FEBRUARY · 1955
PRICE 75 CENTS

electronics

A McGRAW-HILL PUBLICATION

Mechanized TV Assembly Line

Sixteen air cylinders push parts into etched-wiring panels for eight-tube section of television set

LEADERS IN MINIATURIZATION FOR OVER TWENTY YEARS...

MINIATURIZED TRANSFORMER COMPONENTS FROM STOCK

Items below and 650 others in our catalog A.

HERMETIC SUB-MINIATURE AUDIO UNITS

These are the smallest hermetic audios made.

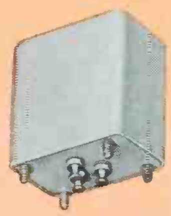
Dimensions . . . 1/2 x 11/16 x 29/32 . . . Weight .8 oz.

TYPICAL ITEMS

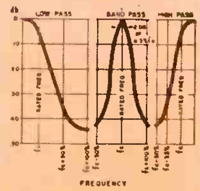
Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	DC in Pri MA	Response ±2 db (Cyc.)	Max. level dbm
H-30	Input to grid	TF1A10YY	50*	62,500	0	150-10,000	+13
H-31	Single plate to single grid, 3:1	TF1A15YY	10,000	90,000	0	300-10,000	+13
H-32	Single plate to line	TF1A13YY	10,000*	200	3	300-10,000	+13
H-33	Single plate to low impedance	TF1A13YY	30,000	50	1	300-10,000	+15
H-34	Single plate to low impedance	TF1A13YY	100,000	60	.5	300-10,000	+ 6
H-35	Reactor	TF1A20YY	100 Henries-0 DC, 50 Henries-1 Ma. DC, 4,400 ohms.				
H-36	Transistor Interstage	TF1A15YY	25,000	1,000	.5	300-10,000	+10

*Can be used with higher source impedances, with corresponding reduction in frequency range and current

COMPACT HERMETIC AUDIO FILTERS



UTC standardized filters are for low pass, high pass, and band pass application in both interstage and line impedance designs. Thirty four stock values, others to order. Case 1-3/16 x 1-11/16 x 1-5/8 – 2-1/2 high . . . Weight 6-9 oz.

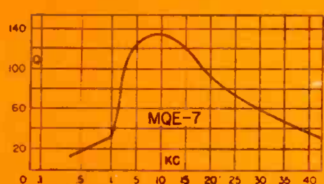


HERMETIC MINIATURE HI-Q TOROIDS

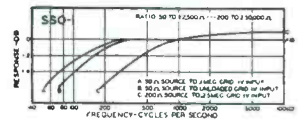
MQE units provide high Q, excellent stability and minimum hum pickup in a case only. 1/2 x 1-1/16 x 17/32 . . . weight 1.5 oz.

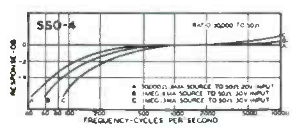
TYPICAL ITEMS

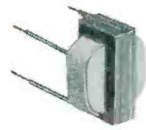
Type No.	Inductance	DC Max.
MQE-1	7 mhy.	135
MQE-3	20 mhy.	80
MQE-5	50 mhy.	50
MQE-7	100 mhy.	35
MQE-10	.4 hy.	17
MQE-12	.9 hy.	12
MQE-15	2.8 hy.	7.2



SUB-SUBOUNCER AUDIO UNITS







UTC Subouncer and sub-subouncer units provide exceptional efficiency and frequency range in miniature size. Constructional details assure maximum reliability. SSO units are 7/16 x 3/4 x 43/64 . . . Weight 1/50 lb.

Type	Application	Level	Pri. Imp.	MA D.C. in Pri.	Sec. Imp.	Pri. Res.	Sec. Res.
*SSO-1	Input	+ 4 V.U.	200 50	0	250,000 62,500	13.5	3700
SSO-2	Interstage /3:1	+ 4 V.U.	10,000	0-.25	90,000	750	3250
*SSO-3	Plate to Line	+20 V.U.	10,000 25,000	3 1.5	200 500	2600	35
SSO-4	Output	+20 V.U.	30,000	1.0	50	2875	4.6
SSO-5	Reactor 50 HY at 1 mil. D.C. 4400 ohms D.C. Res.						
SSO-6	Output	+20 V.U.	100,000	.5	60	4700	3.3
*SSO-7	Transistor Interstage	+10 V.U.	20,000 30,000	.5 .5	800 1,200	850	125

* Impedance ratio is fixed, 1250:1 for SSO-1,1:50 for SSO-3. Any impedance between the values shown may be employed.

OUNCER (WIDE RANGE) AUDIO UNITS

Standard for the industry for 15 yrs., these units provide 30-20,000 cycle response in a case 7/8 dia. x 1-3/16 high. Weight 1 oz.

TYPICAL ITEMS

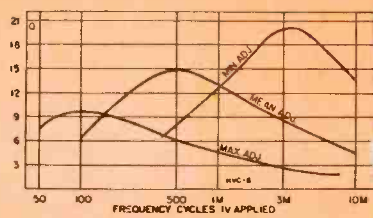
Type No.	Application	Pri. Imp	Sec. Imp
0-1	Mike, pickup or line to 1 grid	50, 200/250, 500/600	50,000
0-4	Single plate to 1 grid	15,000	60,000
0-7	Single plate to 2 grids, D.C. in Pri.	15,000	95,000
0-9	Single plate to line, D.C. in Pri.	15,000	50, 200/250, 500/600
0-10	Push pull plates to line	30,000 ohms plate to plate	50, 200/250, 500/600
0-12	Mixing and matching	50, 200/250	50, 200/250, 500/600
0-13	Reactor, 300 Hys.—no D.C.; 50 Hys.—3 MA. D.C., 6000 ohms		

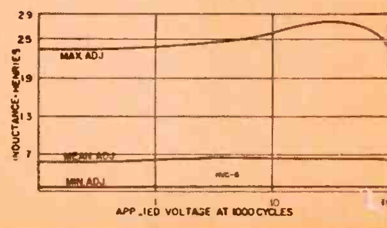
HERMETIC VARIABLE INDUCTORS

These inductors provide high Q from 50 - 10,000 cycles with exceptional stability. Wide inductance range (10 - 1) in an extremely compact case 25/32 x 1-1/8 x 1-3/16 . . . Weight 2 oz.

TYPICAL ITEMS

TYPE No.	Min. Hys.	Mean Hys.	Max. Hys.	DC Ma
HVC-1	.002	.006	.02	100
HVC-3	.011	.040	.11	40
HVC-5	.07	.25	.7	20
HVC-6	.2	.6	2	15
HVC-10	7.0	25	70	3.5
HVC-12	50	150	500	1.5





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electronics

A McGRAW-HILL PUBLICATION

FEBRUARY • 1955

MECHANIZED TV ASSEMBLY LINE—Automatic machine in Admiral's Chicago plant is equivalent to 16-worker conventional line for inserting resistors and wire jumpers. Blank panels start down conveyor line at far end. Details on p 182 .... COVER

SHOPTALK 2

FIGURES OF THE MONTH 6

INDUSTRY REPORT 7

Wall-Mounted TV Takes Giant Step 7
Manufacturers Appraise Prospects... 8
Transistor Portables Boost Output.. 10
Dry-Cell Business Shows Power..... 10
Computing Networks Aid Operations 10
FCC Estimates Its Budget.......... 12
Phosphor Sandwich Brightens Pix.. 12
Ultrasonics Invades New Markets... 12
Magnetron Sales Shift Into High... 14
Automatic Pilot Sales Increase...... 16
Industry Adds Up Volume For 1954 20
Mechanized Production Takes Hold.. 20
Financial Roundup 22
West German Industry Surges...... 22
Offshore Purchases Aid Europe..... 22
Radio Stations Blanket Country..... 24
Set Manufacturers Display Models.. 24
Transistor Radio Details.......... 26
Meetings 26
Industry Shorts 26

CROSSTALK 121

Launching Control for Guided Missiles 122
by J. B. Schrock

Dynamic Receiver Selectivity 128
by J. L. A. McLaughlin

Transistorized F-M Signal Generator 133
by J. J. Hupert and T. Szubski

Tape-Controlled Servos Speed Chemical Analysis 136
by Walt Donner

Phase Measurement for Color TV and F-M 142
by Kurt Schlesinger

Low-Noise Input Stage for Audio Preamplifier 147
by James J. Noble and John K. Hilliard

Special-Purpose Relays Gain New Uses 150
by Frank Rockett

Counting Circuit Batches Components 157
by P. E. Tooke

Wide-Band Analog Function Multiplier 160
by Joseph A. Miller, Aaron S. Soltes and Ronald E. Scott

Generating R-F Energy for 6-BEV Bevatron 164
by C. Norman Winningstad

Infrared Speeds Erasure of Dark-Trace Tubes 170
by F. Holborn and G. Hodowanec

Resonant-Loop Antenna for VHF Direction Finding 172
by James H. Eakin

R-F Filter Design (Reference Sheet) 176
by C. V. Longo and E. Wolf

CONTINUED ON NEXT PAGE

contents continued

ELECTRONS AT WORK 178

Air Force Scientists Plot Static 178
Electroluminescent Light Amplifier 178
Visible Light From Millimeter Waves 180
Radar and Computer Track Shells 180
Portable Analyzer Measures Mobiles 180
The Front Cover 182
Preparing High-Purity Silicon 182
Potentiometer Design 184
New Government Patents 190
Networks For A-C Servosystems 190
Intense Sound Bad for Tubes 196
Transistor Amplifier Performance 196
Weather Warnings 202
Photometer Tests Road Signs 204
Ion-Gage Supply Protects Tubes 210
Reactance Voltage Bias Source 218
Transistor Mike 222
Pertinent Patents 222

PRODUCTION TECHNIQUES 238

Air Cylinder Pushes Pallets On Line 238
Adhesive Tape Capacitors 238
Fiberboard Tote-Boxes for Parts 240
Punching Chassis Stencils 242
Blackboard Substitute 248
Red Flag on Clip Serves as Signal 248
Waterproofing Cable Connectors 250
Tape-Covered Clips Serve as Clamps 252
Precision Photoelectric Wire-Cutter 252
Pressurized Tube Plant 258
Jaws on Pliers Bend Pigtail Leads 260
High-Speed Color Bander 262
Flexible Drying Rods for Tubes 266
Carton Turnover Machine 266
Gap Gate for Coaxial Tuned Stub 268
Stripping Nylon Jacket from Wire 270
Winding Coils on Lathe 274
Paper Templates Speed Start of Line 276

NEW PRODUCTS 278

LITERATURE 324

PLANTS AND PEOPLE 336

NEW BOOKS 370

THUMBNAIL REVIEWS 377

BACKTALK 378

INDEX TO ADVERTISERS 423

SHOP

PROGRESS—Growth of our field is reflected in surveys we make every year of the feature articles that have appeared in ELECTRONICS.

During 1954, there were 218 feature articles, to a total of 777 pages. Some of the subjects covered and the number of pages devoted to each are tabulated below.

Audio	24
Antennas	21
Circuits	48
Components	73
Computers	30
Industrial	96
Measurement	59
Mechanical Design	63
Medical	13
Microwave	40
Nuclear Research	17
Radar	31
Sound Receivers	24
Sound Transmitters	31
Television Receivers	55
Television Transmitters	35
Transistors	66
Tubes	33

Miscellaneous pages include articles involving such subjects as drafting techniques, guidance for the blind, electrostatic field lines and astronomy.

Quite by coincidence, monochrome and color television split almost evenly in both receivers and transmitters.

AUTHOR'S FRIEND INDEED—Communications engineers will find the article on dynamic receiver selectivity on page 128 fits right into their reading passband.

In sending in the manuscript, the author tells us it took two years to write and mentions an engineer

electronics

FEBRUARY, 1955 Vol. 28, No. 2

Member ABC and ABP

TALK

friend, Bert Fox, who is now associated with him in receiver research. He says, further, "his laboratory is proving of great help on measurements . . . he has increased his equipment some $5,000 in the last few months to be of greater help to me. . . ."

FOREIGN—A number of readers write in from time to time commenting on some article that originated abroad and wonder how we obtained the information. One service to which we have access is the McGraw-Hill World News, which maintains correspondents in a number of foreign cities. These newsmen send along items automatically for all of the McGraw-Hill magazines and are on call for special requests.

Here's a typical example of how it works: associate editor Jack Carroll recently visited the Federal Telephone and Radio plant at Nutley, N. J. While there he noticed some interesting pieces of equipment and discovered they had been made in West Germany. A cable to Gerry Schroder, our correspondent in Bonn, requesting more data, triggered a roundup article on the electronics business in West Germany. You'll find it in this month's *Industry Report*.

SETUP TIME—Back in August, 1952, we bought from a news syndicate a short story describing a fog horn operated by radar from a lighthouse some distance away. It was a good story for the lay press, but we felt that it needed more technical "meat".

We wrote the syndicate; it wrote its correspondents in Canada; word was relayed back to us; we wrote the National Research Council of Canada; and officials there agreed that they would prefer to see a "more adequate technical paper published in ELECTRONICS". A busy engineer undertook the job of writing the paper.

Our correspondence file shows 26 letters changed hands. The new manuscript, being edited now, includes the latest modifications and data on another installation. It will appear soon.

NEW PHRASE—Editors, more than most people, are word conscious. Because of that we almost got all fouled up in preparing for publication the article on a transistorized f-m signal generator, page 133. The term, reactance tube, has complete acceptance today but when a transistor simulates a tube that is already simulating a reactance, what should you call it? This led to some semantic soul searching but we took the simple way, called it a reactance transistor. But it's not a new type of transistor.

NEGATIVE TIME—Part of our business that doesn't ever get talked about is the initiation of the work of preparing editorial material for issues many months in the future. Phrases such as deadlines and closing dates have become familiar to nearly everyone but they indicate only the last breathless moments when it is practically too late to do much except move two commas.

Which is to say that now, early January, we have started to prepare the editorial material that will go into the big extra issue, the Buyers' Guide, that comes out in the middle of June, first month of summer. It will contain articles having high reference value for design engineers engaged with circuits, equipment and components.

EDITORIAL DISTAFF, more photogenic than last month's group, includes assistants Arlene Schilp, Jane Christie, Susan Daniels and Gloria Filippone

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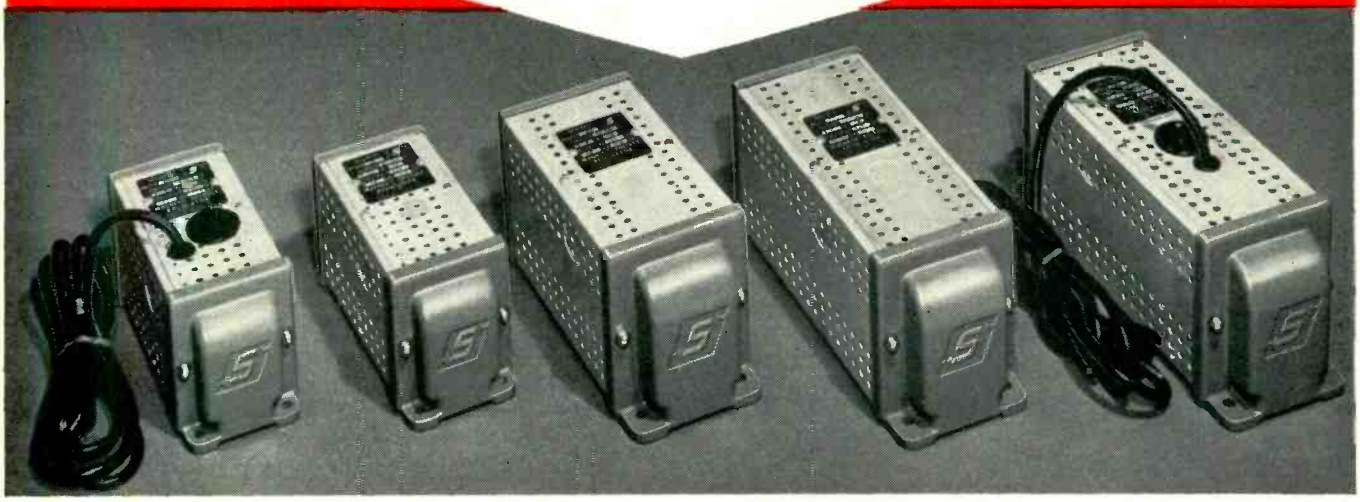
NEW! NEW!
NEW!

MAGNETIC VOLTAGE REGULATORS

These Magnetic Voltage Regulators, or Regulating Transformers, are the first units in a comprehensive line of equipment of this type being developed by Sorensen. They are primarily intended for incorporation into other equipment, where performance becomes more effective when the incoming line voltage is stabilized. However, they can be used as auxiliary line stabilizers.

The units now available have capacities of 15, 30, 60, and 120 VA. Soon to be added will be units of 250, 500, and 1000 VA capacities.



ELECTRICAL SPECIFICATIONS

Input voltage range	95-130 VAC, 1ϕ, 60 cycles.
Output range	115 VAC, RMS, 1ϕ.
Regulation accuracy	±0.5% against line changes.
Load conditions	±0.5% against line at any given load from 0 to full load.
Time constant	From 2 to 6 cycles for line changes.

MECHANICAL SPECIFICATIONS

Model MVR15	Length 6½", Width 2⅞", Height 3½"
Model MVR30	Length 6½", Width 2⅞", Height 3½"
Model MVR60	Length 8 1/16", Width 3½", Height 4¼"
Model MVR120	Length 9 5/16", Width 3½", Height 4¼"

Send for Catalog MVR1, which gives full information on the magnetic voltage regulator line.

Since Sorensen is now offering a new type of line voltage regulator, your inquiries regarding special requirements in magnetic voltage regulators will be welcomed. Write to the Sales Engineering Department, Sorensen & Co., Inc., 375 Fairfield Avenue, Stamford. Conn.

SORENSEN

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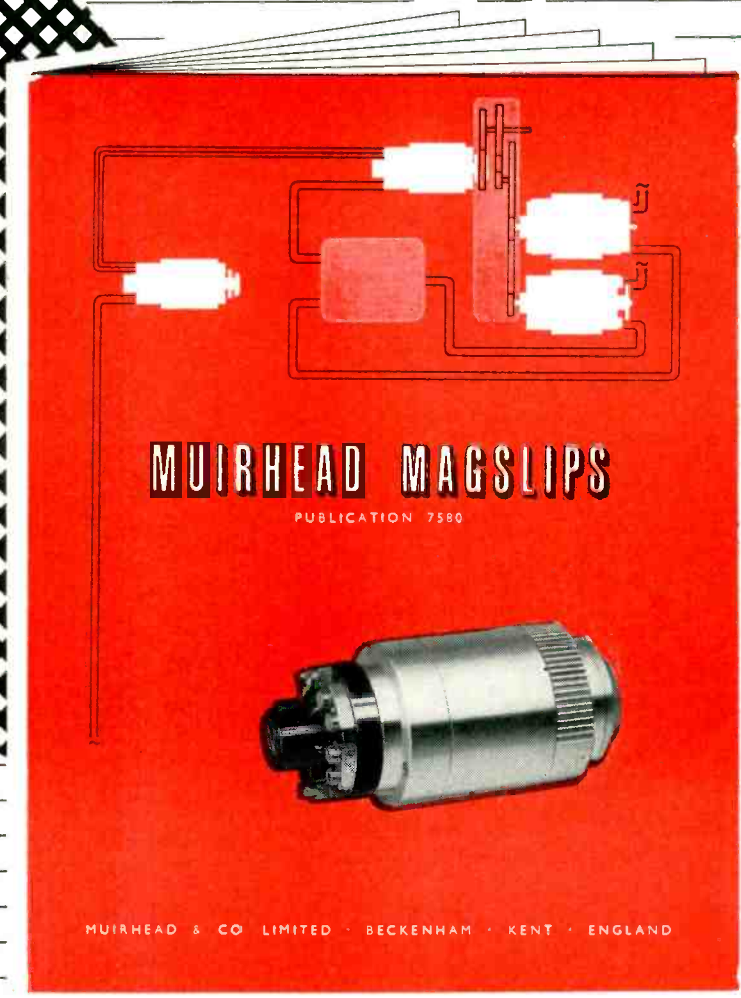

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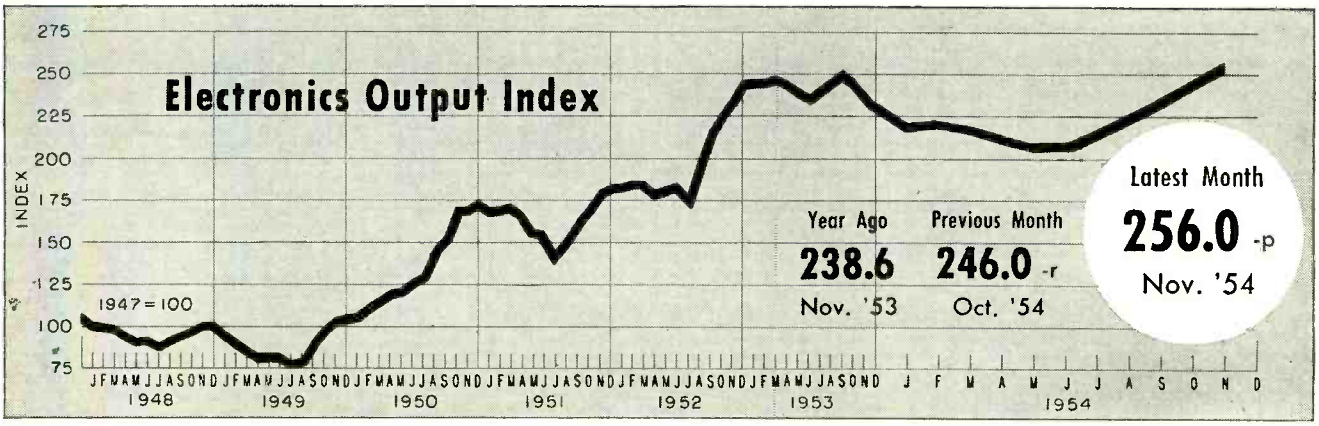


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month	Previous Month	Year Ago
	Nov. '54	Oct. '54	Nov. '53
Television sets, total	858,501	921,476	561,237
With UHF	168,563	161,432	197,311
Color sets	N.R.	2,907	———
Radio sets, total	1,098,725	997,788	1,065,785
With F-M	17,364	12,151	24,084
Home sets	327,973	343,269	457,151
Clock radios	272,583	220,505	171,356
Portable sets	93,716	97,331	127,316
Auto sets	404,453	336,683	309,962

RECEIVER SALES

(Source: RETMA)	Nov. '54	Oct. '54	Nov. '53
Television sets, units	779,105	799,164	678,295
Radio sets (except auto)	669,166	570,285	697,062

RECEIVING TUBE SALES

(Source: RETMA)	Nov. '54	Oct. '54	Nov. '53
Receiv. tubes, total units	38,781,863	42,347,794	31,606,971
Receiv. tubes, value	$27,618,868	$29,228,992	$22,514,227
Picture tubes, total units	1,157,866	1,269,674	693,396
Picture tubes, value	$27,140,693	$26,597,702	$16,794,812

SEMICONDUCTOR SALES

	Oct. '54	Sept. '54	Oct. '53
Germanium diodes, units / Silicon diodes, units	1,506,611	1,433,021	772,381

INDUSTRIAL TUBE SALES

(Source: NEMA)	Quarterly Figures: Latest Quarter	Previous Quarter	Year Ago
	3rd '54	2nd '54	1st '54
Vacuum (non-receiving)	$8,803,740	$8,971,335	$10,400,000
Gas or vapor	$3,570,586	$4,589,239	$3,300,000
Phototubes	N.R.	N.R.	$700,000
Magnetrons and velocity modulation tubes	$13,112,244	$16,135,274	$10,500,000
Gaps and T/R boxes	$1,476,407	$1,517,426	$1,700,000

TV SETS INSTALLED

(Source: NBC Research Dept.)	Latest Month	Previous Month	Year Ago
	Nov. '54	Oct. '54	Nov. '53
Total sets	32,262,000	31,674,000	26,364,000

BROADCAST STATIONS

(Source: FCC)	Nov. '54	Oct. '54	Nov. '53
TV stations on air	434	431	334
TV stations CPs—not on air	141	147	216
TV stations—new requests	18	17-r	236
A-M stations on air	2,650	2,627	2,509
A-M stations CPs—not on air	112	126	113
A-M stations—new requests	174	166-r	185
F-M stations on air	554	558	561
F-M stations CPs—not on air	11	10	20
F-M stations—new requests	3	0-r	5

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Oct. '54	Sept. '54	Oct. '53
Aeronautical	39,873	39,900	42,974
Marine	48,116	47,882	43,292
Police, fire, etc.	16,546	16,308	14,315
Industrial	22,579	22,339	19,287
Land transportation	7,071	7,012	6,287
Amateur	124,563	123,163	114,275
Citizens radio	8,945	8,229	4,026
Disaster	306	306	254
Experimental	627	607	480
Common carrier	1,737	1,730	1,374

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Oct. '54	Sept. '54	Oct. '53
Prod. workers, comm. equip.	381,300-p	369,800-r	428,400
Av. wkly. earnings, comm.	$70.47-p	$69.55-r	$66.97
Av. wkly. earnings, radio	$68.91-p	$68.34-r	$65.44
Av. wkly. hours, comm.	40.5 -p	40.2	40.1
Av. wkly. hours, radio	40.3 -p	40.2 -r	39.9

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Dec. '54	Nov. '54	Dec. '53
Radio-tv & electronics	409.3	454.6	268.1
Radio broadcasters	449.0	408.1	274.1

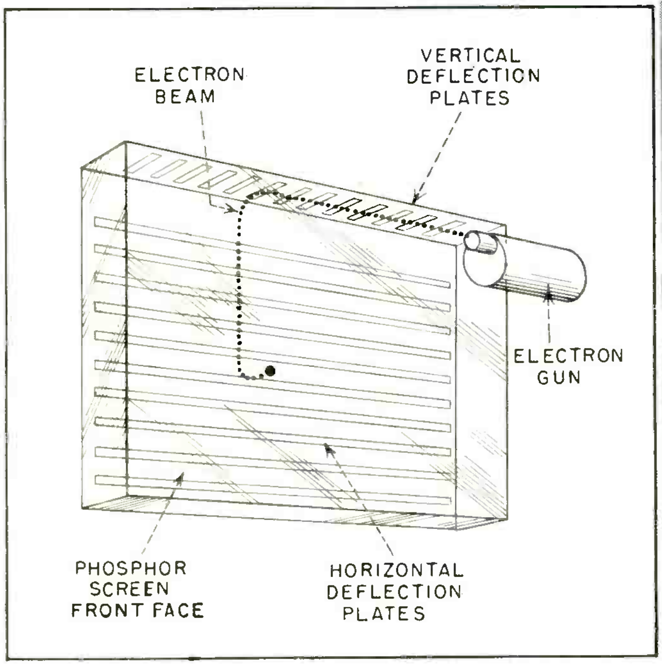
p—provisional; r—revised
N.R.—not reported

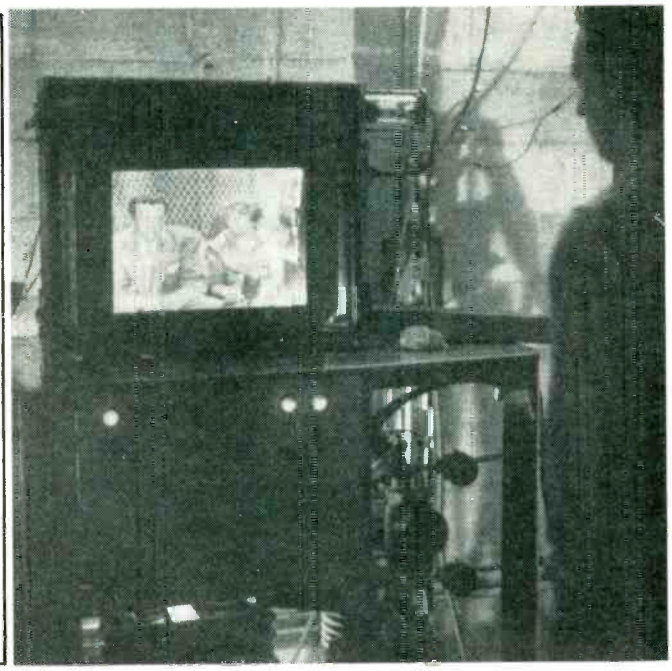
FIGURES OF THE YEAR

	TOTALS FOR FIRST ELEVEN MONTHS: 1954	1953	Percent Change	1953 Total
Television set production	6,513,292	6,766,040	— 3.7	7,214,787
Radio set production	9,138,955	12,267,441	—25.5	13,368,556
Television set sales	6,223,332	5,600,423	+11.1	6,375,279
Radio set sales (except auto)	5,272,155	5,608,447	— 6.0	7,064,485
Receiving tube sales	347,180,564	413,687,529	—16.1	437,091,555
Cathode-ray tube sales	8,904,106	9,194,851	— 3.2	7,582,835

INDUSTRY REPORT

electronics—February • 1955





POSITIONING cathode-ray-tube electron gun at side instead of rear of glass envelope reduces tube depth to approximately 3 inches. Laboratory model of black-and-white version of tube, shown in operation, helps . . .

Wall-Mounted TV Picture Tubes Take Giant Step

RADICALLY differing from conventional tv-picture-display methods, the flat picture tube developed by the west coast Electronics Division of Willys Motors, Inc. holds promise of revolutionizing the tv industry and simplifying aircraft instrumentation.

▶ **How It Works**—Unlike other proposed designs, the Willys tube does not use elaborate grid-switching techniques. It consists of a phosphor screen mounted between two glass plates. The entire unit is evacuated.

The electron beam is injected along a horizontal edge of the tube (see diagram) and flows in a field-free region along this edge, adjacent to a row of transverse deflection plates.

By controlling the voltages on these plates, the electron beam is bent at any desired place along the edge of the tube. The beam then flows vertically in a second field-free region between a series of transparent horizontal deflection plates and the electrically charged phosphor screen.

By controlling the voltages on the horizontal deflection plates, the beam is deflected into the phosphor screen at any desired vertical level.

A raster is scanned by sequentially changing the voltage on the transverse (vertical) and horizontal deflection plates simultaneously. All plates are kept at a high voltage except those opposite the position at which it is desired to bend the beam.

Use of electrostatic deflection eliminates the need for magnetic components, with their higher power consumption.

▶ **Spot Size**—One of the advantages of the new deflection system is said to be a large convergence angle, which solves the beam blow-up problem prevalent in other tubes. Spot size is such that a 2,000-line raster might be scanned.

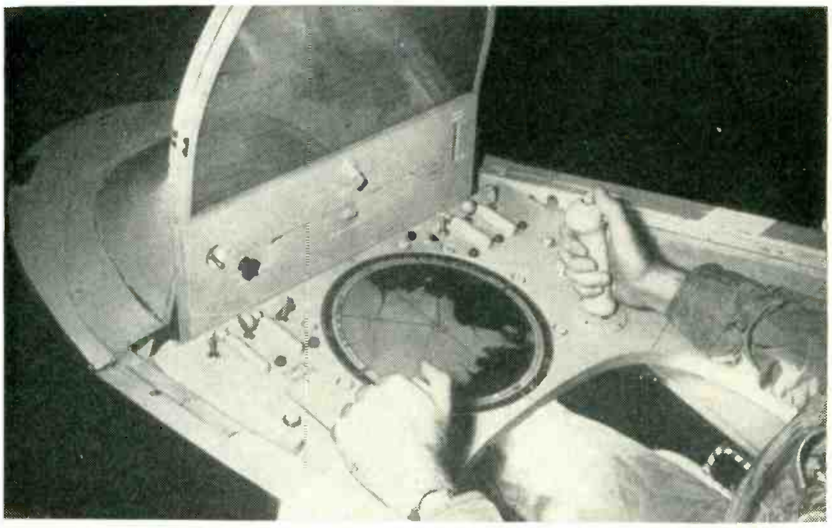
▶ **Screen Size**—Although the tv tubes shown have 15-inch screens, tubes having useful screen areas comparable to that of 24-inch conventional tubes have been built. The new tubes have an approximate depth of only 3 inches in comparison to approximately 20 inches for the conventional tubes.

▶ **Color Use**—It is reported that

progress is being made in developing a color-tv picture tube based on the above principles. Instead of using color dots or strips, the tube might use transparent color phosphors in a multilayer screen, very much like the three color-sensitive layers in some color films. Such a tube should have no registration problem and would be comparatively simple to manufacture. Color modulation would be accomplished by changing the relative potentials of the three phosphor layers.

▶ **Aircraft Instrumentation**—One model of the new tube was adapted by Willys for the Navy's long-range program for simplifying aircraft instruments. This program will result in an instrument panel consisting of only two basic instruments, both picture tubes.

One instrument will be a semicircular plate mounted vertically and directly in front of the pilot. It will be transparent and will not interfere with the pilot's vision during contact flight. Altitude, speed and attitude of the aircraft will be shown on the plate. Physical features such as mountains, which the pilot sees during contact flight, will be depicted artifically.



Mockup of aircraft cockpit made by Douglas Aircraft for Navy's instrument simplification program. The two large instruments are flat-plate Willys tubes on which information needed to fly aircraft will be displayed

The second instrument will consist of a round plate mounted below the first just inside the cockpit rim. Its appearance will be similar to that of a radar map. Broad physical features of the earth below will be depicted by analogy. Calibrations around the rim will indicate number of miles to pilot's base, fuel remaining and similar information.

Because picture tubes are used, several items of information can be selectively superimposed in the same area, to be used as needed. The tubes will not be used to present an actual picture of what is happening in the vicinity of an aircraft. The display the pilot sees will be an analogy of the visual world that he would see if flying by contact in clear weather.

The first interim instrument panel of the program is soon to be installed in aircraft now in production. The first simplified panel to be developed is now being tested.

Television Manufacturers Appraise Prospects for 1955

Companies see increased business for many of the industry's products

YEAR-END statements by manufacturers in the electronics field indicate the wide variety of activities from which business increases are expected in 1955. Following are excerpts from statements by seven electronics manufacturers:

▶ **Admiral**—We look forward to 1955 with cautious optimism. We believe industry tv sales will be off slightly during 1955 to an anticipated 6.5 million sets. From 100,000 to 200,000 color sets may be sold during the year. Mass production of color receivers at prices the public can afford will not be feasible until a color tube is available at approximately $50 to $60.

▶ CBS-Columbia—The outstanding news in the tv industry in 1955 will be the advances made in color tv. The generally anticipated good business, wide employment, increased consumer spending and expansion of new household units plus the growing replacement market (34.5 percent of the total receivers in America today are three or more years old) will help produce an excellent black-and-white receiver market in 1955.

▶ **Du Mont**—We anticipate a large sales volume of industrial closed-circuit equipment in the years ahead. As far as the tv receiver market is concerned, it still looks like primarily a black-and-white year. Color receiver production may not go much over 50,000 units in 1955.

▶ **GE**—New designs in germanium rectifiers will nearly quadruple the volume of this business in 1955. Use of two-way radio communication in mobile applications will continue to expand with total industry sales approximately 10 percent higher than in 1954.

▶ **Philco**—New developments will come from research laboratories with ever increasing speed. This will be true of the electronics industry with the tempo of development of guided missiles as a good example. This country is spending

(Continued on page 10)

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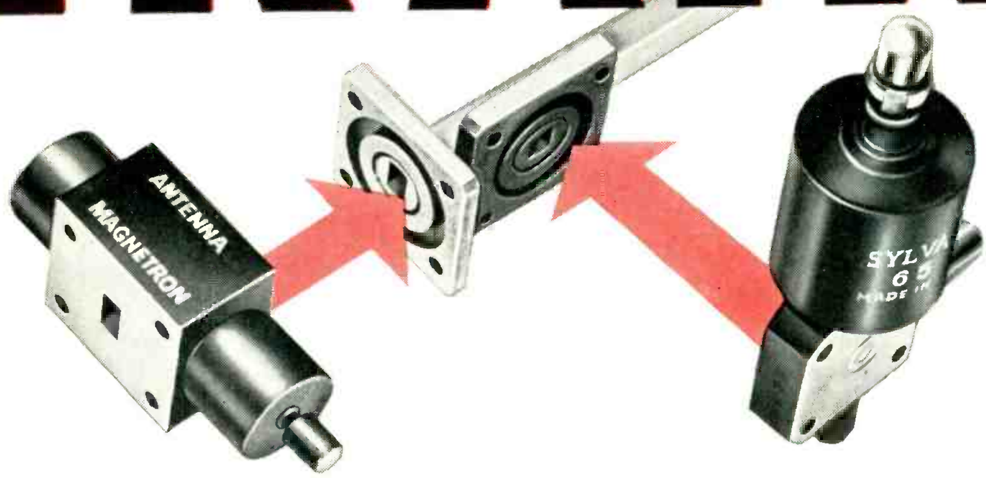
100 KW **35,000 MC**



These high-power microwave components incorporate "ceramic-windows" for peak performance at 100 KW power levels—mounting is simplified

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featuring . . .

- ✓ new unitized construction—dual ATR and mount in one package—eliminate "castle" mounts

TR Type 6545

featuring . . .

- ✓ metal reservoir—extends tube life
- ✓ doubly loaded Q of 50—eliminates critical tuning at any setting

ELECTRICAL SPECIFICATIONS (ATR Type 6546)

Center frequency	34,860 Mc.
Transmitter peak power (min)	20 kw.

LOW LEVEL CHARACTERISTICS

Equivalent conductance (max)	0.15
Tuning susceptance	±0.07

HIGH LEVEL CHARACTERISTICS

Arc loss (max)	0.9 db
Firing time (max)	10 secs.

ELECTRICAL SPECIFICATIONS (TR Type 6545)

Tuning range	33,814—35,906 Mc.
Transmitter peak power	100 kw.
Leakage power (max)	30 mw.
Insertion loss (max)	2.5 db
Ignitor Interaction (max)	0.2 db
Recovery time (max)	4 usec.

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$600 million on guided missiles in the current fiscal year and costs may exceed $1 billion next year.

▶ **RCA**—In the high fidelity field, sales for the industry as a whole during 1954 increased about 50 percent over 1953. It is believed that the annual retail sales total of $225 million in 1954 will rise to $300 million in 1955.

▶ **Raytheon**—The industry will place more emphasis on lower priced black-and-white tv with luxury priced monochrome sets giving way to an increased volume of color receivers. Between 300,000 and 400,000 color receivers will be produced by the fall of 1955 largely in 21-inch screen size.

PRODUCTION model of transistor radio evolves from lab design (right), as . . .

Transistor Portables Boost Output

Circuit using eight transistors provides high gain and 300-microvolt sensitivity

LATEST step in the application of transistors to consumer products is a portable radio receiver that uses eight transistors and performs as well as conventional sets.

The set covers the broadcast band from 530 to 1,620 kc and has a sensitivity of 300–500 microvolts per meter. The audio response is from 100 cps to 8 kc and the unit delivers 100 mw to its 4-in. loudspeaker.

▶ **Production**—On sale March 1, the transistor radio will retail for $79.95 and is a product of Raytheon's radio and television operations in Chicago. The set will run a year at a cost of 60 cents for its four size D flashlight batteries. Mercuric-oxide cells would provide 2½ years of operation.

▶ **Design**—The eight transistors function as mixer, oscillator, two i-f amplifiers, detector, first audio and push-pull output amplifiers. The set uses a standard 455-kc i-f. Commercially available miniature components are used. Weight is five pounds.

Dry-Cell Business Shows New Power

BATTERY manufacturers see an increasing market for their product. They see the plug-in radio becoming obsolete and the battery becoming the dominant power supply.

▶ **Market**—Today, there are about 9.1 million battery-powered radio sets in use. During 1955 this should reach 10.6 million sets. From this market the dollar volume in dry-cell sales may reach about $50 million this year.

According to the Department of Commerce, here is the way production of battery-powered radio-set shipments excluding portables, has run: 1953, 80,000; 1952, 201,000; 1947, 549,000. In the same years, portable radio shipments have run: 1953, 1.7 million; 1952, 1.7 million; 1947, 2.4 million. In 1954 the number of portable sets sold that use batteries totaled 1.5 million. Between 200,000 and 250,000 of these were the small personal type.

Computing Networks Improve Operations

Automatic coding unit lets design groups hook up to centrally located computer

ONE deterent to purchase of giant computers is fear that a single plant or laboratory will not be able to keep the big brain working round the clock.

One answer may be IBM's automatic coding unit called the transceiver. This device duplicates sets of punch cards at remote points by wire or radio circuits.

▶ **Application**—General Electric engineers at the aircraft gas turbine division, Evendale, Ohio; the medium steam turbine generator and gear department, Lynn, Mass.; and the large steam turbine generator department, Schenectady all wanted to use a large computer in their designing.

The only computer, an IBM 701, was at Evendale. The answer was a party-line hookup linking Evendale with Lynn and Schenectady using punch card transceivers. To handle the overflow work, GE rented the 701 at IBM headquarters in New York eight hours a day, Evendale acts as "central", receiving problems and routing them either to its own computer or to New York.

The station at New York will be discontinued in 1955 when GE receives other electronic data processing machines now on order.

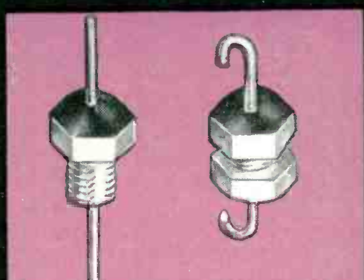
▶ **Other Setups**—A similar computing hookup was used experimentally at United Aircraft's Pratt and Whitney division in Hartford, Conn. Here too, the problems involved jet engine design. However, the only link was one from engi-

(Continued on page 12)

new design freedom with

Sprague Button Ceramic Capacitors


Self-Tapping Stud Style


Flatted Screw Thread Mounting Style


Screw Stud Mounting Style


Dual-Section Threaded Shell Style

Sprague button ceramic capacitors offer distinct advantages to designers of ultra-high-frequency TV receivers and electronic equipment. These tiny capacitors are available in many styles for coupling, bypass, and feed-thru applications. Their wafer-dielectric construction makes possible higher self-resonant frequencies than with capacitors using conventional dielectric tubes. Button stand-off types, for example, minimize ground inductance and hold it at a fixed value while providing a short, uniform bypass to ground. They also provide effective shielding of the capacitor element by the outer metal shell. Sprague button capacitors are sealed against moisture by a high temperature resin, and are conservatively rated at 500 volts d-c.

For complete engineering data, write for Bulletin 605A to Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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neering offices to the computing center.

The Air Force is another customer for the punch card transceiver. An experimental link was used recently to transmit statistical data on men and equipment to Washington from Port Lyautey, French Morocco. Using a Navy radio link, data was transmitted at 1,000 characters a minute (ELECTRONICS, p 184, Jan. 1955).

FCC Estimates Its Budget For '55 And '56

AMOUNT requested by President Eisenhower for the Federal Communications Commission for fiscal year 1956, which begins July 1 of this year, is $6.7 million. The amount authorized in fiscal 1955 for FCC was $6,544,400 while the actual amount obligated in 1954 was $7.4 million.

However, with reimbursements from other accounts, the total available for obligation in fiscal year 1956 is $6,888,335 compared to an estimated $7,075,775 for fiscal '55. The '55 figure includes other accounts and $150,000 reappropriation of prior year balance.

▶ **Uses**—Obligations by activities include: Applied technical research and frequency allocation—1956 estimate, $431,174; 1955 estimate, $437,090 compared with $447,576 in 1954. This activity provides the Commission with basic information for determining the best utilization of the radio spectrum.

Broadcast estimate for 1956 is $1,205,764. For 1955 it is $1,243,992 compared with $1,383,989 for 1954. The slight decrease is due to reduced tv station applications.

Obligation for licensing and regulating safety and special radio services for 1956 is estimated at $724,375 compared to $705,735 for 1955 and an actual expenditure in 1954 of $743,534.

Field engineering and monitoring is estimated at $2,269,709 for 1956 and $2,259,908 for 1955 compared with the 1954 appropriation of $2,339,100.

Phosphor Sandwich Brightens Pix

New solid-state device amplifies light ten times. May aid television viewing

DIRECT amplification of light without electron tubes can be accomplished by a 10-micron film of phosphor sandwiched between conducting plates one of which is made of electrically conducting glass.

Possible applications include x-ray fluoroscopy, photography and see-in-dark-devices utilizing ultraviolet sources. The light amplifier may also brighten television images to enhance the performance of monochrome projection tv units and aid development of picture-on-the-wall screens. The light amplifier is a development of GE Research Laboratories.

▶ **What It Does**—At a recent demonstration, a fluorescent screen four inches across was illuminated with ultraviolet light from a slide projector. Then d-c voltage was applied to the conducting plates and a yellowish image was produced. The glow became brighter as the voltage was increased to about 100 v.

Application of ultraviolet light with no voltage on the light amplifier caused only a faint glow.

▶ **How It Works**—The phosphor film is vapor-deposited at high temperature and low pressure. It consists of zinc sulfide activated with manganese. The chemical content of the film determines what radiation wavelengths the light amplifier will accept and what wavelengths will be returned.

The size of the screen is limited by the size of the vessel available for evaporating the phosphor film on the glass plate.

▶ **Applications**—Probably the most immediate application is in X-ray fluoroscopy. A physician can use a safer dose of x-radiation and study the patient a longer time if one of the light amplifying screens is used to brighten the image.

A screen may be developed to fit over the face of a tv tube and permit lower voltage operation or in projection tv the image may be focused on the light amplifying screen.

One development problem is to reduce the time constant of the phosphor so that images may be erased as fast as produced.

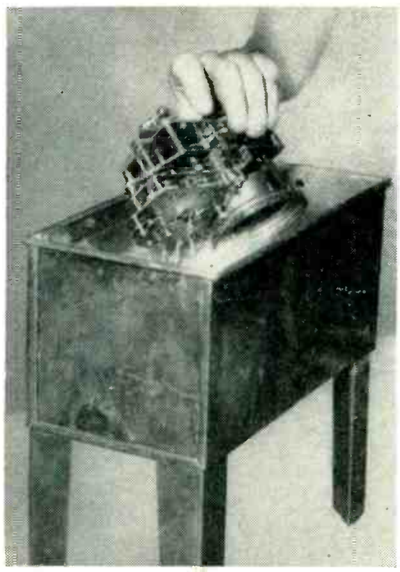
For more details on the device see p. 178.

Ultrasonic Processing Invades Three Markets

Tinning, drilling and cleaning show most industrial promise; 1954 sales approach $1 million

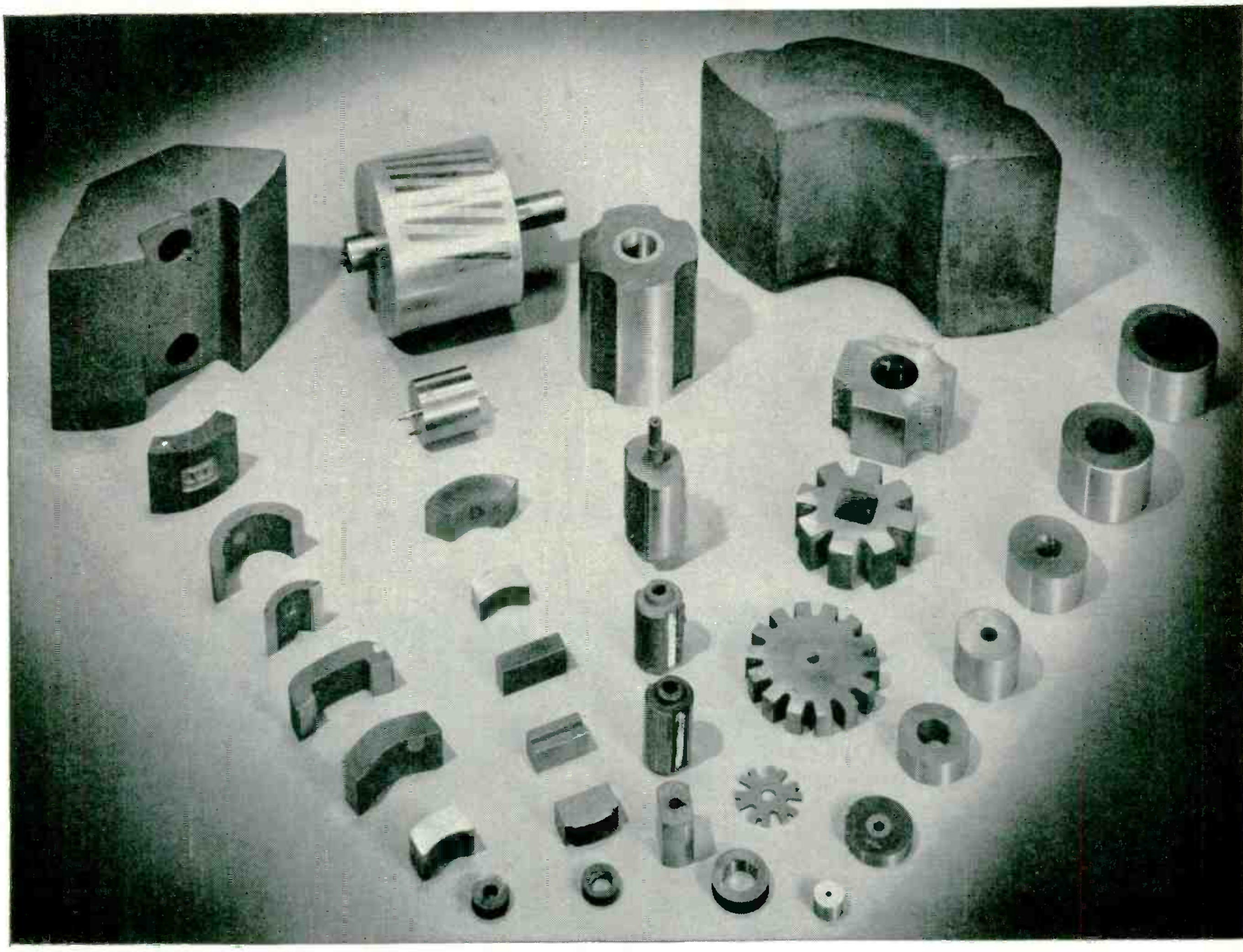
PACKAGED ultrasonic generators for industrial use are now being marketed by some 24 U. S. firms, in sizes ranging from 50 watts to 2 kilowatts of output power, whereas only a few years ago it was difficult to find a single firm having anywhere near a complete line of units.

Sales of the equipment have gone up correspondingly, from an esti-



Cleaning clock movement in ultrasonic bath having two Mullard transducers fed by r-f generator

(Continued on page 14)



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mated $250,000 in 1953 to somewhere around $1,000,000 for 1954. Figures for pulsed ultrasonic equipment, used for measuring and testing in industry and for depth-finding and detection under water, are still larger but data is not available because of military secrecy.

▶ **Markets**—Many laboratory experiments with ultrasonic equipment have been widely publicized but most remain in the labs for purely economic reasons. Even with the largest commercial generators, the equipment costs around $2.50 per watt, and can be as high as $10 per watt for the smallest units. This is luxury-price power, economically justified only when it can do a job not heretofore possible, improve product quality or cut production costs. Three applications show promise of meeting these economic requirements.

▶ **Tinning of Metals** — Low-frequency electronic generators, around 22 kc, are used both with hand-held ultrasonic soldering tools and ultrasonic solder pots for tinning aluminum so it can be soldered conventionally. Magnetostriction transducers produce cavitation in the molten solder and scour away oxide films.

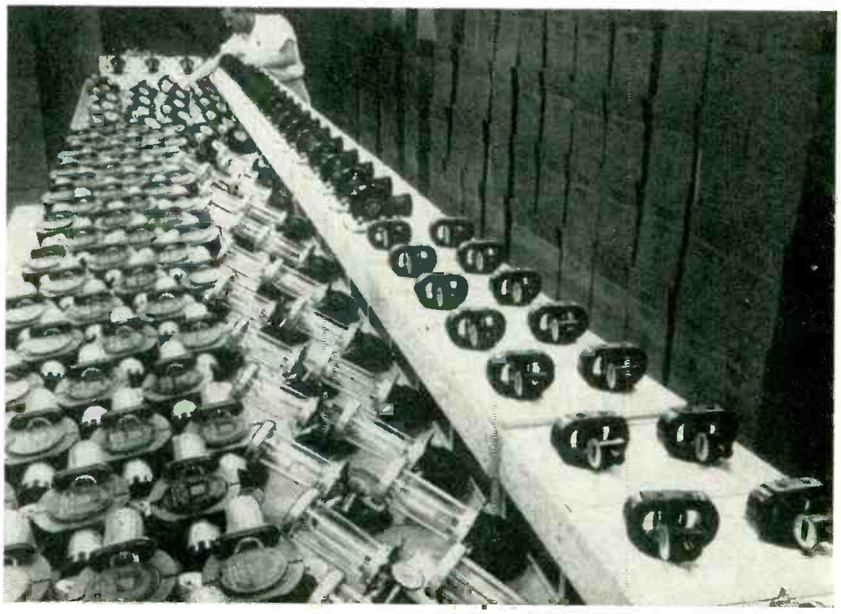
As yet, the technique is used little if at all for dip-soldering of mechanized circuitry, because of the difficulty of inducing cavitation over the large area required. Use of two or more transducers in a pot may solve dip-soldering's current problem of occasional bad joints. Another problem, however, is release of contaminats from some plastic laminates by cavitation.

▶ **Cleaning**—Two methods of ultrasonic cleaning are currently being used. One uses low-frequency generators (around 25 kc) with magnetostriction or quartz transducers for removing hard films from objects by cavitation.

Removal of protective lacquer from optical lenses is one example. Galvanometer movements, glass tubes for semiconductors, vacuum-tube electrodes, relay and other assemblies to be hermetically sealed, and dip-soldered panels are a few electronic products undergoing electronic cleaning routinely in production. The cleaning fluid is either a detergent or a solvent for the material to be removed.

The other method uses frequencies from 200 kc to 2 mc for removing loosely adhering particles from otherwise inaccessible areas of small articles or from complex assemblies such as watch or clock movements. Multiple transducers are usually required, and parts are hand-dipped or conveyor-fed through the activated zone between transducers. Considerable custom design is needed to get optimum combinations of transducers and solvents.

▶ **Drilling**—Though to some extent stalemated now because of patent conflicts, ultrasonic drilling may well have the biggest potential because it will make square or odd-shaped holes and will work far better than existing techniques in superhard materials ranging from tungsten carbide on up through diamonds. The frequency used is around 25 kc. The bigger the hole, the more power is needed. For painless drilling of cavities in teeth, tiny ultrasonic drills show promise.



Part of a day's run of several types of Raytheon magnetrons are readied for shipment as . . .

Magnetron Sales Shift Into High

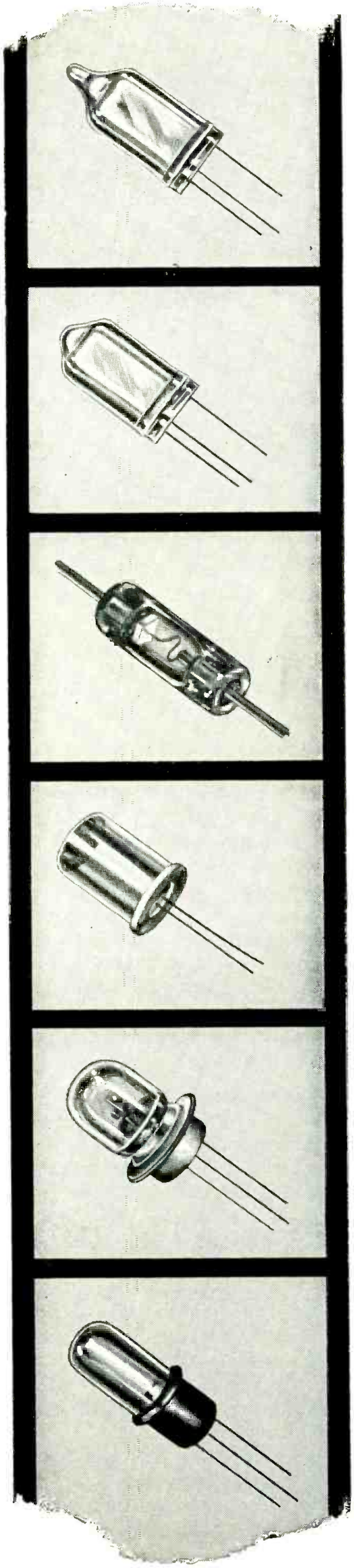
Annual output increases as sales to government and civilian markets climb

In the past year, the magnetron has become, dollarwise, an important tube type. Manufacturers estimate sales this year reached nearly $50 million, an increase of nearly 50 percent over last years sales. Compared to 1952 business, 1954 volume is nearly double the sales in that year.

▶ **Why**—One reason for the growing dollar sales volume of magnetrons may lie in the lag between the time the units are ordered until they are delivered and final billing is made. Since an estimated 90 percent of total magnetron sales go to the government for microwave uses, much of the 1954 sales increase could represent billings on government contracts placed much earlier.

Another reason for the sales rise is that more high-power units are in demand. Magnetrons with peak

(Continued on page 16)



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power ratings ranging up to 5 megawatts are being produced. Since these tubes sell at higher prices total dollar volume swells.

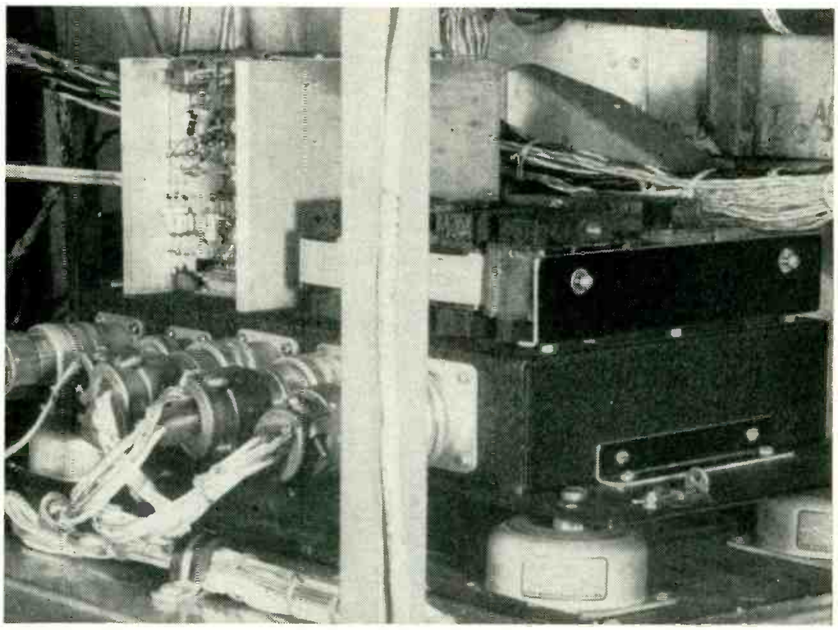
Much of the increase in magnetron sales may be due to the stepped up plans of the government in providing radar defense for the U. S. With much of the continental radar fence still to be erected, indications are that magnetron sales to the government market will continue to grow.

▶ **Civilian**—Increasing use of maggies in commercial radar equipment has also helped. Over 5,000 marine radars are authorized for use according to FCC figures. Use of radar in weather forecasting and observation is another factor in the magnetron market.

The medical field is another important civilian market. In 1953 some 15,000 of the units were in use in microwave diathermy equipment. It is estimated that about 75 percent of all diathermy in use in the U. S. is of the microwave type that uses the magnetron.

Beginning to grow as another commercial market is the food field. Raytheon has two models of radar cookers on the market. One range uses one magnetron; the larger unit uses two. Microwave units are being tried by Heinz for quick quick warming of individual cans of soup. The Santa Fe railroad has used the units in its diners and a number of Howard Johnson restaurants have installed the radar stoves.

▶ **Firms**—Approximately 10 manufacturers produce magnetrons in the U. S. They make over 100 types, ranging in price from $100 to several thousands of dollars. Importance that tube makers place on magnetron sales picture was indicated last year when IT&T dropped out of the picture-tube business to concentrate on magnetrons and other power tubes. Establishment by GE of a new electron tube development laboratory at Stanford University to concentrate on developing and exploring the application of microwave electron tubes has also emphasized the importance of the units.



ENGINEERING prototype of the Bendix autopilot that uses card-type transistorized amplifiers, top left, is flight tested as . . .

Automatic Pilot Sales Increase

VOLUME of the autopilot business is almost anyone's guess because of security regulations surrounding production. However, educated guesses indicate that somewhere in the neighborhood of 50,000 systems have been produced in the past five years, not including those for guided missiles.

One electronic manufacturer estimates that sales of flight control and gyro systems last year were between $30 and $40 million with pure electronics accounting for some $15 to 20 million of the total. An autopilot company estimates that the present backlog of orders totals some $300 million.

Despite the wide disparity in volume estimates, they indicate the importance of the field dollarwise. The average price of commercial autopilot systems has been estimated at $20,000 and systems for military aircraft can cost much more.

Complex systems such as the one used for vertical take-off aircraft and others than can handle complete operations indicate that autopilots will become even more costly.

▶ **Companies**—Many electronic manufacturers share in the autopilot business through subcontracts. One autopilot manufacturer uses over 100 subcontractors. There are about 20 U. S. manufacturers of autopilots.

Most of the work of these companies in autopilots is done under government contracts, but several firms have concentrated on the civilian aircraft field. Use of autopilots in aircraft for executives has been growing steadily. Helicopters are also becoming an important market.

▶ **Transistors**—Bendix Aviation recently announced that the first successful flight of an airplane controlled by an automatic pilot, containing transistors entirely instead of electronic tubes, had been made last May. Flight tests of this equipment are continuing.

The company delivered a completely transistorized automatic pilot system to the Air Force in April. It is being ground tested in a Lockheed F94C for eventual evaluation in high-performance aircraft.

In the equipment shown, three card-type transistorized amplifiers are used for the rudder, aileron and elevator control channels. Bridge-

(Continued on page 20)

The new G-R Slotted Line is amazingly smooth performing . . . offers many significant new design features . . . is extremely valuable for VSWR, impedance and voltage measurements and for determinations of attenuation, power and mismatch at any frequency from 300 to 5000 Mc.

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The new Type 874-LBA is in keeping with this G-R concept around which has been built a complete and integrated line of coaxial elements, oscillators for any frequency range, quality signal and pulse generators, a unique impedance and admittance measuring device, a highly sensitive high-frequency detector and many other instruments and accessories. Write for complete descriptive literature.

Type 874-LBA Slotted Line	$220
Type 874-D20 Adjustable Stub for tuning the crystal rectifier	$11
Type 874-LV Micrometer Vernier for measuring high VSWR ratios	$23

Wide Frequency Range — 300 to 5000 Mc; useful down to 150 Mc and well over 5000 Mc.

Built-In Crystal Detector — electric field within 50-ohm, air dielectric line is sampled by an electrostatic pick-up probe and then detected by a crystal rectifier; both are mounted in a sliding carriage.

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Constancy of Probe Coupling—within 1½% along entire 50-cm line — spring-loaded nylon plugs at probe carriage ends bear on outer conductor, practically eliminating "play" and consequent changes in probe coupling.

Precision-Tooled Probe Carriage — made of cast bronze, it slides on tightly fitting bronze bearings — felt washers at ends prevent dirt from entering carriage — oil holes provided for long-lasting lubrication of bearings.

Sturdy Line Construction — outer conductor is rigidly clamped on heavy brass castings and stiffened by two ½″ stainless-steel rods — rugged center conductor is of steel tubing with heavy copper and silver plating, supported by two teflon insulators at ends; these insulators are electrically compensated to eliminate reflections.

G-R Universal Type 874 Connector at Ends — this low-loss connector has proven superb for instrument use — its VSWR is less than 1.04 to 4000 Mc; its universal construction permits any Type 874 Connector to plug into any other, materially reducing set-up time and the need for large stocks of male and female components; connections and disconnections are made instantly.

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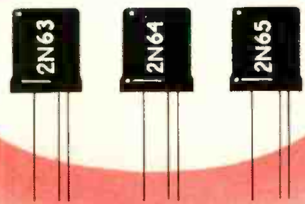

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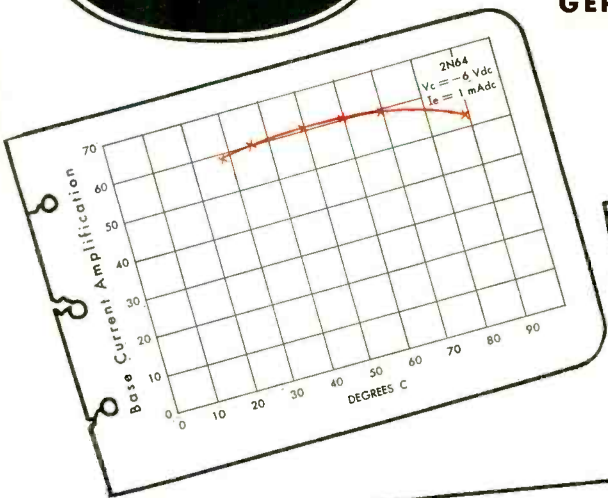
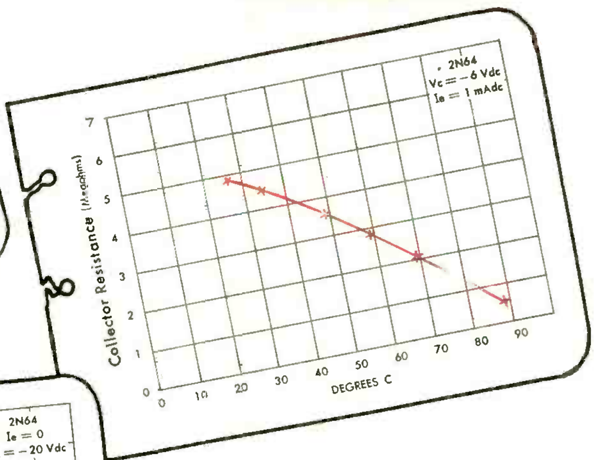
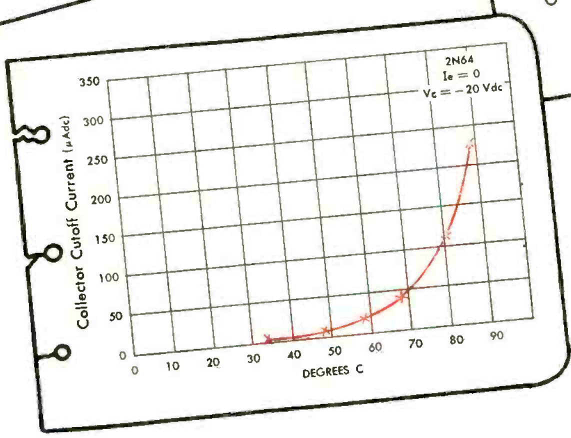






Look at these typical curves taken on a Raytheon 2N64. You can see for yourself how reliably they perform at high temperature. These transistors are rated up to 85°C operating temperature — maximum storage temperature up to 100°C.

There are three of them now available:

2N63 — base current amplification factor 22
2N64 — base current amplification factor 45
2N65 — base current amplification factor 90

All measured at Vc = —6Vdc, Ie = 1mAdc

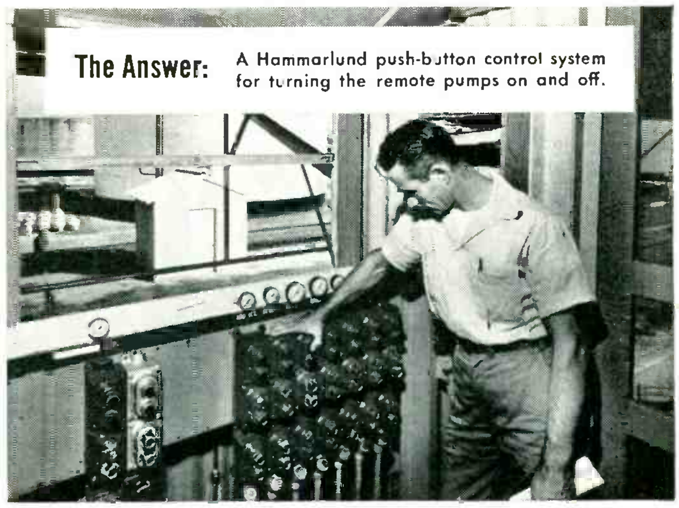
There are several times as many
RAYTHEON TRANSISTORS
in use as all other makes combined!

Want more information? Use post card on last page.

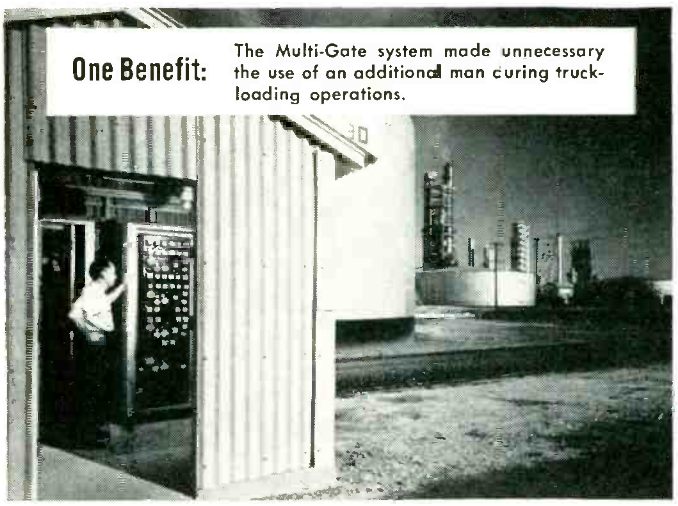
Advertisement

Operating costs cut, efficiency up when Magnolia adds Hammarlund COC*

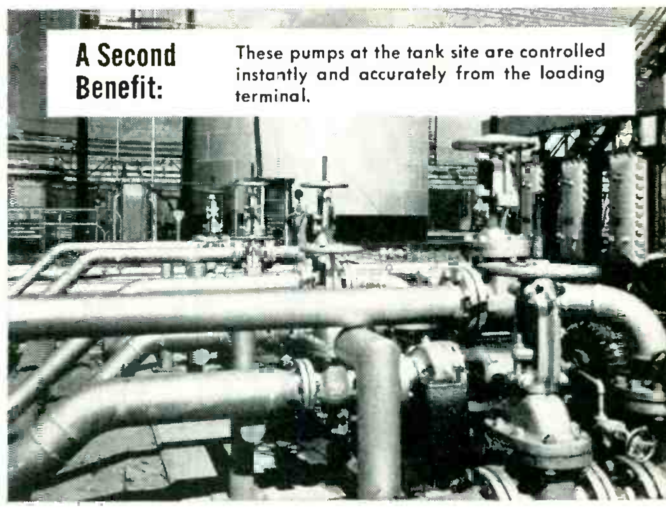
The Problem: To build a new truck-loading terminal outside the congested refinery tank area.



The Answer: A Hammarlund push-button control system for turning the remote pumps on and off.



One Benefit: The Multi-Gate system made unnecessary the use of an additional man during truck-loading operations.



A Second Benefit: These pumps at the tank site are controlled instantly and accurately from the loading terminal.

The Magnolia Petroleum Company planned to build a new truck-loading terminal at its Beaumont, Texas refinery. They wanted it built outside the congested tank area.

Separating the truck-rack from the tanks and pumps, however, would make it necessary to add an additional man per shift. Also, the operations at times—especially in bad weather—would have to wait for this man to move from one pump location to another.

After installing the Multi-Gate remote control equipment, designed and furnished by Hammarlund, the truck-rack operator now has only to push a button corresponding to the type of fuel required. The remote pumps at the tank sites are activated and the required fuel is immediately obtained at the truck-rack. As a result, it was unnecessary to employ the additional man per shift, and it also eliminated the possibility of human error in telephone orders.

According to John Petkovsek, Senior Engineer and Supervisor of Communications and Electrical for Magnolia, other benefits of the Hammarlund system were:

1) Audio tones made it possible to perform many functions using a single telephone line, thus reducing the monthly rental costs. And without the dangers of DC pulses.
2) The system can be extended any time without additional communication lines, or it could be operated over radio or microwave without change.

This is another example of the Hammarlund concept of Centralized Operations Control* at work. Write to Hammarlund, 460 West 34th Street, New York 1, N. Y. for details on COC. Ask for Bulletin E-2

*Trademarks pending on *Centralized Operations Control* and COC.

Want more information? Use post card on last page.

OFFSHORE PROCUREMENT

Electronics Contracts Placed Through June 30, 1954

Country	Dollar (Value in Millions) Army	Navy	Air Force
Belgium-Luxemburg	0.3	0.4	8.2
France	50.4	2.7	5.2
Germany	7.7	..	0.1
Italy	17.6	2.3	1.9
Japan	1.4	..	0.5
Netherlands	3.2	..	0.2
United Kingdom	39.2	9.1	6.0
Yugoslavia	0.2	..	..

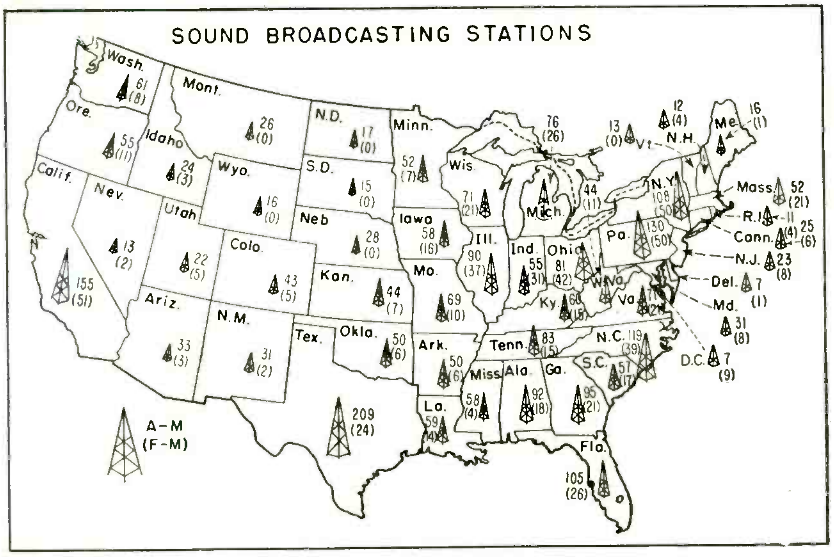
and Navy roughly splitting the difference.

Purchases are typified by two antiaircraft fire predictor computers model PHF-90 for France turned over to the Signal Corps by France's TSF. The contract, valued at $7,450,000, was signed last June.

Other examples include a Contraves electronic predictor of British design for Belgium valued at $347,000 and for Italy, value $2,700,000. Also for Italy, a Contraves optical tracker of British design licensed to an Italian company, value $500,000. For Germany: an AN/TRC-4 radio relay set, $1,400,000 and an AN/GRC-9 receiving and transmitting set.

Examples of Navy equipment contracts let last spring: iff equipment for Great Britain, $11,500,000; an SG-6B radar and spare parts, $719,000 and in spring 1953 two orders for antiaircraft radar of British design, each over $5 million.

Soundcasting Stations Cover Nation



Big Texas has the greatest number of a-m station authorizations as tallied from FCC records in mid-December. As shown on the map, the Lone Star State has 209 (24 f-m, both commercial and educational).

California has 155 a-m stations; Pennsylvania, 130; followed by North Carolina, 119; New York, 108 and Florida, 105.

New York City and Chicago both have 15 a-m stations apiece, followed by Los Angeles with 13. Every territorial possession, including Guam, has a-m grants. Puerto Rico's 26 a-m authorizations are more than those for any of 14 states on the mainland.

▶ **F-M Coverage**—Frequency modulation authorizations (shown on the map in parenthesis, below the a-m figure) show one or more for all but six states—Montana, Nebraska, North Dakota, South Dakota, Vermont and Wyoming. California has the greatest number (total of 51 commercial and educational) with New York and Pennsylvania close seconds (50 each). Ohio has 42.

New York City leads the municipalities with 14 f-m stations. Philadelphia, Washington and Detroit have more f-m than a-m grants.

Set Manufacturers Display 1955 Models

Twenty-five companies introduce new monochrome tv receivers and radio sets

During January many of the industry's tv set manufacturers displayed new monochrome tv sets for the 1955 market while only three companies introduced color models. However, with RCA's recent reduction from $175 to $100 for its 21-inch color tube, more new color models may soon hit the market.

▶ **Lines**—Number of models introduced by individual companies ranged from a few drop-in models to completely new lines of up to 50 models.

Predominant among the models introduced were 21-inch sets, both table models and consoles. Sets with 17-inch and 24-inch screens were emphasized also.

Price changes followed the pattern of last year. Price leading 21-inch and 17-inch table models were lower than last season's equivalent. Two companies reduced prices on carry-over sets.

▶ **Design**—Greater use of the vertical chassis in new tv models was evident with at least five manufacturers showing sets using the design. Ultrahigh frequency tuners were still utilized in much the same way as in previous lines with units costing from $30 to $50 additional.

Emerson plans to incorporate in all its receivers for 1955 a further improvement on series-string circuits. The system cuts operating costs as much as 50 percent and boosts parts life from two to ten times, according to the firm. Picture-tube accelerator voltage is increased substantially. Power consumed is about 120 watts compared to 185 watts in older models. The company also introduced new large-screen sets incorporating circuits operating on both alternating and direct current.

▶ **Radio**—New radio receivers were displayed by manufacturers with prices ranging from $12.95

(Continued on page 26)

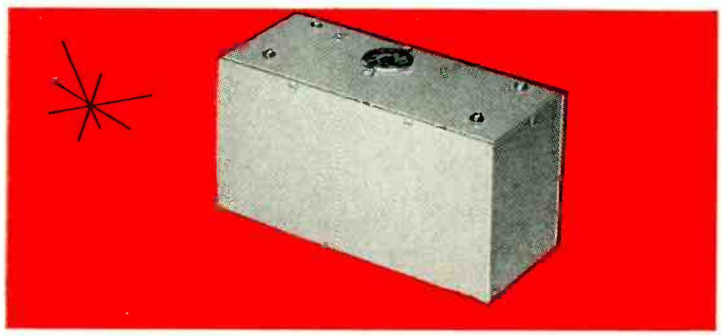
Another Burnell exclusive!

3 BIG REASONS

to check BURNELL first!

ROTOROIDS® A continuously variable, stepless toroidal inductor which can provide a 4:1 range of maximum to minimum inductance in 180° rotation of a shaft. Write for new brochure which gives complete technical data.

TOROIDS Combining the advantages of toroidal type winding with the molybdenum permalloy dust core and other specially selected materials, these toroids provide higher Q than any other structure. They also provide greater stability of inductance vs. temperature and level in a smaller space. Their self-shielding properties permit compact assemblies of coils with a minimum of deleterious effects. Supplied to an inductance accuracy of 1%. Available in standard, miniature and sub-miniature sizes. Also in a wide variety of finishes, including ***for the first time toroids molded in a new special material.***



TELEMETERING FILTERS
Band pass filters available for every channel ranging from 400 to 70,000 cycles for band width between 15 - 40%. Low pass filters available for operation in either unbalanced or balanced line, and range in cut off frequency from 6 up to 10,500 cycles. Also, miniaturized filters that do not sacrifice attenuation characteristics, save up to 80% space.

3 EXTRA REASONS TO CHECK BURNELL FIRST!

- **Proven Top Quality**
- **Competitive Prices**
- **Prompt Deliveries**

Write Department C for Catalog 102A

TELETYPE: YONKERS, N. Y. 3633

BURNELL & CO., INC.
Yonkers 2, New York

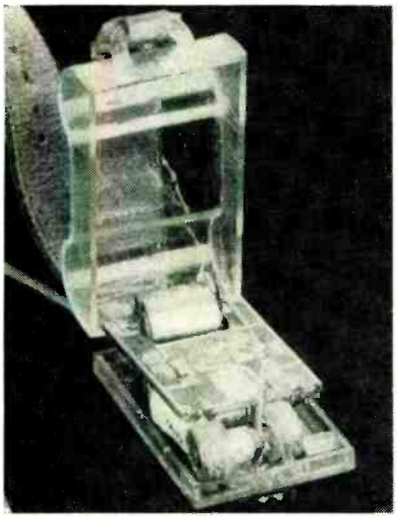
PACIFIC DIVISION: 720 Mission Street, South Pasadena, California

FIRST IN TOROIDS AND RELATED NETWORKS

for table models to over $200 for hi-fi consoles. One portable radio introduced is an 8-band a-c/d-c set with built-in thermometer, barometer and hygrometer for weather forecasting.

DuMont entered the radio set business with the introduction of a 5-tube set that can be installed inside its tv receivers and connected to the loudspeaker.

Transistor Radio Details Released



TECHNICAL information on the experimental wrist watch radio developed by the Army Signal Corps in 1953 (ELECTRONICS, p 5, October, 1953) has been released by the Commerce Department's Office of Technical Services.

▶ **Components**—The receiver shown uses three transistors, a type 1729 point contact for the regenerative stage and two type TA-153 *npn* junctions for the two audio stages. Power supply is a miniature 6.5-volt battery consisting of five RM 412 mercury cells. Battery drain is about 20 milliwatts and battery life about 10 hours. As shown in the photograph, the set utilizes a printed circuit.

Regeneration is obtained inductively with feedback controlled by the proximity of two coils. A miniature capacitor is used for tuning. Bead diodes, type 1764, serve as detector and as a d-c return.

MEETINGS

JAN. 31–FEB. 4: AIEE Winter General Meeting, Hotels Statler & Governor Clinton, New York, N. Y.

FEB. 10–12: Seventh Annual Conference and Electronics Show, Southwestern region of IRE, Baker Hotel, Dallas, Texas.

FEB. 11–13: Los Angeles Audio Fair, Hotel Alexandria, Los Angeles.

FEB. 14–16: Conference On High-Speed Computers; Louisiana State University, Baton Rouge, La.

FEB. 17–18: National Conference On Transistor Circuits sponsored by IRE, AIEE, U. of Penn.; Irvine Auditorium, University of Pennsylvania and Penn Sherwood Hotel, Phila., Pa.

FEB. 20–22: Institute of Surplus Dealers' Fourth Annual Trade Show and Convention, 212th AAA Armory, New York, N. Y.

MARCH 1–3: Joint Western Computer Conference and Exhibit sponsored by IRE, AIEE, ACM; Statler Hotel, Los Angeles, Calif.

MARCH 21–24: 1955 IRE National Convention, Waldorf Astoria Hotel & Kingsbridge Armory, New York, N. Y.

MAR. 28–APR. 1: Society for Nondestructive Testing, technical sessions, Ambassador Hotel, Los Angeles.

APRIL 15–16: Ninth Annual Spring Technical Conference, Cincinnati IRE; Engineering Society Bldg., Cincinnati, Ohio.

APRIL 19–21: Twelfth British Radio Components Show, Grosvenor House, London.

APRIL 25–27: Eighth Annual Conference for Protective Relay Engineers, A & M College of Texas, College Station, Texas.

MAY 2–5: Third Annual Semiconductor Symposium of the Electrochemical Society, Cincinnati, Ohio.

MAY 4–6: Fourth International Aviation Trade Show, 69th Regiment Armory, New York.

MAY 6: American Association of Spectrographers Sixth Annual Conference, Chicago, Ill.

MAY 16–19: Electronic Parts Distributors Show, Conrad Hilton Hotel, Chicago.

MAY 18–20: Annual National Telemetering Conference and Exhibit sponsored by IRE, AIEE, IAS, ISA; Hotel Morrison, Chicago, Ill.

MAY 19–21: Global Communications Conference, sponsored by AFCA; Hotel Commodore, New York, N. Y.

JUNE 3–5: ARRL Hudson Division Convention and Amateur Radio Equipment Show, Hotel Adelon, Long Beach, N. Y.

AUG. 23–SEPT. 3: British National Radio Show, Earls Court, London.

AUG. 24–26: 1955 WESCON, Civic Auditorium and Fairmount Hotel, San Francisco, Calif.

SEPT. 27–OCT. 1: International Analogy Computation Meeting sponsored by the SITEL of Belgium, Brussels.

NOV. 14–17: Second International Automation Exposition, Navy Pier, Chicago, Ill.

Industry Shorts

▶ **Over** 47,000 channel miles of AT&T cross-country communications routes were re-engineered and re-equipped to carry color tv to 139 stations in 101 cities in 1954.

▶ **Eight** companies in the electronics field have been awarded Certificates of Management Excellence for 1954 in the sixth annual management survey by the American Institute of Management.

▶ **Fund** for the Advancement of Education has provided $43,845 to determine the feasibility of using closed-circuit tv for college instruction. The study will be conducted at Pennsylvania State University.

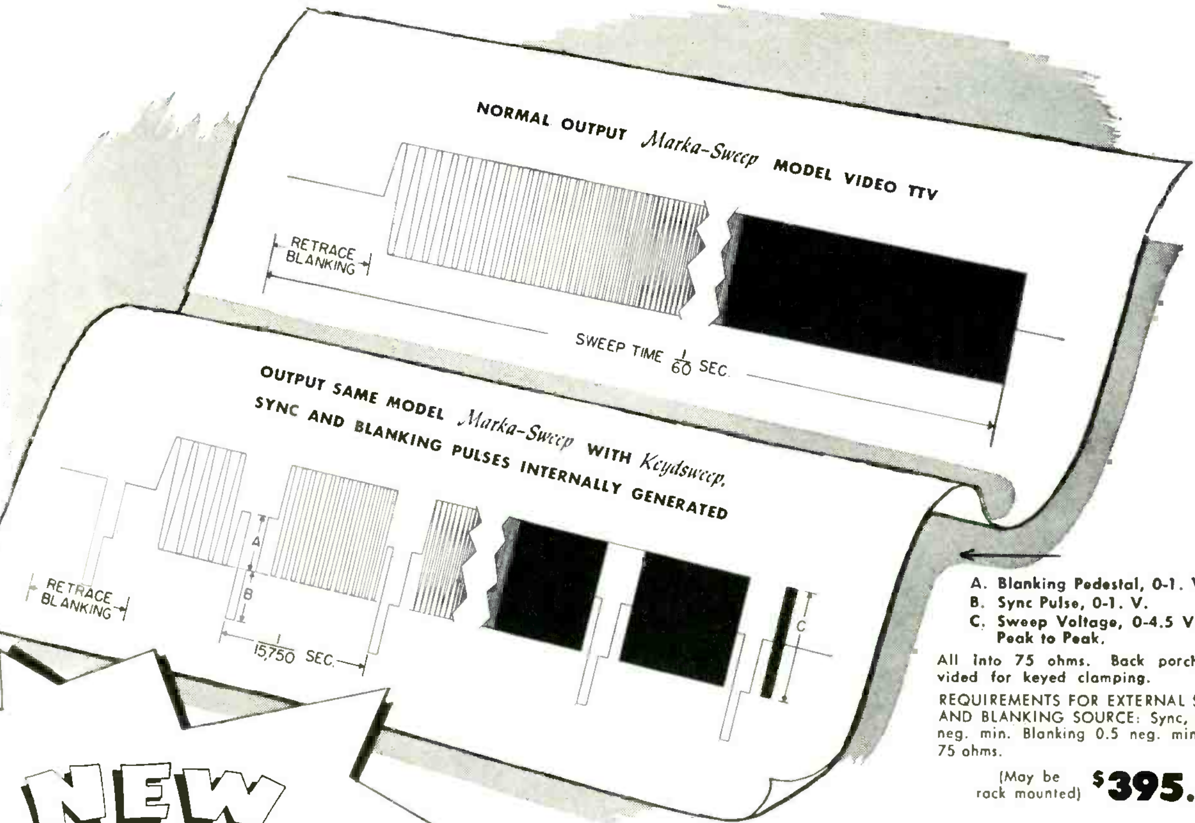
▶ **Number** of retail radio and tv dealers in the U. S. has increased by nearly 12,000 in less than two years, according to RETMA.

▶ **Americans** will need over 5½ million new picture tubes for their tv sets in 1955, according to GE.

▶ **Closed** circuit industrial color tv equipment will be manufactured by CBS-Columbia.

▶ **Spain** now produces some 200,000 radio sets a year and has become an exporter of receivers, according to the country's radio manufacturers association.

▶ **Chimney** sweep in Stockholm has invented a radio transmitter and receiver for detecting flaws in flues.



A. Blanking Pedestal, 0-1. V.
B. Sync Pulse, 0-1. V.
C. Sweep Voltage, 0-4.5 V. Peak to Peak.

All into 75 ohms. Back porch provided for keyed clamping.

REQUIREMENTS FOR EXTERNAL SYNC AND BLANKING SOURCE: Sync, 0.5 V. neg. min. Blanking 0.5 neg. min. into 75 ohms.

(May be rack mounted) **$395.**

NEW

Kay Electric "*Keydsweep*"

Eliminates Spot Frequency Checking

The *Keydsweep* used with our Model Video sweep generators provides complete TV system evaluation.

NOW— in another important advancement from Kay Electric—circuits may be completely evaluated with *spot frequency checking wholly eliminated.* The new Kay KEYDSWEEP provides internal sync pulses, and will operate with an external source of sync and blanking pulses giving pedestals and spacings in accordance with the source characteristics.

SPECIFICATIONS AND PRICES — KAY ELECTRIC VIDEO SWEEP GENERATORS

INST.	FREQUENCY RANGE	TUNING	MAX. SWEEP WIDTH	MARKERS	OUTPUT	PRICE F.O.B. PLANT
Model Video *Marka-Sweep* (illus.)	50 kc – 20 mc	3 ranges 50 kc – 5 mc 50 kc – 10 mc 50 kc – 20 mc	complete range	6 crystals	.3 V. 72 ohms	$495.00
Model Video TTV *Marka-Sweep* (illus.)	50 kc – 8 mc	cont. variable CW signal	8 mc	5 crystals 1 variable	1.5 V. RMS 72 ohms	695.00
Model Video GE *Marka-Sweep*	50 kc – 8 mc	contin.	8 mc	6 crystals	1.5 V. RMS 70 ohms	595.00
Model *Vidaligner*	50 kc – 8 mc	3 ranges 50 kc – 2 mc 50 kc – 5 mc 50 kc – 8 mc	complete range	8 crystals 1 variable	1.5 V. RMS 72 ohms	775.00

Model Video *Marka-Sweep*

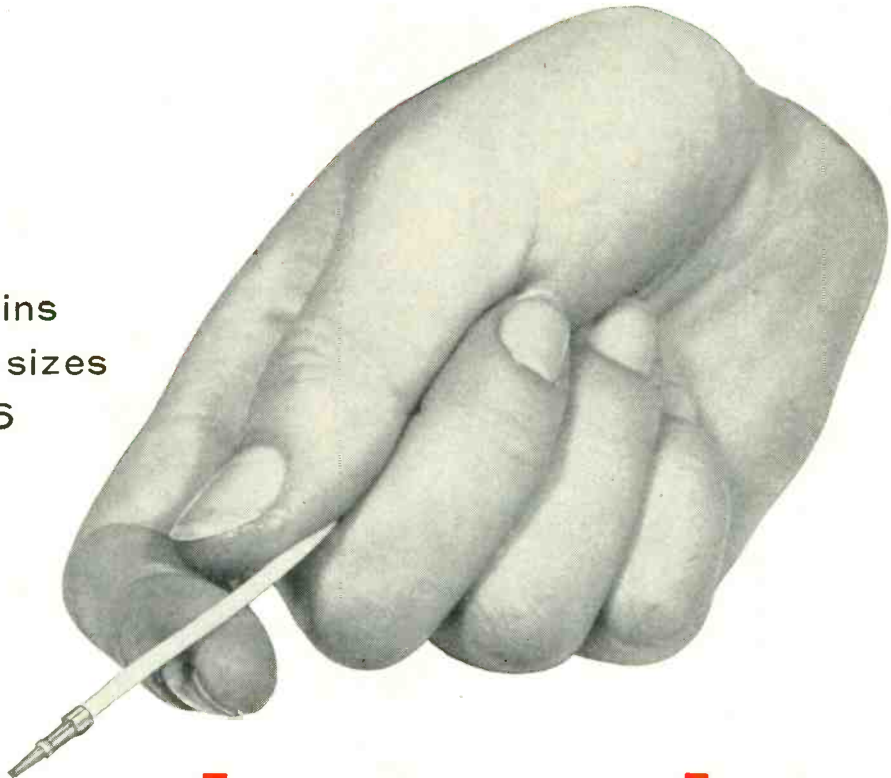
KAY
Electric Company
14 Maple Ave., Pine Brook, N. J.

Model Video TTV *Marka-Sweep*

Write for Technical Data Sheets and copy of Kay 1954-55 Catalog

Want more information? Use post card on last page.

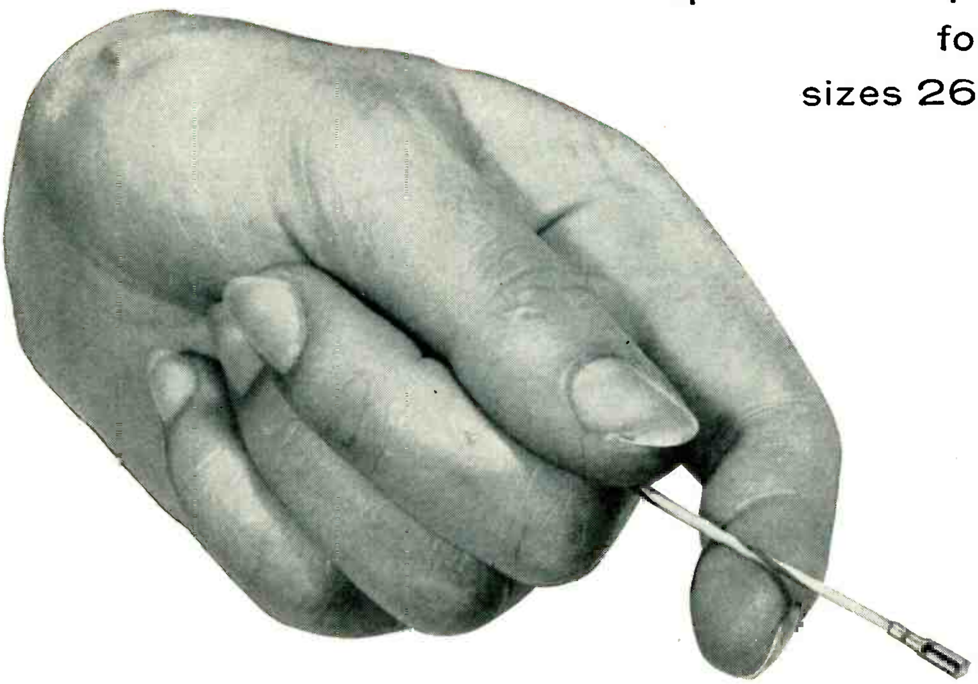
AMP
Taper Pins
for wire sizes
26 to 16

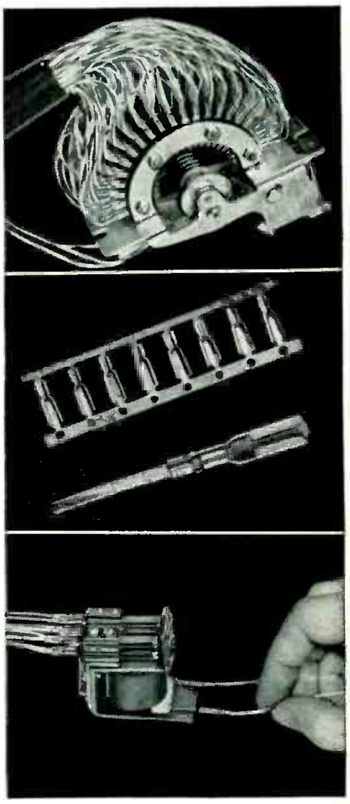


less cube
WITH ADDED

Another example of AMP's Creative Approach to Better Wiring

AMP
Taper Tab receptacles
for wire
sizes 26 to 18





and cost
RELIABILITY

Cubic restrictions have brought about a whole new concept of wire termination. The AMP Taper Technique with AMP taper pins, tab receptacles, blocks and modified miniature components will help you take full advantage of small wire, small insulation and small space for your wire terminations.

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You are cordially invited to visit the AMP booth at the I. R. E. show.

Booths 770 and 772

AMP

Send today for your copy of our brochure, AMP's Creative Approach to Better Wiring.

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In Canada: AIRCRAFT-MARINE PRODUCTS OF CANADA, LTD., 1764 Avenue Road, Toronto 12, Ontario, Canada

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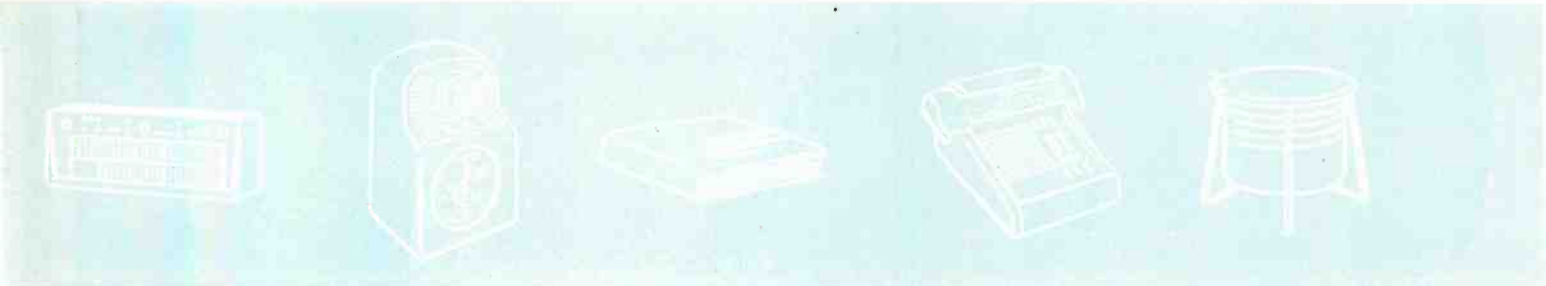
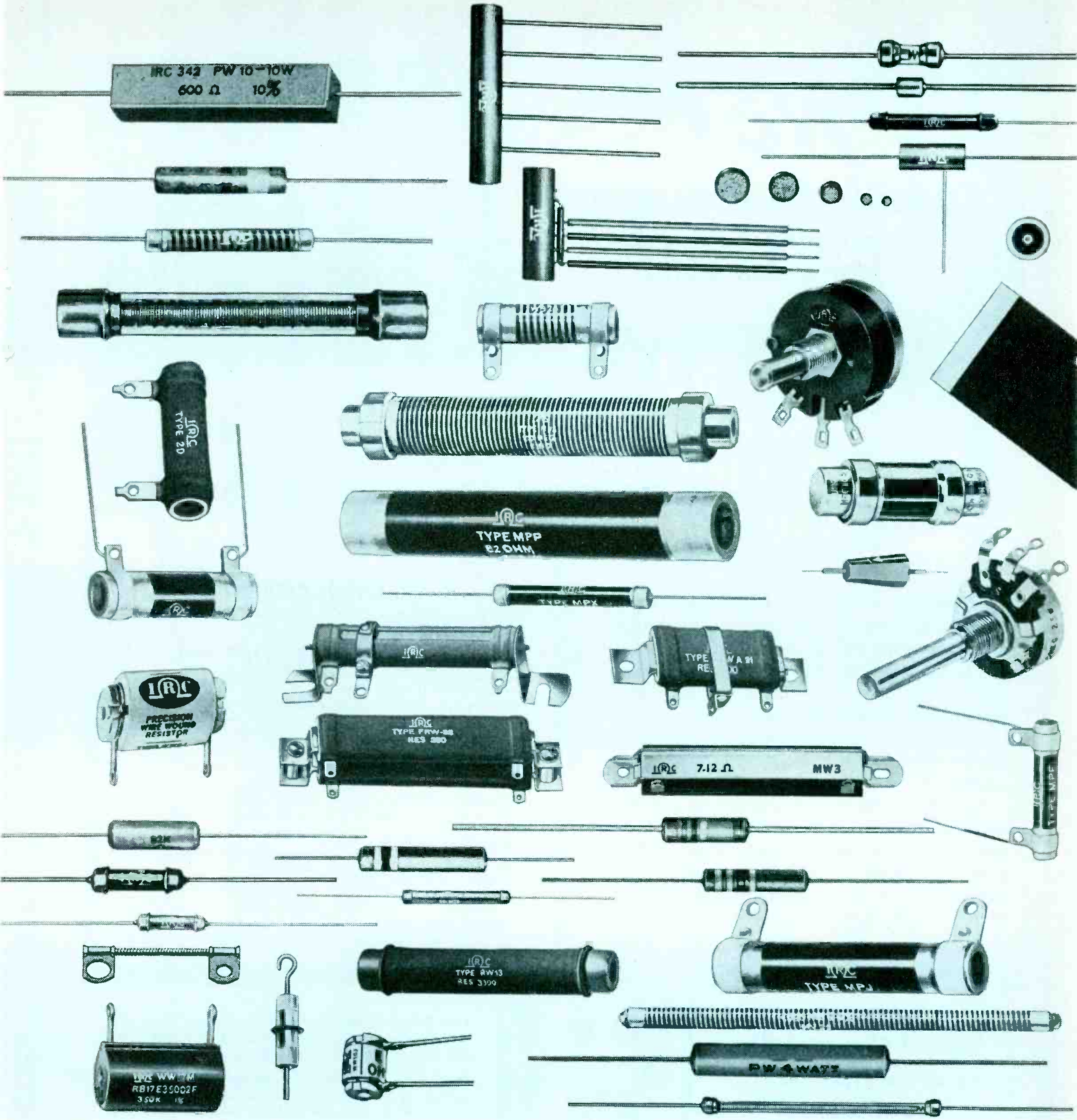
More IRC resistors are used by manufacturers



of military devices, instruments, computers,

electronic and electrical equipment, appliances,

radio and television sets than any other brand.



International Resistance Company, 401 North Broad Street, Philadelphia 8, Pa.

Wholly Owned Subsidiaries: *IRCAL INDUSTRIES, Los Angeles, California*
VAN DYKE INSTRUMENTS, Inc., St. Petersburg, Florida
INTERNATIONAL RESISTANCE CO., Ltd., London, England

Canadian Licensee: *International Resistance Co., Ltd., 349 Carlaw Ave., Toronto*

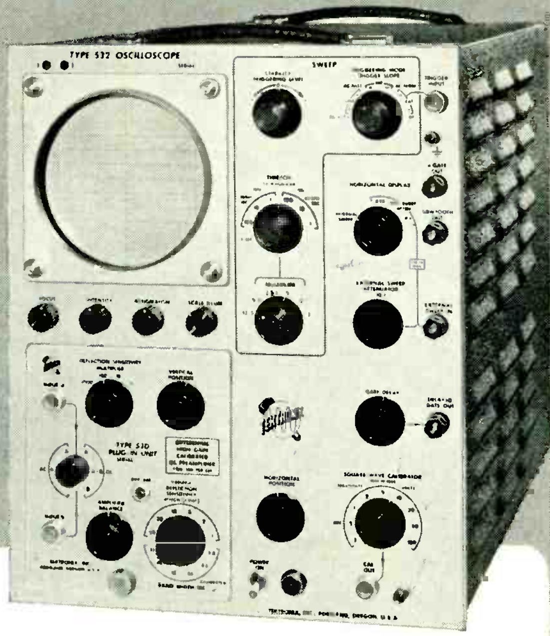
NEW

5-MEGACYCLE OSCILLOSCOPE

joins the Tektronix Type 530 Series

TYPE 532

the most *Versatile* oscilloscope in its class!



This new oscilloscope offers the advantages of all six Type 53 Plug-In Units now available — plus those yet to come. Only the wide-band units are limited by its dc-to-5 mc response. Wide sweep range (0.2 μsec/cm to 12 sec/cm) and 4-kv accelerating potential complement the signal-handling versatility of the Type 532 . . . resulting in performance characteristics desirable for a great many laboratory applications.

Extra dependability is designed into the Type 532, mainly through circuit simplicity and conservative tube loading. Yet it retains all the precision and stability you've come to expect in Tektronix oscilloscopes. It is an instrument that will give lasting satisfaction in all applications within its capabilities.

BASIC CHARACTERISTICS

Wide Sweep Range
21 calibrated sweeps from 1 μsec/cm to 5 sec/cm, accurate within 3%. 5-x magnifier, accurate and valid on all sweep speeds, extends calibrated range to 0.2 μsec/cm. Full range — 0.2 μsec/cm to 12 sec/cm, continuously variable.

DC-Coupled Output Amplifier
Less than 3 db down at 5 mc. Adjusted for optimum transient response with wide-band units plugged in.

Advanced Cathode-Ray Tube
Tektronix 5" flat-faced precision crt with 4-kv accelerating potential provides 8 centimeters of linear vertical deflection.

Sensitive Horizontal Amplifier
0.2 v/cm to 20 v/cm sensitivity.

Versatile Triggering
Internal or external, with amplitude level selection or automatic triggering.

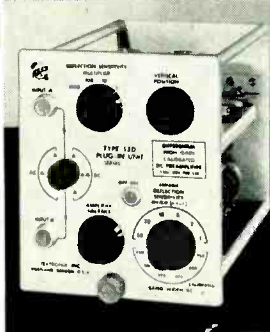
Accurate Amplitude Calibrator
Square wave, 0.2 mv to 100 v in 18 steps, accurate within 3%.

DC-Coupled Unblanking

Vertical Beam Position Indicators

Electronic Voltage Regulation

TYPE 532 — $825.00 *plus price of desired plug-in units.*
Prices f.o.b. Portland (Beaverton), Oregon



Vertical Characteristics of the Type 532 with these Plug-in Units

TYPE 53A — DC to 5 mc, 0.07-μsec risetime. Sensitivity 0.05 v/cm to 50 v/cm, ac or dc, continuously variable, with 9 calibrated steps from 0.05 v/cm to 20 v/cm, **$85.00**

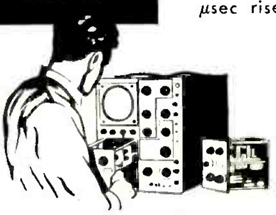
TYPE 53B — Same as Type 53A with additional calibrated ac-sensitivity to 5 mv/cm **$125.00**

TYPE 53C — Dual-Trace Unit. Two identical amplifier channels, dc to 5 mc, 0.05 v/cm to 50 v/cm. Electronic switching triggered by oscilloscope sweep . . . or free running at about 100 kc **$275.00**

TYPE 53D — Differential-input high-gain unit. 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 **$145.00**

TYPE 53E — Low-level differential-input unit. 50 microvolt/cm to 10 millivolt/cm, calibrated. Passband 0.06 cycles to 60 kc. Maximum combined noise and hum, 7 μv rms, with input grids grounded **$165.00**

TYPE 53G — Differential wide-band unit. DC to 5 mc, 0.07 μsec risetime. 0.05 v/cm to 20 v/cm calibrated, with separate attenuators for both inputs. Better than 100-to-1 common-mode rejection for the entire passband **$175.00**



Be sure to see the Type 532 and many other new Tektronix instruments at the 1955 IRE show.

Tektronix, Inc.

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the secret of

OHMITE® resistor RELIABILITY...

TESTING...
TESTING...
never-ending TESTING!

30th Anniversary 1925-1955

RELIABLE RELAYS, TOO!

When you need fast delivery on relays of highest quality, investigate AMRECON® general-purpose relays. They are available in current ratings up to 25 amp AC or DC (in all std. voltages); in a wide variety of contact arrangements; and with hermetically sealed or dust-protected enclosures.

WRITE FOR CATALOG AND DESCRIPTIVE BULLETIN R-10

AMERICAN RELAY & CONTROLS, Inc.
3653 Howard St., Skokie, Ill.
An OHMITE Subsidiary

You can't afford the risk of failure in your equipment. Insist on components of proven reliability. In the modern Ohmite laboratories, Ohmite resistors are tested and retested under the most grueling conditions so that potential sources of trouble can be detected and eliminated. And, Ohmite is constantly searching for new materials, new processes, and new designs—to build Ohmite products that set new standards of long life and trouble-free performance.

OHMITE®

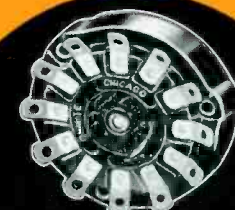
RHEOSTATS • RESISTORS • TAP SWITCHES

OHMITE MANUFACTURING COMPANY, 3610 Howard Street, Skokie, Illinois (Suburb of Chicago)

WORLD'S LARGEST STOCK

RESISTORS
Fixed and "Dividohm" adjustable wire-wound types, 10 to 200 watts. Also composition type.

RHEOSTATS
Ten stock sizes—25 to 1000 watts. All ceramic and metal.



TAP SWITCHES
Rotary type. Five sizes from 10 to 100 amp, with from 2 to 12 taps.

What resistance components do you need in a hurry? From a factory stock of several million resistors, rheostats, and tap switches . . . in 1,859 types, sizes, and values . . . Ohmite can make fast delivery in reasonable quantities to meet your immediate requirements.

Furthermore, by tailoring your specifications to these stock items, you can always get speedy delivery that will help you keep experimental and pilot production operations on a smooth-running schedule.

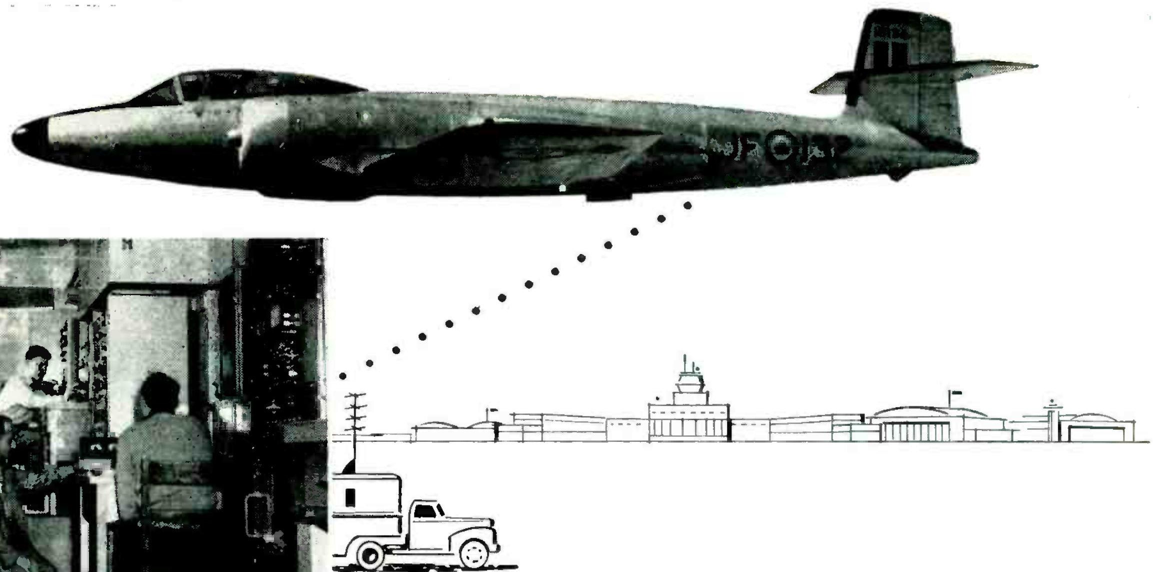
To assist engineers and purchasing agents in making their selection from this huge stock, Ohmite *Stock Catalog* No. 24 contains complete, up-to-date information on all Ohmite stock items. Resistance values, ratings, specifications, and other helpful information are included.

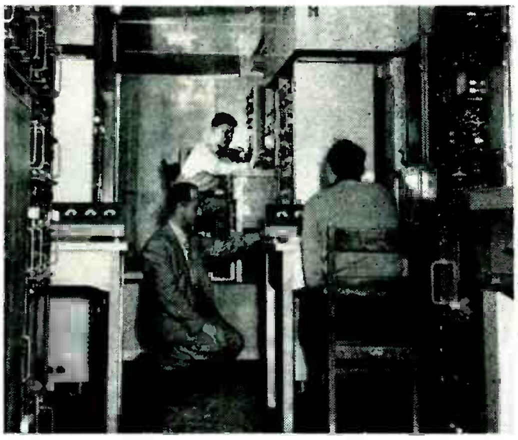
NEED RELAYS? Get in touch with American Relay & Controls, Inc.
3651 Howard Street, Skokie, Ill. . . . an OHMITE Subsidiary

SEND FOR STOCK CATALOG NO. 24

OHMITE® MANUFACTURING CO.
3610 Howard St., Skokie, Ill. (Suburb of Chicago)

30th Anniversary
1925-1955





Inside this mobile ground station, test flights of the Avro Canada CF-100, RCAF all-weather interceptor for continental defense, are "seen" and "heard" with Ampex magnetic tape recorders.

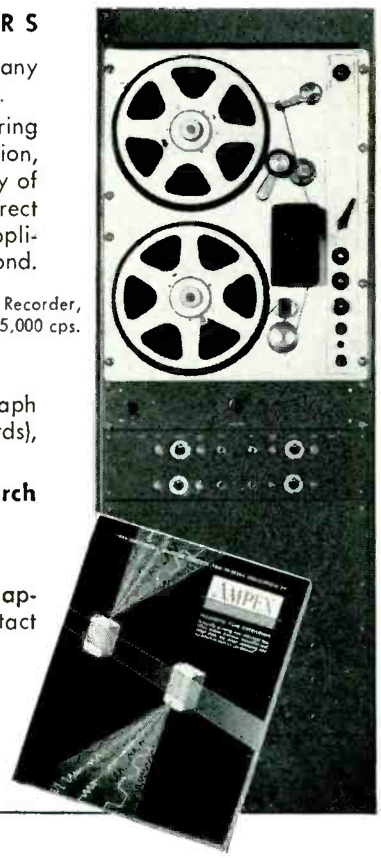
MAGNETIC TAPE RECORDING
helps produce better designs faster

At Avro Canada, as at all major flight test locations in the United States, all test data transmitted by radio telemetry is permanently — completely — and accurately — recorded on magnetic tape. This involves 67 separate items of information **per second** — items such as temperature, pressure, revolutions, acceleration, yaw and roll. The data is "magnified" on playback at slow speed, permitting Avro engineers and aerodynamists to critically study each parameter in gas turbine and airframe designs.

AVRO USES AMPEX MAGNETIC TAPE RECORDERS

The Aircraft Division of Avro Canada, Malton, Ontario is one of the many diversified users of Ampex magnetic tape equipment for data recording.

Ampex recorders are widely preferred for special installations requiring broad frequency response, precise timing, extreme stability of tape motion, high shock resistance and reliable accuracy on transients. A wide variety of models are available featuring pulse width, frequency modulated and direct recording techniques . . . for airborne, mobile, rack-mount or console applications . . . in any frequency band from zero to 100,000 cycles per second.



Ampex 306 Recorder, 0 to 5,000 cps.

MAGNETIC RECORDING HAS MANY APPLICATIONS

Because magnetic tape data is convertible to any form (e.g.: oscillograph traces, scope reading, computor feeds, control signals or punched cards), many practical applications result. Examples are:

- **Data Computing**
- **Machine Control**
- **Advanced Research**
- **Test Cycling**
- **Process Regulation**

LET AMPEX EVALUATE YOUR SPECIAL NEEDS

Without obligation, find out whether "live memory" techniques can be applied to your operation, or ask for our 16-page illustrated bulletin. Contact your nearest Ampex representative, or write or wire Dept. E-1892

AMPEX CORPORATION

Signature of Perfection in Magnetic Recorders

934 CHARTER STREET, REDWOOD CITY, CALIFORNIA

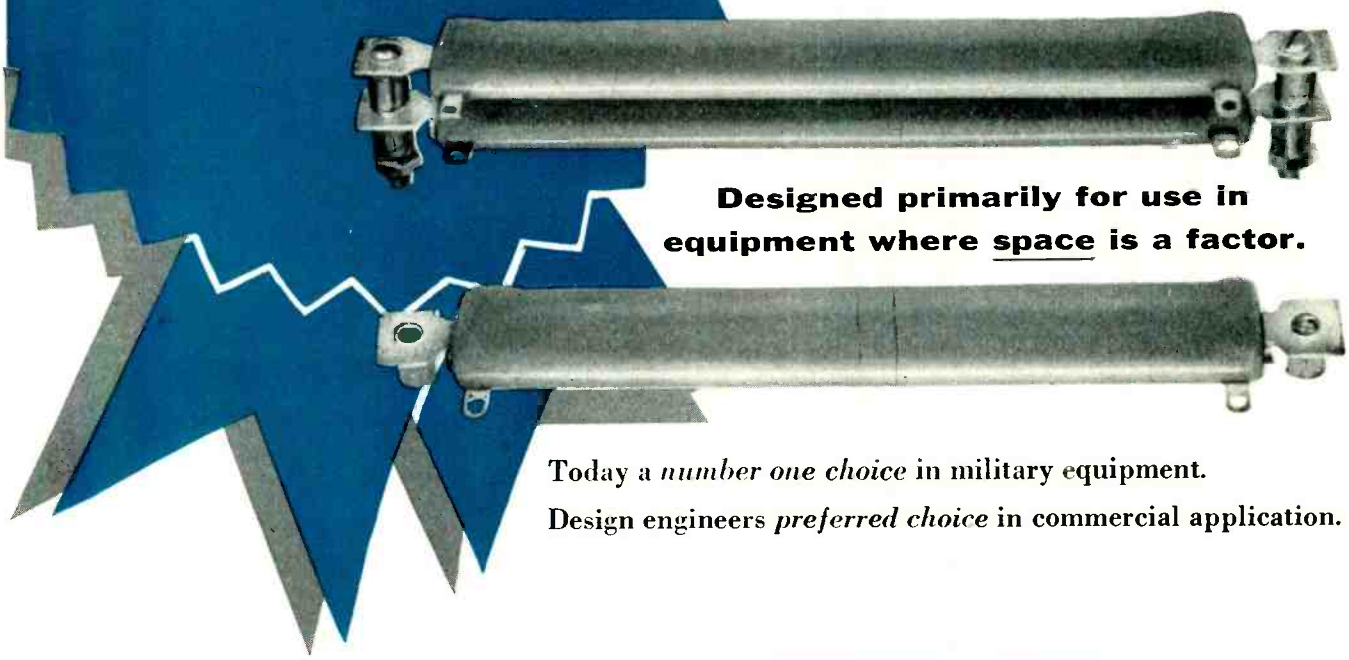
BRANCH OFFICES: New York; Chicago; Atlanta; San Francisco; Dayton; College Park, Maryland (Washington, D.C. Area).

DISTRIBUTORS FOR AMPEX INSTRUMENTATION RECORDERS: Radio Shack, Boston; Bing Crosby Enterprises, Los Angeles; Southwestern Engineering & Equipment, Dallas and Houston; Canadian General Electric Company, Canada

Distributors of Ampex Audio Equipment listed in your phone directory.

Want more information? Use post card on last page.

"BLUE RIBBON Resistor"



Designed primarily for use in equipment where space is a factor.

Today a *number one choice* in military equipment.

Design engineers *preferred choice* in commercial application.

BLUE RIBBON—EXCLUSIVE FEATURES:

1. High temperature vitreous enamel coating, crazeless, moisture resistant.
2. Aluminum thru-bar—distributes heat more uniformly along the entire length of the resistor.
3. Mounting studs—corrosion and rust resistant.
4. Bracket assembly will not loosen under vibration.
5. Field tested welded construction.
   a. Wire to Terminal
   b. Terminal to Core

BASIC CHARACTERISTICS:

1. Higher wattage rating per unit space requirement.
2. Space reduction behind panel or mounting surface.
3. Stack mounting assembly.
4. Light weight.
5. Lower induction.
6. Conforms to MIL-R-26 specifications.

Order the original BLUE RIBBON 1st in performance

HARDWICK, HINDLE, INC.
Rheostats and Resistors
40 Hermon St., Newark 5, N. J., U. S. A.

The mark of quality
For more than a quarter of a century


NEW!
AVAILABLE ON EQUIPMENT LEASE PLAN
FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

MICROWAVE FIELD INTENSITY RECEIVER

BROAD BAND
950—11,260 mcs

- Four interchangeable RF Tuning Heads
- Uni-Dial Tuning
- Double Tuned RF Pre-Selection
- Signal-Lock Automatic Frequency Control
- All purpose AM, FM, Pulse

The new Polarad Model R Receiver is a fully integrated unit which combines reliability, ruggedness and simplicity of operation. Characterized by high sensitivity, low noise figure and excellent gain stability, this versatile instrument is ideal for communications, laboratory measurements, field intensity measurements, production testing, and automatic monitoring.

Range 950 to 11,260 mc with four (4) interchangeable, plug-in RF tuning units featuring direct reading UNI-DIAL control.

Low noise figure.

Excellent gain stability.

Automatic frequency control.

Direct reading output in db with provision for external metering and recording.

Separate audio and video channels.

Connectors for external IF attenuators.

High sensitivity and broadband tuning achieved with double tuned cavity preselector which tracks automatically with the local oscillator.

External type cavity klystron with non-contacting chokes. Klystron voltages regulated and automatically tracked with the oscillator.

SPECIFICATIONS:

Basic Receiver: Model R-B

Tuning Unit Frequency Ranges:

Model RL-T:	950 to	2,040 mc
Model RS-T:	1,890 to	4,320 mc
Model RM-T:	4,190 to	7,720 mc
Model RX-T:	7,260 to	11,260 mc

Signal Capabilities:
CW, AM, FM, Pulse

Sensitivity:
—80 dbm or better throughout range on all models

Frequency Accuracy:
1%

IF Bandwidth:
3 mc

Image Rejection:
Greater than 60 db

Gain Stability with AFC:
2 db for 24 hour period

Automatic Frequency Control:
Pull-out range 10 mc off center

Recorder output:
1 ma full scale

Trigger output:
10 v. pulse across 100 ohms

Audio output:
5 v. undistorted across 500 ohms

FM Discriminator Deviation Sensitivity:
.7 volts/mc

Skirt Selectivity:
60 db to 6 db bandwidth ratio less than 5:1

IF Rejection:
50 db

Input AC Power:
105 to 125 v., 60 cps., 460 watts

Input Impedance: (ANT)
50 ohms

POLARAD PROVEN RELIABILITY

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

REPRESENTATIVES • Albuquerque • Atlanta • Baltimore • Boston • Chicago • Cleveland • Fort Worth • Kansas City • Los Angeles • New York
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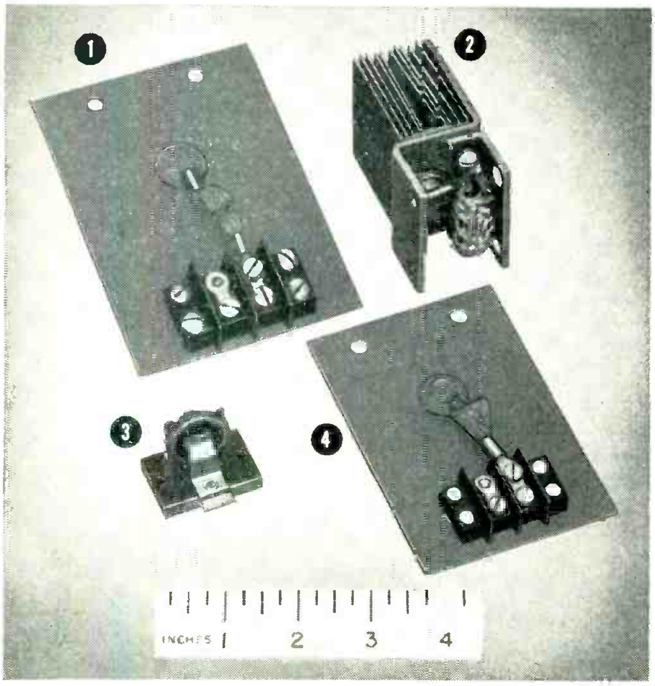
DESIGNER'S

Germanium rectifiers have smallest size/watt output



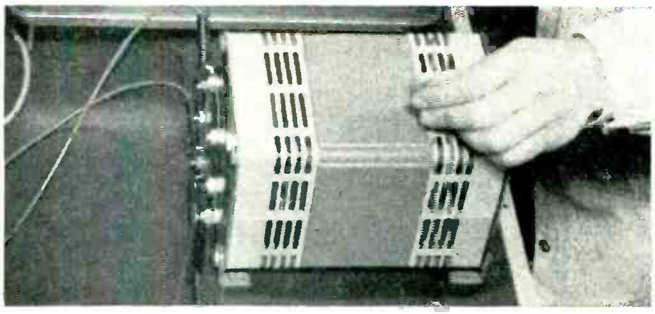
G-E germanium rectifiers operate at extremely high current densities—highest output voltage per cell of all existing metallic rectifiers. A large d-c output is obtained using fewer cells than other types of rectifiers, resulting in a smaller, more compact rectifier. In addition, germanium has the lightest weight per watt output of existing metallic rectifiers. These features give them broad application in power conversion wherever size and weight requirements are at a premium.

(1) Type RA2 has cell mounted on copper cooling fin —fan-cooled at 200 feet per minute. Ratings from 6 volts, 20 amperes d-c up to 26 volts, 8 amperes d-c.

(2) Type RA3 has cell mounted on copper block with multiple fins—blower cooled at 1000 feet per minute. Available in ratings up to 20 volts, 75 amperes d-c.

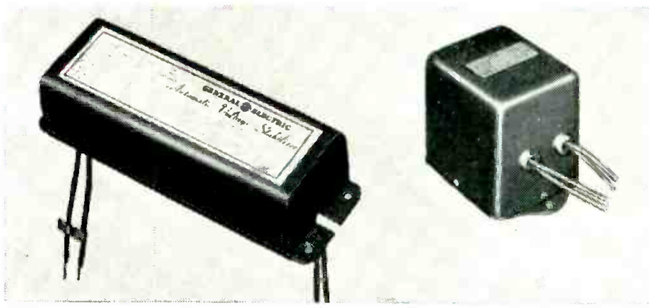
(3) Sealed type RA1 is convection-cooled with ratings from 6 volts, 0.5 amperes up to 50 volts, 0.4 amperes d-c.

(4) Convection-cooled type RA2 has cell mounted on copper cooling fin. Available up to 26 volts, 4 amperes d-c. G-E germanium rectifiers have extremely low reverse leakage and low forward voltage loss. Regulation is less than five percent when operated at the high current densities permissible with germanium. **Bulletin GEA-5773B gives details.**



Inductrols regulate circuits up to 600 V, 520 KVA

Where a-c, or rectified d-c, voltage or current is critical, these induction regulators reduce erratic performance, increase life of your equipment. Available for automatic, motor, or hand (above) operation, Inductrols feature negligible wave-form distortion, begin corrections to 1% accuracy within 1 second. **GEC-795 covers single-phase, GEA-5824 the 3-phase models.**



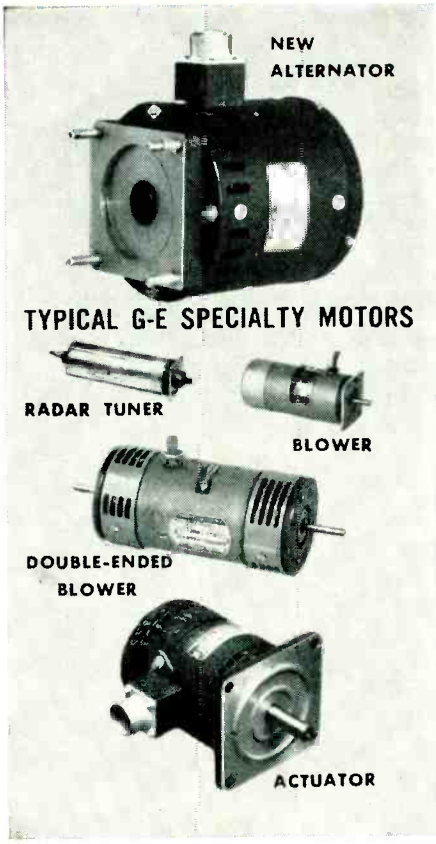
G-E voltage stabilizers give ±1% voltage control

G-E voltage stabilizers reduce the need to derate components to compensate for voltage fluctuations. Single-phase, standard line units from 15 VA to 1000 VA are available to correct fluctuations between 95 and 130, or 190 and 260 volts within ±1%. Rapid-response stabilizers correct for voltage changes in less than two cycles. Stabilizers limit short-circuit current and help safeguard the load. **Check bulletin GEA-5754A.**

GENERAL ELECTRIC

DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS



New 400-cycle alternator added to aircraft specialty motor line

Newly developed to withstand the tremendous range of shock, temperature and atmospheric conditions of guided-missile applications, this explosion-resistant 400-cycle alternator meets military specifications MIL-E 5272 procedure 1. Rated up to 1500 volt-amperes, 12,000 rpm, for output of 115 volts, this unit is designed to be driven by a wide variety of d-c, a-c, turbine, and jet-air drives.

Rigid testing assures that this alternator—and all G-E aircraft and armament motors—meet your design needs. Your specifications are all that G-E engineers need to begin applying their motor experience to your aircraft and armament problems. **Write for GEA-6269 (new 400-cycle alternator) or GEC-988 (aircraft and ordnance motors).**

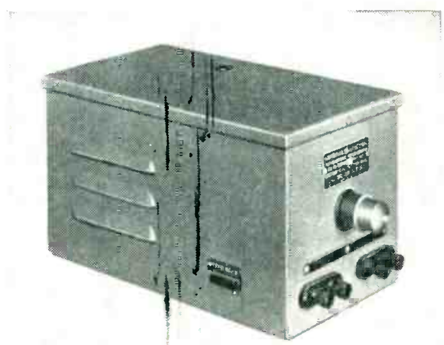
G-E vacuum gages measure pressures from 0 to 20,000 microns

Two G-E vacuum gages accurately measure pressures in such applications as electronic tube manufacture, vacuum coating and plating.

MOLECULAR VACUUM GAGE is available in two calibration types—one for dry air indicates pressures between 0 and 20,000 microns; the other type has a linear scale of 100 uniform divisions which can be calibrated by the customer for measuring other gases. There's no primary element to burn out or replace—gage measures absolute pressure of dry air in direct readings of mm of mercury.

THERMOCOUPLE VACUUM GAGE has range from 1 to 200 microns and 1 to 1000 microns of mercury. Sensitive to both condensable and noncondensable gases, gage does not require recalibration when tubes are interchanged. **For further information write for bulletin GEC-385C (Thermocouple Vacuum Gage) and GEC-986 (Molecular Vacuum Gage)**

G-E potentiometer balances to ±2 microvolts



G.E.'s self-balancing potentiometer converts small d-c voltage to measurable currents—ideal for analyzing electronic circuits because it does not appreciably load the measured circuit. Compact, portable, and self-contained, unit's accuracy is ±2 microvolts or 0.2 percent, whichever is greater. Wide range output permits use of indicating or recording instruments having resistance up to 1500 ohms. **For further information, check coupon for bulletin GEC-367B.**

Section A667-30
General Electric Company
Schenectady 5, New York

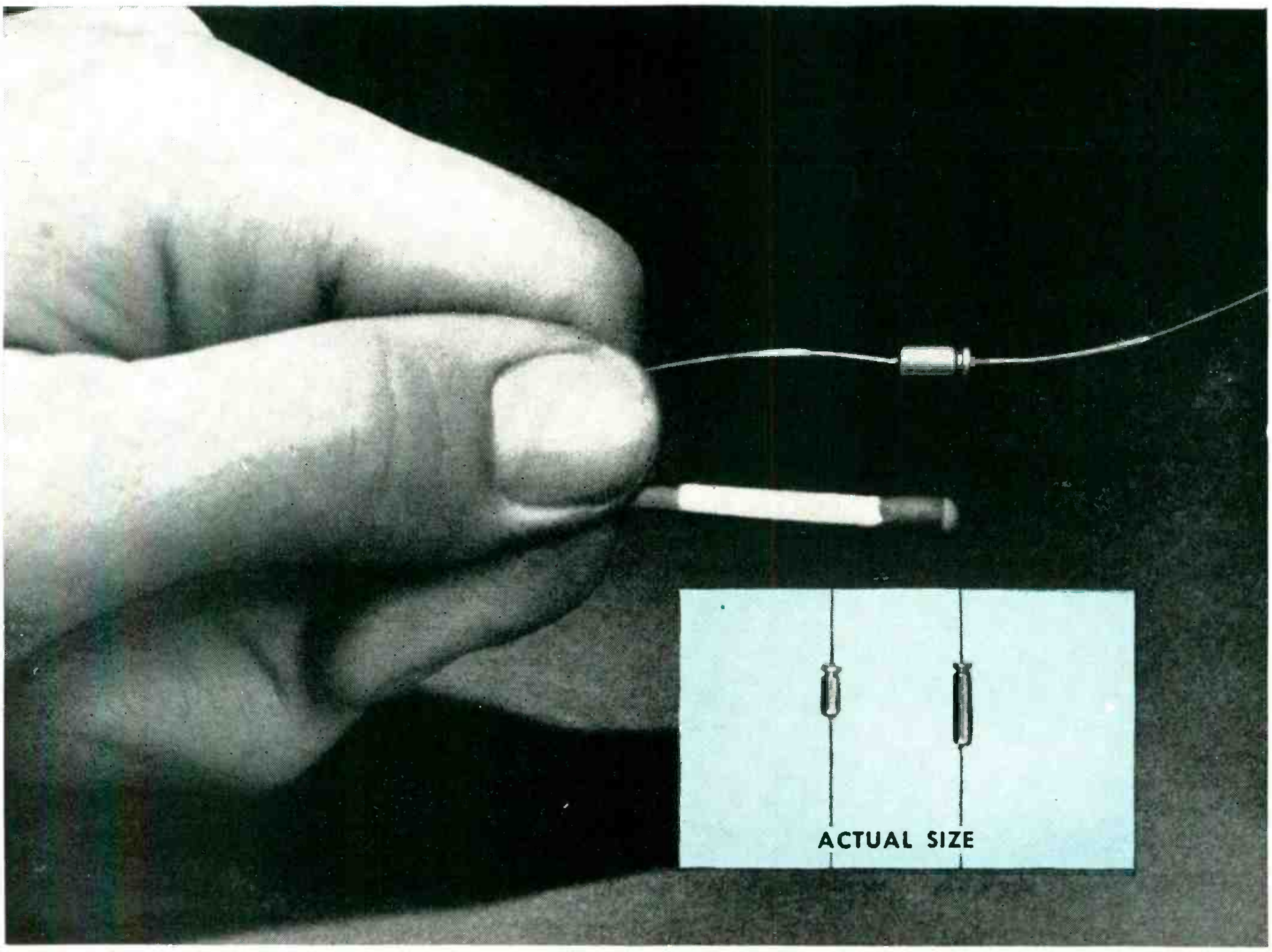
Please send me the following bulletins

√ for reference only ✕ for immediate project

☐ GEA-5773B Germanium Rectifiers
☐ GEA-5754 Voltage Stabilizers
☐ GEC-795A Single-phase Inductrols
☐ GEA-5824 3-phase Inductrols
☐ GEA-6269 400-cycle Alternator
☐ GEC-988 Aircraft and Ordnance Motors
☐ GEC-986 Molecular Vacuum Gage
☐ GEC-385C Thermocouple Vacuum Gage
☐ GEC-367B Self-balancing Potentiometer

NAME ....
COMPANY ....
CITY .... STATE ....

TURN PAGE FOR MORE G-E COMPONENT HIGHLIGHTS



Specify G-E micro-miniature Tantalytic* capacitors wherever large capacitance is required in small space

G-E micro-miniature Tantalytic capacitors represent the ultimate in capacitor miniaturization, and are perfect companions for the transistor or for use in any miniaturized assembly. They have found wide application in hearing aids, paging systems and other transistorized devices. Standard ratings are stocked, and samples are immediately available.

Production quantities can be supplied 6 to 8 weeks after your order is received. Ratings range from 4 to 20 volts, and from 1 to 8 microfarads in the 5/16 in. long case—higher capacitance in the ½ in. case size. Stability of the oxide formation and inert characteristics of the tantalum metal give long operating life over a wide temperature range—−20 C to +50 C. They may be stored at −65 C. Capacitance tolerance is −0% to +200%.

Micro-miniature capacitors are designed for non-resonant, non-critical applications such as coupling, by-pass and filtering where bulk capacity is useful. Their size—smaller than the head of a match—is an advantage over paper capacitors wherever space is at a premium, and their shelf life and electrical stability is greater than aluminum electrolytic capacitors.

G-E capacitors are completely sealed against leakage or contamination of the interior and employ only a non-acid electrolyte. Each unit is identified with a color code. **For further information, contact your nearest G-E Apparatus Sales Office, or check coupon for Bulletin GEA-6065A.**

*Reg. Trade-mark of General Electr c Company.

GENERAL ELECTRIC

DESIGNER'S DIGEST

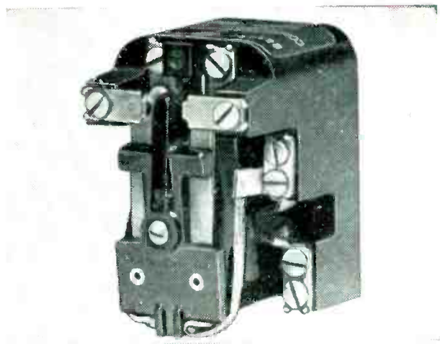
TIMELY HIGHLIGHTS ON G-E COMPONENTS

New subminiature transformers tailored to your needs

G-E engineers designed the new line of subminiature transformers to meet a variety of electronic applications. Available in five case designs, 13/16 in. to 1-7/16 in. high, these new transformers are metal-clad and hermetically sealed. The new subminiature transformers can be designed to withstand high-potential test voltages of 1250 volts RMS, or altitudes up to 100,000 feet.

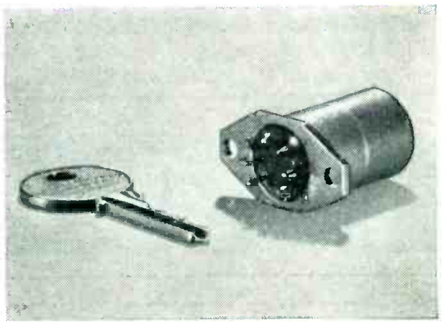
In addition, these units will operate in ambient temperatures of 125 C. The smallest unit (illustrated) is designed for printed circuits and has solid wire conductors two inches long for easy, direct connection to the other components. **Your nearest G-E Apparatus Sales Office will give you complete details.**

Small-size general-purpose relay



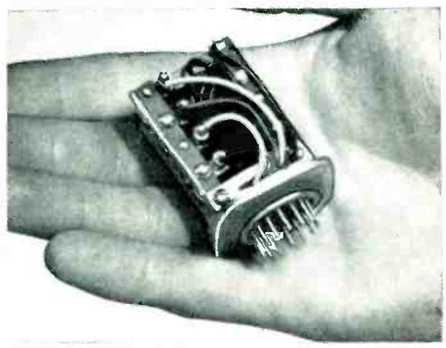
High current rating, small size, and extremely long life make this general-purpose relay ideal for electronic equipment where space is at a premium and reliability is of prime importance. Contact arrangements include DPDT, DPST, SPST, and SPST-double-break. Accessories are available for metal- and compound-base mounting as well as jack assembly for plug-in applications. **Check coupon for bulletin GEC-257C.**

Tiny relay withstands vibration



The G-E subminiature relay withstands vibration of 10g up to 500 cps and operates at temperatures up to 125 C. Lightweight and reliable, this relay has a low capacitance rating making it ideal for switching high frequency signals or pulses. Pickup time is 5 milliseconds or less and dropout time is 2 milliseconds or less. Coils are available for 400-cycle a-c voltage. **Bulletin GEA-6211.**

High-speed polarized relay



This hermetically sealed relay operates at speeds ranging from 250 microseconds to 1 millisecond. It can be adjusted for operating time of less than 250 microseconds, including bounce. Contact combinations up to 4PDT are available in a miniature enclosure 1-7/16 in. x 21/32 in. x 2-3/22 in.—net weight only 5 oz. The relay meets requirements of MIL-R-6106 and MIL-R-5757B. **Bulletin GEA-6212.**

EQUIPMENT FOR ELECTRONIC MANUFACTURERS

Components

Meters, instruments
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Delay lines
Reactors
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Relays
Amplidynes
Amplistats
Terminal boards
Push buttons
Photovoltaic cells
Glass bushings

Development and Production Equipment

Soldering irons
Resistance-welding control
Current-limited high-potential tester
Insulation testers
Vacuum-tube voltmeter
Photoelectric recorders
Demagnetizers

Section A667-30
General Electric Company
Schenectady 5, New York

Please send me the following bulletins;
✓ for reference only X for immediate project

☐ GEA-6065A Microminiature Tantalytic Capacitors
☐ GEC-257C General-purpose Relay
☐ GEA-6211 Subminiature Relay
☐ GEA-6212 Polarized Relay

Name ....

Company ....

City .... State ....

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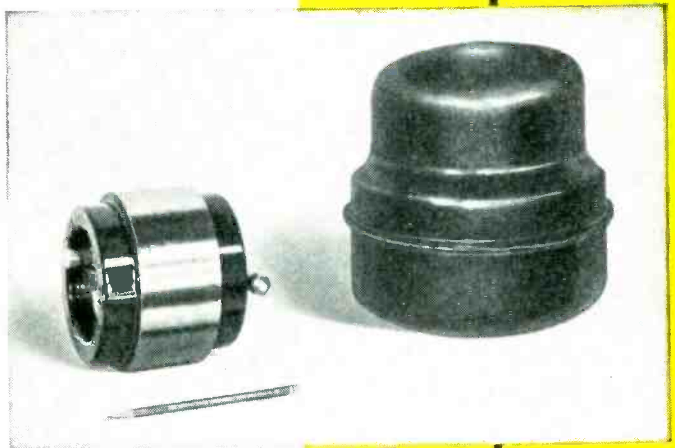
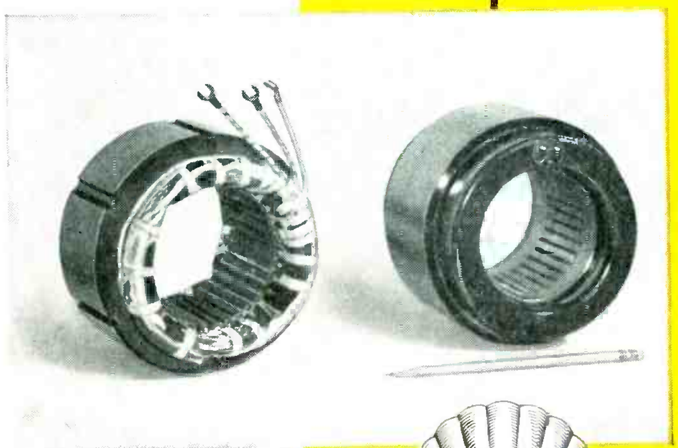
with the help of **EPON® RESIN...**

Motor stator becomes pump housing as well—

in new, ultra-compact, refrigeration motor-compressor



New Compressor (left) takes only 27% of the space of a conventional unit (right). It has only 10% as many parts, weighs 58% less, and will cost much less to produce.



Assembled stator (left). Finished stator (right) has been potted with Epon resin formulation. New compressor was developed by Wetmore Hodges and Associates, Redwood City, California.

Why not combine the pump and the motor? Put a gear pump *inside* the motor stator, encase the stator in plastic, and you can build an entire motor-compressor in the space occupied by a conventional motor alone!

Wetmore Hodges and Associates have done just that. But along the way, they ran into an unexpected problem. With the motor stator doubling as the pump housing, it had to be pressure tight . . . free of voids. This was impossible to achieve with standard potting compounds.

After hundreds of plastic formulations were tried, an Epon resin-based compound solved the problem. The Epon-impregnated stator proved to be pressure tight, stable mechanically and fully resistant to Freon at 350 psi, at temperatures as low as –20° F and as high as 250° F. Important too, Epon resin has excellent dielectric properties; is impervious to air, oil and water.

If you, too, are interested in plastics for electrical applications, write for technical bulletin "Epon 828 in Casting Applications."

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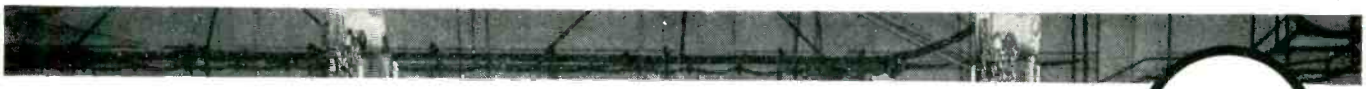
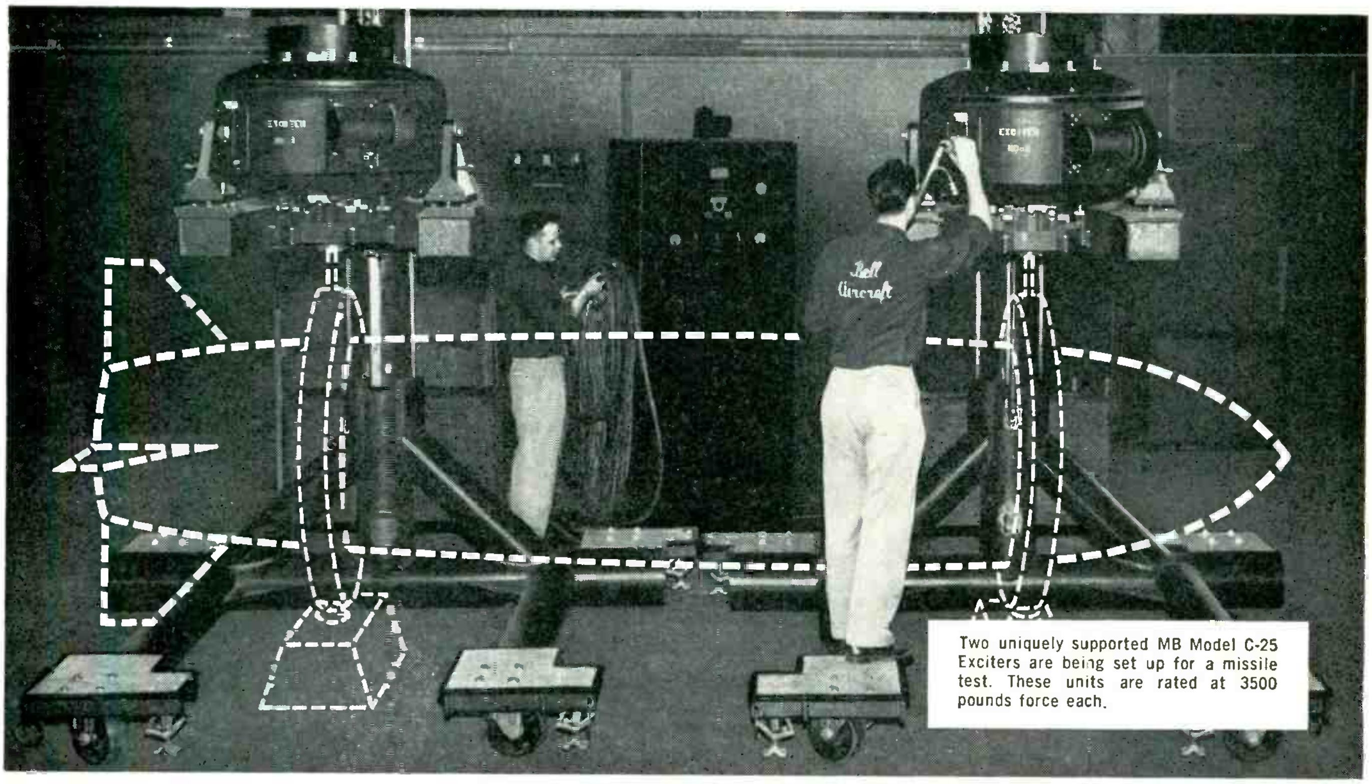


"Shake" tests add extra margin of reliability at BELL Aircraft



Two uniquely supported MB Model C-25 Exciters are being set up for a missile test. These units are rated at 3500 pounds force each.

Operation and quality quickly checked on

M B VIBRATION EXCITERS

Engineers of Bell Aircraft Corporation take advantage of the unusual help provided by shake testing – with a specially mounted setup of two MB Model C-25 Exciters for vibrating missiles.

BENEFITS OF SHAKE TESTING

Because small vibrations can be magnified in a complex missile structure, and because interactions of components are important, such testing checks vital systems. The MB shakers permit Bell engineers to produce conditions more severe than expected in service. In effect, a margin of safety can thereby be added to increase reliability of operation.

Moreover, vibration tests afford a quick, versatile means for checking quality of components. Defective and malfunctioning components are quickly detected.

To cap it all, substantial savings in manhours and fuel costs have been effected by substituting shake tests for hot firing of missiles prior to flight tests.

WHY MB VIBRATION EXCITERS?

Engineered by vibration specialists to deliver maximum performance, MB Shakers can be counted on for pure table motion and dependable operation to full rated capacity. MB's line of vibration testing "tools" is complete – from small specialized-duty shakers to the largest in existence today.

Prompt servicing provided by a special staff of MB engineers. For more information on shakers, send for Bulletin 1-VE -5

the MB manufacturing company, inc.

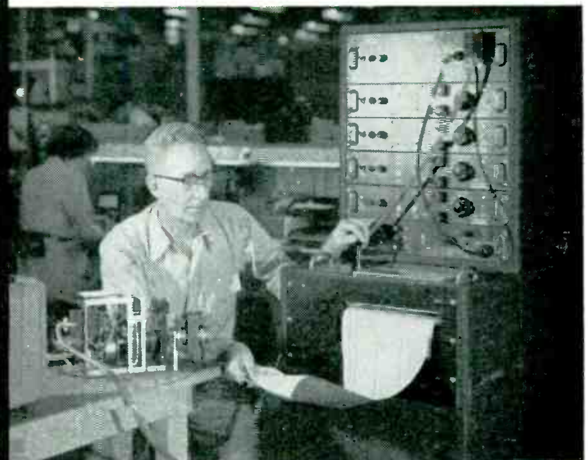
1060 State Street, New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO *ISOLATE* VIBRATION... TO *EXCITE* IT... TO *MEASURE* IT

How two TYPICAL production testing headaches were cured with SANBORN OSCILLOGRAPHIC RECORDING SYSTEMS

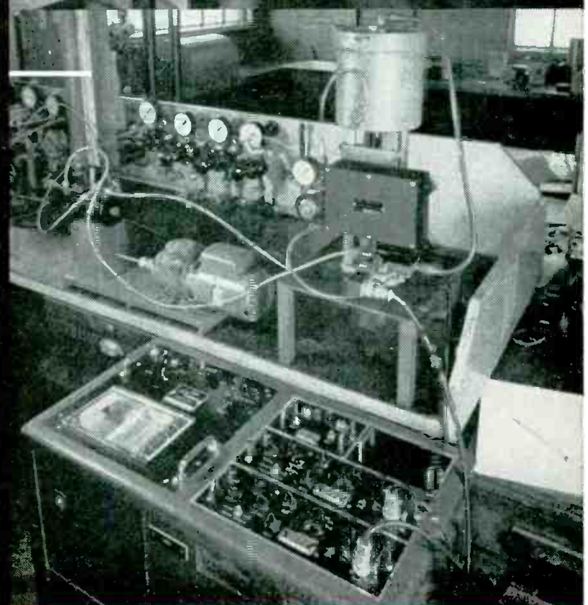
RAYTHEON MANUFACTURING COMPANY'S Waltham, Mass. Inspection Dept. formerly found their incoming inspection of complex, multi-ganged potentiometers a time-taking and costly job which involved tedious calibration, instrument set-up and testing for *each* of the five potentiometer sections, with each operation subject to inevitable human error.

Today, by using a Sanborn four-channel Recording System and a Potentiometer Power Supply, a visual, concurrent strip-chart record of *five* channels (using marker stylus) of phenomena such as phasing, shorting bar, winding noise, and resolution of winding turns is provided. Inspection time is speeded up 900%, the operator sees immediately all causes for rejection, the chart is a permanent test data record, one inspector takes the place of three, and human error is reduced to a negligible factor.



MOORE PRODUCTS COMPANY of Philadelphia uses a Sanborn Model 60 two-channel Recording System to check the Dynamic Performance of their Valve Positioners, which are used on diaphragm top-work valves and power cylinders. The valve positioner acts as a relay, applying additional air pressure to the cylinder or top-work, overcoming effects of unbalance and friction, and compelling the valve stem to take the position dictated by the pneumatic controller or manually-operated air load. A feed-back linkage assures positioning of the valve stem within plus or minus 0.001".

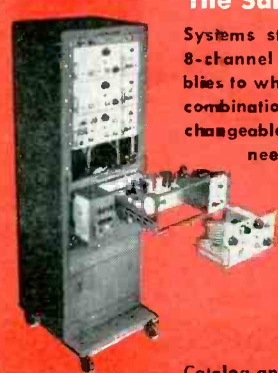
A pneumatic sine wave generator supplies pneumatic impulses with frequencies as high as 20 cycles per second. These impulses are sent to the valve positioner and to a transducer which converts the signal for the recorder. The response of the valve stem is measured by a strain gage pickup for the second channel of the recorder.



The above cases are but two of the many applications possible with Sanborn one-, two-, four-, six- and eight-channel Recording Systems. With a Sanborn you can register permanently and graphically virtually all electrical phenomena within a frequency range of zero to 100 cps. A choice of the number of channels, plus the ready interchangeability of various type preamplifiers (to meet individual recording problems) offers a wider versatility of use, greater overall economy, and increased operating efficiency.

Added to these advantages are the standard SANBORN instrument features: INKLESS recording in true rectangular coordinates, high torque galvanometer movement, time and code marking, and numerous paper travel speeds.

The Sanborn "150" Series



Systems start with 1-, 2-, 4-, 6- or 8-channel Cabinet-Recorder Assemblies to which the user adds whatever combination of the following interchangeable plug-in Preamplifiers is needed for his work.

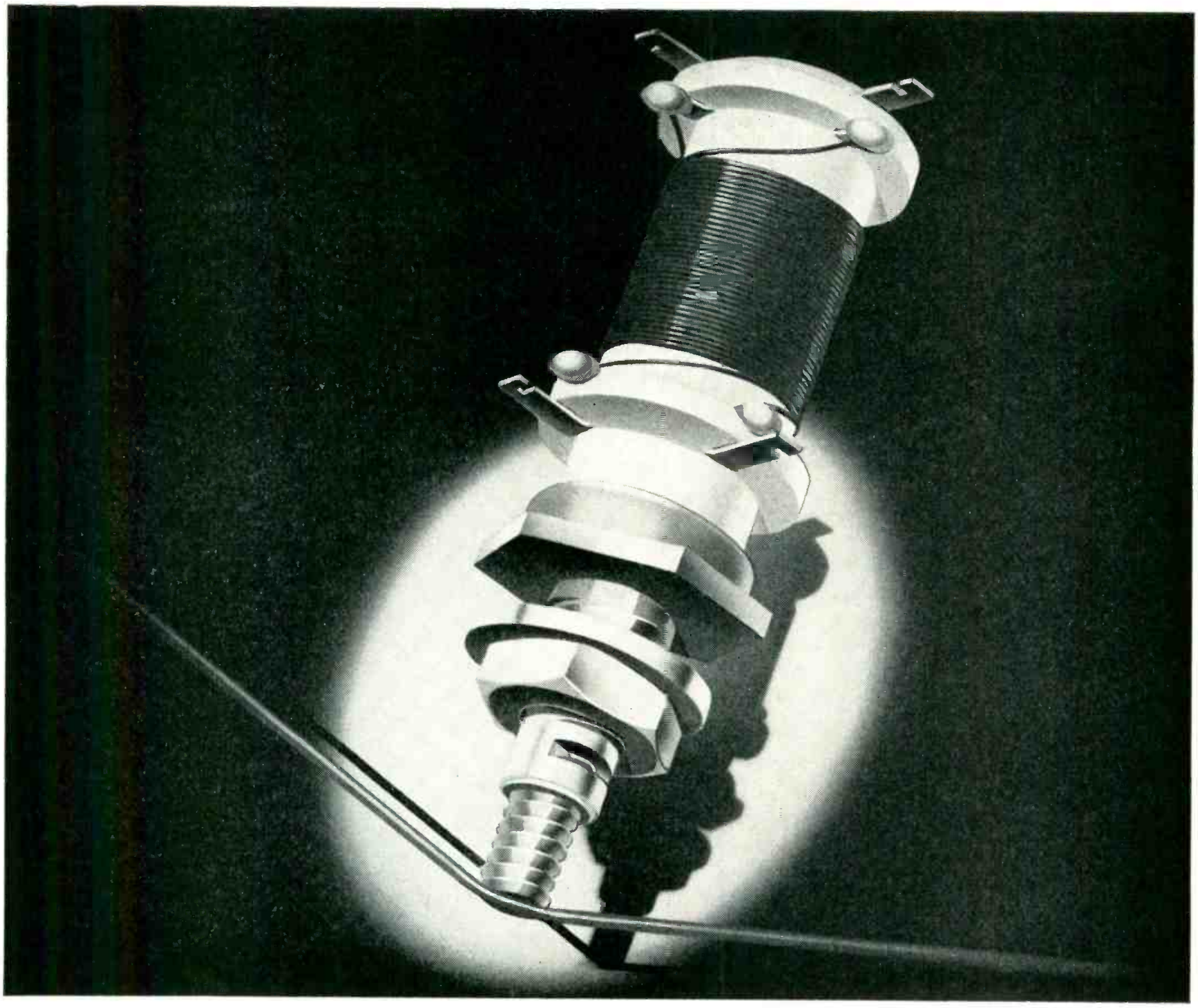
- AC-DC
- Carrier
- Servo Monitor
- DC Coupling
- Log-Audio
- Low Level Chopper
- Input Network

Catalog and Technical Data on "150" Equipment available on request.

SANBORN COMPANY
INDUSTRIAL DIVISION

CAMBRIDGE 39, MASSACHUSETTS

Want more information? Use post card on last page.



Death-defying performance

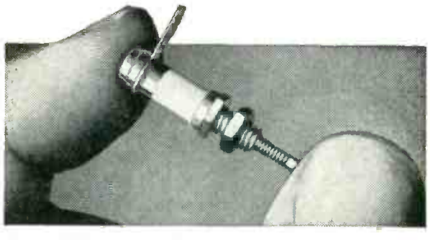
You can depend on C.T.C. coils to give a steady, star performance. They won't go dead despite threats of temperature, climate or vibration. And for very good reasons —

The mounting stud of every C.T.C. coil is fastened to the ceramic body in a special way that does away with weaknesses of ordinary coil fastenings. This special fastening makes C.T.C. coils vibration-proof. What's more, their tightness is preserved in hot, cold, dry or damp weather. All C.T.C. coils are precision-made, of course, to meet individual specifications — and to meet, or better, government specifications, as well. And continuous quality control is maintained.

As a result, you get a *guaranteed* electronic component — custom or standard — whose performance you can depend upon.

Precision-made C.T.C. components that benefit from C.T.C. high quality standards include terminals, terminal boards, capacitors, swagers, hardware, insulated terminals and coil forms. For all specifications and prices, write Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 and 988 Market St., San Francisco, California.

Slug Tuned Coil Data: Single layer or pie type windings to your specifications. Forms of quality paper base phenolic or grade L-5 silicone impregnated ceramic. Mounting studs are cadmium plated brass; ring type terminals are silver plated brass. All units include slugs and mounting hardware. One style (Type C) available with retaining collars of silicone fibreglas which permit 2 to 4 terminals. Windings can be coated with resin varnish, wax or lacquer.

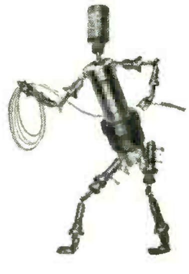


New CST-50 variable ceramic capacitor surpasses range of capacitors many times its size. Stands only 1 9/32" high when mounted, is less than 1/4" in diameter and has an 8-32 thread mounting stud. A tunable element of unusual design practically eliminates losses due to air dielectric giving large minimum to maximum capacity range (1.5 to 12MMFD).

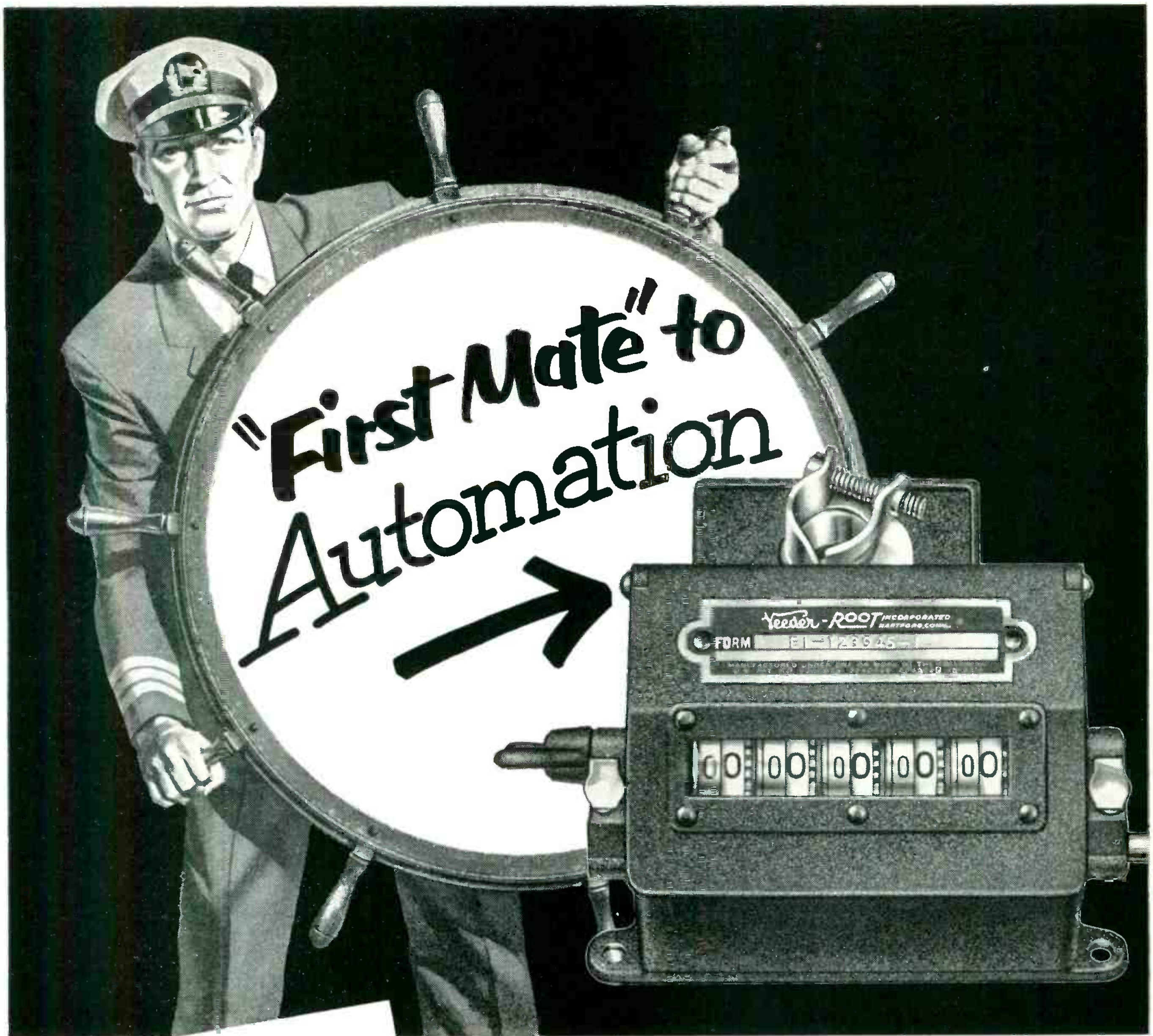
CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components, custom or standard



Want more information? Use post card on last page.

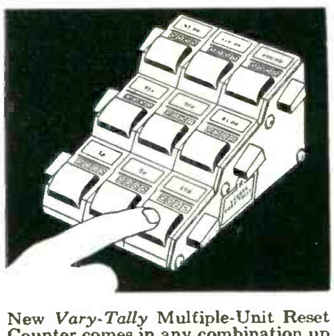


Added Evidence that . . .

Everyone Can Count on

VEEDER-ROOT

In figuring out new systems of automatic electrical control, Veeder-Root *Count*rol can supply vital connecting links. For instance, this Predetermining Counter can be hooked into such a system to light a light, ring a bell, or actuate a mechanism to stop a machine or process *at any pre-set point*. And there are many other Veeder-Root Counters that can serve as "count-ponents" in almost any way desired. Or special counters can be designed for specific applications. Engineers in any industry, now engaged in working out automatic control systems, can count on Veeder-Root engineers to work with them on any problem where reliable facts-in-figures are needed.



New *Vary-Tally* Multiple-Unit Reset Counter comes in any combination up to 6 banks high, and 12 units wide Write for news sheet and prices.

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

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DU PONT
Better Things for Better Living
. . . through Chemistry

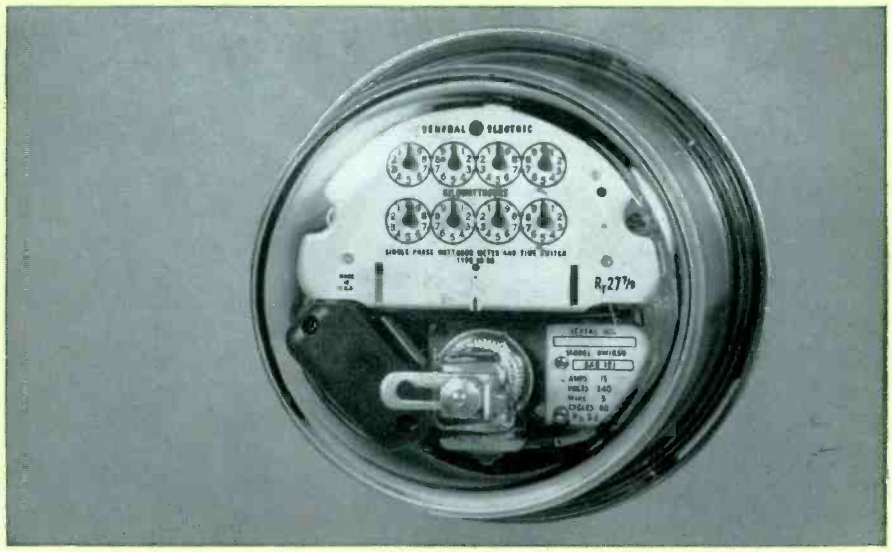
ELECTRICAL ENGINEERING NEWS

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

NO. 1 — 1955

Case of Molded Du Pont ZYTEL* Protects Motor Coil from High Surge Voltage

"Zytel" gives coil same electrical resistance as whole watthour meter . . . permits coil to withstand thermal shock cycling between 100°C and —40°C.



General Electric's TYPE IR-50 combination watthour meter and time switch used to control off-peak water-heater loads. The motor coil is encased with molded Du Pont "Zytel" nylon resin for superior insulation and protection.

This picture shows how a molded jacket of Du Pont "Zytel" nylon resin encapsulates motor coil. This piece is economically produced by a simple molding cycle.

*"Zytel" is the new trade-mark for Du Pont nylon resin.

General Electric investigated the properties of "Zytel" nylon resin very carefully before using it in their TYPE IR-50 combination watthour meter and time switch. What are the dielectric properties of "Zytel"? The motor coil was protected against a 7,000-volt 60-cycle surge, or a 10,000-volt surge to ground when the coil was encapsulated with "Zytel". Thus, the motor coil assembly could have the same electrical surge and high voltage resistance as the watthour meter. What is the thermal stability of "Zytel"? General Electric states that this engineering material has the physical properties needed to withstand severe thermal shock cycling between 100°C. and —40°C.

Simple Molding Technique

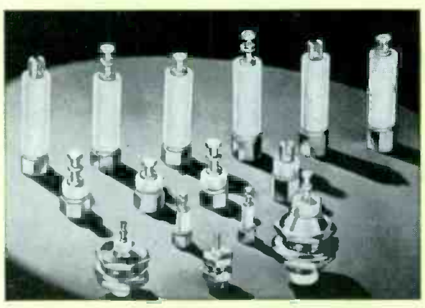
Other considerations dictated the use of Du Pont "Zytel" (Continued, column 1 back side)

OVER

Stand-off and feed-through insulators of TEFLON® used for high-frequency, high-voltage service

Du Pont "Teflon" is unsurpassed as an insulation material. Dielectric constant from 60 cycles per second to 10^8 cycles per second is 2.0 (A.S.T.M. D150-47T). Other properties are practically constant over the entire frequency range. Moreover, "Teflon" will not carbonize under arcing and will not DC-plate.

Good electrical properties are retained over the temperature range of —450° F. to 500° F. "Teflon" will neither soften when soldering is done, nor become brittle in cold weather. Voltage breakdown after 95% humidity at 160° F. is greater than 5,000 V-DC at sea level. Its water absorption is zero (A.S.T.M. D570-42). Extreme humidity, fungus and weathering won't affect "Teflon". This engineering material is not subject to breakage from mechanical or thermal shock. It is inert to all chemicals normally encountered in industry.



These stand-off and feed-through insulators of "Teflon" are unaffected by a wide range in ambient temperature, pressure, altitude, humidity, mechanical shock and vibration. Manufactured by United States Gasket Company, Camden, New Jersey.

Electrical engineers find these properties of "Teflon" tetrafluoroethylene resin particularly useful for stand-off insulators and feed-through insulators—as well as special assemblies such as anode shields and relay contact plates.

ELECTRICAL ENGINEERING NEWS

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

Better Things for Better Living . . . through Chemistry

NO. 1 — 1955

"Zytel" (continued)

nylon resin for this motor coil casing. It is formed rapidly and economically by a relatively simple molding cycle. It makes a compact motor assembly. "Zytel" won't rust. And it has an attractive appearance.

Du Pont "Zytel" nylon resin provides a valuable design and development tool for the electrical engineer. Its dielectric properties, lightness of weight, and resistance to corrosion and high temperatures are valuable properties for many electrical applications. For further information on this unique material, mail the coupon below.

Investigate Du Pont engineering materials in your product development programs

One of the family of these versatile engineering materials is often a key factor in product improvement or new product design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"† nylon resin are helping solve industrial design problems.

NEED MORE INFORMATION?

Clip the coupon for additional data on the properties and applications of these Du Pont engineering materials.

Slotted tubes of ALATHON® for greater battery power

The slotted construction shown above gives greater power and longer life to battery tubes for positive plates. These tubes are extruded from Du Pont "Alathon" polyethylene resin which are slotted so more of the active material around the core is exposed to electrolyte. The active material is retained better during the charge-discharge cycle, lengthening working life of the battery.

"Alathon" won't corrode or erode. It's lightweight, flexible, and strong. Low temperatures don't affect the strength and flexibility of this engineering material. Manufactured by the Electric Storage Battery Company, Philadelphia, Pennsylvania.

Du Pont TEFLON® suggests new ideas for electronic and electrical designs

Du Pont "Teflon" tetrafluoroethylene resin offers a combination of electrical, thermal and mechanical properties *unmatched by any other single plastic material.* It is particularly outstanding for use as electrical insulation at high frequencies and temperatures.

Properties of "Teflon":

Excellent Dielectric Characteristics over a wide range of temperatures and frequencies.

Heat Resistance: "Teflon" is capable of continuous service at 500° F.

Tough and Strong over a wide range of temperatures, from —450° F. to 500° F.

Chemical Inertness: "Teflon" is inert to all chemicals and solvents, except molten alkali metals and fluorine at elevated temperatures and pressures.

Zero Moisture Absorption by A.S.T.M. test D570-42.

Outdoor Durability: "Teflon" is unaffected by years of outdoor weathering.

Advantages of "Teflon":

"Teflon" can be used as thin, flexible insulation—in many cases where the use of such insulation might have been impossible with other materials.

For many types of electrical and electronic equipment, "Teflon" permits simplified, compact design.

"Teflon" can be fabricated into component parts, or produced in tape form, or applied as a coating.

The electrical uses of "Teflon" are numerous. Examples include: spacers for coaxial cables; inserts for coaxial connectors; insulation for high-voltage wires and cables; wrapping tape for insulation in motors, generators and conductors.

Send for more information showing how "Teflon" can help improve electrical designs. Fill out and mail the coupon on this page.

E. I. DU PONT DE NEMOURS & CO. (INC.)
Polychemicals Department
Room 222, Du Pont Building, Wilmington 98, Delaware

Please send me more information on the Du Pont engineering materials checked: ☐ "Zytel"; ☐ "Alathon"; ☐ "Teflon"; ☐ "Lucite". I am interested in evaluating these materials for:

____

NAME ______________ POSITION ______________

COMPANY ______________________________

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TYPE OF BUSINESS ______________________________

TYPE KARU CAPACITANCE METER

Range: 0.5 uuf to 10 uf
Accuracy: ±1%

TYPE LARU INDUCTANCE METER

Range: 0.1 uh to 1 h
Accuracy: ±1%

—EACH INSTRUMENT PROVIDING A UNIQUE COMBINATION OF

- Wide range
- High Accuracy
- Direct reading
- Ease of operation

The KARU and LARU meters, manufactured by Rohde and Schwarz, will solve virtually all problems of capacitance and inductance measurements in the r-f field. Operating over exceptionally wide ranges, they provide accurate direct reading and require minimum skill and training.

Capacitance: KARU, by an application of the resonant circuit technique, measures from 0.5 uuf to 10 uf—covering the entire range of capacitors generally used—and with an accuracy of ±1%.

Inductance: LARU covers the exceptionally wide range of 0.1 uh to 1 h, with an accuracy of ±1%. It will also measure self-resonant frequency and distributed capacitance of inductors. Measurements can be made on components with Q as low as 1.

Both instruments are speedy and easy to operate—their direct reading scales are calibrated to give the result with no scale or multiplication factors to be considered. Six scales, controlled by the range selector switch, provide a total scale length of 54 inches.

Exclusive design features of KARU and LARU include: a novel revolving linear dial which eliminates metering errors . . . the range selector switch brings the appropriate scale into view . . . scale-factor errors are eliminated . . . positive action detent on the range selector switch . . . full protection from overload.

In measuring with KARU, the unknown capacitance is resonated with a built-in standard coil by means of the variable r-f oscillator, to which it is loosely coupled. The vacuum tube voltmeter reads the voltage across the standard coil. LARU similarly measures inductance, utilizing a standard capacitor in place of the standard coil.

These highly versatile instruments are compact, wholly reliable and completely self-contained. Each unit is provided with a recessed folding carrying handle and a removable protective cover.

For complete information, mail the attached coupon to Federal.

SPECIFICATIONS:

Type KARU Capacitance Meter

- Capacitance Range: 0.5 uuf to 10 uf—divided into 6 ranges: 0 to 100/1000 uuf/0.01/0.1/1/10 uf.
- Accuracy: ±1% +.5 uuf.
- Measuring Frequency: 1.6 to 180 kc.
- Test Terminals: 2 knurled binding posts, one at ground potential.
- Tubes: 6SN7, 6H6.
- Power Supply: 110/125/150/220 volts ac, 40 to 60 cps, 10 va.
- Dimensions: 12" x 8¾" x 8¾". Weight: 16 lbs.

Type LARU Inductance Meter

- Inductance Range: 0.1 uh to 1 h—divided into 7 ranges: 0.1 to 1/10/100 uh/1/10/100/1000 mh.
- Accuracy: ±1% +0.01 uh.
- Measuring Frequency: 2.2 kc to 4.7 mc.
- Resonance Frequency Measuring Range: 2.2 kc to 4.7 mc—divided into 7 ranges: 2.2—7/22/70/220 kc/ 0.7/2.2/4.7 mc.
- Accuracy: ±0.5%.
- Test Terminals: 2 knurled binding posts, one at ground potential.
- Tubes: 6SN7, 6H6.
- Power Supply: 110/125/150/220 volts ac, 40 to 60 cps, 10 va.
- Dimensions: 12" x 8¾" x 8¾". Weight: 16 lbs.

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Please send further information on the items checked:
☐ KARU Capacitance Meter ☐ LARU Inductance Meter
☐ Please send copy of your General Catalog.

Name ________________ *Title* ________
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Another example of EDO's Ever-Increasing Role in the Field of MARINE ELECTRONICS

THE NEW EDO *Direct-Reading* LORAN

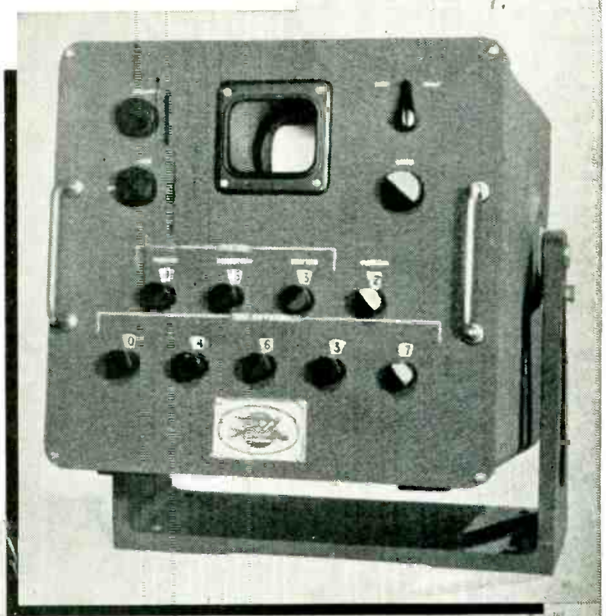
Now, Edo, a recognized leader in marine electronic development, announces a new Loran at a practical price. Built to the highest electronic standards, the Edo Loran gives quick, directly-read time difference readings for accurate plots in a matter of seconds. No calculations, no computations, no tables, no special training needed to operate.

Edo has achieved a practical low price for its new Loran with no compromise in quality by applying the most advanced electronics circuitry. For instance there are less than half the number of tubes in the Edo Loran (only 26) than in any other currently available equipment. This at no sacrifice in accuracy and with the advantage of lower power requirements, easier maintenance, and greater dependability.

Features of the Edo Model 262 Loran

- ★ Only 26 tubes including cathode-ray tube and rectifiers.
- ★ Single, compact, light-weight, self-contained unit.
- ★ Low power consumption, 150 watts, 115 volts @ 60 cycles.
- ★ The unit can be mounted on a table, suspended from overhead or bulkhead.
- ★ Large direct reading dials especially illuminated for night use. Recessed CRT requires no hood.
- ★ Delay is not stored and cannot drift.

SEND FOR THE NEW BROCHURE ON THE-EDO MODEL 262 LORAN.



Edo CORPORATION College Point, L. I., N. Y. SINCE 1925

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LAMINATED PAPER BASE PHENOLIC TUBING

Outstanding for many years as the Top Performer, Clevelite is unmatched in its ability to meet unusual specifications.

Built-in Dimensional Stability, High Dielectric Strength, Low Moisture Absorption, Great Mechanical Strength, Excellent Machining Qualities and Low Power Factor make Clevelite Tubing outstanding.

Available in diameters, wall thicknesses and lengths as desired, for Collars, Bushings, Spacers, Cores and Coil Forms.

☆ ☆ ☆

Our new Torkrite internally threaded and embossed tubing affords better control of adjustments in coil forms using threaded cores.

Write for your copy of the latest Clevelite brochure.

WHY PAY MORE? For Good Quality . . . call CLEVELAND!

*Reg. U. S. Pat. Off.

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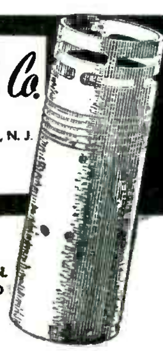
PLANTS AND SALES OFFICES at Chicago, Detroit, Memphis, Plymouth, Wisc., Ogdensburg, N. Y., Jamesburg, N. J.
ABRASIVE DIVISION at Cleveland, Ohio
CANADIAN PLANT: The Cleveland Container, Canada, Ltd., Prescott, Ontario



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WEST COAST IRV. M. COCHRANE CO., 408 S. ALVARADO ST., LOS ANGELES

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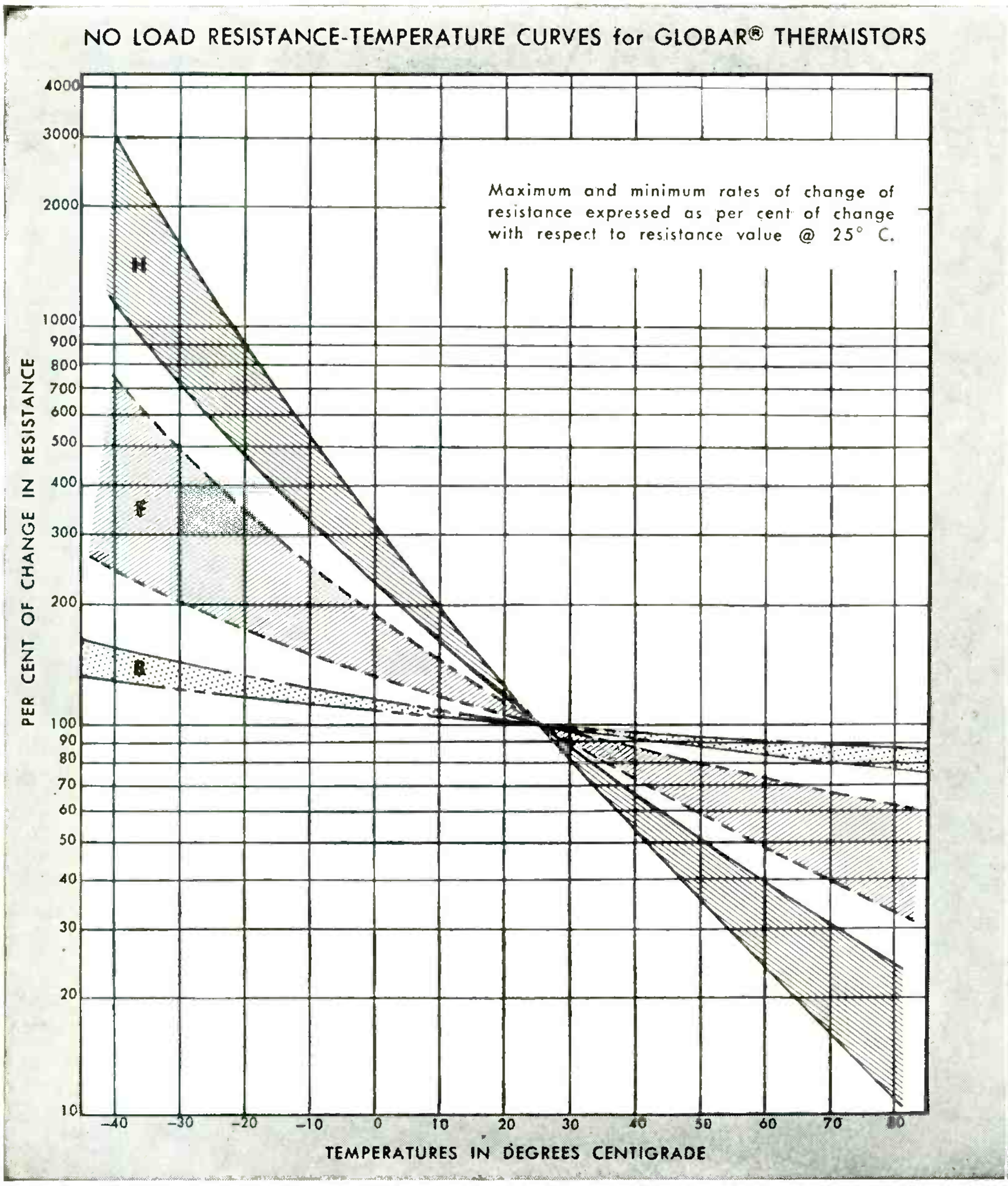

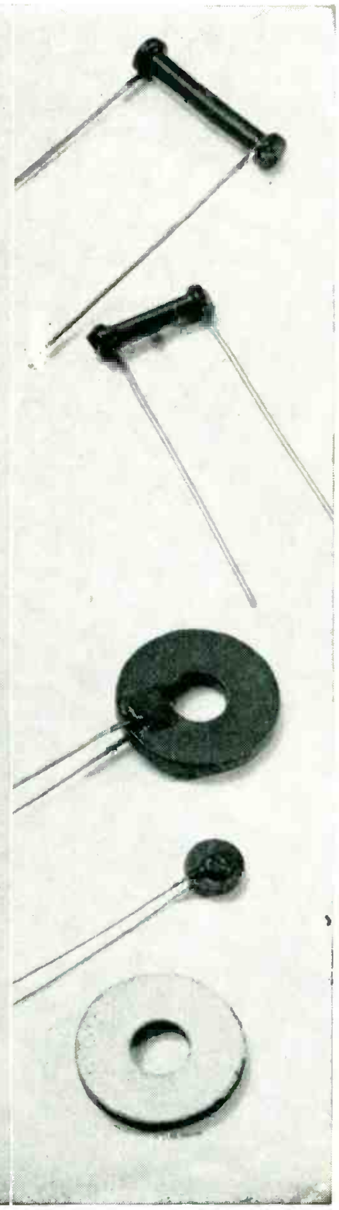

New GLOBAR® TYPE H THERMISTORS can help you solve many circuit problems

Where can *you* use resistors as sensitive to temperature changes as the new GLOBAR® Type H Thermistors shown on this chart? They offer many challenging possibilities in circuit design... can help you cut costs in the manufacture of radios, television sets, motors, relays, meters, temperature indicating devices, and many other products.

The introduction of the Type H Thermistor, which has a maximum negative temperature coefficient of 4.5%/°C at 25°C, supplementing the range previously obtainable with GLOBAR Types B and F, now provides you a working range from .33%/°C to 4.5%/°C at 25°C.

GLOBAR® Type H Thermistors are engineered to meet your exact requirements — in electrical properties as well as shapes and sizes.

TYPICAL APPLICATIONS for Type H Thermistors

- To provide time delays in relay, solenoid circuits.
- For temperature compensation in field coils.
- As protective resistors in series filament circuits of radio and television receivers.
- For temperature compensation in meters.
- To control remote temperature indicating devices.
- For temperature compensation in transistor circuitry.

WRITE FOR ENGINEERING BULLETIN ON THERMISTORS

Engineering Bulletin GR-3 gives detailed information on all three types of GLOBAR Thermistors—H, F and B. Write for your copy—and, if you have a circuit problem, send us the basic details. Our engineers will assist you, without obligation. Address: The Carborundum Company, Dept. E87-47, Niagara Falls, N. Y.

GLOBAR® Ceramic Resistors

CONVENTIONAL • VOLTAGE SENSITIVE TEMPERATURE SENSITIVE

by **CARBORUNDUM**

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AIRPAX

C747 MIDGET

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PROVEN PERFORMANCE
in large volume production
is your best guarantee
of quality!

✓ note these facts...

- AIRPAX has built nearly ¼ million choppers
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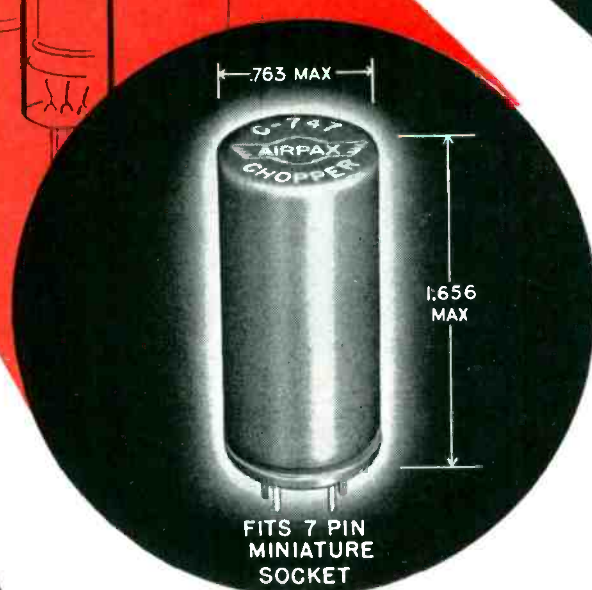

Weighs less than 1 oz.

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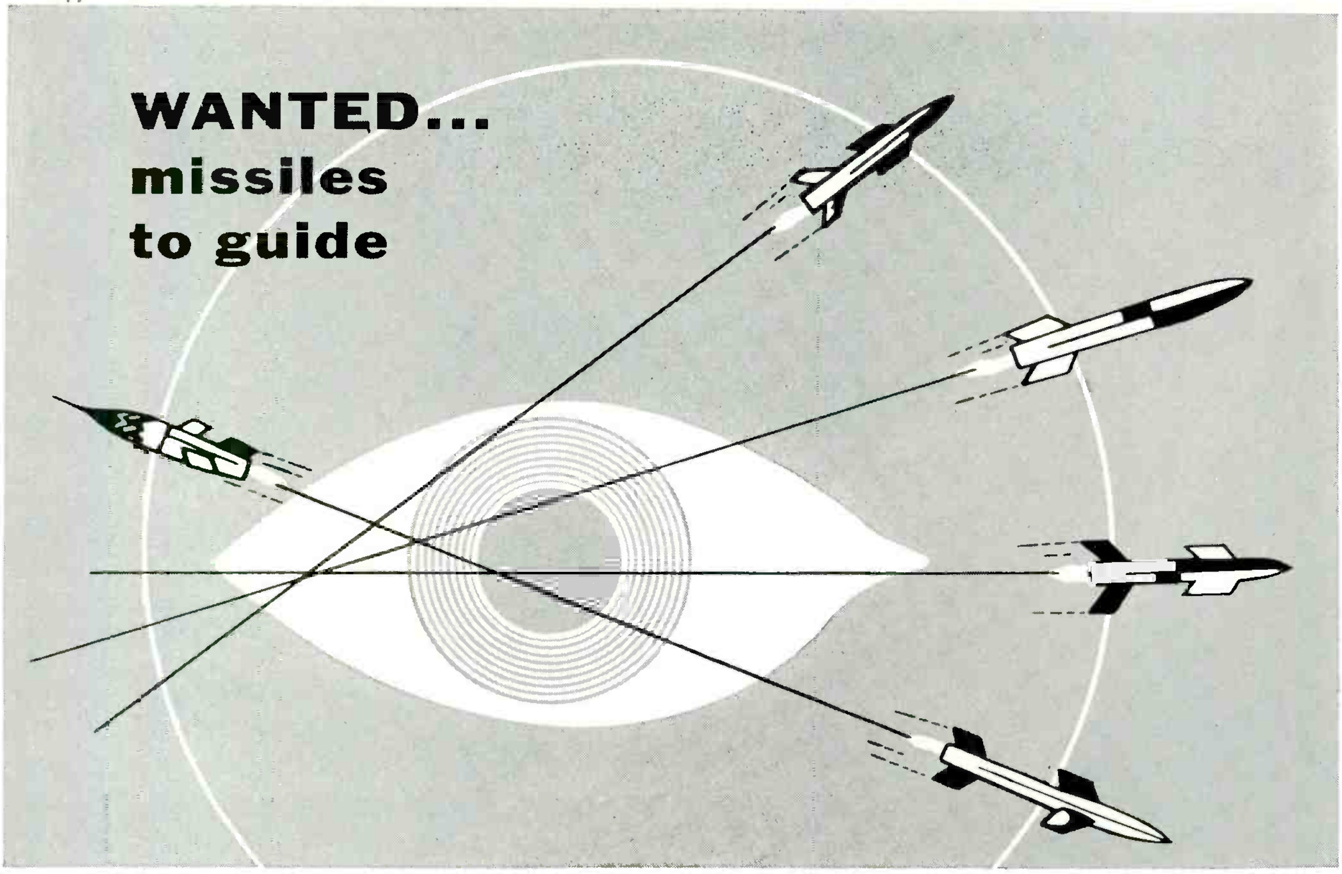
MIDDLE RIVER BALTIMORE 20, MD.



Transmitters and Monitors of proven accuracy and reliability

SYNCHROTEL TRANSMITTERS

for the remote electrical transmission of data such as true airspeed, indicated airspeed, absolute pressure, log absolute pressure, differential pressure, log differential pressure, altitude and Mach number.

PRESSURE MONITORS

to provide control signals which are functions of altitude, absolute pressure, differential pressure, etc.

To CONTROL a guided missile effectively and absolutely is a challenging problem with which hundreds of engineers are grappling every day.

The solution depends upon the efficiency and the reliability of the controlling parts.

For over 25 years Kollsman has been making precision aircraft instruments and equipment used on military and commercial aircraft throughout the world. The talents and skills needed for success in this special and challenging field are equally necessary in the design and manufacture of precision controls for missiles.

Kollsman is presently making Transmitters and Monitors of proven accuracy and reliability for missile control.

Brochures are available on the above two products.

Please write us regarding your specific problems or requirements in the field of missile control.

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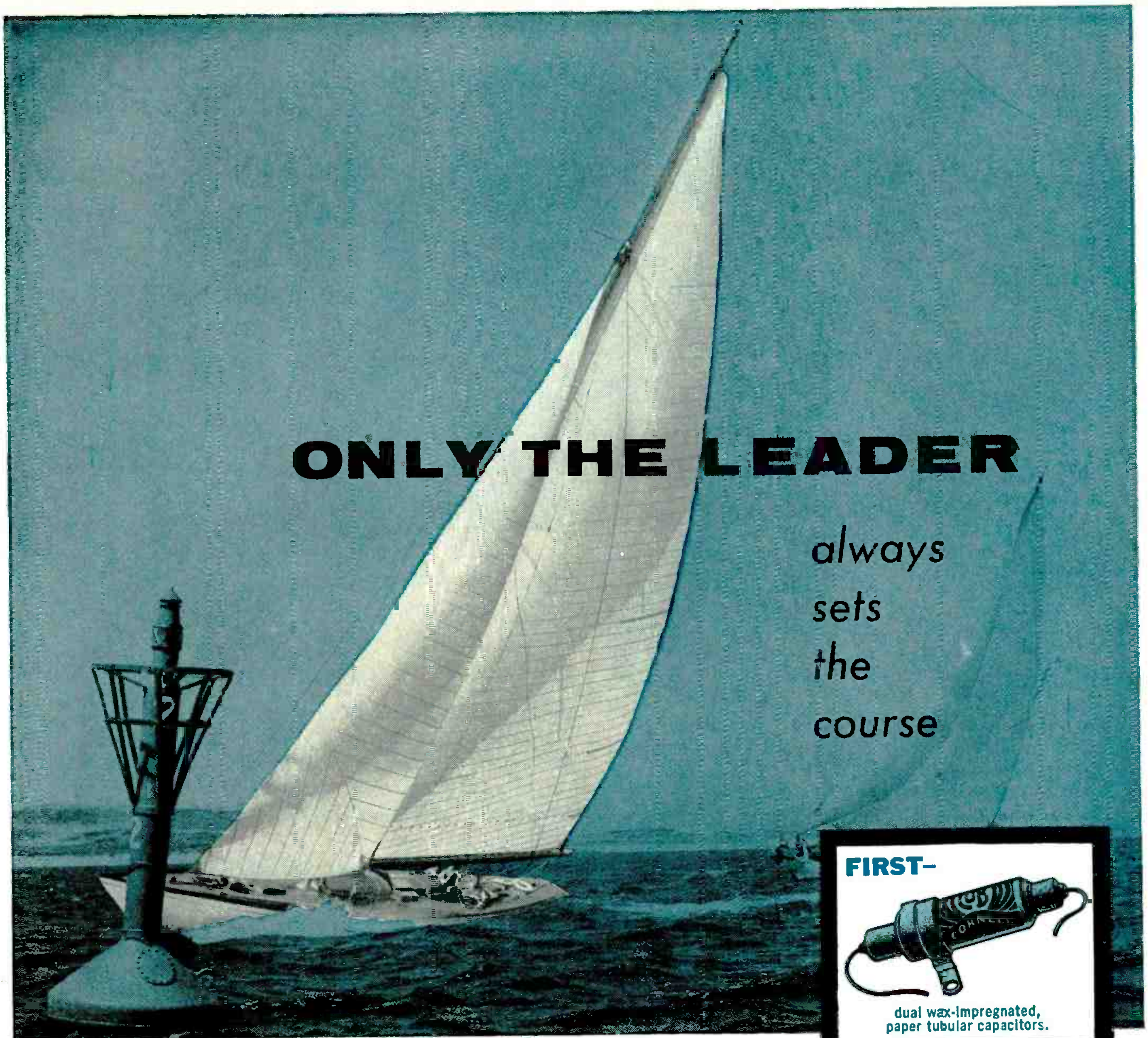
80-10 A 45th AVE., ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.



FIRST–

dual wax-impregnated, paper tubular capacitors.

Charting the course of the future in the manufacture of capacitors has always been the practice at Cornell-Dubilier. Proof of this leadership is that capacitor developments originated at C-D invariably become the standards of comparison for the entire industry.

FIRST–

low voltage dry electrolytic capacitors

C·D...45 YEARS OF FAMOUS FIRSTS

Typical of these "famous firsts" are the three examples shown here . . . proof that whatever your capacitor requirements may be, your needs can be filled by C-D. Write to Cornell-Dubilier Electric Corp., Dept. K-25, South Plainfield, N. J.

FIRST–

capacitor used in proximity fuse.

CONSISTENTLY DEPENDABLE

CORNELL-DUBILIER CAPACITORS

PLANTS IN SO. PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER AND CAMBRIDGE, MASS.; PROVIDENCE AND HOPE VALLEY, R. I.; INDIANAPOLIS, IND.; SANFORD AND FUQUAY SPRINGS, N. C.; SUBSIDIARY, RADIART CORP., CLEVELAND, OHIO.

THERE ARE MORE C-D CAPACITORS IN USE TODAY THAN ANY OTHER MAKE

-*hp*- 608C VHF Signal Generator

-*hp*- 608D VHF Signal Generator

Presenting...

VHF

New premium-quality performance

Wide range, direct calibration

Residual FM less than 1 kc

Drift less than 0.005%

High power output

All types of modulation

Models 608D and 608C are designed to be the best commercial instruments of their type, and to set new standards of VHF generator convenience, applicability and performance. They are the redesigned and improved successors to over 3,000 -*hp*- 608A/B VHF generators now in use throughout the world.

The premium quality -*hp*- 608D

-*hp*- 608D is the ultimate in VHF signal generators. It offers the highest stability attained in production equipment of its type. There is almost complete absence of incidental FM or frequency drift. There is a calibrated output from 0.1 μv to 0.5 v throughout the frequency range, 10 to 420 mc. A built-in crystal calibrator provides a frequency check accurate within 0.01% every 5 mc throughout range.

These unique advantages are made possible in large part by new master oscillator, intermediate and output amplifier circuit design. Other features to improve stability include a regulated filament supply, a new variable condenser design and a completely new coil turret and circuit housing. The result is the most convenient, accurate and effective instrument available for testing and aligning VHF aircraft communications and other receivers having extreme selectivity.

The all-purpose -*hp*- 608C

The -*hp*- 608C is a high power, stable and accurate VHF signal generator for general laboratory and field use. Employing a master oscillator–power amplifier circuit, -*hp*- 608C offers 1 v maximum power and a broad frequency coverage of 10 to 480 mc. The instrument provides outstanding convenience for measuring gain, sensitivity, selectivity and image rejection of receivers, IF

COMPLETE COVERAGE | **HEWLETT-PACKARD**

two completely new

SIGNAL GENERATORS

amplifiers, broad band amplifiers and other VHF equipment. Its 1 v output is more than sufficient to drive bridges, slotted lines, transmission lines, antennas, filter networks and other circuits.

Outstanding features in both

Both *-hp-* 608D and 608C have broadest possible modulation capabilities. There is AM modulation to 80%, and flat response 20 cps to 1 mc which provides high quality internal and external pulse modulation. RF leakage is negligible, and sensitivity measurements to 0.1 μv are possible. Internal impedance is 50 ohms constant, and VSWR is a maximum of 1.2.

Both instruments also feature new mechanical design and quality construction throughout. New aluminum castings and cabinets reduce weight. Circuitry is particularly clean and accessible. Dial, condenser and turret drives are ball-bearing. Variable condensers are specially manufactured by *-hp-* and feature electrically welded Invar low temperature steel plates to minimize drift. Sealed transformers are used throughout, and construction is militarized.

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

WRITE FOR COMPLETE DATA

HEWLETT-PACKARD COMPANY

3099A Page Mill Road • Palo Alto, California, U.S.A.

SALES AND ENGINEERING REPRESENTATIVES THROUGHOUT THE WORLD

SPECIFICATIONS

-hp- 608D VHF Signal Generator

Frequency Range: 10 to 420 mc, 5 bands.

Calibration Accuracy: ±1% full range.

Resettability: Better than ±0.5% after warm-up.

Crystal Calibrator: Frequency check points every 5 mc through range. Headphone jack for audio frequency output.

Frequency Drift: Less than 0.005% over 15 minute interval after warm-up.

Output Level: 0.1 μv to 0.5 v into 50-ohm load. Attenuator dial calibrated in v and dbm. (0 dbm equals 1 mw in 50 ohms.)

Voltage Accuracy: ±1 db full range.

Generator Impedance: 50 ohms, maximum VSWR 1.2.

Modulation Percentage: 0 to 80% indicated by meter.

Envelope Distortion: Less than 2.5% at 30% sine wave modulation.

Internal Modulation: 400 cps ±10% and 1,000 cps ±10%.

External Modulation: 0 to 80%, 20 cps to 100 kc. For RF output above 100 mc, 0 to 30% to 1 mc.

External Pulse Modulation: 10 v peak pulse required. Good pulse shape at 1 μsec.

Residual FM: Less than 1,000 cycles at 30% AM for RF output frequencies above 100 mc. Less than 0.001% below 100 mc.

Leakage: Negligible; permits sensitivity measurements to 0.1 microvolt.

Filament Regulation: Provides highest possible oscillator and amplifier stability for line voltage change.

Power: 115/230 volts ±10%, 50/1,000 cps. Approx. 150 watts.

Size: 13⅜" wide x 16" high x 20½" deep.

Weight: 70 lbs. Shipping weight. approx. 100 lbs.

Price: $950.00.

-hp- 608C VHF Signal Generator

Same as *-hp-* 608D, except:

Frequency Range: 10 to 480 mc, 5 bands.

Crystal Calibrator: In Model 608D only.

Frequency Drift: Less than ±0.01% over 10 minute interval after warm-up.

Output Level: 0.1 μv to 1.0 v.

Residual FM: Less than 0.0025% at 30% amplitude modulation for RF output frequencies 21 to 480 mc.

Filament Regulation: In Model 608D only.

Price: $850.00.

hp INSTRUMENTS | COMPLETE COVERAGE

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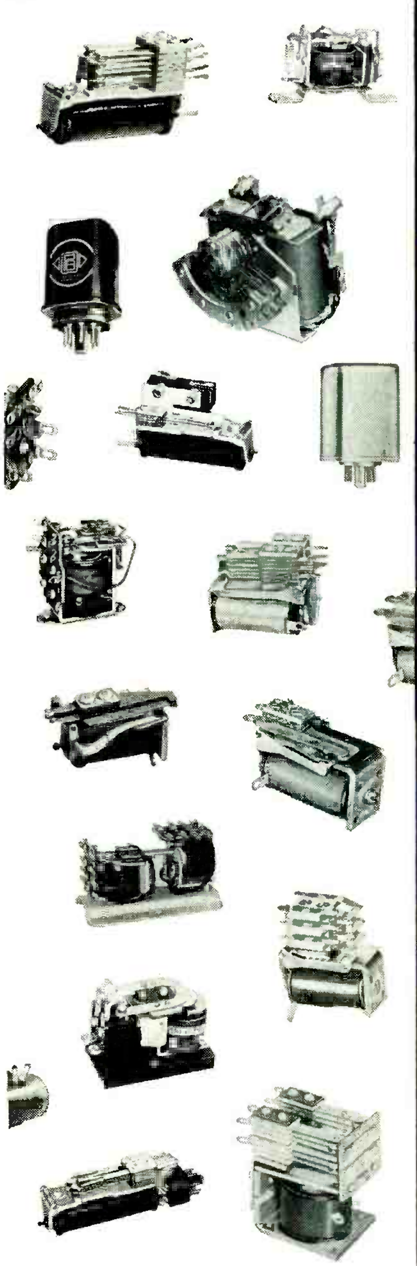
Brumfield and Sterling Engineering



now joined as subsidiaries of AMF
American Machine & Foundry Company

A leader in the design and application of electrical relays for nearly a quarter of a century, Potter & Brumfield combines with Sterling Engineering to provide the finest engineering, production, and testing facilities in the relay industry.

Lower Prices. Our large inventory and wide variety of standard relay components, backed by our increased manufacturing resources, makes it possible for us to fill special needs without added cost. It means operating economy for us—greater savings for you.

Greater Selection. To the extensive line of Potter & Brumfield (over 20,000 combinations and versions), has been added Sterling's wide selection of different relay structures—assuring fast delivery of all but the most highly specialized relay designs. And our new, expanded engineering department is the best equipped in the industry to answer unusual demands for industrial or military applications.

Greater Service. Two outstanding names, each specializing in different relays, now operate under a single greatly expanded research and engineering department. There are sales engineering offices in all principal cities of the United States and Canada, staffed with specialists well versed in relay know-how. Manufacturing facilities in Princeton, Indiana, and Laconia, New Hampshire, for quick deliveries.

Samples of P&B and Sterling relays are available for immediate shipment. Send your specifications for recommendations and quotations. Standard relays are stocked by Electronic Distributors in most cities in the United States and Canada.

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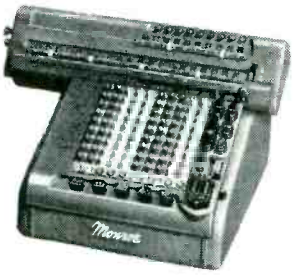
Another AMF Product
Sterling RELAYS

POTTER & BRUMFIELD MFG. CO.
STERLING ENGINEERING CO.
Princeton, Indiana

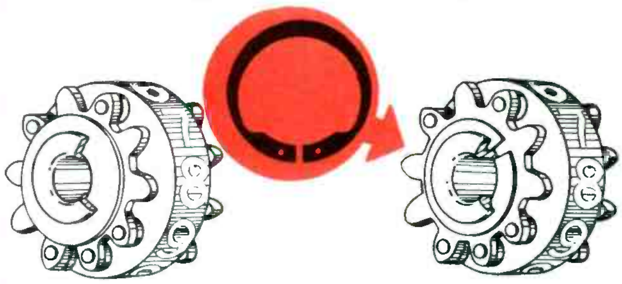
Waldes Truarc rings replace old-fashioned fasteners...save assembly time...end scrap loss...increase operating efficiency

This is the Monroe Calculator



...precision-engineered business machine made even more efficient, and less costly to manufacture through the use of Waldes Truarc Retaining Rings.

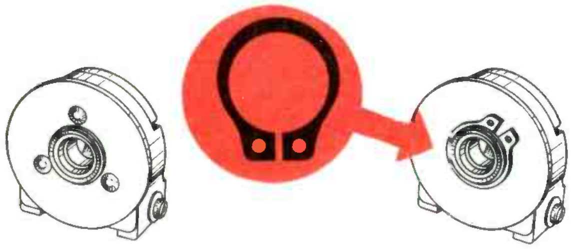
Multiplier Dial Assembly



Old Way. One-piece assembly was spun together. Spinning operation was costly, resulted in high scrap loss.

Truarc Way. Two-piece assembly is held together by one Truarc Ring (series 5108). Rejects: practically zero.

Electric Motor Governor



Old Way. Collector Disc assembly was formerly riveted, requiring skilled labor. Riveted Collector Disc could not be removed in the field.

Truarc Way. Truarc Ring (series 5100) replaces rivets, saves labor, material...improves Collector action. Collector Disc is easily replaced.

Intermediate Gear Shaft

Old Way. Washer riveted on end of assembly for zoning control. Costly, troublesome, hard to obtain critical zoning required.

Truarc Way. Truarc E-Ring (series 5133) cuts assembly time, virtually eliminates rejects and final assembly and zoning problems.

Monroe Calculating Machine Company, Orange, N. J. uses various types and sizes of Waldes Truarc Retaining Rings. Use of Truarc has helped eliminate scrap losses, saved on material and labor, and resulted in increased operating and servicing efficiency of the product. Monroe plans to use Truarc Rings for every possible fastening operation on their entire line!

You, too, can save money with Truarc Rings. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Waldes Truarc Rings are precision-engineered...quick and easy to assemble and disassemble.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc Engineers for individual attention, without obligation.

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: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2 509 081 AND OTHER PATENTS PENDING

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

E027

Waldes Kohinoor, Inc., 47-16 Austel Pl., L. I. C. 1, N.Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print)

Name ....

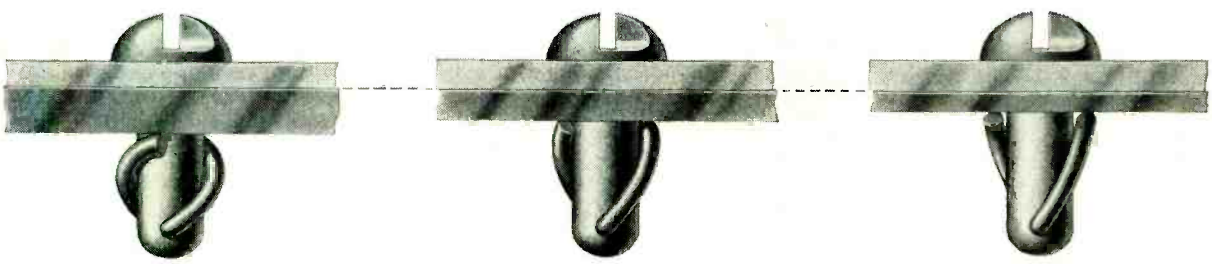
Title ....

Company ....

Business Address ....

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

This fastener works through thick and thin!



Spring-Lock—the easy-to-use removable fastener for modern designs—works whether panel thicknesses run over or under specifications! Spring wire deflects automatically to handle greater or lesser thicknesses. Spring-Lock's design flexibility makes it more than a fastener: it can be adapted as a shelf support, door strike, knob or any similar panel-mounted device. Many standard shapes and sizes of Simmons Spring-Locks are available from stock.

SIMMONS FASTENER CORPORATION
1750 North Broadway, Albany 1, New York

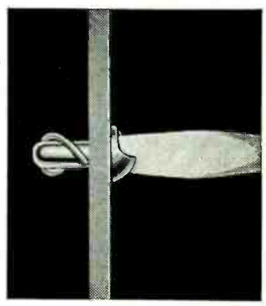
Simmons

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

JUST OUT!
NEW 36-PAGE CATALOG WITH APPLICATIONS
SEND FOR IT!

HERE'S HOW SPRING-LOCK WORKS

1. *Insert fastener.*



2. *Half-turn locks it in place.*

With production costs on the uptrend, you can figure on Spring-Lock as an assembly time and money-saver, because:

- **Installation is BLIND**
- **Installation is EASY: no special tools are needed**
- **Installation is QUICK: a half-turn locks it in place**
- **Installation is SECURE: the *spring* steel *locks* the fastener, resists vibration**

Send for details and samples, or write us about *your* fastening problem.

Monsanto
PROFIT TALK

Resinox gives you both!

High-styling in popular colors! Top safety for printed circuits!

Photos courtesy of Motorola, Inc.

Housings molded of **RESINOX*1500 BLACK** *take any finish without bleeding—and meet specified* **UL STANDARDS!**

If you are seeking a high heat resistant material for cabinets housing printed circuits or prefabricated wiring—Monsanto's Resinox 1500 Black is your answer.

This phenolic compound is specially formulated to meet all specified safety standards of Underwriters' Laboratories.

No sealed chassis or other sheathing is required. Resinox 1500 Black passes oven-heat test of 115° C. for 9 hours!

Resinox is non-bleeding in contact with spirit solvents and rapid-bake enamels. Cabinets can be painted in complete range of best-selling colors, including the new decorator shades.

These cabinets are priced competitively with those made of other materials. Resinox flows freely and cures fast to a smooth finish with high surface gloss. It has excellent rigidity, dimensional stability and resistance to warping—plus good impact resistance.

For colorful printed circuit cabinets, which merit Underwriter approval, investigate Resinox 1500 Black. Write today to Monsanto Chemical Company, Plastics Division, Dept. E-2, Springfield 2, Mass.

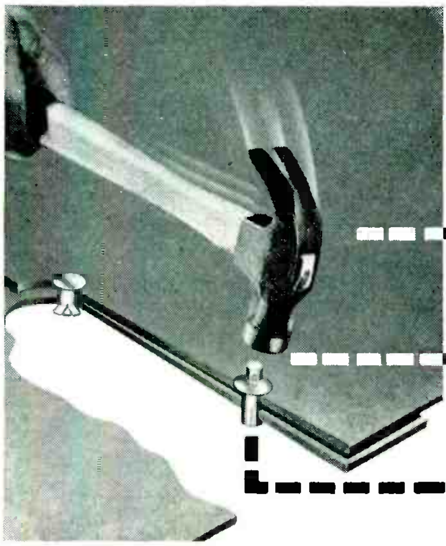
For beauty and safety, specify

MONSANTO

RESINOX
1500 BLACK

*Reg. U. S. Pat. Off.

only SOUTHCO® drive rivets offer all these benefits!

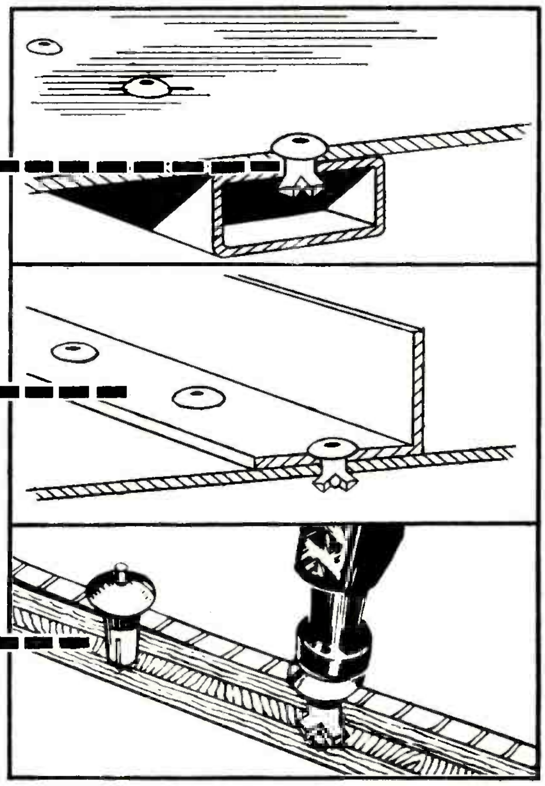


Rivet and Mfg. Patented.

A HAMMER IS THE ONLY TOOL

DRIVE LIKE NAILS

AUTOMATIC "PULL-UP" ACTION FORCES PARTS TOGETHER



FOR BLIND APPLICATIONS

FOR ACCESS APPLICATIONS

FOR METAL-TO-WOOD APPLICATIONS

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Note

No special tools to buy or maintain, no bucking up, no finishing, no noise, no material waste.

Just hit the pin, the rivet's in . . . that's all.

On your production line, where can savings be made with Southco Drive Rivets? Write for complete data. Southco Division, South Chester Corporation, 233 Industrial Highway, Lester, Pa.

SPEED ASSEMBLY . . . CUT COSTS

SOUTHCO® FASTENERS

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OFFICES IN PRINCIPAL CITIES

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER; STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

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Burton Browne Advertising

color tv controls

CHICAGO TELEPHONE SUPPLY
Corporation

ELKHART • INDIANA

Specialists in Precision Mass Production of Variable Resistors • Founded 1896

THE ONLY COMPLETE LINE FOR ALL COLOR TV APPLICATIONS

1. SIZES—"dime size" to 2 1/2" diameter.
2. WATTAGES—2/10 watt to 4 watt.
3. TYPES—carbon and wirewound with and without attached switch.
4. MOUNTINGS—conventional bushing, twist ear and snap-in bracket for printed circuits.
5. TERMINAL STYLES—for conventional soldering, printed circuits and wire wrap.
6. COMBINATIONS—an endless variety of tandems, both single and dual shaft.

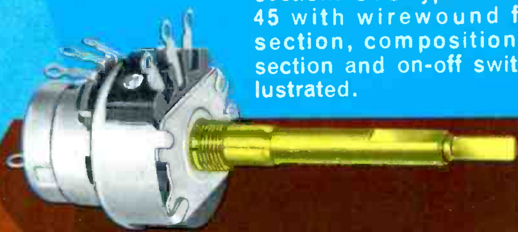
A CTS control can be tailored to your specific requirement.

FURTHER DETAILS ON OTHER SIDE

High voltage control for focus applications. Rated up to 5,000 volts DC across end terminals and 2 1/2 watts depending on total resistance. Will operate up to 15,000 volts DC above ground when mounted on insulated panel. CTS type 85.

Miniature 3/4" "dime size" composition control. Conserves panel space at price comparable to larger size bushing mounted controls. CTS type 70.

1 1/8" diameter composition control for applications where ratings up to 3/4 watt required. CTS type 35.



Concentric shaft tandem control with conventional bushing mounting. Designed for front panel dual knob applications, such as contrast and volume. Available in various combinations of composition or wirewound front and rear sections with or without on-off switch attached to rear section. CTS type GC-C252-45 with wirewound front section, composition rear section and on-off switch illustrated.

Ear mounted two watt wirewound available with or without center tap. CTS type P-254 with tap illustrated.

Ear mounted composition control. Simply twist two ears for rigid mounting. Eliminates bushing and mounting hardware. Available with shafts for knob operation or for preset applications with insulated or metal shaft. CTS type P45 with metal shaft illustrated.

Four watt wirewound control available with or without center tap. CTS type 27 with tap illustrated.

Higher Wattage Carbon Controls With Exceptional Stability Available

- **ONE WATT**: Entire 45 series 15/16" diameter line available with 90 series special one watt military resistance elements.
- **TWO WATT**: Entire 35 series 1 1/8" diameter line available with 95 series special two watt military resistance elements.

Ear mounted tandem for preset applications. Combines panel space saving features of a concentric tandem with the economy of an ear mounted unit. Available in various combinations of composition or wirewound front and rear sections. CTS type P-C2-45 with composition front and rear sections illustrated.

THE ONLY COMPLETE LINE FOR ALL COLOR TV APPLICATIONS

CTS also makes a complete line of controls for military, black and white TV, radio and other commercial applications. Consultation without obligation available for **all** your control applications. Write for complete catalog TODAY.

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Specialists in Precision Mass Production of Variable Resistors • Founded 1896

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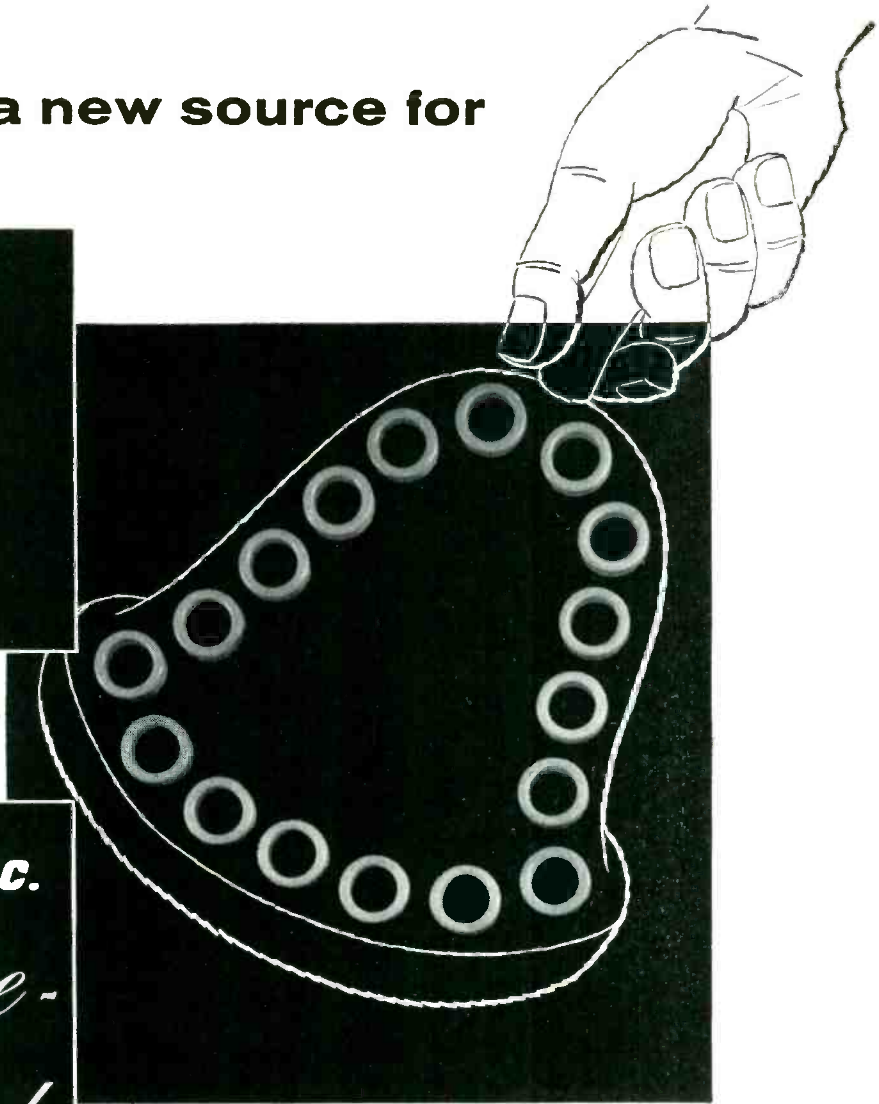
Permalloy POWDER CORES



MAGNETICS inc.

Performance-Guaranteed

Here's something to ring bells about, for Magnetics, Inc., the nation's largest manufacturer of tape wound cores, is now licensed by the Western Electric Company to manufacture molybdenum permalloy Powder Cores.

So now Magnetics, Inc. brings to powder core users the same "Performance-Guarantee" which has already provided a major free bonus to users of our tape wound cores, bobbin cores, magnetic shields and magnetic laminations. This is a guarantee of performance *to your specifications.*

"Performance-Guarantee" is your assurance of savings in production and assembly. It costs you no more . . . our prices are standard in the industry . . . so make sure your next permalloy powder core order reads, "Magnetics, Inc. Performance-Guaranteed."

READILY AVAILABLE Why wait to have your Performance-Guaranteed Powder Core orders filled? Our expanded production facilities can have your order on its way almost as soon as it arrives. And send for our Bulletin PC-103 today so that you're ready to order Performance-Guaranteed Powder Cores as soon as you need them.

Write on company letterhead

MAGNETICS inc.

DEPARTMENT E-19, BUTLER, PENNSYLVANIA

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For Generation of Pulse Voltages—

CHATHAM
MODEL 5C22
HYDROGEN THYRATRON

A three electrode zero bias thyratron with peak power handling capacity to 2.6 megawatts

MAXIMUM RATINGS—Absolute Values

Maximum Peak Anode Voltage	
Inverse	16 Kilovolts
Forward	16 Kilovolts
Minimum Peak Anode Voltage	
Inverse	800 Volts
Forward	4500 Volts
Maximum Cathode Current	
Peak	325 Amperes
Average	200 Milliamperes
Averaging Time	1 Cycle
Minimum D.C. Anode Voltage	4500 Volts
Maximum Operating Frequency (Note 1)	1000 cps
Minimum Peak Trigger Voltage	200 Volts
Maximum Peak Trigger Voltage	600 Volts
Maximum Heating Factor (Note 2)	3.2×10^9
Maximum Current Rate of Rise	1500 Amps/μs.
Maximum Anode Delay Time	1 μs.
Maximum Time Jitter	0.02 μs.
Ambient Temperature	+90 to −50°C

NOTE 1: This is not necessarily the upper operating frequency limit but represents the highest repetition rate for present life test requirements.
NOTE: 2. Heating factor is the product (epy x prr x ib).

ELECTRICAL DATA

	MIN.	BOGEY	MAX.	
HEATER VOLTAGE	5.8	6.3	6.8	Volts
HEATER CURRENT @6.3V	9.6	10.6	11.6	Amps
CATHODE HEATING TIME	300			Sec.
ANODE VOLTAGE DROP, PEAK	100	150	200	Volts

For detailed characteristic data request sheet DSW-104-1

CHATHAM TYPE VC-1257
Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of pulse power up to 33 megawatts.

CHATHAM TYPE 5948/1754
Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 12.5 megawatts.

CHATHAM TYPE 5949/1907
Hydrogen filled, zero bias thyratron with hydrogen reservoir for generation of peak pulse power up to 6.25 megawatts.

CHATHAM TYPE VC-1258
Zero bias miniature hydrogen thyratron for the generation of peak pulse power up to 10 KW. Also available with a 28 v heater and in a super ruggedized type for extreme vibration.

Chatham Hydrogen Thyratrons are the product of many years of concentrated experience in this specialized field. Embodying the most advanced developments in the art, the tubes illustrated offer uniformly high performance when employed in the generation of pulse voltages in the order of microseconds. For complete data and specifications on Chatham Hydrogen Thyratrons, call, write or wire today — no obligation.

Chatham Electronics
DIVISION OF GERA CORPORATION — **LIVINGSTON, NEW JERSEY**

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FINANCIAL AID TO HIGHER EDUCATION

Business Aid for Our Colleges—Voluntary or Involuntary?

Previous editorials in this series have shown that:

- As a group the nation's independent, privately endowed colleges and universities are in grave financial trouble, and
- There are many different means by which business firms can extend a helping hand to these institutions.

This editorial, one of a series devoted to the financial problems of higher education, submits this proposition: **If business firms do not voluntarily go to the financial aid of higher education, there is every prospect that they will soon be providing more financial support for higher education involuntarily, through taxation.**

If this prospect materializes, one of the basic elements of a well-balanced system of higher education—a strong array of independent colleges and universities—may well be dangerously weakened if not destroyed. And in the process a potentially crucial bulwark for freedom of enterprise in the United States—that same strong array of independent colleges and universities—will be undermined.

Acceptance of these propositions implies absolutely no disparagement of tax-supported colleges and universities. These have an indispensable role in the total system of higher education in the United States. Leaders of these institutions would be among the first to agree that their position is strengthened by a strong system of independent institutions, supported privately rather than by political agencies.

What is the evidence that in one way or another, voluntarily or involuntarily, business will be giving more financial support to higher education? One impressive part of this evidence is provided by the recent rapid increase in the proportion of college and university students attending tax-supported institutions.

Rapid Shift in Enrollment

In the fall of 1952 tax-supported colleges and universities enrolled about 7.5 per cent more students than the independent institutions. In 1953 this percentage was doubled. And in 1954 the tax-supported institutions enrolled 26 per cent more students.

In the case of students entering college for the first time the relative growth of the tax-supported institutions recently has been even more striking. In 1952, the number of beginning students in the tax-supported schools, as reported by the U. S. Office of Education, exceeded those in the independent colleges and universities by 35 per cent. In 1954, just two years later, this figure jumped to 49 per cent.

Why has the proportion of students attending tax-supported colleges and universities been increasing so rapidly? There are many reasons. But a dominant reason is that, in order to keep going at all, the independent institutions have been forced to make large increases in the prices they charge for instruction. The purchasing power of their endowment funds has been cut in half by price inflation. The capacity of the wealthy to supplement their endowments by gifts, as they have done in the past, has been greatly reduced by high taxes. As a result these schools have been forced to rely increasingly on higher prices for instruction (tuition as it is called in academic circles) to make both ends meet.

Since 1940, the independent colleges and universities have raised their tuition fees by an average of about 60 per cent. This is considerably less than the increase of about 100 per cent in prices generally since 1940. And it is nowhere near enough to prevent the faculty members of the independent colleges from faring miserably in terms of salaries, a matter of major national importance to which we shall return in this series. But the increase in tuition fees of the independent colleges has been much greater than the increase in the fees charged by the tax-supported schools. And that price differential increasingly tends to shunt students into the schools which are supported chiefly by taxes. Independent colleges now charge, on the average, about $580 per year for a full course of instruction while the tax-supported institutions charge, on the average, about $240.

Bigger Tax Bill in Prospect

A large increase in the total enrollment in our colleges and universities during the next decade is in prospect, particularly when the great increase in births during World War II is reflected in the number of young men and women of college age. With a total of 2.5 million students at present enrolled in our institutions of higher learning, it is estimated that the total will be over 3 million by 1960.

If this trend continues most of the anticipated increase in college and university enrollment will be concentrated in tax-supported institutions. Indeed, if the shift toward tax-supported institutions that has occurred in the last three years were to continue over the next six years at the same rate, about two million of the three million students anticipated in 1960 would be in tax-supported colleges and universities and one million in independent schools. In 1950 there was a 50-50 division in enrollment. This shift would mean, of course, a corresponding increase in the tax bill for tax-supported education. And of this bill, we can be sure that an ample share would be assessed against business firms.

No Easy Solution

The best way, of course, to put a brake on a soaring tax bill for higher education is to help the independent institutions get in shape financially to carry a larger share of the student load. For most companies the development of a mutually satisfactory program of financial aid for higher education is a complicated process. In fact, it is so complicated that some companies with an initial disposition to provide financial help are inclined to despair of working out a mutually constructive plan.

If, however, the leaders of business will contemplate seriously the only available alternative to their extending voluntary help to our independent colleges and universities, their determination to work out a plan will be strengthened. For that alternative involves a grave weakening of our system of higher education, together with an involuntary increase in the financial support of higher education by business. The increase would come through higher taxes. Contemplation of such an alternative should, if necessary, toughen the will of business firms generally to do everything possible to extend financial help to our independent colleges and universities.

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

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Donald C McGraw

PRESIDENT

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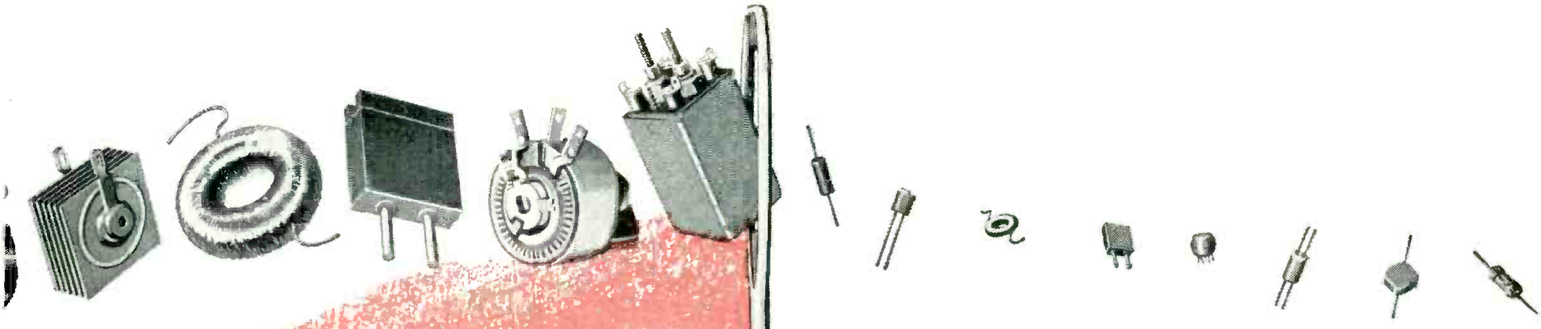


MINIATURIZATION

When there's only room for improvement
...there's a treasury of ideas in KEL-F® PLASTIC

Space saving insulation... machined from KEL-F Plastic rod.

Miniature Test Jacks for 500 volt RMS "HF" circuit...injection molded of KEL-F Plastic.

Contact Bar insulated with KEL-F Plastic...injection molded directly to beryllium-copper.

When you have to squeeze more and more into less and less space...when materials lack the specific properties you need for miniaturization, we suggest you look into the possibilities of KEL-F Plastic.

The development of KEL-F Plastic, a fluorocarbon polymer, was inspired by a vital problem of miniaturization in the field of electronics. What it accomplished then, it can repeat for your products.

KEL-F Polymer is a dense, tough thermoplastic with outstanding resistance to the effects of high and low temperatures. In wire insulation, tube sockets, connector blocks, printed circuit bases, transistor seals, and other applications its zero moisture absorption, non-wettability and dimensional stability can provide high level performance under severe conditions of temperature and humidity.

The compressive strength is high. Bearing loads of 8,000 psi result in only 4% to 5% permanent set. KEL-F Plastic can actually be used for structural members. Electrical properties are outstanding. They include superior resistance to arcing, surface flash-over and thermal cycling.

KEL-F Plastic is readily moldable by extrusion, compression, injection and transfer methods. Molding techniques are fully perfected, and molded components can be depended on to exhibit all the inherent characteristics of the original molding material.

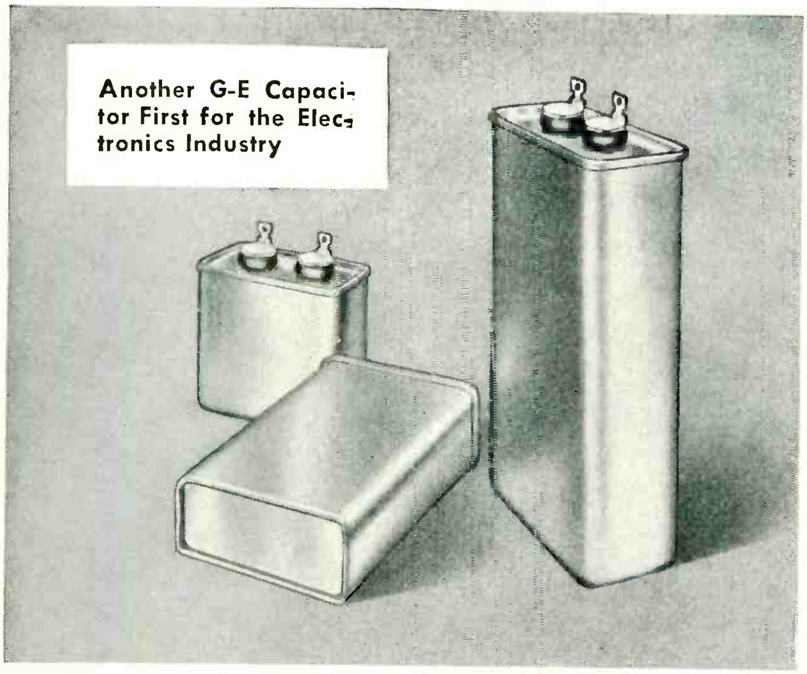
KEL-F Plastic is available as a molding compound, or it can be obtained in rods, tubing, sheets and film from a number of suppliers. It is also available in dispersions, suitable for bake-coating of metals and certain non-metals. The full story of KEL-F Polymer should be in your active file. Write us.

®Registered trademark for The M. W. Kellogg Company's Fluorocarbon polymers.

Miniature Rectifier and mount for parts...injection molded of KEL-F Plastic.

KELLOGG

THE M. W. KELLOGG COMPANY
Chemical Manufacturing Division, P. O. Box 469, Jersey City, N. J.
SUBSIDIARY OF PULLMAN INCORPORATED



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

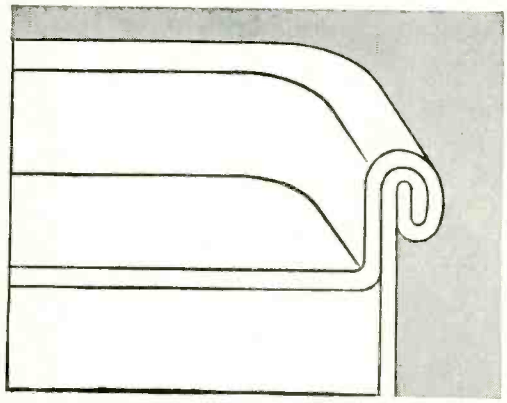
new . . . G-E CAPACITORS IN DRAWN-RECTANGULAR CASES

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

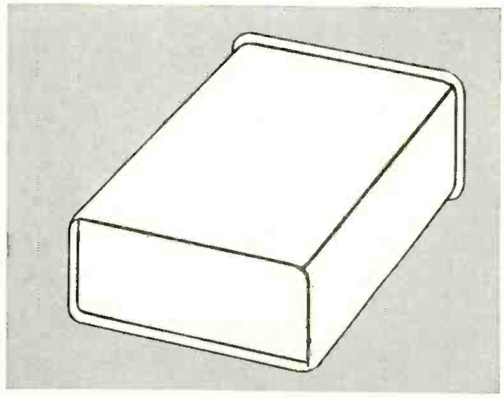
General Electric is now producing fixed paper-dielectric capacitors in seamless, solderless cases with standard dimensions that comply with or exceed MIL specifications. For complete information contact your G-E Apparatus Sales Office or write for Bulletin GEC-809A to Section 442-24, General Electric Co., Schenectady 5, N. Y.

Progress Is Our Most Important Product

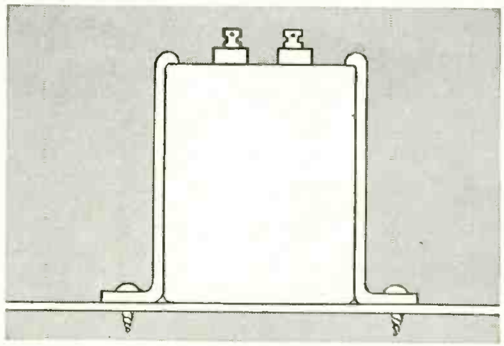
GENERAL ELECTRIC



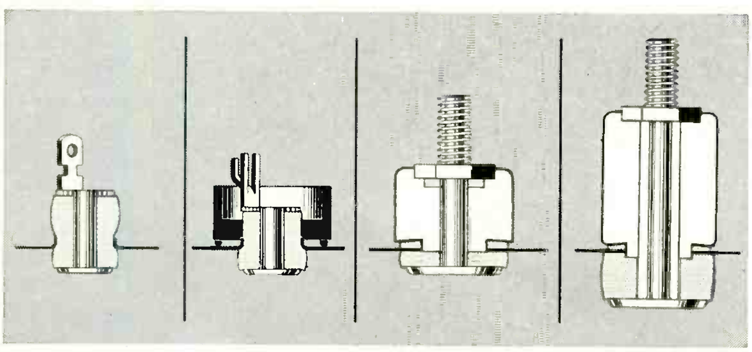
SOLDERLESS DOUBLE-ROLLED COVER SEAM makes a mechanically strong, hermetic seal.



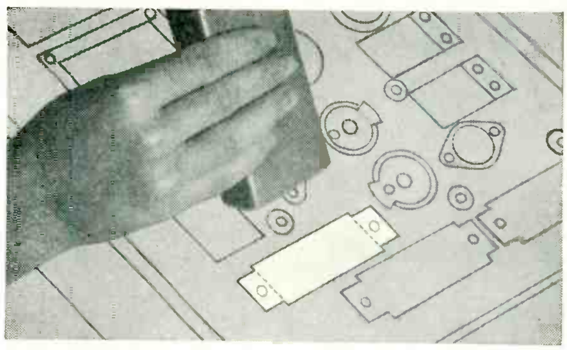
BOTTOM OF CASE IS INDENTED to permit mounting in inverted position.



UPRIGHT OR INVERTED MOUNTING is possible using either spade lug, or footed brackets (above)



FOUR BUSHINGS STYLES are available for applications below 2000 volts d-c, special skirted bushings for higher voltages.



STANDARD CASE SIZES are interchangeable, making it unnecessary to change drawings or circuit layouts.

Want more information? Use post card on last page.

Want more information? Use post card on last page.

CBS-Hytron Qualifies for Signal Corps Honor Inspection Program

CBS-Hytron is the first and (as of January 15, 1955) the only receiving-tube manufacturer qualified for the Signal Corps honor inspection program . . . the Reduced Inspection Quality Assurance Plan — RIQAP.

The Signal Corps Supply Agency has informed CBS-Hytron: "The completeness of your manufacturing process and quality controls, the supporting inspection records, and the quality of your end product have enabled us to adopt a reduced inspection plan on your Electron Tubes."

The Signal Corps found that CBS-Hytron is producing a quality of product which is "either equal to or better than the Acceptable Quality Level established by the Government."

Equivalent quality of product is available to you, too.

Quality products through *ADVANCED-ENGINEERING*

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
CBS Laboratories • CBS-Columbia • CBS International • and CBS-Hytron

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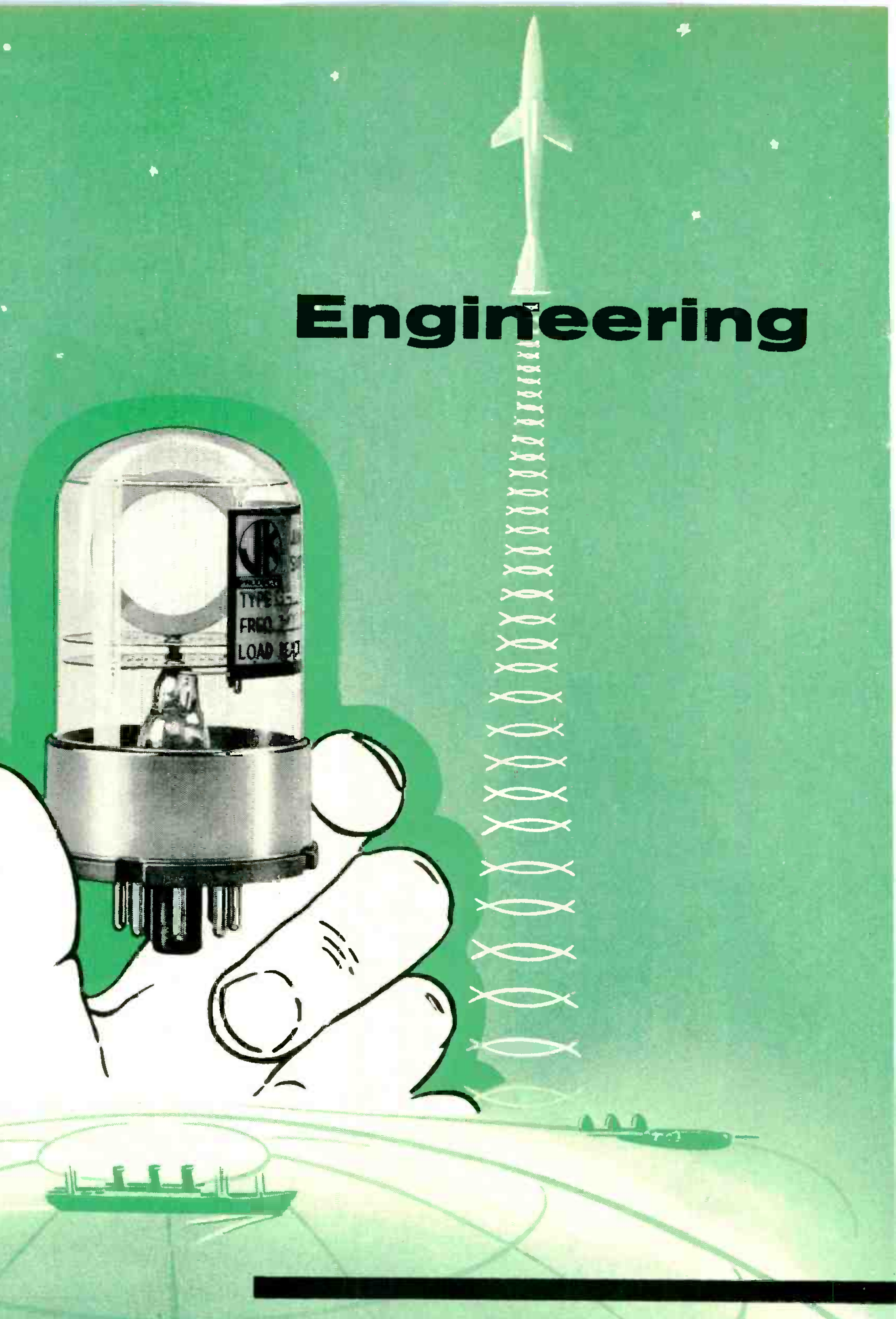
Engineering



THE RECORD-SETTING G-12A*

This is the JK Glasline unit that set a stability record of one part in 100 million over a two week test period at 1000 kc — stability corresponding to a rate of change of less than one second in more than three years. Here is stability that challenges existing methods of measurement — an ultra precision time base for tomorrow's electronic wonders.

*Test by a leading U.S. Government laboratory.

Ultra-Precision frequency control requires that crystal oven, power supply and oscillator circuitry be compatible in design and construction for optimum precision and reliability. The James Knights Company will combine their precision crystals and ovens with tried and proven circuitry in packages that will meet your mechanical layout requirements, at a saving of valuable customer engineering time. Precision frequency signal sources covering the wide frequency range of 60 cycles to 150 mcs can be made available to meet your specific application.

JK-G3: 10 mc to 150 mc. Miniature size, minimum aging drift, high Q for maximum performance. JK miniaturized "Glasline" crystals meet the growing need for minimum size with maximum stability.

(ACTUAL SIZE)

that unlocks tomorrow's door

CERTIFIED STABILITY

performance is the key to spectrum conservation

With the radio spectrum already congested, and channels narrowing, frequency control tolerances must narrow too. Equipment that "drifts" or "ages" has no place on this express way. Nor need it have, for today JK crystals are available that exceed your most critical stability requirements for interference-free land, sea and air radio communications. Crystals of this extreme stability are also serving as filter resonators for radar, for power line carrier communications and telemetering, and as ultra-precision time bases. And our research goes on. JK Glasline crystals, and JK Ovens, offer "packaging" that combines unprecedented enrivonmental control with the compactness your new equipment requires. So precise, so rugged, so protected are these JK crystals that their performance can now be Certified to previously unheard of stability tolerances. So don't let frequency management problems delay your development programs. JK engineering can be the key needed to unlock tomorrow's door for you.

JK-G9: Precision "Glasline" quartz crystals, sealed in evacuated glass for cleanliness and protection, over a complete range of 800 cycles to 5 mc.

TO COMPLETE THE ENVIRONMENTAL PICTURE: THE NEW JK09 OVEN

To the protection JK Glasline design provides against moisture, contamination, vibration and barometric pressure, the JKO9 oven adds control of temperature. It is production tooled for economy and uniformity, is small and light (1.28" x 1.70" ±1.5 oz.), and is capable of maintaining a temperature constant to within ±1°C *over a range of* *−55° to +100°C.* Here is an oven that matches the performance of many, massive multi-stage heaters — an example of JK's ultra-stable miniaturization program.

JK-G4: "Glasline" Crystal Filter Resonator. For broad filter applications such as power line carrier communications and telemetering. Frequency range 50 to 200 kc.

PRODUCTS

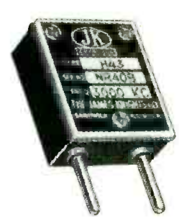
THE JAMES KNIGHTS COMPANY

Crystals for the Critical - Sandwich, Illinois

JK STANDARD MILITARY AND COMMERCIAL TYPE CRYSTALS

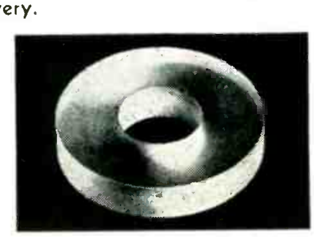
TEMPERATURE CONTROL OVENS: Available for a wide range of applications.

Quality and service are James Knights traditions that apply to the simplest JK crystals as well as to the most complex, and apply to our smallest customer as well as our largest. So whatever your requirements — look to James Knights as a dependable, cooperative source for quality, price and delivery.

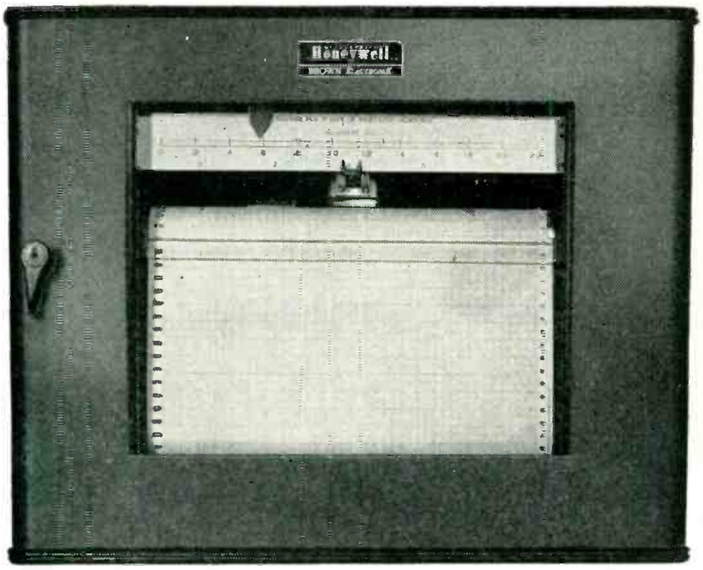


PRESSURE MOUNTED: A complete line of commercial and military types.

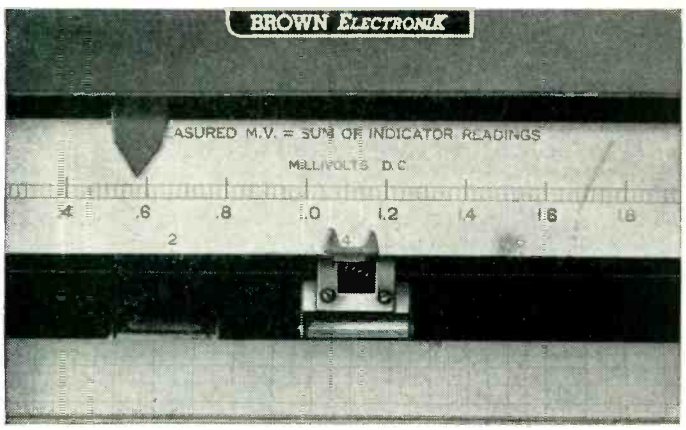
MILITARY TYPES: Hermetic sealed, metal cased, in frequency ranges from 16 kc to 100 mc.



ULTRA-SONIC TRANSDUCERS: Carefully oriented and processed to your specifications, in a variety of shapes with holes, dimples, soldered-on leads, and backing plates. Can be plated with a variety of metals.



Now...the answer to high-resolution recording of test data
...*the* Extended Range *ElectroniK* Recorder



Closeup of indicating scale. Upper pointer shows millivolts within the span; lower pointer indicates millivolts to be added. Total reading: 4.58 mv.

DESIGNED especially for recording variables which change over a wide range, this new *ElectroniK* instrument records on a chart effectively *55 inches in width.* It has five equal measuring spans. Whenever the variable being measured reaches either the upper or lower limit of one of these ranges, the instrument automatically steps to the adjoining range and continues recording.

Two indicating pointers show the range in use and the value within the range. Connected to each pointer is a pen; one draws a purple record showing the range, the other draws a red record of the variable itself. To get the complete reading, you simply add both pen or pointer indications.

The complete range is 10.2 millivolts, in five 2-millivolt steps with an extra 0.2 millivolts on the high end of each span to provide an overlap that facilitates measurements near the change-over point. Pen speed of 4½ seconds full scale affords rapid response to quickly changing variables.

You'll find this new instrument particularly valuable in strain gage measurements and in dozens of other uses where high resolution aids interpretation of data. Your nearby Honeywell sales engineer will be glad to discuss your specific application . . . and he's as near as your phone.

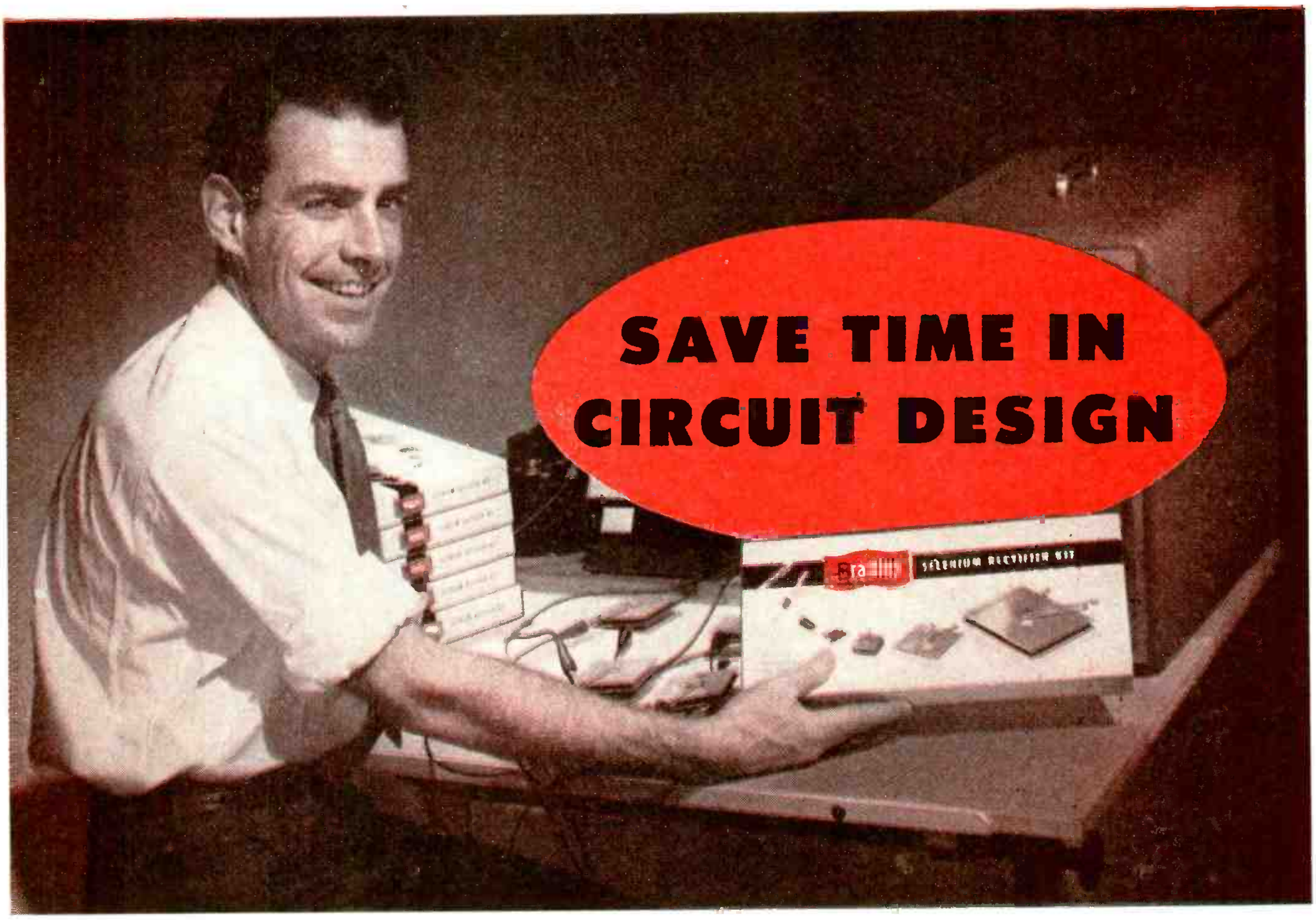
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

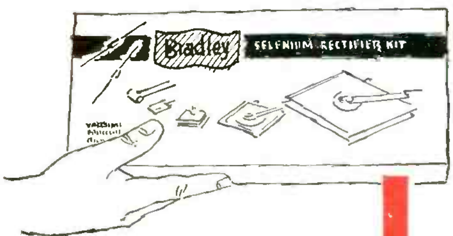
● **REFERENCE DATA:** Write for Data Sheet No. 10.0-18, "Extended Range Recorder."

H HONEYWELL

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls





The rectifier you need
...when you need it!

Bradley Selenium Rectifier Kits are time-savers for the design and development engineer. Seven different kits offer a broad choice of types, all complete units, all with standard commercial coding. Miniature rectifiers from 1.5 ma D.C. up to 3700 volts peak inverse. Power rectifiers from 100 ma D.C. to 10 amperes D.C. up to 740 volts. The smallest rectifiers have 3/16-inch diameter plates, the largest 5- x 6-inch plates. There's a type and size for every conceivable need.

Bradley Rectifier Kits are low in cost, too. The individual rectifiers are all produced by Bradley's standard, high quality production methods — the proven vacuum deposition process with rigid, laboratory-type controls.

With Bradley Selenium Rectifier Kits on hand there's no more waiting for samples — no more delayed projects. Write today for complete details on kits and costs, or see your local industrial electronics jobber.

Bradley
LABORATORIES, INC.

BRADLEY LABORATORIES, INC., 168E COLUMBUS AVENUE, NEW HAVEN 11, CONN.

versatile

Multi-channel -- telegraph Al or telephone A3.

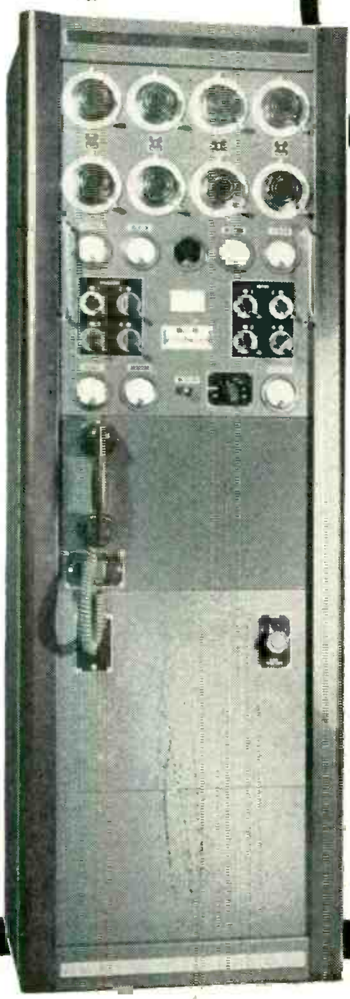
FROM GROUND TO AIR OR POINT TO POINT

STABLE

High stability (.003%) under normal operating conditions.

RUGGED

Components conservatively rated. Completely tropicalized.

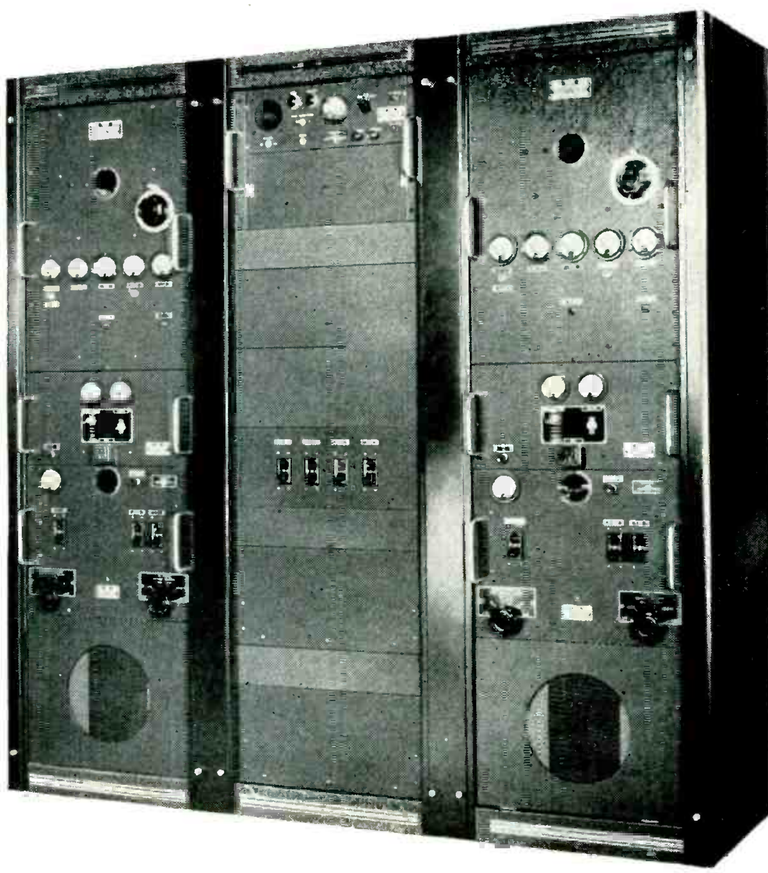


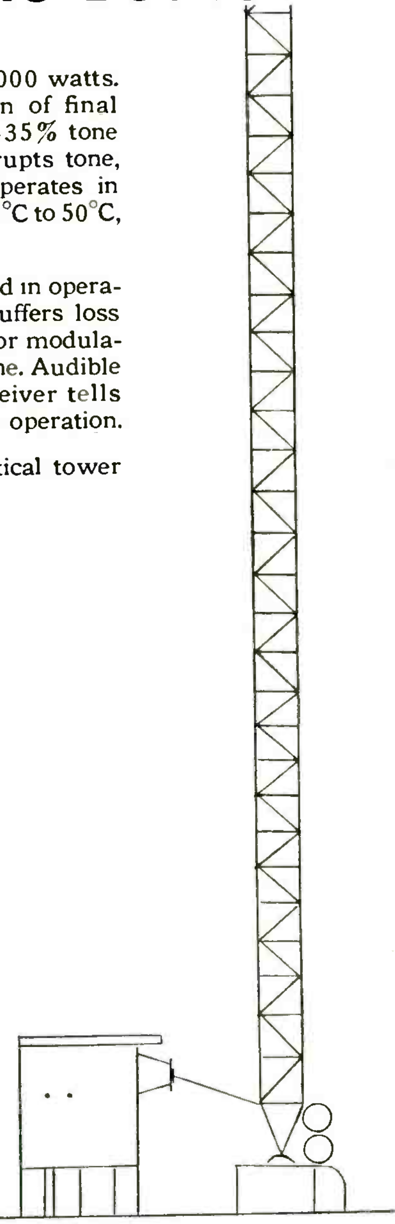
Model 446 transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-24.0 Mcs (1.6-2.5 Mcs available). Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts, A1 or A3. Stability .003%. Operates in ambient –35° to 45°C. Nominal 220 volt, 50/60 cycle supply. Conservatively rated, sturdily constructed. Complete technical data on request.

Here's the ideal general-purpose high-frequency transmitter! Model 446... 4-channel, 6-frequency, medium power, high stability. Suitable for point-to-point or ground-to-air communication. Can be remotely located from operating position. Co-axial fitting to accept frequency shift signals.

AER-O-COM

3090 DOUGLAS ROAD MIAMI 33, FLA.





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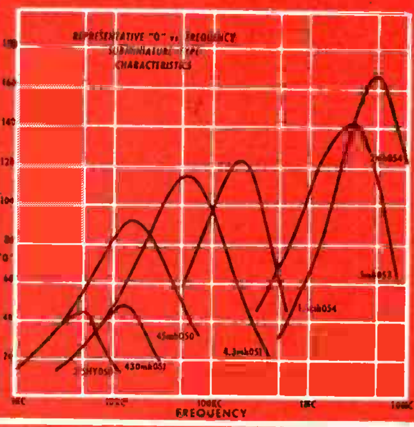
MOLDED PLASTIC TOROIDS

(M. P. Series) STOCKED UNITS FOR IMMEDIATE DELIVERY TO MIL. SPECS - SHOCK, MOISTURE, TEMPERATURE . . .

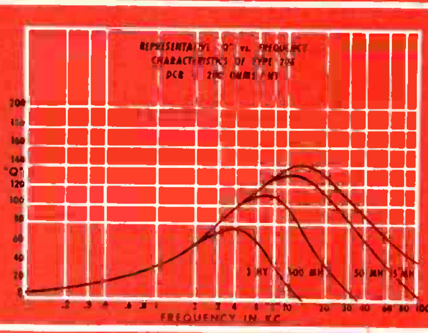
C-A-C ®

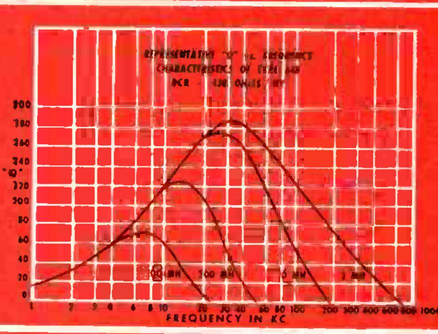
SIZE	TYPES
.688 OD .375 THICK .738 H	MP 050 MP 051 MP 053 MP 054



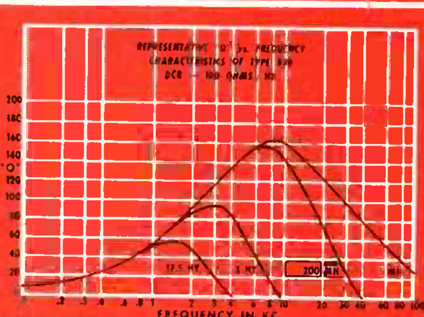
Other Subminiature molded plastic toroids—designs for all requirements—for chassis mount or printed circuits—see your CAC man or write us direct.

SIZE	TYPES
1-1/16 OD 1/2 H 6-32 MTG.	MP 206 MP 848

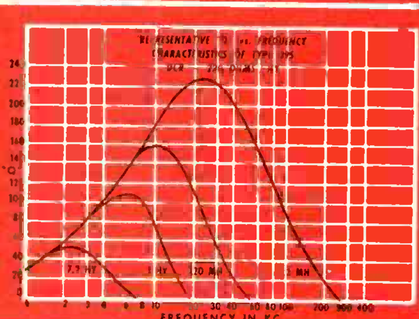




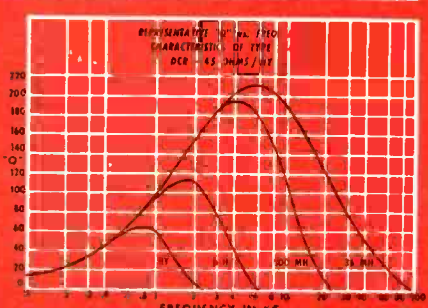
SIZE	TYPE
1-5/16 OD 23/32 H 6-32 MTG	MP 930



SIZE	TYPE
1-5/16 OD 23/32 H 6-32 MTG.	MP 395



SIZE	TYPE
2 OD 1 H 8-32 MTG.	MP 254



LIST OF STOCKED UNITS

All Other Values and Types on Special Order

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

COMMUNICATION ACCESSORIES COMPANY Hickman Mills, Missouri

COMMUNICATION ACCESSORIES COMPANY Hickman Mills, Missouri

PROVED BY USE!

In the short time the Model 1001 Regulator has been on the market, more than 300 of the instruments have been sold, mainly for meter calibration applications and for use in standards laboratories.

As a result, it can now be said — *and proved* — that the Model 1001 gives hairsplitting precision *with the rugged dependability of operation associated with voltage regulators of "ordinary" regulating accuracy!*

0.01% regulation accuracy!
1000 VA capacity!

Sorensen Model 1001

electronic AC Voltage Regulator

specifications

Input	95-130 VAC, 1∅, 50-60∿
Output	110-120 VAC, adjustable
Load range	0-1000 VA
Regulation accuracy	±0.01% against line and ±0.01% against load guaranteed at room temperature, for a resistive load, an input variation of ±10% and over a 2-to-1 load change. For all other conditions within the specifications the 1001 has a proportionate amount of accommodation.
Distortion	3% RMS maximum
P. F. range	0.95 leading to 0.7 lagging
Time constant	0.1 second
Tube complement	6SL7GT (1), 6L6GA (1), 5Y3GT (1), 2AS15 (1)

Even greater capacity with similar accuracy will be available this fall when the Sorensen Model 2501 Regulator — ±0.01% accuracy, 2500 VA capacity — goes into production.

general catalog available

- **AC VOLTAGE REGULATORS** — 150VA to 15000VA capacities, 115 volt and 230 volt output, 400-cycle regulators, 3-phase regulators
- **FREQUENCY CHANGERS** — 60 cycle and 400 cycle, accuracy to ±0.01%
- **NOBATRONS** — Regulated low-voltage, high-current DC sources
- **B-NOBATRONS** — Regulated high-voltage, low-current B power supplies
- **NOBATRON-RANGERS** — Wide-range variable DC sources
- **TUBELESS DC SUPPLIES** — Magnetic amplifier supplies with various outputs and capacities
- **AIRBORNE FREQUENCY CHANGERS & INVERTERS, MILITARIZED REGULATORS, FILTERS, TRANSFORMERS, AND RELATED EQUIPMENT.**

For your copy write Sorensen & Co., Inc., 375 Fairfield Avenue, Stamford, Conn. In Europe, Sorensen A.G., Gartenstrasse 26, Zurich 2, Switzerland.

SORENSEN

375 FAIRFIELD AVENUE, STAMFORD, CONN.

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ALCUPLATE®

The Material of 1001 USES

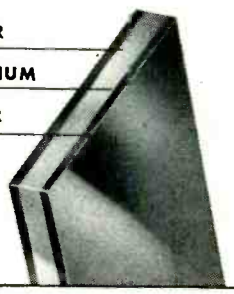
Replaces Strip Copper or Brass at Savings up to 30%

Here's the Story:

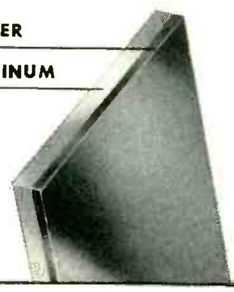
Alcuplate was developed by General Plate to reduce the raw material costs for manufacturers using strip copper or brass.

A composite metal, Alcuplate is a solid layer of copper permanently bonded on one or both sides of less expensive aluminum. This combination has practically the same physical and electrical properties of copper . . . but reduces copper or brass costs by as much as 30%.

COPPER
ALUMINUM
COPPER



COPPER
ALUMINUM



ALCUPLATE FEATURES

- Natural copper appearance
- High electrical conductivity
- Excellent heat dissipation
- Soft-soldering surfaces
- Easy fabrication
- Light weight

Here's how ALCUPLATE can be worked:

ALCUPLATE can be fabricated by stamping, drawing, spinning and forming. Its malleability permits its use in the manufacture of many parts from work-hardened rather than annealed or dead soft materials. The copper provides an ideal surface for soft-soldering operations and electroplated or other finishes.

A few typical products where ALCUPLATE is cutting fabrication costs

Heat transfer units • Electronic chassis and component cases • Electrical terminals Jewelry • Gift ware • Chafing dishes Water pitchers • Drain spouts

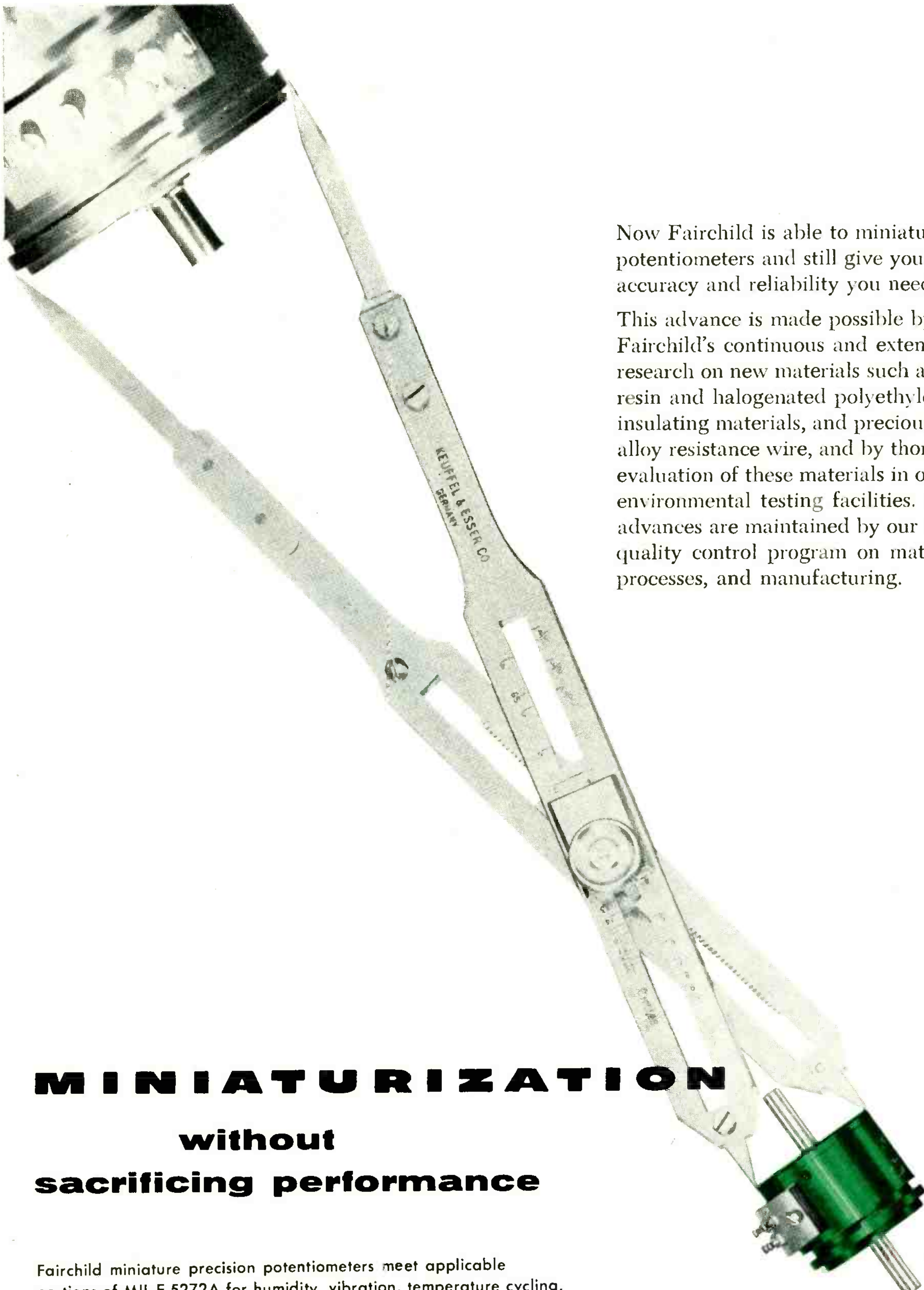
In what Sizes is ALCUPLATE Stock available?

In coils or cut lengths up to 1/16" thick by 13" wide and in a choice of thickness ratios and tempers.

For further information, write or wire

ALCUPLATE®

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
32 FOREST ST., ATTLEBORO, MASS.



Now Fairchild is able to miniaturize potentiometers and still give you the accuracy and reliability you need.

This advance is made possible by Fairchild's continuous and extensive research on new materials such as epoxy-resin and halogenated polyethylene insulating materials, and precious metal alloy resistance wire, and by thorough evaluation of these materials in our own environmental testing facilities. These advances are maintained by our rigid quality control program on materials, processes, and manufacturing.

MINIATURIZATION
without sacrificing performance

Fairchild miniature precision potentiometers meet applicable portions of MIL-E-5272A for humidity, vibration, temperature cycling, fungus resistance and salt spray. These units, in ⅞" and 1⅛" diameters, meet the same requirements for accuracy and reliability as most standard precision units up to 2" in diameter.

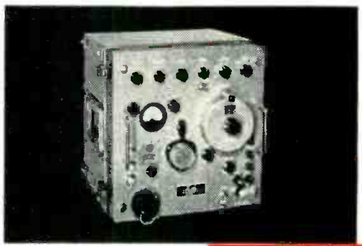
No matter what factors govern your choice of precision potentiometers, you'll find the answer in Fairchild's complete line. Write Dept. 140-59A, Fairchild Camera and Instrument Corporation, Potentiometer Division, 225 Park Avenue, Hicksville, Long Island, New York.

FAIRCHILD
PRECISION POTENTIOMETERS

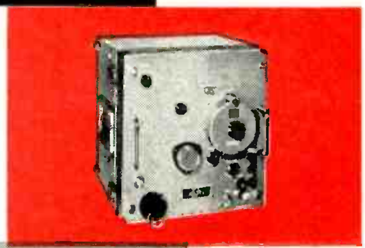
12,800 TO 50,000 MC

integrated equipment for

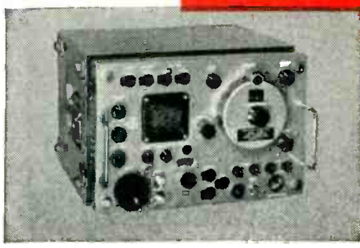
Extremely
High
Frequencies



SIGNAL GENERATORS



SIGNAL SOURCES



SPECTRUM ANALYZERS

Now, Polarad has applied its advanced engineering techniques to produce **fully self-contained** microwave test equipment for use in the Extremely High Frequency region--12,800 to 50,000 MC

This new line of Signal Generators, Signal Sources, and Spectrum Analyzers is designed to save engineering manhours in the laboratory and on production lines—obviating experimental test set-ups.

The Extremely High Frequency Polarad Signal Generator, for example, furnishes monitored power output as well as measures external signal strength and frequency.

Highest accuracy and reliability of operation are assured by careful engineering and the use of highest quality components. For complete information write to your nearest Polarad representative or directly to the factory.

	SIGNAL GENERATORS		SIGNAL SOURCES		SPECTRUM ANALYZERS		
Frequency Range	Model Number	Output Power	Model Number	Power Output (Average)	Model Number	Sensitivity (Signal=Noise)	Dispersion (Average)
12.8 to 17.5 KMC	SG 1218	−10 DBM	SS 1218	15 mw	SA 1218	−70 DBM	30 MC
15.75 to 16.25 KMC	SG 1516*	−6 DBM	SS 1516	5 mw	SA 1516	−70 DBM	45 MC
16.25 to 16.75 KMC	SG 1617*	−6 DBM	SS 1617	5 mw	SA 1617	−70 DBM	45 MC
18.0 to 22.0 KMC	SG 1822	−10 DBM	SS 1822	10 mw	SA 1822	−60 DBM	40 MC
22.0 to 25.0 KMC	SG 2225	−10 DBM	SS 2225	10 mw	SA 2225	−60 DBM	40 MC
24.7 to 27.5 KMC	SG 2427	−10 DBM	SS 2427	10 mw	SA 2427	−60 DBM	40 MC
27.27 to 30.0 KMC	SG 2730	−10 DBM	SS 2730	10 mw	SA 2730	−60 DBM	45 MC
29.7 to 33.52 KMC	SG 3033	−10 DBM	SS 3033	10 mw	SA 3033	−60 DBM	45 MC
33.52 to 36.25 KMC	SG 3336	−10 DBM	SS 3336	9 mw	SA 3336	−50 DBM	45 MC
35.1 to 39.7 KMC	SG 3540	−10 DBM	SS 3540	5 mw	SA 3540	−50 DBM	45 MC
37.1 to 42.6 KMC	External Source Power Measurement Range: +6 to +30 DBM Accuracy with Correction: ±2 DB		SS 3742	Approx. 3 mw			
41.7 to 50.0 KMC			SS 4150	Approx. 3 mw			

Modulation: All units except the SG 1516* and SG 1617* can be modulated as follows:
1. Internal
   1000 CPS Square Wave
2. External
   a. Pulse
      Pulse Width: 0.5 to 10 Microseconds
      PRF: 100 to 10,000 CPS
      Pulse Amplitude: 10 volts Pk to Pk Min.
      Polarity: Positive
   b. Sawtooth or Sinusoidal
      Frequency: 100 to 10,000 CPS
      Amplitude: 15 Volts RMS Min.

*Internal variable pulse and FM modulation

I.F. Gain Control: 0 to 40 DB

I.F. Band Width: 50 KC

Sweep Frequency: 5 to 40 CPS

Polarad ELECTRONICS CORPORATION

43-20 34th St., Long Island City 1, New York

AVAILABLE ON EQUIPMENT LEASE PLAN

FIELD MAINTENANCE SERVICE AVAILABLE THROUGHOUT THE COUNTRY

REPRESENTATIVES • Albuquerque • Atlanta • Baltimore • Boston • Chicago • Cleveland • Fort Worth • Kansas City • Los Angeles • New York Philadelphia • San Francisco • Seattle • St. Paul • Syracuse • Washington, D. C. • Canada, Arnprior—Export: Rocke International Corporation

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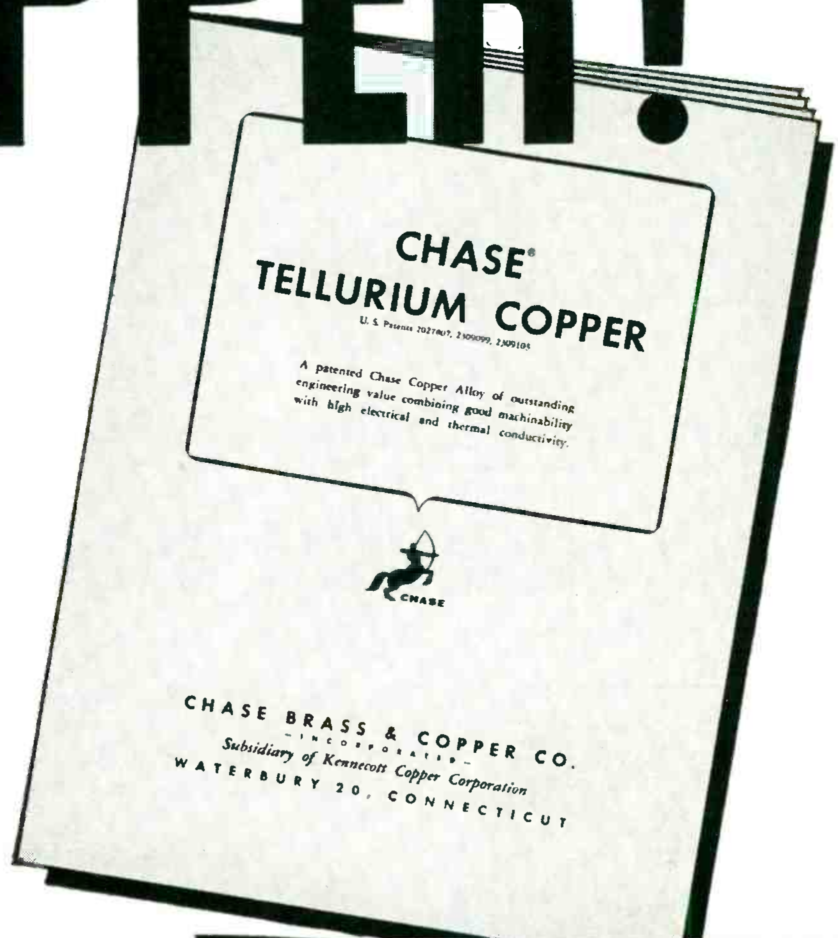
TELLURIUM COPPER!



Has high conductivity, good machinability... saves production time!

Chase Tellurium Copper gives you the advantages of high conductivity *plus* good machinability.

Chase Tellurium Copper can be machined with tool speeds and settings similar to those used with Free-Cutting Brass, permitting high rates of production. But, unlike Free-Cutting Brass, Chase Tellurium Copper can be *hot worked* easily, and can be cold worked almost as extensively as pure copper.

For more information on Chase Tellurium Copper, check the coupon below.

Chase®

BRASS & COPPER CO.

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

The Nation's Headquarters for Brass & Copper

Albany†	Chicago	Detroit	Los Angeles	New York	St. Louis
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Boston	Dallas	Indianapolis	Newark	Providence	Waterbury
Charlotte†	Denver	Kansas City, Mo.	New Orleans	Rochester†	(†sales office only)

FREE

Chase Brass & Copper Co.
Waterbury 20, Conn.
Dept. E-255

Gentlemen:
Please send me your free Tellurium Copper booklet.

Name ____________________

Position ____________________

Firm ____________________

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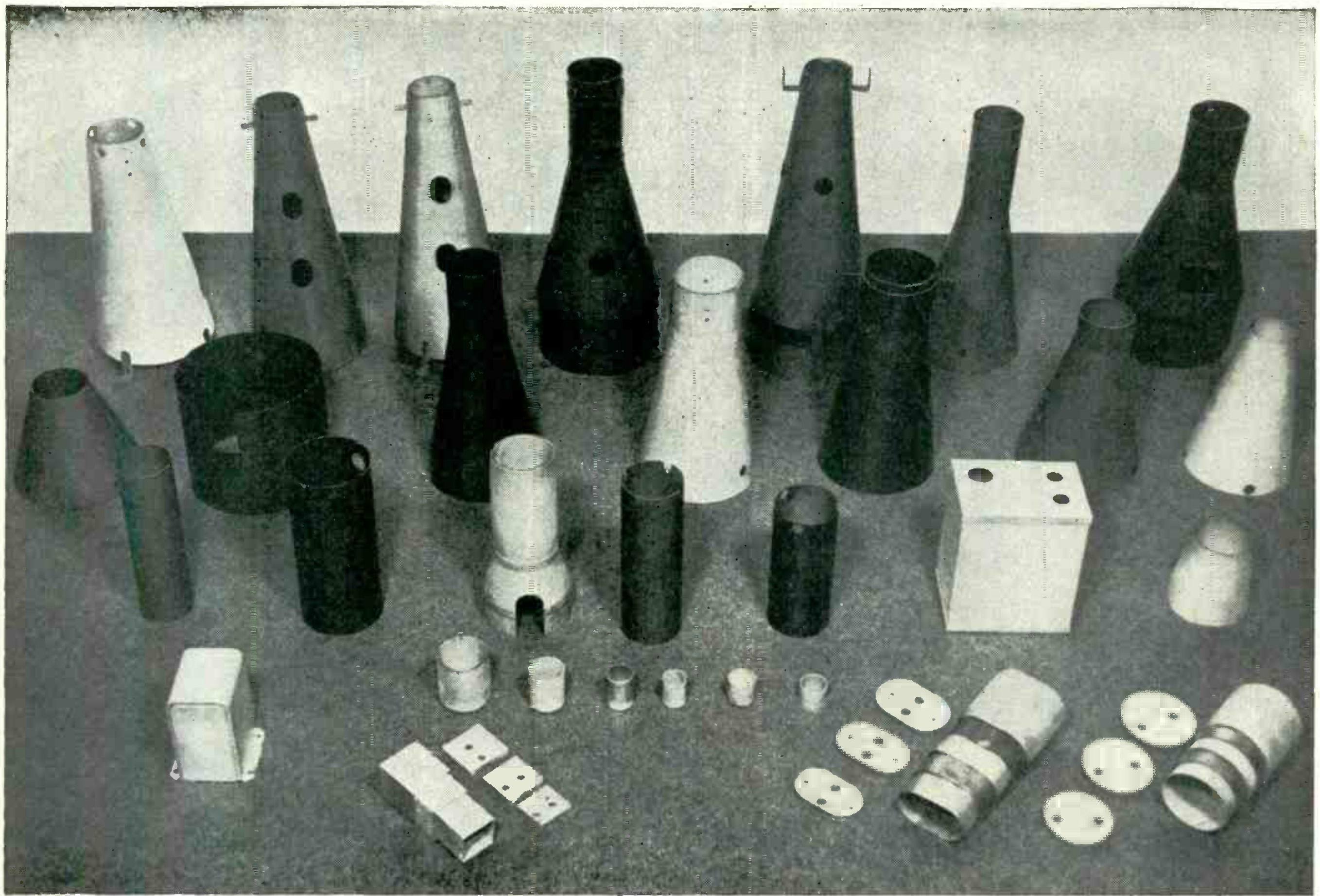
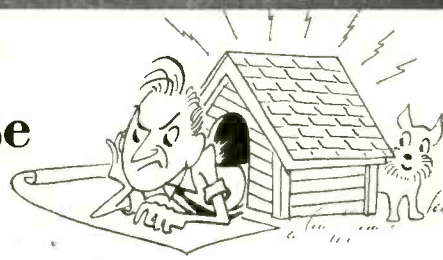


Get out of the Magnetic Doghouse



with MUMETAL Shields

Write for your copy "MAGNETIC MATERIALS"

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

ADDRESS DEPT. E-62

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

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

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

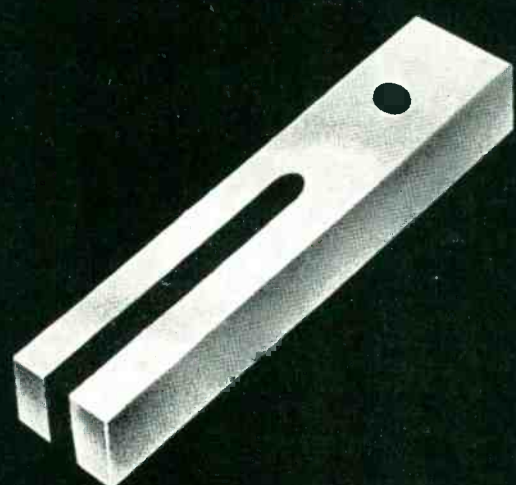
In addition to Mumetal and other high-permeability alloys, we offer a range of magnetic and electrical alloys and steels that is unmatched in its completeness. Our services also include the most modern facilities for lamination fabrication and heat treatment. ● Let us supply your requirements. *Allegheny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

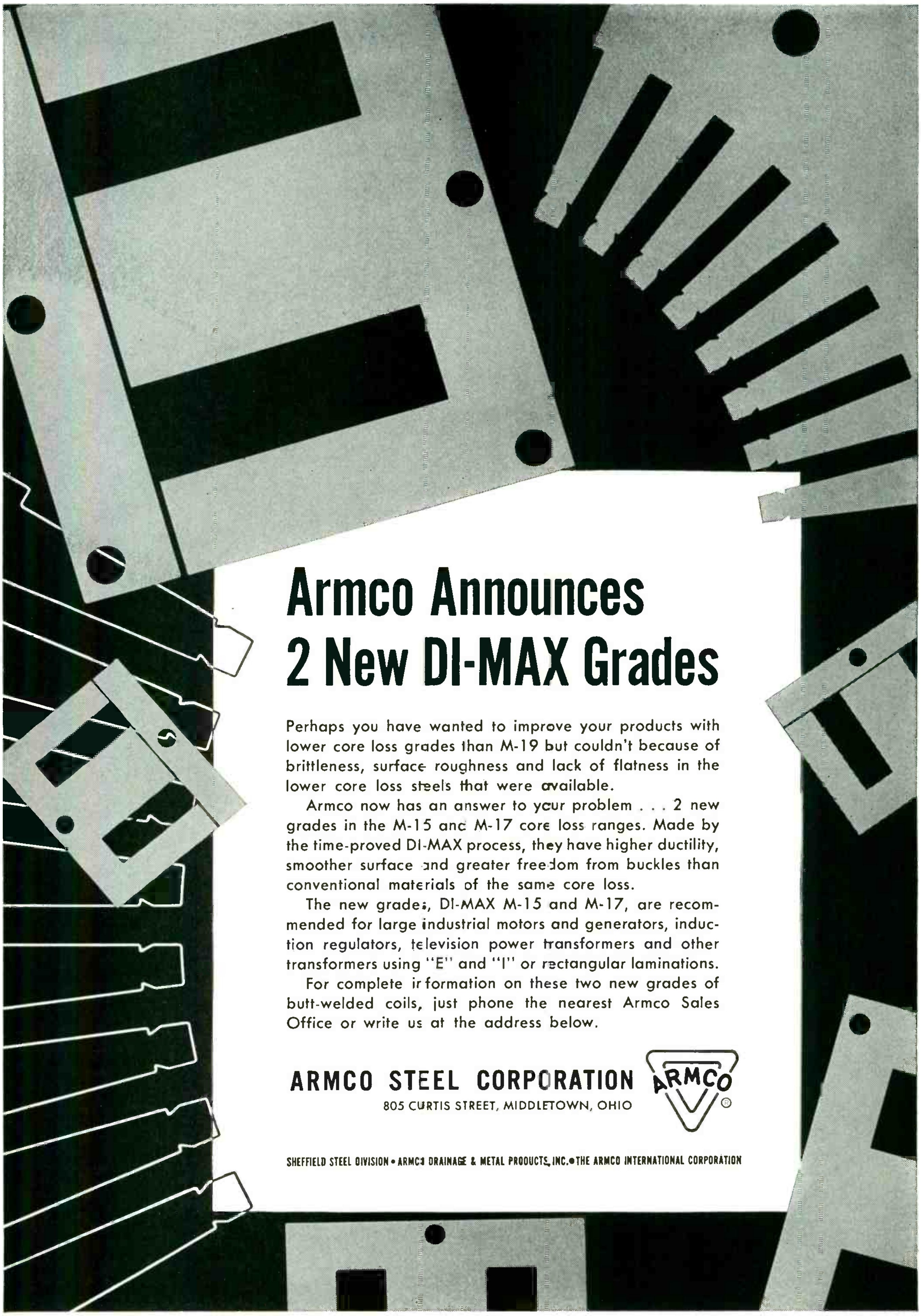
STEELMAKERS to the Electrical Industry

Allegheny Ludlum

W&D 5379

AL® STEELS FOR THE ELECTRONIC AGE





Armco Announces 2 New DI-MAX Grades

Perhaps you have wanted to improve your products with lower core loss grades than M-19 but couldn't because of brittleness, surface roughness and lack of flatness in the lower core loss steels that were available.

Armco now has an answer to your problem . . . 2 new grades in the M-15 and M-17 core loss ranges. Made by the time-proved DI-MAX process, they have higher ductility, smoother surface and greater freedom from buckles than conventional materials of the same core loss.

The new grades, DI-MAX M-15 and M-17, are recommended for large industrial motors and generators, induction regulators, television power transformers and other transformers using "E" and "I" or rectangular laminations.

For complete information on these two new grades of butt-welded coils, just phone the nearest Armco Sales Office or write us at the address below.

ARMCO STEEL CORPORATION
805 CURTIS STREET, MIDDLETOWN, OHIO

ARMCO ®

SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

Good-All **SERAMELITE**
CAPACITORS

OPERATING TEMPERATURE **-65°C to +125°C**

High Heat and Humidity Resistance • Low Cost

Good-All capacitors

WAX FREE! *Will Not Drip!*

Seramelite Capacitors are built with ceramic tubular cases and a new tough plastic end-seal that makes wax coating obsolete.

The ceramic-plastic combination forms the tightest possible seal against heat, moisture and humidity.

Good-All's new thermo-setting plastic end-seal will not lose its bond under any rated operating temperature.

Easily soldered leads. Neat, clean appearance.

After 28 days at 60°C and 95% relative humidity with 100% rated voltage applied, Good-All's new SERAMELITE Capacitor, Model 503S, (operating temperature of −50°C to +100°C) still has an insulation resistance of at least 1,000 megohm-microfarads or a maximum of 10,000 megohms.

Seramelite Capacitors are available with MYLAR* or PAPER DIELECTRIC with extended foil or tab construction with various impregnants.

**Dupont's name for its polyester film.*

BUILT TO YOUR SPECIFICATIONS WITH CERAMIC TUBULAR CASES.

We welcome the chance to submit data, samples and prices. Write or wire today.

Good-All ELECTRIC MFG. CO. 120 FIRST ST • OGALLALA, NEBRASKA

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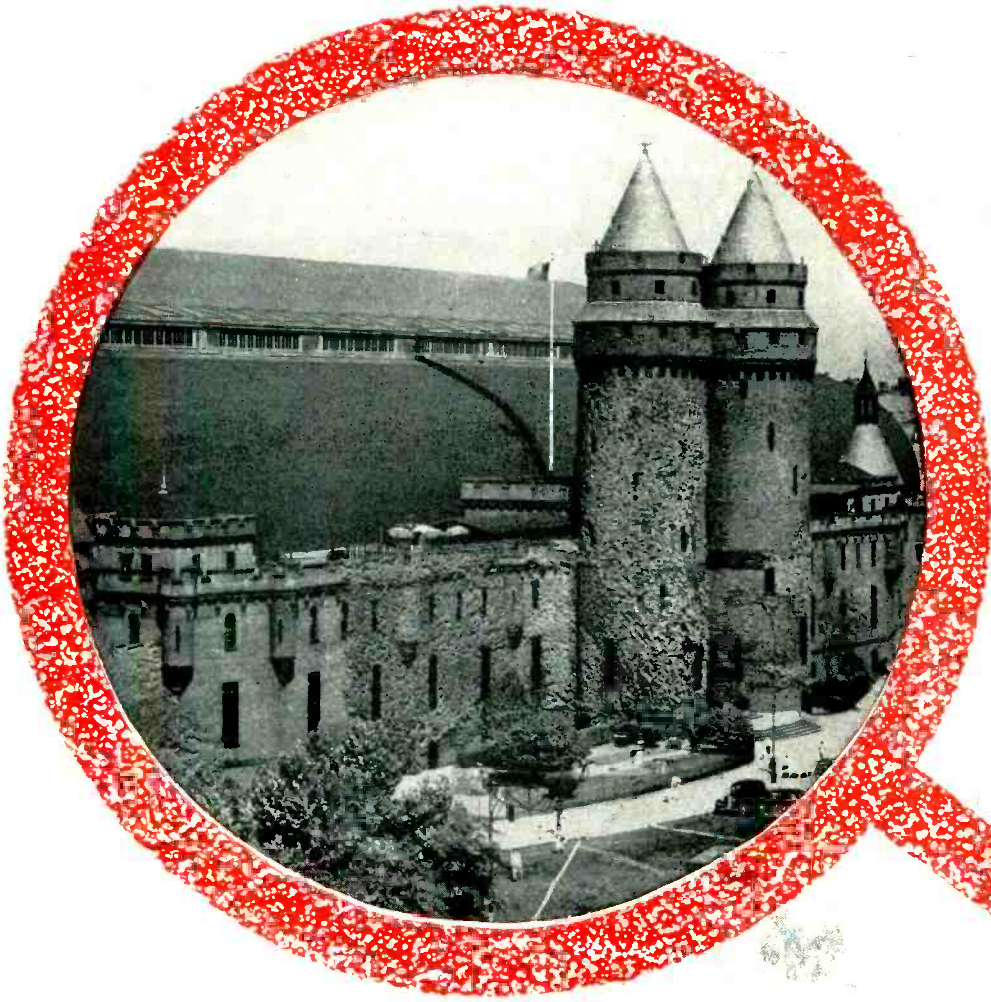
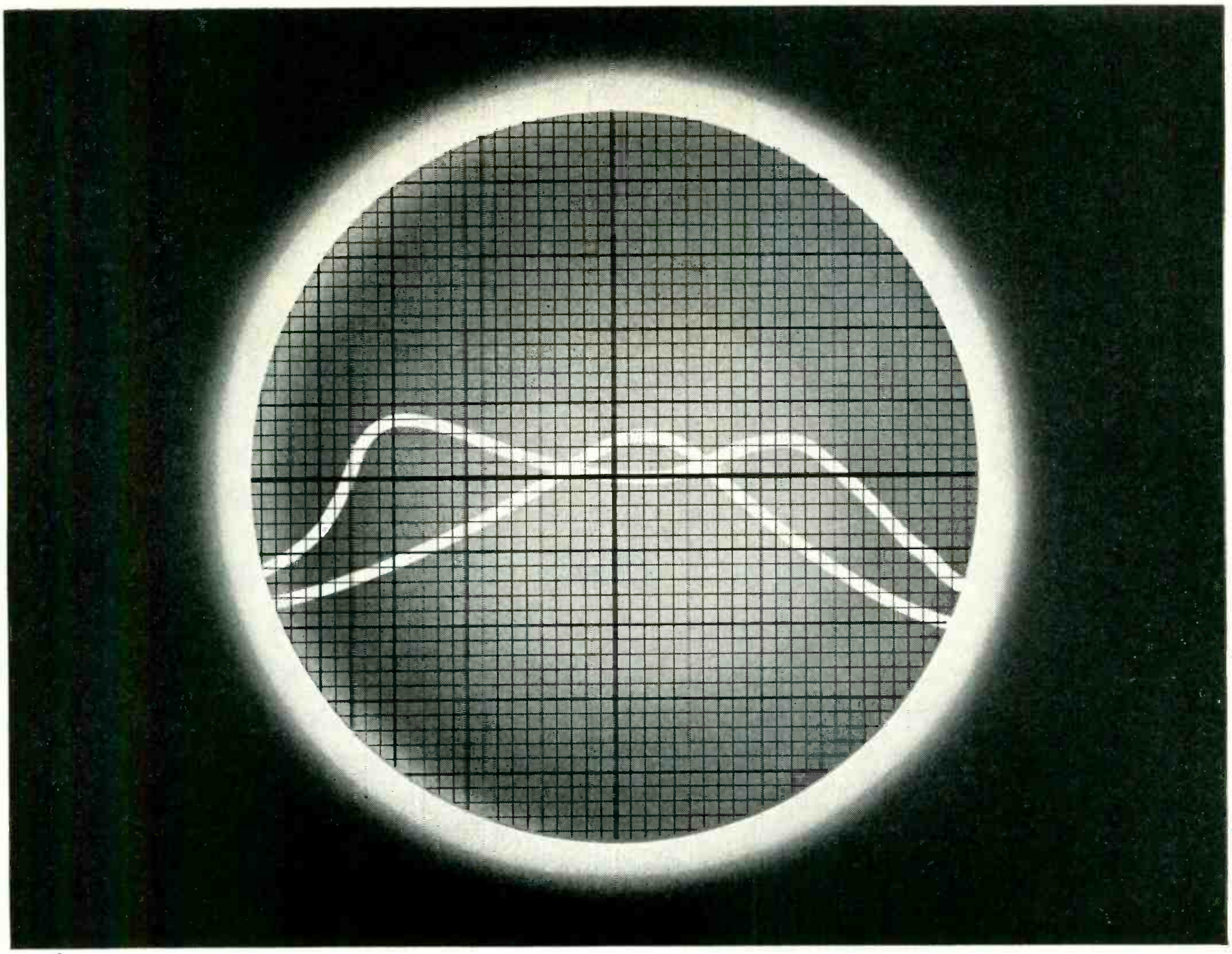


The I.R.E.

On March 21st through the 24th, the doors of the Kingsbridge Armory and the nearby Kingsbridge Palace will be opened for the 1955 Institute of Radio Engineers Show. At that time, electronic designers, engineers, technicians, manufacturers and all those who have anything to do with the electronic industry will be arriving from all sections of the nation and from abroad to inspect the more than 700 exhibits. It will be the biggest show the industry has ever seen.

As in the past, this show will be the focal point of everyone (whether manufacturer or designer) who has a stake in electronics. It is the high point of technical shows and showgoers will have the opportunity to see the latest in equipment, circuitry, components and materials. It is the one technical show that is a "must." On the next page are the reasons why the March Issue of ELECTRONICS is a "must", too, for electronic manufacturers . . . .



how can vacuum-melted metals help the electronics industry?

When a metal is melted and cast in a vacuum, the gaseous impurities are literally sucked out. The result is an important improvement in many critical properties.

For example, cathode nickel alloys, iron, and alloys for metal-glass seals — are all produced to extremely close standards of composition and uniformity. Soft magnetic alloys exhibit improved permeability, both initial and saturation. Copper shows marked increase in purity and soundness.

Vacuum-melted components greatly increase vacuum tube life and reliability. That's because the vacuum-melting process degasses these metals *before they are placed in the tube.*

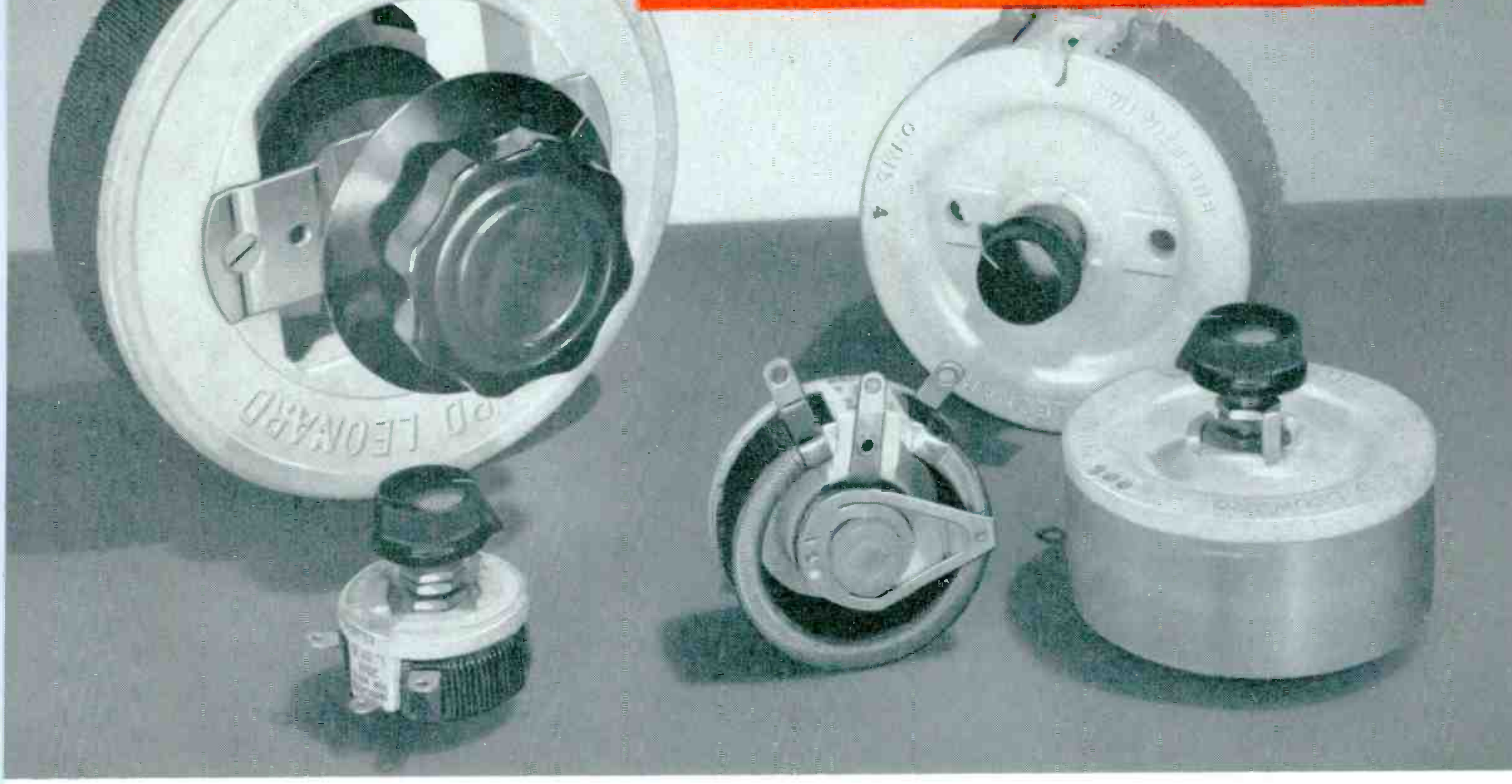
Vacuum Metals Corporation, pioneer in development and leading producer of vacuum-melted metals and alloys, can now offer you a wide range of metals for electrical or electronic applications. If you would like to see how these remarkable new materials can fit into your own production, write on your company letterhead, describing the application in which you are interested. *Vacuum Metals Corporation, P.O. Box 977, Syracuse 1, New York.*

VMC

VACUUM METALS CORPORATION

Jointly owned by Crucible Steel Company of America and National Research Corporation

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.

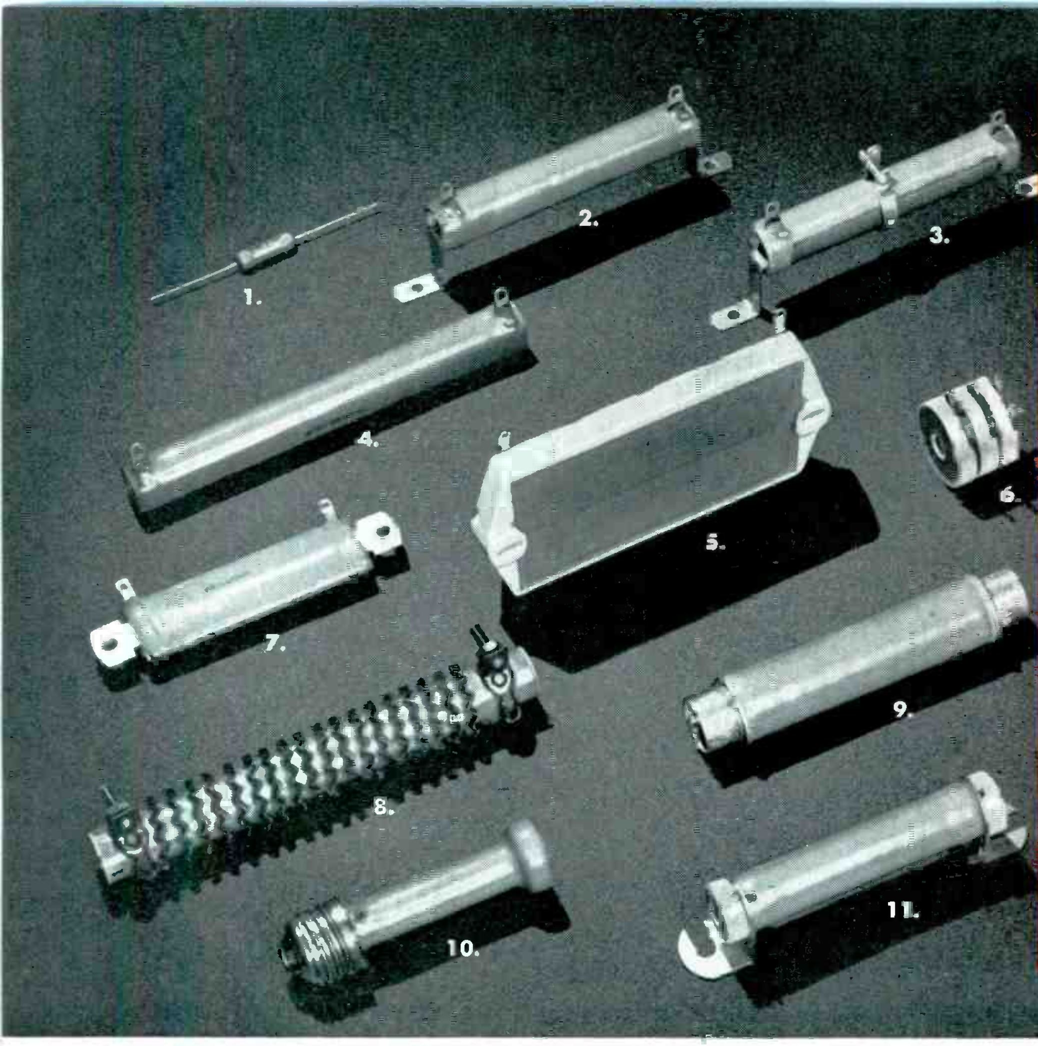
Whether your product is heavy industrial apparatus, sensitive electronic equipment, or a simple appliance requiring rheostats, you'll get more accurate, dependable performance per dollar from the Vitrohm ring line. Write for data-packed bulletins to Ward Leonard Electric Co., 150 South St., Mount Vernon, New York.

Rheostat Type	Watt Rating (based on 300°C Rise)	Total Resistance* Min. Ohms	Total Resistance* Max. Ohms	Approx. Number of Steps at Min. ohms	Approx. Number of Steps 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-Engineered Controls Since 1892



MEET THE world's largest selection of resistors

1. **AXIOHM*** Used in electronic equipment requiring miniature power resistors. 2. **FIXED VITROHM*** Used for voltage dropping and current limiting. 3. **ADJUSTOHM*** Gives circuit adjustability for voltage dividing or regulating purposes. 4. **NON-INDUCTIVE*** For low inductance and distributed capacitance in high frequency circuits. 5. **PLAQOHM*** Used in compact, high frequency electronic equipment. 6. **DISCOHM*** A miniature resistor for low inductance values and distributed capacitance. 7. **STRIPOHM*** For compact aviation, communication and navigation equipment. 8. **RIBFLEX** Used in circuits where high wattage must be dissipated in small space. 9. **FERRULE TERMINAL** For rapid interchangeability of resistance values or resistor replacement. 10. **SCREW BASE** With an Edison screw base for mounting to provide rapid means of changing resistance. 11. **BRACKET TERMINAL** Has leads silver brazed to brackets for easy interchange or renewal of unit.

**These are stock resistor types*

Ward Leonard Vitrohm resistors will best meet your every requirement

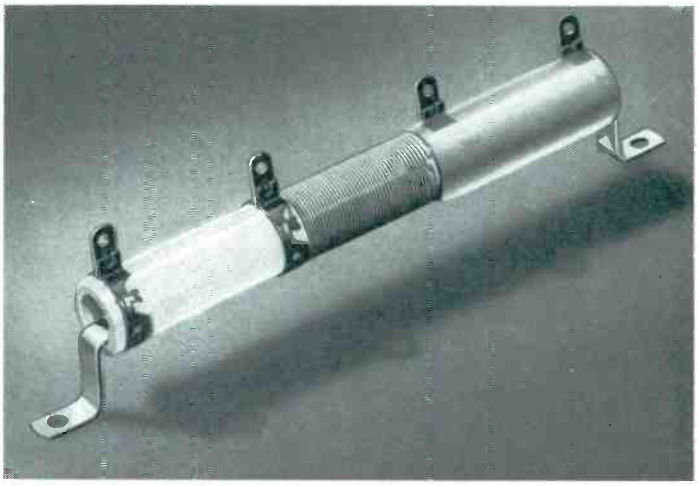
• The eleven resistor types shown above (seven of them stock resistors) represent the most complete line ever offered by any manufacturer.

We carefully control every step in the manufacture, and run more than 19 separate inspection checks on every single resistor we produce to make sure it will perform as rated, even under the most adverse conditions.

That's why you can depend on the performance of every Ward Leonard resistor you use.

We also maintain a stock of component parts so that made-to-order resistors may be quickly assembled to meet your special requirements.

For full information on Vitrohm resistors, write for our Catalog 15, to Ward Leonard Electric Company, 150 South Street, Mount Vernon, N. Y.



WARD LEONARD IS THE ONLY MANUFACTURER that makes its own ceramic cores, Vitrohm enamel and terminals. Even our resistance wire is specially drawn to Ward Leonard's own rigid specifications.

5.23

WARD LEONARD ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

Result-Engineered Controls Since 1892

New 64-page catalog contains useful data, tables, etc., for correct resistor selection.

Hughes

high temperature operation

Silicon

extremely high back resistance

Junction

exceptionally stable characteristics

Diodes

Actual size, diode glass body: 0.265 by 0.103 inches, maximum. Body is coated with opaque silicone enamel to shield crystal from light. Color-coded on cathode end. Ambient operating temperature range: −80° to +200° C.

Now you can take advantage of silicon's operating temperature range and obtain, at the same time, a semiconductor device with phenomenally high back resistance. Actually, many of the types of the new Hughes Silicon Junction Diodes provide essentially an open circuit in the back direction. This means that many entirely new circuit applications are now made possible.

The entire line of these new Silicon Junction Diodes is packaged in the one-piece, fusion-sealed glass body, originated and developed at Hughes. This now-famous construction is impervious to moisture penetration—*ensures* electrical and mechanical stability. With their axial leads and subminiature size, Hughes diodes are easier to mount, easier to spot-weld or solder. So, when temperature or high back resistance requirements call for silicon, be sure to specify *Hughes Silicon Junction Diodes.*

Electrical features: Good forward conductance . . . very sharp back voltage breakdown . . . extremely high back resistance.

Physical features: One-piece, fusion-sealed glass body . . . axial leads for easy mounting . . . subminiature size.

Hughes

SEMICONDUCTOR SALES DEPARTMENT

Aircraft Company, Culver City, Calif.

New York Syracuse
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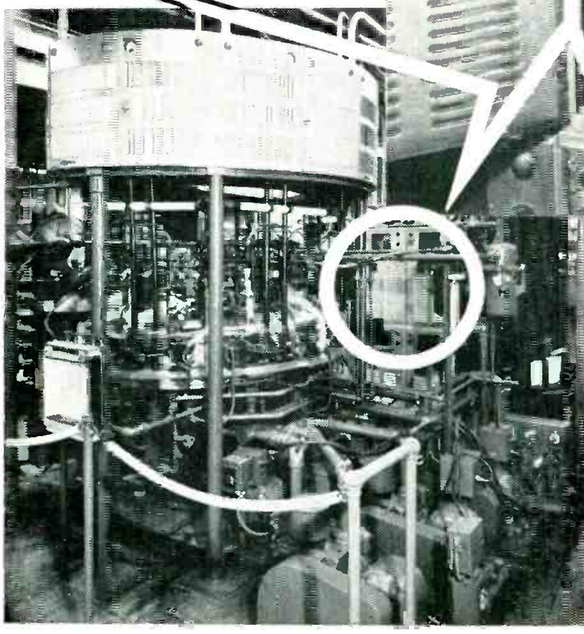
This NWL TRANSFORMER in continuous use for 6 years, 16 hours per day at RCA Tube Division Harrison Plant



This transformer, one of 25 is located in the tube-manufacturing department on the first floor. The rating is 220/8KV C.T. 7.2 KVA. On the floors above there are 95 similar transformers. Elsewhere in this plant NWL Transformers have been giving satisfactory service for 12 years under the same severe conditions.

Above photo, with cabinet safety door open, shows NWL Transformer in place. Photo at left shows tube-sealex machine. Cabinet containing transformer is shown within circle.

NWL Transformers, such as that illustrated above, are used to supply high voltage D.C. current to the tube-sealing machines shown in lower photo. RCA produces only products of the highest quality. Because of the extremely accurate work done by these machines under high speed production schedules, it is imperative that the transformers be completely dependable over long periods of time. NWL Transformers meet these conditions.

From 10 VA to 300 KVA Dry-Type only. Both open and encased. 1, 2, and 3 Phase. 15 to 400 Cycles.

NWL

ESTABLISHED 1920

NEMA

Nothelfer

WINDING LABORATORIES

P. O. Box 455 - Dept. 102, TRENTON, NEW JERSEY

Manufacturers of Electrical Transformers—Testing Equipment

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STACKPOLE

"GA" FIXED COMPOSITION CAPACITORS

...for all low capacity requirements

Stackpole "GA" fixed composition capacitors represent the simplest, most inexpensive capacitor design ever produced—and their operating stability is more than ample for the great majority of applications.

Pioneered by Stackpole, these sturdy little units are now available in an expanded range of values from 0.10 to 10.0 μμf—all with standard RETMA 3 or 4 band color code. Insulated bodies, dielectrics and electrodes are integrally molded for maximum stability and durability. Leads are securely anchored and treated for easy soldering.

Electronic Components Division
STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

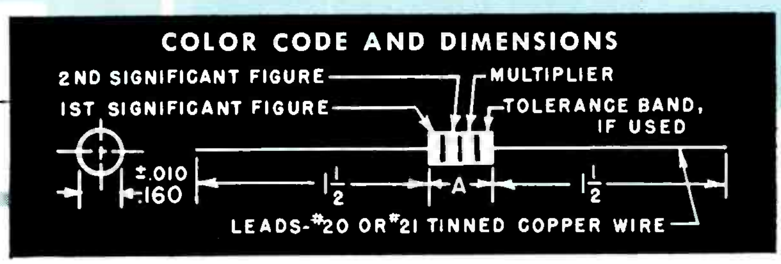
CHOOSE FROM THESE 46 RETMA VALUES...

Capacity in μμf Standard Values in			Color Bands			Max. Dim. "A"
20%	10%	5%	1st	2nd	3rd	
.10	.10	*	Brown	Black	Gray	.330
	.12	*	Brown	Red	Gray	.330
.15	.15	*	Brown	Green	Gray	.330
	.18	*	Brown	Gray	Gray	.330
		.20	Red	Black	Gray	.330
.22	.22	.22	Red	Red	Gray	.330
		.24	Red	Yellow	Gray	.330
	.27	.27	Red	Violet	Gray	.330
		.30	Orange	Black	Gray	.330
.33	.33	.33	Orange	Orange	Gray	.330
		.36	Orange	Blue	Gray	.330
	.39	.39	Orange	White	Gray	.330
		.43	Yellow	Orange	Gray	.330
.47	.47	.47	Yellow	Violet	Gray	.330
		.51	Green	Brown	Gray	.330
	.56	.56	Green	Blue	Gray	.330
		.62	Blue	Red	Gray	.330
.68	.68	.68	Blue	Gray	Gray	.330
		.75	Violet	Green	Gray	.330
	.82	.82	Gray	Red	Gray	.330
		.91	White	Brown	Gray	.330
1.0	1.0	1.0	Brown	Black	White	.330
		1.1	Brown	Brown	White	.330

Capacity in μμf Standard Values in			Color Bands			Max. Dim. "A"
20%	10%	5%	1st	2nd	3rd	
	1.2	1.2	Brown	Red	White	.330
		1.3	Brown	Orange	White	.330
1.5	1.5	1.5	Brown	Green	White	.330
		1.6	Brown	Blue	White	.330
	1.8	1.8	Brown	Gray	White	.290
		2.0	Red	Black	White	.290
2.2	2.2	2.2	Red	Red	White	.230
		2.4	Red	Yellow	White	.230
	2.7	2.7	Red	Violet	White	.230
		3.0	Orange	Black	White	.230
3.3	3.3	3.3	Orange	Orange	White	.210
		3.6	Orange	Blue	White	.210
	3.9	3.9	Orange	White	White	.210
		4.3	Yellow	Orange	White	.210
4.7	4.7	4.7	Yellow	Violet	White	.180
		5.1	Green	Brown	White	.180
	5.6	5.6	Green	Blue	White	.250
		6.2	Blue	Red	White	.250
6.8	6.8	6.8	Blue	Gray	White	.250
		7.5	Violet	Green	White	.220
	8.2	8.2	Gray	Red	White	.220
		9.1	White	Brown	White	.220
10.0	10.0	10.0	Brown	Black	Black	.180

TOLERANCE Color Code

CAPACITIES 0.1 to 10.0 μμf	CAPACITIES 10.0 μμf & over
20% —none	20% —Black
10% —Silver	10% —White
5% —Gold	5% —Green



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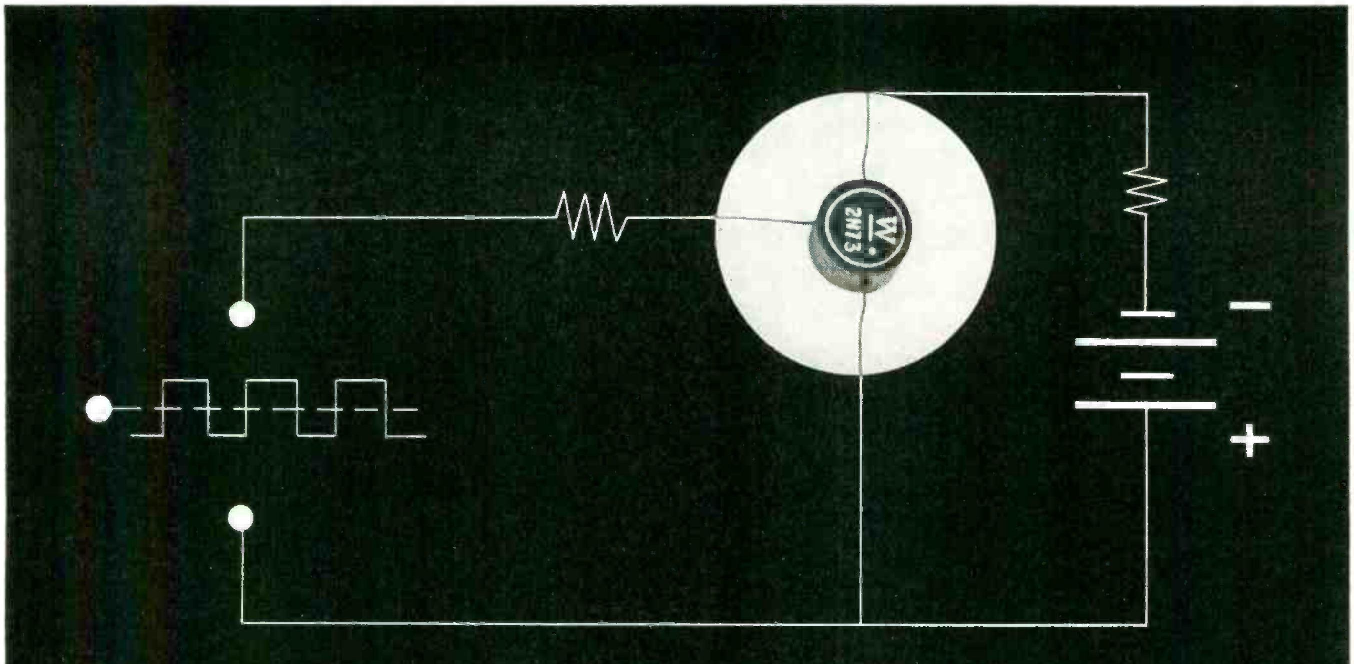


Here are PNP junction transistors designed for reliable applications!

NOW! A New Concept in Transistor Application!

These new Westinghouse transistors offer many new design features for reliable operation in switching applications. In computers, Magamp® systems, as a substitute for relays and in many other devices, you'll find they operate at a high percentage of efficiency, with greater sensitivity, higher power handling ability over wider temperature ranges than transistors in linear operation.

MAXIMUM RATINGS CHART	2N73	2N74	2N75
Voltage Emitter to collector—volts	50	50	20
Total device power at 25° C.	200mw	200mw	200mw
Total device power at elevated temperature	100mw @65° C	100mw @40° C	100mw @100° C

NEW DESIGN FEATURES

- Designed for low frequency switching applications
- Low internal power consumption in the "on" condition
- Low leakage current in the "off" condition
- Capsuled in high dielectric, low loss material
- Sealed with a special moisture-resistant coating

2N73 — A general-purpose low level switch intended for operation in the inverted grounded emitter circuit, as illustrated.

2N74 — A high current level switch for use in the normal grounded emitter circuit.

2N75 — A very low current level switch for use in the grounded emitter connection (some applications use this type in inverted grounded emitter with switch "off" and normal grounded emitter with the switch "on").

Write for detailed characteristics data and the free four-page folder that describes nine working circuit applications. Address your request to:

Westinghouse Electric Corporation
Electronic Tube Division
Commercial Engineering Department A-3015
Elmira, New York

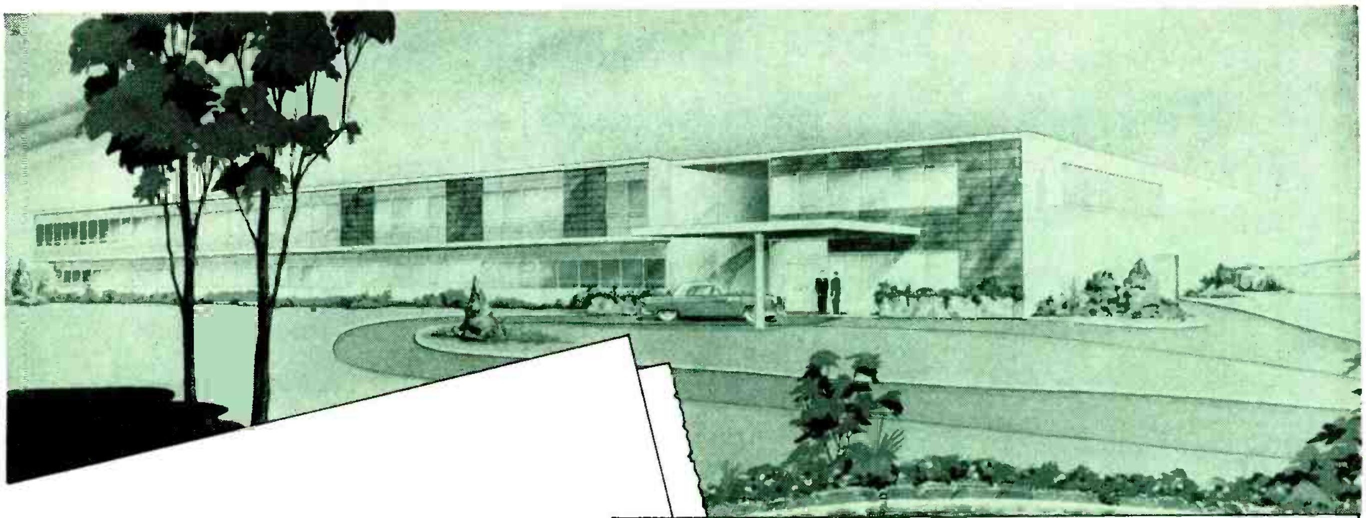
ET-95065

OUR ENGINEERING TODAY IS YOUR PROFIT TOMORROW

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

RELIATRON® TUBES

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, N. Y.



Midwestern Geophysical Laboratory
of Tulsa, Oklahoma

takes pride in announcing that effective January 1, 1955
our new name will be

Midwestern Instruments

Midwestern Instruments will carry on,
as did Midwestern Geophysical Laboratory,
as one of the leaders in the field of
Instrumentation and Control Systems

With its new and greatly expanded facilities, Midwestern Instruments will accelerate its design and manufacturing endeavors in the general fields of instrumentation and automatic control systems. We invite the submission to us, of problems in recording dynamic information in both airborne and ground-based applications, as well as problems concerned with automatic control, particularly those of reasonably high power level and dynamic performance requirements where hydraulic servosystems are at their best.

Write or wire for further information.

Products

- OSCILLOGRAPHS (LABORATORY AND FLIGHT TEST)
- MAGNETIC STRUCTURES
- GALVANOMETERS
- AMPLIFIERS
- HYDRAULIC SERVOVALVES
- TORQUE MOTORS
- SERVOAMPLIFIERS
- DATA REPEATERS
- WATERPROOF CONNECTORS
- GEOPHYSICAL EQUIPMENT

MIDWESTERN MI INSTRUMENTS

MIDWESTERN INSTRUMENTS

41st and Sheridan Road Tulsa, Oklahoma

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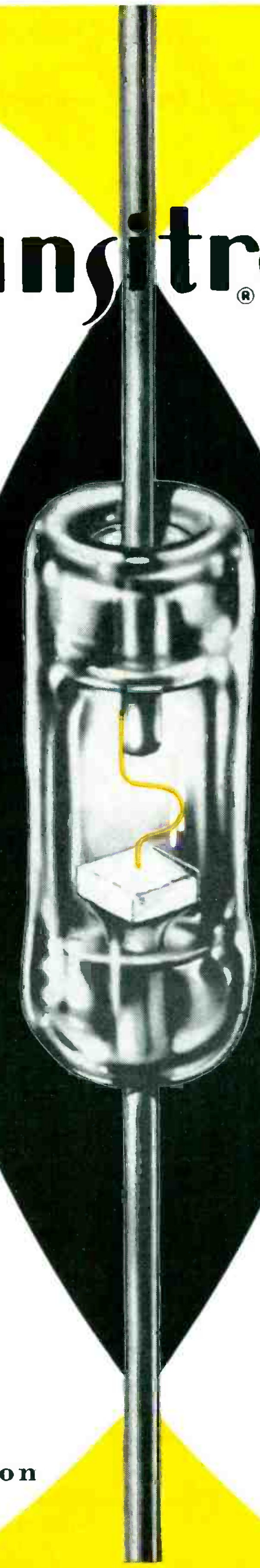
NOW . . . FROM **Transitron**®

GOLD BONDED

SUBMINIATURE GLASS DIODES

designed for specific applications



HIGH INVERSE VOLTAGE TYPES

The 1N55B with a 150 volt rating, and the T5G with a 100 volt rating are particularly suitable for circuits where high voltages are encountered.

HIGH TEMPERATURE TYPES

The T18G and 1N198 diodes are rated, specified, and 100% tested for operation at 75°C. They are specifically intended for use where high inverse resistance and reliable performance is required at elevated ambient temperatures.

HIGH CONDUCTANCE TYPES

For applications requiring high forward conductance, types such as the T7G and T25G with over 200 ma at + 1 volt provide improved circuit performance.

HIGH RESISTANCE TYPES

The T8G and T9G offer several megohms inverse resistance and are ideal for critical circuits requiring a minimum of diode loading.

COMPUTER TYPES

Specified for recovery time, the T16G, T17G, 1N191, and 1N192 are suited for critical pulse circuitry. Types T7G, T6G, and T25G have been designed especially for fast core switching.

JAN TYPES

The 1N126, 1N127, 1N128, and 1N198 are designed and tested to meet all requirements of MIL-E-1B.

actual size

Send for Bulletin TE1319.

Transitron electronic corporation
melrose 76, massachusetts

Power Transistors

Transistors

Germanium Diodes

Silicon Diodes

Quads

Want more information? Use post card on last page.

Phil-trol® **Data**

New Phil-trol Relays Available with

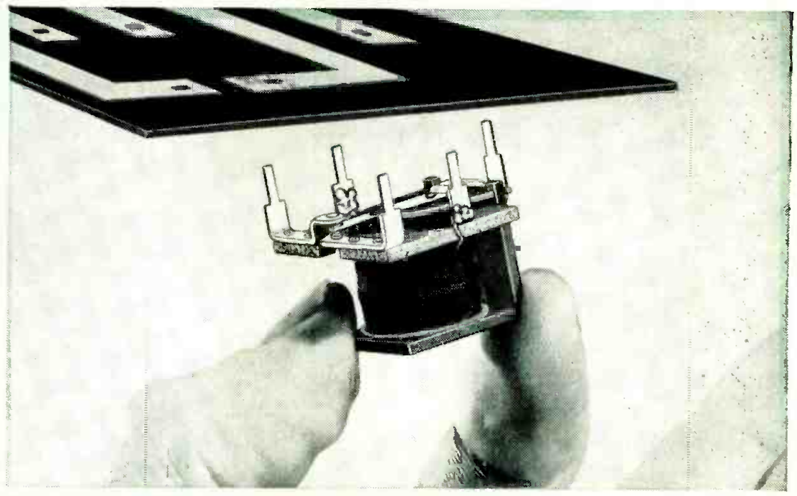
Phil-trol Engineering, in its constant policy to keep abreast and ahead of the rapid progress in electronic design and production techniques, has developed several new relays. Those shown here illustrate a completely new sub-miniature type, the minute, featherweight Phil-trol "15" series. They are available with printed circuit terminals as well as with standard soldering lugs.

Also shown are the popular, improved Phil-trol types "4" and "8" relays, both available with printed circuit or Taper Tab terminals.

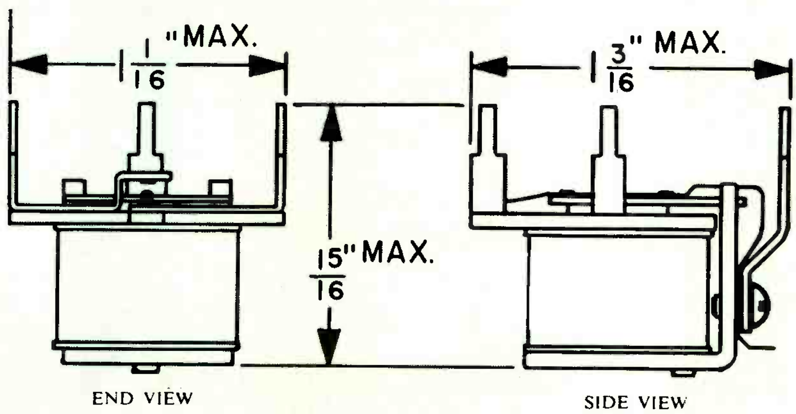
In designing these new relays Phillips Control Corporation applied their long specialized experience and their same standard practice of producing the finest relays possible for the intended applications. And to achieve greatest economy commensurate with top performance and long dependable life.

The new Phil-trol "15" series, and the improved types "4" and "8," added to the Phil-trol line, further broaden the unusually wide selection of Phil-trol Products available for practically every relay application.

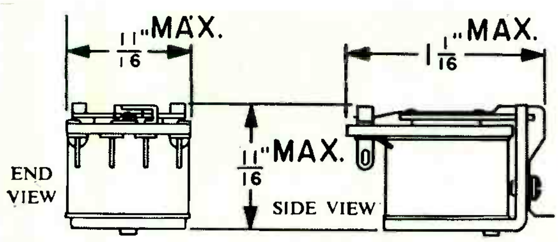
You are invited to call upon the comprehensive Phil-trol Engineering Service to help you determine the exact Phil-trol relay best for your application—or to work with you on "special" problems—without obligation.

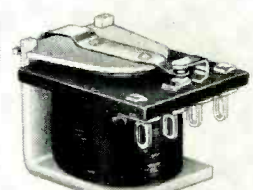


Phil-trol Type 15QA with printed circuit terminals of brass. Contacts are silver. Shown actual size—weight is approximately 1 ounce.



Here are the completely new **Phil-trol Type 15QA Relays** (above and below). Sub-miniature in size, light in weight, they are ideal where dependable performance is a "must"—as in delicate instrumentation, Radiosonde equipment, or the Autronic Eye. Available for DC operation up to 60 V., with contact 1 Form C (S.P.D.T.).





Phil-trol Type 15QA with standard solder terminals of silver. Contacts are also silver. Shown actual size—weight 1 ounce approximately.

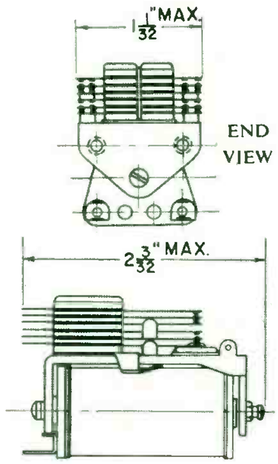
Phillips Control Corporation JOLIET, ILLINOIS

A THOR CORPORATION SUBSIDIARY

Want more information? Use post card on last page.

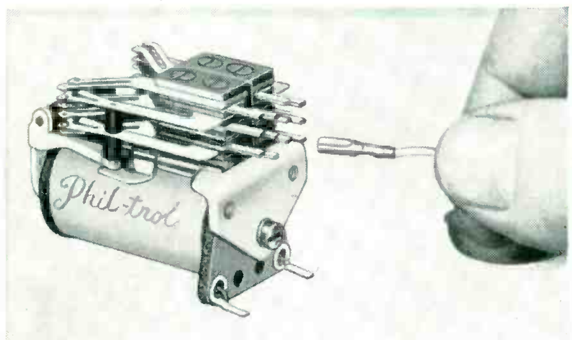
for Relay Users

Printed Circuit & Taper Tab Terminals



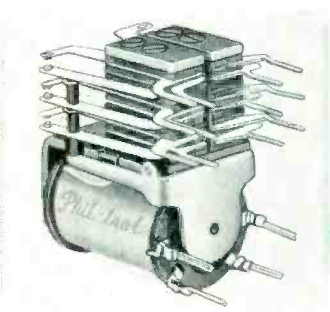
END VIEW

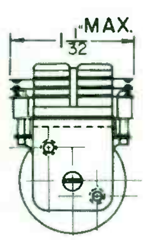
SIDE VIEW



This **Phil-trol 8QA, DC relay** is equipped with the new wedge action Taper Tab terminals for simple, fast, positive connections. No soldering problems. Phil-trol Engineers have made the 8QA available in a Taper Tab model to save time and labor in assembly. It is also available with printed circuit terminals.

The Phil-trol 8QA is highly sensitive, provides fast opening and closing. Heavy duty, long-life bearings give precision operation. Contact springs are equipped with twin contacts to assure maximum reliability. Operating voltage up to 230 volts DC. Weight is approximately 3 ounces.





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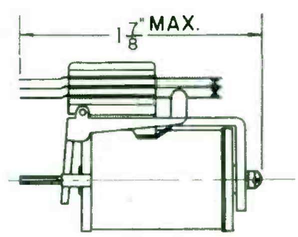

SIDE VIEW

The improved **Phil-trol series "4" relay** (above) is the new printed circuit model 4CQA. It is a multi-contact, DC unit, small in size, light weight, with good resistance to vibration . . . and it is economical in cost. This relay is available with coils having either single or double windings. It operates up to 115 volts DC. Weight is 1¾ oz. (approx.) The 4CQA is also available with Taper Tab or standard soldering terminals.

Phil-trol Sales-Engineering Offices

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Let **Phil-trol Progress**
Help Solve Your
Relay Problems

Plants at Joliet, Illinois,
Santa Monica, California,
and Santurce, Puerto Rico

PHILLIPS CONTROL CORP., Dept. E, Joliet, Ill.

Gentlemen: Please send me your General Catalog ☐
I am also interested in: Phil-trol Type 15 Printed Circuit Relays ☐
Phil-trol Type 8QA Taper Tab Relays ☐
Phil-trol Type 4CQA Printed Circuit Relays ☐

Name ____________________

Company ____________________

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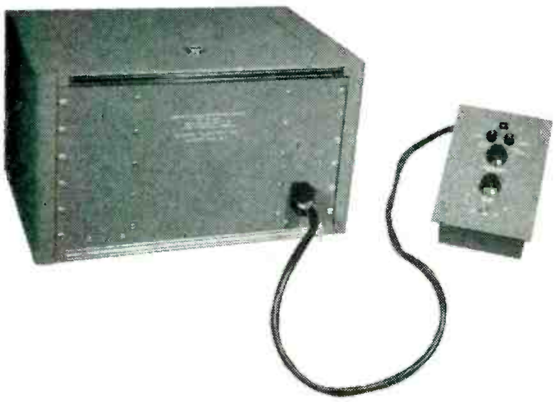
5 to 300 VOLTS REGULATED
WITH NO TUBES!

SURGE-SUPPRESSED MAGNETIC-REGULATED SUPPLY



TYPE AA14

OUTPUT: 5 to 300 V.D.C. continuously variable, 0 to 200 ma.

INPUT: 105 to 129 V.A.C., 60 C.P.S., single phase.

REGULATION: ±0.5% due to line voltage changes. ±1.0% due to combined line and load changes throughout entire range of output voltages.

RIPPLE: Less than 0.3 Volts peak to peak.

A completely static, tubeless, transistorless power supply with double-regulation to strongly suppress input voltage surge effects on the output voltage. A portable remote control is supplied which may be panel-mounted or used on a bench. Designed for long-life and service-free operation. Ideal for general lab work, testing and other applications.

KLYSTRON SUPPLY MAGNETIC-REGULATOR

INPUT: 105 to 125 V.A.C., 55 to 65 C.P.S. Single phase.

REGULATION: ±2.0% under any combination of line, load and environmental conditions.

ENVIRONMENT: −18° C to +71° C, up to 100% humidity.

HIGH SHOCK AND VIBRATION

TYPE AA11

A completely static, tubeless, transistorless power supply regulator for control of an 18,000 V.D.C., 0 to 200 ma. power supply; built in accordance with military specifications. For cabinet-mounting as part of a radar beacon system. Built to meet MIL-E-4158.

General Magnetics is engaged in a program of research and development with a view to expanding its line of magnetic-regulated power supplies and other magnetic amplifier components.

If you have special requirements for magnetic-regulated power supplies, magnetic line regulators, magnetic amplifiers or magnetic modulators, your inquiry will be welcomed.

Write on your letterhead for further details

GENERAL GM INC. MAGNETICS

135 Bloomfield Avenue Bloomfield, N. J.

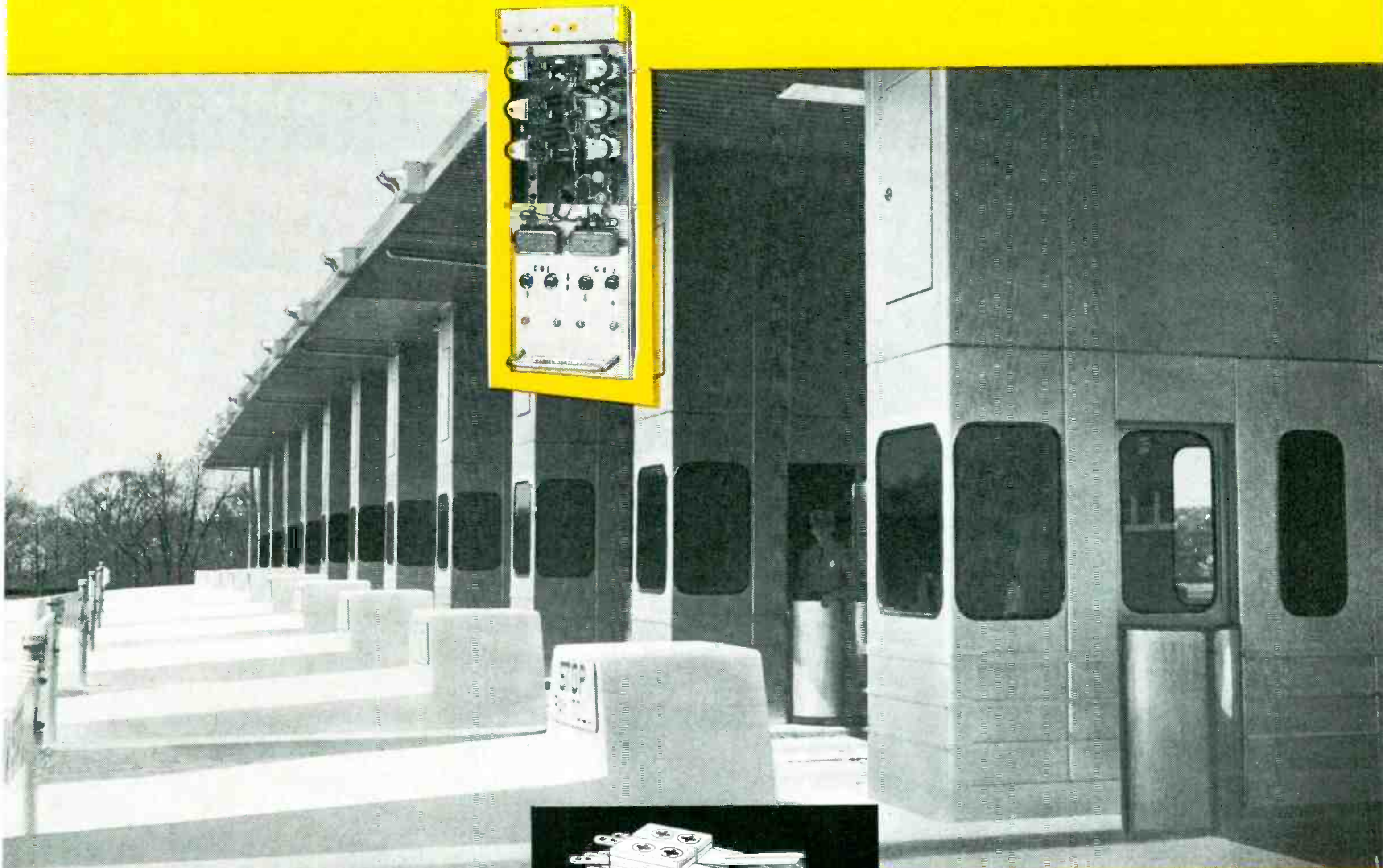
CLARE

Type J Relays

help count cars
ACCURATELY and FAST
. . . on Jersey's
Garden State Parkway

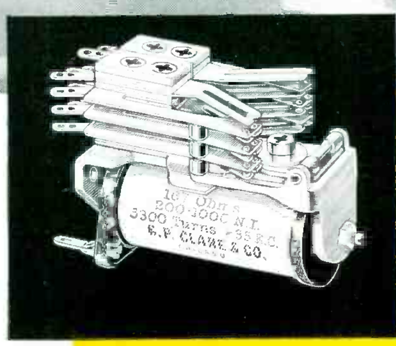
Keeping track of traffic on the Garden State Parkway hour after hour, day after day, is rugged duty for control equipment. Only the most sturdy and precise components can stand the wear and tear.

That's why engineers of Taller & Cooper, Inc., whose toll booths and collection equipment are found on every major American toll facility, chose CLARE TYPE J RELAYS. These relays accurately record the number of vehicles that pass through the Toll Plaza. Their high speed permits accurate readings of automobiles even up to 40 miles per hour.



CLARE RELAYS

FIRST
in the industrial field



The Type J Relay may have just what YOU want in a relay

For complete data on the Type J and all Clare Relays, write for ENGINEERING DATA BOOK. *A Clare sales engineer is located near you. Call him or write C. P. Clare & Co., 3101 West Pratt Blvd., Chicago 45, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable address:* CLARELAY.

SMALL AND LIGHT:
2¼" long; 2¼ oz. (approx.)

LARGE CURRENT CAPACITY:
4 amperes, 150 watts. Twin contact points (palladium) standard.

FAST OPERATE-RELEASE:
1 to 2 milliseconds (Min.) Coils can be provided for time delay on operation, release, or both.

OPERATING VOLTAGE:
Up to 220 volts d-c.

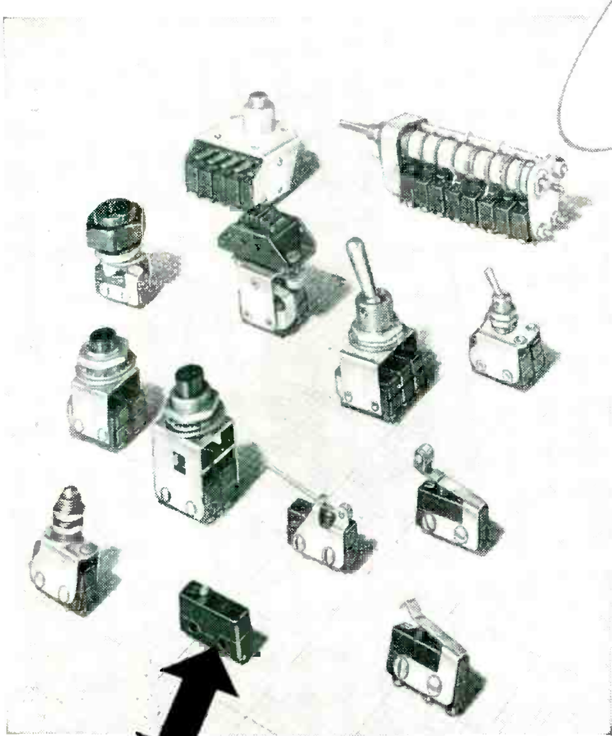
NEW FEATURES:
Independently operating twin contacts minimize contact failure.

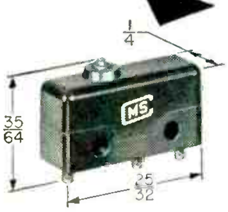
Hinge-type armature recently improved to prolong life and increase stability of relay adjustment.

New heavy duty yoke has stainless steel pivot pin with large bearing surface which turns in precisely reamed bearings of non-ferrous material.

MICRO SWITCH Precision Switches
A PRINCIPLE OF GOOD DESIGN

Here's the small switch Electronic Designers have learned to count on





Subminiature Switch Assemblies to meet every switching need

Ask for Catalog 75

● Designers of electronic equipment are extremely critical of day-in, day-out performance of components. Reliability of MICRO SWITCH products has made them first choice for a myriad of uses in this industry where component failure is intolerable.

In the subminiature switch MICRO SWITCH provides this superior reliability with extremely small-size, light-weight switches and assemblies that meet the requirements of the most streamlined design. Long experience has made MICRO SWITCH men expert in many complex problems of the electronics industry. Both in the field and at the factory they have participated in the development of many special switches to meet unusual specific requirements.

There comes a time in your development work when it will save you time and money to talk to an experienced switch man. Then is the time to call on MICRO SWITCH, the first name in precision switches. There is a MICRO SWITCH branch near you. Look in the yellow pages of your phone book.

See MICRO SWITCH Exhibit
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Kingsbridge Armory · New York, N.Y.

A complete line of snap-action and mercury switches

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.

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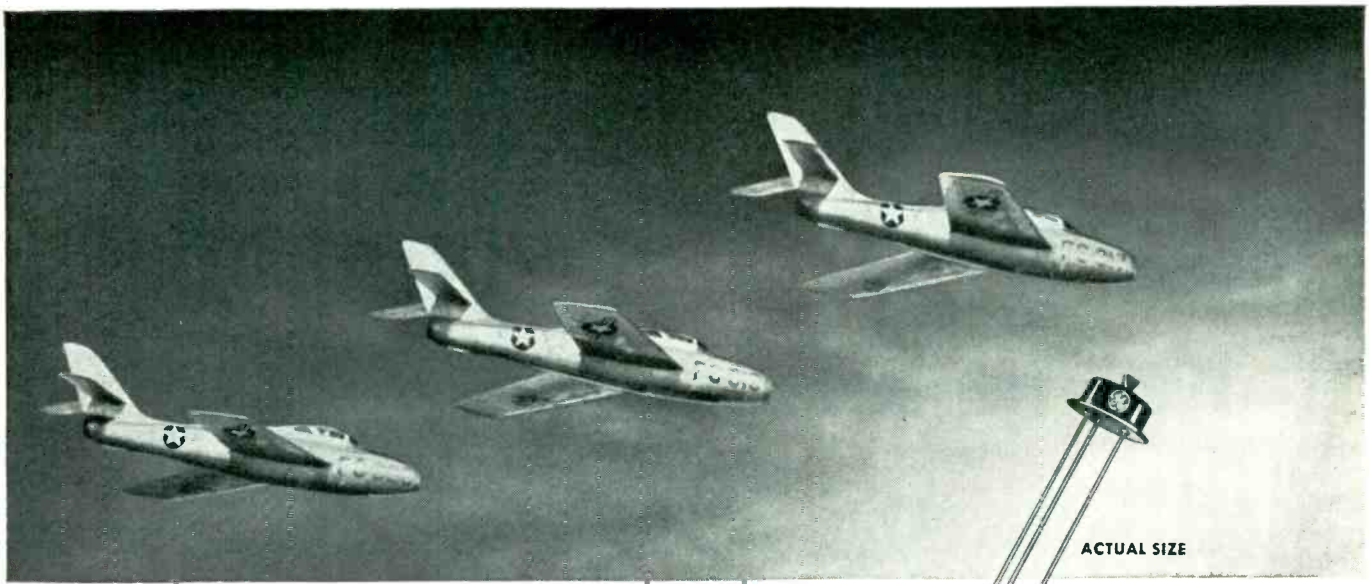


THE INDUSTRY'S FIRST AIR FORCE TRANSISTOR

Now Available!

● G.E.'s NEW Junction Transistor, 2N43A, is the first to be written into Air Force specifications! MIL-T-25096 (USAF) was actually written around this G-E product developed for the Military. It meets the most rigorous requirements on electrical and mechanical characteristics, and reliability. Spread in beta (gain) is held to a 2:1 ratio—far narrower than for ordinary transistors.

Designed for mass production at low cost, this P-N-P transistor offers performance characteristics second to none! It is the completely dependable audio amplifier for *commercial* and *military* applications. Include it in your design plans now while production lots are rolling through the assembly line.

For complete specifications and details on applications write today. *General Electric Company, Section X425, Germanium Products, Electronics Park, Syracuse, New York.*

DESIGN FEATURES:

EXCEPTIONALLY HIGH BETA (GAIN)...and spread is held to 33–66.

STURDY CONSTRUCTION...built to comply with rigorous vibration and shock requirements. Welded seam keeps transistor free from solder-flux contamination.

SEALED JUNCTION...contamination gases permanently eliminated!

HIGH POWER OUTPUT...case design makes possible a collector dissipation of 150 MW.

HERMETIC SEAL...unaffected by moisture.

HIGH TEMPERATURE OPERATION...rated for a maximum junction temperature of 100°C.

LONG LIFE...stable performance throughout the life of your equipment.

SMALL SIZE...extremely compact design provides added flexibility for all applications.

THE MILITARY DESIGN
USAF—2N43A per specification
MIL-T-25096

●

COMMERCIAL DESIGN—2N43A
Absolute Maximum Ratings:

Collector Voltage (Referred to base)	—45 volts
Collector Current	—50 ma
Emitter Dissipation	25 mw
Collector Dissipation	150 mw
Storage Temperature	100°C
Collector Cutoff Current (—45 V)	—10 microamps

Electrical Characteristics, Common Base

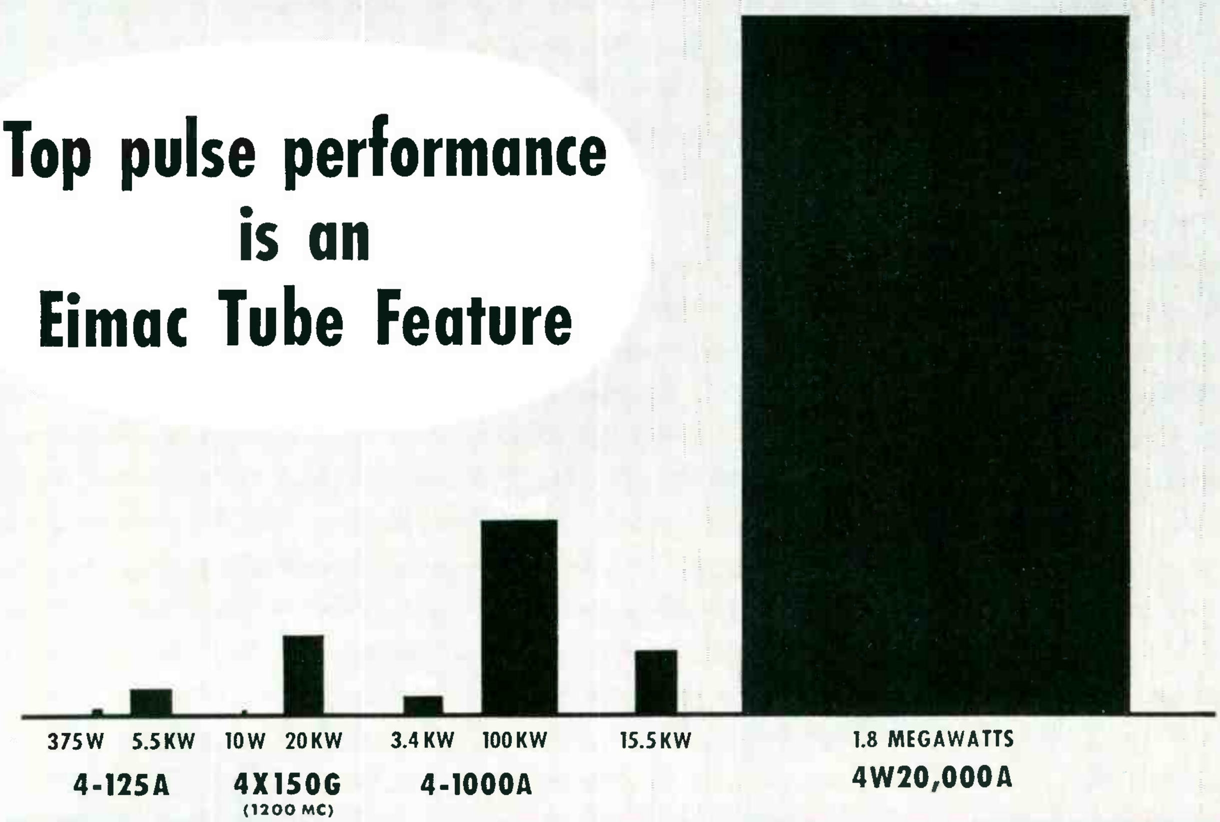
(V_c = —5V, I_e = 1 ma, T = 25°C)

Input Impedance (h_{11})	30 ohms
Output Admittance (h_{22})	1.0 μmhos
Feedback Potential Ratio (h_{12})	4×10^{-4}
Current Transfer Ratio (h_{21})	0.9775

Progress Is Our Most Important Product

GENERAL ELECTRIC

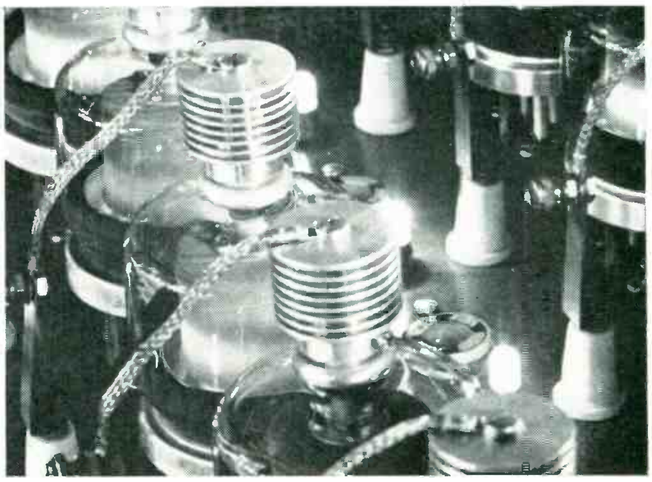
Top pulse performance is an Eimac Tube Feature



EXAMPLE OF HIGH POWER OUTPUT CAPABILITIES OF EIMAC TUBES IN TYPICAL PLATE PULSED RF AMPLIFIER OPERATION

The chart on this page illustrates the amazing power capabilities of versatile Eimac broadcast and communications tubes in typical pulse amplifier application. Incomparable pulse performance is a feature of Eimac tubes stemming from reserve filament emission and ability to handle high electrode voltages and resulting currents. This, plus clean, simple design, free of troublesome internal insulators, and advanced production techniques, produces an unmatched quality enabling Eimac tubes to give long, reliable performance in pulse RF operation and pulse modulator service.

In addition to pulse rated CW tubes, Eimac has designed and produced many tube types specifically for pulse application. The 4PR60A radial-beam pulse tetrode, pictured here, is one of this famous family. An oxide coated cathode tube,



it delivers 300kw of power output in pulse modulator service with only one kilowatt of pulse driving power. From the 100T power triode, used in the first Navy sea radar tests, to the 4W20,000A, Eimac pulse-rated tubes have filled key sockets in sea, land and air pulse operation.

Contact our Technical Services Department for your free copy of Eimac application bulletin No. 3, "Pulse Service Notes."

Eimac

EITEL-McCULLOUGH, INC.

SAN BRUNO, CALIFORNIA

THE WORLD'S LARGEST MANUFACTURER OF TRANSMITTING TUBES

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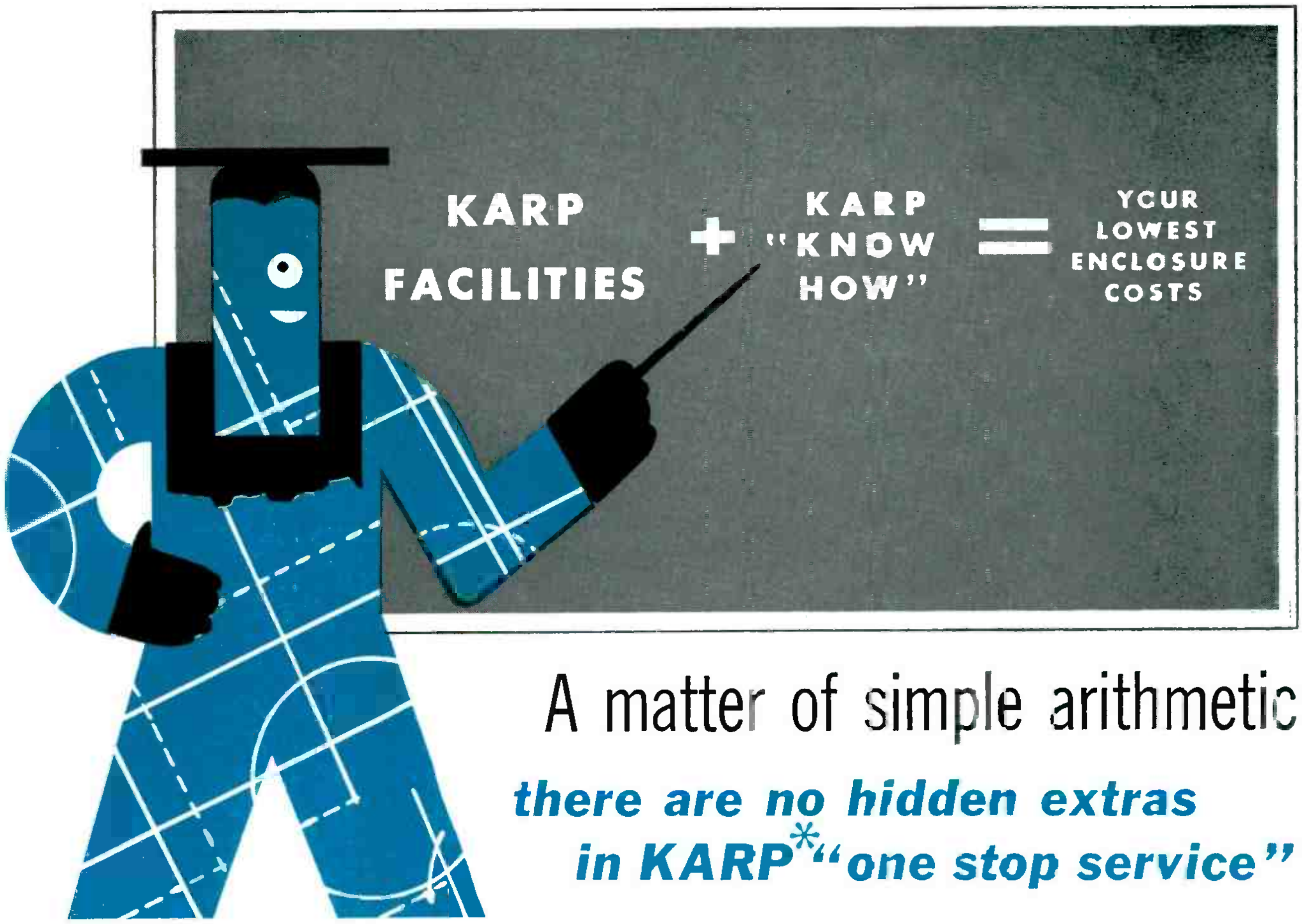


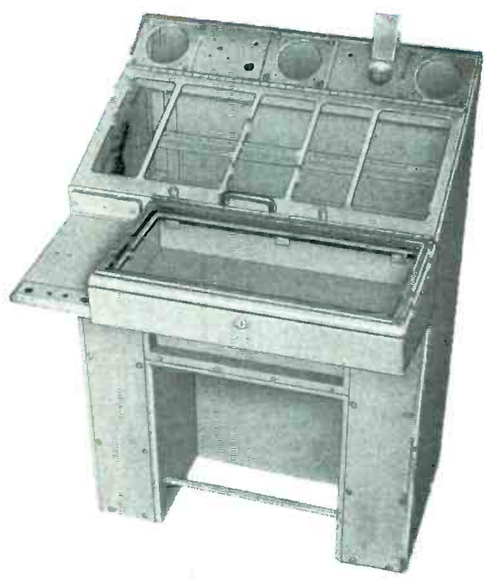
A matter of simple arithmetic

there are no hidden extras in KARP "one stop service"*

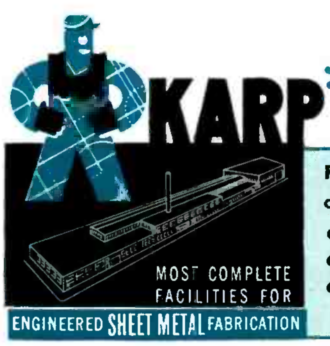
quality production...

- is a matter of routine at KARP. Each unit is so rigidly inspected during manufacturing and finishing that "hidden costs" are prevented.
- Whether you need ten or ten thousand units — whether they are massive or minute — you'll find that it pays to deal with KARP.
- There is no obligation for quotations on your blueprints, samples or sketches. Write or phone today.

Send for descriptive literature.



KARP METAL PRODUCTS CO.
Division of H & B American Machine Company, Inc.
215 63rd STREET • BROOKLYN 20, N. Y.



*** *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

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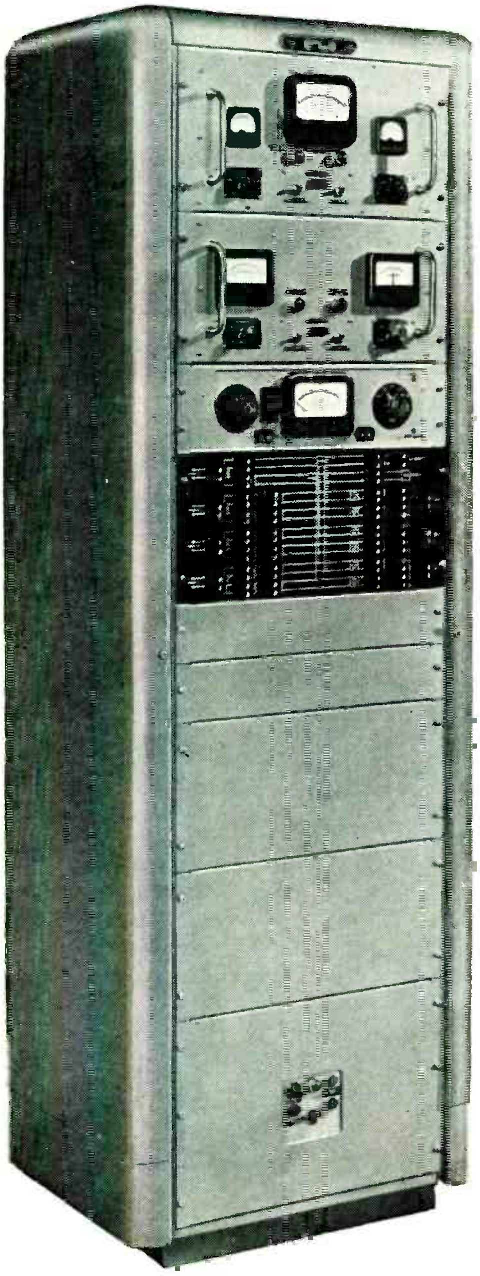
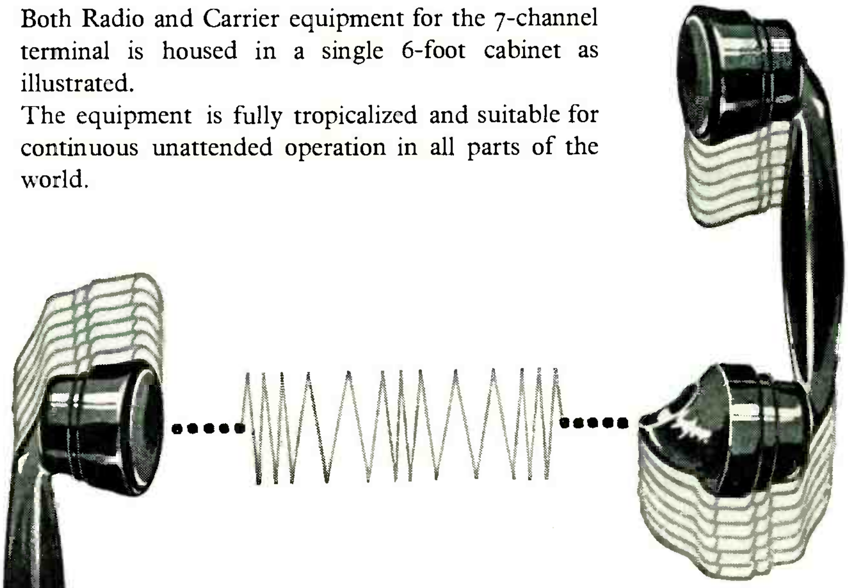
PYE ERICSSON
SEVEN CHANNEL
VHF FM RADIO TELEPHONE SYSTEM

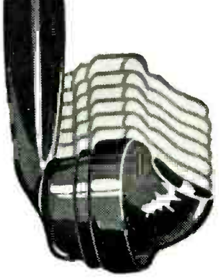


This 7-channel Radio Link System has been designed for economy both in initial cost and maintenance demands.

This has been achieved without sacrifice of essential facilities or relaxation of performance standards. Both Radio and Carrier equipment for the 7-channel terminal is housed in a single 6-foot cabinet as illustrated.

The equipment is fully tropicalized and suitable for continuous unattended operation in all parts of the world.





ABBREVIATED SPECIFICATION

Radio Frequency Range	60—216 mc/s
Transmitter output Power	10 watts, or with Amplifier unit—50 watts
Baseband (7 Channels)	0.3—23.4 Kc/s
Maximum Deviation	50 Kc/s
Receiver Bandwidth	6 db down at ± 120 Kc/s

Telecommunications
CAMBRIDGE ENGLAND

Pye New Zealand Ltd. Auckland C.I., New Zealand	Pye Canada Ltd. Ajax, Canada	Pye-Electronic Pty., Ltd. Melbourne, Australia	Pye Ireland, Ltd. Dublin, Eire
Pye Radio & Television (Pty.) Ltd Johannesburg South Africa	Pye Limited Plaza de Necaxa 7 Mexico 5	Pye Limited Tucuman 829 Buenos Aires	Pye Limited 5th Avenue Building 200, 5th Avenue, New York

PYE LIMITED . . CAMBRIDGE . . ENGLAND

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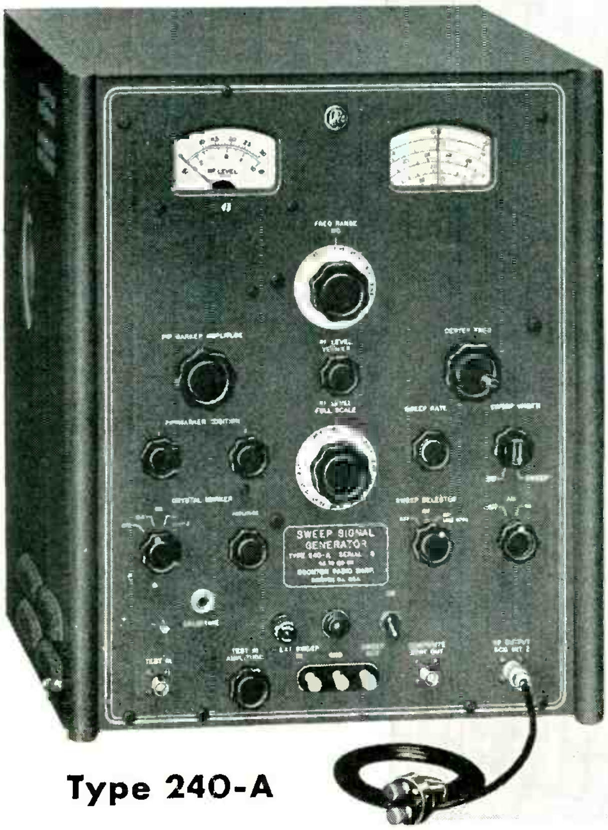
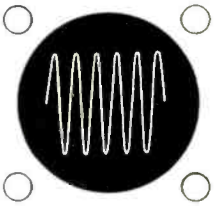
New! MULTI-PURPOSE

Sweep Signal Generator

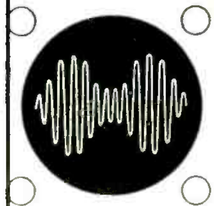
4.5 to 120 mc.



Type 240-A

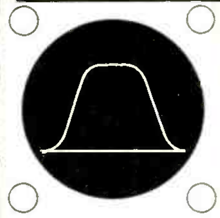


CW Output
4.5 to 120 MC

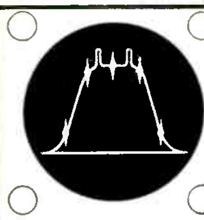


AM Modulated CW
30% at 1000 cps.

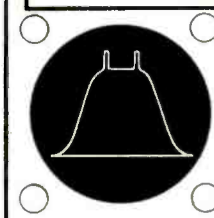
- **A wide range of continuously variable linear-frequency sweep widths.**
- **Crystal controlled frequency identification.**
- **Adjustable frequency-interpolation pip marks.**
- **Internal mixer for forming composite display signal.**
- **Accurate continuously-tuned CW with choice of internal AM.**
- **Internal crystal calibrator for CW.**
- **Wide range of calibrated output voltage.**



Broad Band Sweep
±1% to ±30% of
Center Frequency



Crystal Controlled
Identification of
Frequency—0.1, 0.5,
2.5 MC Spacing



Interpolation Pips
Mark Frequencies
From Crystal
Identification

The Sweep Signal Generator Type 240-A is a continuously tuned accurate CW Signal Generator with internal AM. The output voltage is continuously monitored, indicated and calibrated over a wide range. The CW Signal can be calibrated against an internal crystal. Electronic sweep circuits are included which produce an AGC-controlled, constant-amplitude, variable width linear frequency deviation. Two systems are included for frequency identification while sweeping. One of these is crystal controlled and the other is an interpolation system. An internal mixer adds the frequency identification information to the test receiver output signal prior to its connection to the display oscilloscope.

SPECIFICATIONS:

RF FREQUENCY RANGE: 4.5 to 120 MC continuously variable in five ranges.

RF FREQUENCY ACCURACY: ±1%.

RF OUTPUT VOLTAGE: 1 to 300,000 microvolts. 0.1 to 30,000 microvolts with external attenuator.

AMPLITUDE MODULATION: Factory adjusted to 30% from internal 1000 cps oscillator.

RANGE OF SWEEP WIDTHS: Continuously variable from ±1% of center frequency to ±15 MC or ±30% of center frequency whichever is smaller.

LINEARITY OF SWEPT RF FREQUENCY: Within 10% over middle 80% of sweep excursion, within 20% over remainder.

FLATNESS OF SWEPT RF OUTPUT: Within 7% under all conditions.

FREQUENCY IDENTIFICATION MARKS: Crystal frequency identification spaced 0.1, 0.5, 2.5 MC. Tuning dial identifies center mark. Two adjustable-position interpolation pip marks.

PRICE: $1375.00 FOB BOONTON, N. J.

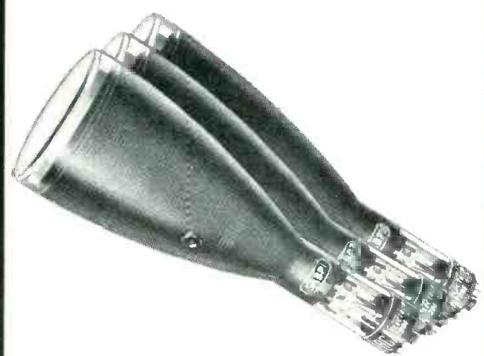
BOONTON RADIO *Corporation*
BOONTON · N · J · U · S · A ·

Want more information? Use post card on last page.

RCA DATA FOR

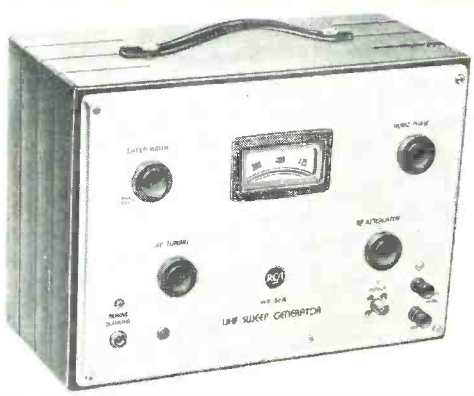
***NEW*—RCA-6BQ6-GTB/6CU6, 12BQ6-GTB/12CU6, and 25BQ6-GTB/25CU6** are directly interchangeable with similar types in the 6BQ6 family. In comparison with previous versions, these types retain the same desirable characteristics, but feature a modified mount design to provide higher perveance and to permit higher ratings.

RCA OSCILLOGRAPH TUBES—RCA-5ABP1, 5ABP7 and 5ABP11 flat-faced cathode-ray tubes feature electrostatic focus, electrostatic deflection, and post-deflection acceleration. These 5-inch oscillograph tubes differ only in spectral-energy emission and persistence characteristics of their respective phosphors. Outstanding features: very high deflection sensitivity, high spot intensity, and high grid-modulation sensitivity. The exceptionally high deflection sensitivity and low capacitance of the pair of deflecting electrodes provided for vertical-deflection, make this pair of electrodes especially suited for operation from wide-band amplifiers. The small size and high brilliance of the fluorescent spot gives finer detail in oscillographic traces . . . even with high-speed phenomena.



***NEW*—RCA-5U4-GB** is the "heavy duty" version of the 5U4-G. The improved design permits operation at higher peak and average currents, especially desirable when used in power supplies of TV receivers and radio equipment having high dc requirements. Additional important features of the RCA-5U4-GB include: double-wing plate design (for more plate area and increased heat conduction) . . . increased plate thickness (for more uniform heating) . . . double mica spacers (which provide better support, more resistance to shock, vibration) . . . flared base which engages button stem (eliminates need for cementing, reduces possible loose bases) . . . button stem (reduces electrolysis and leakage).

RCA WG-298A UHF DEMODULATOR—connects between the output of the WR-86A sweep generator and a 300-ohm termination for use in measuring the approximate standing-wave ratio of a 300-ohm-transmission line throughout the UHF range of 300-950 Mc. The WG-298A may also be used with other instruments such as the WR-40A, WR-41B or any UHF sweep generators using a 50-ohm BNC type output connector.



RCA WR-86A UHF SWEEP GENERATOR—recommended for continuous production line testing and general service applications on color and black-and-white TV. This instrument is also useful for checking converters, tuners, filters and other equipment operating in the 300 to 950 Mc range. The WR-86A provides wide sweep range continuously adjustable to 10% of indicated dial frequency up to 850 Mc; up to 85 Mc for frequencies from 850-950 Mc; flat output with a max. voltage amplitude variation of 0.1 db per megacycle over the swept range, high output voltage at least 0.6 v across 50 or 300 ohms, and wide range attenuation continuously adjustable over a range of 60 db.

For technical data, write RCA, Commercial Engineering, Section B19E, Harrison, N. J.

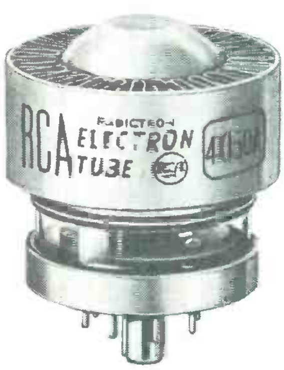
ELECTRON TUBES—SEMICONDUCTOR DEVICES—BATTERIES—TEST EQUIPMENT—ELECTRONIC COMPONENTS

DESIGNERS

RCA-2D21—a sensitive, four-electrode thyratron of the indirectly heated cathode type for use in relay applications. It has a high control ratio (essentially independent of ambient temperature over a wide range), extremely small pre-conduction or gas-leakage currents right up to the beginning of conduction, very low grid-anode capacitance and grid current. The 2D21 is not affected appreciably by line-voltage surges and, in a high-sensitivity circuit, can be operated directly from a vacuum phototube.

RCA-5879—is a sharp-cutoff pentode of the 9-pin miniature type intended for use as an audio amplifier in applications requiring reduced microphonics, leakage, noise, and hum. It is especially well-suited for input stages of medium-gain public address systems, home sound recorders, and general-purpose audio systems.

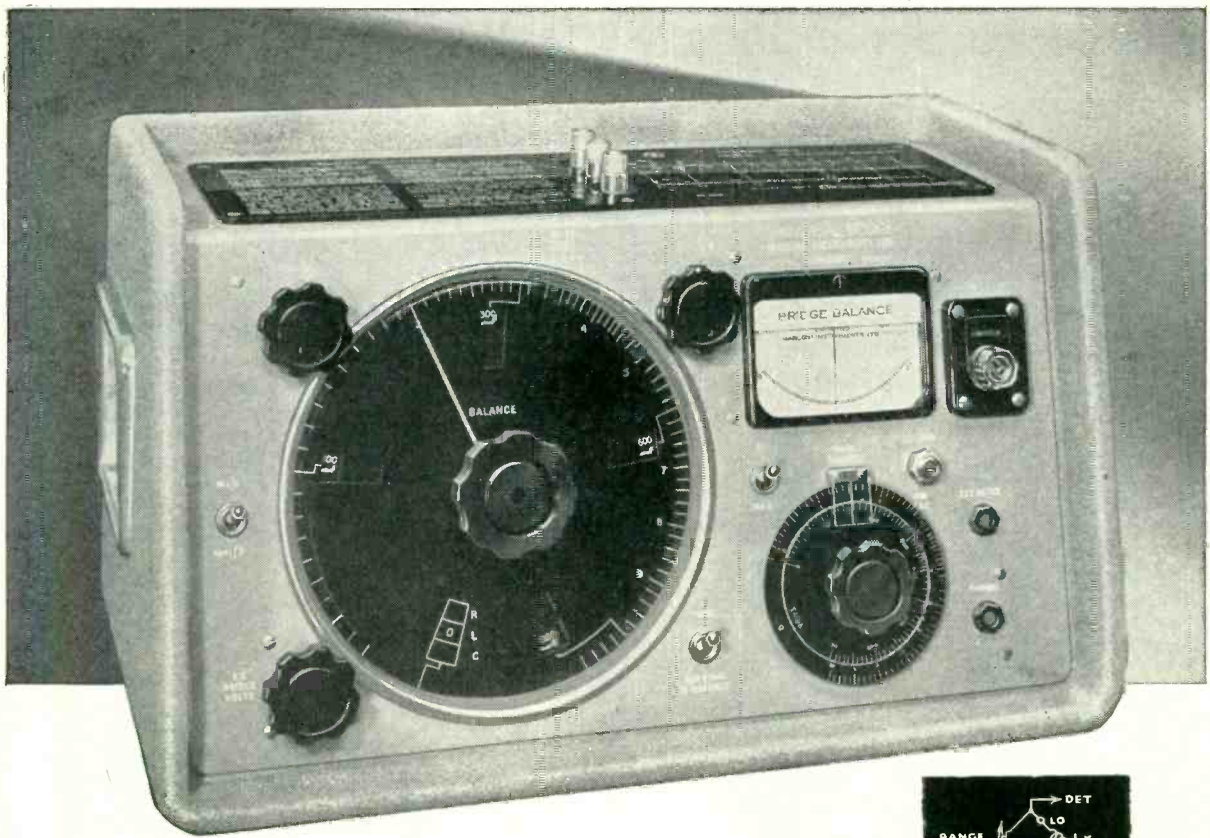
RCA MULTIPLIER PHOTOTUBES—RCA-6342, 5819 and 6199 multiplier phototubes are "head-on" types for use in applications involving low-level, large area light sources. Coupled with suitable phosphors, these tubes are especially useful in scintillation counters for detecting and measuring nuclear particle radiation. Spectral response of these types covers the range from 3000 to 6200 angstroms with maximum response at about 4000 angstroms. Types 6199 and 5819 have luminous sensitivity values of 24 and 25 amperes per lumen respectively when operated with a supply voltage of 1000 volts. Type 6342 has a luminous sensitivity value of 7.5 amperes per lumen with a supply voltage of 1250 volts, or 35 amperes per lumen with 1500 volts.



RCA-4X150-A—a very small and compact forced-air-cooled beam power tube for use in power amplifier or oscillator service at frequencies up to 500 megacycles and also as a wideband amplifier in video applications. The 4X150-A has a maximum plate dissipation of 150 watts. Terminal arrangements of this power tube facilitate its use with tank circuits of the coaxial type. Additional features: unipotential cathode . . . integral radiator . . . coaxial-electrode structure. Max. length: 2.468", max. diameter: 1.645".

RCA WP-25A TV ISOTAP—designed for use as either an adjustable isolation transformer or as an adjustable autotransformer to facilitate testing and trouble-shooting of series string circuits in radio and TV receivers, and other electronic equipment. Seven-position selector switch permits adjustment of primary voltage in 5-volt steps for operation from any supply line voltage from 105 to 130 v. Output voltages of approximately 105, 115, and 130 v are provided throughout the supply-line voltage range.

RADIO CORPORATION of AMERICA
TUBE DIVISION HARRISON, N. J.

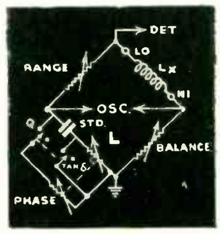


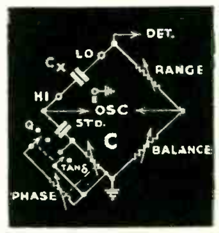
ACCURATELY MEASURED

L - AT 1 OR 10 kc

C - AT 1 OR 10 kc

R - AT D.C.





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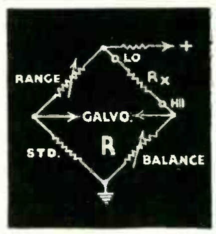

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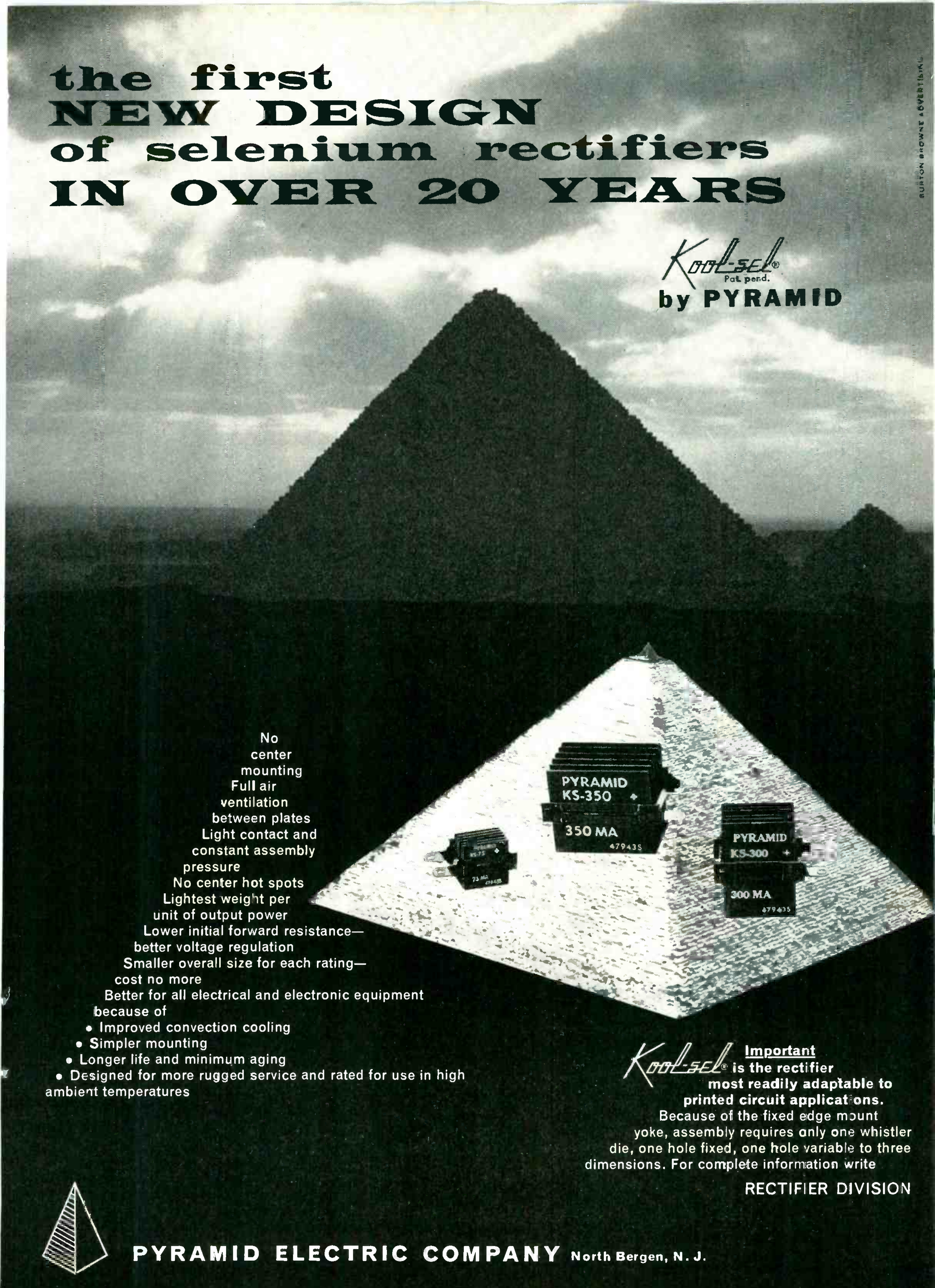
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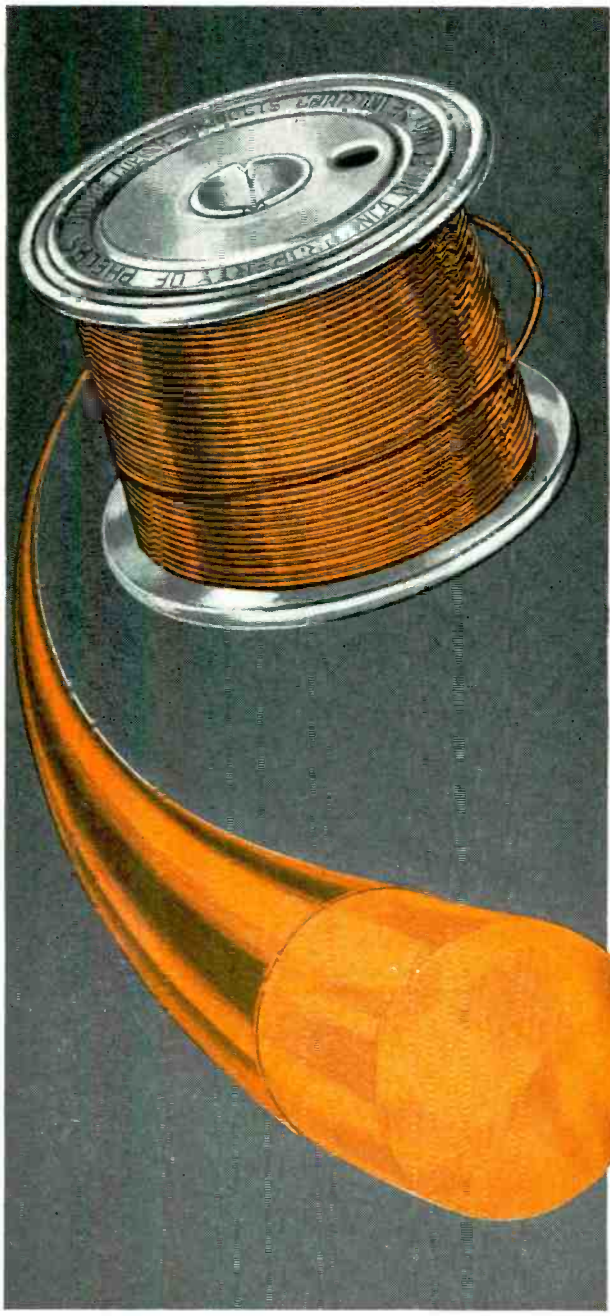

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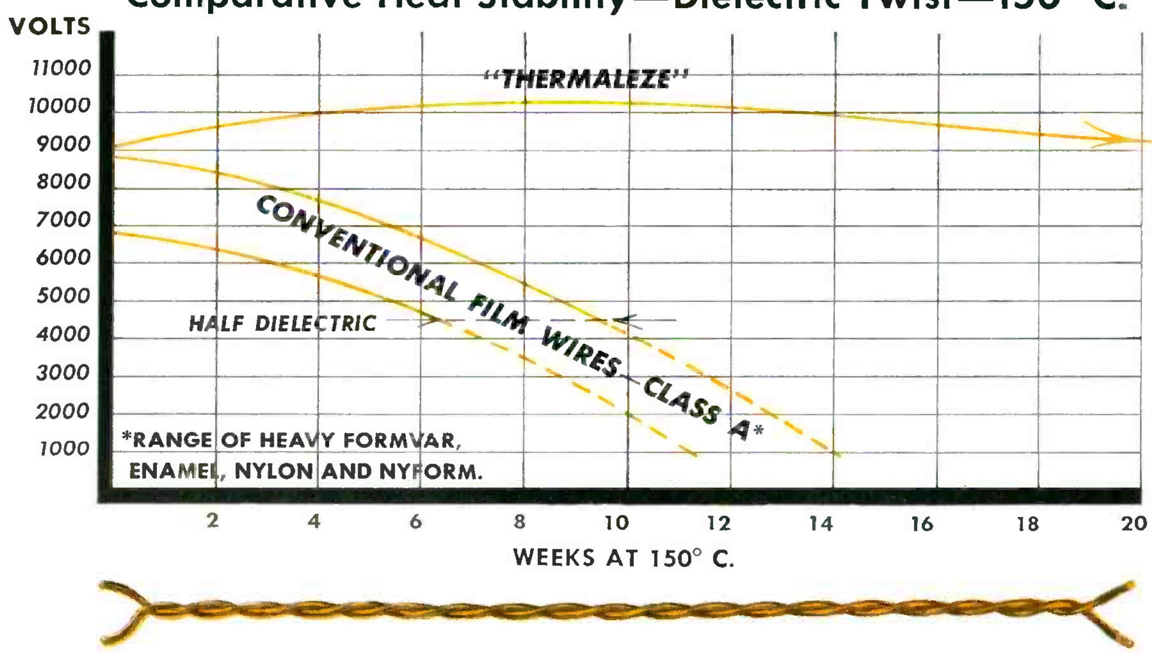

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CROSS TALK

▶ LONG-RANGE PLANNING . . . Making the rounds in the middle west last month, we were impressed by the number of companies working on design, production and sales programs covering the next five to ten years.

This seems smart, since long-range economic forecasts are optimistic and any downward fluctuations in business are likely to be momentary. They should be readily bridged over. Management that failed to provide the bridges, by adopting a short-term policy, could easily lose out to competition.

▶ DYNAMIC TESTING . . . Reliability requirements of giant computers, guided missiles and modern radar have outgrown conventional testing techniques.

The functional or "can-you-see-the-grass" approach went by the boards some years ago. Then marginal testing had its day; this involved boosting voltages until the weakest components popped.

Today emphasis is on dynamic testing. Complex instruments feed new equipment off-beat waveforms simulating the worst possible environment. The test unit evaluates performance and lights up green for good and red for no good. Some testers go on and pinpoint trouble in detail.

▶ TRAINER TROUBLE . . . Speaking of complex instruments, just the other day we saw a very efficient device designed to train radar operators. It uses ultrasonic principles and is equipped with several fancy devices that keep water in a large tray pure; just a little bit of algae shows up as a forest of trees.

▶ MANPOWER PROMISE . . . One of our McGraw-Hill associates who attended a recent Science Fair (some 60 of these are conducted throughout the country each year) reports that high school students in attendance indicated the following career interests:

Electrical, radio and electronics engineering	115
Aeronautical and rocket engineering	97
Physics and atomic energy	94
Medicine	81
Mathematics	75
Biology	67
Mechanical engineering	61
Chemical engineering	51
Dentistry	38
Science teaching	38
Registered professional nursing	35
Civil and sanitary engineering	30
Geology, meteorology, oceanography	30
Pharmacy	15
Metallurgy	12
Engineering and lab assistants	12
Industrial and safety engineereing	12
Mining engineering	4

These are the youngsters (average age 15) upon whom much of the promise of tomorrow rides.

▶ BOOTSTRAP OPERATION . . . High-frequency heating is coming into widespread use as part of the process for growing semiconductor crystals. Thus electronic apparatus is being used to make more electronic apparatus and, particularly, to do it in such a way that larger yields and increased reliability are obtained.

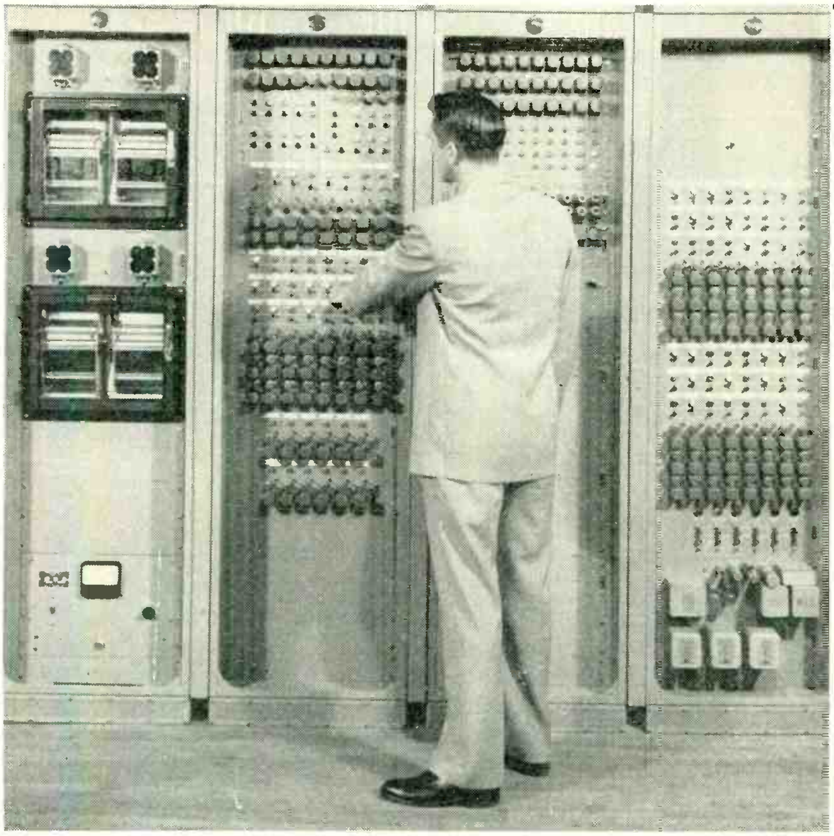
Speaking of semiconductors, one of the major applications now becoming apparent is the control of adjustable-speed drives using d-c motors. This work is well along, one of the few remaining bugs being the inclusion of adequate overload protection.

▶ INGENUITY . . . The tendency to automatically specify special components that may be unnecessarily costly is nowhere more common than in connection with government projects. Just the other day we heard about a designer who successfully leaned the other way; he found that heavy-gage paint cans made excellent shielded containers for electronic equipment that may eventually show up in some far off place such as the South Pacific.

▶ HOT TELEMETER . . . As more and more broadcast transmitters are equipped for unattended operation by remote control it might be a good idea to include in the stl one additional channel monitoring ambient temperature inside the building.

A California transmitter inexplicably went off the air without warning not so long ago, inexplicably, that is, until the studio learned that the distant building in which all the gear was housed had burned to the ground.

Launching Control



View of main control racks illustrates complexity of equipment. Engineer is checking function relays

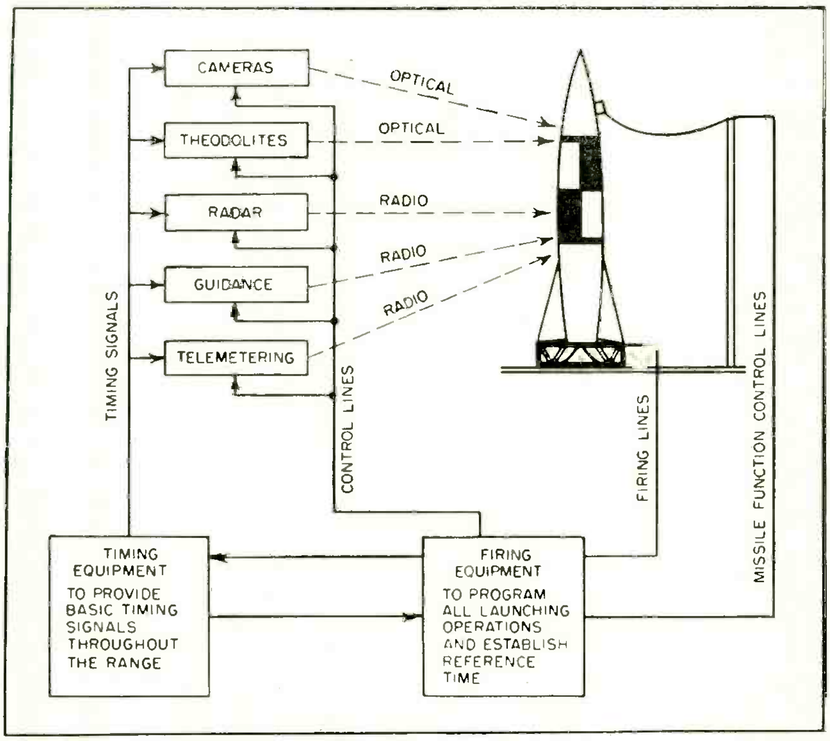


FIG. 1—Relationship of guided-missile firing system to other range instrumentation

By J. B. SCHROCK

Electronic Engineering Co. of Calif.
Los Angeles, California

WELL-PLANNED and completely instrumented missile test facilities provide a central timing system to supply accurate and well-integrated timing and control signals to many pieces of data-gathering equipment, such as phototheodolites, high and low-speed cameras of various types and radar units whose outputs are fed to plotting boards and/or data reduction computers. These recordings are tied together by a correlated set of signals from the basic timing system.

Data recording is highly important in a missile research program whether that research is directed toward the development of a tactical weapon or toward upper atmosphere investigation.

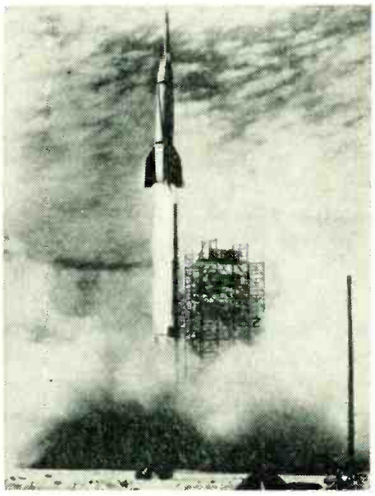
The entire data-gathering operation centers around the launching and flight of the missile, for which it is desirable to start necessary timing signals in close coincidence with the actual launching.

As can be seen in Fig. 1, the firing system is the only link between the base timing system and the missile during the time immediately prior to launching.

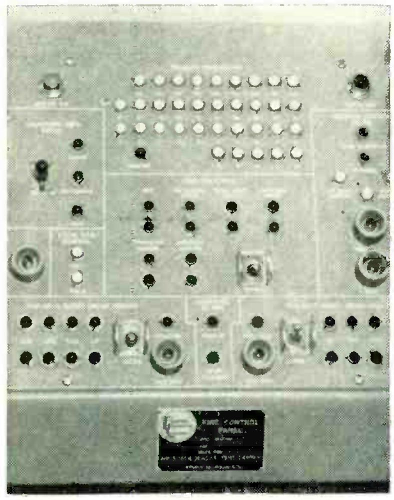
Small rockets such as those used with the bazooka or recoilless antitank rifle, require a firing circuit consisting of only a switch and battery to ignite the propellant and effect a launching. However, in the case of a more elaborate research type of rocket or missile many functions must be performed at predetermined times and with proper time relation to each other, often in the last few seconds before launching. Examples of these functions are: uncage the gyros; ignite flares or auxiliary rockets within the missile; start pressurizing pumps; control various fuel valves; switch in internal power supplies;

for Guided Missiles

Master timing circuits program the firing of guided missiles, actuate guidance and telemetering equipment and alert rocket-range control units. Fail-safe and interlocking provisions guard against premature detonation of propellants



Matador pilotless bomber (left) is typical of missiles fired by automatic launching systems. System can handle needs of two-stage rockets (right)



Essential controls and indicators are grouped on fire control panels

alert or actuate tracking and guidance devices; start instrumentation and recording devices; separate umbilical connectors; operate or alert telemetering equipment.

Manual performance of these functions can lead to confusion and inaccuracy and it is, therefore, desirable to perform as many of them by an automatic programming system as possible. During launching a fraction of a second delay in actuating one valve with respect to another may mean the difference of several thousand feet in altitude attained or several miles in distance traveled by the test vehicle. This is due to the fact that fuel or propellant loads are inefficiently used while the missile is sitting on the pad awaiting the opening of, for example, the main stage valves.

General Description

Normal laboratory procedures require that similar tests be repeated as consistently as possible with only the desired functions being changed and these in a well-controlled manner. The firing system provides a sufficiently versatile and well-controlled programming facility to meet these and other requirements.

The firing system consists of the main control racks and a fire control panel located in each of the blockhouses in the launching area.

The programming section of the main control racks provides fully automatic control of any combination of up to 92 separate functions. These functions may be performed at any ½-second increment during the 180 seconds before and 30 seconds following time T minus 0 or reference time.

The main control racks house also a timing signal separation and synchronizing circuit, automatic summing relays for delaying the program (hold fire) and a group of indicators showing the status of the various sections of the system at all times during an operation. Also included are the events recorders and the d-c power supplies necessary for the various panels. A separate 18-trace recording oscillograph is provided to record higher-frequency signals than those handled by the events recorders. A record of up to 80 slow events and a maximum of 18 high-speed events may be obtained for any given launching. This does not include telemetering recordings.

The fire control panel shown in a photograph provides the launching supervisor with full control over the programming section in the main control racks as well as a complete visual indication of the status of all factors pertinent to the launching control system. Appearing on the panel are such controls as sequence start, hold fire, permit reset, safety circuit breaker open and reset or close controls and launching-area-clear indicator. Since the sequence-start control initiates the series of events leading ultimately to the firing of the rocket, it becomes the pushbutton of the system.

Automatic Sequence Panel

The automatic sequence panel of the programming section sets up a series of unique combinations of pulses to provide actuating voltages

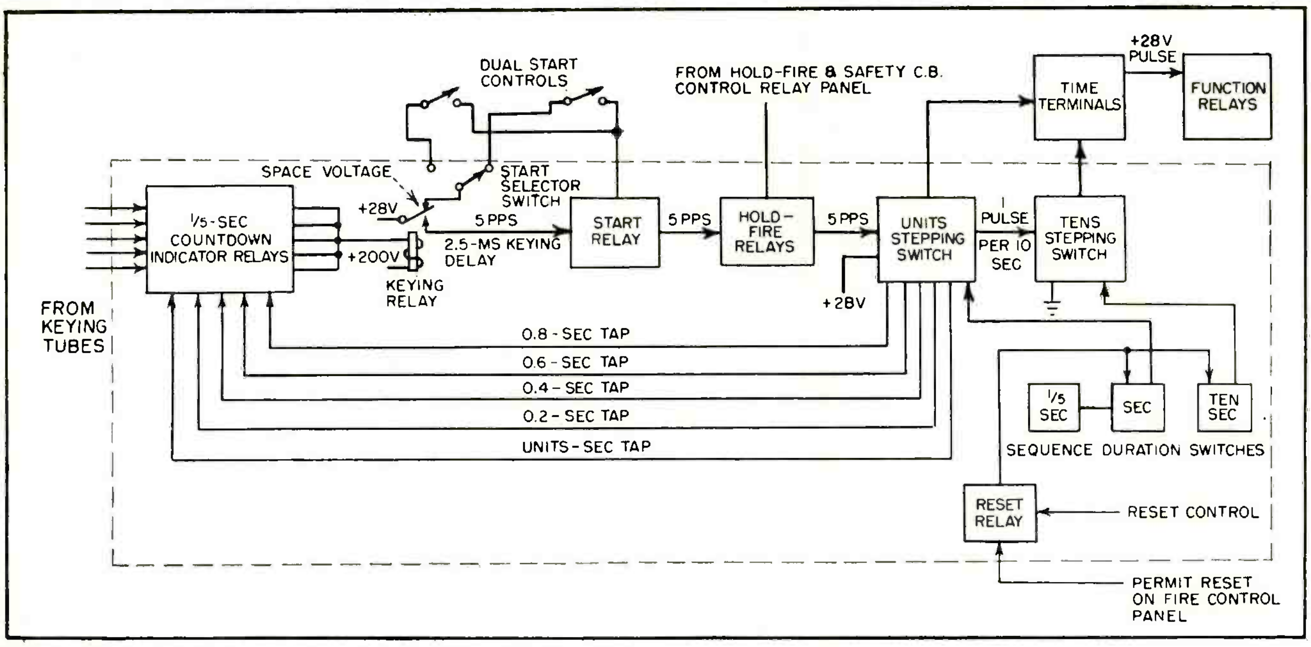


FIG. 2—Functional block diagram of automatic sequence panel

to the function relays at any desired time throughout the sequence. It consists of a high-speed keying relay and a pair of stepping-type rotary switches. Also located on this panel are switches to set the sequence duration, synchronizing relays and the sequence-start and hold-fire relays. Figure 2 is a functional block diagram of the automatic sequence panel.

The keying relay receives its actuating current through any one of five keying tubes. This relay has single-pole double-throw contacts and voltage pulses from both normally-open and normally-closed contacts are utilized.

The circuit uses two types of stepping switches: a 50-point four-level unit and a 25-point three-level unit. The 50-point or units switch is operated through a 10-second interval at a rate of 5 steps per second. At the end of each of these 10-second intervals a pulse is applied to the coil of the 25-point or tens switch. Thus, the units switch programs consecutive 10-second intervals throughout the sequence of an operation while the tens switch programs the 21 10-second increments of time from T minus 180 to plus 30 seconds at the rate of one step every 10 seconds. Figure 3 is a simplified schematic of the stepping switch circuit.

Twenty-eight-volt positive pulses from the keying relay are applied to the units stepping switch actuating coil through contacts on the sequence-start and hold-fire relays. These positive keyed pulses are also fed to the wiper arm of the functions level of this units switch, then through the time terminals to the positive input of the function relay circuits. The wiper arm of the functions level on the tens switch is connected to ground. The contacts of this level, therefore, provide a ground return for the function relays when connected to the respective tens time terminals.

Thus, with the units switch repeatedly programming a 10-second interval of time and the tens switch providing a different ground return for every 10-second block of time, a separate and distinct coincidence of positive voltage and negative return pulse combinations is set up for every $\frac{1}{5}$ second of time throughout the sequence.

Other levels on the stepping switch are used for visual countdown indication, synchronization to the range timing system and sequence duration reset.

Since these stepping switches are electrically cocked and spring driven when the pulse is removed, the function contacts are never used to interrupt current flow. This is conducive to extremely long life and high reliability in these critical circuits. The switches are hermetically sealed and suspended in oil. This type of construction solves the lubrication problem and enhances reliability and life expectancy.

Three rotary selector switches provide for homing or resetting the automatic programming system to any point up to reference or firing time.

The sequence-start and master hold-fire relays are closed when the start button is pushed. This completes the circuit from the keying relay and applies pulses to the actuating coil of the stepping switch. If the start button is operated during the last half of a keyed pulse, any function relays to be operated by that particular pulse will fail to be picked up. This malfunction is prevented by using the space voltage from the back contact of the keying relay. Likewise, a hold fire cannot be effected except during the interval or space be-

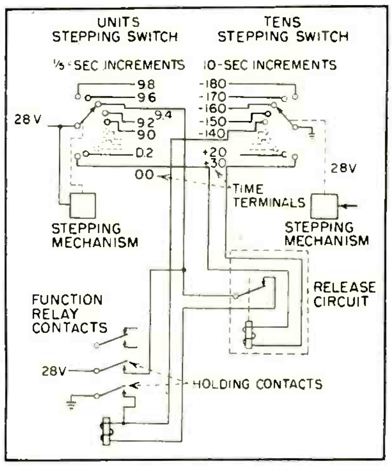


FIG. 3—Simplified schematic of stepping circuit

tween pulses. This prevents a function relay from receiving only the small first part of the pulse.

Function Relays

There are 92 relay groups, designated as function relays, which may be actuated at any time throughout the automatic program and released at any subsequent time. Actuation may apply or remove any voltage in a function circuit or merely close or open a set of contacts as desired.

Assignments of the function relays are: 48 for missile functions; 24 for operational functions, including camera starts, prereference signal, reference time, conditional hold-fire sampling, positive time indication and hold-fire lock; 8 for automatic hold-fire sampling; 6 for firing functions; 6 for safety functions (used to arm the firing-function relays).

Each relay group includes a master function relay which receives the locking pulse, a release relay which operates from the unlocking pulse, a test-operate switch, indicator and suppressor lamps and a group of blocking rectifiers. Electrical arrangement of these components is shown in Fig. 4.

Since the relay circuits are of the electrically holding type, a means of preventing the holding voltages from feeding back into the stepping-switch circuits of the automatic sequence panel is required. Also, since the two sides of the relay coils are operating in a coincidence arrangement and may be in combination with many other

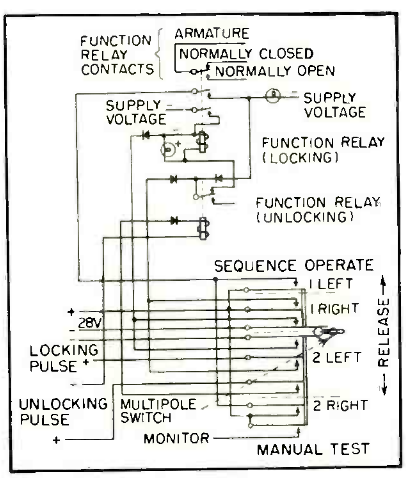


FIG. 4—Typical circuit of a function relay

coils, it is necessary to prevent sneak circuits from actuating the relays at a time other than that intended. It is for these reasons that the selenium blocking rectifiers are used as shown in Fig. 4.

The multipole switch in its lower position allows manual testing of the function circuit. In its center position the switch releases the relay or prevents its operation if desired while the upper position connects the relay group to the automatic sequence panel for automatic operation at the intended time.

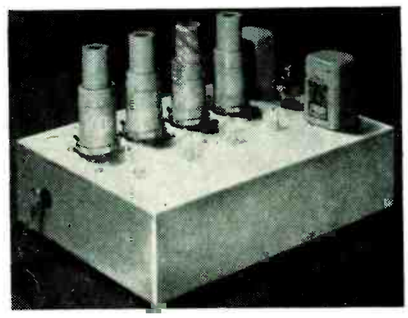
The function relay coils are connected to the automatic sequence panel through the time terminals by jumpers which can be left in place for repeated identical launching programs or may be changed from one launching to another.

This allows a firing sequence to be carefully and accurately controlled for each operation. Such close control cannot be realized when the missile firing operations are controlled manually because of the inconsistancies and errors of human reactions.

Certain functions remain reasonably fixed for all launching operations. These functions have to do with the internal operation of the system or with base instrumentation. Twenty-four of these operational functions are provided for and grouped on a panel. Their electrical operation is identical to the missile function relays.

In some missiles it is necessary to stop or hold certain functions if other prior functions have not yet occurred. In this case, arrangement is made to provide signals from the missile for each critical function or group. Sensing relays located on the automatic hold-fire relay panel read these signals and associated relays sample the circuits of each critical function immediately prior to the operation time for the next critical function. If the signal is present, the system will proceed without hesitation. If the signal is absent, the system will stop immediately and hold until the situation is correct to proceed. Provision is made for eight such samplings to be made throughout a given program.

The launching control system provides six high-current firing-line circuits. These are energized simultaneously or at different times through 50-ampere contactors. The contactors are actuated by the firing function relays located in the main control racks. For safety, the contacts of the firing function relays are not energized until shortly before their operate times. Application of voltage to their contacts is done by the safety function or arming relays. Safety precautions also include eliminating test switches from the firing and safety function relay circuits.



Time base generator for laboratory checkout uses plug-in circuits

It is desirable to program the launching of a missile so that T minus zero or reference time is in coincidence with the one-pulse-per-second signals of the range timing system. Since the firing system operates with a finer resolution than the 1-pps signals and since it is difficult for the launching supervisor to press the start button on any desired $\frac{1}{5}$-second pulse, a means for automatically synchronizing the firing system to the range timing signals is provided by the time pulse separator in conjunction with circuits within the automatic sequence panel in a manner which makes out-of-sync operation of the system practically impossible. Figure 5 shows the basic stepping-switch synchronizing methods.

The 5-pps timing signal is fed simultaneously to a string of bistable multivibrators arranged as a five-stage linear counter, as in Fig. 3. This counter operates in the normal fashion except that the last stage is not fed back to reset the first stage and it is therefore not self sustaining. To make it operate continuously, the first stage is reset by the 1-pps time signal. In this manner, the linear counter operates in synchronization with the 1 and 5-pps time signals. If the counter should miss a pulse it is resynchronized every second throughout the automatic countdown.

Outputs of the individual stages of the linear counter are fed to monostable one-shot multivibrators. The time constants of these one-shots are adjusted to give output pulses having a width of 40 milliseconds. The output of flip-flop 5 and, hence, the output of one-shot 5 will always occur in coincidence with the 1-second time pulse. This 1-second pulse is delayed slightly and used to reset flip-flop 1, so that the $\frac{1}{5}$-second pulse immediately following each 1-second signal will give an output from one-shot 1. The next $\frac{1}{5}$-second pulse will give an output from one-shot 2 and so on through the cycle until the fifth $\frac{1}{5}$-second pulse will give an output from one-shot 5 in exact coincidence with the next 1-second signal. Thus the circuit arrangement provides a means of separating and identifying the 5-pps signals by causing one of the flip-flop one-shot combinations to handle only the 0.8-second pulses, the next combination to handle the 0.6-second pulses and so on.

The output signals from the one-shots are fed to the grids of five keying tubes. Plate voltage for these tubes is fed through the keying relay coil and contacts of five $\frac{1}{5}$-second indicator relays. Only the relay corresponding to the position of the stepping switch will be closed and plate voltage applied to its associated keying tube. If the time signal received corresponds also to this position, plate current will flow and cause the keying relay to pulse the stepping switch coil. The switch will step to the next position and close the next succeeding relay. This prepares the associated keying tube to accept the next time signal. If the signal being received does not correspond to the stepping switch position, the latter will not operate but will wait until the counter has reached that position.

Hold-Fire

Prior to the start of a given programmed sequence or during a period of hold fire, the linear counter continues to operate in synchronism with the timing center. During the hold-fire period, however, the stepping-switch indicator-relay combination performs as a memory register to insure that the automatic sequence will be reinstated on the proper $\frac{1}{5}$-second step and in exact sync with the counter.

Since the function relays operate in approximately 17 milliseconds, the 40-millisecond pulse width was chosen to give an operating margin of slightly better than two to one.

The time pulse separator utilizes packaged circuit units for counting, shaping and controlling the width of the timing pulses. Use of these plug-in units allows a neat component arrangement and cuts maintenance or replacement time to a minimum.

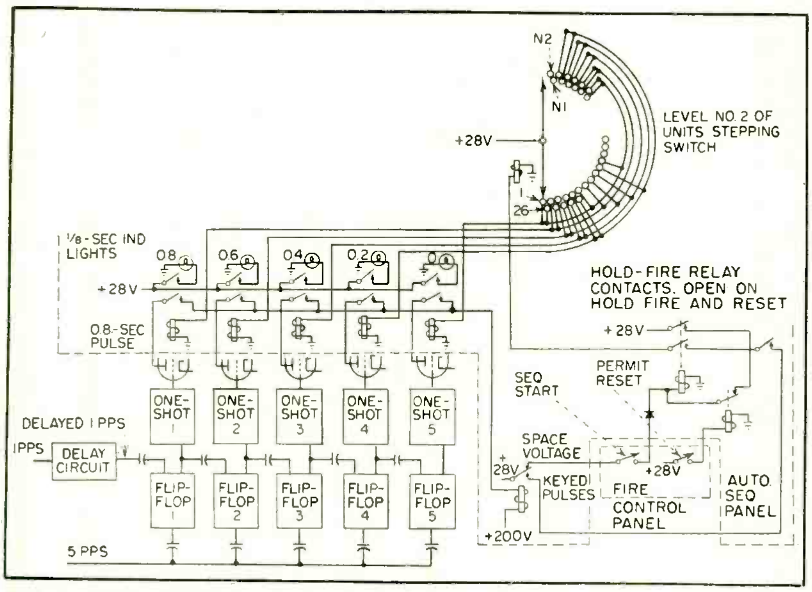


FIG. 5—Basic schematic of stepping-switch synchronizing circuits

The firing system utilizes a group of lamps to indicate the exact status of the countdown sequence throughout the automatic phase. They indicate the exact time remaining until reference time. Main control panels within the blockhouse indicate status to the nearest $\frac{1}{5}$-second increment while remote indicator panels indicate to the nearest second. One person reads the various combinations of lights and gives a voice count over the public address and communications systems.

Some confusion existed when the announcer, counting in one-second increments, would see the zero light come on and say, "Zero", only to have the count progress on through −0.8, −0.6, −0.4, −0.2, and finally to true zero or reference time. Attempts to modify the visual countdown indicators to eliminate this difficulty introduced the problem of obtaining correct transfer of the tens lights.

An effective system was devised that uses two separate ground return busses for the remote tens indicators which are switched to insert a delay during the transfer from 40 to 39, 30 to 29, 20 to 19 etc.

Visual countdown indicators are located throughout the site.

Safety Features

The launching operations of some modern guided missiles involve the use of many tons of highly volatile fuel and/or thousands of pounds of high explosives. It is therefore necessary to take many precautions for the safe control and firing of these vehicles.

The firing equipment is located in a concrete and steel blockhouse located a short distance from the launching pad. Those persons directly responsible for the launching operation are stationed here and view the missile through ports fitted with eight to ten-inch-thick explosion-proof glass. Elsewhere on the range, flight safety officers and test control officers receive information as to whether conditions throughout the range are satisfactory for the safe launching of the missile.

All responsible personnel are provided with controls which will either allow them to stop the prog-

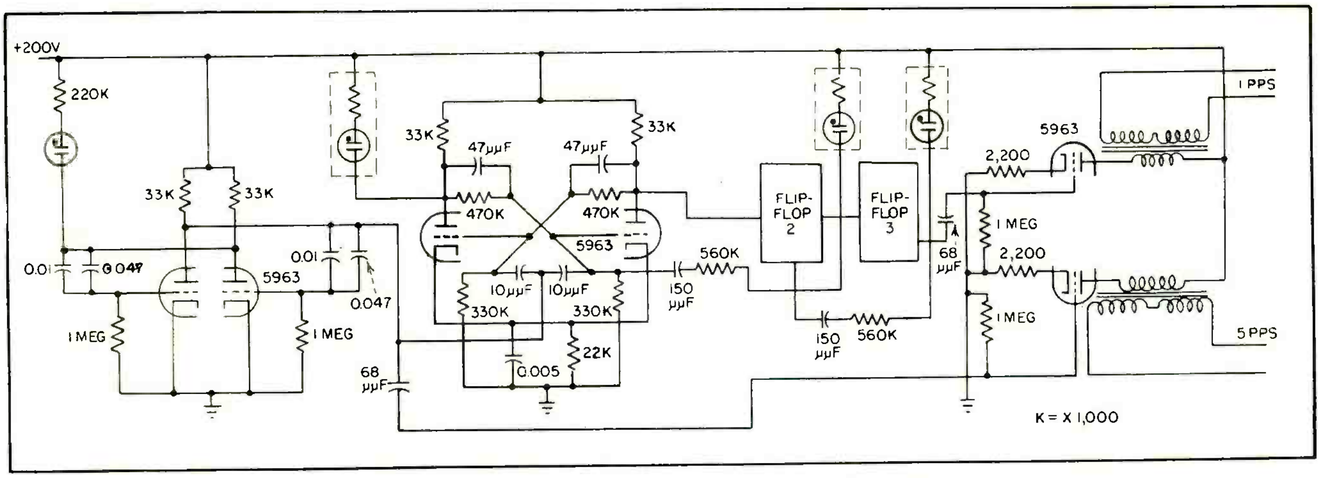


FIG. 6—Schematic of time base generator for laboratory checkout of main control rack circuits

ress of the automatic countdown (hold fire) or prevent launching by opening the safety circuit breakers in the firing lines. Some officers are provided with both sets of controls. When an unsafe condition occurs, any one of these persons has merely to flip a switch and the firing will not take place until the unsafe condition is cleared.

Fail-safe circuits are used in all critical control lines. A control voltage must be present on these lines before automatic operation may proceed. Hold-fire circuits as well as those controlling the safety circuit breakers are arranged to go to a safe condition in event of a circuit or power failure. An individual voltage source for each of these control circuits is located in the same building as the control. Thus, if a control-line pair either opens or shorts, a hold-fire occurs.

The firing circuits are electrically open at points called arming stations. These stations are provided with locked doors and are armed with uniquely keyed plugs. The person making final connections to the electrical firing circuits carries the keys and plugs for the particular lines he is using. Since no other plugs will fit the arming stations on those lines, he is spared the embarrassment of having the missile take off as he connects the last wire.

Booster or RATO bottles and flares are fired by a device called a squib. This is similar to an electrical dynamite cap. A squib checker is provided to measure the electrical continuity of these squibs. This instrument will indicate a readable difference between a good squib, whose resistance may be as low as one tenth ohm, a shorted squib or an open circuit. Current through the measured circuit is limited to a maximum of 3 ma even with a shorted squib or in the event any component should fail within the test set.

The squib checker also provides for measuring the firing lines to detect any d-c or a-c voltages present. The voltage indicator scale is not calibrated since the presence of any voltage denotes a dangerous condition and the firing lines should not be armed. On the most sensitive range, the presence of only a few millivolts can be detected.

Resistors are provided at various places across the firing lines to prevent buildup of static charges on these circuits. Their resistances must be low enough to leak off the charges yet high enough to prevent the flow of current induced from adjacent lines. They are of the composition carbon type, chosen over the wire-wound type because they usually become defective by changing value rather than by opening completely.

Testing

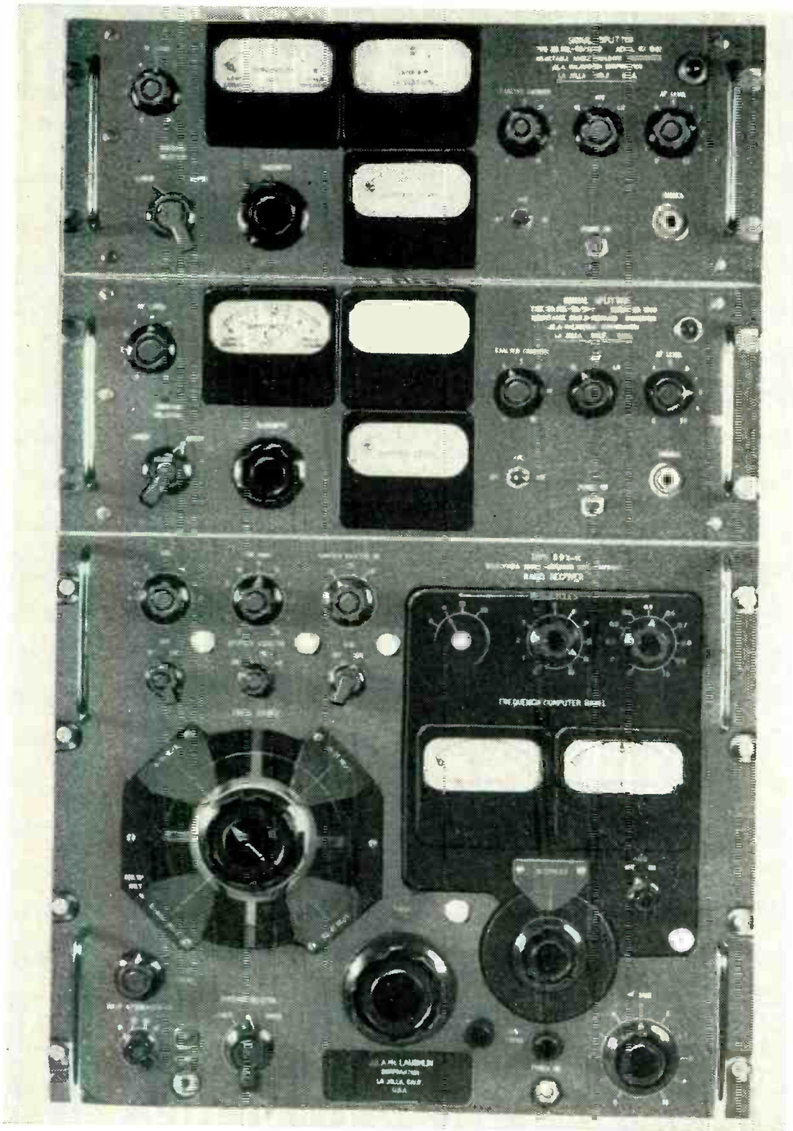
System check-out cannot be completed until the equipment is installed in the various locations throughout the launching site and all interconnections made. Panels can be thoroughly tested in the laboratory, however, either individually or in small groups. Largest units of equipment to undergo lab tests are the main control racks. This part of the system is made operable for such tests by installing jumpers and feeding in voltages to simulate control signals.

The system will not operate if the 1 and 5-pps signals from the central timing equipment are not fed into the time pulse separator. Since this equipment is not available for lab tests, a suitable substitute has been devised to furnish the necessary time signals.

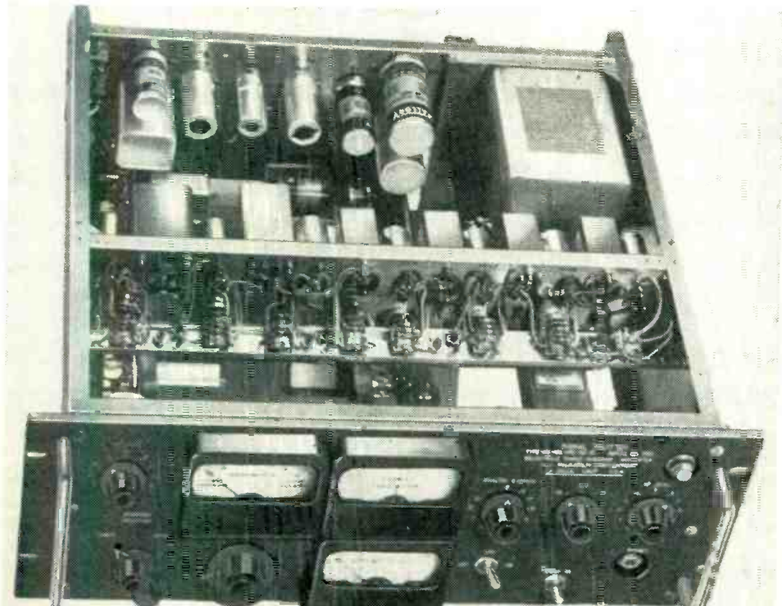
The test set, shown in a photograph, consists of a free-running 5-pps multivibrator and a series of flip-flops arranged as an $n/5$ frequency divider to give the 1-pps signal. High accuracy is not necessary for test purposes but close correlation between the two signals is imperative. By increasing the R-C time constant of the multivibrator, the stepping rate may be reduced for slow-motion tests. Since the 5-pps signal is divided digitally, the 1-pps signal stays in perfect synchronization with it and the system operates smoothly even at extremely low speeds. Figure 6 depicts schematically the operation of the time-base generator.

Special thanks are due to J. R. Wright, project engineer in the systems engineering group at Air Force Missile Test Center, for his help in obtaining data and illustrations used in this paper; to W. R. McQuiston of Electronic Engineering Company of California for helpful criticism and N. Sheegog for the schematic and photographic reproductions.

Equipment described herein was designed, fabricated and installed under USAF contract AF 08(606)-670.



Selectable single-sideband dual-diversity receiver with single-sideband converters (top) for electronic bandwidth control



Top view of signal splitter that embodies bandwidth selection

Dynamic

By J. L. A. McLAUGHLIN

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A SERIOUS LIMITATION to consistently reliable long-distance radio communications in the high-frequency band is the obvious discrepancy that exists, at various times of the day and seasons of the year, between the usable bits of the band as compared to the total allocated. This phenomenon is caused by the vagaries of propagation and behavior of the ionosphere.

In recent years, the heavy and ever-growing world-wide radio traffic in these limited portions of the band adds substantially to the difficulty of long-distance communications and has resulted in increased congestion and jamming interference.

Passband Requirements

The problem of signal-jamming under conditions of spectrum saturation is further complicated by frequency instability of the transmitters and the lack of adherence to world-wide agreement on frequency allocations. Ideal channel spacing to prevent interference at the receiver is determined by more complex considerations than simply that of information bandwidth. Communication links employing fixed-frequency receivers require greater channel spacing than systems using tunable receivers because the selectivity characteristic of the receiver must be broadened at the passband points to allow for the maximum frequency deviation of both transmitter and receiver.

Receiver Selectivity

Continuously variable bandpass filters provide an ideal attenuation characteristic to eliminate adjacent-channel interference or deliberate jamming in high-frequency radio receivers. Electronic control of bandwidth extends to diversity reception

Besides receiver passband requirements and frequency drift, channel spacing for minimum adjacent channel interference is also influenced by the selectivity shape-factor of the receiver. It has been shown[1] that for double-sideband transmissions of voice frequencies having sidebands ±2.5 kc received on fixed-frequency receivers, the required channel spacing is 20.5 kc when the receiver has a selectivity shape-factor of 3-to-1.

Shape Factor

By reducing the receiver selectivity shape-factor to 1.2-to-1 by the use of i-f filters having greater attenuation at the 60-db points, the channel spacing could be reduced to about 14 kc. However, a tunable receiver does not require a selectivity bandwidth in the passband in excess of the sidebands transmitted. Such a receiver with a 1.2-to-1 shape-factor would provide the same degree of protection from adjacent-channel interference as the fixed-frequency receiver when the channel spacing was reduced to but 8.5 kc for the same maximum channel deviation.

It has been assumed, in considering channel spacing and receiver selectivity, that the passband requirements of a receiver must equal the transmitted sidebands plus possible drift in the transmitter and receiver. However, this is not necessarily so since usable jam-free bandwidth in the high-frequency band is not predictable.

Agile Selectivity

It follows that for the maximum effective maintenance of communications, the receiver selectivity characteristics should be agile and capable of matching the actual passband possibility under any given jamming condition, rather than bandwidth of the transmitted sidebands. Otherwise frequency and intensity of the beatnotes produced by jamming may seriously mask the desired information over a large portion of the audio-frequency spectrum. The overall effect with a fixed passband is a much greater loss of intelligibility than would be the

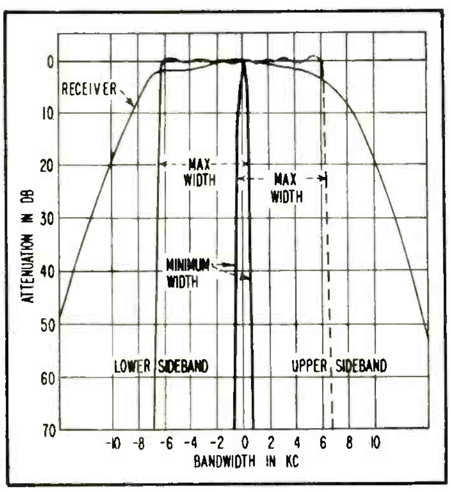

FIG. 1—Single-sideband selectivity versus selectivity of associated receiver

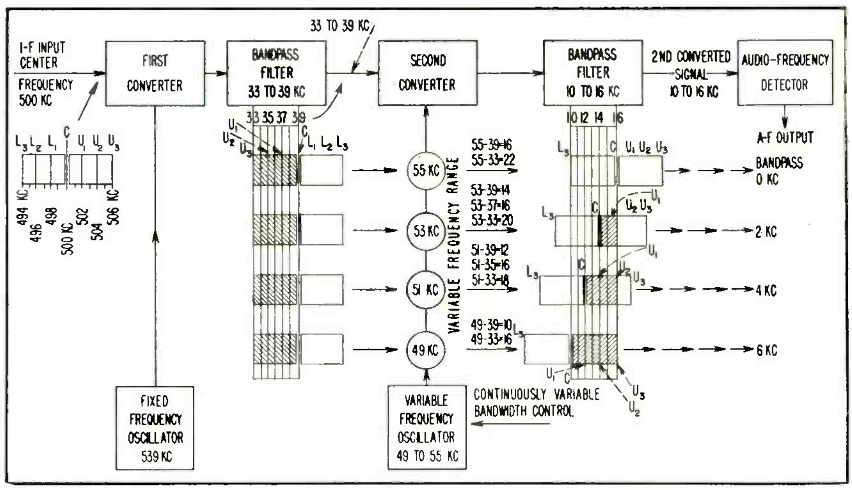

FIG. 2—Elements of electronic variable-bandwidth control system using two converters, crystal and variable frequency oscillators and filter

case in reducing the bandwidth sufficiently to remove the heterodyne beatnote.

In the reception of double-sideband (dsb) transmissions jamming can be eliminated effectively in many cases by reducing the total bandwidth without loss of transmitted information frequencies employing more sophisticated means than is the common concept of receiver selectivity.

By employing a selectable-single-sideband (sssb) demodulator, a jamming carrier in one of the sidebands of a dsb signal can be rejected without sacrifice of the theoretical information passband requirements.

When interference occurs in both sidebands, the jamming effects can

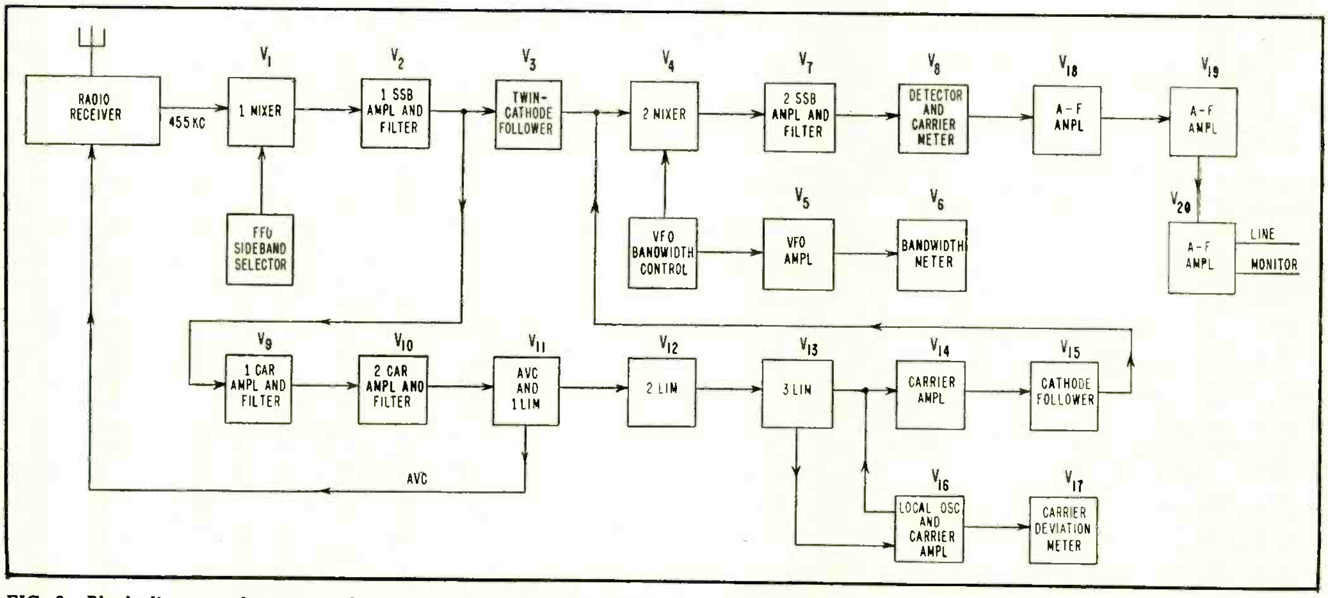

FIG. 3—Block diagram shows signal splitter for which schematic is given in Fig. 4

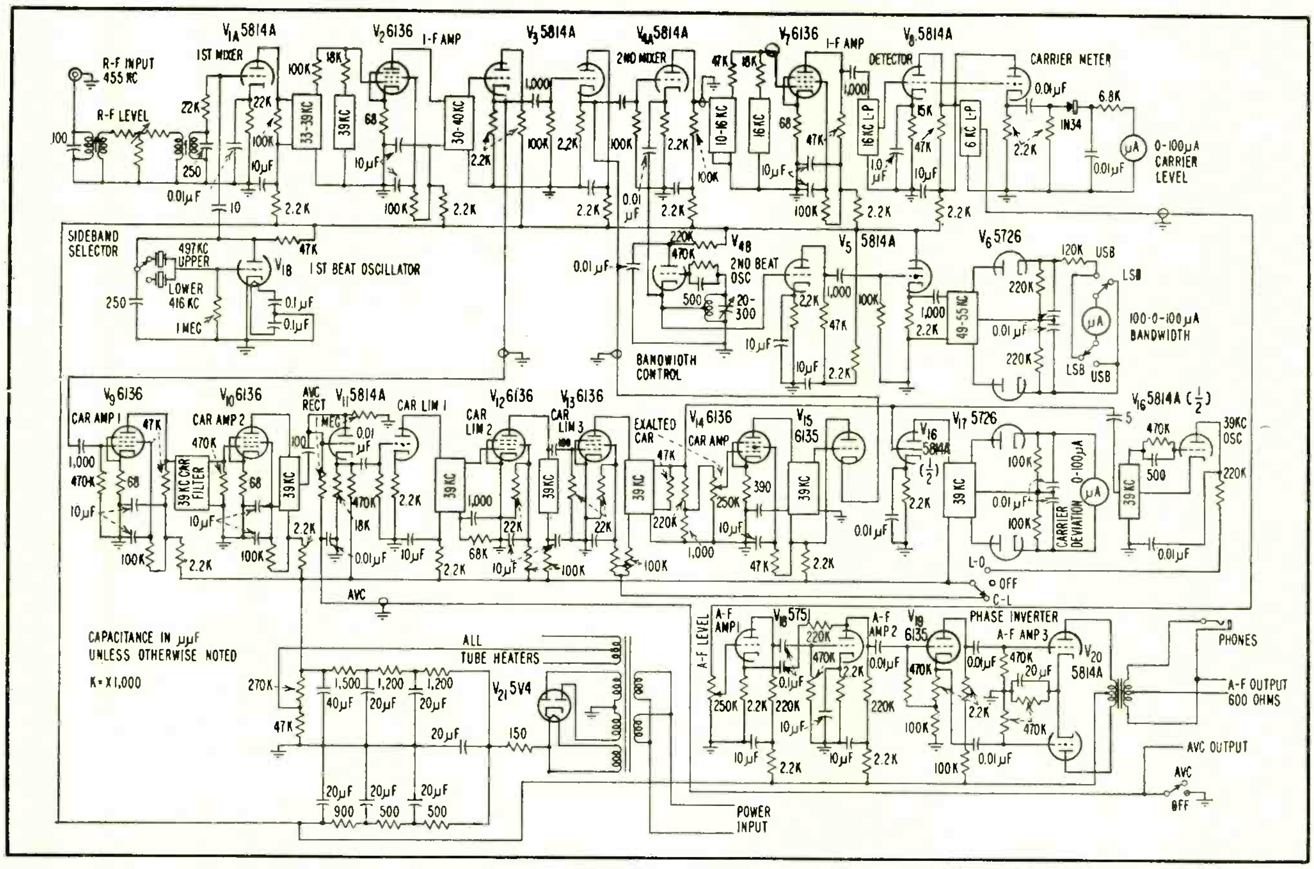

FIG. 4—Upper or lower sideband can be selected at will. Electronic bandwidth control operates by tuning oscillator V_{4B}

be eliminated by use of sssb demodulation for rejection of the jamming signal producing the greater loss of intelligibility and rejection of the jamming effects in the other sideband by precise control of its bandwidth. Precise bandwidth control of the receiver will also provide the greatest intelligibility-to-jamming ratio protection possible for the reception of ssb transmissions subject to jamming.

Bandwidth Control

A commercially available sssb converter (the McLaughlin MCL-50/50-B Signal-Splitter) has been designed to be used with modern communications radio receivers having high-order frequency stability for the reception of dsb, ssb, single-sideband suppressed-carrier or c-w transmissions. This equipment provides exalted-carrier reception for both normal and reduced-carrier transmissions of either ssb or dsb signals.

A stable local oscillator provides a carrier frequency for demodulation of suppressed-carrier or c-w transmissions. The bandwidth of either selected sideband is continuously variable from 6 kc down to approximately 400 cps as shown in Fig. 1. The attenuation outside the chosen bandwidth is 60 db at 500 cps from the 6-db points.

Variable bandwidth is accomplished by cascading fixed bandpass filters having ideal attenuation and passband characteristics, in an electronic dual-modulation bandwidth-product process. A block diagram of the basic system to accomplish this is shown in Fig. 2. In this system, the input signal from the i-f of the associated receiver is converted to a new frequency range by a crystal-controlled oscillator and mixer circuit. It is then applied to a bandpass filter having a passband equal to only one sideband of the signal. These operations are shown in Fig. 3 and 4. Either sideband can be selected by changing the crystal frequency of the fixed-frequency oscillator.

Double Filter

The single-sideband signals are then applied to a second frequency converter and bandpass filter having the same bandwidth as the first. This converter utilizes a variable-frequency oscillator to shift the undesired frequencies (such as jamming signals) passed by the first filter out of the passband of the second filter. This procedure provides continuously variable bandwidth with ideal frequency-shape factor without compromise of the highest intelligibility-to-interference ratio possible under jamming conditions.

However, owing to the unpredictable and fluctuating nature of signal interference in some high-frequency bands, undesired signals may be expected to drift or change instantaneously. This necessitates full attention of an operator who must continually switch sidebands and adjust bandwidth under difficult jamming conditions.

Such is true in international radio broadcasting where it is often required to employ relay stations to rebroadcast on lower frequencies to local audiences. In this field, the relay stations employ selectable-single-sideband receivers to reduce jamming effects on their program rebroadcasts.

Effective program protection from jamming requires that at no time should the program be disturbed by sideband switching clicks. Both sidebands must be monitored to insure that the sideband in use is really the one freest of interference. The problem becomes more difficult where dual or triple-diversity receivers are used, requiring that all receivers be switched separately.

Antijamming Receiver

An improved antijamming receiving method has been designed into the McLaughlin DDX-RID independent ssb receiver. In essence it consists of a precision frequency-controlled superheterodyne with independent ssb demodulators of the type described. One unit demodulates the upper sideband and the other the lower. The demodulated products from both are combined in a common load.

This method of reception greatly simplifies the work of the operator in controlling receiver jamming. By means of binaural headphones (one earpiece connected to the output of each sideband channel) the operator monitors each sideband and adjusts the bandwidth in either or both for minimum interference. Since no bandwidth switching is involved, optimum reception is accomplished smoothly and rapidly. Where diversity reception is employed, servo systems can be supplied to control bandwidth of all receivers remotely. The bandwidth of each sideband for all receivers on the same circuit can be meter-indicated remotely.

Servocontrol

Under some types of operation and where cost is warranted, antijamming bandwidth control can be accomplished automatically by servo-controlling the bandwidth-

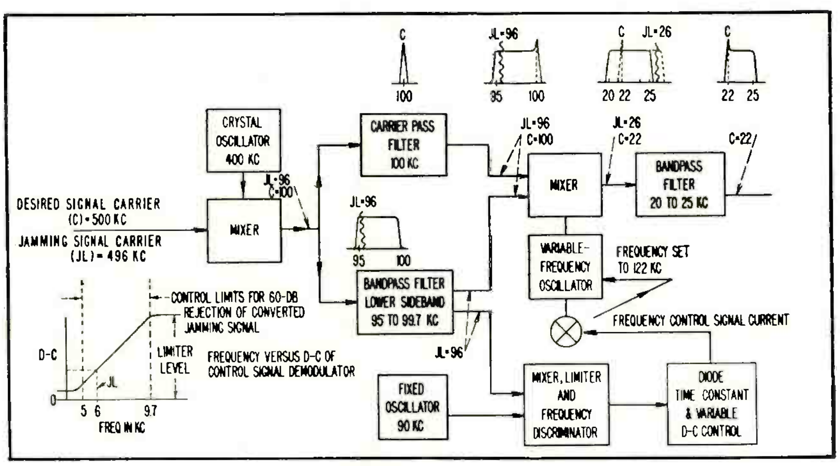

FIG. 5—Elements of automatic bandwidth control that rejects jamming

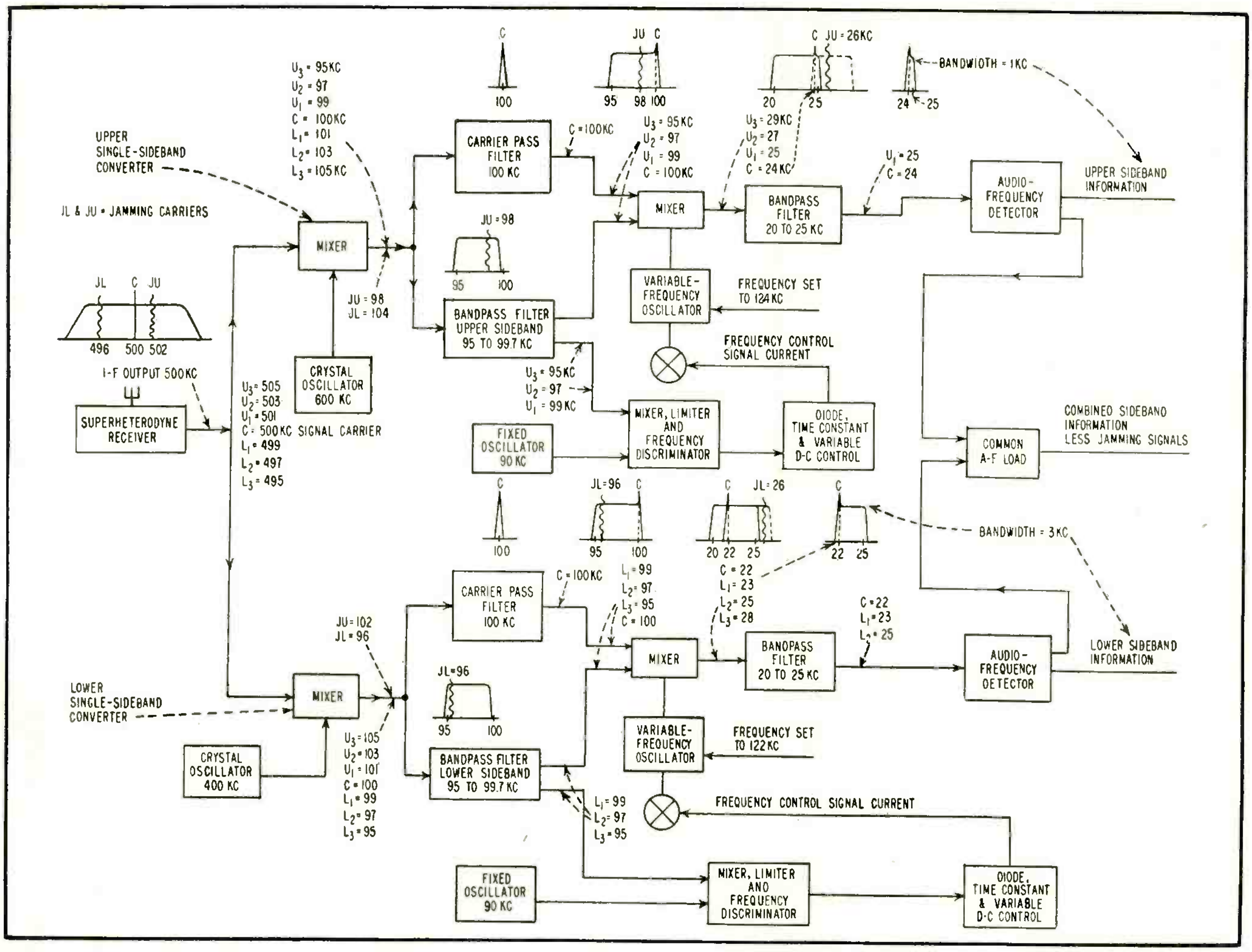

FIG. 6—Automatic bandwidth control rejects jamming carriers in a dual single-sideband receiving system

control oscillator with a signal proportional to the jamming frequency. A block diagram describing a simplified system is shown in Fig. 5 and a complete block diagram for automatic dual-bandwidth control of both sidebands is shown in Fig. 6. This system of ssb variable bandwidth is much the same as that of the DDX-RID receiver. However, it differs in that the signal carrier and the ssb are separated by filters in the first ssb conversion.

Removing Jammers

A jamming carrier in the passband of the first ssb filter is mixed with a local frequency source to produce a beating frequency that will fall in the range from 5,000 to 9,700 cps. This signal passes through a frequency-sensing circuit that provides a d-c signal proportional to the jamming frequency for servo-controlling the bandwidth control oscillator to the correct frequency (bandwidth) for 60-db attenuation of the interference.

When the jamming carrier moves to within a few hundred cycles of the signal's carrier, it falls out of the ssb filter and control circuit and full bandwidth is restored. The low-frequency beat notes are removed from the receiver demodulators by high-pass filters. Such a system assures freedom from beatnote interference.

The jamming monitoring circuit in both independently controlled sidebands automatically adjusts the bandwidth of each ssb demodulator to the exact width required for a 60-db rejection of the jamming carrier.

By combining the demodulated outputs in a common load, the maximum usable information can be extracted from the transmitted a-m signal.

The basic principle of continuously variable bandwidth control has already been proven practical for elimination of carrier jamming in high-frequency receivers. Extending this principle to include automatic features can provide protection from accidental and some forms of malicious jamming to unattended radio communications circuits.

In time of stress it can likewise eliminate an unpredictable human element and still maintain optimum communications in the face of severe jamming.

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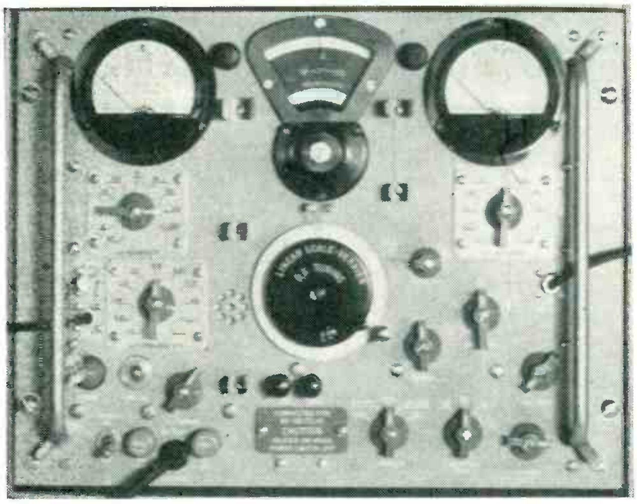

Front panel shows different functions of signal generator

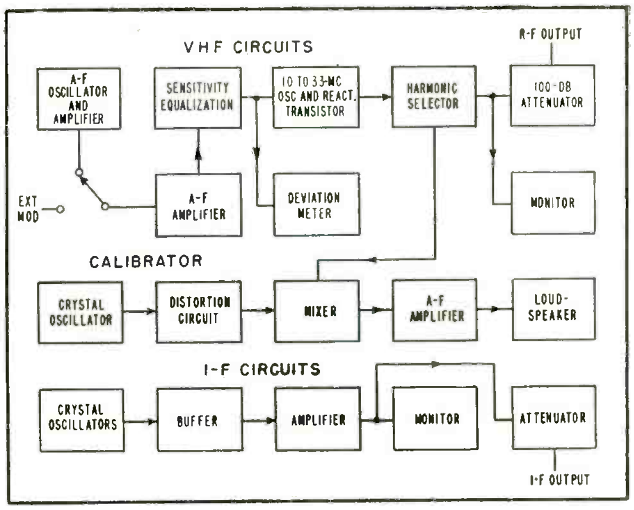

FIG. 1—Instrument has three main circuit sections

Transistorized F-M Signal Generator

Instrument has 10-millivolt output over range of 20 to 100 mc, plus crystal calibrator and nine preset crystal-controlled frequencies for checking i-f circuits. Designed for military applications, circuit has reactance-transistor frequency modulator

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APPLICATION of transistors to test equipment has resulted in a frequency-modulated signal generator covering the frequency range of 20 to 100 mc.

The unit has a maximum output of 10 millivolts across 10 ohms. Auxiliary circuits include a crystal calibrator, which provides calibration marks every even megacycle and nine crystal-controlled oscillators preset to cover 1.4 to 20 mc for checking receiver i-f circuits. The block diagram of the generator is shown in Fig. 1.

Most of the engineering difficulties were due to the inherent inability of transistors to operate efficiently at higher radio frequencies. Two known approaches[1,2] involved application of tetrode-type junction transistors or point-contact transistors adapted by their design features to operate at high frequencies.

Transistors

At the time the project was started only 2N33 point-contact transistors were available for high-frequency operation. Production difficulties connected with the very small spacing between emitter and collector points (of the order of 0.0005 in.) caused the mortality rate of these transistors to be very high initially, but reliability soon improved to a satisfactory degree.

Effects of ambient conditions on transistor performance were dealt with by partial temperature control and stabilization of power supply sources.

Although some point-contact transistors have been known to oscillate up to approximately 300 mc, it was not safe to count on this in production-equipment design. Also, r-f voltage level obtainable from vhf point-contact transistor oscillators varied greatly from sample to sample.

Precision signal generators usually have high insertion loss between their oscillatory circuits and stipulated output load. Efficiency of the power transfer from the tuned circuit is therefore of no consequence and output adjustment methods such as a piston-type attenuator can be used in conventional design. As a result of the extremely low power yield of transistor circuits at high frequencies and their susceptibility to frequency variation caused by load variation, power-transfer efficiency is critical in the case of a transistorized signal generator.

Circuits

The vhf part of the signal generator, shown in Fig. 2, is composed of an f-m oscillator operating at one-half or one-third of the output frequency and a harmonic-selector stage.

Early in the development an attempt was made to use point-contact transistors in an oscillator directly to 100 mc with the oscillator's tuned circuit coupled directly to the output attenuator. This proved feasible in a few selected samples, but had to be abandoned because of the great nonuniformity of behavior of individual transistors in the vicinity of 100 mc and the unfavorable effect of even a slight load variation on the frequency stability of the oscillator. The same type of transistor was found to operate satisfactorily as a harmonic selector and as a driving oscillator at frequencies up to 33.3 mc. The circuit of Fig. 2 was found to accommodate considerable variation of the oscillator output with various transistor samples under identical biasing conditions.

The inherent feedback in the transistor always causes a certain amount of coupling between output and input circuits, which tends to deteriorate the isolation between the oscillator and the output circuit. Since the momentary bias of the transistor is determined by the value of emitter current, less driving power is needed to drive a transistor doubler. This enables lighter coupling to the oscillator and consequent reduction of the undesirable coupling between stages. To realize this fact, it should be remembered that at higher radio frequencies in vacuum-tube frequency-multiplier circuits the r-f power loss in the driver stage occurs mainly in the physical resistance of the tuned circuit of the driver. This is due to the high value of r-f voltage across that circuit necessary to drive the grid circuit of the multiplier fully but with a small angle of plate current flow (high grid bias).

The internal feedback in the harmonic-selector stage reduces the load caused by the L-C circuit tuned to the desired harmonic, resulting in improvement of the harmonic output.

Output Circuit

The output circuit of the harmonic selector must operate efficiently from the point of view of power transfer. This requirement results from the necessity for a simple voltage monitoring circuit, required output of the generator being only 10 mv at 10-ohms output impedance. A voltage of 250 mv is assumed necessary for accurate and simple monitoring by a rectification circuit.

Because of its large insertion loss, the use of a piston-type attenuator, otherwise advantageous in vhf circuits, is excluded.

A resistance attenuator is used instead, varied in ten-db steps. The range of 10-db variation between the adjacent fixed steps is covered by adjusting the r-f output from the harmonic selector and monitoring its value on a panel meter.

Prior to the selection of the modulator circuit, an investigation was carried out to find whether nonlinear properties of barium-titanate capacitors could be conveniently utilized for frequency modulation purposes.[3] Such modulation was found feasible and relatively easy to realize in practice, but this approach was abandoned because the barium-titanate capacitor required too small an area of contact and too thin a dielectric for convenient construction in the frequency range required. In addition, strong impulse noise was observed at lower frequencies while modulation sensitivity and harmonic distortion were found to depend on the modulation frequency.

On the other hand, the design of a transistor-reactance modulator circuit met with complete success, with reservations usually applicable to transistors operating at high radio frequencies.

Equivalent Circuit

Basic operation of the circuit may be explained with the equivalent circuit of the transistor, shown in Fig. 3B. Solving the circuit equations, the equivalent admittance y of the reactance transistor is $y = j\omega C_1 (1 - \alpha)$. For real $\alpha = |\alpha_r|$ inductive impedance results if $|\alpha_r| > 1$ and capacitive if $|\alpha_r| < 1$. Remembering that at high frequencies α is in general complex, $\alpha = |\alpha_r| - j\,|\alpha_i|$ and

$$y = g + jb = \omega C_1[-|\alpha_i| + j(1 - |\alpha_r|)] \quad (1)$$

The imaginary component of α contributes to the negative equivalent conductance of the reactance circuit, while the real component of α contributes to the susceptance component b. If coupling capacitor C_1 in the emitter circuit is substituted by resistor R_1

$$y = g + jb - (1/R_1)[(1 - |\alpha_r| + j|\alpha_i|] \quad (2)$$

In this case α_i contributes to the susceptance component and $|\alpha_r|$ to

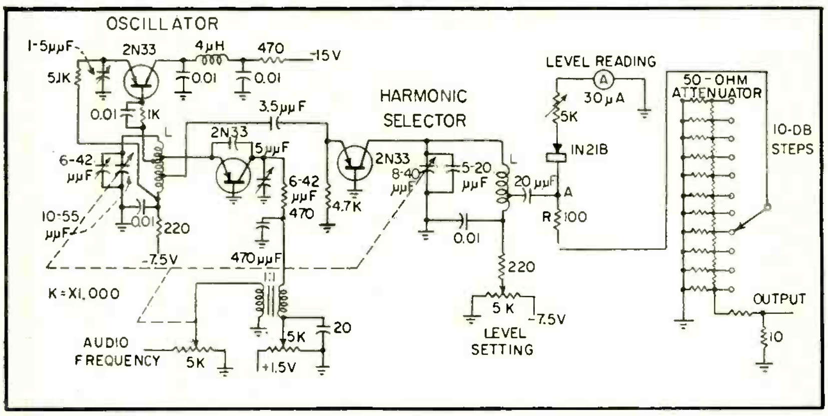

FIG. 2—Oscillator is modulated by 2N33 reactance transistor over vhf range

the conductance component, which is negative for $|\alpha_r| > 1$ and positive for $|\alpha_r| < 1$. At present, capacitive coupling is used and there is evidence of the presence of the negative conductance component. Actually mixed coupling occurs because of the effect of emitter resistance r_e, which cannot be neglected.

Frequency modulation occurs as a result of variation of biasing emitter current I_{eo} at the modulation rate. This variation is associated with the corresponding variation of α and of b. Component $g = -|g|$ also varies correspondingly. Since ample negative conductance to overcome circuit loss is provided by the oscillator circuit with resulting effect of amplitude limiting, the variation of additional negative conductance g is not of consequence and does not cause excessive spurious amplitude modulation. Spurious a-m is below 2 percent at 100-kc f-m deviation at all radio frequencies.

The accurate formula for y considering the full equivalent circuit of the reactance transistor for small signals in Fig. 3C is

$$y = g + jb = \frac{y_c + (g'_e + j\omega C_1)(1-\alpha)}{1 + r_b[y_c + (g'_e + j\omega C_1)(1-\alpha)]} \quad (3)$$

where $g_e = \omega^2 C_1 r_e$.

Equation 3 is equal to Eq. 1 or Eq. 2 depending on whether g'_e or $j\omega C_1$ predominates, when r_b and $y_c = 1/Z_c$ are neglected. The negative conductance component of y can be measured fairly successfully using an auxiliary tuned circuit in conjunction with a vhf Q-meter. The negative g can be evaluated from an apparent increase of the Q value of the auxiliary circuit.

Performance

Proper optimization of emitter bias and radio-frequency voltage across the emitter was found quite critical, but with preset adjustment for both, it was found possible to maintain distortion below 5 percent at all radio frequencies and at all deviations below the specified maximum of 50-kc deviation up to 50-mc r-f and 100 kc for the remainder of the radio-frequency range.

Sensitivity of modulation is likely to vary with the setting of the tuning capacitor at various frequencies throughout each band and

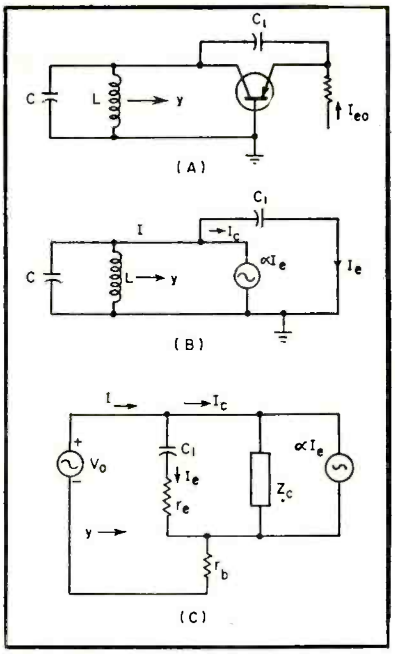

FIG. 3—Basic transistor reactance circuit used in Fig. 2(A) simplified (B) and complete (C) equivalent circuits

also between the bands. As with tube-type f-m modulators, special means of equalization of modulation sensitivity over the range of radio frequencies are required. They take the form of a system of a-f attenuators ganged to the main tuning capacitor and to the range switch.

Transistor Types

The use of RDX300 junction tetrodes in this equipment was investigated. It was found that no particular advantage is gained in using tetrode transistors in the harmonic-selector stage; point-contact performance was equivalent.

In the oscillator-modulator application, junction tetrodes proved considerably superior from the standpoint of freedom from spurious f-m and from the effect of temperature on frequency stability. Spurious f-m caused by contact noise is the main drawback of point-contact oscillators and modulators. In the described equipment, contact noise caused f-m deviations of 250 to 1,250 cps depending on the value of tuned-circuit capacitance and radio frequency of the carrier for the point-contact transistor oscillator and modulator.

Spurious f-m deviation dropped to 50 to 65 cps when junction tetrodes were used. Power output of a junction tetrode is somewhat higher than that of a 2N33, but the uppermost frequency of oscillation does not exceed approximately 35 mc for the junction tetrode.

The performance of the vhf circuits, which form the major part of the discussed instrument, approach on the whole that of their vacuum-tube counterparts, with an additional saving of about 20 percent of volume. The volume of the transistorized equipment is 1.44 cubic feet. The saving in weight exceeds 50 percent of the weight of equivalent equipment, based on vacuum tubes (42 lb with transistors and 113 lb with vacuum tubes). The weight saving is very desirable since it directly affects the portability of the equipment. A temperature oven provided to safeguard the oscillator against frequency changes with ambient temperature variations is responsible for the saving in volume not being as impressive as it might be expected.

The effect of temperature on oscillator frequency and the value of residual spurious f-m due to contact noise (with point-contact transistors only) are the only two major points where the performance of the transistorized generator is affected in comparison with the equivalent vacuum-tube design.

Part of the work described above was performed in connection with Signal Corps Contract DA-36-039-sc-42714. A Rosenblum and H. Spett cooperated in this work as representatives of Coles Signal Laboratory. A. H. Maciszewski, President and Director of Engineering of A. R. F. Products, Inc., contributed to the discussions leading to the present concept of the equipment. A large proportion of laboratory work was performed by K. T. Tsunamura.

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Tape-Controlled Servos

Infrared spectrophotometer for analyzing organic compounds has magnetic-tape memory and servo control to simplify calibration. Circuits include 10-cps low-noise amplifier and five-stage regulated power supply

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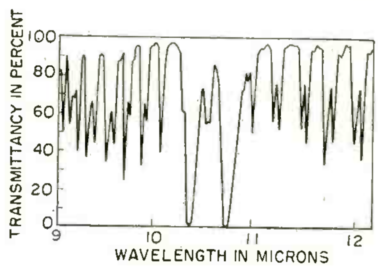
To obtain a curve of transmittancy versus wavelength the sample is exposed to monochromatic infrared radiation of progressively varying wavelength and the radiation passing through the sample is detected by a phototube.

A 100-percent-transmission reference line must first be obtained. This requires that corrections be introduced for absorptions within the monochromator and for the fact that Nernst lamp radiation as a function of wavelength follows a typical black-body radiation curve rather than a straight line. These corrections are made by varying the width of a slit placed in the optical path between the sample and the dispersing prism during a scan. The slit servomechanism is provided for this purpose.

It is necessary also to scan the infrared spectrum produced by the dispersing prism as fast as possible consistent with the resolution desired. However, since resolution varies with slit width, the rate at which the spectrum is scanned must vary. The wavelength servomechanism accomplishes this.

Finally, the strip chart upon which the transmittancy-wavelength curve is automatically plotted must move at a rate corresponding to the spectrum scanning rate. The chart drive is controlled by the chart servomechanism.

Once the 100-percent reference line is established, a sample is introduced into the liquid cell of the spectrophotometer. All the above motions must now be reproduced with great accuracy. This is done by magnetic-tape playback control.



THE INFRARED SPECTROPHOTOMETER

Infrared spectroscopy is a powerful tool for chemical analysis and is particularly valuable in organic chemistry. Chemical compounds are composed of atoms held together by molecular forces. Thus electromagnetic radiation of the proper frequency can excite a number of modes of oscillation in a molecule.

As a result of this action, energy is expended in exciting the molecule; the amount of energy given up and the frequencies for resonance are unique properties of a given molecular structure. Curves of transmittancy plotted against wavelength enable the spectroscopist to identify the compound under test.

Standard transmittancy-wavelength curves have been compiled for hundreds of pure compounds but to correct ordinary spectrograms to read directly in transmittancy is a tedious and time-consuming task. The instrument described accurately records infrared spectrums directly in transmittancy.

The infrared spectrum shown above is for ammonia (NH_3) under 100-mm pressure in a 10-cm test cell. Rocksalt prisms were used in the spectroscope. Actually, two runs were made at moderate speed and resolution; their superposition illustrates the precision and reproducibility of the machine. The 100-percent-transmittancy line at the top was drawn during a standardizing run

Optical Path

Figure 1 shows the optical path of the spectrophotometer. The Nernst lamp is the source of infrared radiation and the phototube monitors this source to maintain its emission constant. The light beam is formed by a condensing mirror and passed through a motor-driven beam chopper, whose function is to chop the light at 10-cps so that a-c amplification may be used. A negative lens collimates the radiation beam in the liquid cell region. Lens H brings the beam to a focus on the entrance slit. Lenses J and H produce an image of the front face of prism M in the plane of the external aperture to permit use of a narrow external beam and avoid introducing radiation into the monochromator at angles wider than can be usefully employed. In the exit beam system lens Q confines the beam, producing an image of the front face of prism M' in the plane of the thermocouple condensing mirror.

The exit multiplier phototubes and off-axis condensing mirror are used to study visible and ultraviolet absorption. Windows can be inserted if it is desired to isolate the exit-beam liquid-cell compartment.

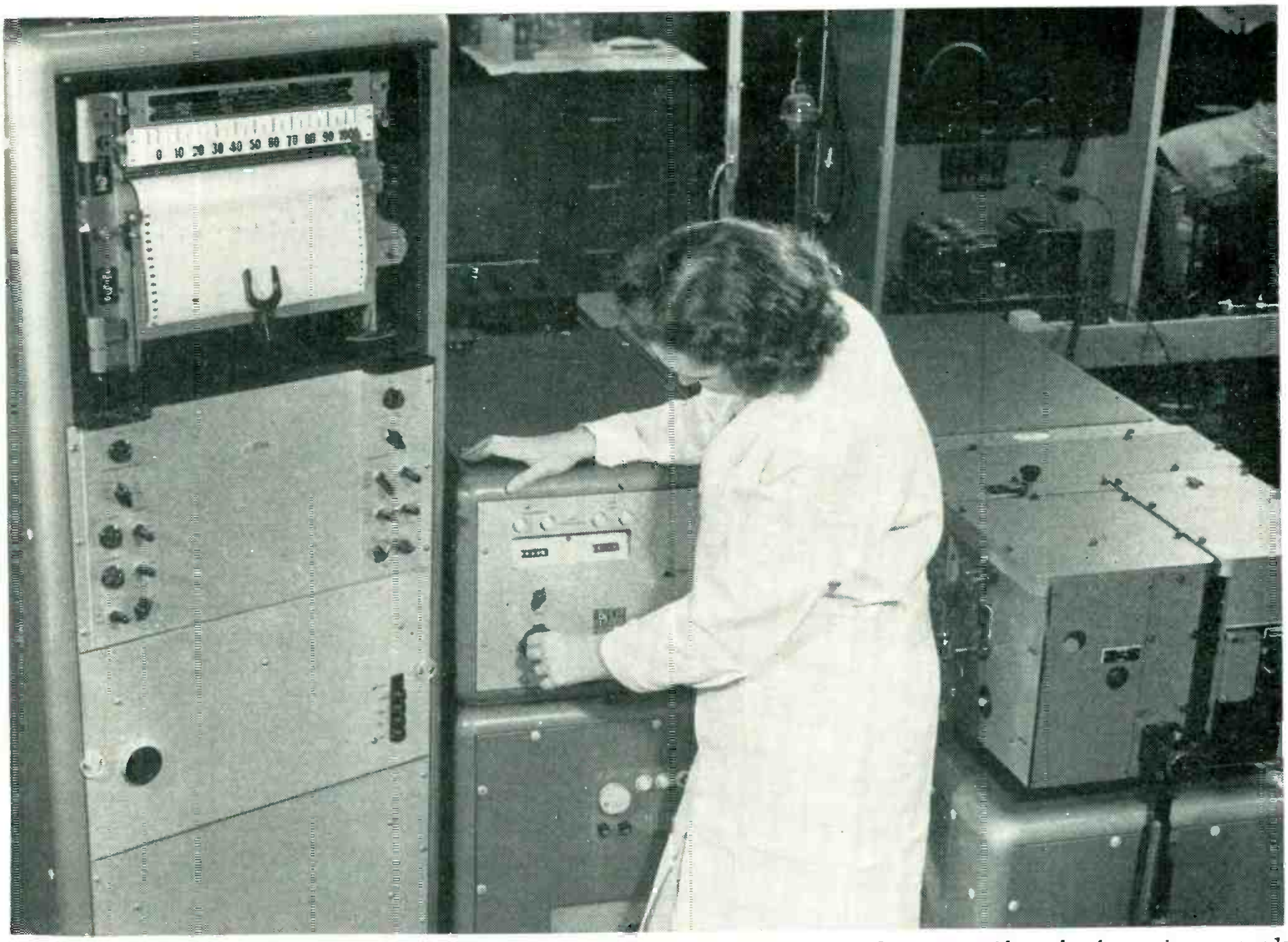
An intermediate aperture is inserted between the first and second monochromators. The thermocouple is the detector of infrared radiation. The smallest detectable signal is in the order of 10^{-18} watt.

Narrow-Band Amplifier

The 10-cps voltage generated by the thermocouple passes through an input transformer to give a voltage gain of 1,000 raising the signal above the amplifier input noise level by a factor of five. The signal-to-noise ratio of the entire instrument is determined by the signal-to-noise ratio of the thermocouple. The rms Johnson noise in the thermocouple is 10^{-10} volts at ambient temperature in a 0.5-cps bandwidth. This represents a noise voltage of 10^{-7} volts referred to the amplifier input.

The 10-cps amplifier shown in

Speed Chemical Analysis



Spectroscopist at National Heart Institute prepares for run with infrared spectrophotometer. Instrument aids study of organic compounds isolated from plants in the search for new drugs to combat heart disease

Fig. 2A has an input section of low-noise design with a voltage gain of 1,000 while the output section also contributes a net voltage gain of 1,000 providing a maximum voltage gain of 10^6 or 10^6 referred to the thermocouple terminals. A manual attenuator located between the two amplifier sections enables the operator to control the overall signal amplification. The maximum signal that can be handled by the input amplifier without distortion is about 20 volts rms. The input stage employs a 14F7, a twin triode with a high shot-noise figure of merit. This measure is taken as the transconductance divided by the square root of the plate current. In addition, the tube has rugged nonmicrophonic construction and excellent insulation. Its 150-ma filament permits economy of d-c heater power for the low-level input stages.

Inverse d-c feedback controlling the grid bias in each amplifier section minimizes the blocking which results from overbiasing a high-level stage by grid current drawn at the positive peak of an excessive signal. Blocking ordinarily lasts a considerable time because the amplifier time constants must be long to give the required low-frequency response. However, with inverse feedback, smaller time constants are used and their effect is further decreased by degeneration.

A schematic of the input amplifier is shown in Fig. 2B. The a-c feedback that stabilizes the amplifier also reduces noise, improves linearity and makes the amplifier noncritical as to tubes.

The output amplifier is similar to the input amplifier except that it is push-pull throughout. Both a-c and d-c feedback loops are employed.

Following the output amplifier, a mechanical synchronous rectifier is used to provide the high degree of linearity required for precise measurements. It consists of a pair of contacts operated by a cam on the same shaft that drives the chopper shutter mechanism. A phasing drum interposed between the cam and the shutter compensates for phase shift occurring in the thermocouple and 10-cps amplifiers. The output voltage then passes through an adjustable filter to a d-c amplifier which drives the strip-chart recorder.

In addition, the 10-cps amplifier chassis contains a regulated power

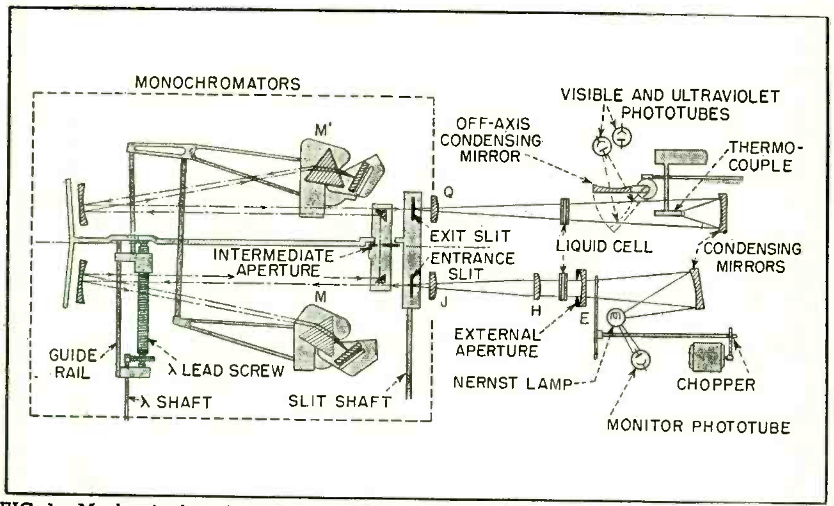


FIG. 1—Mechanical configuration of infrared spectrophotometer showing optical path

supply and Nernst lamp regulator whose output is controlled by the monitor phototube.

Because of the power-supply regulator a 10-percent line-voltage change produces less than a one-part-per-million change in the supply voltage at frequencies near 10-cps. The electronic regulator consists of five stages with a feedback factor of 300,000. The circuit supplies 240 ma at 275 volts. The internal impedance at 10-cps is less than 0.001 ohm and 120-cps ripple is only 25 microvolts rms. Noise voltage is 5 microvolts in a 1.6-cps bandwidth centered at 10-cps. Figure 3 is a schematic of the power-supply regulator. Tubes V_1, V_2 and V_3 are cascaded for voltage amplification and are direct coupled because they must amplify small d-c changes. The d-c reference level depends chiefly upon the space-charge-limited emission of the first stage filament; a 1-percent change in filament current corresponds to about a 25-mv input signal.

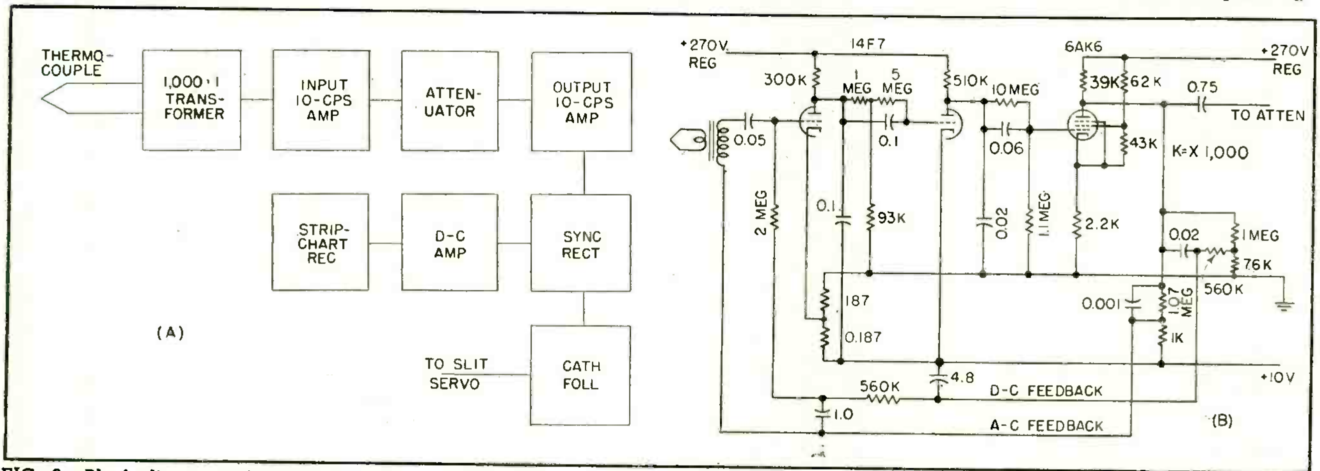


FIG. 2—Block diagram of 10-cps low-noise amplifier (A) and schematic of its input stages (B)

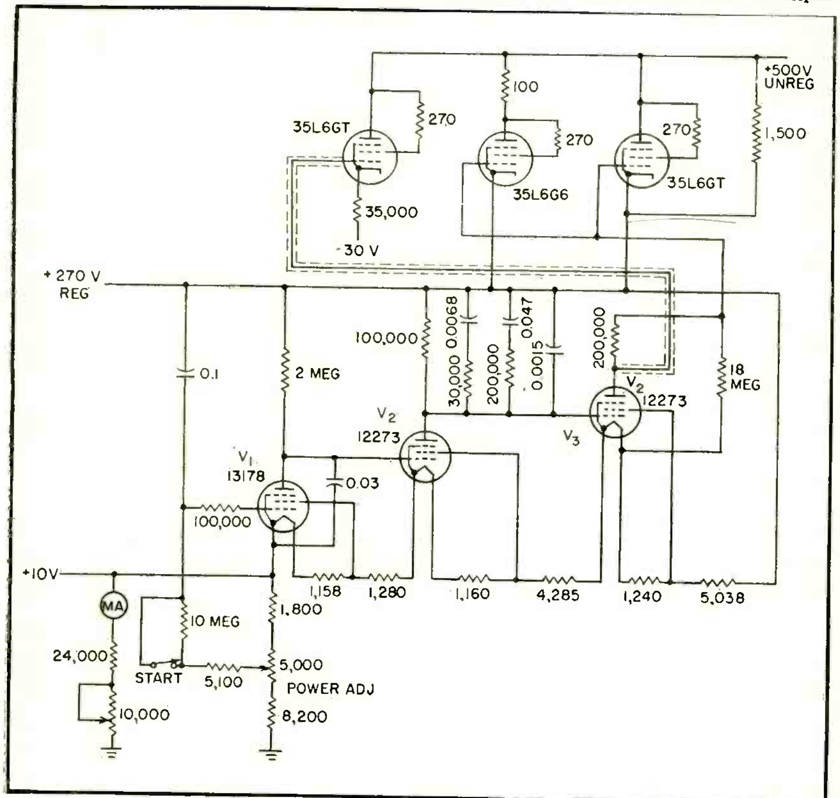


FIG. 3—Five-stage power-supply regulator has a feedback factor of 300,000; supplies 240 ma at 275 v

Direct Transmittancy Servo

The energy radiated from the Nernst lamp has a typical black-body radiation curve. The energy peak occurs at about 2 microns and is down 1,000 times at 15 microns. The uncompensated reference level (no sample) in a single-beam spectrophotometer is essentially the black-body curve of the source neglecting absorptions in the optical path.

A fixed 100-percent reference level to record absorption spectrums directly in transmittancy is attained by varying the slit width in the monochromator automatically as

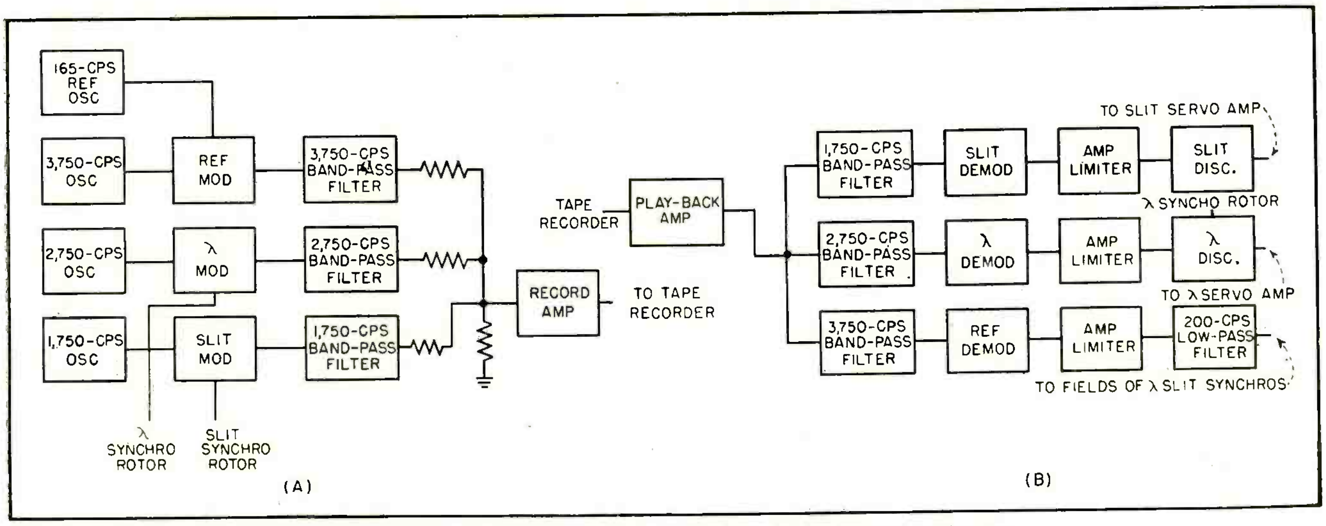


FIG. 4—Recording (A) and playback systems (B) permit use of magnetic tape for instrument calibration

a function of wavelength position. At long wavelengths (15 microns) where the energy is low, the slits are widened and conversely at shorter wavelengths the slits are narrowed to compensate for the increase in radiation from the source. Slit width as a function of wavelength position over the entire scanning interval is memorized during a standardizing run and transmittancy of the sample recorded directly by reproducing the slit-width-versus-wavelength information during a second run, meantime introducing the sample into the instrument.

A servomechanism controls the slit width to maintain a 100-percent reference level by monitoring the output voltage of the 10-cps amplifier and comparing it with a fixed reference voltage. The position of the slit-motor shaft is recorded on a tape recorder as a function of the wavelength position to an accuracy of 1 part in 5,000.

It is necessary to traverse a spectral slit width in a time proportional to the response period of the 10-cps amplifier.

Wavelength Drive Servo

A second special servomechanism is utilized during the standardizing run automatically to set the velocity of the wavelength drive motor proportional to a voltage which varies directly as the geometric slit width and the response period of the amplifier. This voltage is derived from a resistive divider mounted on a 48-position switch driven by the slit motor. The output voltage E_o of the switch may be represented by $E_o = C \log W$, where W is the slit width and C a multiplying factor to compensate for the amplifier time constant used.

The logarithmic function is necessary since a log cam is used to drive the slit jaws, giving a constant change in light output for a given rotation of the slit shaft. It is necessary to memorize the wavelength motor position to an accuracy of 1 part in 15,000.

The slit and wavelength servomechanisms to be described later are both variations of a basic position servo in which a two-phase synchro is attached to the motor shaft through a suitable gear ratio. A reference oscillator provides a 165-cps signal which is split into two components differing in phase by 90 deg. These two voltages are applied to the fields of the synchro. The resultant magnetic field can be represented by a vector of constant amplitude rotating at 165-cps.

The phase of the induced emf in the synchro rotor winding referred to the reference oscillator voltage measures the relative position of the rotor shaft. The reference and the rotor frequencies are recorded on tape and when played back provide control information to reproduce the motor position during the standardizing run. It is necessary only that the synchro be within one-half revolution of its original starting position at the start of the playback

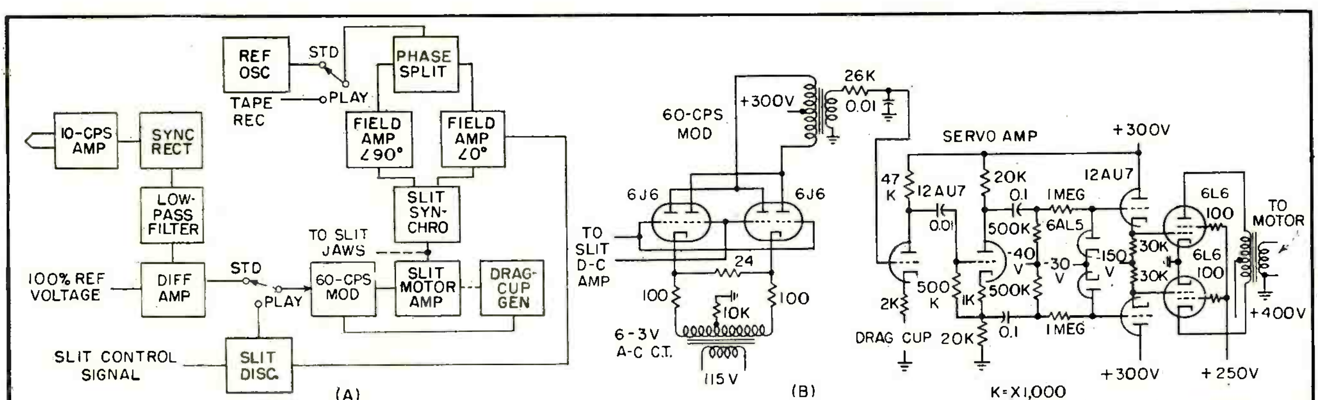
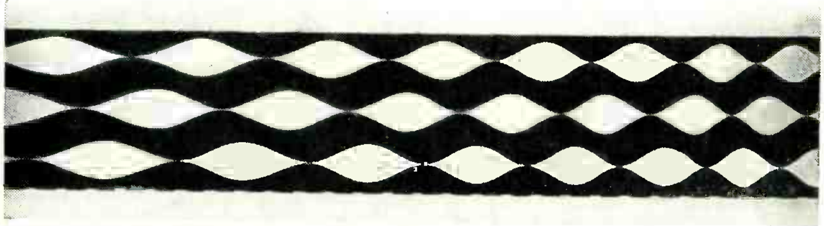


FIG. 5—Block diagram of slit control system (A) and schematic of slit modulator and motor amplifier (B)



Three tracks of varying area on 35-mm film provide memory for chart drive

run to assure perfect lock-in. This is accomplished by observing a counter on the motor shaft.

On playback, the 165-cps reference signal from the tape recorder is split into two components 90 deg apart and applied to the synchro fields. The induced rotor voltage is compared in phase in a discriminator with the previously recorded rotor voltage. The resulting error signal is amplified and applied to the servo motor which drives the synchro to maintain phase balance. As the control signal varies in phase the servo motor maintains the phase balance reproducing any recorded function.

Two control channels are necessary to record both the wavelength and slit motor positions. The same reference frequency is used, however, requiring the recording of only three signals. Since all three signals are essentially the same frequency, ±2 cycles, a modulated carrier system was utilized.

Recording System

A 1,750-cps carrier is used for the slit channel, 2,750-cps for the wavelength channel and 3,750-cps for the reference signal. The three modulated carriers are mixed in a linear resistive divider and applied to the tape recorder through a recording amplifier. See Fig. 4A.

No mechanical synchronization is necessary since the phase of the three signals with respect to each other is independent of the speed of the tape used. Even nonhomogeneous tape presents no problem as long as the signal loss on playback represents no more than a half revolution of the synchro.

On playback, the composite signal consisting of the three modulated carriers is separated by band-pass filters, Fig. 4B. Each channel is separately demodulated, filtered, amplified and applied to the proper discriminator after passing through an amplitude limiting amplifier that insures constant amplitude despite tape nonhomogeneities.

Slit Servomechanism

Figure 5A is a block diagram of the slit servomechanism. A drag-cup generator is used for viscous damping to degenerate the motor time constant and assure fast response with good damping. The low-pass filter between the 10-cps and d-c differential amplifiers is necessary to remove the 10-cps and 60-cps components to prevent overloading the differential amplifier. Figure 5B is a schematic of the slit modulator and motor amplifier.

Any d-c unbalance between the 6J6 grids in the balanced modulator produces a 60-cps component whose amplitude is proportional to the unbalance and whose phase is either zero or 180 degrees with respect to the a-c line depending upon relative grid polarities. The modulator output signal is compared with the drag-cup generator signal in the first stage of the servo amplifier and the error signal is used to drive the slit motor. The diode limiters are biased to limit the top speed of the motor and prevent overloading the power-amplifier stages.

Since the light intensity falling on the thermocouple is proportional to the square of the slit width, it is necessary to drive the slit with a logarithmic cam so that the loop gain remains constant throughout the slit excursions.

Wavelength Servomechanism

During the standardizing run, the wavelength drive functions as a wide-range velocity servo with a large value of d-c feedback from a tachometer tied directly to the motor shaft. The wavelength drive motor runs at a speed such that the output voltage of the d-c tachometer is equal to the applied control voltage. The servo motor can apply full torque continuously from $\frac{1}{3}$ rpm to 2,000 rpm, a dynamic range of 6,000 to 1. The difference between

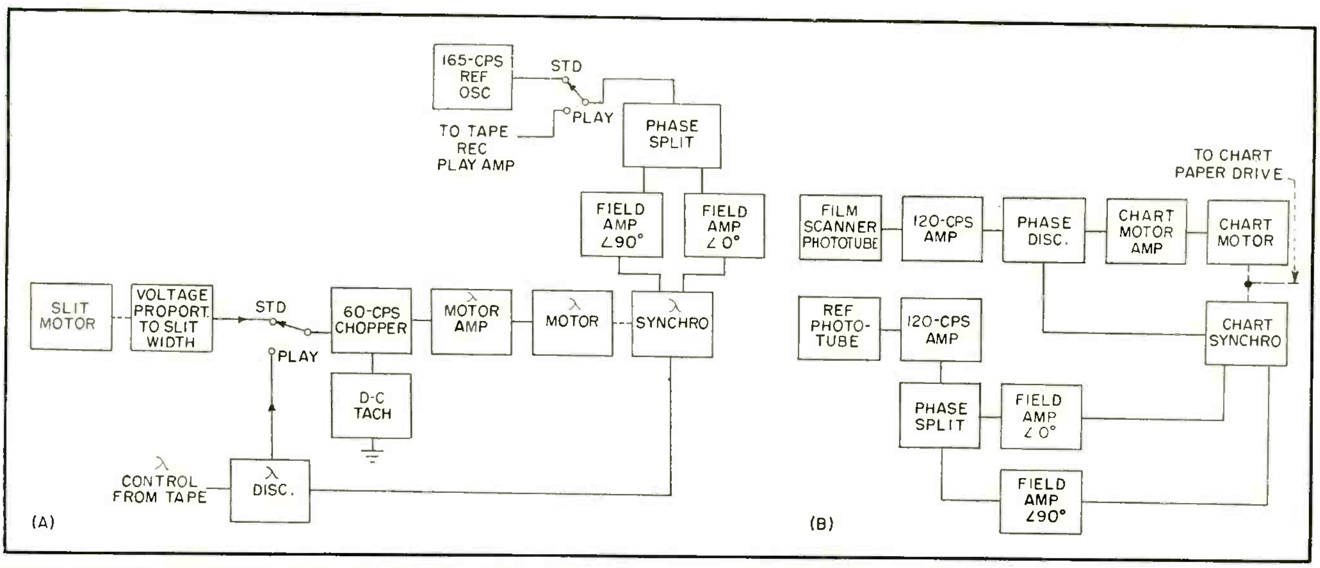


FIG. 6—Wavelength control system (A) and chart drive system (B) demonstrate similarities in their electrical design

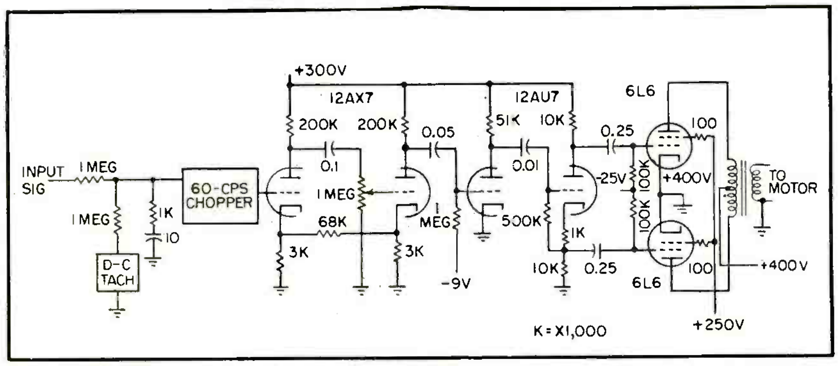


FIG. 7—Schematic of wavelength servo amplifier

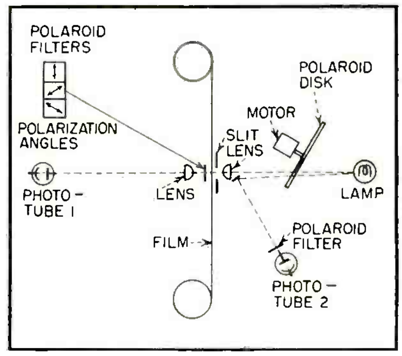


FIG. 8—Film scanner for chart drive

the applied signal voltage and the tachometer voltage is applied to a 60-cps chopper, amplified and impressed across the servo motor. During playback, the chopper measures the difference between the discriminator output voltage and the tachometer, converting the velocity servo to a position servo. The gear ratio to the monochromator wavelength drive is such that a complete scan from 15 to 1 microns can be made in 5 minutes, at wide slit widths. Both the wavelength and slit servos can be controlled during the standardizing run by manually adjusted potentiometers to increase the versatility of the instrument. Figure 6A is a block diagram of the wavelength servo.

Figure 7 is a schematic of the wavelength motor amplifier. The difference voltage between the input signal and the d-c tachometer is chopped at 60-cps and amplified by the first stage. The first two stages are regeneratively coupled to make up for the loss in gain that would incur due to degeneration from the cathode resistors.

Wavelength Presentation

The dispersion of a prism is such that the distribution of wavelength versus angle is a nonlinear function which resembles a portion of a tangent curve. It is desirable to have the chart paper drive linear in wavelength and as a consequence it is necessary to introduce a nonlinear element having a reproducibility of one part in 13,000 between the wavelength drive and the overall chart paper drive system on the strip recorder.

A method was developed for recording phase versus position on 35-mm film, using three identical tracks of variable area. A linear section of the film is shown in the photograph. A 20-ft section of film is driven by a sprocket connected to the wavelength drive mechanism and scanned as it passes a slit only 0.01 inch wide.

The scanning mechanism comprises a projector lamp, optical elements, Polaroid modulating system, slit and phototube and is shown in Fig. 8. At the slit, opposite each track on the film, are three Polaroid filters with their polarization angles differing by 60 deg. Light passes through a Polaroid disk rotating at 60 rps, the film, slit and filters and is picked up by a phototube. The transmission of the first film track is A $(\sin \alpha + 1)$ B $\sin^2\omega t$ is the angular velocity of the rotating disk.

Since the phototube is looking at all three tracks, the signal voltage in the phototube load resistor is

$$E_o = A\,(\sin \alpha + 1)\,B \sin^2 \omega t + A\left[\sin\left(\alpha + \frac{2\pi}{3}\right) + 1\right] B \sin^2\left(\omega t + \frac{\pi}{3}\right) + A \left[\sin\left(\alpha + \frac{4\pi}{3}\right) + 1\right] B \sin^2\left(\omega t + \frac{2\pi}{3}\right)$$

This can be reduced to

$$E_o = k\,[1 + \tfrac{1}{2} \sin\,(2\omega t - \alpha)]$$

The d-c component can be disregarded and the signal voltage becomes a sine wave of angular velocity $2\omega t$ or 120 cps and a phase angle determined by α, which corresponds to the position of the film on the slit.

A small diagonal mirror intercepts a portion of the rotating polarized light and the light passes through a fixed Polaroid filter to another phototube to produce a 120-cps signal for phase reference. This signal is split into two components 90 deg apart and applied to the fields of a synchro in the paper chart drive system (Fig. 6B). The control signal generated by the film system is fed to a phase discriminator that compares its phase with that of the rotor signal from the chart synchro.

The phase difference signal is amplified and used to drive the chart motor. Each time the film tracks are advanced 360 deg the chart synchro is driven through one complete revolution. The phase distribution along the film follows the dispersion curve of the prism. Since the film is geared directly to the wavelength drive shaft no additional memory system is required for the chart paper to follow accurately with wavelength scanning on playback.

Summary

The Beckman Model IR-3 spectrophotometer utilizes an automatic control system which enables the recording of spectra directly in 100-percent transmittancy at a scanning speed proportional to slit width by means of servomechanisms. Wavelength versus slit width information is automatically recorded on a tape recorder for periods of time up to one hour by comparing the rotor voltage of synchros tied to the motors with a reference signal, which is applied to the synchro fields.

The resulting phase differences are applied as error signals to the servo motor amplifiers from discriminators during the playback run, thus causing the motors to exactly reproduce their previously recorded positions as a function of time. Introduction of a sample into the instrument during the playback run allows the sample adsorption to be referred to a 100-percent reference line instead of the usual blackbody radiation curve emitted by the Nernst source.

Phase Measurement for

Indicating instrument displays phase and amplitude of carrier at given frequency in respect to reference phase supplied at same frequency. Phase magnifying feature increases measurement accuracy. Unit is also applicable to direction-finding equipment

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NEED for an instantaneous phase and amplitude indicator in the color-tv field has been recognized for sometime.[1] Today, this need has been met by instruments such as the vectorscope, which are standard equipment in transmitter installations for color tv.[2] These instruments are also likely to be found on future production lines for color receivers and in service shops, this trend being aided by several commercial products, some already on the market[3] and more still to come.[4]

The vectorscope is an oscilloscope for the display of signals that consist of amplitude and/or phase modulation of a carrier at some specific center frequency. Amplitude-modulation is displayed as the radial distance of the scanning spot from center screen and instantaneous phase is displayed as the angle counted from a fixed phase reference on the vector screen.

To supply the reference phase electrically, a continuous unmodulated carrier at center frequency has to be available. This reference carrier may be supplied to the instrument from an external source or may be reconstituted from a composite signal which conveys reference-phase information by a time-division multiplex process. This type of transmission is typical for the color-tv applications of the vectorscope and slightly complicates the instrument.

Circuitry

Figure 1 presents the basic circuit arrangement and the electronic functions involved in obtaining a vectorscope display. The instrument operates on two inputs. The first is a signal input

$$e_x = A \cos (\omega t + \phi) \quad (1)$$

Here, both amplitude and phase may be time variable. In a typical color application, a bandwidth of over 1 megacycle is allotted to these parameters. The second input is a reference input

$$e_r = 2 \cos (\omega t) \quad (2)$$

The amplitude factor 2 indicates the use of a limiter within the instrument. The angular frequency ω stands for a carrier of 3.579545 mc in an instrument designed for NTSC color.

Two synchronous detectors are used for the X and Y coordinates. The X detector operates on the input signal and the reference voltage. Its filtered output is

$$e_x = A \cos \phi \quad (3)$$

The Y detector operates on the input signal and a derived reference component, 90 degrees advanced in phase with respect to the signal of Eq. 2

$$e_q = -2 \sin (\omega t) \quad (4)$$

Its output then becomes

$$e_y = A \sin \phi \quad (5)$$

The detected voltages e_x and e_y result in a stationary dot on the screen with the desired polar coordinates A_t and ϕ_t.

Frequently, it is desirable to enhance visibility of the display by providing radials from each dot to center. This is accomplished by periodically keying the signal amplitude to zero at a rate Ω. This keying process may be accomplished either ahead of detection in the signal amplifier[1] or after detection in the deflection amplifier.[5] The latter approach requires two modulators, the former only one.

Figure 1 exemplifies the predetection modulation in showing a tracer signal $e\Omega$ and a signal modulator. If the tracing frequency is lower than the line rate, say 10 kc, the vectogram is displayed at a

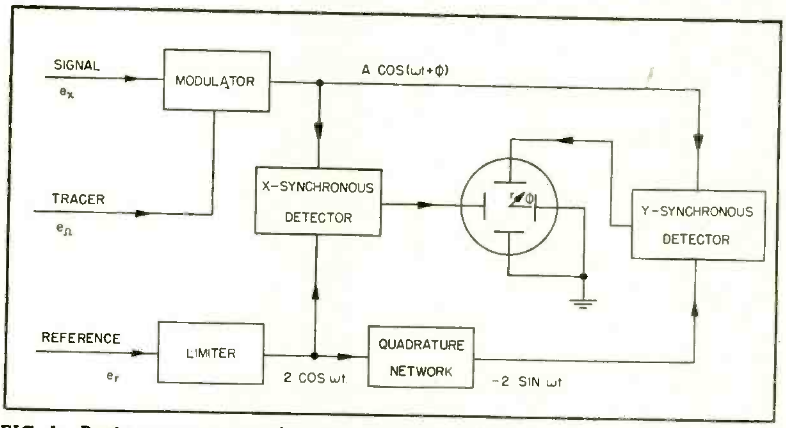
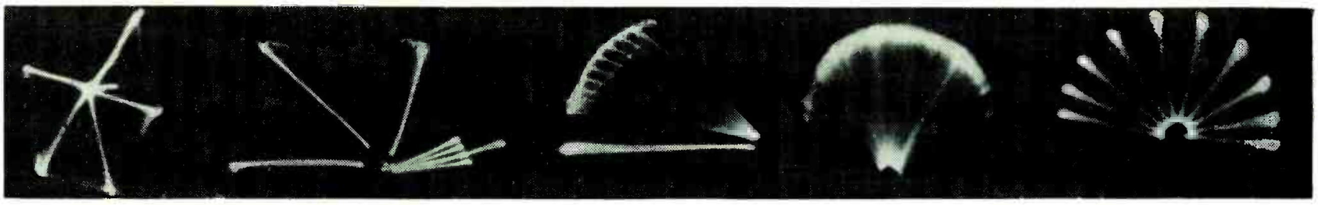


FIG. 1—Basic arrangement of vectorscope elements

Color TV and F-M



Left to right: NTSC color-bar signal as displayed on vectorscope; vector rotation of color carrier with and without phase multiplier; spurious phase rotation in a color-video stage; standard quality f-m signal; phase and amplitude response of delay band-pass filter

pulsating radial scale and the circuitry is particularly simple.

Synchronous Detectors

Figure 2A shows the synchronous detectors used for the vectorscope. These work on the pulsed-envelope principle.[6] In this application, each group of detectors is directly coupled to its pair of deflection plates through a constant-K filter passing 1,500 kc. Band-rejection filters at each plate remove all traces of color carrier from the display. The overall frequency response is shown in Fig. 2B.

Each tube delivers up to 200 volts peak-to-peak from a 4-volt signal. Since the output from each doublet is in push-pull due to the balanced cathode excitation, there is adequate output for full deflection of a 4,000-volt beam on a 5-inch tube.

Other features of these high-level pulsed envelope detectors are inherent amplitude linearity and a phase error of less than 2 degrees, both secured by the high injection ratio of 5 to 1.[6]

Figure 3 shows the low-impedance quadrature network employed. In the tuned-pi structure shown, the quadrature phase between output and input is unaffected by variations of the load resistance r_2 if one L-C branch is tuned to resonance. The basic relations of the tuned pi are

$$e_2 = e_1 j r_2 / Z \qquad (6)$$

where $Z = \sqrt{L/C}$ and $\omega^2 LC = 1$.

The input impedance is a pure resistance

$$r_1 = Z^2 / r_2 \qquad (7)$$

It follows that the amplitude balance can be adjusted by changing the load resistor r_2, but the input impedance stays resistive and the phase relation between voltages does not change. If built for a low impedance ($Z = 100$ ohms), the tuned pi guarantees correct vector display despite load variation so that there is no need for elaborate self-checking devices.

If the vectorscope is used as a color monitor, the additions to its circuitry shown in Fig. 4 are necessary. Since the color signal is composite, the phase reference has to be reconstituted by a separate burst regenerator within the instrument. This requires a separate sync amplifier having conventional video-bandwidth characteristics (0 to 5 mc), so that conventional sync stripping and inverting practices may be used.

For signal amplification chromaticity bandwidth (2.5 ÷ 4.5 mc) is adequate and low and medium frequencies up to 2 mc may be suppressed. In this channel, a variable delay unit is desirable so that the vectogram may be zeroed for phase. Such a delay-control unit, consisting of a single-layer helix on top of a slotted metal tube inside which a moving pickup coil is provided is shown in one of the photographs. At 3.6 mc, a complete 360-degree rotation of the pattern is realized with a delay-line helix of only

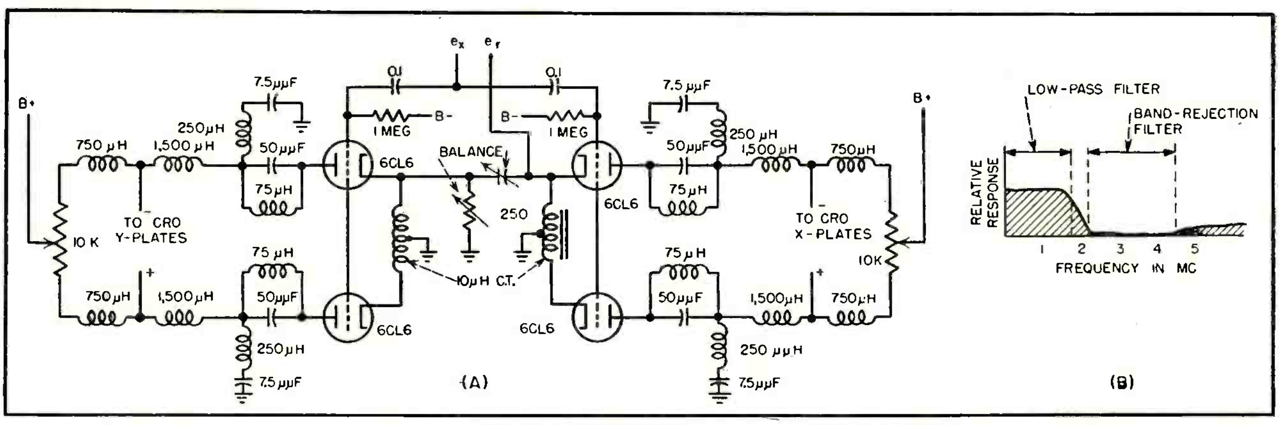
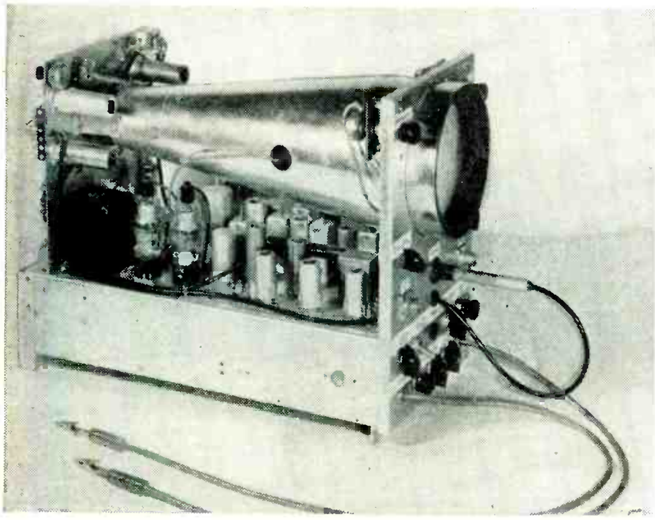
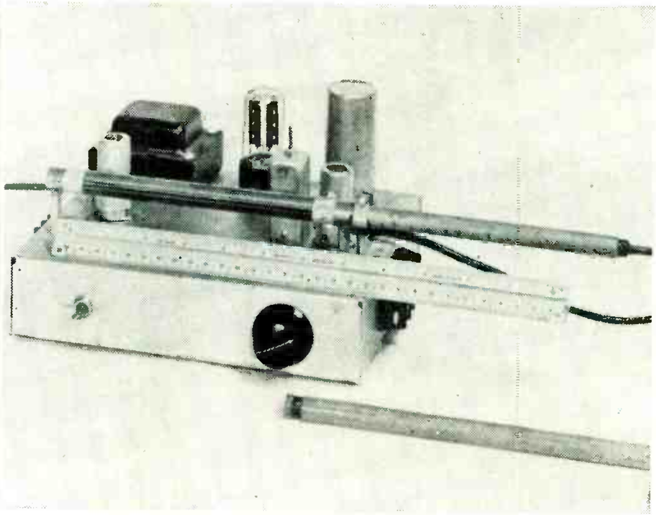


FIG. 2—High-level pulsed envelope detector used in vectorscope (A); relative frequency response of detector (B)



Vectorscope for color-signal monitoring. Separate sync and signal-probe inputs permit constant maintenance of phase reference



Variable time-delay control unit consists of single-layer helix on top of slotted metal tube, with moving-coil pickup inside

eight inches total length.

The complete vectorscope for color monitoring is shown in one of the photographs. Use of two separate probes for sync and signal inputs permits constant maintenance of phase reference while the signal probe explores various parts of receiver or transmitter circuitry. Each probe consists of a small head with an input capacitance of less than 3 $\mu\mu$f attached to a 3-foot cable.

The photograph of the vectorscope waveform obtained from a NTSC transmission of vertical color bars includes the colors red, yellow, green, magenta and blue. Each color persisted for only 7 microseconds at a time. The angles and radials may be compared to the NTSC signal specifications.[7]

Phase Magnifier

The ability of the vectorscope to resolve small phase angles is limited both by the properties of the associated circuits and by the cathode-ray tube itself. A 5-inch tube with an effective spot size of $\frac{1}{16}$ inch would account for a phase tolerance of ± 1 degree. Errors of similar magnitude may be contributed by the synchronous detectors themselves,[6] as well as by the process of color synchronization. As a result, the total error to be expected from a vectorscope may lie within the limits of ± 2 degrees.

Some of the effects with which color-tv engineers are concerned are well below this limit of resolution; one example is the detection of differential phase shift in color-video amplifiers. Transmission of the color carrier through a tube in the presence of large variations of pedestal often causes color-phase errors of the order of $\frac{1}{2}$ to 2 degrees per stage.

Another use for a differential-phase test arises if delay balance is sought for two parallel networks, each having a different bandwidth. A typical example is the delay equalization between I and Q channels. Two and a half feet of cable, having a delay of about 0.1 microsecond, is commonly used for this purpose. This average time corresponds to a color-phase rotation of 5 degrees. Since the K factor of the cables varies by about 10 percent, measurement of $\frac{1}{2}$ degree of phase is of interest. This corresponds to a differential delay of about 400×10^{-12} seconds, the time for a signal to traverse 3 inches of cable.

Figure 5 illustrates the principle of the phase multiplier successfully used to magnify the phase resolution of a standard vectorscope. The network under test causes an incremental phase shift $\Delta\phi$, too small to be seen on the vectorscope screen. The network output is passed into the signal frequency multiplier which raises the signal frequency N_a times. The phase at the multiplier output is rotated by $N_a\ \Delta\phi$ with respect to the reference phase ϕ. The reference carrier is also frequency multiplied, but the order of multiplication is one less than before: $N_b = N_a - 1$.

The outputs of the signal and reference-frequency multipliers are heterodyned in the mixer beating the output back to the reference frequency f_1. The relative phase angle, however, becomes $\phi_2 = N_a\ \Delta\phi$, which in this case is a magnification of ten times. As a result the vectorscope indicates the differential phase shift at a greatly expanded scale. Vector rotation of color carrier with phase multiplier is shown in the photographs.

An application of the phase microscope to the study of a 6AC7 amplifying 0.5 volt of color carrier, while being modulated by 1 volt of stairstep signal is shown in one of the photographs. The stage exhibits both differential phase and gain distortion. The former is almost too small to be seen directly, being only 4 degrees. At the output of the phase microscope, the phase distortion appears magnified to 40 degrees. The gain variation is visible in the direct view as a radial dis-

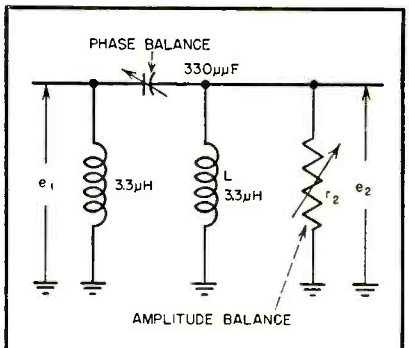


FIG. 3—Tuned-pi quadrature network employed in circuit of Fig. 2

placement, but shows more clearly on the phase multiplier display.

Color tv is not the only type of radio communication which can benefit from an instantaneous phase indicator like the vectorscope. Frequency modulation is another field for its application. Here is a need for an instantaneous deviation indicator to serve as a monitor for broadcast stations or as an aid in the alignment of transmitting equipment. To adapt the vectorscope to this application, the first requirement is an adapter to convert any arbitrary signal-carrier frequency to the preset instrument frequency. Such conversion is basically feasible since the phase relation between two synchronous carriers is unaffected by the process of heterodyning.

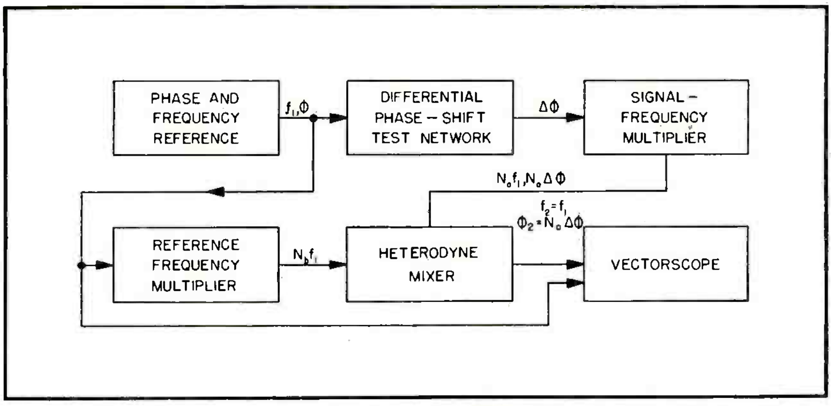


FIG. 5—Use of a phase magnifier in conjunction with the vectorscope permits observation of phase angles that would normally be too small to be seen

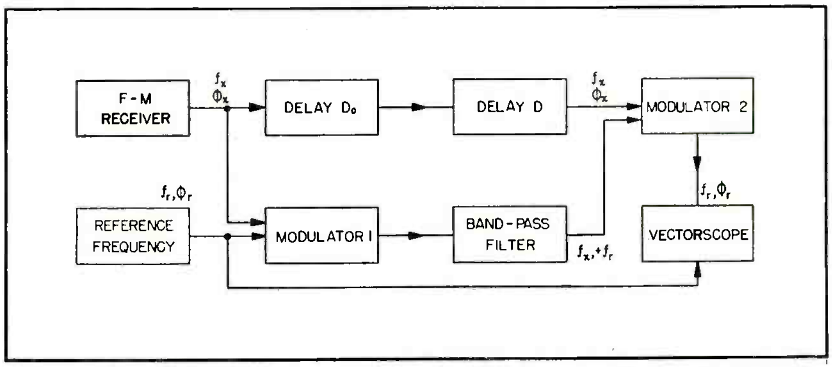


FIG. 6—Application of the vectorscope as an f-m monitor. The signal from the receiver is fed to the vectorscope through a double-beat converter

F-M Monitor

Figure 6 shows how the vectorscope may be used to monitor the frequency deviation of any f-m broadcast transmitter. A conventional f-m receiver is used and its intermediate frequency of 10.7 mc is routed by 72-ohm coaxial cable to the vectorscope through two separate channels. The first channel comprises a double modulator or transponder. The first modulator develops the sum frequency of 14.3 mc $\pm\Delta f$ resulting from a beat between the i-f signal and a local 3.6-mc crystal oscillator. A band-pass filter isolates this sum frequency and supplies it to the second modulator. Here, the sum frequency is beaten back into 3.6 mc by heterodyning it with the original signal. However, before reaching the second modulator, the signal goes through two delay lines. The first, D_o, matches the delay incurred in the transponder band-pass filter. The second delay section, D, has a ferrite core and is so designed that the phase-delay difference for two extremes of deviation amounts to 180 degrees. Since f-m standards call for $\Delta f \leq \pm 75$ kc the required delay is

$$D = 1/4(4\Delta f) = 3.3\ \mu\text{sec} \qquad (8)$$

Since the transponder preserves phase relations, the vectorscope in Fig. 6 will display a fan-shaped pattern which will reach a spread of 180 degrees for peak deviations only, but will stay within this angle for FCC approved transmissions. At the same time, the fanned-out area will be a segment of a circle as long as the receiver limiter is working properly. Any spurious a-m is detected as a noncircularity of the boundary.

A vectogram obtained from a local f-m station is shown in the photographs.

Phase-Delay Display

Phase delay and envelope delay are determining factors for the transient response of video amplifiers. Circuits for equalizing delay distortion are finding increasing application in tv receiving and transmitting equipment.[8,9] In color tv, phase-delay distortion in the chromaticity channel may cause crosstalk and color contamination due to quadrature components; instruments to display such distortion are of assistance to designers of color equipment.

A vectorscope equipped with a transponder displays both phase and amplitude response of a four-terminal network.

Employing a suitable signal

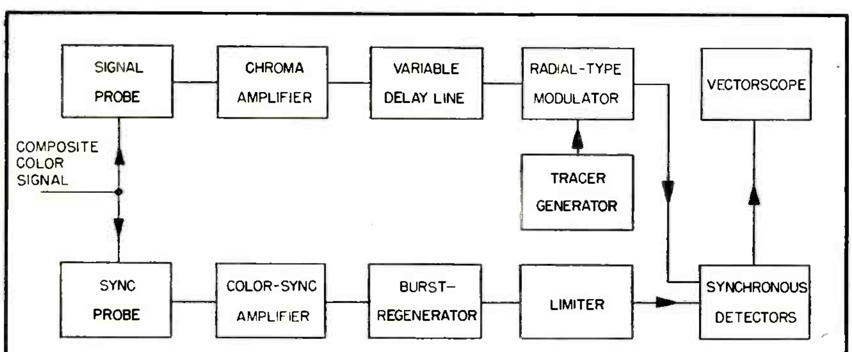


FIG. 4—Setup for using vectorscope as color monitor. Bandwidths of chroma and color-sync amplifier should be 2 to 4 and 0 to 4 mc respectively

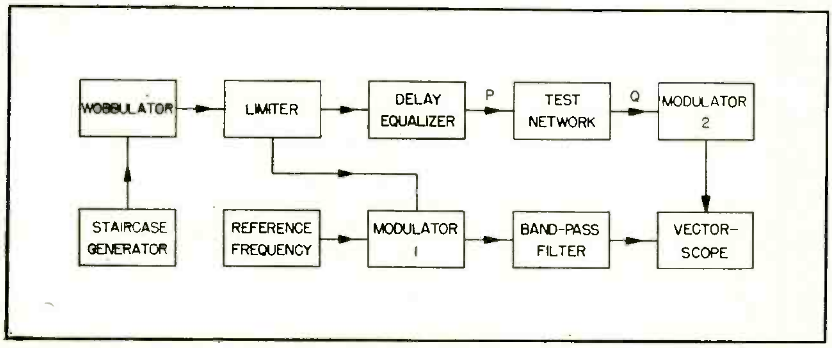


FIG. 7—Setup for phase-delay presentation with the vectorscope. Circuit resembles that of Fig. 6 except that f-m signal is replaced by signal generator

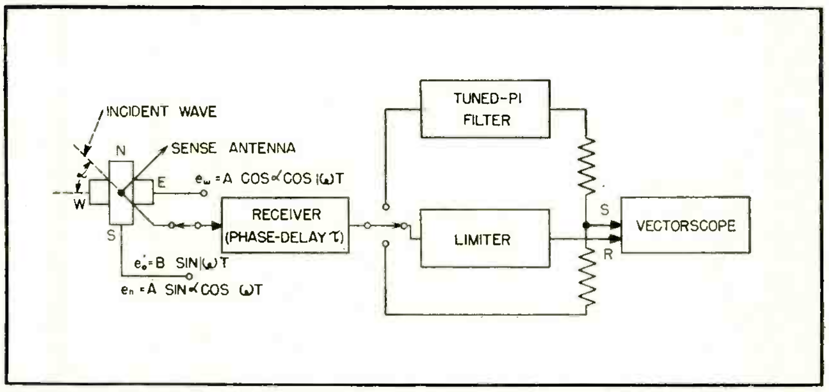


FIG. 8—As an element of an all-electronic direction finder, the vectorscope displays small differences in the time of arrival of a signal carrier at the site of various component antennas forming a directive antenna array

generator whose frequency varies in discrete jumps, the vectorscope displays the overall phase shift per unit change of frequency (phase delay) offering a visual check on phase distortion. Figure 7 shows the test-equipment layout. The equipment resembles the f-m monitor of Fig. 6, except that the f-m signal is replaced by a signal generator whose frequency is varied by constant steps and the test network replaces the dispersion-free delay line used before.

The electronic wobbulator uses a center frequency of 10.7 mc and is frequency modulated by a staircase generator so that a total deviation of ± 1 mc is accomplished in 10 steps, each 200 kc apart, at a repetition rate of 60 cps.

The resultant vectorscope display consists of discrete radials whose length and direction indicate attenuation and phase shift through the network at the step frequencies. If the network is a band-pass filter, the pass band is recognized as that section of the vector envelope which most nearly approaches a circle through the origin at maximum radius. Constant phase delay, on the other hand, is recognized by equal angles between consecutive radials. Crowding or spreading of these angles signify phase distortion at the spot frequencies.

Tests on any arbitrary frequency may be done by heterodyning down to that frequency and back between terminal points P and Q in Fig. 7, using the same local oscillator.

Direction Finding

The vectorscope may also be used as the essential element of an all-electronic direction finder, measuring small differences in the time of arrival of a signal carrier at the site of various component antennas forming a directive antenna array. In this application, it offers several advantages over conventional equipment using mechanical pointer instruments. Some of these are instantaneous operation, nonambiguity and the absence of a critical gain adjustment for the sense antenna. In addition, an approximate information about the signal field strength is supplied since the radial length of the vector display varies with signal input.

Figure 8 shows basic circuitry for adaptation of the vectorscope to direction finding. Two crossed loops develop signal voltages

$$e_N = A \sin \alpha \cos (\omega t) \qquad (9)$$

$$e_W = A \cos \alpha \cos (\omega t) \qquad (10)$$

where α is angle of wave incidence off west and ω signal frequency.

A vertical sense antenna adds omnidirectional signal information

$$e_o = B \sin (\omega t) \qquad (11)$$

All three signals Eq. 9 to 11 are handled by a single receiver on a time-sharing basis using synchronous electronic samplers at input and output. The receiver converts the signal frequency ω into an intermediate frequency Ω, adding in the process, the same delay τ to all channels. This changes the time scale from t to $t' = t + \tau$, but it does not affect the relative phase shift information. After burst-regeneration is performed on all three signals, the receiver outputs are

$$e'_N = A \sin \alpha \cos (\Omega t') \qquad (9a)$$

$$e'_W = A \cos \alpha \cos (\Omega t') \qquad (10a)$$

$$e_o = B \sin (\Omega t') \qquad (11a)$$

Now, e'_w is fed through a tuned-pi network, whose output is

$$e''_W = A \cos \alpha \sin (\Omega t') \qquad (10b)$$

Summing Eq. 9a and 10b at equal amounts, yields the new signal

$$S = \tfrac{1}{2} A \sin (\Omega t' + \alpha) \qquad (12)$$

This signal is fed to the S terminal of the vectorscope and the sense signal Eq. 11a to its R terminal after being limited to

$$e_r = 2 \sin (\Omega t') \qquad (11b)$$

The combination of signals Eq. 11b and 12 is necessary and sufficient to display, on the vector-screen, both the desired azimuth α of the wave front, as well as a radial of the length $\tfrac{1}{2}A$, which for constant receiver gain is proportional to field strength.

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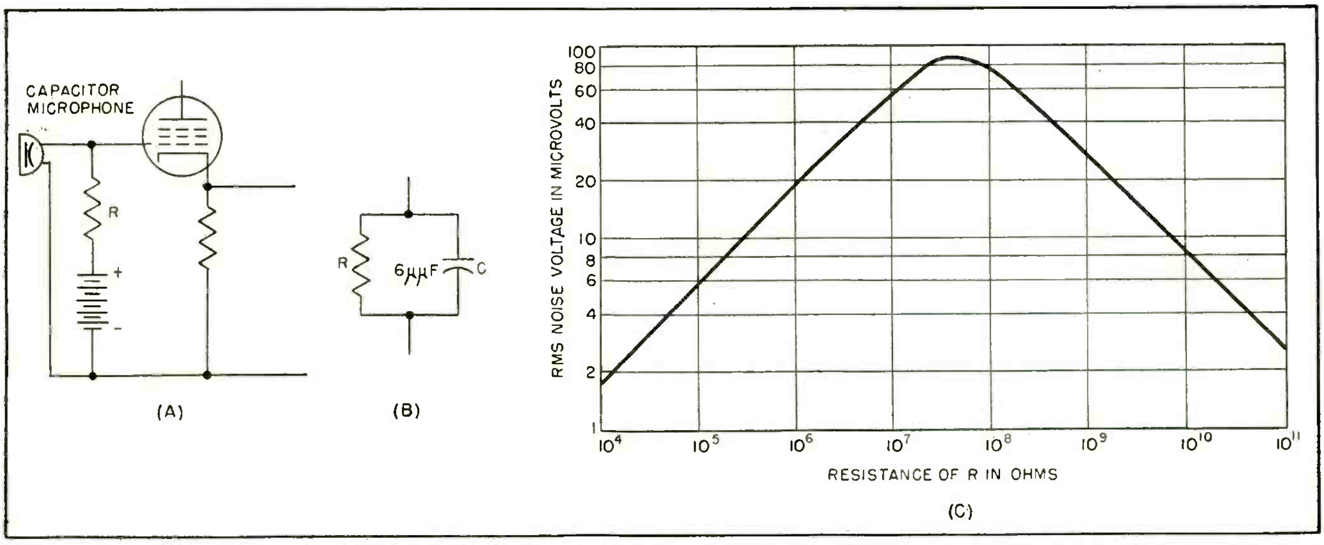

FIG. 1—Hypothetical microphone cathode-follower circuit (A) and equivalent circuit (B). Plot (C) shows open-circuit rms noise voltage produced by thermal agitation in real component of impedance of equivalent circuit

Low-Noise Input Stage for Audio Preamplifier

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Beverly Hills, Calif.

Free-grid-connected cathode follower has noise threshold of 20 to 50 microvolts with equivalent input resistance of 10,000 megohms. Circuit may be applied to capacitor microphones and other low-output signal sources requiring negligible loading

CATHODE FOLLOWERS have found much use as the input stages for devices requiring unusually high values of input resistance. When the signal source demands even higher resistance and lower noise threshold than provided by the conventional circuit, use of the free-grid connection offers many advantages. Such a special case is the Altec 21-type miniature capacitor microphone.

Load Resistance and Noise

In the application to be considered, the cathode follower is used as an impedance translator in close proximity to the capacitor microphone. In the hypothetical microphone cathode-follower circuit of Fig. 1A, a physical grid resistor R is used.

Following conventional practice in the operation of vacuum tubes, the ohmic value of R should be no greater than is required by the signal source, which in this case is a capacitance of 6 μμf. Since the source is capacitive, the ohmic value of R is equal to $1/\omega C$, where ω is 2π times the frequency at which a 3-db loss occurs. Selecting 20 cps as the cutoff frequency, R is computed to be 1,400 megohms.

The equivalent electrical network of this circuit is shown in Fig. 1B as a parallel resistor-capacitor combination in which C is the sum of microphone and stray capacitance and R is the grid circuit resistance. At 23 C, the thermal-agitation noise e for the network is

$$e = 1.27 \times 10^{-10}[(\tan^{-1} 2\pi f_2 CR - \tan^{-1} 2\pi f_1 CR)/2\pi C]^{1/2}$$

where f_2 and f_1 are the upper and lower frequency limits.

A plot of this equation for values of R is shown in Fig. 1C. The thermal noise e increases with R to a point and then assumes a negative slope. Returning to the hypothetical circuit of Fig. 1A, if the calculated value R is located on the graph of Fig. 1C, it will be found to fall beyond the noise maxima on the negative slope. A further increase in the ohmic value of R would result in a lower thermal-noise output. At this point, a resistance of such magnitude is being considered that its complete elimination is justified.

Free-Grid Tube

A decade ago, use of vacuum tubes in low-level circuits without benefit of grid leak was described At that time, plate-loaded tubes were investigated in which it was necessary to determine and provide proper bias for lowest noise operation.

In the microphone system circuit of Fig. 2, grid-leak resistors are absent as is any apparent biasing means. From cathode-loaded amplifier theory, it is known that if a positive potential is established at the grid, the cathode will assume a voltage providing proper tube bias, assuming the circuit constants are correctly established. The problem is one of obtaining a charge on the capacitor microphone and maintaining it at the desired potential.

One explanation is based upon the assumption that the most conductive path across the insulators is the one between grid and cathode. When the circuit is initially energized, full power-supply potential is applied between the plate and screen elements of the vacuum tube and ground. If the control grid were grounded, the cathode would rise to a voltage nearing the cutoff bias value of the tube. In this case, it would be 15 to 20 volts. The grid is not grounded, however. It is connected to a capacitor, which begins to charge to the cathode potential through the major conductive path between grid and cathode.

As the capacitor potential increases, the cathode potential also increases, reducing the voltage gradient across the tube. Since the cathode and grid potentials rise in unison, it can be seen that the microphone is charging to the bias potential, which is the difference in cathode-to-grid voltage. As the cycle nears completion, the charging potential, that is the bias, has reduced to the range of 1 to 1.2 volts and equilibrium is reached. It might be supposed that if this explanation were correct, the capacitor microphone would charge to the full cathode potential, thereby reducing the grid bias to zero. This cannot occur, since in the absence of a charging potential, the capacitor would soon discharge through the dielectric losses, again providing sustaining charging potential.

Stability

This circuit is not subject to drift of the polarizing potential with time giving rise to unpredictable variations in microphone sensitivity. Upon being energized, the circuit stabilizes within a few seconds. In addition, microphone polarizing voltage is more consistent with tube substitution than it would be with the conventional self-biasing arrangement.

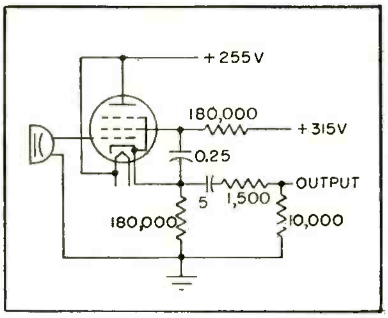

FIG. 2—Stick-type capacitor microphone has free-grid cathode follower incorporated into microphone base

To attain this consistency, the strictest requirements must govern the design and material of the tube socket, the pieces attached to the socket and the basing arrangement of the tube itself. The socket must be molded of a material having a high volume resistivity and low moisture absorption. Its mechanical design must provide maximum length to the surface leakage paths by means of barriers on the pin side and suitable recessing of the contacts on the tube side. These techniques provide consistent equivalent-input-resistance values in the range of 10,000 megohms.

Additional Noise Sources

The low self-noise value indicated on the graph of Fig. 1C is not realized in practice. This arises from the fact that leakage currents flow through the insulators, giving rise to noise through random-particle contact resistance and because part of the input resistance is integral to the tube itself. Hence, this resistance attains a temperature much higher than the 23 C ambient used for calculation. To limit temperature rise, the tube heater is worked at potentials ranging from 5.5 to 6 volts. In addition, to minimize noise arising from leakage current, plate and screen potentials are established at the lowest permissible values consistent with satisfactory transconductance and signal handling ability.

The circuit of Fig. 3 was used to determine the noise threshold of the system; E_o ranged from 20 to 50 microvolts.

A 200-volt battery was then substituted for the microphone, maintaining normal circuit voltages while eliminating impedance in the grid circuit. Voltage E_o, representing all circuit and tube noises exclusive of grid-circuit origin, thus measured between 4 and 8 microvolts.

To determine whether electrical leakage across the microphone insulator contributed largely to grid circuit noise, the 200-volt battery was connected between microphone case and circuit ground. The circuit voltages and the grid impedance were normal but the microphone polarizing voltage was zero, relieving the dielectric stress. Voltage E_o was 20 to 50 microvolts indicating that microphone leakage is not a major noise contributor. These values of E_o are 3 to 6 times greater than the thermal emf calculated, based upon an equivalent input resistance of 10,000 megohms.

The conclusion drawn from the above measurement is that the grid circuit of the electron tube is the major contributor. There are two prime sources of noise to be considered in the tube input circuit.

First, the tube operates at the free-grid potential, defined as the potential at which equilibrium exists between the flow of electrons and ions to the grid. Although the net grid current is zero, the flow of electrons and ions is random by nature, causing minute fluctuations of the grid voltage. The insulators within the tubes assume quite high temperatures, producing noise from thermal agitation and, in addition, are subject to d-c potentials causing noise through leakage. The latter is approximately proportional to the IR product of the insulators.

Noise distribution is of importance in the frequency band when the signal source is capacitive. For the network of Fig. 3, with $R \geqq 1 \times 10^{10}$, rms noise voltage on a per-cycle basis varies at a rate that is inversely proportional to frequency, above a nominal 20 cps. This is a fortunate circumstance in the case where the output is monitored aurally, since average ear deficiencies at low levels render much of this noise inaudible.

A suitable tube for free-grid use must have high transconductance, thereby reducing the input admittance to the minimum value. In the triode-connected follower, the susceptances of the interelectrode capacitances are appreciable. The magnitude of input capacitance is

$$C_{in} = C_{gp} + C_{gk}(1 - A \cos \theta)$$

where A is the magnitude and θ the phase angle of cathode voltage relative to grid voltage. The magnitude of the grid-to-plate capacitance, therefore, is not reduced by cathode-follower action.

The static grid-to-plate capacitance of the pentode is reduced by a factor of 500 to 1,000 by virtue of the screen grid. Although the geometric input capacitance may be larger than for a triode, it exists primarily between control grid and the cathode and screen elements. It is therefore reduced by cathode-follower action and may be expressed

$$C_{in} = (C_{g1g2} + C_{g1k})(1 - A \cos \theta)$$

Hence, when the pentode follower has a sufficiently high gain figure, the input capacitance is less than that of a triode. These factors, as small as they seem, are quite large when it is considered that the miniature microphone is a capacitive generator of only 6 $\mu\mu$f. Because it is capacitive, susceptance reduces microphone sensitivity without frequency discrimination. This might not be too great a price to pay for the simplicity of the triode. Before judging, however, the resistive component of the input admittance for the two types must be compared.

Conductive loads present the problems of noise and frequency discrimination previously discussed. If it is assumed that the cathode load is a pure resistance and the conductance term G_g mathematically determined, the result is found to be zero for triodes and pentodes.

Experimental Results

Considerable experimental work has been done with subminiature triodes. This consisted primarily of selecting types with appropriate characteristics, then obtaining quantities from different sources for actual tests in the circuit. A common difficulty proved to be a loss of sensitivity at low frequencies. Some of all types were involved but not all of any one type. It was felt that the rejection percentage was too high to be commercial.

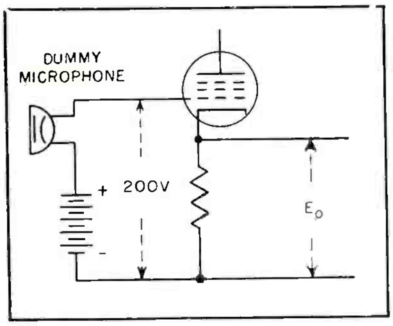

FIG. 3—Circuit used to determine noise

Since measured performance was not in agreement with theoretical results for leakage, it was felt that the losses were due to constructional features of the subminiature triode, rather than to dynamic characteristics. Accordingly, leakage-resistance tests were performed on a number of tubes. A motor-driven megohmmeter was employed which applied a stress of 500 volts. Scale graduations included calibrations to 10,000 megohms and infinity. The measurements were extended to pentodes for comparison purposes, in which case the suppressor and screen grid elements were connected to the cathode to simulate the dynamic operating condition. In all cases, the instrument guard circuit was employed to allow measurement between discrete elements.

As suspected, a portion of all triode tubes gave indication of leakage between grid and plate. The plate is at a-c ground in the cathode-follower circuit, therefore, this resistive component is directly in shunt with the microphone. In this respect, tube type 5718 was the best subminiature triode tested.

All samples were acceptable in terms of grid-to-plate conductance. The 5879 is a miniature 9-pin pentode. It was included for comparison as the only one of many types tested that was specifically designed for low-level audio applications. In consideration of leakage resistance only, this tube would seem to be superior. Some advantage may have been gained from its comparatively larger internal structure. However, tube manufacturers agree there are two other manufacturing improvements of consequence.

Condensation of getter material on the insulating mica supports within the tube causes leakage between elements. The 5879 contains a barrier between getter and top mica support, thus preventing contamination of this surface. The cathode sleeve, usually nickel, evaporates at a rate dependent upon temperature. It deposits on insulators in much the same way as the getter with the same end results. To minimize this, the tube is processed at a low temperature and fitted with a cathode, which in operation functions at a moderately low temperature.

Visual Evidence

Representative subminiature triode and pentode tubes were dissected to see if the measured result could be correlated with visible mechanical features. The triode types were similar in construction and without exception had plate-support tabs passing through mica insulators in close proximity to the grid-support rods. By comparison, the spacing in the pentode was at least ten times as large. In addition, r-f shielding in the pentodes consisted of metal barriers in contact with the mica supports and arranged in a way to isolate the grid from the plate. Since these shields are normally connected to the cathode, they reduce both conductance and susceptance.

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FIF. 1—For video switching, crosstalk is attenuated over 60 db at 4 mc in this Danbury-Knudsen coaxial relay

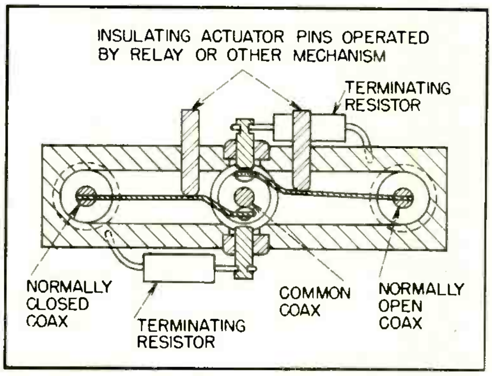


FIG. 2—Actuator pins transfer spring arms between center conductor of common coax and pin grounded through terminating resistor

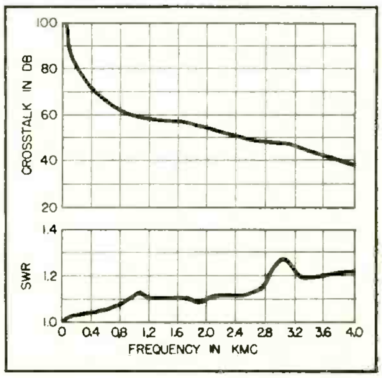


FIG. 3—Measured crosstalk and swr for coaxial spdt relay in which blade shorts to cavity wall in one position

Special-Purpose Relays

Design refinements in choppers, resonant relays, thermal relays, high-speed relays, contact modulators, a-c/d-c relays, coaxial relays and vacuum relays give improved performance and reliability, thereby broadening markets into many new fields of use

CONNECTING and disconnecting electrical circuits, although basically elementary operations, take on many forms in accordance with the operational requirements of the equipment and the functional limitations of the circuits. In the previous article of this series, several relays designed specifically for opening or closing circuits under command were described. Here, various more specialized relays are described to illustrate the flexibility of recent designs in such electromagnetic-mechanical devices.

Coaxial Relay

A coaxial relay or switch presents a problem not normally encountered in switches for lumped-constant circuits. The switch must, in some applications, present the same impedance to the line opened as when closed. The problem is somewhat related to the circuit loading requirement that necessitates use of a make-before-break contact at lower frequencies. The unit of Fig. 1 provides this constant impedance by the arrangement shown by Fig. 2.

Basically this switch consists of two blades mounted in coaxial connectors, placed in a shielded cavity and deflected by insulating pins. As one blade contacts the center common coaxial contact, the other blade contacts an insulated terminal to which a terminating resistor is connected. This construction is used for video switching, where it terminates each input circuit in its characteristic impedance when not connected to the common output.

In circuits where the disconnected line should be terminated in a short-circuit, the blade grounds to the cavity wall in its open position. This construction attenuates crosstalk by 70 db at 400 mc, compared to 40 db for a T-type switch where one blade is alternately deflected to contact one of two opposed contacts, thereby terminating the disconnected line in an open circuit. In addition, the dimensions of the blade, cavity and coaxial connectors have been selected to match the impedance of 50-ohm cable, so that the grounding coaxial relay is reported to be useful well into the microwave region. Figure 3 presents manufacturer's measurements for a spdt coaxial relay with type-N connectors.

A further variation of the grounding relay is a multiposition unit. Two cavity blocks are stacked crisscross, with the common coaxial contact extending through each cavity. Energizing any one relay moves its pin to deflect the associated blade, thereby closing that circuit to the common contact. Switching time is approximately 0.015 second; the operating coil requires approximately 1.5 watts; crosstalk is similar to that of the spdt unit; swr is below 1.2 up to 800 mc. Development is under way to extend this construction up to 16 inputs with characteristics suitable for vhf operation.

Rotary coaxial switches for connecting a generator to any one of as many as six separate loads, manufactured by Thompson Products,

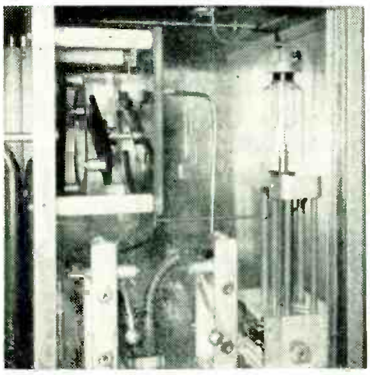


FIG. 4—Vacuum relay for 10-kv power supply has adjustable trip setting from 1 to 8 amp (Jennings Radio)

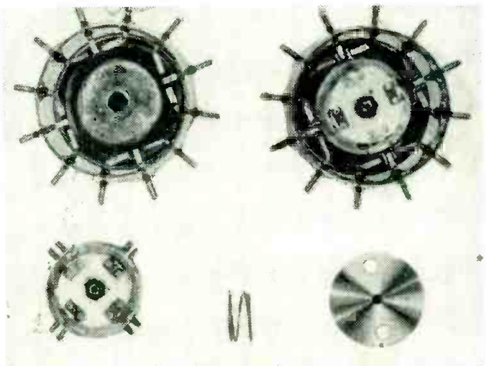


FIG. 5—Jennings multiple-pole double-throw vacuum relay can switch several high-voltage high-current circuits in synchronism

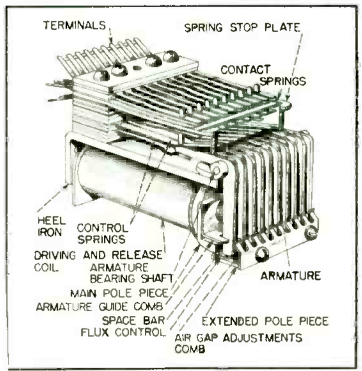


FIG. 6—Ten armatures are attracted sequentially by series of pulses applied to single winding (Kellogg)

Gain New Uses

By FRANK ROCKETT*

Airborne Instruments Laboratory, Inc. Mineola, N. Y.

* *Now with Airpax Products Co.*

are rated for a maximum swr of 1.5 up to 11,000 mc, 0.2 insertion loss, 60-db cross-talk attenuation at 3,000 mc and a characteristic impedance of 50 ohms. They handle 100 watts r-f at 3,000 mc (700 peak r-f v) and operate from −65 F to +165 F with a life of 100,000 actuations.

Vacuum Relay

For switching higher r-f or other voltages encountered in electronic equipment, vacuum relays are used. Switch capacitance is one micromicrofarad or less between open contacts. Some units are rated 5 to 100 kv and continuous current from 1 to 800 amp. The tungsten contacts of such units are held together by an external spring or solenoid, the contacts operating in an extremely high-vacuum enclosure.

Because the dielectric strength of a high vacuum is thirty times that of air, a contact separation of 0.25 inch holds off 100 kv. Deionization time is shorter than for other interrupting media. For example, total breakdown time at 10 kv d-c is only about 5 milliseconds. The negligible sparking and the ability of tungsten to make at high currents without welding result in such life as over 59,000 operations of one relay in a spot welder control making a 100-amp 200-v inductive load.

The trip-free overload circuit breaker of Fig. 4 protects a radio communication transmitter from overload. The lower contact is sealed in a bellows to be movable and is driven by an external solenoid.

For multiple-pole double-throw operation the construction of Fig. 5 has recently been introduced commercially. In the unit shown, four sets of double-throw contacts are sealed into the periphery of the evacuated glass envelope. The unit has a d-c solenoid in the base that moves a clapper plate. Attached to the clapper plate is a ceramic disk with shorting bars attached to it so that the center contact of each set is connected from one outer contact to the other when the relay is actuated. Design emphasis in these units is on switching high currents at high voltages.

Magnetic Impulse Counter

Where the need is for handling a high amount of information at low level, the magnetic impulse counter of Fig. 6 is available. Based on the familiar telephone relay, this digital relay actuates ten sets of contacts sequentially from a single coil without the use of latches or dogs and escapements.

Armatures once attracted are held by residual magnetism in the core until a single pulse applied to a second coil erases the residual magnetism. Associated with each armature is a normally open and a normally closed contact. Standard contact material is palladium, but gold alloy is supplied for low-impedance applications. The small, light-weight armatures ro-

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
Part III: Fixed Resistors Show Stability Improvements, p 132, Sept. 1954
Part IV: Precision Potentiometers Use New Materials, p 144, Oct. 1954
Part V: Iron-Core Transformers Run Smaller and Hotter, p 136, Nov. 1954
Part VI: High-Frequency Coils Use New Core Materials, p 140, Dec. 1954
Part VII: New Relay Materials Improve Performance, p 144, Jan. 1955

COMPONENT DESIGN TRENDS

- Coaxial relays for video switching provide desired impedance match whether open or closed
- Vacuum relays give long life at high voltages and currents in transmitter and spot welder applications
- Solenoid moves ceramic clapper plate in vacuum relay having sealed-in-glass contacts
- Ten-armature counting relay actuates ten sets of contacts one by one; single reverse pulse releases all contacts

tate through so small an arc that life is expected to exceed 10^8 pulses. As with many relays, coils are available for operation within voltage variations of 10 percent of nominal for 6, 12, 24, 48 and 115 v d-c.

The coil core is flat, hard steel with sufficient residual magnetism to hold an armature in its operated position against the contact springs. A pulsing winding at the armature end of the core drives the armatures; a knockdown winding at the heel end releases all armatures. Ten parallel magnetic circuits, completed through the heel iron, are formed by the ten armatures and a double comb assembly that mounts on the main pole piece and an extended front pole piece.

Each armature except the first is initially held against a tooth of the outer or air gap adjustment comb (Fig. 6) by a load spring (upper of the two control springs). When the counter is at its open-circuit position, the first armature is held by the control spring in what is termed the half-step position; that is, with the lower segment of the armature approximately half-way between the main and the front pole pieces. In this position the armature is beyond the influence of the front or extended pole piece and within the pull-in range of the main pole piece.

The first pulse of current to the driving winding attracts only the first armature to the main pole, thus operating the associated spring contacts. During this pulse, the other nine armatures are held by magnetic pull against the front pole piece.

After the first pulse, residual magnetism holds the first armature in its operate position. In this position the first armature has lifted its upper control spring. This spring overlaps the second armature, but being lifted no longer loads it. The motor spring (lower of the two control springs) under the second armature then moves the second armature into its half-step position so that it will operate on the next pulse. The motor spring has only sufficient tension to overcome the residual magnetism through the front pole piece. Because of clearance between the armature arm and the ladder that drives the spring contacts, motion of the armature into the half-step position does not actuate the contacts.

The second pulse of current pulls in the second armature, thereby actuating the associated contacts and lifting the load spring to free the third armature so that its motor spring can advance it to its half-step position. The sequence of operations continues until all ten sets of contacts are actuated or until a reverse pulse of current through the release coil neutralizes the residual magnetism, at which time the overlapping load springs return the armatures against the front comb.

This impulse counter relay mounts in a space equivalent to two standard telephone relays and weighs 1.25 lb. Tests to determine the counter's ability to remain operated on its residual magnetism showed that the armatures remain operated with no current to either winding for more than four months. Tests were discontinued after this interval because it exceeds all foreseeable requirements. Operating current at 48 v is 0.62 amp. Minimum duration of applied pulse is 0.016 second; operate time is between 0.006 and 0.008 second; minimum interval between applied pulses is 0.016 second; minimum duration of release pulse is 0.050 second.

Thermal Time-Delay Relays

The trend, apparent in all electronic components, toward smaller size and less reaction to environment has resulted in miniaturized hermetically sealed thermal time delay relays. Units made by George Ulanet Co. are representative of this trend. Thermal timers are used for long delays because of their low cost, ability to provide a

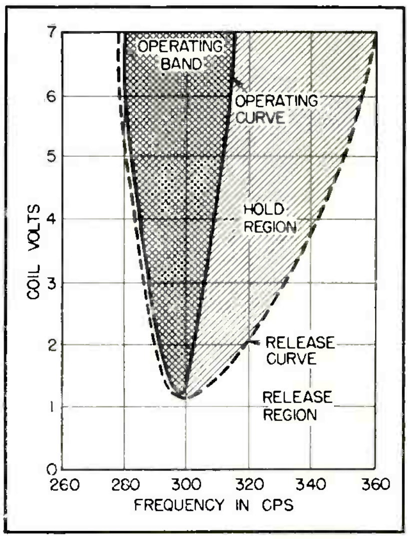


FIG. 7—Typical characteristic of resonant relay shows that operate and release are substantially at same coil voltage below resonance

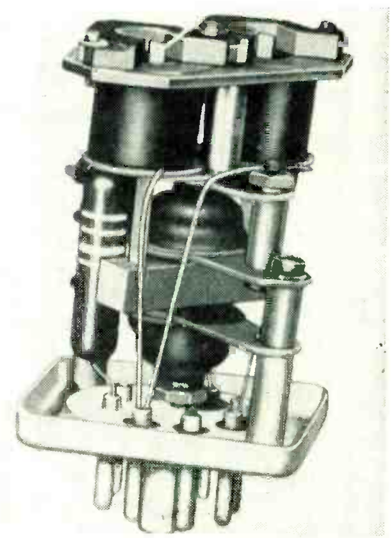


FIG. 8—Frahm oscillator control consists of two reeds mounted on a bar to form a vibrating element isolated by rubber mounts from base (James G. Biddle)

definite time lag or a time lag proportional to overload and ability to take elevated ambient temperature.

At G-V Controls, over 90 percent of their thermal relay production is now devoted to miniature units for mounting in a miniature 7-pin tube socket or directly on a chassis in a punching the same as that for a 9-pin socket. Older units plug into an octal socket. Although hermetically sealed, the delay of these units is adjustable over a 5 to 1 range by an external screw that deflects an arm passing through a diaphragm. Delays of 0.25 second to several minutes are provided by such units. Within 3 or 4 seconds after being de-energized these relays are ready to time another cycle.

These miniature thermal relays consist of two rigid stainless steel bars of equal length which expand equally with temperature rise. The heating element is embedded in one member. A hinge between the two rods carries a long contact arm that is deflected by any differential expansion of the rods to actuate the contacts, which can be either normally open or normally closed. Contact force is about 30 grams and the contacts have a slight wiping action. The nominal time delay is predetermined by the thermal mass of the bars; tolerance is somewhat less than ± 10 percent of normal time delay and is maintained over a range of −70 C to +70 C.

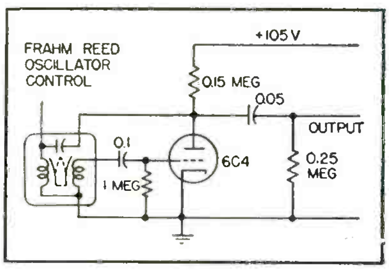


FIG. 9—Oscillator circuit with resonant-reed control of frequency provides 1.5 v output at 20 C with 20,000-ohm load

In addition to the usual characteristics of relays such as life, power drain, contact voltage and current rating, insulation, chatter and effect of shock and vibration, thermal relays have a re-operating time and a recovery time. The re-operating time is the interval which elapses after power to the heater is cut off at the operating point until it re-operates the contacts (closing normally closed contacts, for example). Recovery time is the interval that must elapse after power to the heater is cut off at the operating point for the relay to recover its ability to repeat a specified portion of its timing cycle. Re-operating times are usually of the same order as rated delay times. At the re-operate time a thermal relay has generally recovered about half its rated delay and usually requires about five times its delay time to recover substantially full delay.

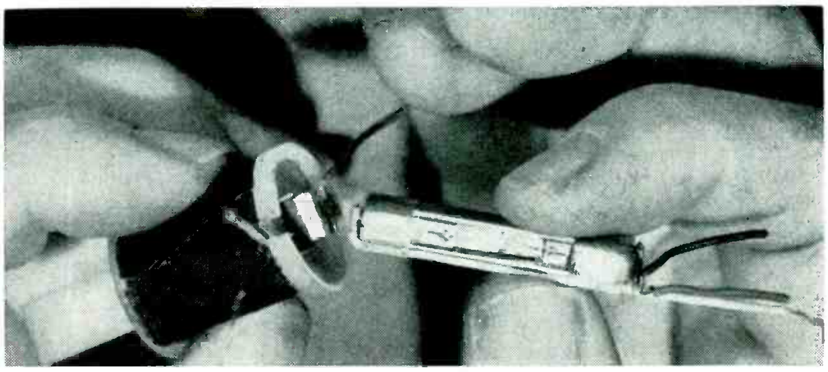


FIG. 10—High-speed relay operates in 0.2 millisecond when driven from a high-resistance power source, and releases somewhat faster (Stevens-Arnold)

To avoid chatter and intermittent contact during the interval that a thermal relay is actuating its contacts, Elly Electronics Corp. manufactures a unit actuated by a bimetallic element with a snap action that develops 20 grams of contact force at the instant of actuation. If the heater remains energized this force increases considerably. These units actuate a spdt switch with silver contacts rated for 10 amperes a-c. Units with twice this rating are under development.

The snap-action thermal relay is compensated for operation from −55 C to +85 C and provides a delay of from 2 to 200 seconds accurate to ±15 percent. It can be supplied, because of the snap action, in a wide range of re-operate times. A laboratory model of this relay operates on one watt, about a quarter of the power usually required.

Resonant Relays

For multiplex telemetering, resonant relays serve both to discriminate between signals of different frequencies and to respond to their respective signals. The Stevens-Arnold resonant relays are designed to respond to a relatively small signal, as shown in Fig. 7, and to actuate an auxiliary relay or thyratron. A vibrating reed mechanism is adjusted at the factory to respond to a narrow band of frequencies. In response to energy at the resonant frequency, the contacts vibrate, closing the controlled circuit intermittently at the resonant frequency. Either a slow-acting relay or an electronic circuit can thus be energized. Standard frequencies are 60, 153, 170, 189, 210, 234, 260, 289, 322, 357, 398 and 442 cps with a bandwidth of ±1 percent minimum at 3 v. There is sufficient spacing between these frequencies to prevent unwanted operation either by another frequency or by a harmonic of another frequency.

Only 20 milliwatts operates a relay at 3 v. Coil resistance is 500 ohms. Contacts are rated for 110 volts d-c at 0.25 amp maximum; contacts are closed for 5 percent of the time.

For signaling at frequencies from 50 to 1,000 cps, a pair of resonant relay units is available consisting of an oscillator control unit shown in Fig. 8 and a reed relay. In the range of 200 to 500 cps, up to 16 channels terminated by such units can operate without interference, the control unit producing a signal at a preset frequency and the relay unit responding to it.

The oscillator control unit consists of a miniature tuning fork used in a circuit such as that of Fig. 9. A drive coil around one reed and a pickup coil around the other couple the mechanical structure to the electrical circuit. Operated in the range of 200 to 1,000 cps, the circuit provides a buildup time of

- Miniaturization and hermetic sealing permit high ambient temperatures, extending uses of thermal time-delay relays
- Tube-socket mountings gain favor for many types of relays
- Snap action reduces chatter in thermal relays
- Resonant relays become more frequency-selective, permitting operation on more channels for given bandwidth in multiplex telemetering
- Thin leaf-spring armatures minimize inertia of moving parts in high-speed relays

less than 30 seconds, an initial frequency within ±0.15 percent of nominal value at 20 C and a temperature coefficient of frequency (for the control separate from the oscillator) of less than −0.003 percent per degree C from −40 C to +80 C.

The signal so generated is transmitted to a mating reed relay. By coding the information to be transmitted as combinations of *n* frequencies, with 16 channels available between 200 and 500 cps and, for example, four relays required to respond for each control function, 1,820 control functions can be handled.

The speed of response of a resonant relay depends on the signal level. These units can be operated at any level between 20 and 200 ampere-turns. At low levels the operating power is in the order of 20 milliwatts, with response time within 25 cycles after a suddenly applied signal; at one watt, response time is less than 8 cycles. Coil resistances are available from about half an ohm to over 500 ohms.

The vibrating contacts are closed about 5 percent of the time during operation; they are rated for 0.75 amp and 200 v. For long contact life, an auxiliary relay should be used that operates at between 20 and 50 milliwatts.

High-Speed Relay

For the most part, the speed of operation of a relay is determined by the inertia and spring loading of the armature. In the spdt unit of Fig. 10, the armature is a leaf spring carrying the movable contact, thereby minimizing the inertia of the moving parts. The normally open contact is supported on the pole piece, while the normally closed contact is supported on a copper strip. This switch assembly is supported in a brass channel and constitutes the core for the coil. (A similar construction is used in a vacuum switch recently developed by Revere Corp. of America.) When the coil is energized, the armature deflects to close the air gap in the magnetic circuit, thereby transferring contact from one fixed contact to the other. An electrostatic shield surrounds the switch assembly.

Rated operating power is as low as 240 milliwatts for spdt and 480 milliwatts for dpdt. Pull-in current is about a third to a half of rating; drop-out current is about a fifth of rating. With constant-current operation, wherein the resistance of the driving circuit at least five times the resistance of the coil, first contact is made 0.2 millisecond after applying power and firm contact is achieved in 1.0 millisecond. After power is removed, the normally open contacts release in 0.1 millisecond; 0.05 millisecond later the normally closed contacts first reclose, and by the end of 1.0 millisecond firm contact of the normally-closed contacts is re-established. Constant-voltage operation produces slower closing times; somewhat faster operation is possible if the R-C time constant of the constant-current generator is in the vicinity of half a millisecond.

Two types of contacts are available for this relay: gold alloy rated up to 110 v and 0.25 amp, and platinum-rhodium rated from 10 to 110 v and from 0.05 to 0.5 amp. Contact resistance of gold alloy contacts is low and stable but the life of such contacts is short if they pass appreciable current. Platinum-rhodium contacts can handle higher current but tend to develop slightly higher contact resistance in use. With either contact material, a spark suppression circuit is required if the relay is connected to an inductive or a capacitive load.

For an inductive load, the suppression circuit consists of a series resistor and capacitor shunting the contacts to provide a critically damped loop with the load. For a capacitive load, a resistor in series with the contacts limits the current to within the contact rating.

A-C/D-C Relay

Heretofore relays have generally been adapted for operation from a-c power sources by using shading coils and other techniques for producing sufficiently slow response to prevent the armature from chattering. Recently developed high-efficiency dry rectifiers provide an alternative solution, illustrated by an a-c/d-c relay being currently introduced by Hi-G Inc. There are a variety of features of this relay indicative of modern trends.

The unit is compact and houses a full-wave bridge rectifier using four miniature germanium diodes and a d-c relay in a hermetically sealed case. Thus the relay operates on d-c of either polarity or on a-c without chatter. The diodes are mounted so that their heat is conducted to the outer case for dissipation. Like so many other components being developed today, this one was initially designed for airborne use on 400-cps power so that a complete switching circuit could be powered directly from the a-c line.

The rotating armature is both statically and dynamically balanced, with the result that the relay withstands shock in excess of 100 g and vibration accelerations in excess of 20 g at 2,000 cps. The armature has a double air gap to produce high torque and fast action in driving the contact arms firmly against solid silver ball contacts. Resilient contact arms provide armature spring return, so that accessory springs are unnecessary. A wiping action keeps the point of contact clean; contact current of 4 amperes can be controlled with a life of over 10^5 operations. Units operating under normal conditions have exceeded

400,000 cycles of operation.

To test the contact noise of these units, a potentiometer noise tester is used to measure relay contact resistances as low as 0.01 ohm. The relay is placed on a shake table and the noise tester used to detect any brief instant when contact resistance rises above a defined threshold.

Where utmost reduction in space and weight is required, entire relay switching networks, including single and ganged relays, are hermetically sealed in a can for custom packaging.

Contact Modulators

Related to spdt relays but requiring some special considerations, especially as to life and symmetry of operation, contact modulators are coming into prominence in automatic control and related applications. Illustrative characteristics of such a unit, for a low-noise model developed by Iron Fireman Manufacturing Co., include reed resonance sufficiently above 800 cps so that input and output can be varied from 60 to 800 cps, 65-degree phase angle between switch action and impressed drive voltage at 400 cps, spdt break-before-make contacts rated from 1 to 10 v d-c and 100 μa with a life in excess of 2,000 hours, drive coil rated for 6.3 v a-c, plug-in mounting for an octal tube socket and construction to withstand usual military and industrial environments. This unit, like the one illustrated in Fig. 11, brings the coil leads out through the top and the contact leads out through the base to minimize pickup of the a-c drive voltage in the signal circuit.

The unit in Fig. 11 is available in two models, for operation at 55 to 65 cps or at 45 to 55 cps. Like the high-speed relay described above, either gold alloy contacts (rated to 1.5 v d-c and 1 ma) or platinum-rhodium contacts (rated from 1.0 to 50 v d-c and 5 ma) are available. The 77-ohm coil is rated for 6.3 v a-c at 90 ma maximum; phase angle between switch action and drive voltage is 22 degrees. A companion chopper is rated for operation from 0 to 500 cps with spdt gold alloy contacts. The unit is rated for a noise of 200 μv, and for 100 μv on special order.

Noise is defined to a great extent by the method of measurement. The setup of Fig. 12 is used at Stevens-Arnold. The decade amplifier and vtvm are commercial units such as Ballantine models 220 and 300. The chopper mounting should be thoroughly shielded. To check the effectiveness of the shielding, disconnect one of the leads to the chopper coil at its source. The steady reading of the voltmeter should be less than 0.001 volt with an amplifier gain of 100, although random fluctuations may send the pointer above this limit. With the chopper operating the noise level is the indicated voltage divided by the amplifier gain. This is the unsymmetrical output waveform of the noise voltage converted by the meter into the rms of an equivalent sine wave.

Where a chopper is used in a null-seeking circuit, the noise masks and thus broadens the null. If, as is the case in such a circuit, the chopper is to operate most of the time near this null, contact rating at low current and voltage may be more significant than full rating. Here, however, as in most contact switches, life decreases rapidly as the volt-amperes to be interrupted increases above the design limit.

Symmetrical Chopper

Another consideration in the choice of a chopper for a particular application is symmetry. Inevitably some drive voltage leaks into the signal input circuit where, if it is not removed by a filter, it is transmitted by the synchronous switch together with the d-c signal. Depending on the phase angle between the switch action and the impressed coil voltage, the chopper will tend to attenuate the in-phase component (phase angle of switching action near ±90 degrees) or the quadrature component (phase angle of switching action near 0 degrees). For perfectly symmetrical switching action, both components vanish. As the switching action becomes asymmetrical, the quadrature component rises rapidly but the chopper transmits less than 10 percent in-phase component for an asymmetry as much as about 25 percent. Thus, both switching angle and symmetry are important properties of choppers. Where the switching angle is stable, a phase-shifting cir-

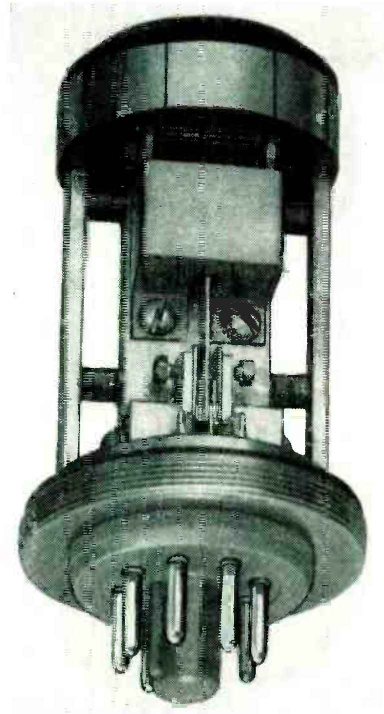


FIG. 11—Chopper housed in Mu-metal case, giving noise level below one microvolt into 100,000-ohm load, rated for operation from 0 to 43 C (Stevens-Arnold)

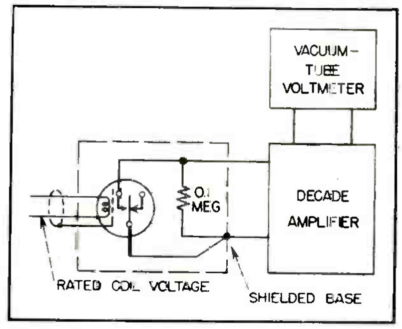


FIG. 12—Measuring noise from chopper

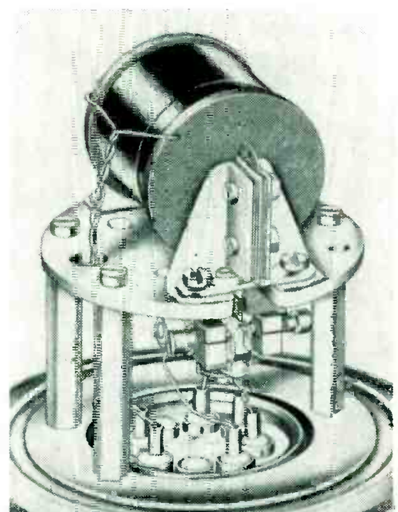


FIG. 13—Chopper provides highly symmetrical low-level switching with stable phase of switching action (Bristol Co.)

COMPONENT DESIGN TRENDS

- Germanium-diode bridge rectifier in relay housing permits operation on either a-c or d-c
- Low-noise contact modulators for automatic control applications use symmetrical vibrating-reed construction
- Relay-type choppers withstanding 30-g shock now being designed
- Heavy-contact choppers withstand 1,000-hour life test
- Photoelectric choppers exceed 10,000-hour life

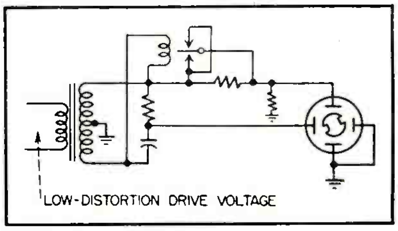


FIG. 15—Test setup for measuring dwell times of Airpax chopper. Accuracy is improved by reversing polarity to drive coil to interchange dwell time periods

cuit can be placed in the coil drive circuit to provide the desired angle if the inherent angle of the chopper is otherwise.

The chopper of Fig. 13 is specifically designed to achieve symmetrical switching (asymmetry below 0.5 percent). The unit provides dpdt action for both synchronous modulation and demodulation of the signal. A permanent magnet constitutes part of the magnetic circuit to bias the switch, as in a polarized relay. The armatures, 0.007 inch thick and weighing only 0.03 gram, are free from resonances up to several thousand cps. Thus, at usual operating frequencies, the switching angle is relatively independent of frequency.

Substantially full reed driving force is developed within a small electrical phase angle after the coil current passes through zero, so that changes of ±20 percent in coil current cause negligible shift in switching phase. The unit makes possible discrimination of a 0.05-μv signal in the presence of stray power line voltages 2,000 times greater, can be operated from 0 to 3,500 cps and has contacts rated for 3 volts and 2 ma with resistive load. A group of units on accelerated life test at 600 cps operated satisfactorily for over two years. A miniature version of this nonresonant reed inverter is hermetically sealed, shock and vibration resistant and fits seven-pin miniature tube sockets and shields.

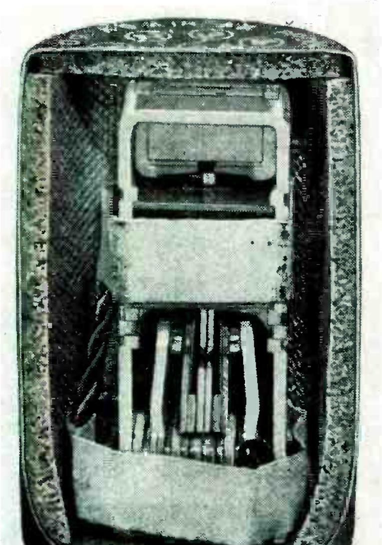


FIG. 14—Cutaway of chopper in which oversize contacts operated with high impact give long life (Airpax Products)

Design for Reliability

As with the other components surveyed in this series, reliability is becoming a pressing problem. If the design of a chopper is such as to withstand environmental extremes, the factors that remain to limit life are erratic contact action, manifesting itself as changes in dwell time, and the appearance of contact resistance. If the contact resistances to the two fixed contacts becomes unequal, the modulation is unbalanced; that is, there is an offset error. An insidious aspect is that the resistance is erratic and may go unnoticed in life tests yet cause faulty operation in equipment.

In the chopper of Fig. 14, large, heavy contacts are driven to produce high impact force, rapid break and wide opening traverses. As a consequence, the unit is capable of handling substantial power during momentary overload. A bolster plate provides damping to limit chatter at closure and to accelerate the contact quickly at break. The units are life-tested at rated 400 cps for 1,000 hours on recording equipment that measures average dwell time for a d-c signal of 50 μv at 50 μa, using the circuit of Fig. 15. Although the tests are discontinued at 1,000 hours (1.44×10^9 operations) to release the test racks for the next sample, users have reported lifes in excess of 5,000 hours. The contacts of this unit are rated for 2 ma and 100 v.

Several miniature versions of this basic structure are available, one rated for operation from 30 to 110 cps, and two models rated for operation to +200 C. All electrical connections are spot-welded; no organic materials or binders are used. Continuous life tests of these units at 200 C indicate that performance is substantially as good as at normal ambient. The leads to the drive coils of these units are twisted.

During final assembly of these choppers at Airpax, dwell times are individually adjusted to equality by observing the times of closure and break as displayed on a circular sweep, from which phase angles can be read accurate to a degree. Phase angle is also checked so that, in those applications where necessary, a phase-correcting circuit can be relied upon to provide the desired contact phasing.

Phase angle of a 60-cps unit 1¼ in. high is held to 21 ±5 degrees, although a tolerance of ±15 is more usual on other models in anticipation that they will be used in circuits that rely upon filters and shielding in the low-level d-c signal input circuit to minimize leakage from the drive voltage. The phase angle of a 400-cps unit is near 90 degrees to minimize transmission of the in-phase component of the driving sine wave. The balance of this unit is within 15 degrees, and it is intended for circuits with well-shielded or filtered signal input.

Counting Circuit Batches Components

Articles such as paper, sweets, buttons and metal parts are automatically counted and batched at count speeds up to 400 per second in quantities of two to 1,000 units. High accuracy of count and special counter packaging ensure long-term reliability

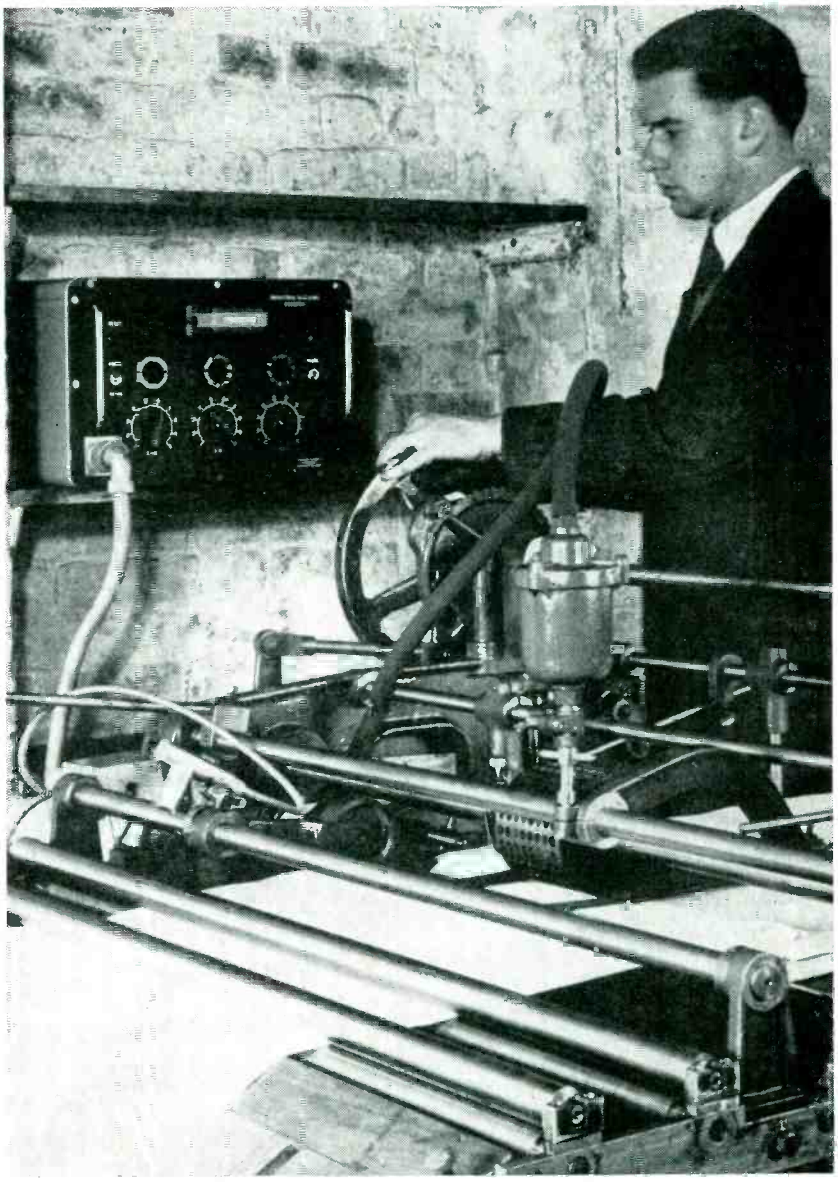
By P. E. TOOKE *Electronic Machine Company Thornton Heath, Surrey, England*

PRESELECTED batching of steel components for various industrial uses is accomplished by a recently developed batching counter.

The counter was designed for a firm requiring batching of small steel components automatically at high speed. The transfer mechanism used to separate the batches was already installed and working, the limiting factor being the necessity of weighing the components against a standard batch before initiation of this mechanism. Also, due to the components being hot when weighed, heavy asbestos gloves had to be used, with consequent reduction of speed and efficiency. A fully automatic system was desired, which would count the components passing along a conveyor belt and after a predetermined number had gone by, would initiate the transfer mechanism.

Requirements for operation of the transfer mechanism are simple. A solenoid operating a small clutch is energized over for a period of not less than 0.1 second. This starts a chain conveyor with buckets to take the selected number of components. During this time the counter is required to reset itself and continue counting since the articles are fed at the same speed during separation of the batches.

The equipment is used in a hot metallic-dust-laden atmosphere and is therefore completely sealed. The problem of heat dissipation was overcome by using cold-cathode



Typical installation of counter on paper cutter counts and batches sheets of paper into quires or other quantities tubes throughout. Due to the very low heat radiation, the equipment runs for 8 hours with a temperature rise of only 10 deg C.

The batch number is selected by three front-panel switches, arranged to select units, tens and hundreds, so that direct reading can be obtained of the number selected. A reset button permits manual zeroing.

Counter Tube Operation

Three GS10C Dekatron selector tubes are used in the counter. These tubes have a counting rate of 550 a second, easily covering the speed requirements. They consist of 30 cold-cathode diodes in a common envelope. The cathodes are in the form of rods and are mounted around a common central plate. The plate is connected through a high resistance to a positive supply of 400 volts. When the cathodes are returned to the negative point, one of the plate-cathode gaps ionizes and the glowing cathode can be seen through the front of the tube. Plate current flows through the plate load resistor and the voltage at the plate drops to the maintaining voltage of the glow. This voltage is less than the voltage required to strike a further discharge, therefore only one cathode glows.

If a cathode adjacent to that already glowing is made negative the ionized gas already in close proximity to this gap causes the breakdown voltage to be only a few volts greater than the maintaining potential and therefore this cathode will strike. Two adjacent cathodes are now glowing, but as there is a constant potential difference between plate and glowing cathode, the plate follows the negative-going cathode potential. This reduces the potential difference across the gap, which was originally glowing, until it is insufficient to maintain the discharge; the second cathode then carries the plate current. Thus the glow circulates. The waveforms of the voltages applied to the cathodes must be such that each electrode is, in turn, the most negative.

The first, fourth, seventh, etc cathodes are all connected internally; the second, fifth, etc likewise. The remaining cathodes are brought out to the tube base separately. The two rings of cathodes are referred to as guides 1 and 2, the next electrode clockwise to any cathode being guide 1.

In operation the second guides are biased positive with respect to the cathodes by a potential at least equal to the transfer voltage. Then at the cessation of the pulse on these electrodes, the following cathode will appear negative and the glow will leave the second guide.

Counter Circuit

Figure 1 shows the counter circuit. The input impulse from the photocell amplifier is fed through C_1 to the trigger of V_1. The +170-volt positive bias on this tube ensures that it will trigger with a positive-going pulse in excess of 5 volts. The plate of this tube is coupled to the first guides of V_2 through C_2.

The second guides are fed from a tap on the plate load through C_3. When V_1 triggers, both capacitors discharge and due to the tapped plate load, the negative pulse passed to guide 1 is larger in amplitude than that at guide 2. Therefore the glow discharge in V_2 transfers from cathode 0, to guide 1. On discharge of C_2 and C_3, V_1 resets due to the insufficient current passed by the plate load, which unless supplemented by the discharge of the capacitors will not maintain the burning voltage.

The charging of C_2 and C_3 causes guide 1 of V_2 to become more positive than guide 2 because of the difference in time constants, thereby causing the glow to surround guide 2 until it becomes sufficiently positive with respect to the cathodes. The glow then transfers, completing one count. This sequence occurs until the output pulse from cathode 10 of V_2 triggers V_3, which then drives V_4 and so on.

Gate and Reset

Figure 2 shows the coincident gate and reset circuit. Should any cathode of the GS10C tubes be made negative to all the others, the glow will jump to this cathode. This offers a convenient method of resetting the counter to zero, by feeding a negative pulse to all transfer cathodes. The sliders of the three selector switches, having been

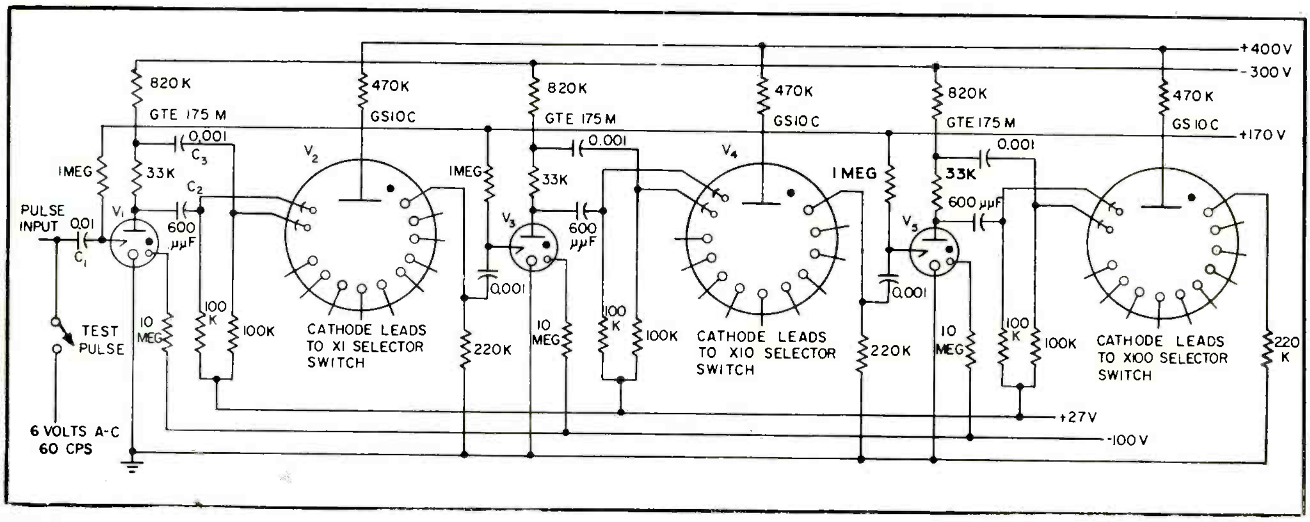


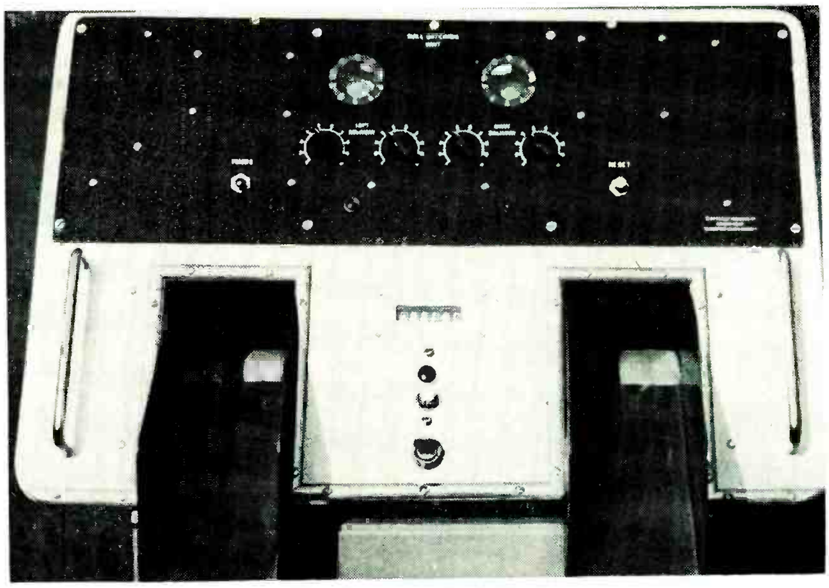
FIG. 1—Counter circuit uses three GS10B dekatron selector tubes. These tubes have a counting rate of 500 per second. Test-pulse switch permits injecting of 60-cycle signal into counter to check its operation

switched to the required cathodes, are connected to blocking crystal rectifiers. Bias is applied to the positive side of these rectifiers, which are also connected to the trigger of gating tube V_1.

During normal operation, the rectifiers pass current through the 220,000-ohm load resistors. However, when the glow discharge rests on a cathode which has been selected, the current passing through that cathode load causes a voltage drop to appear across it, which is sufficient to block the rectifier. Since there are still two other rectifiers passing current, the voltage at point X does not rise until all the selected cathodes have a glow resting on them. Then as all rectifiers are blocked, the positive voltage rise at point X fires tube V_1.

To give counts of less than 100 or 10, the cathode load resistors are returned to the blank pin on the selector switch, which in all other positions but zero is grounded by the grounding slider. On being switched to zero, however, the rectifier for that circuit is open-circuited, allowing two rectifiers or only one rectifier to block before V_1 is triggered. On V_1 triggering, the negative-going pulse at the plate is fed through three crystal rectifiers to the tenth or transfer cathode of each counter tube.

The negative pulse developed across the plate load of V_1 is large enough to reset the GS10C tubes to zero. Tube V_2 is triggered by V_1. Coupling capacitor C_1 on discharging resets V_1 ready for the next batch pulse. A large capacitance C_2 across V_2 ensures that the relay in the cathode circuit is held on long enough to operate a small solenoid. Discharge of this capacitor also resets V_2 for the next pulse.



Counter for batching bread rolls into two loading chutes

Pickups

Various types of pickup heads have been used with this counter, such as photocells, magnetic pickups and snap-action switches. Use of a P50A (Standard Telephone & Cable, Ltd) transistor photocell has extended the field. Due to the small size and high output of the P50A, it is ideal for use on small objects such as cigarettes, pills and other articles. This cell has a sensitive area of 1.5 × 0.5 mm and a sensitivity of 30 ma per lumen. Its chief advantage is that it will operate the trigger tube of the counter directly and can be placed in positions that are inaccessible to normal-size photocells.

With use of a less sensitive photocell, a preamplifier giving a short output pulse is necessary for freedom from jumping and missing counts. The counter input circuit is insensitive to hum pickup, therefore a long input lead can be tolerated without elaborate shielding.

The complete counter has a maximum count speed of 400 per second with a maximum batch speed of 0.5 second. It counts batches of 2 to 1,000 in units of one. Input pulses must be positive, greater than 5 volts and of not less than 100-microseconds duration.

The unit has found application for counting and batching paper envelopes, sweets, metal components and other products. A typical setup on a paper feeder, which batches the sheets into quires or any other convenient number, is shown in the photograph. A variation of the standard counter is used on a machine for predetermined batching of bread rolls into two baskets. As shown there are two output chutes; both of these can be selected alternately to give different numbers of rolls automatically.

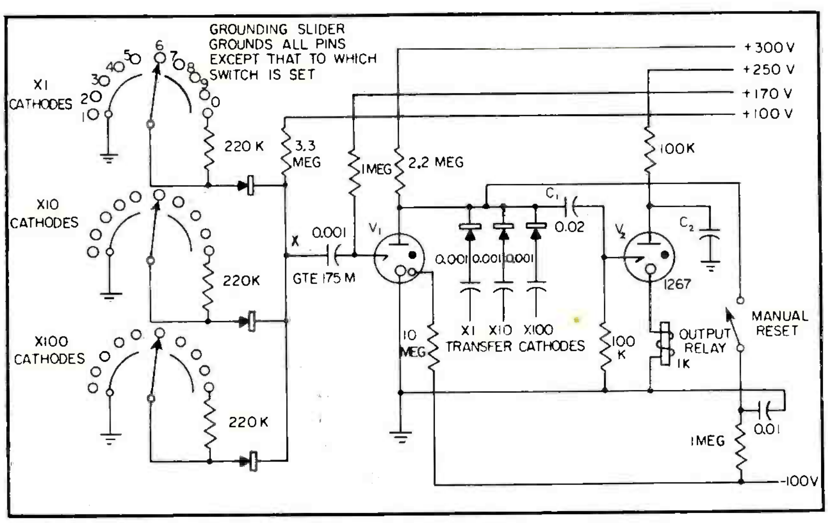


FIG. 2—Selector and reset circuit uses three rotary switches for unit selection. A negative pulse fed to all the cathodes resets the counter to zero

Thanks are due to the Electronic Machine Co. of Thornton Heath, Surrey, England, manufacturers of this counter, for permission to release this article.

Wide-Band Analog Function Multiplier

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Beam-deflection tubes perform nonlinear squaring operations that are the basis of this analog multiplication method. Speed and accuracy are high. Performance is primarily limited by associated circuitry rather than the tubes

DEVELOPED on the quarter-square principle, a simple analog function multiplier takes advantage of the characteristics of recently developed beam-deflection square-law tubes, such as type QK-329. These can provide full parabolic square-law action to an accuracy better than 1 percent of full scale, over a frequency range from d-c to the vhf region.

This particular multiplier was built to explore the possibility of using these square-law tubes for this application. Commercially available plug-in amplifiers were employed in the associated circuits. Results obtained showed that performance of this relatively crude model was, on the whole, limited by the associated circuitry rather than the square-law tubes. Nevertheless a combination of accuracy and speed of response had been achieved that exceeded any other known method of analog multiplication.

A quarter-square multiplier is instrumented around the identity

$$xy = \tfrac{1}{4}(x + y)^2 - (x - y)^2 \qquad (1)$$

The left-hand term is the desired product and requires the performance on the right-hand side of the operations of addition, subtraction, multiplication by a constant, and squaring. All operations but squaring are linear and are readily accomplished using conventional techniques. The particular method selected for achieving the two nonlinear squaring functions, however, presents a design problem and is principally responsible for the characteristics that distinguish one quarter-square multiplier from another.

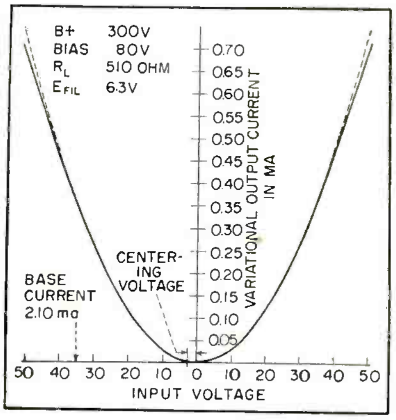


FIG. 1—Comparison of curved portion of static characteristic of square-law tube with parabola

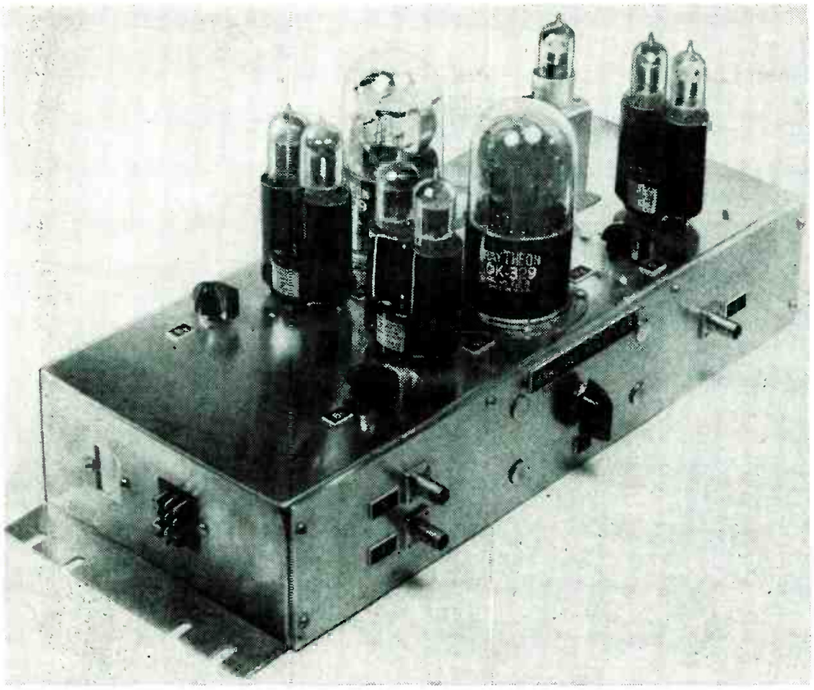
The beam-deflection square-law tubes used as the starting point in the present design are capable of providing accurate reproducible full-parabolic transfer characteristics in a noncritical manner. Over their range of operation, speed of response and accuracy capabilities are essentially independent of each other. That is, the same accuracy obtainable under d-c conditions is achievable at the upper end of its frequency range.

Square-Law Circuit Elements

The principle employed to produce a square-law characteristic in these tubes is that of deflecting a flat sheet of electrons across a target electrode containing parabolic apertures.

The discussed tube is essentially a copy, with only minor modifications of the simplest of the QK-256 series of experimental beam-deflection square-law tubes.[1] More precise methods of measuring and plotting the nonlinear static characteristics have indicated that the accuracies achievable are better than was previously stated.

Figure 1 is a plot of a typical



Complete analog multiplier employs amplifiers that provide a single-ended low-impedance output at an open-loop d-c gain of over 10,000. Present frequency response is limited by amplifier bandwidths

Type QK-329 beam-deflection tube provides full parabolic square-law action with 1 percent accuracy at full scale

static characteristic made on an automatic precision (0.1 percent) plotting board. Within an input range about the origin of approximately ±35 volts the error is too small to measure by such means and remains less than 1 percent up to ±40 volts. Within these limits the static characteristic may be idealized to a close approximation as a parabola

$$i_{out} = i_0 + k(e_0 + e_{in})^2 \text{ amp} \quad (2)$$

with its vertex displaced from the origin by amounts e_0 and i_0.

Current

Scale factor k is expressed in mhos per volt and is essentially a constant for a given tube over a wide range of variations in cathode to anode voltage, when operated with its average deflection-plate potential, E_{bias}, maintained at a fixed fraction of E_{B+}. The voltage required to center the parabola on the vertical axis, $-e_0$, is generally small. Its magnitude may differ from tube to tube, but remains constant with time for a given tube and is not sensitive to changes in operating potentials. Self-centering schemes are, therefore unnecessary to hold e_0 constant.

The current, i_0, is a function of total current and subject to change when any of the operating parameters that affect total current are varied, such as heater voltage, E_{bias} or E_{B+}. Normal precautions appropriate to d-c amplifier design are therefore advisable to keep i_0 stable.

As with most beam-deflection devices, best operation of the QK-329 is obtained with a balanced input. The input conductance between deflection plates is small enough to ignore under most conditions. Where precise operation at d-c is required, account should be taken of the possible presence of diode currents of about 10 microamperes between the cathode and the positively biased deflection plates. This current is not an inherent property of the tube type, but rather a consequence of the fact that its effect had not been noticed in earlier applications.

The Multiplier

Equation 1 can be instrumented in a variety of ways. The block diagram of Fig. 2 illustrates the arrangement of functional components employed. No effort was made to obtain any particular overall multiplier scale factor. Three identical plug-in operational amplifier units are used in standard feedback computer configurations of unity gain to perform both the inverting and subtracting functions. These amplifiers provide a high-impedance differential pair of inputs and a single-ended low-impedance output at an open-loop d-c gain of over 10,000. Both amplifier inputs handle signals in the subtractor stage, whereas one of the inputs in each of the two inverter stages is only used for zeroing purposes.

The output or product of a multiplier with identical inputs may contain frequency components up to twice as high as those present in either input. Consequently, the subtractor must be capable of operating up to a maximum frequency of double that which must be handled by the inverters.

In order to further extend the frequency range of the subtractor it was found necessary to reduce the impedance level of its associated ex-

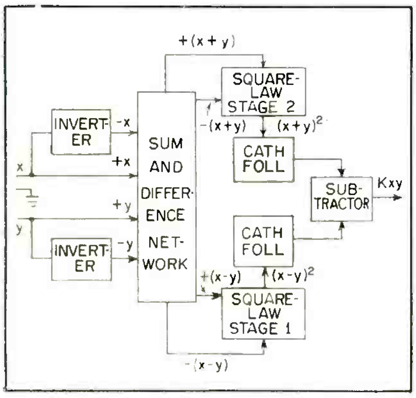


FIG. 2—Multiplier system using identical amplifier units for inverting and subtracting

ternal computing resistance below that used in the inverters.

Ground potential is used as an absolute zero reference for the multiplier input and output signals. The plug-in amplifier circuits when zeroed do not introduce any shift in reference level between their inputs and outputs. However, the input and output of a square-law stage normally operate at different potentials. The deflection plates of the beam-deflection tube rather than its output, operate near ground potential. This avoids complicating the driving circuits to the square-law stages, that are already burdened with provisions for forming balanced sum-and-difference signals.

The potential differences between square-law stage outputs and subtractor inputs are eliminated through the use of conventional voltage-divider step-down arrangements. To prevent excessive signal attenuation, cathode followers are inserted between the high-impedance voltage-divider taps and the lower impedance inputs to the subtractor.

Push-pull sum-and-difference signals for the square-law stage inputs, $\pm(x + y)$ and $\pm(x - y)$, are formed with respect to ground potential in a symmetrical passive summing network. To do this, the network is supplied with balanced versions of the multiplier input signals, $\pm x$ and $\pm y$. Signals $+x$ and $+y$ are derived directly from the input terminals of the multiplier, while the inverters provide their negative counterparts. A schematic diagram of the complete wide-band analog function multiplier appears in Fig. 3.

Instantaneous output accuracy within ± 0.5 percent of maximum product was consistently achieved within the input operating ranges of ± 25 volts after alignment of the function multiplier.

A dynamic range of approximately 30 db at either input and 60 db at the output was obtained.

Overall amplitude response was flat for either or both input frequencies from d-c to 90 kc (output flat to 180 kc) with a gradual roll-off at higher frequencies.

The overall phase response at 90 kc was 65 deg and decreased almost linearly with frequency. Phase response was measured with one input a constant to make input and output frequencies identical.

Long-term drift from all causes including adjustments was within 1 percent of maximum product after an initial settling period of about 3 hours. The output zero required the longest settling time, while other adjustments reached stability more rapidly. Conventional regulated power supplies fed by a 2-percent a-c line regulator were used to power the multiplier during the stability measurements.

Multiplier Adjustment

Circuits employed to instrument the basic multiplier equation produce a nominal over-all scale factor other than one-to-one. No effort has been made to achieve a unity scale factor. The circuits, unless compensated, may introduce a number of extraneous terms that arise from misalignments.

Magnitudes of errors produced by some of the potential sources of extraneous terms, such as deviations of the effective gains of the inverters from unity or the sum-and-difference network from equality, depend upon the accuracy and stability of passive resistive components. Errors contributed by these parts of the multiplier may be minimized during construction by use of accurate and stable resistors and are therefore not considered.

Other errors, more subject to variation with time (those dependent upon the stability of active or replaceable components) are best eliminated by adjustments. Equation 1 may be rewritten to include these terms and their adjustments, in the form

$$Kxy + \Delta = A_1(x + y + z_1)^2 - A_2(x - y + z_2)^2 + C \quad (3)$$

where, in the above equation factor K is the over-all scale factor of the multiplier and Δ is the total error at the output caused by misalignments.

Scale factors of the squared sum-and-difference channels, A_1 and A_2, include the square-law, cathode-follower and subtractor stages.

The off-center terms at the inputs to the square-law stages, z_1 and z_2 include the respective square-law stage centering voltages, e_0, and the inverter zero adjustments, B, used to set them to zero

$$z_1 = (e_0)_1 + B_1 + B_2 \quad (3A)$$

$$z_2 = (e_0)_2 + B_1 - B_2 \quad (3B)$$

The term C is the (zero signal) off-zero term at the output of the multiplier. It includes the subtractor zero and also any d-c unbalance present in the cathode followers or between the outputs of the square-law stages.

Equation 3 may be expanded into the desired product and three types of error terms by carrying out the indicated operations

$$Kxy + \Delta = 2(A_1 + A_2)xy$$

$$\text{(A)}\ + (A_1 - A_2)(x^2 + y^2)$$

$$\text{(B)}\ + 2(A_1z_1 - A_2z_2)x + 2(A_1z_1 + A_2z_2)y$$

$$\text{(C)}\ + A_1z_1^2 - A_2z_2^2 + C$$

$$\left.\begin{array}{l}\text{square-law error (A)}\\ \text{linear error (B)}\\ \text{constant error (C)}\end{array}\right\}\ \text{error terms}$$

A procedure has been devised for systematically eliminating these error terms in a convergent manner. Some method of observing the form of the multiplier output as a function of an input signal is required. Error terms are then eliminated in the order shown in Eq. 4 by the following adjustment routine:

Equating A_1 and A_2 cancels the square-law error, Eq. 4A. This is done by setting y to zero and observing the form of the output as a function of x as A is varied. When the plot is a straight line A_1 and A_2 are equal.

The next two steps eliminate the

linear error terms, Eq. 4B, by setting B_1 and B_2 so that $z_1 = z_2 = 0$. The conditions for this are found from simultaneous solution of Eq. 3A and 3B to be

$$B_1 = -(e_0)_1 + (e_0)_2/2 \quad (5A)$$

and

$$B_2 = -(e_0)_1 - (e_0)_2/2 \quad (5B)$$

The order in which B_1 and B_2 are adjusted is of no consequence.

The term B_1 is adjusted to the criterion of Eq. 5A by setting y to zero and observing the form of the output as a function of x as B_1 is varied. The observed output, Δ, will be a constant for the proper adjustment of B_1.

The term B_2 is adjusted in a similar manner by setting x to zero and observing the form of the output, Δ, as a function of y, while varying B_2. The output will again be a constant for the proper adjustment of B_2 to the criterion of Eq. 5B.

The final step is to adjust C so that the multiplier output is at zero potential with respect to ground when the input terms are zero.

Performance Limitations

Accuracy of the present multiplier stays within close limits for input signals up to a certain level and gradually deteriorates as the inputs get larger in a manner similar to gradual overloading. The error appears to be produced principally by variable current flow between deflection plates and cathode of the square-law tubes, that occurs when the deflection plates exceed a certain positive potential with respect to the cathode. The IR drops produced in the sum-and-difference network by these changes in current are equivalent to shifts of the centering voltage adjustments from their original settings and introduce corresponding errors.

The ideal remedy is to modify the tube design to minimize the deflection currents. It is possible that some of the other developmental square-law tubes already built possess improved characteristics in this respect. Short of this, more accurate multiplier performance is attainable with the same square-law tubes by finding operating conditions with lower deflection currents. Reducing the impedance levels at the inputs to the square-law stages (sum-and-difference network) also improves performance. Inverters with higher output power ratings would then be required to maintain the original amount of drive.

Frequency response is at present limited by the bandwidths of the plug-in amplifiers. The QK-329 square-law tubes have been successfully operated from d-c to vhf. They contributed no measurable phase shift to the over-all multiplier phase shift mentioned in the previous section on performance. Increases in multiplier frequency response of 100-to-1 over the present model could thus be made before the square-law tubes offered a direct obstacle to such improvements. For efficient design, a multiplier with two identical inputs should have a differential amplifier at its output with twice the bandwidth of the input.

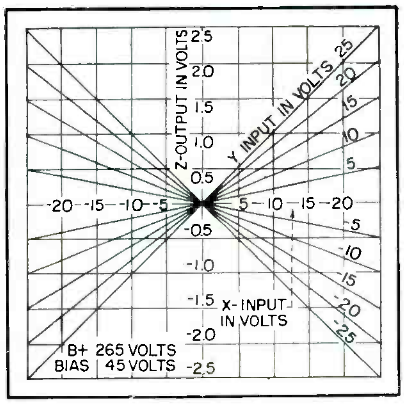


FIG. 4—Plot of multiplier characteristics, Z-KXY, using square-law tubes

Stability

Multiplier drift is primarily zero drift of the output circuits. If the maximum-output signal level were increased to make full use of the capabilities of the differential amplifier, the percent drift would be improved. Use of drift-stabilized amplifiers would also help.

The square-law stages of the present multiplier contribute only 12 percent of the observed overall long-term drift at the multiplier output or approximately 0.12 percent of maximum output. The differential output of the multiplier circuit provides a degree of inherent discrimination against the effects of drift that could result from changes in total current in the square-law tubes.

Sizeable increases in bandwidth, accuracy and zero stability are achievable with existing square-law tubes by improving the associated circuitry. Square-law tubes of the general type employed, therefore, provide a nucleus around which considerable forward progress in analog multipliers can be made.

The work described here was supported in part by the Army Signal Corps, the Navy Dept. (O.N.R.) and the Air Force (A.M.C.) under contracts DA-36-039sc100 and 3-99-10-022 with the Research Laboratory of Electronics, M.I.T.

The authors wish to acknowledge the contributions of J. Gradijan, G. Fine and A. Moccia of the Air Force Cambridge Research Center.

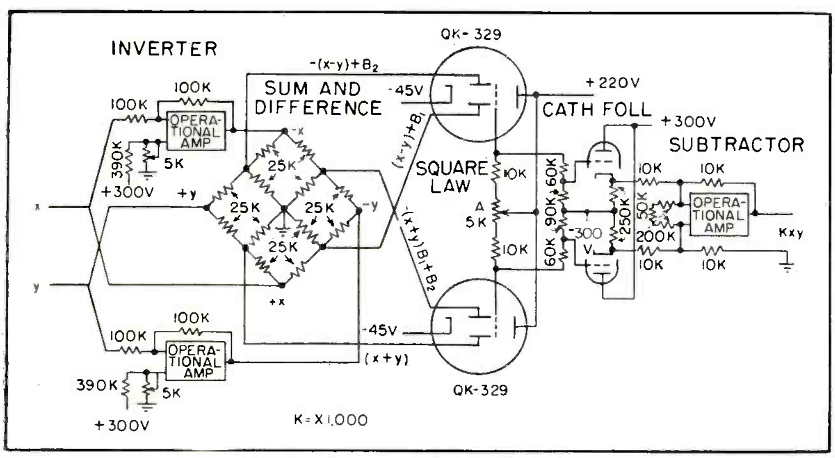
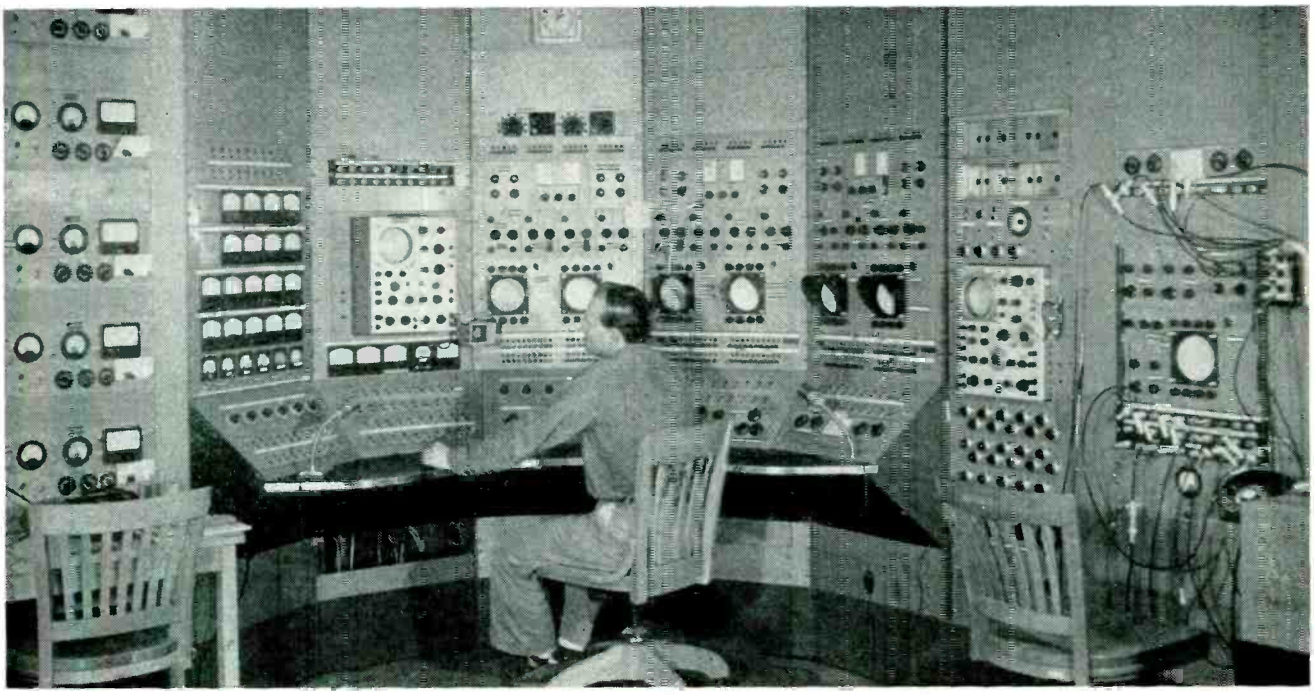


FIG. 3—Schematic of complete multiplier whose performance is primarily limited by circuitry rather than the square-law tubes

REFERENCE

(1) Aaron S. Soltes, Beam Deflection Nonlinear Element, ELECTRONICS, p 122, Aug. 1950.



Main control room showing use of special dual-beam oscilloscopes. Accelerator operator is looking at the frequency monitoring scope (above left hand). Bevatron employs practical self-tuning system

Generating R-F Energy

Radio-frequency field of proton synchrotron accelerates protons from 10-mev linear accelerator to an energy level of 6 billion electron volts. Proton beam is kept at constant radius of travel by a feedback circuit that increases the magnetic field as the particles are subjected to increased accelerating potentials

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PROTONS are received from a linear accelerator at 10 mev and a reasonable percentage of these are further accelerated by a proton synchrotron to a final energy of greater than 6 bev.[1]

The particles are kept at a nominally constant radius of 600 inches by a magnetic field. For a given energy and radius there is only one value of magnetic field that will keep the protons from spiraling inward or outward. As the particle energy increases the magnetic field must also be increased. The increase in particle energy is obtained by passing the proton bunch through a drift tube that is excited with an r-f accelerating potential.

As the bunch makes one revolution per r-f cycle, it receives a small acceleration each revolution and hence a small increase in energy and velocity. The orbit length is nominally constant, hence there must be a slight increase in the frequency of the accelerating potential each time the particles are accelerated, as well as an increase in the magnetic field.

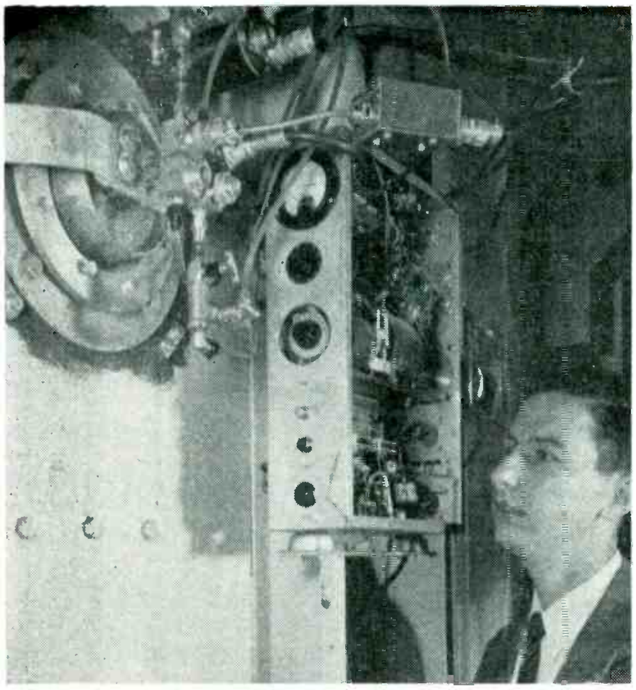
Since the magnet excitation equipment is large and not economically suited to wide control on a rapid basis, the magnetic field is allowed to build up in a manner determined by the characteristics of the magnet excitation equipment and the magnet itself. The r-f is then forced to follow the increasing magnetic field. The relation between the r-f and the magnetic field is

$$f = 2.497\,[1 + (2.056\,/\,B)^2]^{-1/2}$$

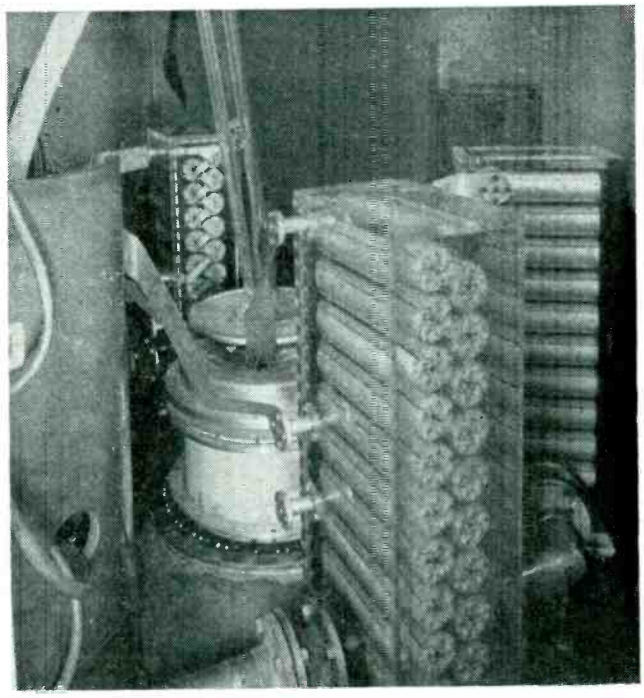
where f = r-f in megacycles per second and B = magnetic field in kilogauss.

System Operation

Figure 1 shows a simplified diagram of the bevatron. The north



Primary frequency generator uses what is basically a grounded-anode Colpitts circuit



Inside r-f house, north tank. Cylindrical unit is final amplifier, surrounded by inductor boxes

for 6-BEV Bevatron

or acceleration tank contains the drift tube. The drift tube is nominally ten electrical degrees long; with an equilibrium phase angle of 30 deg, approximately 12 kv peak r-f would be enough to supply the required energy increase (1.7 kev) per turn. Experiments with a quarter-scale model indicated better performance with approximately twice the required threshold value. Forty kv was chosen as the design figure to allow a generous margin.

The magnet coils are excited by a twin motor-generator, rectifier-inverter system. With motors requiring 5,400 kw, a peak energy storage of 80 megajoules is obtainable in the magnetic field. Thus, at 10 pulses per minute, the Q (2π times the ratio of maximum energy stored to energy dissipated per cycle) of the bevatron magnet system is sixteen. Frequency as a function of magnet current is shown in Fig. 2 while Fig. 3 shows the accuracy required of the r-f system as a function of frequency. How closely the equation is adhered to depends upon how much beam may be lost due to r-f inaccuracy. The beam is subject to various types of comparatively low-frequency oscillations in radial, vertical and orbital directions. At injection, radial oscillations are large and their amplitude reduces as the field increases. At injection, nearly the full four-foot aperture is usable (the proper magnetic field distribution keeps the beam focused).

However, the useful aperture reduces considerably at high fields, owing to saturation of the magnet, and moves radially outwards. The difference between the amplitude of the radial oscillations and the useful aperture is roughly the amount of radial error permissible.

R-F System

A block diagram of the bevatron r-f system is shown in Fig. 4.

The primary frequency generator (pfg) receives information about the magnetic field in terms of current shunted from the magnet windings. This constitutes approximately 95 percent of the frequency-determining information; the other five percent is a flexibly programmed current-derived signal. The circuit makes the output frequency virtually independent of vacuum-tube parameters provided the tubes are in reasonably good condition. The output is nominally 15 volts peak into a 93-ohm coaxial cable.

Although the input signal from the pfg is nominally 10 volts peak, the driver unit, essentially a scaled-down version of the final amplifier, operates satisfactorily with from 8 to 20 volts peak input. The driver must amplify the input signal to a 2,000-v peak level. The effective driver load is the nominal 600-$\mu\mu$f input capacitance associated with the final amplifier. Grid power required by the final amplifier is 20 kva rms at 2.5 mc. To supply this economically, the final amplifier input capacitance is automatically resonated with a variable inductance, allowing the output stage of the driver unit to be a class C amplifier.

The final amplifier stage uses a

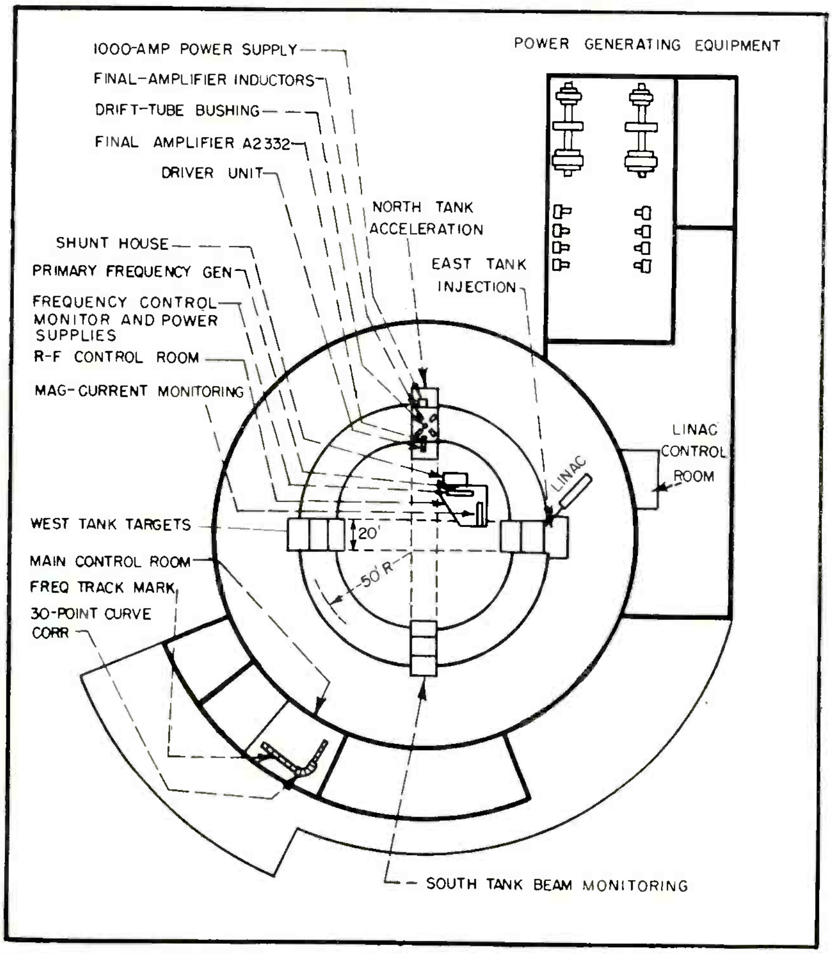


FIG. 1—Simplified plan view of 6-billion electron volt accelerator

shield-grid triode, an A2332S. This tube was chosen for its ample reserve of power-handling ability.

The 400-$\mu\mu$f capacitance of the drift tube is resonated with an automatically adjusting inductance. With 40-kv peak voltage at 2.5 mc, there is 2.5 megavolt amperes peak within the system, maintained by a plate power-supply input of less than 50 kw.

Primary Frequency Generator

The heart of the pfg is the frequency-determining circuit. (Fig. 5). The important element therein is the main inductor consisting of two toroids each wound on a ferroceramic[2] core, $\frac{5}{8}$ inch i.d., 1 inch o.d., and $\frac{1}{4}$ inch thick. Each toroid is wound with 32 turns and when the two are connected in series they constitute an inductance that may be varied from a nominal 1,000 microhenries to 1.1 h. The toroids are arranged so that induced signals between the saturating and r-f circuits buck out thus minimizing magnetic coupling. In addition, a double electrostatic shield prevents any appreciable electric coupling. The unit is mounted coaxially with the shunted current system leads and is oil-insulated for 30 kv.

The main inductor core material was chosen because of its ability to produce a nearly linear frequency-versus-saturation current characteristic, matching the beginning of the curve of Fig. 2. The amount of current diverted from the main magnet influences the rate of saturation. Hence, the initial slope of the frequency-current functions may be matched. A third winding on the main inductor, the bias winding, is utilized to impose approximately five reverse ampere turns.

As the magnet current rises the inductance increases, until the residual magnet, and bias ampere turns balance; then the frequency rises with the magnet current's further rise. Varying the bias current thus translates the frequency-current function, allowing a close match of Fig. 2.

To match the sharp knee and the slowly changing frequency portion, the shaper inductor is used as a relatively fixed inductance. The frequency remains relatively constant as the main inductor saturates so that its inductance is small compared to the shaper inductor. The shape of the knee and the flat frequency portion are approximated by choosing the proper value of resonating capacitance and shaper inductance.

Curve Corrector

Because it is not practical to obtain a match to the required curve with the necessary precision with magnet-current information only, there is provision for modulating the bias supply (effective at low frequencies) and the shaper inductor (effective at high frequencies) with a curve corrector. The curve corrector allows a manual adjustment of roughly 5 percent to be made at about 30 current-determined points with a smooth transition from point to point.

The greatest amount of accuracy is needed near injection. Hence,

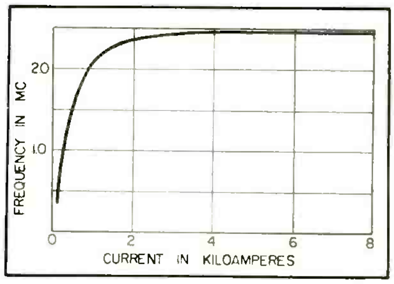


FIG. 2—Accelerating potential frequency plotted as a function of total magnet current

a good match of Fig. 2 may be obtained with virtually no manual correction needed. In the region of the knee of Fig 3, the tolerance allowed is greatest, the match is most difficult and the manual correction utilized is large. Towards the end of acceleration, the tolerance becomes tighter, and the manual correction necessary is less than at the knee, owing to a better match.

Ferroceramic

The stability of the pfg is largely limited by the ferroceramic-cored inductor. Temperature, history, hysteresis, rate of saturation and r-f level are the main factors. Temperature effects are adequately controlled by a 30-deg oil bath held to closer than 0.1 deg C. History effects are rendered negligible after three saturation cycles if the beginning of the cycle is held consistent to 0.1 ampere turns and if the high end is always at least 50 percent of full ampere turns. The bias ampere turns are in excess of remanence. Each saturation cycle thus passes through zero core flux initiating the same hysteresis loop each cycle.

The ferroceramic used has large values of permeability and dielectric constant, hence a low velocity of propagation through the cores. The cores are small enough that at normal bevatron pulse rates the saturation of the core is rate-independent.

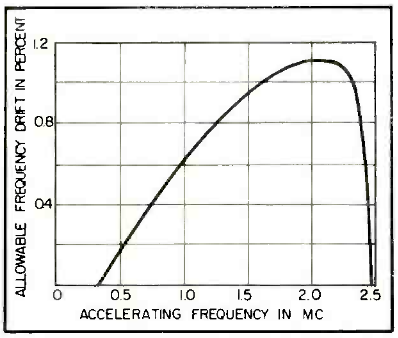


FIG. 3—Frequency tolerance of the radio-frequency system

The r-f level is held constant to within better than ½ volt of the 10-volt peak operating level to keep the r-f field from significantly influencing the saturation cycle. The air-core inductors and the capacitors were chosen on the basis of high stability and Q.

Oscillator

The oscillator circuit (Fig. 5) was developed to maintain the high degree of repeatability of the frequency-saturation cycle independent of the vacuum-tube parameters. The system basically is a grounded-anode Colpitts circuit.

The boot-strap arrangement was adopted to hold the lower cathode follower's plate voltage approximately constant by the upper cathode follower, thus obtaining the desirable characteristics of a screen-grid-tube cathode follower with the reliability of a triode. In addition, the triode is much less susceptible to stray magnetic fields.

The grounded-anode circuit arranges the tube's input capacitance to a minimum. Variation in input capacitance from tube to tube and within a tube's normal life is thus negligible compared to the approximately 200 μμf of the frequency-determining circuit.

Feedback resistor R_1 is made as large as possible to provide isolation from the small variations in output impedance of V_2. The maximum value of R_1 is determined by the minimum value of shunt impedance of the frequency-determining circuit, the relative values of C_1 and C_2, and the gain of cathode follower V_2. Resistor R_1 is close to a maximum when C_1 and C_2 are equal.

To keep the oscillator operating linearly and to preserve a constant r-f amplitude at the ferroceramic cores, a diode limiter V_1 is used. Although there is some theoretical advantage in splitting the feedback resistor R_1 and regulating a diode clamp to hold the r-f output voltage constant by sampling the oscillator level with a detector, tests demonstrated the direct clamp V_1 has a tolerably small effect on the frequency and is simpler. The frequency sensitivity of the ferroceramic to r-f voltage was an order of magnitude larger than the frequency shift due to a direct diode

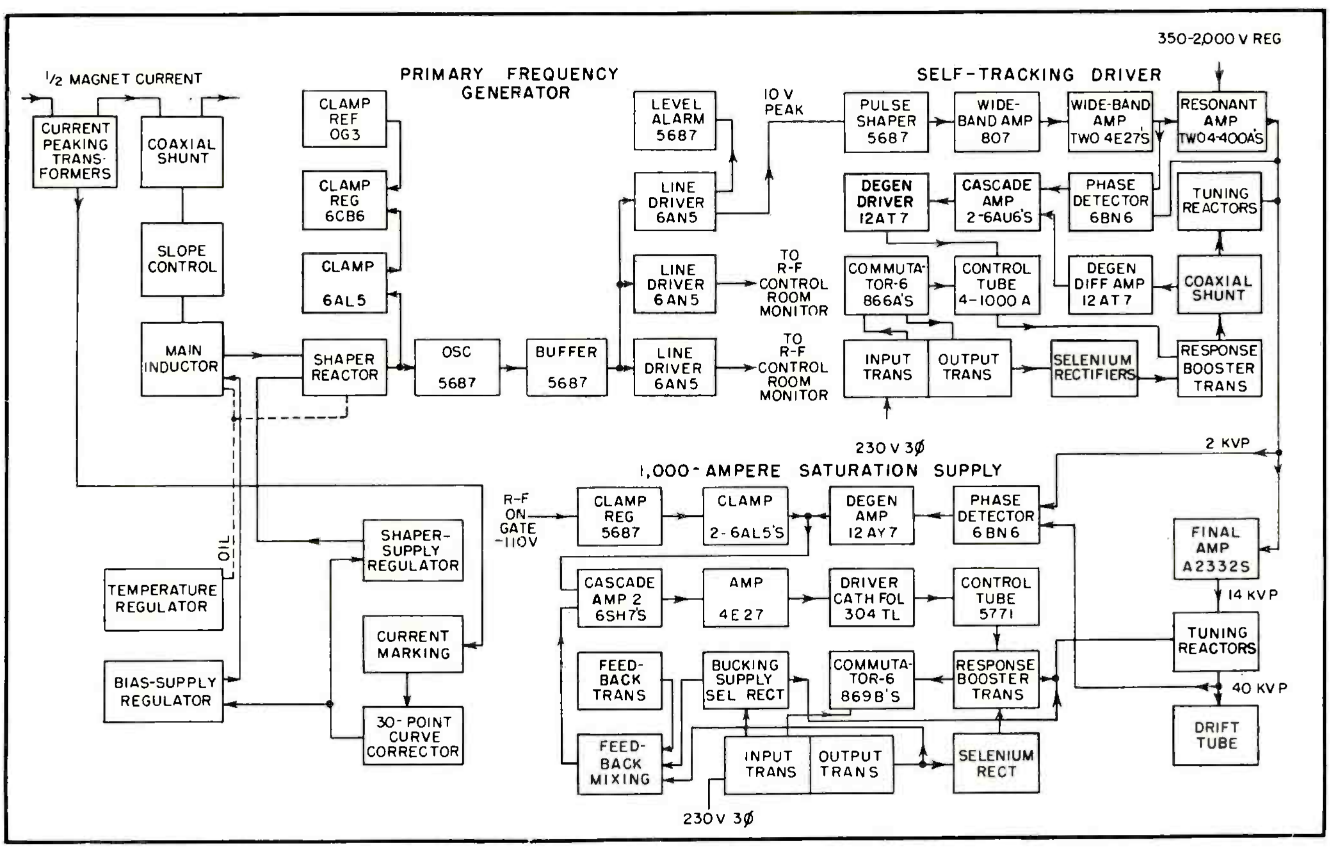


FIG. 4—Block diagram of the bevatron radio-frequency system. Output frequency is virtually independent of vacuum-tube parameters

clamp. The additional complexity of a drive-regulation system might in practice produce a larger frequency error than the simple direct clamp system. A regulator tube holds the clamp voltage constant in spite of varying clamp conditions. The required stability is achieved if the r-f is held to within ½ volt of the 10-volt peak level.

The parasitic suppression resistors, coupling capacitors and output-line driving transformers were designed to provide adequate band pass for the required frequency range. However, they will not provide unnecessary bandwidth for possible noise response. The output transformers are doubly electrostatically shielded to provide good isolation of the ground potential differences that exist throughout the bevatron building.

Automatic Tuning

When an r-f amplifier operates into a highly reactive load, a considerable saving in power may be obtained by resonating the reactive load so that the amplifier need supply r-f current only for the lossy elements of the system. This is normally done where operation is confined to a relatively narrow band of frequencies. Where a broad band of operating frequencies is simultaneously involved, the uneconomical wide-band amplifier must be used.

When there is essentially only a narrow band of frequencies present at any one time within the wide possible operating band, a tuned amplifier may be used. However, it must be in tune and the additional complexity of the tuning mechanism must be economically justifiable.

Power Requirements

The frequency range and rate of change of the bevatron are such as to allow a practical self-tuning system to be used. Total driver-unit power input is 8 kw. With wide-band amplifiers, 30 kw of plate power supply alone would be required, as well as much bigger tubes than the two 4-400A driver-output amplifiers.

The final amplifier and associated self-tuning equipment require a total of about 75 kw instead of roughly 1.5 megawatts of plate supply alone for a broadband system.

Final Amplifier

A simplified diagram of the final amplifier is shown in Fig. 6. The inductance used to resonate the drift tube and stray capacitance is composed of four stacks of 20 inductors each. Each inductor contains ten ferroceramic core toroids, nominally 1¾ inch i.d., 2½ inch o.d. and one inch thick with a rectangular cross section. These ten cores are enclosed by five turns of silver-plated machined copper so that there is nominally ⅛ inch uniform spacing between turns all around the inductor. The five-turn winding serves as both the r-f and saturation winding. The resistance of the 9,600 silver-to-silver bolted joints is small compared with the total resistance of 22 milliohms.

Each stack of inductors is arranged in a lucite box to provide forced oil cooling. In addition, the physical arrangement minimizes stray capacitance and residual inductance. Each inductor is capable of a nominal range of 1.25 μh saturated to 1 mh unsaturated. At the lowest frequency (about 250 kc), with the present oil-flow system capable of removing 75 watts per core, each inductor can safely handle 2 kv peak continuously without exceeding the Curie temperature of 140 deg C.

The shield-grid triode is tapped in between the seventh and eighth inductors in each stack thus operating at a 14-kv peak level. The stacks are 20 inductors high to allow a 40-kv peak output level and four stacks are used in parallel to obtain the required inductance. The stacks are in parallel for r-f and in series for d-c. Less than 1,000 amperes is required to cover the range.

Saturation Supply

The 1,000-ampere saturation power supply, Fig. 7, within its dynamic range, has a time constant of the order of a microsecond. Each phase of the input three-phase transformer has its secondary connected in series with each corresponding primary of the load transformer. All three phases, consisting of series pairs of source

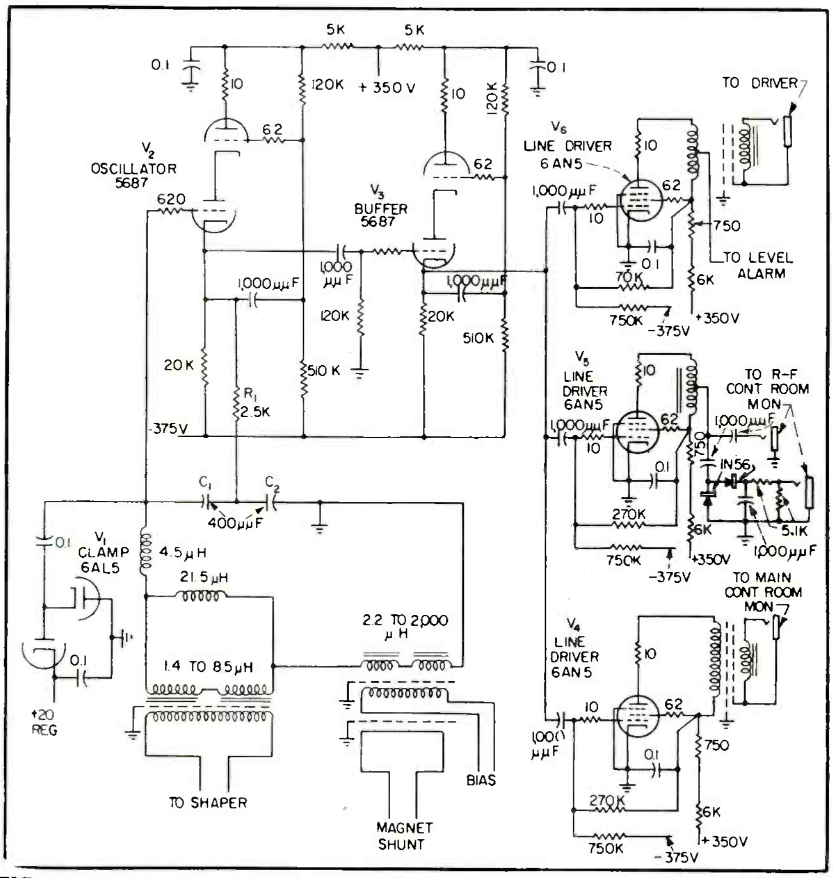


FIG. 5—Simplified schematic of primary frequency generator

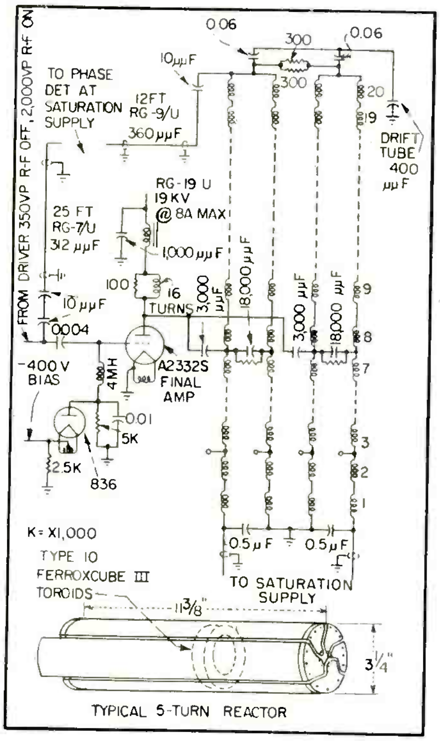


FIG. 6—Final circuit diagram

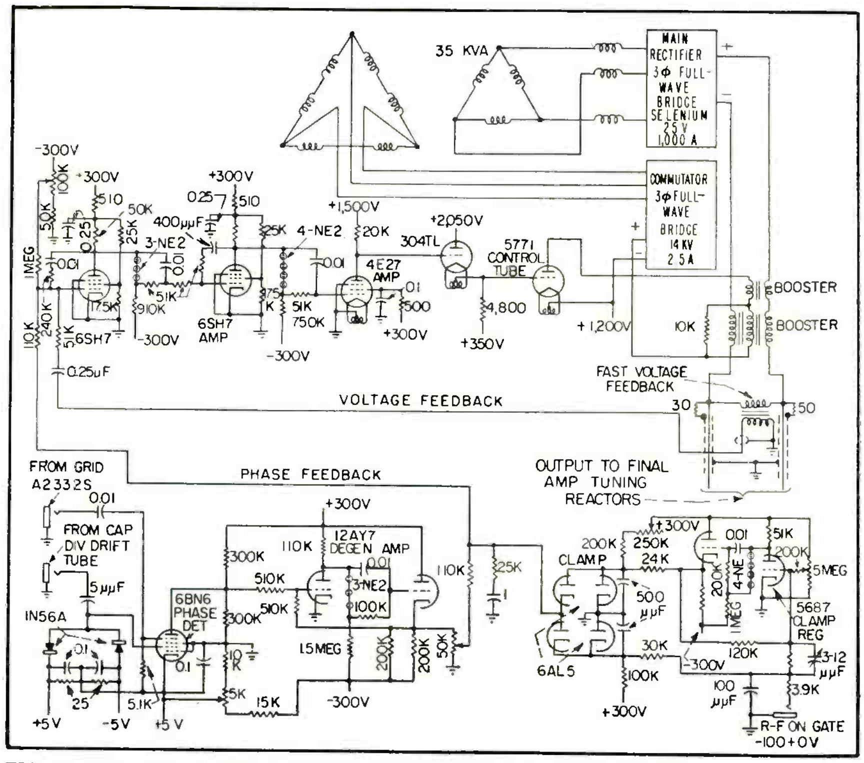


FIG. 7—Saturation supply regulates current from 0 to 1,000 amperes

secondary and load primaries, are connected in delta. Under these conditions, ideally, no power can be delivered to the load. A bridge rectifier system, using 869B's is connected to the junctions at the delta corners and the 5771 control tube acts as a load on the rectifier. If the rectifier were a perfect short, the delta corners would all be at the same potential, changing connection effectively from series delta to parallel wye connections of pairs of source secondaries and load primaries. Thus the single control tube, with the 869B's acting as commutators, effectively controls the amount of polyphase power deliverable to the load. The load transformer output is connected to a 25-volt 1,000-ampere selenium rectifier system.

To improve the high-frequency response of the system, a booster transformer is connected with its primary in series with the control-tube plate circuit and the secondary in series with the output of the selenium rectifier. With the bucking supply, control amplifiers and feedback system, the unit regulates current from 0 to 1,000 amp.

The 6BN6 phase detector receives an in-phase fraction of the final amplifier grid signal for application to the last gate grid. The first gate grid receives a quadrature square wave obtained by capacitance coupling from the drift tube to the IN56A clamping diodes.

Drift Tube

When drift tube potential is 180 deg out of phase with the final amplifier grid signal, the grids of the 6BN6 are in quadrature placing the phase detector in the center of its range. If the drift tube signal is other than 180 deg with respect to the final amplifier grid signal, the 6BN6 gate grids will overlap to a greater (less than 180 deg) or lesser (more than 180 deg) extent. This changes the average voltage delivered through the 12AY7 to the 6SH7 amplifier.

In normal operation, the primary frequency generator continuously delivers a signal to the driver. The output stage of the driver is plate-modulated with a series regulator-tube system. Until the r-f on signal is delivered, the drive to the final amplifier is too low to cause conduction due to fixed bias. However, d-c plate voltage is always present on the final amplifier, because r-f on the drift tube would be detrimental to beam-injection.

Under these conditions, the self-tracking output stage of the driver is tracking with a low-level output, ready to provide full drive with the arrival of the r-f on signal. However, the phase detector for the final amplifier is not operating properly due to the lack of a signal from the drift tube. The 5687-6AL5 regulated clamp system clamps the phase-detector signal to the saturation-supply input-control amplifier 6SH7 so that the correct current will be flowing in the final amplifier reactors when the r-f on signal arrives. The phase detector takes over quickly and the signal on the drift tube locks in proper phase in the order of a millisecond after the r-f on signal. R-f builds up on the drift tube within 30 μsec.

W. R. Baker is in charge of the bevatron r-f system. The original investigation of the ferroceramic materials was done by Q. Kerns and J. Riedel. The high-level r-f equipment was done by Q. Kerns, O. Anderson and N. Norris; the low-level and monitoring equipment by Q. Kerns, O. Anderson, G. D. Paxson and the author.

All bevatron work was done under the auspices of the U. S. Atomic Energy Commission.

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Infrared Speeds Erasure

Aluminum-backed screen absorbs infrared radiation from tungsten filament to provide complete erasure of saturated traces in 2 to 5 seconds. Screen is sufficiently sensitive to record transients in single sweep

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POTASSIUM CHLORIDE (KCL) has been found to be the most suitable scotophor, or screen material, for practical dark-trace tubes. When bombarded with an electron beam the peak of the optical absorption band produced by color, or F-centers, in KCL occurs in the green region of the visible spectrum at approximately 5,600 A. The regions of a KCL screen which contain these color centers appear magenta since green light is absorbed, while red and blue light are diffusely reflected.

Background Theory

The F-centers are attributed to electrons which are trapped in vacant chlorine ion sites within the regular crystal structure. In the writing process internal secondary electrons are released in the crystals by the beam of primary electrons. The secondary electrons, chiefly from chlorine ions, may be trapped by the net positive fields of anion vacancy sites within the crystal, with the formation of F-centers. The chlorine ion which has lost an electron is trapped in the vicinity of a potassium ion vacancy site.

Random thermal agitation can temporarily ionize F-centers. However, F-centers are eliminated only when the trapped electrons are returned to the chlorine holes from which they came. To facilitate their return the KCL must be exposed to 5,600 A light and the F-centers made unstable by thermal agitation. This process is called erasure.

* Deceased

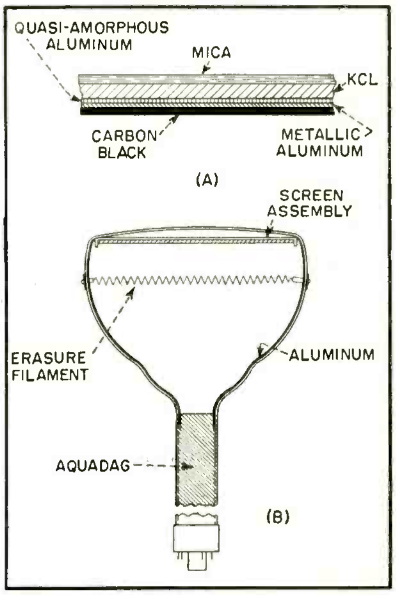


FIG. 1—Scotophor deposited on mica sheet (A) has aluminum and carbon-black backing to absorb infrared radiation. Complete tube assembly (B) shows position of erasure filament

Early tubes were erased by exposing the tube face to intense white light. A portion of the radiant energy was converted into heat in the screen, thus accelerating the decay of F-centers. Because of the large thermal capacity of the face-plate the erasure time was of the order of minutes. In later tubes, shorter erasure times were obtained by placing the scotophor on a substrate of lower thermal capacity such as a sheet of thin glass or clear mica having a coating of tungsten. The tungsten was heated by passing a current through it.

Attempts have been made to heat the KCL film with cathode rays. In this type of erasure system, a thin substrate screen is backed with a metallic aluminum layer. A sharply-focussed electron beam is used for writing. For erasure the beam is defocussed to cover the entire screen and beam current is increased to heat the screen to the point of erasure. Such a tube is simple in structure, but it is difficult to design an electron gun that can produce a well-defined writing beam and can also furnish a high density (but of uniform current density) beam.

In a modified form of electron-bombardment erasure an aluminum coated mica substrate screen is used with an oxide-coated filament mounted in zig-zag fashion at a distance of approximately two inches from the screen. The emission current generates sufficient heat in the aluminum backing to give a 10-sec erasure time.

In the construction of this tube the aluminum layer must be opaque to the 500-volt erasure-beam. Any penetration of the aluminum film by the beam produces changes in the KCL film, mainly by the release of chlorine gas. High gas currents can cause erasure-filament burnout. Even if burnout does not occur, the intense ion bombardment of the erasure filament results in slumping emission.

Infrared Erasure

In a tube designed to overcome some of the shortcomings of the electron-bombardment erasure types, the scotophor is deposited on a thin mica substrate as shown in Fig. 1A. Erasure is effected by

# of Dark-Trace Tubes

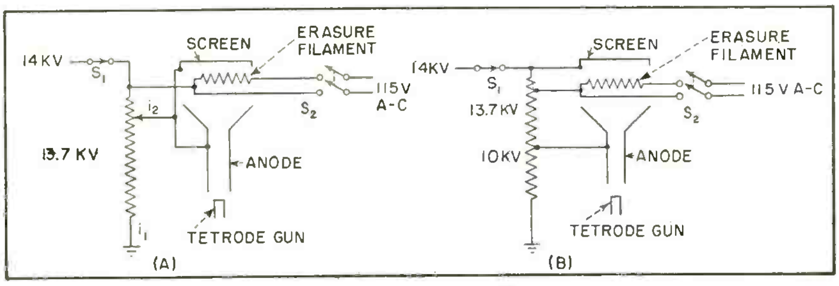


FIG. 2—Divider circuits for elimination of erasure-filament shadow during writing in conventional operation (A) and with post-deflection acceleration (B). Switches are shown in write position. For erasure S_1 would be open and S_2 closed

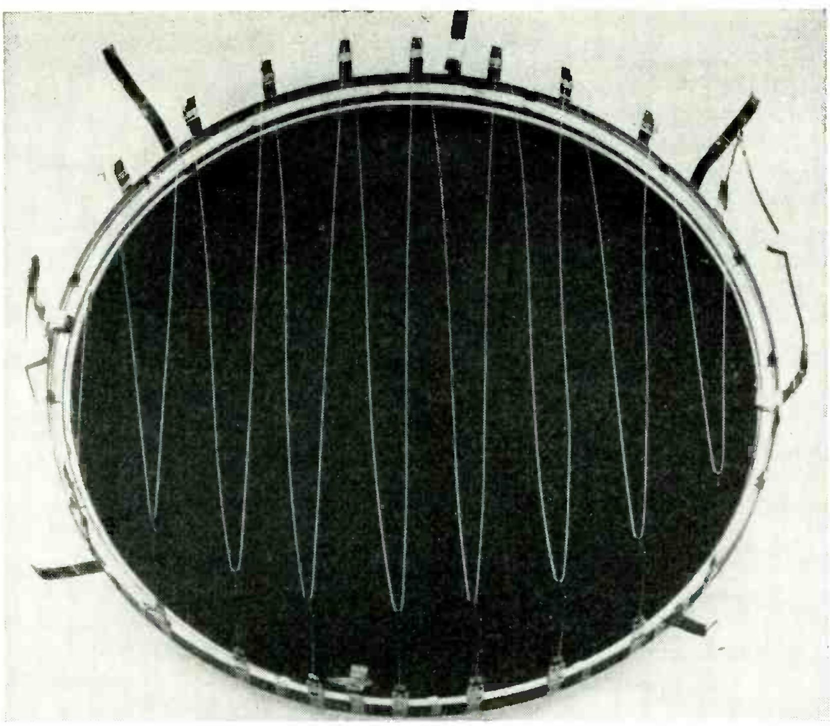
radiant energy to eliminate direct electron bombardment of the screen other than that employed in the writing process.

Radiation erasure depends upon the fact that polar salts, such as KCL, have strong absorption bands in the far infrared region. The F-centers are ionized and kept that way under long-wave infrared radiation. While the released electrons are in the conduction band of energy levels, the metallic nature of the salt at this time gives rise to an additional absorption of radiant energy. This additional absorption in regions containing a concentration of F-centers is sufficient to heat the scotophor to the point of complete erasure.

The general structure of the tube is shown in Fig. 1B. The long-wave infrared radiator is a thin deposited layer of aluminum. The aluminum radiator is heated by radiant energy from a tungsten filament mounted behind the screen. Absorption of radiant energy is facilitated by a thin deposit of carbon black. Erasure time for tubes using this composite erasure device is determined mainly by the time it takes the radiator to reach a temperature of 80 to 90 deg C. Erasure requires 2 to 5 seconds for saturated traces.

Useful contrast is achieved in this tube with a final-anode or screen potential of 8 kv and above. Normal screen potential is 10 to 14 kv. During the writing cycle, the shadow of the erasure filament is eliminated by making the filament slightly more positive than the screen. When operating the screen at 14 kv, the erasure filament must be 300 to 600 volts more positive. The normal way of achieving these potentials is by a voltage divider as shown in Fig. 2A. In this case, the bleeder current, i_1, should be made appreciable compared to the maximum beam current, i_2, to reduce the erasure filament-to-screen voltage variation with signal.

A post-deflection acceleration curcuit is shown in Fig. 2B. Anode voltage is 10 kv and final screen voltage is 14 kv. The erasure filament is maintained slightly negative with respect to the screen. Thus, a voltage-divider network drawing very little current can be used to obtain operating voltages.



Zig-zag erasure filament is mounted on hangers about 2 inches from screen

Other Applications

Although designed primarily as a radar indicator, this tube can be used in other applications. In industrial radiography an x-ray image could be produced by synchronizing the writing beam with a collimated x-ray beam and modulating the tube grid voltage in accordance with x-ray intensity.

In a similar manner, semipermanent recordings of the optical image of translucent objects can be obtained by using a flying-spot scanner. The screen sensitivity of this tube is high enough to record single transients with the images retained long enough for detailed study.

The development of the dark-trace cathode-ray tubes described in this article was done under the auspices of the Navy Bureau of Ships.

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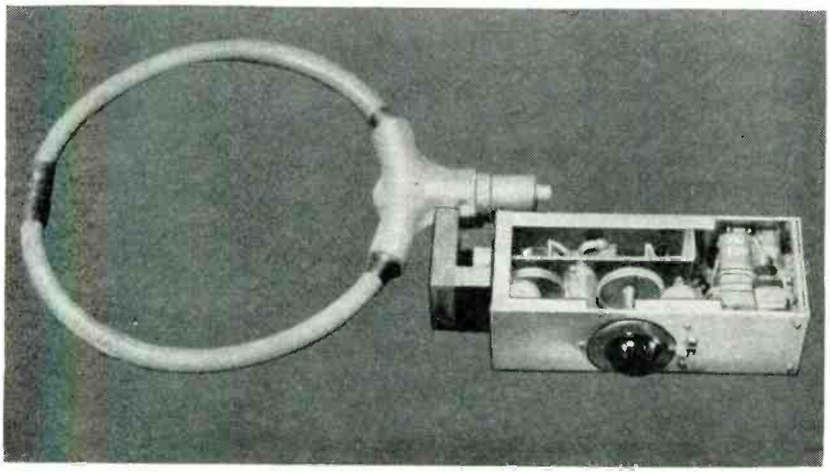
Resonant Loop Antenna

Interference sources are located within ±5 degrees with signal-to-noise ratios as low as 10 db. Construction provides low mechanical inertia and good structural stability required for mobile applications. Can be used either with receiver or field-intensity meter



Antenna and amplifier assembly; amplifier unit is mounted against roof of truck and antenna is screwed into place through a 160-mc mobile antenna mounting hole

MOBILE COMMUNICATIONS in the vhf spectrum are subject to interference from intermittent radiating sources such as industrial and medical r-f heating devices, high-voltage leakage discharge and reradiated intermodulation interference. Such sources are usually difficult to locate as they often contain no identifying modulation characteristic.

Directional antennas provide a means for locating such interference sources. Multielement antennas with sufficient directivity are unwieldly, and therefore unsuited for mobile direction-finding use, especially in the lower portion of the vhf spectrum. The short-duration sporadic nature of frequently encountered interference sources often requires use of directional-antenna systems with low mechanical inertia in order that bearings can be obtained rapidly.

The unit to be described permits rapid bearing measurements in the range of 30-to-40-mc when used with a mobile a-m or f-m communications receiver or standard field-intensity meter. Bearing resolution is approximately ±5 degrees with threshold signal-to-noise ratios in the order of 10 db. For more favorable signal-to-noise conditions, resolution approaches ±2 degrees.

Antenna Characteristics

Loop antennas with diameters on the order of one-tenth wavelength or less exhibit a figure-eight directional characteristic. The radiation resistance of a single-turn loop of this size is approximately 2.5 ohms[1].

The effectiveness of a loop in extracting energy from an electromagnetic field is a function of its effective length. The effective length in meters of a single-turn loop[2] is

$$l_{loop} = 2\pi A/\lambda \qquad (1)$$

where A is loop area in square meters and λ is wavelength in meters.

The effective length of a half-wave dipole[3] is

$$l_{dipole} = \lambda/\pi = 0.32\lambda \qquad (2)$$

For comparison, the ratio of these equations yields

$$l_{dipole}/l_{loop} \cong 0.05\lambda^2/A \qquad (3)$$

At 30 mc, a half-wave dipole is approximately 40 times more effective than a single-turn loop 16 inches in diameter (1/25 wavelength).

A 16-inch loop structure appears to be a practical size for mobile and portable use at 30 mc when wind loading and portability are considered. An additional maximum-diameter limitation is discussed later.

A loop with perfect electrostatic shielding is responsive only to the magnetic component of a vertically polarized electromagnetic field. A discontinuity in the shield must be provided to prevent the magnetic-field lines from being terminated by induced shield currents. With a discontinuity the shield has a negligible effect upon the magnetic field acting upon the loop.

Since the loop is symmetrical about a vertical axis, the vertical magnetic component of a horizontally polarized wave will produce zero net loop current.

Single-Turn Loop

Figure 1 shows the equivalent circuit of the single-turn unshielded loop where e is output terminal voltage, R' is radiation resistance plus r-f resistance of a single loop of wire, L is loop induc-

for VHF Direction Finding

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tance and e_o is induced voltage $= E_o \times l_{loop}$ in which E_o is the field intensity in volts per meter.

The equivalent circuit of the antenna with capacitance added to form a resonant circuit is shown in Fig. 1B. At resonance, $\omega_L \cong 1/\omega c$ and the circulating current, i_c, is e_o/R'.
From this, the output terminal voltage is

$$e = i_c/\omega C = e_o/\omega CR' = e_oQ' \qquad (4)$$

where Q' is effective circuit Q.

In practice, an electrostatic shield is used to obtain a uniform loop conductor-to-ground capacitance, which is independent of loop orientation. The shield also serves to eliminate antenna effect. Equation 4 is therefore only approximate, since the shield forms an added distributed capacitance around the loop. This equation also neglects the shunt admittance presented by the amplifier driven by the resonant loop.

The increased gain of a resonant loop over a nonresonant loop thus becomes evident. For a resonant loop the induced voltage multiplied by Q' appears at the output.

A more exact analysis would include the effect of induced shield currents mutually coupled to the loop conductor.[4] However, the circuit impedance around a discontinuous untuned shield is very large and the loop terminal voltage is only negligibly affected by the presence of such a shield.

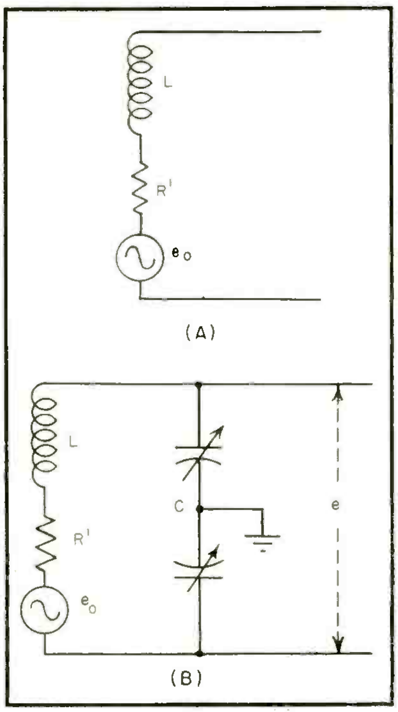


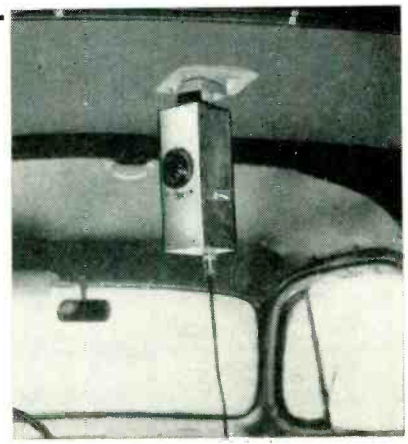
FIG. 1—Equivalent circuit (A) of loop antenna and loop with capacitance added (B) to form resonant circuit

Loop Balancing

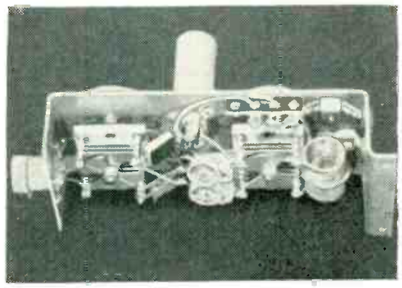
To obtain a symmetrical accurate directivity response to vertically polarized fields, the loop must be balanced with respect to ground and surrounding objects. This is accomplished by an electrostatic loop shield and balanced-output termination. The loop amplifier is shown in Fig. 2. The circuit employs a push-pull amplifier to provide the required balanced loop termination and at the same time providing the necessary impedance transformation to an unbalanced 50-ohm output. The neutralized triodes yield a low amplifier noise figure.

The loop and associate amplifier provide a measured maximum response-voltage gain of 8 db over a standard dipole. Tuning range is 30 to 40 mc. The directivity response to a vertically polarized source is shown in Fig. 3. The measured half-power bandwidth of the instrument is 400 kc.

* Work done while with U. S. Forest Service



Method of mounting amplifier under roof of car



Amplifier subchassis has shafts of two-gang capacitors coupled together for tuning in range of 30 to 40 mc

Loop Construction

Details of the loop construction are shown in Fig. 4. Maximum loop diameter consistent with a 10-mc tuning range is about 13 inches. The diameter is limited by the amount of added shield capacitance that can be tolerated as loop size is increased. Increasing the inside shield diameter would decrease the shield capacitance and permit use of a somewhat larger loop.

Sliding tubular collars of copper can be added to each end of the shield at the top to permit precise adjustment of shield symmetry[5]. Poor symmetry is exhibited when true and reciprocal bearings are not separated by exactly 180 degrees. Care in physical construction of the loop will obviate the need for

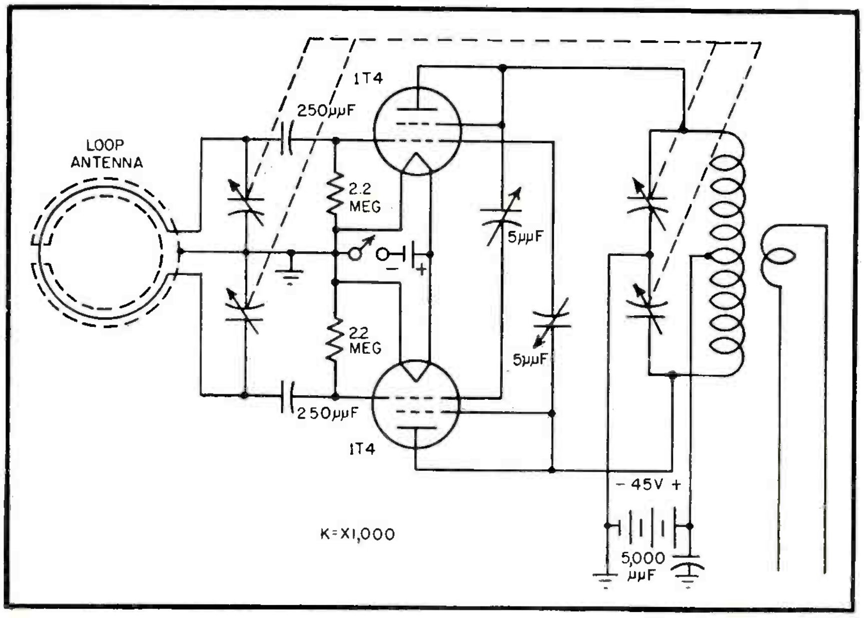


FIG. 2—Push-pull amplifier provides balanced input for direction-finding antenna along with unbalanced 50-ohm output to coaxial line

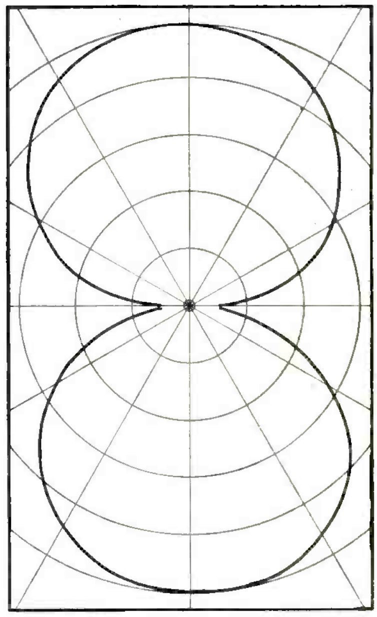


FIG. 3—Directivity pattern of resonant loop in region of 30 to 40 mc

installing these tubular collars.

The photographs show the amplifier subchassis and complete prototype with self-contained batteries and loop assembly. The loop assembly is inserted through a 160-mc mobile-antenna mounting hole in the vehicle roof. A circular metal stiffening plate forms a bearing surface for the loop-assembly collar.

The amplifier is connected from the inside of the truck by a UG-102/U connector and a set screw in the amplifier support bracket. The amplifier output connects to the mobile receiver or field-intensity meter through a 50-ohm flexible cable. The amplifier and the loop rotate as an integral assembly.

A fixed azimuth scale on the underside of the roof and a pointer on the amplifier assembly indicate loop orientation with respect to vehicle heading.

Bearing null indication can be obtained from the rectified detector output of an a-m receiver or the grid current in an unsaturated limiter stage in an f-m receiver.

Locating Techniques

In general, the actual locating of interfering sources is difficult. This is especially true when the source is intermittent or characterized by wide and sporadic changes in frequency.

The situation is further complicated by the possibility of nonuniform radiation fields at bearing-measurement sites. Multipath transmission resulting from reflections generally yields erroneous bearing indications. Wave arrivals other than directly from the source produce a composite received field. The loop is responsive to the resultant vector sum of these components. Thus, the bearing will appear to be along some line between the directions of arrival of the direct and reflected waves.

Presence of energy from reflecting sources near the receiving location can be detected by checking for variations in signal amplitude as the vehicle is moved along a line in the direction of the indicated bearing. The bearing measurement site should be on flat ground which contains no obstructions within a radius of 100 yards or more from the loop.

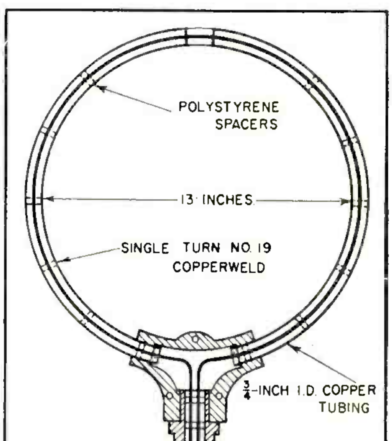


FIG. 4—Cross-section of antenna. Shield is discontinuous at top and bottom

The presence of reflecting and reradiating sources near the interference source is more difficult to establish. The distance between signal maxima and minima along the line of the bearing may be large and therefore difficult to detect.

When nearing radiating sources in built-up urban areas, the loop may prove useless due to severe nearby reflections and reradiation from wire lines propagating the interference. Use of an omnidirectional antenna may prove more desirable under these conditions. Changes in mean signal amplitude then indicate the proximity of the interfering source.

The development described was carried out at the U. S. Forest Service Regional Radio Laboratory, Government Island, Alameda, California.

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(5) W. E. Hopkins, A Loop Direction-Finder for Ultra Short Waves, *Wireless Eng*, Dec. 1938.

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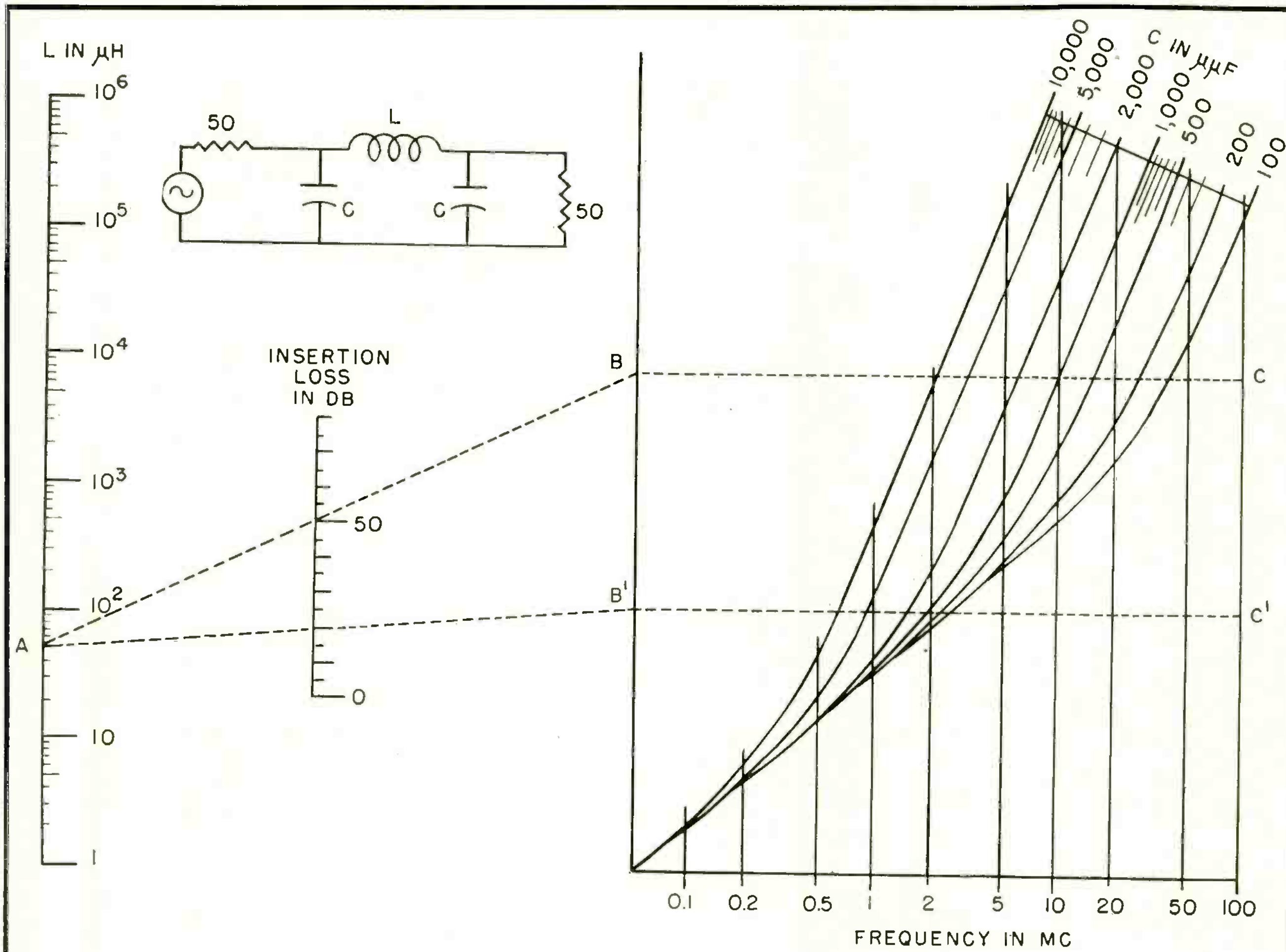


R-F Filter Design

By C. V. LONGO and E. WOLF

Essex Electronics
Berkeley Heights, N. J.

Alignment chart permits solution for insertion loss, reactance and frequency values of nonmatching pi-section radio-frequency interference filters employed in transmission systems of 50-ohm (resistive) characteristic impedance

THIS design chart is based upon a theoretical analysis of the indicated circuit when evaluated in accordance with MIL-STD-220. The chart is also valid if the series element is an antiresonant circuit or self-resonant choke. In this case apparent inductance values should be used and the antiresonant frequency becomes an upper frequency limit.

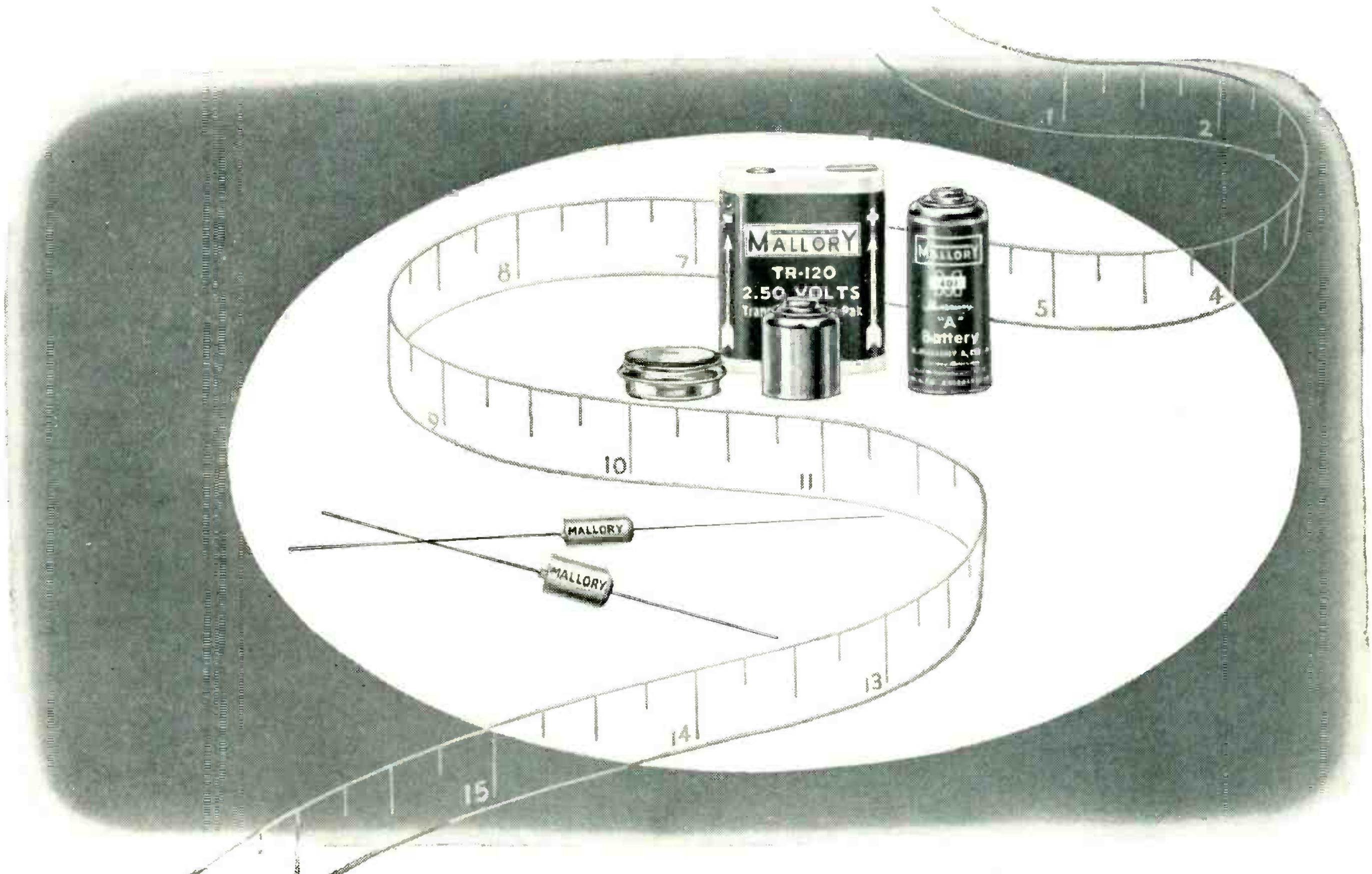
Preparation of the chart is based upon a peculiar relationship between the parameters over a restricted range of values. Extrapolation is thus unwarranted without previous verification.

The chart is a composite of a nomograph relating inductance and insertion loss to an intermediate function (plotted on the dummy axis) and a graph relating the intermediate function to frequency and capacitance. The graph is derived by calculation from the theoretical results. The result is in effect a double-alignment chart. Examples show use.

Line *ABC* indicates that 50-db insertion loss may be attained at 10 mc with a circuit in which *L* equals 50 μh and *C* equals 1,000 μμf. Line *A'B'C'* shows that the circuit constants of the first solution will yield 20-db insertion loss at 2 mc.

Research activity leading to development of this chart was sponsored by Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

ELECTRONICS REFERENCE SHEET



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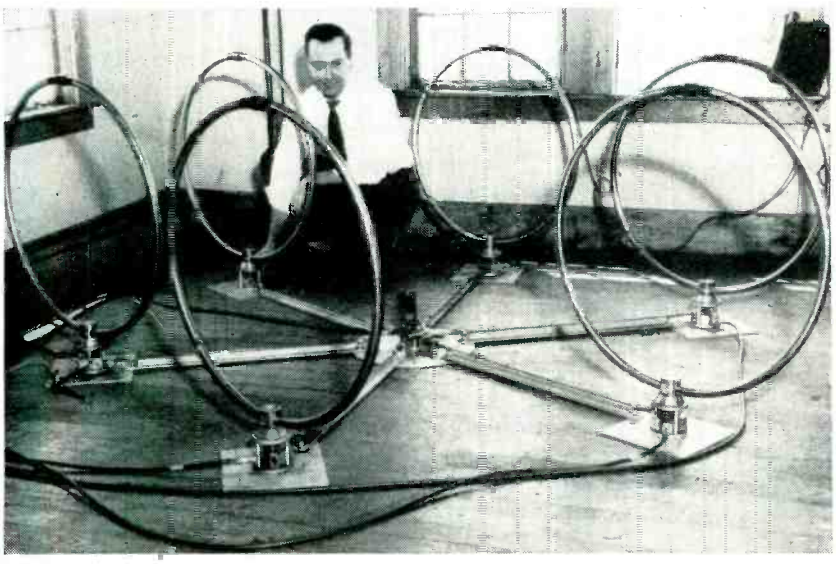
Electrons At Work

Edited by ALEXANDER A. McKENZIE

Air Force Scientists Plot Static Direction in D-Layer Study



Sextuple goniometer driven synchronously records noise or signals at various frequencies. Loop antennas complete a revolution every 15 minutes

USING RADIO signals from Navy low-frequency station NSS to check direction-finding equipment, members of the Ionospheric Laboratory, Air Force Cambridge Research Center are trying to correlate data with atmospheric and extraterrestrial phenomena.

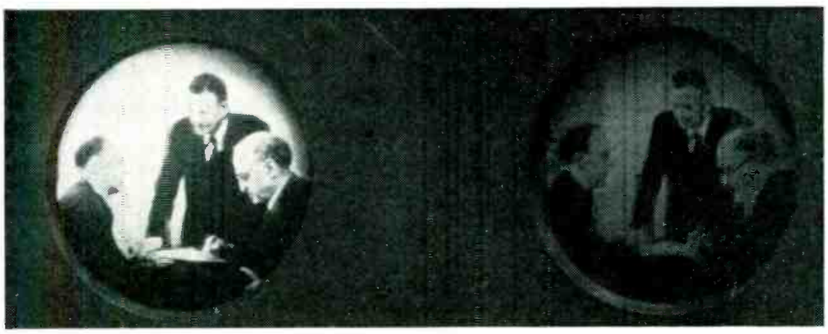
Main interest is study of the D-layer, the lowest stratum of the ionosphere. By using lightning discharges as transmitters of low-frequency electromagnetic energy, it is possible to make observations of height, electric-charge density and formation and deformation of the D-layer with respect to time.

In the experimental station at Fourth Cliff, Scituate, Mass., are six loop antennas about 3 feet in diameter. These loops are driven synchronously to turn one complete revolution every 15 minutes. Their outputs are connected through receivers to a pen recorder that plots response at various frequencies.

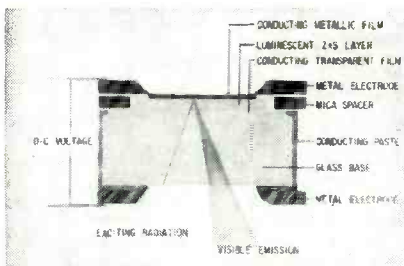
To date, a diurnal variation in static intensity has been noted. Atmospheric noise is highest during the night, probably owing to disappearance of the D-layer. More noise is recorded during the summer months than in the winter.

The recording station is almost completely automatic, being visited only once or twice a week.

Experimental Light Amplifier Employs Electroluminescence



Two pictures on the same strip of film show brightness increase (left) resulting from light amplification and lantern-slide projection without amplification (right)



Special phosphor cell used to effect amplification of light. Ultraviolet photons from a slide projector hit the cell, which reflects visible light. Application of d-c increases intensity

THE PHENOMENON of electroluminescence (which has been put to practical application for the illuminated dial of a commercial radio receiver) forms the basis of a recent demonstration by General Electric engineers and scientists. Ten-fold amplification of ultraviolet light was effected when ten or more visible photons were emitted for every incident ultraviolet photon.

According to D. A. Cusano, who described field enhanced solid-state luminescence before the American Physical Society at the end of January, large increases in the luminescent brightness of ultraviolet excited or x-ray excited zinc sulfide layers have been observed when these phosphors are subjected to electric fields.

Application of 100 volts d-c across vapor-deposited ZnS:Mn films approximately 10 microns thick (10^5 volts per centimeter) increases brightness 50 times. Excitation may be either ultraviolet or

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Model 2650

OUTPUT	VOLTS	CURRENT	REGULATION	RIPPLE
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by means of x-radiation.

For a given value of d-c field, brightness increases monotonically with excitation intensity. The single phosphor layer hence acts as an image intensifying screen. Physically the device used comprises a phosphor film between plane parallel electrodes, one of which is transparent.

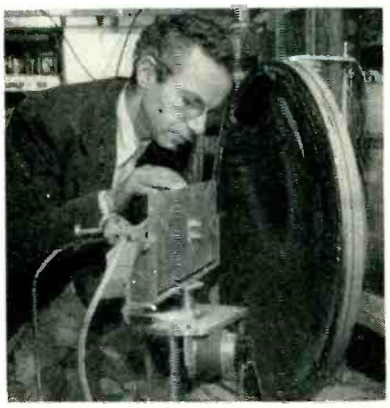
With the phosphor showing negligible emission under action of the electric field alone, the magnitude of luminescence is principally dependent upon the intensity of excitation.

Millimeter Wave Generator Produces Visible Light

WORKING on a project of the Office of Naval Research at Stanford University Microwave Laboratory, Hans Motz and several associates have generated waves down to 0.16 mm (2,000 kmc) with power in the order of 10 to 100 milliwatts.

Outgrowth of electron linear accelerator research, the Motz generator comprises an accelerator, undulator and echelette spectrometer. A 2-mev accelerator produces a pulsed beam of electrons about ⅛ inch in diameter. Traveling nearly the speed of light, these electrons pass into the foot-long undulator.

A rectangular silver waveguide held between 16 steel teeth jutting from the undulator's interior conducts the electrons through its core. These teeth are poles of opposing magnetic fields, all eight of which, alternating in opposite directions, cause the speeding electrons to oscillate at the desired frequency.



Millimeter wave generator produces frequencies between those of radio and infrared. New waves might be used for short-distance communications

Distance between like poles is 40 mm but Lorentz contraction and Doppler effect (owing to the relativistic effect of high speed) cause the effective length of the undulator to shrink to $\frac{1}{50}$th actual size. Wavelength produced is made to shrink to one-fifth so that ultimate wavelength is only $\frac{1}{250}$th of 40 mm.

The echelette spectrometer comprises a grooved aluminum plate and a two-foot aluminum parabolic mirror. The output of the undulator is reflected from the aluminum mirror to the aluminum plate. Angle and depth of the precision grooves cause the desired waves to reflect back to the mirror, while those with undesired characteristics are effectively eliminated.

When a 100-mev beam was employed, visible light was produced.

Radar and Computer Track Mortar Shells Back to Source

COUNTEROFFENSIVE radar used during a part of the Korean conflict was recently unveiled to the general public by U. S. Army Signal Corps and Sperry Gyroscope Co., manufacturers of the equipment.

Long-used for fire control of military weapons, radar performs a special detection function in the counter-mortar radar set AN/MPQ-10 that tracks enemy shells. This tracking information, fed into a computer, reveals the source of the shells.

The radar equipment mounted on a modified gun carriage, can be towed by light Army truck to whatever part of a battleground must be covered. The system comprises the dish antenna shown, controlled by automatic tracker, a gas-engine generator and separate remote control console with radarscopes.

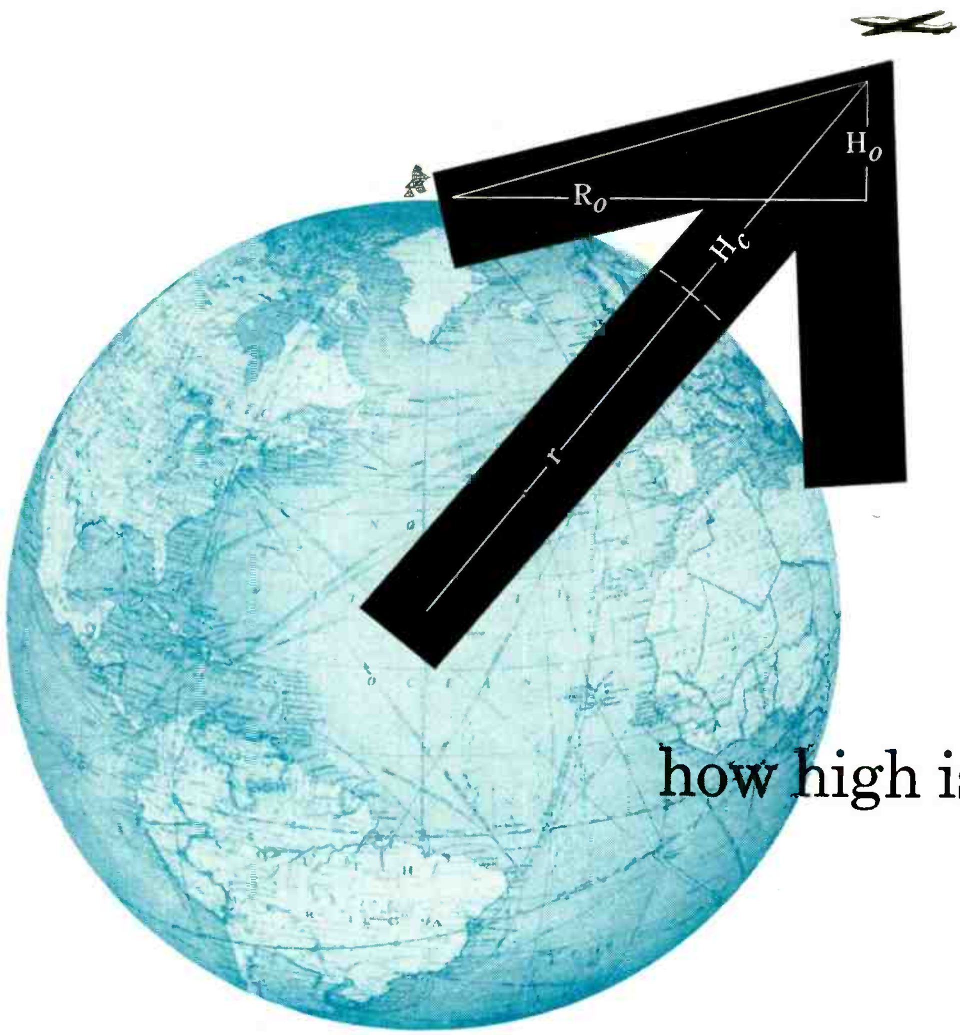
Counter-mortar radar AN/MPQ-10 is mounted on gun carriage

Elevation and range computers are mounted on the modified gun carriage. Extension cables permit separation of the tracking unit and controls by at least 100 feet.

One radar officer commands an operations team that translates the radar plot into precise co-ordinates for artillery counterfire. The portable control unit is about the size of a large-screen home television console and can be easily concealed in dugouts, foxholes or other protected locations. Computer range data reveals the enemy position.

Portable Analyzer Measures Mobiles

BANDWIDTH of radiotelephone emissions is generally measured approximately. Frequency-modulation signals are usually checked by operators using devices that read proportionally to the deviation—accurate only on sustained tones —rather than to actual bandwidth. Distortion in amplitude-modulated transmitters that are not overmodulated may cause adjacent channel interference as



how high is up?

A child's conundrum becomes a matter of life and death... when radar tells a lie. When our radar tracks attacking aircraft... or an incoming missile... the lives of all of us on target balance on the pinpoint of a mathematical riddle.

How high is up? It depends on the point-of-viewing.

Because of earth's curvature, radar sees an interloper... 100 miles away... 6600 feet lower than it really is. Readings must be corrected instantaneously before being fed to our interceptors... otherwise, attacker and defender play true or false at twice the speed of sound.

Electronic Engineering Company of California has designed an analog computer that makes this vital correction... converting radar observation into true altitude above sea level. The computer continuously solves the equation

$$H_c = H_o + (R_o^2/2r)$$

The mathematics are complex. The mechanism, with a two-gang HELIPOT* series A precision potentiometer at its heart, is beautifully simple. Both are fully described in a new application data sheet... write for Data File **201.**

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THE FRONT COVER

DESIGNED and built by Admiral Corporation engineers, this 30-foot long battery of machines automatically assembles approximately half of the company's vertical chassis for 21-inch television receivers. Blank printed circuit boards start down the one at the far end.

The assorted resistors and wire jumpers in the eight-tube section are inserted singly, some two at a time and others three at a time. Assembled boards slide down the chute at the lower left.

The employee is showing the bottom side of a printed circuit board (right) and the assembled board with all parts in her other hand. Printed circuit chassis construction results in more uniform production, trouble-free soldering and lower production costs.

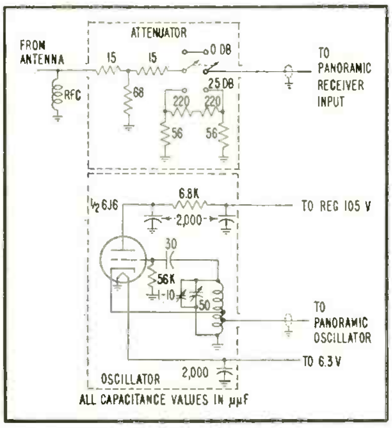


FIG. 1—Attenuator and supplementary oscillator extends frequency range of commercial panoramic spectrum analyzer that is used by monitoring officers to check mobile transmitters

objectionable as that produced by overmodulation.

For more exact determination of the bandwidth of actual spectrum occupancy, engineers often use a panoramic display device that shows the extent of side frequencies. By definition, the bandwidths considered significant in this description include all components of the emission stronger than 25 db below the level of unmodulated carrier. To avoid the complexity of graduating an oscilloscope in db, an attenuator is provided instead at the antenna input terminals of the panoramic device. The attenuator has two positions, 0 and 25 db. Accuracy of level is determined only by the attenuator, so long as all measurements are made at the same point on the oscilloscope scale without changing the gain control between the two settings of the attenuator switch.

The basic instrument scans a region plus or minus 25 kc at 500 kc. An extended frequency range is obtained by adding a local oscillator with a fundamental frequency range between 27 and 70 mc. Harmonics of the oscillator make it possible to obtain operation as high as 200 mc. It is thus possible to use this portable equipment for measurement of true bandwidth of chan-

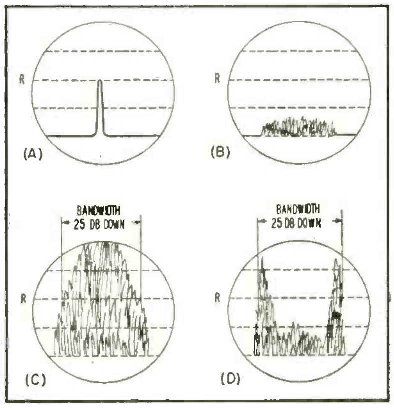
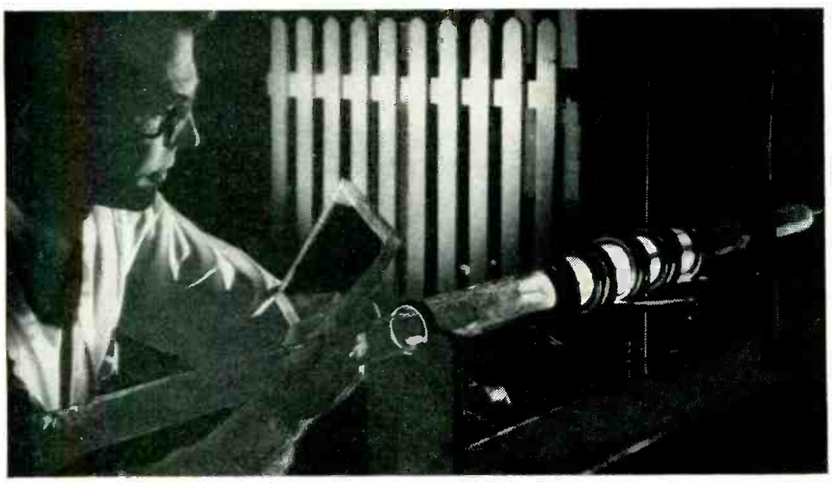


FIG. 2—Unmodulated carrier (A) is frequency modulated (B) with attenuator in. Bandwidth is read (C) with attenuator out. Deviation-limited transmitter has similar bandwidth (D)

nels occupied by land mobile and other radio stations.

Circuit diagrams of the added circuits are shown in Fig. 1. Fundamental range of the oscillator is 27 to 70 mc. Second-harmonic range is 55 to 120 mc and the third harmonic occurs between 85 and

Preparing High-Purity Silicon by Induction Heating



Zone-melting process for production of high-purity silicon is observed by Hubbard Horn, physical chemist in General Electric Research Laboratory. Refining process consists of successive recrystallization as ingot moves slowly through gas-filled quartz tube. Induction coils around outside of tube cause ingot to melt in narrow zones. Impurities in molten regions are swept to the end of the bar. Dr. Horn views the white-hot crystal through a semiopaque water cell that filters out heat

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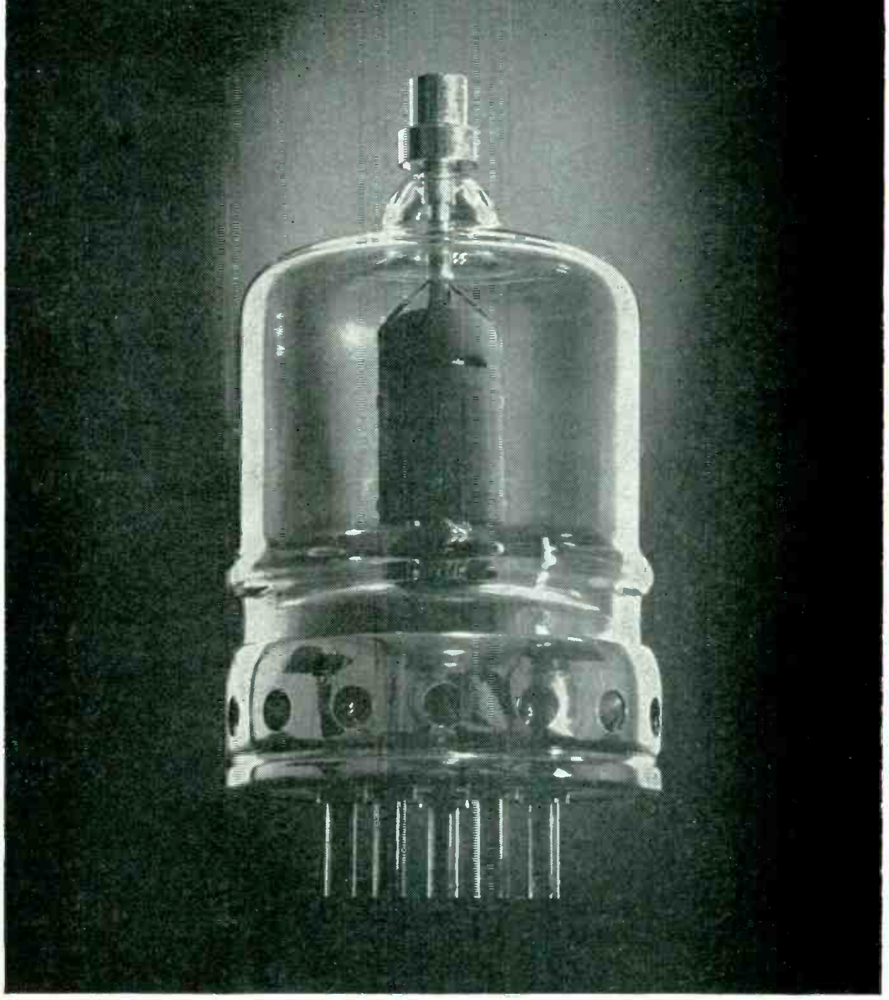

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200 mc. Care must be taken to tune in the carrier of interest. Transmitter harmonics and harmonics of the crystal frequency will give no indication or a false indication of true output bandwidth.

Although there are several precautions to be observed in the operation of the panoramic spectrum analyzer, the essential technique is shown in Fig. 2. At (A), the unmodulated carrier is adjusted to touch reference line R with the attenuator switch at the 25-db setting. When the associated transmitter is frequency modulated, the energy is spread out (B) over a band with lower maximum deflection. In fact, under certain conditions, the energy at the carrier frequency may go to zero with modulation.

At (C) the attenuator switch is now set for 0 db. Conditions are similar to those producing the display at (B). Maximum deflection shows off scale. Bandwidth is measured between two crossings of reference line R.

The display at (D) is essentially similar to that of (C). The transmitter producing it has a nonlinear device for deviation limiting. With heavy modulation the energy piles up against the two edges of the band.

This information has been abstracted from a report of the Laboratory Division of the Federal Communications Commission.

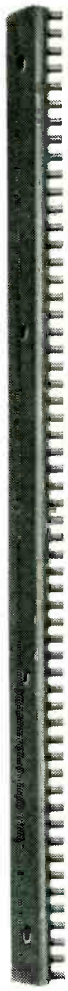
Potentiometer Design for Minimal Loading

By E. F. Coleman

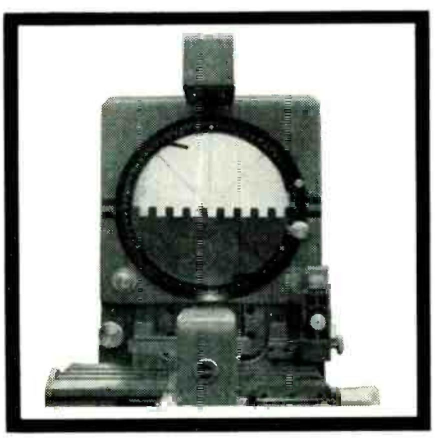
Research Engineer
Mergenthaler Linotype Co.
Brooklyn, N. Y.

Much of the utility of the familiar resistive potentiometer or voltage divider shown in Fig. 1 rests on an approximation. Provided its own total resistance R is low compared to that of its load R_L the voltage transmission T defined as the ratio of output to input voltage is approximately given by the simple arm ratio R_1/R and is approximately independent of load R_L.

In many potentiometer circuits



Saved . . . 296 pieces per thousand!



Like many another manufacturer, the Hoover Company, Canton, Ohio, has its rejection problems. A typical one involved a flexible, rubber-like "litter picker" used in its vacuum cleaners. Although tolerances ranged from .085″ to .101″, rejects ran as high as 30%.

To solve this problem, Hoover employed a Kodak Contour Projector to measure the parts, plotted results in accordance with modern methods of statistical quality control. Based on these studies, alterations were made in the cutting tool and the holding fixture for the part. Rejects dropped from 30% to less than ¼ of 1%. Savings amounted to 296 pieces per thousand.

"Optical gaging with the Kodak Contour Projector," say Hoover engineers, *"eliminated incorrect readings caused by mechanical distortion of the parts. In addition, optical methods of measurement proved from 4 to 5 times faster than conventional gaging techniques."*

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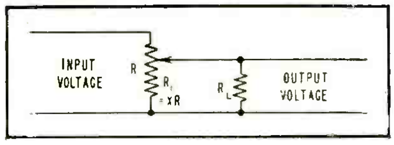


FIG. 1—Simple potentiometer circuit showing symbols used in design equations

the designer avoids making a full circuit calculation, which would show just how valid the approximation is. Instead, R is chosen to be so low that load R_L cannot appreciably affect transmission T. This is an easy and fairly safe way to insure that the voltage division is about as planned, but it gives no indication of how small R must be. As a result the potentiometer resistance is often lower than necessary, in consequence loading down the source, wasting power and perhaps aggravating a dissipation problem.

An accurate rule of thumb that gives the maximum permissible potentiometer resistance in terms of the load resistance R_L and the allowable loading error E is: resistance R must not exceed $4ER_L$.

The loading error E is defined as the relative amount by which the actual voltage transmission T of the loaded potentiometer falls short of the transmission T_0 with no connected load, or an infinite R_L. That is, E is defined as $(T_0-T)/T_0$. This quantity is to be evaluated at the potentiometer setting at which the relative loading error is greatest.

As an example, consider a calibrated potentiometer for driving a grid circuit that acts as a resistive load of 50,000 ohms. At the worst setting, the actual voltage attenuation must not differ owing to loading by more than 2 percent from that indicated on the potentiometer dial. In this case, R_L is 50,000 ohms and E is 0.02. Then by the

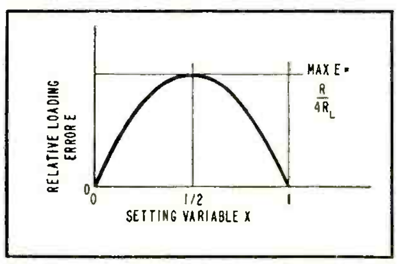
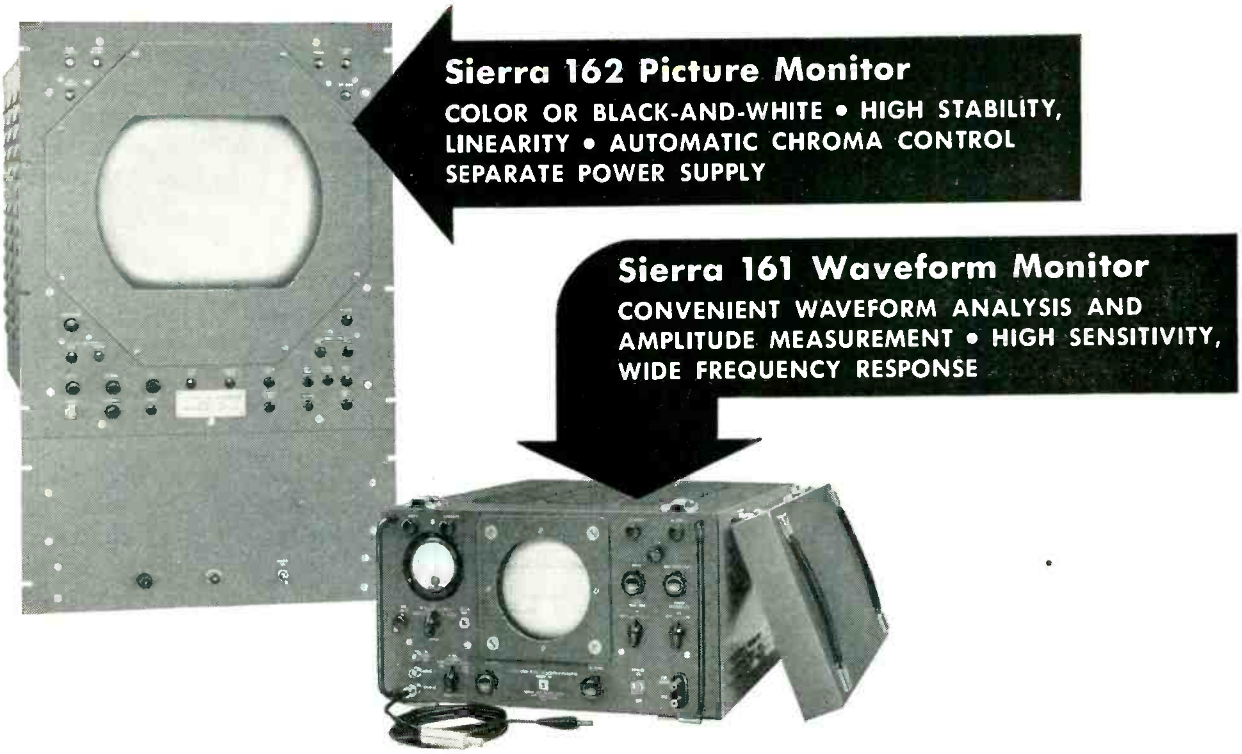


FIG. 2—Error in voltage transmission in potentiometer caused by load is maximized at halfway point in potentiometer range

NEW COLOR TV MONITORS



Together, new Sierra 161 and 162 TV Monitors provide convenient, dependable and complete monitoring of NTSC Standard Color Transmissions or black-and-white video signals.

Model 162 consists of a picture unit and a separate power supply. Features include high-level triode demodulators for linearity and stability, automatic chroma control, numerous test jacks to simplify circuit adjustment, and a regulated high voltage supply for the picture tube.

Model 161 provides convenient video signal waveform analysis and amplitude measurement. Vertical amplification is available to either 2, 4 or 6 mc. Also included are a high impedance, low capacitance probe, an input attenuator and a 60 cps calibrating signal simultaneously displayed on screen and voltmeter. Horizontal sweep may be expanded 12 or 20 tube diameters with return trace blanked.

Write for Data Sheets

SPECIFICATIONS — MODEL 162

Input Video Signal: 0.25 to 2.0 volts peak to peak, black negative.
Input Impedance: 72 ohms, coaxial (BNC connector).
Resolution: 250-300 lines (Full NTSC color signal bandwidth is used).
Picture Tube: 15" tri-color type.
Operating Power Requirements: 105 to 125 volts, 50/60 cps, 4 amperes (approx.).
Mounting: 19" relay rack.
Cabinet Dimensions: Picture Unit $17\frac{1}{4}$" wide, (19" panel), 21" high, 29" deep. Power Supply Unit $17\frac{1}{4}$" wide (19" panel), $8\frac{3}{4}$" high, $8\frac{1}{2}$" deep.

SPECIFICATIONS — MODEL 161

Input Signal Level: .05 to 300 volts peak to peak.
Deflection Sensitivity: 2 mc bandwidth: 0.05 peak to peak volts per inch. 4 mc and 6 mc bandwidth: 0.10 peak to peak volts per inch.
Frequency Response:
Vertical Amplifier: 2 mc I.R.E. —3 db down. 4 mc Normal —3 db down. 6 mc Line Test —3 db down.
Square Wave Response: Less than 5% tilt at 60 cps.
Horizontal Amplifier: 35 kc —3 db down.
Input Impedance: Vertical amplifier without probe 470 k ohms 40 $\mu\mu$f. Vertical amplifier with probe 1 megohm. 14 $\mu\mu$f. Horizontal amplifier (external sweep) 100 k ohms 200 $\mu\mu$f.
Sweep Frequencies: Low range 18 to 80 cps continuously variable.
High range 4,000 to 16,000 cps continuously variable.
Horizontal Expansion: Low frequency sweep 20 tube diameters. High frequency sweep 12 tube diameters.
Operating Power Requirements: 105 to 125 volts 50/60 cps 1.8 ampere.
Cabinet Dimensions: 17" wide, 9" high, and 20" deep.

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rule stated, resistance R must not exceed $4ER_L$ or 4,000 ohms.

To simplify the derivation, let the lower-leg resistance, R_1, of the pot at any setting be written as xR. Thus x is the pot setting variable, which runs from 0 to 1 as the tap point rises from zero-output to full-output position. The no-load transmission T_0 then simply equals x. Analysis of the circuit of Fig. 1 gives for the loaded transmission

$$T = \frac{xRR_L}{xRR_L + (1 - x)(xR + R_L)R} \quad (1)$$

Next formulate the ratio T_0/T of no-load to loaded transmission. With simple rearrangement this can be written

$$\frac{T_0}{T} = 1 + \frac{R}{R_L}\, x\,(1 - x) \quad (2)$$

If loading is not severe, the second term here must be small with respect to unity. Thus in inverting Eq. 2 to the desired reciprocal form the binomial-theorem approximation can be used to obtain

$$\frac{T}{T_0} = 1 - \frac{R}{R_L}\, x\,(1 - x). \quad (3)$$

The second term of the latter can be identified as the relative loading error E. Ignoring its negative sign, the error is

$$E = \frac{R}{R_L}\, x\,(1 - x). \quad (4)$$

As a function of the setting variable x, the error function, plotted in Fig. 2, is parabolic with a maximum at $x = \frac{1}{2}$. The error is zero at both extreme settings. For minimal-design, interest exists only in its maximum vale, which is $E = R/4R_L$. Hence the design rule already stated: $R = 4ER_L$.

As a subsidiary application, a simple calibration formula can be provided for laying out a special scale for a potentiometer used with

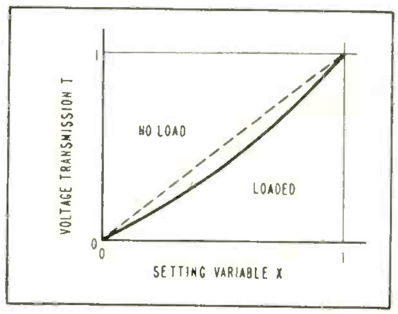
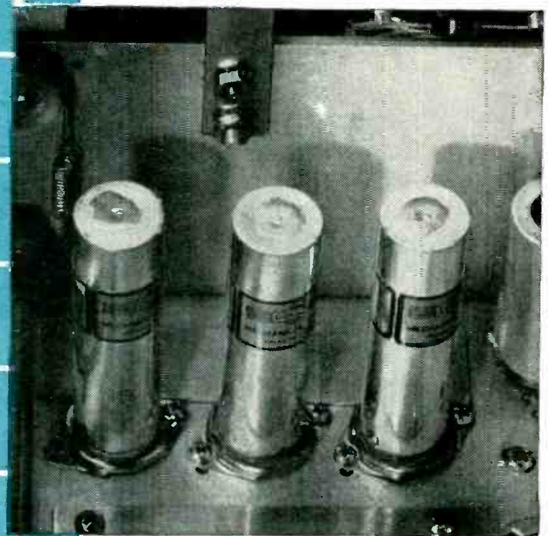
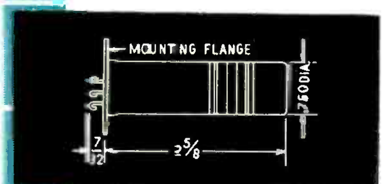


FIG. 3—Effect of resistive load on dial calibration of potentiometer

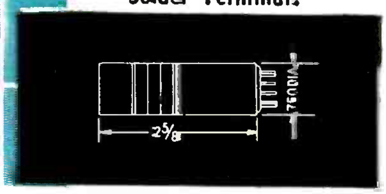
new MECHANICAL FILTER designs by Collins



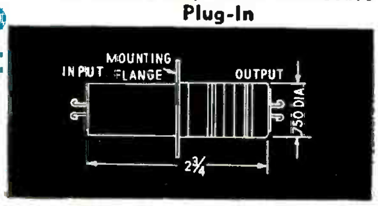
- new low insertion loss
- temperature compensated
- new compact tubular design



F455H-Series, Single-Ended Solder Terminals



F455J-Series, 9-Pin Miniature Plug-In



F455K-Series, Double-Ended Solder Terminals

Sharp selectivity characteristics, compactness of tubular design and choice of terminal style illustrated above are among top features of the new designs.

COLLINS Mechanical Filters have become the byword to electronics people looking for superior selectivity characteristics, compact design, simplified circuitry and maintenance-free service in IF passband filters. Utilizing magnetostrictive principles of mechanical resonance to provide high attenuation of unwanted signals, Collins has established a wide margin of leadership maintained by an intensive research program. The important developments of this research are now available to the electronic industry.

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a known fixed load resistance so that it will read directly the actual loaded transmission. The calibration formula results from reassembling, with the aid of approximate Eq. 4, a simple expression for the loaded transmission $T = x(1 - E)$

$$T = x\left[1 - \frac{R}{R_L}\, x\,(1 - x)\right] \qquad (5)$$

This has the form shown in Fig. 3, which differs slightly from the dashed straight line that represents the no-load condition.

While the value developed for the loading error in this discussion involves an approximation itself, the second-order error thus overlooked is in about the same ratio to the evaluated error E as the latter is to unity.

New Government Patents

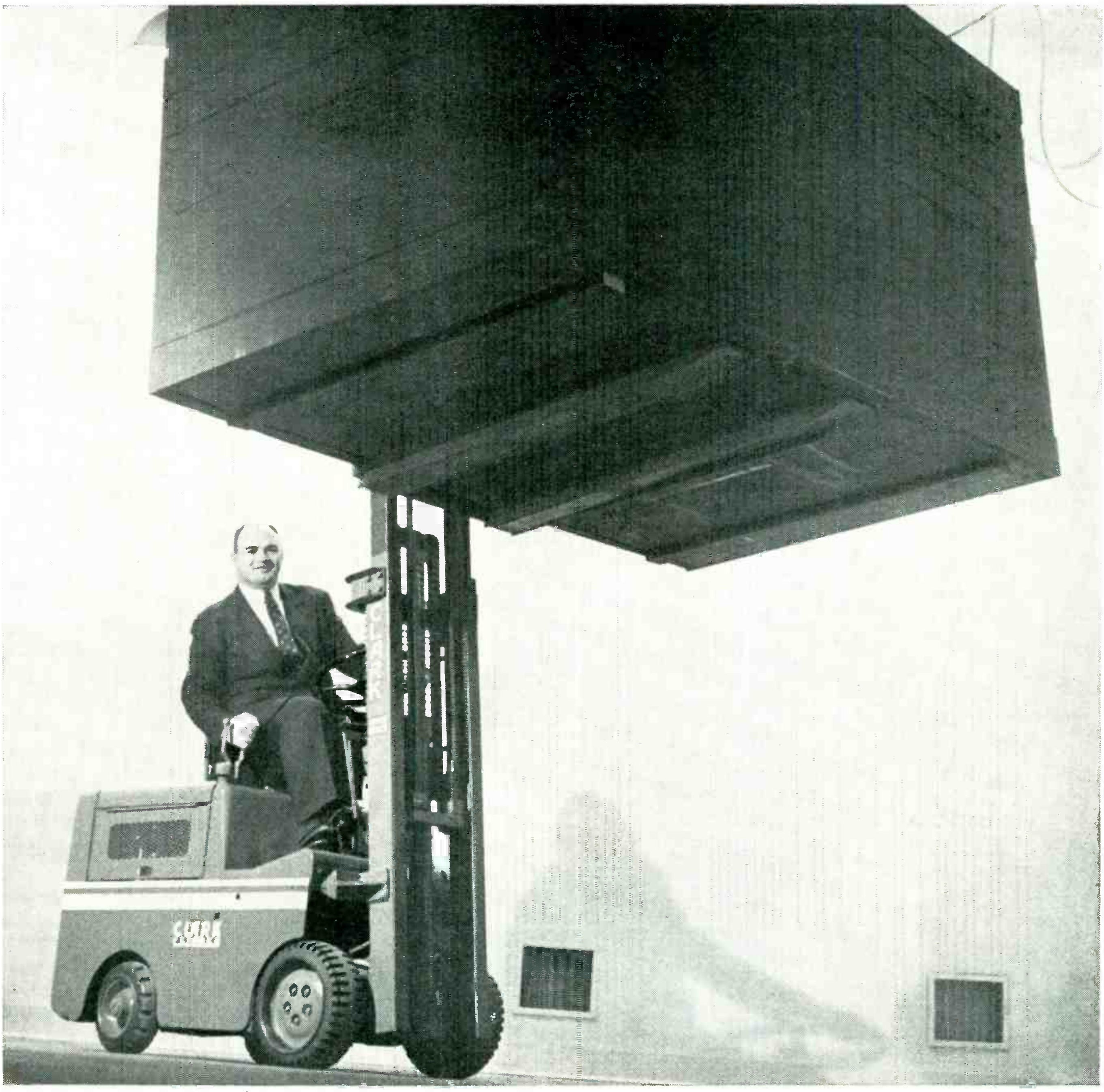
SUPPLEMENTING a list of patents previously published (ELECTRONICS, p 198, Oct. 1954) is "Patent Abstract Series, No. 5, Electrical and Electronic Apparatus" (PB 111-468) for sale at $4 from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

The 1,915 patent abstracts in the new book that are of particular interest to engineers and manufacturers in the field of electronics include those describing radio and navigation apparatus, tubes, computing devices, batteries and telephone and telegraph apparatus.

Electromechanical Networks For A-C Servosystems

By CHARLES A. SAVANT AND CLEMENT J. SAVANT
Whittier, California

BECAUSE OF DRIFT in d-c amplifiers, emphasis has been placed on a-c type servo systems. The typical system utilizes an a-c transducer, tuned amplifier with appropriate feedback and a two-phase a-c control motor. In most systems, some



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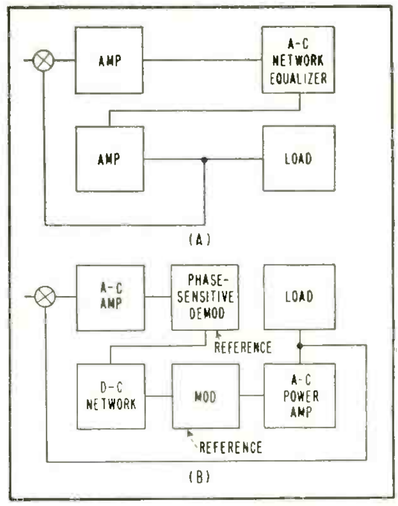

FIG. 1—Servo system using equalization network (A) has greater signal-to-noise ratio than demodulation-remodulation system (B)

form of series equalization is necessary for stability. Although much effort has been expended in using bridged or parallel-T networks, there has been little success. The reason for this rests in the low Q of these R-C notch networks, which results in such a large attenuation of the sidebands that the signal-to-noise ratio becomes intolerable. Figure 1A demonstrates a block diagram of a typical system of this type.

Alternately, demodulation and remodulation systems of the type shown in Fig. 1B have been used. The a-c signal is amplified and demodulated with a phase-sensitive demodulator. The d-c signal is series equalized with the desired passive networks and then remodulated.

This article presents a method of complete a-c series equalization by means of electromechanical networks. These networks are reli-

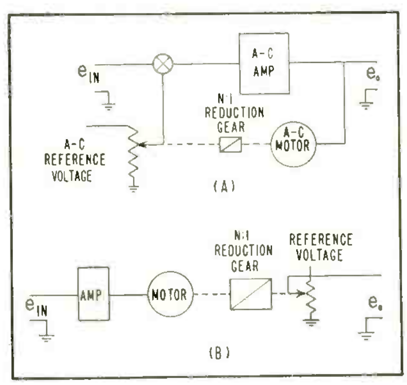

FIG. 2—Electromechanical lead (A) and lag (B) networks are not subject to drift because of their completely a-c character

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at approx. 5 m.a.

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MAGNETICALLY SHIELDED

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These units, which are the result of several years of development and testing, offer a new standard of simplicity and reliability. Particularly noteworthy is the uniformity of output signal voltage with temperature change. Small size and light weight make them ideal for airborne and portable use.

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able, rugged and are not subject to drift because of their completely a-c character.

Figure 2A shows the block diagram of the electromechanical lead network. Using the notation of this figure, the following expression results

$$E = e_o/A = e_{IN} - (K_m N' e_o)/s(\tau s + 1) \quad (1)$$

where s is the Laplace transform operator, K_m is the motor constant, N' is the constant of the potentiometer and τ is the ratio of the motor and gear-train inertia to the slope of the motor torque curve. The transfer function of the motor is

$$K_m/s(\tau s + 1) \quad (2)$$

For large gain, A, Eq. 1 reduces to

$$e_o = s(\tau s + 1)/K_m N' e_{IN} \quad (3)$$

For small values of τ and frequency

$$e_o = s/K_m N' e_{IN} \quad (4)$$

Thus, in operational notation, e_o is proportional to the derivative of e_{IN}

Since the amplifier is tuned and a-c, high-gain is possible with relative ease. Drift is no problem and with appropriate tuning the noise can be appreciably reduced. Reference voltage is provided for proper subtraction at the amplifier input.

The block diagram of the integrator system is shown in Fig. 2B. No feedback is necessary here since the transfer function now is

$$e_o = AN'K_m/s(\tau s + 1)e_{IN} \quad (5)$$

Again for low frequencies approaching zero, Eq. 5 becomes

$$e_o = AN'K_m/s \quad (6)$$

This then is the desired expression.

It is possible to use an integrator in a system and produce zero steady-state error. If the integrator is inserted in a loop with feedback, the input to the inte-

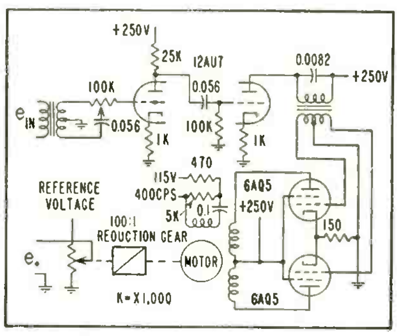
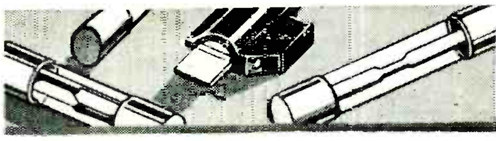


FIG. 3—Integrator for electromechanical system can provide a-c or d-c output depending on the signal used to excite the motor-driven potentiometer



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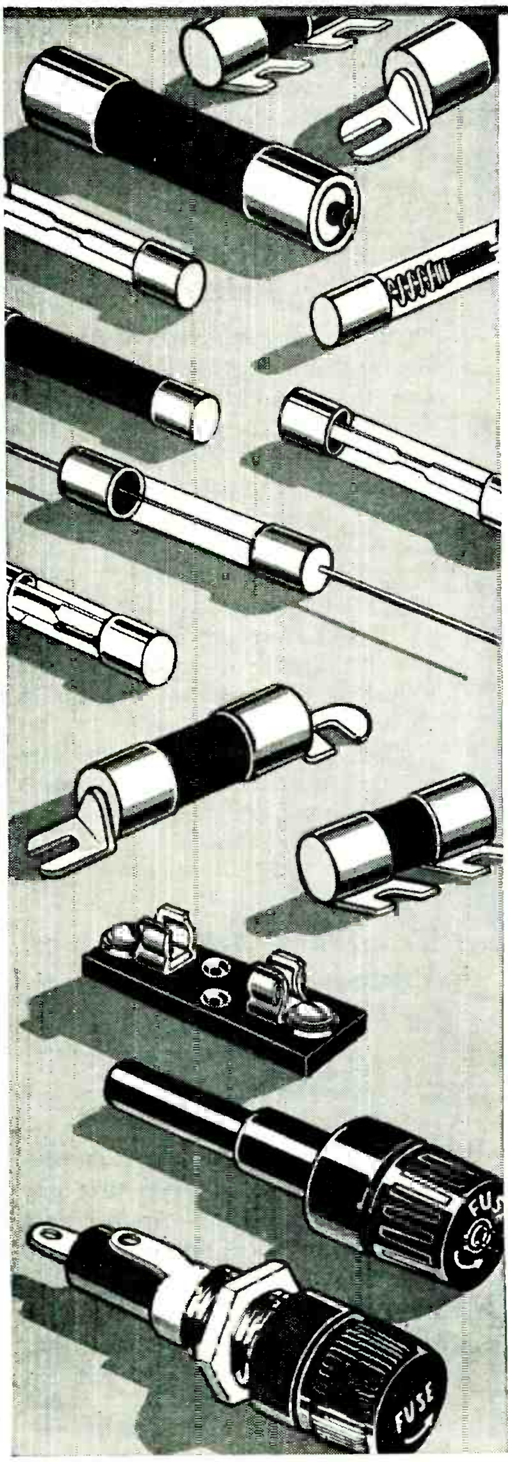

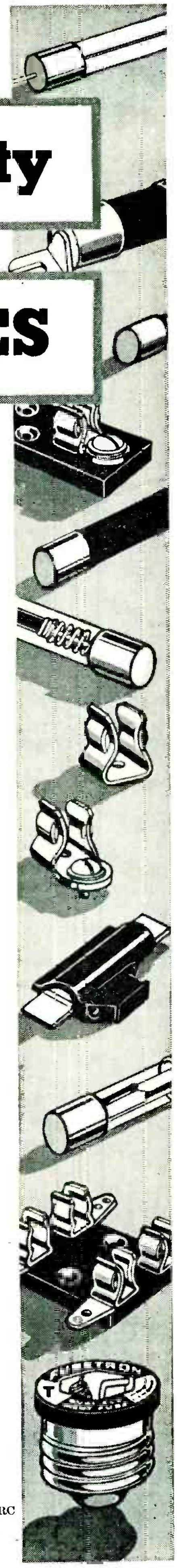

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grator will be the error. Even at d-c, the motor will continue to turn until the error is reduced to zero and hence the system has zero steady-state error. Threshold effects of the motor and amplifier can be minimized by increasing the gain.

The circuit of a completed integrator is shown in Fig. 3. The unit is small, reliable and has either a d-c or an a-c output as desired since the excitation of the motor-driven potentiometer can be either type of signal. A wide range of transfer functions is available if various other mechanical components are added. For example damping, spring rate or a combination of these when added to either network permits a variety of functions.

Intense Sound Bad for Tubes

TESTS made by engineers of Armour Research Foundation on small electron tubes and relays showed malfunction at high sound levels. Components were tested in a sound chamber at simulated sound levels typical of jet and rocket engines and guided missiles.

Sound spectra of an Air Force jet aircraft may approach 150 decibels at 10 feet from the tail pipe when the jet engine is operating full thrust and approaches 140 db in the equipment bay.

Such sound intensities are high enough to affect reliable operation of electronic components, particularly vacuum tubes.

Transistor Amplifier Performance

By CECIL E. WILLIAMS

Electrical Engineer
Armour Research Foundation of Illinois Institute of Technology
Chicago, Ill.

COMMERCIAL JUNCTION TRANSISTORS have internal capacitances that may cause a reduction of amplifier gain at frequencies slightly above the audible range. The conventional T equivalent circuit does not indicate the frequency response since it contains no terms for transistor capacitances. The equivalent circuit values of alpha, base resistance,

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emitter resistance and collector resistance are readily obtained for a given operating point but internal capacitances cannot be directly measured. The equations become tedious to solve if internal capacitances are added to the equivalent circuit.

Several transistors were tested to measure their performance as a function of input frequency. The grounded-emitter circuit was selected because it has a higher input impedance than the grounded-base circuit and a higher gain than the grounded-collector circuit. The input voltage was held constant at approximately 1 millivolt and supplied from a zero-impedance generator.

Figure 1 shows the variation of input impedance and voltage gain

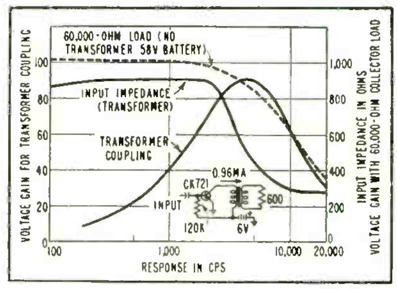

FIG. 1—Frequency response of transistor amplifier with load matched for maximum power output

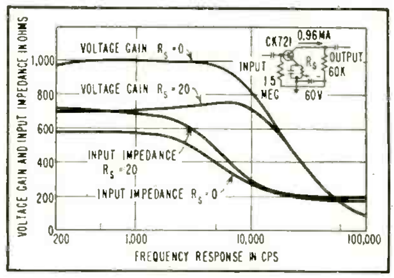

FIG. 2—Frequency response of grounded-emitter amplifier with series emitter resistance

with frequency for a transformer-coupled load. The amplifier load was adjusted for maximum power output at 1-millivolt input. The direct current in the transformer primary reduced the low-frequency response and all further tests were made without transformer coupling.

Results of adding a partially bypassed resistance in series with the emitter lead is shown in Fig. 2. This gain stabilizing circuit lowered the peak gain approximately 30 percent but reduced the gain variation to less than ±3 percent over the

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Rugged Construction — *The advanced design features which have made the Tung-Sol 5881 so extremely reliable are embodied in the 6550.*

1. Glass button stem construction is strong and compact and provides a rugged support for the tube structure.
2. Micanol wafer and metal shell base provides full lifetime electrical insulation and greater mechanical strength.
3. Cathode materials of exceptional stability give more uniform emission with greater life expectancy. Cathode is not poisoned by inactivity during standby periods.
4. Maximum control of grid emission achieved by gold plating and carbonizing.
5. Triple gettering promotes long, gas-free life. Getters are confined by a spray shield to prevent mica contamination.
6. Life tests are made under severe overload conditions to assure adequate safety factor.

MECHANICAL DATA

Coated Unipotential Cathode	
Outline Drawing	Bulb—Short St-16
Base	Large Wafer Octal 8-Pin Mical with Metal Sleeve B8-86
Maximum Diameter	2 1/16"
Maximum Overall Length	4 3/4"
Maximum Seated Height	4 3/16"
Pin Connections	Retma Basing 7S
Pin 1—Base Shell	Pin 5—Grid No. 1
Pin 2—Heater	Pin 7—Heater
Pin 3—Plate	Pin 8—Cathode and Grid No. 3
Pin 4—Grid No. 2	
Mounting Position	Any

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(INTERPRETED ACCORDING TO RETMA DESIGN CENTER SYSTEM)

DIRECT INTERELECTRODE CAPACITANCES — *No Shield*

Grid #1 to Plate	0.85 μμf
Input	14.0 μμf
Output	12.0 μμf

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Heater Voltage (AC or DC)	6.3 ±10% VOLTS
Maximum DC Plate Voltage	600 VOLTS
Maximum Plate Voltage (Triode Connection)	450 VOLTS
Maximum Plate Dissipation (Triode Connection)	40 WATTS
Maximum DC Grid #2 Voltage	400 VOLTS
Maximum Grid #1 Voltage	—300 to 0 VOLTS
Maximum Plate Dissipation	35 WATTS
Maximum Grid #2 Dissipation	6.0 WATTS
Maximum DC Cathode Current	175 MA.
Maximum Heater-Cathode Voltage	
Heater Positive (Peak) (DC not to exceed 100V)	+200 VOLTS
Heater Negative (Peak or DC)	—300 VOLTS
Maximum Grid #1 Circuit Resistance (Fixed Bias)	50 KILOHMS
Maximum Grid #1 Circuit Resistance (Self Bias)	250 KILOHMS
Maximum Bulb Temperature	250 °C

HEATER CHARACTERISTICS

Heater Voltage	6.3 VOLTS
Heater Current	1.8 AMP.

The TUNG-SOL engineering which has produced the 6550 is constantly at work on a multitude of special electron tube developments for industry. Many exceptionally efficient general and special purpose tubes have resulted. Technical data sheets, or circuitry suggestions for the 6550 may be obtained by writing to Tung-Sol Commercial Engineering Department.

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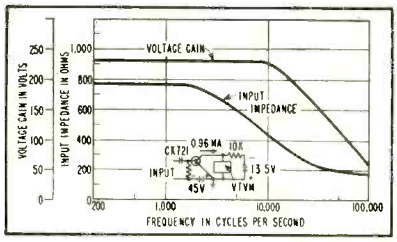

FIG. 3—Grounded-emitter transistor amplifier response curves

range from 200 to 10,000 cps. The input impedance was increased approximately 15 percent over this same range by adding the stabilizing circuit.

Figure 3 shows the performance of a transistor amplifier with a 10,000-ohm collector load. The same d-c operating point was used in all cases. Voltage gain is constant from 230 to 10,000 cps but power gain is only a third that obtained in Fig. 2. All of these circuits were biased for constant base current and circuits of this type are sensitive to temperature changes. This sensitivity is shown by a change of collector current and will produce a large change in collector-to-emitter voltage if the collector circuit has a high d-c resistance.

This changes the operating point and the voltage gain of the amplifier may vary beyond permissible limits. The effects of temperature changes are slightly reduced by using transformer coupling or lower-resistance collector loads. Further stabilization may be obtained by biasing for constant-emitter current operation instead of for constant base current.

Figure 4 shows the results obtained when 10 different transistors were tested in the same circuit. The circuit is arranged to give partial compensation for the effects of temperature variation and differences in transistors. The d-c base current is proportional to the potential difference between the 16-volt battery and the voltage drop produced by the emitter current flowing through the 4,700-ohm series resistance. A decrease in emitter current increases the base current and this tends to increase the emitter current by an amount almost equal to the initial decrease.

The test results obtained show excellent correlation between tran-

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SPRAGUE TYPE NO.	WATTAGE RATING	DIMENSIONS L (inches)	D	MAXIMUM RESISTANCE
151E	3	17/32	13/64	10,000 Ω
27E	5	1 1/8	5/16	30,000 Ω
28E	10	1 7/8	5/16	50,000 Ω

Standard Resistance Tolerance: ±5%

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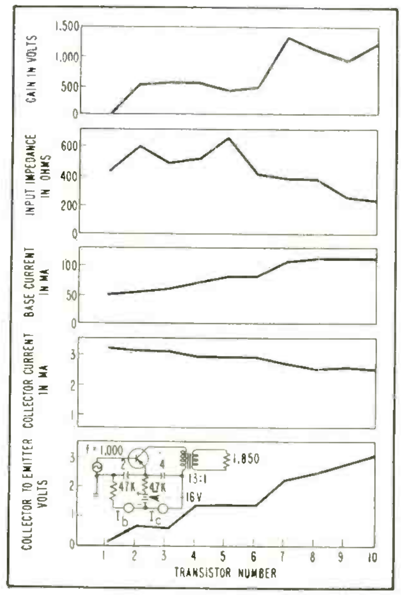


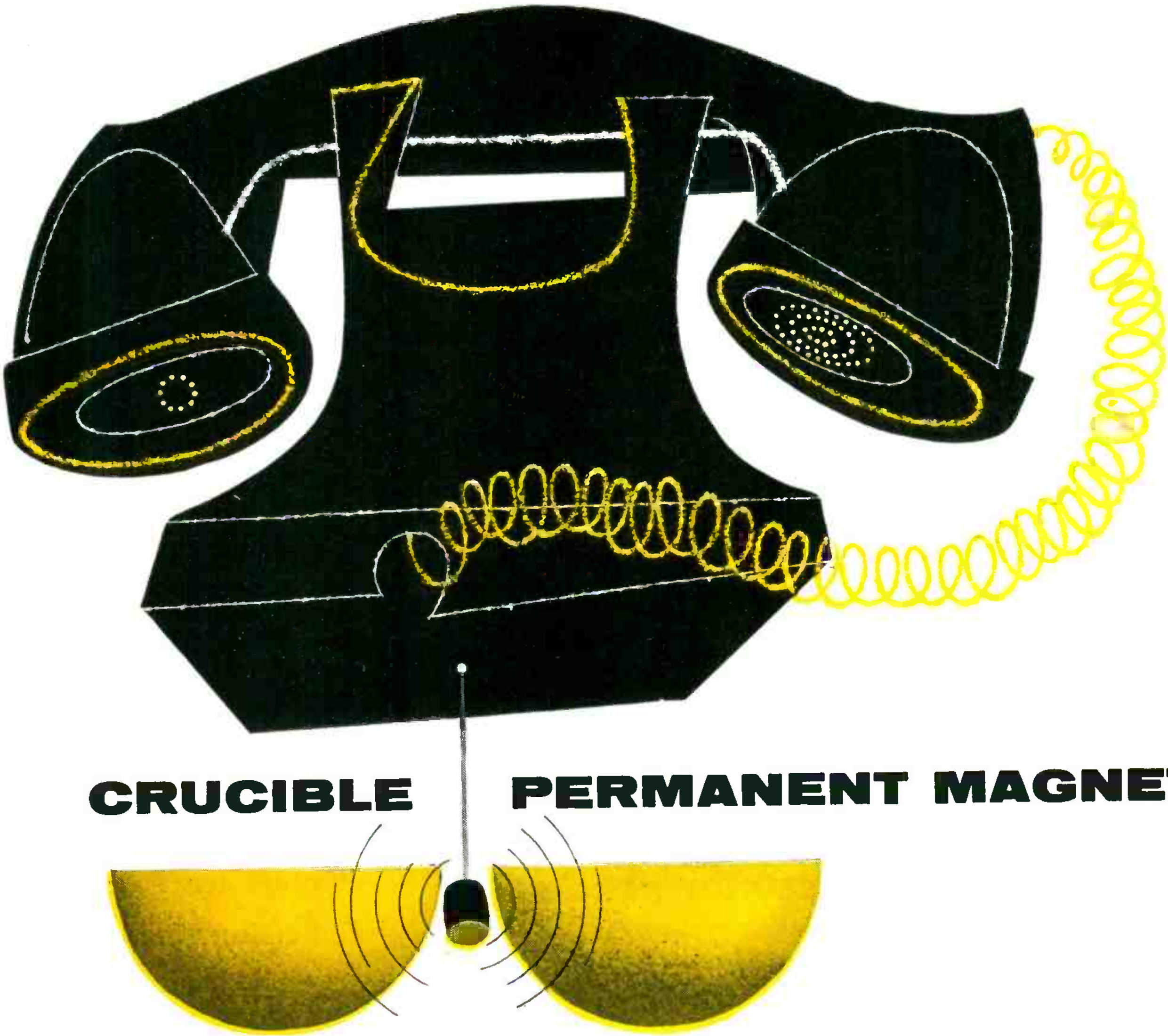
FIG. 4—Uniformity of characteristics for ten CK 721 transistors

sistor operating points and voltage gain. Transistor 1 was obviously abnormal and showed severe output distortion at input levels above 0.5 millivolt. Transistors 2 to 7 have similar voltage gains and stabilized with approximately 1 volt between emitter and collector. Transistors 7, 8, 9 and 10 had higher gains and operated with approximately 2.5 volts between emitter and collector. The transistors with the highest voltage gains had the lowest input impedances.

In designing transistor amplifiers the loading effect of the transistor upon the signal source must be considered. The frequency response and input impedance are determined by the transistor operating point and the nature of the load. Circuits requiring gain stability and transistor interchangeability must be carefully checked experimentally after the basic circuit configuration has been established.

Weather Warnings

CONTINUOUS aviation weather forecasts in New York and Chicago on 162.55 mc using unattended facilities, may be extended in future to other parts of the country. Experimental broadcasts utilize CAA low-frequency range stations. Weather information can thus be broadcast simultaneously with range signals and the desired information se-



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Battery of ten tape recorders that can be switched in sequence

lected by means of filters. Aircraft capable of tuning in the ranges are generally equipped with the filter equipment. Using several short-length tape recorders that automatically switch from unit to unit, it is possible to revise individual parts of the broadcast from time to time, avoiding necessity of re-cutting an entire new tape.

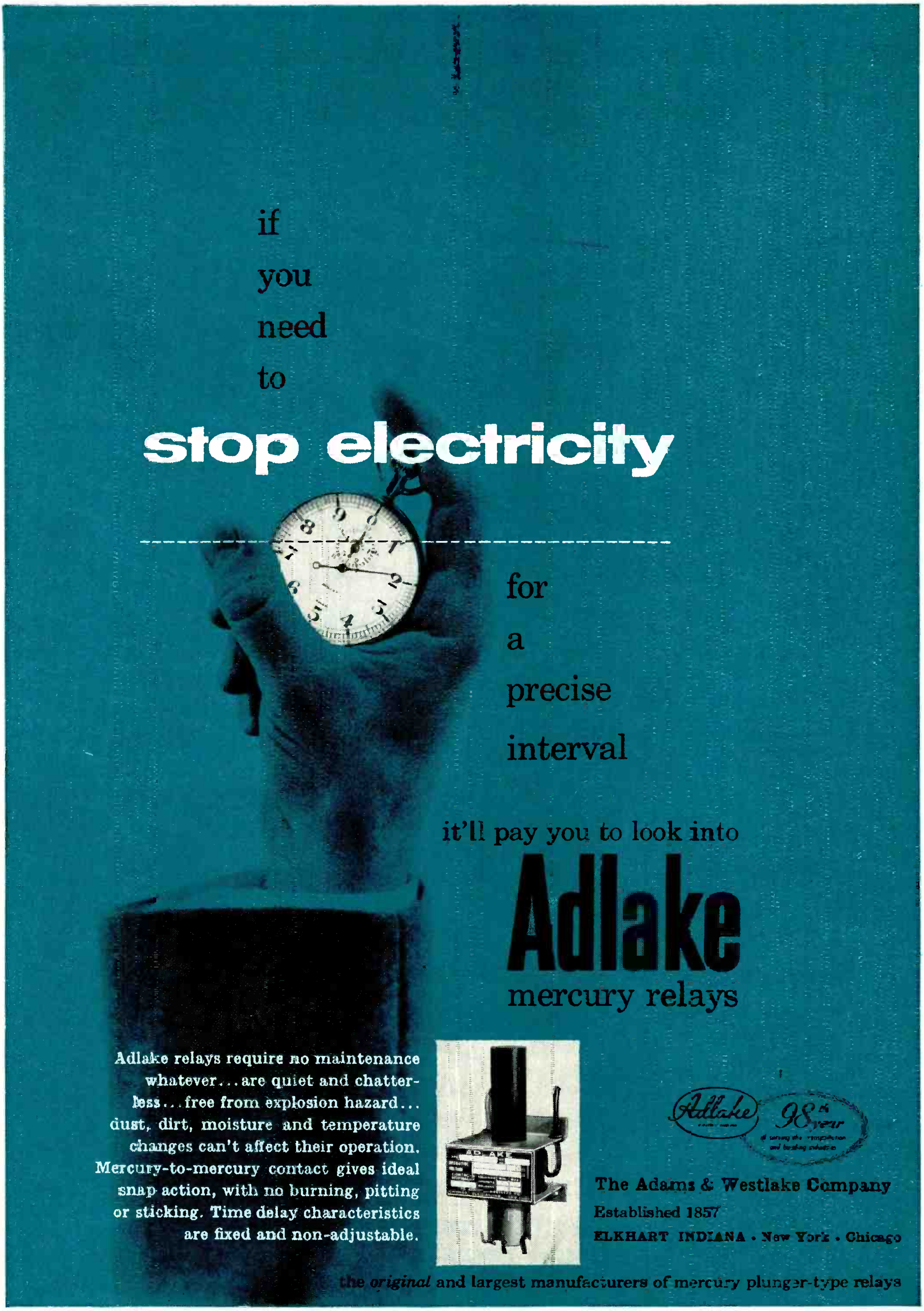
Photometer Tests Reflecting Road Signs

BY R. G. GIOVANELLI
Division of Physics
National Standards Laboratory
Sydney, Australia

DURING REVISION of the Australian Standard Road Signs Code it became clear that to lay down limits for use in manufacture and checking of reflecting road signs, a simple form of portable reflectometer was required. The color-corrected photoelectric photometer described here has been developed to meet this need.

For most purposes it is neither necessary nor desirable to have detailed angular reflection information. Tests at one angle of divergence yield adequate information for road-sign purposes. The angle selected for the present instrument is in the order of ½ deg, or the angle subtended by a projected distance of 3 ft between driver and headlamp at a distance of some 350 ft.

The reflectometer is shown schematically in Fig. 1. The effective light source is at the hole in an



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annular photocell that lies in the focal plane of a collimator lens, the light reflected by a sample being measured with the photocell. In this way the sample is examined in collimated light as if it were at a great distance from the observer. The angle of incidence may be varied by rotating a frame against which the sample is rested.

For reflectorized material, the simple illuminating system shown in unbroken lines in Fig. 1 can be used. It provides uniform luminance over the aperture, but the sample is illuminated nonuniformly. This should not matter greatly, as the surface is nominally uniform. A filament lamp is imaged onto the collimator lens by a lens placed as near as practicable to the annular photocell.

A filter is incorporated between lens and the back of the photocell, correcting the spectral sensitivity of the latter so as to agree approximately with that of the CIE standard observer. For results of highest accuracy on colored samples, calibration can be readily effected either by inserting a spectrophotometer filter between lens and a clear sample of known reflectance (the filter being such that if of double the thickness, its color would approximate that of the sample) or by separate calibration of the color response of the photometer using a calibrated filter and external light source.

The photocell output is measured by direct reading of a galvanometer having a resistance of 47 ohms and sensitivity of 560-mm per μamp. A universal shunt is provided for sensitivity control. A portable galvanometer of this high sensitivity is necessary because of the small light flux received on the photocell. The particular galvanometer used

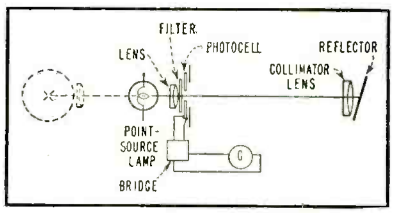
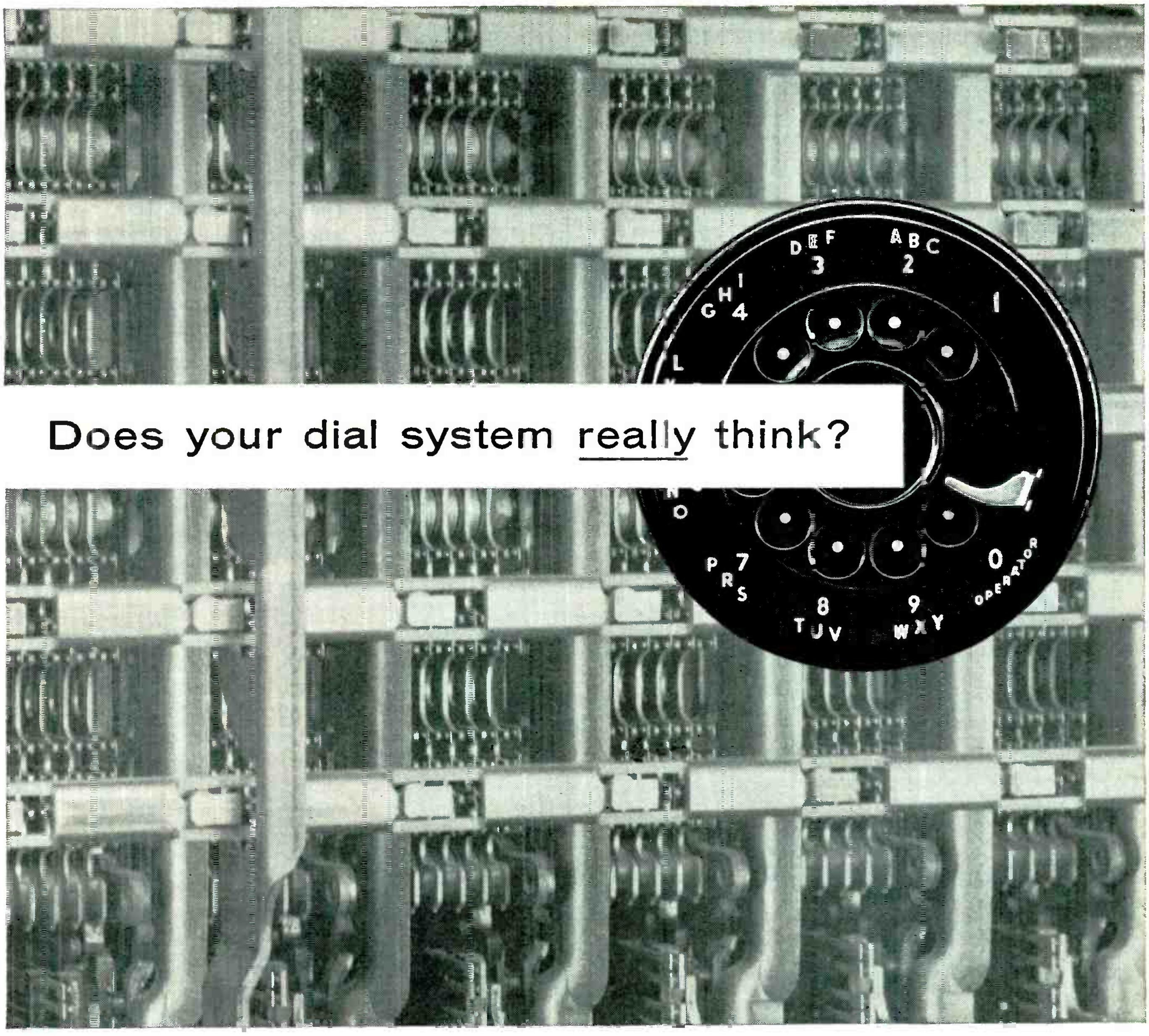


FIG. 1—Optical system of photometer has two positions. Reflective surfaces are measured with point-source lamp in position shown. Retroreflective surfaces (like reflector buttons) are measured with the lamp and lens retracted (dashed lines)

Does your dial system really think?



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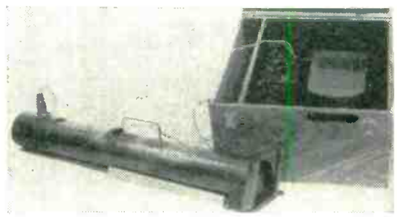
has been found linear over its full scale.

In the instrument described, the collimator lens has a diameter of 9 cm and a focal length of 63 cm. The other lens has a 6.3-cm focal length. The light source is a 6-v, 50-cp lamp. A 25-mm diameter photocell is used, stopped down to 16.5-mm, with a 5.5-mm diameter hole cut in the center, the light source thus subtending an angle of 30 minutes at the collimator lens, the mean angle of divergence having the same value.

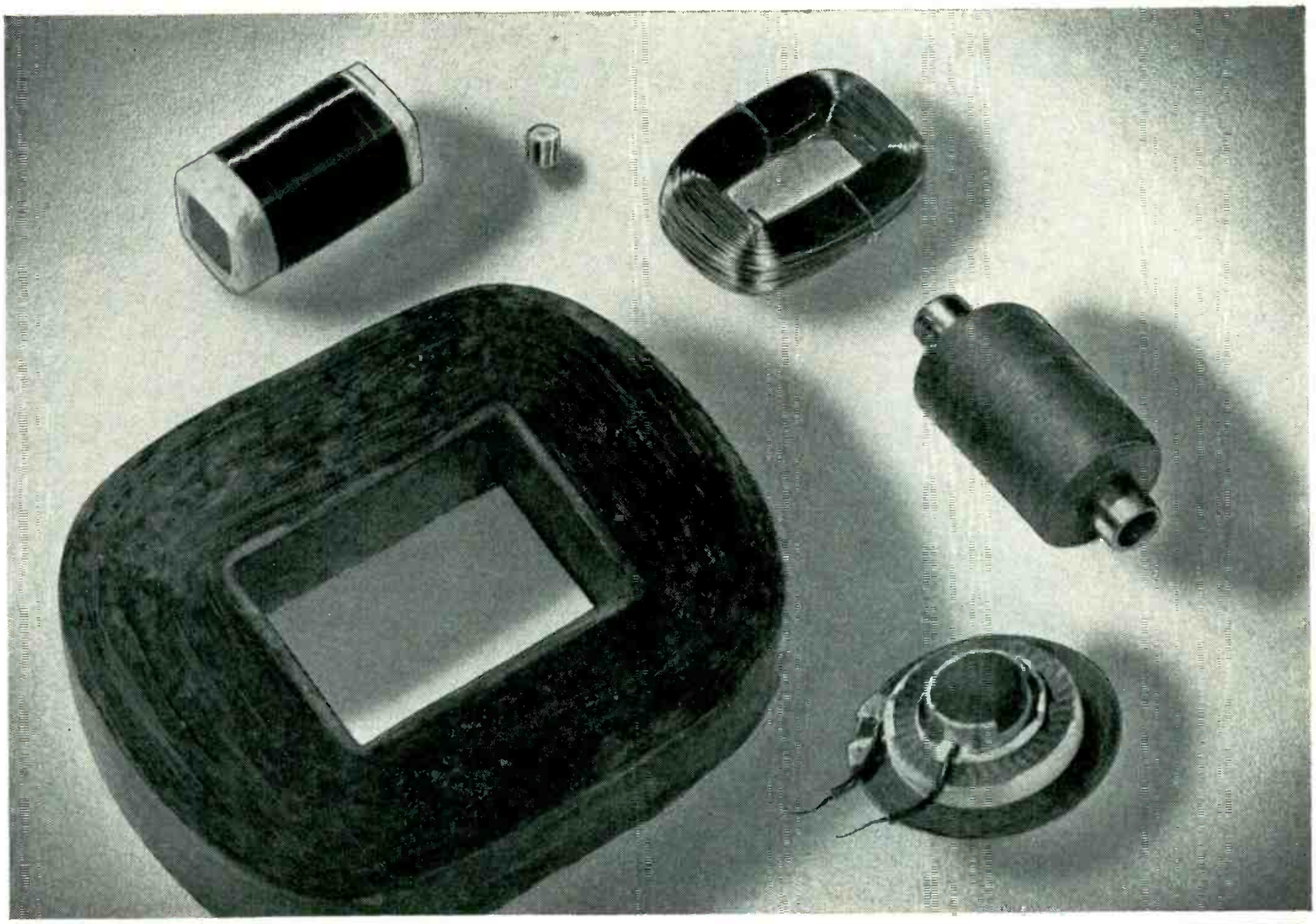
For retroreflectors, different parts of whose surface are utilized in sending light back in different directions, it is essential to provide uniform illumination across the sample surface. This is achieved by withdrawing the lamp and placing a lens of 2.5-cm focal length in front of it as shown in broken lines in Fig. 1. The lens behind the photocell is replaced by one of 6.9-cm focal length. The same system can also be used on reflectorized materials. The light source is imaged onto the photocell aperture through the two lenses forming a uniform image on the collimator lens. Optimum conditions are achieved if the image of the light source on the plane of the photocell completely fills the hole diameter. The complete instru-



Photometer is constructed as portable unit to facilitate measurements on the road under actual field conditions

ment, with separate carrying case for the galvanometer, is shown in the photograph.

Results obtained at normal incidence with this instrument without the use of separate colored calibration filters are in good agreement with those obtained with more elaborate equipment. Of eight samples of beaded material, four showed appreciable differences in the results obtained by the two methods and there is little doubt that the differences arise from specular reflection. Except for samples such as these



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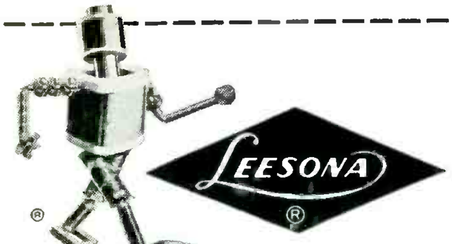

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having special properties the other samples showed negligible variation.

The specular component is usually of no use in road signs, and so it would be desirable to find a satisfactory method of testing that ignores the specular component. Measurement has indicated that the specular beam is negligible outside an angle of 9-deg total width and the solution is to test samples at a 5-deg angle of incidence, rather than at normal incidence.

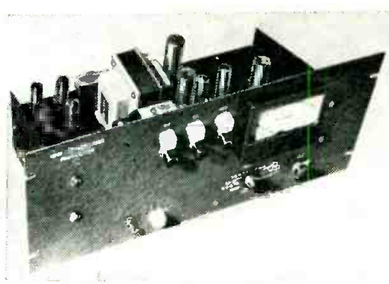
The reflectometer has been used both in the laboratory and on road signs that have been installed. In the latter case, night observations are straightforward, both on reflectorized material and on retroreflectors; with simple screening, equally reliable results are obtained in daylight.

Acknowledgment is made to C. Maguire and K. S. Sarma, who assisted in the testing of the reflectometer.

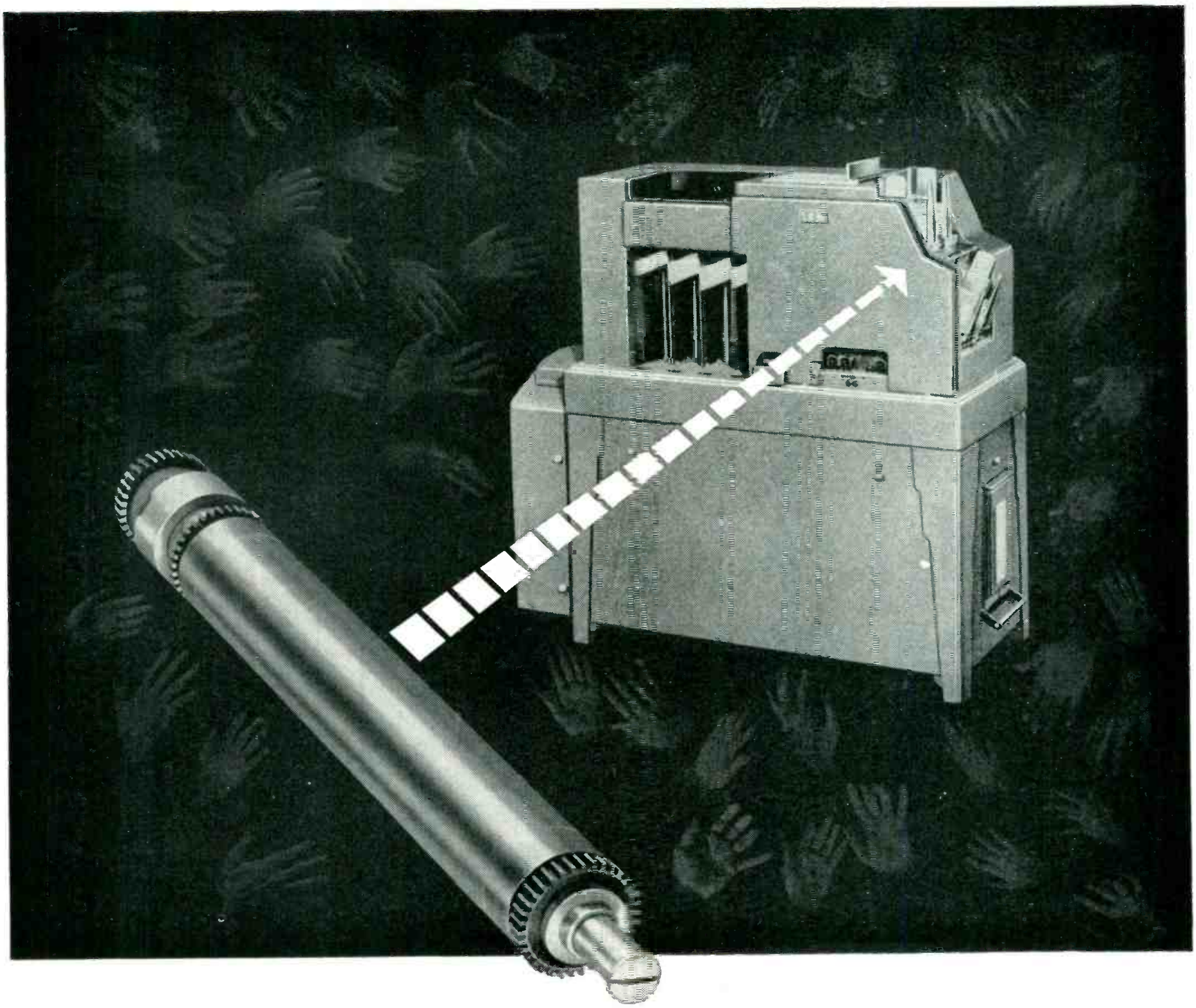
Ion-Gage Supply Protects Tubes

R. W. RAIBLE and M. K. TESTERMAN
Engineering Experimental Station
University of Arkansas
Fayetteville, Arkansas

LABORATORIES with several experimental vacuum systems in simultaneous operation, find it desirable to have a compact portable ionization gage-tube supply available. The supply may be attached quickly to an ion-gage tube previously sealed into a vacuum system. It is wasteful and frequently inconvenient to have a supply for every ion-gage tube in use. Thus, a few portable supplies easily moved from one



(A) Ion-gage supply constructed for rack-panel mounting. Use of miniature tubes makes possible smaller portable unit that can be connected to gage



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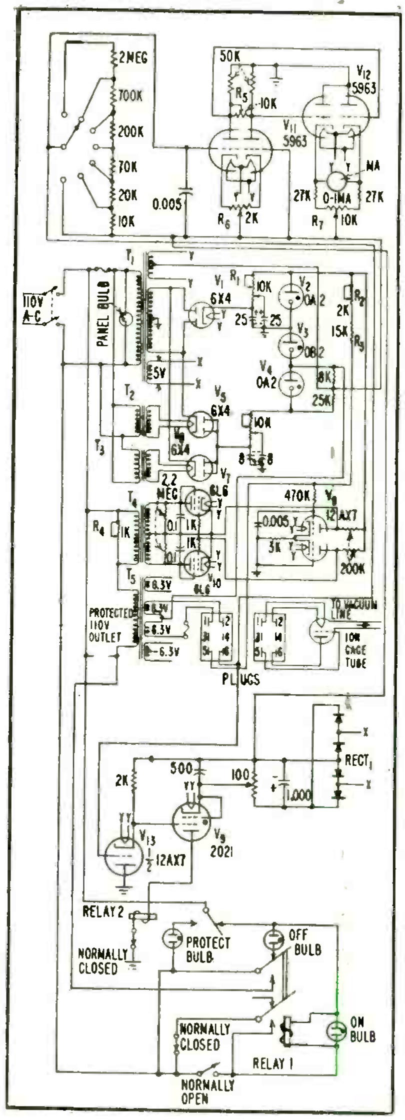
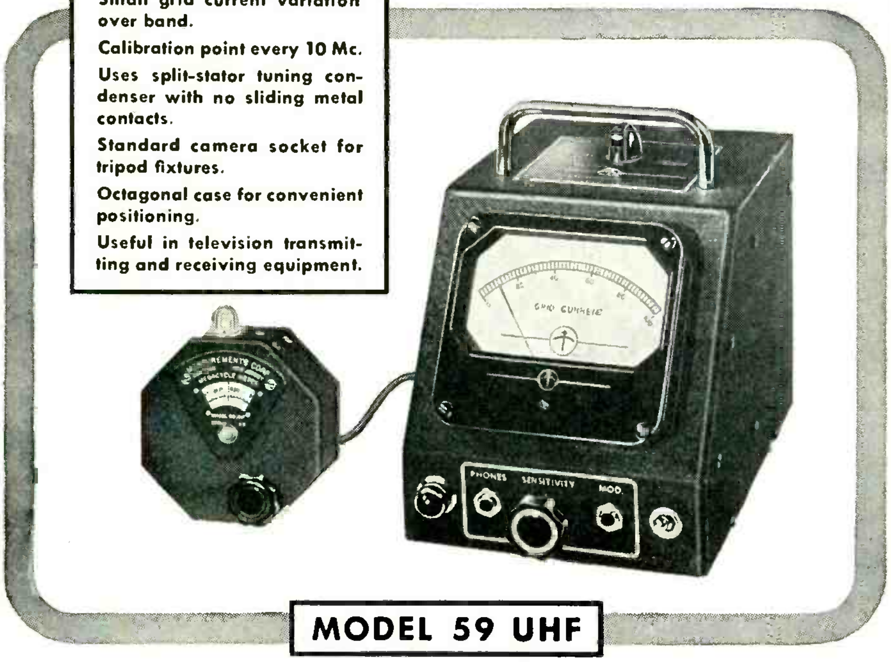


FIG. 1—Ion-gage supply controls current to gage-tube filament in relation to gas pressure

ion-gage tube to another are of value. The circuit described in this article was found to be adequate for such applications and to be reliable in its operation over long periods. The filament-emission regulator circuit is a modification of previously reported filament-emission regulators utilizing temperature control[1,2,3] of the filament.

A schematic diagram of an ion-gage-supply protection circuit is presented in Fig. 1. The power supply for the unit consists of transformer T_1 and tubes V_1 through V_6. This supply provides voltages of +150, −150 and −255 volts with vr-tube regulation. A single transformer provides both positive and negative d-c voltages with full-wave rectification.

The electron emission of the fila-



ment is regulated against temperature changes of the filament resulting from changes of gas pressure in the ion-gage tube and also fluctuations in line voltage. The filament-emission regulator consists of transformers T_4 and T_5 along with tubes V_7, V_8, and V_{10}. The regulator is actuated or controlled by the ion-gage grid current, which passes through R_2 and R_3.

A change in ion current will produce a change in the voltage drop across these two resistors and thus a change in the d-c potential appearing at the grids of the balanced difference amplifier V_8. The amplified d-c signal then is applied to the control grids of V_7 and V_{10} which in effect, changes the load placed on the secondary windings of T_4.

This change of impedance is reflected into the primary of T_4, which is in series with T_5. Thus, the voltage applied to the filament is altered to correct for the original variation in the ion-gage grid current. The grid current is regulated to within approximately 1 percent for variations in line voltage of ± 10 percent over all ranges of gas pressure normally encountered with an ion-gage tube. In the particular application shown here, resistors R_2 and R_3 were chosen to produce a 155-volt drop with an ion-gage grid current of 10 ma.

Adjustment

This causes the signal-input grid of V_8 to be at or near ground potential under equilibrium conditions. An example of the adjustments in the regulator is given below for the type 1949 ion-gage tube for which this supply was primarily designed. However, it would be easy to adjust this supply to operate properly with almost any ion-gage tube.

The 1949 tube requires a nominal filament voltage of approximately 5 volts. To supply this potential the secondary of T_5 is tapped across two 6.3-volt windings in series. Because of the reduced voltage on the primary of this transformer, the connection gives approximately the required filament voltage.

A milliammeter is placed in the grid lead to the ion-gage tube and a variable transformer is used in the power line leading to the entire unit for the purpose of varying the input voltage. Resistor R_2 is so

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adjusted that the regulator operates in its optimum manner over the desired variation of input-line voltage and filament-temperature changes. The multiple windings on T_5 permit almost any desired ion-gage tube to be used and, by appropriate adjustment of R_2, R_3, and R_4, optimum regulation can be obtained at almost any ion-gage grid current.

The ion current of the ion-gage plate passes through a divider which gives scales of sensitivity of 1, 3, 10, 30, 100 and 300. The circuit is such that there is a maximum of only 1-volt developed across this divider on any range setting so that the voltage appearing on the ion-gage plate does not deviate appreciably with changing ion currents.

Gain

In the specific case of the type 1949 ion-gage tube, the gain of the amplifier V_{11} and V_{12} can be adjusted so that one volt across it produces full-scale deflection of the meter. When the sensitivity is thus adjusted, full-scale pressure sensitivities of 9×10^{-4}, 3×10^{-4}, 9×10^{-5}, 3×10^{-5}, 9×10^{-6}, 3×10^{-6} millimeters of mercury are obtained. Potentiometer R_5 is the sensitivity adjustment for the vacuum-tube voltmeter and R_6 and R_7 are the coarse and fine meter-zero adjustments respectively. The same d-c signal from the ion-gage collector plate that goes to the vacuum-tube voltmeter is also applied to the control grid of V_{13}, a cathode follower, which places it on the shield grid of thyratron V_9. The cathode-bias voltage on the thyratron is obtained by a bridge rectifier operating off of the filament winding of transformer T_1. Bias is adjusted on the thyratron so that a signal causing $1\frac{1}{2}$ times the full-scale reading will cause the thyratron to fire and close relay 2. Cathode follower V_{13} was found necessary to isolate the grid of the thyratron from the collector plate of the ion-gage tube because appreciable currents flowing in this grid circuit caused a false signal to be applied to the vacuum-tube voltmeter. When relay 2 is closed, the 110-volt a-c is removed from the filament circuit and also the 110-volt outlet provided on the back of the chassis.

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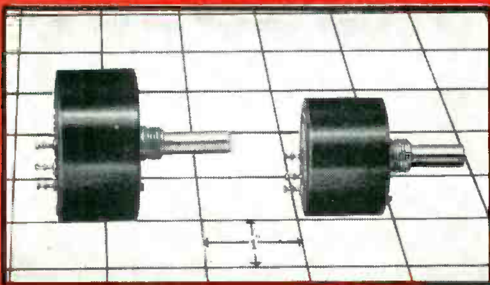

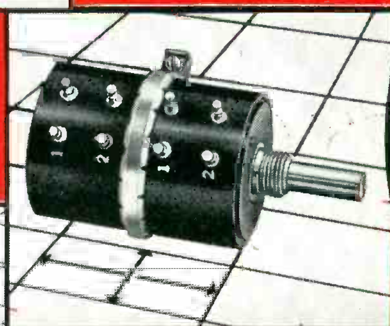

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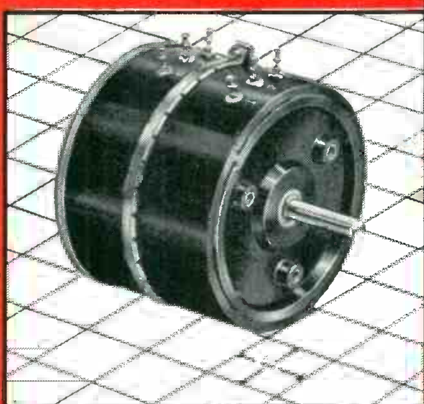

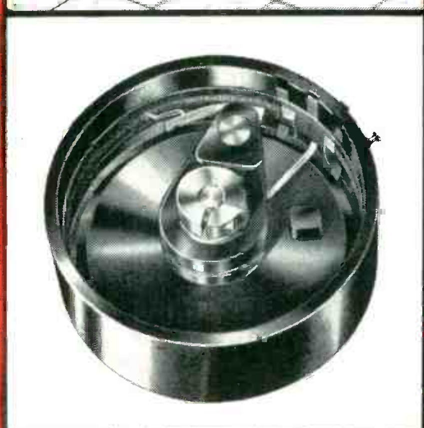

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tect other tube filaments in the vacuum system and also may be used to stop the diffusion and forepumps in the event of a leak. Use of pilot lights to indicate the condition of the circuit is desirable when working with systems that have opaque envelopes. If the filament of the ion-gage is visible, the on and off indicator bulbs are unnecessary.

Type 2050 thyratrons can be used without any major circuit changes in place of the 6L6's, which presently are used as the control tubes in the variable impedance. Also, the miniature thyratron 2D21 can be satisfactorily used at this position to produce a circuit consisting entirely of miniature tubes. When thyratron tubes are used as the regulating tubes in the variable impedance, there is an occasional tendency for the filament-emission regulating circuit to oscillate at high-pressure conditions in the ion-gage tube.

Recent work has shown that the 6L6 tubes can be replaced by type 6216 hard miniature tubes, with an improvement in filament-emission regulation. This results in a compact circuit and eliminates the oscillating tendency present when miniature thyratrons are used. When 6216 tubes are used in place of V_7 and V_{10}, transformer T_4 is replaced by one having a 350-0-350v, 90 ma secondary winding.

REFERENCES

(1) J. Rainwater, *Rev Sci Inst*, 13, p 118, 1942.
(2) R. B. Nelson and A. K. Wing, *Rev Sci Inst*, 13, p 215, 1942.
(3) L. N. Ridenour and C. W. Lampson, *Rev Sci Inst*, 8, p 162, 1937.

Reactance Voltage Bias Source

By FRANK J. BURRIS
Tacoma, Washington

THE REACTANCE-GENERATED bias source shown in the diagram provides an increase in efficiency over the ohmic voltage drop possible in this portion of the circuit at no further expense to the supply source. A two-stage inductively operated filter is shown but a single-stage unit will also function likewise. Po-

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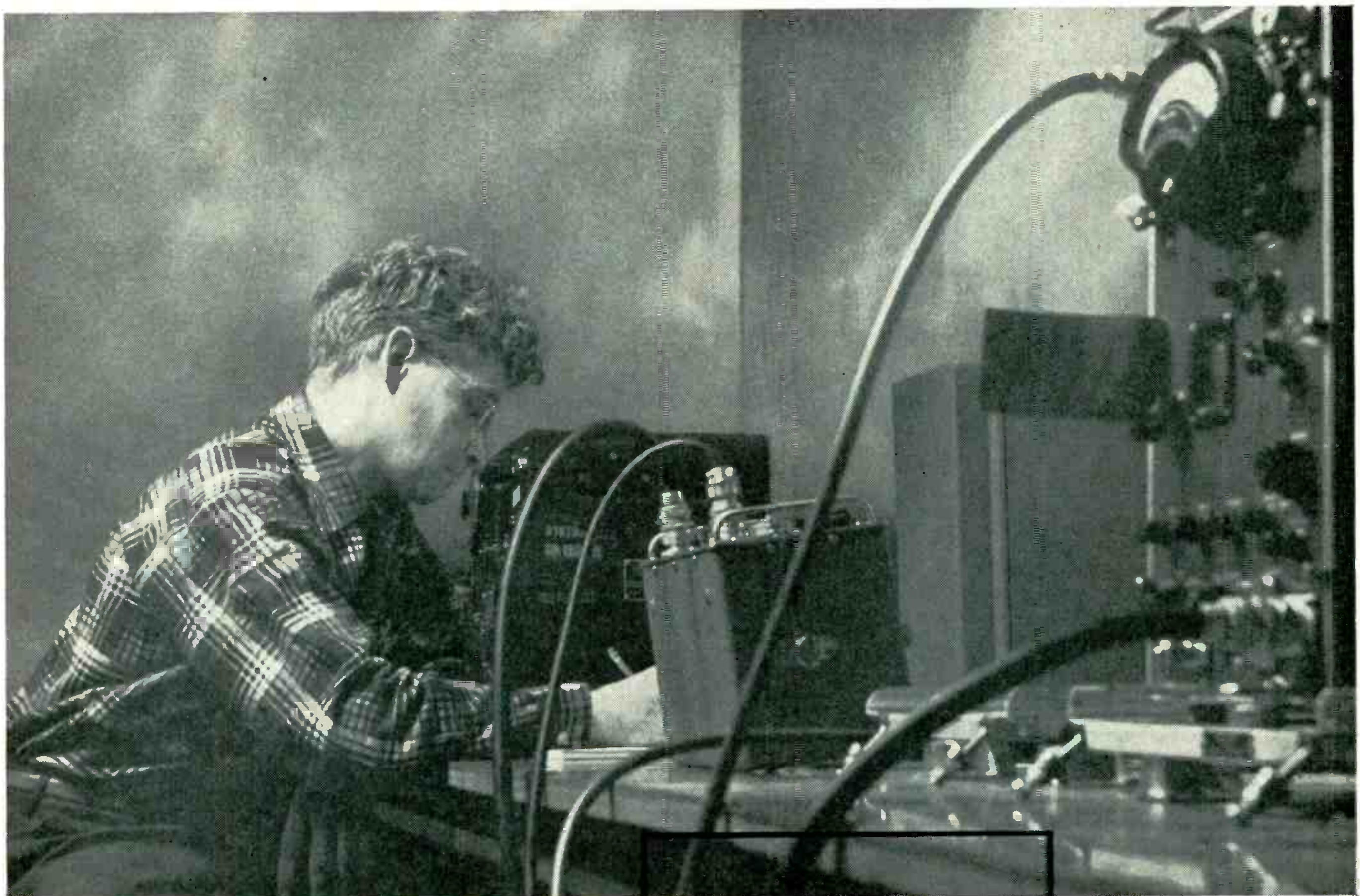

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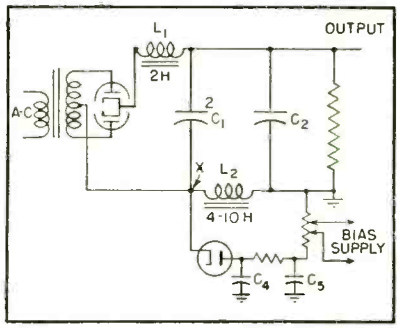

Half-wave power supply provides 100-volt bias source without excessive loading of power output

larity is reversible in either case.

Although a transformer is indicated, a capacitor or direct coupling such as utilized in a-c/d-c radio receivers may also be employed. A small choke coil, L_1, suppresses line noises from pickup at the output terminals. Capacitor C_1 is a small smoothing capacitor of less than critical value and L_2 is the principal smoothing reactor, which may be from 4 to 10 or more henrys inductance value. This choke is inserted in the return circuit at a below-ground potential. Capacitor C_2 is the principal smoothing capacitor.

Point X is below ground potential because of L_2. It is commonly used as a direct negative-bias source connection making use of the ohmic voltage drop across this reactor. However, this drop is ordinarily kept to a minimum because of economic considerations and engineering limitations. Such practice usually requires placing resistances in series with the cathode circuits of power-amplifier tubes, which subtracts from the available power across the power supply output.

In the model shown, the ohmic voltage drop across L_2 was 22 volts but the reactance voltage was measured at 160 volts. To further utilize this high reactance voltage, at no expense to the power supply, an additional rectifier is connected as shown. The rectified bias current is small and peak rectification may be realized in C_4. In this manner, filter choke L_2 is not bypassed. A simple high resistance filter or divider network is added to complete the device.

In the half-wave model shown, a filtered bias voltage in excess of 100 volts is available, as against the

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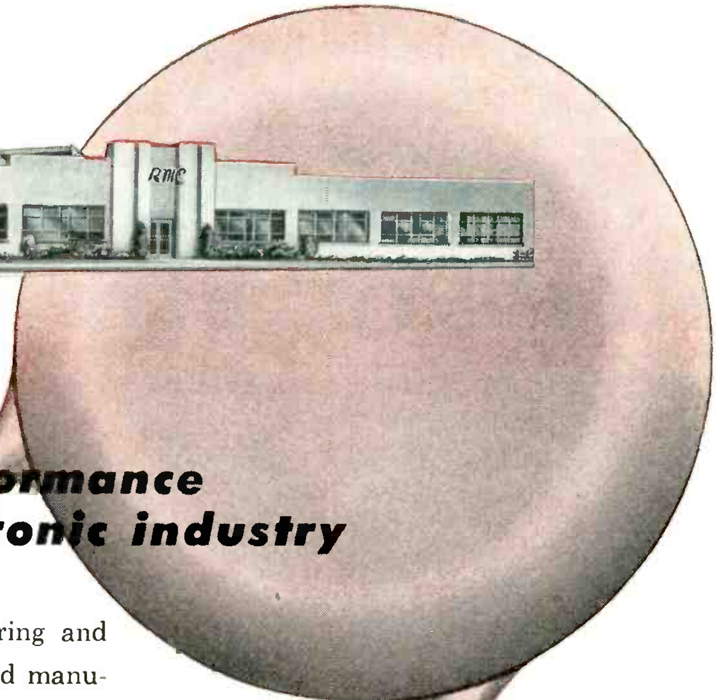

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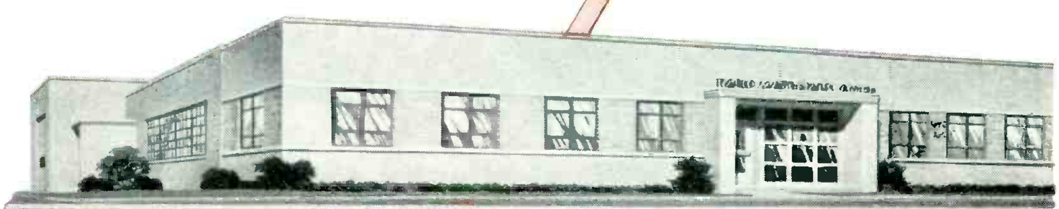

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ohmic value of 22 volts. Any ohmic bias voltage developed across L_2 is incidental and also supplementary to that generated by the reactance method. The idea is suited to audio systems, as well as being applicable to other a-c or d-c electronic amplification apparatus.

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COMPUTING DEVICES differ in function, magnitude and method. In the three computer patents reviewed this month, one application reviews the art and a portion of this information is printed below.

Electrical Computer

A recent patent for an "Electrical Computer," issued to C. J. Hirsch of Douglaston, N. Y., is assigned the Hazeltine Research Corporation of Chicago, Ill. This patent 2,652,-194 reviews the computer art as quoted below:

"One general type of . . . computer, which may be referred to as a digital computer, includes relay machines, punch-card machines and adding and multiplying machines utilizing either mechanical or electronic counting devices. These computers can handle numerical data after the problem has been reduced to a numerical routine susceptible to solution by digital methods, which often requires extensive programming of the operation of the machine.

"The accuracy usually is limited only by the number of places to


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which a computation is carried out, but the machine may have to perform a very extensive counting operation to solve even a single algebraic expression. Computers of this type tend to be bulky and cumbersome in operation, particularly when the problem is at all complex.

"Another type of . . . computer may be classified generally as a continuously variable computer. These computers deal with quantities by continuous correlation with mechanical displacements or electrical effects. Tachometer instruments come under this classification. Another example of this type of computer is the resolver, in which a primary winding carrying a voltage the amplitude of which represents a vector is coupled to two secondary windings on a rotor mechanism.

"The rotor is moved in such a way that the coupling of the primary winding to these two secondary windings varies as the sine and cosine respectively of the angular direction of the vector. Thus the amplitudes of the voltages induced in the two secondary windings may represent respectively the components of the vector as projected on the axes of a system of Cartesian co-ordinates.

"Compared with digital computers, the continuously variable computers usually have the advantage of high speed and facility of setting up the computer to solve a given problem, but have the disadvantage that their accuracy tends to be lower. In order to provide a computer of the continuously variable type to solve a particular problem, it is necessary to find an effect which can be made to follow the independent variables involved in the problem continuously with proper tracking and without objectionable backlash or time lag effects.

"Much ingenuity has been exercised to devise mechanical, electrical or electromechanical devices suitable for accomplishing these purposes and for providing a useful indication of the result of the computation. In general, however, each such computer can be used to solve only a very restricted form of problem and hence usually is permanently coupled mechanically

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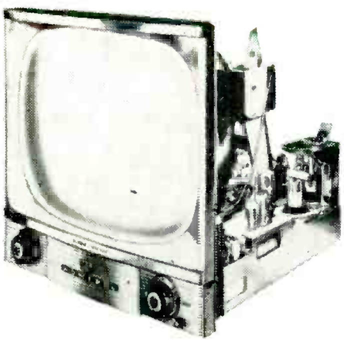

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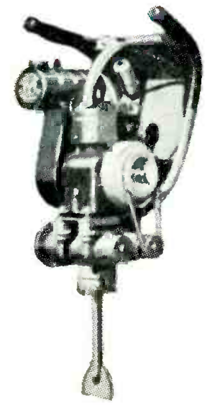

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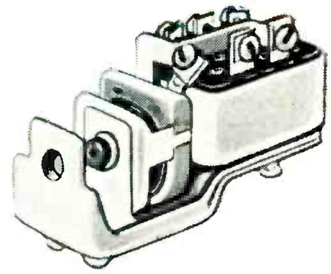

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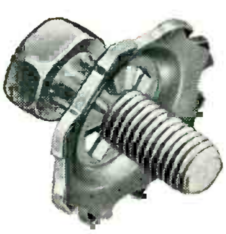

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or electrically to the source of the independent variable involved in the computation.

"This specialization of function, dictated by the special nature of the mechanical or electrical devices utilized in the computer, makes the continuously variable computers of limited usefulness in the solution of the mathematical problems or algebraic expressions most frequently encountered."

The present invention provides an electrical computer for solving equations involving known and unknown parameters. A great many relationships may be expressed in the form of equations in which known parameters include one or more independent variables some of which may be assigned constant values in a particular case and in which the unknown parameter is the dependent variable.

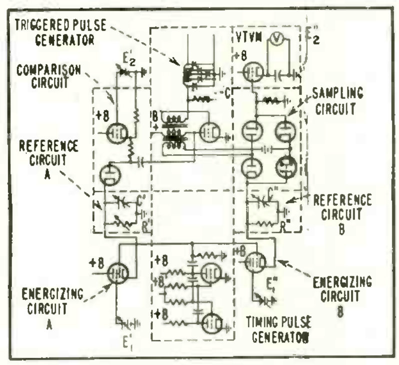

FIG. 1—Number can be raised to power greater or less than unity in this circuit, which forms portion of new computer design

The invention is devised to provide high-speed solution of equations by the computation of common mathematical relationships involved; by continuously and rapidly recalculating variable parameters; and by referring, in algebraic computation, all of the independent and dependent variables, represented by voltages, to a convenient reference or datum voltage.

In Fig. 1 there is shown a circuit according to the Hirsch patent in which a number may be raised to a power either greater or less than unity.

The computer comprises a plurality of circuits in the form of energy storage networks such as the reference circuits A and B energized by batteries E_1' and E_1'' through vacuum-tube cathode-follower circuits under the control of a timing gen-

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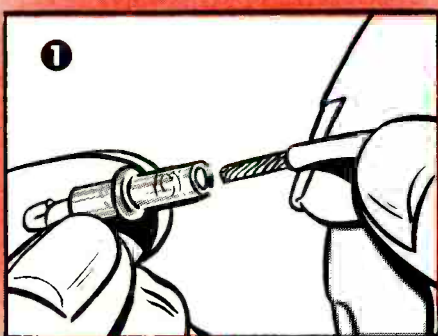

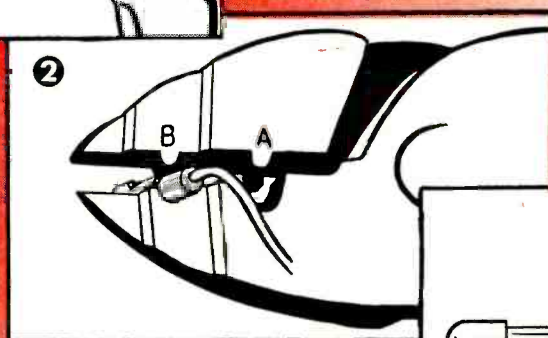

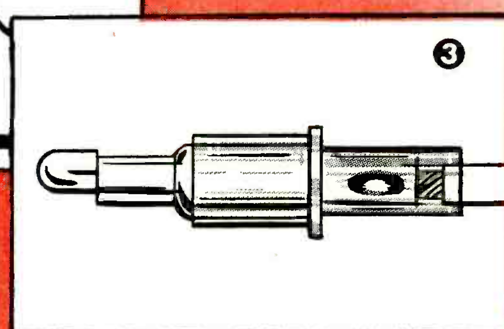

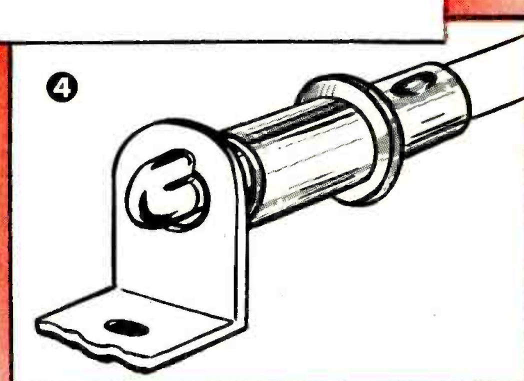

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erator. The timing generator operation may be seen from the curves of Fig. 2.

A comparison develops the negative pulse of curve (C) to trigger a pulse generator. The pulses (curve D of Fig. 2) are applied to a sampling circuit containing a diode bridge. The pulses are applied across one diagonal of the bridge to overcome the bias of a voltage applied across the same diagonal terminals.

The bridge is thus rendered conductive for the duration of the triggered pulse. During this interval the voltage of reference circuit B is applied across the resistor in

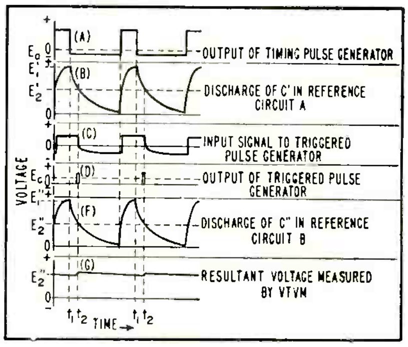


FIG. 2—Timing generator operation in terms of waveforms

the grid of the vtvm circuit to charge the capacitor in its cathode.

To solve an equation of the form

$$y = x^n$$

batteries E_1' and E_1'' are adjusted to equal unity on any convenient voltage scale. The inventor shows that there is a relation between the voltages in the system of

$$\frac{E_1''}{E_2''} = \left(\frac{E_1'}{E_2'}\right)^n$$

so that in the case of adjustment noted above $E_2'' = (E_2')^n$; therefore E_2'' is parameter x and E_2' is parameter y.

As an example let $x = 0.6$ and $n = 2.1$ where $(E_1') = (E_1'') = 1$.

The time constant of the reference networks B and A are adjusted to the ratio $n = 2.1$.

Battery E_2' is then adjusted to equal 0.6 on the same scale as used for the other adjustments. The value as read on meter m is found to be 0.34, thus y (0.34) $= x^n$ ($0.6^{2.1}$).

There are further details of the utility of the circuit shown in the patent and other more complex

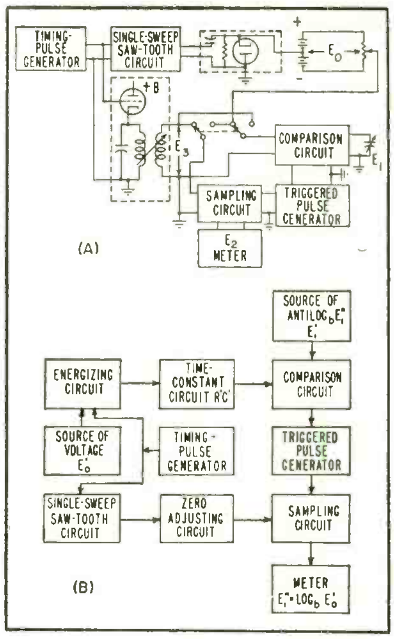


FIG. 3—Blocks showing system for solving an equation (A) or finding logarithms to any base (B)

variations of the circuit for achieving results of computations for $z = xy$, or $z = x/y$, or $y = k/x$, for $z = xy$, or $z = x/y$, or $y = k/x$, (where a is a convenient constant).

Figure 3B shows a block diagram of the system for finding logarithms to any base or antilogarithms.

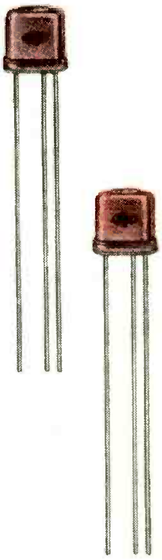
Figure 3A shows an arrangement for solving equations of the form $y = \sin(x \pm \theta)$ or $x = \theta \pm \sin^{-1} y$.

Continuous Computer

Patent 2,661,152 recently granted to Peter Elias of Cambridge, Mass. covers a "Computing Device" for providing a continuous indication of the instantaneous magnitude of the product of two independent variables either or both of which may vary rapidly with respect to time. This invention provides such indication with electronic circuits and no moving or mechanical parts and may be used with direct reading indicators or with graphic electrical recorders.

In the invention each of the independent variables is expressed as a signal voltage whose instantaneous magnitude is proportional to the magnitude of one of the factors of the product and whose polarity is determined by the positive or negative coefficient of the factor.

Figure 4 is a circuit diagram of the invention in its simplest form. Two pentodes are shown with a



Radio Receptor announces the RR106

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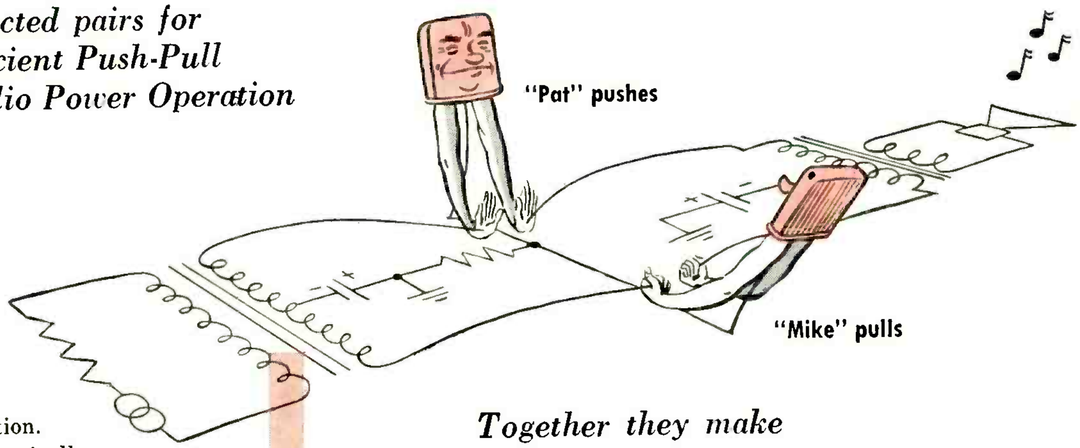

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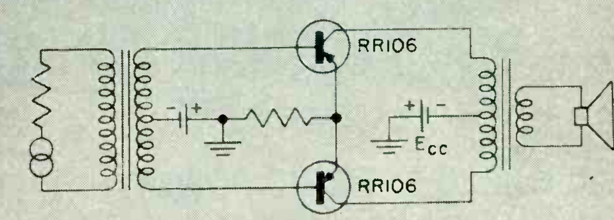

Figure 1

TYPICAL RR106 OPERATION

See figure 1

collector supply volts	*zero signal collector current (total) (1)*	*max. signal collector current (total) (2)*	*circuit efficiency (3)*	*power gain*	*power output (4)*
12	1 ma	25 ma	67%	18 Db	200 mw
9	1 ma	25 ma	67%	17 Db	150 mw
6	1 ma	25 ma	67%	15 Db	100 mw

For further information, without obligation, write Department E-6.

1. This current level is established by the forward base bias and is essential to minimize distortion at *low* levels.
2. For rated power output. For normal commercial broadcast service the battery drain averages to approximately 10 ma. A class A amplifier, under similar conditions would drain approximately 37 ma!
3. This is total circuit efficiency and includes transformer losses as well as power dissipated in the emitter stabilization resistor.
4. This rating is established for a maximum harmonic distortion of 10% and for conservative operation at an ambient temperature of 45° C (113° F).

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common cathode return, a common plate circuit, a common negative suppressor bias voltage source but independent input circuits to the grids. The common plate circuit is designated output xy. The suppressor circuits are the y input. The control grid circuits are the x input. The common controls for each of these inputs are linked together.

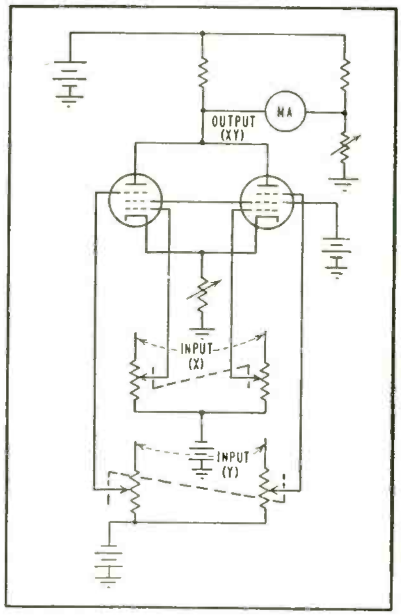

FIG. 4—Product of two independent variables is continuously indicated

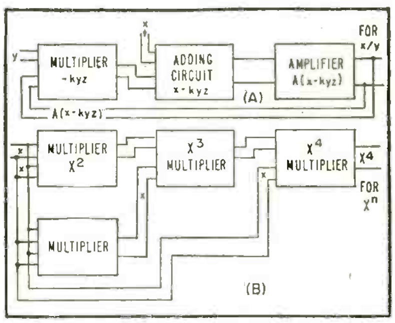

FIG. 5—Method of dividing (A) or raising to a power (B)

Suitably adjusted the sum of the output currents in the common output circuit is equal to xy. In the patent complete derivations of the resultant are shown to indicate the degree of accuracy and more accurate circuits, which are combinations of the basic circuit are indicated.

An example of the use of circuits shown in the patent (not all of which are reproduced above) is shown in Fig. 5A for computation of x/y.

The input multiplier such as one of those shown in Fig. 4, but hav-

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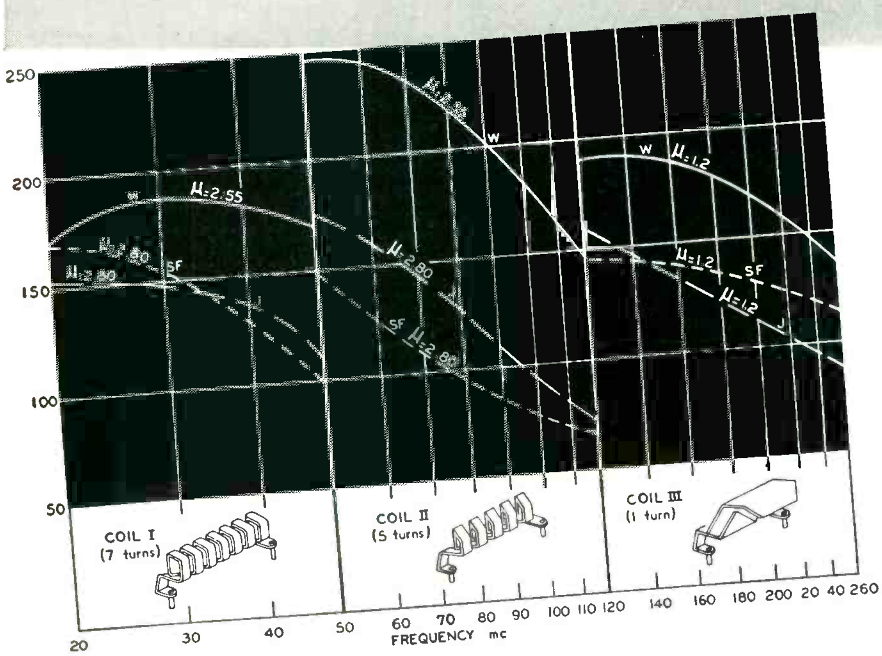

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(Roller Analyzer) $d = \Sigma d_1^4 / \Sigma d_1^3$ (microns)	3	9	3
Surface-average particle diameter (Fischer Sub-Sieve-Sizer)			
$d = \Sigma d_1^3 / \Sigma d_1^2$ (microns)	2.5	4.5	2.5
Density of particles, g/cm³	7.35	7.35	7.81
Apparent density, g/cm³	2.6	2.8	3.0

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ing a transformer output is arranged to generate a voltage proportional to the negative of the product of two input voltages, $-kyz$ where k is a positive constant. The output is applied to a conventional adding circuit which has as its second input the dividend voltage x. The resultant $x - kyz$ is applied to an amplifier of gain A, which provides thus $A\ (x - kyz)$ so that the input voltage z is now $z = A(x - kyz)$ or $z\ (1 + Aky) = Ax$ and $z = x/[(1/A) + ky]$.

For a non-zero y, z may be made as nearly proportional to x/y as desired by increasing A, the gain of the amplifier.

A further example is shown in Fig. 5B where when the same voltage is applied to both inputs of a multiplier such as shown in Fig. 4 an output voltage proportional to the square of the input voltage is obtained. Higher powers to give a resultant x^n may be obtained by applying the original voltage x to one side of a multiplier while the last x^n is applied to the other side.

Shift Register

In computing devices shift registers are used for storing items of information for variable lengths of time, for converting serially occurring information to parallel or simultaneous operation and so forth. Such circuits frequently require a number of stages under some periodic control to advance the operation of the computer.

An invention of a "Shift Regis-

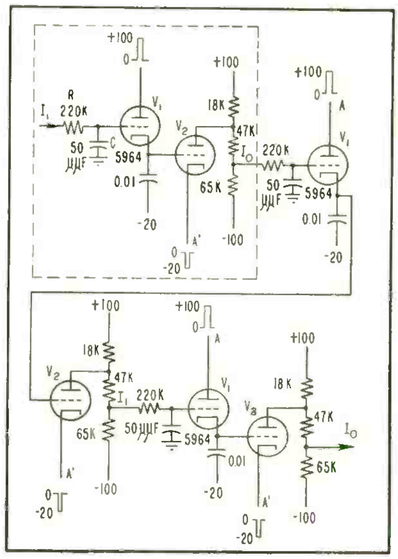

FIG. 6—Three-stage shift register (one stage within dashed lines)

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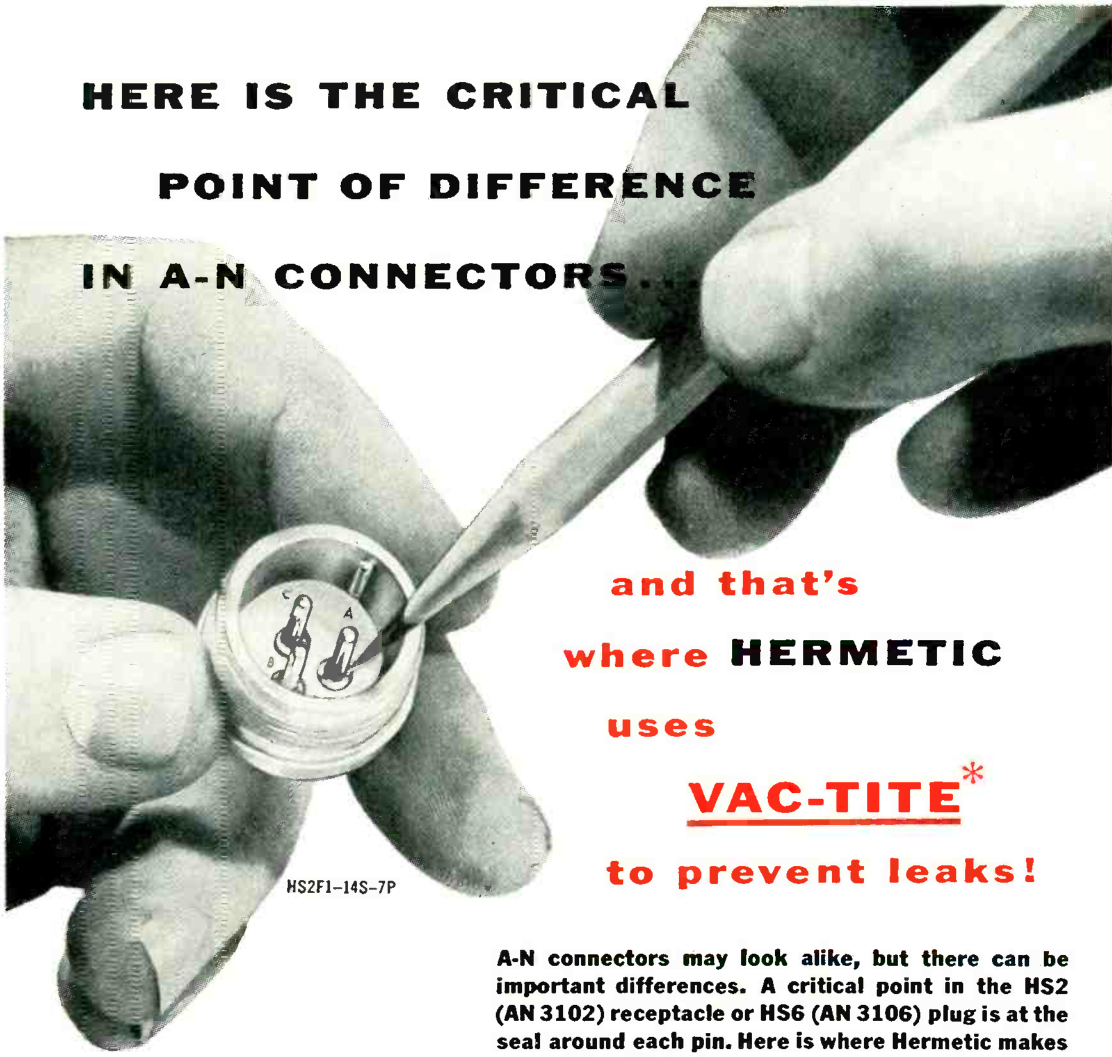

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In addition to our standard line of HS 2 and HS 6 connectors, special units with particular plating requirements, varied flange style, and extra-high pressure resistance, etc., are being designed and manufactured to meet the most specialized needs.

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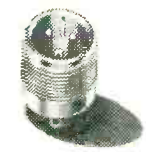

HS2-10SL-3P

HS2-28-21P (Mod.)

HS2-28-15P

HS2-14S-7P

AND10427-14S-6P (Mod.)

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FIRST & FOREMOST IN MINIATURIZATION

ter" by H. M. Fleming, assigned to Monroe Calculating Machine Co., of Orange, New Jersey, was awarded patent 2,638,542.

The principal object of the Fleming device is to provide a shift register capable of being used in the manner of prior shift registers with a minimum number of electron tubes per stage.

One form of the invention is shown in Fig. 6, where three stages of the invention are indicated in the circuit. One stage is in the dashed outline. Figure 7 shows the time

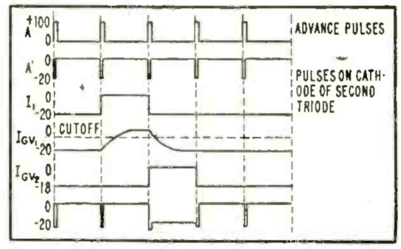


FIG. 7—Time relationship of pulses in shift register

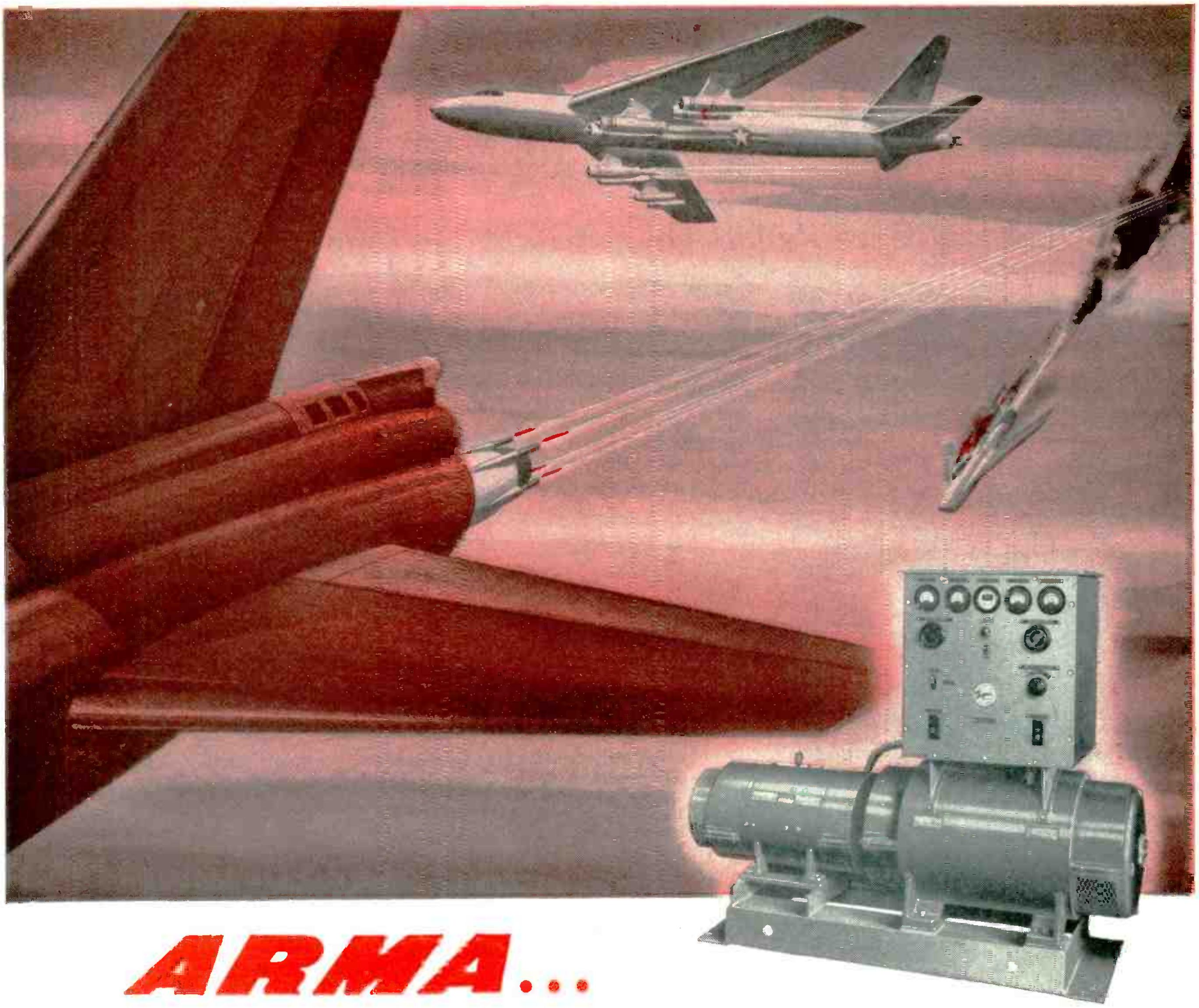
relationships of the pulses involved in the operation of the invention.

High and low input signals are applied to the input triode through an integrating circuit R and C. The anode of the first triode is connected to a source of positive advance pulses that provide anode potential during the pulse period occurring at regular intervals.

The cathode of the first triode is connected through a capacitor to a source of negative potential and to the grid of the second triode. The cathode of the first triode is connected through a capacitor to a source of negative potential and to the grid of the second triode. The cathode of the second triode is connected to a source of negative pulses that occur in coincidence with the advance pulses.

The signals are applied to each stage of the register, each in coincidence with an advance pulse but due to the action of the integrating circuit are not in effect until the occurrence of the next advance pulse.

Conduction of the first tube of the pair in response to a signal charges the capacitor in the cathode of the first tube which maintains the second tube conducting until a third advance pulse occurs. If the applied signal is such as to cut off the first tube the second does not conduct.



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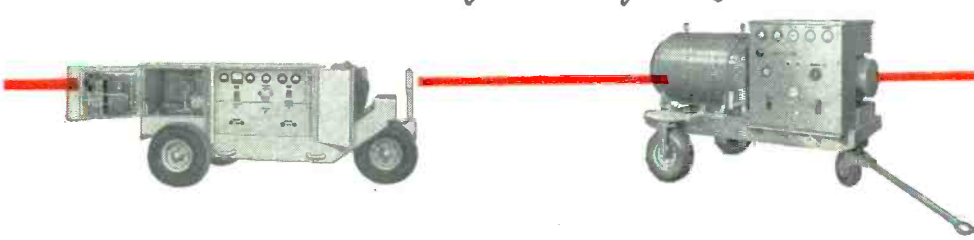

PRECISION ELECTRICAL EQUIPMENT
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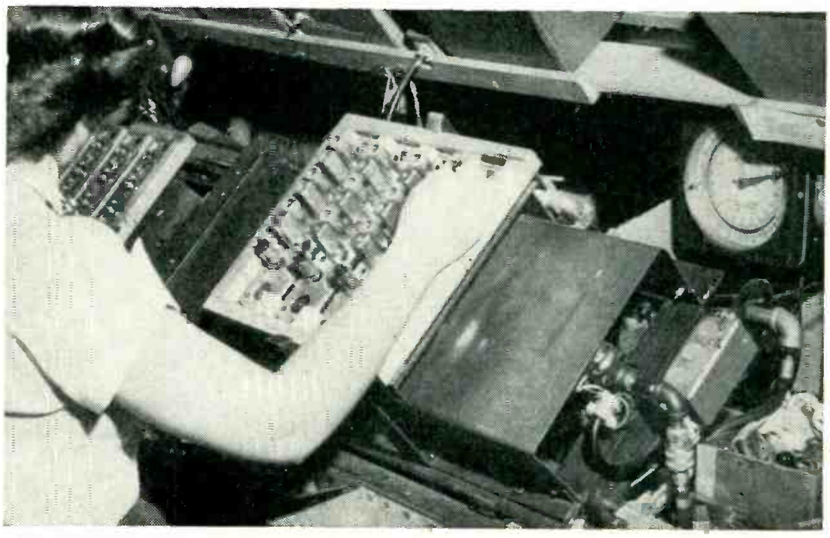
Production Techniques

Edited by JOHN MARKUS

Air Cylinder Pushes Pallets On Subassembly Line

Start of assembly line for i-f strips, showing operator loading strips into four-strip rack



Air cylinder under metal cover here operates every four minutes to drive plunger that pushes racks on line at left one position further down slowly

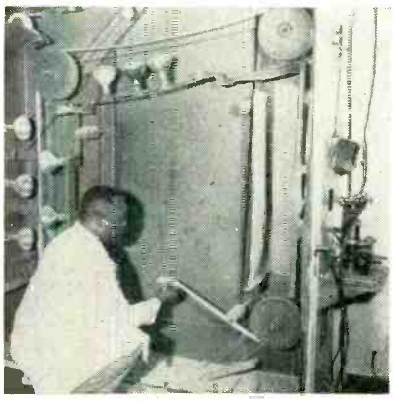
AN AIR CYLINDER operating every four minutes under control of a time clock provides automatic pass-along action for an i-f subassembly line in the Westinghouse Metuchen, N. J. plant. Red lights flash 15 seconds before each plunger operation, to warn assemblers that their racks will soon begin to move.

Adhesive Tape Capacitors for Mechanized Assembly

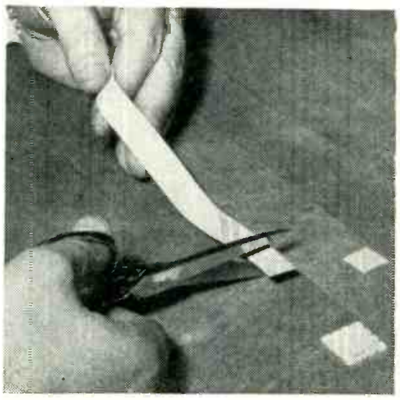
SINCE THE ANNOUNCEMENT of a new mechanized production system, code-named Project Tinkertoy (ELECTRONICS, Dec. 1953, p 160), the National Bureau of Standards has developed a compatible adhesive-tape capacitor for this ceramic-wafer system under the sponsorship of the Navy Bureau of Aeronautics.

A conducting tape, coated on one side with a dielectric, provides one element of the capacitor. The other element is a silver pattern printed and fired on the wafer. It is now possible to apply an adhesive-tape resistor to one side of a wafer and an adhesive-tape capacitor to the other side.

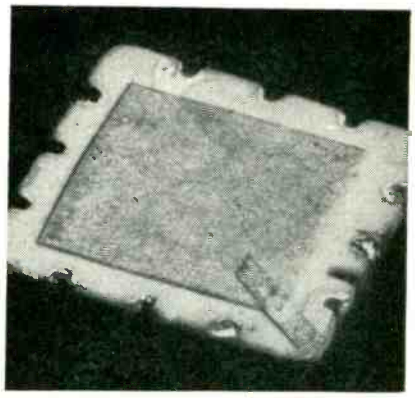
The materials required for the manufacture of tape capacitors are a heat-resisting asbestos paper tape, silver flake, silicone resin, butyl cellosolve, a powdered high-K titanate body, N-hexane and epoxide resin. The electrically conducting formulation (a mixture of the silver flake, silicone resin and solvent) is ground in a ball mill. The mixture is sprayed on a loop of tape



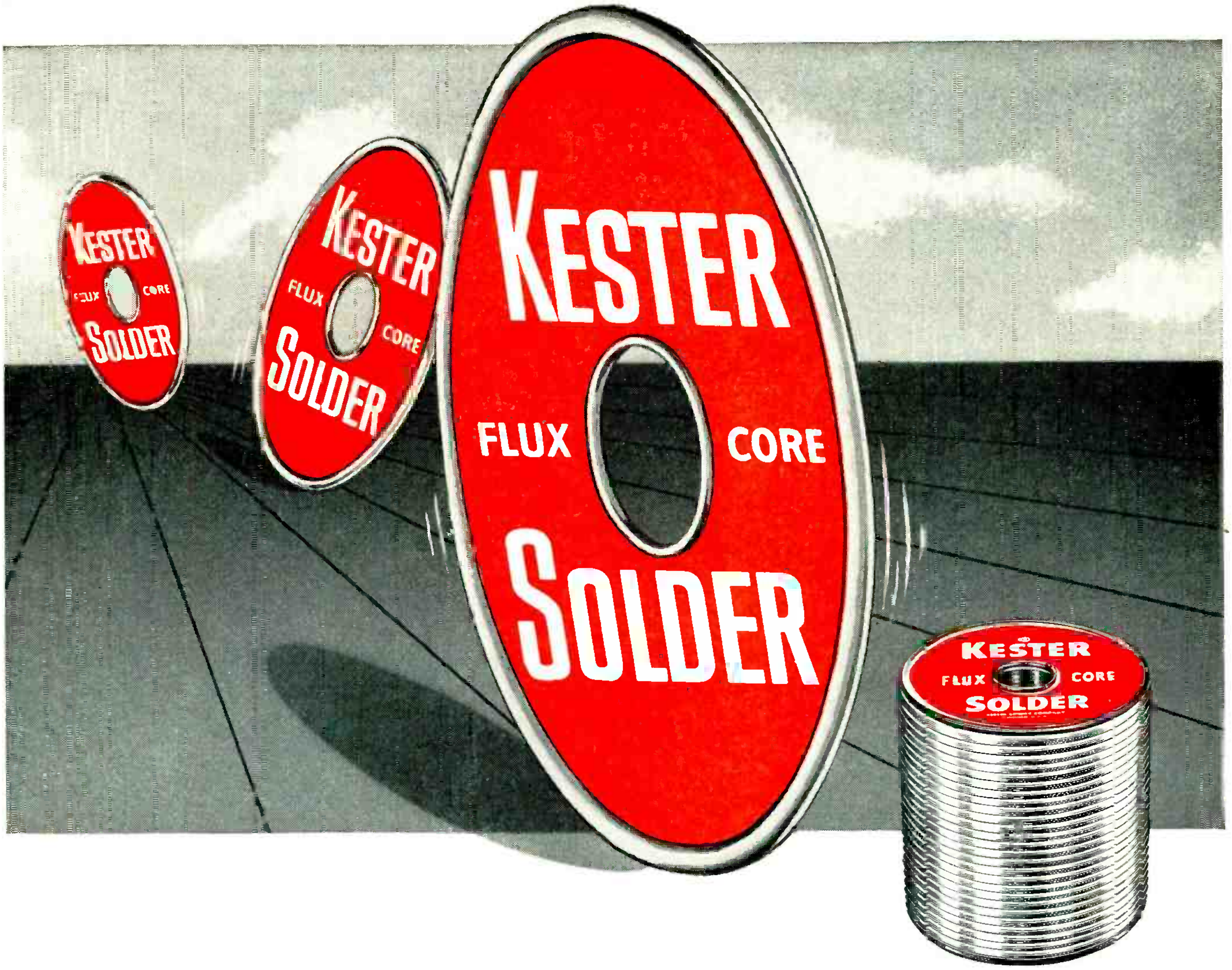
Tape spray chamber, with spray gun at right. Infrared lamps dry coating



Applying NBS adhesive-tape capacitors manually to steatite blank wafers



Finished unit. Conductive tape connects top element to tinned notch



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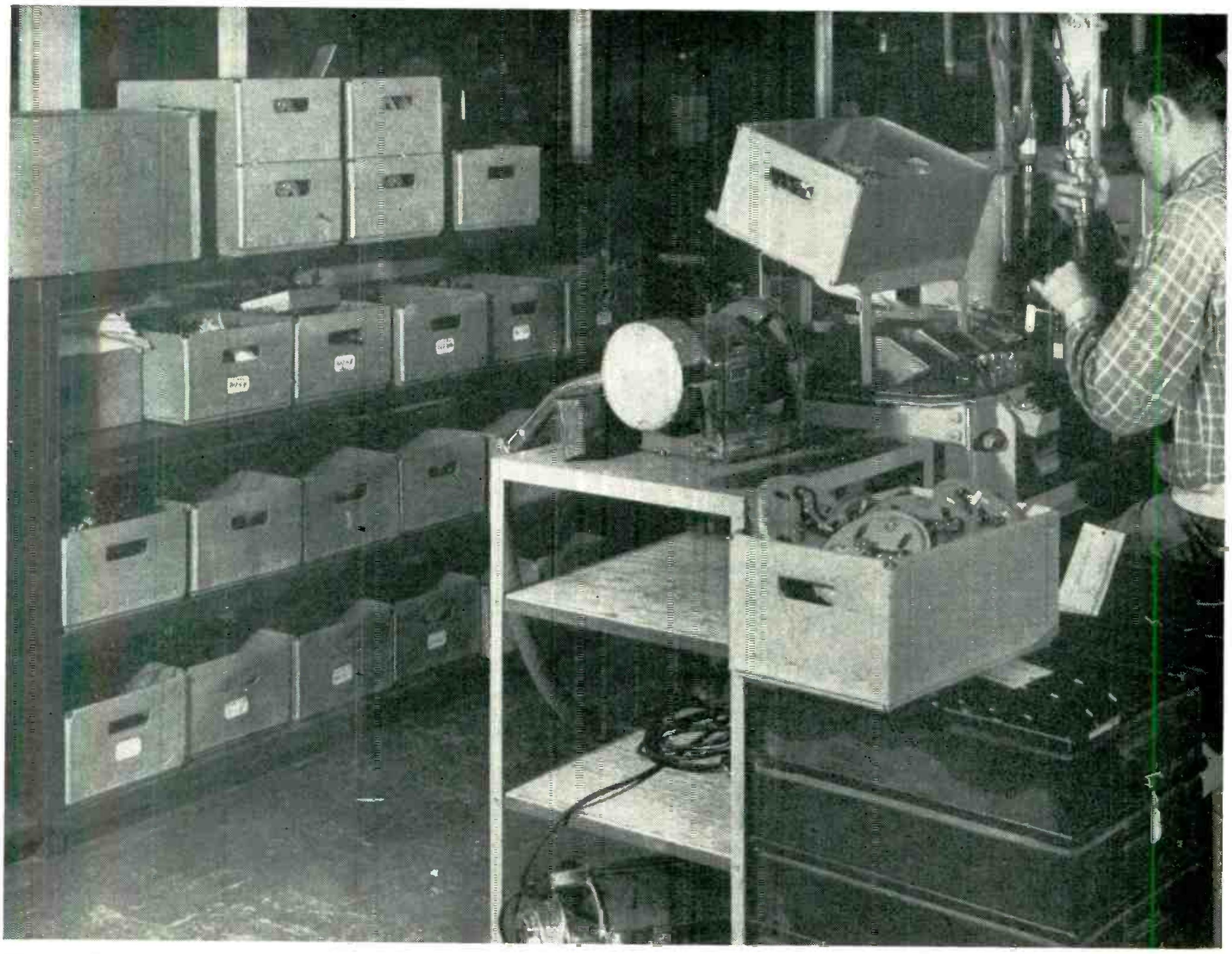
1¼-in. wide, allowed to dry thoroughly, and then sprayed on the other side. When cured, the metallized tape is conductive along each side and from one side to the other. After slitting along the center to form two ⅝-in. tapes, it is ready for application of the dielectric film.

The dielectric formulation is composed of high-K titanate body that has been pulverized in a ball mill with N-hexane until the particle size is about 1 to 2 microns, after which the slurry is allowed to evaporate under a hood. The ground titanate body is mixed with epoxide resin and further ball-milled. This tacky dielectric mixture is then sprayed on the metallized base tape in various thicknesses determined by the number of passes the tape makes in front of the spray gun. Thicker applications make capacitors of lower value.

The silver pattern that forms one electrode of the capacitor is applied to the steatite wafer by means of a screen press. It is then dried and fired onto the ceramic. The adhesive dielectric-coated tape that forms the other electrode is cut into squares slightly larger than the silver contact and pressed down on it. A narrow conductive strip, similar to resistor tape but with a conductivity of approximately 0.02 ohm per half inch, is laid down between a contact on the edge of the wafer and the top side of the capacitor. The complete assembly is then cured by placing it in an oven at room temperature, raising it to 225 C over a period of one-half hour, and holding this temperature for 45 minutes.

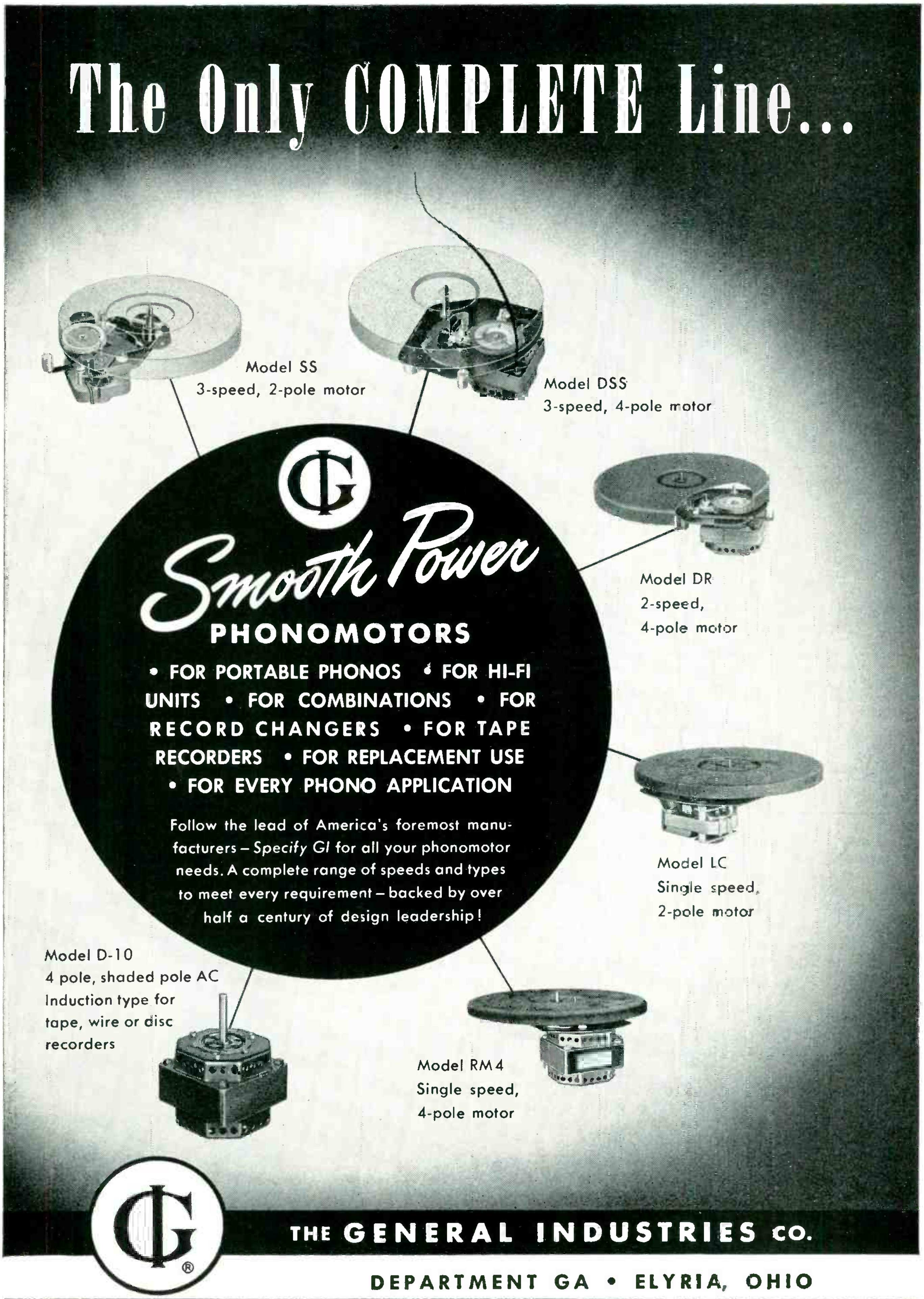
Capacitors of higher values can be manufactured by applying a number of layers of tape, one on top of another, with appropriate connections to the edge of the wafer. Smaller capacitors can be made by reducing the area of the silver pattern printed on the wafer.

Fibreboard Tote Boxes for Parts Use Beer-Case Construction



Fibreboard tote boxes in use on precision instrument assembly line, along with conventional metal boxes. Note use of Electrolux vacuum cleaner under grinder, with hose going to sheet-metal enclosure around buffing wheel, to keep down dust during operations

NEW LIGHT-WEIGHT tote boxes made of moisture-resistant solid fibreboard—the same type of board used in multiple-trip beer bottle carriers—are used for delicate parts and subassemblies of precision instruments in the Springfield, Ill. plant of Sangamo Electric Co. The construction of this new tote-box includes a stepped-back protruding bottom section, permitting one unit to be nested into



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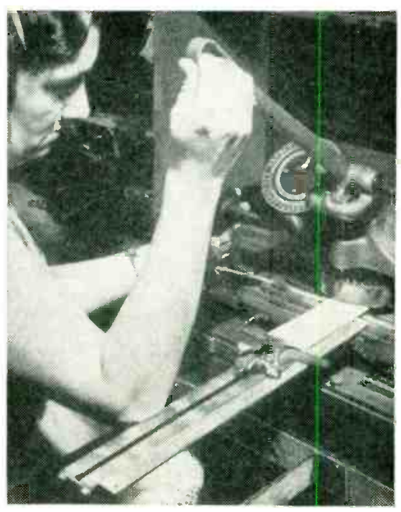
another. Strength and rigidity are accomplished by the use of a wire reinforcement built in the top rim.

Size of the Sangamo tote box was determined by the dimensions of storage shelves, with three boxes 18 inches deep completely occupying one shelf from back to front. The boxes are made by Gaylord Container Corp., Saint Louis, Missouri, and are shipped knocked-down for assembly with a power stitcher as needed. Cost is about one-fifth that of comparable steel boxes.

Punching Chassis Stencils on Addressograph

WITH only minor modifications a standard Elliott addressing machine serves for cutting stencils used for spraying identifying legends on resistor terminal cards and chassis sections for the Matador guided missile in the Baltimore plant of The Glenn L. Martin Co. With the Addressograph machine permanently set up on a bench adjacent to assembly positions, new stencils can be cut in a few minutes whenever needed because of production changes.

Conversion from embossing of metal to punching out of stencil paper merely involves use of a special soft backup paper on the solid anvil. This paper is obtained in the form of green tape from The Elliott Addressing Machine Co., Cambridge, Mass. Each operation



Stencil-cutting setup. Left hand of operator is on character-selecting knob. Line-spacing holes can be seen on paper feed plate in foreground

Exciting New Development

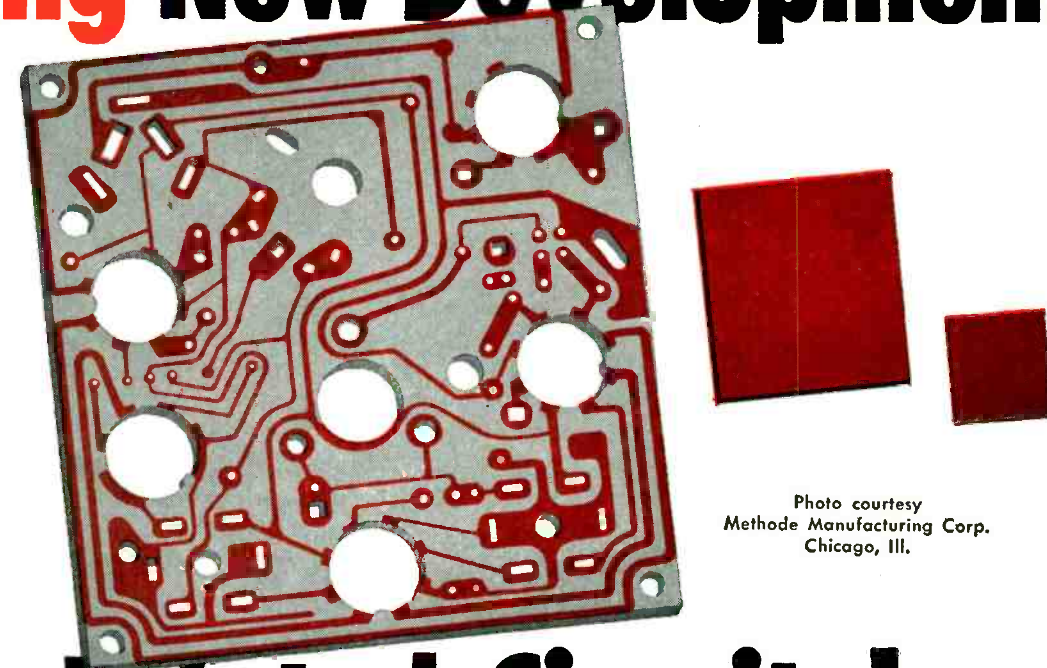


Photo courtesy
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PUNCHABILITY—Excellent

SURFACE RESISTIVITY, megohms
C-96/35/90 .... 7.3×10^4

VOLUME RESISTIVITY, megohm cm.
C-96/35/90 .... 3.7×10^5

WATER ABSORPTION
1/16" th., E-1/105 + D-24/23 copper on 0.1%
1/16" th., E-1/105 + D-24/23 copper removed 0.7%

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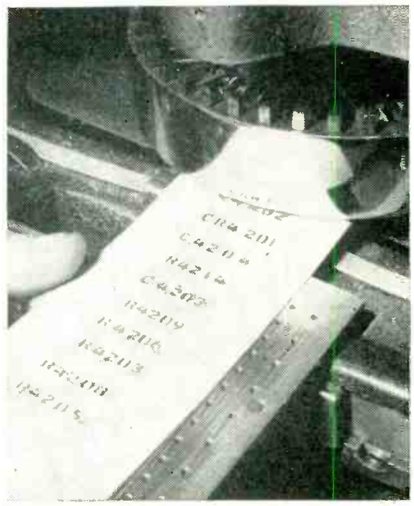

Closeup of punching head, showing finished stencil for resistor board. Paper backing tape feeds automatically from right to left. Tape supply reel is off at right. Stencil can be fed either in or out of the addressing machine advances the tape the space of one character, so that fresh backup paper is always under the die.

The major machine modification involves providing for stencil paper feed from front to rear through the machine. Standard stencil paper cut to the width of a resistor terminal board is used. Larger stencils for other purposes are made by cutting apart the punched strip and taping or cementing the pieces into windows of the larger stencils.

Precise indexing of characters is provided by the machine itself. Line spacing is achieved by means of holes drilled into the stencil paper feed table. The end of the paper strip is held by a spring clip on the feed slide. A spring-loaded metal pin on this slide drops into the drilled holes. To advance to the next line, the operator merely pulls

Method of pressing stencil down against chassis with fingers in vicinity of window being sprayed

Precision Designed for LOWEST VSWR!

PRD microwave TRANSMISSION LINE components

TYPE 116-A
WAVEGUIDE
TERMINATION

TYPE 354-B
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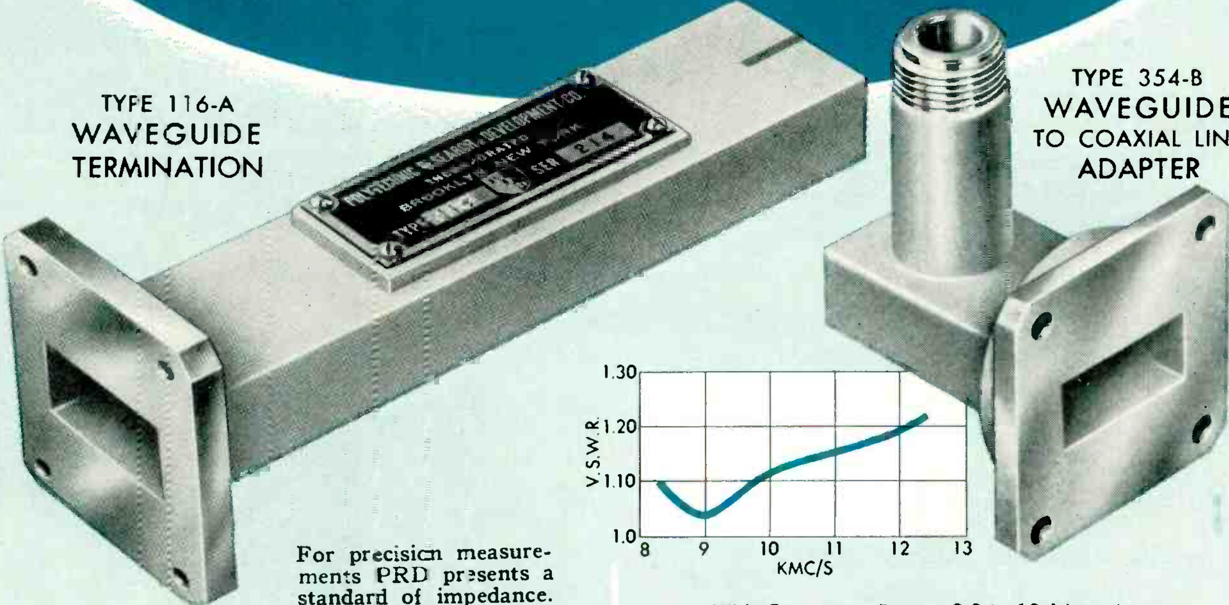

- Frequency Range: 8.2 to 12.4 kmc/s
- Very Low VSWR: Less than 1.01
- Stable Characteristics
- Rugged
- Waveguide Type: RG-52/U
- Flange Type: UG-39/U

For precision measurements PRD presents a standard of impedance. The termination consists of a matched resistive insert terminating a section of RG-52/U waveguide. Each insert is tested to insure that its VSWR is less than 1.01. Dimensions of the waveguide are maintained so that its characteristic impedance is within 0.5 percent of nominal. Flange faces are milled flat and the screw holes are referenced to the center line.

- Wide Frequency Range: 8.2 to 12.4 kmc/s
- Low VSWR: (See curve)
- Waveguide Type: RG-52/U
- Flange Type: UG-39/U
- Coaxial Connector: Mates with UG-21B/U or equivalent

The Type 354-B Adapter is designed for making minimum reflection connections between waveguide and coaxial line. Typical VSWR is shown in the curve. The low VSWR assures least disturbance of the electrical properties of mating components.

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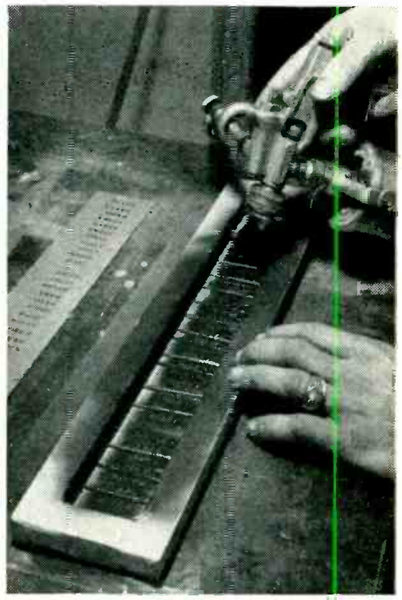
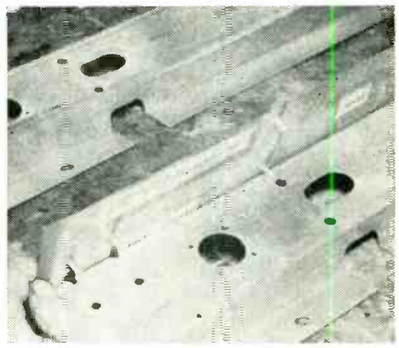


Spraying resistor board with DeVilbiss spray gun, using stencil frame having wires that automatically press stencil against board



Example of metal-plate stencil having positioning pins

up the pin and pushes the slide forward. The pin automatically drops into the next hole to give precise line spacing.

When spraying small quantities of a piece, the stencil can be held in position over the work or taped to the work. To get a clean sprayed impression, the operator presses the stencil down on the chassis at each spraying location in turn with one hand while manipulating the spray gun with the other hand.

For larger runs and for standard items such as resistor boards, stencil hold-down frames are used to speed up the work. These are made from metal, and have wires running across in between the lettering to get pressure across the entire width of the stencil. The stencil is attached to the underside of the frame with masking tape, so that the operator can transfer the stencil from one piece to the next with a

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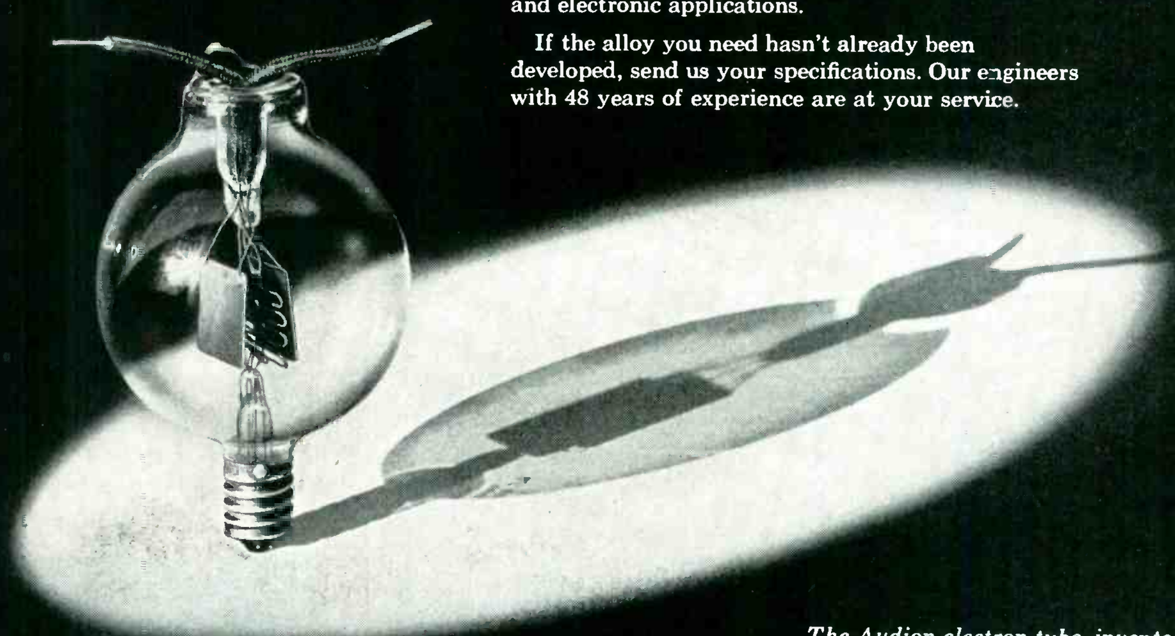

The Audion electron tube, invented by Lee de Forest in 1906

SOME PROMINENT DRIVER-HARRIS RADIO ALLOYS: Nichrome* • Gridnic* • Nickel "A", "D", "E", "Z", 330, 499, 599 • Therlo* • 152 Alloy • 142 Alloy • 146 Alloy

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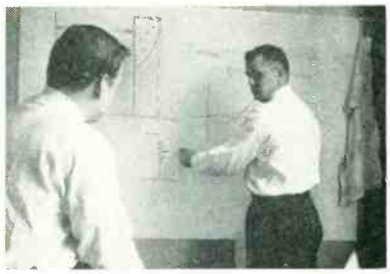
quick movement of the hand.

Another type of stencil uses positioning pins that fit into chassis holes. These pins are staked into a piece of sheet metal having cut-out windows over which the stencil pieces are taped.

Blackboard Substitute

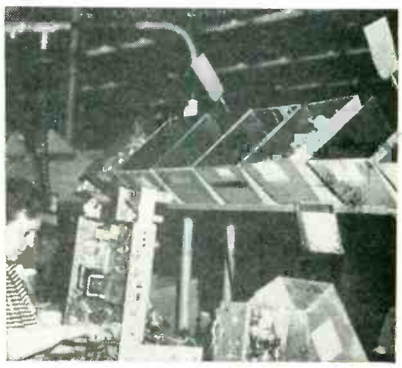


Working out design problem for non-linear precision potentiometer on pressed-wood board painted with ordinary cream-colored oil paint

IN PLACE OF BLACKBOARDS at Helipot Corp., South Pasadena, Calif., engineers work out problems by using water-base crayons on a cream-colored board. The eraser is simply an ordinary towel. The crayons are available at most art supply stores.

Red Flag on Clip Serves as Parts-Needed Signal

AN ORDINARY red shipping label attached to a spring-type paper clip is used as an indication that parts are needed on television receiver assembly lines in the Westinghouse Metuchen, N. J. plant. The mast of the flag is a metal strip that is soldered to one handle of the paper clip and riveted to the reinforced hole in the shipping tag. This flag can easily be clipped to the side wall



Method of attaching parts-needed flags to tote boxes needing refilling

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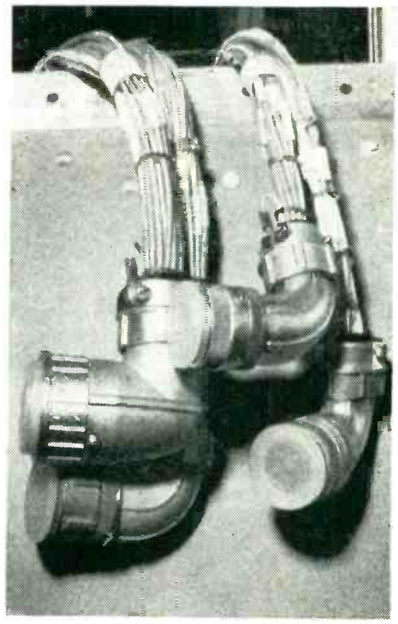
of an empty tote box. The added height achieved with the metal strip permits tags to be seen several aisles away. The tags are put up and removed by production clerks, and serve as a continuous indicator to foremen on the performance of their stock men.

Waterproofing Cable Connectors

MOLDED PLASTIC CAPS like those used on pill bottles serve to seal the ends of cable connectors in the Baltimore plant of The Glenn L. Martin Co. These can be applied in considerably less time than was formerly required to wrap water-



Method of using plastic caps to waterproof plugs and keep out dirt

Old method of waterproofing plugs by wrapping and taping

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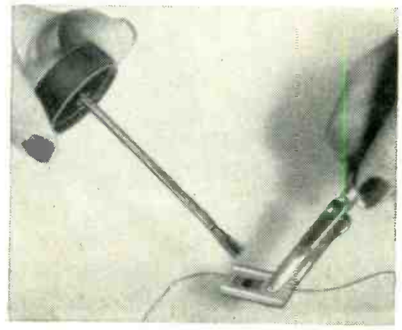
proof paper around the connectors and anchor it with adhesive tape.

The new plastic plugs, made by Cannon Electric Co. of Los Angeles in various sizes to fit its line of connectors, are left in position until final assembly of the electronic equipment in the intended aircraft or guided missile.

Tape-Covered Clips Serve as Clamps



Holding photocell element together with padded spring clamp while applying cement

COVERING the jaws of ordinary alligator clips with adhesive tape or masking tape converts them into spring clamps for holding small parts together during assembly operations. This technique is used in the Paramus, N. J. plant of Avion Instrument Corp. for sealing tiny lead-sulfide photocells for photoelectric choppers. The light-sensitive units are placed between Nisa glass conductive plates and held together with the padded clamp while cement is applied with a small brush.

Precision Photoelectric Wire-Cutting Machine

LENGTHS OF WIRE required for circuit cables of the P5M Martin antisubmarine plane, the Matador guided missile and other aircraft in production at the Baltimore plant of The Glenn L. Martin Co. are automatically cut to precise length even though up to 15 feet long. The desired length can be set to within $\frac{1}{16}$ inch on the dials of a four-decade predetermined electronic counter made by Potter Instrument Co., Great Neck, New York. The

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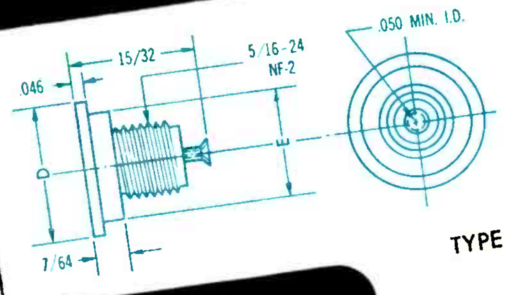
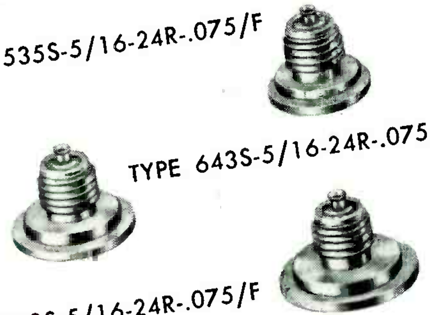
Threaded Barrel Flared Tubing Types



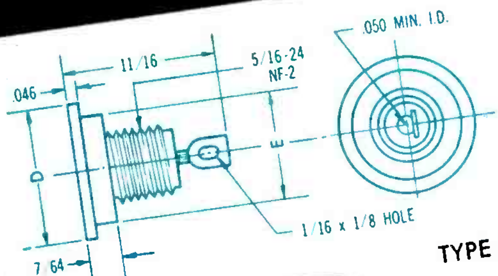
TYPE 535S-5/16-24R-.075/F

TYPE 643S-5/16-24R-.075/F

TYPE 723S-5/16-24R-.075/F



Threaded Barrel Lug Types

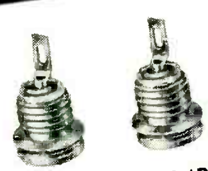


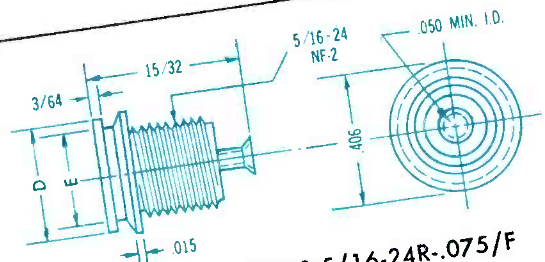
TYPE 535S-5/16-24R-.075/PT

TYPE 643S-5/16-24R-.075/PT

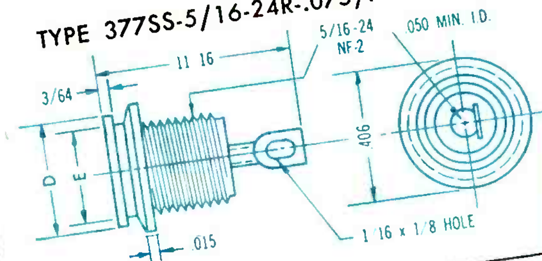
TYPE 723S-5/16-24R-.075/PT

Grooved Flange Threaded Barrel Lug Types



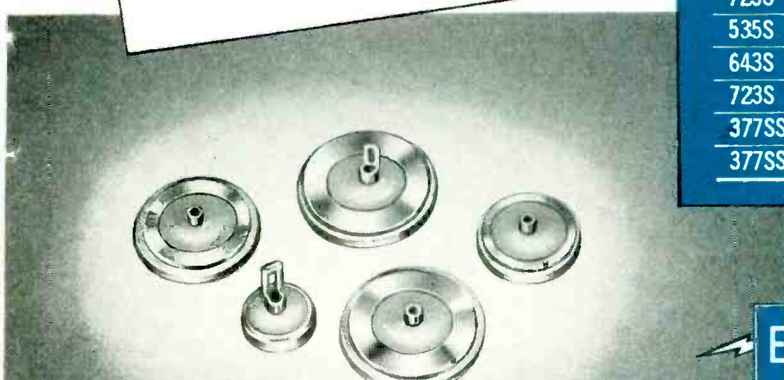


TYPE 377SS-5/16-24R-.075/PT



TYPE 377SS-5/16-24R-.075/F

TYPE NUMBER	DIMENSION D	DIMENSION E
535S -5/16-24R-.075/F	.535	.437
643S -5/16-24R-.075/F	.643	.500
723S -5/16-24R-.075/F	.723	.562
535S -5/16-24R-.075/PT	.535	.437
643S -5/16-24R-.075/PT	.643	.500
723S -5/16-24R-.075/PT	.723	.562
377SS-5/16-24R-.075/F	.377	.323
377SS-5/16-24R-.075/PT	.377	.323



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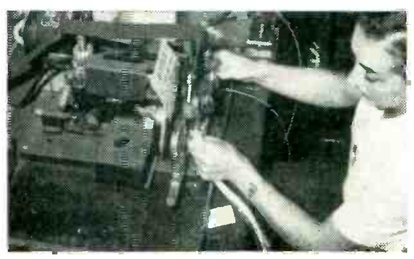
Setup for measuring, cutting and printing wires for electronic aircraft cables

first three decades read in inches and the fourth reads in sixteenths of an inch (achieved by leaving the last binary decade unaltered during manufacture of the counter, whereas the others are altered conventionally for conversion from the scale-of-sixteen binary system to the scale-of-ten decimal system).

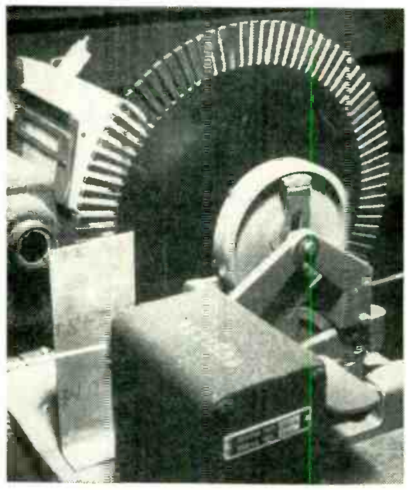
The incoming wire runs between two wheels, one of which is on the same shaft as a chopper disk whose teeth interrupt a light beam directed at a phototube. The wire is pulled by a standard drive taken from an Artos wire-cutting machine. The speed of this drive is easily adjusted to achieve approximate synchronism with a wire-stamping machine at the next position.

At the left of the drive is a wire-chopping arrangement operated by a solenoid connected to the counter. When starting up with a run of new wire, the operator threads it be-

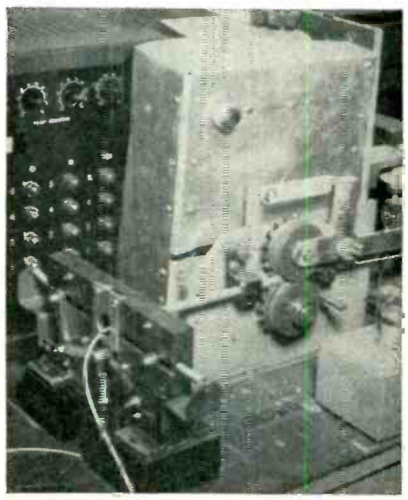


Operator holds finished wires in left hand as she threads into stamping machine with right hand the start of the wire that is emerging from the measuring and chopping equipment at the rear

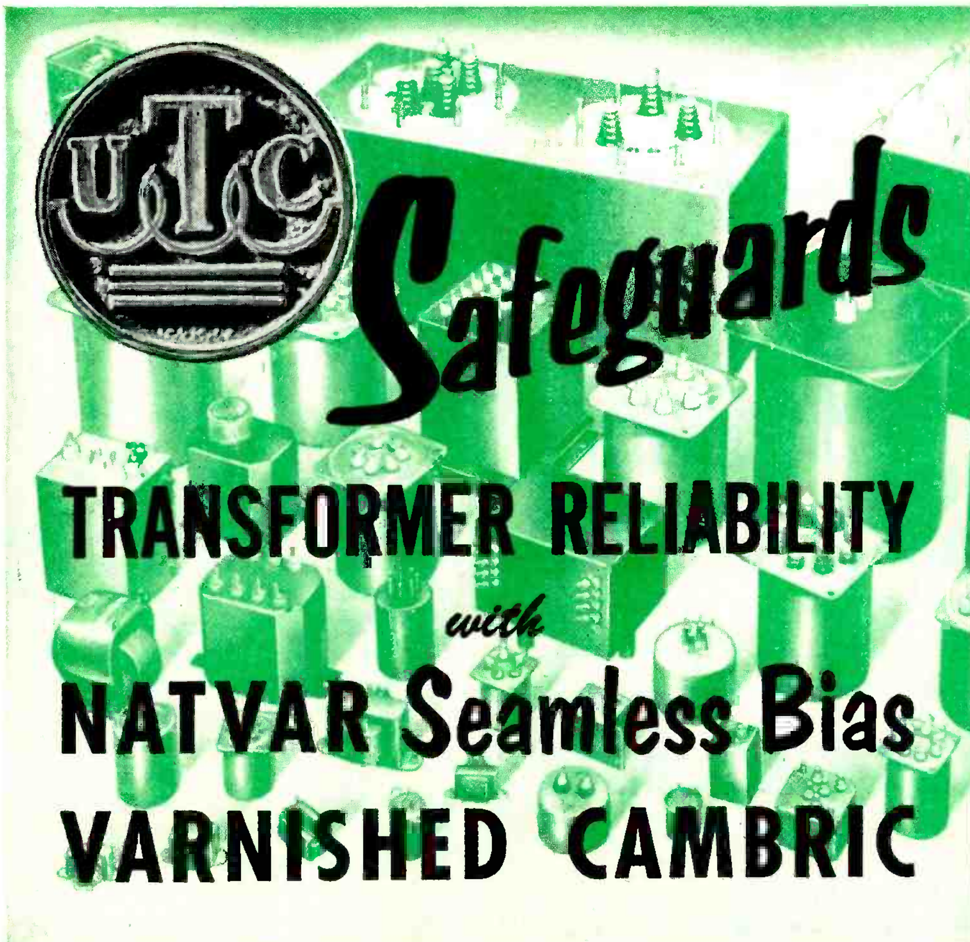
tween the measuring wheels, through the guide tube of the Artos drive and then through the chopper jaws. She then pushes a button on the bench to clear the counter and chop off whatever short length of wire is projecting. The counter then takes over, keeping the Artos drive running until a count corresponding to the preset length has been reached; this automatically takes into account the fixed distance between the measuring wheels and the chopping blades. The counter then operates the solenoid which simultaneously pulls the Artos drive wheels apart and pulls down the chopping blades. Stopping the feed prevents buckling



Photoelectric setup for measuring wire length in conjunction with electronic counter. Sheet of aluminum in path of light beam serves as mask, with light passing only through tiny drilled hole to phototube at far side of wire

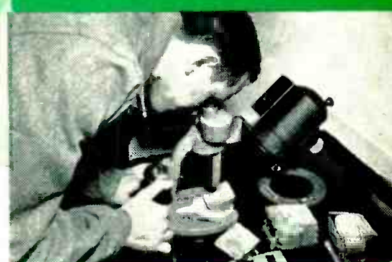


Artos drive and chopper with protective housing removed. Pushbutton in left foreground clears counter and actuates chopper as required after threading in new wire



One reason UTC transformers can carry a strong materials workmanship-performance guarantee is that all incoming materials are thoroughly tested against specs before they are accepted and used. Here, tensile strength of insulation is being checked.

Other quality control tests are made as fabrication progresses. Corrosion resistance of insulating materials is checked as coil assemblies are tested.



After being overloaded until they fail, units are dissected and given a microscope examination to determine the cause of failure. The analysis guides development toward still higher reliability standards.

THE UNITED TRANSFORMER COMPANY, New York, manufactures high reliability transformers ranging from one-third ounce subminiatures to units weighing several hundred pounds. They recently shipped their ten millionth military transformer.

At UTC a great deal of the credit for their present position of leadership goes to the engineering and quality control staffs and the best of laboratory facilities. These are supplemented by a separate Material Testing Laboratory where all electrical insulating materials are evaluated. Natvar Seamless Bias Varnished Cambric is used because it consistently meets requirements. Natvar Varnished Tubing and Straight Cut Varnished Cambric are also used.

Natvar flexible insulations are dependably uniform no matter when or where they are purchased. They are available either from your wholesaler's stock or direct from our own.

Natvar

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- Varnished cambric—cloth and tape
- Varnished canvas and duck
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of the wire during the interval that the blades are down. Release of the solenoid restores the drive automatically for initiating measurement of the next piece. The cutter has two mating blades moving together, to eliminate crushing of insulation such as might occur with one blade working against a fixed bar or anvil.

Independently of the measuring setup is a Productimeter, made by Durant Mfg. Co., Milwaukee, which is set to the number of wires wanted in a given length. This sounds a buzzer when the quota is reached.

As each new length of wire begins coming out from between the open chopper blades, the operator picks it up and threads it into a standard stamping machine made by Kingsley Stamping Machine Co., Hollywood, Calif. for stamping of the assigned part number on the wire at separations specified for military electronic equipment. Manual threading is required, rather than inserting the stamping machine ahead of the measuring setup, to meet the requirement that there be a stamped notation within three inches of one end of the wire. Wires emerging from the stamping machine are caught by the operator with her left hand and held there for batching. When the desired number of wires is completed, she ties them together temporarily with Wire Ties, which are wire-reinforced paper strips made by H. F. Hanscom and Co.

Pressurized Tube Plant

ROOM AIR pressure is maintained at about one-quarter inch of water above atmospheric to keep lint and dust out of a critical tube

Scarf held in open door illustrates how air pressure keeps dust out of radar tube assembly area

IBM *News* FOR ENGINEERS

THIS MONTH'S BIG CAREER OPPORTUNITIES

DEVELOPMENT ENGINEERING *

Digital computer circuit design—electronic pulse circuits for accounting and data processing machines—arithmetic, switching and logical circuitry—magnetic storage—transistor circuitry—input-output device controls—pulse amplifiers, shapers, gates, etc. **ALSO** excellent openings in systems planning, functional and reliability analysis, electronic component development, packaging, diagnostic and application program development.

"IBM GREAT PLACE TO WORK"

says development engineer now in his 8th year with the company

"Every year with IBM is more challenging than the last," says Max E. Femmer, Development Engineer at Poughkeepsie. "It was a tremendous satisfaction in 1952 to help develop IBM's outstanding 701 Electronic Computer. Today our projects and our work are even more interesting. Both my wife and I think IBM is a wonderful company."

Mr. Femmer is Technical Administrator of the entire Electronic Data Processing Machine Development Program.

MAGNETIC CORE MEMORY DEVELOPED BY IBM STAFF

This is a Microsecond Memory—developed and perfected by IBM engineers—with data transmission in and out of storage at the rate of more than 43,500 characters a second. A random access unit, the IBM magnetic core can locate and move 5 characters to a programmed location in 35 millionths of a second.

MANUFACTURING ENGINEERING *

Design and development of electronic test equipment for digital computer production testing—circuit design—systems planning and analysis—test planning. **ALSO** excellent openings in functional and acceptance testing—test equipment installation and maintenance—automation engineering—manufacturing research.

* Required—a degree in E.E., M.E., or a Physics B.S. or B.A., or equivalent experience.

Desirable—experience in any of the following fields: digital and analog computers, including airborne types, radar, TV, communications equipment, relay circuitry, automation, servo-mechanisms, instrumentation, or data handling systems.

For information on these career opportunities WRITE, giving details of education and experience, to:

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IBM, Dept. 686(4)
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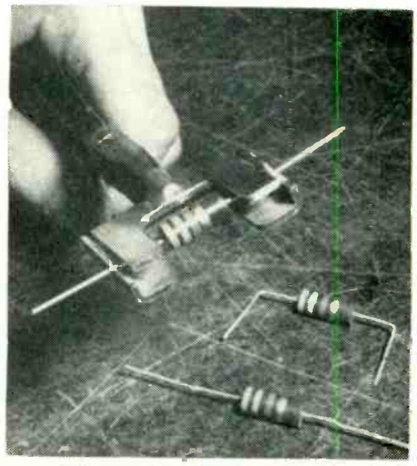
assembly area at the new General Electric industrial and transmitting tube plant at Scranton, Pa. A 40-hp centrifugal fan provides pressure for the 138,000-cubic-foot room. The fan blows 62,000 cubic feet of air per minute into the room. The pressure may be regulated by a series of vent louvers.

In the room are lines for assembly of completed tubes or parts of hydrogen thyratrons, magnetrons, lighthouse transmitting tubes, and the tiny metal-and-ceramic GL-6299 low-noise triode.

For further protection against lint and dust, incoming air is electrostatically filtered, and operators wear nylon gowns and gloves.

Similar pressurized rooms are used for critical tube operations at the firm's Owensboro, Ky. receiving tube plant and at its Syracuse and Buffalo, N. Y. cathode-ray tube plants.

Jaws on Pliers Bend Pigtail Leads



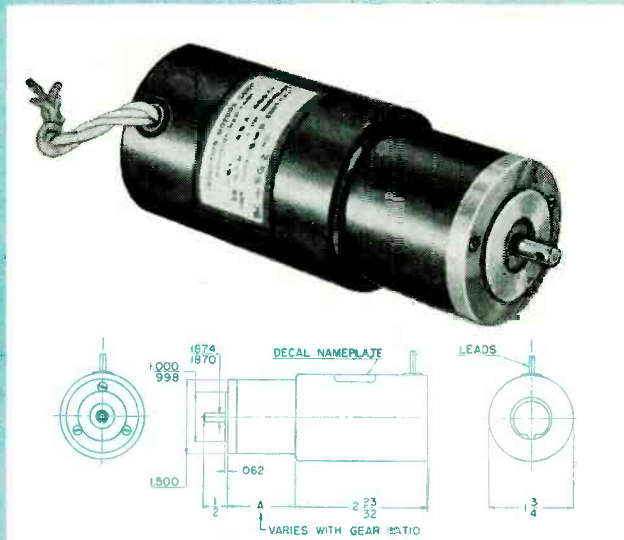
Tool for making single right-angle bends in axial-lead resistors

FORMED STEEL jaws brazed onto longnose pliers serve as efficient hand tools for bending both leads of small components simultaneously to the required shapes for most efficient use on standard resistor terminal boards or on etched wiring plates. The central openings in the forkshaped jaws accommodate the body of the part and provide automatic centering. Parts shorter than the opening can readily be centered visually where required, or offset to

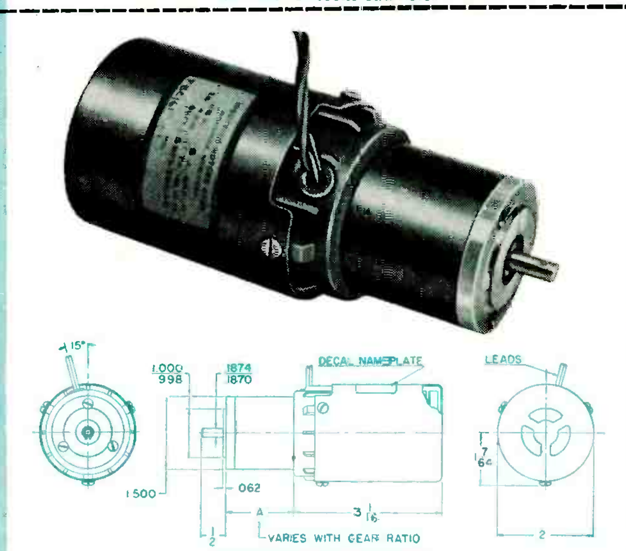
These *New* GEAR HEADS are our Answer to HIGH TORQUE at LOW SPEEDS

We are producing a complete line of gears for our 1600 frame motors to meet any precision, low speed high torque requirements. Gear reduction units built to withstand impact, vibration and high acceleration are available. If your requirements are such that control problems are the important factor we incorporate the correct actuating device in the design.

Our 1600 frame motors are available in highly efficient induction, non-synchronous types or in hysteresis or reluctance synchronous types. They may be for 60 cycle, 400 cycle or variable frequency operation (50-1600 cps), single or polyphase. Supplied in ratings from 1/1000 to 1/10 horsepower for continuous duty. Housing is anodized aluminum. Ball or sleeve bearing construction. Will withstand ambient temperatures from −55° up to 150°C.



1600 FRAME NON-COOLED GEAR MOTOR



1600 FRAME SELF-COOLED GEAR MOTOR

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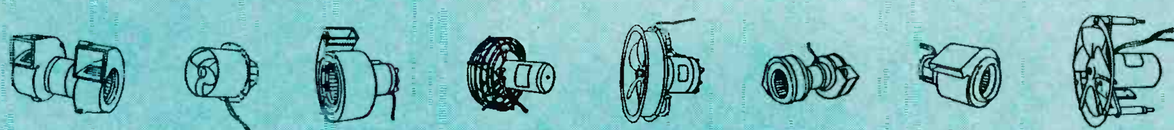
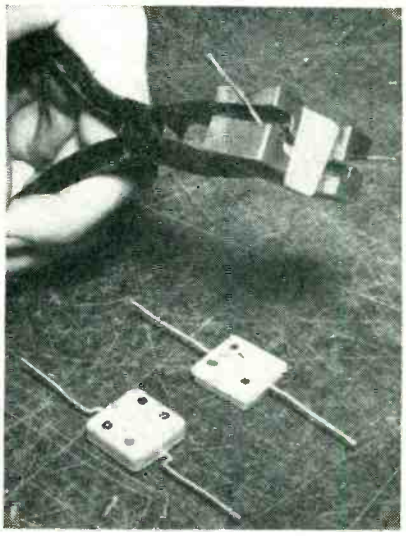




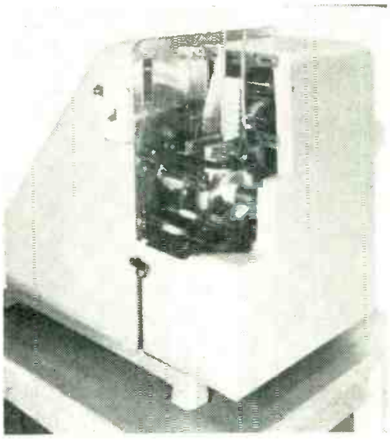
Tool for making double bends in leads of mica capacitors for mounting on turret terminals

get unequal lead lengths.

Either single or double bends can be obtained by appropriate shaping of the jaws. These tools are in use in the Baltimore plant of The Glenn L. Martin Co.

High-Speed Color Bander

A COMPACT, new bench-model color bander designed and manufactured by the Markem Machine Co. of Keene, New Hampshire, has been designed to meet increased requirements of precision in applying up to six color bands for identification of crystal diodes and the new subminiature resistors and capacitors. The stack feed is adjustable to take parts ranging from $\frac{3}{8}$ to $2\frac{3}{4}$ inches



New high-speed printer as set up for applying four color bands to molded paper capacitors at rate of 50 parts per minute. Painted parts drop down slide at left into tote box (not shown)

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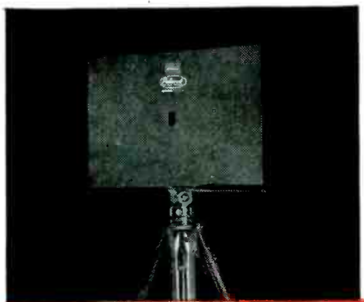
A NEW LINE OF BROADBAND MICROWAVE COMPONENTS



MICROWAVE TEST ANTENNAS

Covering 1,000 to 26,600 mc. Rugged, portable units built especially for field intensity measurements, antenna pattern recording, leakage measurements and other communications use. Supplied complete with tripod mount, adjustable pan head, and convenient carrying case.
Each of these Polarad test antennas is highly directional with excellent front to back ratio, and is supplied with flexible waveguide or coax couplings.

MODEL No.	FREQUENCY RANGE	MAX. VSWR
L	1,000 to 23,000 mc	3:1
S	2,150 to 4,600 mc	2:5
R	4,450 to 8,000 mc	2:5
X	7,850 to 12,400 mc	2:7
KU	12,400 to 18,000 mc	1.5:1
K	18,000 to 26,000 mc	1.5:1

BROADBAND-PASS FILTERS

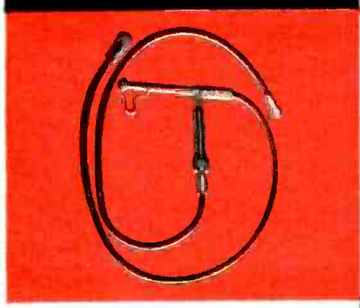
Covering 650 to 13,000 mc. These Polarad Broadband-Pass filters are the first of their kind commercially available. They feature sharp skirt selectivity and low pass band insertion using standard 50 ohm co-axial connections. Curves showing typical bandpass characteristics are available on request.

MODEL No.	FREQUENCY RANGE
F 650	650 – 1,300 mc
F 1100	1,100 – 2,200 mc
F 1800	1,800 – 3,600 mc
F 3500	3,500 – 7,400 mc
F 6100	6,100 – 13,000 mc

MICROWAVE WAVEMETERS

Covering 500 to 4000 mc. Precision, adjustable, cavity-type meters designed for measuring frequency with ± 0.2% accuracy over the range 500 to 4000 mc. Each meter in the series has a 2:1 frequency range. Specific frequency metering is accomplished by adjustment of micrometer head until a dip of at least 20% in output occurs when input or output impedance is nominal 50 ohms. Micrometer head readings are easily converted to frequency by using calibration chart furnished with each instrument. Utilizes Type "N" coax connectors.

MODEL	FREQUENCY RANGE
FR	500 – 1,000 mc
FL	1,000 – 2,000 mc
FS	2,000 – 4,000 mc



MICROWAVE ATTENUATOR—Model SIJ

Covering 4,000 to 12,400 mc. A continuously variable, stub-tuned, mutual inductance attenuator (waveguide beyond cut-off) designed for external use in making microwave measurements with spectrum analyzers, signal sources, receivers and for power measurements. The Model SIJ can be used as a standard calibrated attenuator; for circuit protection; or for monitoring and measuring. It will insure RF circuit isolation. It may be used to convert signal source or laboratory oscillator into a signal generator.

SPECIFICATIONS:

Frequency Range:	4 to 12.4 kmc
Impedance:	50 ohms
Attenuation Range:	130 db
Minimum Insertion Loss:	Approximately 10 db depending on frequency.

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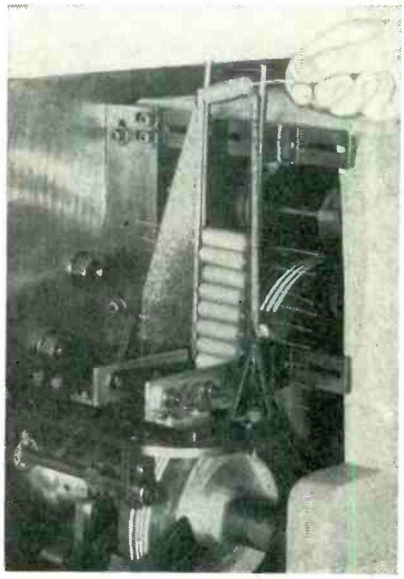
in body length and 3/16 to 1 inch in diameter.

Each component is individually selected from the bottom of the stack by slotted fingers that grip the leads loosely, then slide forward to hold the component against a revolving common die doll applying up to six colors simultaneously. The component rotates against the die roll until a recess in the roll reaches the component. The fingers then eject the component into the recess,



Method of loading chute

from where it rolls out and down the output chute after another quarter-revolution of the die roll. Simultaneously, the fingers retract to select the next piece.

Small units may be fed by manually loaded turret feed mechanisms, insuring positive control while the component is banding and ejecting.

Interchangeable reservoir units govern the positions of the color bands. The reservoirs apply their individual colors to an ink transfer roll at the rear, which in turn transfers the ink to the die roll.

Recommended operating speed is 50 units per minute. Components may be loaded into the chute at any time, even while the machine is in operation. Special fast-air-dry inks are used, so that parts can generally be dropped directly into tote boxes without smudging the color bands. Accessories include a variable-speed unit, separately-powered take-away conveyor and heating element.

The equipment may be inserted

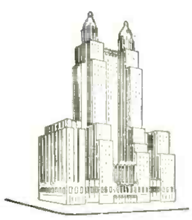
March 21-24

The Radio-Electronic

SPECTACULAR of 1955!

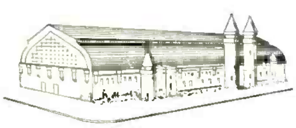
See! Hear!

IRE National Convention



At both the Waldorf-Astoria (convention headquarters) and Kingsbridge Armory, you'll attend what actually amounts to 22 conventions fused into one. Hundreds of scientific and engineering papers will be presented during the many technical sessions, a large number of which are organized by I R E professional groups. You'll meet with the industry's leaders—enjoy the finest meeting and recreational facilities in New York.

and Radio Engineering Show



At the Kingsbridge Armory and Kingsbridge Palace, you'll walk through a vast panorama of over 700 exhibits, displaying the latest and the newest in radio-electronics. You'll talk shop with the industry's top manufacturers—enjoy the conveniences provided for you in the world's finest exhibition halls, easily reached by subway and special bus service.

Admission by registration only. $1.00 for I R E members, $3.00 for non-members. Social events priced extra.

The Institute of Radio Engineers
1 East 79 Street, New York

7 out of 704*

good reasons why you should attend the Radio Engineering Show

Hear...

vital research and engineering papers on computers, transistors, color TV, etc., subject-organized in 55 sessions.

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"1955 Instrumentation" shown on Instruments Avenue. Exhibit grouping helps you see more on the Avenues named.

Audio • Broadcast • Radar
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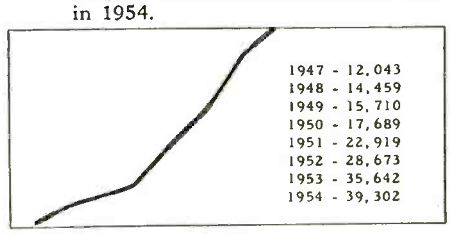


Enjoy...

The Convention's Social Events. It is good to mingle with your industry friends at IRE.

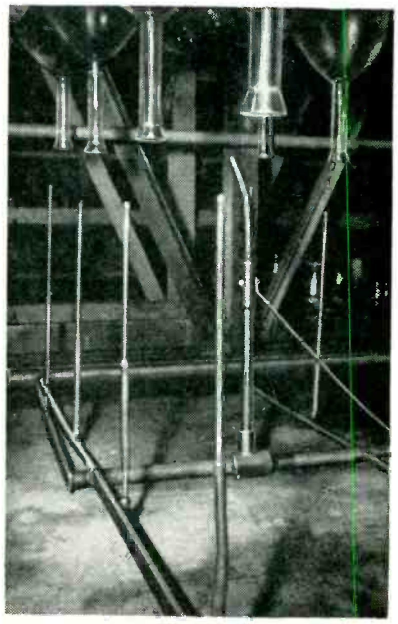
Get the facts...

faster and easier at exhibits and sessions than you could from weeks of your own "digging."

**Send for the 1954 Directory of 604 Exhibitors and list of 100 new exhibitors.*

directly into a production line, receiving components directly from a degreasing or deflashing operation automatically by means of a conveyor.

Flexible Drying Rods Prevent Tube Breakage



Drying rods on carriage which moves at same speed as overhead conveyor for picture tubes

FLEXIBLE coil-type air drying rods prevent breakage of picture tube necks on an automatic drying unit in the General Electric tube plant at Electronics Park, Syracuse, N. Y. In normal operation the rods, mounted on a carriage which moves along parallel to the bulb conveyor, rise into the bulbs as they pass over the drying unit. If a bulb or its drying rod is misaligned, however, the bulb neck might be damaged if it were not for the flexibility of the coil-type rod. On this unit, a 21-inch bulb can be dried in about five minutes, with larger or smaller bulbs requiring more or less time.

Carton Turnover Machine

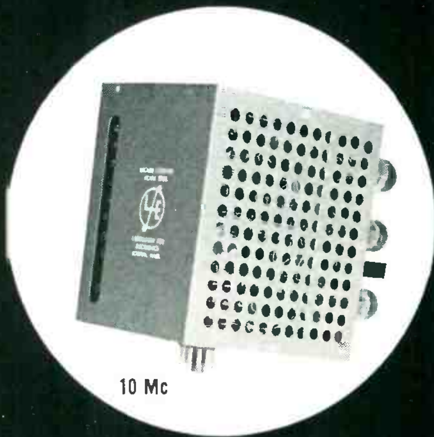
FINAL PACKING of black-and-white television receivers is achieved in three steps in the Westinghouse Metuchen, N. J. plant with the aid of automatic turnover machines actuated by air cylinders.

First, an empty upside-down

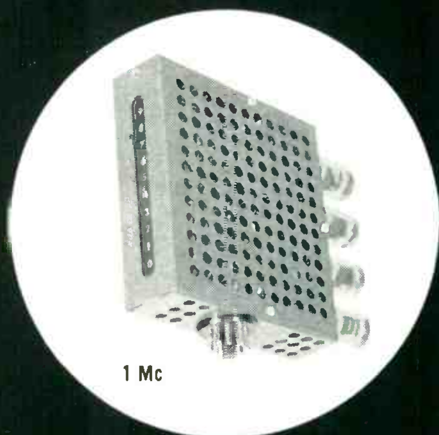
DECADE SCALERS

by L/E

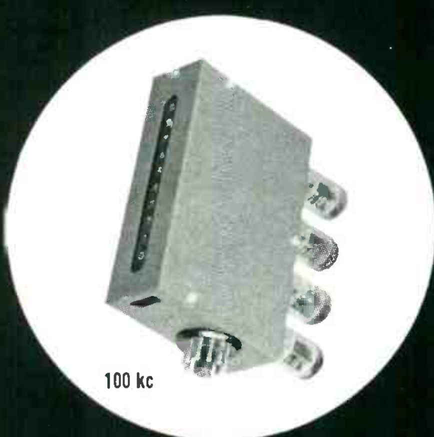
NOW 0-10 MC!



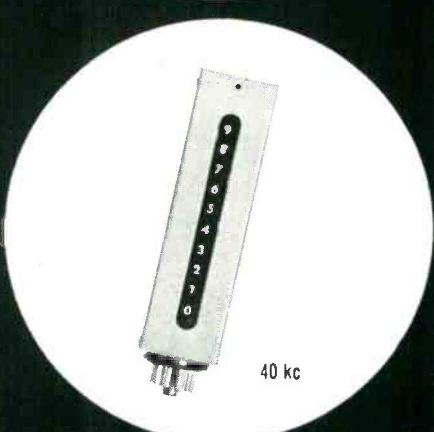
10 Mc



1 Mc



100 kc



40 kc

DECADE SCALERS — 1700 SERIES

- 0 to 10 Mc covered in four ranges, 40 kc, 100 kc, 1 Mc and 10 Mc Max.
- Direct Decimal Display throughout, including 10 Mc.
- Light in Weight.
- Plug-In Construction for all 4 ranges:
  - *Decade Output with 8 pin base*
  - *Individual Stage Outputs for remote readout with 11 pin base optional on 40 kc, 100 kc and 1 Mc models.*
- Zero Reset; "9" Reset optional on 40 kc and 100 kc models.
- Reliabilized Tubes.
- Low Power Consumption.
- Wide Operating Voltage Range:
  - *approximately ±30% on 40 kc Model*
  - *±20% on 100 kc and 1 Mc Models*
  - *±5% on 10 Mc Model*

Dimensions, approx.	40 kc	100 kc	1 Mc	10 Mc
Width	1½"	1½"	1½"	4⅛"
Height	5¼"	5¼"	5¼"	5¼"
Depth (including tubes)	5¼"	5¼"	6⅝"	6⅝"
Weight	10 oz.	10 oz.	13 oz.	24 oz.
Nominal Current	9 Ma	14 Ma	75 Ma	140 Ma 45 Ma
Nominal Voltage	300 V.	300 V.	300 V.	200 V. 275 V.
Tube Complement	4-5963	4-5963	4-5965 (or 12AV7)	6-5687

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Inquiries on export sales should be addressed to: Andrew S. Szucs, Inc., 50 Broad Street, New York 4, N.Y.

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Pulling lever at left operates carton turnover machine

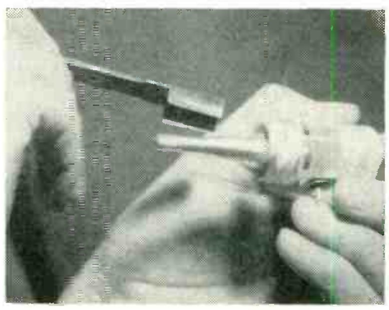
carton is slipped over the palletized television set and the combination is pushed into the first turnover machine. This turns the carton right-side-up, so that the television set inside is upside down.

Next, the pallet is removed, protective covering is placed on the bottom of the set, the carton flaps are brought in and tape is applied to seal the bottom of the carton.

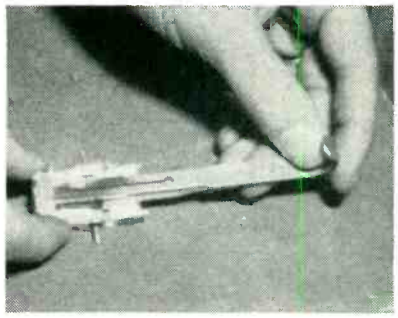
Finally, the carton is pushed along a metal chute to a second turnover machine. This turns the set right-side-up for final sealing of the carton. The packed set is then trucked to the warehouse for storage and shipping.

Gap Gage for Coaxial Tuned Stub

SPACINGS between the two inward-projecting signal feeds and the central conducting member of the quarter-wave coaxial tuned stub used as a tuned circuit in Motorola's 400 to 470-mc two-way radio are checked with a U-shaped gage in the firm's Chicago plant. The gage



Method of inserting gap gage in coaxial tuned stub



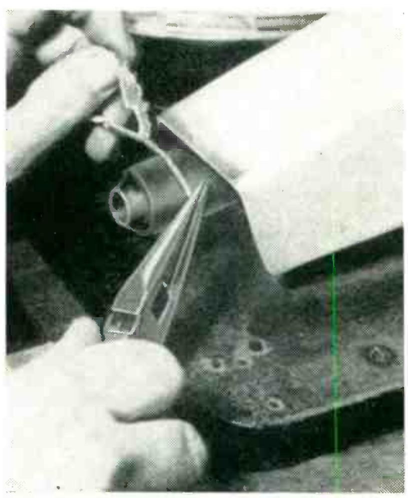
Gage in position in stub that has been sawed in half to show inner construction of coaxial unit

construction shown permits pushing the gage alongside the central conductor. The gage handle is slotted for part of its length to give the springiness needed to accommodate varying central conductor diameters, since it is gap spacing rather than conductor diameter that is critical.

Different gages are kept on hand for the various tuned circuits of this type, because of the varying degree of coupling and consequent variations in required gap length.

Stripping Nylon Jacket from Shielded Wire

PREPARATION of insulated shielded wire generally involves removal of a length of the nylon jacket to expose the shielded wire. This must usually be done without nicking or cutting the strands of the shielding braid. One method of doing this at the Baltimore plant of The Glenn L. Martin Co. involves holding the



Method of mounting standard American Beauty iron without tip for stripping nylon jacket

First Navy Jack, which unfurled the historic warning to the world in 1775—believed to have been first hoisted to the jackstaff of the ALFRED by one Lieut. John Paul Jones.

naval history is being made today

At 0955 on January 5th, one of the major events in naval aviation history took place. It was the unveiling of the United States Navy's great new XP6M SeaMaster—Ship No. 1 and prototype of an entirely new concept in military aircraft.

As a component of a powerful new arm of the naval arsenal—the Seaplane Striking Force—the Martin SeaMaster focuses national attention upon a revolutionary principle of military strategy, known as the WBA* concept. Here's why:

The SeaMaster is a highly versatile 4-jet waterbased aircraft, in the over 600 MPH class, which requires no fixed base and can operate from the seas, lakes and rivers, the coastal bays, lagoons and estuaries of the world... bases unlimited!

Today the top-level talk is turning to WBA... and shown here is the reason.

*WaterBased Aircraft

MARTIN

BALTIMORE · MARYLAND

insulation over the hot shank of a bench-mounted soldering iron. The operator holds the end of the wire with long-nose pliers and slowly pulls the wire from left to right across the iron for the desired distance. The melted jacket can then easily be pulled back with the fingers.

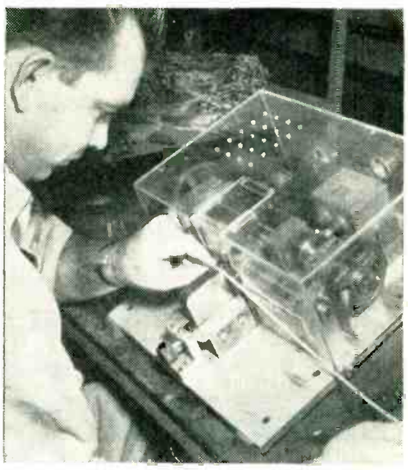
The operation is done quickly to minimize softening of the insulation inside the shield.

A sheet aluminum housing for the soldering iron covers all but the working surface, to minimize chances of burning fingers. The tip of the soldering iron is removed, since the larger-diameter shank provides faster melting of the jacket.

Nylon-jacketed shielding wire is used in the Matador guided missile to prevent undesired circulating currents that would occur with bare shielded wire touching various grounded points intermittently.

An automatic cutting machine for shielded wire was built recently at this plant, following a General Motors design. This employs contra-rotating cutters in conjunction with a precisely machined anvil to cut through the nylon jacket and shield as it is rotated on the anvil by the operator. The machine is being used on an experimental basis at present, with the hope of modifying its design so as to cut selectively through the nylon jacket without nicking the shielding braid, thus eliminating need for the slower nylon-melting technique currently being used for the purpose.

The anvil is spring-loaded in such a way that it is normally open, to



Method of holding shielded wire on anvil of automatic cutter

Look what NEW DU PONT MYLAR
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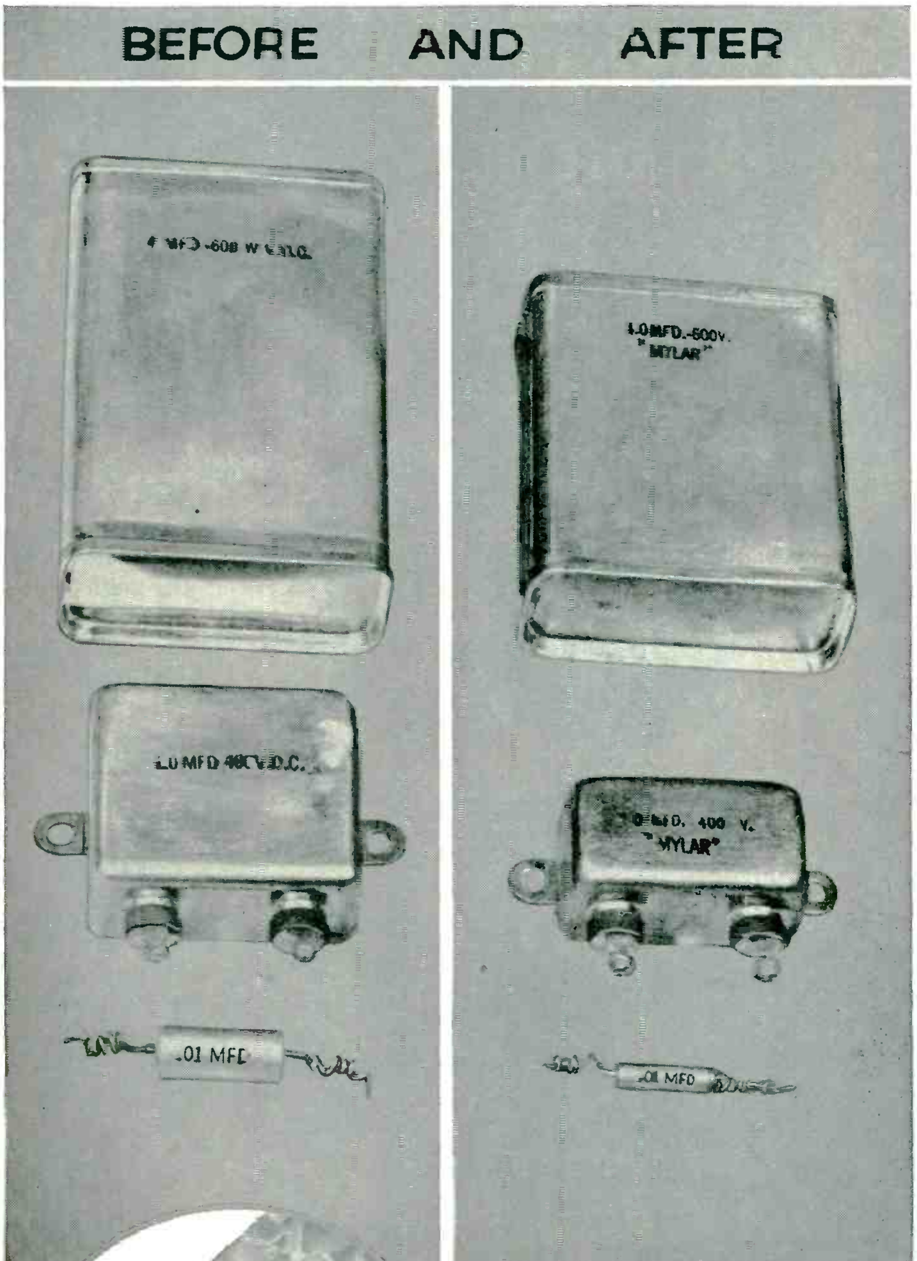
is doing to capacitors!



Used as dielectric, new Du Pont "Mylar" makes possible significant size reduction in capacitors.

How about your electrical product?

There's almost no limit to the new ideas for better electrical products made possible by "Mylar" polyester film. The smaller capacitors shown are just one example. Consider the opportunities for improving the design of your *own* product with this amazing new film.

"Mylar" offers you a combination of electrical, physical, chemical and thermal properties never before available in a plastic film. It has a dielectric strength of 4000 volts/mil, which makes it ideal for a variety of insulating purposes. Tensile strength of 23,500 p.s.i. permits its manufacture in gauges as thin as ¼ of a mil (0.00025 inch). Besides being the strongest of all plastic films, "Mylar" is inert to the attack of many solvents and insensitive to moisture. Its thermal stability permits an operating range of −60°C. to 150°C.

Find out more about "Mylar." Send for your free copy of the new booklet that gives you the facts and figures . . . shows you how this versatile film is already being used to advantage as slot, phase, and wedge insulation in motors . . . conductor insulation in transformers . . . as primary insulation and barrier tape for wire and cables. Write to: E. I. du Pont de Nemours & Co. (Inc.), Film Dept. E, Wilmington 98, Del.

DU PONT MYLAR®

Polyester Film

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BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

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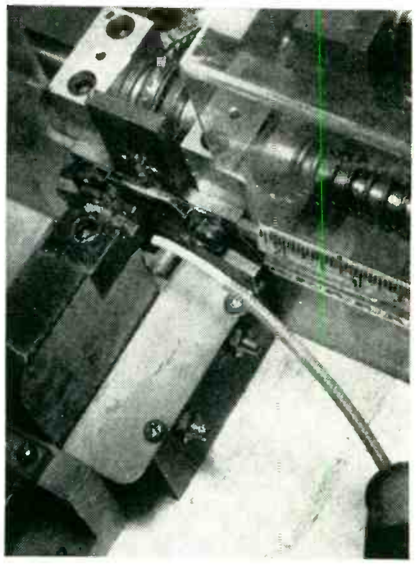


View of cutting blades, with anvil in retracted position for easy insertion of wire on which braid is to be cut

permit easy insertion and removal of wire. When ready for cutting, the operator presses a foot pedal that is linked mechanically to the anvil, to move up the anvil and actuate a snap-action switch to start the motor that drives the cutters.

The motor is belt-coupled to a Boston speed-reducing gear box. The beveled output gear of this box mates with two larger beveled gears facing each other, to drive two shafts in opposite directions. On the other ends of these shafts are gears which in turn drive the shafts on which the milling cutters are mounted. The cutters are essentially in contact with each other as they rotate in opposite directions and their teeth are beveled away from the contacting surfaces to achieve practically a razor-thin V-shaped cut.

Winding Coils on Lathe

ON PRODUCTION RUNS too small to warrant setting up a high-speed continuous-operation coil-winding machine, for certain types of precision potentiometers, a winding lathe is used at Helipot Corp., South Pasadena, Calif. The heavy enameled copper core is locked in a Jacobs chuck on the headstock and supported by smoothly machined rollers on the carriage. The spool of resistance wire rides on a projection of the carriage at the rear of the

— by changing from hand-assembled gaskets to the DAREX "Flowed-in" Gasket Process

THIS saving was experienced by *one* manufacturer on one part in one year. If you've ever added up the excessive time, motions and money required in hand assembly of gaskets to *your* parts, you'll appreciate the "Flowed-in" principle as the outstanding gasket development of the decade. Wherever "Flowed-in" gaskets are used, they cut deeply into the cost of hand assembly.

The "Flowed-in" Process is amazingly simple. A fluid flows onto a spinning surface. As the surface revolves, a uniform circular track of "Flowed-in" gasket material is deposited on the part. Baking or drying transforms the fluid into a rubbery gasket that won't fall off the part.

The DAREX Process leads to savings: In labor — by eliminating hand assembly. In materials — by eliminating waste and improving quality. Or, more probably, in both!

DEWEY and ALMY
Chemical Company
DIVISION OF W. R. GRACE & CO.
Cambridge 40, Massachusetts

FULLY PROVEN — The DAREX Flowed-in Gasket Process is more than a sealing compound . . . more than a machine . . . more than an engineering service. When you switch to Flowed-in Gaskets you get:

Gaskets with built-in resistance properties — Over 800 gasketing formulations have been tested for their effectiveness against high and low temperatures, weather, gases, solvents, moisture, vibration, hydraulic fluids, pressure . . . other problem conditions.

Machines — To apply the compound, Dewey and Almy designs and builds machines based on more than 30 years' field experience.

Service — Every machine is adjusted precisely to your specifications. Dewey and Almy engineers install the machines and train your operators to full efficiency.

Discover what DAREX "Flowed-in" GASKETS can do for you!

MAIL THE COUPON TODAY!

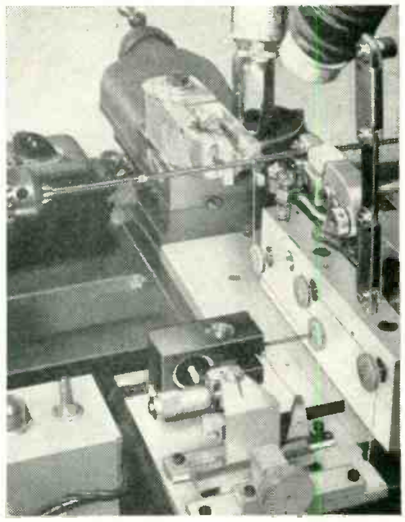
DEWEY AND ALMY CHEMICAL COMPANY
Division of W. R. Grace & Co.
Cambridge 40, Mass.
Please send me the new DAREX Flowed-in GASKET Brochure.

Name ....

Firm ....

Street ....

City .... State ....


Winding lathe as seen from rear, with tension-sensing system in foreground

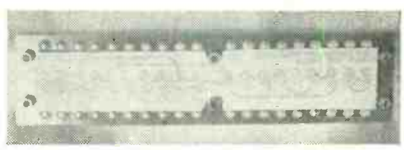
lathe. The wire comes up from the spool and passes over a pulley mounted on the shaft of a sensing element for the servo system that automatically maintains exactly the correct tension of the resistance wire as it is wound.

A light source and microscope, also mounted on the carriage, permit observing the uniformity of winding pitch while the lathe is in operation.

Paper Templates Speed Start of New Wiring Line

CRANING of necks between instruction charts and work when starting up a new assembly line is eliminated at Martin Aircraft by taping a small removeable paper template containing all this information to each resistor board or chassis. Workers place the components directly over indicated locations.

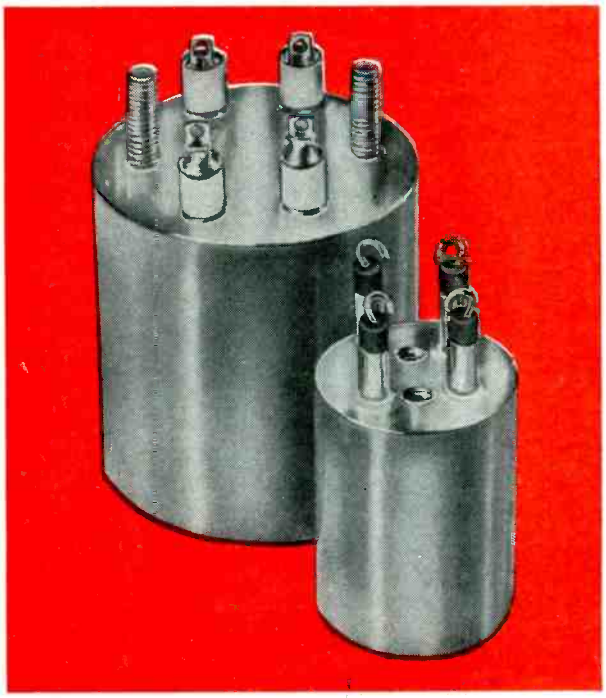
The idea was first introduced on the USAF B-61 Martin Matador production line. Here a total of 1,500 man-hours of work was saved using this new method, according to factory supervisors. The templates are discarded as soon as workers have memorized the new procedure.


Jumper wire hookup template for resistor board of ground-to-ground guided missile

miniature and standard

Pulse Transformers

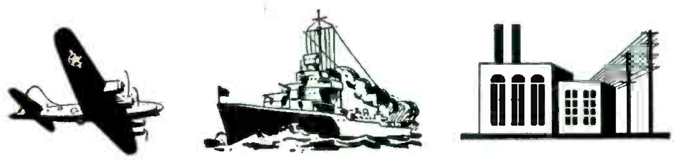
by Keystone



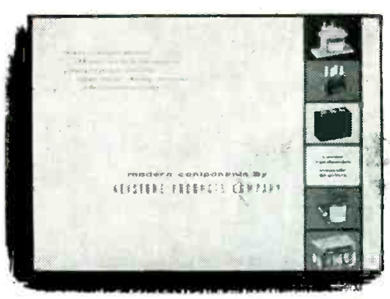
Design engineers and component manufacturers are constantly running into new problems requiring special pulse transformers.

Performance standards are higher for both military and commercial users. Rather than trying to make a standard unit stretch to do the job, more and more major component manufacturers are turning to Keystone custom-engineereed pulse transformers. Keystone produces a wide variety of pulse transformers designed to meet your individual performance requirements with minimum size and weight.

Shown here are two typical Keystone units custom-engineered to meet specific requirements. The smaller one, model PT-175, is a line matching transformer. Pulse repetition rate is 1300 c.p.s., pulse duration is .1 to 1 microseconds, impedance is 75–1000 ohms. The unit is $1\frac{3}{8}$" high, has a diameter of 1", and weighs just 1.6 ounces. The larger unit is also a line matching transformer, model PT-403. It has a pulse repetition rate of 1500 c.p.s., pulse duration of .3 to 3 microseconds, and impedance of 100-2000 ohms. Diameter is $1\frac{3}{4}$", height is $1\frac{7}{8}$" and it weighs just 4 ounces. Both units are hermetically sealed, both meet applicable MIL specifications.



If you are working on a particular problem involving a special pulse transformer—or if you would like to compare the performance of an individually-designed unit to the stock unit you are now using—contact the Engineering Department with an outline of your requirements. No obligation, of course.



write for new illustrated brochure, "Modern Components"

This new brochure describes and illustrates a wide variety of transformers and magnetic amplifiers produced to help you meet unusual and difficult specifications.

Write today for your copy.

keystone

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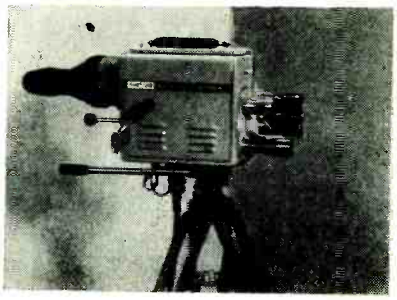
New Products

Edited by WILLIAM P. O'BRIEN

77 New Products and 48 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

VIEWFINDER ASSEMBLY

fits over standard camera



KALBFELL LABORATORIES, INC., 1090 Morena Blvd., San Diego 10, Calif., announces a new 5-in. electronic viewfinder assembly to be used in conjunction with its standard small-sized tv camera to provide flexibility necessary for studio or remote control commercial broadcasts. The assembly may be easily installed or removed. It consists of a lens turret with 4 mounts on the front and a 5-in. crt fed by a 6-mc video amplifier on the rear. The crt is flat-faced and magnetically deflected and provides brightly-focused images of high resolution and excellent contrast. The assembly discussed is self-contained and is driven from the standard cable that feeds the Vidicon camera. It may be ordered together with, or as a separate unit from, the standard camera.

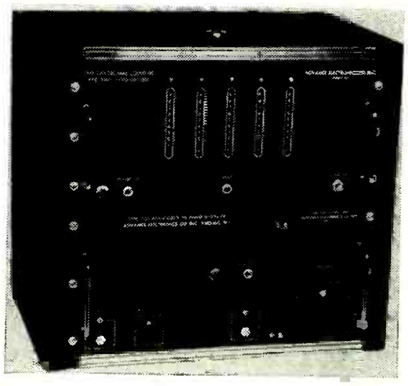
DIODE TESTER

measures d-c characteristics

TRANS ELECTRONICS CO., 7243 Eton Ave., Canoga Park, Calif. Designed to measure the d-c characteristics of diodes in both the forward and reverse directions, the model B production diode tester will meet all the requirements of diode manufacturers for rugged production equipment. Three voltage supplies, E_1, E_2 and E_3, preset from 0 to 25 v, 25 to 75 v, and 75 to 150 v respectively, are available for measuring reverse currents. An electronic microammeter measures the current at E_1, E_2 or E_3 in 4 ranges selected by lever switches. Ranges are 0 to 50, 0 to 5, 0 to 0.5 and 0 to 0.05 μa full scale. Voltages are monitored in 3 ranges—0 to 3, 0 to 30, and 0 to 300 v full scale. All range and scale selection is automatically taken care of in the switching.

PHASE COUNTER

composed of 3 plug-in units

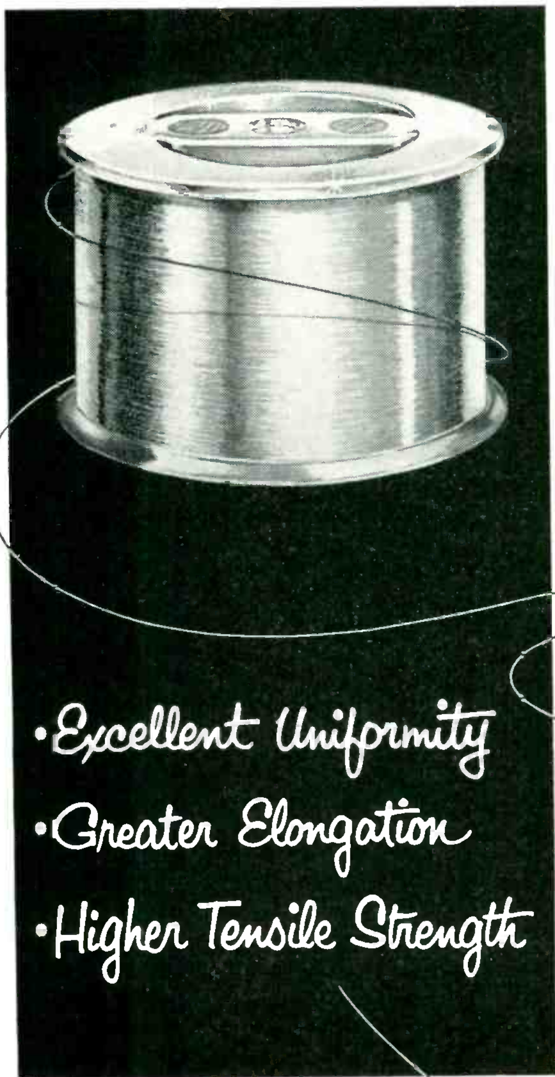


ADVANCE ELECTRONICS CO., INC., 451 Highland Ave., Passaic, N. J. Three plug-in units—a decade counter and switching circuit, a timing unit and a function unit comprise a new phase measuring instrument. The decimal counter and switching circuit has a fast gate with interlocking arrangement and a decade counter consisting of 5 decimal counters connected in tandem. The timing unit consists of a 100-kc crystal oscillator and 5 stages of 10-1 frequency dividers. The function unit consists of 2 circuits. One of them is used to generate a sharp pulse at the instant when the input signal E_1 intersects with the zero axis. This pulse is used to start the counting of the signal from the timing unit. The other circuit is used to generate a sharp pulse at the instant when the input E_2 intersects with the zero axis. This second pulse is used to stop the counting of the signals from the timing unit. As a result, the number displayed by the counter will correspond to the phase angle.

WAVE ANALYZER

operates automatically

THE DAVIES LABORATORIES, INC., 4705 Queensbury Road, Riverdale, Md. Completely automatic reduction of vibration, seismic, power line transient, noise, shock, and



NEW!

Solves your flat or stretch grid problems

SYLVANIA 50/50 TUNGSTEN-MOLYBDENUM WIRE . . .

Developed to meet the exacting requirements of newer tube types that require flat or stretch grids—this new Sylvania grid wire offers a higher degree of uniformity than previously achieved in an alloy of this type.

In addition to excellent uniformity, Sylvania 50/50 tungsten-molybdenum wire has higher elongation than tungsten; greater tensile strength than molybdenum—a combination of properties that mean fewer rejects, lower production costs in your tube manufacturing operations.

Sylvania offers you the only line of grid wires—plain or plated—made every step of the way by a single manufacturer. It is a complete line, meeting the highest requirements of tube manufacturers . . . tungsten, molybdenum, 50/50 tungsten-molybdenum, D-nickel, in a full range of sizes. Plating available includes gold, rhodium, silver or nickel.

Precision manufactured and quality-controlled through drawing and plating, Sylvania wires have the characteristics known to be needed for producing the world's finest radio tubes. Write for complete information.

SYLVANIA ELECTRIC PRODUCTS INC. • 1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., St. Catherine St., Montreal, P. Q.

SYLVANIA

Lighting • Radio • Electronics • Television • Atomic Energy

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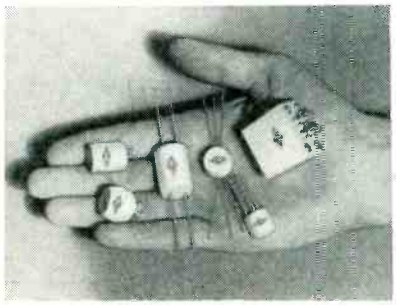
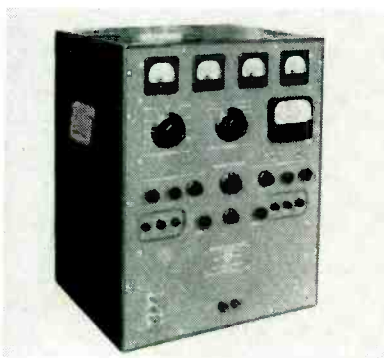
similar data can now be made on a new heterodyne-type automatic wave analyzer. The analysis is a Fourier analysis—amplitude vs frequency. Suited for operation from any source supplying a repetitive signal such as a magnetic tape loop, the wave analyzer covers the frequency range of 2 to 2,000 cps. It features variable bandwidth ½ to 45 cps, analysis down to 3 cps, amplitude accuracy ±5 percent of reading on logarithmic scale, frequency accuracy 0.5 percent of reading, input voltage range 60 db, and input impedance 2½ megohms. The complete automatic wave analyzer consists of 6 basic units which are available individually as well as in an assembly—input switching panel, oscillator-controller, modulator-filter, recorder, power supplies and rack. Complete details are given in bulletin 54-C.

PULSE TRANSFORMERS
available in two types



ACME ELECTRIC CORP., 1375 W. Jefferson Blvd., Los Angeles, Calif., has developed two distinct types of miniature pulse transformers. One group is available in a series of metal case designs, with approved type glass seal terminal header plates. The second group is encapsulated in molded epoxy resin with several types of terminal connections. This pulse transformer line was especially developed for triggering and counting circuits, and for d-c isolation, inversion pulse shaping and pulse transmission circuits. Their development and engineering have taken into consideration severe temperature changes, shock and humidity environmental conditions of use. Bulletin PT-301 lists 6 distinct designs available in 19 sizes with 21 different ratios in each category as stock units.

PHASE METER
uses comparison method



THE W. L. MAXSON CORP., 460 W. 34th St., New York 1, N. Y. An electronic instrument for precise measurement of phase difference between two sinusoidal voltages, model P-1060 precision phase meter provides absolute accuracy of 0.1 deg with incremental accuracy of 0.01 deg operating throughout the frequency range from 30 to 20,000 cps. Any phase angle from 0 to 360 deg may be measured without ambiguity. Insensitive to even harmonics, it can tolerate approximately 1 percent third harmonic content within the rated accuracy of measurement. Applications include use in the design of ssb transmitters, and in the measurement of capacitor power factor, stray capacitance across resistors and residual inductance in noninductive resistors. Shift through amplifiers and other computer characteristics demanding precise phase relationships are accurately measured by this instrument.

FREQUENCY STANDARD
for l-f timing applications

INDUSTRIAL TEST EQUIPMENT CO., 55 E. 11th St., New York 3, N. Y., has introduced frequency standard model 620, which can deliver up to 5 v at a precise frequency of 60 or 120 cps (factory set to within ±0.01 percent). Other frequencies precisely set can also be supplied upon request. Frequency stability is such that temperature variations from −40 C to +85 C or line voltage variations from 105 to 125 v will affect frequency of oscillation by less than ±0.01 percent. Output distortion is less than 1 percent. The output amplifier is transformer coupled which presents the option of either isolated output or grounding one of output terminals. Dimensions are 9 in. high, 15 in. wide, and 8 in. deep. Weight is 17 lb. The instrument should be extremely useful in accurate l-f timing applications.

A-C/D-C RELAY
with built-in rectifier

HI-G INC., Bradley Field, Windsor Locks, Conn. A new a-c/d-c relay contains 4 miniature germanium diodes to rectify a-c excitation signals and provide chatter-free d-c switching action. The diodes are

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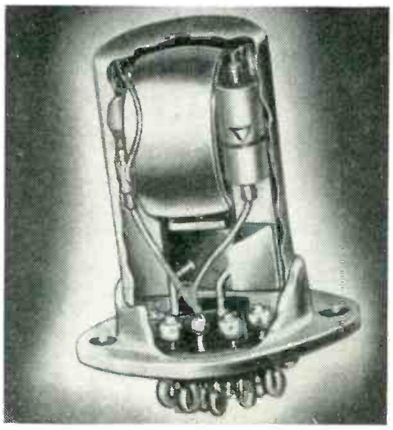
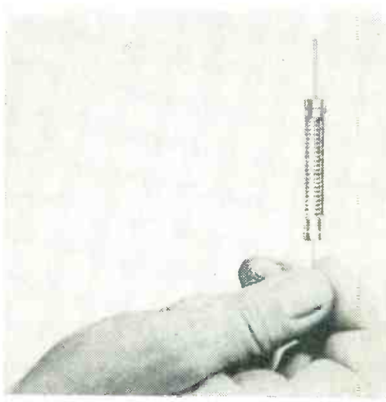


hermetically sealed in the standard relay can, and are mounted to allow heat conduction through the can wall. Networks of these relays can be operated directly off the a-c power line, without the need for large d-c rectifiers. These relays can also operate on d-c excitation of either polarity. The new relay has a balanced rotating armature which can withstand shock accelerations in excess of 100 g. and vibration accelerations in excess of 20 g over the frequency range of 2 to 2,000 cps. A highly efficient magnetic circuit drives 1-pole, 2-pole, 4-pole and 6-pole ganged contact arms firmly against solid-silver ball contacts. Contact bounce and arcing are held to a minimum, and reduced interference noise meets requirements of MIL-E-6181.



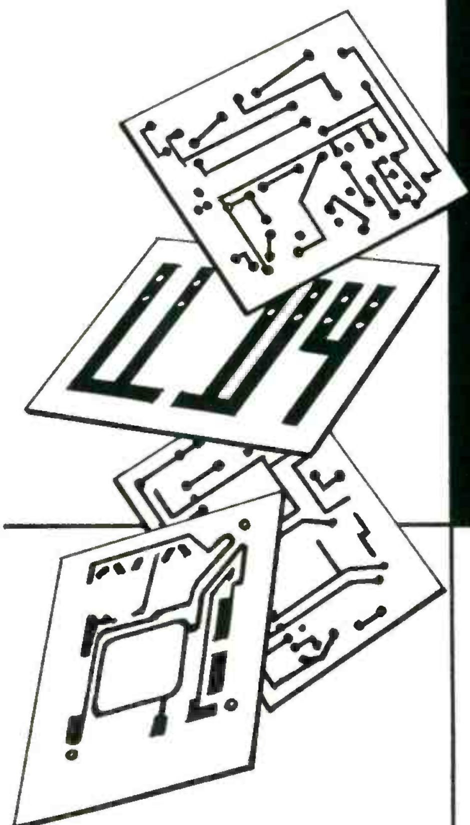
RESISTOR
of the metal film type

THE DAVEN CO., 191 Central Ave., Newark, N. J., announces a new hermetically sealed, metal film type resistor, series 850. It is expected to fill the gap between precision wire-wound types and the low-cost composition types. The pure, noble metal resistive element is deposited

For superior printed or etched circuits use copper-clad

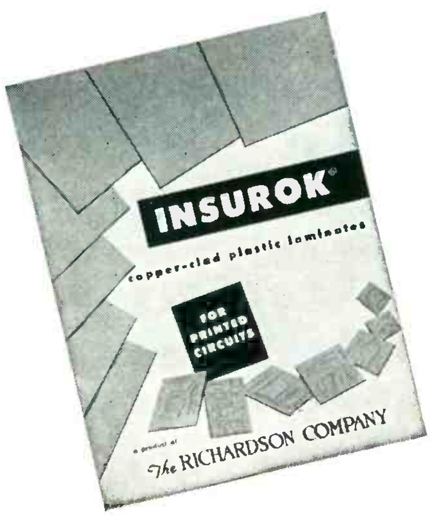
INSUROK T-725 and T-812

plastic laminates



ASK FOR BULLETIN ON COPPER-CLAD

INSUROK®



For printed circuits, the important consideration is the laminate base since other characteristics are often similar. In buying printed circuits, therefore, it pays to insist on the best —INSUROK T-725 or T-812—because of their outstanding electrical properties which remain remarkably stable under repeated temperature and humidity cycling.

Laminated INSUROK Grades T-725 and T-812 have made history ever since they were first introduced to the electronics industry. Possessing a unique combination of properties, they have been used successfully for many years in critical high-frequency applications.

INSUROK T-725 and T-812 have high physical strength and low cold flow, and are readily punched into intricate shapes. Richardson also furnishes copper-clad INSUROK in many other grades, in addition to T-725 and T-812.

Experienced Richardson engineers will gladly assist you in the selection and application of copper-clad INSUROK . . . write or phone your nearest Richardson sales office today.

The RICHARDSON COMPANY

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2797 Lake Street, Melrose Park, Illinois (Chicago District)

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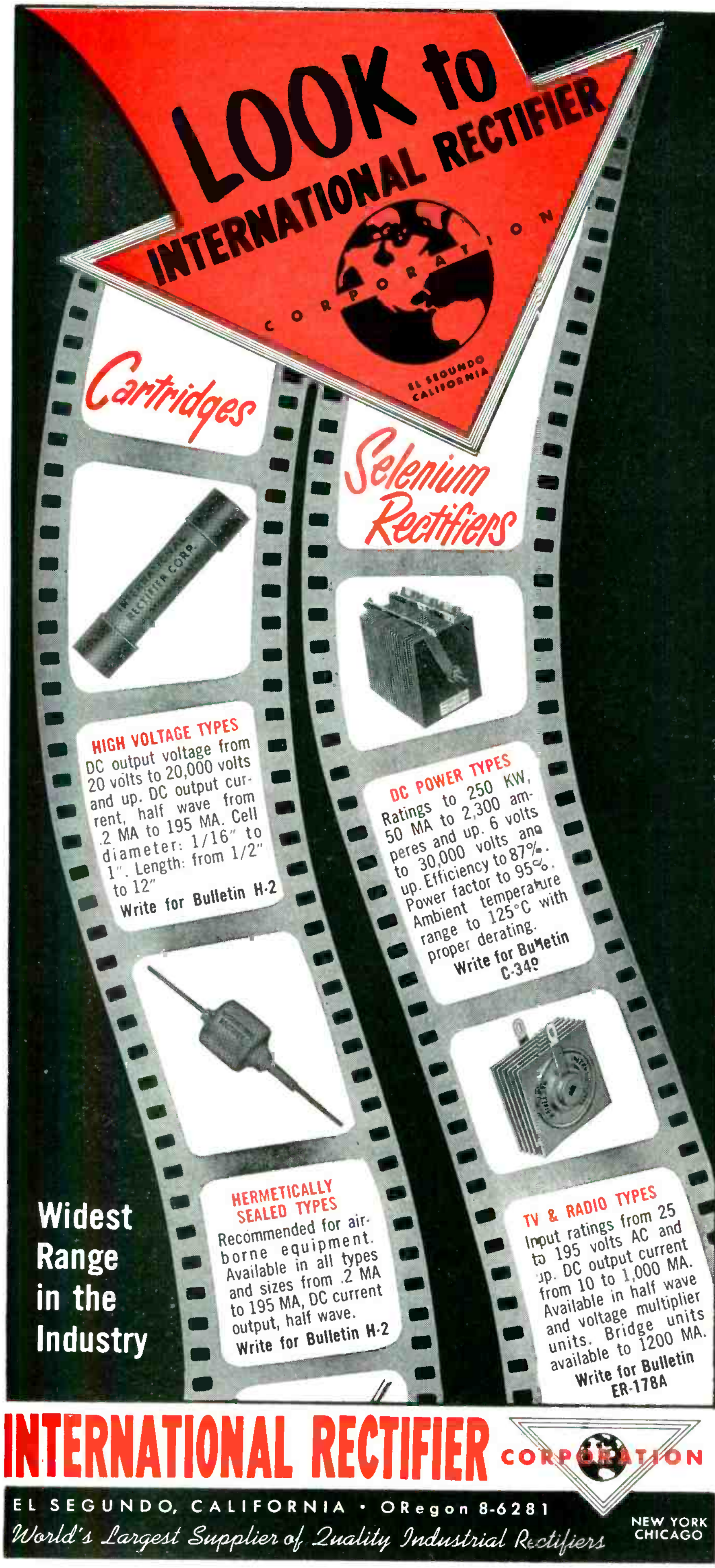
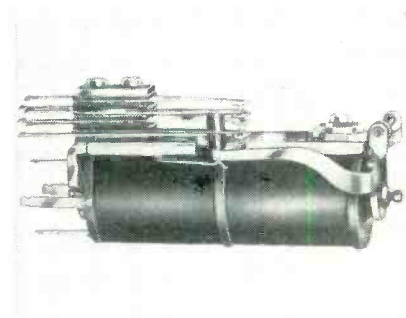
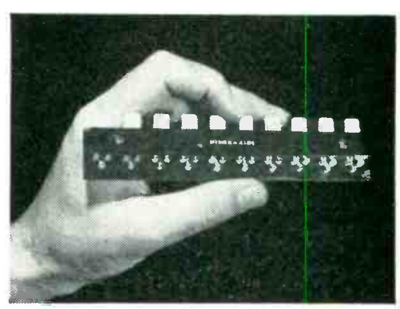


on the inner surface of a glass tube. Electrical connections are silver bands fused to the element and the glass. End caps are bonded to the glass in a glass-to-metal seal, providing complete hermetic sealing for over 60 psi. Extreme stability and a temperature coefficient independent of resistance value, plus a very low reactive component of impedance, make the series 850 a preferred type for military or h-f use. Performance characteristics far exceed the requirements of MIL-R-10509A. The series 850 resistors are available in ½, 1 and 2-w sizes.



TELEPHONE RELAYS
open and close fast

KURMAN ELECTRIC CO., INC., 35–18 37th St., L.I.C., N. Y., has introduced a newly designed line of telephone relays (type A) for applications requiring rapid opening and closing time up to 14 individual circuits. Among the relay's features are its d-c operation; fast operate and fast release; coil resistance up to 63,000 ohms; coils single or double armatures. Maximum coil dissipation is 10 w.



TRANSISTOR SOCKETS
insure space conservation

HYDRO-AIRE, INC., 3000 Winona Ave., Burbank, Calif., have developed a standard strip of transistor

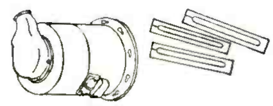
TAYLOR Shop Talk

Laminated Plastics
Vulcanized Fibre

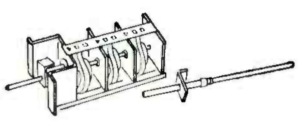
TAYLOR FIBRE CO.

Plants in Norristown, Pa. and La Verne, Calif.

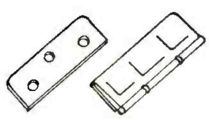
Tips for designers



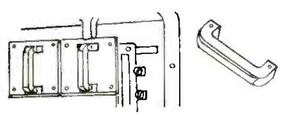
High temperatures in an aircraft generator posed a tough problem for rotor insulation . . . solved by Taylor Silicone Laminate.



Television tuner uses a shaft made of Taylor polyester glass rod . . . a strong material with excellent insulating qualities.



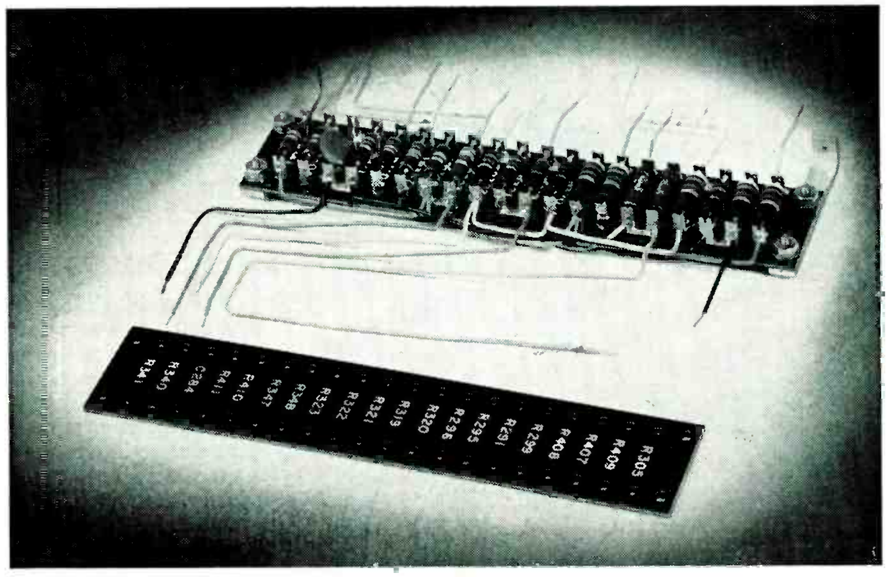
Refrigerator doors are hung with hinge spacers of Taylor Super White Vulcanized Fibre . . . tough, smooth, abrasion-resistant and readily formed.



Handles for heavy-duty fuse boxes are made of Taylor melamine laminate for resistance to arcs, corrosion . . . and for high mechanical strength.

TAYLOR FABRICATING FACILITIES

Your production problems can often be simplified . . . schedules safeguarded . . . inventory headaches cured . . . and overall costs reduced by having Taylor fabricate finished parts of vulcanized fibre and laminates to your specifications. Efficient, modern facilities are ready to serve you. Write to Taylor about your specific requirements.



Terminal boards for Hewlett-Packard high-precision electronic instrument circuit are made of Taylor XXXP-301 laminate... chosen for its excellent, stable insulating qualities.

Unique hot punch laminates— *set new performance standards*

Taylor's new "300" series of paper base laminates were developed specifically to meet the stringent demands of modern electronic products. These hot-punch materials now make it possible for you to get premium physical and electrical properties . . . without premium price.

These new Taylor materials are unique. They're uniform all the way through . . . no surface overlay of resin. Their superior performance will add to the value of your products. And their excellent fabricating qualities will give you substantial savings in production. Equally important, you are always sure of these properties in every shipment, thanks to Taylor's methods of manufacture and strict laboratory control in each phase of processing.

A wide selection of grades of the new laminates have been developed to fill varied requirements of electronics manufacturers:

XXXP-301—the ultimate in electrical properties. Unusually high insulation resistance under all climatic conditions . . . low water absorption . . . excellent punching and staking . . . phenomenal recovery. Premium performance at standard price.

XXP-351—a high-grade laminate second only to XXXP-301, with closely comparable characteristics at a lower price.

Grade 353—a quality laminate with outstanding electrical and physical properties . . . priced for economy.

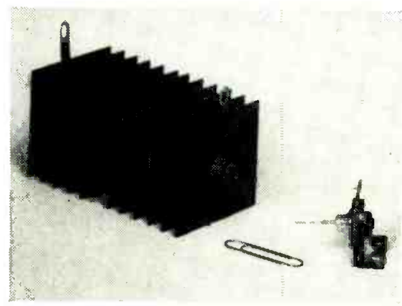
Grade 354—a laminate that's especially easy to fabricate. Good stability, low water absorption, and economical price.

Grade 381—flame retardant with high arc resistance.

Plan to take advantage of these new laminates in the products you are now designing. Write to Taylor for full data, and for a consultation by a Taylor engineer.

Want more information? Use post card on last page.

sockets for use in transistor circuits. This makes it possible to group transistors, particularly in computer circuitry. Dimensions of the first model are 6 in. × 1 in. × $\frac{1}{4}$ in. This model has 10 sockets. Other models are being developed to accommodate 30 or more sockets in a single strip. The strip material is phenolic, the transistor contacts are of phosphor bronze and the solder contacts are copper. Internal connections are handled by a printed circuit.

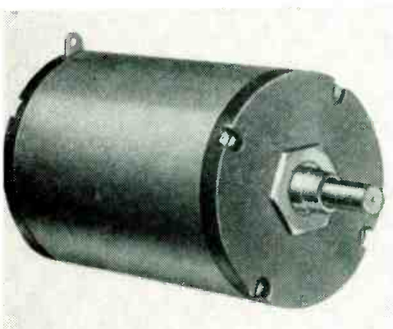


POWER RECTIFIER
in new silicon type

TRANSITRON ELECTRONIC CORP., Melrose, Mass., has developed a new silicon power rectifier that is capable of operating efficiently between the extremes of 150 C above and −60 C below zero, and possesses large power handling ability. These silicon rectifiers can be made extremely compact. Savings in weight and volume will make these units especially adaptable for communications in military aircraft.

COMPARISON BRIDGE
for rapid testing

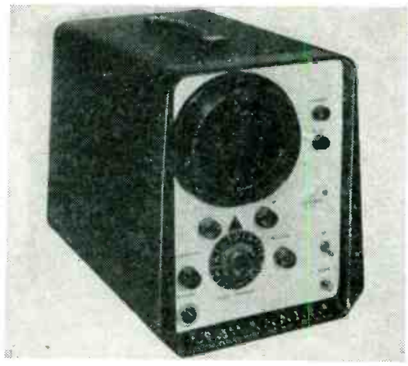
FREED TRANSFORMER CO., INC., 1715 Weirfield St., Brooklyn 27, N. Y. Type 1870 incremental inductance comparison bridge is designed for rapid testing of transformers and chokes under actual operating conditions. Use of 4-in. easy-to-read meters and keeping the number of operating controls to a minimum assures rapid and reliable operation. The instrument consists of a variable 0 to 500-ma d-c supply, a 60-cycle 0 to 135-v a-c supply, a comparison circuit and a vtvm. A jack is incorporated for connecting an external oscillator to supply other test frequencies. Inductances of 25 mh to 25 h can be compared on a deviation range of ±20 percent with an accuracy of ±1 percent and deviation of ±50 percent with an accuracy of ±5 percent. All controls and power supplies are contained in one unit.



DELAY LINE
is continuously variable

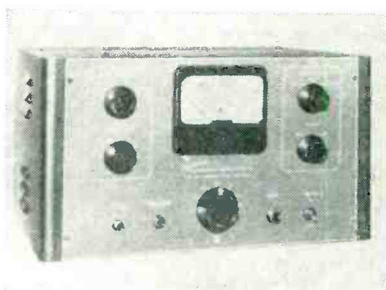
Helipot Corp., 916 Meridian Ave., South Pasadena, Calif., has introduced the Helidel delay line for use in color tv broadcasting, radar scanning, h-f oscilloscopes, short-time memory systems and many other applications. These delay lines are continuously variable units of the distributed-constant electromagnetic type. Delay is adjustable in increments of only 0.02 millimicroseconds and signals are transmitted with minor distortion of waveshape. The Helidel also features sharp rise-time of 0.0175 μsec maximum, extreme bandwidth of 20 mc and negligible overshoot or phase distortion. It resembles a multiturn helical potentiometer—only 2⅛ in. in diameter. Two standard models are available—a 10-turn unit with total delay of 0.2 μsec, and a 15-turn unit with total delay of 0.3 μsec. Both are internally terminated by 2-w resistors in their

characteristic impedance of 1,350 ohms. The 15-turn unit, providing more than 360 deg of phase-shift at 3.58 mc, is particularly useful for color-tv phasing requirements.



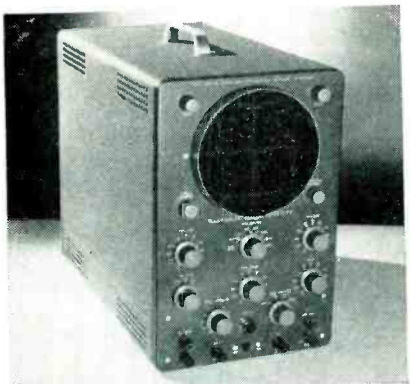
SIGNAL GENERATOR with built-in oscilloscope

CANOGA CORP., 5955 Sepulveda Blvd., Van Nuys, Calif. The latest model wobbulator signal generator—an integral unit combining a swept frequency signal generator with a built-in oscilloscope—has a frequency range from 2 to 1,000 mc, and offers continuous single-knob turning with calibrated dial. Featuring an all-electronic sweep circuit, it is possible to sweep in frequency any bandwidth of 100 mc or smaller. Amplitude variation is less than 0.01 db per mc. The instrument is ideal for use by anyone who manufactures, services or tests any type of receiving equipment such as video, r-f, i-f and distributed amplifiers. When used by tv-set manufacturers in production tests, it shows gain, band-pass characteristics and response to spurious frequencies in one picture.



VSWR AMPLIFIER is a high gain unit

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. Type 277 vswr amplifier is an inexpensive, low noise, high gain audio amplifier. Sensitivity is 0.3 μv for full-scale deflection on the meter. It is ideally suited for use with slotted sections in measuring vswr over the range of 1.0 to over 100. A selector switch permits either high input impedance for such applications as low level crystal operation and null indication in bridges or low input impedance. The meter is calibrated both in vswr and db. A panel switch permits either a 15 or 50-cps bandwidth centered at 1,000 cps or broadband operation from 350 to 2,500 cps.



OSCILLOSCOPE
valuable in color tv work

HEATH CO., Benton Harbor, Mich. Model 0–10 oscilloscope has features that make it valuable in color tv work. Essentially flat vertical channel response is from 5 cps to 5 mc. It is down only 1.5 db at 3.58 mc (color tv sync burst frequency). Model 0–10 employs printed circuit boards for stable circuit operation. It uses full 5-in. crt and employs a sweep generator circuit that will produce stable, linear sweeps up to 500,000 cps.

DUAL-PURPOSE TUBES
feature stable operation

CBS-HYTRON, a division of Columbia Broadcasting System, Inc., Danvers, Mass., has produced dual-purpose reliable tubes that provide stable operation as both voltage regulators and voltage-reference tubes. Types USN-OA2WA and USN-OB2WA are designed for dependability under severe environmental conditions and for a wide

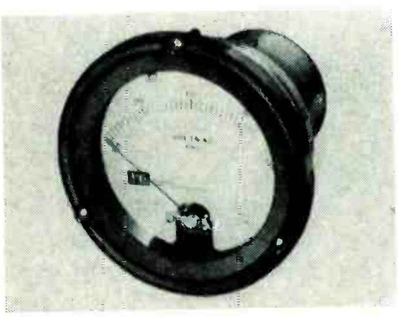
range of applications. Features include: flat, smooth voltage-current characteristic; improved voltage repeatability; and stable electrical characteristics. Bulletin No. E-235 gives complete technical information and test ratings.

MARKER GENERATOR for uhf tv use

KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N. J. The Ultra-Marker is a crystal-positioned uhf tv marker generator. Designed for use with a sweeping oscillator, it develops a highly accurate oscilloscope display marker signal at all uhf sound and picture frequencies covered by an associated sweeping oscillator. The Ultra-Marker, together with a suitable sweeping oscillator and an oscilloscope, form an ideal uhf tv production test and alignment setup. A switching system which eliminates all but every fourth set of channel markers permits the instrument to be used with less accurately calibrated sweep generators. Additional features are: calibrated r-f output attenuator to make marker levels independent of sweeping oscillator output settings, narrow pip type markers fed directly to the oscilloscope—not through the receiver under test, and a sweeping signal input requirement of only 10 mv into its 70-ohm input circuit.

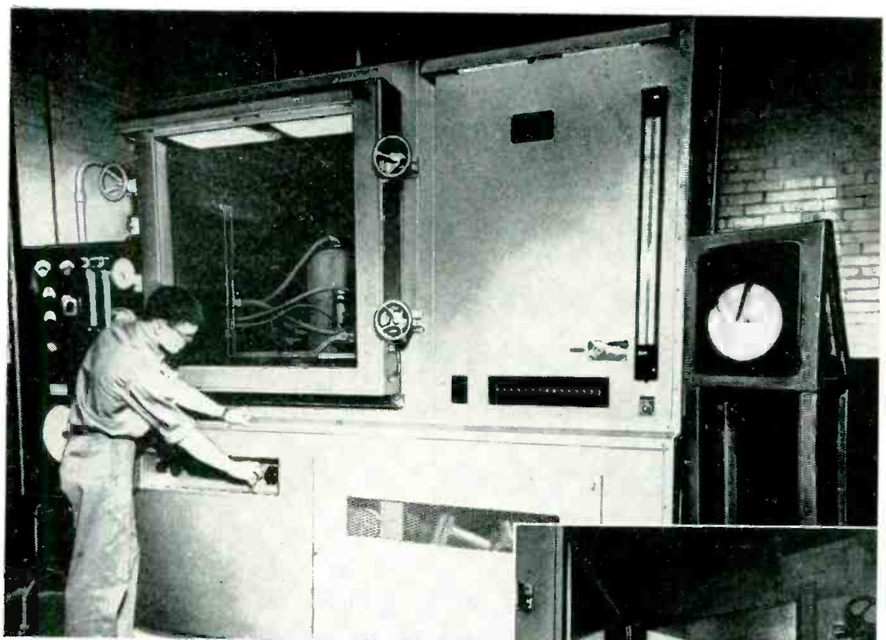
TESTER
for junction transistors

DEVENCO INC., 150 Broadway, New York 38, N. Y. A new tester provides a rapid, positive means of testing the current gain of any *npn* or *pnp* junction transistor. A front panel selector switch allows rapid changeover from *npn* to *pnp* testing. The tester incorporates direct reading calibration by a single knob adjustment, with conversion from beta to alpha values by means of a simple table or curve, both of which are supplied with the unit. A self-contained oscillator provides high signal stability with considerable harmonic output, enabling the tester to detect transistors with a low beta cutoff.



PANEL VOLTMETER
with expanded scale

ARGA DIVISION, Beckman Instruments, Inc., 220 Pasadena Ave., South Pasadena, Calif. With the new expanded scale panel voltmeter a-c voltage readings accurate to 0.5 percent over the frequency range of 50 to 2,000 cps are obtained. Use of a thermal bridge permits the indication of a narrow voltage range. The scale is expanded about a given normal voltage which may be as low



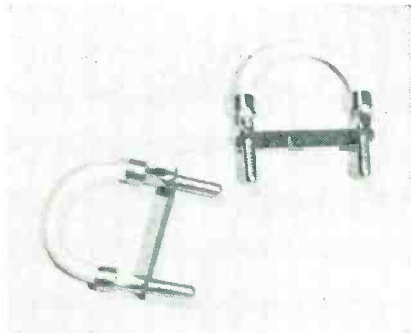
as 6.25 v with a span of ±0.25 v, or as high as 230 v with a span of ±30 v. A complete line of 3½ in. and 4½ in. diameter models is supplemented by square (3½ in.) and rectangular (4 × 6 in.) models. Hermetically sealed and ruggedized models offer extreme durability under exacting conditions.

METER CONTROLLER priced at $165.00

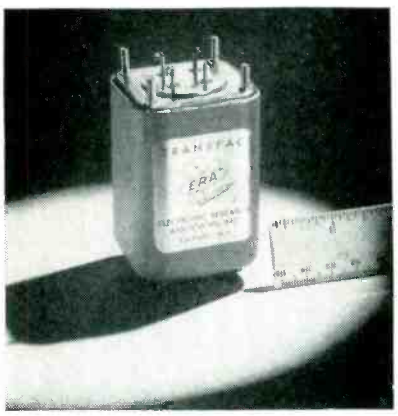
DAYTRONIC CORP., 216 S. Main St., Dayton, Ohio. Almost any electrical indicating or recording instrument can be quickly converted into an automatic controller or monitor using the new meter controller. Such quantities as radiation, pH, pressure, flow, strain, vibration and voltage can be caused to actuate alarms, counters or complete closed-loop control systems upon approaching or deviating from preset limits. The unit features an improved, low impedance, positive locking, contact meter movement which can be placed in series with standard movements of most indicating instruments or Esterline-Angus type recorders with negligible effect on accuracy.

FUSE-TYPE RESISTOR designed as low-cost unit

CLAROSTAT MFG. CO., INC., Dover, N. H., has developed a dual-purpose plug-in fuse-type resistor or Fuz-ohm. It is designed as a low-cost unit, to protect critical and expensive electronic equipment particularly in tv sets. These resistors will repeatedly withstand high-surge currents without damage,



but will fuse when surge becomes dangerous to expensive components. An example of this type resistor is the series 4FYG-001, Part No. CM14282, a 7.5-ohm resistor normally carrying 1 ampere and withstanding surge currents of 1.75 amperes. It is designed to fuse at 2.3 amperes in less than 30 sec.

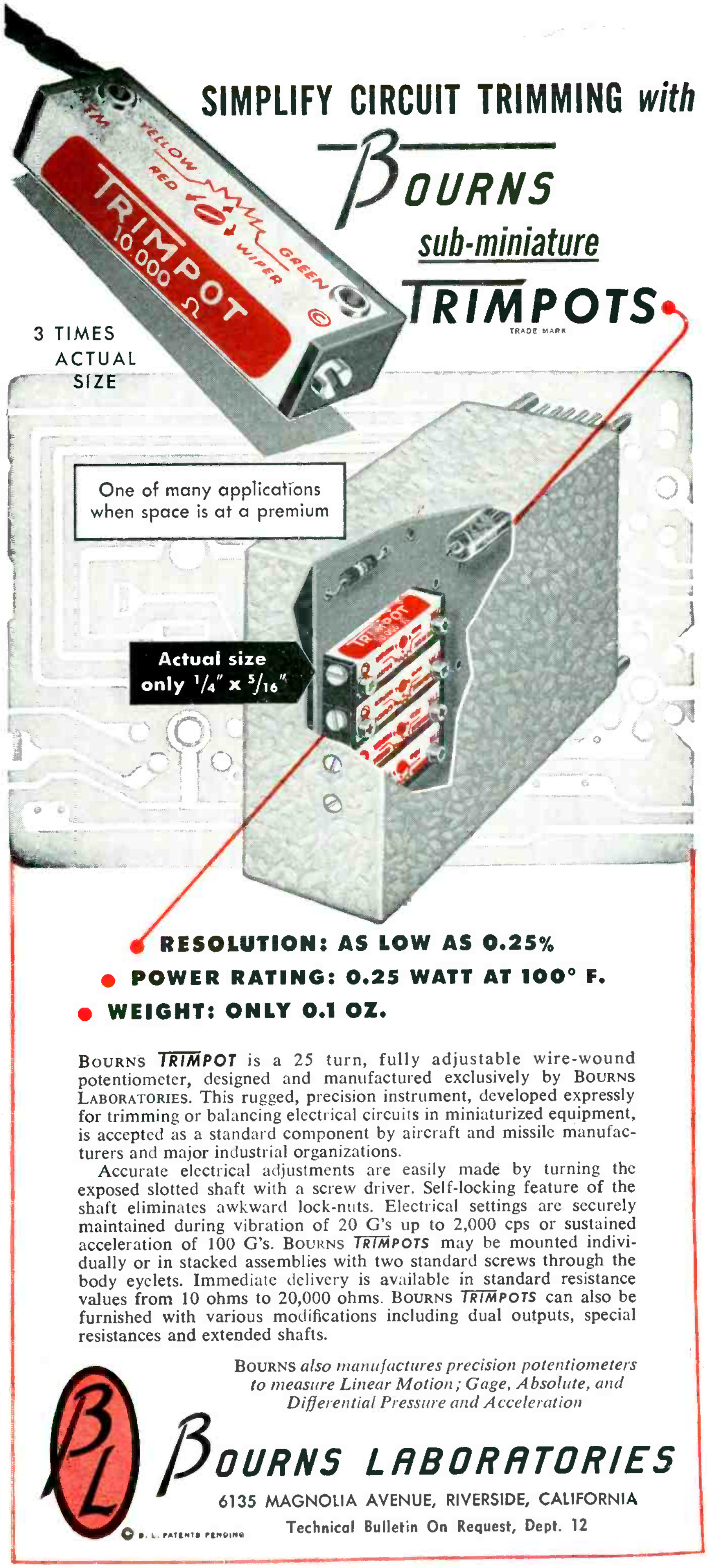


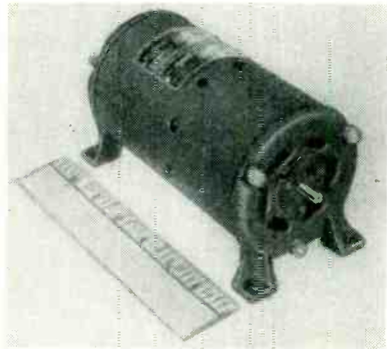
POWER PACKS
in miniature size

ELECTRONIC RESEARCH ASSOCIATES, INC., 715 Main St., North Caldwell, N. J., has announced a new group of Transpac self-contained a-c operated low voltage regulated d-c power packs designated as the models CV5, 10, 15, 20, 25 and 30. Wired into circuits like other components they provide a rugged, reliable source of d-c voltage reference or d-c power for magnetic amplifiers, transistor equipment, vacuum tube biasing and other constant voltage applications. Size is 2¾ × 2⅜ × 2¾ in.

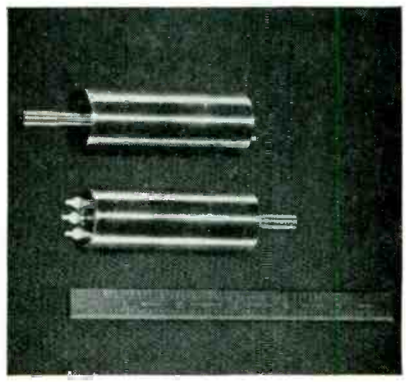
ALTERNATOR
is light and small overall

ELECTRIC MOTORS AND SPECIALTIES, INC., King and Hamsher St., Garrett, Ind. Model HA-2 motor-alter-



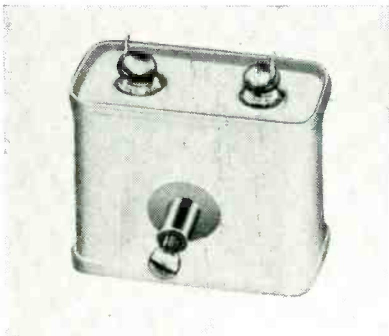


nator features 2-phase, 30-cycle output at 18.5 v. The rotor shaft, extended at both ends of the motor-alternator, permits the unit to perform several functions simultaneously. Power output is equivalent to 2.7 w from the shaft and 1.37 w for electrical power. Input is 115 v, single-phase 60 cycles at 26 to 30 w. The unit features synchronous operation, dynamically balanced rotors on a common stainless steel shaft and two-bearing construction. It conforms to AN-E19 specifications. The HA-2 weighs 6 lb and is of sufficiently small overall dimensions (about 7 in. long and 3½ in. in diameter) for incorporation into production equipment.



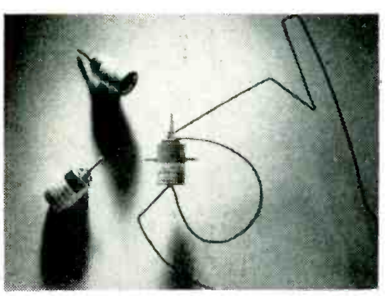
LINEAR TRANSDUCER
is extremely versatile

Crescent Engineering & Research Co., 14828 Arrow Highway, Baldwin Park, Calif. The extensometer linear transducer illustrated is designed for operation at elevated temperatures. It measures linear motion, relative displacement, position and vibration. The unit may be operated at temperatures between −160 F and +1,300 F, and has linear ranges available from 1 in. to 32 in. Resolution of all models is 0.000,000,1 in. It features operating sensitivities to 5 v per in. and linearities to 0.1 percent of linear range. Simple design and heavy construction prevent damage from shock or mistreatment. No force is required for displacement of the sensing probe. Instrument housing measures 1 in. in diameter. Length is determined by the range required, and varies from 3 in. to 65 in.



CAPACITORS
with adjustable values

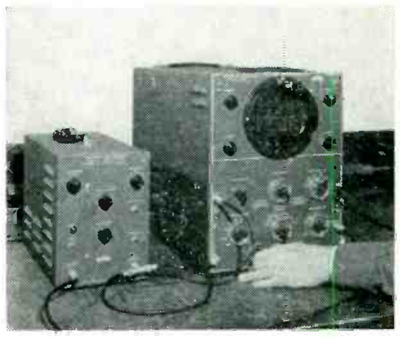
FILM CAPACITORS, INC., 3400 Park Ave., New York 56, N. Y., announces a new series of polystyrene and Teflon dielectric capacitors with adjustable capacitance values. These capacitors may be adjusted to values from 1 percent below to 1 percent above nominal. They employ a self-rigid type of winding which is inherently stable without external pressure. The winding is completely noninductive, thus minimizing power factor and soakage. These capacitors find extensive applications in computers, tuned circuits, and timing circuits, where extreme precision is required. Units are available in all capacitance values from 0.01 μf to 1.0 μf. Rated working voltage is 200 d-c.



VARIABLE INDUCTORS
in 10 standard values

LEVINTHAL ELECTRONIC PRODUCTS, INC., 2760 Fair Oaks Ave., Redwood

City, Calif. Available both shielded and unshielded, the style A type 1 variable inductors are supplied in 10 standard values from 56 μh to 1.8 mh and up to a maximum of 25 mh in special units. They feature an inductance variation range of 2 to 1; Q's of approximately 200; operating temperature range from −50 C to +100 C; and temperature coefficients of inductance less than 50 ppm per deg C. Embedment of the entire powdered carbonyl-iron cup core and coil assembly in epoxy resin gives these variable inductors high resistance against the effects of large-amplitude vibration or shock, as well as providing good protection against moisture and chemical attack. Capable of dissipating 2.5 w with a temperature rise of 20 C, the units have voltage ratings of 400 v maximum, dimensions of $1\frac{1}{8}$ in. long × $\frac{3}{4}$ in. diameter, and weigh approximately 1 oz.

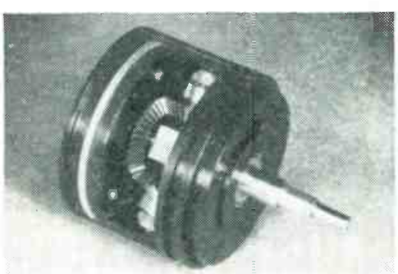


PACKAGE LABORATORY for TV broadcasting use

ALLEN B. DUMONT LABORATORIES, INC., 760 Bloomfield Ave., Clifton, N. J., has announced a video-signal monitor primarily for use in tv broadcasting, made available by packaging the types 325 tv line selector and 327 cro. Type 325 tv line selector is operated by 3 controls which enable the operator to count down to any particular horizontal line, serrated or equalizing pulse of a composite tv signal, at which point it produces a synchronizing signal to trigger the oscillograph and display the signal from the selected point. Type 327 cro is a medium-frequency oscillograph designed primarily to fill the gap in the oscillograph line resulting from the trend in the industry to concentrate on l-f or h-f instruments. The d-c to 5-mc bandwidth of the new oscillograph encompasses the frequencies found in the black-and-white or color tv signal realm. Accurate time and amplitude measuring features are included in the type 327.

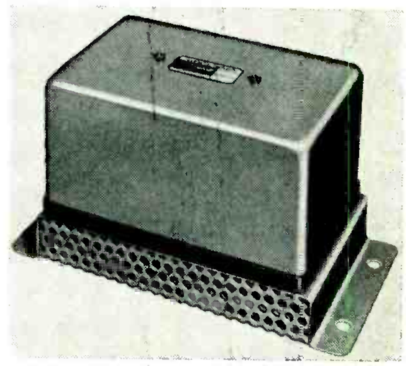
PYROMETER
has many industrial uses

Photoswitch Division, Electronics Corp. of America, 77 Broadway, Cambridge 42, Mass., has developed a photoelectric pyrometer for industrial use which makes possible the precise monitoring and control of the temperature of hot materials. The complete system consists of 2 units: a scanner type 41AU4 consisting of a phototube and lens assembly with a variable iris, and a control type 27LJ7 containing an electronic amplifier, a relay and a meter. The plug-in design of the control chassis provides for simplified replacement and maximum accessibility for examination, adjustment and repair. The company has available a sheet giving tentative specifications and a typical calibration light intensity chart.



DIFFERENTIAL
for precision servo use

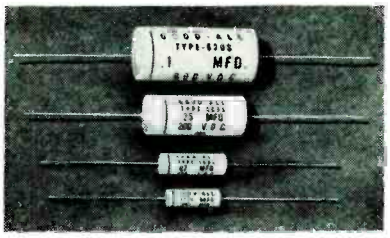
Trans-American Precision Instrument Corp., 34-17 Lawrence St., Flushing 54, N. Y. Model 750 single-ended differential is primarily designed for use in high precision servos. The basic differential unit is constructed to meet all requirements for minimum backlash, low break-away torque and minimum power transmission losses. All three shafts (two inputs and the output) extend concentrically from one end of the housing. The entire mechanism is enclosed in a sealed housing. Mounting dimensions for the unit are identical to those of the Mk 8 Mod 0 servo motor. This type design permits the engineer to mount the differential to be mounted on a single plate, thus providing the advantage of a single row gear train.



MAGNETIC AMPLIFIER with 0.0083-sec time lag

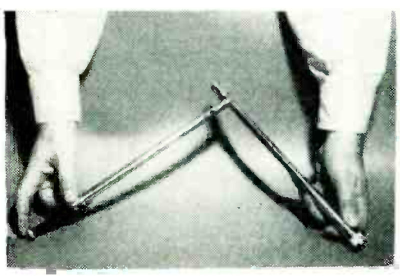
LIBRASCOPE, INC., 808 Western Ave., Glendale, Calif. A new ultra-fast magnetic amplifier has been developed for use in control systems where a high-gain amplifier and fast response are required. Speed of response is independent of the number of stages of amplification. This makes possible the present 3-stage amplifier in which the input and output phase occur during the same half cycle of the power supply. Reduction of the series major loop lag permits the use of more negative feedback in the inner loop, resulting in improved stability. These magnetic amplifiers can be used either as phase reversible a-c amplifiers or as polarity reversible d-c amplifiers for d-c inputs with no changes in the internal wiring of the amplifier. Model 504-1 has a power gain of 50,000; power output, a-c, 15 w, phase reversible with a-c input; d-c, 15 w, polarity reversible with d-c input. Load impedance is

800 ohms; input impedance, 15,000 ohms. Weight is 10 lb. Dimensions are 6 in. × 5 in. × 10½ in.



CAPACITORS
are humidity resistant

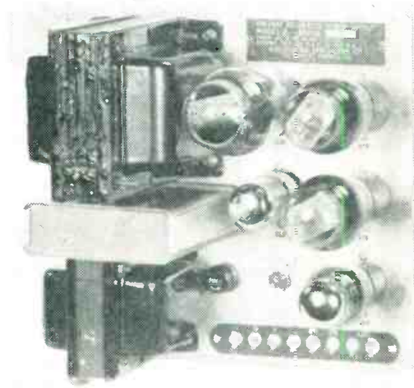
GOOD-ALL ELECTRIC MFG. CO., Ogallala, Nebraska. Seramelite capacitors have high humidity resistance and will operate continuously over a temperature range of −50 C to +100 C. They are available with either paper or mylar dielectric, are encased in ceramic tubes and are sealed with a new thermosetting plastic. The wax free units will not drip at temperatures even higher than 100 C. After 28 days at 60 C and 95 percent relative humidity with 100 percent applied voltage, model 503S still has an insulation resistance of 1,000 megohm-μf with a maximum of 10,000 megohms. Seramelities are available in a capacitance range of 0.001 μf to 2.0 μf with a voltage range of 100 to 1,600 working volts d-c, in sizes as small as 0.215 × 27/32 in.



COAXIAL TUNER
for microwave region use

DUNN ENGINEERING ASSOCIATES, INC., 11 Windsor St., Cambridge, Mass. A new broadband coaxial tuner, for use in the microwave region, makes possible impedance matching over a wide frequency range with a single instrument. Utilizing the line-stretcher and single-stub principle for matching to 50-ohm lines, the model C-50-A tuner reduces vswr's in excess of

30 to 1 to less than 1.2 over the frequency range 750 mc to 10,000 mc. Ruggedly built, the tuner is constructed largely of coin silver, rhodium plated for tarnish resistance. Settings of the instrument are retained by simple finger-tightened locking nuts. The tuner is intended for use with systems employing type N fittings and is furnished with male or female type N connectors in combinations specified by the customer.

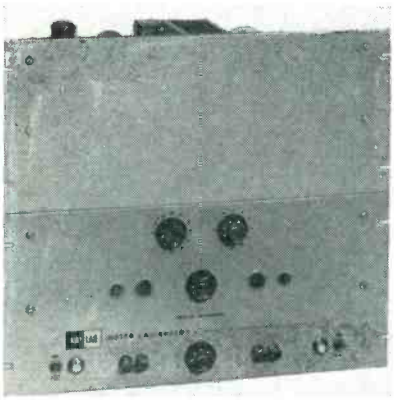


D-C POWER SUPPLIES
are constant voltage type

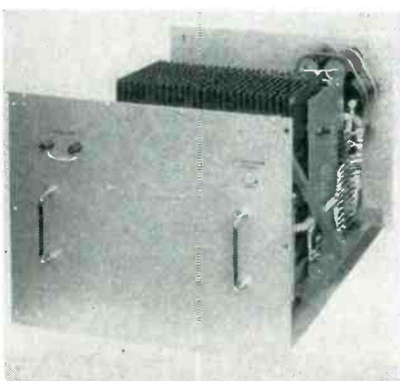
ASSOCIATED SPECIALTIES CO., 1751 Main St., Orefield, Pa. Model 2 is a subchassis mounting type electronically regulated d-c constant voltage power supply. These supplies can be mounted on a chassis along with other components and thereby save space which would be used by a relay rack mounting supply. The d-c output voltage is continuously variable from 200 to 325 v d-c for load currents from 0 to 100 ma. Regulation of d-c voltage is better than 1 percent for loads of 0 to 100 ma and line voltage variations from 105 to 125 v. Ripple output is less than 10 mv rms. Price is $51.00.

METER CALIBRATOR
is 0.01 percent stable

KALBFELL LABORATORIES, INC., 1090 Morena Blvd., San Diego 10, Calif., announces a new combination voltage and current meter calibrator to be used in laboratories and on electronic production lines as a secondary standard, to provide combination voltage and current



calibration. The calibrator employs the company's absolute d-c power supply circuitry and provides variation of the output voltage or current in small steps. Stability is 0.01 percent, with 0.05 percent accuracy. It is especially recommended for computer facilities, telemetering groups, magnetics laboratories and standards laboratories.



POWER SUPPLY
for digital computer use

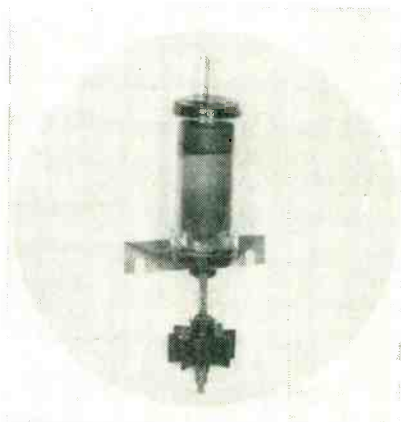
MAG-ELECTRIC PRODUCTS, INC., 12822 Yukon Ave., Hawthorne, Calif., has developed a new type of regulated power supply specifically intended for digital computer application. The units are constructed with rugged long lasting magnetic components and conservatively rated selenium rectifier. Line voltage is 115 or 220/440, single phase, 220/440 three phase. The $E_{d\text{-}c}$ is adjustable to ±5 percent of nominal value. Accuracy is ±0.5 percent from 10-percent load to full load with ±10-percent change in line voltage and ±5-percent change in line frequency. Ripple is 0.5 percent rms of d-c output voltage. Speed of response is 0.17 sec 10 percent load to full load. These power supplies

 For additional information on all items on this page, use post card on last page.

can be provided for assembly in standard relay racks to facilitate computer wiring.

DIGITAL READOUT
provides in-line display

ELECTRO INSTRUMENTS, Box S, Old San Diego Station, San Diego 10, Calif. A new digital display unit provides in-line numerical indication for instrumentation, production, or wherever ambiguous readings cannot be tolerated. Standard displays are available with one to six windows, each window 1⅝ in. wide × 2 in. high with 1 in. numbers. The in-line display is obtained with edge-lighted engraved lucite plates, mounted in an aluminum frame with miniaturized incandescent bulbs located either at the top or bottom. Each numeral is associated with a single, removable light bulb. Units may be purchased with 6, 14 or 28-v lamps. Tapped holes are provided for panel mounting.

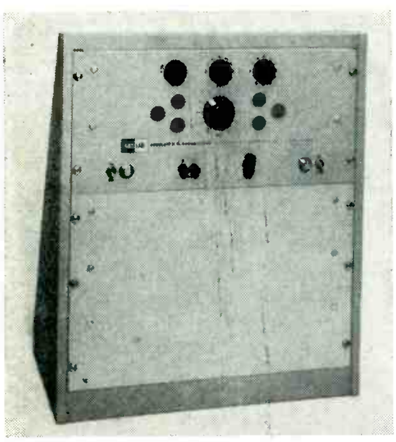


RECTIFIER
is mercury-vapor filled

NATIONAL ELECTRONICS, INC., Geneva, Ill., has announced the NL-633 high-current rectifier, rated at 30 amperes d-c and 225 amperes peak. It is bracket mounted and of rugged construction, making it particularly adaptable to industrial applications. The NL-633 is mercury-vapor filled and has wide temperature limits. Construction is such that the condensed mercury temperature rise is almost independent of load, if proper phasing is observed. Other ratings are: filament volts, 2.5 v; filament current, 50 amperes; maximum peak inverse volts, 900 v.

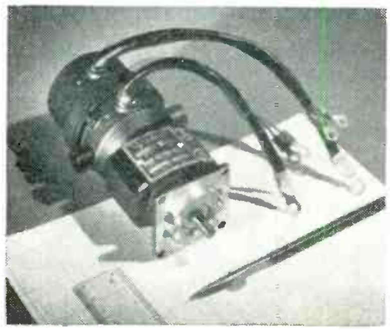
LITTLE TRANSISTOR
is hermetically sealed

CBS-HYTRON, Danvers, Mass., is producing a transistor about the size of the head of a wooden match. This newly developed transistor is hermetically sealed in a cylindrical metal case that is only about $\frac{1}{4}$ in. long and $\frac{1}{8}$ in. in diameter. Three of these tiny transistors, with a total weight of less than a penny, are used in hearing aids. Ask for bulletin E-240.



D-C POWER SUPPLY
for h-v applications

KALBFELL LABORATORIES, INC., 1090 Morena Blvd., San Diego 10, Calif. Model 200D-2 absolute d-c power supply provides a high powered source of voltage with standard cell stability. Output voltage is varied from 100 to 2,000 v in 10-volt calibrated steps. Between steps it is varied with a potentiometer. The unit is provided with an output current of 20 ma. Long time stability is 0.01 percent; and short time stability, better than 50 parts per million per hour. Output voltage is calibrated within 0.02 percent. The model 200D-2 is ideal for photomultiplier, t-w tube, magnetron-klystron, and other applications where high voltage and moderate current are required.



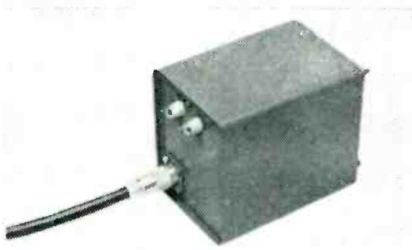
P-M MOTOR
for 28-v d-c operation

DALMOTOR CO., 1329 Clay St., Santa Clara, Calif. Type PM-4 permanent-magnet motor for 28-v d-c operation has an integral brake separately actuated from 28 v d-c, and capable of bringing the armature to a stop from the rated operating speed of 4,500 rpm within one shaft revolution. Designed for continuous-duty applications requiring good speed regulation, the unit supplies a high starting torque of 50 oz in. at 10 amperes. Standard ratings include a total input current, including the 0.25-ampere brake current, of 2.5 amperes with 40-w load. The dynamic brake torque is 100 oz in. minimum. The unit, weighing 2.4 lb., has reversible rotation.

TOROIDAL INDUCTORS
with ± 1 percent tolerance

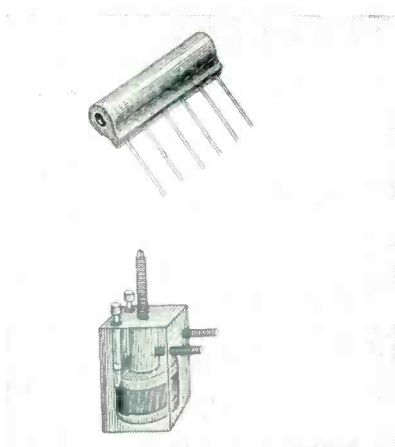
FREED TRANSFORMER CO., INC., 1715 Weirfield St., Brooklyn 27, N. Y., has announced a wide variety of standard and subminiature toroidal inductors. All have a standard tolerance of ±1 percent with frequency ranges up to 200 kc and inductance values up to 50 henrys. They are available in stabilized and nonstabilized types. The subminiature inductors feature 4 types covering frequency ranges from

500 cps to 200 kc with inductance values to 2 henrys. These are supplied cased or uncased.



POWER PACKS
for airborne use

Plastic Capacitors, Inc., 2511 W. Moffat St., Chicago 47, Ill., has announced a new line of power packs for airborne use. Input frequency is 400 cycles and the output range from 1 to 25 kv d-c is covered by 6 models. Temperature range is from −60 C to +85 C, and the unit can be operated in any position. Ripple on all models is less than 5 percent per milliampere. Featured is the new output terminal construction which is small, but provides adequate flashover for operation at 50,000 ft.

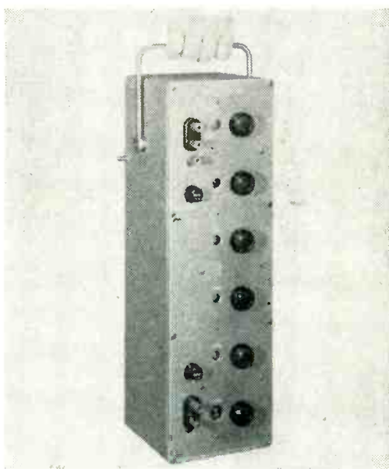


POTTING COMPOUNDS
for electronic components

Electronic Plastics Corp., 130th St. & 90th Ave., Queens 18, N. Y., announces a new material called EM-BED-IT, which was especially formulated to solve the problems encountered in encapsulating delicate electronic components for the armed forces. It is extremely fast setting, taking only minutes; requires far less expensive molds, and effects savings up to 50 percent compared to epoxy resins. Besides supplying the material, the company announces the inauguration of a complete service for embedment of electronic components and assemblies as well as the manufacture of rods from ¼-in. diameter up.

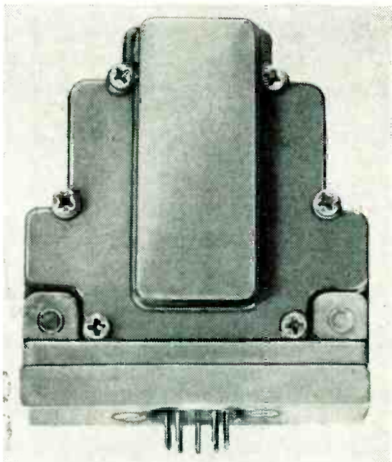
SELENIUM RECTIFIER
for high temperature use

FANSTEEL METALLURGICAL CORP., North Chicago, Ill., has announced a new type of selenium rectifier intended for operation at temperatures substantially above the limits of conventional rectifiers. Both laboratory and service tests show that the rectifier will operate in ambient temperatures up to 100 C (212 F) without derating. It will operate continuously at the same normal full rated loads as at lower temperatures. The new rectifier is available in all standard cell sizes and circuit arrangements.



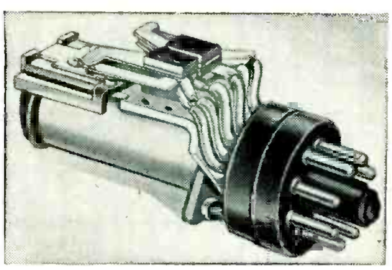
AUTOTRANSFORMER
for voltage ratio selection

GERTSCH PRODUCTS, INC., 11846 Mississippi Ave., Los Angeles 25, Calif. Model PT-5 precision auto transformer permits rapid selection of accurate voltage ratios by means of rotary switches. Five decade switches followed by a single turn potentiometer provide continuous resolution and readout of better than 6 significant figures. Ratio value is indicated as direct decimal reading. Every switch position displays its corresponding digit through a dust-proof transparent window. Frequency range of the PT-5 is 50 to 10,000 cps.



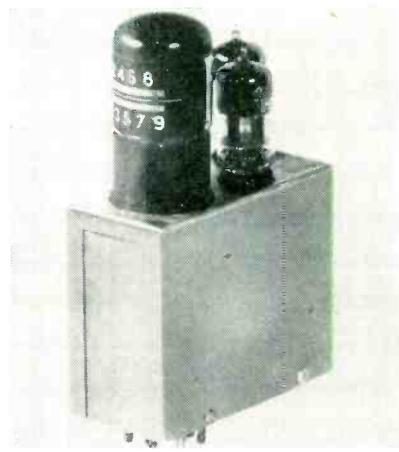
DPDT CHOPPER
with isolated circuits

JAMES VIBRAPOWR CO., 4036 N. Rockwell St., Chicago, Ill. Model C-976, a new dpdt chopper, features a unique coax construction, fully isolated circuits and low residual noise, and is suitable for a 60-cps, 6.3-v operation. The chopper will withstand extremes of shock, temperature, vibration and humidity. Connection is through a 9-pin miniature header. The height of the chopper is 2 13/16 in.; width, 2 3/8 in.; and depth, 1 in.



PLUG-IN RELAY
is conveniently installed

MAGNECRAFT ELECTRIC CO., 1448 W. Van Buren St., Chicago 7, Ill. New convenience for installation, inspection, interchange or replacement is provided by open-type plug-in relays. They can be installed, inspected or replaced without disturbing the wiring. When used in portable equipment, plug-in relays can be removed readily for protection in transit. They can be furnished with standard contact combinations up to 24 arms per relay. Standard contact ratings are 2 amperes at 24 v, d-c or 115 v, a-c. Bifurcated contacts for extremely low voltage and low current or heavier contacts rated up to 5 amperes can be furnished. Operating voltages available range from 6 to 230 v, a-c or d-c. Dimensions, including plug, are 3½ in. long, 1⅛ in. wide. Height varies with number of contact arms required.

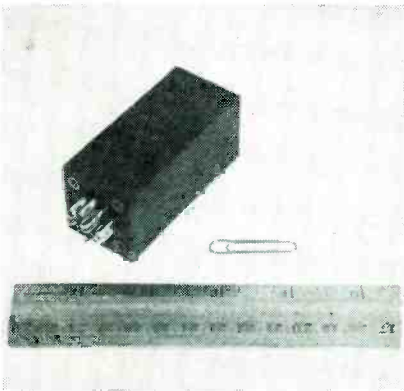


DECADE COUNTER
weighs 11 oz with tubes

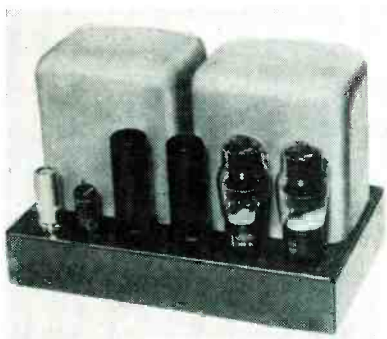
RANSOM RESEARCH, P. O. Box 382, San Pedro, Calif., has developed a miniaturized electronic decade counter using the EIT decade scaler tube and weighing only 11 oz with tubes in place. Available are a 20-kc scaler, a 40-kc scaler, a 100-kc scaler and an output stage scaler operating at 10 cps which can be used to feed a mechanical counter. The decade counters described employ plug-in construction using an Alden 20 pin plug for quick installation and removal as well as to permit their use as building blocks to form any desired combination. All types now available measure only 1¾ in. × 3¼ in. × 3¾ in. exclusive of tubes.

TAPPED DELAY LINES
in 46 combinations

THE JACOBS INSTRUMENT CO., Bethesda 14, Md., has announced a series of the lumped-constant type tapped delay lines. This W series of military types are offered in a wide variety of delay times and

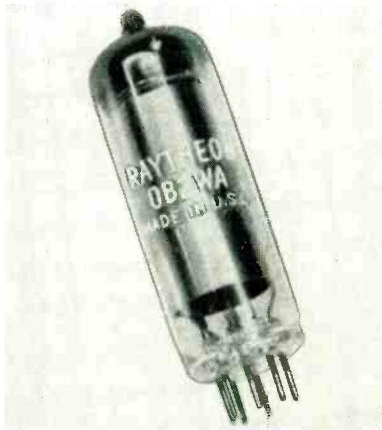


characteristic impedances. All of this series of tapped lines are completely encapsulated in a special stable thermosetting resin which completely surrounds and supports each comment, protecting it against shock and vibration. These lines are usable over a wide temperature range and have excellent thermal stability of delay. They are hermetically sealed. The W series of lines contains tapped inserts for 6-32 mounting bolts. External connections are made by means of strong solder lugs.



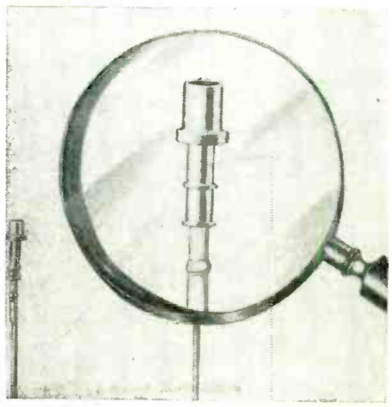
POWER AMPLIFIER
for high-fidelity uses

FAIRCHILD RECORDING EQUIPMENT Co., 154th St. and 7th Ave., Whitestone, N. Y., is manufacturing a new compact 50-w power amplifier for high fidelity applications. Model 260 power amplifier is only 12 in. wide, 7 in. deep and 7¼ in. high. It features low intermodulation distortion and low harmonic distortion as well as excellent signal-to-noise ratio, and is guaranteed not to ring at any level regardless of load power factor. One design feature is the self-contained balance control which permits adjustment for minimum distortion, proper phase inversion and dynamic balance of the output tubes to be made aurally without test equipment of any type.



REGULATOR TUBE
is rugged under shock

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass., has announced the new, improved, 108-v regulator tube type OB2WA to replace type OB2 in critical military and commercial applications. This development features ruggedness under shock and vibration, tightly controlled specifications and 150 C bulb temperature ratings. It is now available to MIL specifications.

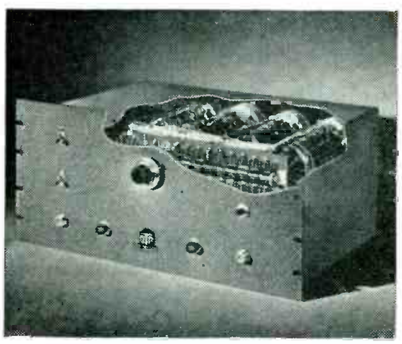


TERMINALS
in new taper pin types

LYNN ELECTRONIC RESEARCH CO., 501 S. Varney St., Burbank, Calif. Four new taper pin terminals have been added to the line of electronic hardware. Included are double-end taper, taper from front, taper from back and taper from front with blind hole. Sizes are available for standard terminal board thicknesses, or special terminals may be ordered to specification. The new taper pins are of half-hard brass bar, with copper flash and electro-tin plate finish. A complete catalog of the company's electronic hardware is available on request.

FLIP-FLOP
packaged as plug-in unit

EECO PRODUCTION CO., 827 S. Vermont Ave., Los Angeles 5, Calif. A new high-speed flip-flop is designed for use in counting and frequency division applications. It has a 0 to 1-mc range for decade operation. Packaged as a plug-in with an 11-pin base, the flip-flop unit has a 1½ in. o-d and a seating height of 3$\frac{21}{32}$ in. A minimum input signal of 80 v is required for input frequencies from 0 to 500 kc. Its output signal has an amplitude of 80 v. The plug-in unit is designed to permit it to be taken apart or assembled without the use of any tools.



SWEEP DIGITIZER
has low torque

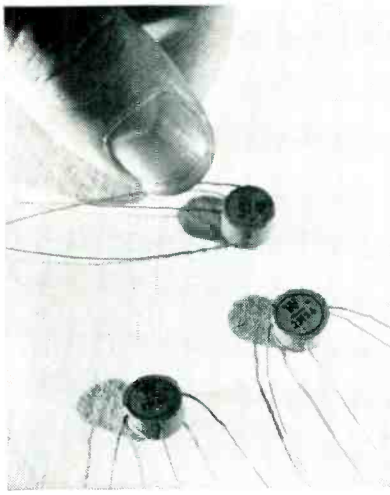
OERLIKON TOOL & ARMS CORP. OF AMERICA, Asheville, N. C. Extremely low torque is the key feature of a digitizer recently developed. Converting either shaft positions or voltages to unambiguous digits, the Quantasweep can be used in a large variety of applications. It will convert to digits any information measured by either shaft rotation or voltage, such as speed, pressure, tension, weight, remote temperature and humidity. Operation is based on detection of null voltage. If the input is a shaft position, a low-torque potentiometer is mounted on the shaft to convert shaft positions into voltages. Output commutators have sufficient capacity for operating items such as card or paper tape punches. Least count of the Quantasweep is 1 part in 10,000 and precision is 0.025 percent of full-scale reading. Torque required to actuate may be as low as 0.007 in. oz.

DELAY LINES
for color television

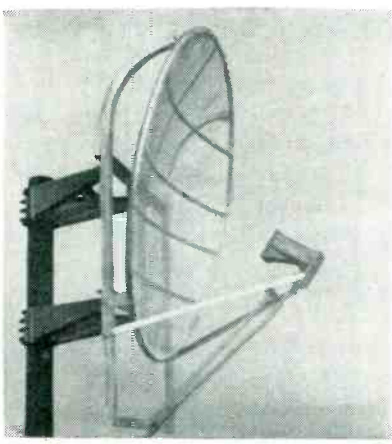
THE GUDEMAN CO. of CALIFORNIA, INC., 9200 Exposition Blvd., Los Angeles 34, Calif., has developed a new series of epoxy resin impregnated miniature delay lines to meet the requirements of color tv manufacturers. Model GTV.6-2.5K provides an 0.6-μsec delay with an impedance of 2,500 ohms. Length is 1¼ in. Model GTV.8-4.1K provides an 0.8-μsec delay with an impedance of 4,100 ohms. Length is 2⅛ in. Both units are ½ in. in diameter and have flexible axial leads. Other delays and impedances are available to meet special requirements.

JUNCTION TRANSISTORS
of the *pnp* type

WESTINGHOUSE ELECTRIC CORP., Box 284, Elmira, N. Y., has available three new germanium *pnp*



junction transistors. The transistors (types 2N54, 2N55, and 2N56) are designed for low-power, low-frequency amplifier applications. Each is capable of dissipating 200 mw at 25 C. All are provided with leads for wired-in installation. The average cutoff at the 6-mw power level is 500 kc. The average current gain of the transistors are: 2N54—0.97; 2N55—0.95; and 2N56—0.92.



FEED ANTENNA
for microwave relay use

PRODELIN INC., 307 Bergen Ave., Kearney, N. J., announces a new antenna for microwave relay communications. The new radiator is called the Off-Set feed antenna and features broadband electrical characteristics. Only two types now make it possible to operate over the entire 1,700 to 2,450 and 2,450 to 2,700-mc bands with a vswr at 1.02 for tv use. Four and six-ft. size antennas are available. Low side lobe radiation permits two antennas to be operated back-to-back with greatly reduced crosstalk interference. Weighing less than 16 lb. the new antenna is adaptable to a variety of supporting structures and transmission line input connectors.

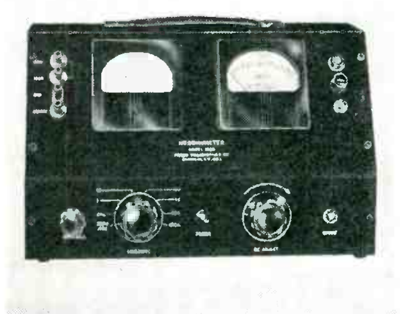
JUNCTION TRANSISTOR
for low-power applications

GENERAL ELECTRIC Co., Syracuse, N. Y. Type 2N76 fused junction transistor was designed to cover a broad specification range, giving designers a stable, relatively inexpensive component. Shelf life and exposure to full rated temperature will not change the characteristics of the transistor. It is hermetically sealed (accomplished by use of glass-to-metal seals and resistance welded seams). The transistor was developed for use in audio and supersonic frequency stages. It has a maximum frequency cutoff at 2.5 mc with the design center at 1.0 mc. Alpha design center is 0.95, while maximum collector voltage is −20 v, and the maximum junction temperature is specified at 60 C. The transistor is capable of dissipating 50 mw in 25 C free air. Illustrated is the 2N76 transistor compared to a 1-w resistor.

SYNCHROS
feature high accuracy

CLIFTON PRECISION PRODUCTS CO., INC., Marple at Broadway, Clifton Heights, Pa., has developed a new series of size 15 synchros. The instruments feature very high accuracies for their size and weight. Maximum diameter is 1.437 in.;

and maximum overall length, 1.640 in. Average weight is 4.7 oz. The synchros are available with leads, or can be specially ordered with radial or axial terminals. The size 15 synchros are available in the following types: signal generators, receivers, regular and high impedance control transformers, high output control transformers, control differentials, regular and high impedance resolvers and sine-cosine generators.

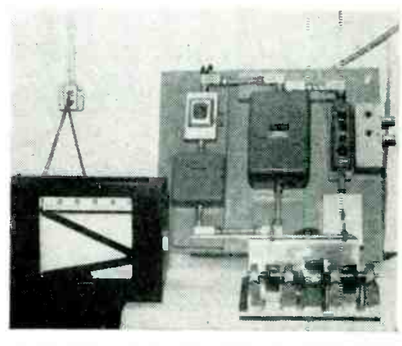


MEGOHMMETER
measures leakage resistance

FREED TRANSFORMER CO., INC., 1715 Weirfield St., Brooklyn 27, N. Y. Type 1620 megohmmeter is invaluable for measuring leakage resistance of transformers, insulating materials, cables, motors, standoff insulators, resistors and capacitors. The 1620 is a direct reading precision balanced electronic ohmmeter with a variable d-c test potential included as part of the unit. The d-c test potential is variable from 50 to 1,000 v. The range of resistance readings is from 0.1 megohm to 4,000,000 megohms in 6 overlapping ranges. Resistance readings and applied test voltage are indicated on separate 4-in. meters. A relay operated from the front panel disconnects the high voltage from the test terminals and eliminates all danger of shock to the operator.

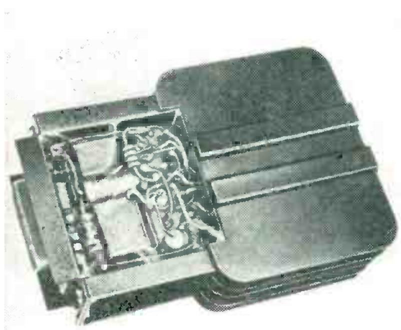
COURSE INDICATOR for VOR installations

AIRCRAFT RADIO CORP., Boonton, N. J., has announced a course indicator for use with type 15D VOR airborne receiving equipment. It combines all functions of a cross-pointer meter and course selector in one unit to save valuable instrument panel space which is particularly necessary in dual VOR installations. It fits a standard 3⅛ in. instrument hole and weighs 3.3 lb.



PROGRAMMING DEVICE operates automatically

SCIENTIFIC SPECIALTIES CORP., Snow and Union Streets, Boston 35, Mass. Basically, the automatic programming device consists of a chart recorder on which a program is drawn in the form of a black line on the recorder chart. The X axis represents the rate of change and the Y axis represents time. In actual operation, a photovoltaic cell observes the black line and discriminates between the black and white portions of the chart. This information is inserted into the recorder amplifier which in turn controls the position of a retransmission slide wire. By using this continuously variable slide wire and an electronic motor drive unit, stepless speed motor control can be achieved.



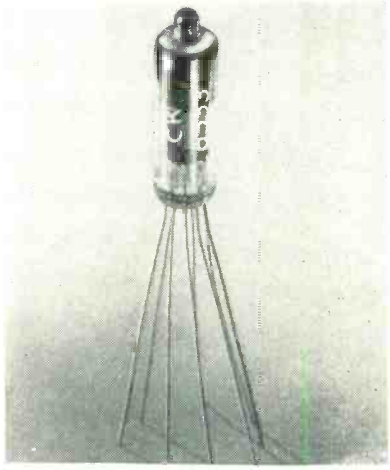
SERVO AMPLIFIER
for 400-cps operation

CLIFTON PRECISION PRODUCTS CO., INC., Marple at Broadway, Clifton Heights, Pa., has developed a new servo amplifier, type VA-4-A-60, designed for 400-cps operation. High sensitivity and power output are featured. Maximum height is 4 in., maximum width $2\frac{5}{8}$ in. and maximum depth is $1\frac{1}{4}$ in. Weight is 6.6 oz. This amplifier is designed to deliver 4 w into the control phase of a servo motor. An input of 20 mv 400 cps drives the amplifier to 4-w output. Gain of the amplifier may be varied externally. The complete amplifier is capsulated in epoxy resin to minimize the effects of moisture, vibration and other adverse environmental conditions. Data sheets giving characteristic data, outline dimensions and mounting information are available on request.

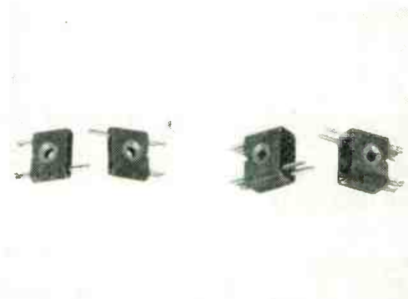
LOW-NOISE TRIODE
with 6.3-v, 200-ma heater

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass. Type CK6533 is an improved low noise subminiature triode with 6.3-v, 200-ma heater, amplification factor of 53 and mutual conductance of 1,750 μmhos. At the standard test condition of 40 cycles, 15-g vibration, noise output across 10,000 ohms in

 For additional information on all items on this page, use post card on last page.

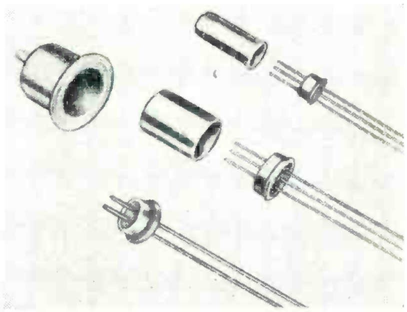


the plate circuit is a maximum of 1 mv with typical tubes usually reading between 100 and 200 μv. At vibration frequencies as high as 10,000 cycles, 15 g, the noise output seldom exceeds 1 mv thus making this type of extreme interest for guided missile and other critical electronic equipment applications.



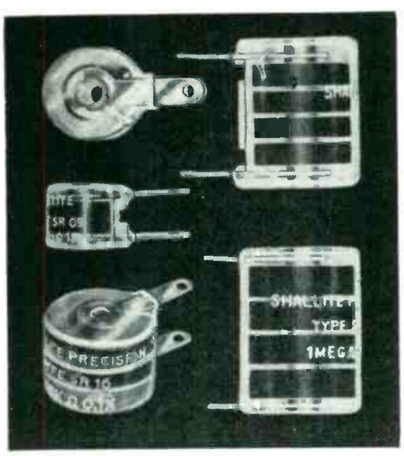
SMALL CONNECTORS
with side mounting hole

WINCHESTER ELECTRONICS, INC., Norwalk, Conn. The countersunk side mounting hole and narrow width of series JF connectors permit exceptionally flat mounting, thus minimizing connector protrusion when installed on equipment. This is proving effective in solving circuit terminal problems in apparatus where space is limited, or where unusual design prohibits conventional connector mounting. Contacts are rated at 5 amperes, use No. 20 Awg wire, and are precision machined and gold plated over silver for low contact resistance, prevention of corrosion and ease of soldering. Mineral filled Melamine bodies provide high dielectric strength and arc resistance. Available with either 2 or 4 contacts, the reversed pin and socket assembly provides positive polarization. Connector dimensions are: 7/16 in. high; 1 1/32 in. maximum overall engaged length; 1/8 in. wide (2 contact type) and 1/4 in. wide (4 contact type). Minimum voltage breakdown at sea level is 2,250 v d-c; at 60,000 ft altitude, 700 v d-c. Weight of the 2 contact connector is 0.03 oz; the 4 contact connector, 0.06 oz.



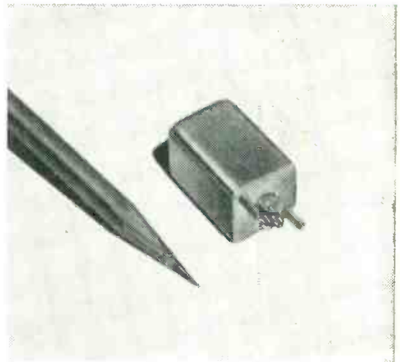
TINY COMPONENTS
in standard types

ELECTRICAL INDUSTRIES, division of Amperex Electronic Corp., 44 Summer Ave., Newark 4, N. J., has introduced new miniature components for transistors and other assemblies requiring hermetic sealing. They are available in standard types with three, two or single wires. All outside leads are approximately 1 1/4 in. in length. Both Kovar and compression types are included in the line, and shapes include squares, rounds and rectangulars.



WIRE-WOUND RESISTOR
with visibility feature

SHALLITE, INC., 10 Mill St., Paterson, N. J., announces a new development of precision wire-wound resistor based on transparent encapsulation. This visibility feature assists materially in precluding service failures due to internal strains. The resistors include other improvements, such as mechanical fastening, electric welding of all wire, leads and the phosphor bronze terminals—all being completely visible through the transparent encapsulation. They are designed to meet the requirements of Government specifications JAN-R-93 and MIL-R-93A.

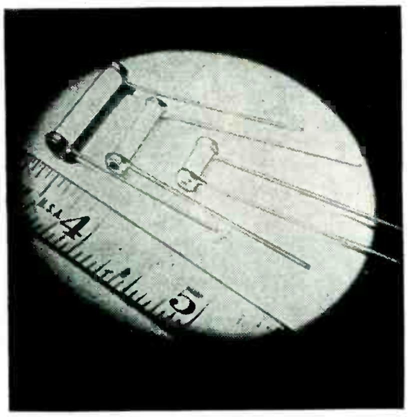


BAND-PASS FILTERS
are subminiature units

COMMUNICATION ACCESSORIES CO., Hickman Mills, Mo., has available a new standard series of subminiature band-pass filters measuring $\frac{23}{32}$ in. × $\frac{23}{32}$ in. × $1\frac{1}{16}$ in. high. These units have a 0.55 cu. in. displacement and exhibit excellent characteristics for telemetering and airborne applications. They are designed to meet MIL specifications with 6-percent bandwidth at 3 db, 40 db per octave. The units are hermetically sealed with compression glass header and drawn metal can. The 2/56 studs afford a positive mounting arrangement. Custom designs are available on request.

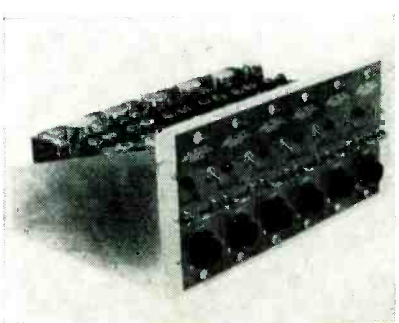
COAX CONNECTORS
are heavy-duty type

TRU-CONNECTOR CORP., 416 Union St., Lynn, Mass., announces a complete family series of newly-designed r-f coaxial connectors developed to maintain performance under the most adverse operating conditions. They combine excellent electrical performance at microwaves with the proven mechanical dependability and quick-disconnect features of high-pressure hydraulic fittings. Units are available in plugs, jacks, panel-jacks, receptacles and right-angle plugs for cables similar in size to RG-10/U.



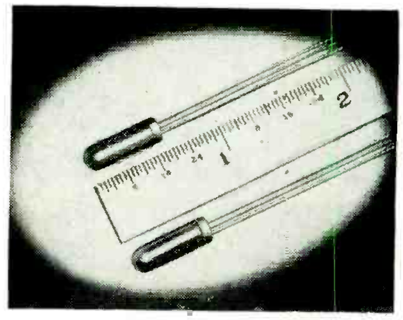
CERAMIC CAPACITORS
meet military requirements

AEROVOX CORP., Hi-Q Division, Olean, N. Y. Type CNP ceramic capacitors can be supplied in close temperature-coefficient limits without individual t-c testing. These units are available in a noninsulated tubular style with radial leads and a clear nonhygroscopic plastic coating. They meet the performance requirements of MIL-C-11015A, JAN-C-20A, and RETMA REC-107-A specifications. Engineering details, including tolerances and typical temperature-coefficient curves, are contained in bulletin NPQ-100.



D-C AMPLIFIER
features high stability

ELECTRO-MECHANICAL RESEARCH, INC., Ridgefield, Conn. Model 62A stabilized d-c amplifier has a passband from d-c to 25 kc, has zero drift restricted to 20 μv equivalent input over any period of operating time, a gain of 1,000 ±1 percent, input impedance 200,000-ohm calibrated step attenuator, output range for load impedances greater than 1,000 ohms is zero to ±5 v, output range for load impedances less than 1,000 ohms is zero to ±5 ma; noise is less than 15 μv equivalent input; linearity is ±0.25 percent. Accessory equipment includes strain gage bridge balance and supply and an output amplifier for driving pen motor recorders and high-frequency string galvanometers.



PNP TRANSISTORS
are low noise-level types

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y., has available 4 new *pnp* junction transistors. Type OC70 has a grounded emitter current gain from 20 to 40, while the OC71 has a gain of 30 to 75. Both have average noise figures of only 10 db and are particularly suited to hearing aids and other portable circuits. They are designed for mass production and are all-glass with true fusion seals. The 080C and 081C are metal-cased transistors having the standard JETEC base and dimensions. The metal casing allows a higher collector voltage and a dissipation of 50 mw at 45 C. Otherwise the electrical characteristics are the same as for the OC70 and OC71 respectively.

INSULATING LACQUER
has high adhesion

INSL-X SALES CO., 26 Rittenhouse Place, Ardmore, Pa. The A-11 air-dry acrylic coating finds wide application in the electrical-electronic fields: as a binder for pie-wound coils; in the manufacture of potentiometers; as a sealant for plastic molded units, oil-filled capacitors, and decals on phenolic surfaces; and as a general purpose high quality adhesive. Supplied in colors as well as clear, it is also used for color coding such units as ceramic capacitors which are subject to high operating temperatures. For most uses the compound is best applied by brushing or dipping. Complete information is provided in bulletin A-11, available on letterhead request to the company.

SOCKET SAVER
for installation on tube testers

POMONA ELECTRONICS CO., INC., 524 W. Fifth, Pomona, Calif., has developed a device designed to be installed on tube testers and other electronic equipment to prevent wear and tear of sockets on original equipment. It comes in a 7-pin miniature, 9-pin miniature and 8-pin octal. The unit is built of quality materials including silver plated contacts and pins to give maximum service.

GEIGER COUNTER
with tropicalized circuit

THE RADIAC CO., INC., 489 Fifth Ave., New York 17, N. Y. Model GC235 Prospectometer features a watertight directional probe containing a highly sensitive thin-walled Geiger tube. The probe, which has a shield for beta-gamma discrimination, is connected to a

5-ft cable to permit the easy investigation of holes, crevices and other likely hotspots. The Prospectometer's tropicalized circuit assures maximum efficiency in every type of weather or climate. Engineering design features a patented printed circuit and a stable electronic power supply operating off inexpensive low-voltage batteries. Radioactivity is signaled in 3 ways at once: loud earphone clicks, meter indication and flashing neon light. The unit comes equipped with its own calibration chart and calibrating standard. Weight is 5½ lb.

Literature

Servo Analyzer. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Ave., Philadelphia 44, Pa. Analysis of servomechanisms and process equipment, using frequency response techniques, is now speeded by the Brown servo analyzer, an automatic transfer-function measuring and plotting system. Bulletin 1170 describes and illustrates the components and operation of the versatile instruments.

Subminiature Receiver. Lehigh Valley Electronics 215 S. Third St., Allentown, Pa., has available a single-sheet bulletin illustrating and describing a subminiature receiver no larger than a pack of cigarettes. The receiver discussed is designed to operate at frequencies between 25 and 60 mc and has an effective range of about 20 miles. It weighs 5½ oz.

Transformers and Lab Test Instruments. Freed Transformer Co., Inc., 1715 Weirfield St., Brooklyn 27, N. Y., announces availability of two new comprehensive catalogs covering a line of transformers (catalog 545) and precision laboratory test instruments (catalog 546). Catalog 545 is a 24-page bulletin, completely indexed, which contains illustrations, dimension tables, technical specifications, and complete descriptive material on the company's transformers, filters, magnetic amplifiers, reactors and torelectronic controls. Of particular interest to engineers is the page devoted to formulas frequently used in transformer and reactor computations.

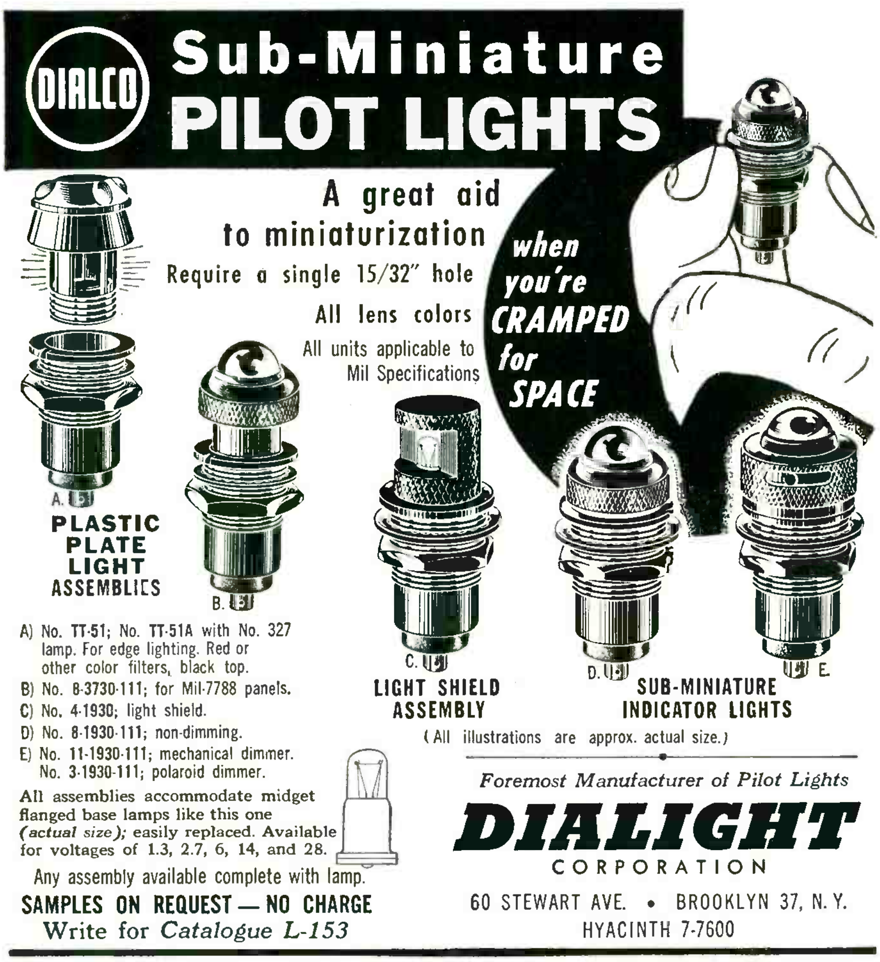
Oscillographs and Amplifiers. Brush Electronics Co., 3405 Perkins Ave. Cleveland 14, Ohio. Information detailing recently developed models of oscillographs and amplifiers is provided in a new brochure. The literature gives basic details of the company's 4 and 6-channel oscillograph in combination with universal and dual-channel d-c amplifiers. It also provides related information concerning universal amplifier model BL-520, and dual-channel direct-coupled amplifier model BL-530. The instruments described have numerous applications in many fields of research and industry.

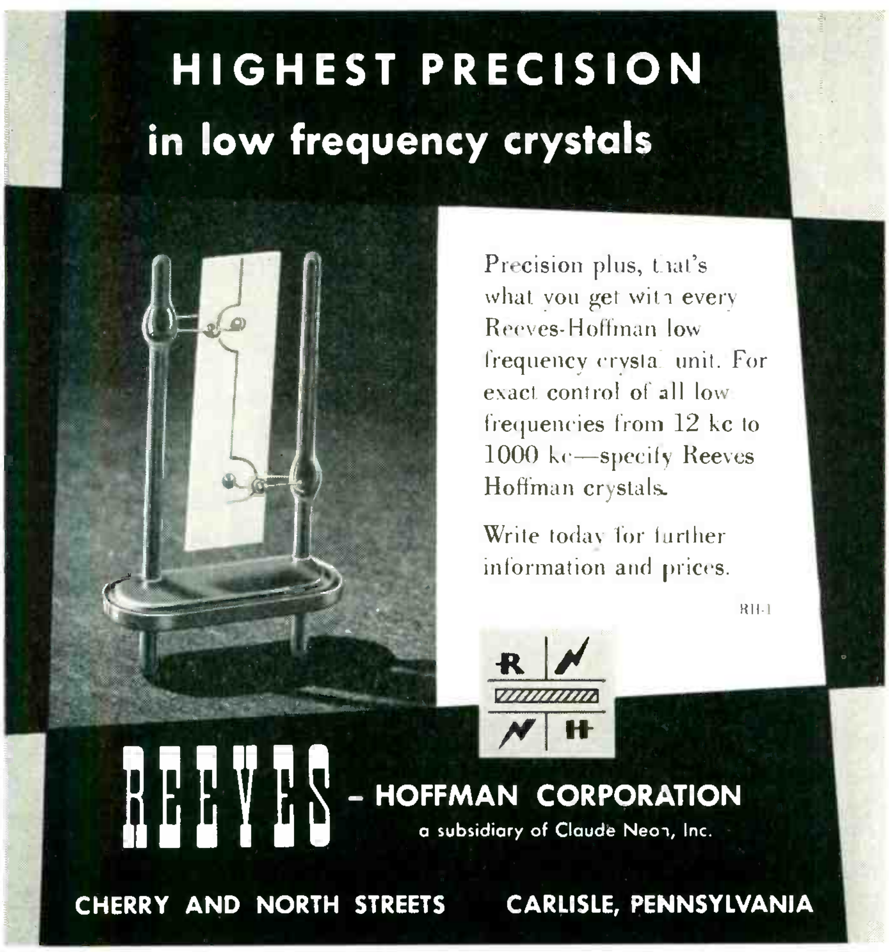
Television Camera System. Kalbfell Laboratories, Inc., 1090 Morena Blvd., San Diego 10, Calif. A 4-page folder illustrates and describes the Kay Lab tv camera system that employs only 3 basic units—the camera, camera control and synchronizer-monitor. Each of the units is discussed and specifications and significant features are listed.

Color Planning Packet. Allen B. DuMont Laboratories, Inc., 1500 Main Ave., Clifton, N. J., has available a color planning packet which is an attempt to simplify the color film packaging so that one can choose for himself the combination which best fits in with his proposed color plans, and see for himself the relative costs of various combinations. In addition there is given complete descriptive literature on each item in the company's color line, including a complete 20-page brochure on the film Multi-Scanner.

Time Delay Relays. The A. W. Haydon Co., 232 N. Elm St., Waterbury, Conn. Bulletin TD500 contains technical data and specifications on a line of special time delay relays. The relays described are motor-driven and provide accurately controlled time delay periods adjustable over a wide range.

Permanent-Magnet Motor. Dalmotor Co., 1329 Clay St., Santa Clara,





oidal inductors. Catalog 546 is a 16-page bulletin describing and illustrating the company's complete line of test instruments including voltmeters, megohmmeters, filters and magnetic voltage regulators. All technical specifications are given.

Instrument Calibration Standard. Radio Frequency Laboratories, Inc., Boonton, N. J. A single-sheet bulletin describes and illustrates the model 454 a-c instrument calibration standard which has been designed to provide a medium for quickly and accurately calibrating a-c voltmeters, ammeters and milliammeters. Information on accuracy, safety features and applications is included. Electrical specifications are given.

Antenna Equipment. Andrew Corp., 363 E. 75th St., Chicago 19, Ill. Bulletin 200 tells how to choose the most economical combination of base, antenna, tower, transmitter and line for required range. This 4-page reprint contains an illustration, complete description and tabular data.

Power Rheostats. TRU-OHM Products, 2800 Milwaukee Ave., Chicago 18, Ill., has available complete illustrated literature on a line of power rheostats. The rheostats described are designed for use in series with other applicances rated 300 v or less, and are 25, 50, 75, 100 and 150 w.

Antenna Design Calculations. Technology Instrument Corp., 531 Main St., Acton, Mass. Laboratory Report No. 14 deals with antenna design calculations for determining field patterns synthesizing antenna arrays and studying pattern behavior by use of the company's complex plane analyzer. It also describes the application of the complex plane analyzer to other engineering design calculations which involve complex numbers.

Special Transformers. Central Transformer Co., 910 W. Jackson Blvd., Chicago 7, Ill. A 4-page brochure provides a description of special designs produced by the company for a wide variety of applications in such fields as communications, nucleonics, ordnance and

Calif. Details on the new type PM-36 p-m motor are given in a new leaflet—Form PM36–954. The publication includes full dimensional details on this 20-w, 6,000-rpm unit which is recommended for applications where high efficiency, good speed regulation, and low r-f interference are required. Specification data are tabulated and performance curves given to cover relationships between torque output and input current, rpm, output watts and percent efficiency.

Power Transistors. Minneapolis-Honeywell Regulator Co., Minneapolis 8, Minn. A 6-page folder contains illustrated information on a power transistor that directly drives a servo motor, operates a speaker, handles numerous electrical switching operations, and has already been applied to the operation of a transistorized aircraft fuel gage. Included are data sheets giving preliminary specifications and characteristic curves for the 2N57 power transistor.

C-R Tubes. General Electric Tube Department, Schenectady 5, N. Y., announces availability of a new 40-page designer's booklet (ETD-985) on crt's for industrial and military applications. The booklet provides data on 24 standard GE tube types, and describes the company's engineering and production facilities available to meet specialized customer requirements. The tube types covered are used in oscilloscopes, radar indicators, industrial tv and tv studio monitors. Technical information in the booklet includes tube essential characteristics, gun design factors, and a description of standard phosphors covering color, persistence and spectral response.

Motor-Alternator. Electric Motors and Specialties, Inc., King and Hamsher Sts., Garrett, Ind. A recent piece of literature illustrates and describes the model HA-2 precision-built 30-cps motor-alternator. Included are applications, features, typical performance and standard dimensions.

Decade Counters. Hewlett-Packard Co., 3204 Page Mill Road, Palo Alto, Calif. A 4-page loose-leaf perforated folder illustrates and discusses the AC-4A decade counters. The etched circuit in the units described makes for reliability and highspeed counting to 120 kc. The counters shown use binary flip-flop circuitry. Specifications are included.

Pulse Generators. Burroughs Corp., 1209 Vine St., Philadelphia 7, Pa. A simple guide to the speedy assembly of a variety of pulse testing systems is provided in a new 6-page brochure. The three generators described collectively cover a frequency range from 15 cycles to 4.5 mc. The manner in which the units are assembled into logical pulse systems, without need for breadboarding special pulse circuits, is covered thoroughly. Making liberal use of block diagrams and pulse timing charts, the folder explains the basic functions of the individual building blocks, shows how they are assembled to form basic test tools such as square wave generators, pulse burst generators, pulse stretchers, pulse distributors, frequency dividers, pulse synchronizers and other practical systems.

Transmitting-Type Pentode. Penta Laboratories, Inc., 312 N. Nopal St., Santa Barbara, Calif. A 4-page catalog describes and illustrates the PL-6549, a 75-w dissipation aligned-grid pentode featuring good performance at low plate voltage, but also capable of good performance at relatively high voltage, for medium-power applications. Included are electrical and mechanical characteristics, information on r-f and a-f operation, and maximum ratings.

Etched Circuits. Hastings Instrument Co., Inc., Warwick, Va. Catalog No. 130 reveals the company's policy of designing, etching, plating and fabricating circuits, as well as assembling components. The single-sheet well-illustrated catalog lists applications and advantages of etched circuits, and gives tips on ordering.

Magnetic Field Measuring Equipment. Donald C. Seibert, Box 281, Wilmington, Del., is distributing descriptive information on the AEG (Allgemeine Elektricitaets-Gesellschaft of Frankfurt, West Germany) magnetic field measuring equipment. Features of the equipment described are direct measurement of magnetic fields with full-scale ranges between 2 and 20,000 oersteds. Applications include measuring distributed magnetic fields, measuring gap strength, measuring the earth's magnetic field and indirect measurement of direct current.

Crystal Diodes. CBS-Hytron, Danvers, Mass. The second edition of the company's reference guide for crystal diodes is now being distributed. It lists 185 types of diodes; gives all basic data concerning them; and includes 18 dimensional diagrams.

Auto Radio Vibrators. American Television & Radio Co., 300 E. 4th St., St. Paul 1, Minn., announces the availability of an auto radio vibrator wall chart which incorporates complete cross reference vibrator equivalent charts, vibrator specifications, base diagrams, and popular auto radio vibrator replacement types.

H-F Generator. Industron Corp., 50 Brook Rd., Needham Heights 94, Mass., has available literature on the company's new h-f generator which eliminates the need for a shielded room where dielectric heating devices are used by staying within the FCC-assigned 27 mc band. One- and two-kw generators, with accurately rated output and single dial selector for a complete range of sealing capacity, are described in the latest bulletin.

Servo Systems and Components. Feedback Controls, Inc., 1332 North Henry St., Alexandria, Va., has available its latest brochure on standard servo systems and components. Included are illustrations, listings of chief features, dimensional drawings and specifications for magnetic servo amplifiers, booster amplifiers, a universal operational amplifier, a d-c instrument servo amplifier and standard electronic servo systems.

Transmitter Equipment Bulletin. Allen B. DuMont Laboratories, Inc., Clifton, N. J. Bulletin TR-779 discusses the type 5411-A Diplexer, which permits simultaneous operation of both aural and visual transmitters into a single antenna. The bulletin includes an illustrated description, a listing of features, and electrical and mechanical specifications.

Time Delay Relays. The R. W. Cramer Co., Inc., Centerbrook, Conn., has released a 12-page production bulletin describing a line of time delays. Bulletin PB-310 covers adjustable time delay relays for panel mounting as well as fixed and adjustable units designed for built-in applications. Cutaway and exploded views provide a clear look at the design and application features. Load circuit operation tables, time ranges, dimension drawings and other pertinent information are also included.

Output Voltage Source. The Calidyne Co., Winchester, Mass. Bulletin 2354 illustrates and describes the model A23 Calivolter, a precision electrical instrument designed for use with an a-c or d-c voltage source. The Calivolter is to be used wherever accurate voltage measurements over a wide frequency range must be made. The bulletin lists advantages and features as well as specifications.

Differential Transformer Amplifier. Daytronic Corp., 216 South Main St., Dayton, Ohio. A single-page bulletin is devoted to the model 400 differential transformer amplifier for the dynamic study of physical phenomena. Chief features, a block diagram and specifications are included.

F-M Tuner. Noroton, Delmenhorst, Fichtenstrasse 21, Germany. Now available is a 6-page folder on the ultra-short-wave built-in 126 42 f-m tuner. An illustration, schematic diagrams and circuit are included. The unit described features 12 circuits: 3 preliminary circuits, an oscillator circuit and 8 i-f circuits. The bulletin lists the following tube types used: PCC84, EC92, EF42, EF41 and 2 diodes. The usw construction discussed fits organically into almost any type of receiver.

Millivoltmeter Pyrometers. The Bristol Co., Waterbury 20, Conn., has published a bulletin (P1244) on a complete line of millivoltmeter pyrometers and accessories. Included are data on the model 580 indicating pyrometers for service up to 4,000 F, indicating controllers with mercury switches or thyratron-operated relays, and portable indicating pyrometers. Also included are two-point and multiple-point pyrometer switches for use when a single indicator is intended to monitor temperature measurements from more than one station. Model 580 described has a 7-in. mirror scale for easy readibility. The indicator has also been incorporated into an electronic Free-Vane controller, which is pictured and described in the 12-page bulletin.

Copper Alloy Precision Strip. Penn Precision Products, Inc., 501 Crescent Ave., Reading, Pa. A new 4-page bulletin presents general information on precision-rolled beryllium copper, phosphor bronze, nickel silver, chromium copper and copper strip. It describes material furnished to extremely close thickness tolerances (±0.0001 and ±0.0002 in.). The bulletin includes discussion of available alloys, sizes and tolerances together with tabular data on engineering properties.

Phone Jacks. Carter Parts Co., 213 W. Institute Place, Chicago, Ill., has released a new catalog sheet covering 21 types of IMP miniature phone jacks. The sheet includes mounting dimensions, circuit diagrams and complete descriptions.

High-Speed Relay. General Electric Co., Schenectady 5, N. Y., has available a new publication containing information on a high-speed relay "with a memory." Listed as GEA-6212, the bulletin describes the function and operation of the hermetically sealed, high-speed, polarized relay for electronic applications. In addition to information on various applications of the relay, the bulletin provides data on ratings, specifications and dimensions.

Precision Phase Meter. Advance Electronics Co., Inc., 451 Highland Ave., Passaic, N. J., has available a single-page bulletin illustrating and describing the type 405 phase meter, a simple and convenient device for studying phase relation-

 For additional information on all items on this page, use post card on last page.

ships between two signals. The unit discussed is particularly suitable for production work. Specifications and chief features are listed.

Electronic Timer. Ferrara Inc., 8106 W. Nine Mile Rd., Oak Park 37, Mich. The T-2 electronic timer is well illustrated and described in a recent 4-page folder. The instrument covered is designed for interval timing, timed delay, repeat cycling, programming and pulsing. Complete technical specifications with diagrams are included.

Impulse Magnetizer. Raytheon Mfg. Co., 100 River St., Waltham 54, Mass., has available technical and catalog data on its model 8100 impulse magnetizer, which has made possible the economical production of permanent magnets of special configuration. Illustrations, specifications and applications are included.

H-V Connectors. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A recent catalog sheet contains an illustrated description of the series 800 high-voltage connectors which were designed for critical applications where breakdowns tend to occur. The connectors described feature 3 h-v, removable center contacts surrounded by 12 fixed contacts. They are designed for AN36 shell. The catalog sheet shows mounting and clearance dimensions, and lists complete electrical and mechanical ratings.

Defense Electronics. Otis Elevator Co., Electronic Division, 35 Ryerson St., Brooklyn 5, N. Y., has published a 3-color 32-page report entitled "Electronics for Defense." It describes the combined experience and resources for research, development design and manufacture of electronic equipment which the company offers to the armed services and industry. Also explained are the organization's field service training programs.

Self-Locking Inserts and Tapped Holes. Banc-Lok Division, Boots Aircraft Nut Corp., Newtown Turnpike, Norwalk, Conn., has available a detailed diagrammatic catalog on its self-locking threads for blind fastening in metal, wood and plastic, especially in material too soft or too thin to tap. Included among the many applications of the inserts described are the assembling of electronic chassis and mounting instruments. Information on how to specify parts is given. The catalog along with actual test samples may be had for the writing.

Tubeless Magnetic Amplifier D-C Supplies. Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn. Three models of tubeless magnetic amplifier d-c supplies are described in a recent data sheet. Input, output, load range, ripple, regulation accuracy, recovery time and size of each instrument are given.

Synchronous Motor. The R. W. Cramer Co., Inc., Centerbrook, Conn., has developed a new high torque synchronous motor which is described in bulletin PB-110. This 8-page illustrated bulletin covers the complete line of the company's motors: the type 112 synchronous motor, type 142 clutch unit motor, and the type 152 dual motor. The bulletin provides complete detail about each type, including cutaway views, dimension diagrams, speed ranges, shaft details and construction schematics.

Transistor Design Sheets. Westinghouse Electronic Tube Division, P. O. Box 285, Elmira, N. Y., has available a 10-page set of design sheets describing transistors and their application. Design data are given for three new Reliatron transistors *pnp* junction types 2N54, 2N55 and 2N56. General semiconductor theory is discussed and equivalent circuits and equations are derived for grounded-base, grounded-emitter and grounded-collector connections. Circuits for a phonograph preamplifier and an audio oscillator are shown to illustrate typical transistor applications.

Cold Casting Compounds. Thiokol Chemical Corp., 780 N. Clinton Ave., Trenton 7, N. J. Several trial formulations and properties of cold casting compounds based on the company's liquid Polymer LP-2 are described briefly in a 4-page bulletin. The compounds discussed may be poured and cured at room temperature to resilient rubbers with negligible shrinkage. They are currently being used for potting electronic components.

Miniature Continuously Variable Delay Lines. Advance Electronics Co., Inc., 451 Highland Ave., Passaic, N. J., has published a single-page bulletin on a line of miniature continuously variable delay lines with less than 5×10^{-10} second resolution time. Included are an illustrated description, schematic diagram and a table of specifications covering 11 different types.

Dynamotor Data. Gothard Mfg. Co., 2110 Clear Lake Ave., Springfield, Ill. A condensed catalog has been published on a line of commercial, military and mobile dynamotors. The new literature, bulletin No. 410, contains much valuable information on d-c to d-c power conversion as provided by the company's various units.

High-Resolution Radar. Sperry Gyroscope Co., Division of the Sperry Corp., Great Neck, New York. A new 6-page folder illustrates and describes the Mark 3 high-resolution radar. The unit described provides superior range resolution, its 0.10-μsec pulse length insuring extremely high definition at short ranges. It makes available a stabilized picture, or a stabilized azimuth ring plus a stabilized plotting surface. Technical data are included.

Audio Recording Services. The Dubbings Co., 41-10 45th St., Long Island City 4, N. Y. A new 12-page bulletin describes the complete range of tape and disk recording services offered by the company's audio laboratory for broadcast stations, sound studios, businesses, record companies, prerecorded tape firms and high-fidelity enthusiasts. The bulletin covers the various types of dubbings in use, and presents price lists for small and large quantities. Included are tape recording, multiple tape duplication, disk recording, disk masters and pressings, off-air monitoring and editing. The company's line of audio test products are also described. These include test records, test tapes and test level indicator.

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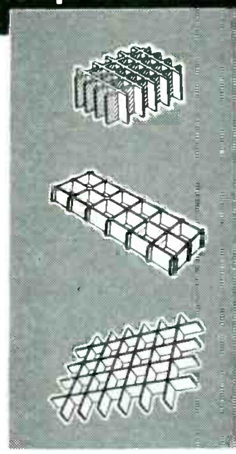

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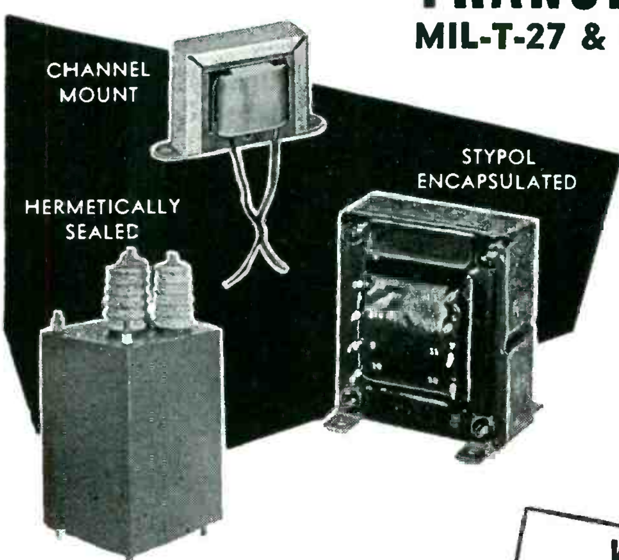

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In reality, *Metex Electronic Weatherstripping* can do more for you than just shield RF leakage. It can cut the cost of machining mating surfaces to close tolerances. It can eliminate the need for extra fasteners and many other costly means of making 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.

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ROSELLE, NEW JERSEY

Plants and People

Edited by WILLIAM G. ARNOLD

Manufacturers acquire more companies and plan further plant expansions. Electronic engineers and management executives are promoted. The industry's technical societies elect officers and announce future plans

Army Heads Visit West Coast Electronic Laboratories

ASSISTANT SECRETARY of the Army Frank Higgins, center, began visits to west coast contract installations with an inspection of the Sylvania Electronic Defense Laboratory in Mountain View, Calif., a research facility for the study of electronic counter measures.

He was joined by Lieut. Gen. W. B. Palmer, left, Deputy Chief of Staff for Logistics and Supply and Brig. Gen. W. Preston Corderman, right, Chief E. & T. Division, Office of the Chief Signal Officer, both of Washington, D. C.

They were guided through the installation by Henry Lehne, standing, director of the Mountain View laboratory.

Motorola Buys Auto Radio Plant, Promotes Engineer

MOTOROLA has purchased 60,000 sq ft of car radio tuner manufacturing facilities from Lee J. Drennan in Arcade, New York. The firm also appointed William Firestone assistant chief engineer of the research department of its Communications and Electronics Division.

The newly acquired plant will devote its entire production to supplying the company with car radio tuners. It will ship finished goods to the Quincy, Illinois plant and the Canadian subsidiary in Toronto.

Because of additional production requirements, anticipated employment is expected to increase from the current 350 employees to 450 people. The payroll in Arcade is expected to be in excess of one million dollars per year.

William Bruyere has been named to continue in his capacity as plant manager. He will report to Walter B. Scott, vice-president in charge of manufacturing for Motorola.

Dr. Firestone in his new research department position will have responsibility for specific phases of departmental administration. He will also continue in his present position as head of the advanced investigation section of the research department. This group is engaged primarily in vhf two-way radio research and pulse code work.

WCEMA Councils Elect Officers for 1955

THE SOUTHERN California and San Francisco Councils of WCEMA elected officers for 1955. Southern California elected Gramer Yarbrough as chairman for 1955. Yarbrough is assistant manager of American Microphone Co. in Pasadena.

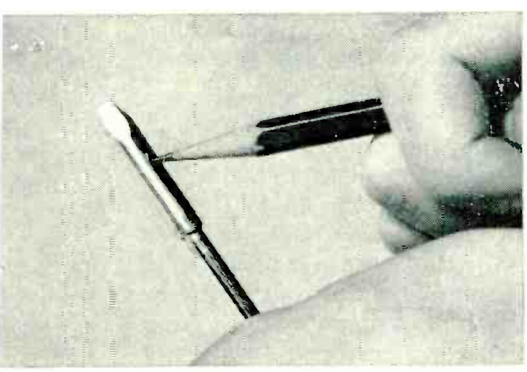
Elected as vice-chairman of the 130 company association of electronic manufacturers is Hugh P. Moore, president of Acme Electronics of Monrovia. D. C. Duncan, vice-president and general manager of the Helipot Corp. in South Pasadena, was named secretary-treasurer of the group.

Directors of the association include Hugh F. Colvin, vice-president and general manager of Consolidated Engineering Corp. of Pasadena; E. P. Gertsch, president of Gertsch Products of Los Angeles; Paul R. Repath, president of Paul R. Repath Co. of Los Angeles and T. P. Walker, vice-president of Triad Transformer

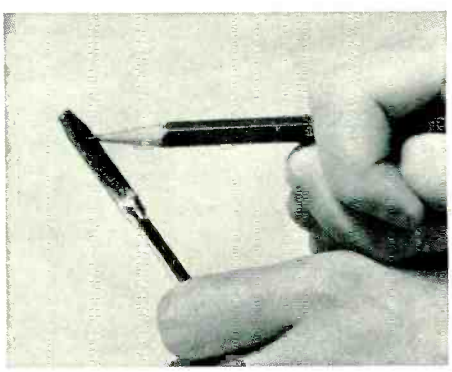
CRAFTSMAN USES JEWELER'S GLASS and the G-E Midget iron to solder a potentiometer joint the naked eye can't see. Equipped with a pencil-fine tip, the Midget can solder delicate connections without damaging adjacent parts. A Calrod* heater cast in the tip provides amazingly rapid heat transfer. Tests prove the Midget iron melts solder in less than a minute.

*Reg. Trademark of the General Electric Company

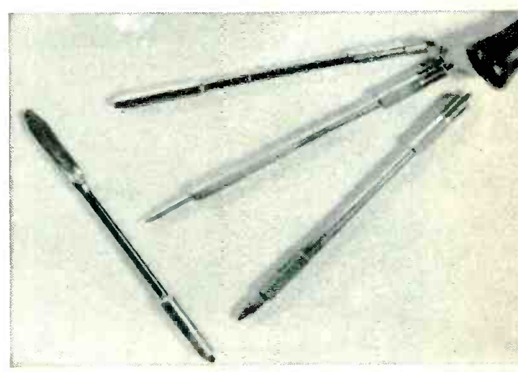
G-E Midget Iron melts solder in less than a minute, quickly solders joints the naked eye can't see



IRONCLAD-COPPER TIP NEEDS no tinning or filing. And by actual test a General Electric Midget iron lasts up to ten times longer than an ordinary iron.



RAPID HEAT TRANSFER is achieved through a Calrod heater cast in copper. The Midget iron can melt solder in less than a minute, recovers heat in seconds.



THREE-IN-ONE IRON with $\frac{1}{8}$", $\frac{1}{4}$", $\frac{3}{16}$" tip sizes. Weighing less than three ounces, the General Electric Midget iron speeds production by reducing operator fatigue.

Write for GED-2243, G-E Midget Soldering Iron, Section 724-1, General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC

Corp. of Los Angeles.

The San Francisco Council of the West Coast Electronic Manufacturers Association elected H. Myrl Stearns as chairman for 1955. Stearns is executive vice-president of Varian Associates of Palo Alto.

Elected to the position of vice-chairman of the 180-company electronics association was Winfield G. Wagener, director of technical services for Eitel-McCullough of San Bruno. Calvin K. Townsend, vice-president and general manager of Jennings Radio of San Jose, was elected secretary-treasurer.

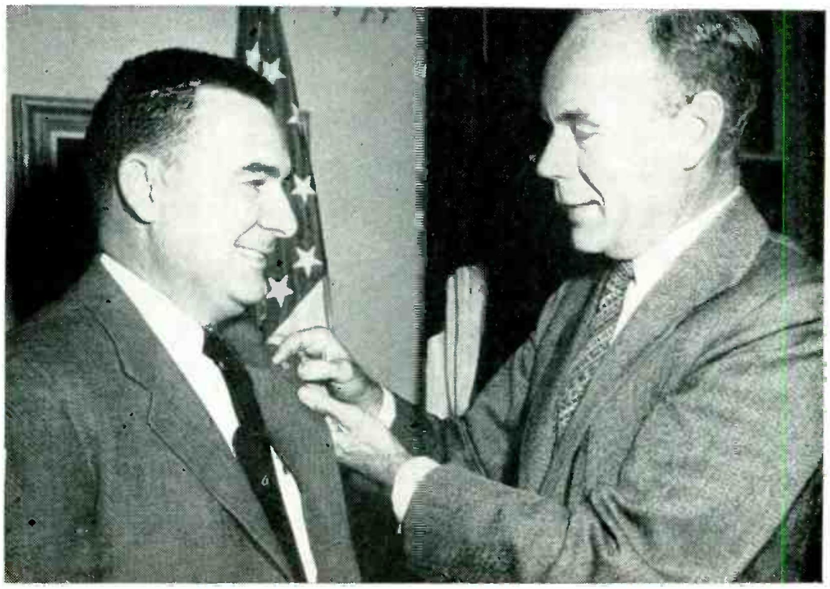
New directors of the association for 1955 are John A. Chartz, vice-president and general manager of Dalmo Victor Co.; J. J. Halloran, vice-president and chief engineer of Electro Engineering Works; George I. Long, executive vice-president and general manager of Ampex Corp. and Douglas C. Strain, president and general manager of Electro-Measurements.

Navy Honors Electronics Engineer

JAMES E. GALL was awarded the Navy's highest civilian award for his "outstanding" work in the development of improved electronic techniques and equipment and accomplishments in the field of signal analysis. He is now an electronics engineer with the Army Signal Corps in Washington.

The award was made by Assistant Secretary of the Navy James H. Smith.

The citation read in part, "The new and revolutionary signal analysis equipment development (made) on the basis of your endeavor has met with continuing success and has culminated in the production of valuable electronic equipment now in use by various components of the Armed Services."



Assistant Secretary of the Navy James H. Smith, right, and James E. Gall

Gall joined the Naval Research Laboratory in 1940, following work as an engineer with several radio manufacturing companies. He transferred to the Navy's Bureau of Aeronautics in 1950, and, in 1953, to the Army Signal Corps.

GE Selects Haller As Labs Head, Plans Germanium Move

GEORGE L. HALLER has been appointed manager of the laboratories department of GE's Electronics Division, according to an announcement by the company.

GE also announced plans to center all engineering and manufacturing of germanium rectifiers and diodes at its Clyde, N. Y. plant.

Dr. Haller was dean of the College of chemistry and physics at Pennsylvania State University prior to his appointment. For the past two years he also has acted as a consultant to the laboratories.

The laboratories employ approximately 500 persons including 300 engineers and scientists. Its prime function is advanced development and investigations in the broad field of electronics, both civilian and military. Its projects cover such fields as transistors and other semiconductor devices, radar, color television, electronic computers, video tape recording and automatic assembly machines.

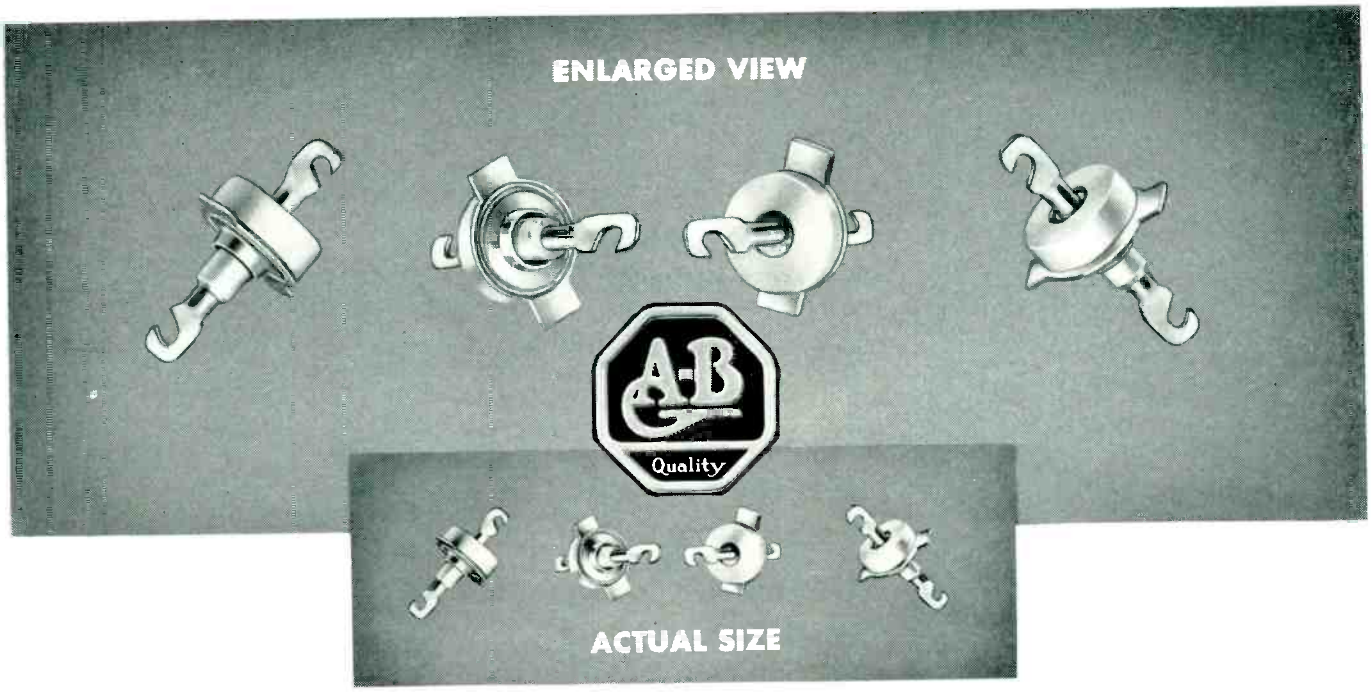
The Advanced Electronics Center at Cornell is engaged in several studies of the application of complex electronics systems and various aspects of automation.

The Microwave Laboratory in California is concentrating on the development and application of microwave electron tubes.

Dr. Haller was a radio engineer for Westinghouse from 1927 to 1929 and audio engineer for E. A. Myers & Sons in Pittsburgh from 1929 to 1933, before returning to Penn State as a graduate assistant.

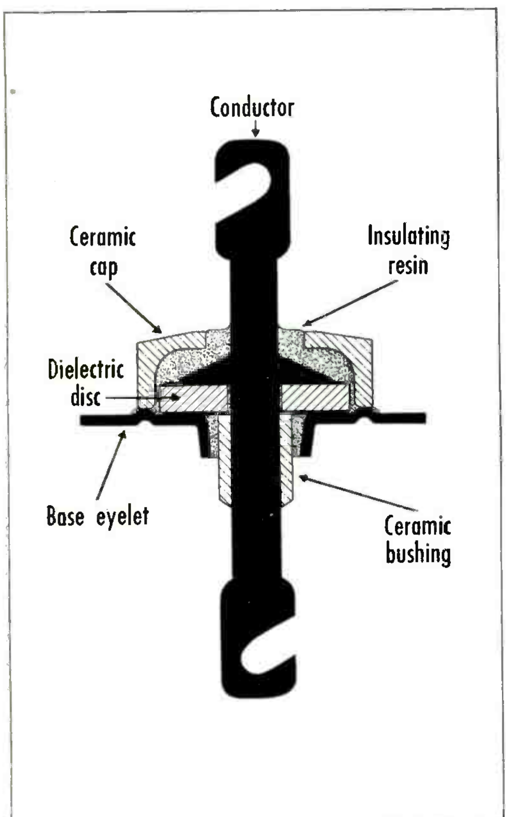
He remained at the university until 1935 when he became a radio engineer for the War Department at Wright Field where he served until 1942. From 1942 until 1946 he served in the Signal Corps and later the Air Corps.

Design and development of GE's



ANNOUNCING — A New Allen-Bradley Electronic Component

The Bulletin 5420 Discoidal Feed-Thru Capacitor



The isolating or filtering performance of a feed-thru capacitor is a function of its common or "coupling impedance." This is the shunt impedance between its free electrode and the metal shield or chassis on which it is mounted. Capacitors which exhibit the smallest "coupling impedance" are superior for those applications where filtering is desired.

In the frequency range between 100 megacycles and 1000 megacycles (VHF and UHF television), tubular type feed-thru capacitors have been found unsatisfactory because of parallel resonance effects resulting in high "coupling impedances." **Allen-Bradley discoidal feed-thru capacitors do not exhibit such resonance effects at frequencies of 1000 megacycles or less.** The absence of these parallel resonance effects and the relatively high capacitance values with resultant low coupling impedances make Allen-Bradley discoidal feed-thru capacitors ideal for ultra high frequency television receiver applications. Measurements have shown improvements in filtering of more than 20 db through their use.

These tiny discoidal capacitors, in addition to their excellent electrical characteristics, possess remarkable mechanical properties. They are unusually strong and have ample safety factor with respect to the mechanical stresses and thermal shocks incidental to installation and soldering.

They are currently available in production quantities in accordance with the following electrical specifications. Capacitance values are between 1000 MMF and 2000 MMF for all usual operating temperatures. Insulation resistance in excess of 10,000 megohms. Rated continuous working voltage 500 V. D. C. Hi-Pot test 1250 V. D. C.

Please write for Bulletin 5420 covering feed-thru and stand-off capacitors.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Limited, Galt, Ont.

ALLEN-BRADLEY

RADIO, ELECTRONIC AND TELEVISION COMPONENTS

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germanium rectifier and diode units at Electronics Park in Syracuse will be transferred to the Clyde plant where they have been and will continue to be manufactured.

Raymond A. York was named manager of germanium diode and rectifier engineering.

York has been manager of product engineering.

He joined GE in 1948. In his new position he assumes additional responsibility for complete engineering of diodes and rectifiers.

Du Mont Sells WDTV, Realigns Executives

TELEVISION STATION WDTV in Pittsburgh was purchased by Westinghouse Broadcasting Co. from Allen B. Du Mont Laboratories. Shown at the signing of the purchase agreement are (left to right, seated): C. J. Witting, president of Westinghouse Broadcasting; A. B. Du Mont, president of Du Mont Labs; (standing) E. V. Huggins of Westinghouse and Ted Bergmann of Du Mont.

The purchase price agreed upon was $9,750,000. The sale, has been approved by the Federal Communications Commission.

WDTV was established by Du Mont and went on the air January 11, 1949. It was the first television station in Pittsburgh and still is the only vhf station there.

A petition seeking formal consent was filed with the FCC. Until the FCC acted on that petition, WDTV continued to operate as a DuMont station.

The election of William H. Kelley as vice-president and general man-

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William H. Kelley

ager of all manufacturing and sales divisions and the appointment of William C. Scales as manager of the receiver sales division was also announced by Du Mont.

Under the new alignment, the company's instrument, cathode-ray tube, communication products, international, government contracts and receiver manufacturing and sales divisions will report to Kelley.

Kelley has served RCA in many important capacities. Later he went to Motorola where he was vice-president in charge of sales. After serving that company for ten years, he joined Du Mont as vice president, marketing.

Scales moves into his new post after serving as sales manager for Du Mont's cathode-ray tube division since 1950. He joined the company in 1948.

CBS Divisions Promote Engineers

ROBERT G. MARCHISIO has been appointed a vice-president of CBS-Hytron.

He will have general authority in all phases of the firm's operation. He will also have line authority in any activity or area in the performance of assignments as directed by CBS-Hytron president C. F. Stromeyer.

Marchisio came to CBS-Hytron in 1951 as assistant to Stromeyer, then a vice-president. He previously had worked at Sylvania, first as assistant chief engineer, then chief engineer for proximity fuses and later as chief engineer of the fixture division at Ipswich. Re-

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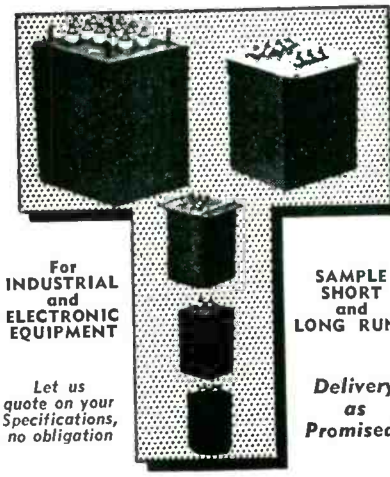

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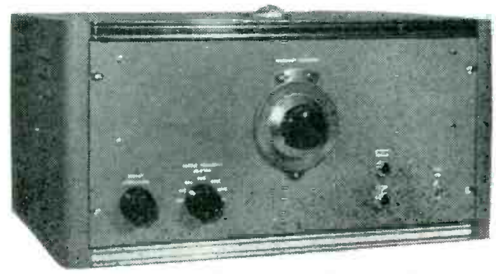

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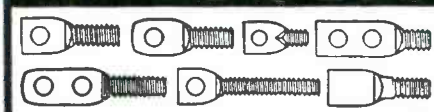

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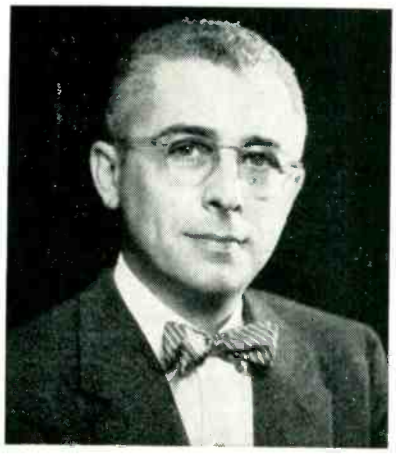

Robert G. Marchisio

cently he supervised the construction of the new $5,000,000 CBS-Hytron television picture tube plant at Kalamazoo, Mich.

In the CBS-Columbia division of CBS Harold M. Zimmermann has been named director of purchasing for the company and L. G. Stone has been named chief cabinet designer.

In the newly established post Zimmermann will report directly to Will James, director of operations, who is responsible for all purchasing and manufacturing.

Zimmermann was, for six years, in charge of all procurement for engineering products at RCA.

Stone will have charge of tv and radio cabinet design and styling.

For eight years he was chief stylist for Magnavox and was in a similar post with Capehart-Farnsworth for more than 5 years.

Willys Personnel Form New TV Firm

FORMER KEY PERSONNEL of Willys Motors electronics division of Toledo, Ohio have formed a new corporation to manufacture and supply a complete tv station package including vidicon camera and transmitter. To be known as The Fleetwood Corp., the new company will have its main manufacturing and development facilities in Toledo, Ohio. John W. McGee, former general manager of the Willys electronics division, is president of the company.

Other officers include A. R. Bitter, former head of educational sales and Homer Humiston, former chief engineer of the electronics

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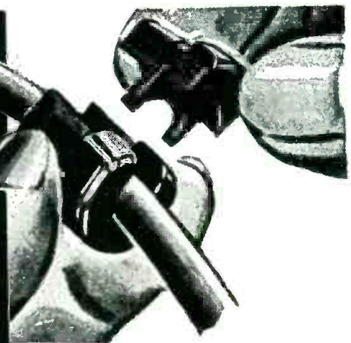

1. *Slip over wire*
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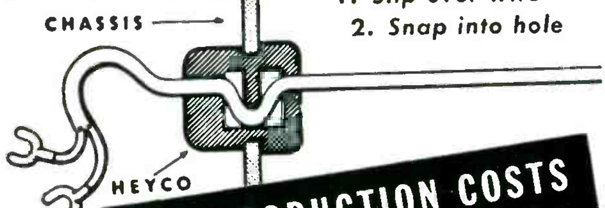

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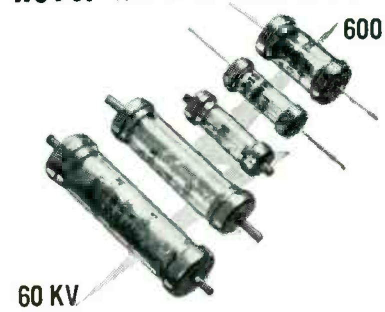

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Voltage Range, D.C.	600V to 60 KV
Capacitance Range	.0001 to 0.1 MF
Power Factor	0.3% @ 1 KC
Dielectric Absorption	0.1%
Voltage Derating at 85° C.	30%
Voltage Derating at 125° C.	66%
Temperature Coefficient	+500 PPM/° C.
I.R. at Room Temperature	10^6 megohms/MF
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John W. McGee

division of Willys. They will assume the same positions with the new firm.

RCA Plans New Lab, Names Two Generals

RCA PLANS TO ESTABLISH an engineering laboratory in the greater Boston area for the development of specialized electronic fire-control systems for military aircraft. The company also named Generals Smith and Richardson to executive posts in the corporation.

Robert C. Seamans, Jr. has been appointed manager of the new laboratory. Location of the new facility is still to be determined but it is expected to be equipped and in operation by early February. By the end of 1955 it will provide employment for approximately 100 scientists, engineers and laboratory personnel.

Dr. Seamans has been associate professor at M.I.T. since 1949 and for the past two years served also as director of the M.I.T. flight control laboratory. From 1941 to 1949 he was first instructor and then assistant professor of aeronautical engineering subjects at M.I.T.

General Walter Bedell Smith was elected a member of the board of directors of RCA. He is vice-chairman of the board of directors of the American Machine & Foundry Company. He served as Under Secretary of State from February, 1953 to October, 1954.

Major General William L. Richardson, U. S. Air Force (Ret.) was appointed to the newly created post

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of manager of defense projects coordination in the Engineering Products Division of RCA.

He assumes responsibility for overall coordination of the division's broad military programs and for policy planning affecting government-business operations.

General Richardson retired from military service in July, 1954. He served as Commander, Air Force Missile Test Center, Patrick Air Force Base, Florida from 1950 until his retirement. From 1946 to 1950 he was assistant for guided missiles to the Deputy Chief of Staff, Operations, U. S. Air Force Headquarters, Washington, D. C.

General Mills Selects Baller

HOWARD BALLER has joined the staff of General Mills' engineering research and development department as manager of electronics research.

Since 1949 he has served as assistant manager of the electronics department for W. L. Maxson Corp. in New York. He was also head of that firm's research section and a member of the graduate faculty of Brooklyn Polytechnic Institute.

He has served two years as a physicist with the Naval Ordnance Test Station in Pasadena and three years as co-chief of development group in the electronics division of Fairchild Engine and Aircraft Corp. before joining the Maxson Corp. in 1949.

At General Mills Dr. Baller holds responsibility for the research program in electronics. He will also assist in planning the company-sponsored items in the field of in-

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Want more information? Use post card on last page.

dustrial instrumentation and controls.

Hallicrafters Elects New President

RAYMOND W. DURST, executive vice-president of Hallicrafters, has been elected president and William J. Halligan, president, has been elected to the newly created post of chairman of the board of the company.

The new Hallicrafters president joined the company in 1936 as executive vice-president. Prior to that, from 1930 to 1936, he was first comptroller and later secretary-treasurer and a director of the Echophone Radio Corp. of Chicago.

Before joining Echophone, from 1928 to 1930, Durst was secretary-treasurer of the Ahlbell Battery Container Corp.

The company also announced that Daniel F. Shea, Jr. has been named engineering laison executive of the government contract division.

For the past year and a half, Shea had been affiliated with the Hazeltine Electronics Corp. of Little Neck, New York as a senior project co-ordinator.

General Radio Promotes Sinclair

DONALD B. SINCLAIR was appointed vice-president for engineering of General Radio Co. Dr. Sinclair joined the firm in 1936 and has served the company as engineer, assistant chief engineer and, For consistently high purity...

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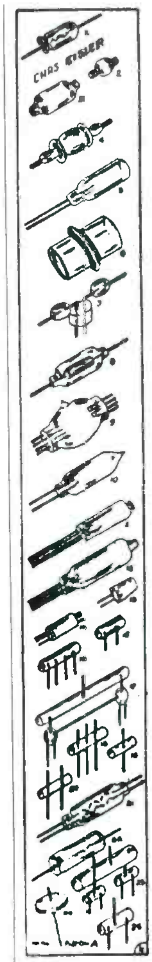

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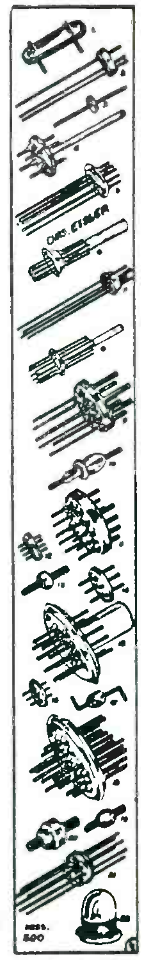

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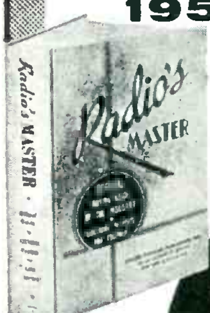

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since 1949, as chief engineer.

During World War II, he was associated with the National Defense Research Committee program, under Dr. Vannevar Bush, working on radar countermeasures and guided missiles. For his work overseas on the former project he received the President's Certificate of Merit.

Honeywell Buys Instrument Firm

MINNEAPOLIS-HONEYWELL has purchased all of the outstanding capital stock of Doelcam Corp. of Boston, Mass., manufacturer of precision instruments and control equipment.

The firm will be operated as a new division of Honeywell. There will be no change in the management, headed by John J. Wilson, president and founder of Doelcam.

The Boston firm employs more than 600 persons.

Bendix Advances Three Executives

E. K. FOSTER, a vice-president and member of the administration committee of Bendix Aviation, has been named a group executive in charge of four divisions—Bendix Radio, Bendix Television and Broadcast Receiver, York and Cincinnati. He joined Bendix in 1936.

Howard Walker, formerly plant manager of the York division in York, Pa., has been promoted to general manager.

Maurice W. Horrell, director of

E. K. Foster

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Maurice W. Horrell

Howard Walker

engineering and assistant general manager of the Bendix Computer division at Los Angeles since 1952, has been promoted to general manager. Palmer Nicholls, a vice-president and group executive, has held the title of general manager of this division.

Bendix Aviation also announced that it has changed the name of the Eclipse-Pioneer Foundries division to Bendix Foundries.

The change was made to emphasize the division's policy of serving the needs of a wide range of industrial customers in the aviation, electronic and marine fields.

Huggins Receives Air Force Award

WILLIAM H. HUGGINS was recently presented the Air Force Decoration for Exceptional Civilian Service by Lt. General Thomas S. Power, Commander of the Air Research and Development Command.

Dr. Huggins, who has been a professor of electrical engineering at Johns Hopkins University in Baltimore since August, 1954, was awarded the decoration for his exceptional performance of duties as chief of the plans branch, directorate of electronics research, at ARDC's Air Force Cambridge Research Center, Cambridge, Mass., from January 1946 to August 1952.

The citation reads, in part, ". . . Mr. Huggins successfully established new approaches in the fields of electronics, hearing and communications. . . . His many scientific achievements have had a profound and far reaching influence on the design of practical equipment for the United States Air Force."

Arvin Establishes Military Division

ARVIN INDUSTRIES has formed an electronics products division to specialize in subcontract work on military and industrial electronic projects.

Leo W. Burns, with the company for more than five years in several different sales and administrative capacities, has been named sales manager for the newly formed division.

Airborne Conference Attracts Engineers

MORE THAN 900 engineers and industrial representatives were at hand to inaugurate the first East Coast Conference on Airborne and Navigational Electronics held in Baltimore. Twenty-eight technical papers were presented by authors from fifteen separate industrial and government organizations. Thirty-one development and manufacturing companies displayed their products at the Sheraton-Belvedere hotel.

The conference, jointly sponsored by the Baltimore Section of the IRE and the IRE Professional Group on Aeronautical and Navigational Electronics, is intended to be an annual affair. Tentative plans for the 1955 conference are being formulated at present.

Technical session moderators included: Harry Davis of R.A.D.C.; C. E. McClellan and N. V. Petrou of Westinghouse Air Arm Division; W. W. Bender and H. Schutz of Glenn L. Martin. A highlight of the technical program was a symposium on air navigation and traffic control. Taking part in this symposium were Col. J. Taylor of ANDB; W. O. Arnold of Bell Laboratories; G. C. Cornstock of Airborne Instrument Laboratories; S. Barkowitz of Franklin Institute and Cmdr. W. W. Bush and J. Anast of ANDB.

ElectroData Promotes Carpenter

RICHARD E. CARPENTER has been promoted to chief production engineer of ElectroData Corp.

He has served as staff assistant to L. P. Robinson, ElectroData vice-president, since January, 1954 and will continue to report to Robinson in his new post. As production engineering chief, he will be responsible for translating computer and computer component development projects into manufacturing requirements.

Joining Consolidated Engineering Corporation as a production engineer in 1946, Carpenter was made staff assistant to the director of engineering in 1947, a post he held until recalled to active naval service during the Korean emergency.

Returning to Consolidated in 1953, he was made staff assistant

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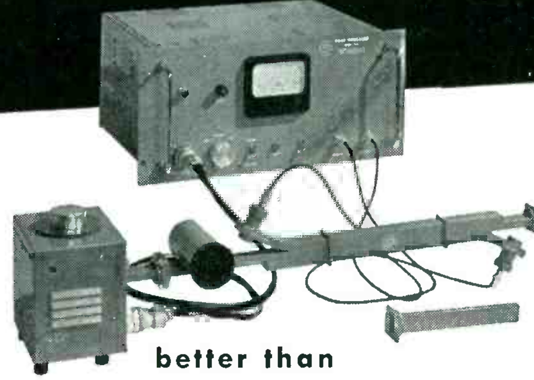

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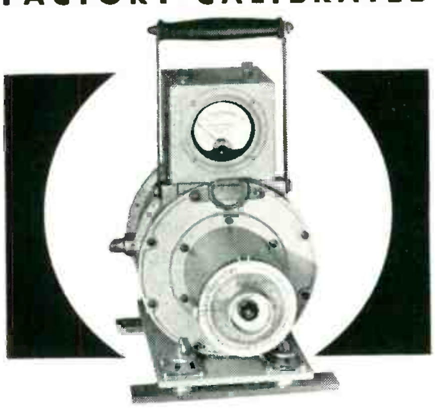

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in the company's computer division. In 1954 he became staff assistant to the vice-president of the newly-formed computer firm.

Polarad Electronics Expands Plant

POLARAD ELECTRONICS CORP. has acquired 55,000 sq ft of additional manufacturing space in a new plant located in Long Island City, New York.

The existing plants in Brooklyn will continue to operate. The additional facilities will provide for increased manufacturing and engineering activity.

The company has opened up three new divisions for the manufacture and development of computers, Klystron tubes, and microwave components. Polarad's new plant will increase its engineering and production capacity by fifty per cent.

The administration and executive offices and engineering will be centralized in this plant.

Ketay Buys Vari-Ohm Stock

KETAY INSTRUMENT has purchased the majority stock interest in the Vari-ohm Corp. of Amityville, Long Island, N. Y., manufacturers of potentiometers.

As a result of the purchase by Ketay, Vari-ohm is now expanding its facilities to permit larger volume production of its units.

Officers of the reorganized Vari-ohm Corporation, now a subsidiary of Ketay, are M. Sherman, president; J. L. Daniels, who developed the units, executive vice-president and J. Stadler, secretary-treasurer. Sherman is a vice-president of Ketay and Stadler is secretary.

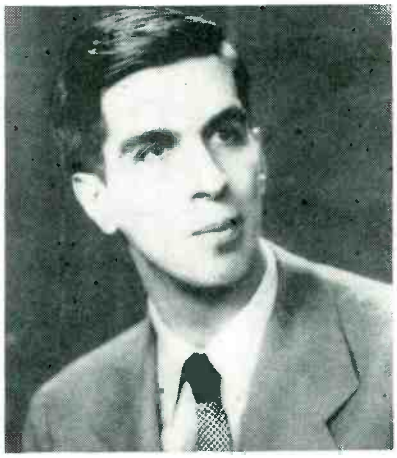
Printed Circuit Firm Organized

A NEW COMPANY, Printed Circuits, in Bloomfield, Conn., has been formed for the design, engineering, and manufacture of all types of printed circuit boards. Production is now underway.

Chauncey T. Mitchell will serve

as general manager of production and engineering.

Officers of the new firm include Ernest E. Carpenter, president, Arthur H. Kruh, treasurer and Judge Morris J. Cutler, secretary.



Rod Advanced By Boque Electric

ROBERT L. ROD was promoted to assistant to vice-president of Bogue Electric Mfg. Co. He will assist John A. Herbst, vice president-engineering, in the administration of engineering activities.

Previously Rod was assistant director of research and development and headed the company's activities in the development of electronic devices. Before joining Bogue in 1951 he was associated with Melpar and Radiomarine Corporation of America.

Aerovox Acquires Ceramic Firm

AEROVOX CORP. of New Bedford, Mass. has acquired all outstanding stock of Henry L. Crowley & Co. of West Orange, N. J., manufacturers of powder-irons and steatite products.

The Crowley plant has 110,000 sq ft of floor space.

Gross Joins Chem-Tronics

BERNARD GROSS, formerly director of laboratories at Rohr Aircraft Corp. in Chula Vista, California, has been named president of Chem-

Tronics, a newly organized firm in San Diego. The firm has purchased a six-acre tract for construction of a plant in San Diego.

The company will specialize in research and manufacture of electroform metal parts and electronic process control equipment.

Named to succeed Gross at Rohr is Hugh M. Rush, who has been assistant chief engineer for the aircraft sub-assembly firm.

Hydro-Aire Expands Electronics

HYDRO-AIRE, aviation subsidiary of Chicago's Crane Co., plans expanded activities in the electronics field. The formation of a new electronics division to be headed by Reagan C. Stunkel, formerly the firm's vice-president in charge of operations, is planned. Stunkel will take on full responsibility for the company's sales, research and development and manufacturing in the electronics field.

Robert J. Trivison has been appointed works manager for the firm. He was formerly production manager.

President of Daystrom Joins Weston Board

THOMAS ROY JONES, president of Daystrom, was elected a director of the Weston Electrical Instrument Corp.

Jones has been president of Daystrom and its predecessor companies since 1932 and is chairman of the board of directors of each of

Thomas Roy Jones

 Want more information? Use post card on last page.

Daystrom's five operating units. Prior to this, he was vice-president and general manager of Harris, Seybold, Potter Co. of Cleveland, Ohio and held executive positions with Cincinnati Milling Machine Co. and Moline Plow Co.

ACF Industries Acquires E&R

ACF INDUSTRIES has acquired the Engineering & Research Corp. of Riverdale, Md. E & R produces electronic and aircraft equipment and employs about 1,800 people. ACF has two other electronics companies as subsidiaries. They are ACF Electronics of Alexandria, Va. and Avion Instruments of Paramus, N. J.

Pioneer Enters New Fields

PIONEER INDUSTRIES of Reno, Nevada has entered the field of nuclear detection and is producing custom built scientillation counters for survey work. Another new division of the company for color television research is in process of formation.

Executives of Pioneer include W. E. Osborne, president, who until last summer headed Resdel Engineering Corp. of Los Angeles; J. R. Chown, executive vice-president, who has directed Pioneer since its formation; J. W. Braithwaite, also long with Pioneer but formerly from Marquardt Aircraft and R. P. Banaugh from the Livermore, California laboratories of the Atomic Energy Commission.

Mettler Named By Honor Society

RUBEN F. METTLER, systems department head at Hughes Aircraft and now on loan to the Department of Defense in Washington, has been named the outstanding young electrical engineer of 1954 by Eta Kappa Nu, Electrical Engineering Honor Society.

He was voted the outstanding young engineer "By virtue of his outstanding planning and development of air defense control systems, his participation in civic affairs and his various artistic attainments. . . "

Certificates of honorable mention have been awarded to Lindon E. Saline and Leon K. Kirchmayer of GE, Edward E. David, Jr. of Bell Telephone Laboratories and Jackson F. Fuller of GE.

The Award, which was first made in 1936, is given annually to an outstanding electrical engineer, who has been out of college not more than 10 years and who is not more than 35 years old, in recognition of his technical achievements and for meritorious service to his fellowmen.

Teasdale Named By Tempco Aircraft

A. ROBERT TEASDALE, JR. has joined Temco Aircraft as chief of electronics design.

The new design chief will supervise design and installation of electronics systems and will report to G. B. Spaulding, technical director of systems design.

Teasdale was formerly with GE, the University of Texas and Convair.

Preco Acquires Two More Firms

ELECTRA MOTORS and California Gear Co., both of Anaheim, California, were acquired by Preco of Los Angeles. Several months ago Preco also acquired ownership of Electron Products of Los Angeles, manufacturers of capacitors and filters.

The two concerns, who jointly

employ approximately 125 people, will continue to operate separately under Arval Morris, president, with no change in policies or management.

Seneca Falls Machine Expands

SENECA FALLS MACHINE Co. is constructing a new building adjacent to its main plant in Seneca Falls, New York to house its newly formed electronics division and to provide space for its engineering department. The new building is scheduled for completion about April 1, 1955.

Brubaker Promotes Myers And Byall

FRED MYERS, director of field engineering for Brubaker Manufacturing and former head of the design branch of the Electronics Division, Bureau of Aeronautics, has been elected vice-president of the Los Angeles firm.

Paul W. Byall, formerly controller of the company, was elected treasurer.

Sperry Forms Aero Division

SPERRY GYROSCOPE has formed a new aeronautical equipment division at the Great Neck, N. Y. main plant.

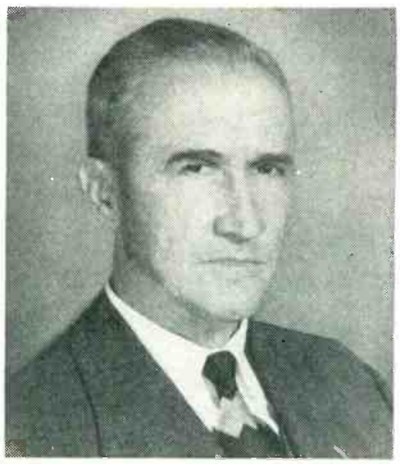
Named as manager of the new

H. C. Bostwick

Want more information? Use post card on last page.

aero division is Herb C. Bostwick, formerly engineering director for flight research. Current move is in line with a program begun last year of streamlining Sperry operations along product lines.

Bostwick began his career with Sperry in 1936 as an aeronautical field engineer. He served subsequently as aircraft armament manager, aircraft radio manager, and engineering director for flight research.



IT&T Promotes General Leavey

MAJOR GENERAL EDMOND H. LEAVEY, U.S.A. (Retired), has been elected president of International Standard Electric Corp., overseas manufacturing subsidiary of IT&T.

General Leavey joined IT&T in 1952 as vice-president and since June, 1953 until his present appointment had been president of Federal Telecommunication Laboratories at Nutley, New Jersey. He is also a director of various IT&T associate companies.

The firm also announced that R. J. Miller, former sales manager of rectifier equipment, has been appointed manager of the firms rectifier equipment product line. He assumes responsibilities for all engineering, manufacturing and sales functions of the department.

IBM Appoints Defense Engineering Head

CHARLES F. MCELWAIN was appointed director of defense engineering and defense manufacturing for IBM. McElwain has been the company's defense engineering coordinator since July, 1953. In his new position he will work closely with manufacturing and engineering defense departments in the company's plants at Poughkeepsie, Kingston and Endicott, New York.

Tsumeb Corp. Names American Metal

THE AMERICAN METAL Co. of New York, N. Y. is now selling germanium dioxide in the U. S. as sales agents for Tsumeb Corp. of the Territory of Southwest Africa. Production is on a modest scale at present but can be increased substantially if demand warrants it, according to the company.

Potentiometer Firm Appoints Gangi

S. GANGI has been appointed general manager of the George Rattray & Co., manufacturers of precision potentiometers in Richmond Hill, N. Y.

He is a graduate engineer with 25 years experience in the engineering and production of precision instruments and components.

Electronic Research Expands Plant

THE LABORATORY and manufacturing facilities of Electronic Research Associates of North Caldwell, N. J. have been moved to a new plant in Nutley, N. J. The new plant has more than double the space of the transistor equipment firm's previous plant.

Bauman Joins Transco Products

TRANSCO PRODUCTS of Los Angeles, California, manufacturers of aircraft and electronic equipment, appointed Harold Bauman, formerly

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a vice-president of Standard Business Machine Mfg. Co., as chief engineer.

Before joining Standard, he was chief electrical engineer of Ampro Corp. and before that was a department head supervising electronic and electro-mechanical projects for Bell & Howell.

USECO Purchased By Litton Industries

USECO of Glendale, Calif., formerly known as U. S. Engineering Co., has been purchased by Litton Industries.

USECO has been a producer of electronic terminals and terminal boards and for the last year has entered into the fields of etched and printed circuitry.

North Electric Appoints Ayers

RAYMOND W. AYERS, formerly executive vice-president of Allen D. Cardwell Co., has been appointed manager of the newly expanded industrial division of The North Electric Manufacturing Co. of Galion, Ohio.

Lansing Adds Space

JAMES B. LANSING SOUND of Los Angeles, Calif., has added an annex of 10,000 sq ft for cabinet construction.

Magnetic Recorder Firm Formed

A NEW CORPORATION, Tape Recorders Incorporated, in Chicago, has begun operation as manufacturers of magnetic tape recorders.

NEW BOOKS

Electrical Transients

By L. A. Ware and G. R. Town. *The Macmillan Co., New York,* 1954, 222 *p,* $4.75.

Increasing use of pulse circuits in communications engineering has contributed a widespread interest in electrical transients among circuit designers. Engineering colleges have therefore tended to build post-war graduate courses in electronic circuit design around the study of transients and the methods of operational calculus required in their solution. Currently this trend has been extended to include the study of transients in the undergraduate curricula in electrical engineering.

Scope of Book

This book is written to furnish a text for a senior-level course in electrical transients. Presumably it is intended for both communications and power majors although in content it seems slanted for the former group. The authors have based the book on course material used over a four-year period in senior electrical engineering courses although they indicate that the text might also be used by third-year students.

The book deals with finding the response of R-L, R-C and RLC circuits to alternating emf, compound, switching and transistor transients, nonsinusoidal applied emf and repeated discontinuous functions. It is liberally sprinkled with illustrative examples. The differential equations involved are solved by both classical and operational methods—often both methods are employed on a single problem.

Contents

Chapter 1, 35 pages excluding problems, leads off with a definition of the transient problem and illustrative examples of finding the transient response R-L and R-C circuits when a direct emf is applied. Also presented is a discussion of the time constant and the voltage relationships in a simple sweep circuit. The classical method for solving differential equations is used.

A particularly lucid description of the Laplace transform is given in chapter 2. The method is introduced by analogy to the use of logarithms. One of the problems given in chapter 1 is reworked using the Laplace transform. Chapter 3 gives further examples of the use of Laplace transforms with classical solutions also given for comparison.

Response of R-L and R-C circuits to compound, switching and transition transients is dealt with in chapter 4 of 29 pages. The Laplace method is stressed although classical solutions also are shown. Circuits considered include the L-coupled T section and capacitance-coupled circuit.

Chapter 5 concerns transient response of R-L-C circuits; chapter 6 deals with alternating applied emf while chapter 7 considers miscellaneous applied emfs.

Repeated and discontinuous emf functions such as the Morse dot, full-wave rectifier output sawtooth waveform, class-C amplifier pulse and half-wave rectifier output are treated in chapter 8.

The final chapter considers the transient response of vacuum-tube circuits. Included are the R-C amplifier, video amplifier and cathode follower. The index has rather few entries but is perhaps adequate for a book of this type and length. The book includes only 85 problems, all of which seem quite instructive. However, an instructor seeking to establish adroitness in handling transients through an intensive problem-solving course might like to see more. The fact that answers are not given may discourage some practicing engineers from using the book for self-study to bring their knowledge of circuit design up to date.

Conclusions

On the whole the book is readable, easily understood and worth reading both by students and engineers whose academic preparation antedates the introduction of courses in transient analysis. It seems quite adequate for a senior-level course in electrical transients and might indeed be within the

comprehension of third-year students where a course on electrical transients is taught on that level.
—J.M.C.

Quality Control

By N. L. Enrick. *The Industrial Press, N. Y.*, 1954, 181 *p*, $4.00.

It is my opinion that Mr. Enrick in writing his book for the practical man has overshot the mark in his effort at simplification. His philosophy, particularly in the earlier chapters, seems to be that some control is better than no control at all. While this can be accepted for the sake of expediency, I believe it extremely inadvisable to send the practical quality man into a factory with a false sense of confidence, especially in these days when engineers and supervisors have more than a casual interest in the statistical tools used in quality control.

Defining Accuracy

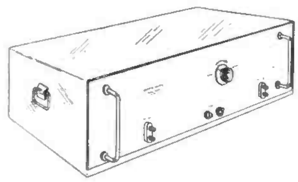
It is very misleading where, on page 36, he says "Where absolute accuracy is the aim" (referring to adjustment factors). It seems that this absolute accuracy referred to boils down to two sigma limits and I wonder how many statisticians or mathematicians will go along with this regardless of the number of standard deviations. The chart on page 112 falls into the same category where the computations to obtain sigma are shown. I doubt if this would find ready acceptance.

In the chapter on simplified analysis of variance Mr. Enrick had a golden chance to shine. The chapter proves interesting as far as it goes but I believe he could have gone further with it.

A more complete chapter on the mathematical derivation of the adjustment factors would help to satisfy those interested enough and who would like to put a little more than blind faith into it.

Conclusions

In spite of all this criticism, with the exception of some liberties taken with statistical theory, the book is not without merit. The text on application and administration is based on accepted and proven practice and should prove a handy *the NEW*



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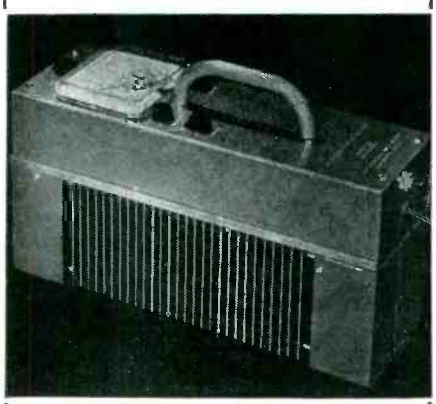

The toxic limit is a full scale reading on the high sensitivity scale of Model 23, illustrated above. The weight is 7 pounds and the size is 13 x 8½ x 4½ inches.

A bibliography on the mercury vapor hazard is available on request as well as literature on the different models of the Kruger Mercury Vapor Meter.

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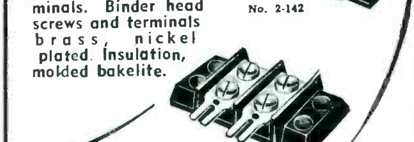

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reference for those without actual experience.

In calling a spade a spade, it is my opinion that the book does not add too much to the knowledge of the subject found in existing literature which tells the story adequately and just about as simply.—R. MCGHEE, *Sylvania Electric Products Inc., Kew Gardens, N. Y.*

Amplitude-Frequency Characteristics of Ladder Networks

BY E. GREEN. *Marconi's Wireless Telegraph Co., Ltd., Marconi House, Chelmsford, Essex, England*, 155 p, 1954, 25 *shillings.*

THE PRIME PURPOSE, essential scope and especial limitation of this text are well summarized in the author's opening remarks: "In the continually expanding field of communication there is need for design information on broadband circuits, which is more exact than that supplied by classical filter theory. In particular we require to know what is the best that can be done with comparatively simple networks. Recently a number of papers have dealt with the design of low-pass and band-pass filters (consisting of chains of resonant circuits) producing desired exact amplitude characteristics. The most outstanding of these is by Dishal *Proc. IRE*, 37, 1949, p 10, 50–69. It therefore seemed worth while to work out on similar lines a basic theory of the low pass ladder network which could be applied by well-known analogies to the derived band-pass, high-pass and band elimination filters.

"The results could then be used in the design of broadband couplings between valves, between a valve and a resistance (load or generator) or between a transmission line and a reactive load or generator. For most applications we shall simplify the theory by assuming no loss in the coupling network. The basic equations, however, will be worked out for the general case."

Chapter Titles

The actual content encompassed is excellently epitomized in the statements of the chapter headings. Thus: Part I—General Theory comprises: Properties of Low Pass Ladder Network; Response Type B (Butterworth or Maximally Flat); Response Type C (Chebyshev or Oscillatory); Application to Band Pass Networks; and High Pass and Band Pass Networks. Part II—Applications comprises: Design of Networks to Obtain Optimum Performance of Valves (Power Bandwidth and Gain Bandwidth Figures of Merit); Analysis of Two and Three Branch Networks; Broad-Band Matching of Reactive Loads; Design of Low Pass and Band Pass Filters with Either Type B or Type C Response; Input Impedance (or Admittance) of a Low Pass or Band Pass Network Adjusted for Type B or Type C Response and Collected Formulae. The Appendices comprise: Low Pass to High Pass and Band-Elimination Transformations; Band Pass Amplifier Chains with Stagger Damped Double Circuits, or Stagger Tuned Single Circuits; Improvement in Power-Bandwidth Figure of Merit by Stagger Damped Amplifier Stages; Networks with Undercoupled Type A Response; Multiple Solutions for Network Elements; Alternative method of Calculating the Transferred Decrement and Coefficients of Chebyshev Polynomial.

This theoretical content is buttressed by a bibliography of 26 pertinent references; a noteworthy, carefully detailed listing and definition of the several score of symbols used in the text—which very useful item is omitted in most circuit books; and a friendly, pertinently remarked introduction by M. Dishal of the Federal Telecommunications Laboratories, who is a very active American worker on problems of network synthesis.

Dishal's Introduction

A prime value of this book and a good indication of the gap it fills, are well-stated by Dishal, in his introduction: "It is particularly this generalized person—the designing engineer—who is most in need of this modern network theory design information, for he is the man who must not only deal with the general concepts and qualitative ideas required by modern electronic systems, but must also be concerned with the actual numerical performance of the circuits— . . .

"It is this important requirement for accurate numerical information that is not satisfied by the image or iterative parameter design procedures which are still [the only procedures] being taught in so many of our schools today, and it is this type of information which is supplied by Mr. Green's book."

Reviewer's Opinions

Now Mr. Green is both one of the most active English writers on problems of network synthesis and a long-practiced design engineer (in Marconi's Wireless Telegraph Co. Ltd.). Accordingly, it is to be anticipated that he is exceptionally fitted by experience both in exposition and in application-work to advance a well-integrated account of his subject. And, in fact, careful reading reveals that this book fulfills precisely such expectation. Thus, the development of the theory is lean in work, precisely-phrased, and well-detailed.

The illustrative examples are numerous, varied in nature and panoramic about application in practice; the results obtained are carefully discussed as to both freedom and limitation of use. Additively, the many charts, tables and graphs of the text provide a wealth of directly-useful design data. Finally, the typography is excellent; the figures carefully drawn and labeled; the paper and binding, respectively, of excellent grade and workmanship.

Conclusions

We have here an authoritative work on the particular topic evidenced in its title. It provides a good purview of the practical values of a mode of analysis that is as yet familiar to few. The reviewer recommends the book to the earnest attention of the graduate student, teacher, practicing design engineer, research and development worker, or any other who would familiarize himself with the theory and use of a branch of network synthesis which—though rooted in Darlington's classic paper published sixteen years ago (1939)—is as yet little familiar to the rank and file of those mentioned.—THOMAS J. HIGGINS, *Professor of Electrical Engineering, University of Wisconsin.*

Valves for A. F. Amplifiers

BY E. RODENHUIS. *Philips' Technical Library. United States distributors, Elsevier Press, Inc., Houston 6, Texas,* 1954, 150 *p*, $2.25.

FOR THOSE who design and build audio amplifiers, this is a practical and useful book of a type not found in this country. The considerable amount of material on the numerous Philips' tubes for a-f work is more voluminous than is found in any of our tube handbooks; when added to the chapters describing the actual layout and construction of several amplifiers, the book serves as a guide to the whole a-f art.

Problems of hum, distortion, layout on the chassis and choice of tube for specific purposes are handled in such a way that an American designer could learn a great deal. He would have to correlate the characteristics of Dutch versus American tubes to choose properly the American counterparts, but this should not be difficult.

All in all, this is a book which shows the reader how to choose the proper tube for a particular job and how to use that tube properly for best results.—K.H.

THUMBNAIL REVIEWS

Plastics Engineering Handbook. Society of the Plastics Industry, 850 p, 1954, $15 from Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. Design, materials, processes, equipment, finishing, assembly, testing and standards of plastics and plastic products.

Miniature I-F Amplifiers. By R. K-F Scal. NBS Circular 548, 46 p, 1954, 40¢, Government Printing Office, Washington, D. C. Descriptions of three high-gain high-frequency i-f amplifiers (20 to 100 mc), ⅓ the size and ½ the weight of equipment they replace, using subminiature tubes with low-noise input circuits.

Statistical Theory of Extreme Values and Some Practical Applications. By Emil J. Gumbel. NBS Applied Mathematics Series 33, 51 p, 1954, 40¢, Government Printing Office, Washington, D. C. Applications to meterological problems, to strength of materials, quality control, oldest ages at death, extinction times for bacteria, etc.

BACKTALK

Home Movie Sound

DEAR SIRS:

WE WERE very much interested in reading the article "Home Movies Sound Off on Tape", in the July, 1954 issue of ELECTRONICS (p20). However, in certain respects the story seems contrary to our own experience with magnetic sound.

The article states that the "normal expansion and contraction of film with temperature and humidity tends to crack off the striping." To date we have coated approximately 5,000,000 feet of film. In no instance have we ever seen cracking of our Soundstripe.

The comment is made that magnetic striping is considered satisfactory only for 16-mm film, because there is not enough room on 8-mm film to get adequate fidelity. Although we do not stripe 8-mm film, the width of this stripe is the same as the track we place on double-perforated 16-mm film. The argument resolves around the term "adequate", but we believe that it is possible to get adequate quality from 8-mm magnetic film.

The system, outlined, of recording and playback using a tape recorder, we feel has several disadvantages. If damaged film causes the projector to lose its loop, the only way of obtaining synchronism again is to go back to the original sync mark at the beginning of the film. Also, since the tape and the film run at different speeds, it is almost impossible to edit out sections of film and sound simultaneously, while this is no problem at all when the stripe is on the film itself.

Synchronous control systems have been used for some time in various forms in commercial practice. But all of them have essentially the same drawback when it comes to editing or finding a synchronizing point on the film. Based on several years of intensive engineering and development work, we have concluded that the most practical and simplest way to record and play back a magnetic sound track is to put the sound on the film itself.

We would also like to point out that the present price for Soundstripe is 2½¢ per foot rather than 3½¢ per foot.

J. P. WEBER

Manager, Sales Engineering
Bell & Howell Company
Chicago, Illinois

Editors Note: We agree that "adequate" sound quality is impossible to define and hope that current consumer interest in and appreciation of high-fidelity audio will not reflect adversely on the public's impression of the quality obtainable from striped home movie film. It seems to us that the 2.5 million 8-mm fans have long been awaiting even barely adequate sound.

Drafting Aid

DEAR SIRS:

I WAS extremely interested in the article "New Drafting Tools and Techniques" (p 120, Aug. 1954). The exchange of such information will help engineers responsible for handbook illustrations and engineering drawings.

Our department has evolved a simple process for duplicating symbols and special notes which saves drafting time. Tailor-made symbols can be made to supplement available printed acetate symbols . . . the adhesive is a non-wax type and drawings may be reproduced as blue-line or Van Dyke prints.

Provided an Ozalid machine is available, multiple copies of any symbol, waveform, or special lettering to be used on drawings can be made on acetate in three steps. Ink the desired symbol or lettering on regular drawing paper. Expose the original tracing on Ozalid Viewfoil X101 (black) and develop. Stick Minnesota Mining Co. double-coated transparent cellophane tape No. 666 to underside of viewfoil (the adhesive tape comes in roll form with a protective backing).

To use, cut out the desired symbol, peel the protective backing from the tape and place it on drawing. Press the symbol smooth and it will stay locked in place. It can be shifted by prying up and relocating.

In completing a schematic, attaching lines may be inked directly over the acetate or made up on acetate also and laid over other symbols. The completed art work may be photographed for offset printing or blue-line prints for checking or manufacturing purposes can be made.

Viewfoil scratches easily in development, and the manufacturer recommends that tissue paper be placed over the acetate. A piece of plastic window screening works very well and permits faster development.

There is no difficulty in getting an excellent line negative for offset printing, but if work consists of four or five layers of acetate a Wratten G15 (yellow) filter on the camera prevents fogginess.

JAMES A. LIPPKE
Supervisor, Tech. Manual Dept.
March-Theiss, Inc.
Huntington, N. Y.

Editors Note: The samples sent us indicate that this should be a very useful technique for producing special symbols and waveforms.

Ideal World

DEAR SIRS:

I AM a student of electronics at the Madras Institute of Technology (chromepet). I submit a short passage describing the possibility of an ideal world which can come into existence with help of electronics.

Machines (electronic) do all work for human beings, so that human beings need not do anything. That is, they become angels enjoying themselves and immersed in their art in which they have excelled. Art will flourish and there will be beauty everywhere.

Murder, killing, theft and other bad events happening today will be avoided with the help of electronic robots. These robots will impart suitable punishment to those doing crimes—all work being done automatically. An electronic "bad thought detector" will detect bad thoughts and locate the source of such thought and at once punish the source. As a result there would not be any bad thoughts in this world.

What more is required for an ideal world? Now there will also be the freedom of thinking and every fellow can think any thing he wants except bad thoughts.

M. HARIHARAN
"Amritha Vilas"
Madras, India

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Send NEW ADVERTISEMENTS to N. Y. Office, 330 W. 42 St., N. Y. 36, for the *March issue closing February 3rd.* The publisher cannot accept advertising in the Searchlight Section, which lists the names of the manufacturers of resistors, capacitors, rheostats, and potentiometers or other names designed to describe such products.

POSITIONS FOR ELECTRONICS EXECUTIVES

$5,000 - $50,000

One of the nation's largest executive agencies presents an exclusive service for men in the electronics and allied industries. This is a confidential, professional and rapid service for the nationwide placement of successful men under 45 in the engineering, technical, sales and administrative fields. Send a short resume including age, education and work history and we will tell you by return mail what we have available for you and how we can help. Write to H. Graebner at Graebner's Executive Exchange, 116 South Michigan, Suite 705, Chicago 3, Illinois. We also offer a special service to companies seeking qualified applicants in any field. Write for more information.

POSITIONS VACANT

(Continued from opposite page)

FLORIDA POSITIONS (a few elsewhere) $3,600 to $25,000 up. Electrical-electronic engineers, scientists, physicists, inventors, mathematicians. Aeronautical design engineers. Electronic interviewers, inspectors, instructors and technical writers. Electronic technicians (all specialties). Flight test instrumentation mechanics. Precision machinists (optics type). Design draftsmen and drafting inspectors (electrical-electronic). Send resume and photograph to Tech-Associated Agencies, P. O. Box 1324, Orlando, Florida.

ELECTRONICS ENGINEERS Wanted to design communications-equipment circuitry. Must have a minimum of 5 years experience. Salary commensurate with ability. Pleasant working conditions. Manson Laboratories, Inc., 207 Greenwich Avenue, Stamford, Conn.

POSITIONS WANTED

ELECTRICAL ENGINEER of 15 years standing experienced in organizing and supervising department and coordinating patent, research and manufacturing activities, presently and for past 9 years engaged in corporation patent department. under 40, BSEE, LLB, Patent Office, State and Federal Bars, Senior member IRE, desires to join rising research or manufacturing concern. PW-5046, Electronics.

AGGRESSIVE RADAR systems engineer with microwave specialty desires change. Presently directs several r and d contracts and has strong theoretical background in electronics, physics and mathematics. $12,500 minimum. PW-5068, Electronics.

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(Additional Selling Opportunities Wanted on Page 386)

SUCCESSFUL SOUTHERN California manufacturers' representatives expanding organization. Established among aircraft and electronic manufacturers and wholesalers. Offers experienced, aggressive representation to companies with good growth potential. Warehouse and offices in Los Angeles. RA-4446, Electronics, 1111 Wilshire Blvd., Los Angeles 17, Calif.

REPRESENTATIVE SEEKS printed circuit components and other lines. Selling electronic and industrial manufacturers in Ohio, and Indiana on printed wiring and plastics. RA-5183, Electronics.

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WRIGHT ASSOCIATES
Manufacturer's Representatives
P. O. Box 623 Rome, New York

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Design of electronic instrumentation for underwater ordnance, including high gain amplifiers, conventional filters, power amplifiers, oscillators and detectors in the ultrasonic range.

Analytical and experimental treatment of scientific research problems in the fields of hydrodynamics, acoustics, electronics, network theory, servomechanisms, mechanics, information theory and noise analysis, including analogue and digital computations.

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Experienced engineers and recent graduates can work at their maximum skills in these aviation-related engineering fields:

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- SERVOMECHANISMS
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- ELECTRONIC COMPONENTS
- ELECTRONIC CIRCUITRY
- AUTOMATIC FLIGHT CONTROLS

Electrical Engineer or Mechanical Engineer degree or equivalent practical engineering experience. Background in design of intricate precision mechanical, electrical or electronic devices preferred.

To apply, send resume to: EMPLOYMENT MANAGER

LEAR, INC.
110 Ionia Avenue, N.W., Grand Rapids 2, Michigan

To the Engineer who is Very Particular

RCA expansion opens the kind of permanent opportunities you'll find most desirable

A whole new program of expansion at RCA—in Research, Systems, Design, Development and Manufacturing—opens a broad variety of permanent positions with all the features that appeal to the alert, creative engineer. These are opportunities with a future . . . available *today* for the man who wants to move ahead professionally with the world leader in electronics. They include work in fields of phenomenal growth. At the RCA engineering laboratories *listed in the chart on the right*, you'll find the kind of living and working conditions attractive to the professional man and his family.

Engineers and scientists find every important factor that stimulates creative effort . . . including a quality and quantity of laboratory facilities unsurpassed in the electronics industry . . . and everyday association with men recognized at the top of their profession.

RCA's benefits add up to an impressive list of "extras." Among them: tuition for advanced study at recognized universities . . . a complete program of company-paid insurance for you and your family . . . a modern retirement program . . . relocation assistance available.

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The development of new technologies at General Electric has opened the door on a program of advanced electronics work requiring the skills of top engineers and physicists. To engineers this means long-range, continuing opportunity enabling them to build a solid future as they enjoy the vast facilities, stimulating challenges and many incentives and rewards offered by General Electric.

Positions available in the following fields:

Advanced Development, Design, Field Service and Technical Writing in connection with:

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COMMUNICATIONS
ELECTRONIC COMPONENTS
TELEVISION, TUBES & ANTENNAS

Bachelor's or advanced degrees in Electrical or Mechanical Engineering, Physics, and experience in electronics industry necessary.

Please send resume to: Dept. 2-5-E, *Technical Personnel*

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Electronics Park, Syracuse, N. Y.

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This position has excellent growth potential commensurate with the company's advances in the electronics field.

Link has a well rounded benefit program, excellent housing and ample recreational opportunities in the upstate New York area.

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Manager of Industrial Relations

LINK AVIATION
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A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

SALES ORGANIZATION AVAILABLE

Headquarters Cleveland, Ohio, covering Ohio, Indiana, Kentucky, Western Pennsylvania, serving Industrial Manufacturers using Electrical, Mechanical, and Plastic Parts in finished products. Interested in one additional line with potential volume. References and pertinent information exchanged.

RA-4816, Electronics
330 W. 42 St., New York 36, N. Y.

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Is your company adequately represented at Wright Patterson Air Force Base, Gentile Air Force Depot and Ohio area? Sales Engineer (B.E.E.) with experience selling electronic equipment, desires lines of test equipment, computing devices, components, etc.

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Engineer desires newly manufactured electronic and electro-mechanical products for sale to Guided Missile and Aircraft Companies located in Southern California. Reply to:

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Phone Hollywood 9-6278

LINES WANTED

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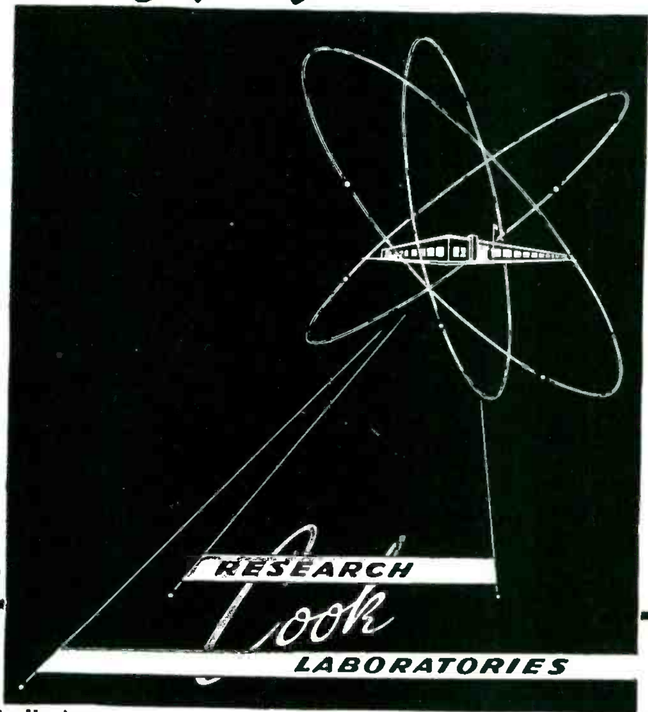

We maintain one of the nation's most progressive research and development laboratories and are looking for qualified engineers—Senior and Junior—who are interested in furthering their careers in the field of research.

If you are interested in becoming part of A GROWING COMPANY—with OUTSTANDING PERSONNEL—at HIGH STARTING SALARIES—and EXCELLENT WORKING CONDITIONS contact

Mr. D. M. Halliday

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The modern facilities and congenial atmosphere at Kollsman, designers of America's finest aircraft instruments, provide an environment conducive to truly creative work.

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Instrument Corp.
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Positions are available in all levels of experience above Junior Engineer

ELECTRONIC ENGINEERS AND PHYSICISTS

BS degree and experience is required, advanced degree with experince to back it up is even better

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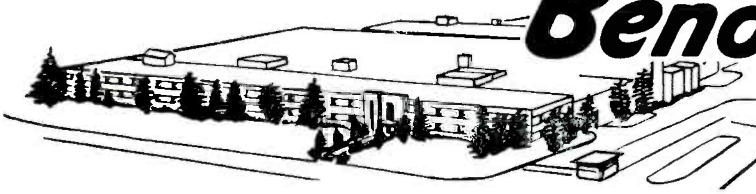
Baltimore 4, Md.
Phone: VAlley 3-2200



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YOU will benefit from HRB's location in the cultural environment of State College. You can continue your advanced education at The Pennsylvania State University which is within a minute's walk of HRB. The knowledge and experience of some of the finest minds in the country are within telephone reach.

YOU will work for one of the country's fastest growing research companies, staffed with top flight men in advanced fields of electronic research, development and design. You may join other staff members in purchasing HRB stock through a number of convenient plans, assuring yourself that your voice will not go unheard with regard to company affairs or policy. You will earn a liberal salary and share in such company policies as paid vacations, company-paid group life insurance and retirement plans.

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An application form can be obtained from:
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All inquiries will be regarded as confidential.
HALLER, RAYMOND & BROWN

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LEAR, INC. will expand its top notch Field Service organization in 1955 to keep pace with increasingly widespread military acceptance of LEAR flight control systems and flight reference systems.

Attractive salary, liberal expense arrangements. Assignments may require travel or residence at assigned stations. Company orientation prior to assignment.

Qualifications include:

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3. Tech. Rep. experience.

To apply, send resume to:
FIELD SERVICE MANAGER

LEAR, Inc.
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Grand Rapids 2,
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Manufacturer of laminates has open a responsible new position for an Electronics Engineer with diversified training and experience. Position will involve working with customers on applications and assisting in guiding our research and development activities. Salary open. Replies confidential. Send resume to:

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THE RICHARDSON COMPANY
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Excellent opportunities to represent well-established, rapidly growing Eastern transformer manufacturer. Must have good technical background, preferably electrical engineering graduate. Now calling on government agencies and manufacturers of electronic equipment doing industrial, commercial and government work. Territories open: Detroit, Chicago and Los Angeles. Write full particulars to

RW-5019, Electronics
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REPRESENTATIVES WANTED

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RW-4823, Electronics
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TRANSISTOR CIRCUITRY

Opportunity to study fundamental transistor circuit problems and to apply transistors in the design of receiver, guidance and control systems of guided missiles.

Transistor experience desirable but not essential.

Located in residential suburb of Nation's Capital. Advanced educational facilities available. Moving expenses paid. Other liberal benefits.

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MECHANICAL ENGINEERS

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Section Heads, Engineers-in-Charge, Senior Engineers, Engineering Specialists and Junior Engineers for Research, Design, Development and Product Design on complex subminiaturized airborne electronic equipment and computers, experienced in:

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- Microwave Techniques
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- Heat Transfer
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- Technical Writing
- Analytical Problems
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- Systems Development & Testing
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- Component Analysis & Testing
- Component Specifications
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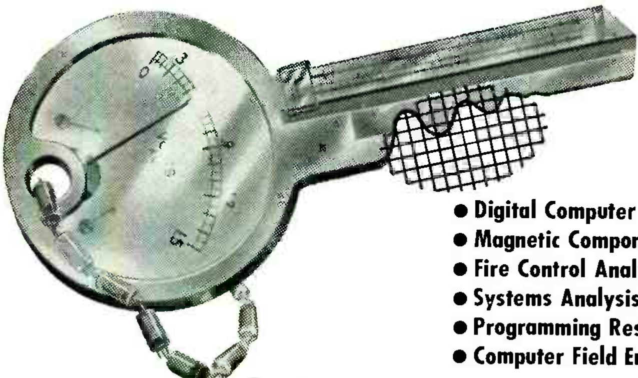
Please forward complete resume to:
MR. CHARLES KEPPLE

SYLVANIA
ELECTRIC PRODUCTS INC.
175 Great Arrow Avenue, Buffalo, New York

YOUR CALLING CARD FOR A BRILLIANT FUTURE...

Bendix Missile Section is a major contractor in the U. S. Navy's guided missile program--a part of the "new look" in our defense plan. Our expanding program has many opportunities for senior engineering personnel: Electronics Engineers, Dynamicists, Servo-Analysts, Stress Analysts, Project Coordinators, and Designers. Take time now to look into the opportunities which Bendix can offer you. Write Employment Dept. M, 401 Bendix Drive, South Bend, Indiana.

ELECTRONIC ENGINEERS • PHYSICISTS • MATHEMATICIANS



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- *Openings at all levels of experience.*
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- *Salaries commensurate with experience.*
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The country's foremost computer development organization has permanent positions open in the above fields for qualified professional personnel. Opportunities for personal advancement and professional growth are exceptional in today's most rapidly expanding technological field.

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E.E. Degree plus demonstrated ability in design of electronic equipment. Three to Five years' experience in Industrial Instruments involving A.C. and D.C. Amplifiers, Meters, Signal Generators, Oscilloscopes.

Practical production background also desirable. Positions offer secure future with aggressive and expanding organization. Excellent working conditions and associations. Starting salaries commensurate with training and experience.

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3 to 5 years' experience in production of small electro-mechanical components. Familiar with manufacturing techniques and tolerances.

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Internationally known research organization seeks experienced engineers for challenging research and development programs in the following areas:

Radar and Radio Communications
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Our expanding staff assures permanent positions and excellent opportunities for personal and professional growth. Liberal benefits including generous tuition refunds for graduate study. Send resume to:

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Experienced, for design and development work on switches of all types—microswitches; leaf-type; tap; etc; for circuitry control. Opening also for engineer experienced in precision potentiometer design. With progressive midwest manufacturer of small electrical components. Attractive conditions, good opportunity. Give full details, include salary desired.

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DEVELOPMENT

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- ELECTRONIC EQUIPMENT PACKAGING
- INSTRUMENT DESIGN
- MISSILE SYSTEMS DEVELOPMENT
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Please send your resume to

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APPLIED PHYSICS LABORATORY

THE JOHNS HOPKINS UNIVERSITY
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Silver Spring, Maryland

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Research Or Development For

SYLVANIA

2 TO 5 YEARS' EXPERIENCE in tube development. Minimum B.S. Degree in Physics or E.E.-Ph.D. in Electronics-Physics acceptable in lieu of experience.

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E. W. Doty
Manager of Personnel
Research Laboratories

SYLVANIA
ELECTRIC PRODUCTS INC.
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Applied research, development and design of magnetic amplifiers and transformers, reactors and saturable reactors.

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Applied research, development and design of military UHF communications apparatus at all power levels, and for both transmitters and receivers.

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Applied research, development and design of antennas and waveguide systems for military communications and radar equipment.

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Planning, studying, proposing, and advanced research, development and design to include search, fire-control and missile guidance systems.

WRITE TODAY TO ARRANGE FOR CONFIDENTIAL INTERVIEW:
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Employment Supervisor, Dept. 88
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Baltimore 3, Maryland

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

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Big opportunities await you at Bendix York!

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Unusual opportunities exist for young men whose backgrounds qualify them for sales and engineering positions with expanding manufacturer of fine electronic organs.

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EXCELLENT SALARIES
MINIMUM PREREQUISITES

ENGINEER EE Graduate with 3 years experience

TECHNICIAN 2 years technical school in communications and 3 years experience.

Require installation adjustment and maintenance experience with communication receivers and associated terminal equipment. Also, men with similar experience with high-powered transmitters, antennas, transmission lines.

Must be willing to travel in United States and Overseas.

Page Communications Engineers, Inc.
710 Fourteenth St., N.W., Washington 5, D.C.

ENGINEERS PHYSICISTS

NEW Growth Opportunities As Sylvania's Missile Systems Laboratory Prepares to MOVE to BOSTON

Early next summer, Sylvania's Missile Systems Laboratory, now located at Whitestone, Long Island, N. Y., will relocate permanently in new, larger quarters in the Boston area. As a Sylvania engineer, you can look forward to:

- Creative work and challenging technical problems
- Opportunity to grow with an expanding organization
- Financial support for advanced educational studies
- Liberal benefits in insurance, pension and medical programs
- Live and work in model suburban Boston area offering many cultural and recreational activities.

Moving expenses to Boston will be paid by Sylvania.

An office has already been opened at Newton, Massachusetts, with immediate openings there and on Long Island.

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ANTENNA THEORY & DESIGN

ANALYSIS OF MISSILE GUIDANCE SYSTEMS

MATHEMATICAL ANALYSIS & SYSTEM DESIGN OF FIRE CONTROL & COMPUTER EQUIPMENT

INERTIAL GUIDANCE OR INFRA-RED FOR DETECTION & TRACKING

SERVO SYSTEM DESIGN & ANALYSIS

AERODYNAMICS

PROPULSION

AIRCRAFT OR MISSILE STRUCTURES

Please forward resume to
Manager of Personnel

SYLVANIA
ELECTRIC PRODUCTS INC.

20-21 Francis Lewis Blvd.
Whitestone, L. I., N. Y.

All inquiries will be answered within two weeks

Electronic Engineers
Mechanical Engineers
Physicists

• • • • • •

Expanding operations in ORDNANCE DEVELOPMENT including guided missiles, fuzes and safety and arming devices assures permanent positions. Openings for both experienced and inexperienced men in these challenging and rapidly expanding fields. Opportunities to participate in this new concept of electromechanical miniaturization.

write

ALLIED PRODUCTS DIVISION

HAMILTON WATCH CO.
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SEMICONDUCTOR DEVELOPMENT

Responsible positions are now available with one of the leading and fastest growing semiconductor manufacturers. These are outstanding opportunities for Physicists and Engineers in research, development, or production of advanced germanium and silicon diodes and transistors.

Experience in semiconductors or other components such as tubes or capacitors is desirable.

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- **Metallurgists**
- **Device Engineers**
- **Production Engineers**
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Send Resume or call

Transitron Electronic Corporation
407 Main Street, Melrose, Mass.
MElrose 4-9600

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Think "Searchlight" First!
"Searchlight" — classified Advertising — "spots" current Employment, Equipment and Business Opportunities—both offered and wanted—in the industry served by Electronics.

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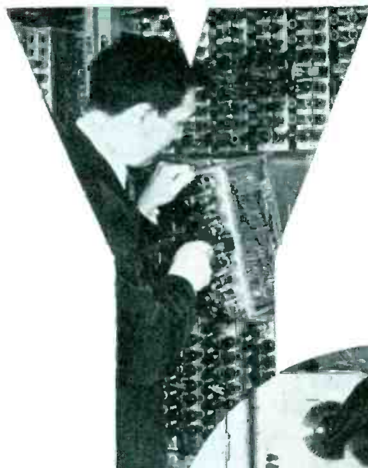

ELECTRONIC ENGINEERS
and
ELECTRONIC TECHNICIANS

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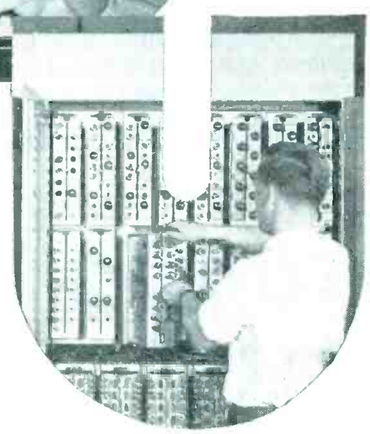
These are
PERMANENT
Positions with a leader in the dynamic field of
ELECTRONIC COMPUTERS



Your best chance for increasing responsibility and rapid advancement in the electronic field is in the challenging field service work associated with digital computers. *Computer experience is not necessary.* You will receive extensive training in computer logic and circuitry and specialized training on specific computers. Good salaries start with the training period. After training you will be assigned to one of our large computer installations in continental United States. You will enjoy liberal travel allowances and other employee benefits.

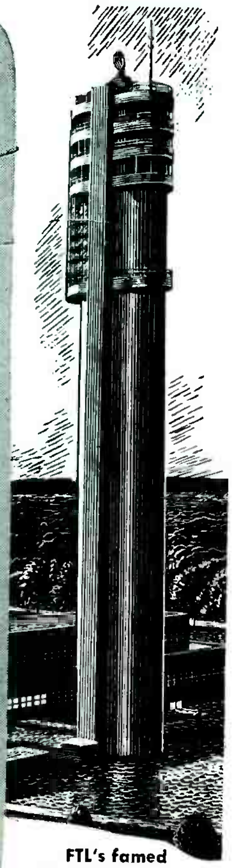
The practical knowledge of computers obtained from actual experience at field installations will aid you greatly in advancement.

Minimum qualifications for ELECTRONIC ENGINEERS
Bachelor Degree—2 years electronic experience

Minimum qualifications for ELECTRONIC TECHNICIANS
High school plus electronic school (armed forces acceptable) and four years electronic experience

For further information regarding our computers and training programs, send a brief resumé of your education and experience to **Mr. R. A. Nelson, Employment Manager.** Interviews at our expense by arrangement. All contacts are held in strict confidence.

Remington Rand
INC
ENGINEERING RESEARCH ASSOCIATES DIVISION
1890 W. MINNEHAHA AVENUE • ST. PAUL W4, MINNESOTA



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With Experience in VHF and UHF Frequencies

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THE ALLEN D. CARDWELL ELECTRONICS PRODUCTIONS CORPORATION
Plainville, Connecticut

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Electro-Voice, Inc. has positions open for engineers with degrees in Electrical Engineering or Physics for work in the field of Audio. Openings in both production and engineering departments.

Excellent opportunity for men with experience in loudspeaker manufacturing.

Write:
Vice President, Engineering
ELECTRO-VOICE, INC.
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Permanent Magnets

Experienced in Alnico production and control with practical and theoretical background for developing magnetic material. Must be U. S. citizen.

CRUCIBLE STEEL CO. OF AMERICA
Att. Mr. J. A. Kearney
HARRISON, N. J.

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Intriguing opportunity for an electronics engineer to use his knowledge and experience in a new way with definite long-term investment possibilities. Desirable background:—knowledge of military equipment; skill at gathering, writing, organizing technical data; ability to communicate; an alert, inquiring incisive mind. Some sales engineering would help. Should be free to travel.

Location—New York City
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Admiral *Increases* ENGINEERING STAFF

Diversification at ADMIRAL is making itself felt in more and better engineering careers.

Real ability and originality can find new challenge and opportunity with a leader in electronic development and manufacturing.

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★ MICROWAVE ENGINEERS
Experienced in UHF and SHF circuitry and components, with understanding of wave guides, cavities, and duplexers.

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Junior and Senior engineers for television receiver circuit design. Experienced men also needed for V.H.F. and U.H.F. tuner work.

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Duties involve designing household and portable radio receivers. FM and AM experience preferred.

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Electro-Mechanical designers. Assignments involve the design and layout of small mechanical devices at the development level.

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Applied development and design of radar and other specialized military systems.

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A special opportunity exists in the field of applying automation and printed circuit techniques in the above categories. Your imagination and engineering talents can be used in furthering this development.

Good starting salaries and working conditions with complete program of employee benefits. Opportunity for professional development with excellent facilities in Chicago area to carry on University graduate work while working full time.

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- RADIO COMMUNICATIONS
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- MICROWAVE
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Independent research & development with established control company. Capable of designing electro-magnetic devices. Experience in design of controls for A-C & D-C service to 750 volts from 10 to 1000 amperes. Substantial salary. Advancement.

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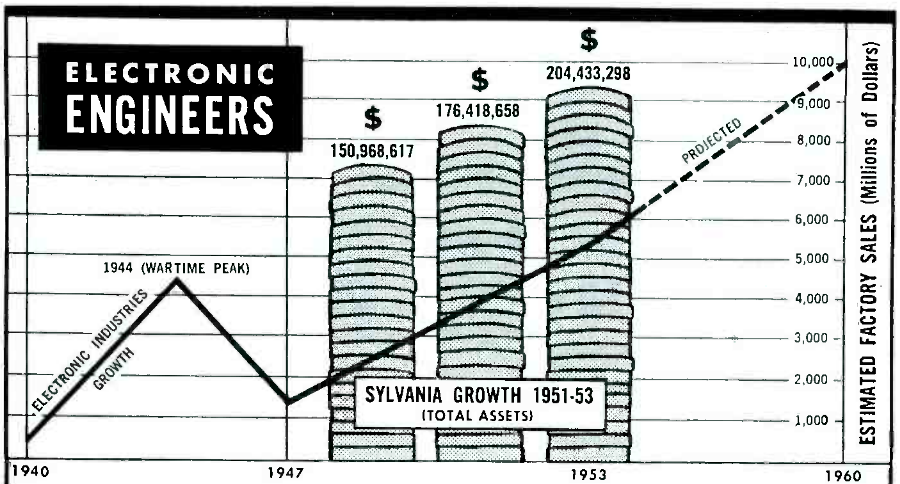

How Sylvania An Aggressive Leader In Electronics Can Help You Chart Your Growth In The Field

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And, fast as electronics is expanding, Sylvania continues its important growth as a leader in the industry. The electronics field has jumped from $1,350,000,000 in 1947 to $5,500,000,000 in 1953 and is projecting a $10 billion year in 1960; Sylvania's assets have jumped from $150 million in 1951 to over $200 million in 1953. Today Sylvania is reaching out in more new directions, heavily emphasizing research, and development of new products.

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Transistors • Microwave Diodes
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Live and work in Boston's suburbs: WOBURN, NEWTON, IPSWICH Plants. Excellent living conditions and unrivalled educational facilities.
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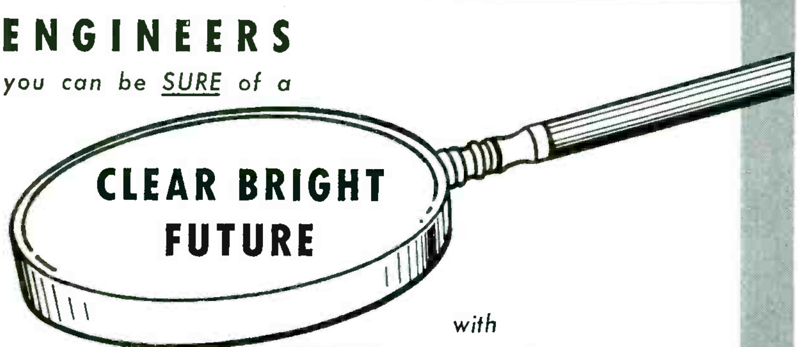
Please forward complete resume to:
Mr. Miles Weaver, Personnel Manager
ELECTRONICS DIVISION

SYLVANIA
ELECTRIC PRODUCTS INC.
Woburn, Massachusetts

ENGINEERS

you can be SURE of a



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Westinghouse

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Electrical Design Engineers: Designing, costing and guiding construction of processing and testing equipment, e.g. atmosphere furnaces, electrical welders, induction heaters, X-ray seasoning and test units, waveguide apparatus, transistor life test units.

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COMPONENTS CF-1-A THRU CF-7-A

ALL NEW MATERIAL

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We Carry A Large Stock of Electronic Components & Equipment

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—Portable—for stopping motion—adjustable frequency—Complete with 1D21/SN4 tube, reflector & Power Supply $39.50

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100,000 1619 Tubes

$7,000.00

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FOR SALE

2 Each, UHF Radio Noise and Field Strength Meter, Measurements Corp. Model 58 with Accessories.

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Haydon relay 115v 60 cy adjustable in 5 sec. steps to 40 seconds max. 3½x3½x2½...............$4.50

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Hundreds of other items. Write for listings.

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Type R19/TRC-1 Receivers.

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Part of GCA equipment. Manufactured by Philadelphia Naval Yard. Approx. 200 each required.

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MULTIPLE RANGE CONTINUOUS INDICATING PORTABLE TACHOMETER

Three Ranges in R.P.M. and in F.P.M.
LOW RANGE 300- 1500
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LARGE OPEN DIAL 4″ DIAMETER...$37.50

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New Sola Const. Volt. Transformers
Input 95-125VAC, output 118VAC 60 cycle 165VA, $24.95, 225VA $32.95, 310VA $42.50, 500VA (115V out) $47.50, Raytheon 120VA (115V out) $19.95.

Plate Transformer
Primary, 240/220/200 VAC 60 cycles 1 Phase secondary 1310VCT@850 Ma. $19.95.

Filament Transformer
Primary, 115VAC 60 cycles 1 Phase, dual secondary 2.2V@18 amps each, $3.95.

1% Wire Wound Precision Resistors
Up to 1 meg., 35¢ each. Send us your list.

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WILL BUY ALL

Art-13 T-47A Transmitters $200.00
BC-348 Rec'r modified $35.00
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BC-788C Altimeters $100.
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Ship via Express C.O.D., Subject to Inspection to:

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WANTED

ART-13 transmitters, parts, and components, DY-12 and DY17 dynamotors, CU-25 etc. Also ARC-1 and ARN-7 material.
Advise price, condition first letter.

FLORIDA AIRCRAFT RADIO & MARINE, INC.
International Airport Branch
P. O. Box 205 Miami 48, Florida

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PRECISION LABORATORY POTENTIOMETERS

Helipot 100 ohm 0.5% $15 Reg $6.49*
Micropot 20,000 ohm 0.1% ... $5.49
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* Buy In Quantity Six for $26.

VARIABLE VOLTAGE XFMRS

SUPERIOR-GR-STACO-UTC

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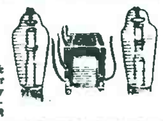
Cased 0-270V/9A†	132.00
Cased 0-270V/12A†	103.00
Cased 0-270V/15A†	132.00
Cased 0-270V/30A†	163.00
GR50A/0-135V/45A/LN	100.00
GR50B/0-270V/31A/LN	115.00

(LN) Like New. (*) New. (†) 3 Phase New
Industrials: 6 or more 10% disc.

866A KIT and XFORMER



(2) 866A Tubes & Sockets. Transformer Rated, PRI 115V/60cy Sec 2.5VCT/10A Hi-Volt Insulation $4.99

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#9-115 4 Drawers 3 Div. Per Draw 9¾H/10¼W/11¾D. $3.99; 4/$14
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Plastic Utility Boxes Size 10¾" x 6.4" x 2¼". 1-12-18-18 Compartments @ $1.59 ea. Your choice any Seven.
"TAB" Special ..... 7 for $10
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SEE IN DARK TUBE
Image-Converter Tube Hi-Sensitivity simplified design 2" dia Willemite screen—Resolution up to 350 lin/in Tube & Data "TAB" Special .... $10 2 for $18
Snooperscope Pwr Supply 1800VDC/35MA. Using Doubler Crkt. Transformer, Rectifiers, Sockets, Resistors, Capacitors and Diagram 115V/60cy Oper ... $6.98

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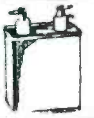


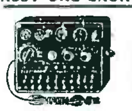
4MFD 1200VDC or 10MFD 600VDC **$1.50** lots of 12
Or any assortment of 12
Sold Singly $1.79

HI-MEG HI-VOLT RESISTORS

.75 MEG "MVP" 10W 10KV	.79	10 for $5.00
2MEG 5W 10KV	.99	10 for 8.50
2.5 MEG "MVT" 5W 7.5KV	.89	10 for 7.00
7 MEG "MVP" 10W 10KV	1.35	10 for 12.00
12 MEG 10W 10KV	1.69	10 for 15.00
20 MEG "MVO" 35W 50KV	2.25	10 for 20.00
50 MEG "MVE" 25W 40KV	2.75	10 for 25.00
100 MEG "MVP" 10W 10KV	2.25	10 for 20.00

ASST ONE EACH QTY 8 for $12.95

TEST EQUIPMENT *Prices Slashed*



EMC #208 Tube Tester $24.90 Reg $21.95
EMC #106K VTVM Kit $23.90 Reg $21.95
EMC #104 Multitester (20,000 ΩPV) $26.95 Reg $23.95
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Write for Daily "TABOGRAM" Bargain Sheet

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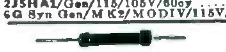
AY1 & AY5 Autosyn/26V/400 cy $4.98
AY1 Autosyn ..... 2/$3.98
C69406-1 Type 11-2 Syn Rptr/115V/60cy ..... 2/$38
C56701/Syn Rptr/115V/60cy $21
C78249/Syn Diff/115V/60cy ..... $7; 2/$12
2J1G1/Syn Tr/57.5/57.5V/400cy ..... $6; 2/$11
2J1F1/Syn Gn/115/57.5V/400cy ..... $9; 2/$16
2J5HA1/Gen/115/105V/60cy $57
6G Syn Gen/MK2/MODIV/115V/60cy $49

PRECISION RESISTORS



Western Elec.—IRC—Wilkor-Mepco
All 1% Accuracy Gtd
"TAB" SPECIAL 35c EACH; 10 OF ONE VALUE **25¢ Ea.**
100 OF ONE VALUE $20.00
10 ASSORTED VALUES (U-SELECT) $3.00

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Heinmann Magnetic Bkrs. Amps: .230, 3, 7, 9, 12, 30, 35 40, 60, 180 EA: 1.98 12/$20; 50/$75
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CG166U/42"/UG52U(E165003) ..... $7, 3/$18
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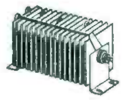
MAGNETRON TRAN 6.3V/40A/60KV $36

NEW "BERG" Sewdish Steel PLIERS

Tapered Diagonal, Cutters, Box Joint $3.49
Long Nose Pliers, w/cutters $2.48
Industrials Qty 12 addn'l 10% Disc

NEW "TABTRON" SELENIUM RECTIFIERS
ENGINEERED for INDUSTRY



"TAB" manufactures power rectifiers to your specifications. From one amp up to and above 1000 amps, convection or fan cooled, single or 3 phase. "NEMA" & JAN Specs. Write for catalog.

* FULL WAVE BRIDGE
DATED & ONE YEAR GTD

Max Amp	18VAC* 14VDC	36VAC* 28VDC	72VAC* 56VDC	130VAC* 100VDC	144VAC* 118VDC	266VAC* 217VDC	Ctr Tap AC/DC 30/12	3 Phase Bridge 120VAC 150VDC	240VAC 300VDC
1	$1.35	$2.35	$4.60	$7.50	$12.75	$22.25	$2.10	$14.90	$28.95
2	2.00	2.75	6.00	9.25	15.75	28.85	Q	15.90	30.90
3	2.95	4.15	7.90	12.90	Q	Q	Q	Q	Q
4	3.50	6.50	14.50	22.00	26.75	38.85	2.95	18.90	36.95
6	4.10	8.00	17.50	29.95	34.75	54.85	3.25	20.90	39.95
10	5.95	11.50	25.00	41.50	44.75	84.85	4.75	36.90	71.95
12	7.50	14.50	30.00	44.50	54.75	90.85	5.95	41.90	81.95
20	12.00	23.00	49.00	72.00	82.75	160.85	7.95	50.90	97.95
24	14.50	29.00	58.00	81.50	94.75	190.85	9.95	89.90	159.95
30	18.00	34.50	72.00	110.00	128.75	235.85	Q	117.90	225.95
36	22.50	42.50	88.00	135.00	165.75	......	14.95	134.90	269.95
50	29.75	54.50	105.75	175.00	195.75	405.85	23.95	179.90	359.96

NEW "BRADLEY" RECTIFIER BOOK $1.96
NEW SARKES TARZIAN RECTIFIER BOOK & TECHNICAL MANUAL ..... .96

NEW HIGH CURRENT POWER SUPPLIES GTD*

Variable 0-28VDC. Completely Built. Ready to Go Full Wave Selenium Rectifier. Transformer, Variac, Volt & Amp Meters, Switch Terminals & Fuse. In Hvy Duty Steel Cabinet Std 115V/60cy Input 110 & 220V† (3 Phase) to order.
* One Year

Stock Number	Continuous Rating	With Meters
T28V5A	0-28WVDC at 5 Amp	$45.00
T28V5ACC	5 Amp (1% Ripple)	60.00
T28V12A	0-28 VDC at 12 Amp	99.00
T28V12ACC	12 Amp (1% Ripple)	139.00
T28V24A†	0-28 VDC at 24 Amp	135.00
T28V/24ACC†	24 Amp (1% Ripple)	195.00
T28V50A†	0-28 VDC at 50 Amp	260.00
T28V/50ACC†	50 Amp (1% Ripple)	370.00
T28V100A	0-28 VDC at 100 Amp	469.00
T28V/100ACC†	100 Amp (1% Ripple)	650.00

New! Low Priced High Current Basic Supplies

Consisting of Transformer & Full Wave Bridge Rectifier mfg & wired with no frills. Ready to deliver constant DC Power.

Stock Number	Continuous Rating	Basic
B28V/5A	0-28WVDC at 5 Amp	$35.00
B28V/5ACC	5 Amp (1% Ripple)	49.00
B28V/12A	0-28VDC at 12 Amp	75.00
B28V/12ACC	12 Amp (1% Ripple)	109.00
B28V/24A	0-28 VDC at 24 Amp	110.00
B28V/24ACC	24 Amp (1% Ripple)	159.00
B28V/50A	0-28 VDC at 50 Amp	205.00
B28V/50ACC	50 Amp (1% Ripple)	319.00
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B12V/50A for BC1;1		110.00
B28V/100ACC	100 Amp (1% Ripple)	499.00

Now Power Your Gov't Surplus Recr's & Transmitters from the Set
Power Pack or Dynamotor

B28V/5A for ARC5, BC312, BC342, BC348 $35.00
B28V/24A for BC654 or BC375 ..... 110.00
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B28V/100A for ART13 ..... 395.00

CONVERT YOUR 6V "FAST" CHGR
to 12v/50A as well as 6v/100A Use Details & Rectifier $22 ea; 3/$60

HEAVY DUTY BATTERY "FAST" CHARGER RECTIFIER

13-0 13V (CT) 100 Amp Fan Cooled or 34 Amp Air Cooled. Replacement 6 Volt Booster Charger. Model CR16 ..... $10 @ 3 for $27
16-0-16V (CT) Fan Cooled. For 12V/60Amp and 6V/100 Amp Booster Chargers.
Model CR30 ..... $11 @ 3 for $30

RECTIFIERS XFMRS

PRIMARY 115V 60cyc
SEC 18-15-9-0-9-15-18 Volts
4 amp ..... $8.65; 2 for $15.75
12 amp ..... $16.65; 2 for $29.95
*24 amp ..... $35.75; 2 for $69.95
*50 amp ..... $59.00; 2 for $112.00
*100 amp ..... $108.; 2 for $210.00
18 Volt 2 amp .... $1.98 @, 3 for $5, 12 for $18
25.2V/2A or 12.6V/4A or 2X12.6V/2A Cased 2½ W/3½H/2¾"D ..... $3.59; 3/$10; 12/$36
* DUAL PRIMARY 115 & 220V 60cy

New Rectifier & Transformer Combo Sel/Bridge 115 v 60 cyc Input

up to 14VDC at 12 amps Cont. Duty ... $19.98
up to 28VDC at 4 amps Cont. Duty 14.98
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*up to 28VDC at 24 amps Cont. Duty .. 59.98
*up to 28VDC at 50 amps Cont. Duty .. 117.98
*up to 28VDC at 100 amps Cont. Duty . 199.00
*TRANSFORMER HAS DUAL INPT 115&230V

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Variable DC Power Supply Full Wave Rectification 6000MFD Condenser Filter Ready to Operate Input 115V 50 cy Output 6.3V or 12.6V 2 Amp.
Model 2DCF (2 amp) $12.98
Model 5DCF (5 amp) $22.98
5DCF ACC/5 amp/1% Ripple $32
BCT2/2A/12 & 6V Battery|TR Charger .. $5.98

"TAB" *All Mdse Sold* ON MONEY BACK GUARANTEE

NEW RECTIFIER CHOKES

CH1/1 Amp/0.1HY/1.4 *Ohm*/3 Lbs $3.95
CH2/2 Amp/0.1HY/.67 *Ohm*/3 Lbs $5.95
CH07/4 Amp/.07HY/.6 *Ohm*/10 Lbs $7.95
CH01/12 Amp/.01HY/.1 *Ohm*/12 Lbs $14.95
CH004/24 Amp/.004HY/.025 *Ohm*/20 Lbs .. $29.95
CH001/50 Amp/.001HY/Hipersil Core $54.05
CH0035/70 Amp/.0035HY/.0096 *Ohm* $66.00

TUBES

"TAB" TESTED & GUARANTEED
PRICES SUBJECT TO CHANGE
WRITE FOR COMPLETE TUBE LISTING

OA2	$0.88	4J52	$199.99	6SN7GT	$.59	211/VT4C	$5.86	2050	$1.48
OA3/VR75	1.04	5C21/C6J	9.89	6SQ7GT	.62	RX215	7.98	2050W	2.48
OB2	1.37	5C22	38.95	6T8	.96	RX233A	3.49	5618	3.50
OB3/VR90	.96	5D21	14.98	6U4	.74	250TH	18.97	5635	11.57
OC3/VR105	.92	5R4GY	1.28	6U8	.99	250TL	17.75	5637	6.53
OD3/VR150	.92	5R4GYW	1.75	6V6	1.39	304TH	12.49	5641	7.67
1B3/8016	.79	5U4G	.54	6V6GT	.59	304TL	12.49	5642	11.57
1B22	8.87	5V4G	.95	6W6GT	.39	371B	.88	5644	11.57
1B23	8.87	5Z3	.99	6X4	.49	388A	1.48	5646	11.57
1B24	8.98	6A7	.85	6X5GT	.54	446A	1.05	5651	2.24
1B26	2.24	6A8GT	.90	6Y6G	.88	446B	3.48	5654	1.72
1B27	11.98	6AC7	.80	7C7	.82	450TH	49.37	5656	12.08
1B35	9.15	6AG5	.80	7F7	.72	450TL	52.00	RK5657	298.48
1B37	14.87	6AG7	1.14	7F8	1.24	460/HF200	15.95	5663	1.06
1B42	17.48	6AH6	1.21	7H7	.72	CK502AX	1.49	5670	3.44
1B46	1.98	6AJ5	1.40	7N7	.92	CK503AX	1.49	5687	3.74
1L4	.46	6AK5	.45	7Y4	.72	CK505AX	1.79	5691	7.54
1L6	1.35	6AK5W	2.79	8D21	298.00	CK512AX	1.45	5692	8.52
1LD5	.98	6AL5	.92	12AL5	.54	CK532DX	1.89	5693	6.24
1LN5	.78	6AL7GT	.98	12AT6	.54	WL532A	3.68	5694	3.65
1V2	.70	6AN5	3.27	12AT7	.54	CK536AX	.89	CK5703	1.29
1X2A	.49	6AN5	.52	12AU7	.59	CK539DX	2.19	5713	120.00
2C39A	26.98	6AQ5W	2.78	12AV6	.52	CK541DX	1.99	WL5736	130.00
2C40	4.98	6AQ6	.81	12AV7	.98	CK543DX	.99	5749	1.72
2C43	17.48	6AQ7GT	1.29	12AW6	1.18	CK544DX	.99	5751	2.88
2C44	1.15	6AR6	3.27	12AX7	.98	CK546DX	1.99	5769	298.00
2D21	1.15	6AS5	.72	12AY7	1.69	WL652	65.00	5812	2.99
2E43	1.49	6AS6	2.22	12BA6	.59	WL676	34.98	5820	148.00
2J31	27.00	6AS7G	3.48	12BA7	.94	703A	4.72	5844	2.98
2J32	29.48	6AT6	.54	12BD6	.59	705A	1.88	5881	2.70
2J33	24.98	6AU5GT	1.10	12BE6	.89	707A	7.90	8012	2.58
2J34	24.98	6AU6	.98	12BF6	.55	707B	14.88	8013	3.92
2J36	[illegible]	6AV5GT	.98	12BH7	.29	715A	4.96	Xtal Diodes	
2J42	148.98	6AV6	.49	12SA7GT	.68	715B	7.94	1N21A	$1.55
2J49	84.00	6B4G	1.18	12SF7GT	.84	715C	17.98	1N21B	2.10
2J50	99.98	6B8G	.60	12SG7	.80	719A	24.48	1N22	1.22
2J51	238.98	6BA6	.45	12SH7	.63	721A	3.97	1N23	1.35
2J55	48.45	6BA7	1.09	12SJ7GT	.54	722A/287	1.94	1N23A	1.89
2J61	29.98	6BC7	1.23	12SK7	.66	723A/B	16.98	1N23B	2.00
2K22	23.48	6BC7	.83	12SL7GT	.62	724A	3.95	1N25	4.98
2K23	11.48	6BD6	.54	12SN7GT	.69	724B	2.74	1N26	8.75
2K25	28.49	6BE6	.58	12SQ7GT	.54	725A	9.98	1N27	1.55
2K28	27.49	6BG6G	1.58	15E/C82	349.00	726A	14.49	1N34/.40, Q 100	$34
2K33	218.48	6BH6	1.58	SRX16	149.00	726B	31.00	1N34A	.88
2K39	134.99	6BK7	1.58	FG17	3.90	726C	44.00	1N35	1.65
2K41	126.00	6BL6	58.00	24G/3C24	1.32	801A	.42	1N38A	1.29
2K42	219.48	6BL7GT	1.19	25BQ6GT	.98	803	3.48	1N41	8.95
2K45	72.50	6BN7	2.69	25Z5	.78	805	3.22	1N42	16.95
2K48	99.48	6BQ6GT	1.65	25Z6GT	.58	807	1.25	1N45	1.45
2P23	298.00	6BQ7	.52	35Z5GT	.54	808	2.62	1N46	.69
2X2	.42	6C4	.59	35T	4.88	809	3.58	1N47	4.00
3B22	2.48	6CB6	1.69	35L6	.67	810	10.88	1N51	.47
3B23/RK22	4.95	6CD6G	4.98	35Y4	.88	811	2.98	1N52	.45
3B24	4.70	6D6	6.20	45Z3	.88	812	2.70	1N54A	.78
3B26	3.70	6F4	.79	50A5	.76	813	11.48	1N58A	1.00
3B28	7.90	6F6	9.89	50C5	.54	814	4.98	1N60/.40, Q 100	$34
3C22	85.00	6G5/6CJ/5C21	6.66	50L6GT	.62	815	5.98	1N63/K63	2.49
3C23	8.67	6J4	.58	RK61/XFG1	2.08	826	7.94	1N64	.69
3C31/C1B	9.51	6J5	.58	FG67	14.68	829B	12.49		
3C33	9.51	6J6	.54	HY69	4.98	832	7.72		
3C45	9.98	6K6GT	.58	71A	.74	832A	9.92		
3D6/1299	.69	6K7	1.08	80	.78	833A	39.65		
3D21A	2.95	6K8	1.08	81	.78	836	5.95		
3D22	13.97	6L6	1.08	83	1.38	849	29.45		
3D23	4.90	6L6GA	1.08	83V	1.12	860	4.48		
3E29	14.49	6SA7GT	.66	100TH	1.22	866A	1.25		
3K23	349.00	6SC7	.90	FG104	9.88	872A	3.29		
3K27	149.00	6SF5	.78	FG105	24.98	1613	2.92		
4C35	21.49	6SF7	.73	CV148	19.48	1614	.82		
4D21	18.99	6SG7	.64	FG166	9.98	1625	1.95		
4E27	22.49	6SK7GT	.56	FG172	48.49	1642	.32		
4J22	123.51	6SL7GT	.64		29.00		.62		
4J31	99.51								

Dept. 2E-5
We Wholesale to Dealers, Stock Markets, Xporters & Tube Brokers! Get Our Price B4 U BUY!!!

IMPORTED POCKET AC-DC *Multitester*

Model TS-52
$6.49 ea
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Sold Singly $6.89
(plus 40c ea ship in U.S.A.)
Smallest Precision Built Pocket VOM Jeweled 3" D'Arsonval meter., 1000 Ohms per/v. Ranges AC & DC.
Volts: 0-10, 250 & 500V. DCMA: 0-1 & 250 MA Ohms:0K. 0-10 Measures 2⅛" D. 4" L. 3⅛" W
Model 12C Pocket size VOM, engineerp for Hi-Accuracy & durability. 1000 Ohms per/V. Reads AC & DC Volts: 0 to 5. 25, 250. & 1000V. DCMA: 0 to 1, 10, 100 MA. Ohms: 0 to 10K & 100K. Size 1¼" D.34⅛" L. 3¼" W. Test Leads. $9.89 ea (plus 40c ea Ship in U.S.A.)
Special Model TS-52 & 12C @ $15.00

230 TO 115V AUTOFORMERS

For 220-240V/50-60cy Input. To 110-120V or Step-up with Cord Plug & Receptacle.

TPA050/50W	$2.55
TPA100/100W	4.00
TPA250/250W	6.75
TPA500/500W	8.25
TPA075/75W	3.65
TPA200/200W	5.75
TPA300/300W	7.25
TPA750/750W	11.75
Model TPA1000/1000 Watts/1 KW	16.95

TPA1500/1500W .. $22.50; TPA2000/2KW .28.95
Model TPA3000/3000 Watts/3KW 49.95

106 WATT PHOTO-FLASH KIT—AC

Includes transf condensers two/525MFD/450V Total 103W, Seeds. Resistors, capacitors, rectifier, flash tube in indicating flash gun, guide $40 on Koda chrome. Special $33.98

BATTERY 106 WATT/SCDS KIT

Same specs batteries $32.98
525MFD/450V/53W Seds conds new low leakage famous mfgr ..... $9 @ 2/$16
16MFD/2500VDC/16WS Conds Oil ... $6 @ 2/$10
16MFD/1.5 to 2.5KV/60WS Cond .... $5 @ 2/$8
CK5517 mini gas Rectifier $2.88
600VAC Selenium Rectifier $4.25
1600VDC Selenium Rectifier $2.98
Electronic Flash Handbook ckt data 50c

PHOTOFLASH & STROBE LAMPS

"TAB" No.	Replaces	W-Sec Max	Each
TLH	FA 104/FT118	150	$5.98
THI	Amglo 5804X	100	10.98
23ST	GE FT 210	200	9.98
THVA	SYLV. 4330	200	9.98
V4X4	X400	200	10.98
TLX	DX & FA10Q	150	9.00
TDX	DXC/250-350	150	10.00
853GTQ	FT 503	2000	49.98
FT105	GE FT105	150	4.29

TRIGGER COIL LO & HI VOLT FLASH $1.47
Write for "TAB" Flash Tube Data 50c

"TAB" METER SPECIALS

0-1MADC/3½ Rnd ..... $3.95, 2/$7
0-1MADC/3½ Sq $7
0-5MADC/3½ Rnd $3.70
0-100MADC/3½ Rnd ... $3.50, 2/$6
150VAC/2½ Rnd/WH $3.25
150VAC/3½ Sq/WH $4.95
800VDC/3½ Sq $8.95
1500VDC/3½ Rnd $4.95
5MADC Tuning Meter/AN ..... $1.39, 3/$4
Weston 120MA/RF/3" Rnd/301# ... $10.95, 2/$20
Weston VU −20 to +3/Sq 3"/301#. $15.98, 2/$30

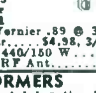
GOV'T SURPLUS EQUIPMENT
New—Low, Low Prices

LM Freq. Meter 125-20,000 KC $69.95
T-30V Throat Mike ..... 98c @, 12 for $8
RM25 Field Telephone Set or Remote Control. New. O'Seas Packed ..... 2/$29.95
BC906 Freq. Meter 14-28Mc Tubes $15.95
R19/ARC-4 Transceiver 100-156Mc. less tubes & dynamoter. Excellent Cond $27.95
Scanner Mount, Unit of AN/APG-13B RADAR. Used, Good Cond $6.98
EE65 Telephone Test Set Complete $15.98
RCA Rider Chanalyst, Type 162C $65.00
G.E. YYZ-1 Decade Scaling Unit. Rate 5X106 (5Mc) Counts Per Sec Max $252

TYPE "G" MICA CONDENSERS
HIGH CURRENT TRANSMITTING

MFD	KILO-VOLTS	FREQ. CURR.	LIST PRICE	"TAB" PRICE
.00035	20		$134.	$18.00
.0004	20	4.5A/.3MC	135.	18.00
.0005	20	6A/.3MC	135.	18.00
.0012	20	14A/1MC	142.	30.00
.0025	25	22A/3MC	325.	39.00
.01	10	27A/1MC	151.	39.00
.09	1.5	40A/1MC	70.	9.00

"TAB" BARGAIN BUYS



New Planetary Drive 5:1 & 1:1 $5.29 Reg .... $2.49 @, 3 for $9
Var Condsr 146 mmf/.030 .. 2/$2
Pentode Outpt Trto V.C. 3 for $1
IF Trans. 456KC .49 @, 6/$2
HS 30 Cord & Clip Type CD630R ... 49 @, 12/$5
"Brach" MCD4 Neon Arrester 3 for $1
Var. Condsr. 10 to 369 mmf Vernier .89 @ 3/$2
BT14/.012/25000WVDC Condsr ..... $4.98, 3/$12
Isol. Trans. V/8 110 to 220 or 440/150 W $4
Globar T2FD/850 ohms/500WRF Ant $2

PULSE TRANSFORMERS

Pulse Blocking Osc, 3 wndgs. 1:1:1 ratio, 1mh G.E. H'Sld. Hi V ..... $2 @, 6 for $10
Pulse Blocking Osc, Video Interstage, 3 wndgs, 1:1:1 ratio, 4.3 mh. G.E., H Sld, Hi V 1 Micro Sec. rise time ..... $2 @, 6 for $10
VM/TR Raytheon UX7361B/4 wndgs U.B.N. $3 @, 5 for $10
UTAH 352-7178/0340 type/3 wndgs ..... $5 @
WSTGHSE Pulse TR #145 EWP/L420802 $5 @
D163247 W.E. P/O SCR717A/7.5 KV Pulse $10 @
W.E. TF1A31YY/0.25µsec pulse/4300:500 ohms/1:3 & 4:5 ..... $3 @

NEW OIL CONDENSERS

25MFD/1000V ..... $8 @, 2 for $14, 6 for $36
26MFD/1000V ..... $8 @, 2 for $15, 6 for $38
0.38MFD/2400V ..... .29 @, 6 for $1, 50 for $6
0.25MFD/1200V ..... .30 @, 5 for $1, 50 for $7

NEW RELAY LIST

R7CL1 Clare SK 5010 VAC SLD /DPDT/18-28 VDC/3A CTS Octal Base ..... $2.98, 3/$7.50
G.E. CR2792B/117A3/SPST/28VDC/50A CTS $1.98
R1ST1 Stevens Arnold Resonant Relay 189 Freq 240 cy ..... $3.98; 3 for $10
R10SD1 SPST/115VAC/6-80 ACTS $2.00
R11AC2 Allied-BJ DPDT/115VDC/5A CTS $1.39
R12AC3 Allied-BJ DPDT/6VDC/5A CTS .. $1.49
R14AU1 DPDT & SPNO/12VDC/10A CTS $2.25
R18LE2 Leach/DPST/70VDC/10A CTS $1.49

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COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS

10 CM.—RG 48/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 $17.50
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 $12.50
LHTR. LIGHTHOUSE ASSEMBLY. Part of RT39 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 MCS. Silver Plated $15.00
BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. Bernard Rice, each $27.50
MAGNETRON TO WAVEGUIDE Coupler with 721-A Duplex Cavity, gold plated $31.50
721A TR BOX complete with tube and tuning plungers $12.50
McNALLY KLYSTRON CAVITIES for 707B or 2K28 2700-2900 Mc. $4.00
AS14A AP-10 CM Pick Up Dipole with "N" Cables $4.50
HOLMDELL-TO-TYPE "N" Male Adapters. W. E. #D167284 ....$2.75
I.F. AMP. STRIP: 30 MC, 30 d.b. gain, 4 MC Bandwidth, uses 6AC7's—less tubes $17.50
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

3CM. DIPOLE FEED, 15" L. for APS-15 ....$14.50
MITRED ELBOW, Cast aluminum, 1¼"x⅝" W.G. W.E. Flanges. "E" Plane $3.50
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 ....$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 $35.00
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: 20 db Nominal $15.00
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 2J41 Magnetron $24.50
Rotary joint choke to choke with deck mounting ..$17.50
90 degree elbows. "E" plane 2½" radius $8.50
ADAPTER, waveguide to type "N", UG 81-U, p/o TS 12, TS-13, Etc. $7.50
ADAPTER, UG-163/U round cover to special BTL Flange for TS-45, etc. ....$2.50 ea.

PULSE NETWORKS

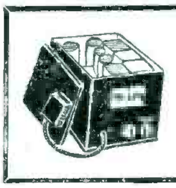
15A—1-400-50: 15 KV, "A" CKT, 1 microsec, 400 PPS, 50 ohms imp $22.50
G.E. #3E (3-84-810) (8-2.24-405) 50P4T; 3 KV "E" CKT Dual Unit; Unit 1, 3 sections, 0.84 Microsec. 810 PPS. 50 ohms imp; Unit 2, 8 Sections, 2.24 microsec. 405 PPS 50 ohms imp $6.50
7-5E3-1-200-67P, 7.5 KV "E" Circuit, 1 microsec, 200 PPS, 67 ohms impedance 3 sections $7.50
7-5E4-16-60. 67P, 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 H @ .02A. 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. 9000 Vac 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

GE #K2748-A, 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW. impedance 40:100 ohm. Pri volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifiar rated at 1.3 Amp. Fitted with magnetron well $24.50
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. Bifiar: 1.3 Amp. Has "built-in" magnetron well $32.50
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: 200/130 KW Bifiar: 1.3 Amps. Fitted with magnetron well ..$29.50

PULSE MODULATORS

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-B, 3-'72's, 1-'73. New ....Less Cover—$135
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 900 mc. at .001 duty. Complete with pulser unit and all tubes $185.00



PE 204 VIBROPACK

Input 12VDC/0.58 Amp. Out: 2x4.3V/50MA. 2x45VDC/0.5 MA. 2x85VDC/5MA. New. Complete with Spare Vibrator. Well-Shielded and Portable. Shown with cover removed. $6.75

LATE ARRIVALS

- L&N #1553 RATIO BOXES, $275
- ESTERLINE-ANGUS RECORDING MILLIAMMETERS, 0-1 MA $155
- IFF, AIRBORNE SET, TYPE APX-1, WITH 28 TUBES AND DYN....$21.50

MAGNETRONS

Type	Peak Range (MC)	Peak Power Out (KW)	Duty Ratio	Price
2J21A	3345–9405	50		$3.25
2J22	3267–3333	265		2.75
2J26	2992–3019	275	.002	4.50
2J27	2965–2992	275	.002	6.95
2J29	2914–2939	275	.002	22.50
2J31	2820–2860	285	.002	17.50
2J32	2780–2880	285	.002	14.75
2J38*	3249–3263	5	[illegible]	7.50
2J39*	3267–3333	8.7		7.50
2J48	9310–9320	50	.001	24.50
2J56*	9215–9275	50	.001	75.00
2J62†	2914–3010	35	.002	9.50
3J31	24–27KMC	50	.001	85.00
4J34	2740–2780	900		25.00
4J38	3550–3600	750	.001	125.00
4J42†	670–730	30	.003	169.50
5J23	1044–1056	475	.001	49.50
700B	690–700	40	.002	22.50
700D	710–720	40	.002	39.75
706EY	3038–3069	200	.001	32.50
706CY	2976–3007	200	.001	32.50
QK60†*	2840–3005	.100	CW	65.00
QK61†*	2975–3170	.100	CW	65.00
QK62†*	3135–3350	.100	CW	65.00

*—Packaged with magnet.
†—Tunable over indicated range.

I. F. AMPLIFIER STRIPS

Model 15: 30 Mc center frequency. Bandwidth 2.5 Mc. gain figure: 65 db. Uses 5 stages of 6AC7's. Has D. C. Restorer and Video Detector. A.F.C. Strip included. Input impedance: 50 Ohms. Less tubes $17.50
60 MC. Miniature IF strip, using 6AK5's 60 Mc center Freq. Gain: 95db at Bandwidth of 2.7 Mc. New. Complete with tubes $17.50

400 CYCLE TRANSFORMERS

(All Primaries 115V. 400 Cycles)

KS13101	6.3V/15A, 6.3V/0.9A, 6.3V/0.4A, 6.3V/0.2A	$3.85
KS13104	1450VCT/0.283A, 1050VCT/0.217A	7.50
KS9615	6.3V/4A, 3V/1A	1.57
KS9318	6.3V/4A, P/O R-55/ARQ-9	1.35
KS9608	1233/.35MA, 1140VCT/.07A	5.79
352-7102	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 ID-39/APG-13	4.95
352-7039	640VCT @ 380MA, 6.3V/.9A, 6.3V6A 5V/6A	5.49
702724	9800/8600 @ 32MA	8.95
K59584	5000V/290MA, 5V/10A	22.50
KS9607	734VCT/.177A, 1710VCT/.177A	6.79
352-7273	700VCT/350MA, 6.3V/0.9A, 6.3V/25A, 6.3V/.08A. 5V/CA	6.95
352-7070	2x2.5V/2.5A (2KV TEST) 6.3V/2.25A, 1200/100/750V. @ .005A	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, 6.3V/CT 20A, 2x6.3VCT/6A	4.75
RA6400-1	2.5/1.75A, 6.3V/2A—5KV Test	2.39
901692	13V/9A	2.49
901699-501	2.77V @ 4.25A—10KV Test	3.45
901698-501	900V/75MA, 100V/.04A	4.29
Ux8855C	900VCT/.067A, 5V/3A	3.79
RA6405-1	800VCT/65MA, 5VCT/3A	3.69
T-48852	700VCT/806MA, 5V/3A, 6V/1.75A	4.25
352-7098	2500V/6MA, 300VCT/135MA	5.95
KS9336	110V/50MA TAPPED 625V 2.5V/5A	3.95
M-7474319	6.3V/2.7A, 6.3V/.66A, 6.3VCT/21A	4.25
KS8984	27V/4.3A, 6.3V/2.9A, 1.25V/.02A	2.95
52C080	650VCT/50MA, 6.3VCT/2A, 5VCT/2A	3.75
32332	400VCT/35MA, 6.4V/2.5A, 6.4V/.15A	3.85
68G631	1150-0-1150V 2MA	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
KS9685	6.4/7.5A, 6.4V/3.8A, 6.4/2.5A	4.79
70G30GI	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/1.79A, 5V/13A, 6.5V/6A, 6.5V/1.2A, D/O BC800	4.95

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
35X.059	19	3.8	405	.095	$4.35
POSX-15	14	2.8	220	.08	8.95
DA-7A	28	27	1100	.400	15.00
DM 33A	28	7	540	.250	3.95
23350	27	1.75	285	.075	3.95
B-19	12	9.4	275	.110	6.95
			500	.050	
DA-3A*	28	10	300	.260	6.95
			150	.010	
			14.5	5.	
PE 73 CM	28	19	1000	.350	17.50
BD 69‡	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	2.50
DM 25†	12	2.3	250	.05	6.95
BDAR 93	28	3.25	375	.150	6.95

‡ Less Filter. * Replacement for PE 94.
† Used, Excellent.
PE 94-, Brand New 5.95

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 $32.50
PE206: Input: 28 vdc, 36 amps. Output: 80 V 800 cy. 500 volt-amp. Dim. 13 x 5½ x 10½. New $22.50
EICOR—ML 3011-5, Input: 13.75V; 18.4A. Output: 115 V/400~, 3ϕ, 0.95 PF. New $59
PU 7/AP. Input: 28 vdc/160A. Output: 115 VAC, 400~, 1ϕ, 2500 VA., 21.6 Amp. Volt, and Freq. Reg. Used, Exc. $75

MICROWAVE ANTENNAS

3 cm. Horn, 1" x ½", with twist and 180 deg. bend. With dielectric window $22.50
AT49/APR—Broadband Conical, 300-3300 MC, Type N Feed $8.95
Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½' x 3'. New $72.50
Discone Antenna. AS 125 APR. 1000-3200 mc. Stub supported with type "N" connector $14.50
AS14A/AP. 10 CM pick up dipole assy, complete w/ length of coax and "N" connectors $4.50
AS46A/APG-4 Yagi Antenna, 5 element array ...$22.50
30' **Parabolic** Reflector Spun Aluminum dish $4.85
AN/APA-12—Sector Scan adaptor for APS-2 radar—Complete Kit $37.50
TPS-3, 10 Ft. Dish, "Chicken Wire" Parabola. Extremely lightweight, portable $125.00
AN-154 3 vertical dipoles working against a rectangular mesh approx. 3'x4'. Freq. 140-200 mc. with lobing switch (115v, 60 cy) and portable slatted crate. Extremely rugged $27.95
LP-24 Alford loop, for use with glide-path transmitters (MRN-1, etc.) 100-108 mc $32.50

POWER TRANSFORMERS

COMBINATION—115V/60 ~ INPUT

CT-133	150-C-150V/65MA, 6.3V/2.5A, 6.3V/0.6A	$1.79
CT-127	900V/25MA PK. 5V/2A, 2V/7.5A	2.79
CT-006	350-0-350V/120MA, 5VCT/3A, 2.5VCT/12.5A, 2.5VCT/3.5A	4.39
CT-965	78V/0.6A, 6.3V/2A	1.95
CT-004	350-0-350V/90MA, 5VCT/3A, 2.5VCT/12.5A	4.60
CT-002	350-0-350V/50MA, 5VCT/2A, 2.5VCT/7.5A	3.65
CT-479	7000V/.018V, 2.5V/5A/17,800 V. Test	22.50
CT-013	450-0-450V @ 200MA, 10V/1.5A, 2.5, 3.5A, 5V/3A	4.35
CT-403	350VCT .026A 5V/3A	2.75
CT-931	585VCT .086A 5V/3A. 6.3V/6A	4.25
CT-929	4200V/.001A, 2.5V/2A, 6.3VCT/.6A	5.35

PLATE—115V/60 ~ INPUT

PT 07	400VCT/4.0 AMPS For RA43	17.50
PT 034	125V/45MA (For Preamp)	$1.15
PT 157	660-0-660VAC (500VDC) or 550-0-550 VAC (400VDC) at 250 MADC	8.70
PT 167	1400-0-1400 VAC (300MADC) or 1175-0-1175 VAC (1000VDC) at 300 MADC	22.50
PT 168	2100-0-2100 VAC (1750VDC) or 1800-0-1800 VAC (1500VDC) at 300 MADC	33.00
PT 371	210-0-210V at 2.12 Amp	9.45
PT 133	3140/1570V. 2.36KVA	85.00
PT 801	22,000V/234 MA., 5.35 KVA	115.00
PT 521	7500V/.06A. Half Wave	59.50
PT 913	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

FILAMENT—115V/60 ~ INPUT

FT-140	5VCT @ 10A 25KV Test	17.50
FT-157	4V/16A, 2.5V/2.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25A/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 1.2V/7A, 6.4V/10A 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-38A	6.3/2.5A, 2x2.5V/7A 5KV Test	2.79
FT-650	2.5V/10A-3KV TEST LO-CAP	7.50
FT-025	2.5VCT/10A, 10KV TEST	6.95

THERMISTORS

D-164699 Bead Type DCR: 1525-2550 Ohms @ 75 Deg F. Coefficient: 2% Per. Deg. Fahr. Max. Current 25 MA AC/DC $1.00
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D-167613 Disk Type DCR: 355 Ohms @ 75 Deg. F.P.M. 2.5%, 1 Watt $1.00
D-166228 Disk Type 7120 Ohms @ 60° F. 4220 Ohms @ 80°F. 2590 Ohms @ 100°F., 1640 Ohms @ 120°F.. $1.00

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1B23	3.75
1B24	4.50
1B27	8.75
1B32	1.00
1B35	4.75
1B42	4.50
1C21	1.50
1P23	2.00
1P24	1.50
1P30	2.25
1P36	2.50
1V5	1.50
1Z2	2.00
VG-2	10.00
2AP1	5.00
2C21/1642.	.50
2C22	.50
2C20A	.50
2C33/RX-233A	1.25
2C34/RK-34	.25
2C39A	9.00
2C40	6.50
2C43	12.00
2C44	.50
2D21	.75
2D21W	1.75
2E22	2.50
2E24	2.25
2E26	3.25
2J21A	3.50
2J26	2.25
2J27	2.50
2J29	25.00
2J30	50.00
2J31	15.00
2J32	15.00
2J33	15.00
2J34	15.00
2J36	50.00
2J37	10.00
2J38	15.00
2J39	10.00
2J40	25.00
2J50	35.00
2J55	50.00
2J56	50.00
2J61	15.00
2J62	5.00
2J-B51	1.00
2K25	12.50
2K30	100.00
2K33A	60.00
2K41	90.00
2K54	20.00
2K55	15.00
2P21 (Image Orthicon)	250.00
2V3G	2.25
2x2/879	.25
2X2A	1.00
EL3CJ	7.50
3A4	.50
3A5	.50
3AP1	5.00
3B22/EL1C	1.50
3BP1	2.00
3B24	2.00
3B24W	5.75
3B25	3.00
3B26	3.25
3B28	3.50
3C23	5.00
3C24/24G	1.00
3C45	7.00
3D21A	6.00
3D22	9.75
3DP1A	7.50
3E29	9.00
3EP1	1.50
3FP7A	5.00
3GP1	2.50
3HP7	3.00
3KP1	7.25
4AP10	3.75
4B22	6.50
4B26	3.50
4B27	3.50
4B31	25.00
4C22/HF-100	7.50
4C27	4.00
4C35	15.00
4E27	12.00
4J34	20.00
4J35	75.00
4J42	25.00
4J52	50.00
5AP1	2.00
5B21	3.50
5BP1	2.00
5BP2A	2.50
5BP4	2.00
5C22	30.00
5C30/C5B	1.50
5CP1	2.75
5CP7	7.50
5D21	8.50
5FP7	1.00
5FP14	5.00
5GP1	5.00
5J23	25.00
5J29	7.50
5J30	15.00
5J32	25.00
5JP1	12.50
5JP2	7.50
5JP4	7.50
5JP5A	7.50
5LP1	9.75
5R4GY	1.00
C6A	10.00
C6F	10.00
C6J	5.00
C6L/5528	3.75
6AC7W	1.25
6AJ5	1.25
6AJ6	2.50
6AN5	3.00
6BM6	35.00
6C21	15.00
6G4/X-102B	2.50
6J4	3.75
6L6GAY	1.25
6Q5G	3.25
6SB7Y	1.00
6SC7GTY	2.00
6SK7Y	.50
6SN7WGT	2.00
7BP7	1.00
7C29	50.00
7CP1	15.00
9GP7	5.00
9LP7	3.50
9MP7	7.50
10Y	.25
12A6	.50
12GP7	14.00
12J5WGT	2.50
12K8Y	.50
12L8GT	1.00
LM-15	250.00
15E	1.50
15R	.25
FG-17/5557	3.00
RK-19	1.25
RK-20A	12.50
RK-21	1.00
PJ-22	1.75
RK-23	3.00
HK-24	2.75
CE-25A/B	2.00
28D7	.75
28D7W	1.50
TWIN 30	10.00
FG-32/5558	7.25
FG-33/5720	11.50
GL-34	1.00
35TG	5.75
VC-50	5.00
FP-54/5740	44.00
HK-54	1.75
RK-60/1641	1.75
RK-62	1.75
FG-67/5728	10.00
RK-72	.75
RK-73	.75
75T	5.00
75TL	5.00
FG-81A	5.00
FG-95/5560	14.00
C-100D	2.00
100TH	5.75
RX-120	15.00
VT-127A	2.00
F-128A	50.00
HK-154	3.00
VT-158	10.00
FG-190	3.50
HF-200	9.50
C-202	10.00
203A	2.00
203Z	5.00
204A	5.00
205B	.50
207	35.00
211	.75
212E	25.00
217A	1.50
WL-218	25.00
220C	182.50
221A	.75
CE-235	5.00
249B	3.00
250TH	17.50
250TL	15.00
251A	30.00
252A	7.50
253A	3.50
257A	2.00
FG-258A/5553	132.50
264C	3.00
267B	6.00
271A	7.50
272A	5.00
274A	4.75
WE-274B	3.00
274B	.50
275A	5.00
276A	3.00
282A	2.50
283A	3.50
286A	6.00
304TH	6.00
304TL	5.00
305A	3.50
307A/RK-75	1.00
310A	3.50
311A	5.00
313C	2.00
316A	.50
323A	10.00
323B	5.00
327A	3.50
328A	2.75
348A	4.50
349A	7.50
350A	3.50
350B	3.50
352A	10.00
353A	5.00
354A	15.00
355A	15.00
368AS	4.00
371A	.75
388A	1.00
393A	7.00
394A	2.00
410R	100.00
WL-417A	4.50
GL-434A	3.00
446A	.50
446B	2.00
450TL	40.00
WL-460	8.00
464A	2.25
WL-468	15.00
SS-501	7.25
CK-510AX	1.00
527	15.00
WL-530	10.00
WL-531	3.50
559	.75
575A	15.00
WL-579B	12.50
HY-615	.50
WL-632A	15.00
WL-670A	8.75
WL681/636	25.00
701A	2.00
702A-B	1.00
703A	1.25
704A	.75
705A	.75
706AY-GY	20.00
707A	3.50
707B	4.75
708A	1.00
709A	1.00
713A	.50
714AY	17.50
715A	1.25
715B	5.00
715C	12.50
717A	.50
719A	10.00
721A	1.00
722A	1.00
723A/B	8.75
724B	.75
725A	5.00
726A	7.50
726B	25.00
726C	25.00
728AY-GY	10.00
730A	10.00
801A	.25
802	2.50
803	1.50
804	9.75
805	2.75
806	15.00
807	1.00
808	1.50
809	2.75
810	10.00
811	3.00
811A	3.50
812	2.25
813	10.00
814	2.00
815	1.00
822	15.00
826	1.00
828	7.50
829	5.75
829B	9.00
830B	1.00
832	4.00
832A	5.50
833A	35.00
834	7.50
835	15.00
836	2.25
837	1.50
838	1.50
842	2.50
843	.25
845	7.50
845W	10.00
846	50.00
849	20.00
850	10.00
851	15.00
860	2.50
861	7.50
865	.50
866A	1.00
868/PJ-23	2.00
869B	17.50
872A	1.00
874	.50
876	1.00
878	.50
884	1.00
885	1.25
902P1	5.00
905	3.00
917	2.00
918	2.00
920	2.50
922	1.00
923	1.00
925	1.75
927	1.25
931A	2.75
933	2.00
954	.25
955	.25
956	.25
957	.25
958A	.25
959	1.00
991/NE-16	.35
CK-1005	.25
CK-1006	1.00
R-1100	5.00
R1130B/1B59	10.00
1500T	75.00
1603	4.00
1608	3.50
1611	2.00
1612	1.50
1613	.75
1614	1.50
1616	.50
1619	.25
1622	1.50
1624	1.00
1625	.25
1630	.50
1851	1.50
1852	.75
1853	.75
1960	.50
2050	1.00
2051	.50
ZB-3200	100.00
R-4330	7.50
GL-5545	25.00
5551/652	40.00
5556/PJ-8	6.75
5610	1.25
5645	6.50
5656	9.75
5670	2.50
5696	1.00
5703	.75
5725	2.00
5801/VX-33A	3.50
5820 (See 2P21)	
5827X	3.50
CK-5829	1.75
5933	6.50
5963	1.00
5981/5650	50.00
R-7301	10.00
8002R	10.00
8005	4,00
8011	.50
8012	1.00
8012A	2.50
8013	2.75
8013A	3.75
8014A	50.00
8016	2.00
8020	1.25
8025	1.75
8025A	2.75
PD8365	50.00
9001	.75
9002	.75
9003	1.00
9004	.25
9005	1.00
9006	.25
9906R	1000.00

western engineers

** Prices do not include transportation*

** Fully guaranteed*

ELK GROVE, CALIFORNIA

GEORGE WHITING, OWNER

N. Y.s RADIO TUBE EXCHANGE

TERRIFIC SLASHES IN PRICE UP TO 70% FROM PREVIOUS LOW PRICES

Type	Price
OA2	$1.00
OA3	1.10
OB2	.99
OB3	1.10
OC3	.96
OD3	.89
C1B	2.95
1B21	1.50
1B22	1.50
1B23	6.95
1B24	12.00
1B26	1.75
1B27	12.50
1B32	2.95
1B38	35.00
1B50	23.90
1B51	7.50
1B56	35.00
1B60	35.00
1N21	1.25
1N21A	1.75
1N21B	2.75
1N21C	19.50
1N22	1.00
1N23	1.95
1M23A	2.75
1M23B	2.75

Type	Price
1N23C	7.50
1N25	4.50
1N26	6.75
1N27	3.50
1N34A	.79
1N43	2.25
1P25	75.00
2B4	1.25
2B22	1.75
2C34	.15
2C40	9.00
2C42	12.00
2C43	14.50
2C44	.60
2C46	7.50
2E22	2.25
2J21A	12.00
2J22	9.00
2J26	15.00
2J27	15.00
2J31	24.00
2J32	29.00
2J33	32.00
2J34	36.00
2J36	90.00
2J38	8.95
2J39	8.59

Type	Price
2J40	29.00
2J42	135.00
2J49	60.00
2J50	55.00
2J55	150.00
2J56	110.00
2J61	35.00
2J62	35.00
2K22	15.00
2K23	15.00
2K25	27.50
2K26	68.00
2K28	35.00
2K29	35.00
2K33A	75.00
2K39	140.00
2K41	135.00
2K45	80.00
2K50	275.00
2854	45.00
2K55	25.00
2K56	72.00
3AP1A	10.00
3BP1	7.20
3B24	5.50
3B25	5.50
3B26	5.00

Type	Price
3B28	8.00
EL3C	5.50
3C22	99.00
3C24	1.50
3C31	2.95
3DP1	7.50
3DP1A	10.00
3DP1A-52	10.00
3EP1	5.00
3E29	15.50
3FP7	5.00
3HP7	5.00
3GP1	5.00
3J21	75.00
4B26	5.40
4C27	22.50
4C28	35.00
4E27	16.00
4J25	150.00
4J26	150.00
4J27	150.00
4J28	150.00
4J29	150.00
4J30	150.00
4J31	150.00
4J32	150.00

Type	Price
4J33	150.00
4J34	100.00
4J35	150.00
4J36	150.00
4J37	150.00
4J38	150.00
4J39	150.00
4J40	150.00
4J41	150.00
4J42	190.00
4J51	190.00
4J52	225.00
4J53	225.00
C5B	250.00
5BP1	3.95
5BP2A	12.00
5BP4	3.95
5CP1	7.50
5CP7	9.95
5CP7A	18.00
5D21	18.00
5EP7	1.95
5JP1	27.50
5JP2	19.50
5JP4	27.50
5J23	45.00
C6A	11.00

Type	Price
C6J	7.50
7BP7	5.00
7DP4	9.00
12AP4	50.00
12DP7	24.00
LM15	225.00
15E	1.75
15R	.75
NE16	.59
20-4	.75
KY21A	8.25
RX21	8.00
HK24G	1.50
25T	2.95
45 Special	.35
RK39	2.75
HF50	1.75
VT52	.35
HK54	4.50
RK72	1.00
RK73	1.00
FG95	19.95
100TH	7.95
FG105	20.00
122A	1.75
203A	7.50
211	.95

Type	Price
217C	12.00
242C	10.90
244C	9.50
249C	4.25
250TH	19.95
250TL	12.00
282A	3.00
274B	2.75
304TH	10.00
304TL	10.00
307A	3.50
310A	4.50
310B	4.95
311A	6.50
312A	3.50
323A	15.00
327A	3.75
393A	6.75
350A	7.50
350B	5.95
HK354C	15.00
357A	15.00
368AS	4.95
371B	1.50
385A	4.50
388A	1.80
393A	7.50

Type	Price
394A	3.95
MX408U	.50
417A	15.00
434A	15.00
446A	1.95
446B	3.95
450TL	45.00
450TH	52.50
464A	7.50
471A	1.25
527	18.00
WL530	23.00
WL531	22.50
WL532	1.75
WL533	15.00
HK654	35.00
700A/D	10.00
701A	4.50
703A	3.95
704A	1.95
705A	21.75
706AY/FY	25.00
707A	9.75
707B	15.00
714AY	18.00
715A	4.50

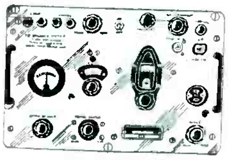
Type	Price
715B	9.00
715C	22.50
717A	1.50
718AY/EY	30.00
719A	22.50
720AY/GY	150.00
721A	3.50
722A	3.50
723A/B	18.00
724A	1.95
724B	2.25
725A	18.00
726A	18.00
726B	45.00
726C	45.00
723AY/GY	15.00
730A	22.50
750TL	99.00
801A	.90
802	3.95
803	5.95
805	4.95
807	1.50
808	1.95

Type	Price
809	2.95
810	10.50
811A	3.75
812A	3.95
813	13.75
814	3.75
815	6.25
816	1.45
829	11.00
829A	12.00
829B	15.00
830B	2.00
832A	9.95
833A	45.00
834	7.50
836	3.95
837	2.75
838	5.95
840	35.00
860	3.50
861	25.00
866A	1.50
869B	67.50
869BX	50.00
872A	3.50
878	1.50
879	.50

Type	Price
884	1.50
885	1.50
914A	75.00
931A	5.00
954	.35
955	.50
956	.75
957	.25
958A	.60
959	2.25
E114A	.25
1280	.95
1500T	135.00
HK1554	75.00
1603	5.00
1612	1.50
1613	1.25
1616	1.25
1619	.45
1622	1.50
1624	1.75
1625	.35
1626	.25
1851	1.80
2000T	150.00
2050	1.80
2051	1.00

Type	Price
Various 5000 and 6000 series of new production	
5280	475.00
8012	2.00
8012A	2.50
8013	3.00
8013A	3.50
8019	1.75
8020	1.80
8025	3.75
PD8365	96.00
9001	1.25
9002	.90
9003	1.25
9004	.35
9005	2.75
9006	.25

Thousands of other tubes



NEW TS-147 B AND C/UP TEST SET SIGNAL GENERATOR

Hard-to-get X-Band Now Available

Test Set TS 147 UP is a portable Microwave Signal Generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency range of 8500 MC to 9600 MC.

NEW MICROWAVE TEST EQUIPMENT TS148/UP SPECTRUM ANALYZER

Field type X Band Spectrum Analyzer, Band 8430-9580 Megacycles. Will Check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator, etc. Available new complete with all accessories, in carrying case.

NEW UNUSED SURPLUS TS 259 K BAND 23400-24500 MEGACYCLES SIGNAL GENERATOR

OTHER TEST EQUIPMENT USED CHECKED OUT, SURPLUS

TSK1/SE, TS3A/AP, RF4/AP, TS12/AP, TS13/AP, TS14/AP

TS33/AP, TS34/AP, T35/AP, TS36/AP, I-96A, TS45

TS47/APR, TS69/AP, TS100, TS102A/AP, TS108, TS110/AP

TS125/AP, TS126/AP, TS147, TS270, TS174/AP, TS175/AP

TS182, TS226, TS239A-TS239C, TS251, TF890/1, 834

SURPLUS EQUIP.: APA10, APA38, APS 3 APS 4, APR4, APR5A, APT2-APT5

SPECIAL

Wide Band S Band Signal Generator 2700/3400MC usinig 2K21 or PD 8365 Klystron, Internal Cavity Attenuator, Precision individually calibrated Frequency measuring Cavitiy. CW or Pulse Modulated externally or internally.

You Can Reach Us on TWXNY1-3235

Large quantities of quartz crystals mounted and unmounted

Crystal Holders: FT243, FT171B others

Quartz Crystal Comparators.

North American Philips Fluoroscopes Type 80.

Large quantity of Polystyrene beaded coaxial cable.

Minimum Order 25 Dollars

Phone: WOrth 4-8262

LIBERTY ELECTRONICS, INC.

135 LIBERTY STREET, NEW YORK 6, N. Y.

Cables: TELSERUP

NEW REPAIR PARTS For BC 348

MODELS H, K, L, R, ONLY

Main Tuning Capacitor	$ 2.00
1st I-F Transformer Assembly	2.00
2nd I-F Transformer Assembly	2.00
3rd I-F Transformer Assembly	2.00
4th I-F Transformer Assembly	2.00
Crystal Filter Assembly	6.50
C. W. Oscillator Assembly	2.00
915 kc Crystal mounted	2.75
Antenna Unit Assembly	12.50
R. F. Unit Assembly	12.50
Resistor: Volume Control	2.75
Knob for Main Tuning Condenser	.50
Band #1 Coils—per set of 6	3.00
Band #2 Coils—per set of 4	2.00
Band #3 Coils—per set of 4	2.00
Band #4 Coils—per set of 4	2.00
Band #5 Coils—per set of 4	2.00
Band #6 Coils—per set of 4	2.00
Complete dial assembly	$16.50

RADAR ANTENNAS

SO-1 (10CM) assembly with reflector, waveguide nozzle and drive motor. New $279.50

SO-3 (3CM) Surface Search type with reflector and drive motor, but less plumbing. New in original cases $149.50

SO-13 (10 CM) Complete assembly with 24" dish, dipole, drive motor and gearing. New $89.50

G. E. SERVO AMPLIFIERS

Used in B29 planes for Central Station Fire Control Systems B2, B3 and B4. Used to drive Amplidyne 5AM31NJ9A and Control Motor 5BA50LJ2A listed in this ad. New less tubes $29.50

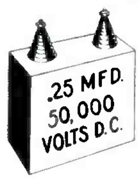
SCR-522 EQUIPMENT

Complete BC-624C receivers and BC-625AM Transmitters including mounting racks, plugs, connectors, dynamotor. Brand new equipment with instruction manuals. Write for full details.

RA38 RECTIFIER

Variable output 0-15000 V DC @ 500 MA. Input 115V 60 cy. 1 ph. Size 63 x 53 x 56 in. Write for detailed information.

HIGH-VOLT OIL CAPACITORS



Mfd.	Volts	Price	Mfd.	Volts	Price
.001	50 KV	$22.50	.25	15 KV	$15.50
.21	5 KV	1.29	.25	20 KV	17.50
.02	8 KV	2.65	.25	50 KV	44.50
.02	20 KV	9.75	.5	25 KV	49.50
.025	50 KV	19.75	1.	7.5 KV	6.95
.025/.025	50 KV	34.50	1.	15 KV	34.50
.1	3 KV	.95	1.	20 KV	49.50
.1–.1	4.5 KV	3.50	2.	5.5 KV	9.50
.135	7.5 KV	6.95	2.	6 KV	12.50
.2	50 KV	37.50			

ALL TOP BRANDS

BARGAINS IN TEST EQUIPMENT

FLUXMETER. Measures field strength of magnets from 500 to 4000 gauss. Indicates polarity. Probe gap 1¼". British handicraft in fine hardwood case with hinged cover. Operating instructions on underside of cover. Size 12-¾ x 9 x 6 in. A lab instrument. Also ideal for classroom magnetics instruction. A real buy at only **$24.50**

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300-1200 Mc TRANSMITTER T85/APT5. Nominal output 10 to 30 watts. Tunable cavity provides range from 300-1200 Mc. Filament transformer operates from 115 V 60 Cy. Uses 8 tubes: 1—931A, 2—6AC7, 2—6AG7, 1—6L6G, 2—829B, 1—3C22 (oscillator). Price with tubes **$139.50**

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5 AM21JJ7. Input 27 VDC @ 15 A. Output 60 VDC @ 2.5A 4600 RPM. New $34.50

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Navy type CAJO-211444. Input: 105 to 130 VDC. Output: either 26 VDC at 20 amps. or 13 VDC at 40 amps. Radio filtered and complete with line switch. New $89.50

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Oster E-7-5. 27.5DC. 1/20 HP. 3600 RPM. Shunt Wound. New $9.50

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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.

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AN/ARC-2

2-9.5 mc autotune transmitter-receiver. This equipment will provide 8 channel autotune operation on voice or C.W. power output is app. 30 watts. This set is similar to ART-13 but incorporates a receiver which is automatically tuned to the trans. freq. as channels are changed, providing a very compact communication pkge. for air or ground use. Power input is 28v DC. POR.

AN/CPN-6, 17 RADAR BEACONS

3 cm & 10 cm. High Pwr. Airport Radar Beacon. Output approx. 40 kw. Complete installation available. POR.

AN/TXC-1, RC-120 FACSIMILE SETS

Page sending and receiving equipment. These sets will transmit and receive a 12 by 18 inch or a 7 by 8 inch page of written or picture material over a telephone line or a radio circuit in 20 minutes. The copy may be sent on or received on either photographic printing paper or on direct recording paper. Power input is 110v 60 cyc. 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.

SCR-506A

2-6mc mobile or field radio transmitting and receiving equipment. This equipment is a currently used mobile communication set by many govts. The power output is 90 watts CW and 25 watts phone. The trans. may be set to 4 pre-selected channels or tuned manually. Power input is either 12 of 24v DC. POR.

SCR-694

3-6mc. portable field radio. This equipment provides reliable communications in the field or vehicle. Provisions are made for 2 preset channels, or the set may be tuned manually. Power output is 5 watts phone and 20 CW. This set can be supplied with either a vibrapack for 6 or 12 volt operation in a vehicle; or a hand generator for field use. POR.

AN/TRC-1

70-100 mc point to point VHF radiotelephone equip. This is a frequency modulated 50 watts point to point radio trans. and receiver set to be used as a communication channel in mountain country where a land wire is impractical, or where temporary operation is desired such as a construction project. The range is approx. 60 miles line of sight. The set is completely portable and operates from 110v 60 cyc. POR.

AN/TRC-7

100-156 mc. portable crystal controlled 2 channel walkie-talkie battery operated. POR.

AN/ARN-6 RADIO COMPASS

This is a very compact light weight automatic radio compass covering 100 KC to 1750 KC in 4 bands. All components are miniaturized including the loop for use in high speed aircraft. Complete sets and components are available. Input 110 Volts 400 cyc. and 28 Volts DC. POR.

AN/GSQ1-A SPEECH SCRAMBLERS

Speech scrambler for use on any comm. channel to insure privacy. We can supply complete installations of this equipment 28v DC input. Also 110v, 60 cyc.

RC-115B 75 MC BEACON

This is a 75 MC Marker Beacon Ground Station. This equipment comes mounted in a transporting trunk. The set can emit either inner, outer, or airways signals. The transmitter is crystal controlled and operated from 110 Volts 60 cyc. POR.

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.

AN/ARC-1

100-156 mc. VHF transmitter-receiver. This equip. provides phone operation in 10 crystal controlled automatically selected channels from 100-156 mc. with one guard channel. We can also modify these sets for 20 and 50 channel operation and can supply complete sets for ground operation from 110v 60 cyc supply. Normal input 28v DC. POR.

SCR-682 A RADAR

10CM high power long range harbor surveillance and early warning RADAR. This equipment is a 3000 mc mobile search radar that can be transported in a truck. The equipment incorporates a 7" PPI for operation up to 240,000 yards. Azimuth accuracy is ± 1%. Range accuracy is 100 yards at 10,000 yard range and 5000 yards at 240,000 yard range. Trans. output is approx. 225KW, pulse width is one microsecond. Antenna beam width is 6°. Input is 110v 60 cyc. Can be supplied with or without operating shelter or antenna tower. POR.

AN/APQ-15

Multiple echo equipment. This set will pick up signals from a ground search radar and re-transmit them making the plane carrying it look like an entire fleet of planes on the ground radar ....POR

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44 Step, 2 Levels, Bridging Wipers, Gold Plated Contacts, Oper. Voltage 5.5 to 12 V.D.C. 4.4 Ohms, Inter. Contact I Break-Make. Price One to 10 Pieces $12.00 Each. Brand New. Quan. Discounts.

60MC. IF STRIP

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TRANSITION, 1"x½" to 1¼"x⅝" Lgth 3⅛", $6.50.
WAVE GUIDE, RRG52V/, 1"x1½". Per Ft. Length, $10.00.
TWIST 90 DEGREE, UG39 to UG40. Silver plated, $6.50.
CRYSTAL MOUNT. Hold any IN23 type xtal. 1"x½" guide std coax output. UG40 flg. input, $15.00.
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S BAND

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K BAND

MAGIC TEE, precision..........$22.50
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BC-230 Transmitter 2500-7700 KC w/Coils..U. 6.95
BC-347 Amplifier 1/6F8G Tube..N: $3.95—U: 1.95
BC-357 Marker Beacon Receiver............U: 4.95
BC-367 Amplifier 2/6V6GT Tubes.N: $4.95—U: 3.95
BC-375 TRANSMITTER ....U: 29.95
BC-453 RECEIVER 190 to 550 KC.........U: 14.95
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BC-659 FM TRANSCEIVER 27 to 39 MC..U: 24.95
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BC-684 FM TRANSMITTER 27 to 39 MC..U: 19.95
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BC-745 TRANSCEIVER 3 to 6 MC.........U: 14.95
BC-745 TRANSCEIVER—Chassis Only.....N: 5.95
BC-791 Code Tape Recorder..............U: 4.95
BC-966 IFF SET 160 to 211 MC, 13 Tubes, Less Dyn. LN: 8.95
BC-1206 RECEIVER 200 to 400 KC — Less Tubes U: 6.95
R-25/ARC-5 RECEIVER 1.5 to 3 MC — Less Tubes U: 9.95
R-27/ARC-5 RECEIVER 6 to 9 MC — Less Tubes U: 4.95
R-1/ARR-1 RECEIVER — Converts 2 or 6 Meters N: 3.95
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BD-72 Switchboard — Portable — 12 Line..U: 39.95
FL-8A Range Filter..$1.49 FL-5 Filter..U: 1.00
TS-9 Carbon Handset......U: $3.95 TS-13 Handset U: 6.95
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TG-34A KEYER F/Inked Code Tapes.LN: $16.95— N: 24.95
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TU-6 Tuning Unit F/BC-375—BC-191......U: 3.95
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115 Volt 60 cycle: Blower 100 CFM. Heating element can be turned on & off separately from blower. Surplus. #2570—

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DM-42—14 V. input; output 1030 VDC—260 MA & 515 V. 215 MA @ 6 VDC. Approx. half of Voltage New: $12.95 — USED: $8.95

INPUT VOLTS:	OUTPUT: VOLTS:	MA:	STOCK No.:	PRICES: USED:	NEW:
14 VDC	230	90	DM-21	$6.95	
14	330	150	BD-87	3.95	$5.95
14	250	50	DM-25	6.95	8.95
14	1000	350	BD-77	14.95	29.95
28	1000	350	PE-73	8.95	
12 or 24	500	50	USA/0515		4.95
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12	230	90	PE-133	4.95	6.95
14 VDC	350	175	BD-83	3.95	4.95

POWER SUPPLY — 24 VDC — 3 Amp output; 115 Volt 60 cycle input. Completely filtered with 0-75 VDC Output Meter & 2 Tungar Bulbs—Used, Tested.$12.95

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MP-22 BASE — Ins. spring action; direction of bracket can be raised or lowered easily **$2.95**

MP-S-33 BASE — Insulated type with heavy coil spring and 5" dia. Ins. Requires 2" hole for mounting. Weight: 9 lbs.......... **$5.95**

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Tubular steel, copper coated, painted, in 3 ft. sections, screw-in type. MS-53 can be used to make any length with MS-52-51-50-49 for taper. Any section.. @ 50¢ Each
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MODELS H-J-G-K-L-N-P-R

Ohm	Watt	Each	Ohm	Watt	Each	Ohm	Watt	Each
.1	150(L)	$5.54	50	50	1.47	500	100(K)	3.55
.25	50	1.64	60	25	1.30	500	150(L)	6.98
.5	100(K)	3.79	75	25(H)	1.86	500	150	4.20
.5	150(L)	5.34	75	25	1.30	500	300(N)	8.42
1	25	1.47	75	50	1.47	585	150(L)	5.05
1	50(J)	2.34	75	75(G)	3.15	750	25(H)	1.86
1	50	1.64	75	300	6.30	750	150	4.20
1.1	50	1.64	80	50(J)	2.10	780	100(K)	3.55
2	25(H)	1.86	80	500(R)	12.18	800	25	1.30
2	100(K)	3.79	100	25(H)	1.86	1000	25(H)	2.10
3	100(K)	3.79	100	25	1.30	1000	25	1.47
3	225(P)	6.99	100	50	1.47	1000	50(J)	2.22
5	25	1.30	100	100(K)	3.55	1200	225(P)	6.99
5	50(J)	2.10	100	150(L)	5.05	1200	300	6.30
5	100(K)	3.79	125	25(H)	1.86	1250	50(J)	2.22
6	25(H)	1.86	125	25	1.30	1250	150(L)	5.34
6	50(J)	2.10	150	50(J)	2.10	1500	25(H)	2.10
6	75(G)	3.15	175	25	1.30	1500	25	1.47
7	25	1.30	175	25(H)	1.86	1500	50(J)	2.22
7.5	75(G)	3.15	175	500(R)	12.18	1600	50(J)	2.22
7.5	225(P)	6.99	185	25	1.30	1800	50(J)	2.22
8	50(J)	2.10	200	25(H)	1.86	1800	150(L)	5.62
8	50	1.47	200	25	1.30	2000	25(H)	2.10
10	25(H)	1.86	200	50	1.47	2000	50	1.55
10	50	1.47	200	100(K)	3.55	2250	150(L)	5.62
10	100	2.97	200	150(L)	5.05	2300	25	1.47
12	25(H)	1.86	250	25(H)	1.86	2500	50(J)	2.22
12	50	1.47	250	25	1.30	2500	100(K)	3.71
13	100(K)	3.55	300	50(J)	2.10	2500	150	5.62
15	25(H)	1.86	300	50	1.47	2500	500(R)	12.18
15	25	1.30	300	75(G)	3.15	3000	25	1.47
15	50	1.47	350	25(H)	1.86	3000	100(K)	3.79
15	50(J)	2.10	350	25	1.30	3500	25	1.47
15	75(G)	3.15	350	150(L)	5.05	5000	25(H)	2.22
15	100	2.97	370	25	1.30	5000	50(J)	2.34
15	150(L)	5.05	378	150(L)	5.05	5000	100(K)	4.04
16	50	1.47	400	25	1.30	7500	50(J)	2.34
20	25(H)	1.86	400	75(G)	3.15	7500	100(K)	4.30
20	50(J)	2.10	500	25(H)	1.86	10K	50(J)	2.50
25	25(H)	1.86	500	50	1.47	10K	100(K)	4.54
30	50	1.47	500	75(G)	3.15	15K	25	1.93
50	25	1.30				20K	4	.75

AVAILABLE IN ALL SHAFT SIZES

OIL CONDENSERS

MFD	Volt	Each	MFD	Volt	Each	MFD	Volt	Each
.0025	1500	$1.59	.5	2000	1.85	2	4000	10.95
.004	10 KV	2.25	.5	3000	4.25	3	600	2.09
.0075	7000	2.95	.5	7500	8.95	4	400	1.75
.0075	10 KV	3.75	.75	1000	1.25	4	600	1.95
.05	2500	1.65	1	600	.68	4	1000	2.50
.05	20 KV	P.U.R.	1	1000	1.59	5	600	2.35
.1	2000	1.65	1	1500	1.85	6	400	2.49
.1	3500	3.90	1	2000	2.35	6	600	2.85
.1	6000	7.95	1	2500	3.49	8	600	3.38
.1	7500	11.25	1	6000	12.95	8	2500	13.95
.25	2000	1.80	2	200	.49	10	600	3.75
.25	3000	3.49	2	400	.65	10	1000	4.25
.25	3500	3.95	2	600	.75	10	1400	5.95
.25	4000	6.50	2	1000	1.98	10	2500	14.95
.25	5000	7.49	2	1500	2.49	12	1000	4.59
.5	600	1.19	2	2000	2.75	15	600	2.79
.5	1500	1.59	2	2500	5.49	15	1000	7.49

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HIGH POWER TRANS. MICAS

"J" .95
"JL" $1.10
Ohms
50
100
150
200
250
300
400
500
1000
1500
2000
2500
3000
4000
5000
10K
15K
20K
25K
30K
50K
100K
150K
200K
250K
500K
1meg
2meg
3meg
5meg

"JJ" $2.95
Ohms
60
600
2K
10K
40K
100K
150K
250K
300K
500K
1meg
2meg
4meg

G-1 TYPE (CM-75)

.0001	6 KV	$12.18	.001	6 KV	14.00
.00015	5 KV	12.18	.02	3 KV	15.44
.00015	6 KV	12.18	.032	2 KV	15.44
.0002	6 KV	12.18	.04	1 KV	17.55
.00024	6 KV	12.78	.051	1.5 KV	18.21
.00025	6 KV	12.76	.08	1.5 KV	19.73
.0004	6 KV	13.31	.09	1.5 KV	20.25
.0005	6 KV	14.00			

G-2 TYPE (CM-80)

.0001	10 KV	19.67	.0004	5 KV	19.67
.00015	10 KV	19.67	.0005	10 KV	19.67
.0002	10 KV	19.67	.00065	10 KV	19.67
.00027	12 KV	19.67	.001	10 KV	19.67
.0003	10 KV	19.67	.03	2 KV	21.00
.000375	10 KV	19.67	.045	2 KV	21.00

G-3 TYPE (CM-85)

.00005	20 KV	33.27	.001	20 KV	42.35
.0001	20 KV	36.30	.0011	20 KV	43.50
.0001	25 KV	37.80	.0012	20 KV	44.62
.00015	20 KV	37.80	.00124	15 KV	44.75
.00025	20 KV	39.33	.0016	15 KV	42.96
.0003	20 KV	39.33	.002	12 KV	42.35
.0004	20 KV	41.15	.0025	12 KV	45.00
.00045	15 KV	41.15	.006	10 KV	45.38
.00047	20 KV	41.15	.015	3 KV	45.33
.0005	20 KV	41.15	.015	7 KV	45.33
.0008	20 KV	41.15	.05	3 KV	45.81
.00095	5 KV	42.35	.25	1.6 KV	45.81
.001	15 KV	42.35			

G-4 TYPE (CM-90)

.00025	30 KV	66.35	.006	15 KV	75.68
.0003	25 KV	66.35	.0066	15 KV	75.68
.00032	25 KV	66.35	.0075	15 KV	78.00
.00032	30 KV	66.35	.01	15 KV	81.73
.00062	30 KV	66.35	.01083	12 KV	81.73
.00065	35 KV	67.50	.01163	5 KV	30.60
.001	25 KV	68.73	.03	8 KV	81.73
.0015	25 KV	68.73	.056	5 KV	81.73
.0025	25 KV	68.73	.05668	2 KV	30.75
.005	20 KV	75.68			

G-5 TYPE (CM-95)

.000155	30 KV	139.20	.0000533	30 KV	151.25
.0004	30 KV	139.20	.01	30 KV	163.20

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Clean like new (with all tubes)
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D151426 95 db gain 2.7 Mc Band width
MAGNETS for 725A . . . $7.50 (with 725A Tube) . . . $10.00

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UG 167 U	2.95
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UG 245 U	1.49
PL 259 (49195)	.39
M 359 (19192)	.29

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Type W 20KV

12 mmfd	5.95
50 mmfd	6.95
60 mmfd	6.95

Type VC 20 KV

75 mmfd	8.95

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SIGMA RELAY $72934
3,000 ohm 2.95
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.1 .1-7000 V 25F328	2.95
.1-7500 V 25F475	2.39
.1-25 KV 14F52	29.50
.15 .15-6000 V 26F435	1.95
.25-6000 V 25F659	1.79
.25-20 KV	24.95
.5-7500 26F393	2.95
2-400 V Bath tub side terminal	.60
2-600 V Bath tub side terminal	.75
2-1000 V	1.75
4-600 V TLA type	.97
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400 PPS-50 ohm impedance $9.95
1 Micro second

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SPECIAL	
723AB	6.95
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2½ watt Argon Bulbs	.15 ea.

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APN - 1 Altimeters modified to AVQ6 Type certificated $25.00 each 200 available. Excellent condition.
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TS-117 New $300.00
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Miniature BLOWER 27.5V — 10,000 RPM
Delco type 5068-571 . . . . . . $4.49
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type BD-1 27.5 V 5600 RPM $2.95
2 reduction app.—5 RPM & 20 RPM Mfg. by John Oster Company
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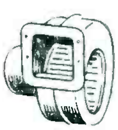
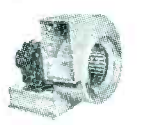
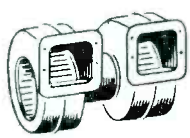


100 C.F.M.—3" DIAMETER ROTOR Powered by choice of Fasco or Heinze shaded pole, two pole, enclosed motors. 3" inlet, 2" outlet. Sheet steel housing. No. BL100. . . . . $7.75



600 C.F.M.—6" DIAMETER ROTOR Powered by Westinghouse ¼ H.P. 1725 rpm motor. 5½" Inlet and 7" x 3½" outlet. Base mounted. No. BL600. . . . . $28.50

200 C.F.M.—4½" DIAMETER ROTOR Powered by Bodine split phase, 1725 rpm 40°C. Ball bearing motor. 4½" Inlet and 5½" x 3" outlet. No. BL200B. $16.50



TWIN BLOWER —520 C.F.M.—5¼" DIAMETER ROTORS Redmond shaded pole four pole motor. 5" inlets and 3½"x3½" outlets. Discharge flanges shipped unmounted. No. BL520R $22.50

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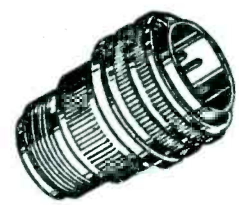

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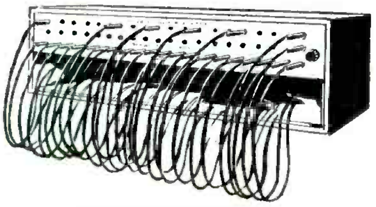

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Perfect for Audio patch panels, etc. 60 jacks (JK-24) 27 plugs and cords (PL & PL 48), the schematic included. NEW....................$9.95

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CU-27/SCR-1, Network, Broadband Impedance Matching balanced to unbalanced line 300 to 1000 Mc. Type "N" fittings. NEW..............$12.50

CU-19/SPR-1-Same except 40 o 300 Mc..$12.50

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RA-49A. A precision instrument. Voltage range 0-300 and 0-600. Complete with tubes, 6ea-2A3, 4ea-274B, 2ea-6SJ7, 1ea-VR105, 1ea-VR150. VERY SPECIAL $49.50

DYNAMOTORS

TYPE	INPUT	OUTPUT	MILS	
DM-34	12V	220V	80	7.95
DM-35	12V	625V	225	14.95
DM-36	24V	220V	80	5.95
DM-37	24V	625V	225	7.95
DM-65	12V	400V	440	12.50
BD-77	12V	1000V	350	17.50
Tcs Rcvr	12V	225V	100	12.50
TCS Xmtr	12V	400V	180	22.50
DM-32A	28	250	60	1.95
CBY-21531	28	250	60	.95
DY2-ARR2	28	250	60	1.25
PE-86	28	250	60	.95
D-101	27	285	60	.95
DM-416	28	330	170	1.95
SP-22	28	330	170	1.95
DM-33A	25	575	160	2.50
SP-125	18	450	60	2.50
BD-83	14	375	150	7.50
DM-414	14	220	80	4.95
AD7-377	14	425	163	6.50

HIGH VOLTAGE CONDENSERS Oil Filled

CAT. No.	MFD.	WVDC	
26F444	8	2 KV	5.95
	2	3 KV	2.95
	.5	3 KV	1.00
21F47	2	4 KV	3.95
25F509G2	1	6 KV	1.75
	.25	6 KV	1.95
25F774	.1X.1	7 KV	1.95
25F450	.1	7.5 KV	1.75
	.5	7.5 KV	2.25
25F360	.1	12 KV	6.95
Inerteen	.25	15 KV	14.95
14F91	1.0	15 KV	17.50
Inerteen	.5	25 KV	22.50
Inerteen	1.0	25 KV	37.50
Fast A6734	1.0	25 KV	39.95
14F52	.1	25 KV	15.00

HIGH CURRENT MICA CONDENSERS

Ceramic Cased, Type G-1, or Similar

Mfd	WVDC	Amp @ 1 mc	
.04	1 KV	25	7.50
.05	1.5 KV	35	12.50
.08	1.5 KV	40	15.00
.02	3 KV	21 (600 Kc)	15.00
.00035	6 KV	5	12.50
.00075	6 KV	7	14.50
.0005	6 KV	5	12.95

Type G-2 of Similar

Mfd	WVDC	Amp @ 1 mc	
.0012	5 KV	8	17.50
.003	7 KV	15	19.00
.0002	10 KV		19.50
.00025	10 KV	3	19.50
.0003	10 KV	5	19.50
.0005	10 KV	6	19.50
.00057	10 KV	8	19.50
.00065	10 KV	6	19.50

Type G-3 or Similar

Mfd	WVDC	Amp @ 1 mc	
.05	3 KV	50	45.00
.005	5.5 KV	25	37.50
.00015	20 KV	5	36.00
.0012	20 KV	15	36.00

Type F-2, Type 6, or Similar $1.50 each

Mfd	VDC	Amps @ 1 Mc.	Mfd	VDC	Amps @ 1 Mc.
.00005	5 KV	.8	.001	5 KV	4
.00009	5 KV	.8	.0012	5 KV	4.5
.0001	5 KV	1	.0015	5 KV	5
.00015	5 KV	1.5	.002	5 KV	5
.0002	5 KV	1.7	.002	6 KV	6.5
.00025	5 KV	2.5	.002	6 KV	6.5
.0003	5 KV	2	.0025	5 KV	6
.00035	5 KV	2	.003	2 KV	6
.000375	5 KV	2	.003	3 KV	6
.00039	5 KV	2.7	.004	3 KV	6
.0004	5 KV	2.5	.005	3 KV	5
.0004	5 KV	2.5	.005	5 KV	11
.0005	5 KV	2.5	.01	2 KV	8
.0005	7.5 KV	3	.02	2 KV	12
.0006	2.5 KV	1.5	.03	2 KV	12
.0006	5 KV	3	.07	1 KV	13
.00072	5 KV	3.5	.12	.5 KV	18
.0008	5 KV	4			
.0008	6 KV	4			

F-1, Type 15L or Similar $1.00 each

Mfd	VDC	Amps @ 1 Mc.	Mfd.	VDC	Amps @ 1 Mc.
.00005	3 KV	.6	.0008	3 KV	2.5
.00009	3 KV	.8	.001	3 KV	3
.0001	3 KV	.08	.0012	2 KV	3
.00015	3 KV	1	.00125	2 KV	3
.000175	3 KV	1	.0015	3 KV	3.5
.0002	3 KV	1	.0016	2.5 KV	3.5
.0003	2 KV	8	.002	3 KV	4
.0003	3 KV	2	.0025	3 KV	4.5
.0004	3 KV	4	.003	2 KV	5
.0005	3 KV	2	.004	2 KV	6
.0006	2.5 KV	2	.005	2.5 KV	6.5
.0006	3 KV	2	.006	2 KV	5.5
.000625	3 KV	2.5	.008	1.5 KV	8
.0007	3 KV	2.5	.01	2 KV	14
.00075	3 KV	2.5	.1	1 KV	12

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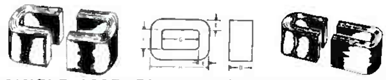
TRANSFORMER "C" CORES



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STK. No.	D	E	F	G	Wt.	Price
C-11	2.0"	0.7"	1.4"	3.0"	4¼ lb.	$1.75
C-14	1.6	1.1	1.6	4.3	7	2.50
C-17	2.8	1.1	1.6	4.3	12	3.50
C-25	4.1	1.4	2.5	6.6	35	8.75
C-28	4.0	1.3	2.4	7.7	35	8.95

HEAVY DUTY TRANSFORMERS

Cat. #1239.—1.1 KVA. Input 117 volts 60 cycle. Output: 13.0 and 14.0 volts at 80 amps. Pri. leads 22" long. Sec. leads 6". Size 5¾x6x5½". Wt. 15½ lbs. Note: Two of these can be connected to obtain 26 and 28 volts or three to obtain 39 and 42 volts at 80 amps. respectively. Price Brand NEW........$8.95

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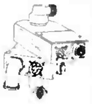

EMERSON ELECTRIC—Part No. ET-35300 (shown with and without housing). Used to transfer voltages between stationary and moving parts as in revolving antennas and turrets. Full 360° rotation. Rating 12 conductors—ten 10 amp and two 100 amp at 28 VDC. Adaptable to higher voltages. Also has swivel plumbing designed to transfer oxygen. Size 9x6x10". Wt. 10 lbs. Price complete with housing NEW....................$8.50

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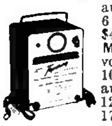
Made by Associated-Hartman Corp. Feature heavy-duty construction and parts, over-size transformers, and full-wave Sarkes-Tarzian selenium rectifiers. Charging current indicated by glow signal light and tapers off as battery becomes charged. Heavy Mueller connector clips on output cables. Also used as power supplies where 6 or 12 VDC is needed. Input 110-120 VAC 60 Cy. Fresh late '54 stock complete with cables.

MODEL (S-6)—6 amp. 6 volt. Size 5x4½x6½". Wt. 7 lbs. List $18.60. Price Brand NEW............$11.95
MODEL (U-6)—Same as above but has special output connector to plug into any car cigarette lighter. List $19.95. Price Brand NEW....$12.45
MODEL (U-10)—10 amp. 6 volt. Size 6½x5½x7½". Wt. 11 lbs. List $32.50. Price Brand NEW....................$19.45
MODEL (S-20)—20 amp. 6 volt. Has ammeter and automatic reset circuit breaker. Size 6½ x 6½ x 8½". Wt. 15½ lbs. List $44.50. Price Brand NEW......$26.95



MODEL (S-20-6/12V)—Dual 6 and 12 volt. Charges 20 amps. at 6 volts and 10 amps. at 12 volts. Ammeter and automatic reset circuit breakers. 6V-12V switch. Size 6½x6½x8½". Wt. 17 lbs. List $54.95. Price Brand NEW $34.95

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HEWLETT-PACKARD 200B Audio Oscillator (Rack Mounting type) 20 to 20,000 cycles
Reg. price—$120.00 Special $75.00

HEWLETT-PACKARD 400A Vacuum Tube Voltmeter—.005 to 300 V AC—9 ranges
Freq. response—10 cps to 1 mc
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FURST ELECTRONICS Model. 1210 Electronically Regulated. Multiple Power Supply (Rack mounting with meter). input—115 VAC 60 cy.
Outputs + 200 to + 470 VDC, 0-1 ma
+ 50 to + 200 VDC, 0-70 ma
− 50 to − 150 VDC, 0-10 ma
All outputs 1% regulation—less than 5 mv RMS ripple.
Special $55.00

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12½ KW High Frequency Induction HEATING UNIT

200 to 500 Kilocycles, practically new. Sacrifice.

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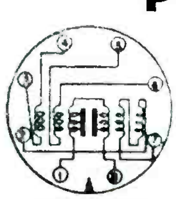
PULSE TRANSFORMER



TYPE UX 7350
Each Coil—50-T#36E
Max. DC Res. Ohms
1 & 8=4.02Ω
2 & 7=4.542Ω
3 & 4=2.357Ω
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Tube base plug in type

Here are precision made, high quality compact pulse transformers wound on hypersil cores. They are built in octal bakelite tube bases and can be adapted to many uses. They are completely impregnated and sealed.

SUGGESTED USES

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★—Wherever Accurate Timing and Triggering are necessary.
★—Unexcelled in circuit applications for generating low power and low voltage pulses.
★—Can be used in circuits utilizing repetition rates from 0 to well over 1 MC and pulse widths ranging from .05 Microsecond up.

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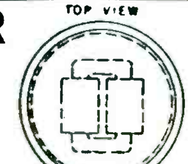

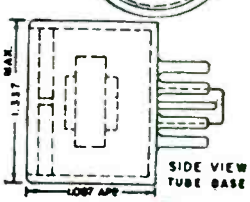

SIDE VIEW TUBE BASE

Cramer Electronics, Inc.

811 Boylston St., Boston 16, Mass. CO 7-4700

INDEX TO ADVERTISERS

Acme Wire Co. 366
Adams & Westlake Company 205
Aeronautical Communications Equipment, Inc. 80, 81
Aerovox Corporation 294
Aircraft-Marine Products, Inc. 28, 29
Aircraft Radio Corp. 371
Airpax Products Co 53
Allen-Bradley Co. 339
Allen Co., Inc., L. B 382
Allen Manufacturing Co 348
Allgehany Ludlum Steel Corp 88
Allied Industries, Inc. 268
Allied Radio 346
Allison Laboratories 362
Allmetal Screw Products Company, Inc. . 368
Almo Radio Company 351
American Electric Motors 274
American Electronic Laboratories, Inc. . . 380
American Gas Furnace Co 365
American Lava Corporation 213
American Metal Co., Ltd 369
American Phenolic Corp 184
American Television & Radio Co 372
American Time Products, Inc 193
Ampex Corporation 33
Antara Chemicals, A Sales Division of General Aniline & Film Corp 233
Armco Steel Corp 92
Arnold Engineering Co 13
Arrowhead Rubber Company 340
Artisan Metal Works Co 306
Art Wire & Stamping Co 360
Assembly Products, Inc. 344
Atlas Engineering Co., Inc 380
Augat Bros. Inc. 379
Automatic Electric Mfg. Co 236

Ballantine Laboratories, Inc 196
Barker & Williamson, Inc 212
Barry Corp. 21
Belden Manufacturing Co 223
Bell Telephone Laboratories 207
Bendix Aviation Corporation
Eclipse-Pioneer Div. 222
Red Bank Div. 304
Bennett Manufacturing Company 341
Berkeley Division, Beckman Instruments, Inc. 310, 311
Bird Electronics Corp 324
Bliley Electric Company 192
Boesch Mfg. Co., Inc 378
Bogue Electric Manufacturing Co 237
Boonton Radio Corp 113
Bourns Laboratories 293
Bowser, Inc. 292
Bradley Laboratories, Inc. 79
Bruno-New York Industries, Corp 42
Brush Electronics 112A, 112B, 317
Burnell & Co., Inc 25
Bussmann Mfg. Co 195

C B S Hytron, A Div. of Columbia Broadcasting System, Inc 75
Calidyne Company 210
Cambridge Thermionic Corp 46
Cannon Electric Company 89
Cannon Muskegon Corp 289
Carborundum Company 52
Carter Motor Co 332
Chase Brass & Copper Co 87
Chatham Electronics Corp 68
Chatillon & Sons, John 200
Chicago Standard Transformer Corp 202
Chicago Telephone Supply Corp 64A, 64B
Cinch Mfg. Corp 175
Cinema Engineering Co 382
Clare & Co. C. P. 107
Cleveland Container Co 51
Clevite-Brush Development Co. 341
Clifton Precision Products Co., Inc 208
Cobehn, Inc. 424
Cohn Corp., Sigmund 342
Collectron Corporation 347
Collins Radio Co 189
Color Television, Inc 357
Communication Accessories Co 82
Continental Communications, Inc 343
Continental-Diamond Fibre Co 90
Continental Wire Corp 330
Cornell-Dubilier Electric Corp 55
Corning Glass Works 312
Cornish Wire Co., Inc 346
Cosmic Condenser Co 365
Cramer Co., Inc., R. W 276
Cross Co., H. 365
Crucible Steel Co. of America 203
Cunningham, Son & Co., Inc. James 369

Dale Products, Inc. 308
Danbury-Knudson, Inc. 230
Dano Electric Co 341
Daven Company . . . . 3rd Cover
Daven Electronic Sales Corp 342
Daystrom Instrument. Div. of Daystrom, Inc. 286
DeJur-Amsco Corporation 256, 323
Dewey & Almy Chemical Company, Div. of W. R. Grace & Co 275
Dialight Corporation 326
Diehl Manufacturing Company 266
Dimond-Union Stamp Works 287
Driver-Harris Co. 247
Dumont Airplane & Marine Instruments Inc. 327
DuPont de Nemours & Co. (Inc.) E. I.
Film Dept. 273
Polychemicals Dept. 48A, 48B
Dyna-Labs, Inc. 343

Eastern Precision Resistor Corp 325
Eastman Kodak Company 185
Edin Company Inc 308
Edo Corporation 50
Eisler Engineering Co., Inc 351, 382

Eitel-McCullough, Inc. 110
Electra Manufacturing Co 291
Electrical Industries, Div. of Amperex Electronic Corp. 253
Electronic Instrument Co., Inc. (EICO) .. 374
Electronic Parts Manufacturing Co., Inc 357
Electronic Tube Corp 188
Electro Tec Corporation 281
Elgin-Neomatic, Inc 377
Emerson & Cuming, Inc 361
Engineering Co., The 370
Epco Products, Inc 343
Erie Resistor Corp 305

Fairchild Camera & Instrument Corp 85
Falstrom Company 322
Federal Telephone & Radio Company 49
Film Capacitors, Inc. 345
Ford Instrument Company 242
Frenchtown Porcelain Company 372
Furst Electronics, Inc 373
G M Laboratories, Inc 353
Gamewell Company 226
Garfield Wire Division of the Overlakes Corp. 353
Gee-Lar Manufacturing Co 324
General Electric Company
Apparatus Dept. 38, 39, 40, 41, 72, 337
Chemical Div. 251
Electronics Div. 109
Tube Dept. 35
General Industries Co 241
General Magnetics, Inc 106
General Radio Company 17
Genisco, Inc. 300
Gertsch Products, Inc 377
Good-all Electric Mfg. Co 93
Grant Gear Works, Inc 301
Green Instrument Co 355
Greenleaf Manufacturing Co 219
Gries Reproducer Corporation 364
Guardian Electric Mfg. Co 229

Hammarlund Manufacturing Co., Inc 23
Hardwick, Hindle, Inc 34
Harrison & Co., Phillip H 364
Harvey Hubbell, Inc 227
Hathaway Instrument Company 307
Haydon Manufacturing Company, Inc ... 309
Heath Company 358
Helipot Corporation, a Div. of Beckman Instruments, Inc. 181
Henry & Miller Industries, Inc 382
Hermetic Seal Products Co 235
Hewlett-Packard Company 56, 57
Heyman Manufacturing Co 345
Hoffman Laboratories Inc 219
Hopkins Engineering Co 367
Houghton Laboratories, Inc 270
Hughes Aircraft Company 97
Hughes Research & Development Labs 306, 352, 359
Hycor Company, Inc. 356

Ilsco Copper Tube & Products Inc 329
Indiana Steel Products Company 102

Industrial Development Committee of 100. 361
Industrial Development Div. State of Florida 260
Induction Motors Corp.................. 261
Industrial Timer Corp.................. 60
Infra Electronic Corp.................. 361
Institute of Radio Engineers............ 265
Instruments for Industries, Inc......... 350
Instrument Resistors Co................ 334
International Business Machines........ 259
International Rectifier Corp............ 284
International Resistance Company.....30, 31
Ippolito & Co., Inc., James............ 330

Jet Propulsion Laboratory.............. 347
Johnson Service Co.................... 357
Jones Div., Howard B. Cinch Mfg. Corp. 373

Kahle Engineering Co.................. 15
Karp Metal Products Co., Div. of H & B American Machine Co................ 111
Kay Electric Co........................ 27
Kearfott Co., Inc...................252, 333
Kellogg Company, M. W................ 71
Kenyon Transformer Co., Inc........... 348
Kepco Laboratories 179
Kester Solder Co....................... 239
Ketay Instrument Corp.................. 74
Keystone Products Company............ 277
Knights Company, James.............76, 77
Kollsman Instrument Corp.............. 54
Kruger Instrument, Harold............. 373

Laboratory for Electronics.............. 267
Lampkin Laboratories, Inc.............. 372
Lapp Insulator Co., Inc................ 262
Lewis & Kaufman Ltd.................. 183
Librascope, Inc. 354
Linde Air Products Company, Div. of Union Carbide & Carbon Corp......... 351
Litton Engineering Laboratories........ 370
Lockheed Missile Systems Div........... 376
Lynn-Deatrick, Inc. 282

M B Manufacturing Company, Inc....... 44
Magnecraft Electric Co................ 332
Magnetics, Inc. 65
Magnatran, Inc. 363
Malco Tool & Manufacturing Co........ 362
Mallory and Co., Inc. P. R..........120, 177
Mansol Ceramics Co.................... 347
Marconi Instruments, Ltd.............. 116
Martin Company, Glenn L...........220, 271
Maxson Corp., W. L.................... 313
McCoy Electronics Co.................. 206
McGraw-Hill Book Co., Inc............. 353
McLean Engineering 365
McMillan Industrial Corp.............. 282
Measurements Corporation 214

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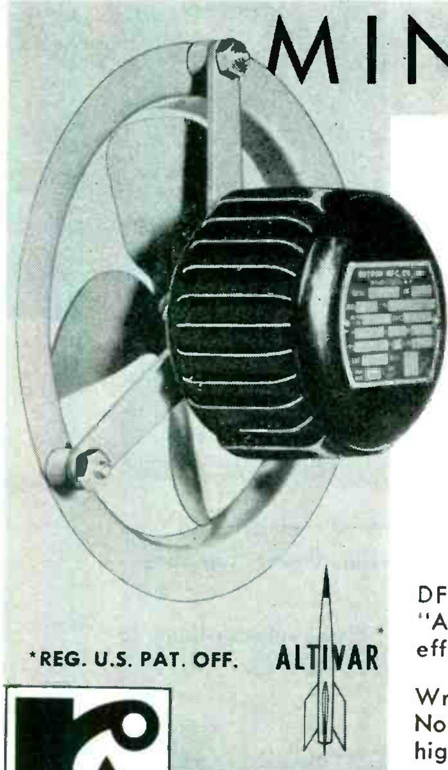

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ROTRON MFG. CO.
Schoonmaker Lane Woodstock, N. Y.

Metal Cal, C & H Supply Co 303
Metal Textile Corporation 335
Metals & Controls Corp., General Plate Div. 84
Methode Manufacturing Corp 374
Meyercord Co., The 341
Mica Insulator Co 243
Mico Instrument Co 369
Micro Switch, A Div. of Minneapolis-Honeywell Regulator Co 108
Microwave Associates, Inc 228
Midwest Instruments 101
Miles Reproducer Co., Inc 382
Millen Mfg. Co., Inc., James 340
Minneapolis-Honeywell Regulator Co. Industrial Div. 78
Monsanto Chemical Company 63
Muirhead & Co., Ltd 5
Multicore Solders, Ltd 250
Murphy & Miller, Inc 358

N.R.K. Mfg. & Engineering Co 368
Narda Corporation, The 290
National Moldite Co 255
Natvar Corporation 257
New Hermes Engraving Machine Corp ... 363
New London Instrument Co 355
Nothelfer Winding Labs 98

Ohmite Mfg. Co 32A, 32B
Olympic Metal Products Company, Inc .. 272
O'Neil-Irwin Mfg. Co 423

P M Industries, Inc 288
Pace Electronics Corp 350
Pacific Scientific Co 331
Panoramic Radio Products, Inc 272
Perkin-Elmer Corp. 295
Perkin Engineering Corp 425
Permag Corp. 369
Peter Partition Corp 335
Phalo Plastics Corp 218
Phelps-Dodge Copper Products Corp. Inca Mfg. Div 118, 119
Philamon Laboratories, Inc 91
Phillips Control Corp 104, 105
Polarad Electronic Corporation. 36, 37, 86, 263
Polytechnic Research & Development Co., Inc. 245
Potter & Brumfield 58, 59
Precision Apparatus Co., Inc 428
Precision Paper Tube Co 216
Progressive Manufacturing Co 198
Pye, Ltd. 112
Pyramid Electric Company 117

R-B-M Division, Essex Wire Corp 186
R S Electronics Corp 316
Radio Corporation of America 114, 115
4th Cover

Radio Engineering Laboratories, Inc.... 73
Radio Frequency Laboratories, Inc..... 254
Radio Materials Corp................. 221
Radio Receptor Co., Inc................ 231
Railway Express Agency, Air Express Div............................... 191
Raytheon Mfg. Company..18, 19, 194, 269, 298
Reeves-Hoffman Corp. 326
Resin Industries, Inc.................. 344
Richardson Company, The............. 283
Rotron Mfg. Co., Inc................... 426
Rumple, Inc. 190

Sage Electronics Corp.................. 258
Sanborn Company 45
Sargeant & Wilbur Heat Treating Corp.. 357
Scientific Radio Products, Inc.......... 264
Secon Metals Corp.................... 334
Sensitive Research Instrument Corp..... 426
Shallcross Mfg. Co.................... 302
Shell Chemical Corp................... 43
Shure Bros., Inc...................... 297
Sierra Electronic Corp................. 187
Sigma Instruments, Inc................ 246
Signal Engineering & Mfg. Co.......... 351
Simmons Fastener Corp................ 62
Sorensen & Co., Inc...................4, 83
South Chester Corp.................... 64
Southern Electronics Co............... 319
Sperry Gyroscope Co.................. 345
Sprague Electric Co............11, 201, 224
Stackpole Carbon Co................... 99
Standard Electric Time Co............ 197
Sterling Engineering Company, Inc...58, 59
Sterling Transformer Corp............. 335
Stevens Arnold Inc.................... 359
Stoddart Aircraft Radio Co., Inc.....248, 320
Stokes Machine Company, F. J........66, 67
Stupakoff Ceramic & Manufacturing Co. Div. of the Carborundum Company.314, 315
Superior Tube Co...................... 211
Sylvania Electric Products, Inc........9, 279
Syntronic Instruments, Inc............ 367

T L G Electric Corp................... 379
Taylor Fibre Co....................... 285
Technical Service Corp................ 361
Technology Instrument Corp........... 217
Tektronix, Inc. 32
Texas Instruments Incorporated........ 204
Thompson-Bremer & Co............... 225
Trad Television Corp.................. 366
Transitron Electronic Corp............. 103
Transradio Ltd. 329
Tubular Rivet & Stud Co.............. 244
Tung-Sol Electric Inc................. 199

Ungar Electric Tools Inc............... 373
Union Carbide & Carbon Corp., Linde Air Products Div. 351
Union Switch & Signal, Div. of Westinghouse Air Brake Co................... 318
United States Gasket Co.............. 427

United States Motors Corporation 232
United Transformer Co............ 2nd Cover
Universal Winding Company............ 209

Vacuum Metals Corp.................. 96
Varian Associates 47
Veeder-Root, Inc. 48
Victory Engineering Corp............... 321
Vokar Corporation, Vo-Tron Div......... 375
Vulcan Electric Co..................... 369

Waldes Kohinoor, Inc................. 61
Ward Leonard Electric Company...96A, 96B
Waterman Products Co., Inc........... 299
Waters Manufacturing Inc.............. 328
Watlow Electric Mfg. Co............... 354
Welch Scientific Co., W. M............. 424
Wenco Mfg. Co........................ 343
Westinghouse Electric Corp............ 100
Wheeler Insulated Wire Co., Inc........ 296
White Dental Mfg. Co., S. S............ 234
Williams & Co., C. K.................. 352
Winkler Laboratories 373

■

PROFESSIONAL SERVICES.......... 381

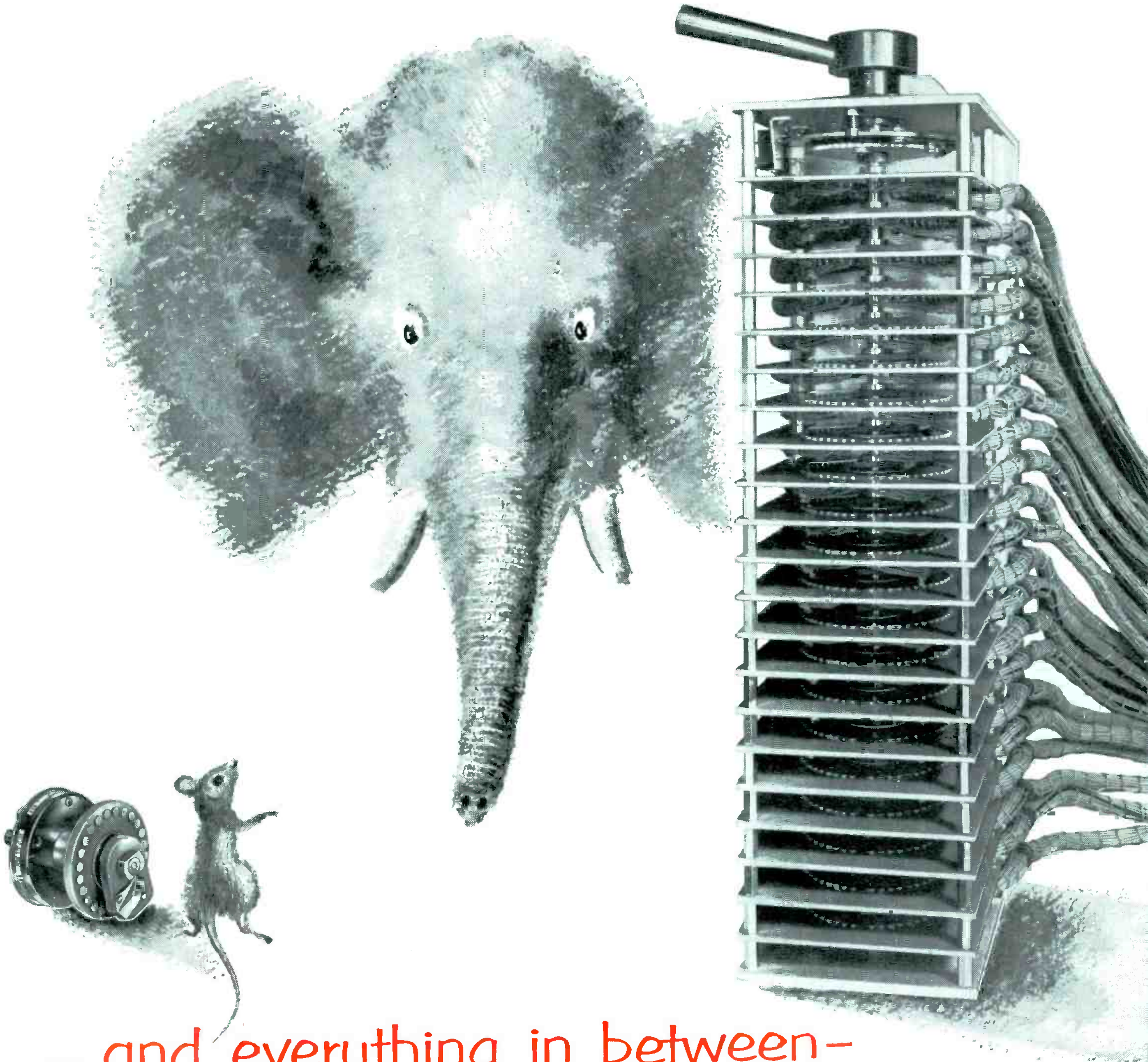
■

SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.

EMPLOYMENT
Positions Vacant.....................382-406
Selling Opportunities Offered.......386, 392
Positions Wanted 383
Selling Opportunities Wanted.......383, 386
Employment Agencies 383
BUSINESS OPPORTUNITIES......... 383
EQUIPMENT
(Used or Surplus New)
For Sale..........................406-422
WANTED
Equipment 406

ADVERTISERS INDEX

Admiral Corp.......................... 403
Allied Electronic Sales.................. 414
Anson Articles, Art..................... 422
Arcby Electronics Inc...............406, 414
Armour Research Foundation............ 396
Arrow Sales Inc........................ 415
Automatic Switch Co.................... 405
Barry Electronics Corp.................. 419
Bendix Aviation Corp., Missile Section Products Div. 396
Bendix Aviation Corp., Pacific Div 404
Bendix Aviation Corp., York Div.......... 399
Bendix Radio, Division of Bendix Aviation Corp. 389
Birtcher Corp., The..................... 406
Blan 415
Brush Electronics Co.................... 396
Burroughs Research Center.............. 391
Cardwell Electronics Prod. Corp. Allen D.. 403
Chase Electronic Supply Co.............. 406
C & H Sales Co......................... 408
Communication Devices Co............... 412
Communications Equipment Co............ 409
Compass Electronics Supply.............. 417
Cook Research Laboratories.............. 388
Continental Oil Co...................... 394
Convair, A Division of General Dynamics Corp. 395
Cornell Aeronautical Laboratory Inc...... 388
Cramer Electronics...................... 422
Crucible Steel Co. of America............ 403
Electroncraft Inc. 416
Electronic Industries 421
Electronics Corp. of America............. 404
Electric Trading Co..................... 421
Electro-Voice Inc..................394, 403
Emeltone Electronics Co................. 417
Emmons Radio Supply................... 422
Empire Electronics Co................... 406
Engineering Associates 421
Fair Radio Sales........................ 420
Farnsworth Electronics Co............... 390
Fay-Bill Distributing Co................. 413
Federal Telecommunication Labs.......... 402
Finnegan, H. 406
Florida Aircraft Radio & Marine Inc...... 406
Freed Electronics and Controls Corp...... 404
General Electric Co., Syracuse Div....... 386
General Precision Laboratory Inc......... 400
Goodyear Aircraft Corp.................. 387
Graebner's Executive Exchange........... 383
Haller, Raymond and Brown Inc.......... 392
Hamilton Watch Co...................... 401
Hanover Electronics..................... 414
Harjo Sales Co.......................... 422
Hoffman Laboratories Inc................ 394
Industrial Research Laboratories......... 390
Instrument Service...................... 412
Johns Hopkins University, The.......393, 397
JSH Sales Co........................... 410
Kollsman Instrument Corp............... 388
Lapirow Bros........................... 406
Lear, Inc.........................383, 392
Lectronic Research Laboratories.......... 422
Lewis & Kaufman Ltd.................... 393
Liberty Electronics 416
Link Aviation Inc....................... 386
Maritime Switchboard 406
Maryland Electronic Mfg Corp............ 405
Massachusetts Institute of Technology..... 394
Maxson, W. L........................... 394
McNeal Electric & Equipment Co......... 422
Medical Salvage Co., Inc................. 414
Melpar Inc. 395
Mogull, Alexander 420
Monmouth Radio Laboratories............ 415
Page Communications Engineering Inc.... 399
Pennsylvania State University, The...... 383
Radalab 418
Radio Corp of America.............384, 385
Radio & Electronic Surplus.............. 420
Radionic Products Co.................... 406
Radio Research Instrument Co........... 418
Rava Trading Co........................ 415
Relay Sales Inc......................... 414
Remington Rand Inc., Engineering Research Associates Div..........390, 396, 401
Richardson Co., The..................... 392
RW Electronics Corp.................... 414
Sikorsky Aircraft 402
Snyder Co., Lee Grant................... 386
Solo Electronics........................ 418
Stavid Engineering Inc.................. 398
Stromberg Carlson Co...............382, 398
Sylvania Electric Products, Whitestone, N. Y. 399
Sylvania Electric Products, Bayside, N. Y. 397
Sylvania Electric Products Inc., Buffalo... 393
Sylvania Electric Products Inc., Wodburn, Mass. 405
"TAB" 407
Teleregister Corp....................... 396
Terminal Radio Corp.................... 419
Transitron Electronic Corp............... 401
Universal General Corp.................. 412
Victor-Bernard Industries Inc............ 412
Vitro Laboratories, Silver Spring Md...... 398
Vitro Laboratories, West Orange N. J.... 382
Western Engineers 411
Westinghouse Electric Corp., Baltimore, Md. 397
Westinghouse, Elmira, N. Y.............. 406
Westinghouse-TV-Radio Div.............. 400
White & Associates Inc., R. E............ 406
Wilgreen Industries..................... 421
Wright Associates....................... 383



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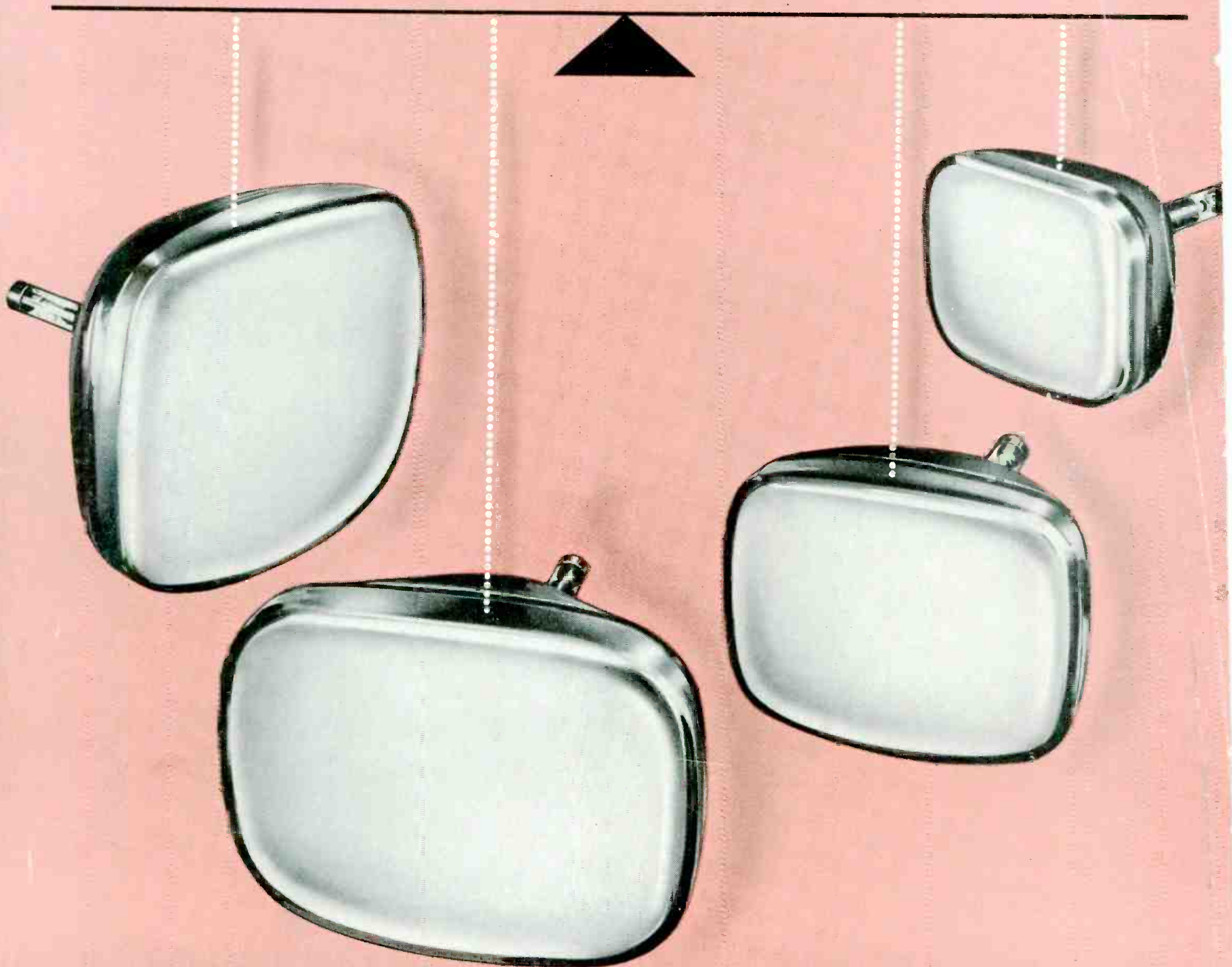

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