
Silver Plated.

YOUR CHOICE
\$4.95



TYPE C 300 to 1000 MC Can Use 368AS Tube Silver Plated

TYPE D 300 to 1000 MC Has Clip For Xtal Detector

DE-ION MOTOR WATCHMAN



\$9.95

3 Pole 3 Position Toggle 110 VAC 13.5 Amp-3 PH Motors 110 VAC 1/4 H.P.—Cont Rated 15 Amp CW. 2 Relay Heaters Trip at 3 Amp. Size 0 Mfd. Wesco.

RHEOSTAT 5.0hm



7.5 - 5.8 Amp 125V Used with Rectifier RA-39. **\$3.95**

RCA OUTPUT TRANS.



PP 6L6's 25 Watt Pri. 5.00 Ohm Sec. = 1 5.0 Ohm #2 6.0 Ohm Sidetone 15to15-.0 0 0 cy Plat. **\$1.95**

PLATE TRANS.



Only **\$9.95**
Pri. 90 VAC 60 cy 3 Amp. Sec. 6400 V. 1 Amp 6% x 5 1/4 x 6 1/4 H.

TRANSFORMERS

- Tapped Pri. 100, 105, 110, 115, 120, 125 VAC 60 cy Sec. 2 Windings 2.6V 10 Amp, 5.15V 3 Amp, 6.4V 5 Amp; 2 Windings 10.1V 8 Amp, 434 VCT—120 MA. **\$14.95**
- Pri. 117 VAC 60 cy Sec. 2000V. RMS 2.5 MA; 2.5 V at 1.75 Amp; 6.3V at 6 Amp Moisture Proofed. **\$2.75**
- Pri. 100 VAC 60 cy; Sec. 400 VCT 20 MA 6.3V 1 Amp; 5V 2 Amp. **\$1.29**
- Pri. 117.5 VAC 50-60 cy Sec. 6.3V. 0.9 Amp. **\$.95**
- Output Pri. Impedance 20,000 Ohms Sec. Impedance 2,000 Ohms 5 MA. DC. Freq Response ±2db. 100 to 5000 cy. Used with Freq Meter BC 438. **\$.95**
- Pri. 117.5 VAC 60 cy Sec. 220 V. at 50 MA; 5V. 6 Amp; 6.3V 2 Amp; 6.3V. 1 Amp. **\$1.29**
- Pri. 115V 400 cy. Sec. 800V 150 MA; 200V 30 MA 5V 3 Amp; 6.3V 7.5 Amp. **\$3.95**

CHOKES AND REACTORS

- Dual 4.5 H 120 MA; 4.54 70 MA. **\$1.95**
- Dual 1 H 400 MA; 4.2H 75 MA. **\$2.95**
- Swinging 2-7 H 550 MA. **\$5.95**
- 15 H 80 MA. 385 Ohm. **\$1.95**
- 1.3 H 1 VDC .020 Amp 60 cy. 600 V Ins. **\$.49**
- 5 H 225 MA 400V Ins. **\$1.95**
- Coil: Telephone Retardation—27 H 3 Amp 2 Ohm DC Res. **\$7.50**
- Coil Repeating 20, 135 and 1000 cy Signaling; Impedance Ratio 1-1. **\$4.95**
- Reactor Oil Filled 60 H 50 MA Used with SCR 682-A. **\$19.95**

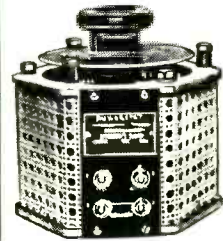
FILTER UNITS

- FL-15U Freq up to 57 MC—Drake. **\$3.95**
- FL-17 Used with Dyn. PE 101. **\$.95**
- FL-41 Used with Control Unit RM-35. **\$2.95**

BK22K RELAY

Used with SCR-220P Change over contains 28V Step Relay 5 Deck 6 Position SW D.P.S.T. **\$3.95**

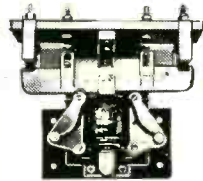
POWERSTAT



15 AMP
\$29.95

Pri. 115 V 60 cy Sec. 0-135 V-2KVA 1.5 Amp. Brand New.

CONTRACTOR RELAY



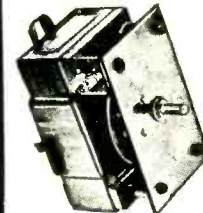
\$9.95

110 VAC 60 cy 4P.S.T. 15 Amp Contacts 2500 V. RMS to Ground Meca-lex Ins. Brand New.

RELAY SPECIALS

- Coil 14 VDC. 47 Amp 30 Ohm Res. D.P.S.T. Contacts 1000 VDC. G.E. **\$2.45**
- 6 Contact D.P.D.T. 115 VAC 6 Amp. 530 Ohm DC Res. Each. **\$3.95**
- Oper. Voltage 18 V. 60 cy. 4 Amp Contacts Rated 115 VAC 8 Amp. Single Winding Coil S.P.D.T. AC Res. of Coil 4 Ohm. **\$3.95**
- 24 VDC 5 Amp 240 Ohm—120 VAC 400 cy Inductive Load. Potter Brumfield. **\$1.49**
- D.P.D.T. 110 VAC 15 Amp Will Operate 24 VDC 15 Amp Fast Action. **\$2.45**
- D.P.D.T. Coil 3V. 27 Amp DC Res 11 Ohm. **\$1.49**

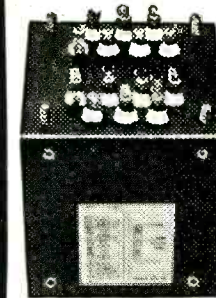
VARIABLE TRANSFORMER



\$4.95

Pri. 115 VAC 4 Amp 50-60 cy Sec. 30 to 135V. 25 Amp. Used with Dictaphone Reproducer MFD. U.T.C.

FILAMENT TRANSFORMER



\$4.95

Pri. 117 VAC 60 cy. Sec. #1 6.4V 12 Amp, #2 6.4 V 10 Amp, #3 5.0V 8 Amp, #4 5.0 V 3 Amp, #5 5.0V 3 Amp, #6 2.5V 1.75 Amp. Size 5 - 9/16" x 5 - 1/16" x 5 1/4" H.

CIRCUIT BREAKERS

- 115 Vac 3 Amp. **\$.95**
 - 115 Vac 15 Amp. **1.95**
 - 115 Vac 25 Amp. **2.45**
- Mfg. Heineman Co.

HERSHEL RADIO CO.

5245 GRAND RIVER
Detroit 8, Michigan
Phone TYler 8-9400

TERMS: Cash with order or 25% DOWN—BALANCE C.O.D. NET 10 DAYS RATED ACCOUNTS ALL PRICES NET F.O.B. DETROIT Merchandise Subject to Prior Sale

QUARTZ CRYSTALS!

Guaranteed to oscillate!

COMPLETE SETS

SCR-508

Channels 0-79. FT-241 HOLDERS. Fundamental crystal frequency range: 370.370 to 516.667 KC. Set of 80 crystals..... **\$25.00**

SCR-509 & SCR-510

Channels 0-79. FT-243 HOLDERS. Fundamental crystal frequency range: 5708.7 to 8340 KC. Set of 80 crystals..... **\$32.00**

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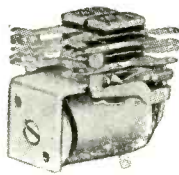
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SEPTEMBER, 1954

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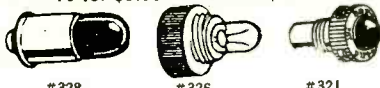
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1B21	1.50	4J38	150.00	718AY/EY	30.00
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1B23	6.95	4J40	150.00	720AY/GY	150.00
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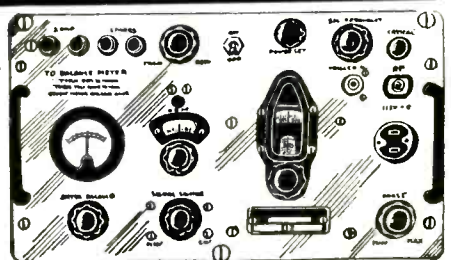


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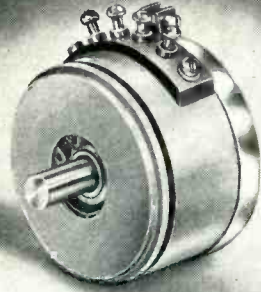
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Add per section, in.	0.500	0.615	0.615	0.615	0.880	1.560
Resistance Range, ohms:						
Linear, max.	50,000	140,000	178,000	283,000	100,000	350,000
Non-linear			Depends on function involved.			
Electrical Contact Angle	350°	350°	350°	350°	1080°	3600°
Functional Tolerances:						
Linear	±0.35%	±0.15%	±0.10%	±0.075%	±0.1%	±0.075%
Non-linear	to ±0.5%	±0.5%	±0.4%	±0.3%	±0.5%	±0.3%
Torque Per Section, oz. in.	0.5	0.5	0.5	0.5	1.0	1.0
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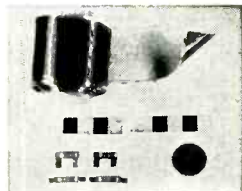
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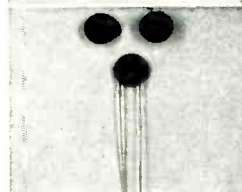
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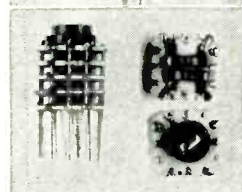
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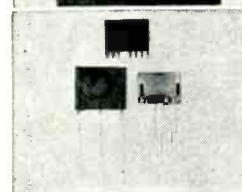
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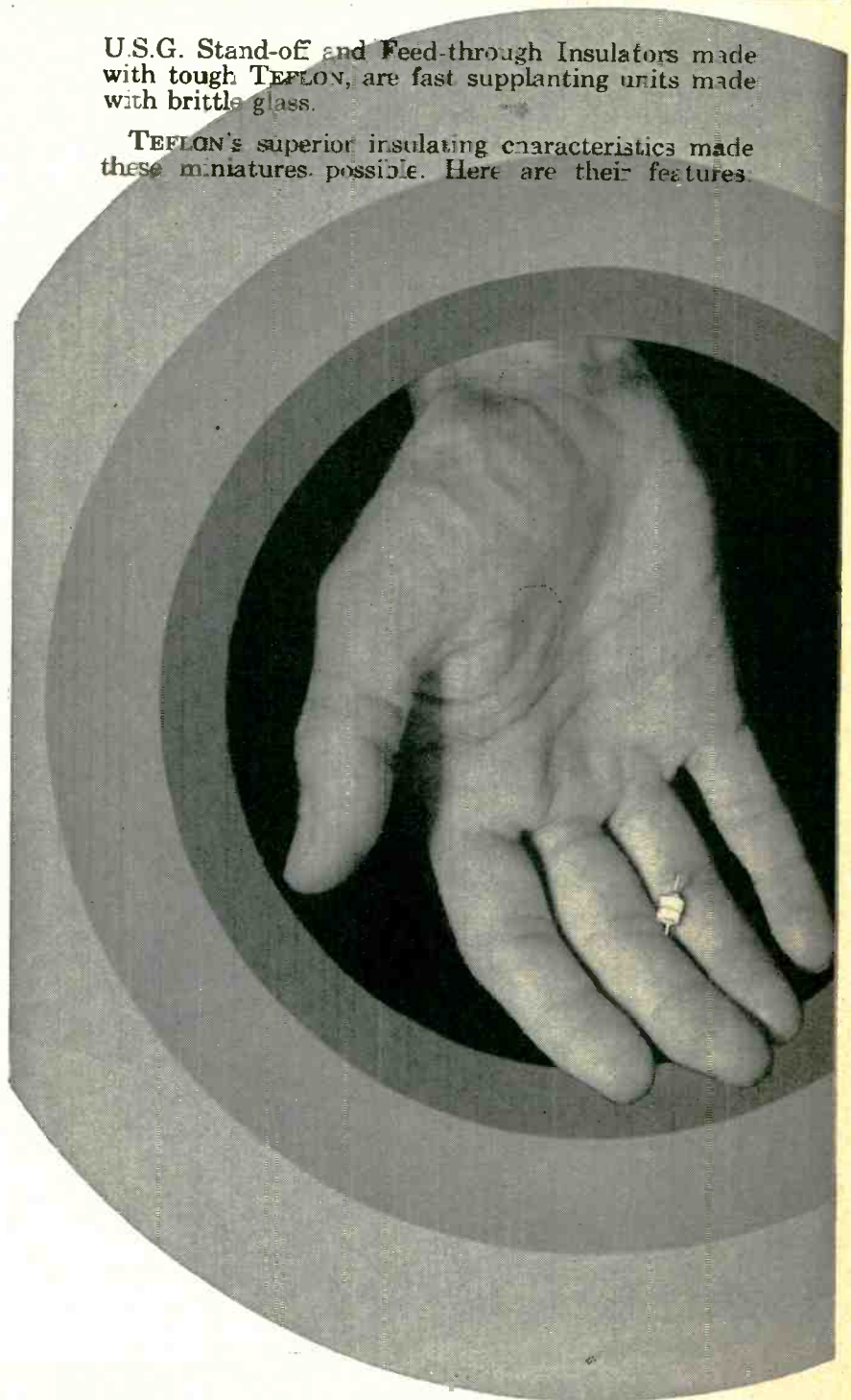
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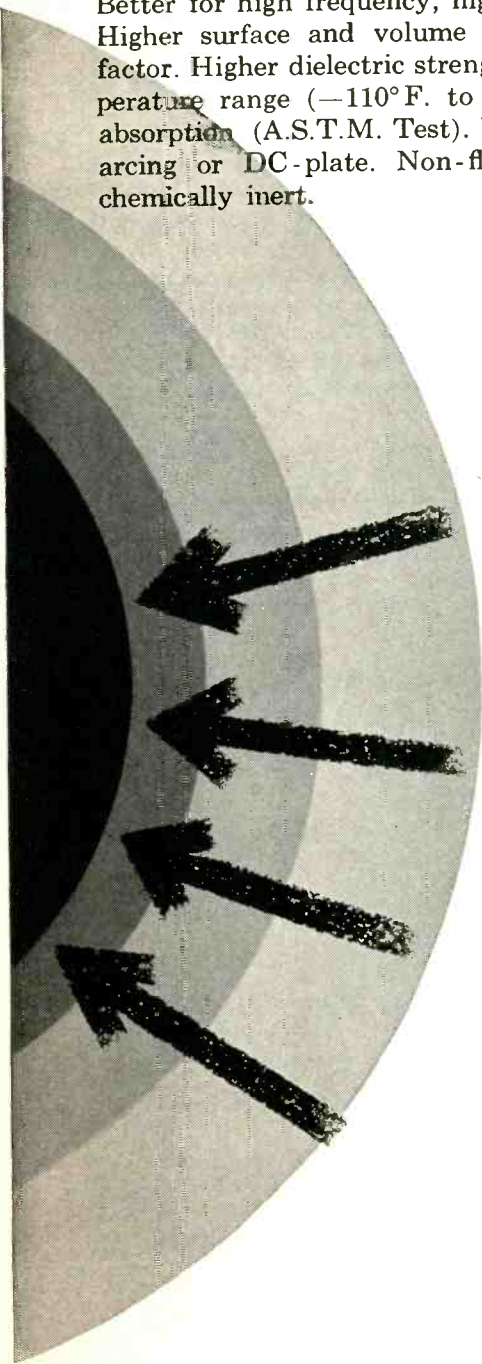


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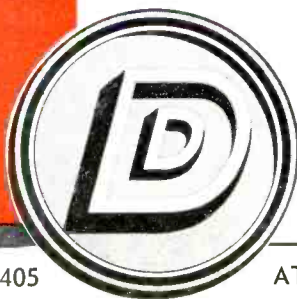
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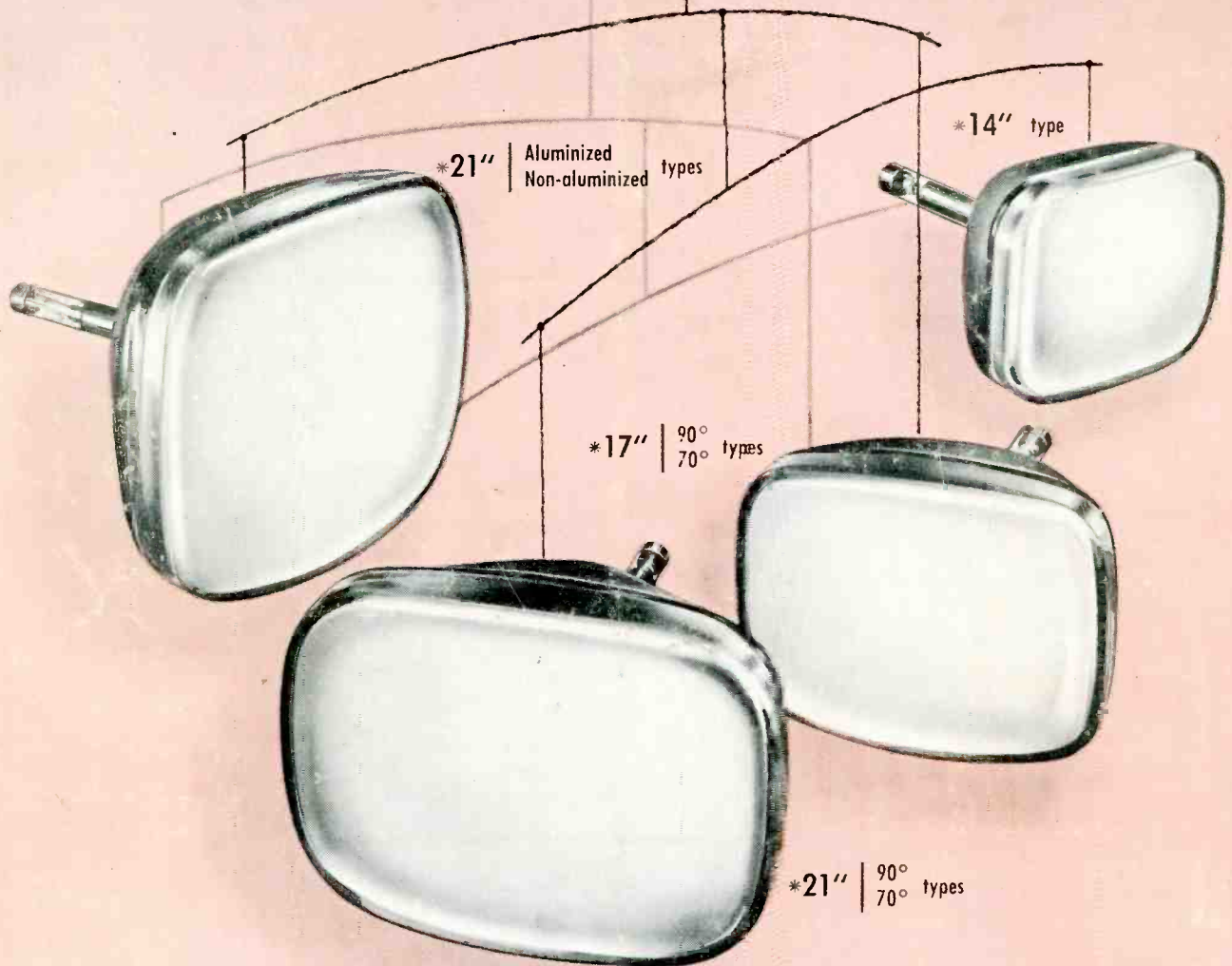
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