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electronics

JANUARY · 1956

ULTRASONIC SLICING OF QUARTZ CRYSTALS

A McGRAW-HILL PUBLICATION • PRICE 75 CENTS

NEW HERMETIC POWER COMPONENTS

HIGHEST RELIABILITY FOR MILITARY AND INDUSTRIAL USE

Listed below are just a few of the 50 new **stock items** in the United hermetic power series. These MIL-T-27 power components add to the 200 other hermetic stock items of filter, audio, and magnetic amplifier types. Through the use of proven new materials and design concepts, an unparalleled degree of life and reliability has been attained, considerably exceeding MIL-T-27 requirements. Test proved ratings are provided, not only for military applications but for **industrial, broadcast, and test equipment service (55°C. ambient).**

For complete listing of these new items, write for Catalogue #56.

MIL-T-27 RATINGS IN REGULAR TYPE — INDUSTRIAL RATINGS IN BOLD TYPE

TYPICAL POWER TRANSFORMERS, PRI: 115V., 50-60 cycles.

Type No.	HV Sec. C.T.	Approx* DC volts	DC MA	Fil. Wdg.	Approx* DC volts	MA DC	Fil. Wdg.	MIL Case
H-81	500	L 180	65		**L 170**	**75**		
		C 265	55	6.3VCT-3A	**C 240**	**65**	**6.3VCT-3A**	HA
	550	L 200	60	5V-2A	**L 190**	**70**	**5V-2A**	
		C 300	50		**C 280**	**60**		
H-84	700	L 255	170		**L 240**	**210**		
		C 400	110	6.3V-5A	**C 360**	**150**	**6.3V-6A**	KA
	750	L 275	160	6.3V-1A	**L 260**	**200**	**6.3V-1.5A**	
		C 420	105	5V-3A	**C 380**	**140**	**5V-4A**	
H-87	730	L 245	320		**L 210**	**420**		
		C 390	210	6.3V-6A	**C 350**	**310**	**6.3V-6A**	NB
	800	L 275	300	6.3V-2A	**L 245**	**400**	**6.3V-2A**	
		C 440	200	5V-4A	**C 400**	**300**	**5V-4A**	
H-93	1000	L 370	280	6.3V-8A	**L 340**	**340**	**6.3V-10A**	OA
	1200	L 465	250	6.3V-4A	**L 455**	**300**	**6.3V-5A**	
				5V-6A			**5V-6A**	

*After appropriate H series choke. L ratings are choke input filter, C ratings are condenser input.

United "H" series power transformers are available in types suited to every electronic application. Proven ratings are listed for both high voltage outputs . . . condenser and choke input filter circuits . . . military and **industrial** applications.

United "H" series filter reactors are extremely flexible in design and rating. Listings show actual inductance at four different values of DC. Bold type listings are **industrial** application maximums.

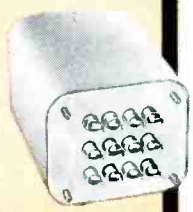
A FEW TYPICAL LISTINGS OF FILTER REACTORS.

Type No.	Ind. @ Hys.	MA DC	Ind. @ Hys.	MA DC	Ind. @ Hys.	MA DC	Ind. @ Hys.	MA DC	Res. Ohms	Max. DCV* Ch. Input	Test V. RMS	MIL Case
H-71	20	40	18.5	50	15.5	60	10	70	350	500	2500	FB
H-73	11	100	9.5	125	7.5	150	5.5	175	150	700	2500	HB
H-75	11	200	10	230	8.5	250	**6.5**	**300**	90	700	2500	KB
H-77	10	300	9	350	8	**390**	**6.5**	**435**	60	2000	5500	MB
H-79	7	800	6.5	900	6	1000	**5.5**	**1250**	20	3000	9000	9x7x8

*Based on maximum ripple voltage across choke in choke input filter circuit, in terms of DC output voltage.

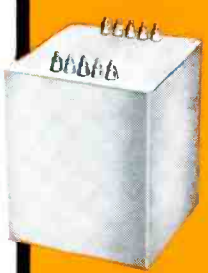
TYPICAL FILAMENT TRANSFORMERS, PRI: 105/115/210/220V., 50-60 cycles.

Type No.	Sec. Volts	Amps. (MIL)	Amps. (Ind)	Test Volts RMS	MIL Case
H-121	2.5	10	12	10000	JB
H-124	5	3	3	2000	FB
H-127	5	20	30	21000	NA
H-131	6.3CT	2	2.5	2500	FB
H-132	6.3CT	6	7	2500	JA
	6.3CT	6	7		
H-136	14, 12, 11CT	10	14	2500	LA



United "H" series filament transformers have multi-tapped primaries, good regulation, and are rated for **industrial** as well as military service.

United "H" series plate transformers incorporate dual high voltage ratings and tapped primaries to provide versatile units for a wide range of military and **industrial** electronic applications. Large units have terminals opposite mounting for typical transmitter use.



TYPICAL PLATE TRANSFORMERS, PRI: 105/115/210/220V., 50-60 cycles.

No. Type	Sec. V. C.T.	Approx.* DC volts	MA DC	Choke No.	MA DC	Choke No.	Case
H-110	1050	380	275	H-75	385	H-77	MB
	1200	465	250	H-75	350	H-77	
H-113	2500	1050	280	H-77	340	H-77	5¼ x 6 x 7
	3000	1275	250	H-76	300	H-76	
H-115	3500	1500	265	H-77	350	H-77	8¾ x 6½ x 8
	4400	1900	225	H-77	300	H-77	
H-117	5000	2125	900	H-79	1100	H-79	13½ x 11 x 14½
	6000	2550	800	H-79	1000	H-79	

*After filter choke. All ratings are for choke input filter.

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electronics

A McGRAW-HILL PUBLICATION

JANUARY • 1956

ULTRASONIC SLICING OF QUARTZ CRYSTALS—Multiple-blade cutting tool mounted on cone of Raytheon 25,000-cps impact grinder slices quartz block into 20 thin wafers for frequency control crystals. Stream of abrasive fluid is directed at setup (see p 132) ..... COVER

FEATURES

CONTINUED ON NEXT PAGE

contents

continued

SHOP

▶ **IN THIS ISSUE** . . . Because of the rapidly increasing use of transistors, ELECTRONICS felt that engineer-readers would find a complete new compilation of transistor properties and design data useful in their work.

About a year ago, associate editor Carroll sent out an inquiry to manufacturers of transistors requesting information on their products.

Soon we learned via the grapevine that Seymour Schwartz, an engineer at MIT's Lincoln Lab, was also asking manufacturers for the same data. We contacted him and learned that not only was the information necessary in his work on Project Lincoln but that he also had an article for ELECTRONICS up his sleeve.

We thereupon presented him with all the material we had collected to date and told him his proposed article would be welcome as the flowers in May. It begins on p 161 and covers a dozen other pages.

Incidentally, the author did not merely follow product bulletins in obtaining his data. He tells us that he has personally checked the characteristics and circuit behavior of many of the units in the course of his work.

▶ **STANDARD PRACTICE** . . . Like many engineers, we have small offices or modules. These provide considerable desk area as well as storage space in drawers for old editorial projects, love letters and the like. Usually loaded, a shelf facing a seated editor is convenient for holding back copies of ELECTRONICS.

On a recent trip in the field, one editor reports he felt completely at home. While visiting a chief engineer and two staff engineers of a company not usually considered as being in

electronics

JANUARY, 1956 Vol. 29, No. 1

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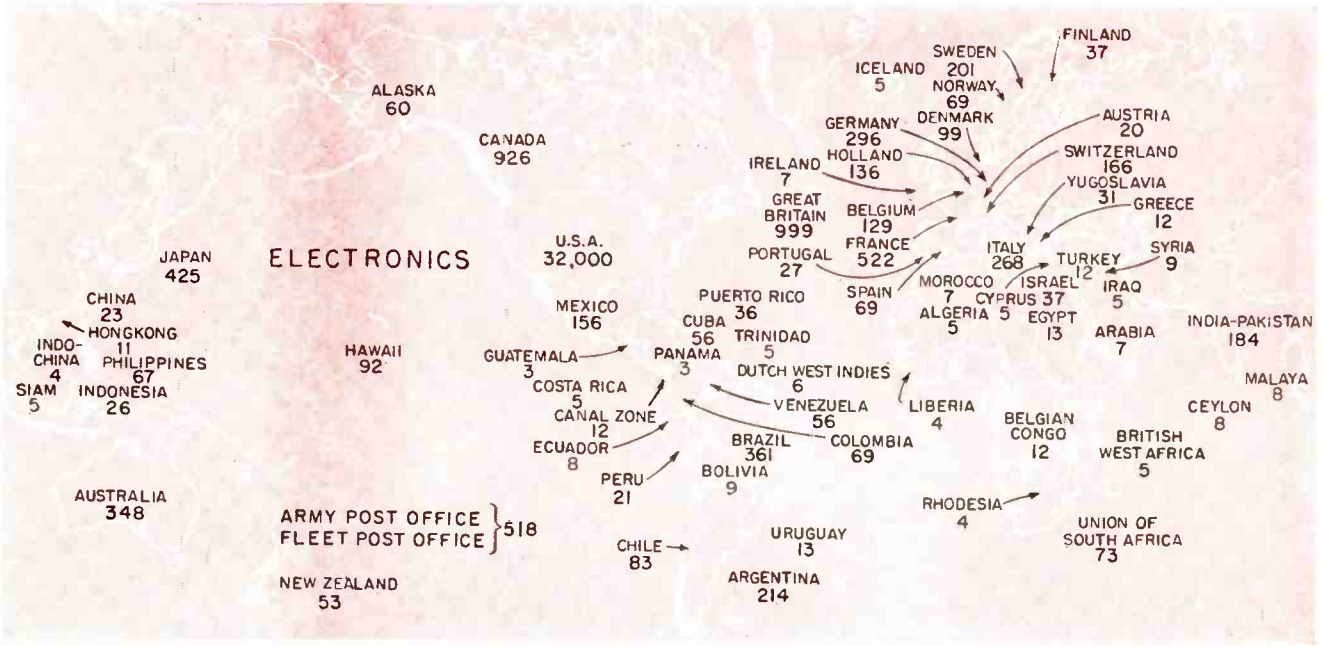
TALK

People We Edit For . . .



the electronics industry, he found himself sitting in each of their offices, facing a shelf holding three years of ELECTRONICS.

► **NEXT MONTH** . . . Growing interest in automatic production, or automatization, has caused a number of machine tool manufacturers to add electronic controls to their equipment.

February ELECTRONICS will contain an article, "Electronic Controls for Machine Tools", that will tell engineer readers about the techniques and circuitry employed. One new bandsaw, for example, provides a new look for the machine shop. It steers just like an airplane.

Prepared by assistant editor Findlay, the article involves a survey of more than five hundred machine-tool makers. Dave traveled nearly 4,000 miles while gathering the material.

Some of the original diagrams set new records. One covered two six-foot desks and left an overhang all around.

Only about 12 square feet of the original 60-odd-foot circuit drawing will appear in the article, however. (In reduced size, of course.)

He tells us that he will never again be able to read the old-style parallel-line capacitor symbol. He has seen so many of that one in industrial circuits that it now means only a contactor to him.

Bandsaw pilot and control panel of DoAll machine for cutting extrusion dies

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This new standard cell is hermetically sealed and mounted in a bakelite case, and its miniaturization permits mounting in even the most compact test assemblies. It is of the Cadmium type with a constant absolute voltage of 1.01859 volts (+ 110 microvolts, —90 microvolts) at 20° C. Internal resistance is approximately 600 ohms and the temperature coefficient is —0.00004 per degree C. Currents of up to 20 microamps may be drawn for short periods.

With a weight of only 4 ounces and dimensions of $1\frac{5}{16}$" x 1" x $3\frac{3}{8}$", this cell may be used with a potentiometer for measuring current or voltage, and also in circuits of the NULL balance type.

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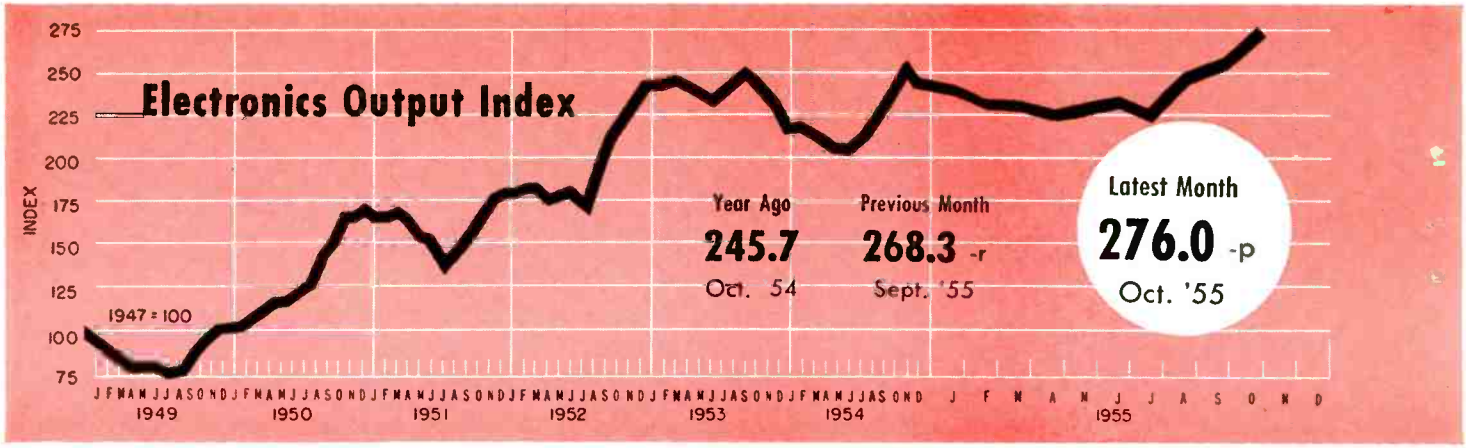


FIGURES OF THE MONTH

RECEIVER PRODUCTION (Source: RETMA)	Latest Month	Previous Month	Year Ago
	Oct. '55	Sept. '55	Oct. '54
Television sets, total	759,735	939,515	921,476
With UHF	109,574	140,022	161,431
Color sets	nr	nr	nr
Radio sets, total	1,500,206	1,302,350	997,788
With F-M	38,920	27,313	12,151
Home sets	398,087	417,802	343,269
Clock radios	282,393	234,106	220,505
Portable sets	168,709	139,164	97,331
Auto sets	651,017	511,278	336,683

RECEIVER SALES (Source: RETMA)	Oct. '55	Sept. '55	Oct. '54
Television sets, units	746,274	978,838	799,164
Radio sets (except auto)	724,305	753,068	570,285

RECEIVING TUBE SALES (Source: RETMA)	Oct. '55	Sept. '55	Oct. '54
Receiv. tubes, total units	48,119,000	47,588,000	42,347,794
Receiv. tubes, value	$35,000,000	$34,596,000	$29,228,992
Picture tubes, total units	1,224,990	1,202,430	1,269,674
Picture tubes, value	$23,800,000	$22,867,851	$26,597,702

SEMICONDUCTOR SALES	Sept. '55	Aug. '55	Sept. '54
Germanium diodes, units	1,850,000	1,700,000	1,433,021
Silicon diodes, units			

INDUSTRIAL TUBE SALES (Source: NEMA)	Quarterly Figures: Latest Quarter	Previous Quarter	Year Ago
	3rd '55	2nd '55	3rd '54
Vacuum (non-receiving)	$9,027,845	$8,933,453	$8,803,740
Gas or vapor	$3,438,835	$3,365,008	$3,570,586
Phototubes	nr	nr	nr
Magnetrons and velocity modulation tubes	$10,998,967	$13,193,395	$13,112,244
Gaps and T/R boxes	$1,421,138	$1,677,574	$1,476,407

TV SETS INSTALLED* (Source: NBC Research Dept.)	Latest Month	Previous Month	Year Ago
	July '55	June '55	July '54
Total sets	36,477,000	36,100,000	30,717,000

BROADCAST STATIONS (Source: FCC)	Nov. '55	Oct. '55	Nov. '54
TV stations on air	477	473	434
TV stations CPs—not on air	109	110	141
TV stations—new requests	28	35	18
A-M stations on air	2,808	2,788	2,650
A-M stations CPs—not on air	115	110	112
A-M stations—new requests	217	235	174
F-M stations on air	536	539	554
F-M stations CPs—not on air	20	14	11
F-M stations—new requests	4	9	3

COMMUNICATION AUTHORIZATIONS (Source: FCC)	Oct. '55	Sept. '55	Oct. '54
Aeronautical	43,648	44,183	39,873
Marine	53,426	52,908	48,116
Police, fire, etc.	19,377	19,153	16,546
Industrial	27,091	26,357	22,579
Land transportation	8,216	8,078	7,071
Amateur	140,799	139,628	124,563
Citizens radio	13,862	13,530	8,945
Disaster	319	319	306
Experimental	662	661	627
Common carrier	2,040	2,001	1,737

EMPLOYMENT AND PAYROLLS (Source: Bur. Labor Statistics)	Sept. '55	Aug. '55	Sept. '54
Prod. workers, comm. equip.	389,700-p	371,300-r	359,900
Av. wkly. earnings, comm.	$74.34 -p	$72.32 -r	$69.55
Av. wkly. earnings, radio	$70.30 -p	$69.43 -r	$68.34
Av. wkly. hours, comm.	41.3 -p	40.4 -r	40.2
Av. wkly. hours, radio	40.4 -p	39.9 -r	40.2

STOCK PRICE AVERAGES (Source: Standard and Poor's)	Nov. '55	Oct. '55	Nov. '54
Radio-tv & electronics	438.4	428.9	454.6
Radio broadcasters	502.7	486.9	408.1

p—provisional; r—revised
nr—not reported
*being revised in light of Census data

FIGURES OF THE YEAR

	TOTALS FOR FIRST TEN MONTHS 1955	1954	Percent Change	1954 Total
Television set production	6,520,241	5,654,791	+15.3	7,346,715
Radio set production	11,527,568	8,040,230	+43.4	10,400,530
Television set sales	5,896,251	5,444,227	+ 8.3	7,317,034
Radio set sales (except auto)	4,666,981	4,602,989	+ 1.4	6,430,743
Receiving tube sales	395,787,000	308,398,701	+28.3	385,089,458
Cathode-ray tube sales	8,905,771	7,746,240	+15.0	9,913,504

INDUSTRY REPORT

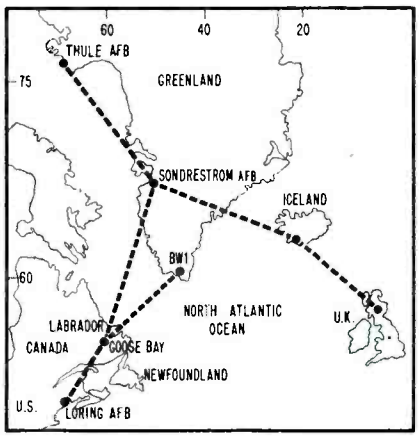
Scatter Circuits To Link Three Continents

Paris-Naples-Ismir, Turkey system planned by NATO will extend US-UK links now in use

COMMUNICATIONS system to connect radar stations from Norway to Turkey has been approved by NATO Ministerial Council. The system will use both tropospheric and ionospheric forward-scatter circuits.

▶**Pilot**—U. S. will finance and supply a pilot tropospheric system for Norway and an ionospheric circuit linking Paris, Naples and Ismir, Turkey. Cost will be about $45 million.

U. S. will shoulder one-fourth or more of the cost of the entire system. The countries in which the equipment will be installed will let final contracts on competitive bids subject to NATO approval. Work will take about three years.



Forward-scatter circuits linking U. S. and Canada with United Kingdom

▶**Tie In**—The completed NATO system will tie into existing forward scatter circuits connecting points in the U. S., Canada and the United Kingdom as shown on the map.

▶**Radar**—Coincident with establishing the new communications network, existing national radar systems of NATO members will be integrated into an overall European radar fence. This move will not necessarily involve installing new equipment.

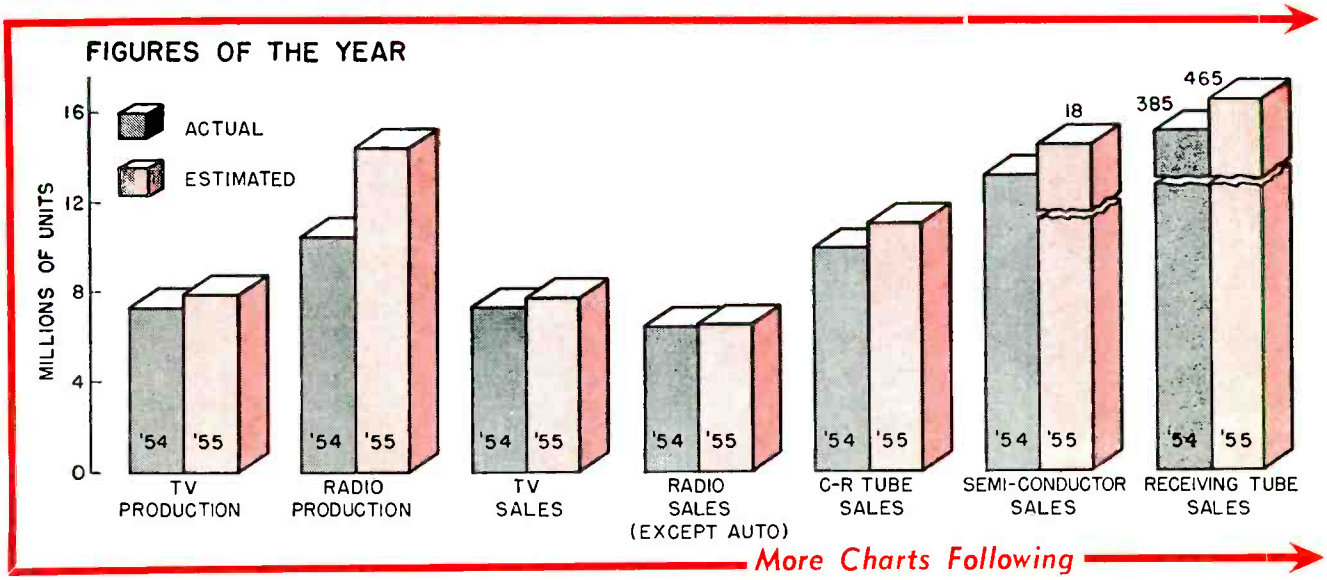
Auto Firms Eye Radar Brake Unit

PACKARD Motor Car is considering radar controlled automobile brakes for use in its 1957 models.

Ford and General Motors have seen demonstrations of the $300 system, which is being promoted by a Detroit new-car dealer.

▶**System Details**—An antenna about 5 inches high and 30 inches

ELECTRONIGRAPHS—*A Year-End Glance at Electronics Industry Figures*



wide is mounted between the front bumper and grille of the demonstration car. Circuitry fits into the glove compartment.

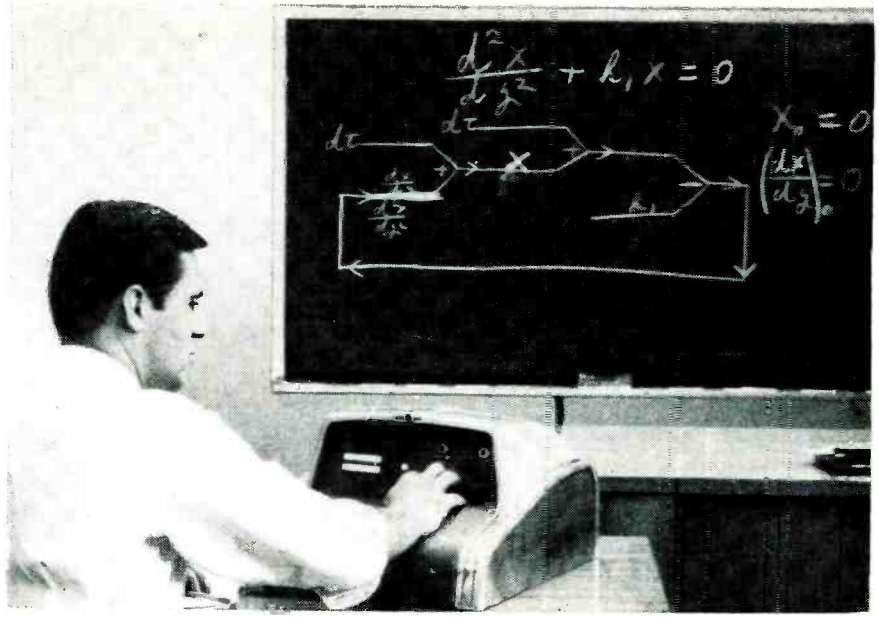
The car's brakes are applied with a force proportional to the distance away that an object appears on the road ahead. The driver may brake manually while the radar control is in operation and may, at will, disconnect the radar control.

Electronics Output Hits New High

DOUBLING of the electronics industry since 1950 is indicated by the ELECTRONICS Output Index which this year is expected to hit a yearly average of nearly 250 points.

▶ **Comparison**—However, the gross national product has increased by only 35 percent according to RCA. By the end of 1965, the firm expects the value of electronics to more than triple its 1950 value. The gross national product is not expected to have quite doubled.

Now there are 1.6 million workers directly employed and 3 million indirectly employed in companies that serve the electronics industry, according to RCA. In ten years, the firm believes that the industry will employ more than 6 million workers directly and indirectly.



ENGINEER gets assist in solving differential equation as . . .

Desk-Top Analog Computer Appears

Digital computers also figure in the news. Russian computer ordered by India

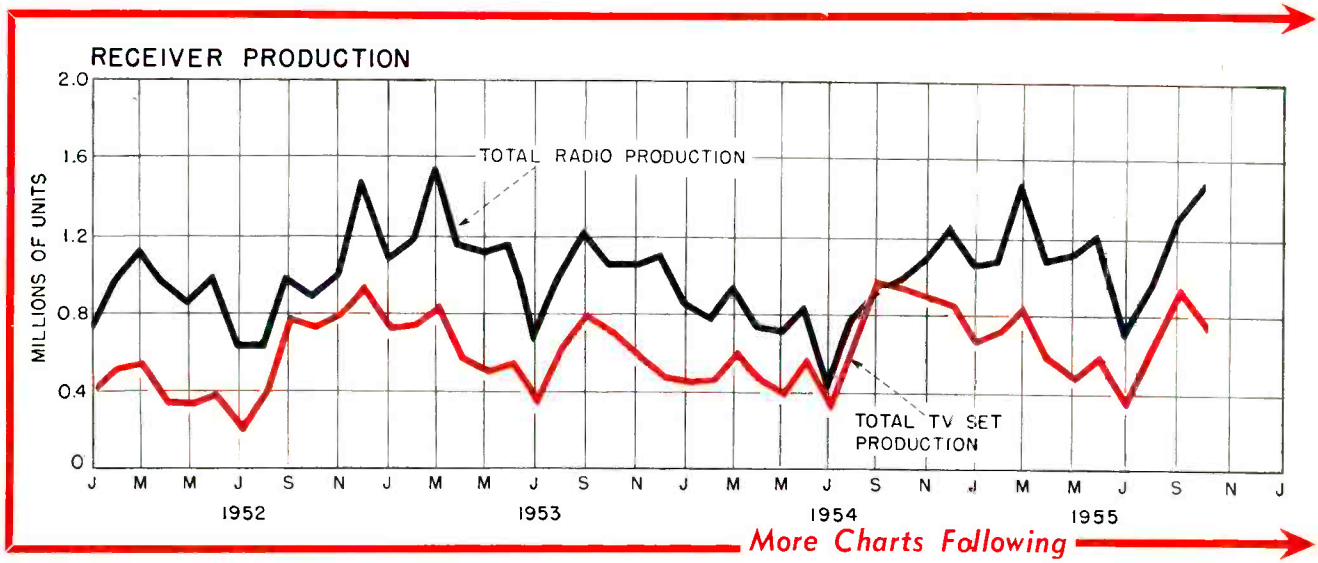
BURGEONING computer business passed more mileposts during the recent month.

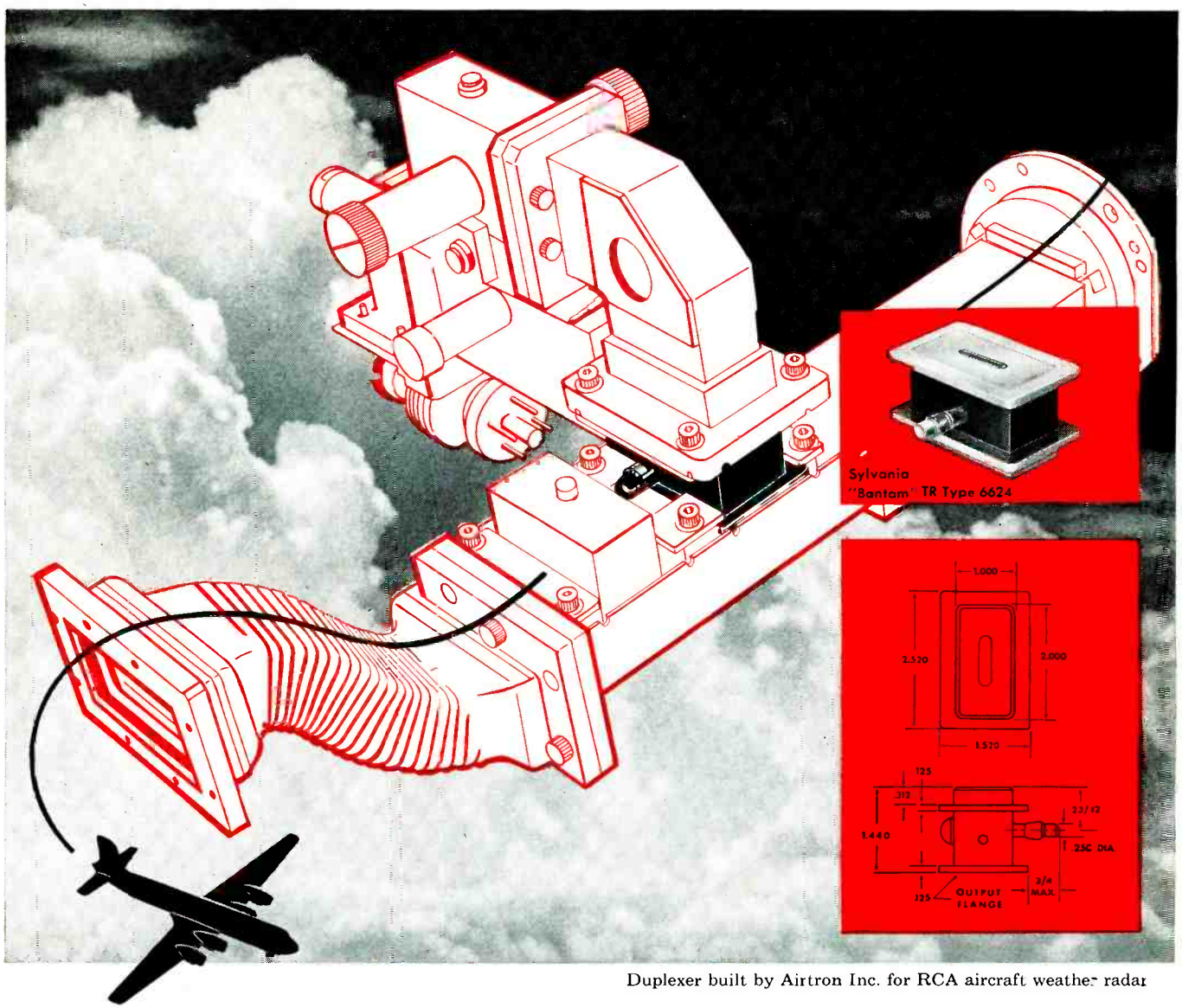
An electronic differential analyzer about the size of a portable typewriter has been announced by California's Litton Industries. Selling in the $10,000 range, the computer contains 20 integrators with accuracies of one part in 250,000. Control is provided by a five-button panel. Answers appear in a miniature crt. The firm indicates the computer will be available in quantity about the first of the year.

▶ **Digital Bookkeeper**—A new digital computer, the Modac 404 will handle accounting for a book club. Produced by Mountain Systems of Thornwood, N. Y., the computer uses magnetic-drum storage with capacity for 20,000 six-digit num-

(Continued on page 10)

ELECTRONIGRAPHS Continued





Duplexer built by Airtron Inc. for RCA aircraft weather radar

New "BANTAM" TR tube saves space and weight in airborne weather radar

If your Microwave design includes a branched duplexer, here's a new concept in TR tubes which can produce savings in equipment weight and space and offers simplified mounting with easier maintenance.

These were the primary considerations when Sylvania, in close co-operation with Airtron Inc., developed a special TR tube for use in RCA aircraft weather radar.

The "Bantam" TR type 6624 is the product of this development. Its smaller, more compact design with contact mounting moves the TR a full step toward miniaturization.

The 6624 is a broad-band, fixed tuned TR tube. Operational center is at 5400 mc. Contact mounting is at the input end. The Sylvania ATR type 6591 serves as the companion to the TR 6624.

Write for complete data on the Type 6624 and Sylvania "Bantam" TR tubes for other frequency bands.

"Another reason why it pays to specify Sylvania"

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bers on the drum.

Read-in and read-out are done by perforated paper tape. Addition and substraction are accomplished at 15 operations per second. Output to paper tape is 20 characters per second.

▶**Soviet Brain**—The Indian Statistical Institute in Calcutta has ordered a Soviet-made electronic computer to cost $500,000. The computer will supplement a British-made machine currently being installed.

▶**More Memory**—High-speed storage capacity of the IBM 704 scientific computer will be increased by 32,768 words by a new magnetic-core storage unit. Magnetic cores will add 20,000 memory positions to the IBM 705 business computer. The magnetic-core memories supplement existing magnetic tape and drum memories.

▶**Electronic Scales**—An electronic scanning and counting unit announced by Toledo Scale may tie into automatic industrial control applications. Lines on a graduated scale that moves to register weight are scanned and counted electronically. Digital read-out is available at a remote point.

Slow-Scan TV Speeds Business Data

Transmission via telephone lines cuts closed-circuit tv costs

ELIMINATING the need for microwave and coaxial links in closed-circuit tv systems, a low-speed scanning system transmits business data over 25 miles on conventional telephone circuits.

▶**Showing**—The Pennsylvania Bell Telephone Co. recently demonstrated the closed-circuit equipment developed by Dage Television Division of Thompson Products. Present plans are for Bell to offer the service in metropolitan areas with distance between transmitter and receiver limited to 25 miles.

▶**Operation**—Using a scanning system that completes the picture on the screen in two to four seconds, the transmission requires a band of 8,000 cps—about 1/500 of that required for conventional television. A long-persistence picture tube retains the image over the relatively long scanning cycle.

▶**Applications**—Uses for the new system include transmission of signatures for verification at branch banks, printed materials, meter and gage faces, and other types of slow or nonmoving pictures.

Mergers Keep Pace In Electronics

New companies move into the field, old ones enlarge their holdings

IN 1955 more than 200 companies were involved in mergers in the electronics field. In the first six months, nearly 50 mergers were consummated or planned (ELECTRONICS, p 15, July '55). Almost as many took place in the second half. Nearly twice as many took place in 1955 as in 1954.

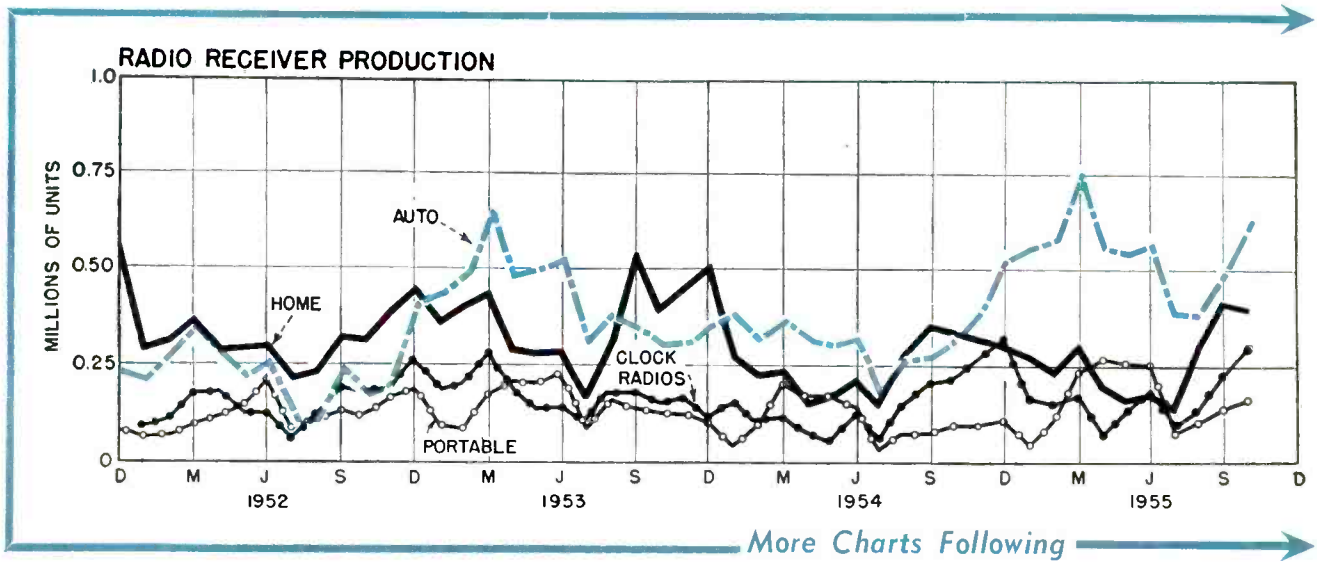
▶**Why**—According to the Federal Trade Commission, the most frequent advantage to be gained by an acquisition is additional capacity to supply a market already supplied by the acquirer. This was observed in two acquisitions out of every five studied by the FTC in making its merger report of May, 1955.

▶**Size**—High in the merger rate in the electronics industry in number of firms acquired is Litton Industries. The company has integrated 10 firms into its operations in the past 24 months.

Two of the largest mergers in the past year were the Sperry, Remington Rand and the Strom-

(Continued on page 12)

ELECTRONIGRAPHS Continued

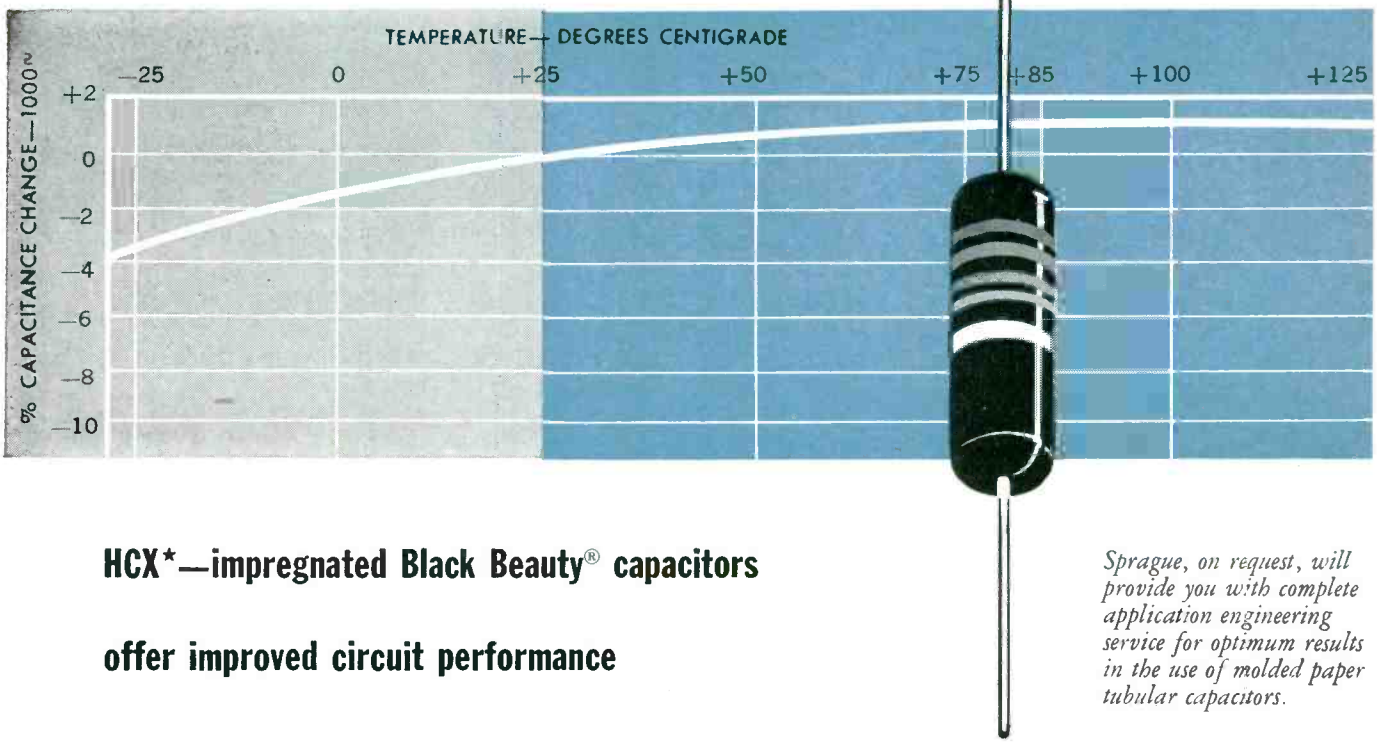


More Charts Following

new!

a solid-dielectric molded paper tubular capacitor

with flat capacitance-temperature characteristics



HCX*—impregnated Black Beauty® capacitors

offer improved circuit performance

Sprague, on request, will provide you with complete application engineering service for optimum results in the use of molded paper tubular capacitors.

SPRAGUE'S NEW TYPE 109P CAPACITORS use a unique new impregnant identified by the trademark HCX. Developed in the Sprague research laboratories in the search for a better material than the polyesters customarily used for impregnating solid dielectric paper tubulars, HCX is a hydrocarbon which polymerizes after the rolled section has been vacuum impregnated. Its salient electrical characteristic of insulation resistance, power factor, and capacitance change with temperature are superior to those of the ordinary polyester units on the market today.

Type 109P Black Beauty Telecaps are molded in non-flammable phenolic and are mechanically rugged. They make an ideal capacitor for all TV and auto radio operations and are well suited for automation assembly by machine since the lead concentricity is closely fixed and there is no outer wax dip to jam inserting heads or magazines.

Complete performance data covering the wide range of sizes and ratings are in Engineering Bulletin 223, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 35 Marshall Street, North Adams, Massachusetts.

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SPRAGUE® *world's largest capacitor manufacturer*

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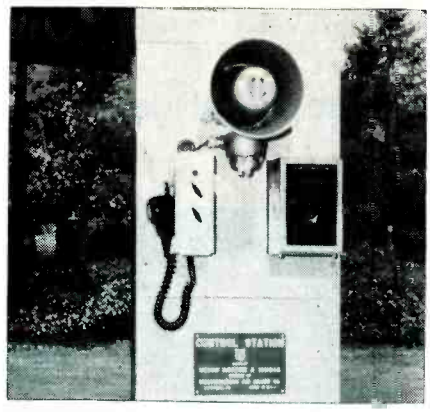
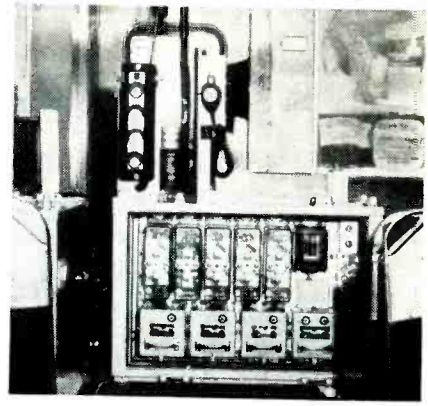
berg Carlson, General Dynamics. The Sperry Rand action formed a new firm with assets of approximately $484 million. The Stromberg, General Dynamics merger joined the 55,000 employees of General with the 5,200 of Stromberg for a total work force of over 60,000.

▶ **Character**—Following is a list of mergers in the electronics field in the last half of 1955. Most companies are parts manufacturers and instrument firms.

Mergers In Electronics
(Last Six Months 1955)
Air Associates, Great American Industries
American Cyanamid, The Formica Co.
American Electronics, R-C Scientific
Atomic Instrument, Kaye Development
Beckman Inst., Liston-Becker
Beckman Inst., Place Ceramics
Borg-Warner, Byron Jackson
Cinch Mfg., Graphik Circuits
Frank Cook, Hart Machine
Eastern Industries, Neptune Meter
Electromation, Kinevox
General Cable, General Insulated Wire
General Instrument, Automatic Mfg.
Titus Haffa, Webster Chicago
Hall-Scott, Dynamic Analysis
Hermetic Seal, Glass Solder
Hoffman, National Fabricated
Hoover, Phebco
Hupp Corp., Pioneer Electric
IDEA, Radio Apparatus Corp.
IRC, EMEC
IT&T, Kuthe Labs
Jerrold Electronics, Cable Vision
Litton, Automatic Seriographic
National Aircraft, Florida Aviation, Hydro-Aire Division, Mag-Electric
N. Y. Transformer, Tartack Electronics
Norden-Ketay, Frohman Mfg.
Ohmite, American Relay
Penn-Texas, Hallicrafters
H. K. Porter, Electric Service Eng.
J. B. Rea, Robey Rotor Co.
RCA Estate, Seeger, Whirlpool, Sears Roebuck
Siegler, Hallamore Mfg.
Sperry Products, Western Inspection
Stewart-Warner, J. W. Hobbs
Stromberg-Carlson, Electronic Control Systems
Superior Tube, Johnson & Hoffman Mfg.
Thomas Industries, White Corp.
United Carr, Plastic Process
Van Norman, Insuline and Transitron, Inc.





WAYSIDE station controls, left, and safety equipment in car run train as . . .

Casey Jones Goes Electronic

Remote control, cab signal gear and two-way communications are used in test run

A LOCOMOTIVE on the New Haven Railroad in the New Rochelle to Rye, N. Y. area moved east or west, coasted or stopped, without an engineer at the controls. Its movements were controlled by remote control equipment at a wayside station.

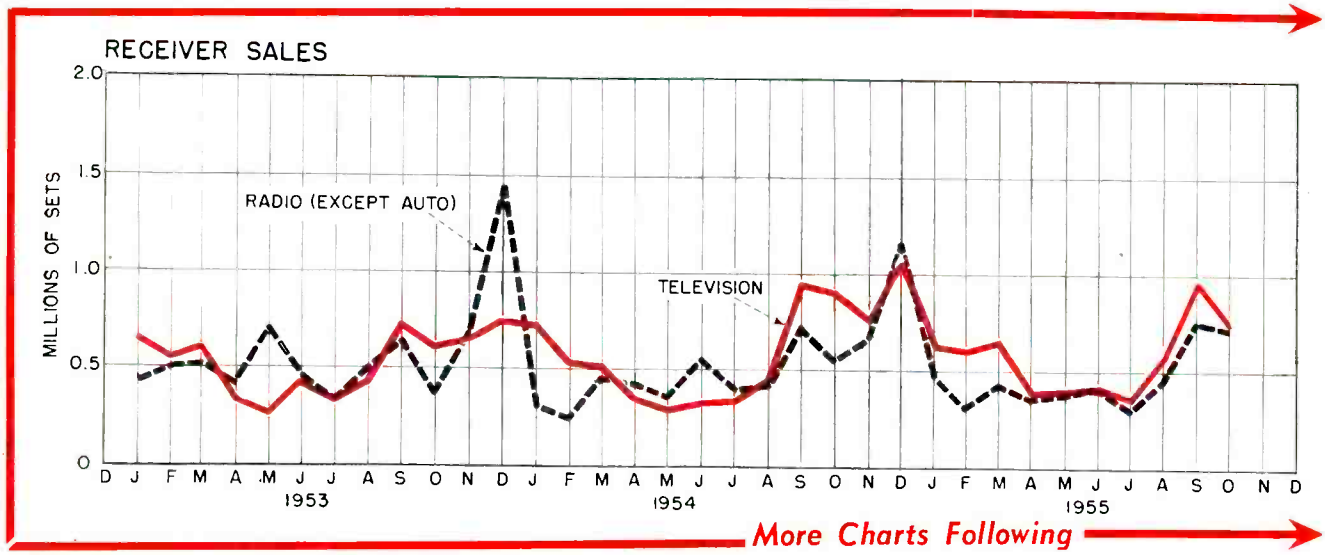
Automatic train control equipment on the train continuously monitored conditions ahead to make sure all was safe. Two-way inductive voice communication equipment was available to keep passengers informed of control changes to be made. The control, safety and communication equipment was provided by Union Switch & Signal Division of Westinghouse.

▶ **Remote**—The way side equipment has a locomotive control panel with two control levers. One controls direction and the other selects between "neutral," "run," and "stop." When the lever is on neutral, the train brakes are released and power is cut off. To stop, a service application of the train brakes follows, bringing the train to a halt.

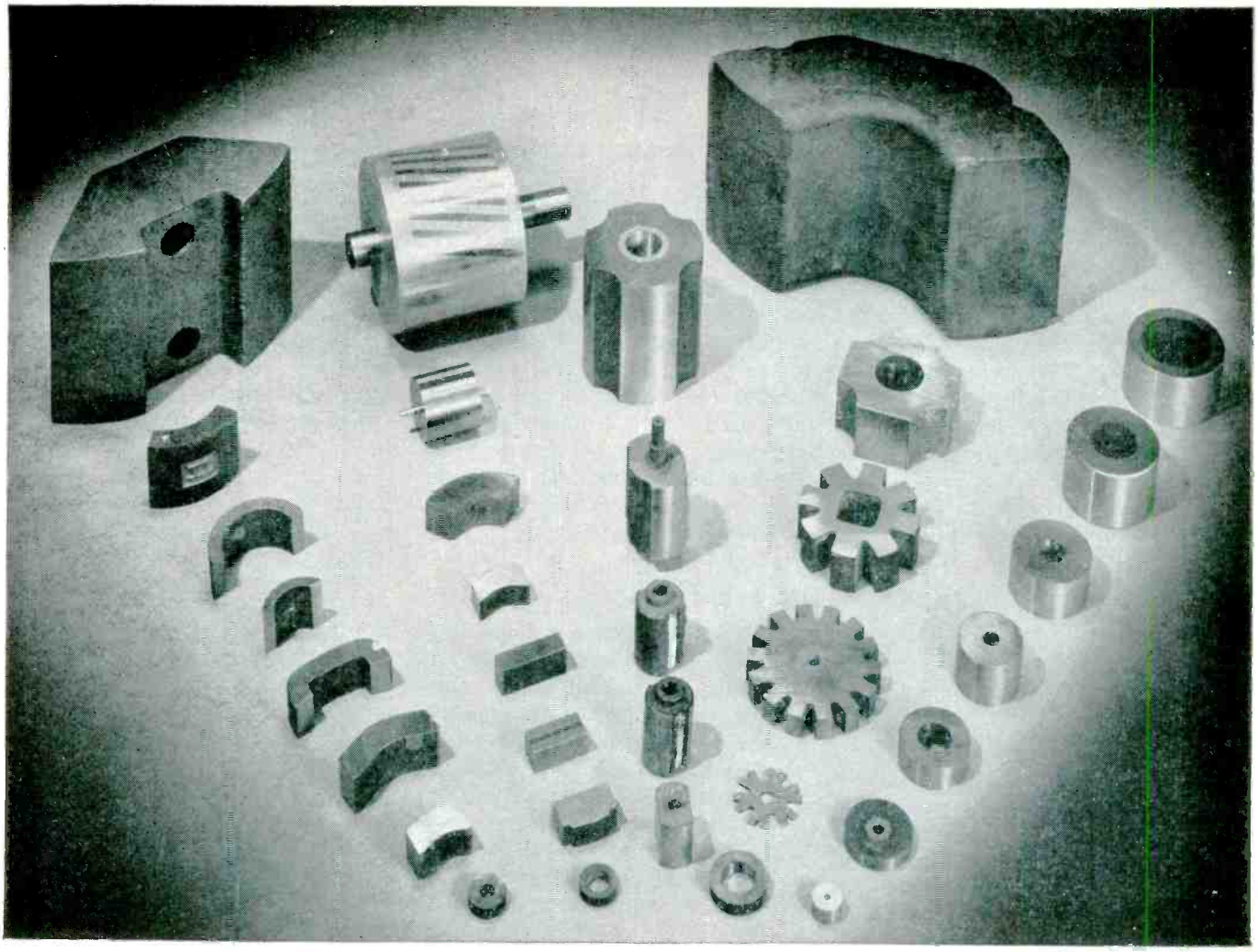
The electronic portion of the wayside equipment consists of a power supply, an audio oscillator and a carrier modulator. A carrier frequency is modulated with certain audio frequencies, depending on the control desired. Amplified to the desired level of signal cur-

(Continued on page 14)

ELECTRONIGRAPHS Continued



More Charts Following



Magnets for rotors or stators ...any design or size you may require

"MAGNETIC MATERIALS CATALOG"

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Contains handy data on various types of Alnico Magnets, partial lists of stock items, and information on other permanent magnet materials. Also includes valuable technical data on Arnold tape-wound cores, powder cores, and types "C" and "E" split cores in various tape gauges and core sizes.

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The use of Alnico permanent magnets in rotor and stator assemblies of motors, generators, magnetoes and tachometers has revolutionized the designs of these devices. Whatever your need may be —from a tiny rotor for a timing device to a large slab for power generators—Arnold can take care of your requirements, either for experimental samples or production quantities.

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Los Angeles: 3450 Wilshire Blvd. Boston: 200 Berkeley St.

rent, the carrier output is fed to existing line wires which parallel the track.

The train receives its commands through inductive coupling between the modulated carrier current flowing in the line wires and a receiving coil mounted on the locomotive.

When the remote control lever is in the run position, two audio frequencies are introduced into the modulator—when the lever is in the neutral position only one audio frequency is used—and when the lever is in the stop position no audio is present. A visual indicator on the train displays the control commands transmitted from the remote station.

▶ **Transistors**—For safety, the locomotive used was equipped with additional automatic train control. It is continuously responsive to rail-carried currents which reflect track conditions in advance of a train. If all is not safe, the brakes are automatically applied and the train is brought to a stop regardless of control signals from the wayside station. Junction-type silicon transistors were used in place of vacuum tubes.

Parts Houses Gain Business

INCREASING volume of electronic parts and products rolling off the production lines of the industry has swelled the importance of the distribution side of the business.

▶ **Number**—According to Market Planning Service, a division of the National Credit Office, there are some 1,143 electronics parts distributors in the U.S. today with 300 branches. In 1954 there were 1,100 with 250 branch locations.

In addition, there are some 230 distributors who handle electronics parts but whose main business volume lies in other fields.

▶ **Volume**—In 1954 all these companies did over $1.3 billion, a seven-percent increase over 1953.

Sales were 12 percent ahead of '54 in the first quarter, 9 percent ahead in the second and 15 percent ahead in the third quarter. If the increase is maintained in the fourth quarter, total sales for the year should exceed $1.5 billion.

Parts inventories have been some 17 percent ahead of 1954. Purchases equaled 77 percent of sales in the first three quarters of 1955, indicating fast turnover.

▶ **Future**—Sylvania's president, Don G. Mitchell, predicts that by 1965 the distribution and service businesses will reach a combined volume of $5.1 billion. For 1956 he foresees a volume of $2.3 billion and $3.3 billion by 1960.

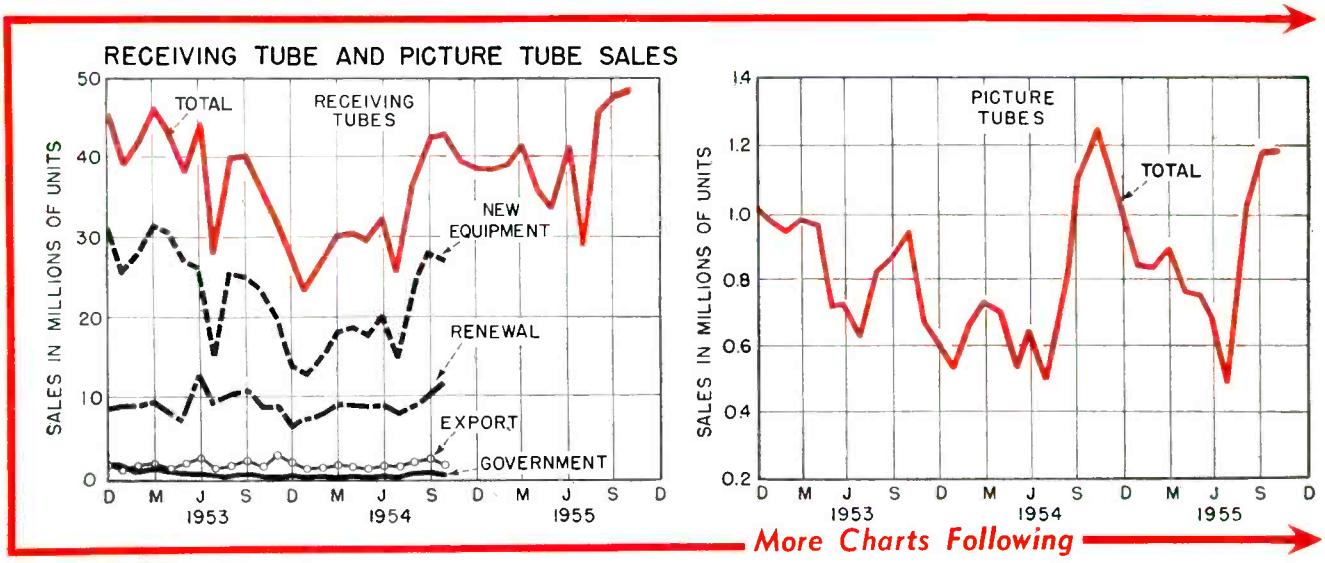
Electronics Invades Chemical Labs

MORE than 1,000 chemical laboratories are maintained by major colleges, metal producers, chemical plants and drug houses. At a typical laboratory, that of Lehigh University in Bethlehem, Pa., the chemistry department uses 142 electronic instruments having a value of roughly $250,000.

Instrument	Number of Tubes	Number of Instruments
Conductivity bridge	3–5	4
Recording potentiometer	5–8	15
Colorimeter	4–5	2
Radiation counter	6–20	4
Dielectric-constant meter	6	1
Electrometer	20–24	2
Electron microscope	60	1
Frequency meter	6–12	3
Strain-gage amplifier	6	2
Oxygen analyzer	4	1
pH meter	2–5	20
Impedance bridge	4	1
Ionization gage	5–6	6
R-F combustion furnace	8	1
Mass spectrometer	40–60	2
Gauss meter	6	1
Audio oscillator	2–8	3
R-F oscillator	4–5	3
Ultrasonic oscillator	4–14	2
Oscilloscope	10	4
Electronic relay	1–2	20
Servomechanisms	5	4
Photoelectric x-ray spectrometer	40	1
Infrared spectrophotometer	25	1
Ultraviolet spectrophotometer	2–18	3
Stroboscope	4	1
Electronic timer	3	2
X-ray thickness gage	20	2
Thyratron relay	4	4
Titrimeter	4	10
Voltage regulator	8	2
Tube tester	4	3
Nephlometer	3	1
Viscometer	5	1
Vacuum-tube voltmeter	4	8
X-ray diffraction equipment	45	1

(Continued on page 16)

ELECTRONIGRAPHS Continued



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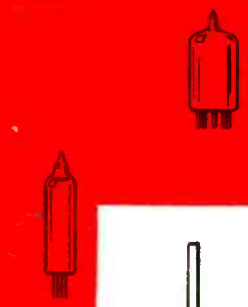
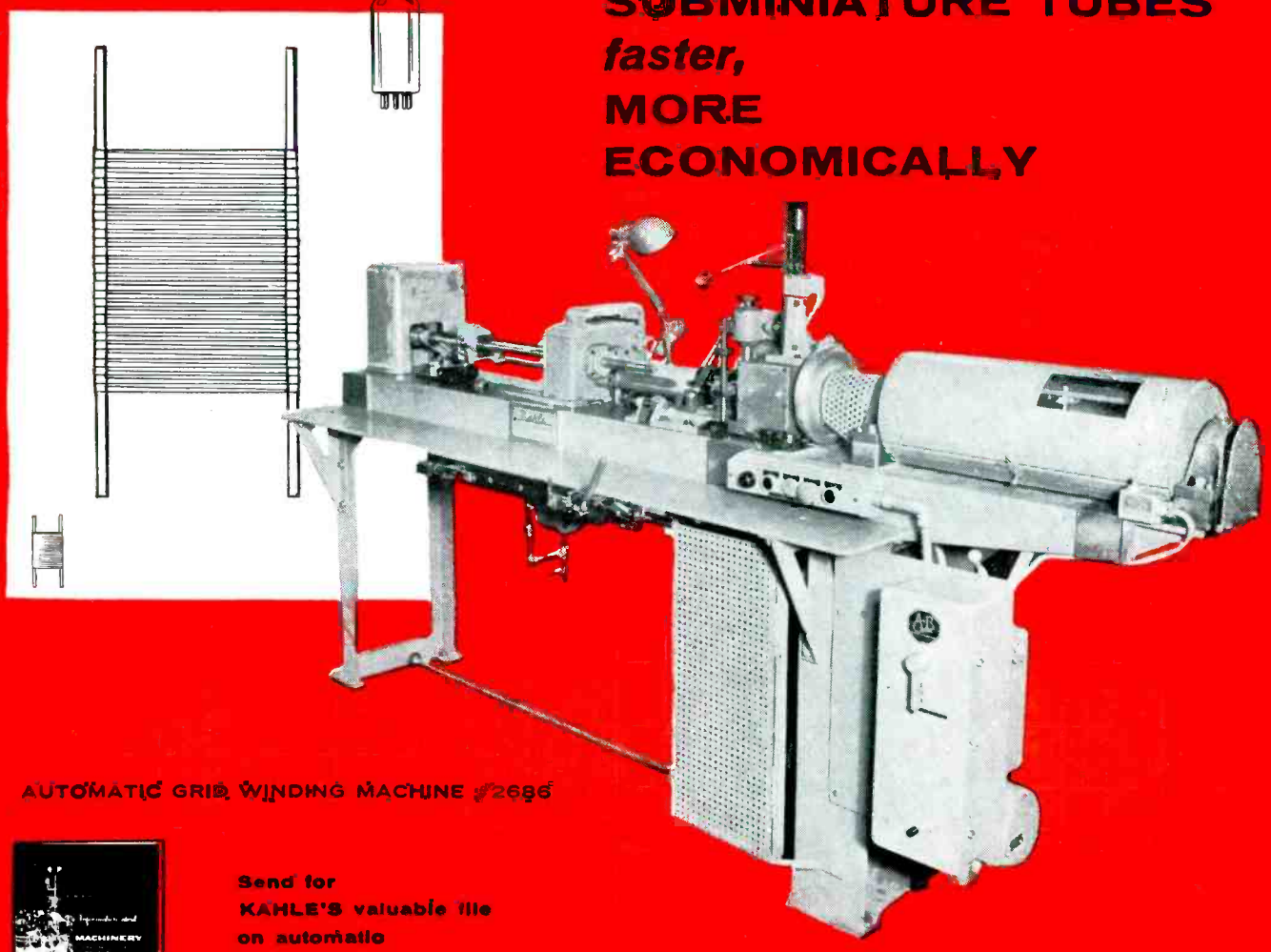


TUBE COMPONENTS, GLASS DIODES, TRANSISTORS AND SUBMINIATURE TUBES *faster,* MORE ECONOMICALLY



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DESIGNERS AND BUILDERS OF AUTOMATIC AND SEMI-AUTOMATIC EQUIPMENT FOR ALL INDUSTRIAL OPERATIONS

PLANT facilities such as these will be used by Hughes Aircraft for commercial production as . . .

Airplane Firms Spread Interests

Manufacturers apply military electronics know-how to civilian products

IN little more than a year's time, three large aircraft manufacturers have moved into the non-aviation side of the electronics business.

Curtiss-Wright now makes and sells industrial tv equipment. General Dynamics, through the acquisition of Stromberg-Carlson, is now heavily engaged in all phases of commercial electronics. Latest aircraft manufacturer to make the move from primarily military electronics to civilian products is Hughes Aircraft Co.

▶ **Products**—The firm has set up the Hughes Products Division which will be responsible for making the products created by its research activities available to industry. The new division, initially, will concentrate on the field of semi-conductors, producing germanium diodes, silicon diodes and transistors; electronic storage tubes, display tubes and related products. All of these are outgrowths of developments made in the areas of electronic systems, computers and guided missiles.

Up to now the developments of the company's research have been used in the Falcon guided missile and electronic systems for interceptor airplanes.

▶ **Size**—Magnitude of Hughes Aircraft operations is indicated by the fact that it employs some 19,000 persons. Total plant area of the company is 3.1 million sq ft. Its total annual payroll is $81.4 million and sales in 1954 exceeded $200 million. Its current backlog of orders exceeds $316 million.

The company has produced more than 8,000 electronic control systems for interceptor planes. Each system is the equivalent, in number of parts, of 200 tv sets. Today it has approximately 5,000 scientists, engineers and technicians employed in electronics research and development work.

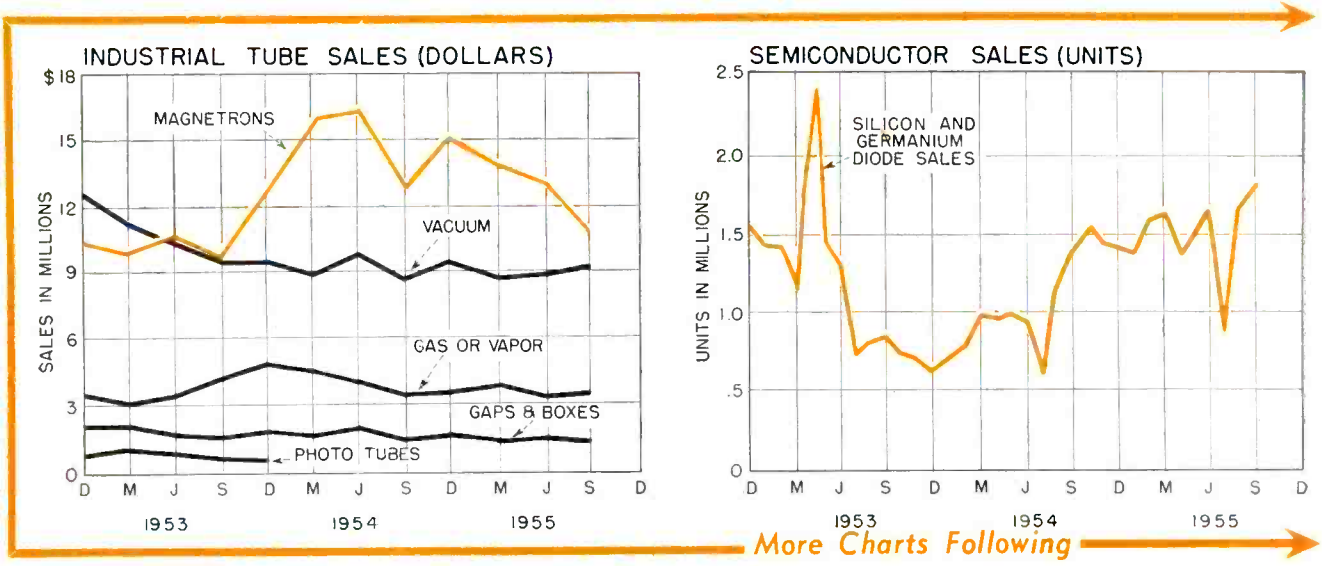
U. S. Counts Engineers In Industry Fields

Report consolidates latest valid figures on scientific personnel resources

SUMMARY of significant data on the supply, utilization and training of scientific and technical personnel in the U. S. has been made

(Continued on page 20)

ELECTRONIGRAPHS *Continued*



Type 970 Potentiometer

. . . An Achievement in Simplicity

Linearity Better than ±0.2% *for Larger Units graded to ±2% for smaller sizes*

Seventeen Stock Resistances *from 2 to 500,000 ohms*

Ratings From 2 to 20 Watts *at 40° Ambient*

1¼" Diameter to 4¼"

Prices From $3.10 to $10.00

All Phenolic Case chosen for minimum capacitance to ground — geometry of these moldings prevents unequal curing or aging stresses, providing a uniformly concentric surface on which to mount the wound-wire card — cleanliness resulting from total enclosure helps keep noise low.

External Phasing — only two screws in rotating hub secure the shaft; this permits convenient brush orientation and substitution of shafts of other materials or lengths without exposing interior to dust.

Glass-Reinforced Polyester Shaft for superior electrical performance, strength and insurance against warpage.

Good Linearity, Low Electrical Noise — brush rides on edge of tightly-wound resistance card where wire is firmly seated and holds its spacing — card is cemented to cylindrical surface of base, and complete assembly is baked to cure cement and stress-relieve the card — linearity of high order is obtained and this important characteristic is not affected by age, temperature or moisture — each pot is individually tested for conformity with linearity specifications and acceptable noise.

Electrical Continuity — terminals are solder-secured directly to winding ends for positive connection — no permanent electrical connections depend on pressure.

Mounting Rigidity — potentiometers may be mounted on any thickness of panel or shelf by screws through base; units are then keyed against rotation.

Precious Metal-Alloy Brush is specially selected for compatibility with metal of winding — brush is spot welded to spring arm and has small diameter giving best possible resolution — alloy used is noncorrosive to keep electrical noise low, is heat hardened to give long life.

Uniform Contact Pressure — phosphor bronze brush-arm acts as extra long spring assuring uniform pressure at all settings — bearing in same plane as contact brush minimizes effects of side-thrust on shaft.

Single Cover Retaining Screw also acts as brush stop — easy inspection even when pot is mounted — restraining force of stop does not act on active portion of brush spring, preventing bending or straining of operating elements.

The G-R Type 970 Potentiometer is not just another potentiometer, but a precision unit which is sturdy and versatile, has resistance-performance characteristics approaching the best available, a-c performance substantially better than that found in higher precision types, *but which is available at reasonable cost.*

This potentiometer is different by its simplicity . . . a simplicity of design which makes possible manufacturing economies with no sacrifice in quality. This design makes available a potentiometer of superior performance at very low price.

The new 970 Series Potentiometers have accurate resistance values and low capacitance; feature good linearity and long contact life; have low noise and are totally enclosed; there are no fixed-pressure connections, and settings are stable and repeatable. Ganged units are available with no loss of the low capacitance characteristic which makes the individual units so valuable in instrument service.

This simple, well thought-out design provides performance which you don't expect at low cost. The outstanding mechanical and electrical performance built into these units has been obtained only by utilizing to the utmost today's materials and manufacturing techniques.

Versatility — In addition to potentiometers normally stocked, units will be provided on special order with: 360° mechanical rotation—taps as close as ¼" apart along entire winding — special all-metal or metal-filled shafts — resistance values other than standard — resistance functions other than linear — resistance and linearity tolerances better than standard.

Attractive prices can be offered when quantities are sufficient to warrant special production.

Write for the G-R POTENTIOMETER BULLETIN which gives complete specifications for all resistance sizes and power ratings.

General Radio Company

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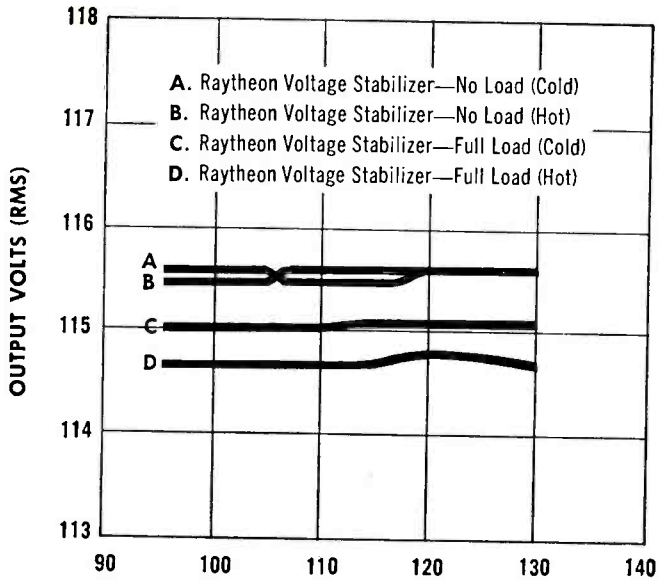
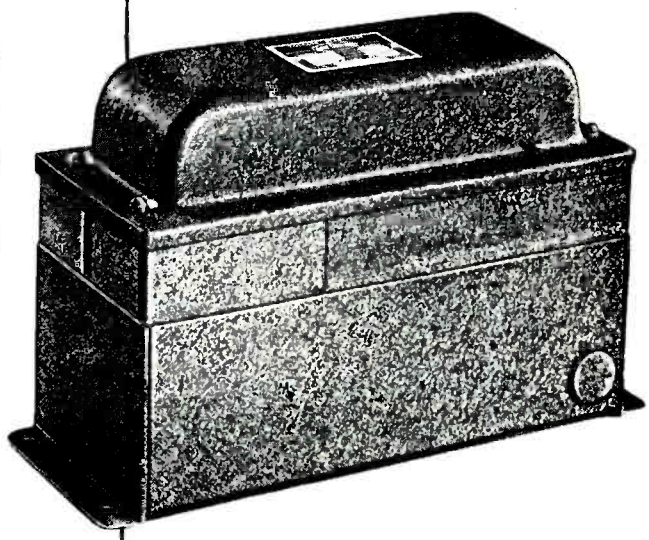
WE SELL DIRECT. Prices are net, F.O.B. Cambridge or West Concord, Mass.

Output vs. Input Voltage





Why Raytheon Voltage Stabilizers mean satisfied customers for you

When you incorporate a Raytheon Voltage Stabilizer in your equipment, you help assure complete customer satisfaction—for these important reasons:

1. Your equipment will operate as it was designed to, regardless of voltage variations of your customers' electrical source.

2. Since most components have maximum life when operating at their designed voltage, a Raytheon Voltage Stabilizer prolongs the life of components—and your equipment. A plus feature is provided by the short-circuit protection inherent in Raytheon Voltage Stabilizers.

3. Because Raytheon Voltage Stabilizers are superior to any other static type stabilizer under virtually all operating conditions, your equipment will work better and longer—characteristics your customers really appreciate.

Check these important points of Raytheon Voltage Stabilizer superiority

Raytheon Model VR-6113 (120 watts) chosen at random and compared with a similarly rated competitive model.

- Guaranteed to deliver accurate AC voltage within ±½% (competitive model 1%)
- 14% lighter, 22% smaller
- Three times more accurate no-load to full-load regulation
- 17% less change in voltage output as frequency varies
- 28% closer regulation as temperature changes

For full information see your electronic supply house or write Dept. 6120

RAYTHEON MANUFACTURING COMPANY

Equipment Marketing Division, **Waltham 54, Mass.**

RAYTHEON

Excellence in Electronics

X-RAY

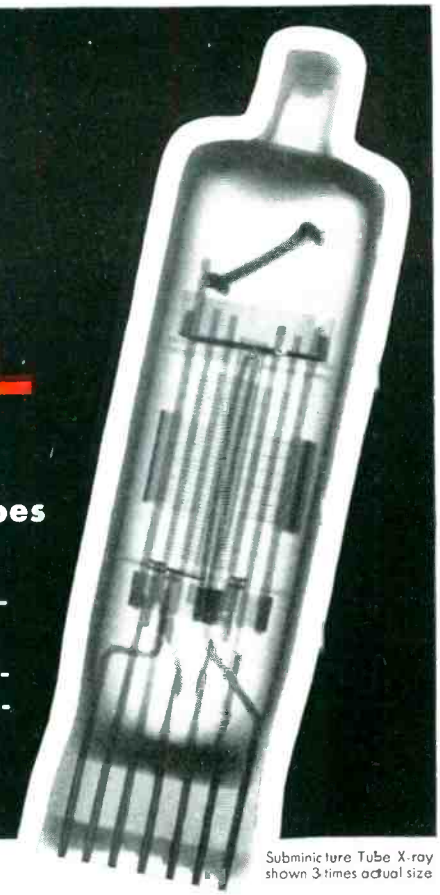
a new and important contribution to

QUALITY CONTROL

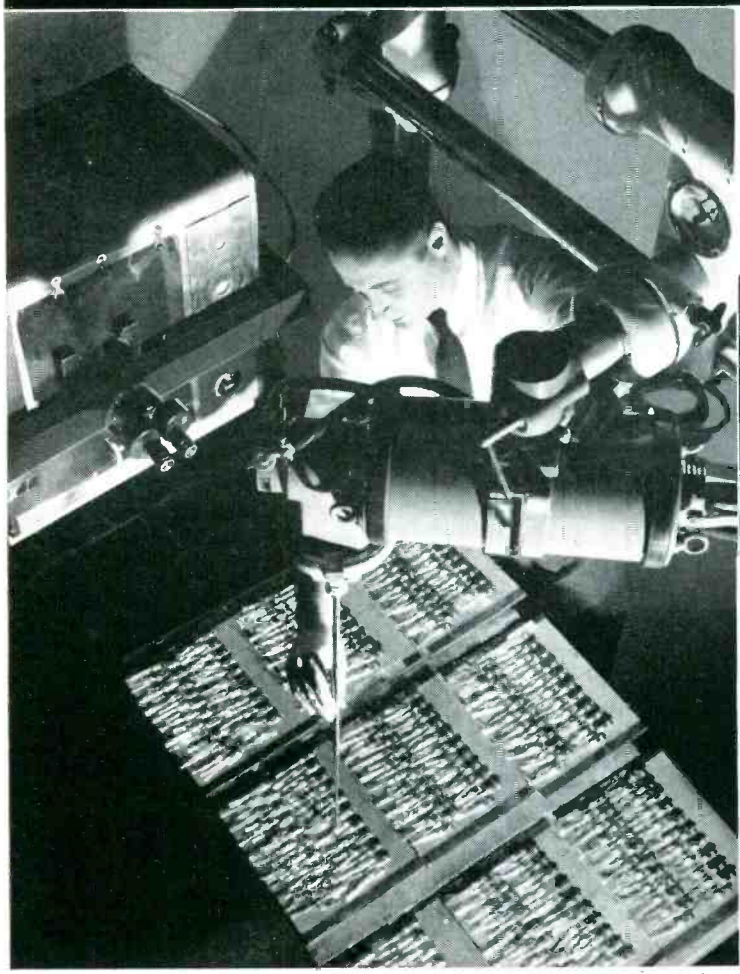
of RAYTHEON RELIABLE Miniature and Subminiature Tubes

You're looking at the last word in quality control technique — an X-ray sampling check on all Raytheon Reliable Tubes.

X-ray analyses are instantly transmitted to Raytheon's engineering and production personnel for guidance in continuous maintenance and improvement of tube quality.



Subminiature Tube X-ray shown 3 times actual size



Here in a lead-lined room specially designed by Raytheon engineers is the 300,000 volt X-ray unit equipped with fractional focus tube to provide high resolution of even the smallest parts. The room with its specially developed equipment has no counterpart in the tube industry.

Raytheon's X-ray equipment looks right through the tube to make sure that there are no cold, burned, brittle welds or weld blowholes. The X-ray proves that grid siderods are straight, grid wires properly spaced, glass perfectly sealed, getters intact, and heater coating free of chips. X-ray examination checks internal defects of leads, proper lead spacing, parts alignment, tube completeness, and tube cleanliness.

The X-ray photographs of tube structures are examined by trained experts. Potential defects are instantly detected. Thus Raytheon adds one more safeguard to the control of tube quality and reliability.

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Excellence in Electronics

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by various groups. National Science Foundation estimates that there were approximately 200,000 scientists and 650,000 engineers in the U. S. in 1954.

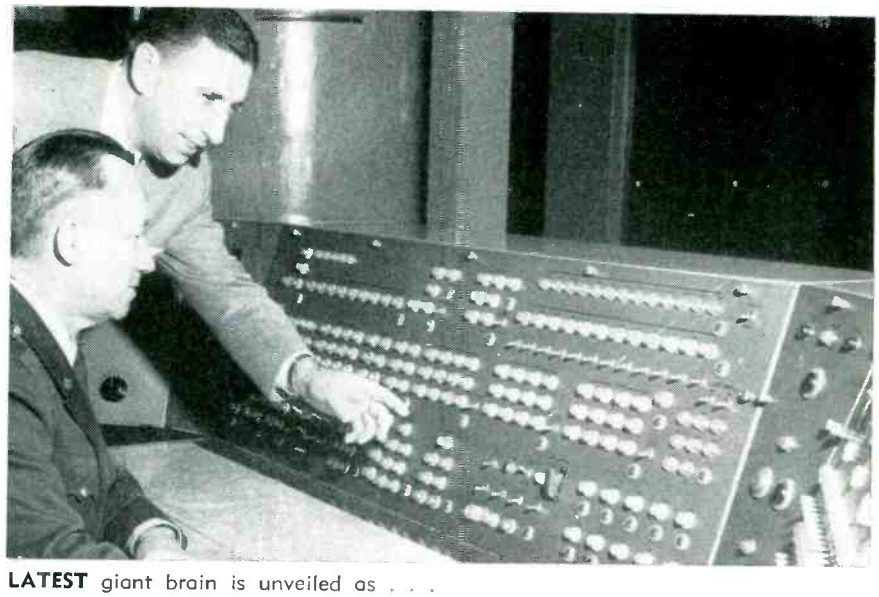
▶ **Electronics**—The Bureau of Census reported approximately 105,000 electrical engineers in the country in 1950. Some 90 percent were employed by private industry with 21.1 percent employed in electrical machinery and electronics, 8 percent by government agencies and 2 percent by educational and nonprofit institutions in this country.

▶ **Degrees**—According to the U. S. Office of Education, 4,485 bachelor's degrees in electrical engineering were conferred in 1954, a decline of some 8,000 since 1950.

Master's degrees in the field also decreased, from 1,114 in 1951 to 978 in 1954. Doctor's degrees conferred in 1954 numbered 111 compared to 113 in 1951.

▶ **Education**—Nearly 11 percent of those classified as electrical engineers in the 1950 census had less than four years of high school. Sixteen percent had completed high school but did not go on farther. Another 16 percent completed 1 to 3 years of college.

Largest percentage, 39 percent, completed 4 years of college and 13 percent completed 5 years of college or more.



LATEST giant brain is unveiled as . . .

Army Buys $4-Million Computer

Large-scale digital unit will inventory replacement parts for tanks and autos

FIVE years abuilding, RCA's entry in the digital computer field, Bizmac, has been purchased by the Army Ordnance Tank-Automotive Command in Detroit.

The $4-million computer will maintain stock control on 200,000 kinds of tank and auto replacement parts.

▶ **Performance** — The computer stores 2.5 million characters on a 10½-in. reel of magnetic tape. It reads 10,000 characters a second at a tape speed of 80 in. a second.

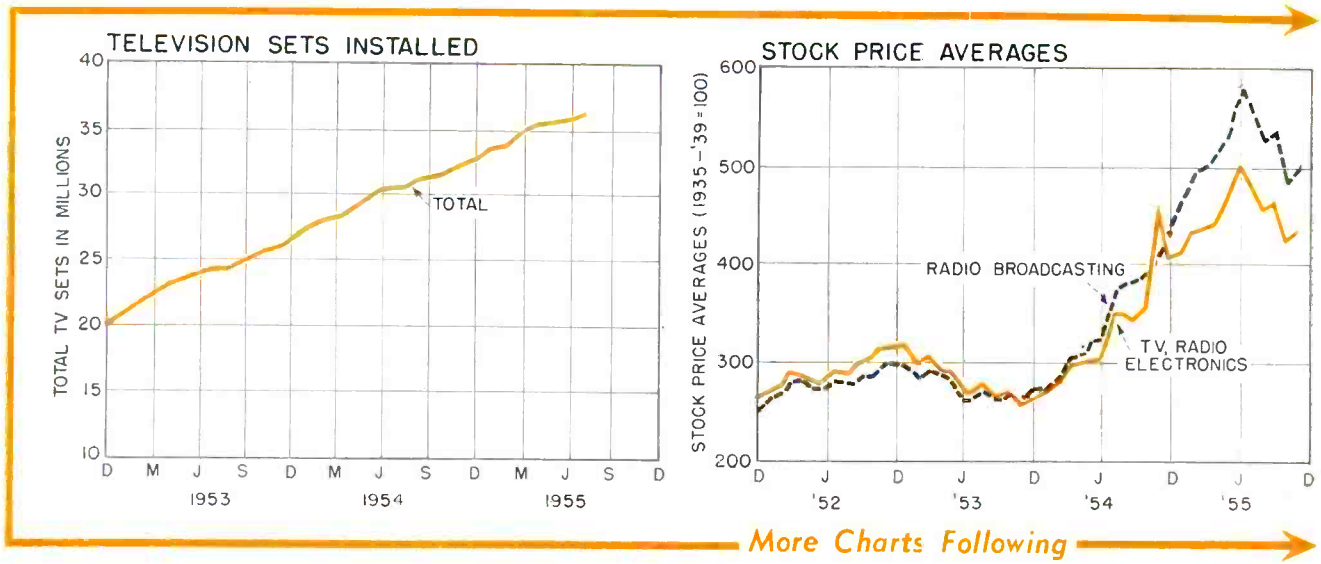
Operations include addition, subtraction, multiplication and division. Internal program storage provides for 4,000 three-address instructions.

▶ **Design**—There are 200 units of 13 equipment types that make up the computer. Magnetic-core rapid-access storage is used.

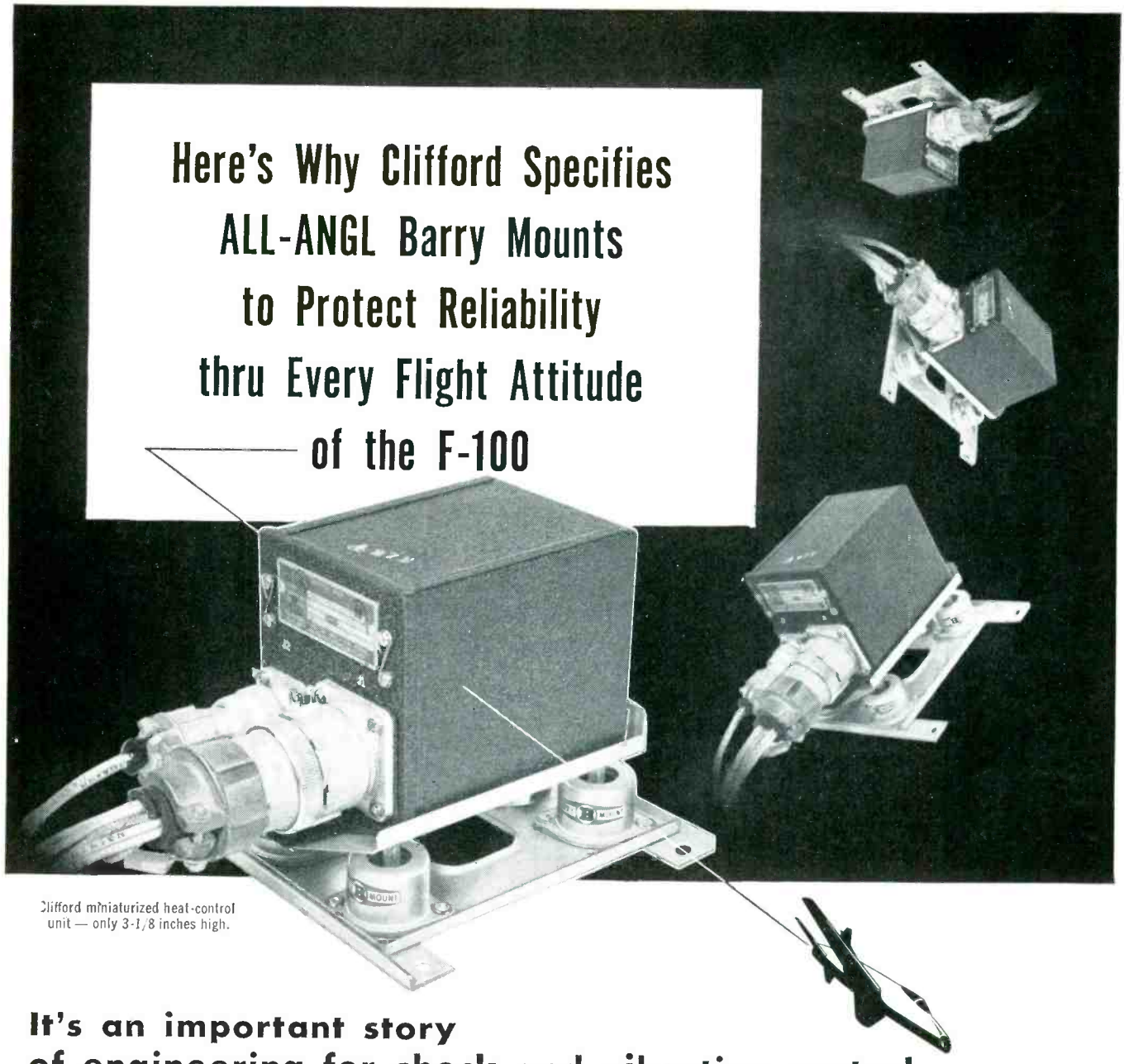
An electronic sorter assists in file maintenance. An interrogation unit can query the magnetic-tape files. Central control of all units minimizes idle time throughout

(Continued on page 22)

ELECTRONIGRAPHS *Continued*



Here's Why Clifford Specifies ALL-ANGL Barry Mounts to Protect Reliability thru Every Flight Attitude of the F-100



Clifford miniaturized heat-control unit — only 3-1/8 inches high.

It's an important story of engineering for shock and vibration control

North American Aviation, builders of the F-100 Super Sabre, specify that the control box must be able to mount at any angle. MIL-E-5272A requires the mount to operate under vibration as high as 0.080" double amplitude. Temperature requirements preclude the use of rubber mountings. And experience demands that the mounting system handle the load bias added by large connectors and cables — often a serious problem with miniaturized equipment.

Because they are specifically designed for jet and missile service, ALL-ANGL Barry Mounts meet all these requirements. So Clifford's choice of this mount assures the protection of their new miniaturized heat control under every operational condition.

The ALL-ANGL Barrymount® isolators used in the Clifford base are standard miniature size. These advanced-design mountings are also available in MIL-size 1 and (Feb. 1) MIL-size 2. Write for data sheets.

When your problem is protection through all flight attitudes, your answer is ALL-ANGL Barry Mounts. For recommendations, call your Barry Sales Representative.

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BARRY CONTROLS
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SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

New engineering opportunities are open in Barry's expansion program, at all levels in all departments. Send resumé.

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the installation. The computer accommodates variable word and message lengths.

► **Input/Output**—The input equipment produces a verified punched paper tape and a typed copy. A punched tape to magnetic tape converter transcribes characters electronically at 12,000 characters a minute. A card-to-tape converter handles 400 cards a minute.

Output is a 600 line-a-minute printer and a magnetic tape to punched tape converter.

Russians Look At U. S. Electronics

Two engineers express disappointment after tour of electronics plants

GEORGI P. Kazanski of the Collegium Radio-Technical Ministry in Moscow, who specializes in electronics, and Vladimire P. Loukine of the Machine Construction Ministry in Moscow, who specializes in instruments for automation, both expressed disappointment in American industry with regard to electronics and automatic production.

After a two-week tour of U. S. plants they said they did not see what they had expected to see and expressed the doubt that the impressions gained from the tour represented the true state of affairs.

► **Visits**—Among the places visited by the two engineers while in the U. S. were the International Automation Exposition in Chicago, Panellit Co. in Skokie, Ill., Ford engine plant in Cleveland, AT&T's relay station in Washington, D. C., and RCA in New York City.

Their official host on the trip was the ASME which provided an escort for the engineers at the request of the State Department.

► **Transistors**—When asked about the use of transistors in Russia, Kazanski said that they are replacing vacuum tubes to about the same extent as in the U. S. He said that transistors are used largely in measuring instruments and computers.

► **Computers**—The Soviet engineers said that Russia is using computers particularly for statistical work. They indicated that production of electronic apparatus in the Soviet Union has increased five-fold since 1950 but gave no specific estimates as to the size of the increases.

They expressed particular interest in flow meters and estimated that 20 percent of the flow meters used in Russia are electronic.

► **Return**—Three U. S. engineers are making a reciprocal two-week trip in Russia. They are N. L. Bean of Ford's automatic transmission division, W. H. Brandt, engineering manager of Westinghouse and A. C. Hall, general manager of research for Bendix.

TV Flexes Its Muscles And Takes First Place

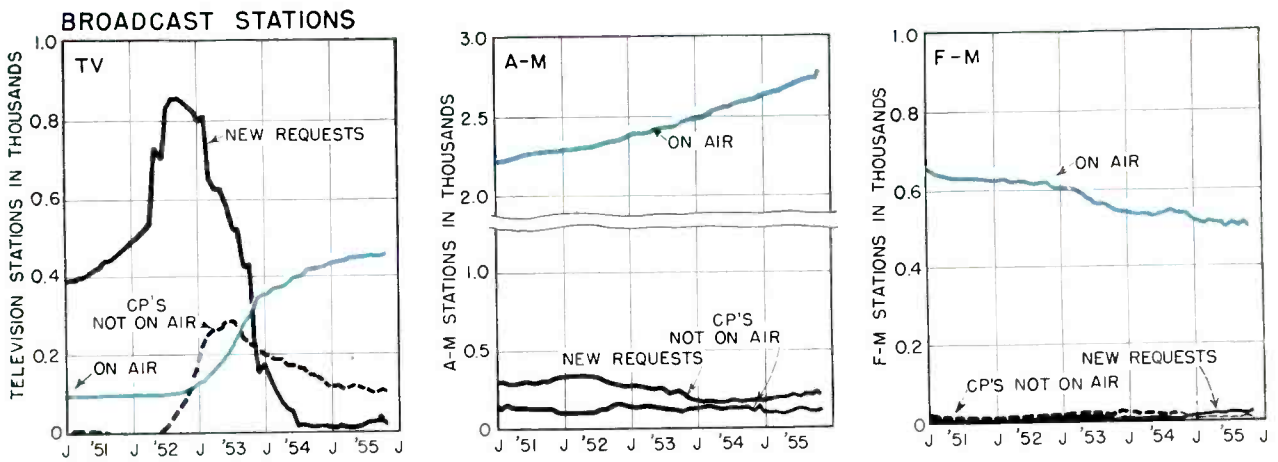
Final FCC report shows how tv topped radio revenue record for the first time

THE radio and tv broadcasting industry passed the $1-billion mark in total revenue in 1954 for the first time, according to FCC. Television accounted for $593 million and radio for $449 million. Thus, 1954 was the first year in which tv revenues exceeded that of radio.

The tv total of $593 million surpassed the all-time high for radio of $475 million, reached in 1953. Radio revenues in 1954 dropped 5 percent compared to 1953 totals, the first time in the last 16 years that the radio industry failed to establish a new high for total revenues.

(Continued on page 24)

ELECTRONIGRAPHS Continued



More Charts Following

G.E. again helps TV manufacturers cut costs...introduces new 2B3 high-voltage rectifier, with 1.75-v filament!

IN LINE with General Electric policy to help manufacturers cut costs of volume-production TV sets, the new 2B3 rectifier tube saves by eliminating a resistor, associated wiring, plus their share of circuit-assembly expense.

No need for filament-voltage stepdown . . . instead, the new 2B3, supplying power to the picture-tube anode, operates directly from the flyback transformer!

Designed to replace the 1B3-GT for increased circuit economy, G.E.'s 2B3 also outperforms its prototype. A new filament construction gives longer tube life, increases dependability.

Step by step, General Electric tube engineers have cooperated with designers and builders in reducing TV-set costs. In 1954 came the 6CD6-GA and 6AU4-GTA—new G-E sweep tubes with high ratings, usable both for monochrome and color, lower in cost than any color sweep tubes then available.

Also in 1954, the famous "600-series" family of 50 G-E tubes, all with controlled heater warm-up time . . . making possible mass production of reliable, economical series-string TV receivers. Last year, General Electric introduced the 6CN7 duo-diode triode—saving some $.23 over the 6AQ7-GT whose circuit functions it assumed.

Profit from G.E.'s consistent drive to cut TV manufacturing expense with new tubes that save components, circuitry, and labor! Get ratings, characteristics, and prices of the cost-saving 2B3! Address *Tube Department, General Electric Company, Schenectady 5, New York.*

Progress Is Our Most Important Product

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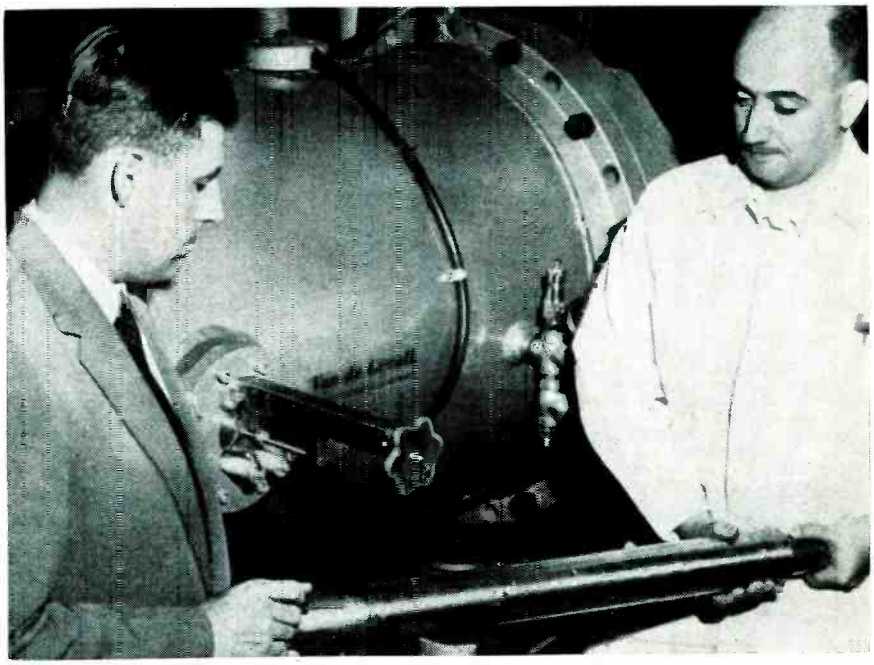
162-1A1

▶ **Profits**—Radio and tv stations made profits before taxes of $132 million in 1954, some 7 percent above 1953. Television broadcast profits of $90 million were 32.8 percent higher, while radio profits of $42 million were 24 percent lower than in 1953.

▶ **Contrast**—Changing make-up of revenues in the broadcasting business since tv is shown in the report. Of the $593 million total tv revenue, $452 million or 76 percent was from the sale of time and $141 million or 24 percent from sales of talent, program material and production. Radio's total revenue of $449 million consisted of $404 million or 90 percent in time sales and $45 million or 10 percent from talent and program sales.

▶ **Nets**—TV networks, including the 16 owned and operated stations, accounted for $306.7 million or 52 percent of tv total revenues. The other 394 stations reported $286 million or 48 percent of total revenues. Profits of the four nationwide and three regional radio networks including 21 owned stations were reported at $8.2 million or 22 percent below 1953. A total of 2,577 other radio stations had combined profits of $34 million, or an amount that represents the value of 24.5 percent below station profits for 1953.



BABY-SIZED accelerotor developed by High Voltage Engineering because . . .

Particle Accelerators Gain Sales

Use of the instruments in industry and in institutions is steadily increasing

ALTHOUGH only a handful of companies are in the particle accelerator manufacturing business and total dollar volume is small, the field is gaining in importance.

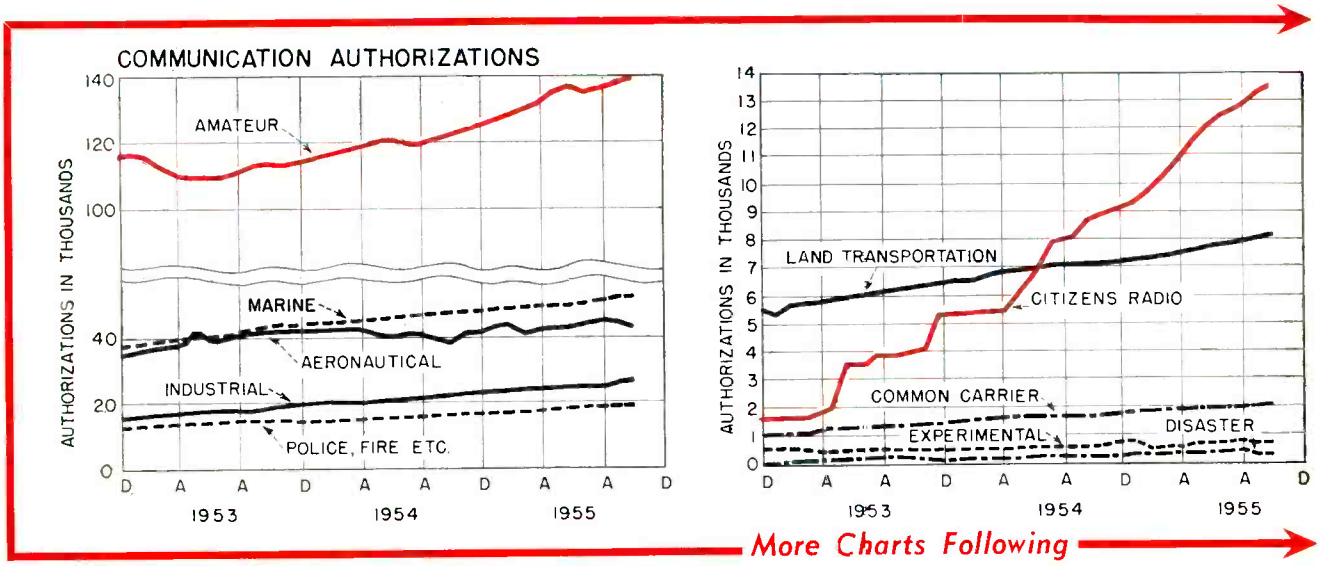
There are probably not more than 300 particle accelerators in use in the world today and many of these are homemade.

Prices of the units vary considerably depending on size and installation costs. Most units are in the one-million electron volt plus range. However, there are commercial accelerators available rated to 50-million electron volts.

A new machine being constructed at the Brookhaven National Laboratory is expected to accelerate protons to an energy of 25 billion electron volts.

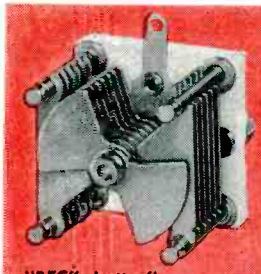
(Continued on page 26)

ELECTRONIGRAPHS *Continued*



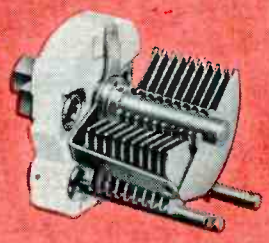
More Charts Following

for VARIABLE CAPACITORS...



"BFC" butterfly-type capacitor with isolated rotor, very low minimum capacity and low inductance. For VHF applications as series capacitor with no rotor connection.

"MAC" Low minimum capacity and very low inductance. Ideal for VHF-UHF applications. Designed for use in miniaturization. Also available as butterfly type "MACBF".

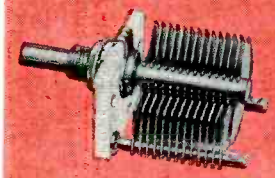


"APC" A compact, high quality air dielectric trimmer. Extremely high resistance to temperature changes, moisture and vibration.

"MAPC" A scaled down version of the "APC". Designed to fill the needs of miniaturization. Suitable for VHF use.

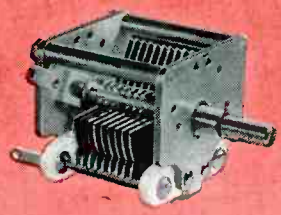
"HF" A high frequency design featuring extra long sleeve bearing and positive contact nickel-plated phosphor bronze wiper. Also available as a dual unit.

naturally,

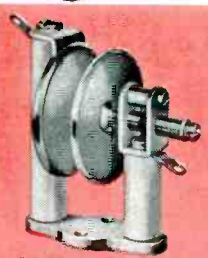


"HFA" Similar to "HF" model, but with larger air gaps for higher breakdown ratings. Used for high-frequency, low-power transmitting. Also available as dual unit.

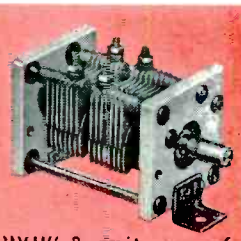
"MC" Designed for maximum versatility in mountings, connections and capacity characteristics. Rotor stop permits 180° clockwise rotation with increasing capacity. Also available as dual unit.



"RMC" Similar to "MC-S" but featuring extra rigid design. Heavy frame of aluminum tie rods and end plates.



"NZ" Compact transmitting neutralizing capacitor designed for easy and accurate adjustment. Long leakage paths to ground from both rotor and stator.



"VU" Permits use of "lumped constant" circuits up to 500 MC. Two sections in series eliminate rotor wiper. Pyrex glass ball bearings eliminate noise from usual metal-to-metal bearings.

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For commercial, military and industrial applications, you just can't beat Hammarlund Variable Capacitors for uniformly high quality design, materials and workmanship. The capacitors illustrated here are just a small representative portion of the complete Hammarlund line. In addition to stock designs, Hammarlund offers you unparalleled variable capacitor know-how in development, design and production. Whatever your needs, when it comes to special or standard variable capacitors, naturally, come to Hammarlund.

● *Send for your copy of Bulletin 55E*

HAMMARLUND MANUFACTURING COMPANY, INC.
460 West 34th Street, New York 1, N. Y.

▶ **Growth**—Steady growth of the field is indicated by the rising sales of companies producing the instruments. High Voltage Engineering Corp., sole manufacturer of the Van de Graaff accelerator, has had sales increases of approximately $200,000 nearly every year since its formation in 1947 and expects sales to hit the $1.8 million mark in 1955. Other manufacturers in the field are American Instrument, GE, Marblette Corp. and Stanford Laboratories.

▶ **Firm**—New manufacturer to enter the accelerator field is Varian Associates. The company is planing construction of its own linear electron accelerator, under license from Stanford University, and is developing special accelerator parts for others. According to Varian, it is the second firm to contract with Stanford for manufacture of the high-energy machines. General Electric signed a similar contract in 1954.

▶ **Markets**—Principal markets for accelerators lie in the fields of scientific research, medical therapy, industrial radiography and radiation processing. The market for instruments in industry and institutions engaged in general nuclear research and development is growing.

Projections by the Atomic Industrial Forum indicate that $13.5 million will be spent by private industry between 1954 and 1958 on research and development in the use of particle accelerators and that institutions will spend about $1.5 million. In 1953 industry spent $698,000 on particle accelerator research and institutions spent $234,000.

Industry Invests In Australia

Country lists 37 U.S. electronics firms with manufacturing interests there

AN estimated $240 million in private U. S. investment has been made in Australian manufacturing and a substantial portion is accounted for by U. S. electronics firms.

Some 37 U. S. electronics manufacturers have direct financial interests in Australia. An increase in such investments is expected in the future as tv takes hold down under.

▶ **Reasons**—To encourage investment from overseas, Australia has negotiated a double taxation convention with the U. S. It prevents double taxation on income flowing between the two countries.

Also, Australia allows all net income after taxes, earned by U. S. firms in Australia, to be remitted without restriction.

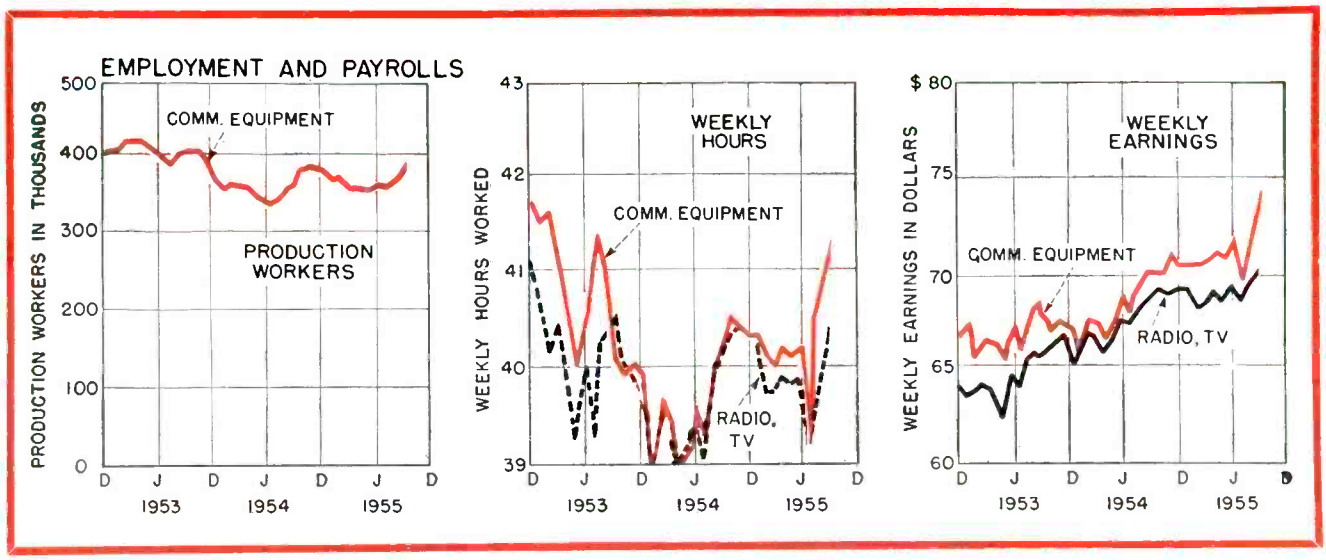
▶ **Set-up**—Nine of the U. S. electronics firms with investments in Australia have a subsidiary or affiliate in the country. The remaining 28 companies have other arrangements with companies in Australia such as license or royalty agreements.

▶ **Companies**—Following is the list of U. S. electronics firms with investments in Australian electronics in 1955:

Admiral
Aerovox
Alertronic Corp.
Alliance Mfg.
Am. Phenolic
Armour Research
Astatic Corp.
Automatic Electric
Bendix Aviation
Bussman Mfg.
A. B. Du Mont
Federal Telephone & Radio
Foxboro Co.
General Ceramics
General Magnetic
General Radio
Hazeltine Electronics
IBM
Int'l GE
Int'l Resistance
IT&T
Jensen Mfg.
Walter Kidde
Magnecord
P. R. Mallory
Motorola
New England Mica
Philco
RCA
Shure Bros.
Sola Electric
Stromberg-Carlson
Western Electric
Westinghouse
Westrex Corp.
X-ray Mfg. of Am.
Zenith

(Continued on page 28)

ELECTRONIGRAPHS



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The NEW PERKIN MODEL MR532-15A with ±1/2% REGULATION

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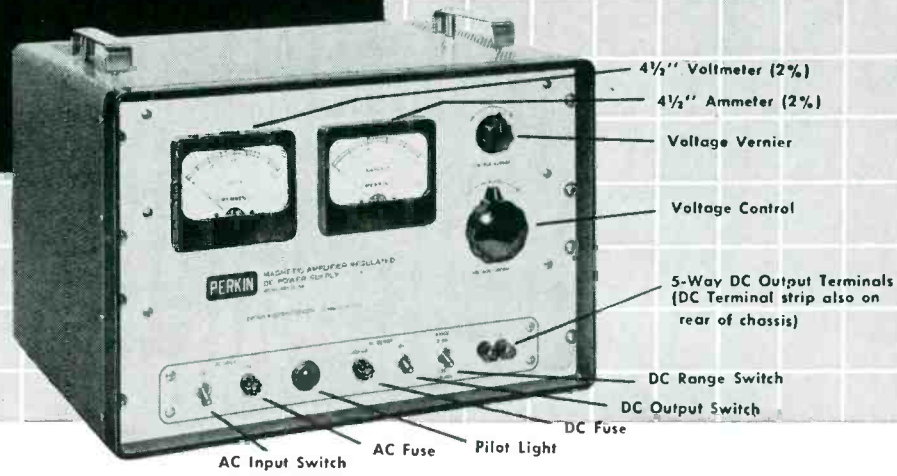

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Dallas:	FOrrest 8-8306
Denver:	MAin 3-0343
San Francisco:	ULmar 1-7129
Syracuse:	2-1167
Pittsburgh:	WAlnut 1-2959
Minneapolis:	MIdway 2-7884
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Ontario, Canada	AXminister 3-5771

- **REMOTE SENSING** • **VERNIER VOLTAGE CONTROL**
- **NO TUBES, MOVING PARTS OR VIBRATING CONTACTS**

Specifications . . . .

REGULATION: 5-32V Range: ± ½% for combined line changes of 105-125VAC and load of 0-15A. DC.
2-5V Range: ± 2% for combined line changes of 105-125VAC and load changes of 0-15A. DC.
32-36V Range: ± 2% for combined line changes of 110-125VAC and load changes of 0-15A. DC.

RIPPLE: 1% rms max. @ 36 volts and full load. Increases to 2% @ 2 volts and full load.

AC INPUT: 105 to 125 volts, 1 phase, 60 cps. (8 amps, Input)

RESPONSE TIME: 0.1 to 0.2 seconds maximum.

DIMENSIONS: 19½" wide x 15½" deep x 13¼" high with cabinet. (19" wide x 14¾" deep x 12¼" high rock panel construction)

FINISH: Gray Hammertone **WEIGHT**: *Approx. 135 lbs.*

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PERKIN ENGINEERING CORP.

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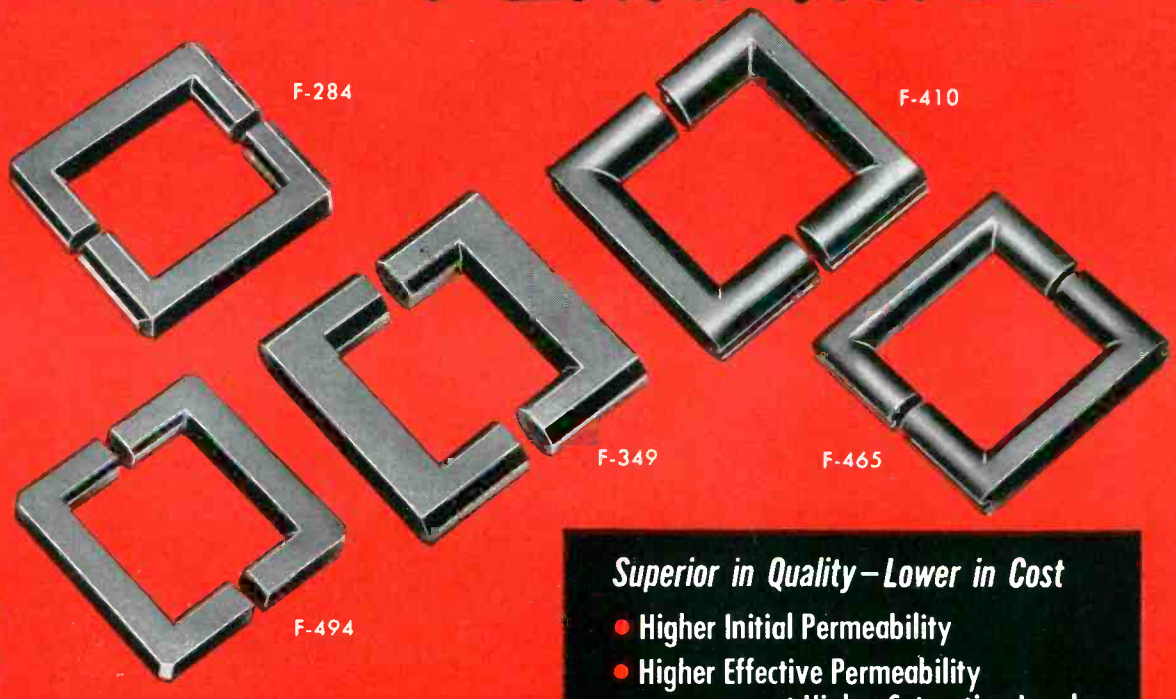

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New Super-Grade Ferrites from the Laboratories of General Ceramics—

New Super-Ferramics are magnetic ferrites with properties once considered beyond the realm of achievement. The first of this series Ferramic O, (see property chart) has been released and is now available in production quantities. Engineers and product designers are invited to request complete information on Ferramic O. Call or write for data today!

MAGNETIC PROPERTIES OF FERRAMIC O-1

PROPERTIES	UNIT	FERRAMIC O-1
Mu_0 at 50 kcs.	—	1200
Mu_{max}	—	6000
Saturation Flux Density B_s	Gauss	4100
Residual Magnetism B_r	Gauss	2500
Coercive Force H_c	Oersteds	0.20
Curie Temperature	+ °C.	165
Volume Resistivity	—	Low
Loss Factor at 50 kcs.	$\frac{1}{u_0 Q}$	0.000010
Temp. Coeff. of Initial Perm. (50 Kcs)	%/°C.	+0.75

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FILTRON's four plants, with complete production facilities—capacitor manufacturing, coil winding, metal fabricating and stamping, tool and die department, assembly division—are producing more RF interference filters than ever before.

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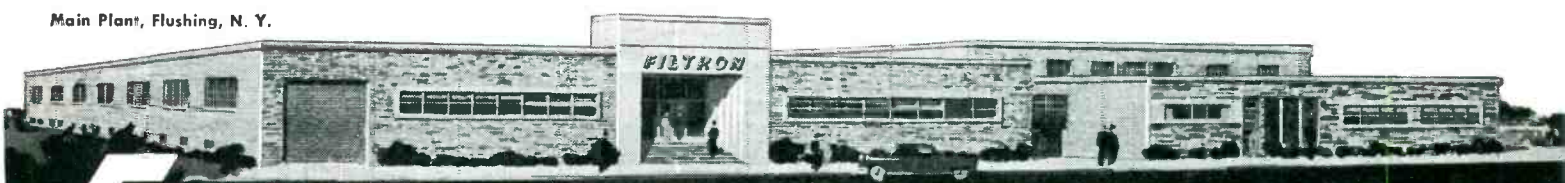

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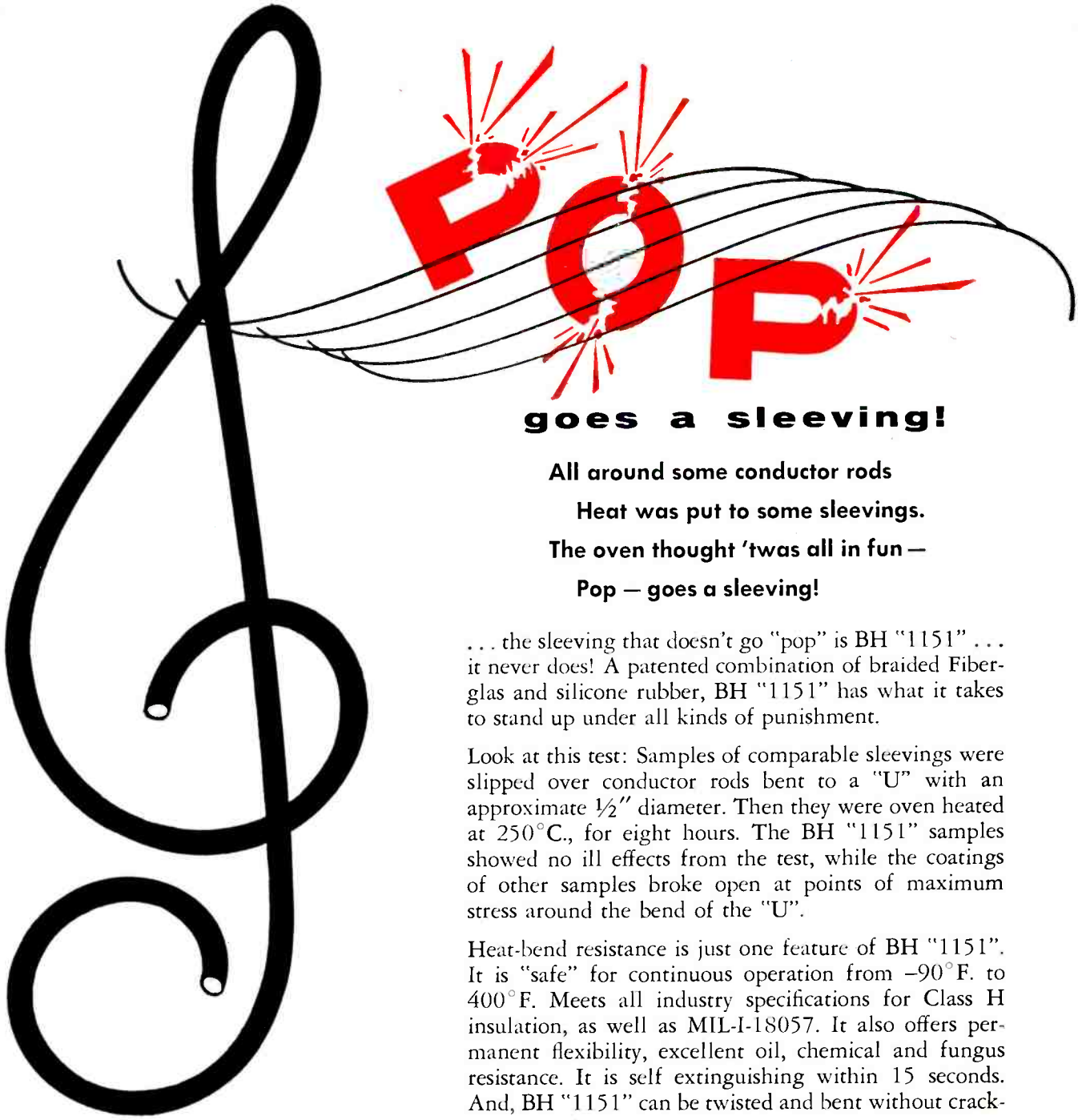

goes a sleeving!

All around some conductor rods
Heat was put to some sleevings.
The oven thought 'twas all in fun—
Pop — goes a sleeving!

. . . the sleeving that doesn't go "pop" is BH "1151" . . . it never does! A patented combination of braided Fiberglas and silicone rubber, BH "1151" has what it takes to stand up under all kinds of punishment.

Look at this test: Samples of comparable sleevings were slipped over conductor rods bent to a "U" with an approximate ½" diameter. Then they were oven heated at 250°C., for eight hours. The BH "1151" samples showed no ill effects from the test, while the coatings of other samples broke open at points of maximum stress around the bend of the "U".

Heat-bend resistance is just one feature of BH "1151". It is "safe" for continuous operation from –90°F. to 400°F. Meets all industry specifications for Class H insulation, as well as MIL-I-18057. It also offers permanent flexibility, excellent oil, chemical and fungus resistance. It is self extinguishing within 15 seconds. And, BH "1151" can be twisted and bent without cracking or crazing.

Available in all standard colors, BH "1151" is packaged in spools or coil put-up, with 36" lengths or short pieces on special order. Try it now — send for data sheets and free Production Testing Samples.

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*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U.S. Pat. Nos. 2393530; 2647296 and 2647288). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

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to Prevent Crazing

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"Brown Devil"® RESISTORS

Ohmite "Brown Devil" Resistors have been carefully designed to provide *balanced thermal expansion.* All parts—core, resistance wire, vitreous enamel coating, and terminal band—have a thermal expansion that has been carefully matched. Consequently, Ohmite "Brown Devil" Resistors expand and contract as a unit. This eliminates cracking of the enamel, keeps terminals firmly anchored, and prevents the entrance of moisture.

THE RESULT: You are assured high-quality resistors that provide the utmost in dependability under the toughest service. Specify Ohmite "Brown Devils" on your next job.

They Last Longer!

1 PATENTED WELDED TERMINALS
Ohmite welded terminals provide a perfect and permanently stable electrical connection that is unaffected by vibration or high temperature.

2 HIGH TEMPERATURE STEATITE CORE
This strong, rugged, steatite core has excellent electrical characteristics, and a coefficient of thermal expansion that matches the other resistor materials.

3 EXCLUSIVE HIGH TEMPERATURE VITREOUS ENAMEL
This special-formula enamel was developed by Ohmite after extensive research. Its thermal expansion is properly related to that of the steatite core, terminal, and resistance wire.

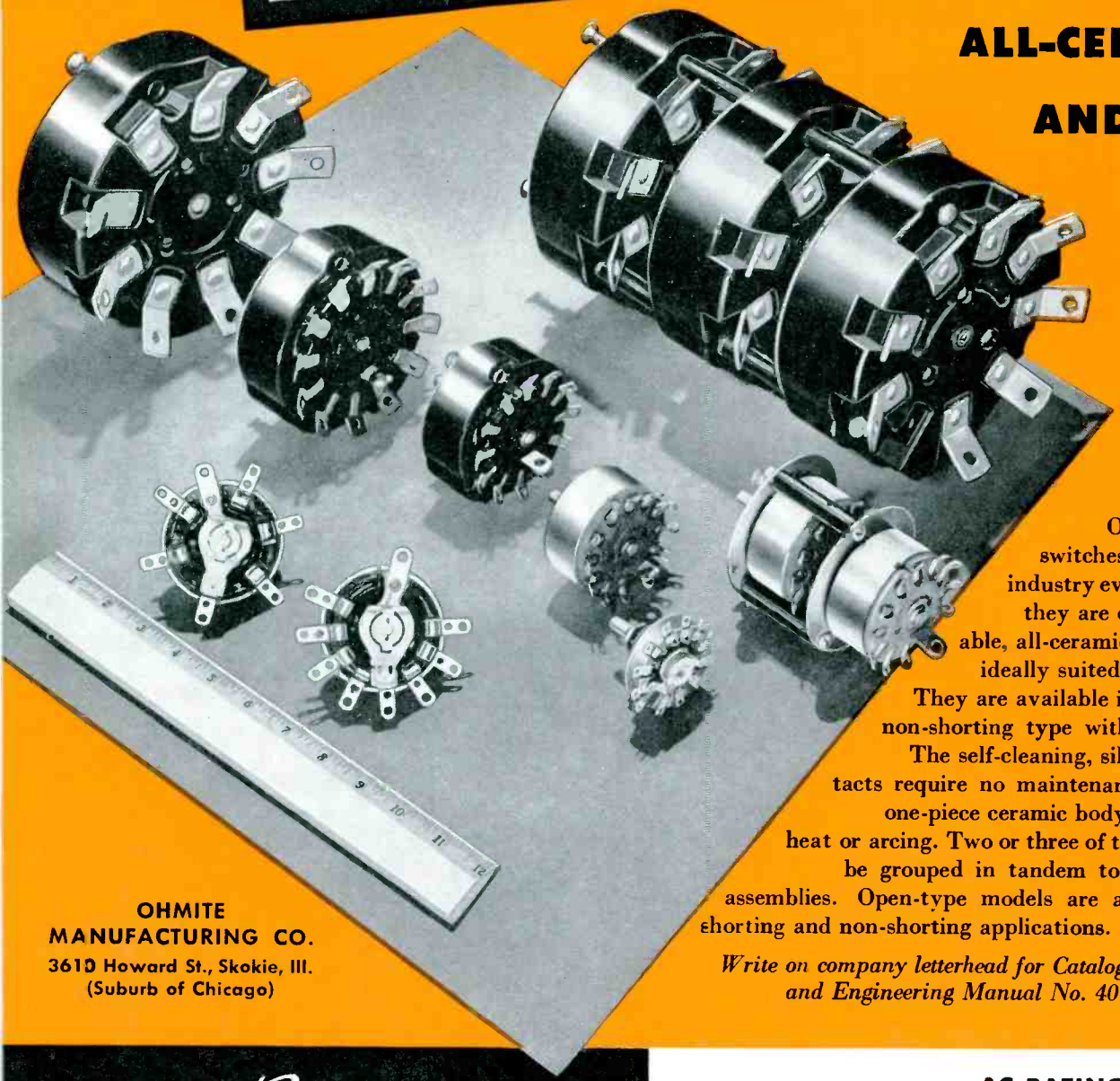
Be Right with OHMITE®

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

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES

WON'T CHAR OR BURN!

OHMITE® HIGH CURRENT ROTARY TAP SWITCHES



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Ohmite rotary tap switches are preferred by industry everywhere because they are compact, dependable, all-ceramic and metal units ideally suited to a-c operation. They are available in the single-pole, non-shorting type with up to 12 taps. The self-cleaning, silver-to-silver contacts require no maintenance. The rugged, one-piece ceramic body is unaffected by heat or arcing. Two or three of these switches can be grouped in tandem to form multi-pole assemblies. Open-type models are also available for shorting and non-shorting applications.

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5 SIZES

AC RATINGS

AMP	VOLTS	NO. TAPS
10	150	2 to 11
15	150	2 to 12
25	300*	2 to 12
50	300*	2 to 12
100	300	2 to 8

*150 Volts between taps.

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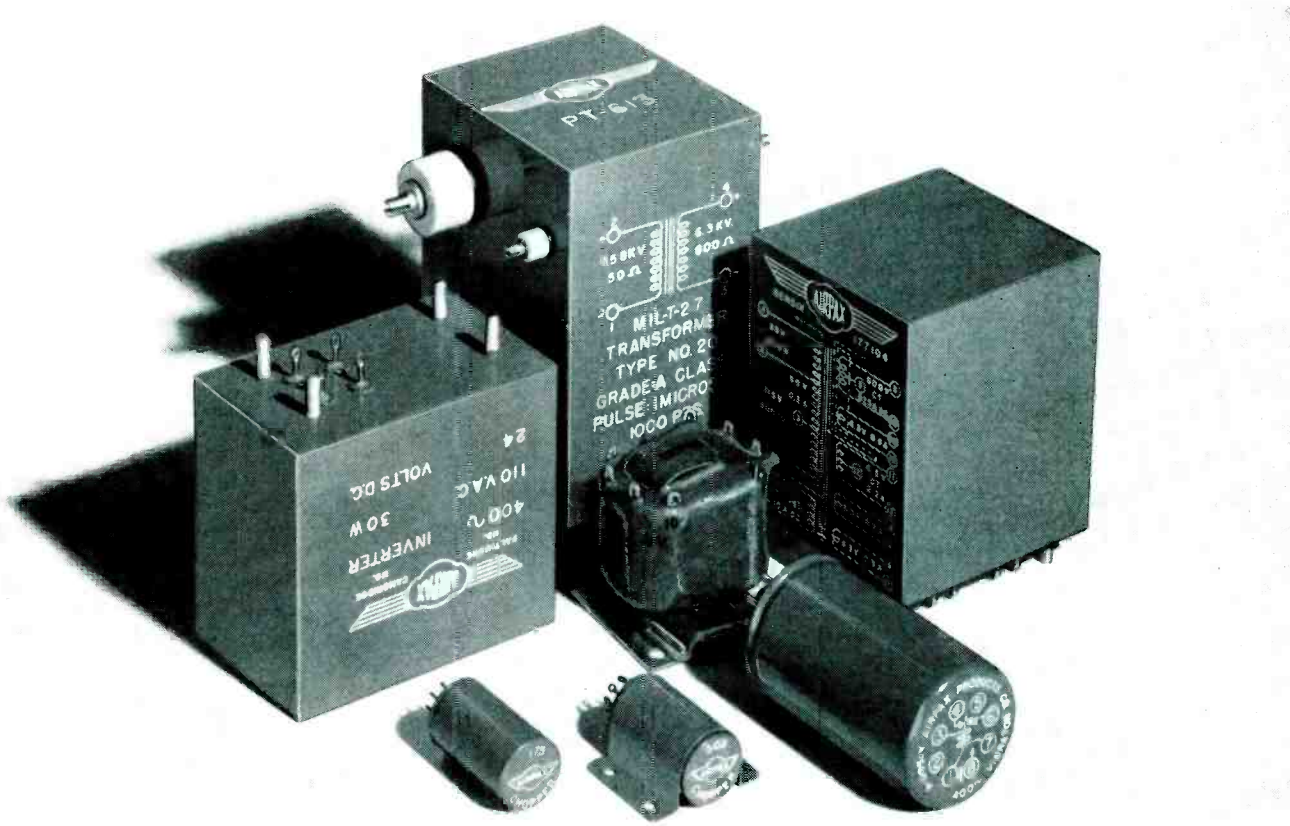

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For your power needs seriously consider the advantages of an Airpax supply. You can minimize the weight of your airborne equipment by using a Airpax 400-cps power vibrator, or, for the fullest saving in space and weight, ask Airpax to manufacture the complete power supply: transformers, chokes, wired, potted and tested to your specifications.

Several standard supplies, converters, and inverters are available based on our 400-cps vibrators and quality transformers—ratings up to 30 watts, higher for intermittent operation.

Equipment manufacturers who pride themselves on producing the most reliable devices use Airpax custom designed and built transformers and reactors. These include audio units for communication equipment, pulse and high-voltage units for navigation equipment, and power units for control equipment—all to the same high precision.

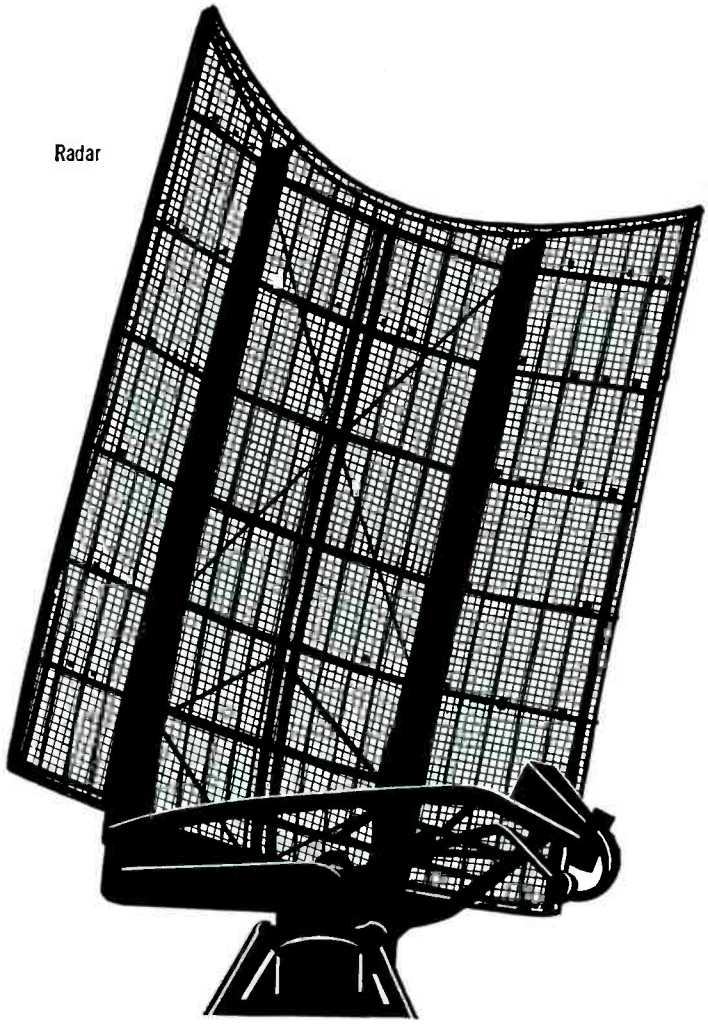
For protection against adverse environments, as in military equipment, these units are hermetically sealed and conform in all respects to MIL-T-27A. Where light weight is important, they can be protected by encapsulation.

You can rely upon Airpax to maintain high quality in making any quantity of these products that you may need. We do not attempt to produce both a quality grade and a commercial grade; Airpax personnel are trained to maintain quality first. Your engineering design will show to best advantage when built with Airpax components.

Write today for technical data; place your present design and production problems in competent hands at

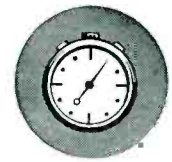
DESIGNERS AIRPAX ENGINEERS

MIDDLE RIVER BALTIMORE 20, MD.



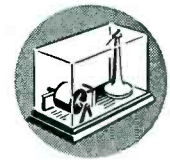
Radar

Navigation

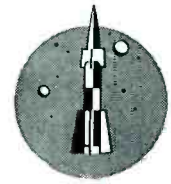


Timing

Nucleonics



Geophysics



Ordnance

PRECISION DIGITAL DELAY GENERATOR

FOR GENERAL-PURPOSE LABORATORY USE

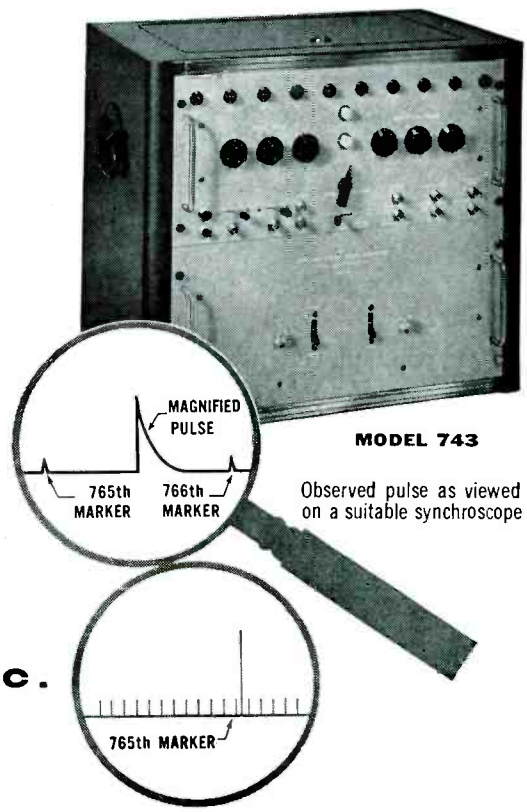
Generates pulses accurately spaced in time with respect to an internally generated reference pulse—range 0 to 100,000 microseconds

Complete generality permits numerous and varied uses such as radar range calibration, target simulation, generation of secondary frequency standards, elapsed time measurements, phase measurements, etc. Fields of application include Radar, Navigation, Telemetry, Nuclear Studies, Computor Research, Geophysics, Ordnance, and any other fields in which timing is significant.

The ability to generate a specific delay at accurate variable repetition rates sets this instrument apart from any other pulse or delay generator in the field today. Write for full details.

Pulses can be supplied under either one-shot conditions or at variable repetition rates. Both pulse delay and repetition period can be established in increments as small as 1 microsecond.

The repetition period can also be externally triggered, in which case two independently variable delayed pulses are available. Accuracy of both repetition period and pulse delay are held to one part in 10^6 by the thermostatically controlled crystal oscillator. The digital circuitry and the built-in self-checking features make continuous calibration unnecessary.

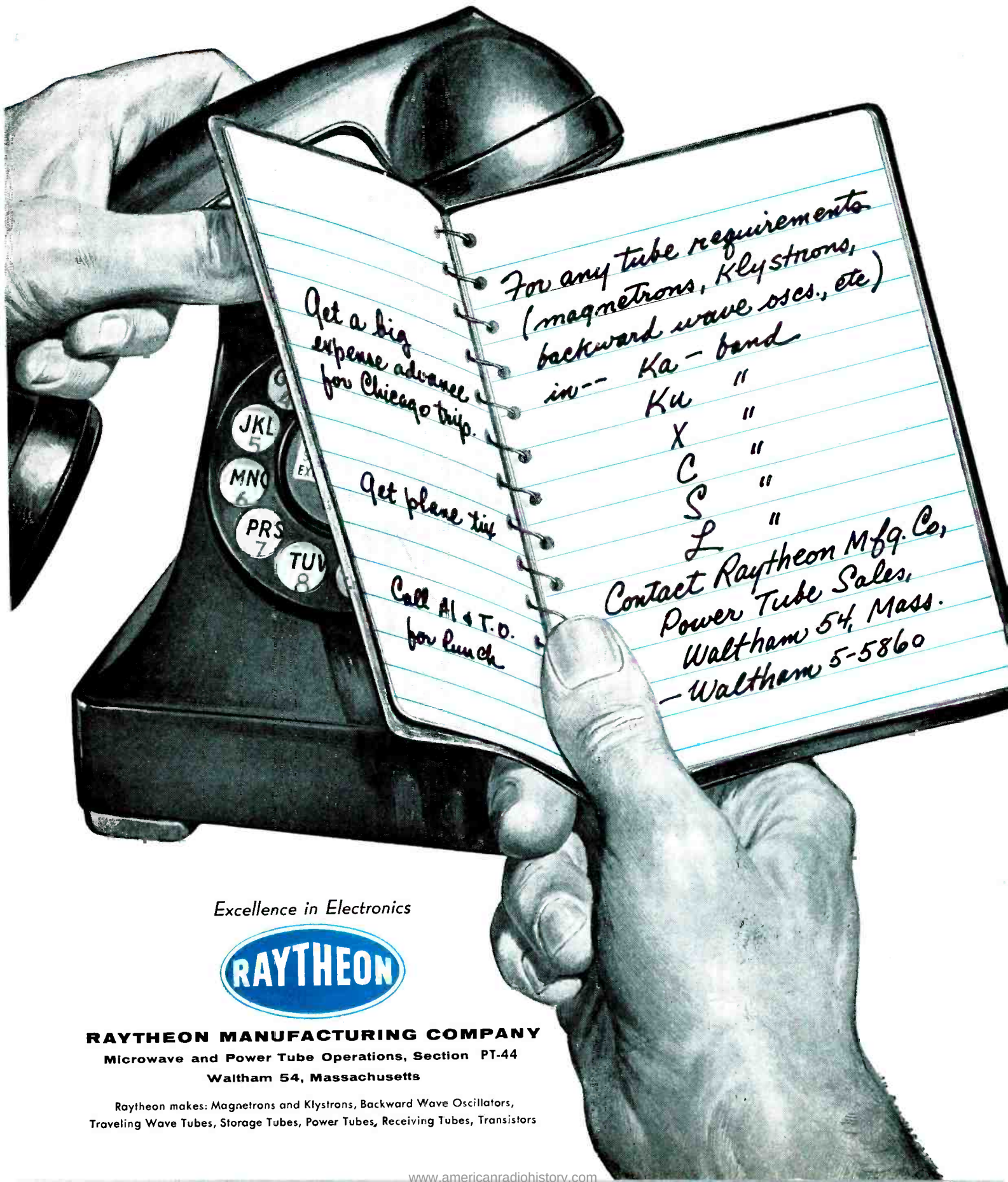


MODEL 743

Observed pulse as viewed on a suitable synchroscope

KAISER METAL PRODUCTS, INC.
BRISTOL, PA.

Raytheon — World's Largest Manufacturer of Magnetrons and Klystrons



Excellence in Electronics

RAYTHEON

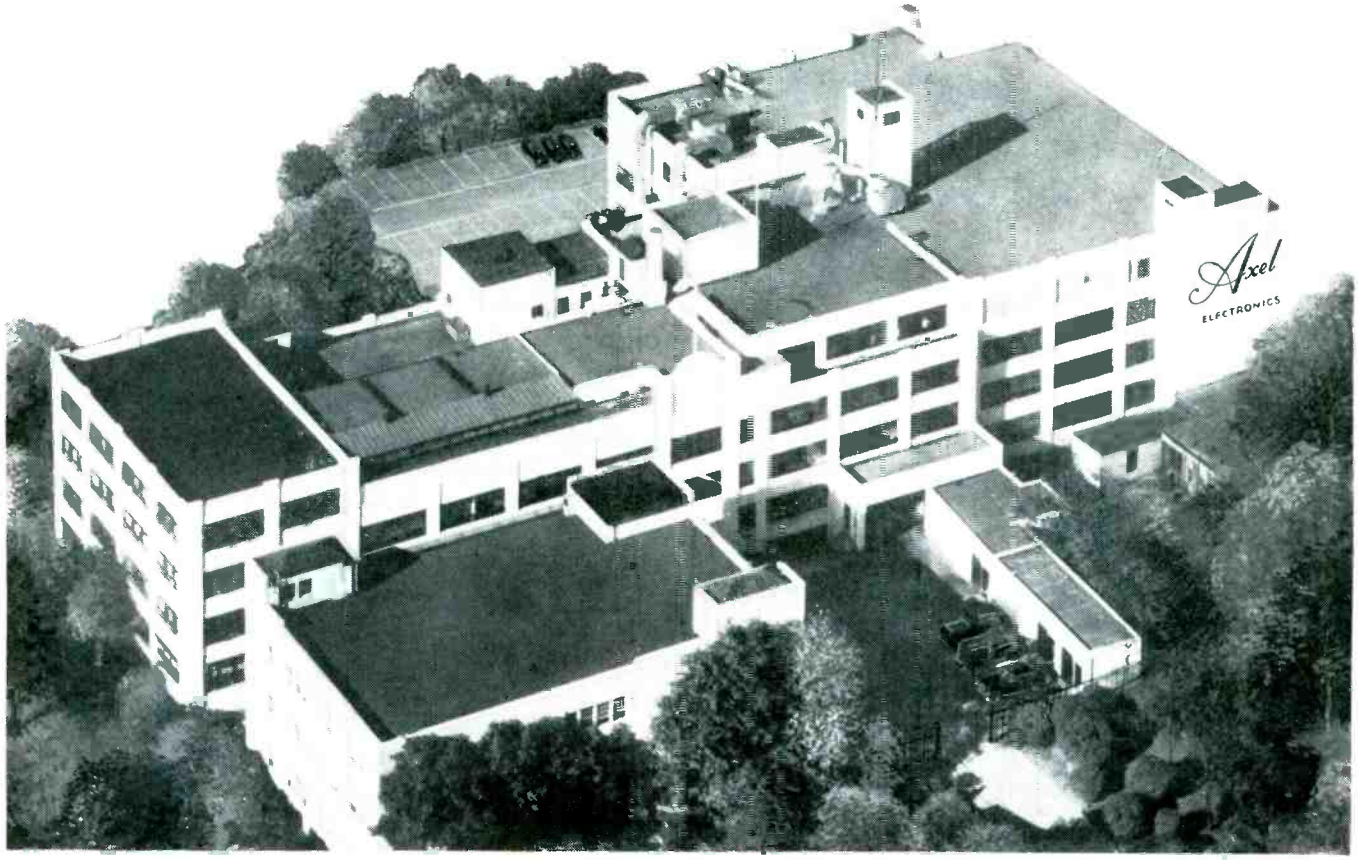
RAYTHEON MANUFACTURING COMPANY

Microwave and Power Tube Operations, Section PT-44

Waltham 54, Massachusetts

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

AXEL ELECTRONICS
EXPANSION



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Expanded Building...

With greatly enlarged space in a new convenient location geared to provide top quality products with speedy, efficient service.

Expanded Staff...

Headed by five new top sales and design engineers – each of them a specialist, expertly skilled in progressive design.

Expanded Equipment..

Modern production, laboratory and test equipment – designed to meet the high standards of quality and reliability made famous by Axel Bros.

PRECISION MANUFACTURERS OF

- **Paper & film dielectric capacitors**
- **Precision wire wound resistors**
- **Radio noise filters**
- **Pulse networks**
- **Delay lines**

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We will be pleased to send you our regular Engineering Bulletins. Address: "Dept. E"

Quality and Precision Since 1916

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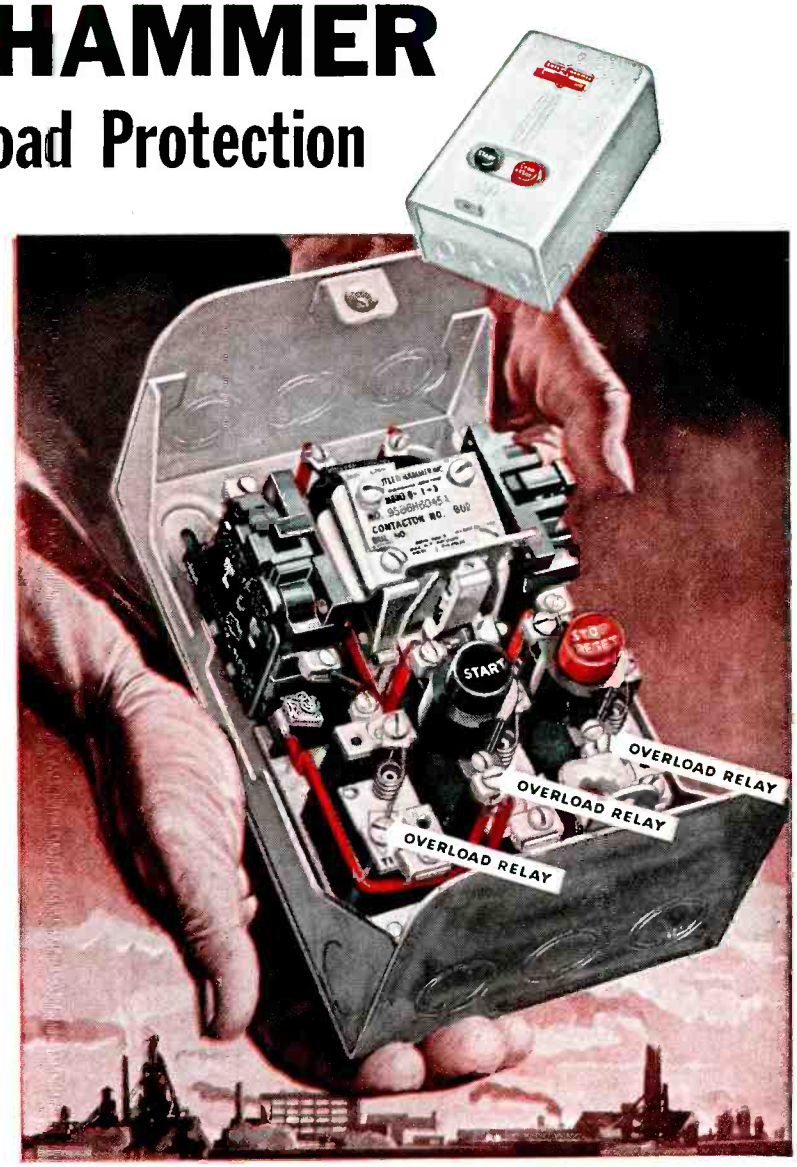
DRIVER-HARRIS

salutes a great engineering achievement

CUTLER-HAMMER

Eutectic Overload Protection



Cutler-Hammer engineers made history with their eutectic alloy type overload relay for electric motor protection. Virtually all leading manufacturers of motor control today offer this type of overload protection. And more than 25 million electric motors in daily use bear witness to the acceptability and dependability of this proven protection.

Driver-Harris salutes this Cutler-Hammer achievement. The Cutler-Hammer Eutectic Overload Relay shows the dependability of certain alloys in practical use. In the Cutler-Hammer Relay, both the eutectic element which must function so precisely and the heater element which causes it to function are alloys. We are proud that Driver-Harris Nichrome is the resistance alloy used in the heater element of millions and millions of these successful overload relays.

It is not surprising that Driver-Harris alloys are selected by so many leaders of American industry. Driver-Harris alloys are the product of manufacturing methods employing the most precise metallurgical checks and quality controls. Nichrome*V and Nichrome* have long been accepted as the standard by which all electrical resistance alloys are measured. And these are only two of the 112 special purpose alloys developed by Driver-Harris since 1899 for electrical heating, resistance, and electronic applications. Do you need a special alloy? Send us your specifications.

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

Why Eutectic Alloy Overload Relays Stay Accurate

Basic in any overload relay is the need of having a disconnect mechanism respond to dangerous heating of the motor windings. All such relays use heater coils in series with the windings to provide the danger signal within the control unit. In the millions of overload relays using eutectic alloy elements to respond to the increased heating, disconnect occurs when the alloy melts. As this alloy has one definite melting point, the overload relay must always be accurate, regardless of how often or how infrequently it operates.

Sole producers of Nichrome V and Nichrome

SPECIAL PURPOSE ALLOYS SINCE 1899 — DH — TRADE MARK REG. U. S. PAT. OFF.

Driver-Harris COMPANY

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Louisville, Los Angeles, San Francisco • In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD

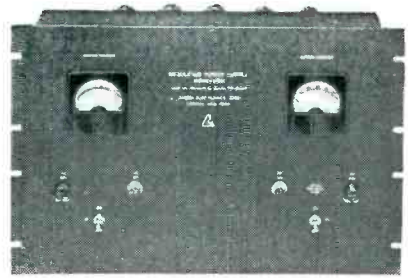
WHY engineers vote Lambda Power Supplies FIRST

This year again, in an impartial preference survey, LAMBDA has been the overwhelming first choice of engineers concerned with power supplies. The superior design and construction of LAMBDA equipment have been, of course, important elements in achieving this leadership.

Four new heavy-duty models, 60, 60M, 61 and 61M reflect these desirable qualities. These models, for fixed voltage use but adjustable over ranges indicated, have been engineered primarily for industrial applications. They will stand up under continuous-duty operations at maximum ratings.

LAMBDA'S "600 MA" series now includes twelve models, six voltage ranges to 405V. They are exceptionally suited for television studio and transmitter equipment, tube ageing apparatus, computer installations and multi-channel equipment, among other applications.

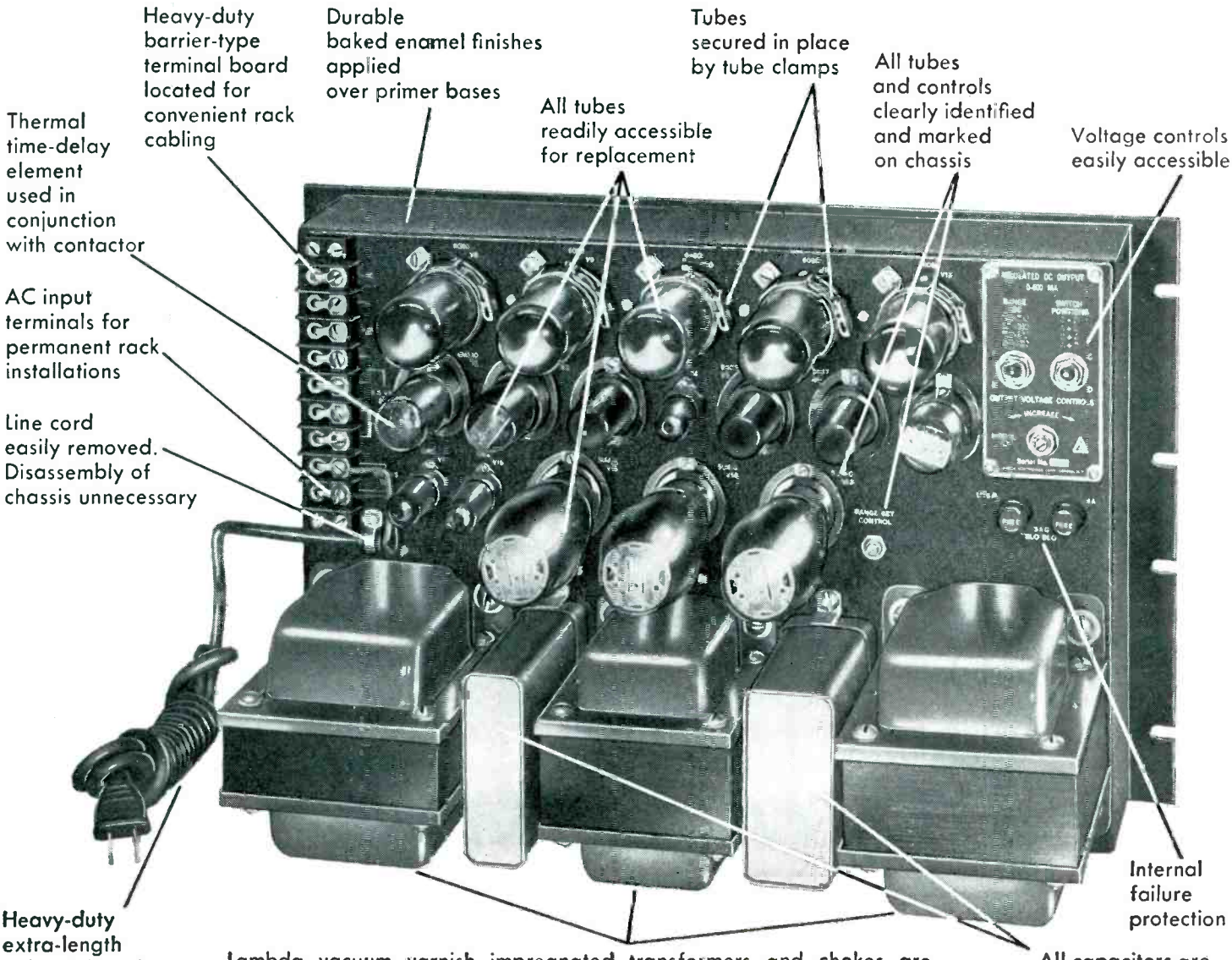
Send for complete LAMBDA power supply catalog.



SCHEDULE OF PRICES

Model 60	$259.50	Model 63	$239.50
Model 60M	289.50	Model 63M	269.50
Model 61	249.50	Model 64	244.50
Model 61M	279.50	Model 64M	274.50
Model 62	239.50	Model 65	249.50
Model 62M	269.50	Model 65M	279.50

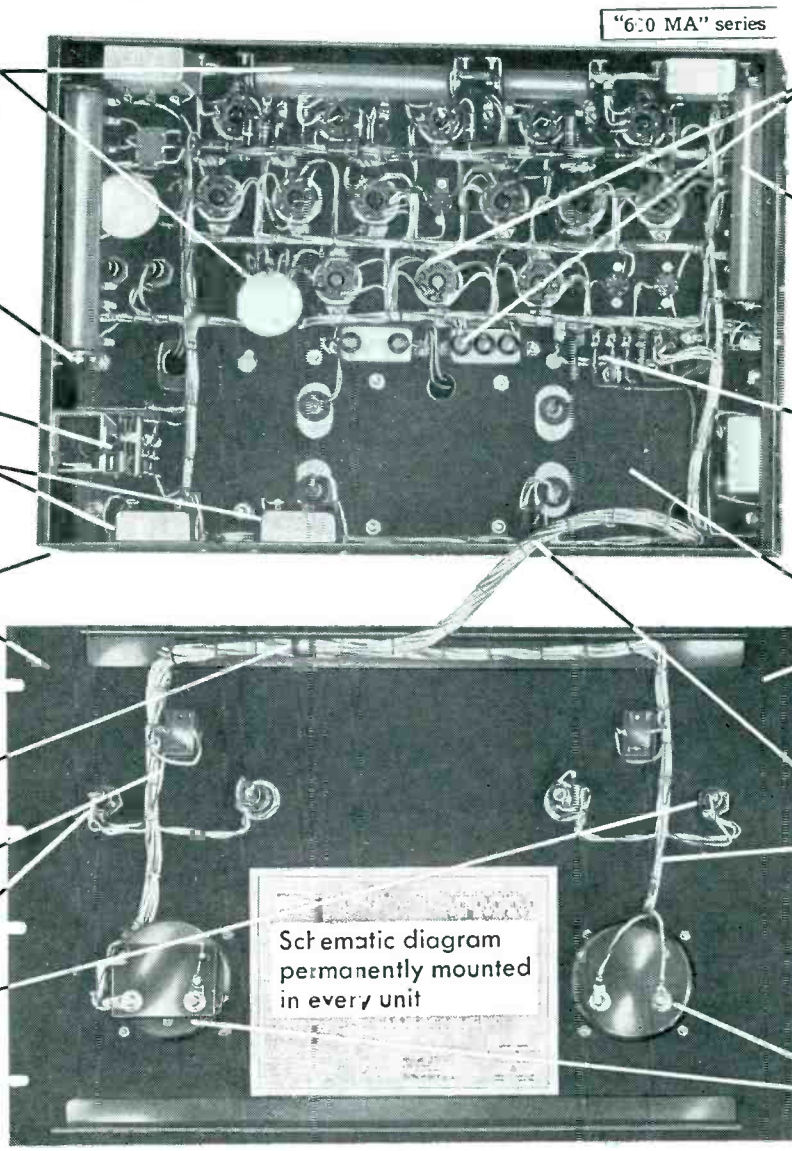
Available for immediate delivery. Prices F.O.B. factory, College Point 56, N.Y.



Lambda vacuum varnish impregnated transformers and chokes are engineered for continuous heavy duty service. They are designed especially for Lambda Power Supplies and manufactured in our own plant.

All capacitors are hermetically sealed and oil-filled

Interior photos of new 405V models show construction for continuous heavy-duty service



Stable, low-noise wire-wound voltage reference networks and controls

All components securely mounted

Heavy-duty contactor

All capacitors are hermetically sealed and oil-filled

Durable baked enamel finishes applied over primer bases

Sturdy cable clamp anchors

Harness wiring

External overload protection

Every connection and solder joint individually inspected and checked

Vitreous enameled wire-wound power resistors

All parts easily accessible for inspection and servicing

Heavy gauge chassis and panel construction

Nylon jacketed vinyl wire

Accurate, dependable meters

SPECIFICATIONS FOR "600 MA SERIES"

AC Input:
105-125VAC, 50-60C, 840W (Model 60); 810W (Model 61); 775W (Model 62); 715W (Model 63); 675W (Model 64); 585W (Model 65)

DC Output (regulated)
Voltage and currents:

Models	Voltage range*	Current range**
60 & 60M	345-405VDC	0-600MA
61 & 61M	295-355VDC	0-600MA
62 & 62M	245-305VDC	0-600MA
63 & 63M	195-255VDC	0-600MA
64 & 64M	100-200VDC	0-600MA
65 & 65M	0-100VDC	50-600MA

**Voltage range for any given model is completely covered in four continuously variable bands.*
***Current rating applies over entire voltage range.*

Regulation (line) ..... Better than 0.15% or 0.3V
Regulation (load) ..... Better than 0.25% or 0.3V
Impedance ..... Less than 2 ohms
Ripple and Noise ..... Less than 5 millivolts rms
Polarity ..... Either positive or negative may be grounded

AC Output (unregulated):
6.5VAC at 20A (at 115VAC input). Allows for voltage drop in connecting leads. Isolated and ungrounded.

Ambient Temperature and Duty Cycle:
Continuous duty at full load up to 50°C (122°F) ambient.

Controls, Terminals and Overload Protection:

DC output controls:	Band-switches and screw-driver adjusting vernier-control, rear of chassis
AC and DC switches:	Front panel
External overload protection:	AC and DC fuses, front panel
Internal failure protection:	Fuses, rear of chassis
Input and output terminals:	Barrier terminal block, rear of chassis

Meters:
3½" rectangular voltmeter and milliameter (Models 60M, 61M, 62M, 63M, 64M and 65M only).

Voltage Reference Tube:
A stable 5651 voltage reference tube is used to obtain superior long-time voltage stability.

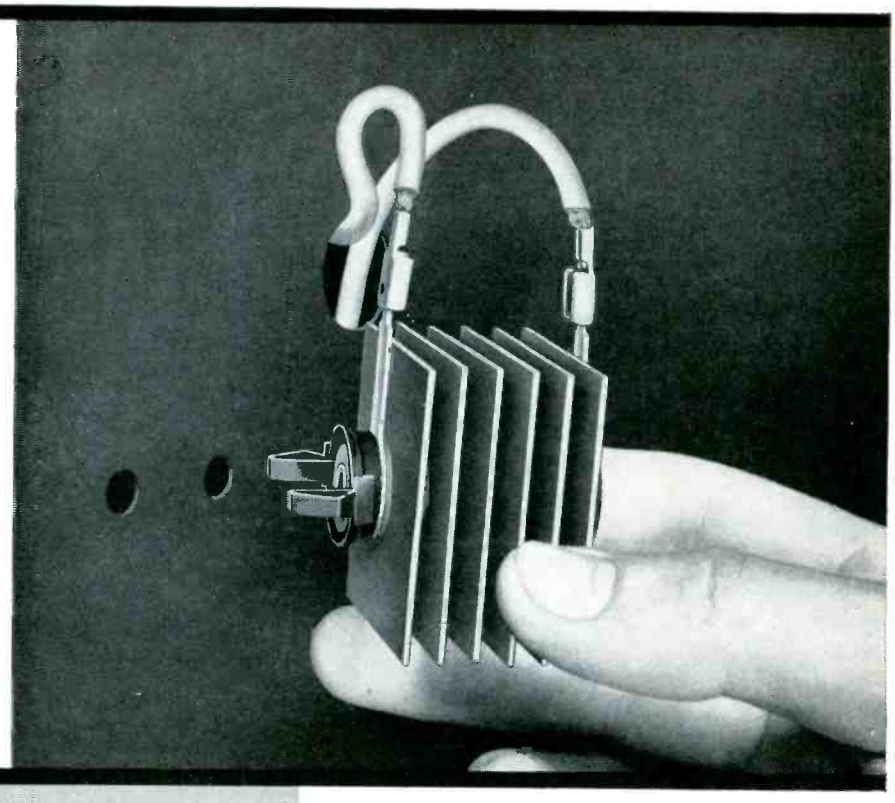
Time-Delay Relay Circuit:
A 30-second time-delay relay circuit is provided to allow tube heaters to come to proper operating temperatures before high-voltage can be applied.

Physical Data:

Size:	Standard 19" relay-rack mounting 12¼" H x 19" W x 9" D
Weight:	70 lb. net; 110 lb, shipping
Panel Finish:	Black ripple enamel (standard)

LAMBDA Electronics Corp.
THE FIRST NAME IN POWER SUPPLIES
11-11 131 STREET • COLLEGE POINT 56, NEW YORK • INdependence 1-8500

Radio Receptor's NEW money saving rectifier mounting!



"QUI-KLIP" *snap-in type* SELENIUM RECTIFIERS

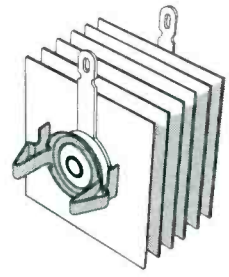
Radio Receptor's unique QUI-KLIP rectifiers will soon make their debut in TV sets produced by one of the country's leading manufacturers, saving them countless dollars in production costs.

QUI-KLIP requires no tools or sockets for mounting. There are no studs to break or threads to strip and the locating tab is now unnecessary. QUI-KLIP provides a positive seat for the rectifier – no rocking. Yet any serviceman can remove the stack quickly by squeezing the QUI-KLIP prongs with his fingers and removing the solderless connectors.

Let us show you how to put the cost saving QUI-KLIP selenium rectifiers to work in *your* production . . . Available in most popular sizes with cells from 1" square to 2" square, for radio, TV and other electronic circuits. For detailed information, write Dept. E-14.

QUICK MOUNTING! QUICK REMOVAL!

Spring steel clips with safe edges snap into two round, large tolerance holes in chassis (approx 3/16" dia., 3/4" c. to c.). Solderless connectors as shown, when used, simplify servicing



- Speeds assembly time.
- Slashes production costs.
- Simplifies assembly.
- Eliminates stud rejects (No studs or nuts needed.)
- Permits easier replacement in the field.

Really RR Reliable

Semiconductor Division

RADIO RECEPTOR COMPANY, INC.

In Radio and Electronics Since 1922

SALES OFFICES: 251 WEST 19TH ST., NEW YORK 11, N. Y., WAtkins 4-3633 • Factories in Brooklyn, N. Y.

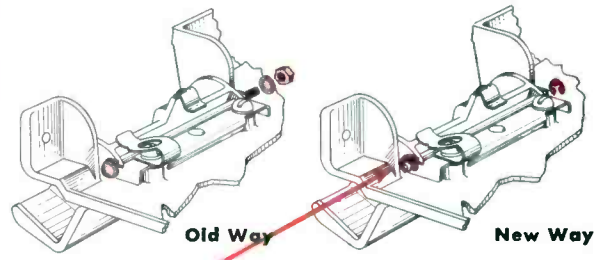
SELENIUM RECTIFIERS, THERMATRON DIELECTRIC HEATING GENERATORS AND PRESSES, COMMUNICATION, RADAR AND NAVIGATION EQUIPMENT

5 Waldes Truarc rings eliminate parts, speed assembly, in light, compact dictating machine

Edison's "V. P." Voicewriter

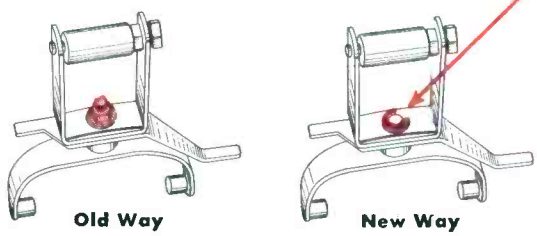
Edison engineers built this new dictating instrument for small size, light weight, and rugged performance. Waldes Truarc rings replace old fashioned fasteners, cut production costs; keep unit light, compact, and achieve faster more economical assembly.

Disc Lever Cover Assembly



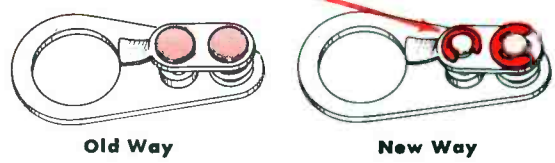
Two Waldes Truarc E-Rings (Series 5133) replace nut, bolt, washer assembly, eliminate one component and assure precise alignment of parts. Truarc rings facilitate pivoting without binding. Production assembly time is decreased.

Lift Bracket and Fork Assembly



A single, easily assembled Waldes Truarc E-Ring (Series 5133) replaces nut-bolt-washer fastening. Free pivoting is assured, one component eliminated, labor and material costs reduced.

Clutch Plate Assembly



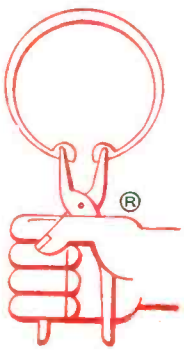
Two Truarc E-Rings eliminate staking operation, prevent damage to spring coil. Simple assembly operation speeds production, eliminates rejects, reduces labor and material costs.

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

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

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

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



WALDES
TRUARC®
RETAINING RINGS

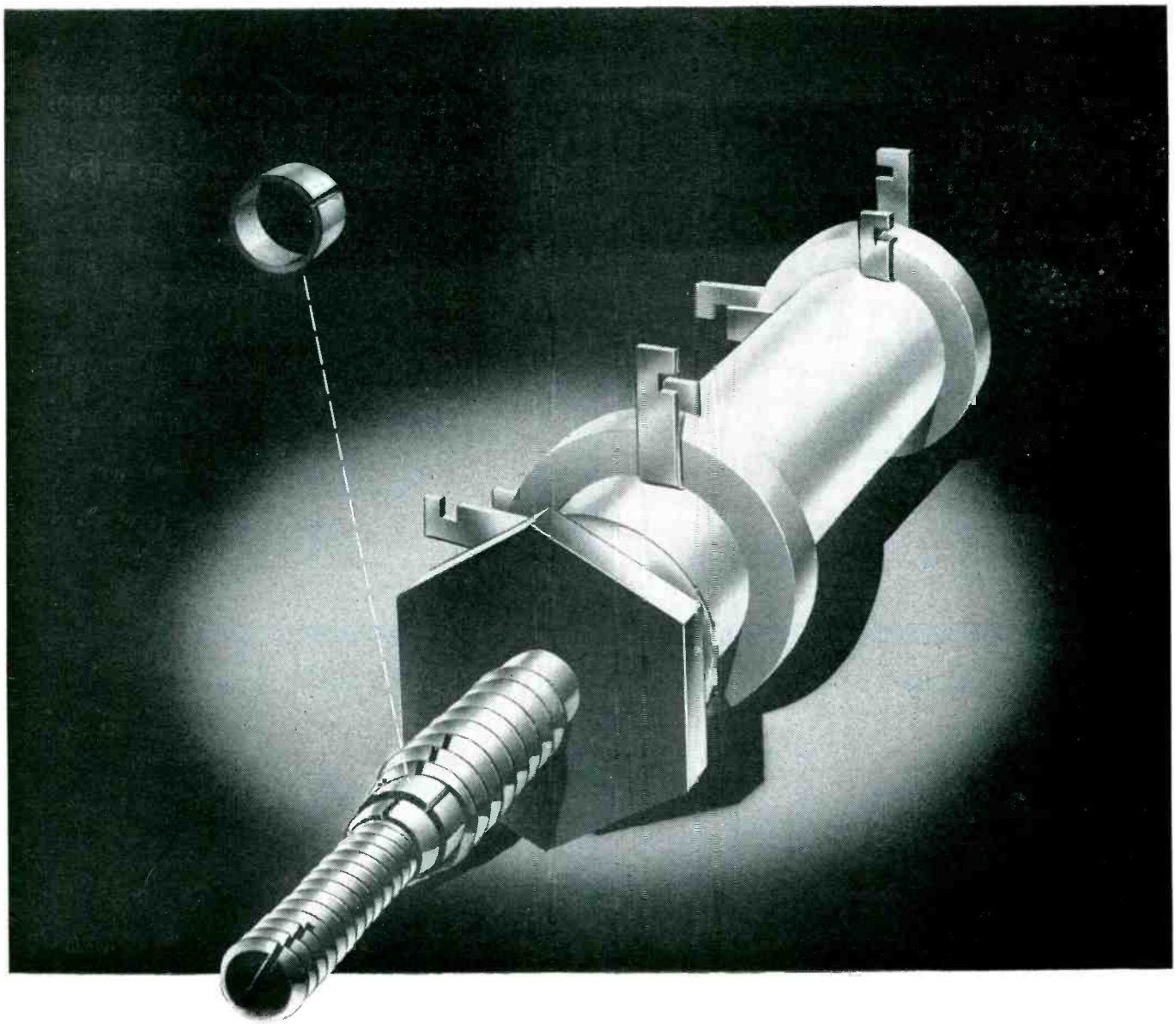
Send for new catalog supplement

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

*Name*_____
*Title*_____
*Company*_____
*Business Address*_____
*City*_____ *Zone*_____ *State*_____

E-018

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



Always tense but never tired

Again CTC comes up with an advancement for more secure, more effective electronic assemblies. It's the new Perma-Torq* constant tensioning device for tuning cores of standard CTC ceramic coil forms.

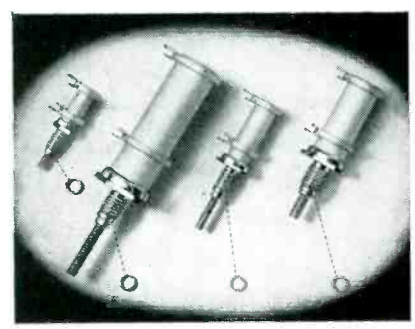
CTC's Perma-Torq, a compression spring of heat treated beryllium copper, has very high resistance to fatigue and keeps coils tuned as set, under extreme shock and vibration. It allows for immediate readjustment without removal or loosening of any mounting nut or locking spring. But most important of all — Perma-Torq like all CTC components is *quality controlled.*

CTC's *quality-control* means you get consistent top quality components. Each step of production is checked, each component part — even though already certified — is checked again. And finally CTC's finished product is checked. That's why CTC can offer you a guaranteed electronic component — standard or custom — whose performance you can depend upon.

CTC researchers and practical experts are always available to help solve your components problems. For samples, specifications and prices write to Sales Engineering Dept., Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge 38, Mass. On the West Coast contact E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 or 988 Market St., San Francisco, Cal.

NEW PERMA-TORQ UNITS come completely factory assembled to mounting studs, eliminating the bother of assembling and adjusting separate locking springs. CTC coil forms with Perma-Torq Tensioning Device are designated PLST, PLS5, PLS6 and PLS7, are completely interchangeable with the LST, LS5, LS6 and LS7 series, and are available at no increase in price.

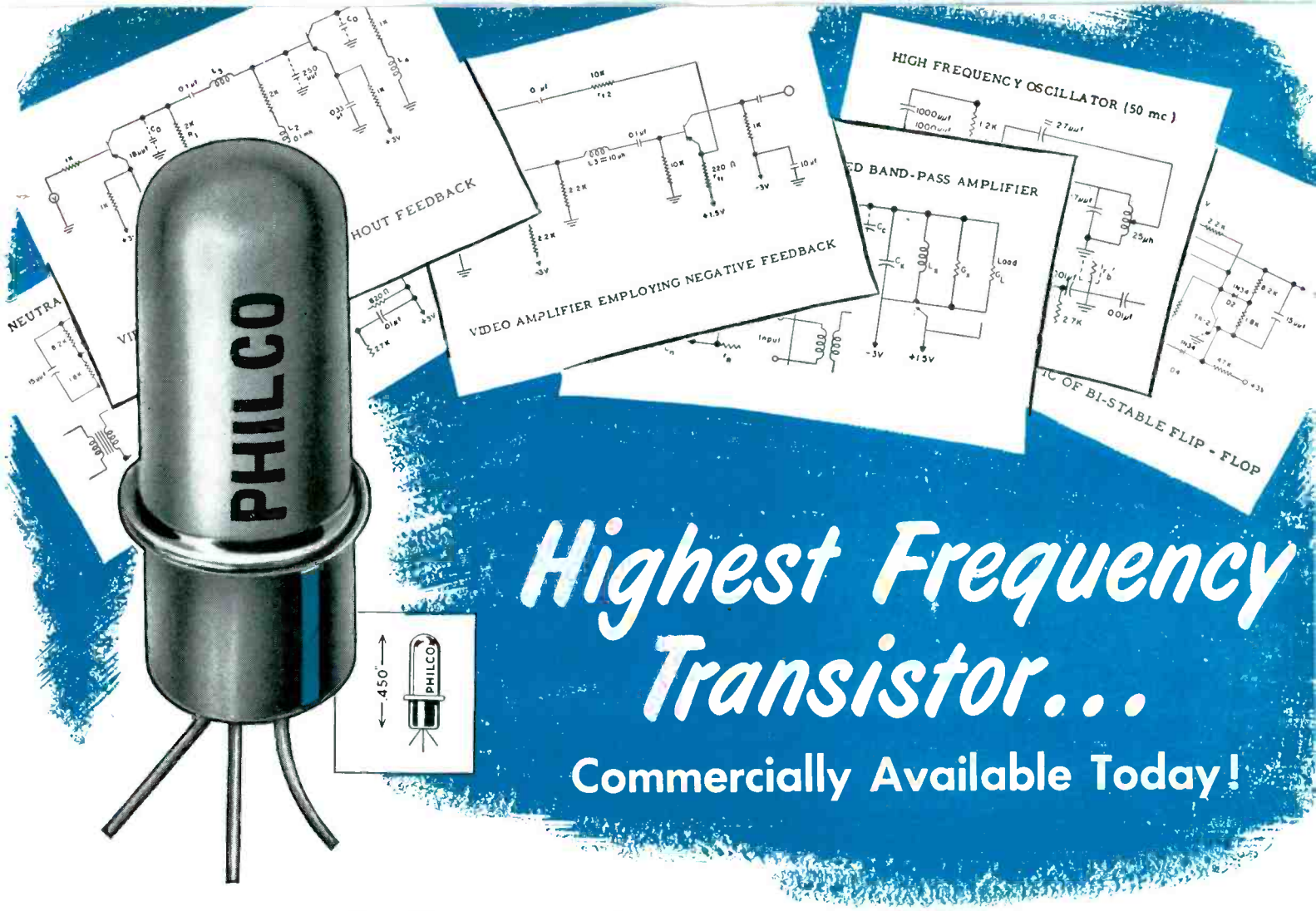
*Patent pending



CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components
custom or standard



Highest Frequency Transistor...

Commercially Available Today!

PHILCO S-B-T (Surface Barrier Transistor)

Available now! . . . in quantity . . . Philco Surface Barrier Transistors are opening entirely new fields for design engineers . . . are being incorporated in high frequency units *now in production!* Commercial, industrial and military thinking is swinging over fast . . . to complete transistorization.

Philco has gained a wealth of experience in the practical application of Surface Barrier Transistors. Make the Philco S-B-T a part of your forward looking plans—now.

FEATURES

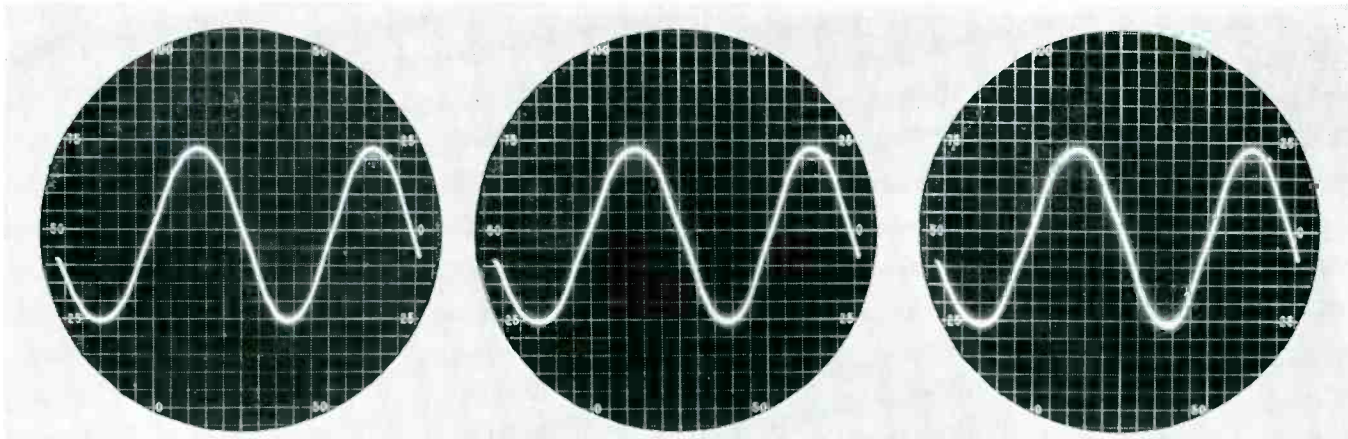
- **Lowest Power Consumption**
- **Hermetically Sealed Resistance-Welded Metal Case with Leads Sealed in Glass**
- **Long Life and Reliability of Operation**
- **Uniform Characteristics Insured by Controlled Processing and Complete Testing**
- **Extremely Low Collector Cut Off Current for Stable Operation**
- **Extremely Low Output Capacitance for Ease of Neutralization**

For complete technical information on the PHILCO SB Transistor write Dept. E

PHILCO CORPORATION

GOVERNMENT AND INDUSTRIAL DIVISION • PHILADELPHIA 44, PENNSYLVANIA

In Canada: Philco Corporation of Canada Limited, Don Mills, Ontario



No load | Half load | Full load

UNRETOUCHED OSCILLOGRAMS OF OUTPUT VOLTAGE: 1000va Sola Harmonic-Neutralized Constant Voltage Transformer operating from 110v input and correcting output to 115v with less than 3% harmonic distortion. "Commercial sine wave" is maintained regardless of load capacity served.

±1% static magnetic voltage regulation with less than 3% harmonic distortion

Static magnetic voltage regulation with all its advantages —automatic, continuous operation; instantaneous response; no maintenance; self-protection against short circuits; and input-output circuit isolation — has harmonics in its output voltage. In the case of the Sola Standard CV Regulator, harmonic distortion is held within an average of only 14% at full load. However, even 14% is excessive on some applications.

Sola Harmonic-Neutralized Constant Voltage Transformers have the characteristics of the Standard Sola CV Stabilizer *plus* the added advantage of less than 3% harmonic distortion in the output voltage wave.

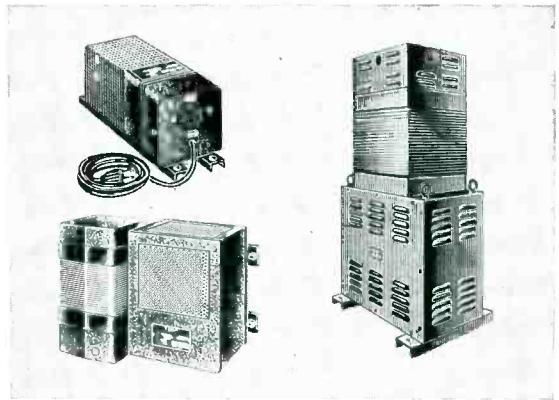
Sola sinusoidal output stabilizers are ideal for the most exacting applications. They are widely used to provide stabilized undistorted voltage for instruments, production control components, and communication gear. They are especially suitable for input to a rectifier when close regulation of the dc output is required.

Six standard ratings from 60 to 2,000va are immediately available from your electronic distributor's stock. Custom-built designs with ratings from 30 to 15,000va can be ordered in production quantities. A Sola sales engineer will be happy to discuss your specific requirements.

***TYPICAL HARMONIC ANALYSES, TYPE CVH CONSTANT VOLTAGE TRANSFORMER**

	Input Volts	Output Volts	3rd	5th	7th
Full Load	115	115.0	0.77%	1.20%	0.34%
50% Load	115	116.1	1.00	0.70	0.55
No Load	115	116.2	0.65	0.36	0.60

**On production units, the lowest residual harmonic content may occur anywhere between full load and no load.*



TYPICAL MECHANICAL STRUCTURES: The two stabilizers on the left are stock units, the transformer on the right is a "special" in the 7,500va size range.

SOLA *Constant Voltage* **TRANSFORMERS**

WRITE FOR BULLETIN 7A–CV–200 FOR COMPLETE DATA

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TUNG-SOL MINIATURE GERMANIUM TRANSISTORS NOW IN PRODUCTION

These new Tung-Sol Transistors, now available in production, meet a wide range of applications where miniaturization of equipment is essential.

The Tung-Sol semiconductor design and development program is characterized by laboratory-control processing and 100% testing—including rigid life, mechanical and electrical tests. It is your assurance of uniformity, long life and reliability *in excess of design specifications.*

High production standards for Tung-Sol Transistors are consistent with the manufacturing policy which safeguards Tung-Sol's *second-to-none* reputation for quality in all its products.

For engineering assistance in adapting Tung-Sol Transistors to your product, write to Commercial Engineering Department.

TUNG-SOL ELECTRIC INC. Newark 4, New Jersey

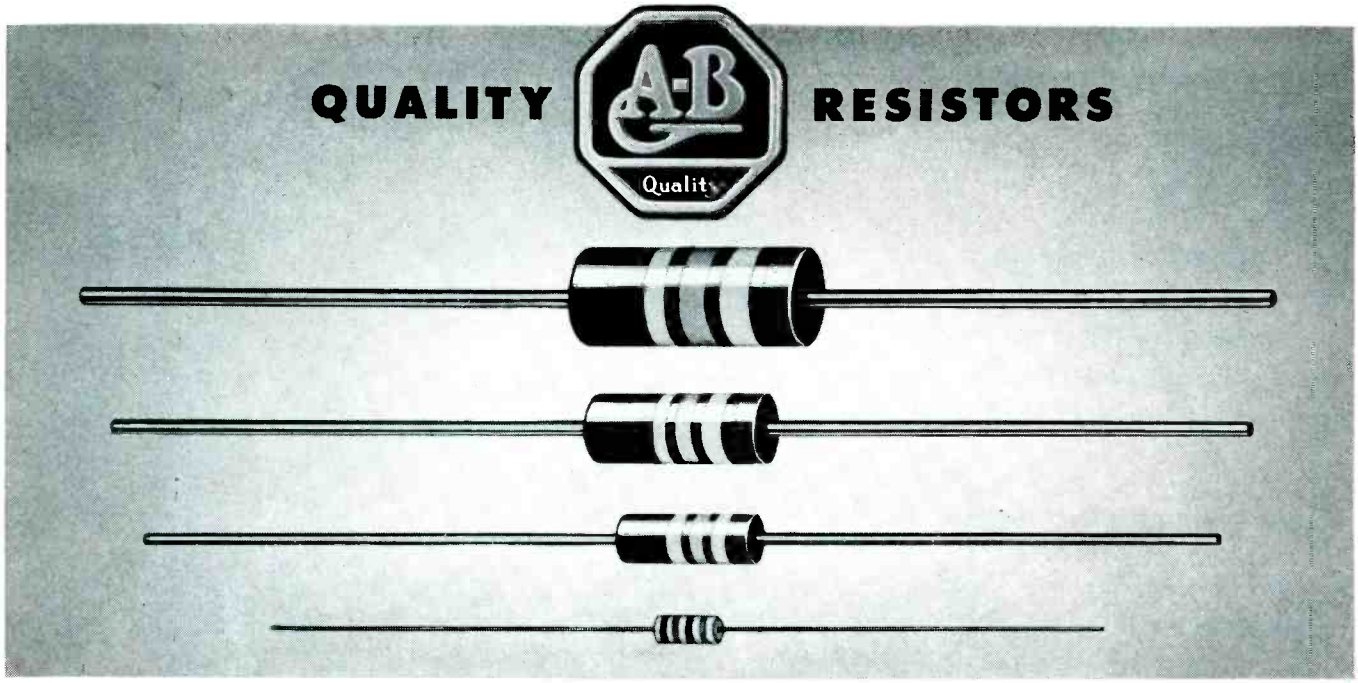
Sales Offices: Atlanta, Chicago, Columbus, Culver City, Dallas, Denver, Detroit, Newark, Seattle.

CHARACTERISTICS OF TUNG-SOL TRANSISTORS

	TS-162	TS-163	TS-164	TS-165	TS-166
RATINGS (Abs. Max.)					
Collector Volts	−10	−25	−25	−25	−10
Collector MA	10	10	10	10	10
Dissipation at 25°C (MW)	50	50	50	50	50
Junction Temp. (°C)	85	85	85	85	85
AVERAGE CHARACTERISTICS (Common Base, I_e = 1.0MA. E_c = −6v)					
Cutoff μA (Max.)	15@-10v	25@-25v	25@-25v	25@-25v	15@-10v
Current Gain	.93	.96	.98	.99	.97
Noise Figure	20	20	20	20	15
Frequency Cutoff (MC)	0.5	0.7	0.9	1.1	—
Power Gain (DB)	37	39	41	42	36

The Tung-Sol semiconductor development program also includes a line of high frequency and high power transistors.

Want more information? Use post card on last page.



FIXED COMPOSITION RESISTORS IN FOUR SIZES

All rated at 70C — not 40C

There is an EXTRA MARGIN OF SAFETY in Allen-Bradley molded fixed resistors, because they are rated at 70C ambient temperature . . . not at 40C. These resistors can withstand extremes of temperature, pressure, and humidity without deterioration. They require no impregnation to pass salt-water immersion tests.

Allen-Bradley fixed resistors are available in 4 sizes... Type HB—2 watt; Type GB—1 watt; Type EB—1/2 watt; and Type TR—1/10th watt, in standard RETMA values from 10 ohms to 22 megohms. Their close dimension tolerances are an outstanding advantage when used in automatic assembly lines. The color coding does not chip.

For applications where resistors must not fail, use Allen-Bradley. Of course, they are also "the best" for all uses . . . and they cost no more than ordinary resistors. Send for Allen-Bradley resistor data.

Allen-Bradley Resistors Are Packaged in Cartons and on Reels

Allen-Bradley resistor patented cartons have corrugated strips which hold the resistors in an upright position which prevents bending or tangling of leads.

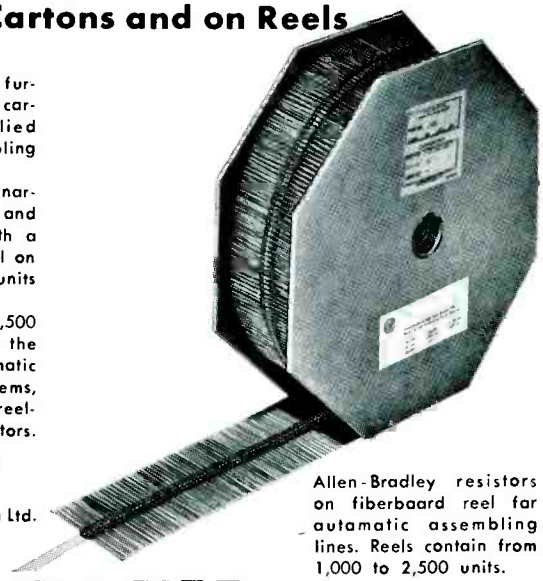
Allen-Bradley fixed resistors are furnished, as standard, in patented cartons. They can also be supplied in reels for automatic assembling equipment.

The resistors are aligned on a narrow, pressure-sensitive tape and wound on a fiberboard reel with a 9/16-inch mandrel. A lateral pull on the resistor leads detaches the units from the tape.

Reels contain from 1,000 to 2,500 units per reel, depending upon the size of the resistor. If automatic assembling is one of your problems, it may pay you to investigate the reel-packaging of A-B QUALITY resistors.

Allen-Bradley Co., 110 West Greenfield Avenue

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



Allen-Bradley resistors on fiberboard reel for automatic assembling lines. Reels contain from 1,000 to 2,500 units.

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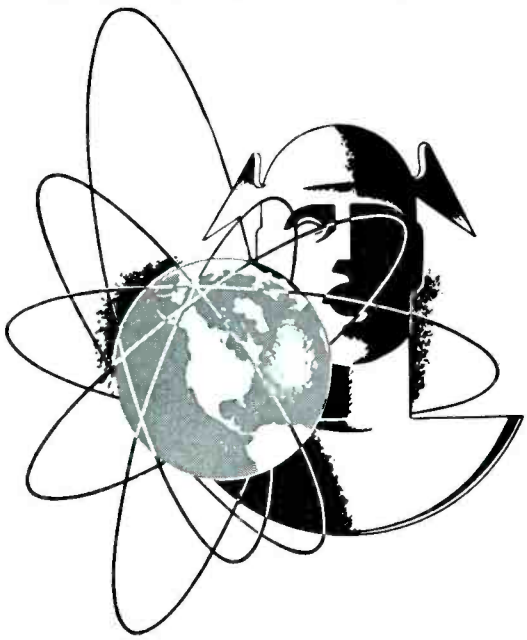
THE SPERRY RAND CORPORATION ANNOUNCES



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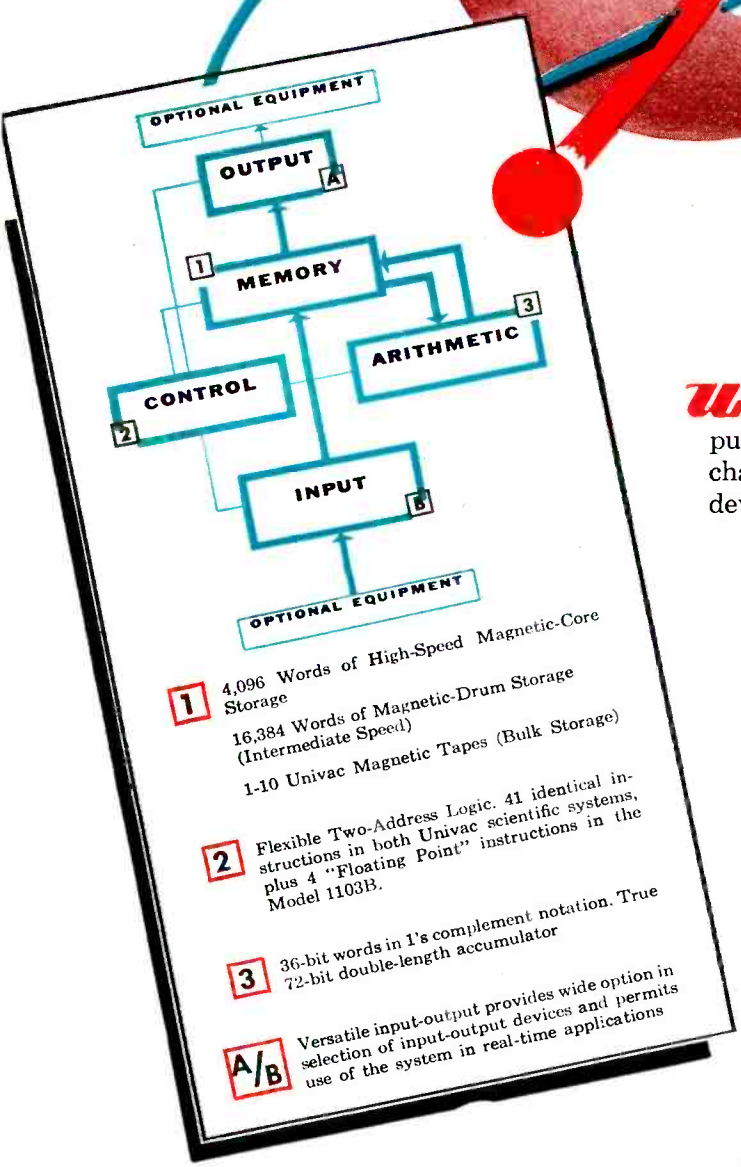

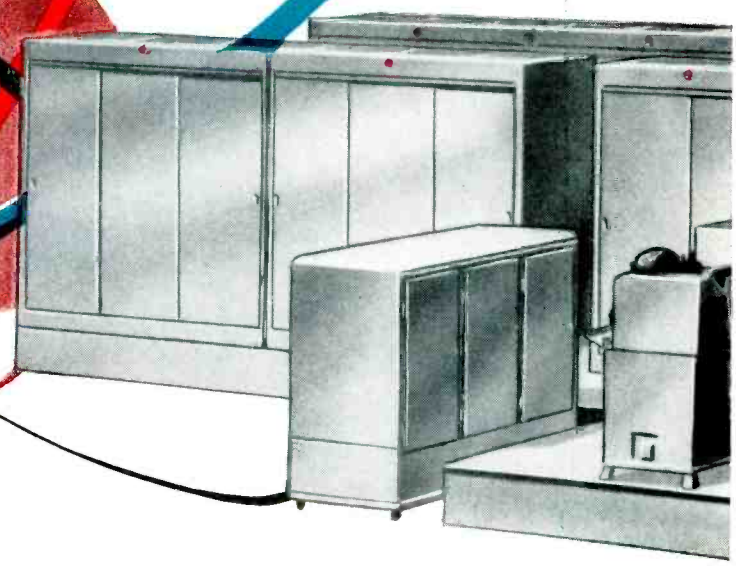

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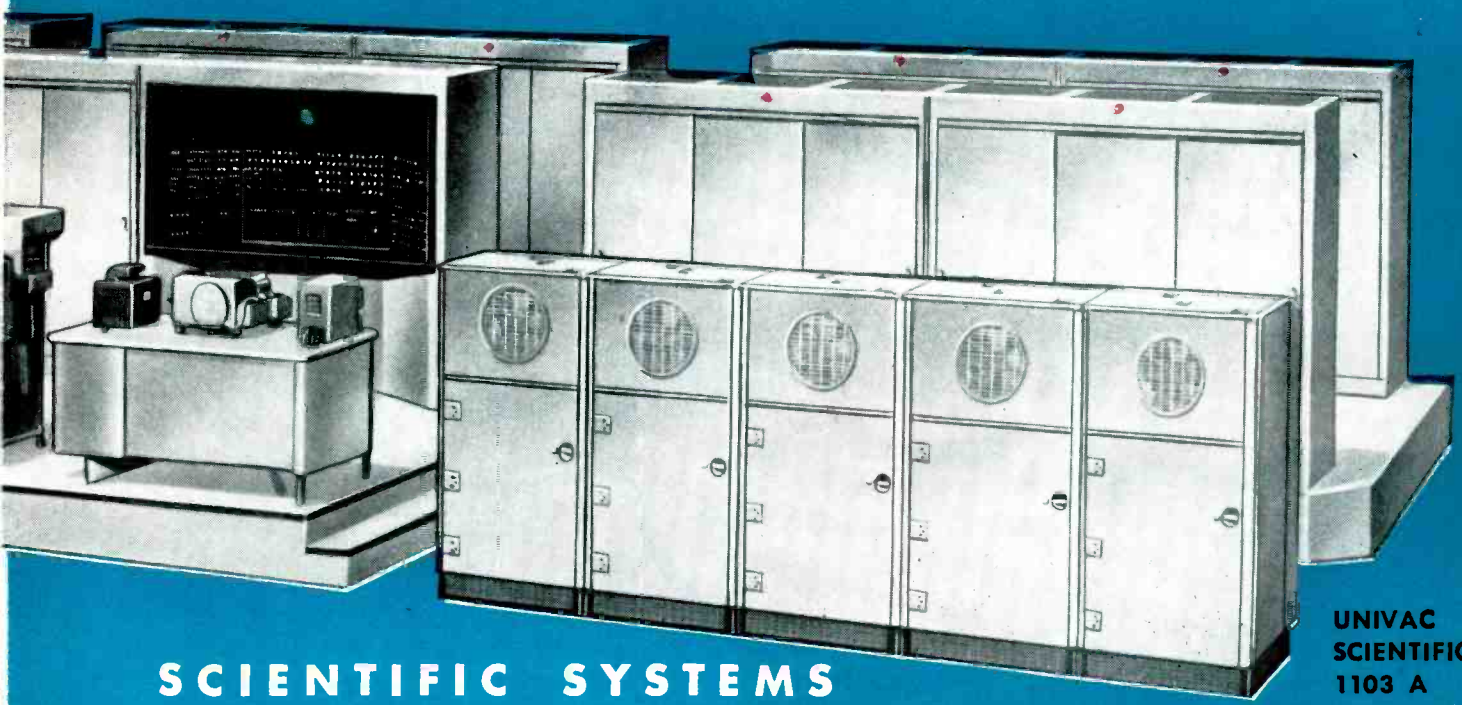

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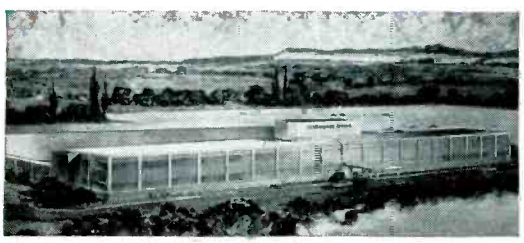
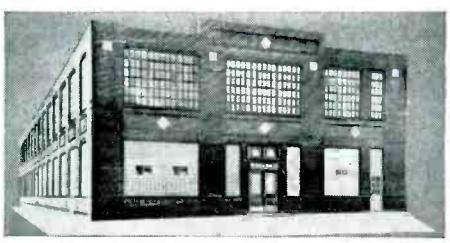


Laboratory under Construction at St. Paul, Minn.



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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.

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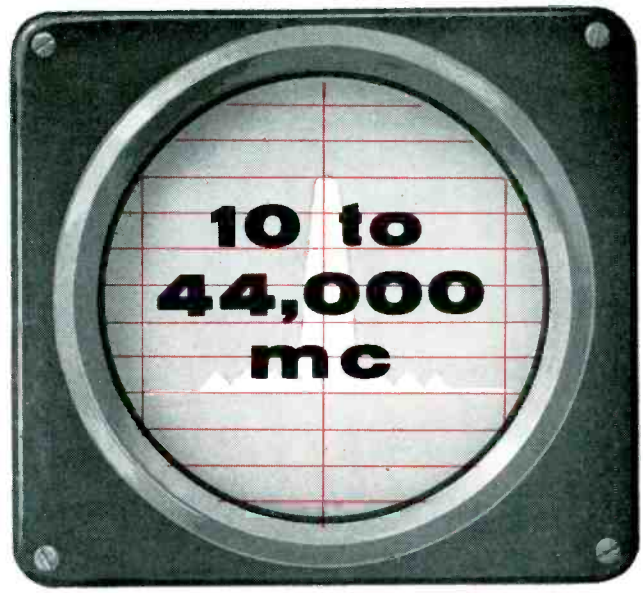


DIRECT READING SPECTRUM ANALYZER

UNI-DIAL CONTROL

Years of day-in, day-out field operation by most exacting users, have proven the Polarad Model TSA Spectrum Analyzer to be a versatile test instrument of highest reliability and accuracy for both laboratory and production applications.

It is a broadband instrument with greatest pulse sensitivity over the band—10 to 44,000 mc. And each of its five interchangeable RF tuning heads operate with utmost simplicity and frequency stability. All tuning is by Uni-Dial control. Frequencies are read with 1% accuracy right on the linear dial as the set is tuned. No mode charts or interpolations necessary.

The Polarad Model TSA has been designed to save engineering manhours. Its 5 inch CRT display of the RF spectrum is bright and easily defined. And its 1 cycle sweep speed makes for fine resolution. For detailed specifications, contact your nearest Polarad Representative, or write directly to the factory.

APPLICATIONS

- Transmitter characteristics tests
- Broadband receiver for AM, FM, CW, MCW, and pulse modulated signals
- Component tests
- Frequency measurements
- Leakage, interference and radiation measurements
- Bandwidth measurements
- Modulation tests
- Adjacent signal channel tests
- Attenuation measurements
- Filter measurements
- Standing wave measurements

MULTI-PULSE SPECTRUM SELECTOR

MODEL SD-1

Increases the versatility of Polarad Spectrum Analyzers. It displays and allows selection for analysis of a specific train of microwave pulses, as well as any one pulse in the train; selects and gates a group of pulses up to 180 μsec. in length; and is designed to work with fast, narrow pulses; can be adjusted to gate any pulse including the first at zero time. Special circuitry discriminates automatically once pulses have been selected. Operates at any of the frequencies accepted by Polarad Spectrum Analyzers.

FEATURES:

Continuously variable sweep widths; 15 to 180 μsec. • Continuously variable gate widths for pulse selection; 0.4 to 10 μsec. • Continuously variable gate delays for pulse selection; .3 to 180 μsec. • Automatic gating of spectrum analyzer during time of pulse consideration. • Intensified gate (brightening) to facilitate manual pulse selection. • Triggered sweep on first pulse in any train. • No sweep in absence of signal.

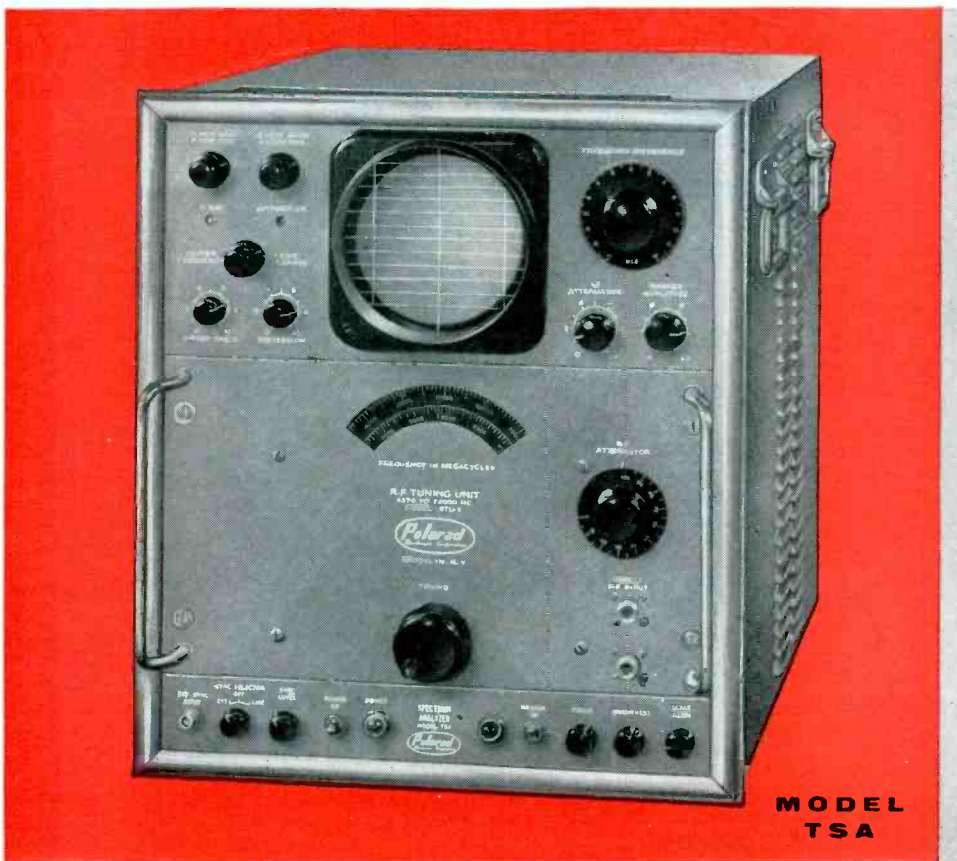
SPECIFICATIONS:

Maximum Pulse Train Time 180 μsec. • Pulse Rise Time .05 μsec. Minimum • Minimum Pulse Separation .2 μsec. • Repetition Rate 10—10,000 pps. • Minimum Pulse Width .1 μsec. • Input Power 95 to 130 volts, 50/60 cps., 325 watts. • Input Impedance 50 ohms. • Output Impedance 50 ohms (to match TSA Spectrum Analyzer).

BROADBAND SPECTRUM ANALYZER

FEATURES

- Greatest signal sensitivity over entire frequency band.
- Single frequency control with direct-reading dial accurate to ±1%.
- Complete frequency coverage from 10 mc to 44,000 mc.
- Internal RF attenuator (RF Tuning Unit Models STU-1, STU-2A, STU-3A).
- Adjustable frequency display from 400 kc to 25 mc.
- Frequency differences as small as 40 kc measurable by means of adjustable frequency marker with variable amplitude.
- 25-kc resolution for all bands.
- Stable klystron oscillators using non-contacting plungers to insure longer life.
- No klystron modes to set.
- 5-inch CRT display.
- Portable and completely self-contained.



MODEL TSA

SPECIFICATIONS

Model No.	Equipment
Model Du.....	Spectrum Display and Power Unit
Model STU-1...	RF Tunning Unit 10-1,000 mc.
Model STU-2A.	RF Tuning Unit 910-4, 560 mc.
Model STU-3A.	RF Tuning Unit 4,370-22,000 mc.
Model STU-4	RF Tuning Unit 21,000-33,000 mc.
Model STU-5...	RF Tuning Unit 33,000-44,000 mc.

SPECIFICATIONS:

Frequency Range: 10 mc to 44,000 mc.
Frequency Accuracy: ±1%
Resolution: 25 kc.
Frequency Dispersion: Electronically controlled, continually adjustable from 400 kc to 25 mc per one screen diameter (horizontal expansion to 20 kc per inch)
Input Impedance: 50 ohms—nominal
Sensitivity:*
STU-1 10-400 mcs—89 dbm
400-1000 mcs—84dbm
STU-2A 910-2,200 mcs—87 dbm
1,980-4,560 mcs—77 dbm
STU-3A 4,370-10,920 mcs—75 dbm
8,900-22,000 mcs—60 dbm
STU-4 21,000-33,000 mcs—55 dbm
STU-5 33,000-44,000 mcs—45 dbm
Overall Gain: 120 db
Attenuation:
**RF Internal 100 db continuously variable, IF 60 db continuously variable
Input Power: 400 Watts
*Minimum Discernible Signal
**STU-1, STU-2A, STU-3A

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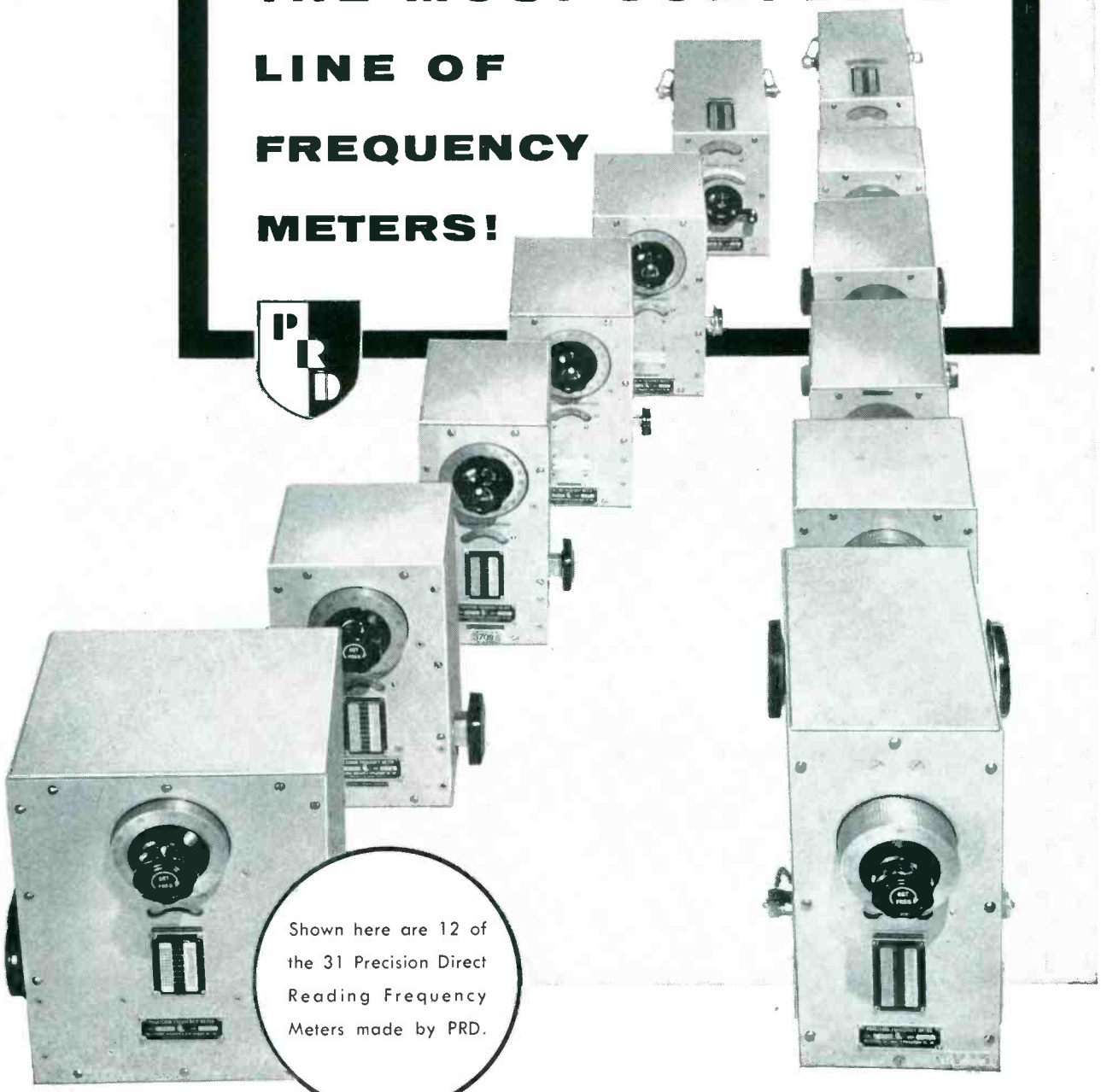

Shown here are 12 of the 31 Precision Direct Reading Frequency Meters made by PRD.

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- ✓ Calibrated Precision Frequency Meters
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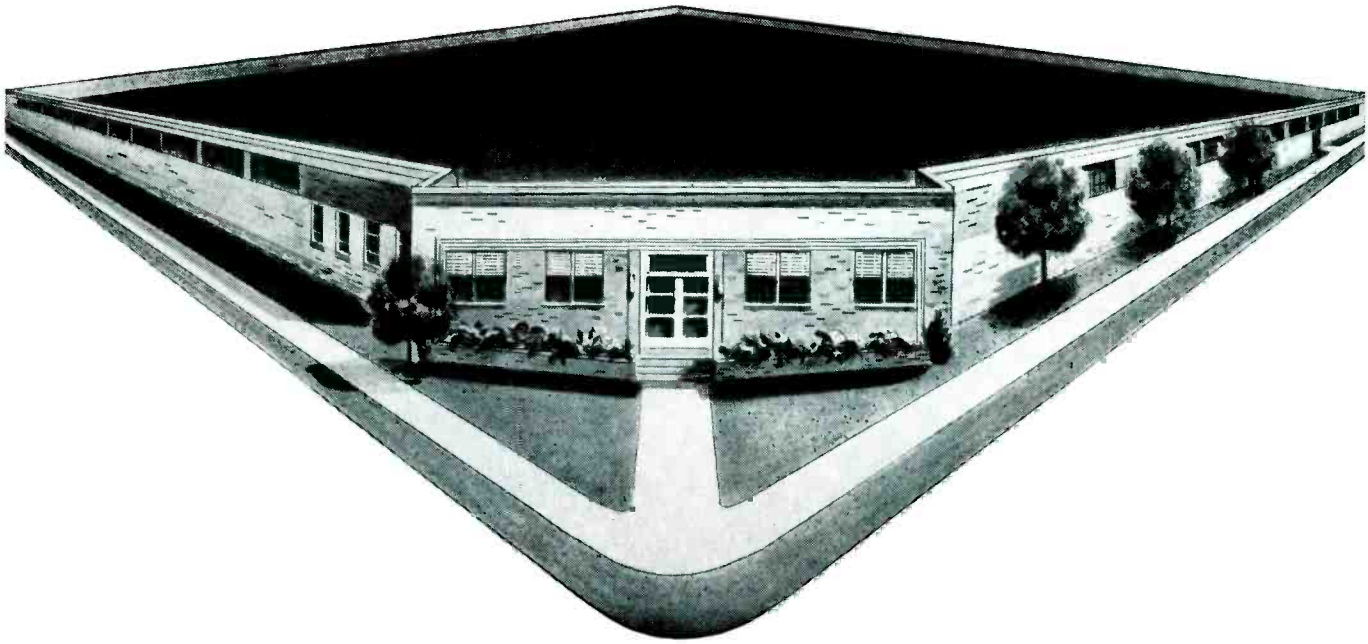
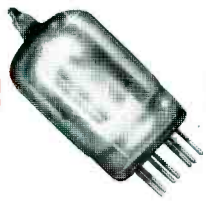


here's what's behind the  crystal that's so far ahead

The Midland Factory shown above is the world's largest plant devoted exclusively to producing crystals for frequency control. It is equipped with the finest and most complete production and testing machinery ever developed for this purpose. Here Midland pioneered development of crystals for color television, and is now ready for full-scale production.

All this is important to you for just one good reason: Every Midland crystal you use has been produced by such advanced techniques and under such rigid quality controls that you can be sure it will prove its completely reliable quality under every operating stress.

Midland Critical Quality Control extends through every step of crystal production, and includes precise angular control by X-ray. Uniform accuracy is maintained to the millionth part of an inch.

Whatever your Crystal need, conventional or highly specialized,
When it has to be exactly right, contact

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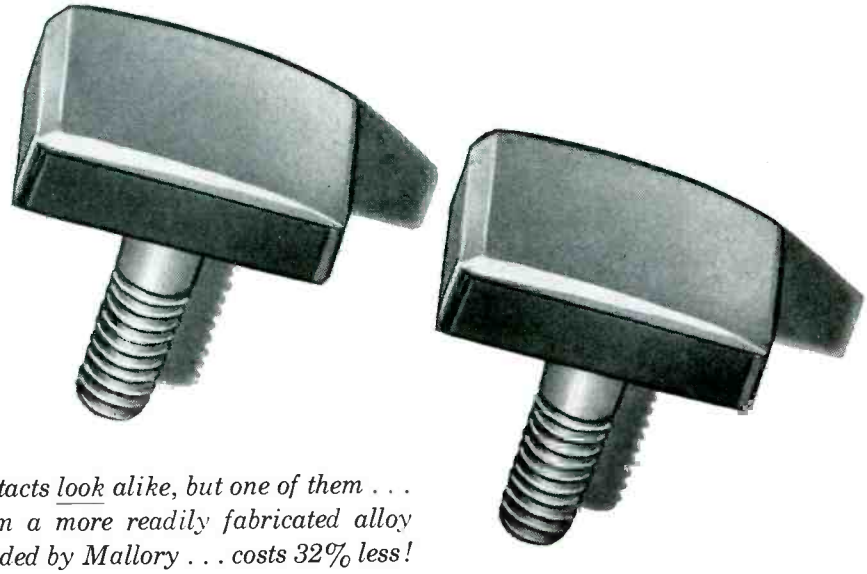

These contacts look alike, but one of them . . . made from a more readily fabricated alloy recommended by Mallory . . . costs 32% less!

Mallory Engineered Materials Selection Can Cut Your Contact Costs

Mallory Contact Engineering Offers Five Ways To Improve Economy

1. **The most effective contact material** from the extensive line developed by Mallory. More economical alloys often can satisfy *actual* service conditions.
2. **The most economical contact design** . . . for your purchasing, production and product needs.
3. **The most economical backing material** . . . from a group of Mallory alloys developed for this use.
4. **The most economical backing member design** . . . in relation to contact and product design requirements.
5. **The most economical method of assembly** of contact and backing member.

By coordinating *all* these important elements of contact design, Mallory can help you put into effect a long-range plan for cutting contact cost and assuring peak performance.

CHOOSING the contact material that exactly matches your product requirements can often reduce over-all contact costs. For example, designers of a circuit breaker selected one of the Mallory Elkonite® materials for the contacts. This is a superior material for heavy-duty service, with high resistance to sticking and arc erosion.

Mallory engineers examined the product requirements . . . and recommended a change in materials. They found another ELKONITE, a higher silver content material, would give excellent performance on this medium-duty application. And because this material involved fewer manufacturing operations, the contacts could be made at lower cost. The customer's savings amounted to $10.16 per thousand . . . a total of over $8,000!

Mallory engineers are especially well qualified to help you get the best economy and performance in your contacts. They have a uniquely broad range of Mallory contact alloys from which to choose. And their extensive application experience is valuable in coordinating *all* phases of contact, backing member and assembly design to assure you of top value for your contact dollar. Write or call Mallory for a consultation on your particular application.

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REVERSIBLE
SILICON MIXER DIODES

by Bomac

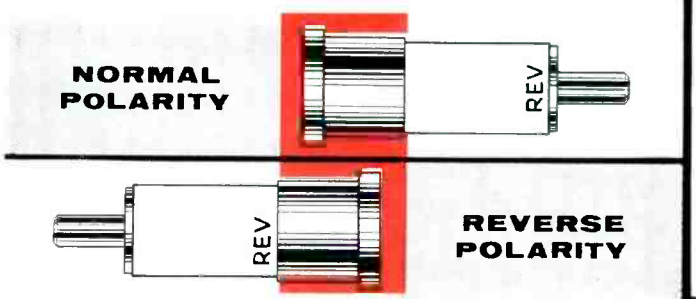
Here's another step forward by Bomac — a *reversible* silicon mixer diode. The 1N415 and 1N416 series are the first silicon diodes to have selective polarity.

Polarity is indicated by the letters REV located at one end of the diode. To change the polarity, just switch the position of the end cap.

With the end cap attached to the contact pin at the unmarked end of the cartridge, the diode will be of normal polarity. With the end cap attached to the end marked REV, the diode will be of reverse polarity. The complete assembly, with either polarity, is electrically the same as its equivalent type of regular silicon diodes.

The Bomac 1N415 and 1N416 series will meet all conditions of JAN 1A specifications.

1N415 - 1N416 SERIES



Band	Type	Equivalent Type	Frequency (Mc)	Max. Conversion Loss (db)	Noise Ratio (Times)	Max. (VSWR)	IF Imped. (OHMS)	Burnout (erg)
X	1N415B	1N23B	9375	6.5	2.7	—	—	1.0
		1N23BR	9375	6.5	2.7	—	—	1.0
X	1N415C	1N23C	9375	6.0	2.0	1.50	325-475	1.0
		1N23CR	9375	6.0	2.0	1.50	325-475	1.0
X	1N415D	1N23D	9375	5.0	1.7	1.30	350-450	1.0
		1N23DR	9375	5.0	1.7	1.30	350-450	1.0
S	1N416B	1N21B	3060	6.5	2.0	—	—	2.0
		1N21BR	3060	6.5	2.0	—	—	2.0
S	1N416C	1N21C	3060	5.5	1.5	—	—	2.0
		1N21CR	3060	5.5	1.5	—	—	2.0

UNIQUE PACKAGE PROTECTION

For complete protection during shipment and storage Bomac has designed a reusable RF Protective Package* which conforms with MIL-E1B specification. Diodes stored in this package are completely protected no matter how many times they are handled after the original seal is broken.

*PAT. APPLIED FOR

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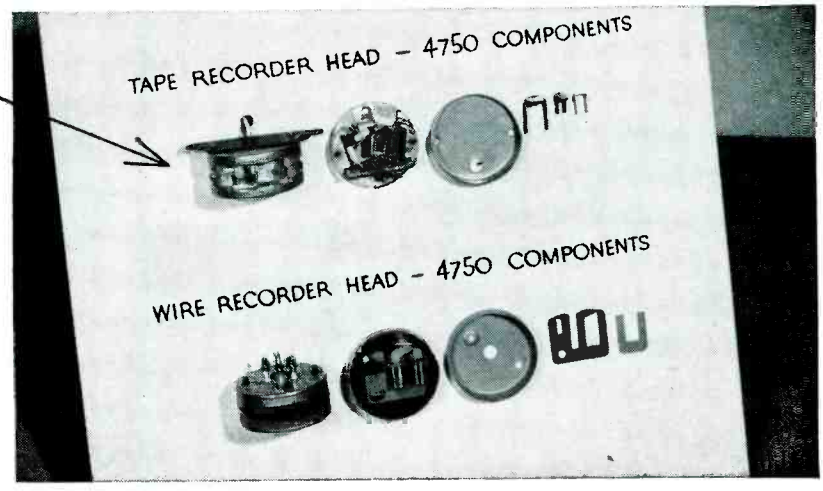

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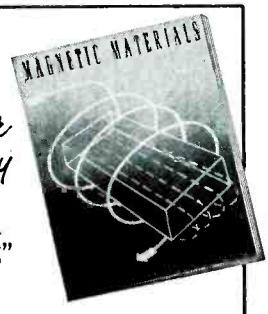

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"MAGNETIC MATERIALS"

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.

ADDRESS DEPT. E-73

You can *rely* on core materials like the Allegheny 4750 components illustrated above, in your receivers, recording heads or microphone assemblies.

In fact, whether your equipment is small or large, the extra-broad line of A-L magnetic materials will solve your magnetic core problems. It includes all grades of silicon steel sheets or coil strip, as well as Allegheny Silectron (grain-oriented silicon steel), and a wide selection of high-permeability alloys such as 4750, Mumetal, Permendur, etc.

Our service on these materials also includes complete facilities for the fabrication and heat treatment of laminations. (For users of electrical sheets and strip, our lamination know-how is a real bonus value!) Either way, we'll welcome the chance to serve you. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

STEELMAKERS to the Electrical Industry

Allegheny Ludlum

W&D 5335

AL
STEELS FOR THE ELECTRONIC AGE

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UNITED ELECTRONICS

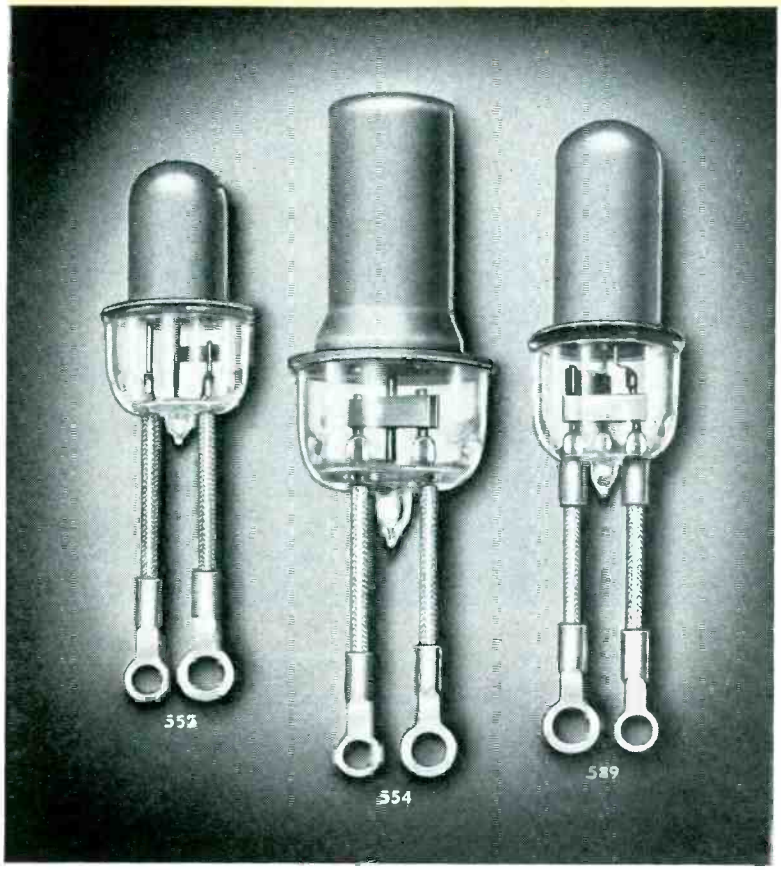
PRESENTS

Three NEW Miniaturized

HIGH VOLTAGE, HIGH VACUUM

External Anode Thermionic Rectifiers

TYPES: 552, 554, 589



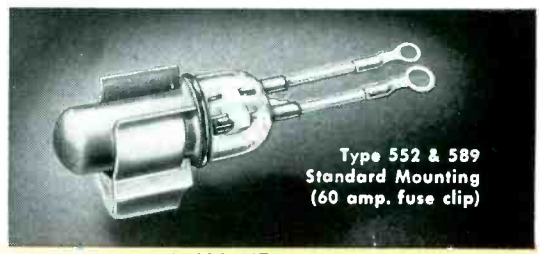
actual size

These new United tubes will provide immediate answers to many complex design problems of modern electronic instrumentation.

Among the advanced design features, the flanged construction of the external Kovar anode provides for a rugged glass-metal seal which minimizes high thermic rise and electron deterioration of the glass seal region.

The use of specialized techniques in cathode processing in types 554 and 589, and the exclusive UNITED *bonded thoria tungsten core filament* in type 552, contribute to high emitter efficiency.

Far-sighted practical UNITED designing establishes new milestones by building into these tubes qualities which meet supremely well not one but all *five* vital requirements: good service life expectancy, ruggedness, small size, light weight, ease of installation. Also—moderate cost. Orders filled rapidly.



For Oil or Air Cooled Operation

TUBE TYPE	CATHODE			MAX. TOTAL LENGTH WITH LEADS	MAXIMUM DIMENSIONS			IMPACT RATING G	ANODE RATINGS						
	DESCRIPTION	SUPPLY			LENGTH EXCLUDING LEADS	DIAMETER AT ANODE SEAL	ANODE CONTACT DIAMETER		AS RECTIFIER			AS CLIPPER DIODE			ENVIRONMENT
		VOLTS	AMPS						epx in kv	ℓb in a	lb in mAdc	epx in kv	ℓb in a	lb in mAdc	
552	FILAMENTARY	2.5	1.67	3.04	1.375	.875	.553	300	20	040	10				AIR
									20	040	10				OIL
554	UNIPOTENTIAL OXIDE-COATED	6.3	3.5	3.91	2.25	1.200	.688	300	17	225	70	16	12	20	AIR
									17	470	150	16	12	60	OIL
589	UNIPOTENTIAL OXIDE-COATED	6.3	1.55	3.50	1.94	.875	.590	300	10	180	45				AIR
									16	125	30	10	8	10	AIR
									10	400	100	10	8	20	OIL
									16	250	65				OIL

UNITED ELECTRONICS, 42 Spring Street, Newark 4, N. J.

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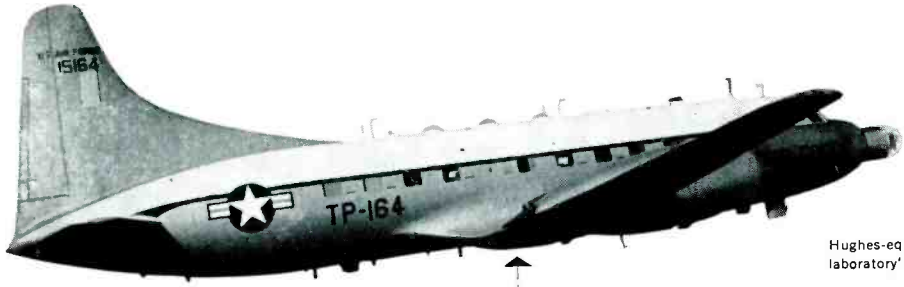


Hughes-equipped T-29 "flying laboratory" for systems evaluation.

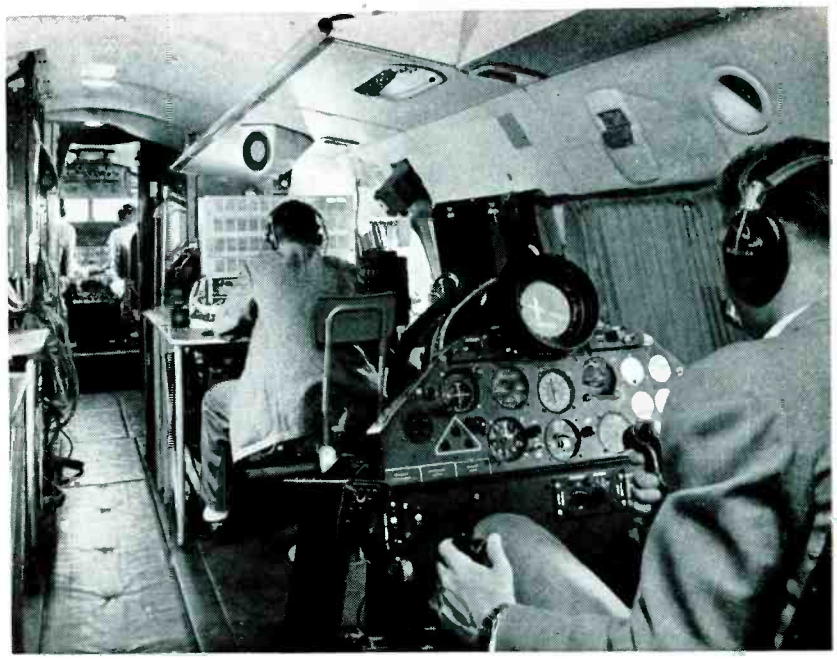
Flight evaluation of advanced interceptor electronic system uses unique approach.

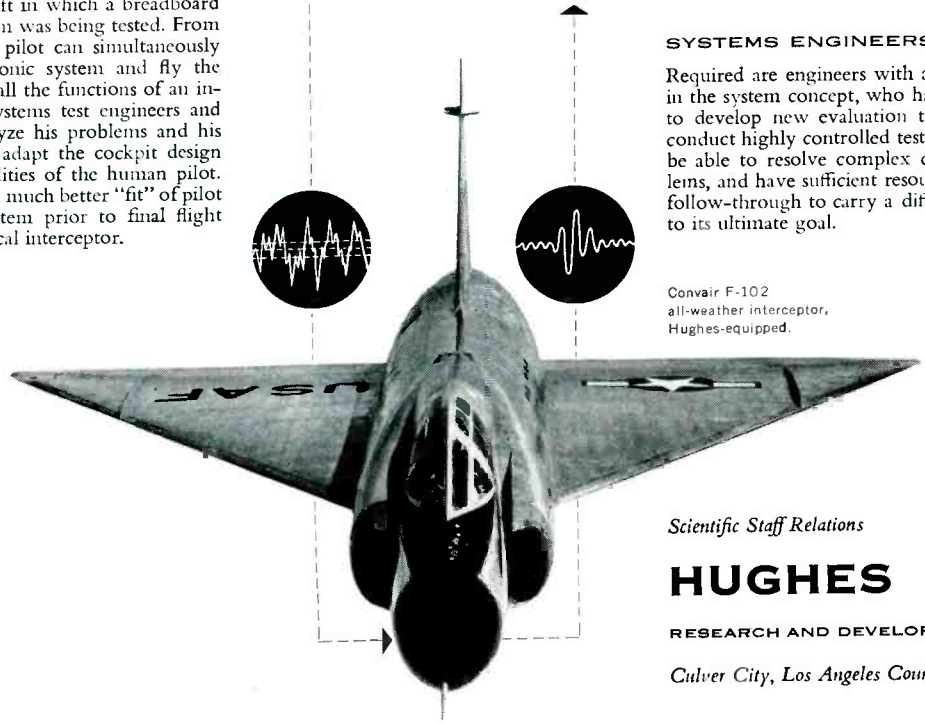
T-29 "INTERCEPTOR"

THE DEVELOPMENT OF AIRBORNE ELECTRONIC SYSTEMS REQUIRES THOROUGH FLIGHT EVALUATION OF BREADBOARD AND PROTOTYPE EQUIPMENT PRIOR TO FINAL DESIGN. AT HUGHES, SYSTEMS FOR INTERCEPTORS ARE FIRST TESTED IN "FLYING LABORATORIES" IN WHICH THE EQUIPMENT IS READILY ACCESSIBLE TO SYSTEMS TEST ENGINEERS.

One interesting problem recently confronting Hughes engineers was that of evaluating the requirements imposed upon the pilot of a high-speed one-man interceptor. This arose in the development of a new integrated electronic system to control several phases of an all-weather interceptor's flight. Because of the great importance of providing the pilot with the optimum design and arrangement of displays and controls, it became necessary to determine accurately the pilot's work load during flight, and the human factors that affect his ability to carry out his task.

The solution was to install a complete mock-up of the actual interceptor cockpit in a large T-29 aircraft in which a breadboard model of the system was being tested. From this cockpit a test pilot can simultaneously operate the electronic system and fly the T-29, performing all the functions of an interceptor pilot. Systems test engineers and psychologists analyze his problems and his performance, and adapt the cockpit design to the natural abilities of the human pilot. The result will be a much better "fit" of pilot and electronic system prior to final flight testing in the tactical interceptor.





Convair F-102 all-weather interceptor, Hughes-equipped.

SYSTEMS ENGINEERS

Required are engineers with a basic interest in the system concept, who have the ability to develop new evaluation techniques and conduct highly controlled tests. They should be able to resolve complex circuitry problems, and have sufficient resourcefulness and follow-through to carry a difficult program to its ultimate goal.

Scientific Staff Relations

HUGHES

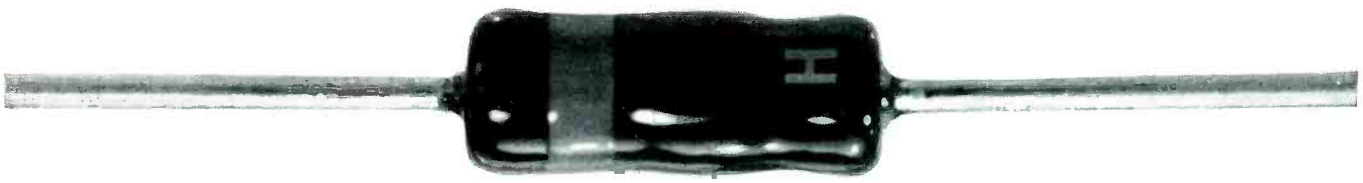
RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

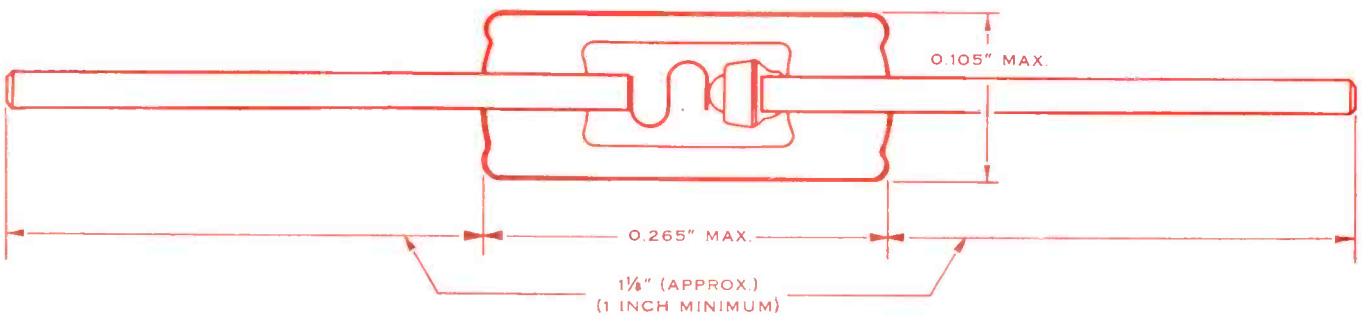
HUGHES

SILICON JUNCTION

DIODES



Dimensions are maximum for standard Hughes Silicon Junction Diodes.



*High Temperature Operation**

Extremely High Back Resistance

Exceptionally Stable Characteristics

FEATURES—High temperature operation...*extremely* high back resistance . . . very sharp back voltage breakdown . . . one-piece, fusion-sealed glass body . . . axial leads for easy mounting . . . subminiature size . . . exceptionally stable characteristics.

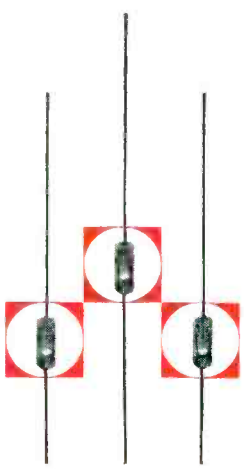
TESTED—All Hughes Silicon Junction Diodes are subjected to rigorous testing procedures. Specific electrical characteristics are measured and, when specified, special tests are also performed.

CONSTRUCTION—Hughes Silicon Junction Diodes are packaged in the famous fusion-sealed glass body, developed at Hughes. This construction is impervious to moisture penetration—*ensures* electrical and mechanical stability, and freedom from contamination.

When high temperatures or high back resistance requirements call for silicon, be sure to specify *Hughes* Silicon Junction Diodes. They are first of all—for RELIABILITY!

Diode glass body is coated with opaque black enamel, color-coded on cathode end. Available now in nine types: HD6001, HD6002, HD6003, HD6005, HD6006, HD6007, HD6008, HD6009, HD6011. Ask for descriptive Bulletin SP-4.

**Characteristics rated at 25°C and at 150°C. Ambient operating range, −80°C to +200°C.*



Actual Size

HUGHES PRODUCTS DIVISION

Aircraft Company, Los Angeles 45, Calif.

New York Chicago Los Angeles

DUPONT

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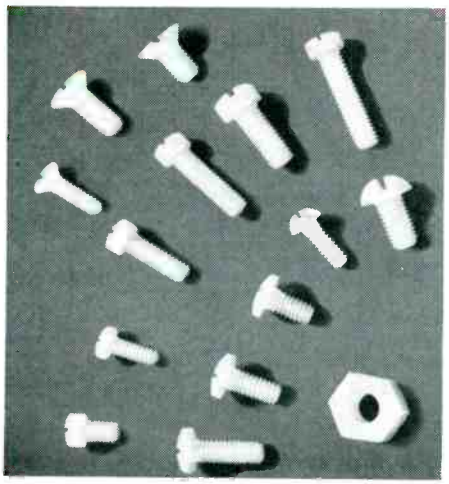
ELECTRONIC DESIGN NEWS

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

Fastenings of ZYTEL® won't shake loose



Fastenings made of "Zytel" nylon resin are available in many types and sizes. An example is the "Nylo-Fast" fastenings shown above. These precision-machined bolts are lightweight and durable. The resiliency of "Zytel" permits interference fit which prevents loosening under vibrational conditions. The electrical insulating properties of "Zytel" are good. Temperatures as high as 250°F will not affect the "Nylo-Fast" parts of "Zytel." Where color coding is desirable, various colors are available. (Manufactured and stocked by Anti-Corrosive Metal Products Company, Inc., Castleton-on-Hudson, New York, from rod stock supplied by The Polymer Corporation of Reading, Pa.)

Laminations of TEFLON® for printed circuit bases

Typical uses for laminations of glass cloth and Du Pont "Teflon" tetrafluoroethylene resin include: conductor and ground insulation, hookup wire, power cable, printed circuit bases and structural parts. The laminations combine the dielectric properties, chemical inertness and heat resistance of "Teflon" with the tensile strength, resistance to cut-through, and resistance to creep, of woven glass fiber.

An informative free bulletin describing the preparation and uses of laminations and impregnations of glass cloth employing "Teflon" tetrafluoroethylene resin is now available. Specify Bulletin X-64.

Coil forms of "Zytel" for the General Electric AK-4 and AK-5 hook-on volt-ammeters are shown above. The high dielectric strength and easy moldability of this material make it suited for such applications. Photo below shows relative size of easily held volt-ammeter.

Light, molded coil forms of ZYTEL® simplify ammeter design problem

Compact designs, such as the coil form for this G.E. hook-on volt-ammeter, are possible when using "Zytel" nylon resin. This is because "Zytel" can be molded into complex shapes . . . retains its strength even in thin sections. Another important advantage of Du Pont "Zytel" is that it can be injection-molded at low cost per part.

In electronic applications of all kinds, "Zytel" offers many design advantages. Whether it is used for molded components or jacketing for wire and cable, its mechanical strength and heat resistance, coupled with its superior insulating characteristics, give outstanding results. A thin jacketing of "Zytel" nylon resin on electrical wire provides good insulation and abrasion resistance.

You can get all the details on "Zytel" by mailing the coupon below.

NEED MORE INFORMATION?

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

**"Teflon," "Alathon," "Zytel" and "Lucite" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.).*

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Room 221, Du Pont Building, Wilmington 98, Delaware
In Canada: Du Pont Company of Canada Limited,
P. O. Box 660, Montreal, Quebec.

Please send me more information on the Du Pont engineering materials checked: ☐ "Teflon"* tetrafluoroethylene resin; ☐ "Alathon"* polyethylene resin; ☐ "Zytel"* nylon resin; ☐ "Lucite"* acrylic resin. I am interested in evaluating these materials for_____

NAME_____

COMPANY_____ POSITION_____

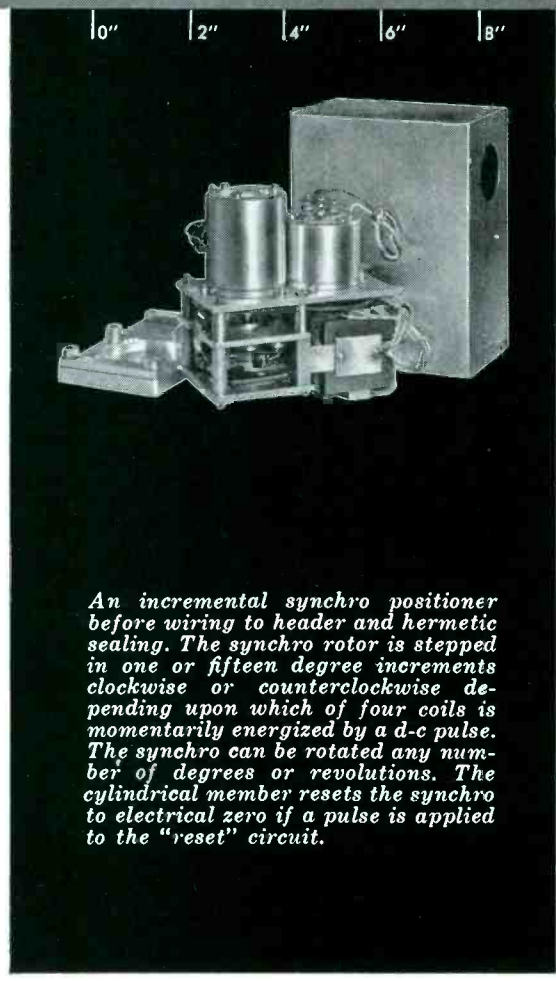
STREET_____

CITY_____ STATE_____

TYPE OF BUSINESS_____

built to do just one servo control job . . .

perfectly



An incremental synchro positioner before wiring to header and hermetic sealing. The synchro rotor is stepped in one or fifteen degree increments clockwise or counterclockwise depending upon which of four coils is momentarily energized by a d-c pulse. The synchro can be rotated any number of degrees or revolutions. The cylindrical member resets the synchro to electrical zero if a pulse is applied to the "reset" circuit.

Like all Transicoil servo assemblies, this incremental positioner "does the job right" because it was designed for a single application . . . by a company whose major function is to provide complete servo assemblies precisely engineered and manufactured to solve individual servo control problems.

Of course, if you merely want servo *components*, you'll find Transicoil's control motors, motor-gear train combinations, motor-gear train-generator combinations, and servo amplifiers built to the highest order of precision and accuracy. But it is in the "package" engineering of unique assemblies that Transicoil's experience and creative imagination offer the greatest value. And in most cases, these assemblies cost no more than the individual components would purchased separately.

That's why it pays to check your servo problems out with Transicoil first. Write outlining your problem, and ask for Transicoil's new gear-motor bulletin. You'll find it a mighty handy availability guide in designing for tight production schedules.

Transicoil

CORPORATION

Worcester • Montgomery County • Pennsylvania

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ALSiMAG®
HIGH TEMPERATURE HERMETIC TERMINALS
INDIVIDUALLY LEAK TESTED

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STRONGER!
Alumina ceramics with higher tensile and impact strengths. Permanent bonding. New glaze with superior surface resistivity. Rugged. Greater resistance to wear, chipping and breakage. Exceed MIL-T-27A torque requirements.

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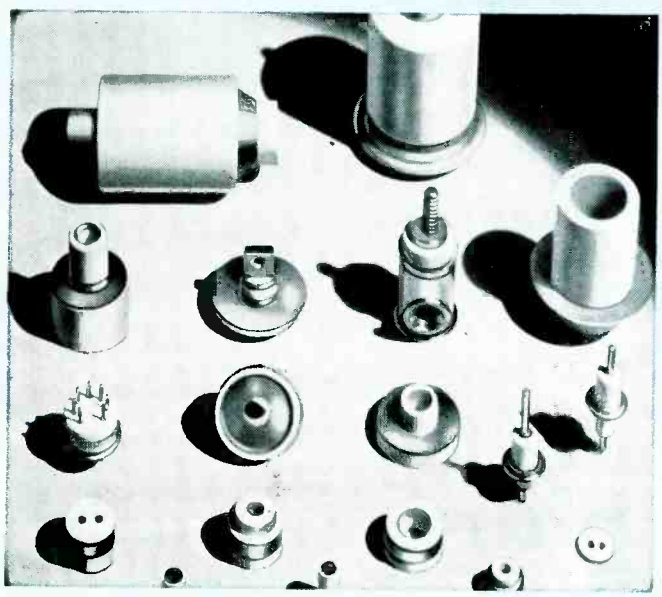
New, superior metalizing techniques. Pace-setting AlSiMag Alumina ceramics. Greatly extended operating temperature range. Readily attached with hard solder. Permit designing to higher temperatures.

GREATER THERMAL SHOCK RESISTANCE:
Retain their excellent electrical and mechanical characteristics and deliver outstanding performance throughout their wider operating temperature range.



CUSTOM ITEMS
in High Temperature Alumina Ceramics with High Temperature Metalizing also available, produced by the same highly skilled techniques. For special applications, a wide choice is offered in metals and ceramics in appropriate design configurations. Metalized parts for low temperature applications can also be supplied. Send blueprint or sketch for complete details.

WRITE FOR FREE BULLETIN FULLY DESCRIBING STANDARD PARTS SHOWN ABOVE

AMERICAN LAVA CORPORATION

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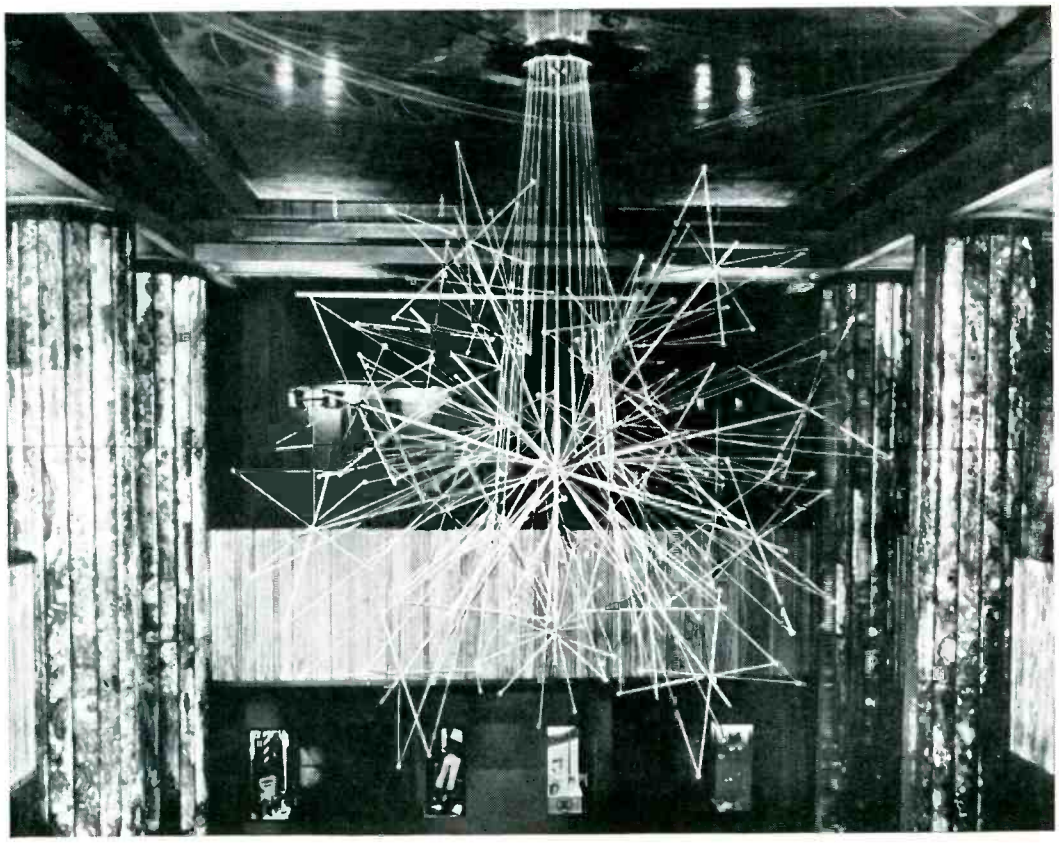


What carries the current in the wireless chandelier of New York City's Barbizon-Plaza Hotel? The fixture is constructed of gleaming Inco Nickel tubing in an intricate pattern — and the tubing carries the current! Nickel tubing is light and rigid, too — so the chandelier can be slowly rotated from above. The chandelier was designed by Richard Kelly and fabricated by Edison Price — both of New York City.

A chandelier without wires!

. . . *and three other unique designs in* Inco Nickel Alloy *tubing*

There's a similarity in all four tubing applications here.

In each, a needed *combination* of useful properties is provided by Inco Nickel or an Inco Nickel Alloy. For example, in the chandelier above: electrical conductivity *plus* rigidity and light weight. Or in the radar antenna lens at the right: electrical properties *plus* strength and corrosion resistance *plus* brazing facility.

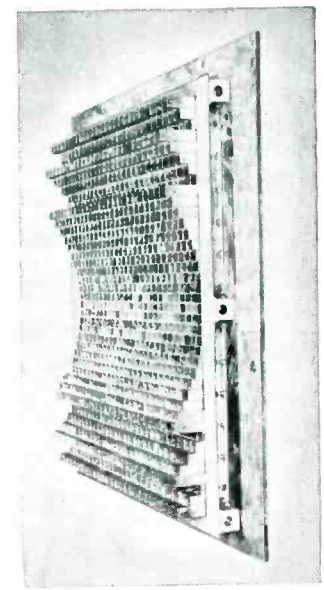
Perhaps *your* design requires a hard-to-find combination of electrical properties with others such as thermal conductivity, non-magnetic properties, resistance to corrosion, or to vibration, shock, and fatigue. With these alloys you also get the advantages of fabricability, high strength-to-weight ratio, hardness, rigidity, or other properties.

So for help in selecting the alloy that fits your needs, call on Inco's Technical Service Section.

And, remember, you can get Inco Nickel Alloy tubing in all useful sizes from your distributor — or from redrawers who supply it as fine as 0.012" O.D.

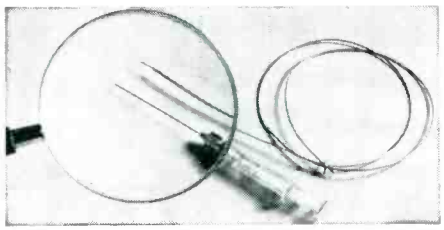
The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

INCO TRADE MARK **Nickel Alloys**

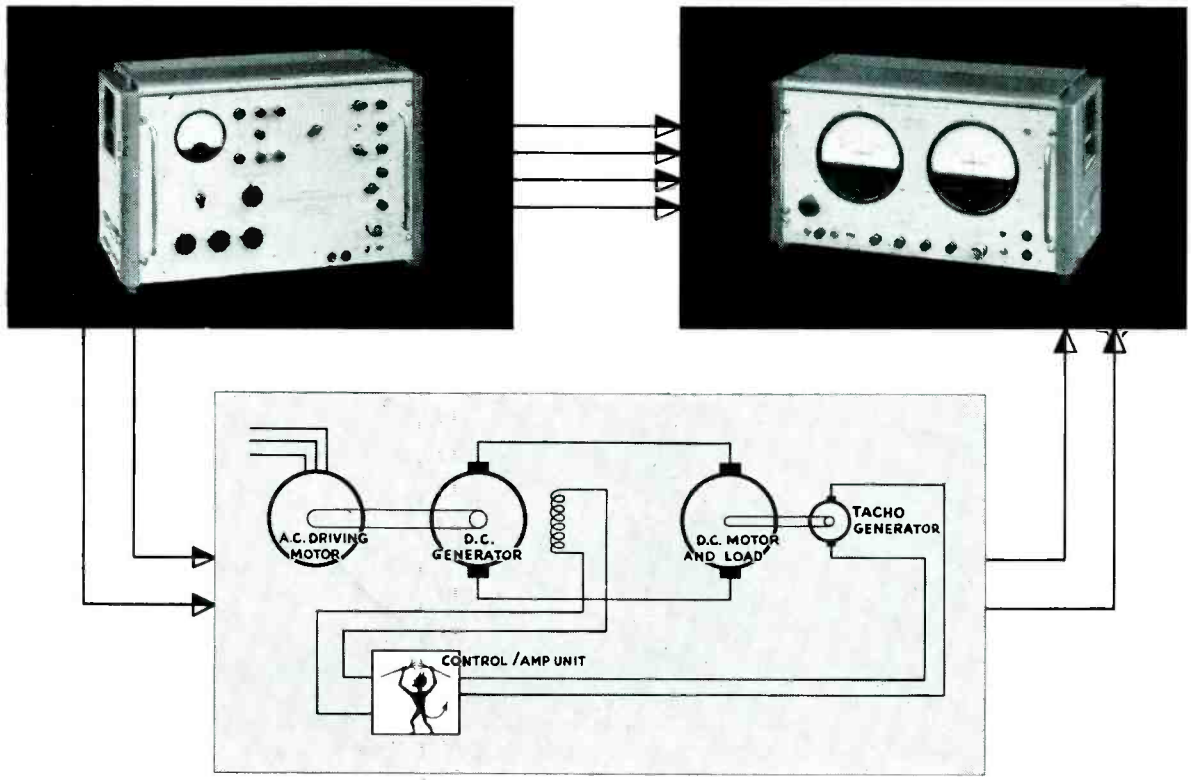


Radar antenna lens uses square seamless tubing of Monel* nickel-copper alloy. Superior Tube Company, Norristown, Pa., recommended Monel to I-T-E Circuit Breaker Company, of Philadelphia, for strength, corrosion resistance, electrical properties, and brazing facility. *Registered Trademark

Aircraft fire detector's 0.065-in. diameter Inconel tube encloses two Inconel wires. A special ceramic between them becomes conductive when heated — closes the circuit. The box flashes a warning. Walter Kidde & Company, Inc., Belleville, N. J., uses Inconel nickel-chromium alloy because it withstands temperatures up to 2000°F., resists vibration and shock.



Nuclear reactors' temperatures measured—Inconel* nickel-chromium alloy tube, almost as thin as a hypodermic needle, is both thermocouple unit and thermocouple protection tube. The Inconel tube resists oxidation, which might set up a heat barrier and interfere with accuracy of the reading. Photo courtesy of Argonne National Laboratory, Lemont, Ill.



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with the Solartron Transfer Function Analyser

- Tests AC, DC or carrier servos
- Plots high accuracy Nyquist diagrams
- Covers 0.1 c/s to 1,000 c/s
- Independent of harmonics, noise & spurious frequencies
- Answers G.M., fire-control, simulator, computor, vibration, magamp and all servo problems

Instability, backlash, underdamped response—all these problems can be identified, measured and rectified with the aid of the Solartron T.F.A. Now adopted as the standard British test equipment for all Guided Missile development and testing. It has recently been hailed in the U.S.A. as the world's foremost servo test equipment.

Other Servo Testing Equipment available

T.F.R. CONSOLE	CARRIER CONVERTOR JX 541
SERVO TEST SET JX 563	MECHANICAL REFERENCE GENERATOR

THE SOLARTRON ELECTRONIC GROUP LTD.

Cables: Solartron, Thames Ditton. THAMES DITTON, SURREY, ENGLAND. Telephone: EMBerbrook 5522.

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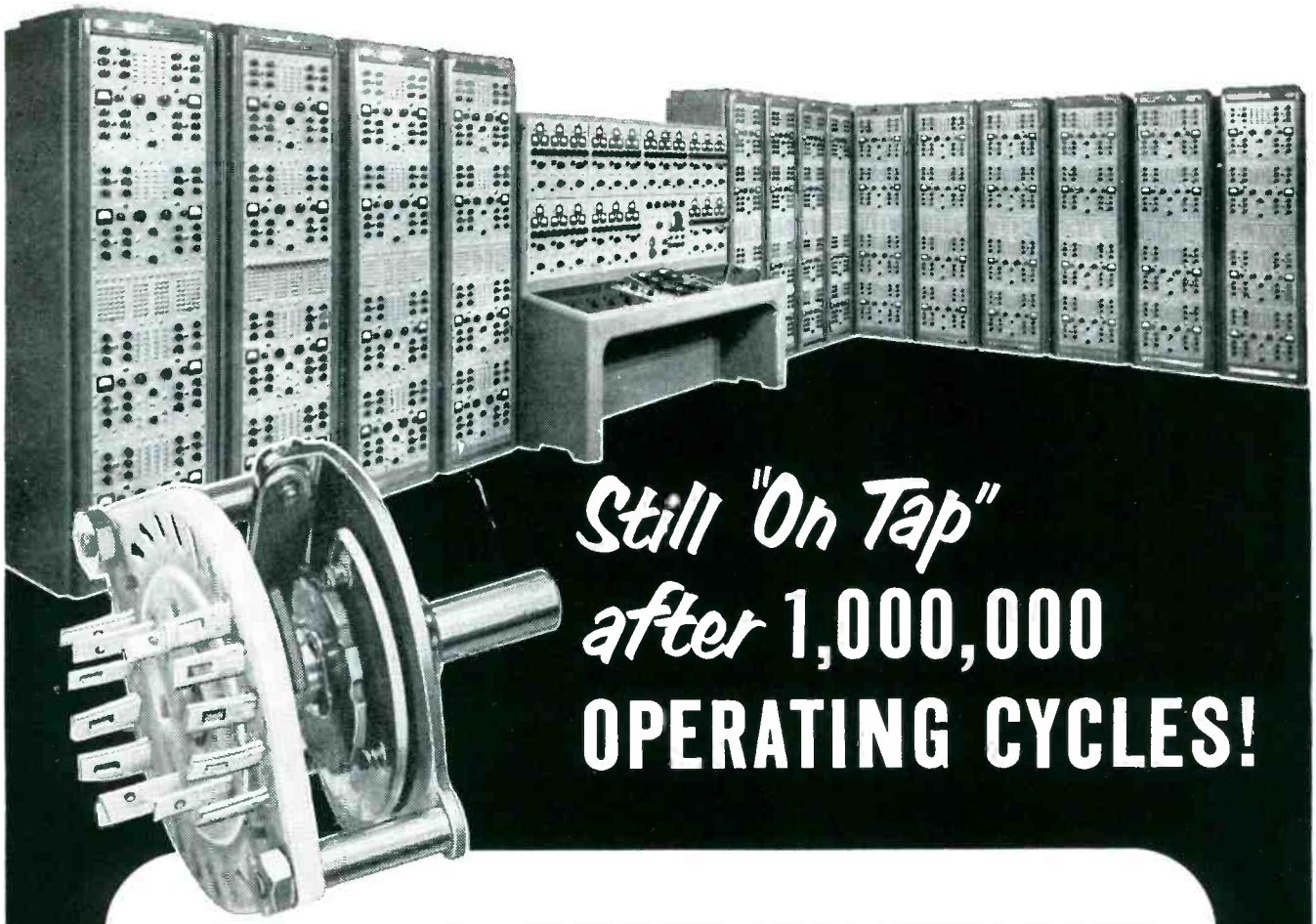


Still "On Tap" after 1,000,000 OPERATING CYCLES!

That's why the SYSTEM ANALYZER CORP. Chose Tech Laboratories Tap Switches for $200,000 Electronic "Brain"

With more than 2100 tap switches incorporated in the design for their huge analog computer, engineers at the System Analyzer Corp., Nokomis, Illinois, made exhaustive tests to check the efficiency and operating life of many types. Of all those tested, Tech Laboratories Type 2C and 2A Tap Switches were the **only** ones that met every requirement. After 1,000,000 complete cycles of operation, they showed approximately the same contact resistance as at the beginning.

Designed primarily for analyzing electrical power networks — as large as the power system of an entire city — the electronic "brain" handles mathematical problems with as many at 220 unknowns, 400 times faster than the work can be done manually. It is easy to understand why dependability is a major factor in the selection of its components.

WRITE FOR FULL INFORMATION

TYPE 2C TAP SWITCH SPECIFICATIONS

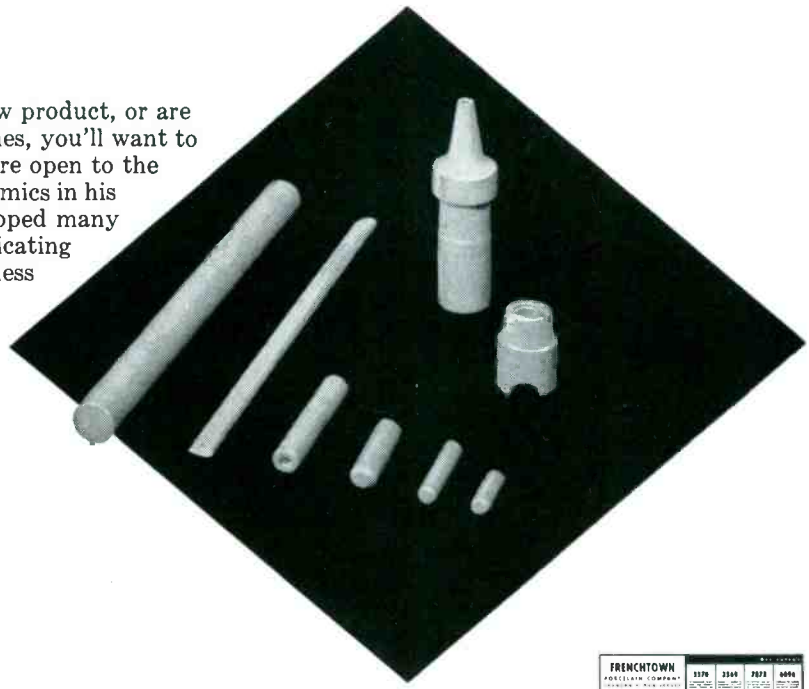
Contact resistance: 3-4 milliohms
Contact material: Silver plated brass
Contact design: Laminated wiper arm, self-cleaning, shorting or non-shorting
No. of contacts: 2 to 24 single pole, 2 to 11 double pole, 2 to 7 triple pole, 2 to 5 four pole; shorting or non-shorting
Spacing: 15° or 20° shorting or non-shorting
No. of poles per deck: 1 to 4
No. of decks: According to requirements
Current carrying cap.: 3 amp.
Max. operating voltage: 120 V., a.c.
Mounting: Single hole, 3/8"-32 bushing
Size: 1 3/4" dia.
Detent: Ball and spring
Weight: Approx. 1 oz. per deck

TECH LABORATORIES, INC.

Manufacturers of
Precision Electrical Resistance Instruments
PALISADES PARK, NEW JERSEY

FRENCHTOWN ENGINEERED CERAMICS OFFER

big advantages!



Whether you plan the development of a new product, or are seeking ways to further improve existing ones, you'll want to look into the many new possibilities which are open to the design engineer who includes *engineered* ceramics in his planning. Our ceramic engineers have developed many formulae which, together with modern fabricating methods,* have greatly enlarged the usefulness of these amazing materials. Always outstanding as electrical insulators, Frenchtown ceramics, particularly the high alumina bodies, are being specified more and more for critical mechanical applications.

Check these BIG advantages:

- MECHANICAL STRENGTH
  Compressive strength up to 187,000 psi.
- ABRASION RESISTANCE
  Demonstrated by use for sand blast nozzles.
- HEAT RESISTANCE
  Softening temperatures up to 1971° C.
- THERMAL CONDUCTIVITY
  Coefficient (c.g.s. units) up to 0.0180.
- THERMAL EXPANSION
  as low as 2% cumulative at 700° C.

**Grinding and extrusion facilities* • NICOTE® *Metallized Ceramics*

Send for this helpful bulletin giving complete data on mechanical and electrical properties of all Frenchtown Engineered Ceramics.

frenchtown PORCELAIN COMPANY

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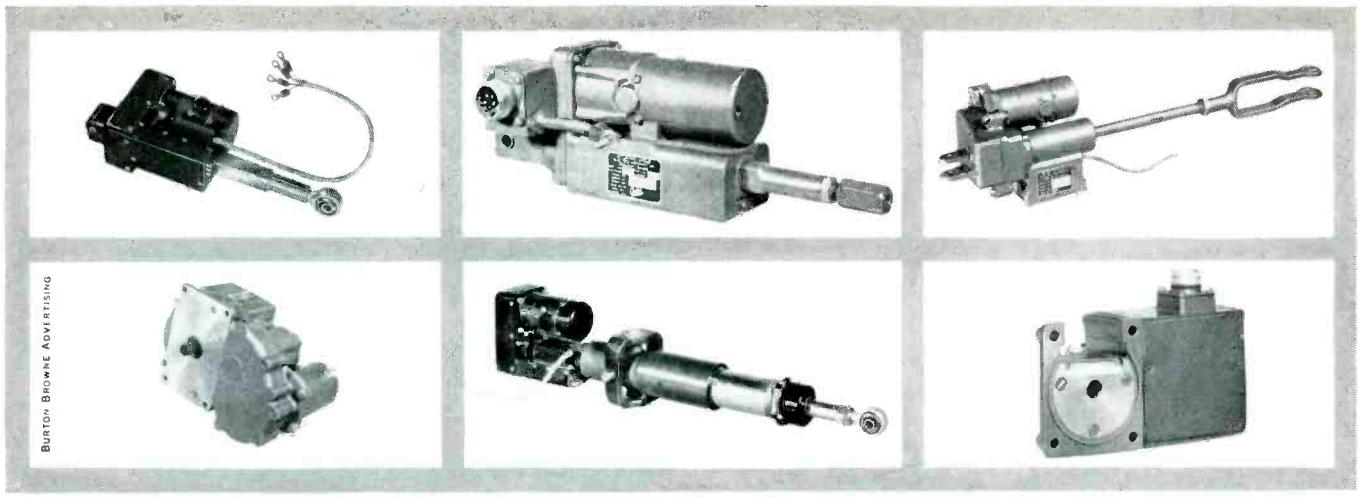

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smaller lighter more versatile actuators

Oster®

A wide variety of smaller, lighter, more versatile linear and rotary actuators. One can be adapted to your specifications.

- 25% smaller, lighter because gear train and motor blended into single, unique homogeneous unit.
- 180,000 #/in.^{2} yield strength steel used in all gears.
- New high stability limit switch can be adjusted internally or externally.
- Unique design positive mechanical stops.
- Exclusive overload clutch dissipates extremely high forces in "impact" stopping.

LINEAR ACTUATORS

- 0.0018" end play in screw and nut. Specially designed acme screw made to AGMA pitch diameter standards but held to much closer tolerances than specified by any known standard today.
- Exceptionally long life due to new different continuous self-lubrication on acme screw.
- Rate adjustable from 1.6" to 30" per minute.

ROTARY ACTUATORS

- 3:1 to 523:1 gear ratio range available.
- 60° to 360° travel.
- 2° maximum backlash on output shaft.

TYPE	LINEAR	LINEAR	LINEAR	LINEAR	ROTARY	ROTARY
PART NO.	ACT-3090	ACT-2425	ACT-3047	ACT-2439	ACT-2274	ACT-2408
WEIGHT	1.3# WITH 1.5" STROKE	3.1#	3.25#	3#	5#	2.2#
NORMAL OPERATING RATE & LOAD	1500# IN./MIN.	10.5 IN. PER MIN. 200# LOAD	2.9 IN. PER MIN. 10# LOAD	0.5 IN. PER SEC. 240# LOAD	5 RPM AT 250# IN.	200 RPM AT 3# IN.
TEMP. RANGE	—65° F TO 300° F	—65° F TO 260° F	—60° F TO 250° F	—65° F TO 250° F	—65° F TO 160° F	—65° F TO 260° F
VOLTAGE	28 V.D.C.	26 V.D.C.	26 V.O.C.	28 V.D.C.	27 V.D.C.	27 V.D.C.

Write for further details, stating your requirements.

Other products include Servos, AC Drive Motors, DC Motors, Motor-Gear-Trains, Fast Response Resolvers, Servo Torque Units, Synchros, Reference Generators, Tachometer Generators, and Motor Driven Blower and Fan Assemblies.

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2 KMC TO 12.4 KMC

Broad band amplification

Amplitude, pulse modulation

Frequency, phase modulation

Constant gain, output

NOW 4 -*hp*- TRAVELING-WAVE TUBE AMPLIFIERS!

With the introduction of two brand-new traveling-wave tube amplifiers, Models 492A and 494A, -*hp*- now offers you a totally new standard of electronic measurement — one that brings the ease, accuracy and versatility of low frequency measurements *to the microwave range 2 to 12.4 KMC!*

Think what this means! With these -*hp*- instruments you can eliminate klystron starting delay and jitter, make wide dynamic-range antenna tests and SWR measurements, generate a stable power level, calibrate CW Doppler radar systems, calibrate attenuators over a wide range, FM a high stability SHF source, amplify wide band width signals containing complicated modulation. These are but a few of the ways -*hp*- traveling-wave tube amplifiers provide straightforward solutions to complex measuring problems—or do routine laboratory measurements better and faster.

New -*hp*- 492A (4 to 8 KMC), 494A (7 to 12.4 KMC) and the established -*hp*- 490A (2 to 4

KMC) are low level, high gain instruments, providing unique versatility of amplitude, pulse, phase and frequency modulation.

-hp- 491A is a power amplifier providing 1 watt output and 30 db gain for the frequency range 2 to 4 KMC. This instrument, together with a 1 mw signal generator such as *-hp-* 616A, provides a highly useful 1 watt source for "S" band testing.

All *-hp-* traveling-wave tube amplifiers use the exclusive *-hp-* coupling system with two separate helices for full transfer of energy over a broad frequency band. All have front panel controls for varying grid or anode and helix voltage, and a meter and selector for measuring basic currents in performance evaluation or continuous monitoring. Modulation connections are also brought to the front panel for greater convenience. During normal operation of the amplifiers, no adjustments are necessary. To do away with critical pre-operation adjustments of traveling-wave tubes, and assure that tubes and helices are properly matched, *-hp-* original equipment and replacement tubes are encapsulated in a single unit. This unit is factory tested, ready to install and use.

WRITE NOW FOR APPLICATION NOTES!

Explains how to use *-hp-* TWT Amplifiers as sensitive linear detectors, buffer-isolators, narrow band low noise level amplifiers and many other new applications. Sent immediately — no charge or obligation. Write today!

SPECIFICATIONS	-hp- 490A	-hp- 491A	-hp- 492A	-hp- 494A
Frequency Range:	2 KMC to 4 KMC	2 KMC to 4 KMC	4 KMC to 8 KMC	7 KMC to 12.4 KMC
Gain:	35 db minimum	30 db minimum	30 db minimum	25 db minimum
Output Power:	10 milliwatts minimum into 50-ohm load.	1 watt minimum into 50-ohm load.	10 milliwatts minimum into 50-ohm load.	5 milliwatts minimum into 50-ohm load.
Noise Figure:	Less than 25 db.	Less than 30 db.	Less than 25 db.	Less than 25 db.
Pulse Rise & Decay Time:	Approx. 0.015 μsec.	Mod. not provided.	Approx. 0.015 μsec.	Approx. 0.015 μsec.
Modulated Pulse Delay:	Approx. 0.035 μsec.	Mod. not provided.	Approx. 0.020 μsec.	Aprox. 0.015 μsec.
Amplitude Modulating Voltage:	Approx. 50 volt peak positive pulse will produce a 40 db change in rf power output. Sensitivity, approximately 1 db/volt.	Mod. not provided.	Approx. 50 volt peak positive pulse will produce a 40 db change in rf power level. Sensitivity, approximately 1 db/volt.	Approx. 50 volt peak positive pulse will produce a 40 db change in rf power level. Sensitivity, approximately 1 db/volt.
Helix Modulating Voltage:	Approx. 30 volts peak to peak provides 360° phase shift. Input impedance 1 megohm.	Mod. not provided.	Approx. 30 volts peak to peak. Provides 360° phase shift. Input impedance 1 megohm.	Approx. 30 volts peak to peak. Provides 360° phase shift. Input impedance 50 ohms.
Hum & Spurious Modulation:	At least 30 db below signal level.	At least 30 db below signal level.	At least 30 db below signal level.	At least 30 db below signal level.
Input Impedance:	50 ohms, SWR less than 2.	50 ohms, SWR less than 2.	50 ohms, SWR less than 2.	50 ohms, SWR less than 2.
Output Internal Impedance:	50 ohms, SWR less than 3.	50 ohms, SWR less than 3.	50 ohms, SWR less than 3.	50 ohms, SWR less than 3.
Size:	7" wide, 10¾" high, 18" deep. 55 lbs.	7" wide, 10¾" high, 18" deep. 65 lbs.	7" wide, 10¾" high, 18" deep. 55 lbs.	7" wide, 10¾" high, 18" deep. 55 lbs.
Power Supply:	115 volts ±10%, 50-60 cps, approx. 125 w.	115 volts ±10%, 50-60 cps, approx. 250 w.	115 volts ±10%, 50-60 cps, approx. 175 watts.	115 volts ±10%, 50-60 cps, approx. 175 watts.
Traveling-Wave Tube:	Huggins Laboratories HA-1.	Huggins Laboratories HA-2.	Huggins Laboratories HA-3B	Huggins Laboratories HA-4
Price (including tube):	$1,100.00	$1,100.00	$1,500.00	$1,500.00

Data subject to change without notice. Prices f.o.b. Palo Alto, Calif.

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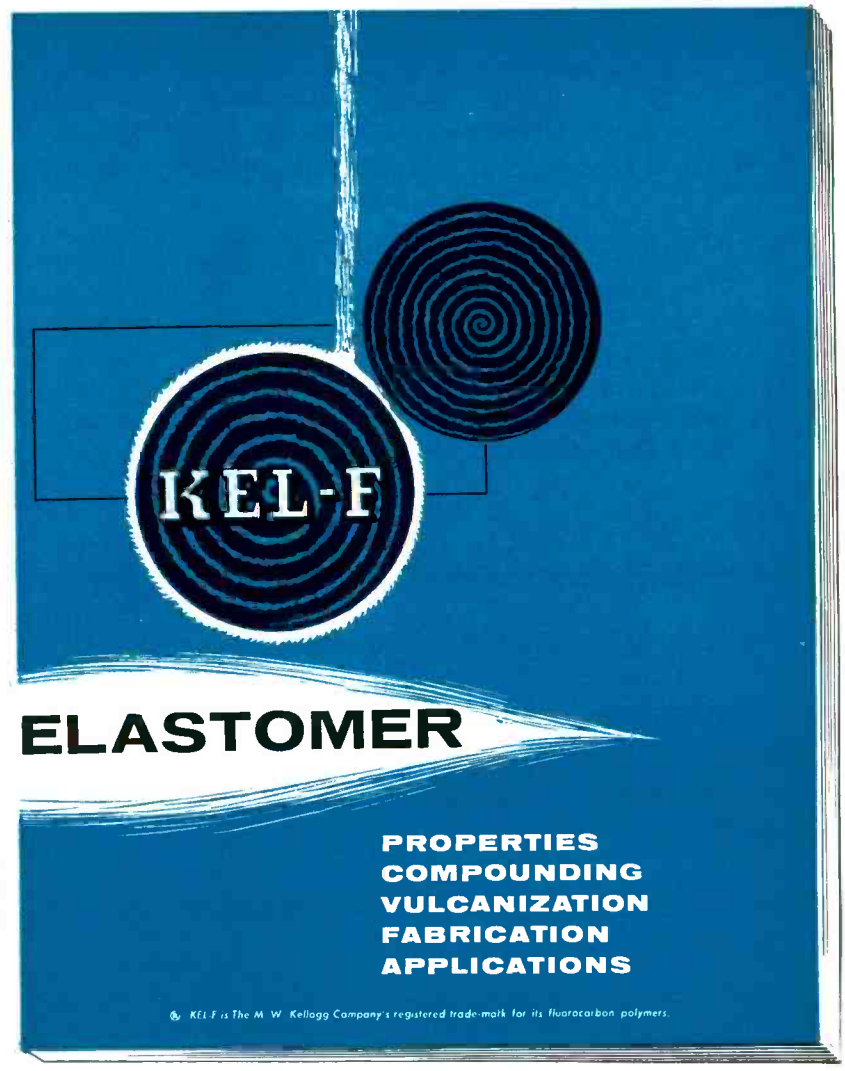

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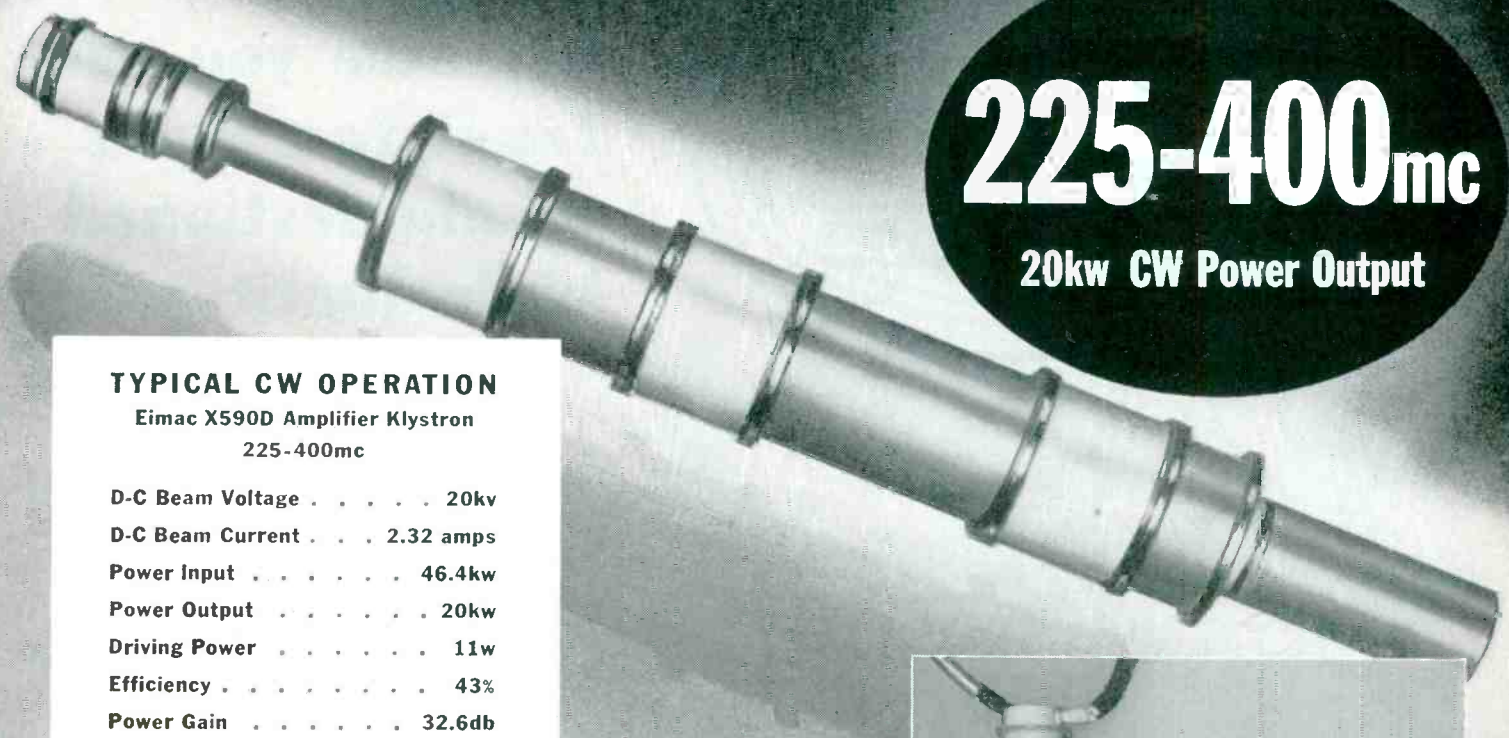
EIMAC klystrons bring high power to another frequency range...



225-400mc

20kw CW Power Output

TYPICAL CW OPERATION

Eimac X590D Amplifier Klystron
225-400mc

D-C Beam Voltage	20kv
D-C Beam Current	2.32 amps
Power Input	46.4kw
Power Output	20kw
Driving Power	11w
Efficiency	43%
Power Gain	32.6db

Another frequency range, 225-400mc, has been spanned with a commercially available Eimac high power amplifier klystron. The Eimac X590D, the first klystron developed for operation at the VHF-UHF junction, delivers 20kw/CW power output with only 11 watts drive. Its high power gain of 1800 times and efficiency of 43% typifies the incomparable performance of Eimac klystrons.

Incorporation of Eimac's unique modulating anode gives X590D outstanding versatility. It can be 100% modulated to peaks of 40kw in AM operation or easily pulse modulated with low pulsing power.

A new, indirectly heated oxide cathode greatly simplifies cathode power and cooling requirements.

With the X590D, Eimac now covers the 225-1000mc range at high power with only four klystron types. Wide range tuning and an easy, economical approach to high power UHF transmitters is made possible by the Eimac feature of completing RF circuitry outside the vacuum system with permanent circuit components.

Microwave high power is easily obtained by driving an Eimac klystron amplifier with existing low power equipment.

Transmitters employing Eimac klystrons give incomparable performance and reliability plus unmatched economy, since costly RF circuitry is not repurchased with each tube replacement.

Eimac X590D amplifier klystron with circuit components permit ease of transmitter design by equipment manufacturers

● *Eimac offers the most extensive selection of high power amplifier klystrons for pulse, CW and AM applications. For information contact our Technical Services Dept.*

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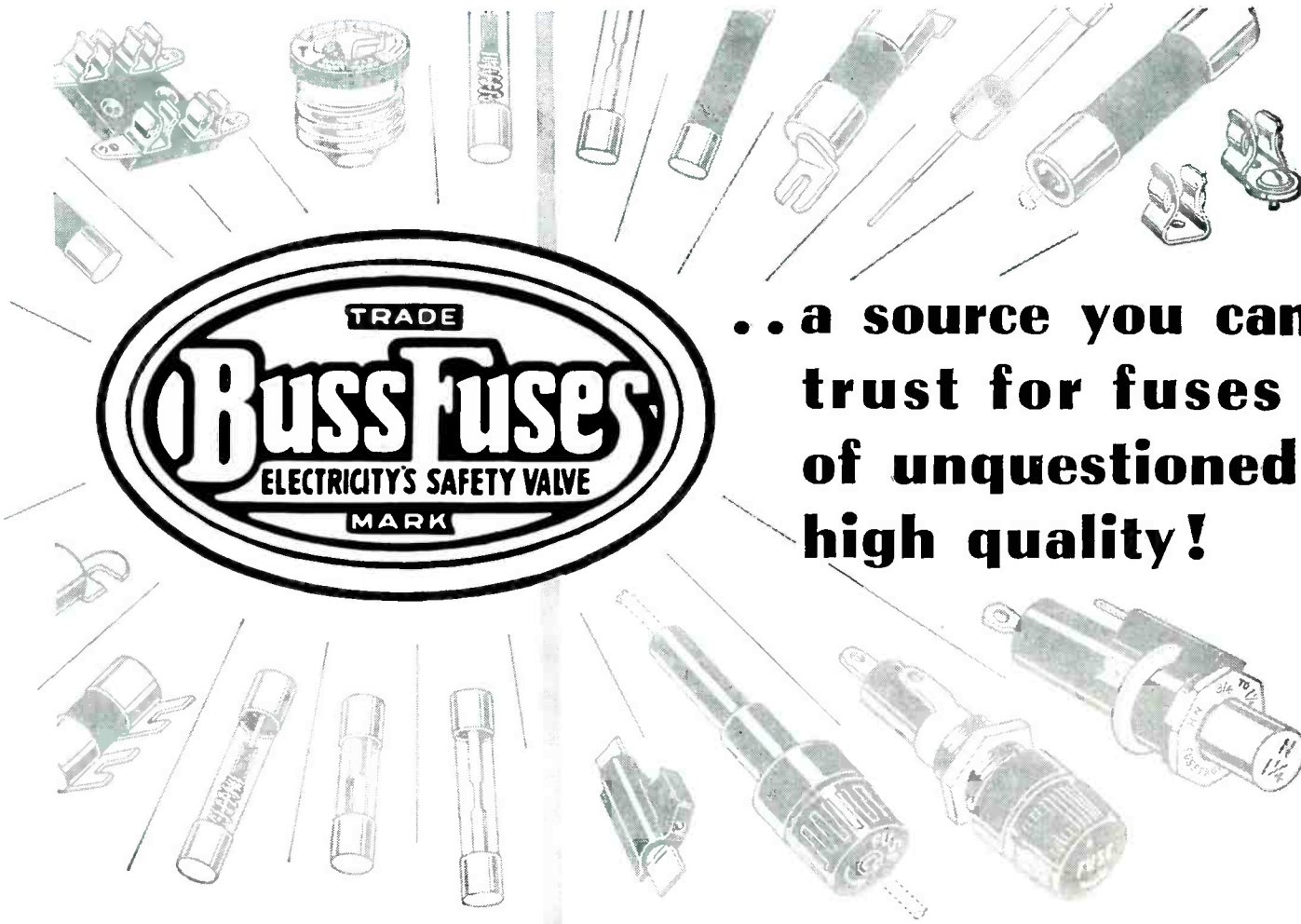

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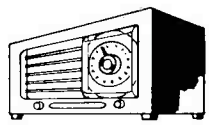

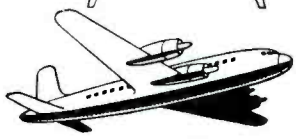

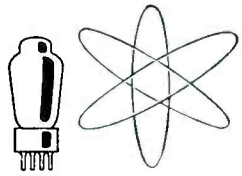

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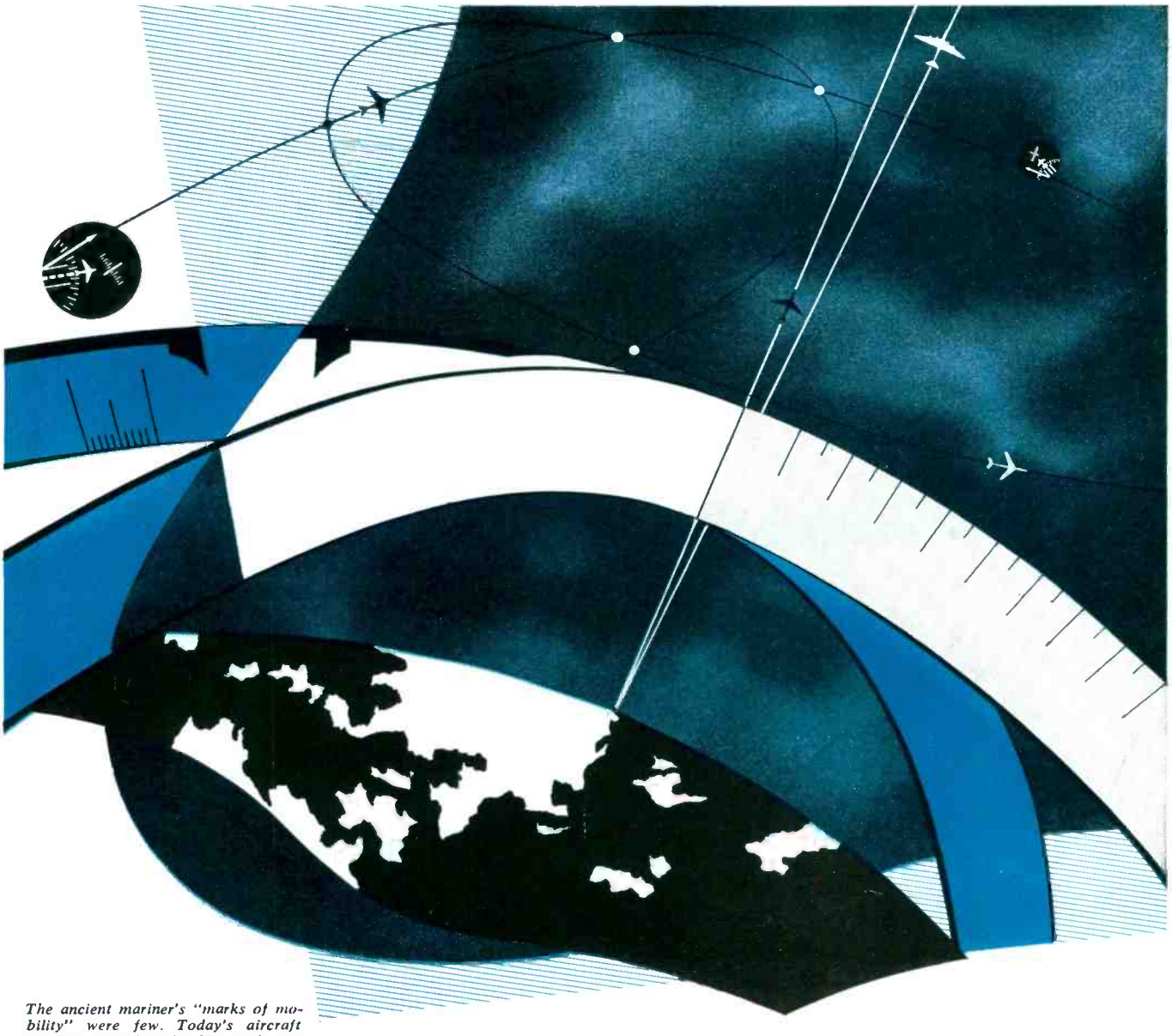

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In an aircraft, instruments and controls are the very marks of its mobility . . . for accurate measurement and observation are the only guides to safe, predictable flight. There are no "marks of mobility" more accurate and dependable than Kollsman in the seven fields of . . .

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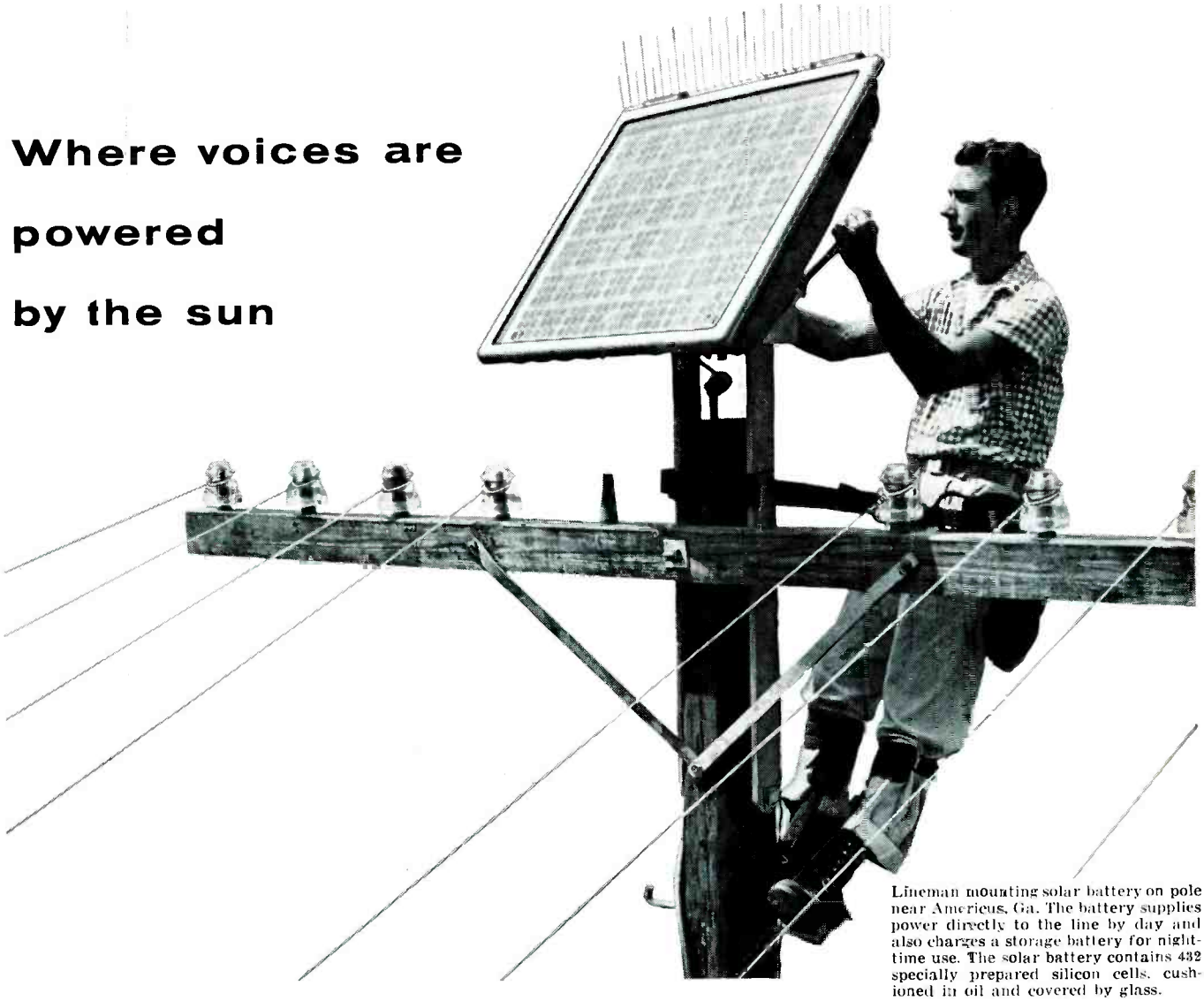
Where voices are powered by the sun

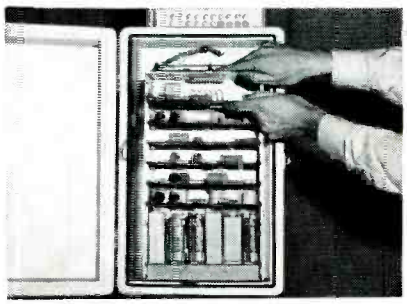


Lineman mounting solar battery on pole near Americus, Ga. The battery supplies power directly to the line by day and also charges a storage battery for night-time use. The solar battery contains 432 specially prepared silicon cells, cushioned in oil and covered by glass.

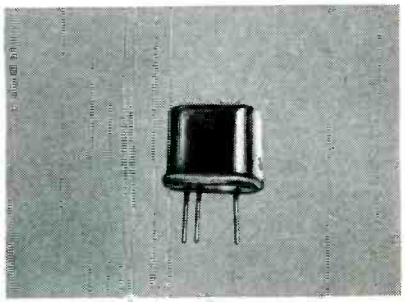
A new kind of telephone system developed by Bell Telephone Laboratories for rural areas is being operated experimentally by electric current derived from sunlight. Electric current is generated as sunlight falls on the Bell Solar Battery, which a lineman is seen adjusting in position.

The exciting achievement is made possible by two Laboratories inventions—the solar battery and the transistor. The new system uses transistors to the complete exclusion of electron tubes. Transistors require little power and this power can be easily supplied by the solar battery.

Compact and economical, the transistorized system can carry several voices simultaneously without interference. It has proved its ruggedness by standing up to heat, cold, rain and lightning. It promises more and improved telephone service for rural areas and it typifies the Laboratories' continuing efforts to make American telephony still better each year.



In sending and receiving terminals, transistors are used as oscillators, amplifiers and regulators, and for signaling.



One of the transistors (actual size) used in the new system. New ideas, new tools, new equipment and new methods had to be developed for this project.

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All of these essential services—and more—are important components in a new concept of representation pioneered by Neely Enterprises — with over half a hundred qualified personnel to serve the Western Electronic Market.

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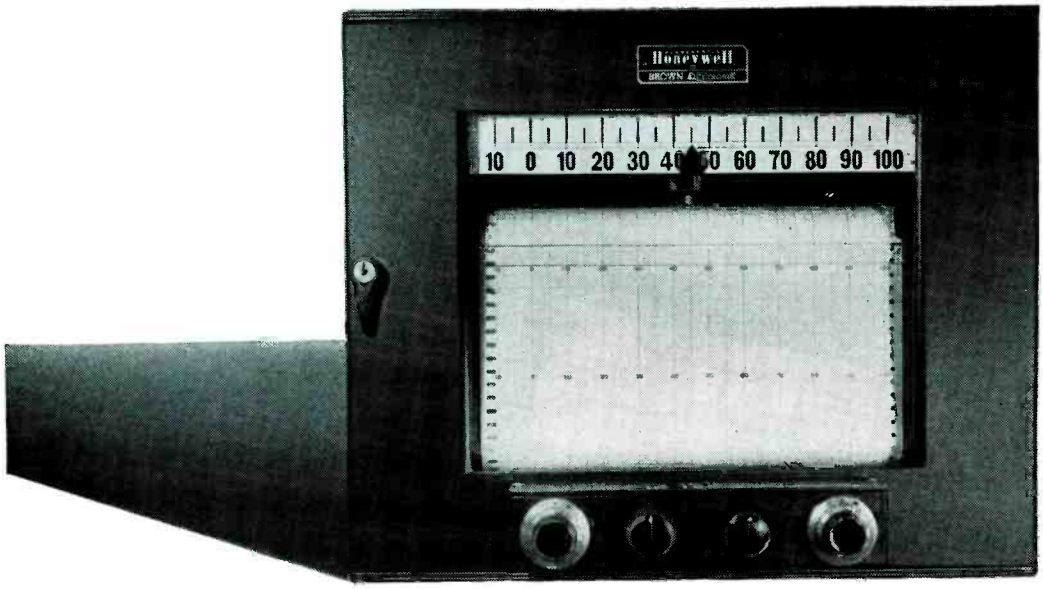
—the Adjustable Span *ElectronIK* Recorder



Here's a recording potentiometer that is a real jack-of-all-trades (and master of each one) in any development or test laboratory. Just turn the dials, and in seconds, you can set it up for the exact range and sensitivity you want. You don't have to do any rewiring or changing of calibrating circuits.

50-to-1 span adjustment. Millivolt span of the recorder is continuously variable over as much as a 50:1 range. Span adjustment is independent of zero setting.

Variable zero suppression. Coarse and fine adjustment dials let you move the electrical zero point up and down scale, to concentrate recording on only the part of the span in which you're interested. Zero adjustment does *not* affect span setting.

Sensitivity adjustment makes it easy to get the recording characteristics you want to match the span being used.

Many optional features: you can choose from recording speeds of ½, 1, 2, 4½, 12 or 24 seconds full scale . . . fully automatic, push-button, or solenoid-actuated remote or locally controlled standardization.

Find out how this versatile instrument can save time in your test work, by calling your local Honeywell sales engineer . . . he's as near as your phone.

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● **REFERENCE DATA: Write for Data Sheet No. 10.0-10a, "Adjustable Span Recorder."**

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Actual size

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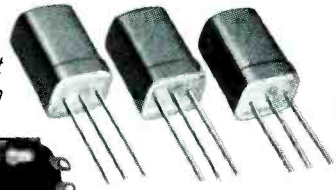

Model 6 with switch enclosed

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Applications:	Hearing aids, military electronic devices, telephone equipment, sub-miniature radios, and a wide variety of other applications.
Size:	5/8" diam., without knob. 23/32" diam., with knob.
Resistance:	500 ohms to 10 megohms. Tested for 25,000 cycles. Seven standard tapers.

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Has completely enclosed switch protected against dirt and other foreign matter.

Applications:	Designed especially for transistor applications.
Size:	1/2" diam.
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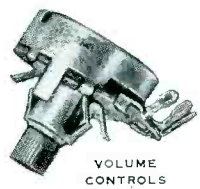
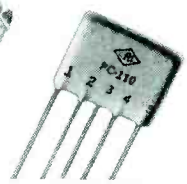


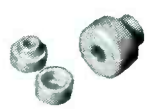
VOLUME CONTROLS

CAPACITORS

SWITCHES



PACKAGED ELECTRONIC CIRCUITS



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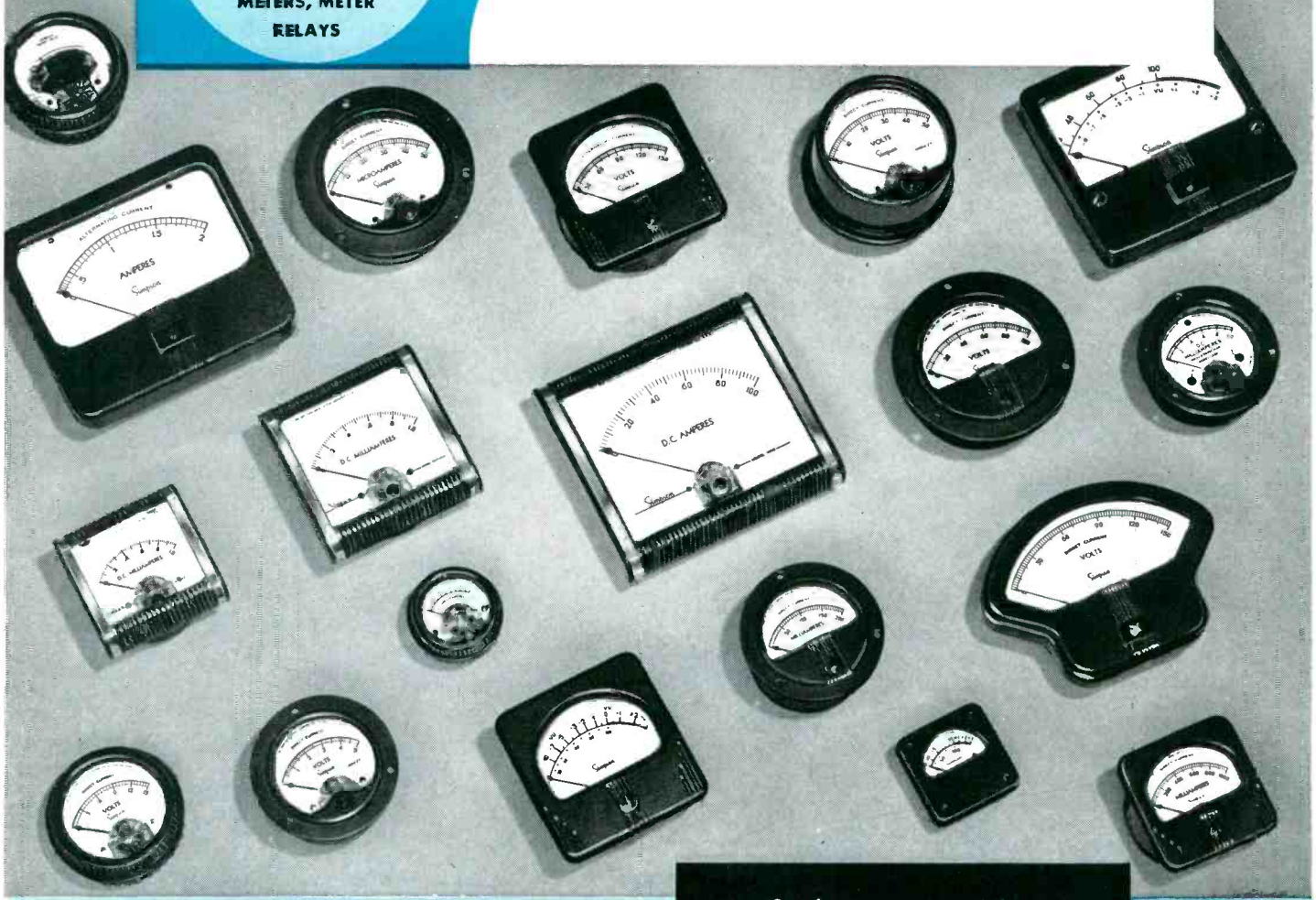

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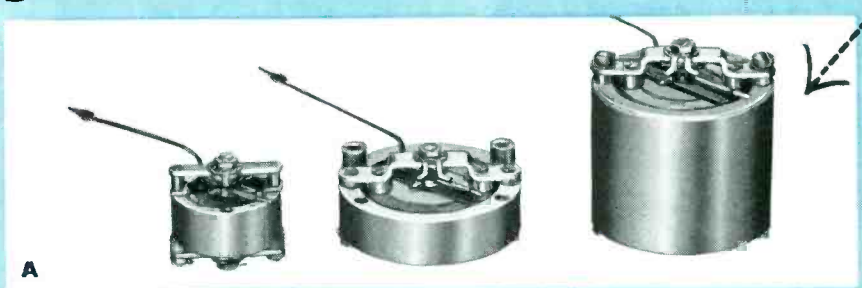

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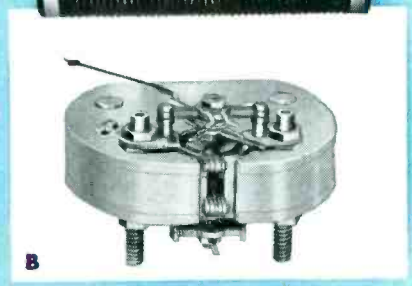

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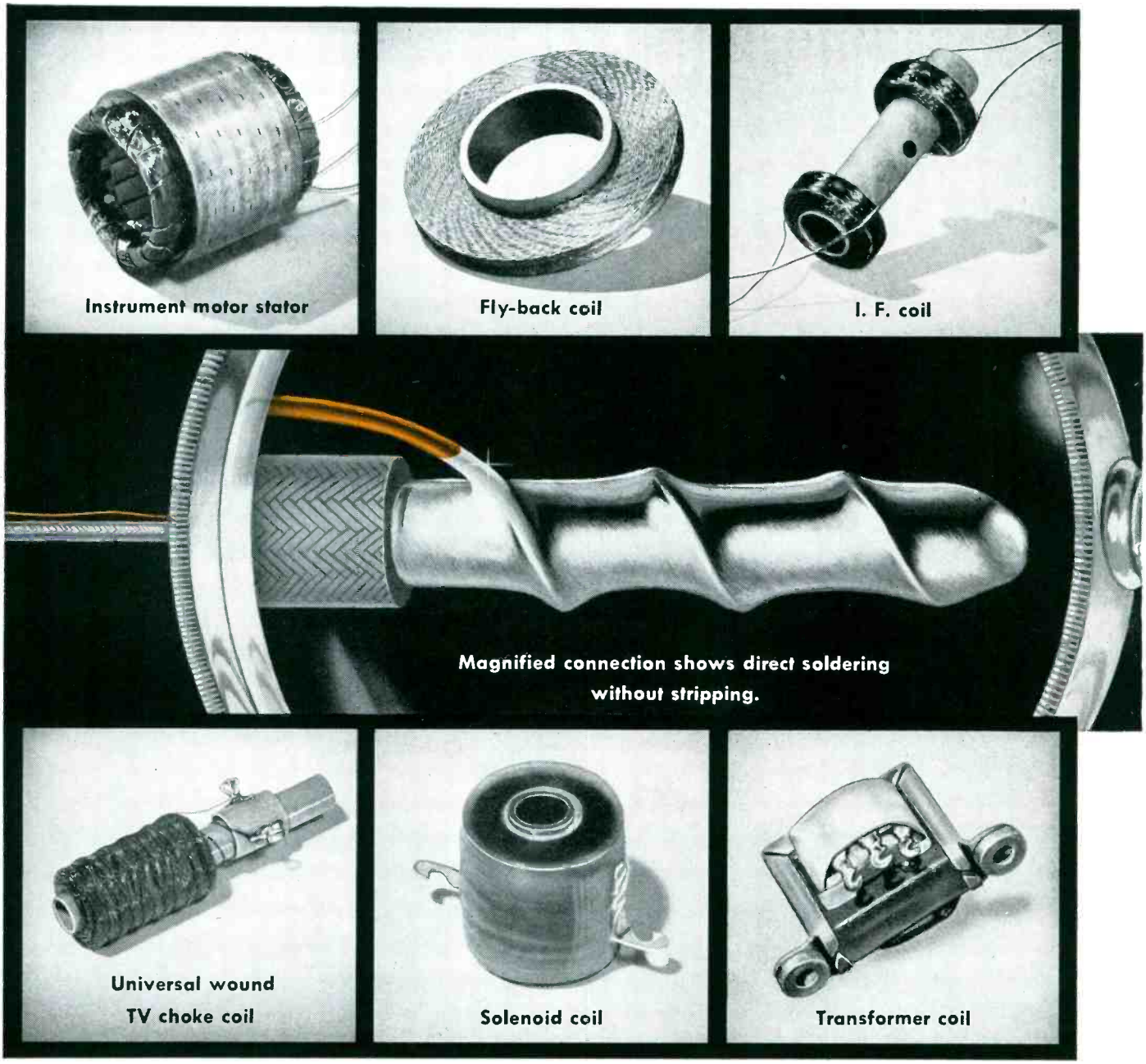


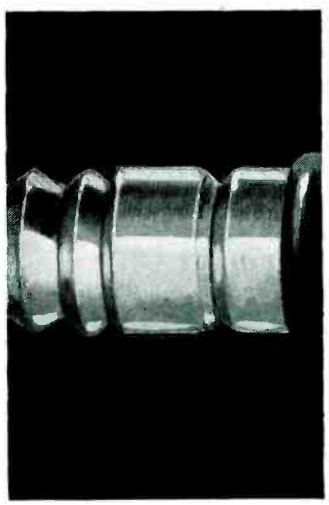
First for Lasting Quality—from Mine to Market!

*Reg. U. S. Pat. Off.

GIVES HIGH "Q"...

CLASS "A" APPLICATIONS!

- **New materials assure high "Q".**
- **All essential properties equal or superior to existing film wires.**
- **Positive uniform soldering. No stripping or cleaning necessary.**



Phelps Dodge Sodereze represents a new advance in ready-to-solder magnet wire. It's a typical Phelps Dodge development designed to keep pace with industry's growing need for wires that handle easily, reduce over-all cost and satisfy a variety of operating conditions.

Phelps Dodge Sodereze offers a unique combination of improved chemical and mechanical properties with the advantage of high "Q". The versatility of Phelps Dodge Sodereze not only permits its use wherever solderable wires have been proven practical but suggests new applications, particularly in the finer sizes, to replace conventional wires.

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

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PUTTING YOUTH IN BUSINESS

PHELPS DODGE COPPER PRODUCTS CORPORATION
MINE TO MARKET

PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION
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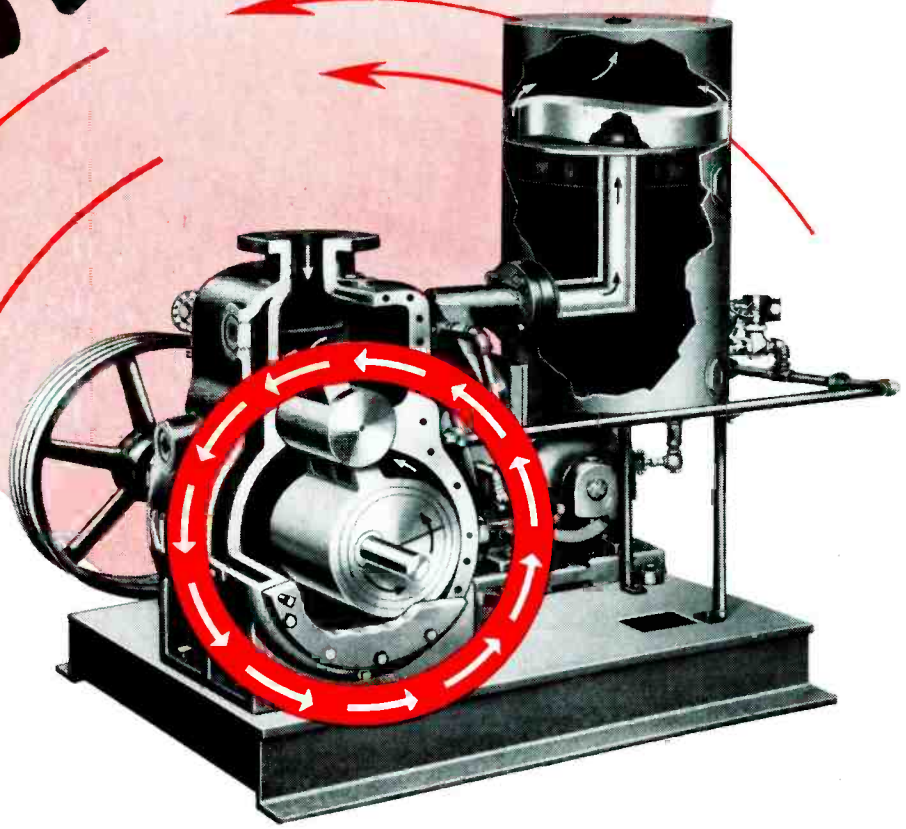
REVOLUTIONARY REVOLUTIONS!



World's largest line of vacuum pumps — from 2 cu. ft. per min., ¼ h.p. to 780 cu. ft. per min., 40 h.p.

Vacuum pump performance standards were revolutionized when Kinney introduced the cam and piston design . . . establishing new criteria by which all other pumps are judged. Through continuing research, Kinney constantly adds more features to these superior basic designs . . . controlled gas ballasting . . . dynamic balancing for reduced vibration . . . consistently quick recovery of operating pressures, etc. . . . to make each revolution of a Kinney High Vacuum Pump an economy move in thousands of installations . . . in a wide variety of applications . . . throughout industrial America.

Competent vacuum engineers in all our district offices are ready to help you solve your particular problem. Send the coupon for details. Kinney Mfg. Division, Boston 30, Massachusetts.

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THE NEW YORK AIR BRAKE COMPANY
3565 WASHINGTON STREET • BOSTON 30 • MASS.
INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N.Y.

Please send Bulletin V54 describing the complete line of Kinney Vacuum Pumps.

Our Vacuum problem involves .....

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Company .....

Address .....

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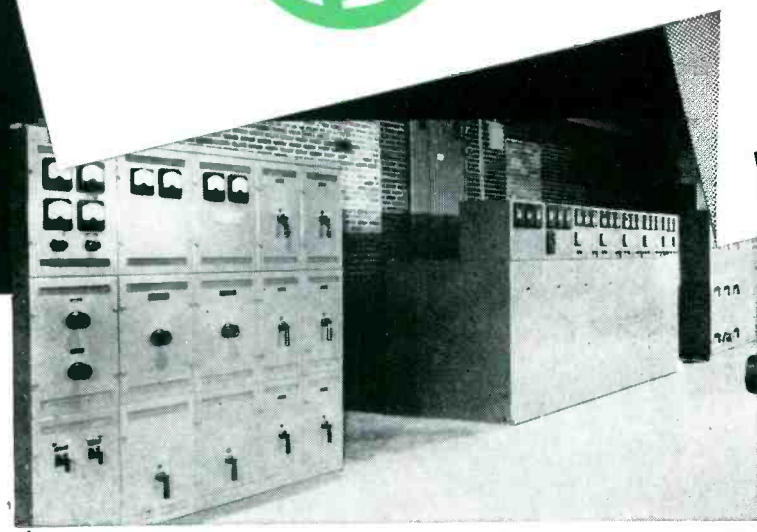
For more dependable Switchgear, Specify

For more dependable Insulation, Specify

NATVAR 400

EXTRUDED VINYL TAPE



↑ I-T-E MULTUMITE Switchgear is compact and efficient. It is designed and built to provide positive protection of secondary distribution systems with an extra margin of safety for uninterrupted service. Instrument transformers are designed specifically for switchboards.

Natvar 400 Extruded Vinyl Tape is used on this Type C-2, 5,000 volt, 600 amp. primary → transformer coil to protect the instrument circuit, because it has good dielectric strength, requires fewer layers than VC, is flexible enough to conform to sharp bends without wrinkling, and because it has adequate heat resistance.

Natvar

Natvar Products

- Varnished cambric—cloth and tape
- Varnished canvas and duck
- Varnished silk and special rayon
- Varnished—Silicone coated Fiberglas
- Varnished papers—rope and kraft
- Slot cell combinations, Aboglas®
- Vinyl coated—varnished—lacquered tubing and sleeving
- Extruded vinyl tubing and tape
- Styroflex® flexible polystyrene tape
- Extruded identification markers

Ask for Catalog No. 23

For more than 60 years I-T-E has been known in the electrical industry for the *quality* of its products. This reputation has been maintained through sound engineering and manufacturing skill.

Component parts and materials that go into I-T-E Switchgear are the finest obtainable, and are carefully coordinated into efficient functional units. Natvar 400 extruded vinyl tubing and tape and other Natvar flexible insulations are used because they consistently meet I-T-E's rigid requirements.

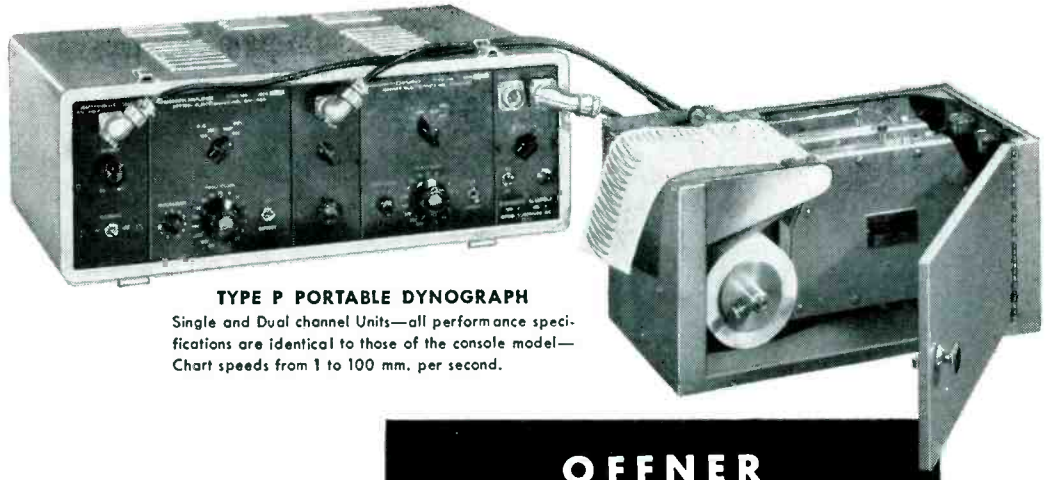
Natvar 400 and other Natvar flexible electrical insulating materials are available for immediate delivery, either from your wholesalers' stocks or direct from our own.

NATVAR CORPORATION

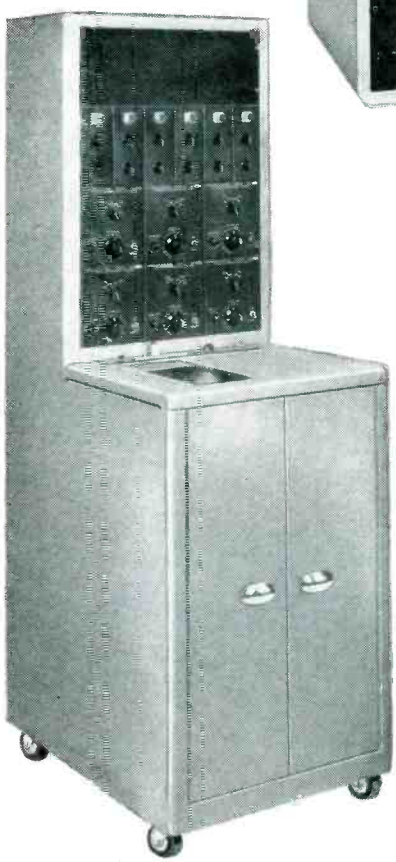
FORMERLY THE NATIONAL VARNISHED PRODUCTS CORPORATION

TELEPHONE RAHWAY 7-8800 — CABLE ADDRESS NATVAR: RAHWAY, N. J.

201 RANDOLPH AVENUE • WOODBRIDGE, NEW JERSEY

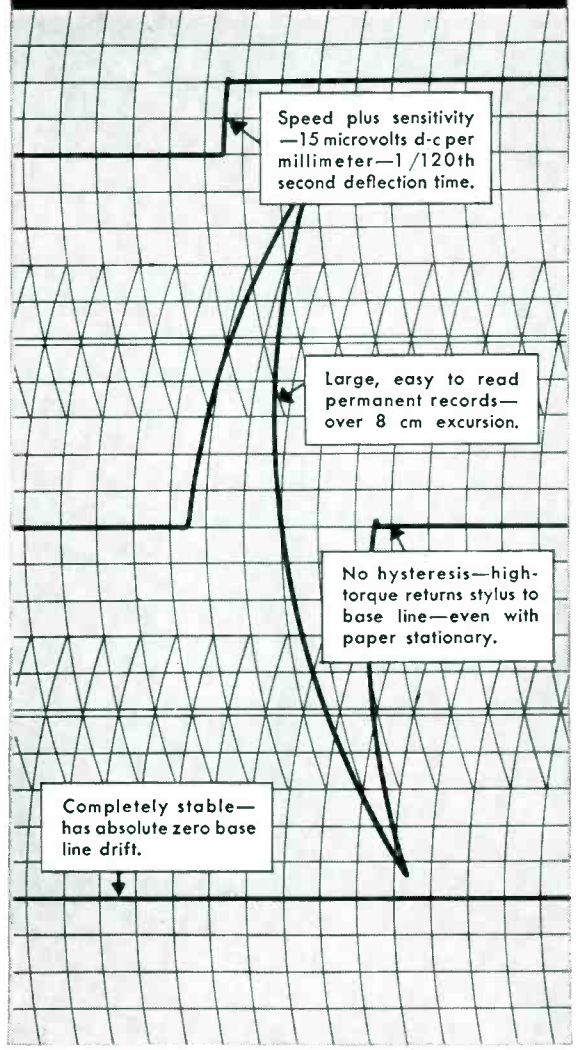


TYPE P PORTABLE DYNOGRAPH
Single and Dual channel Units—all performance specifications are identical to those of the console model—Chart speeds from 1 to 100 mm. per second.



TYPE M CONSOLE
Six channels—accommodates up to six Type 146 amplifiers with input couplers, uses roll or folded charts—eight chart speeds, 1 to 250 mm. per second.

OFFNER DYNOGRAPH RECORDERS



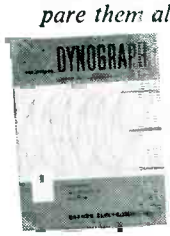
IF YOU COMPARE—YOU WILL SELECT THE OFFNER DYNOGRAPH!

Compare the direct writing oscillographs on the market today. If you do, you will select the Offner Dynograph because only the Offner Dynograph has these features:

15 microvolt per millimeter d-c sensitivity . . . Absolute *drift-free* stability . . . One amplifier for d-c amplification, resistance and reluctance gages . . . True differential input, isolated from ground . . . Rugged, low resistance movement.

No other direct writing oscillograph on the market has *any of these features!* The Offner Dynograph *has all these features and many more!*—because the Dynograph uses the exclusive patented Offner *chopper amplifier*. This amplifier must be distinguished from a chopper *stabilized* amplifier, which merely reduces, does not eliminate drift, and provides none of the other features of the Offner Dynograph.

If you want the widest versatility, highest accuracy, greatest reliability in direct writing high speed oscillographs—*compare them all!* You'll select the Offner Dynograph.



Write for your copy of Bulletin L-742. Get complete details and application information on both Portable and Console Models. Write for a demonstration by our Engineering Representatives in your area. Compare—and you will select the Offner Dynograph.

OFFNER ELECTRONICS INC.

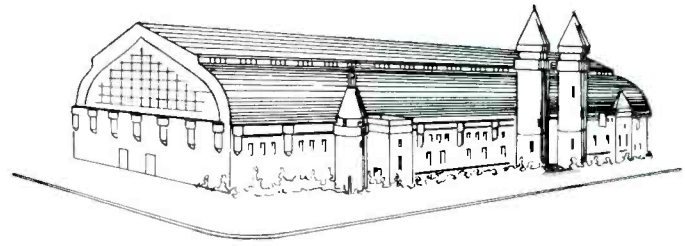
5324 N. Kedzie Avenue, Chicago 25, U. S. A.

Want more information? Use post card on last page.

This year it's KINGSBRIDGE 3

March 19-22
New York City

for the
Radio Engineering Show



For the third year in succession, the great annual IRE Radio Engineering Show will open its doors to the industry for four spectacular days at the Kingsbridge Armory and Kingsbridge Palace in New York City. As in the preceding years, the Show will be filled to capacity with 704 exhibits and displays of the latest and newest developments in radio-electronics.

Is it too big? Not as a true representative of this giant industry. More than 200 papers presented by 22 Professional Groups at the Convention's 55 technical sessions are an accurate index to new research and development . . . and the 704 exhibitors represent about 80% of the productive capacity of the industry . . . not one whit larger than necessary to keep pace with electronic America today!

Plan now to attend the industry's most vitally important Show where

Over 42,000* meet!

*At the 1955 Show, 42,133 men and women from coast to coast and every field of radio-electronics attended the Radio Show. This year, attendance is expected to go even higher. Don't miss it!

Over 700 Exhibitors will show all that is NEW in radio-electronic engineering!

THE INSTITUTE OF RADIO ENGINEERS
1 East 79 Street, New York

Leaders in Electronics rely on Good-All Capacitors

. . . whether for a critical fraction of a second or for a long life of trouble-free performance. Our technical and production people gain real satisfaction from working out capacitor problems with design and component engineers. The confidence of these engineers in Good-All "know-how" has contributed greatly to our rapid growth in the industry

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

MIL TYPES

Good-All produces a broad line of hermetically sealed tubular and bathtub capacitors to specifications MIL-C-25A. Custom designs of various metal enclosed styles can also be provided to your individual specifications.

MYLAR TYPES

The space-saving size and extremely high IR of Good-All Mylar* types are ideal for many special purpose applications. These are available in several metal enclosed designs as well as in ceramic or plastic impregnated tubes.

*DuPont's trademark for polyester film.

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

HARNESSING THE POWER OF THE POLES...

Berkeley MAGNETICS

a totally NEW concept of industrial instrumentation

Berkeley FERRISTOR* Circuitry

Brings You High Speed Counting and Control Without Vacuum Tubes!

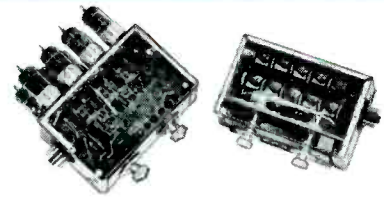
featuring

RELIABILITY—designed for *continuous* duty!

RUGGEDNESS—immune to shock, vibration, overload!

SIMPLICITY—installation, operation, maintenance by regular plant personnel!

Utilizing rugged BERKELEY Ferristors* to perform most vacuum tube functions, new BERKELEY industrial counting and control instruments offer electronic speed and precision **plus** the unfailing reliability, simplicity and long service life of electromagnetic devices:



"TUBELESS" Decimal Counting Unit (right) generates ⅛th the heat of vacuum tube model (left); no component in the Ferristor* DCU operates at more than 25% of its ratings.

- **CONTINUOUS-DUTY RELIABILITY**—rugged encapsulated Ferristors*, developed and manufactured by Berkeley, are immune to damage caused by shock, vibration, moisture and overloading. They're non-aging, require no filaments, operate at extremely low current and voltage levels; produce little or no heat.

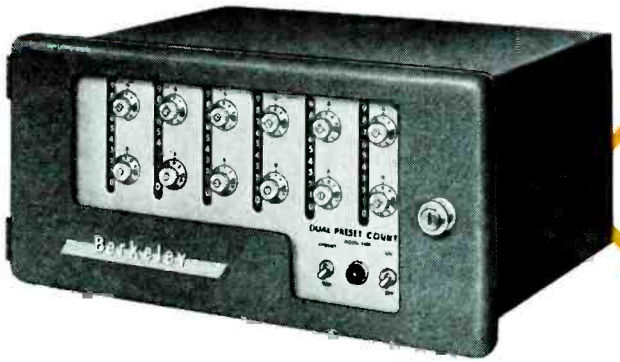
- **INSTALLATION, OPERATION, SERVICING BY REGULAR PLANT PERSONNEL**—no electronic "experts" required! Connections made on clearly-marked terminal strips, with standard industrial wiring procedures. Simple tamper-proof adjustments; sturdy, easily-understood controls!

- **LONG COMPONENT LIFE**—circuits operate at a fraction of component ratings. Elimination of excessive heat ends heat-caused deterioration and instability, permits use of dust-tight enclosures (no ventilation needed).

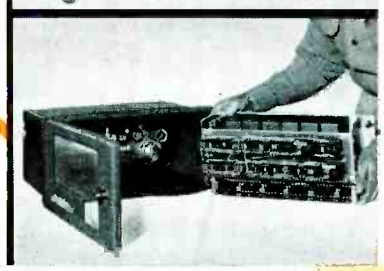
*Trademark

a totally NEW concept of industrial instrumentation

Berkeley Series 5840 Long-Life MAGNETIC Dual Preset Controller



TAMPER-PROOF, dust-tight transparent cover can be locked to prevent re-setting by unauthorized personnel.



SWING-OUT chassis construction simplifies installation, inspection and servicing.

Counts at rates to 10,000 per sec, produces electrical output signals at any two preset totals. Absolute accuracy. Operates from photocells, magnetic pickups, electrical contacts. Built-in DPDT output signal relay operates solenoids, solenoid valves, power relays, other control devices. First signal may be used to slow down operation preparatory to stop at final (second) count, etc. Has only two vacuum tubes (vs. 54 in electronic model), both used in low-level rf oscillator-power supply. Simple marginal test indicates approaching tube failure, permits replacement before failure occurs.

BRIEF SPECIFICATIONS

Max. Count Rate: 10,000 counts per sec

Input Sensitivity: 0.1 ma p-p into 10k load

Output Signal: From built-in DPDT relays; contacts rated at 5 amps (non-ind.)

Accuracy: Absolute

Power Requirements: 105/130 or 210/230 v. 60 cycle, 85 w.

Dimensions, Weight: 18⅞"W x 8¾"H x 13⅝"D; 50 lbs.

Price (f.o.b. factory): Model 5846 (6 digit) $1,295.00.

APPLICATIONS

Control of counting, weighing, sorting, packaging, shearing, metal forming, coil winding equipment; cut-off of motors, turbines, jet engines at precise predetermined rev count or speed, computer timing, etc. Continuous-duty reliability makes new MAGNETIC Preset Controller ideal for all process and production control applications where elimination of costly downtime is a vital factor.

Berkeley Model 7650 Long-Life MAGNETIC EPUT* Meter

Measures events occuring during precise 0.1, 1 or 10 sec time interval, displays results in digital form. Operates from photocell, magnetic pickup or any suitable transducer to measure pressure, temperature, flow, velocity, viscosity, frequency, rpm, or to count events or objects at rates to 40,000 counts per second.

Only three vacuum tubes used (35 in comparable electronic model) in rf oscillator-power supply operating at low levels. Simple marginal test indicates approaching tube failure, permits replacement before failure occurs. Has digital "count-down" time base for precise gating: no adjustment of time base required.

BRIEF SPECIFICATIONS

Count Capacity: 5 digits

Counting Rate: 0 to 40,000 per sec

Time Base: 0.1, 1 or 10 sec

Accuracy: ± 1 event, ± 50 ppm

Input: 0.3 ma p-p into 10k load

Power Requirements: 105/130 or 210/230 v. 60 cycle, 100 w

Dimensions, Weight: 18⅞"W x 8¾"H x 14⅝"D (overall); 55 lbs.

APPLICATIONS

Aircraft, automotive, jet or piston engine test cells, dynamometer test stands; laboratory or production tachometry systems; process control systems; data reduction systems; hydraulic and pneumatic servo testing; acceleration-deceleration determination; measurement of linear or centrifugal speeds, forces, strains; measurement of any optical, electrical, mechanical or physical event occurring during a precise time interval.

BERKELEY Long Life Magnetic EPUT* Meters and Magnetic Controllers are ready now to serve in your laboratory, inspection rooms and test cells, on your production, processing or packaging lines. You'll be hours and dollars ahead to call your nearest BERKELEY representative or write us now for complete data. Please address Dept. G-1.

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Berkeley *division*

BECKMAN INSTRUMENTS, INC.

2200 Wright Avenue • Richmond 3, California

Tests show two CATHALOYS most versatile cathode materials

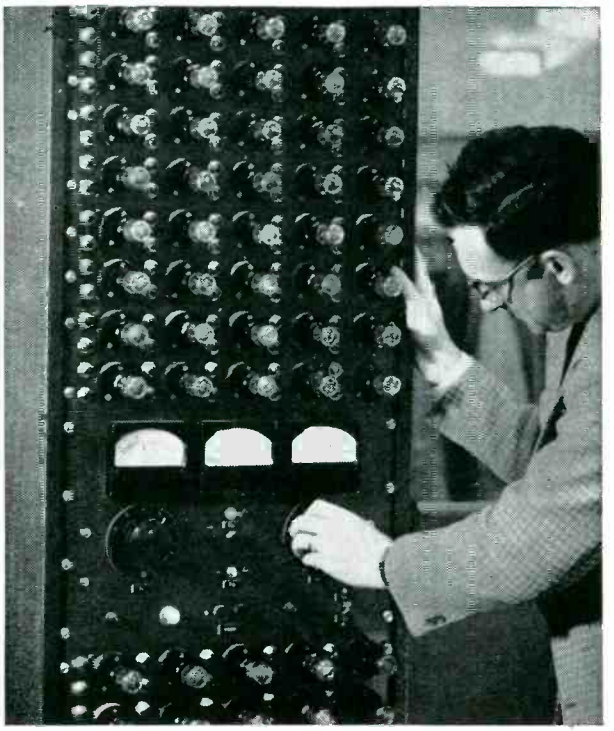
New alloys from Superior Tube simplify selection, prolong tube life

Now the engineer's job of selecting the right cathode alloy for practically any electron tube can be a simple choice between two new CATHALOYS from Superior Tube.

CATHALOY A-32* is an active alloy characterized by rapid activation, high emission level throughout life, absence of interface impedance, and very low sublimation. These remarkable advantages are the result of using aluminum in place of silicon or magnesium as the reducing agent. The addition of a small percentage of tungsten also makes A-32 approximately 50% more shock resistant than cathodes without tungsten. Thus A-32 is suitable for virtually any active alloy application, including ruggedized tubes.

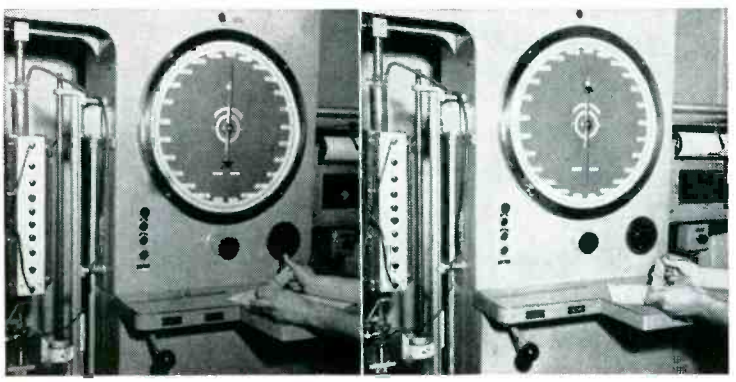
CATHALOY P-50 is a passive alloy of carefully controlled analysis that is commercially available in WELDRAWN† cathodes as well as Lockseam.‡ It can be made in WELDRAWN form because of its capacity to take much more severe reductions in cold drawing without rupture than other grades of passive alloys. P-50 is identical in composition with the well-known ASTM Grade 21. The important difference is in the method of melting which improves the uniformity and completeness with which deoxidation is accomplished. All heats are tested in Superior Tube's laboratory before being approved for production.

Ask for complete technical reports on both these new CATHALOYS. Write Superior Tube Co., 2500 Germantown Ave., Norristown, Pa.

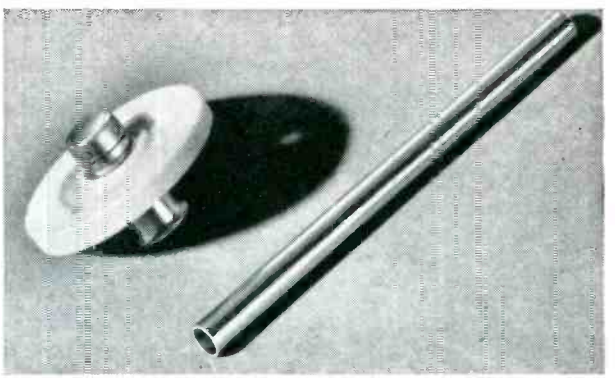


ON TEST. Laboratory photo of test diodes used in Superior Tube's electronic laboratory. Under exhaustive tests, the new Cathaloys display performance characteristics not present in other alloys.

*Patent applied for †TM Reg. U.S. Pat. Off., Superior Tube ‡Manufactured under U.S. patents NOTE. Cathaloy is a trademark of Superior Tube Co., Reg. U.S. Pat. Off.



CATHALOY A-32—3750 psi **Tungsten-free cathode alloy—2500 psi**
50% STRONGER. High temperature tensile testing machine proves Cathaloy A-32 approximately half again stronger than tungsten-free cathode alloys.



WELDRAWN PASSIVE ALLOY. Typical uses for Cathaloy P-50 are in Weldrawn cathode sleeve shown at right and in disc cathode shank at left. Heretofore, passive alloys have not been commercially available for these applications.

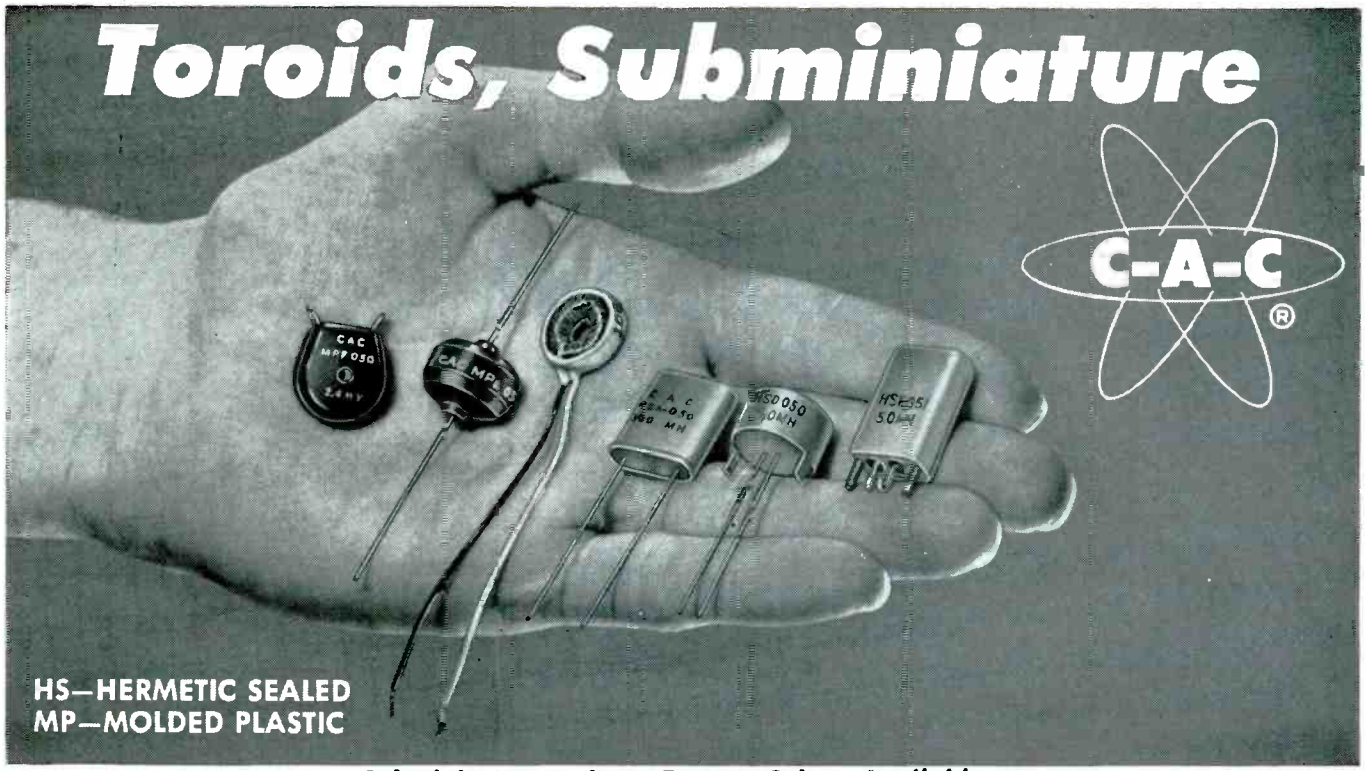
Superior Tube
The big name in small tubing

All analyses .010" to ⅜" OD. Certain analyses in light walls up to 2½" OD.

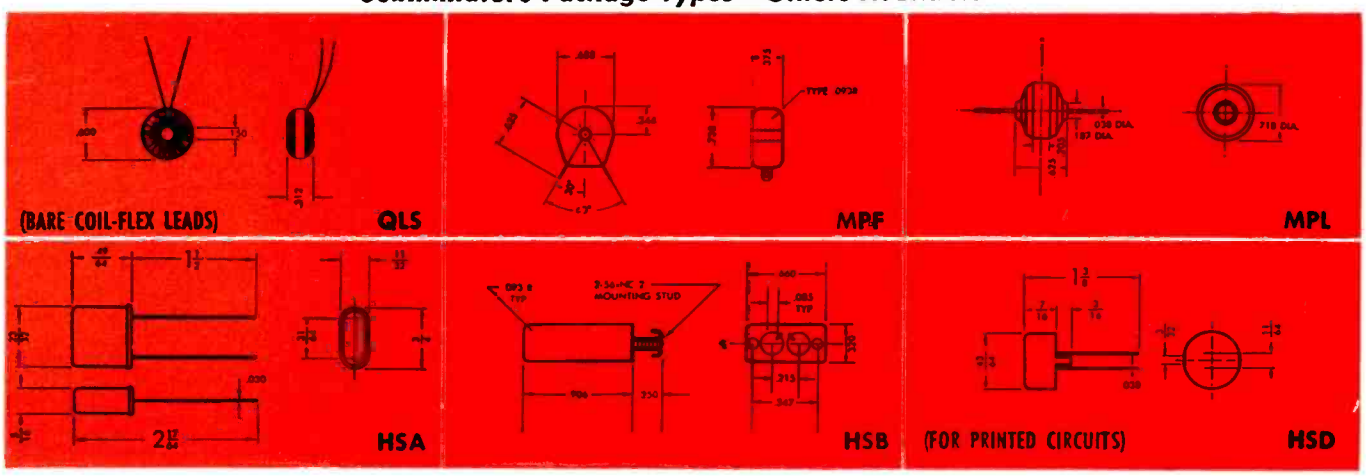
Want more information? Use post card on last page.

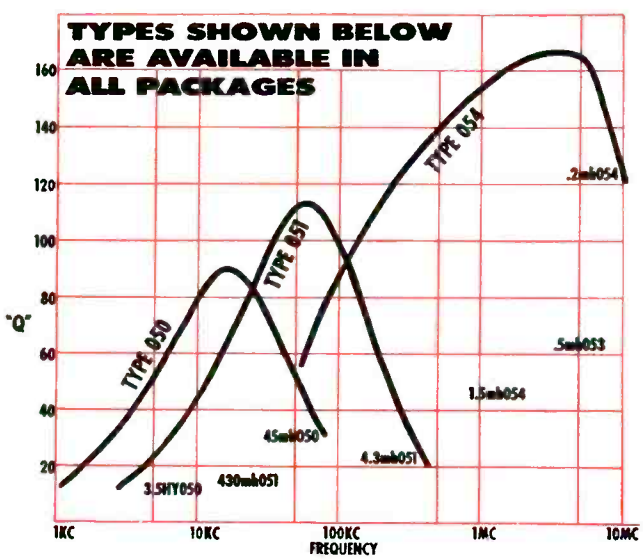
Toroids, Subminiature

C-A-C®



Subminiature Package Types — Others Available





Our Network Designers can solve your space problems in filters, discriminators and delay lines with the subminiature toroids.

Inquiries are invited.

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BALTIMORE DIVISIONS

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for experienced electronic engineers seeking long-range positions of responsibility and opportunity.

Current opportunity at the Westinghouse Baltimore Divisions combines most of the ordinary advantages—such as good income and employe benefits—with a foremost program of professional recognition, advanced education at company expense, and long-range development work that is creative and interesting. Work in modern facilities that are ideally located. Apply today!

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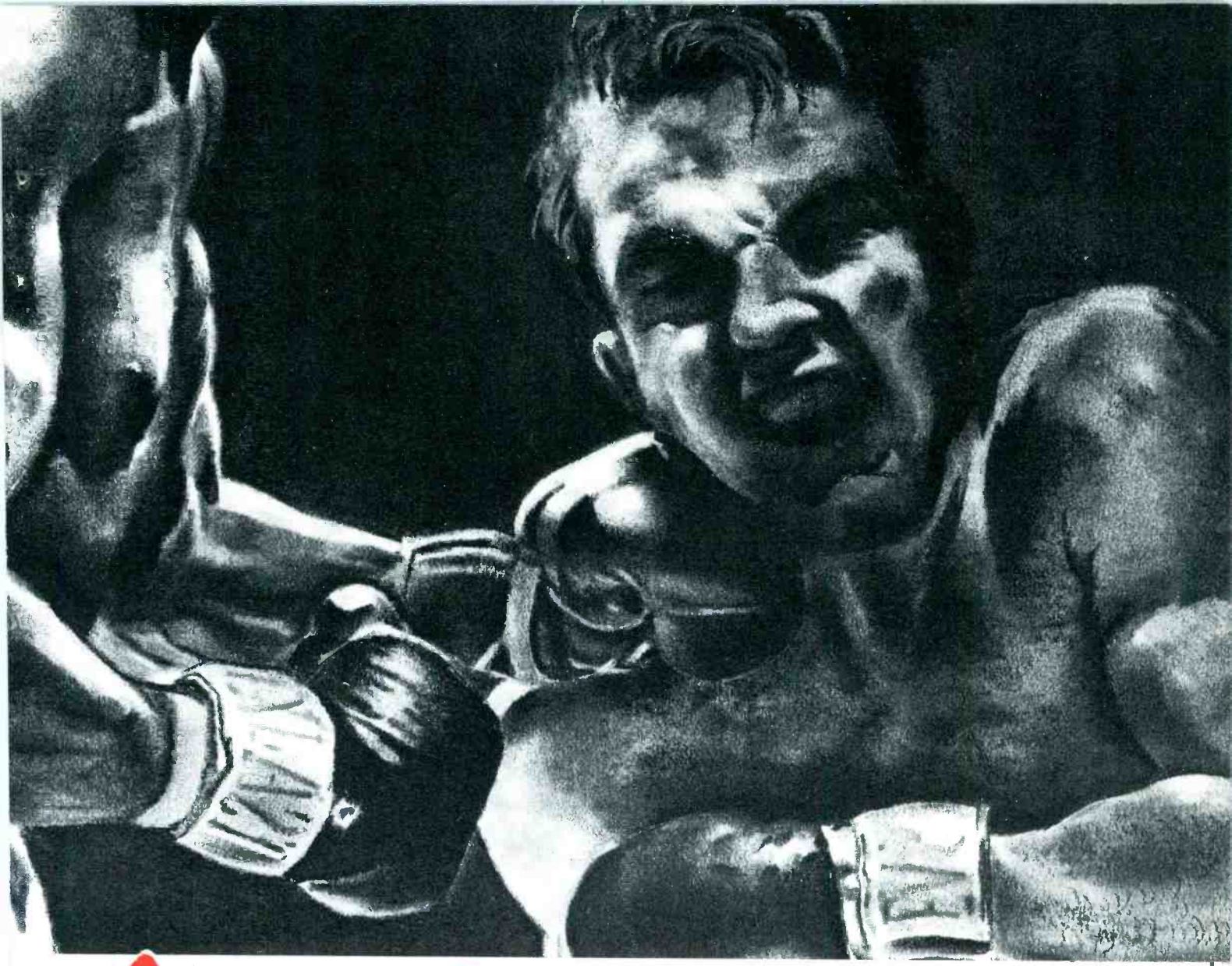
Send letter outlining your experience to—

Technical Director, Dept. 284
Westinghouse Electric Corp.
2519 Wilkens Avenue
Baltimore 3, Maryland

YOU CAN BE SURE...IF IT'S

Westinghouse



force!

When you want to measure it look to **Brush Recording Systems**

Torque of an engine balancer shaft is recorded by Brush instrumentation in this set-up at Caterpillar Tractor Co. Test data helped Caterpillar engineers reduce vibration, improve engine performance.

A boxer's punch, a heart's contraction, a piston's thrust—you can measure almost any form of force with Brush Recording Systems. These versatile instruments give you the answers in writing, charting instantaneously as phenomena occur. Brush offers a complete line of portable, console or rack mounting oscillographic systems for recording 1, 2, 4 or 6 channels of data.

These and other Brush instruments can help you in virtually any measurement problem involving electrical, mechanical, heat, light, sound or nuclear quantities. For complete information, call or write Brush Electronics Company.

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

BRUSH 6 ELECTRONICS

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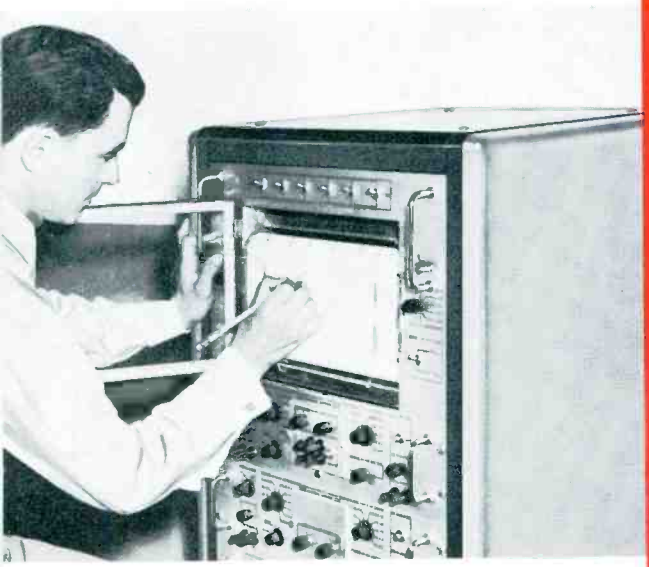
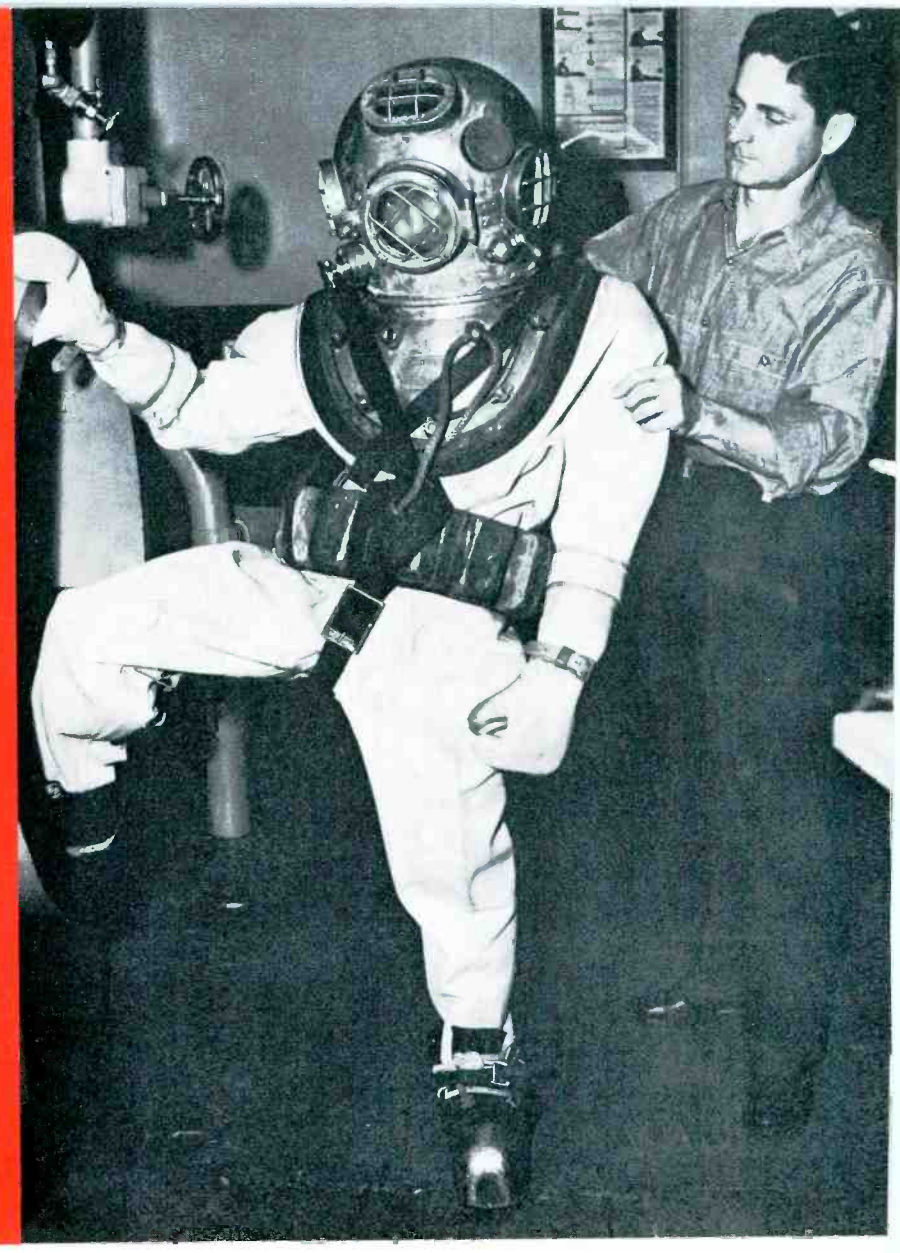
NEW IDEAS IN MEASUREMENT FROM BRUSH



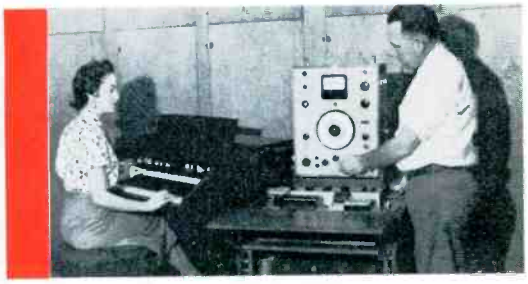
Chooses best recording speed.

Test engineer has a choice of up to 16 recording speeds on this Brush Recording System. Result—he can choose the best speed for the signal being measured for optimum accuracy and clarity of chart records. Wide speed range helps economize on chart paper too! Systems like this can record a wide range of electrical or mechanical variables.



How well does he breathe?

This diver is entering a pressure chamber for a "dry-land dive" at various simulated depths. Through strain transducers, Brush recording instruments chart the pressure of the diver's breathing and the rate of air flow. Tests help evaluate physical effects on the diver as well as performance of equipment.



Keeps the music sweet.

This test set-up at Hammond Organ uses a Brush Frequency Response Recorder to test the ringing time of tone generating circuits. Brush offers an integrated line of precision equipment for measuring sound, noise, vibration, analyzing frequency spectra, etc. Chart records simplify analysis and provide permanent records of tests.

Counts anything?

The "Countess"—Brush's outstanding digital counter—counts anything up to 100,000 pulses per second. Unit requires only one-half the voltage, one-fourth the power needed by conventional counters. The result is less heat, greater reliability. Use the Countess as a component in equipment for testing, controlling, computing, etc.

Call BRUSH for the answer!

For help in your measurement problems, call your nearby Brush representative, or write Brush Electronics Company, Department 777, 3405 Perkins Avenue, Cleveland 14, Ohio. Your request will receive prompt attention!

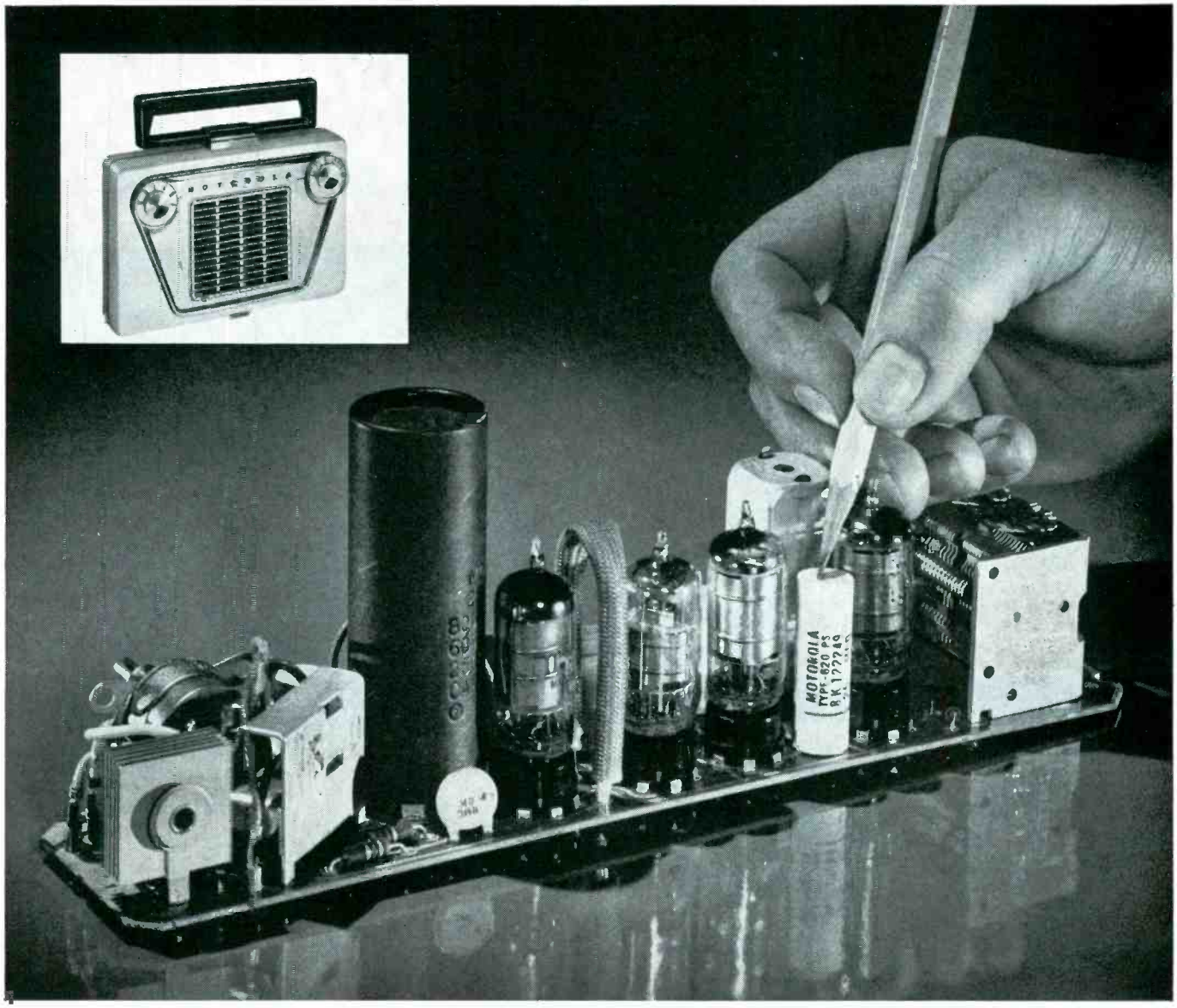
BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZOELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT AND COMPONENTS

BRUSH ELECTRONICS

Division of Clevite Corporation

Convenient, more compact portable radios for Motorola



Capacitors made with new Du Pont MYLAR* help Motorola obtain essential space savings

"In designing our top-selling portable radios, the essential element of compactness was achieved through the help of capacitors made with Du Pont 'Mylar,'" reports Motorola, Inc. "Smaller capacitors are possible because 'Mylar' is tough, thin, and has high dielectric strength. In addition, the moisture insensitivity of these new capacitors assures superior performance, whether on the hot, humid beach or in cool mountain air."

This successful product innovation is only one example of the way an imaginative industry is putting the unique properties of Du Pont "Mylar" polyester film to profitable use. From metallic yarns to smaller transformers for guided missiles, Du Pont "Mylar" is making possible better products at lower cost in a wide variety of fields. Here's why:

"Mylar" has a tensile strength of 20,000 pounds per square inch. It has greater dielectric strength than most known insulating materials, and an impact strength at least twice that of any known commercial film. What's more, Du Pont "Mylar" is resistant to moisture and solvents, and remains flexible and stable over a temperature range extending from –80°F. to 300°F.

How about your product? There may be a way "Mylar" can solve those knotty problems and improve over-all performance. Mail the coupon today for a fact-filled booklet telling you more about this new versatile film—"Mylar."

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MYLAR®

DU PONT POLYESTER FILM

REG. U.S. PAT. OFF.

Better Things for Better Living...through Chemistry

*"Mylar" is the registered Du Pont trade-mark for its brand of polyester film.

E. I. du Pont de Nemours & Co. (Inc.)
Film Department, Room E-I, Nemours Bldg.
Wilmington 98, Del.

Please send me sample and further information on "Mylar" polyester film.

Name_____

Firm_____

Street Address_____

City_____ State_____

A Wide-Deviation Crystal-Standardized F. M. DEVIATION METER

MARCONI

F.M. DEVIATION METER

TYPE TF 928

Carrier Frequency Range:
20 to 100 Mc.

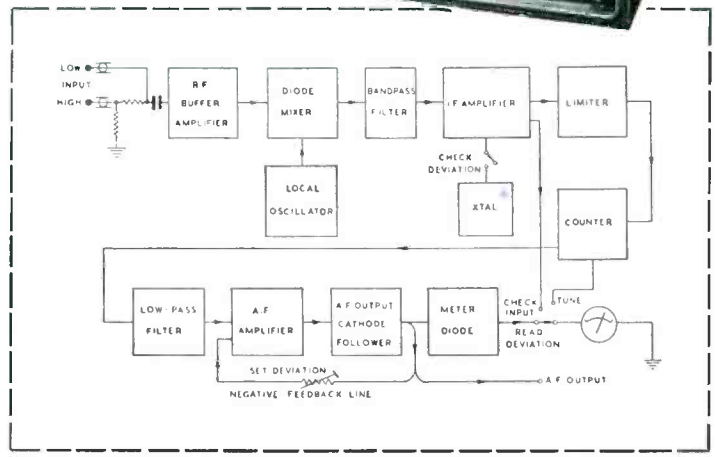
R. F. Input Level:
55 mv to 10 v.

Deviation Measurement Ranges:
100, 200 and 400 kc full-scale.

Accuracy of Deviation Measurement:
±3%

F.M. DEVIATION METER Type TF 928 accurately measures the frequency deviation of f.m. transmitters operating at carrier frequencies in the range 20 to 100 Mc.* Designed to accommodate wide-deviation systems employing modulation frequencies between 50 cps and 120 kc, the Meter has three deviation measurement ranges extending from 0 to 100, 200 and 400 kc respectively. A particularly valuable feature of the design is the inclusion of a self-checking arrangement introducing an oscillator crystal into the grid circuit of the second i.f. amplifier stage. At the same time, an alternating potential is impressed on the screen of the ensuing tube which suppresses the generated frequency at alternate half-cycles; this produces a test signal of constant effective deviation against which the deviation scale may be standardized.

** or 500 Mc using oscillator harmonics.*



MARCONI INSTRUMENTS

VACUUM TUBE VOLTMETERS · FREQUENCY STANDARDS · OUTPUT METERS
F.M. & A.M. SIGNAL GENERATORS · DEVIATION METERS · WAVEMETERS
WAVE ANALYSERS · Q METERS · BEAT FREQUENCY OSCILLATORS

Full data and prices will be mailed immediately on request

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ENGLAND: Head Office: Marconi Instruments Ltd., St. Albans, Herts. Managing Agents in Export: Marconi's Wireless Telegraph Co. Ltd., Marconi House, Strand, London, W.C.2

TC74

Highway to automation

Engineered Wiring—*and why Rome Synthinol® protects it from heat, corrosion, solvents and moisture.*

You can avoid failure of hook-up and control wiring, because of inferior insulations or construction, by using Rome Hook-Up, Machine Tool and Control Wires. Rome wires are made to stand up under high-speed, automatic operation day after day.

Hook-Up Wires

Rome Synthinol is UL approved for 80°C.–has high resistance to acids, oils, alkalies, moisture and flame.

Rome Synthinol 901 is UL approved for 105°C.–has all the advantages of regular synthinol *plus* higher resistance to heat deformation, shrinkage and cracking, and improved solderability.

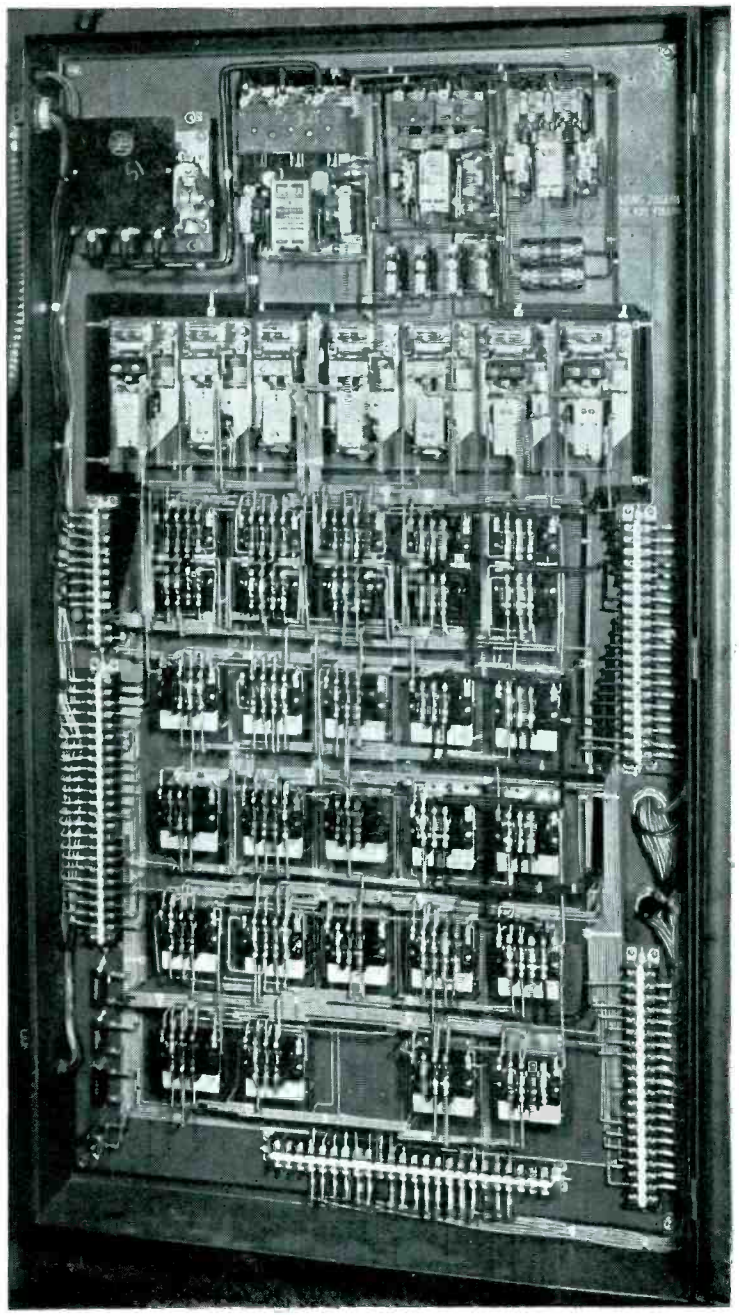
Also, Rome makes *Rome Hi-Temp*, a rubber insulation with great heat and moisture resistance–UL approved for 75°C. . . . and a full line of special and standard *commercial* and *military* hook-up wires.

Machine Tool and Control Wires

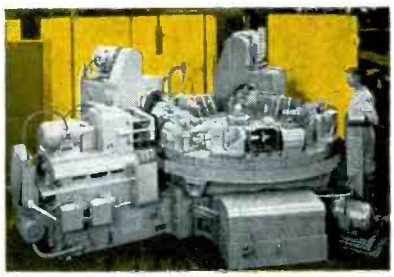
Rome insulates its machine tool and control wires with synthinol to proof them against high ambient temperatures and corrosive conditions. They conform to National Machine Tool Builders' Association Standards and are UL approved as Type TW with end use approval for 80°C. operation in air; and in oily, moist locations for 60°C. operation.

Rome Synthinol and *Synthinol 901* are thermoplastic compounds designed for exceptional resistance to high ambient temperatures, corrosion, oil and chemical solvents. Synthinol-insulated wiring is especially suitable for machine tool use. It is available in a variety of permanently clear colors, solid or with spiral markings.

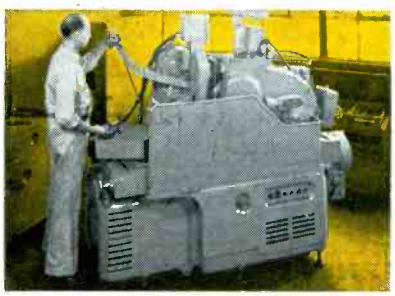
Send for complete data and specifications on Rome Hook-Up Wires, Machine Tool and Control Wires. They're available in special and standard constructions.



Without this control panel, *equipped with dependable wiring*, relays, starters and limit switches, the machine operator would do most of the work. Automation takes the machine through complex cycles without operator attention.



Once the hopper is loaded, this machine automatically grinds roller bearing races to precision tolerances. The machine also trues and dresses the grinding wheel–automatically.



This machine is built for automatic machining of a specific automobile part. Machine tool and hook-up wires carry the power and signals which make its automation possible.

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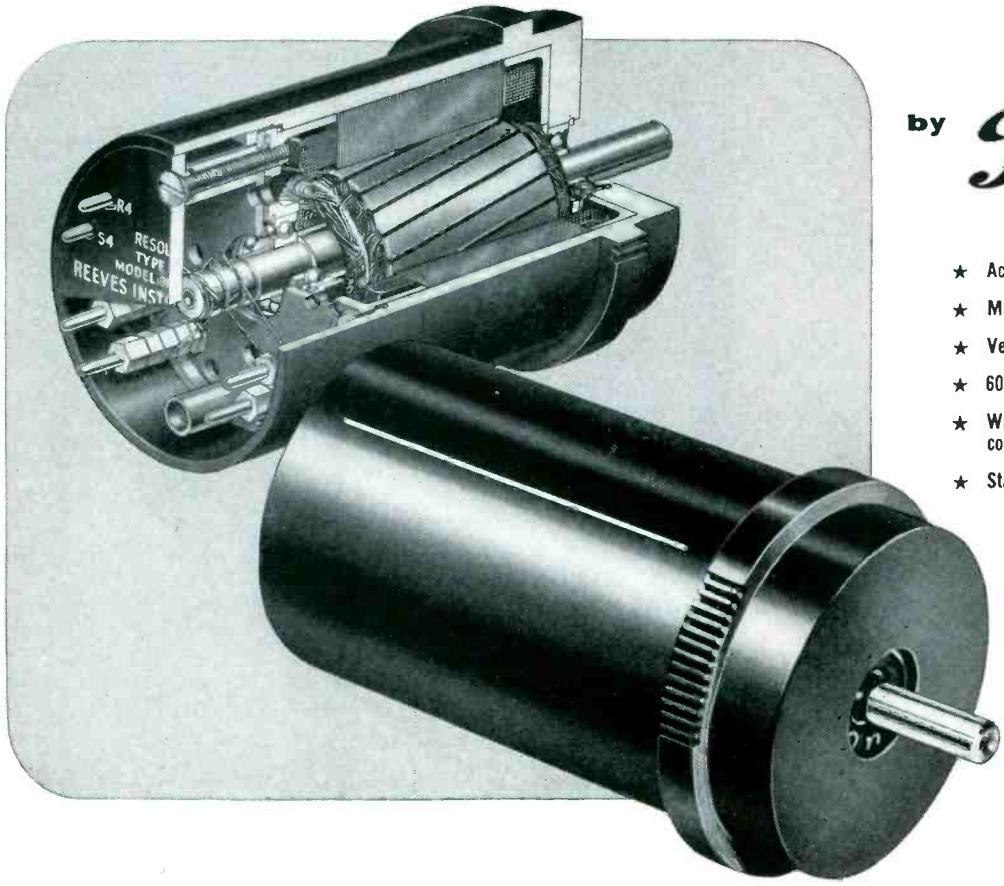
PRECISION RESOLVERS



by Reeves INSTRUMENT CORPORATION

- ★ Accuracy better than 0.05%.
- ★ Maximum interaxis error as low as 1'.
- ★ Very low distortion.
- ★ 60 or 400 cps. or wide band.
- ★ With or without booster amplifier compensation.
- ★ Standard military frame sizes.

the HIGHEST PRECISION resolvers available

Reeves' many years of experience as a pioneer in the field has made it possible to manufacture these compact precision resolvers in quantity production to a functional accuracy of 0.05% without culling—or to an accuracy of 0.03% on special order. Harmonic distortion and null voltages are held below one-tenth of one per cent.

Reeves resolvers are primarily designed for 60 and 400 cps. operation, with or without booster amplifier compensation. Special units are available for use at over 100 kc bandwidth. The Reeves R600 series is the standard of comparison among precision resolvers. Miniature resolvers of highest precision are also available.

Write for the Reeves Resolver Handbook.

REEVES PRECISION RESOLVERS AND RELATED COMPONENTS

MINIATURE PRECISION RESOLVERS

BOOSTER AMPLIFIERS

PHASE SHIFTERS

CONTINUOUS RESOLVER CHECKER

Reeves INSTRUMENT CORPORATION

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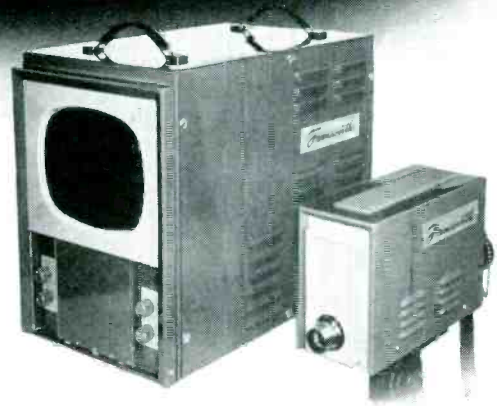
MORE THAN 30 YEARS

experience in electronic television



MODEL 600A
Consists of a compact light weight camera and portable monitor interconnected by multiconductor cable.

for defense and industry . . . bring you Farnsworth closed circuit television that is second to none! Engineered especially for industrial, educational and commercial use this new, economical medium is saving time, and money in countless applications.

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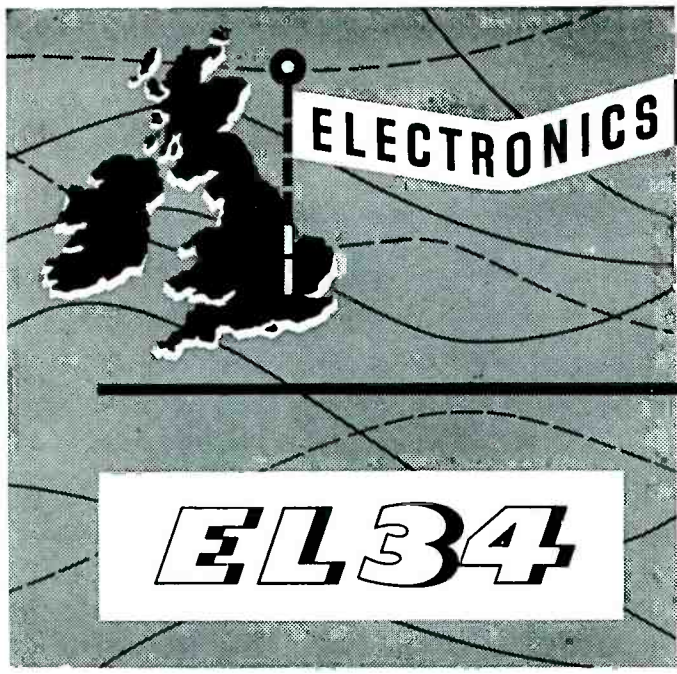
Want more information? Use post card on last page.



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

EL34

Britain's foremost pentode for 25W high fidelity equipment

The Mullard EL34 can be rightly acclaimed as the most efficient high fidelity output pentode tube yet produced in Britain. It is being fitted in many of the British sound reproducing equipments which are becoming increasingly popular in the United States and Canada.

Used in push-pull ultra-linear operation (distributed load), two EL34 tubes will give 32 watts output at a total distortion of less than 1%. The application of negative feedback reduces distortion even further.

The EL34 is equally capable of supplying higher power outputs where an increased distortion level is acceptable. Under class B conditions, 100 watts are obtainable from a pair of EL34 tubes in push-pull for a total distortion of 5%.

Another significant feature of this tube is its high transconductance value of 11,000 μmhos, resulting in high power sensitivity and low drive requirements.

Supplies of the EL34 are now available for replacement purposes from the companies mentioned below.

Principal Ratings

Heater
6.3V, 1.5A

Max. plate voltage
800V

Max. plate dissipation
25W

Max. screen voltage
425V

Max. screen dissipation
8W

Max. cathode current
150mA

Base
Octal 8-pin

Available in the U.S.A. from:—
International Electronics Corporation,
Dept. E1, 81 Spring Street, N.Y.12,
New York, U.S.A.

Available in Canada from:—
Rogers Majestic Electronics Limited,
Dept. 1E, 11-19 Brentcliffe Road.
Toronto 17, Ontario. Canada.

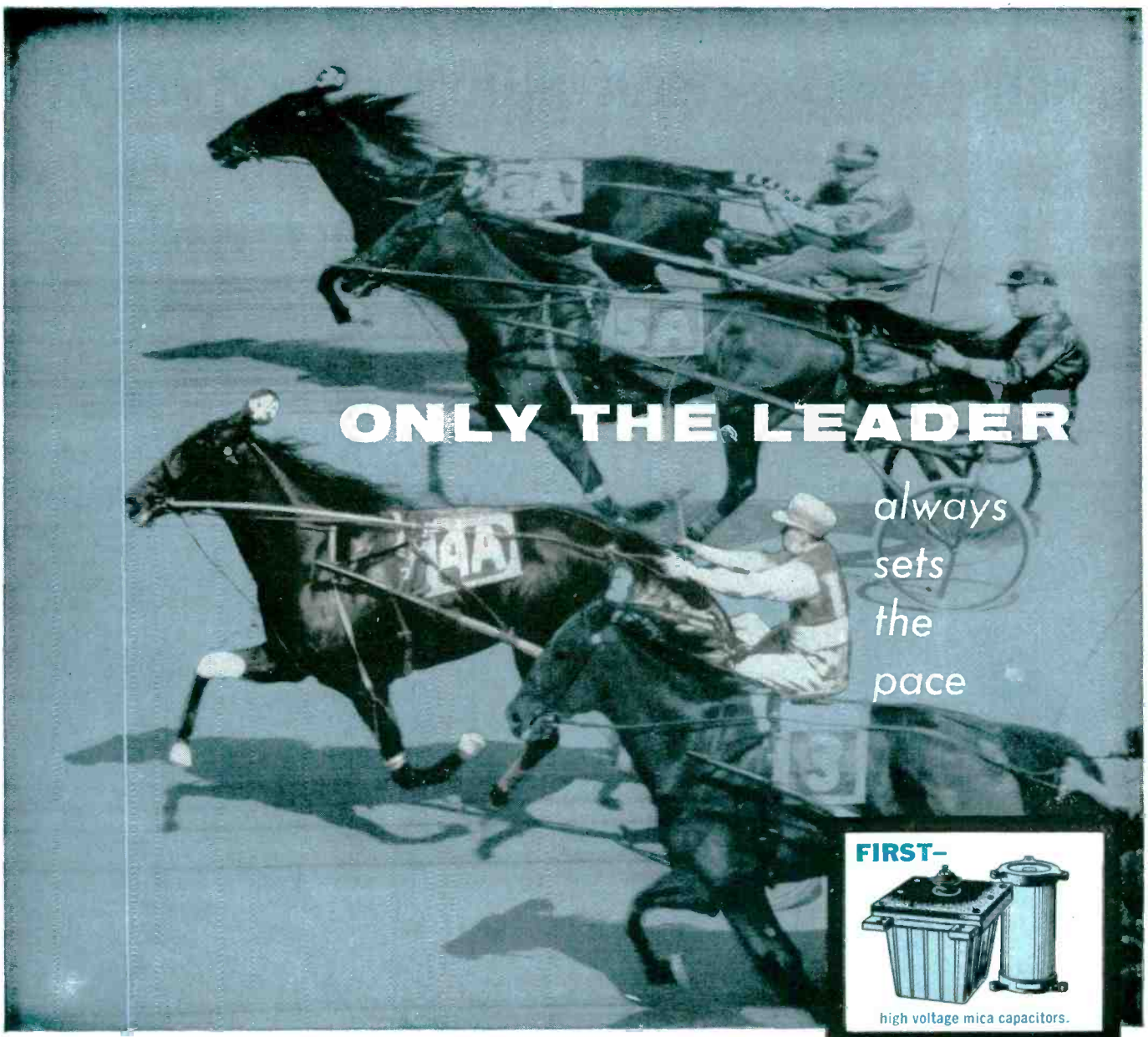
Mullard

ELECTRONIC TUBES

used throughout the world

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

MEV35



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high voltage mica capacitors.

FIRST–

super-power tank
circuit mica capacitors.

In harness racing as in capacitors you pick the leader by looking at the record. That's why at Cornell-Dubilier, we're mighty proud of our record of new capacitor designs, consistent dependability and outstanding field performance –a record no other company can even come close to approaching. That's the record of

C·D...45 YEARS OF FAMOUS FIRSTS

Typical of these "Famous Firsts" are the examples shown here ... just three of the hundreds of money-saving answers in capacitors a C-D engineer can show you. Write to Cornell-Dubilier Electric Corp., Dept. K-16 South Plainfield, N.J.

FIRST–

carrier current
coupling capacitors.

CONSISTENTLY DEPENDABLE

CORNELL-DUBILIER CAPACITORS

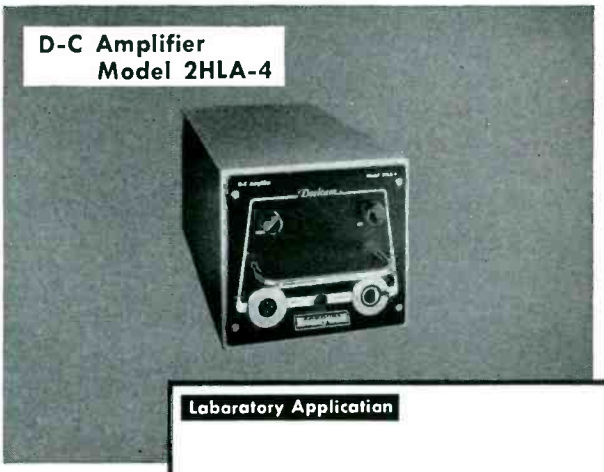
PLANTS IN SO. PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER AND CAMBRIDGE, MASS.; PROVIDENCE AND HOPE VALLEY, R. I.; INDIANAPOLIS, IND.; SANFORD AND FUQUAY SPRINGS, N. C.; SUBSIDIARY, RADIART CORP., CLEVELAND, OHIO.

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

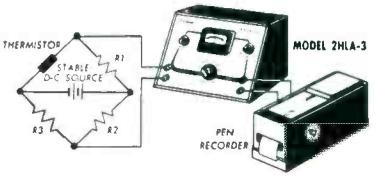
NEW DOELCAM PROPORTIONAL AMPLIFIERS OFFER GREATEST VERSATILITY IN LOW LEVEL D-C SIGNAL APPLICATIONS

HERE ARE TWO PRECISION AMPLIFIERS incorporating the new *Doelcam Second Harmonic Magnetic Converter* as the input stage. This unique design concept makes possible low noise level, high sensitivity and linear output.

The Model 2HLA-3 is both a Linear Indicator and a Multirange Amplifier. The Model 2HLA-4 is a Single Range Amplifier with provision for interchanging range by plug-in units. Both are ideal for either laboratory or production use.

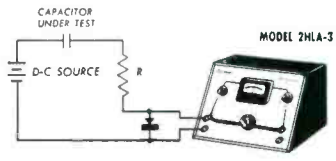


Laboratory Application



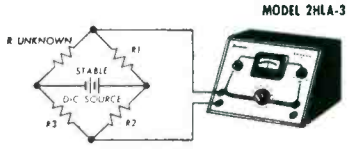
The fast thermal response of highly sensitive thermistors can be accurately measured and recorded.

Production Application



Measuring the dielectric leakage current of capacitors.

Production Application



Production testing of precision resistors or potentiometers in a balanced bridge circuit.

Write for Bulletin 1A-7 Write for Bulletin SRA6

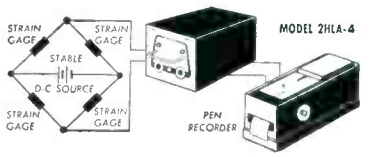
WHETHER YOUR APPLICATION is in the laboratory or on the production line, one of these two instruments is ideally suited. Their versatility is illustrated in the diagrams shown here. The Model 2HLA-3 is both a precision measuring laboratory instrument and a rugged production test instrument. The Model 2HLA-4 is designed for rack mounting as a component part of a control or measuring system.

HERE ARE SOME PERFORMANCE CHARACTERISTICS:

- High Gain — 10^4 for 2HLA-3, 10^5 for 2HLA-4
- Low Noise — less than 5 microvolts equivalent input
- Linear Amplification—better than ± 1% on all ranges
- High Stability — zero drift less than 10 microvolts
- Rugged — withstands inputs of 1.5 volts

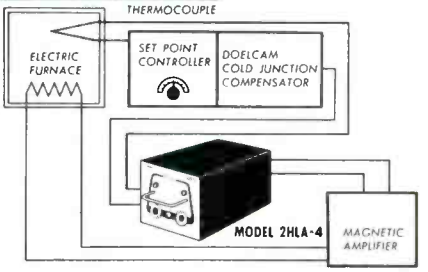
SPECIAL APPLICATIONS: These instruments can be easily adapted to provide linearity down to 0.1%, isolated input, multiple inputs, increased gain, increased power output and extended frequency response. Send us your complete requirements.

Laboratory Application



Dynamic stress measurements made with linear response up to 20 cps.

Control Application



Temperature control within a small temperature range.

Doelcam

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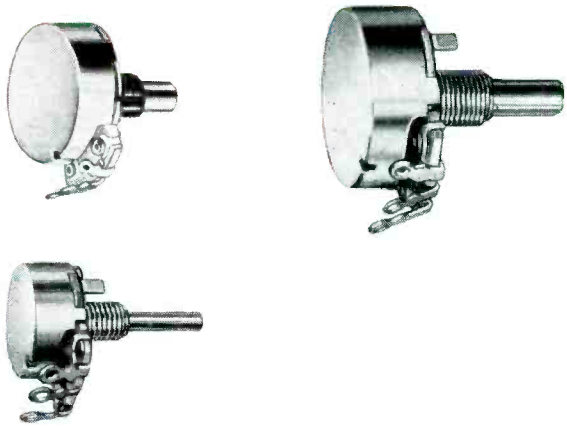

VARIABLE RESISTORS

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Henry E. Sanders
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Camden 2, New Jersey
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TWX No. Camden NJ 380
Phila. Phone: Market 7-3129

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Robert A. Stackhouse
928 S. Robertson Blvd.,
Los Angeles 35, Calif.
Phone: Crestview 4-5931
TWX No. BEV H 7666

SOUTHWESTERN U.S.A.
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6815 Oriole Drive
P.O. Box 7224
Dallas 9, Texas
Phone: Dixon 9918

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Phone: 310

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Montevideo, Uruguay
Rio de Janeiro, Brazil
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OTHER EXPORT
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New York 18, New York
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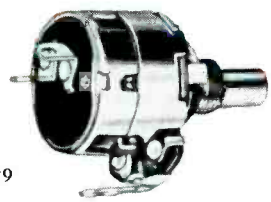

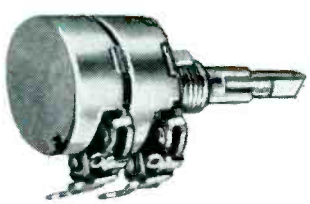

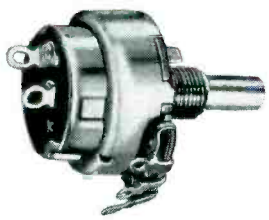

275,000 sq. ft. plant area . . . 1500 employees . . . making ALL TYPES of variable resistors by the million . . . for ALL TYPES of military and commercial applications.

Dependable delivery. Exceptionally good delivery cycle due to enormous mass production facilities.

A CTS control can be tailored to your specific requirement. Refer your control problems to CTS specialists today.

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The Exclusive Specialists in Precision Mass Production of Variable Resistors

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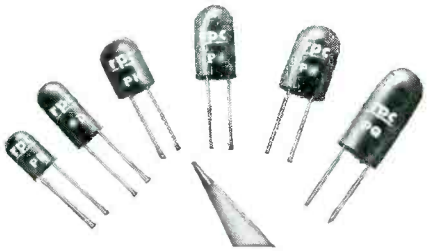


NEW **Printed Circuit Precision Resistors**

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

rpc

HIGH QUALITY RESISTORS FOR ELECTRONICS

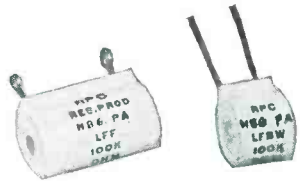
RPC is a widely recognized supplier of high quality resistors to industry, Government Agencies and the Armed Forces. Advanced production methods, modern equipment and scientific skill enables RPC to manufacture resistors of *highest quality* in *large quantities* at *reasonable cost*. Modern manufacturing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

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

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

Wire Wound Precision Meter Multiplier Resistors

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

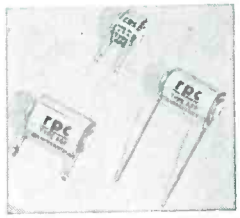


Encapsulated Precision Wire Wound Resistors

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

High Voltage Resistors

Type B Resistors are stable compact units for use up to 40 KV. These resistors are used for VT voltmeter multipliers, high resistance voltage dividers, bleeders, high resistance standards and in radiation equipment. They can be furnished in resistance to 100,000 megohms. Available as tapped resistors and matched pairs. Sizes range from a 1 watt resistor 1 inch long x 3/16 inch diameter rated at 3500 volts, to a 10 watt resistor 6½ inches long x ⅜ inch diameter rated at 40 KV. Low temperature and voltage coefficients. Standard resistance tolerance 15%. Tolerances of 10%, 5% and 3% available. Tolerance of 2% available in matched pairs.



Wire Wound Precision Resistors

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

High Megohm Resistors

Type H Resistors are used in electrometer circuits, radiation equipment and as high resistance standards. Resistance available to 100 million megohms, (10^{14} ohms). For utmost stability under adverse conditions Type HSD and HSK Hermetically Sealed are recommended. Eight sizes fram 7/16 inch to 3 inches long are available. Voltage rating to 15,000 volts. Low temperature and voltage coefficients. Standard resistance tolerance 10%. Tolerance of 5% and 3% available. Also matched pairs 2% tolerance.

RESISTANCE PRODUCTS CO.

914 S. 13th Street
HARRISBURG, PA.

leadership in semi-conductors

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All Transitron semi-conductors are produced to the most rigid military and commercial specifications to assure long life and complete reliability. They provide the trouble-free, dependable performance that is so essential in modern complex electronic equipment.

Whether your requirements are for Germanium or Silicon, the solution can be found in Transitron's diversified line of semi-conductors. A wide variety of standard types, along with over 300 special types, are available. Your inquiries are invited.

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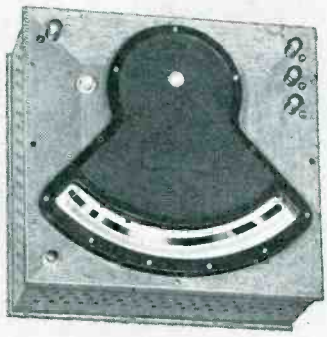
✻ 1/10 OF 1%... LABORATORY STANDARDS



the primary instrument standards the world over... for instrument checking and maintenance, and wherever measurements must be made to a high degree of accuracy. Available as D-C Voltmeters and D-C Ammeters, and as A-C and D-C Voltmeters, Ammeters, and Single Phase Wattmeters.

✻ 1/4 OF 1%... PORTABLE STANDARDS

the portable reference standards, for checking instruments, certified test work, and laboratory measurements. Available as A-C and D-C Voltmeters, A-C and D-C Ammeters and Milliammeters, D-C and Single Phase A-C Wattmeters, Poly Phase Wattmeters, Power Factor Meters, Frequency Meters and Phase Angle Meters.

✻ ACCURACY RATED

Weston's comprehensive selection of accuracy ratings enables you to choose instruments which *exactly* meet your measurement needs from every standpoint...*conservatively rated accuracy, long life, low cost.* For literature, consult your local Weston representative, or write direct.

WESTON Instruments

WESTON Electrical Instrument Corporation

614 Frelinghuysen Ave., Newark 5 N. J. — *A subsidiary of Daystrom, Inc.*

✻ 1/2 OF 1%... WORKING STANDARDS

the rugged portables for general test work where long, readable scales and high shielding are desired. Available as D-C Voltmeters, Ammeters, Milliammeters and Volt-Ammeters; and as A-C Voltmeters, Ammeters, Milliammeters, and multi-range Ammeters and Voltmeters; A-C and D-C Single Phase Wattmeters.

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Cushioned Glass Construction
High Dielectric Strength
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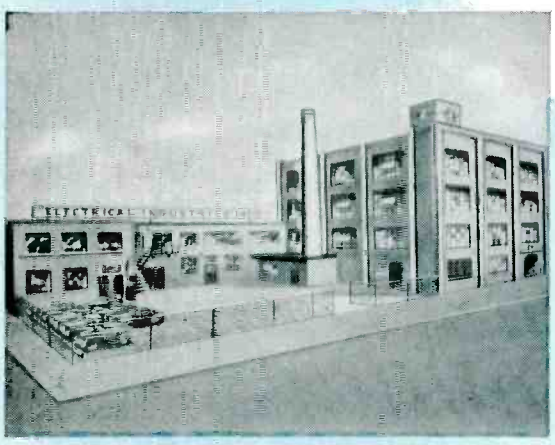

-and COMPLETE FACILITIES

MAIN PRODUCTION FACILITIES IN NEWARK, NEW JERSEY The Newark plant houses the main engineering and production facilities at E-I. Designing, tooling and assembly departments include the most modern methods and equipment known to industry, today.

CONTINUING RESEARCH KEEPS PACE WITH INDUSTRY'S NEEDS. The complete research laboratory located in Irvington-on-Hudson in New York assures products that anticipate the ever more critical requirements of the electronic industry.

THE HICKSVILLE PLANT ON LONG ISLAND IS EQUIPPED for all types of electronic production. The Hicksville facility is one of the oldest producers of transmitting tubes, x-ray tubes, magnatrons and all forms of glass-to-metal seals.

E-I HEADQUARTERS—for Compression Seals, Multiple Headers, Sealed Terminals, Condenser End Seals, Threaded Seals, Transistor Closures, Miniature Closures, Color Coded Terminals, etc.

One **dependable** source for **all** hermetically sealed terminal requirements!

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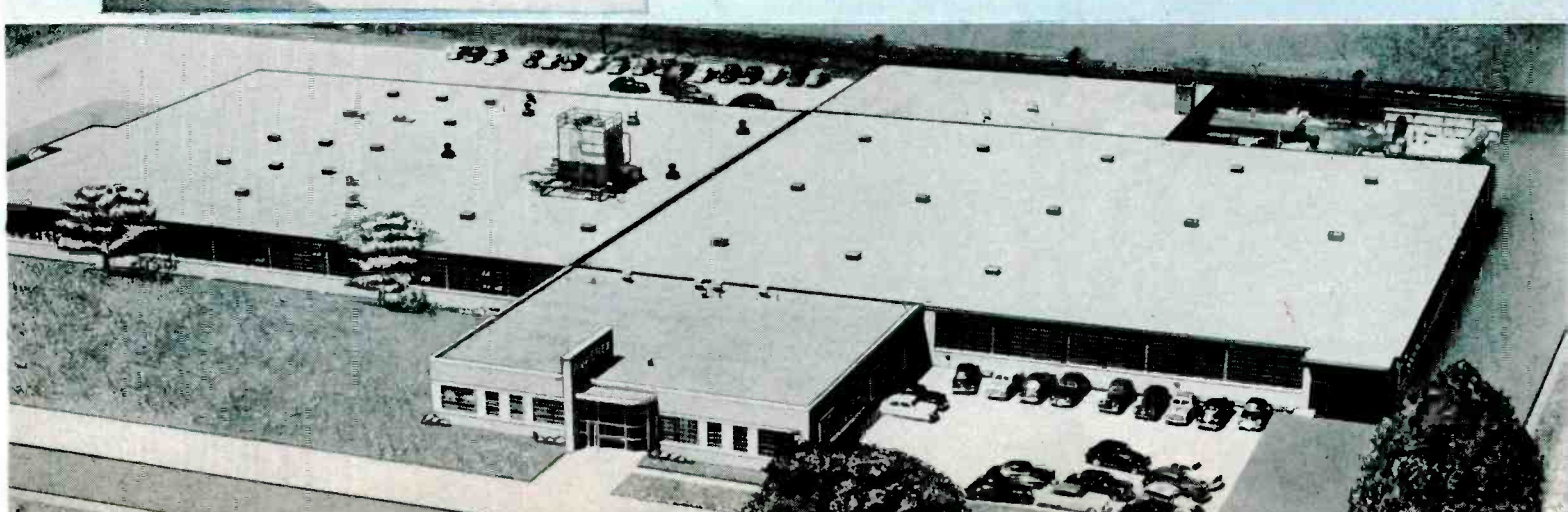
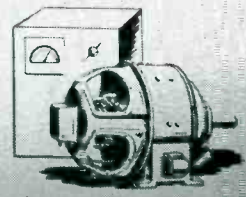
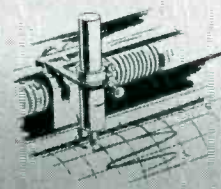


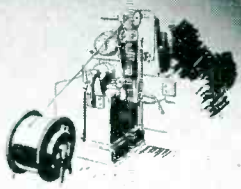
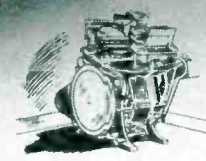
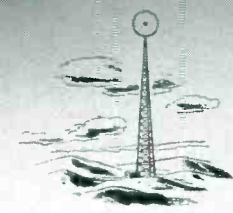





WHEN LONG-LIFE *PLUS* IS ESSENTIAL

SPECIFY RCA "SPECIAL REDS"

...electron tubes with 10,000 hour minimum life warranty!

RCA "Special Reds" provide that extra "life-line" you need in industrial electronic equipment, air, marine, and land-mobile communications, and unattended relay and transmission circuits—that extra margin of safety and dependability that *keeps things going!*

RCA "Special Reds" feature remarkable *stability*, excellent resistance to shock and vibration, exceptional *uniformity* of characteristics from tube to tube—and are backed by RCA for 10,000 hours minimum life!

RCA "Special Reds" are recommended for initial designs in industrial electronic equipment. They are excellent as replacements in existing circuits where there is a prototype operating under conditions within the ratings of the "Special Reds."

CONTACT YOUR LOCAL RCA TUBE DISTRIBUTOR TODAY. Ask for your free copy of the booklet "RCA Receiving Type Tubes for Industry and Communications" (form RIT-104).

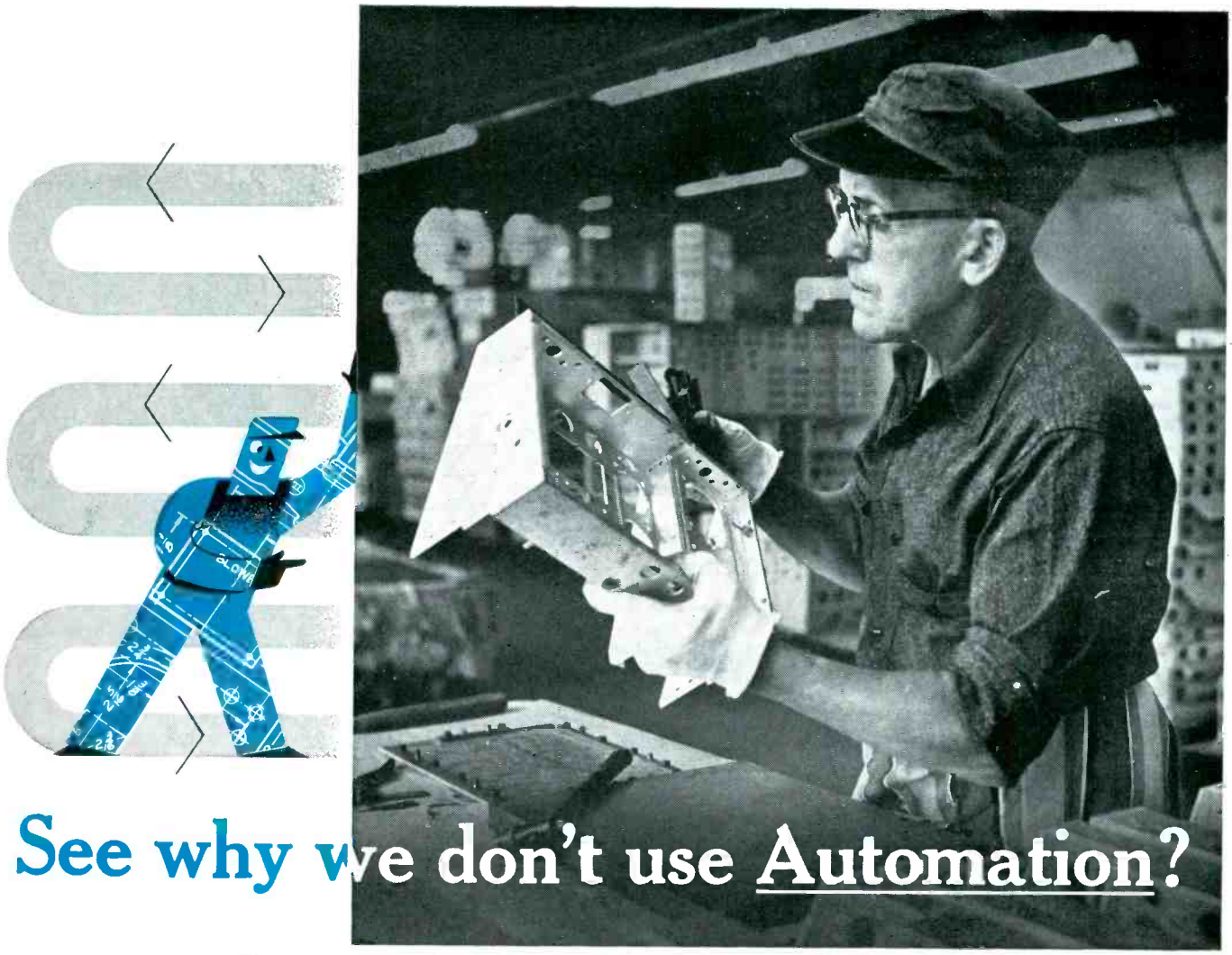
RCA-5690—Full-Wave Vacuum Rectifier with separate heaters and cathodes.

RCA-5691—High-Mu Twin Triode. Similar to the RCA-6SL7-GT, but has twice the heater current.

RCA-5692—Medium-Mu Twin Triode. Similar to the RCA-6SN7-GTB.

RCA-5693—Sharp-Cutoff Pentode. Similar to the RCA-6SJ7.

RCA **ELECTRON TUBES**
RADIO CORPORATION OF AMERICA



See why we don't use Automation?

It's not that we are old-fashioned, here at Karp. Far from it. We have one of the best tooled and equipped sheet metal fabrication plants in the world. Many of our machines, indeed, are equipped with electronic timing controls.

If the time ever comes when we feel that automation can give you finer work than our several hundred skilled craftsmen... we'll install automation. But that time is not now—nor in the foreseeable future.

You see, Karp was founded upon a perfectionist's idea about custom craftsmanship. Our methods are paying off because our painstaking work to exact specifications results in quality products to you, often at "ready-made" economies. And remember—our men who were skilled craftsmen ten or twenty years ago are even more highly skilled craftsmen today.

Let us quote you on your next requirement.

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Custom fabricators of enclosures, chassis, panels in any metal • All welding facilities U. S. Air Force Certified • Air-conditioned spray room • Complete baking facilities • Over 3,000 dies available Complete sub-assembly facilities

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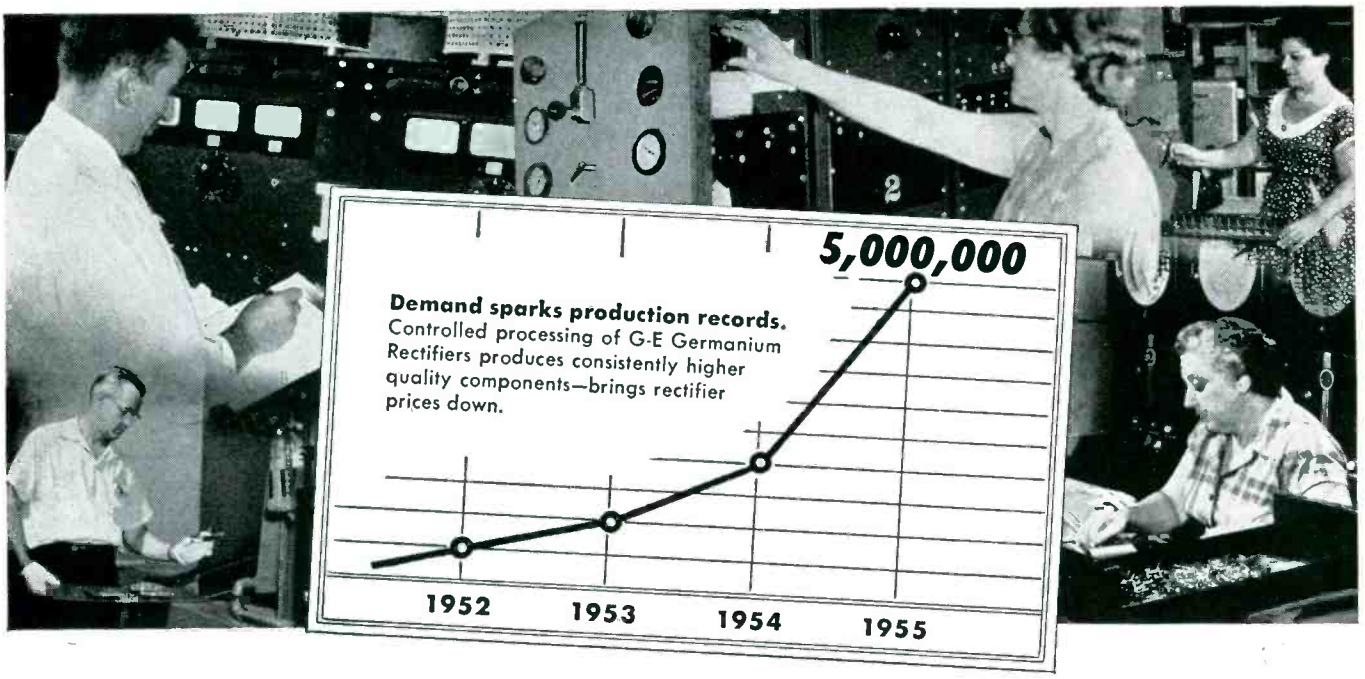


G-E Germanium Rectifier Production Breaks the 5 Million Mark

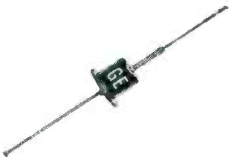
Customer requirements accelerate the production of a full line of highly reliable, long-life germanium rectifiers

THE NEW germanium rectifiers were introduced by General Electric in 1952 and since then more than 5 million units have been produced for industrial and military needs. In effect, this achievement represents more than *ten billion hours* of rectifier life—in hundreds of diversified commercial and military applications.

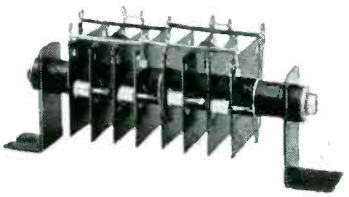
> **PROVED QUALITY!** Of the 5,000,000 rectifiers produced, only a fraction of 1% have required adjustment under the terms of General Electric's full year warranty!

Wide Range of Designs. G-E rectifiers are available in a broad range of designs for many applications—for electronic computers, control equipment, power supply units, magnetic amplifiers; for military and industrial needs requiring custom designs; and for almost any application where DC power is required. G-E Germanium Rectifiers are more compact, and weigh less—as much as 75% less than comparable rectifiers of other types—and meet the rigid requirements for performance established by the U. S. Navy, Air Force, and Signal Corps. What's more, G-E Germanium Rectifiers are *warranted for one full year.*

Immediate Delivery. Mass production assures fast delivery on all G-E Germanium Rectifiers regardless of quantity. For complete information concerning your rectifier needs, contact your G-E Semiconductor Representative. Or, write: *General Electric Company, Semiconductor Products, Section X 416, Electronics Park, Syracuse, New York.*



Diffused Junction Germanium Rectifiers combine very high forward conductance with very high back resistance. The high temperature and magnetic amplifier rectifiers feature very low reverse current ratings at ambient temperatures of 85°C.



Power of the basic rectifier unit is boosted 5 times by adding a copper fin. Stacked one to twelve fins in series or parallel, the rectifier may be operated as half wave, full wave, or bridge circuits, and many other types of single or polyphase circuits. Typical power ratings are as high as 3 amps @ 190 volts; 1.3 amps @ 575 volts; 3.6 amps @ 140 volts, etc.

The Medium Power Rectifier has a 5 amp rating at 200 volts (55°C). At 85°C it is rated 2.5 amps at 100 volts. These rectifiers, stacked in series or parallel, have ratings in thousands of watts depending on the design of the circuit.

Progress Is Our Most Important Product

GENERAL ELECTRIC

UNLIMITED HORIZONS

THE NEW LIGHTWEIGHT U.S.A.F. J4 COMPASS SYSTEM PERMITS PRECISE FIGHTER NAVIGATION AT ALL LATITUDES

ANOTHER MAJOR GYRO PROBLEM SOLVED BY WEAPONS GUIDANCE LAB. U.S.A.F. AND KEARFOTT

This miniature Kearfott Directional Gyro is the heart of the U.S.A.F. J4 Compass System. The System provides both latitude corrected and magnetic slaved directional gyro heading information. Suitable output transmitters are incorporated to supply compass data to autopilots, course indicators, and other systems requiring this information. This system provides all the functions of the Kearfott designed U.S.A.F. N1 Compass System with little loss in accuracy despite a 66% reduction in weight. The J4 Compass System as designed by Kearfott was selected by the Air Force ". . . due to its adaptability to product improvement and Kearfott's ability to meet the urgent requirements of the Air Force."

U.S.A.F. J4 Directional Gyro
Random drift rate 3° per hour max.
Weight 7½ lbs

OTHER KEARFOTT GYROS IN PRODUCTION

VERTICAL GYROS: Precise verticals with 2 mins. vertical accuracy (Bench) weigh 7 pounds and measure 5⅛" diam. x 6⅜" high. Miniature verticals with 15 mins. vertical accuracy weigh 3.5 pounds and measure 3" x 3" x 4" approx.

FREE GYROS: Designed specifically for missile applications with 1° per minute drift. Under 2000 cps vibration at 3G drift will not exceed 5°/ min. The gyro withstands 60G shock.

FLOATED RATE INTEGRATING GYROS: Designs include 2.5 x 10^6, 2 x 10^4 and 6 x 10^6 wheels. Representative random drift rate .25°/ hour on day-to-day basis. Standard deviation for one day run .05°/ hour.

STABLE PLATFORMS: 3 gyro, 3 and 4 gimbal designs now in development, flight test or production are suitable for primary gyro reference or for inertial applications.

There is a Kearfott Gyro suitable for every aircraft and missile application. Write today for detailed technical data.

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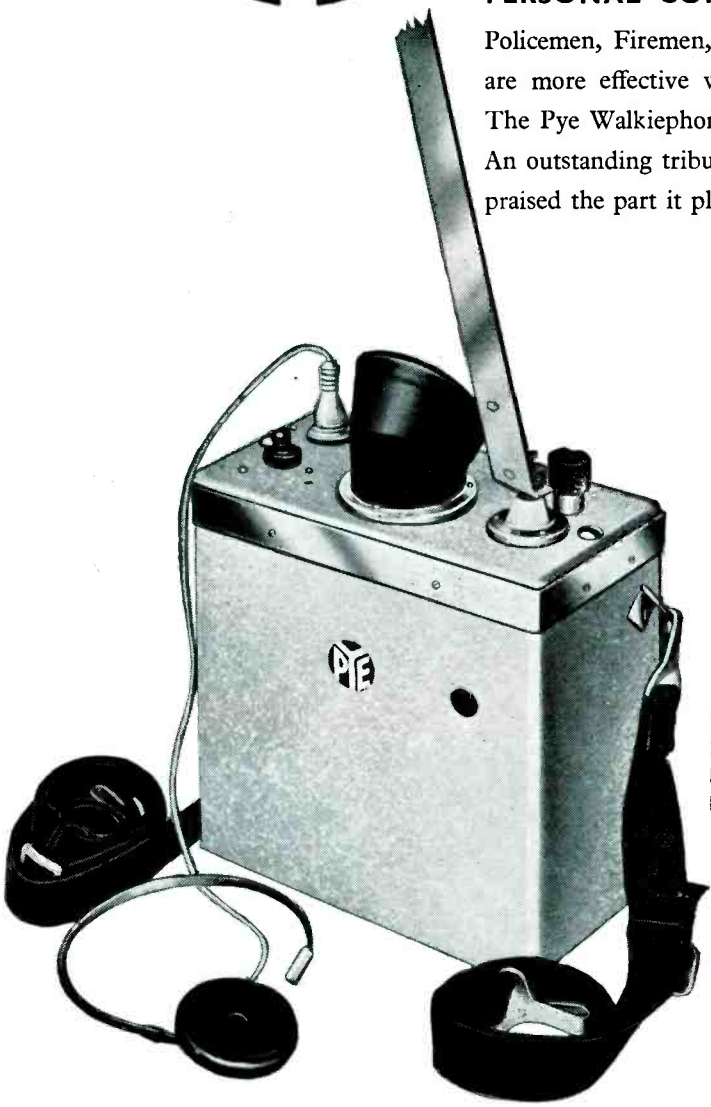

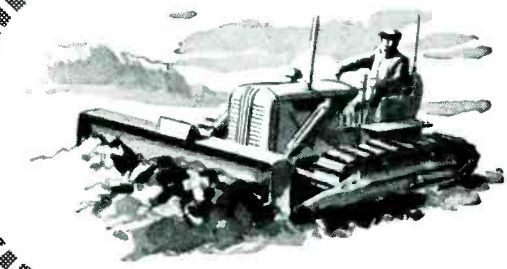

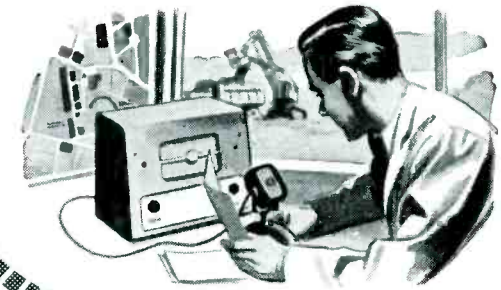

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Over the twelve years that Fairchild has been making precision potentiometers — from our first unit (Type 736), on through the more than eighteen different types now in production — we have established and are carrying out a research and development program on new designs and materials, techniques and equipment that is constantly improving our potentiometer reliability. The results of this program are quickly applied to production units and these improved methods and designs are maintained by comprehensive quality control and type testing programs.

MAXIMUM RELIABILITY . . .

how do you get it?

Reliability in precision potentiometers resolves itself into three basic factors; longer shelf life, longer rotational life, and longer environmental life. Fairchild has increased the average shelf and rotational life expectancy of precision potentiometers far beyond usually expected life cycles, in one way, by compounding and using special potentiometer lubricants. Life expectancy and stability under abnormal operating conditions have been vastly increased through the use of precision-machined aluminum alloy case construction. Epoxy resin insulation, one-piece Paliney conductive springs and contacts, and precious metal alloy resistance elements, for certain applications, also contribute to increased life and functional reliability. Whether one or all of these factors of reliability are important to you, you'll do better to choose Fairchild Precision Potentiometers. For specific facts, write Fairchild Camera and Instrument Corporation, Potentiometer Division, 225 Park Avenue, Hicksville, Long Island, New York, Department 140-64A2.

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PRECISION POTENTIOMETERS

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1. POTENT POWER + **2. SMALL SIZE**

Up to 5100 mmf at 300 vDCw
Up to 3900 mmf at 500 vDCw

(size) Length 3/4", average Width 7/16", average Thickness 3/16" DM-20 shown actual size

El-Menco

Dur-Mica

DM-20

DIPPED MICA CAPACITOR WITH PARALLEL LEADS

3. PEAK PERFORMANCE

ideal for new miniatured designs and printed wiring circuits

MEETS ALL HUMIDITY, TEMPERATURE AND ELECTRICAL REQUIREMENTS OF MIL-C-5 Specifications!

TEST IT AND COMPARE!

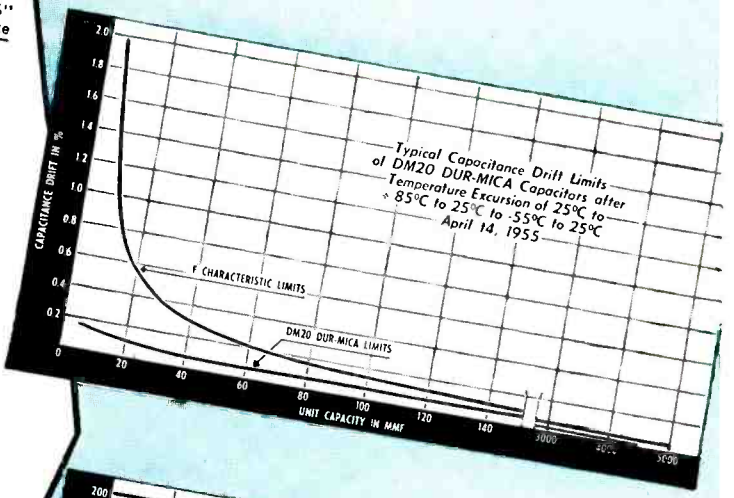
- El-Menco's Dur-Mica DM20 costs even less than our famous molded mica capacitors.
- Provides greater versatility — wider applications.
- Tougher phenolic casing assures *longer-life* and *greater stability* through wide ranges in temperature.
- Parallel leads simplify application in transistor and sub-miniature electronic equipment including printed circuits for military and civilian use.

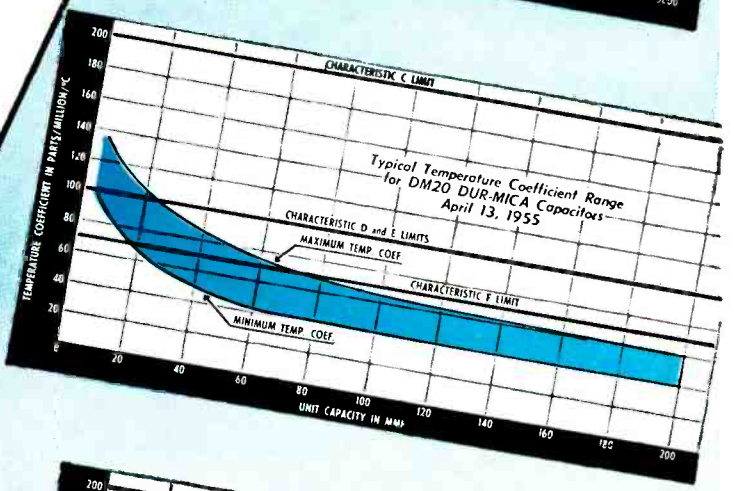
For Extreme Miniaturization Use Our DM15

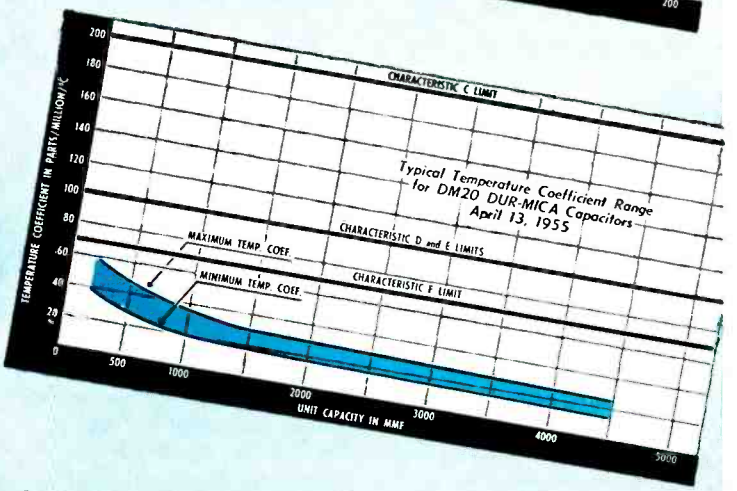
DM15 — Up to 510 mmf at 300 vDCw
Up to 400 mmf at 500 vDCw

Available in 125°C operating temperature. Minimum capacity tolerance available ±½% or 0.5 mmf (whichever is greater).

to meet modern miniature requirements







For your special requirements — we are pleased to offer information and assistance. Write for free samples and catalog on your firm's letterhead.

THE ELECTRO MOTIVE MFG. CO., INC.

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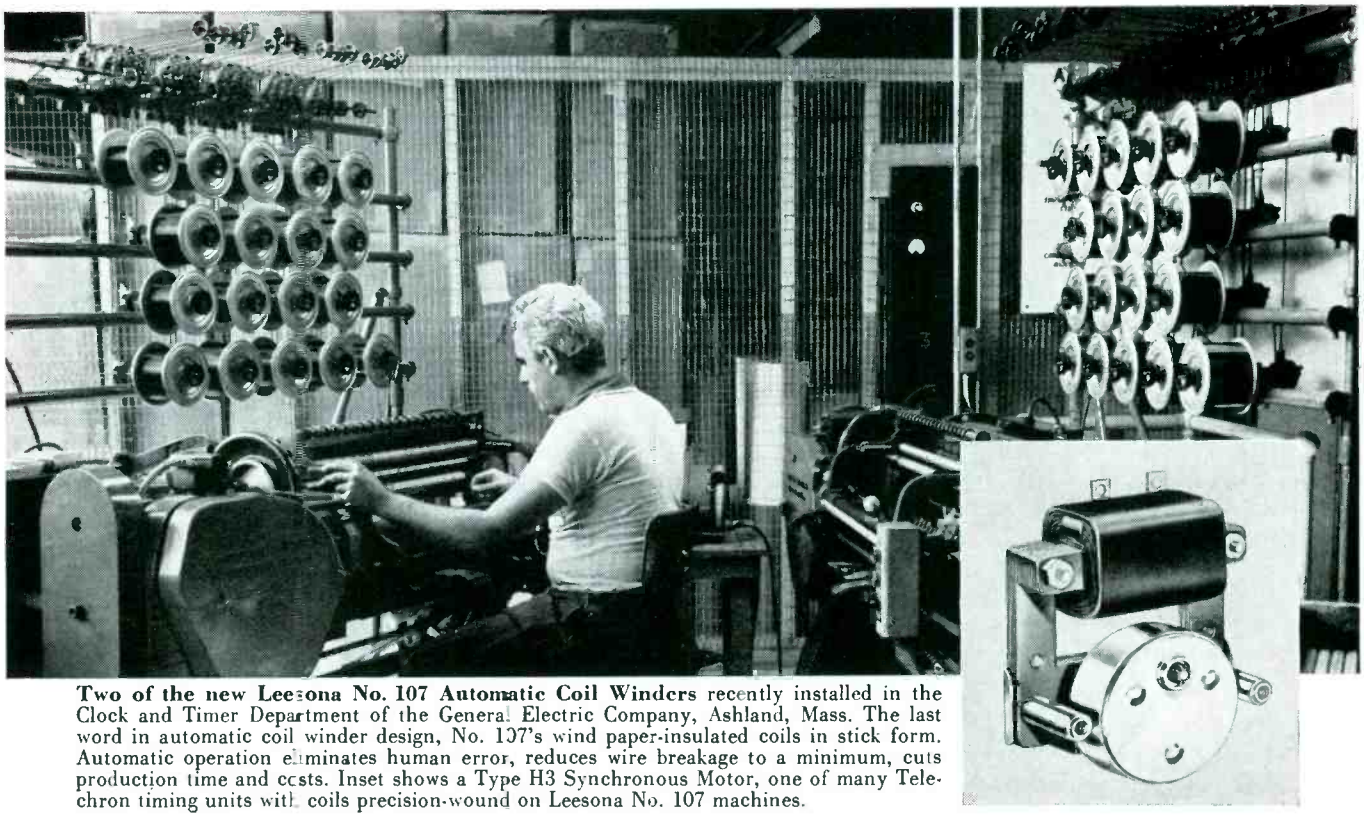
El-Menco Capacitors



Two of the new Leesona No. 107 Automatic Coil Winders recently installed in the Clock and Timer Department of the General Electric Company, Ashland, Mass. The last word in automatic coil winder design, No. 107's wind paper-insulated coils in stick form. Automatic operation eliminates human error, reduces wire breakage to a minimum, cuts production time and costs. Inset shows a Type H3 Synchronous Motor, one of many Telechron timing units with coils precision-wound on Leesona No. 107 machines.

Clock and Timer Department, General Electric Company selects Leesona Coil Winders as standard equipment

General Electric Department adds No. 107 machines for proved production advantages

The synchronous timing motors made by the Clock and Timer Department of the General Electric Company are famous for accuracy and dependability.

One reason why is the high efficiency maintained by this department of the General Electric Company, in its wide range of coil winding operations. Leesona Coil Winders are standard equipment at General Electric Telechron plants — and during a recent expansion of production facilities, Leesona No. 107 Automatic Coil Winders were important new additions.

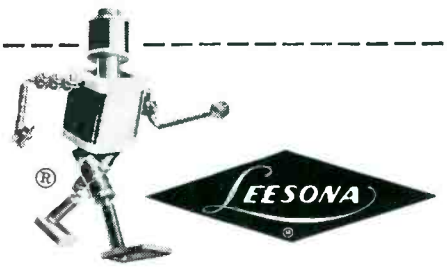
Leesona No. 107 machines are fully automatic. Every feature is designed to produce compact, uniform, paper-insulated coils — in fastest time — with minimum operator attention — at lowest cost. This General Electric department reports:

"The Short Paper Attachment on our Leesona No. 107 Coil Winders is a big advantage. Allowing an initial paper insert of 1 1/16", it eliminates the usual 2 3/4" insert when starting winding. On these particular coils the result is considerable savings in wire."

Get the Whole Story

on how Leesona No. 107 Automatic Coil Winders can bring new, profit-boosting efficiency to your own coil winding production. For complete details on this advanced machine — and other helpful coil winding information — check and mail the coupon today.

B.5.4



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IN QUANTITY...ACCURATELY
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UNIVERSAL WINDING MACHINES

UNIVERSAL WINDING COMPANY

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Please send me

- ☐ Bulletin on the Leesona No. 107 Automatic Coil Winder.
- ☐ Condensed catalog of Leesona Winders.
- ☐ Bulletin on the new Leesona *Pay-As-You-Profit Plans* for purchasing or leasing modern coil winding machinery.

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TRUFLEX® Thermostat Metal Coils Over ⅓ Mile Long in One Piece Simplify Fabrication and Reduce Costs in Thermal Element Manufacture

The problem . . . to obtain thermostat metal strip in a series of types having sufficiently uniform dimensional control and temperature response to be fabricated into finished parts on automatic machines.

The solution . . . Step 1; the consistent quality of each type of TRUFLEX tested quickly demonstrated that mass production by machine was fully practical for all types.

Step 2; General Plate Division then supplied the required types in long coils 3 feet in diameter with center hole to fit the customer's automatic machine arbors. Each coil is a continuous piece 1800 feet long, by 0.040″ thick and 0.250″ wide.

These coils save the customer many dollars by minimizing idle machine time and eliminating costly waste of material in fabrication.

If your products require temperature control . . . indication or compensation, the accurate performance and uniform high quality of TRUFLEX Thermostat Metals will save you money too.

Here's why! General Plate Division uses advanced production methods, combining the best equipment available with years of manufacturing "know how", to insure positive consistence in thermal and mechanical performance of TRUFLEX Thermostat Metals.

General Plate Division will fabricate parts from TRUFLEX to meet the specific mechanical and electrical performance demands of your particular applications. Or, if you prefer to make your own parts, General Plate Division will supply TRUFLEX Thermostat Metal in strip to meet your specifications.

Write today for your copy of the new TRUFLEX Thermostat Metal Catalog. Engineering assistance available without obligation.

GENERAL PLATE ELECTRICAL CONTACT KIT FOR LABORATORY AND DEVELOPMENT USE

Kit K11 contains a wide assortment of silver rivet contacts; Kit K12 has representative standard button contacts. Also included are metal strips for fabrication of contact parts. These kits are available at nominal cost.

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You can profit by using General Plate Composite Metals!

MEMO

FROM: THE ENGINEERING STAFF AT NJE

TO: ENGINEERS INTERESTED IN HIGH VOLTAGE

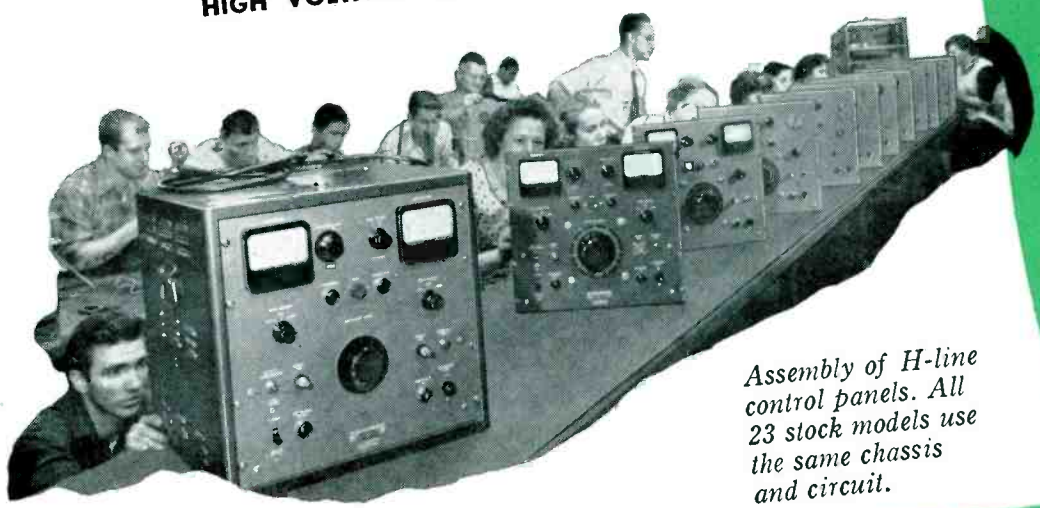
SUBJECT: **What is Mature Design?**

Our "H-line" Industrial High-Voltage power supplies are a good example of mature design.

- 23 stock models blanket 95% of all applications.
- They are completely safe.
- They protect themselves against abuse and/or mishap.
- They are very flexible—reversible polarity, triple-range metering, 100% voltage control, wide-range trip-out adjustment.
- They are compact and relatively light. They mount in rack or cabinet. They make a striking appearance.
- Their simple, logical design uses the same circuit, the same components, the same techniques over and over again. This means purchasing and mass-production savings, which are reflected in our prices.

As we have said before, with the introduction of our H-line,

HIGH VOLTAGE COMES OF AGE!



Assembly of H-line control panels. All 23 stock models use the same chassis and circuit.

For our complete line of electronic power supplies See electronics Pp. 113-120 BUYERS' GUIDE

Write for Catalog H-5 with complete prices and specifications of our H-line Industrial High Voltage Power Supplies.

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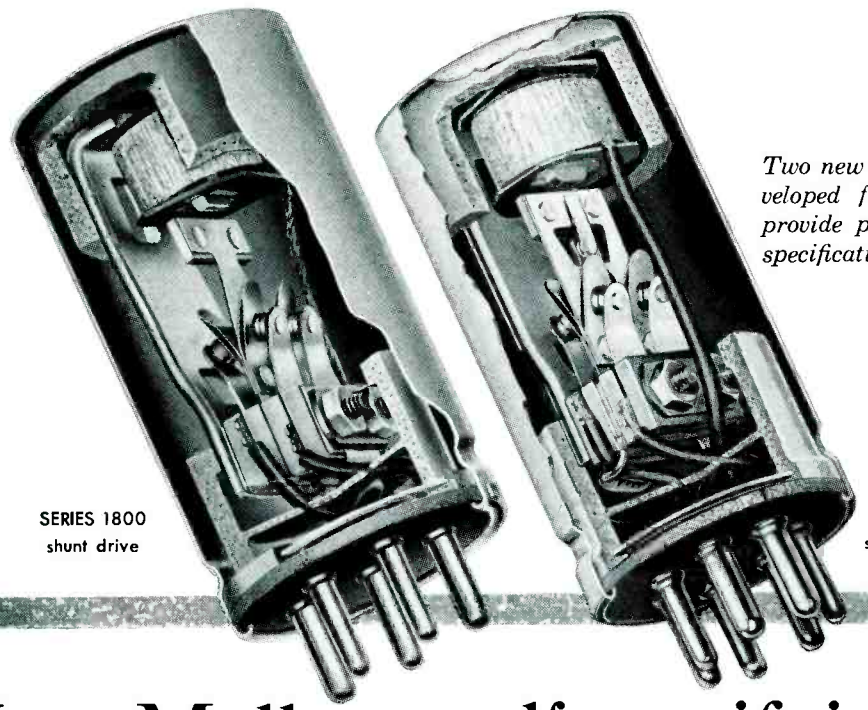

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electronics

W. W. MacDONALD, Editor

JANUARY • 1956

CROSS TALK

► **FUTILITY?** . . . Referring again to the editorial entitled D.O.A., which appeared here in November and was followed up in December, it is interesting to note that several tv manufacturers reported unexpected increases in the sale of higher-priced sets in the last quarter.

There could be many reasons for this switch away from rock-bottom leaders on the part of the public. Among them, it is possible that people who have had their fingers burned by shoddy merchandise hope they can get good merchandise by paying more for it.

This may or may not be so at the moment, depending upon whether the additional dollar went into the chassis or into the cabinet. But it does indicate that the pendulum may be swinging back toward quality.

► **REVERSE ENGLISH** . . . As the trend toward greater automation continues, more and more manufacturers of machinery will get million-dollar orders largely on the strength of thousand-dollar electronic controls. And in many instances the controls will be made by somebody else.

Where the somebody else is an established maker of electronic equipment our industry will gratefully accept the new business and run. If history repeats there will be little thought on the part of the average electronics manufacturer about the relative size of the two orders, the thousand-dollar and the million-dollar package.

What prevents an occasional manufacturer of electronic controls from building or buying materials-handling, or production, or packaging machines for sale in combination with his controls? Must the tail always wag the dog?

► **UPSET THEORIES** . . . Up in the northland, near the spot where Marconi's first transatlantic wireless message was received 55 years ago, is a scatter-propagation station pushing radio signals hundreds of miles on a frequency believed for many years limited to just a little more than line-of-sight distances.

This reminds us that prior to 1901 many scientists thought that "magnetic signaling" would forever be limited to a maximum range of 165 miles.

► **NO SMUGNESS** . . . No industry is more reliant upon new technical developments for its future markets than the electronics industry.

The president of one of the largest companies in the field expressed this well in a recent speech in which he said "In our own company last year, forty-eight percent of our sales were in product lines which our research laboratories and engineers have developed within the past 10 years."

Even more significant because it promises continued growth was his statement that "There is no such thing as an entrenched and unassailable position in the electronics or appliance business."

► **CRYPTOGRAM** . . . One of our most cryptic critics says the word "reliability" is rapidly becoming as meaningful as the words "high-fidelity."

We'll be cryptic too, and leave it right there.

LOOKING AHEAD . . .

Rash of new-year market surveys, extreme activity of public-relations people, indicates increasing industry interest in commercial versus military business

Desire for shallower television-receiver cabinets points toward 110 or even 120-degree picture tubes; engineers are burning midnight oil to develop deflection circuits

Growing importance of electronics market to machine builders accustomed to leasing equipment could spread lease idea further as, for instance, in the instrument field

Electronics and other engineers are doing a lot of serious thinking about the nature of gravity; maybe it would help to think about it as a combination of centrifugal forces from outer space pressing upon the earth rather than as a pull from within the planet

Transistors Up Reliability

SUMMARY —— Four-channel broadcast remote pick-up amplifier similar to conventional equipment operates either from power line or internal batteries. Automatic cut-over relay prevents loss of program. Printed circuits help keep weight to 17 pounds

By PAUL G. WULFSBERG

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Research and Development
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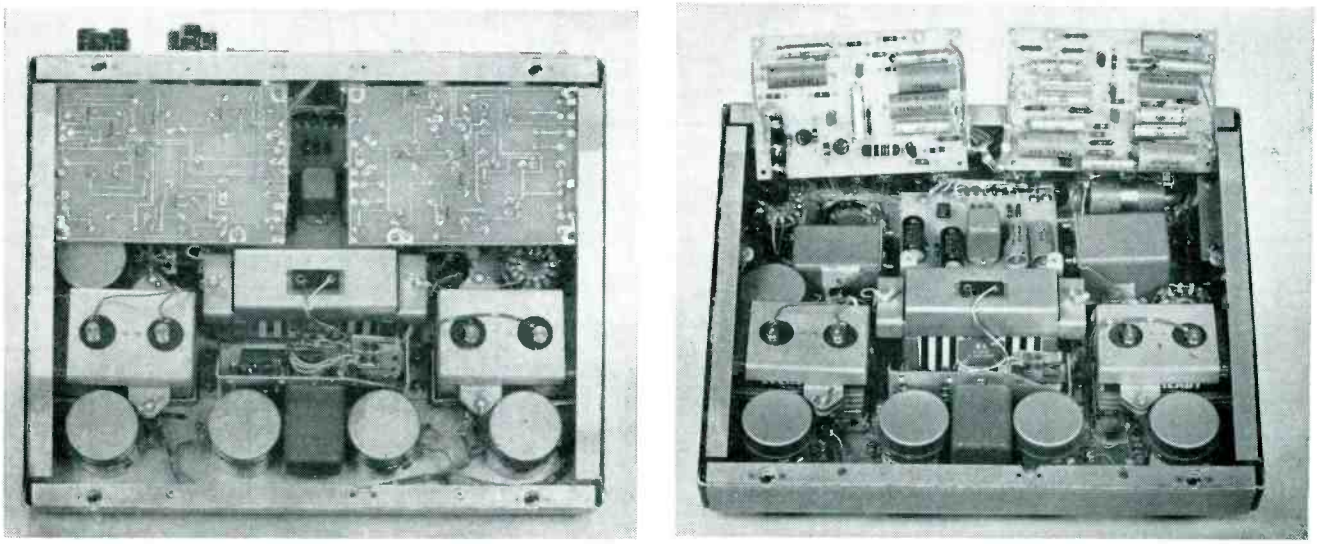
DEVELOPMENT of low-noise, low-cost, hermetically sealed transistors has opened the door to another area of products that can be transistorized. The broadcast remote amplifier is an example of a product in which transistors may be used exclusively without any sacrifice in cost or performance.

In addition, many new performance features may be achieved that were previously beyond the state of the art. Although little has been published on the use of transistors in high-fidelity audio circuits, they are well suited to this field, especially since they have the virtue of producing no microphonics. Reliability, which is important in broadcast equipment, is well served by the increased life of transistors and the fact that they are not susceptible to catastrophic failures but rather to a gradual decline in performance. This gradual decline is

Operating engineer using the self-contained transistor remote pickup broadcast and public address amplifier

# of Broadcast Remotes



Printed wiring boards shown as normally attached (left) and removed (right) to show components attached to underside

readily spotted in routine performance checks and does not cause program outages. This article describes the design considerations and details of an amplifier which takes advantage of new transistors now available in production quantities.

The broadcast remote amplifier is, in reality, a portable studio console. It permits the broadcast station to move the studio out to the program source and usually involves the use of several microphones. For example, a sporting event such as a football game may use as many as four microphones for full coverage of the event. The various microphone outputs are suitably mixed and amplified to a level of zero to +8 vu (+10 to +18 dbm) for transmission to the main studio over wire lines.

Customer Preferences

Design details of the remote amplifier were influenced by answers to a questionnaire mailed to a representative sample of broadcasting stations across the country. Among the features desired are a power source of both 115-v a-c and batteries with automatic power changeover when a-c power fails. Self-contained batteries with life of approximately 50 hours (25 hours minimum) are wanted. Maximum gain specified was 90 to 100 db. Also requested was a bridging volume control for public address feed and tone oscillator for line-level setup.

Preamplifier Problem

The first problem considered was suitability of transistors in low-level preamplifier service. After testing many transistors for noise figure, it was found that a preamplifier could be built with performance comparable to that of the best studio consoles. Figure 1 shows the curve of noise figure vs frequency for selected samples of type 2N106 units.

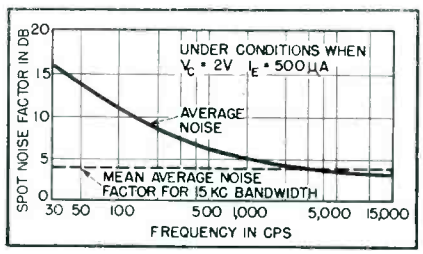


FIG. 1—Noise figure vs frequency for selected samples of 2N106 type transistors

Although the noise factor for frequencies below 1,000 cycles is not too impressive, the mean average noise for a 15-kc bandwidth is only about 3.6 db, which is considered acceptable. Noise power output of an ideal resistor of any resistance value for a bandwidth of 20 kc (typical for broadcast amplifiers) is −124.8 dbm.

The final design of this amplifier provides an equivalent noise input as low as −120 dbm (60 db below a −60 dbm input) which is only 5 db above the ideal amplifier. The input impedance of the grounded-emitter circuit used is about 1,000 ohms. Since it was found that the mismatch losses between the microphone and the transistor were only 1 to 5 db, as shown in Fig. 2, the usual input transformer was eliminated. This also eliminated the hum pickup and frequency-response problems associated with this transformer.

The weight and cost saved by eliminating the input transformer made practical high-level mixing through the use of individual microphone preamplifiers. In vacuum-

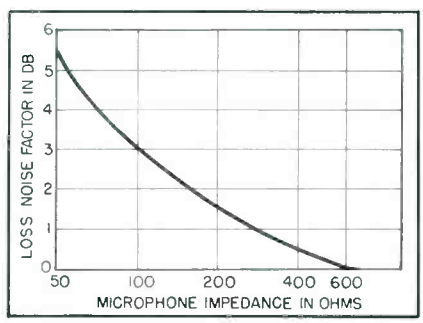


FIG. 2—Mismatch loss between microphone and transistor is slight enough to eliminate transformer

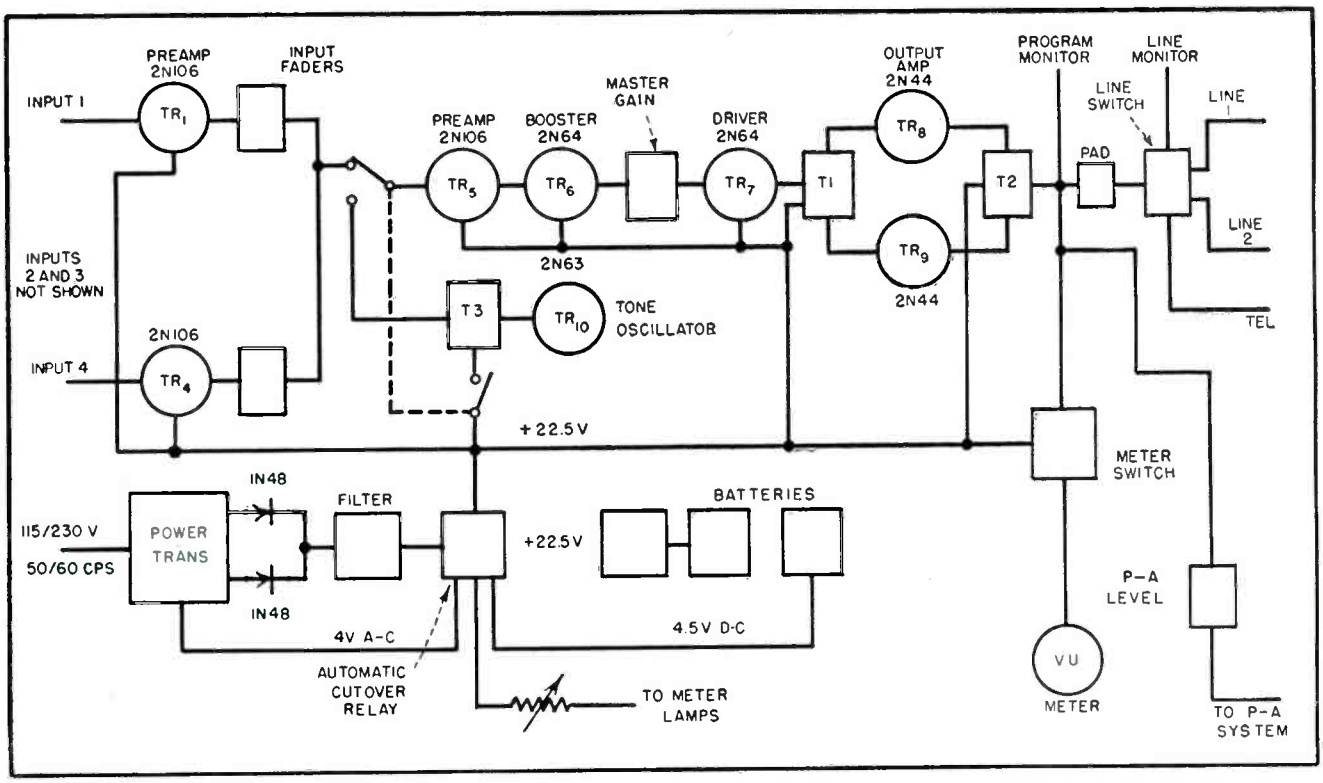


FIG. 3—Elements of the transistorized broadcast remote pickup amplifier. Detail of two input stages similar to others has been eliminated for simplicity. Complete circuit detail is given in Fig. 4

tube designs, high-level mixing is not nearly so easily attained since the battery drain for individual preamplifiers is high and multiple input transformers are heavy and costly.

As illustrated in Fig. 3 and Fig. 4, the individual preamplifiers are followed by ladder type input faders. Outputs from the four faders are paralleled and fed to the second preamplifier stage, which is nearly a duplicate of the input stage. The booster stage follows, using a less-expensive higher-noise transistor.

Owing to the high level from this point and on, noise is no longer

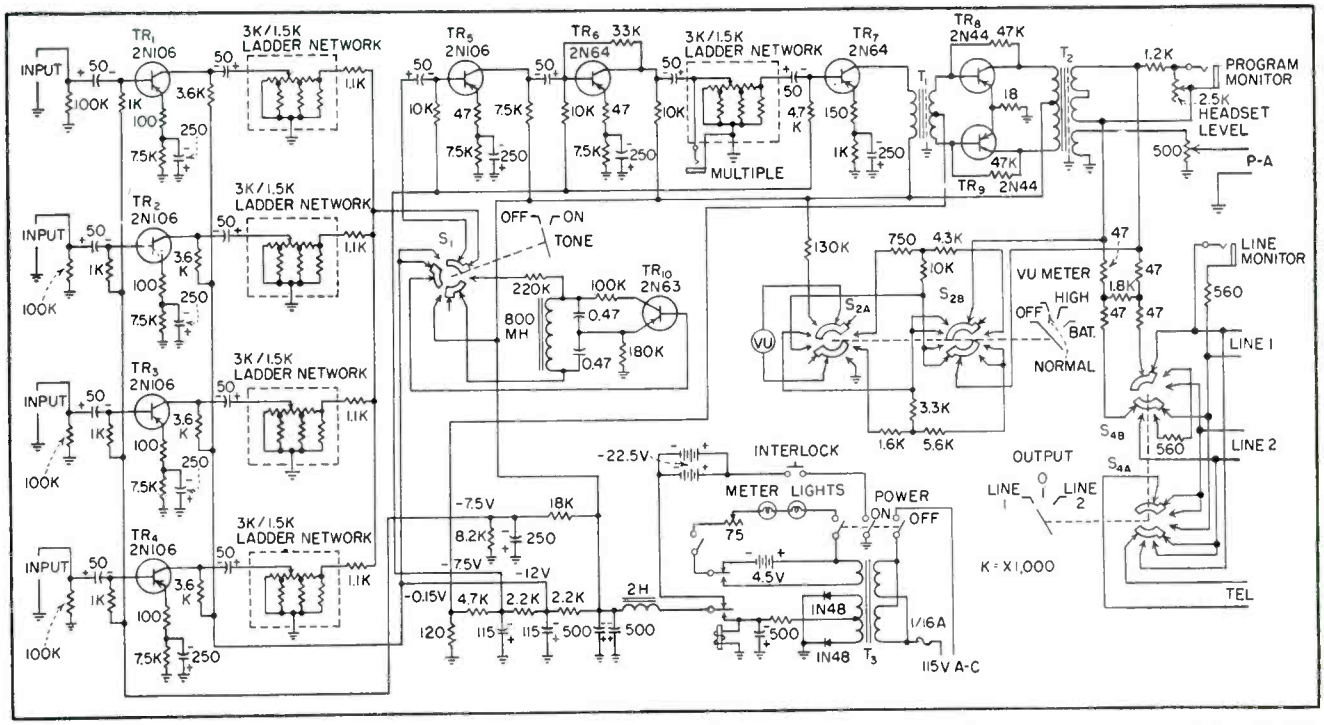


FIG. 4—Complete diagram of the remote amplifier shows that it can be operated from power line for best economy but switches automatically to batteries in event of power failure

a design consideration. This condition is indicated in Fig. 5, which shows typical operating levels throughout the amplifier. The booster stage is followed by the master gain control that is used for initial output level adjustment and is not normally varied during a broadcast. Both the input and master gain attenuators use a 2-to-1 step-down impedance for low insertion loss.

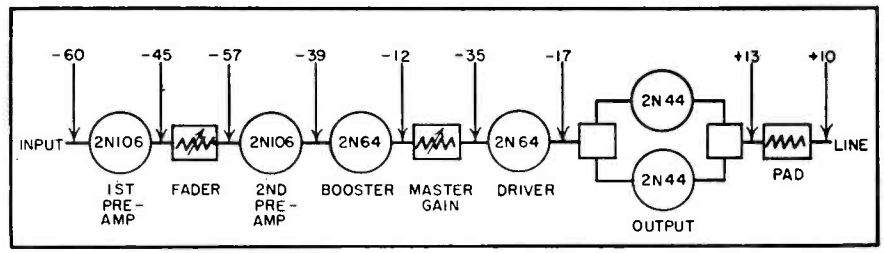


FIG. 5—Typical operating levels in dbm throughout amplifier

Output Circuits

The master gain control feeds the driver stage, which in turn drives the high-level push-pull output stage. Techniques for achieving the high-fidelity characteristics[1] of this section have been described. The output transformer feeds the line through suitable switching as shown in the diagrams. It has a second output winding for feeding a bridging load, normally the public address system often used for the audience present at the broadcast.

This eliminates the need for separate public-address microphones and gives the engineer better control of the local public address system, since it may be operated by another person not concerned with the broadcasting end of the program.

Other Circuits

A tone oscillator, employing a Colpitts circuit, is used to provide 400 cycles for advance circuit lineup to the main studio. It is fed through the TONE switch to the second preamplifier. The microphone circuits are cut when the tone oscillator is in use.

The power supply for the amplifier permits either a-c or battery operation. The a-c supply uses a full-wave circuit employing a pair of 1N48's to give an output of 22.5 volts at 15 to 20 ma. The total a-c power consumption from the line is 1.5 watts.

Emergency Battery

In case of a-c power failure, a relay automatically transfers to the battery supply, preventing program outages. Several instances have been reported in which this feature has been valuable in a previous design. However, in one case where the announcer was covering a collegiate basketball game, the power and light failure caused the game to be halted, leaving the announcer with an operating amplifier but no game to broadcast.

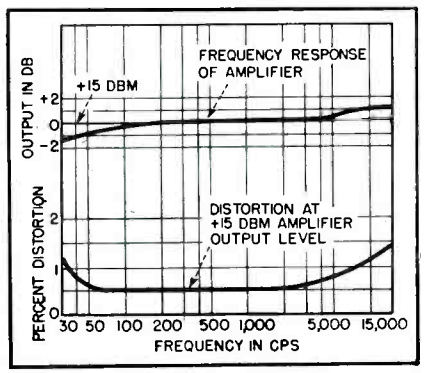


FIG. 6—Response and output level taken at 15 dbm output

As will be noted from the schematic diagram, extensive filtering is employed in the power supply to control hum and noise. One of the characteristics of transistors appears to be the need for well filtered supply voltages.

Battery power consumption is 350 milliwatts, which is only about one-third that of a typical heater-cathode tube filament. An additional 4.5-volt battery may be used if desired for vu meter illumination. An interlock switch prevents the power from being left on when the unit is in its carrying case.

Printed Circuits

Printed circuits are used extensively in the amplifier to reduce the space and cost factors. It is also expected that uniformity from unit to unit will be improved with printed circuits. For maximum strength and resistance to heat and humidity, glass-base epoxy resin type boards, shown in the photograph, are employed.

The remaining components are for the most part fastened directly to the chassis proper. The a-c power supply is, however, mounted on a separate bracket and may be seen at the lower center of the photographs. The batteries are mounted in such a way that they cannot be seated if they are reversed in polarity. This prevents damage to the transistors from operator error.

Performance Summary

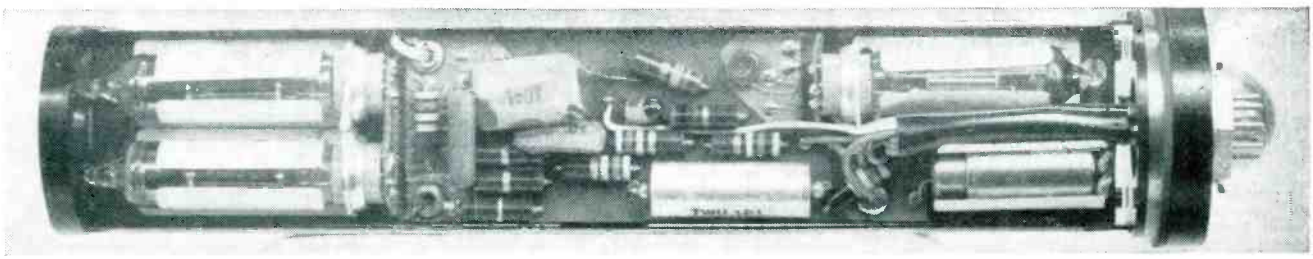
The performance of the amplifier in its final form has exceeded expectations. Weight of the complete units including batteries is only 17 pounds. The carrying case, used like a portable typewriter case, adds five pounds additional weight bringing the total to 22 pounds. The height of the amplifier scarcely exceeds five inches, and the volume of the unit is half that of its predecessor.

Figure 6 shows the response and distortion taken at an output level of +15 dbm. The measured equivalent noise input is −116 to −120 dbm and the gain into the line pad is 96 db.

The amplifier shows that transistors have their place in high-fidelity circuits, particularly where portability and low battery power are important. In this particular unit, battery power was reduced by a factor of 15 over the previous design. The absence of microphonics in transistors is another advantage which in some applications, such as hearing aids, is important. This feature should make transistors useful in the preamplifier stages of studio consoles, especially since the noise factor has been recently improved.

REFERENCE

(1) Robert L. Riddle, High Fidelity Transistor Power Amplifier, ELECTRONICS, p 174, Sept. 1955.



Top view of control relay shows arrangement of circuit components with explosive squib at lower right-hand corner

Fuel Cut-Off Control

SUMMARY — Low-frequency audio signal applied to relay cuts off missile fuel. Parallel-T feedback network provides stable, high-Q selectivity over 2-to-1 range of frequencies. Built-in low-power gamma-ray source stabilizes operating potential of neon voltage regulator

DESIGNED for use in conjunction with a radar-beacon system as as fuel cut-off control for guided missiles, frequency selectivity and stability of operating potentials were factors of prime consideration in the development of an audio-frequency operated relay.

Subminiaturization techniques were used to develop the unit shown in the photograph. The complete unit measures only 6¾ inches end to end.

Selective Circuit

By developing a tunable parallel-T feedback circuit, stable high-Q selectivity was obtained over a 2-to-1 range of audio frequencies.

Tunable from 88 to 154 cps, the input circuit in the schematic of Fig. 1 comprises a center-fed parallel-T network connected between the plate and grid of high-transconductance triode V_{1A}. By center feeding the network, several advantages are obtained. The R-C integrating network formed by the input circuit greatly reduces any response to noise and transients.

For maximum Q, a parallel-T network should feed into as high an impedance as possible. If the grid end of the network were used as signal input, the relatively low impedance of R_1 plus the generator impedance would shunt the output of the parallel-T. The resultant loss of Q would be detrimental to the performance of the circuit, especially when the center frequency is detuned from the point of best symmetry. This effect is substantially reduced by feeding the network at the center or low-impedance point. At the same time, a high degree of stability is obtained due to the integration of the input signal.

Oscillation will occur in all phase-shift networks whenever too much

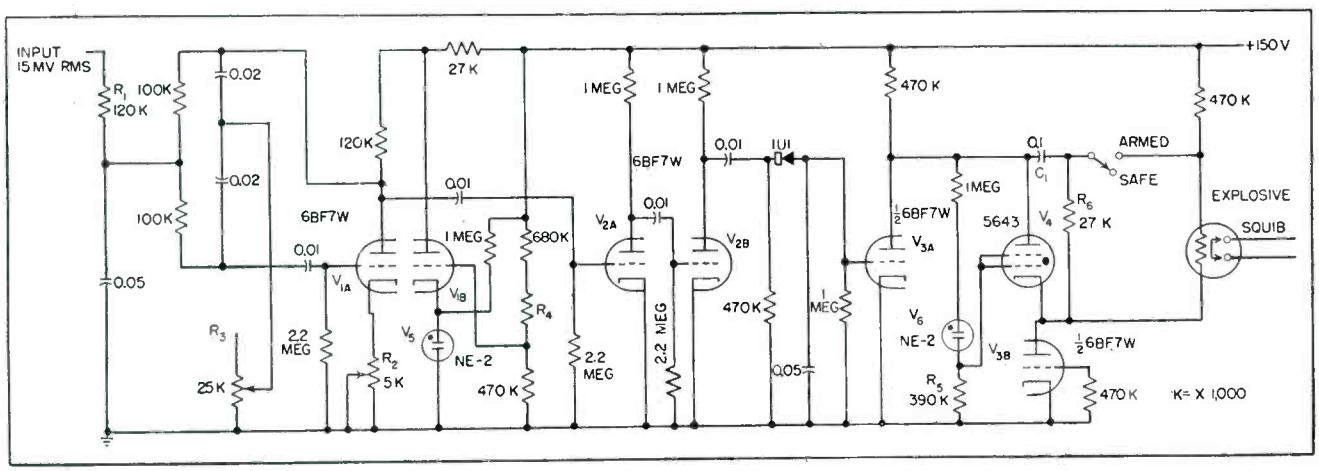
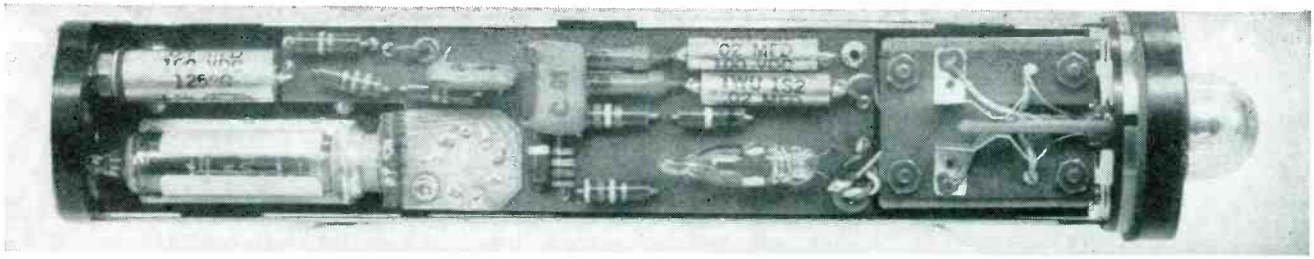


FIG. 1—Selective a-f control relay. Radium-coated metal band encircles V_5 to stabilize its operating potential. Squib consists of carbon element, which when heated ignites a small explosive charge that propels a silver pin between two contacts



Bottom view of control relay shows arming pin inserted in switch (safe position). Neon regulator with radium band is at center

for Guided Missiles

By GERALD L. ZOMBER and DONALD MACMILLAN

Avion Instrument Corporation
Paramus, New Jersey

gain is applied for a given amount of feedback. Gain of the amplifier is controlled by R_2, which is adjusted for the desired Q. The circuit will provide stable Q values up to 100. Rheostat R_3 controls phase shift and sets the frequency of the selective circuit.

Voltage Regulation

Since variations in the plate supply could cause instability, voltage regulation of the input plate supply is essential. Therefore, tube V_{1B} is utilized as an open-loop shunt regulator, with an NE-2 neon lamp, V_5, serving as a voltage reference. It was found that the ionization and operating potentials of this neon tube could be stabilized by subjecting its elements to low-power gamma radiations. To effect this, a small precious-metal band containing a microgram of radium was glued around the envelope of the NE-2 using glyptal cement.

Resistor R_4 is selected to provide +128 v at the cathode of V_{1B}.

A conventional a-c amplifier having a gain of approximately 400 is used to bring the signal level up to an amplitude which, after rectification, is sufficient to cut off V_{3A}.

In the quiescent state, V_{3A} and V_{3B} conduct essentially equal currents. Since their plate voltages are nearly equal, no net potential exists between the plate and cathode of thyratron V_4, so that this tube is not conducting.

When a signal of proper amplitude and frequency is applied to the input, it passes through the selective portion of the circuit and is rectified by the 1U1. Resulting negative voltage drives the grid of V_{3A} to cutoff. This action causes the plate potential of V_{3A} to rise, thereby charging C_1. As this charging voltage reaches a level sufficient to fire neon lamp V_6, the consequent flow of current through R_5 increases the grid voltage of thyratron V_4 until it fires. This action permits C_1 to discharge through the squib, provided the switch is in the armed position (arming pin withdrawn). Ignition of the squib sets off a tiny explosive charge that closes the output circuit, thereby closing a solenoid valve to cut off the fuel supply of the missile in which it is installed.

Safety Feature

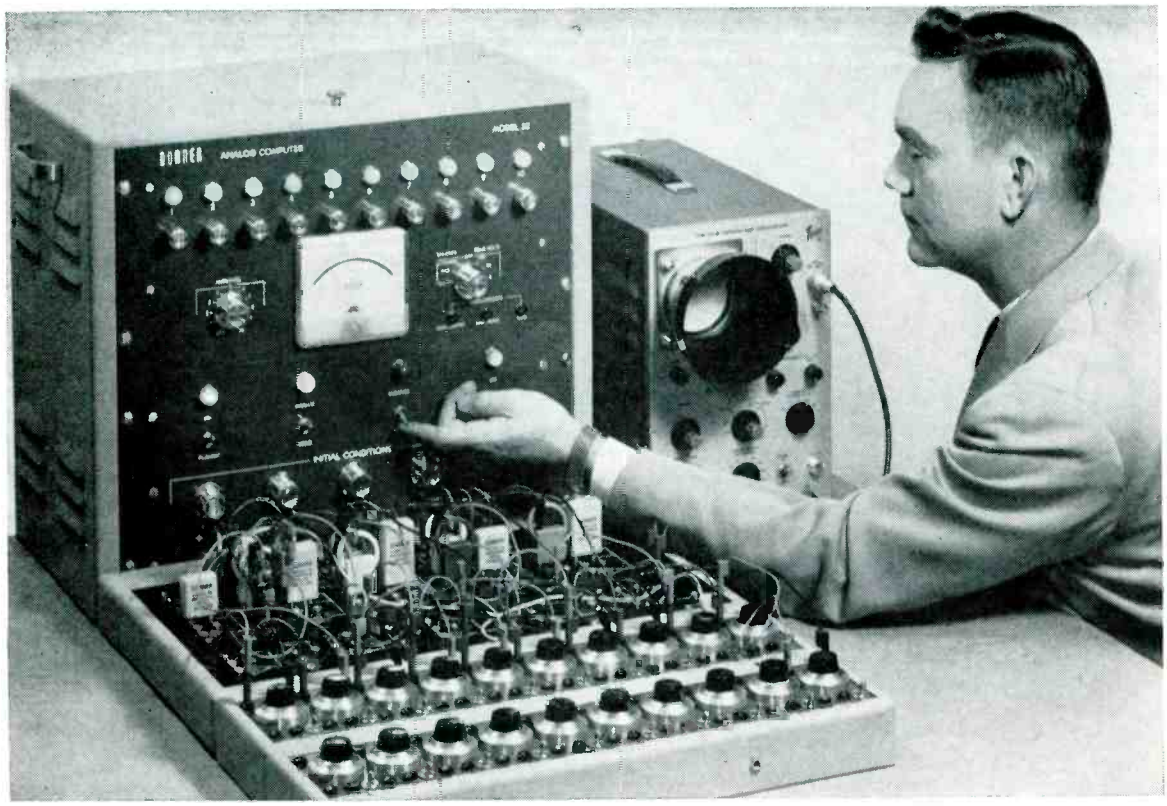
When the arming pin is inserted in the switch, resistor R_6 is substituted for the explosive relay and the latter is connected in series with B+ to apply voltage to the plate of V_{3B}. If the explosive squib should be open circuited, the anode of V_{3B} will be at or below ground potential, so that V_4 will have no cathode bias. In this case, it would fire before V_5 fires and V_5 would not glow. This indicates a defect in the squib circuit. Failure of any tube will cause the unit to remain inoperative, since C_1 will not be charged and the squib will not ignite. Also, in case of plate or heater voltage failures, the squib will not ignite.

Other Applications

Besides its application as a fuel cut-off control for missiles, this selective a-f control relay may be used, upon substitution of a suitable relay for the explosive squib, as a telemetering-switching-command detector in missiles, radiosondes, weather balloons and as a relay in other remotely controlled devices.

Development of this device was sponsored by the U. S. Army Signal Corps.

The authors appreciate the assistance and encouragement rendered them by the engineers of the GMI Branch, Radar Division, Evans Signal Laboratory, Belmar, N. J.



Solution of five-component chemical kinetics problem requires only five of computer's ten amplifiers

Ten operational amplifiers, power supplies and detachable problem board comprise a . . .

——Simplified Analog

FUNDAMENTAL BEHAVIOR of physical systems, whether electronic, aerodynamic, mechanical, acoustic or other, is best described by differential equations. With a simple computer, an unlimited number of practical system equations may be solved even more easily than setting down the explicit equations themselves.

Elaborate electronic computers are an indispensable aid in solving complicated problems like the stability of high-speed aircraft or the accuracy of fire-control systems. Appropriate emphasis is placed on accuracy and versatility so that the most complex problems can be handled. Economic considerations are entirely secondary.

By contrast, the computer in the photograph provides the same facility for solution of everyday problems in differential equations that the desk calculator gives for problems in arithmetic—with comparable investment and operating economy.

The computer is applicable to monitoring or control of industrial processes, solution of closed-loop problems in the laboratory and the analysis of regulating systems or devices. In addition, the computer provides an ideal means for study or demonstration of differential equations, Laplace transforms, exponential functions, modulation, oscillating systems, logarithmic decrements, damping factor and other aspects of mathematical or physical systems. Accessory equipment can adapt it for the solution of general nonlinear problems.

Theory of Operation

The computer is an electronic differential analyzer which solves physical or mathematical problems by analogy between two sets of equations. One set of equations expresses the problem which the computer is asked to solve. The second set is set up by the computer operator to form a consistent quantitative analogy between the two sets of equations.

The computer yields the time-dependent solution of differential equations automatically through the use of operational amplifiers. These units provide the fundamental functions of integration, multi-

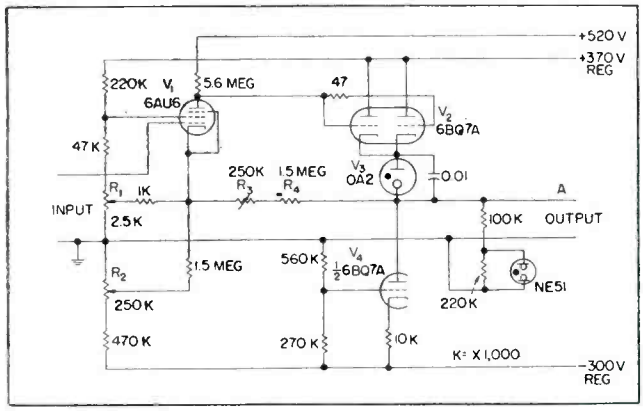


FIG. 1—High-gain d-c amplifier

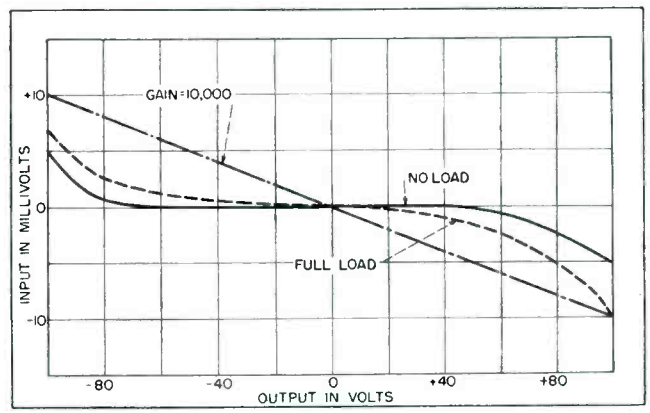


FIG. 2—Amplitude transfer characteristics of d-c amplifier

SUMMARY —— Everyday problems in differential equations yield to solution by compact analog computer that sacrifices extreme accuracy and elaborate design but is sufficiently versatile to handle the most complex problems

By VICTOR B. COREY

Technical Director
Donner Scientific Company
Berkeley, California

Computer

plication or division by a constant, addition, subtraction and sign changing required to reduce the differential equations to a closed representation in analog form. Rules of procedure permit progressive setup of the differential equations to be solved through repeated integration and summation of terms to find the variables of final interest.

Operational Amplifiers

The ten operational amplifiers in the computer are identical. Using the circuit of Fig. 1, each amplifier meets the requirements for reliable and accurate performance in an electronic analog computer intended for both repetitive and extended time solutions.

The amplifier employs a 6AU6 high-gain input pentode, V_1, and a direct-coupled 6BQ7A dual triode, V_2, operated as a cathode-follower output. The load impedance of the cathode follower is a series arrangement of an OA2 voltage-regulator, V_3, and one triode section of a 6BQ7A, V_4. Returned to a regulated source of −300 v, V_4 maintains essentially constant plate current over a wide range of plate voltage. An output voltage balanced about zero for zero input voltage is generated with respect to ground at point *A*. The second triode section of V_4 serves a duplicate function for an adjacent operational amplifier.

Coarse d-c balance potentiometer R_1 compensates for gross offset in output voltage at zero input voltage. The fine d-c balance potentiometer R_2 has a more limited range and is used for final setting of 6AU6 cathode potential to make zero output voltage correspond with zero potential on the input grid. Once this adjustment has been made, output voltage will be proportional to input voltage over an output range of ±100 volts.

The conductance through R_3 and R_4 changes the cathode potential of V_1 in the same direction as the output voltage. This is equivalent to an increase in the potential at the input grid and represents positive or regenerative feedback. Thus less signal is necessary at the input grid to obtain a given output voltage. Increasing the conductance of the feedback path by decreasing

R_s can increase positive feedback to the point of infinite gain so that the ratio of output voltage to the signal on the input grid increases without limit. Infinite gain can be achieved under one set of operating conditions, but the changes in tube characteristics over the operating range impose a practical limit on average gain at the extremes of the range.

Characteristics

Experimental measurements of output voltage versus input voltage for a typical amplifier are shown in Fig. 2. Infinite gain over the full operating range would be represented by a horizontal line through the origin extending from −100-v output to +100-v output. The curve for the unloaded amplifier ($R_L = \infty$) shows that a maximum grid signal of 5 mv is required for operation over the full ±100-v range and that average gain over most of the range is greater than 40,000. The lowest value of average gain under full load (R_L = 20,000 ohms) is 10,000 at +100-v output, where an input of −10 mv is required. Even under full load, average gain exceeds 30,000 over most of the operating range.

The amplifier of Fig. 1 is shown symbolically in Fig. 3A. Gain A is high and the input and output are of opposite polarity.

When a high-gain amplifier is used in an analog computer it is made an operational amplifier by adding two passive external impedances, as shown in Fig. 3B[1]. Impedance Z_i is connected in series with the input voltage e_i. Impedance Z_f is connected directly between output and input of the amplifier and introduces negative feedback. In Fig. 1, Z_f would be connected between point A and the grid of V_1.

The value of grid current for V_1 has been found consistently below 1 millimicroampere under normal operating conditions. Since currents in Z_i and Z_f of Fig. 3B will nearly always be between five hundred and five million times this value, the grid current may safely be neglected.

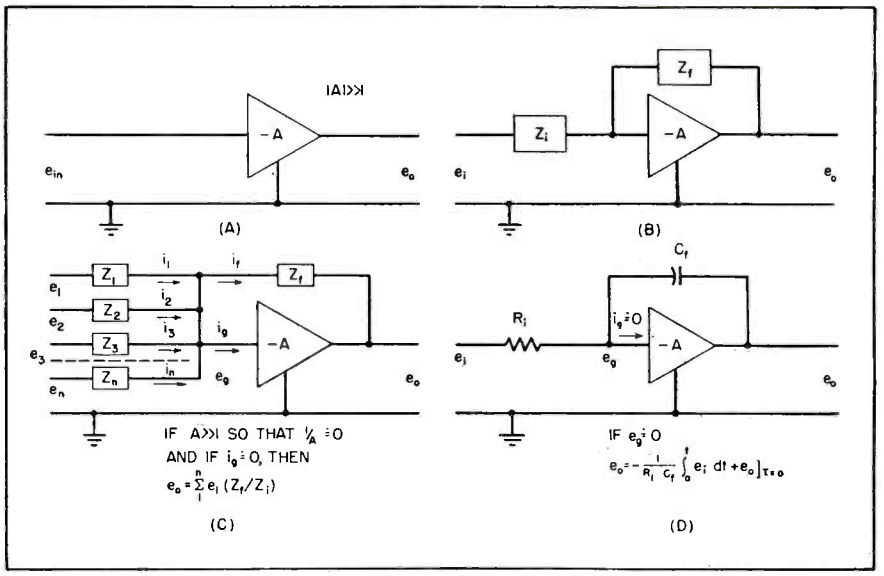


FIG. 3—High-gain amplifier (A) is converted to operational amplifier (B) by external impedances. Amplifier can be used for summation (C) and integration (D)

With the addition of Z_i and Z_f, the gain of the amplifier becomes independent of all circuit parameters except Z_i and Z_f. The general case is illustrated in Fig 3C where n separate voltages e_1, e_2, e_3, ..., e_n are fed to the amplifier through n input impedances Z_1, Z_2, Z_3, ..., Z_n. A single impedance Z_f is connected directly between input and output of the amplifier.

For algebraic summing of input voltages, sign changing and multiplication or division by a constant, impedance Z_f and all input impedances are resistances. In practical operation the ratio R_f/R_i is not allowed to exceed 50. For integration, impedance Z_f is a capacitance and the input impedances are resistances. The characteristic operation of such an arrangement can be seen in the simple integrator of Fig. 3D. Since $i_g \doteq 0$, the current through R_i is continuous with the charging current on C_f.

If the voltage across the capacitor is V and its instantaneous charge is $q(t)$, the charging current is

$$i(t) = dq(t)/dt = d(VC_f)/dt = C_f(dV/dt)$$

But the negative feedback operation of the high-gain amplifier keeps $e_g \doteq 0$ so that the input grid is held at ground potential for any normal value of output voltage. The current equation therefore becomes

$$e_i/R_i = C_f(dV/di) = -C_f(de_o/dt)$$

It follows that

$$e_o = -\frac{1}{R_i C_f}\int_o^t e_i dt + e_o]_{t=o}$$

The arbitrary constant of integration $e_o]_{t=0}$ is supplied by the voltage across C_f when $t = 0$.

Differential Equations

By more complicated input and feedback impedances, single operational amplifiers may serve a variety of special functions such as the generation of the electrical analogs of Laplace transforms. However, the amplifiers' basic role in the computer involves their use in combination to solve differential equations.

To solve such a problem with the computer a formal procedure[2] may be adopted in which it is assumed that an input signal representing the highest derivative is available to a specified operational amplifier in the computer. If this amplifier is connected as an integrator, its output voltage will be proportional to the next lower derivative with sign reversed. This voltage may serve as input to the next operational amplifier, again connected as an integrator and the process repeated.

The highest derivative in the differential equation to be solved by the computer may be expressed

mathematically in terms of lower derivatives, the dependent variable itself and the driving function. As a final step in setting up the computer to solve the problem, the highest derivative is so expressed in circuit form. Lower order terms are taken from the operational amplifier outputs where they are assumed to be generated through integration.

The input driving function is supplied from an external function generator or synthesized by other operational amplifiers in the computer. All terms are combined in the proportions specified by the differential equation and fed into a summing amplifier. Any necessary changes of algebraic sign are introduced by additional operational amplifiers.

Output of the summing amplifier is connected to the amplifier input where the highest derivative was first assumed to exist. Alternatively, the summing operation can be combined with the first integration in a single operational amplifier. When the highest derivative is synthesized in the proportions specified by the differential equation, the unique requirements of the equation are imposed on the solution delivered by the computer. To generate the correct definite integral at the output of each operational amplifier connected as an integrator, it is necessary to apply the initial condition voltages which correctly define the various constants of integration. These voltages are maintained by separate sources until the time $t = 0$ when the voltage sources are simultaneously disconnected and the problem is released to the computer for solution.

Functional Arrangement

The computer comprises the amplifier section, power supply section, cabinet and problem board. The amplifier panel and power-supply panel are the upper and lower sections of the computer. The completely detachable problem board plugs into two multiconductor connectors near the bottom of the power-supply panel.

The amplifier section contains ten operational amplifiers, arranged side by side on a single chassis.

The front panel of the amplifier section is furnished with controls for both selection and adjustment and a $4\frac{1}{2}$ in. zero-center meter. A row of lights near the top of the panel indicate actual or approaching overload for the operational amplifiers.

The power supply section contains the main regulated power supplies for the operational amplifiers, separate regulated initial-condition power supplies with their output controls, relays and connectors.

The two multiconductor connectors near the lower edge of the panel carry the amplifier and relay connections to the problem board. To minimize crosstalk between amplifiers, all the amplifier input wiring is routed through the connector at the left while the connector at the right carries the wiring from the amplifier outputs. For the same reason the ten compute-reset relay poles are divided into two equal groups which are routed separately through the two connectors.

The main positive and negative high-voltage power supplies for the operational amplifiers are individually electronically regulated to approximately 0.25 percent for line-voltages changes from 105 to 125 v and amplifier loads up to 5 milliamperes. The negative supply, which delivers a regulated voltage −300 v at 130-ma constant load current, is controlled with respect to the voltage drop across an OA2 voltage regulator operated at constant current. The positive voltage supply uses the regulated voltage of output of the negative supply as a reference and delivers 370 v at load currents up to 180 ma.

The problem board provides connections between operational amplifiers and external computing elements which generate the electrical analogs of differential equations.

Each problem board is furnished with a bottom cover plate which serves as a shield and reduces 60-cycle hum on any amplifier output to an unimportant level.

The compute-reset relays maintain an independent initial-condition voltage across the feedback capacitor of each operational amplifier used as an integrator until the problem is released to the computer for solution. Thereupon the compute-reset relays disconnect each integrating capacitor from its initial-condition power supply and connect the input of each operational amplifier used as integrator to the proper driving point in the circuit analog.

Hold-Operate Relays

During normal reset or compute operations the hold-operate switch is kept in the operate position. The hold-operate relays remain deenergized in this position. The center terminal of each relay group is directly connected to the pole of its compute-reset relay. However, when the switch is thrown to HOLD, the hold-operate relays are energized and the center terminal of each relay group is disconnected from its compute-reset relay pole.

The hold function is used when problem solution is to be interrupted temporarily for examination or change of parameters or scale and then resumed.

Two or more computers may be used as a single larger computer. To synchronize compute-reset operations the two-conductor compute-reset plugs at the lower rear of the computer cabinet are connected in parallel for all computers. Operation of the compute-reset switch of any one computer produces simultaneous operation of the compute-reset relays in all computers combined with it. A similar arrangement may be used to synchronize the hold-operate function.

Many design aspects of this computer are directly related to characteristics of simplified analog computers originated by the Systems Development Section, Aviation Ordnance Department, Naval Ordnance Test Station, Inyokern, California, and used there since 1949.

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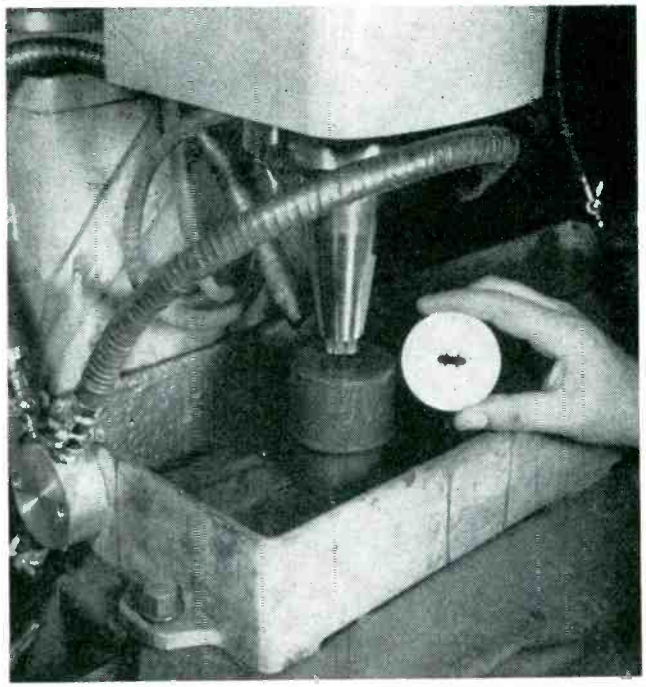
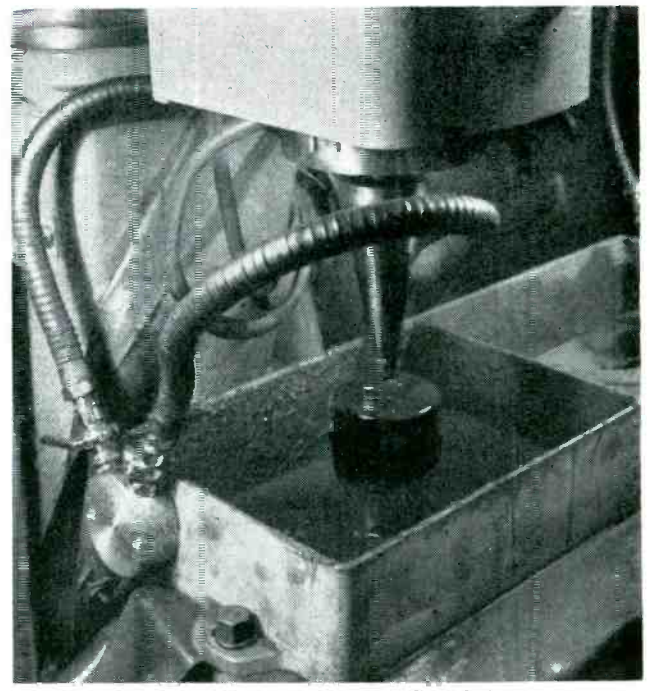
(1) Dewitt H. Pickens, Electronic Analog Computer Fundamentals, ELECTRONICS, 25, p 144, Aug. 1952.
(2) R. C. H. Wheeler, "Basic Theory of the Electronic Analog Computer", Donner Scientific Co., Berkeley, Calif.





THE FRONT COVER—Tool setup for cutting intricate shape in aluminum oxide in a single operation, note finished workpiece

Ultrasonic Machining of

SUMMARY — Slicing or cutting germanium, silicon, quartz, ferrites, glass-bonded mica and other materials at high speed by impact grinding results in greater precision and makes possible a great variety of shapes

SEMICONDUCTOR DIODES and transistors, as well as complex ferrite and ceramic shapes, must be produced in volume and at minimum cost. Since no compromise in precision can be allowed, conventional machining methods are no longer adequate. All these requirements are met by ultrasonic impact grinding, with significant advantages.

The processing of germanium, silicon and quartz for diodes, transistors and frequency-control crystals is performed in two operations: slicing and dicing.

In the first operation, boules of the material, usually between 0.5 inch and 1.25 inches in diameter, are sliced into thin wafers.

After being sliced, the wafers are cemented flat onto a glass or ceramic block and cut into small squares or disks or into rectangular bars. This operation is called dicing.

Slicing and dicing have usually

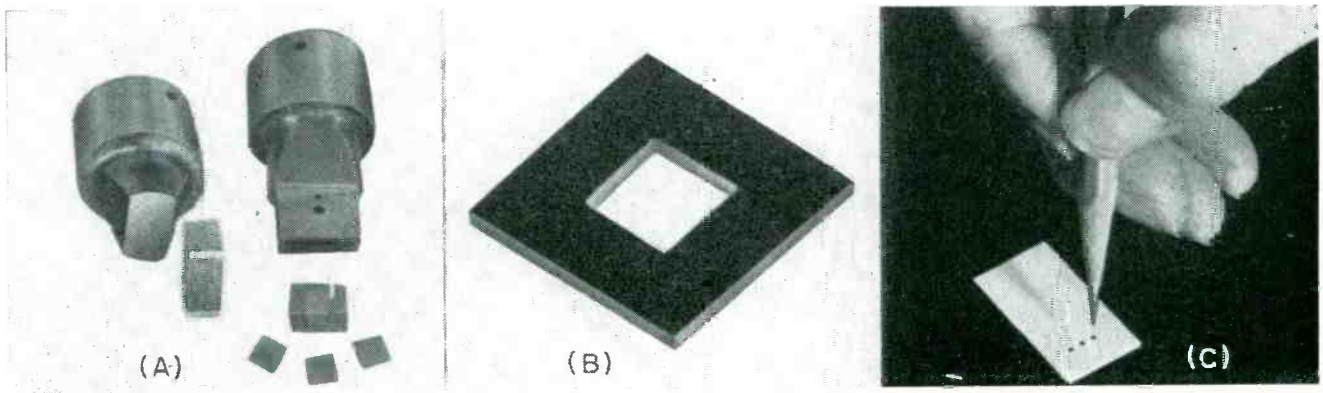


FIG. 1—Tool for slicing quartz crystals showing quartz boule and wafers (A) machined ferrite core (B) and ceramic-spacer holes cut to close tolerances (C)

ULTRASONIC IMPACT GRINDING

- The cutting tools are rugged and usually inexpensive
- Attaching tools to the machine is simple. The setup is readily changed from one tool to another, providing great versatility
- The operating principle insures sharp edges on every cut, as well as perfect duplication of the tool shape in the workpiece
- Since tool shape is duplicated in the workpiece, there are no restrictions on the shape to be cut. Tools can be round, square, triangular or any other shape
- Because lapping grades of abrasive are used to do the cutting, a fine surface finish is produced which requires a minimum of subsequent surface lapping

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Brittle Materials

been done by means of diamond wheels ganged on an arbor to give the desired wheel spacing. This method has several drawbacks: diamond wheels are costly, and very thin wheels are subject to breakage; much time and skill are required to assemble an arbor of precisely spaced wheels, thus restricting the versatility of the ganging setup; diamond sawing tends to leave rough edges at the edge of each cut, especially in deep cuts, so that extensive lapping is required to finish each wafer; a diamond wheel cannot be used for dicing round disks from the wafer.

Impact grinding offers a number of advantages, the most important of which are listed in the box.

In ultrasonic impact grinding, as with diamond-wheel cutting, there are limits to the area which can be machined in one operation. Also, it is not possible at present to slice wafers thinner than 0.015 inch with consistent results.

Figure 1A shows a multiple-blade cutting tool assembly, mounted on its supporting and driving tool cone, with typical crystal wafers.

Designers of magnetic cores for high-frequency transformers, electronic computer switches and microwave transmitting devices can now explore the advantages offered by the electrical and magnetic properties of ferrite crystals.

By means of impact grinding, this material can readily be shaped in one piece with sharp corners and precisely oriented sides. Moreover, the core is not subjected to stress during machining.

The ferrite core shown in Fig. 1B was cut from an 0.125-inch thick single crystal wafer in less than two minutes. The procedure, developed for the study of domain patterns in ferrite, involved six steps. Each ferrite crystal was first x-rayed to determine the orientation of its lattice structure, then mounted on a rectangular steel block with the edges properly located. The block was mounted on a rotary table which was placed on the worktable of the impact grinder. This arrangement permitted the crystal to be positioned at any desired angle with respect to the face of the soft-steel tool.

For each cutting, 600-grit boron-carbide abrasive in liquid suspension was dammed around the crystal with modeling clay. Grinding was accomplished without producing stresses that might have affected the internal structure of the crystal.

Glass-Bonded Mica

Glass-bonded mica, like other hard abrasive materials with a strong grain structure, is difficult to machine by conventional methods. The operator must take special care not to force the tool since the material is susceptible to internal damage from heat and pressure even when the cut looks perfect. By the use of impact grinding this material is readily machined with no danger of hidden damage.

Ceramics

When aluminum-oxide ceramic spacers are fired after the conventional molding process shrinkage occurs which makes it difficult to obtain the required shape. Each change in the location and shape of the holes requires expensive mold design and fabrication.

Simultaneous machining of multiple holes in finished blanks on the impact grinder was tried as an alternative to molding and proved to be an immediate success. Figure 1C shows a 0.030-inch-thick, 0.75 by 1.25-inch ceramic spacer produced at the rate of three per minute.

Not only are the tolerances uniform from piece to piece, but changes in location of the holes are made by positioning of the workpiece. Shape changes are also economically accomplished by conventional machining of the cold-rolled-steel tool tip, which is then easily soldered to the tool cone of the grinder.

The impact grinder, sketched in Fig. 2, comprises: a driver unit which serves as a source of ultrasonic (25-kc) electrical power for the cutting head; a pedestal unit that carries the cutting head and locates and feeds the work to it; an abrasive unit that circulates and feeds an abrasive fluid to the cutting tool; a head unit that sup-

* Work done while at Raytheon, Waltham, Massachusetts.

ports and drives the cutting tool; an interconnection unit that provides electrical services and interconnections to the various units; and a water-flow switch unit to prevent operation without cooling-water flow through the head unit.

Incorporated in the head unit is an electromechanical transducer which converts alternating current supplied by the driver unit into mechanical vibrations at 25 kc. These vibrations are amplified and transmitted to the cutting tool by means of a shaped tool cone. The cutting tool is secured to the tip of the tool cone and vibrates perpendicularly to the tool face (along the cone axis) without side-to-side motion.

The transducer, shown in cross-section in Fig. 3, is of the magnetostriction type and utilizes pure nickel laminations as the core material. Attached to the nickel is a mechanical-amplitude transformer, the transmitting cone, and the resonant support which is rigid at low frequencies but highly compliant at 25 kc. The resonant support is designed to hold the device securely but permit free vibration, while the transmitting cone drives the tool cone to relatively large longitudinal vibrational amplitudes at the resonant frequency. The tool cone is also a mechanical-amplitude transformer which supports and drives the cutting tool. Typical amplitude of vibration for a 0.5-inch-diameter cutting tool is 0.003 inch. Larger amplitudes may be obtained with smaller cutting tool diameters.

Table I—Impact Grinder Performance

Material	Ratio of Stock Removed to Tool Wear	Maximum Practical Grinding Area (sq in.)	Typical Grinding Rate ½"-dia. Tool, ½" Deep (in./min)
Quartz	50/1	1.4	0.045
Ferrite	200/1	3.1	0.075
Germanium and Silicon	200/1	3.1	0.075
Ceramic	150/1	2.4	0.060
Glass	200/1	3.1	0.100
Carbon	150/1	2.0	0.060
Glass-Bonded Mica	200/1	3.1	0.075
Synthetic Ruby	2/1	1.2	0.020
Mother of Pearl	200/1	3.1	0.075
Boron Carbide	3/1	1.1	0.015
Tungsten Carbide	1/1	1.2	0.009
Tool Steel	1/1	1.2	0.007

Impact grinder employs 320-grit boron-carbide abrasive and cold-rolled steel tool

Cutting Process

A small space filled with abrasive fluid develops between the vibrating tool face and the workpiece. Tiny particles of abrasive, accelerated by the motion of the cutting tool, are driven with tremendous impact against the work. Thereby an exact counterpart of the tool face is chipped or ground into the work. The work is fed up to the tool to maintain constant grinding force between the two.

Despite the fact that the abrasive particles strike the work with impact forces up to 150,000 times their own weight, the grinding force required seldom exceeds 10 pounds. This small force, together with the vibratory nature of the process, the absence of direct tool-to-work contact and the use of cool abrasive, combine to make impact grinding a cold-cutting and stress-free process.

The work material is not stressed or distorted and is not raised in temperature. It is normally unnecessary to clamp the work, and there is no tendency for the tool to wander. Existing or unfinished work may be taken up again with old or new tools without difficulty in recentering or relocation.

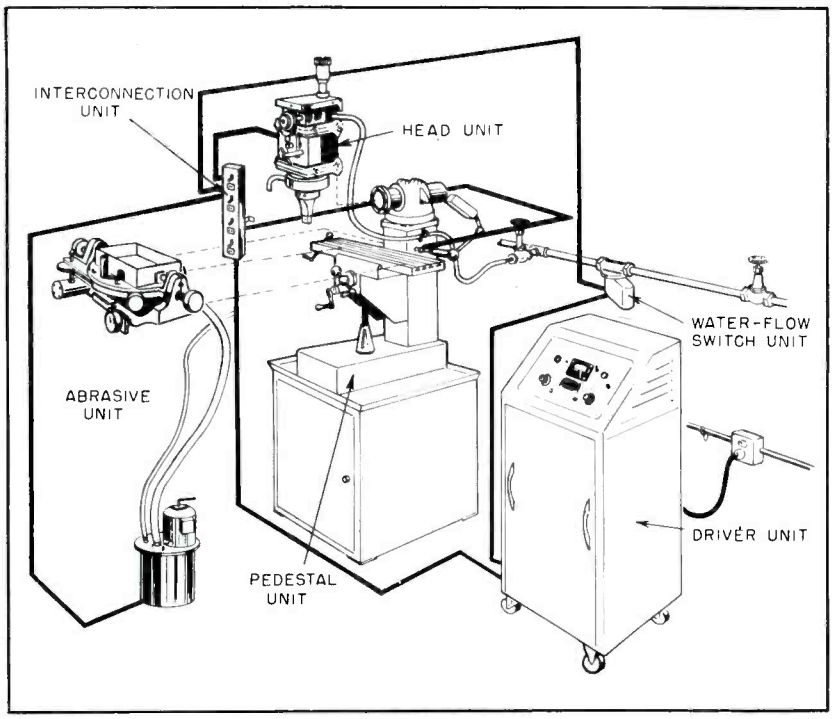


FIG. 2—Diagram of the impact grinder showing all units of the equipment

Design

The transducer design problem is the central one in impact grinding. Cutting rate varies directly with frequency and amplitude of vibration, and so it is desirable to have these as high as possible. The maximum useful amplitude is limited by the strength of available materials for the cutting tool, for the tool cone, and for joining these together, since vibration amplitude is largest for these parts. The cutting-tool face is limited in size to the maximum area which can be made to vibrate all as one piece. This sets an upper limit to vibra-

tion frequency for a given area. Inaudibility of the vibration is also desirable for physiological reasons.

A practical compromise among these considerations, together with transducer efficiency and reliability, results in the choice of the magnetostrictive transducer operating at 25 kc. For a given output power level at a set frequency, vibration amplitude of the parts coupled to

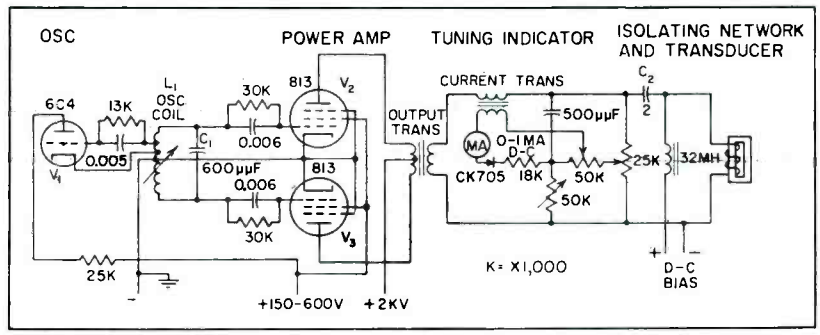


FIG. 4—Circuit of driver unit incorporating tuning-indicator circuit

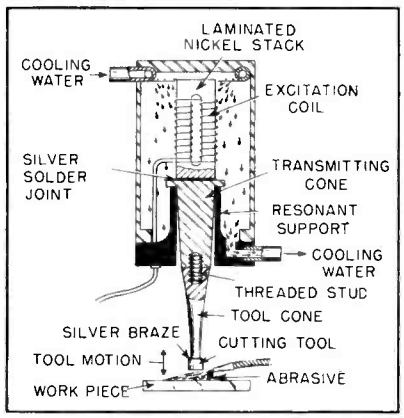


FIG. 3—Cross-section of transducer assembly of the magnetostriction type

the transducer varies inversely with their cross-sectional area. This means that small tools can be driven with high amplitude, large tools with smaller amplitude. The smallest useful tool size is therefore determined by material strength, the largest by lowest tolerable cutting rate.

The choice of nickel for the transducer laminations is indicated by its availability, ease of fabrication, high fatigue strength, high tensile strength, ease of bonding to other metals, high Curie temperature and good magnetostrictive efficiency at convenient impedances.

Driver Circuit

As shown in Fig. 4, the driver unit is relatively simple and straightforward. The basic circuit consists of a 6C4 Hartley oscillator driving a pair of push-pull 813's operating class AB_2. A special output transformer matches the transducer load impedance to the power amplifier.

A tuning-indicator circuit is incorporated to enable the operator to tune the oscillator easily and reliably to the mechanical resonant frequency of the transducer. Although this resonant frequency does not produce a maximum or minimum electrical impedance that permits direct indication, it does produce a unique impedance value that can be measured.

In effect, a sample of the current to the transducer and the voltage across the transducer are compared in magnitude and phase with values determined at the factory to exist at resonance. Correspondence of these values as they vary with tuning of the driver is indicated as a dip in the reading of the panel meter. This meter is actually backward-reading, so that the dip looks like a maximum. The tuning feature is valuable since it enables an unskilled operator to tune for maximum output without error.

The transducer requires a standing d-c bias current for proper operation. This is provided through an isolating network which prevents the d-c from saturating the output transformer. It also prevents the d-c source from shunting the ultrasonic output current.

Grinding Performance

Table I shows the effectiveness of the impact grinder in working with a variety of materials, using a cold-rolled-steel tool and 320-grit boron-carbide abrasive. These figures, while generally descriptive of impact grinding machinery, apply specifically to machines of the Raytheon Model 2-332 Series, which have 700 watts output.

In stock removal the abrasive grit, vibrating at ultrasonic rates, wears away both the tool and the workpiece. The work normally receives much greater wear, resulting in the desired stock removal. Some of the ratios shown in column 2 of Table I are as great as 200 to 1. Tool wear is confined mostly to the bottom face where dimensions are usually not critical. Because there is little lateral cutting action, the precise profile of the tool is maintained. Moreover, the soft cutting tool is usually inexpensive to replace.

For each tool and material combination there is a maximum grinding area which it is impracticable to exceed. These maximum areas are indicated in column 3 for the tool and abrasive specified. Impact grinding can be performed over larger surfaces but of approximately equivalent grinding area. Portions of stock can be removed by making several connected cuts with the impact grinder.

Column 4 shows conservative grinding rates for each material, using the tool and abrasive noted.

Further development of ultrasonic impact grinding equipment will be directed toward the achievement of higher machining speeds and larger areas.

Higher speeds will require higher power (more amplitude) which will require stronger materials. Larger areas will also require higher power, but may also enforce the use of lower frequencies. Sonic impact grinders operating at high power levels in soundproofed rooms may prove both necessary and entirely practical.

Much investigational work remains to be done on the actual mechanism of cutting, reduction of tool wear by variations in tool design, and methods of supplying abrasive.

Development work on the ultrasonic impact grinder was supported in part by the Signal Corps under Contract DA-36-039-sc-30282.

Servo Amplifier Uses

SUMMARY —— Power outputs of better than 5 watts obtained from servo power amplifiers using silicon power transistors in push-pull output stage. Amplitude distortion is under 10 percent measured at 3.5-watt output

EXPERIMENTAL power transistors have been used in several recent circuit designs. A typical application is a servo-motor drive amplifier which utilizes overall closed-loop negative feedback.

This unit was designed to drive the control phase of a 3,400-ohm split control-winding servo-motor. The amplifier is well stabilized and has a voltage gain of 400 at 400 cps.

At an operating power-output level of 0.115 watt, the output voltage would be approximately 20 volts. The characteristics of a resulting design are listed in Fig. 1.

A schematic of the amplifier is shown in Fig. 2. The unit uses type 904 silicon transistors in the low-level input and driver stages. The grounded-emitter input stage is current-stabilized by the 220,000-ohm resistor between collector and base.

The output stage uses two experimental silicon power transistors in push-pull. No output transformer is required because the control winding of the motor is center tapped. The d-c component of current flowing in the winding is small because the output stage is biased for class-B operation.

The feedback-loop stabilizing voltage is fed from the output of the amplifier through voltage divider $R_f - R_e$ to the emitter of the input stage. For degeneration, the voltage fed back across R_e must be in phase with the 400-cps signal input at the base of the first transistor. Approximately 0.24 percent of the output signal voltage is applied across R_e for stabilization.

Stability

The 4-μf capacitor in the emitter circuit of the second stage adequately bypasses the 680-ohm emitter resistor at the 400-cps operating frequency and at higher frequencies. However, at lower frequencies it has little effect. Hence, the circuit degenerates these frequencies and acts to stabilize the amplifier at lower frequencies.

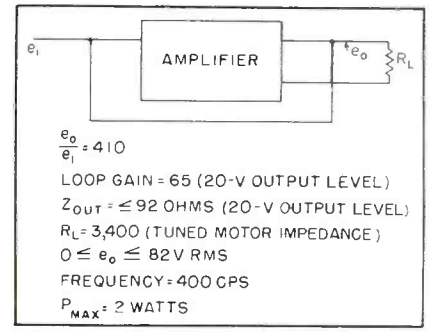
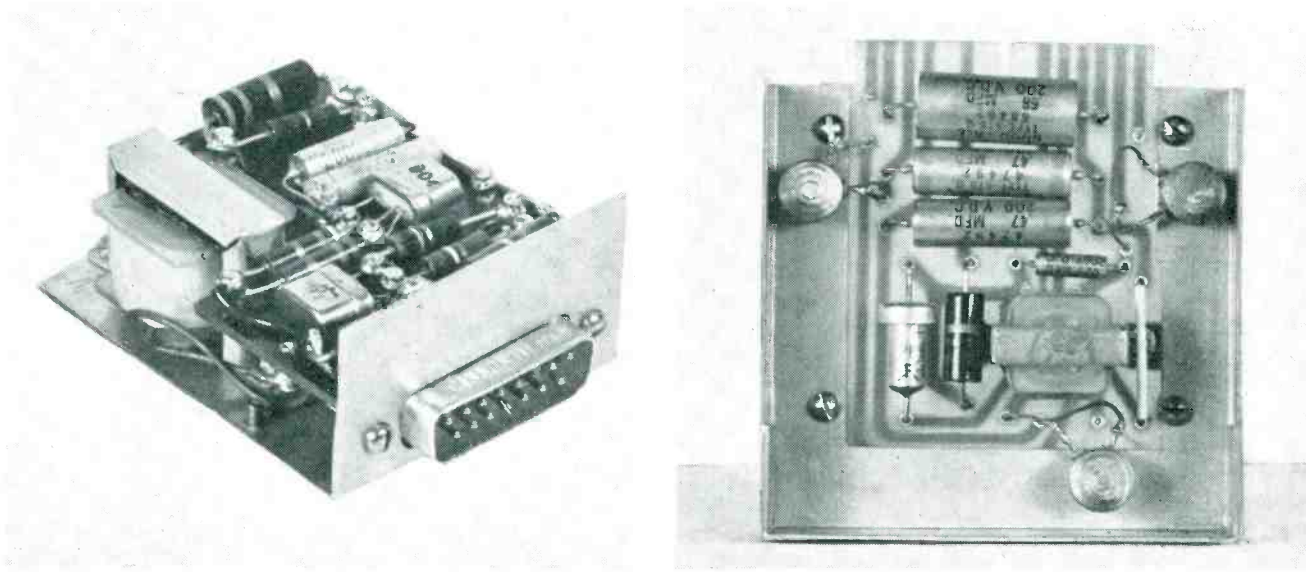


FIG. 1—Specifications for servo-motor drive

Similarly, the 0.018-μf capacitor across the primary of the output-stage drive transformer and the R-C series network between the base and collector of the second stage stabilize the amplifier at higher frequencies.

The amplifier feedback voltage gain and phase-shift characteristics with the feedback loop closed are shown in Fig. 3. The gain is con-



Servo-motor drive amplifier at left is not much larger than a matchbook; power amplifier at right shows component mounting designed to give increased heat dissipation

Silicon Power Transistors

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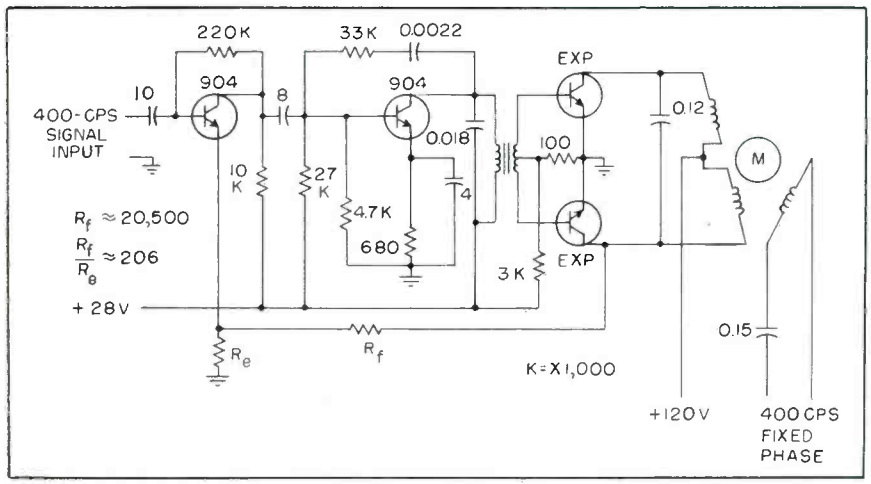

FIG. 2—Circuit diagram of servo amplifier which uses two experimental silicon power transistors in push-pull

Table I—Servo Amplifier Data

Input impedance:	
Closed Loop	130K
Open Loop	5K
Output impedance:	
Closed Loop	Under 100 ohms
Open Loop	Approx. 10 K
Voltage gain:	
Closed Loop	Approx. 410
Open Loop	Over 10,000
Power gain:	
Open Loop	83.2 db
Ambient temp:	100 C Maximum
	71 C Nominal operating

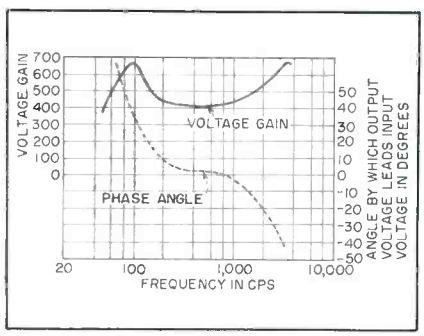

FIG. 3—Closed-loop characteristics of servo amplifier

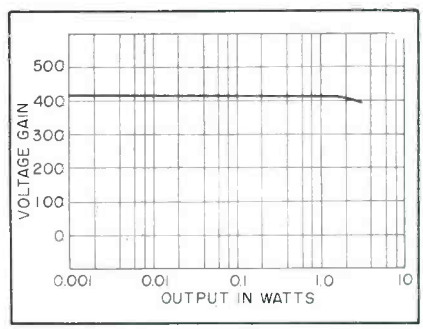

FIG. 4—Voltage gain plotted as a function of power servo amplifier output

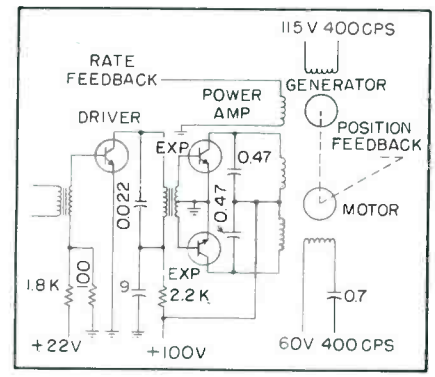

FIG. 5—Servo power amplifier with an output in excess of 5 watts

stant over a wide range of frequencies on either side of 400 cps. Also, the phase shift is near zero over the same range.

Although there are gain peaks at two points, 90 cps and 3,000 cps, outside of the desired operating frequency range, the phase shift at these points is still sufficiently low to eliminate any tendency toward oscillation. Additional data is shown in Table I.

Voltage gain characteristic as a function of power is shown in Fig. 4. The gain of the amplifier is constant for output signal levels up to about 2 watts and drops only slightly at 3 watts.

The output section of a servo amplifier, from which more power output is required, is shown schematically in Fig. 5.

To obtain power outputs greater than those of the amplifier previously described, it is necessary to have more drive signal current available than is practical for the type 904 transistor to supply. Higher driving currents require a higher-wattage bias supply for the power transistors. In this case high gain at low signals is not needed. Consequently, the power supply requirements are reduced by eliminating the bias. The output characteristics of the amplifier are shown in Fig. 6.

Due to the need for the a-c driving signal to swing well into the nonlinear region of the collector characteristic, an increase in output is accompanied by an increase in amplitude distortion. However, this distortion is not detrimental. Actually, in using the motor as a tuned load, the measured distortion is under 10 percent at 3.5 watts.

The authors thank the engineers at Texas Instruments for their assistance. Particular thanks go to C. De Weese, W. Jurek and E. Heckman.

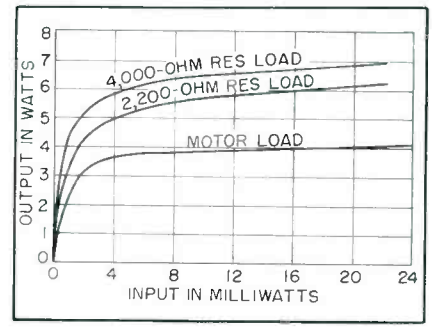

FIG. 6—Output characteristics of servo power amplifier

Measuring Phase at R-F

SUMMARY —— Time delay or phase angle of two sine waves in the frequency range between 10 kc and 20 mc can be measured by comparison-type instrument with an accuracy of 0.1 degree or 1 percent of dial reading. Unaffected by tube variations or noise and harmonic content of input signals, it can measure 5×10^{-10} second delay

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President
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COMPARISON METHODS of measuring direct potential, using a standard cell and a linear potentiometer, are generally far more accurate than the direct indication of a voltmeter. Similarly, in measuring a phase angle between two alternating voltages, the comparison method is likely to be more accurate than the direct-indication method.

The instrument to be described is essentially a comparison device employing a continuously variable delay line as a standard phase shifter and a sensitive balanced phase detector to indicate the phase difference of the two input signals.

Continuous Delay

A continuously variable delay line is effectively a compressed radio-frequency cable with one conductor changed into a long thin coil and the other conductor spaced closely to the first, thus producing a large amount of time delay while maintaining a low attenuation at high frequencies. Figure 1A shows a schematic diagram of a continuously variable delay line.

The variable contact can be adjusted to travel from one end of the line to the other; thus the time delay between the output terminal and the input terminal can be varied from zero to the maximum time delay of the entire line. A dial can be made to measure time delay directly, or phase delay in degrees can be determined by multiplying the frequency of the signals and 360.

A balanced phase detector is a special type of peak rectifier capable of producing a direct potential at its output terminals, proportional to the vector difference of the two alternating voltages applied to its input terminals. Therefore, when the input signals applied to the balanced phase detector are in phase, the reading of the output d-c meter will be equal to zero when the amplitudes of both input signals are equal and equal to a minimum when the amplitudes of both input signals are unequal. Figure 1B shows a simple circuit diagram of a balanced phase detector.

The operation of the instrument may be explained with the aid of the block diagram of Fig. 1C. Both E_1 and E_2 may be introduced with two low capacitance probes. Potentiometer R_1 is used with the input capacitance of the amplifier to introduce a small lagging phase angle to E_1 channel in order that the phase difference caused by lead inductances and stray capacitances can be balanced out by the initial adjustment of the continuously variable delay line.

The differential tuned amplifier is used to increase the sensitivity and to reduce the effects caused by noise and harmonic contents of both signals. A gain control is installed in the differential tuned amplifier for balancing the difference in absolute amplitudes of E_1 and E_2.

First E_2 is disconnected and signal E_1 is applied to both input probes. Then the continuously variable delay line is adjusted until the meter reading becomes minimum. The reading of the continuously variable delay line is recorded

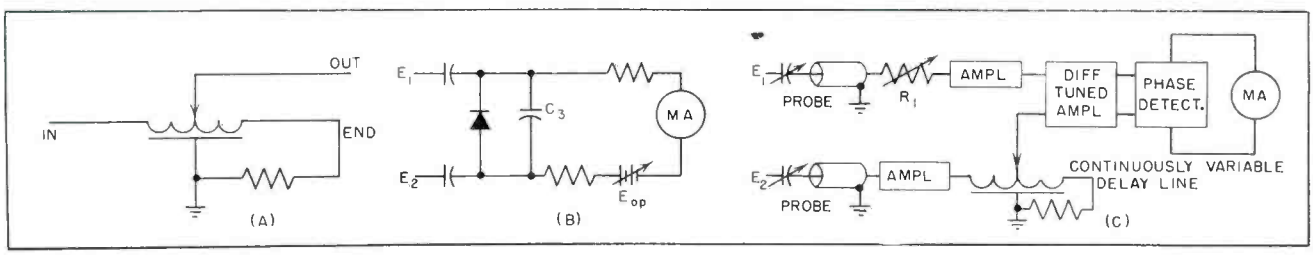
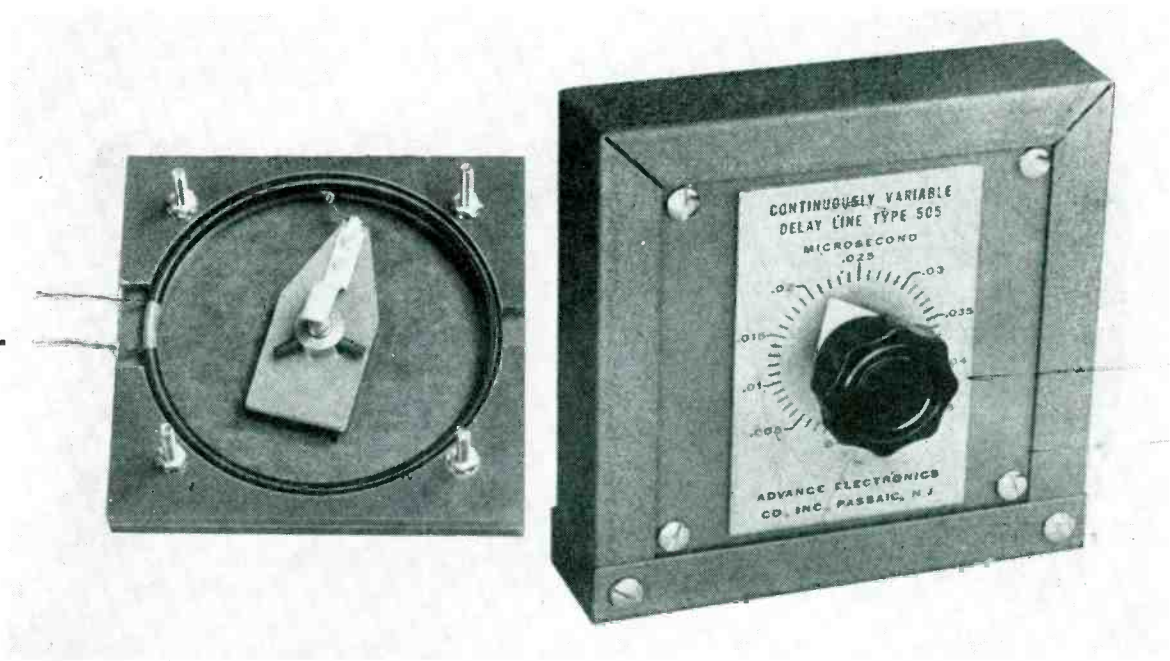


FIG. 1—Schematic of continuously variable delay line (A) and circuit of balanced phase detector (B) combined to form precision phase detector shown in block diagram form at (C)

and Video Frequencies



Delay line is coiled around a copper-plated ring. Moving contact is shown at left. Front of unit (right) gives delay in microseconds on direct-reading dial

as t_1 or θ_1. At this point, both input channels have equal time delay.

With E_1 and E_2 separately applied to the input probes the continuously variable delay line is adjusted until the meter reading again becomes minimum or zero and the dial reading recorded as t_2 or θ_2. The unknown phase angle θ is $\theta_2 - \theta_1$ in degrees or $t_2 - t_1$ in microseconds.

Circuit Description

In Fig. 2, V_2 is an amplifier feeding the continuously variable delay line. Amplifier V_1 is the input amplifier for E_1 channel. Potentiometer R_1 and the input capacitances of V_1 are used to introduce a lagging phase angle to the E_1 channel. The purpose of adjusting R_1 is to balance the difference in phase shift caused by lead inductance and stray capacitance of E_1 and E_2 input channels. Tubes V_3 and V_4 are connected as a differential tuned amplifier, in which a single tank circuit is connected between the two plates. Phase shift caused by off-resonance of the circuit will not affect instrument accuracy.

Switch S_1 selects the frequency band. Variable capacitor C_1 is used for tuning. In case the amplitude of E_1 is higher than E_2, both bias and screen voltages of V_3 can be adjusted by potentiometer R_2 and R_2' until the amplitudes of the output signals at the plates of V_3 and V_4 are approximately equal. Resistor R_2 is used for coarse adjustment and R_2' is used for fine adjustment. Diode D_1 is connected as a balanced phase detector. Duotriode V_5 is connected as a d-c amplifier.

Potentiometer R_3 is used for zero adjustment of the panel meter, and to supply a negative direct voltage to offset a part of the input d-c signal from the phase detector. The output of V_5 is used to excite the output meter. The power supply of this unit has 300 volts unregulated potential and a 150 volts regulated potential.

The continuously variable delay line unit illustrated is a ring with a layer of copper coated on a part of its surface. This form is wound toroidally with Formex magnet wire. Both the dimensions and the number of turns on the coil are very accurately controlled to obtain good linearity and precise time delay.

The time delay of the line can be accurately measured by the following procedure: (1) apply a single signal whose period T is shorter than the total time delay of the delay line to both E_1 and E_2 input terminals of the instrument; (2) adjust for minimum meter reading near the beginning of the dial and record the dial reading as t_1; (3) adjust for the second minimum meter reading near the middle or the end of the dial and record the reading as t_2. A correction factor C for the dial of this instrument may be found by using

$$C = T/(t_2 - t_1)$$

Another method for checking the value of time delay is to connect E_1 binding post to ground, short the END terminal to the GROUND terminal at the rear of the delay line unit and apply a signal with frequency f_s to the E_2 input binding post. Then the delay line dial is turned slowly from its end gradually to its beginning until the meter indication becomes maxi-

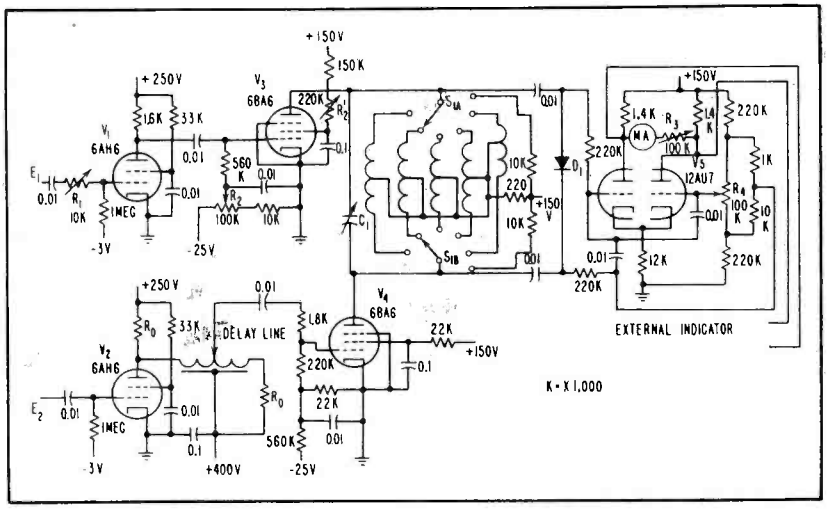


FIG. 2—Complete circuit of comparison type phase indicator

mum. The dial reading is recorded as t_a. Increasing the signal frequency to f_b, the delay line dial is again adjusted until the meter reading becomes maximum and the dial reading recorded as t_b. Correction factor C can be determined by

$$C = \frac{1}{4(t_b - t_a)} \frac{1}{(f_a - f_b)}$$

Both terminating resistors R_0 from INPUT terminal and END terminal to GROUND terminal of the continuously variable delay line must be equal to the characteristic impedance of the line. Otherwise, standing waves will be introduced within the line, thus decreasing the accuracy of the instrument. The value of R_0 can be determined by applying a single sine-wave signal to E_2 input binding post and rotating the delay line dial. If the line is properly terminated, no maximum or minimum reading can be found on the panel meter. If the meter reading decreases rapidly when the variable contact is being rotated away from its END terminal, the value of R_0 is too high. On the other hand, if the meter reading increases rapidly, R_0 is too low.

Meter Sensitivity

Maximum sensitivity for full-scale deflection is 0.01 volt rms in the instrument described. Since the phase detector is based on measuring the vector difference of the two input signals, the meter indication can be expressed in terms of the absolute amplitude of one signal, say E_2 and the phase angle θ when the absolute amplitudes of both signals are equal.

$$\text{Meter indication} = 2E_2 \sin(\theta/2)$$

To obtain an adequate minimum indication, the amplitude of the input signals can be calculated by using the above expression; the results are given in Table I.

This table shows that the required amplitudes of the input signals become larger when the phase angle is small. When the input signals are 0.5 volt, the panel meter has an indication of about 0.00087 volt when the phase angle θ is 0.1 degree according to the above expression. In other words, the deflection will be about 9 percent of full scale under this condition. Thus, 0.5 volt is recommended as the minimum input for detection of 0.1 degree to produce 9 percent of full-scale deflection.

The significance of minimum indication on the panel meter when the delay line dial is being rotated depends not only on the amplitude but also on the frequency of input signals. Therefore, it is desirable to consider the relationship between signal frequency and rotation of the delay line dial. For a 0-to-0.25 microsecond continuously variable delay line, the change in meter indication becomes full scale as the delay line dial is rotating from one end to the other when E_2 equals 0.01 volt at 2 megacycles.

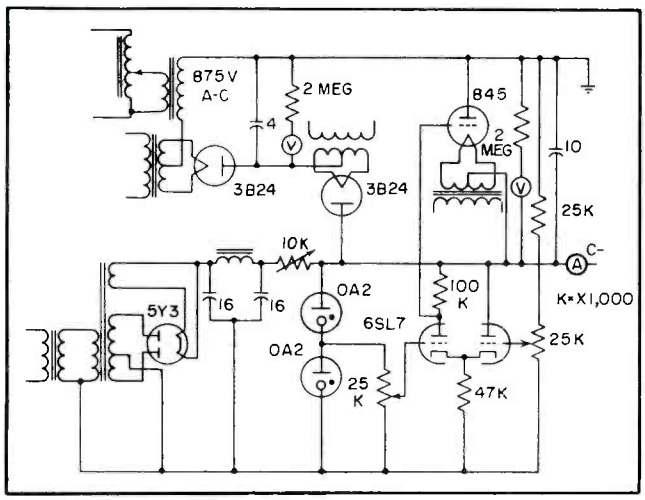
Table I—Input Amplitudes Required for Full-Scale Deflection

Input amplitude in volts	Phase angle in degrees
0.01	180
0.014	90
0.01	60
0.115	10
0.286	4
1.15	1
2.3	0.5

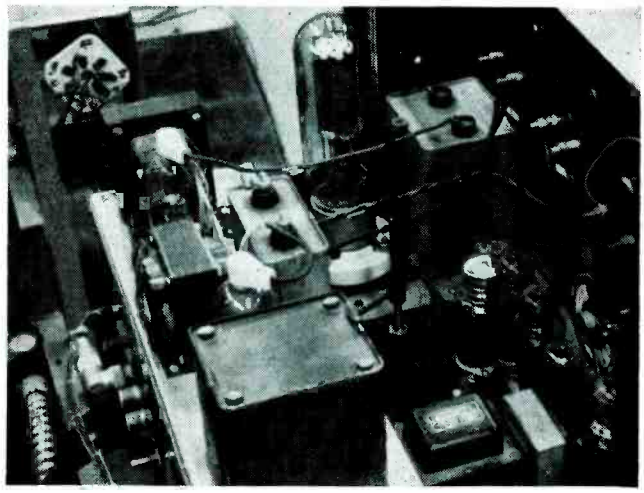
This is found from the above expression by substituting 0.25 microsecond at 2 megacycles equal to 180 degrees. Similarly, the change in meter indication will be full scale as the delay line dial is rotating from one end to the other when E_2 equals 0.115 volt at 111 kc. Therefore, the significance of minimum indication becomes poor when the signal frequency decreases. To remedy this condition, it is possible to use longer delay lines for low-frequency signals. A variation of the circuit by addition of a step variable delay line of 5 microseconds total delay in steps of 0.05 microsecond connected in series with the continuously variable delay line has been built and tested. The results are satisfactory below 10 kc.

One of the advantages of this instrument is that stray capacitance and inductance of input leads and all circuit elements do not affect the accuracy of the measurement. Furthermore, the accuracy is completely independent of variations of tube factors, meter tolerance, and other circuit parameters, since the instrument is based entirely on a comparison principle. Because a continuously variable delay line is employed as a phase shifting element, the instrument can be used to measure very small time delay and phase angle of transmission networks at very high frequencies where other phase measuring devices fail.

Many instruments of this kind have been constructed and tested. It has been found that the accuracy is always better than ± 0.1 degree or ± 1 percent of the time delay indicated on the dial of the continuously variable delay line. The resolution time is 5×10^{-10} second or smaller; the smallest phase angle in degrees that can be read on the dial is aproximately equal to $5 \times 10^{-10} \times 360 \times$ frequency in cps. The practical frequency range can be from 10 kc to 20 megacycles. The indicator sensitivity is about 0.01 volt full scale.



Regulated bias supply uses two power transformers. Section at upper left supplies standby bias in case of failure of main supply. Lower section provides regulated voltage for control tube



Power supply as installed in linear accelerator. Standby supply is at left, with 845 tube used as grid-leak resistor at rear center. Small power supply for 6SL7 is at lower right

Biasing Large Amplifiers

SUMMARY —— Tube acting as variable grid-leak resistor provides constant grid bias to linear-accelerator amplifiers over a wide range of grid current demands. Supply will provide up to 100 ma at 1,000 volts

By W. G. WADEY
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New Haven, Conn.

MAINTAINING a constant bias on the twenty-two 6401 triode amplifiers used in the Yale linear accelerator normally requires a bias supply large enough to hold the bias steady regardless of variations in grid current.

The amplifiers operate at 600 mc and have a peak power output of 200 kw, which they deliver for 15 μsec at a repetition rate of 100 pps. At a plate voltage of 12 kv the required grid bias is about 600 volts, but it is convenient to be able to vary the bias up to 1,000 volts or more. The tubes draw grid current, but it is variable from tube to tube.

These conditions would require a large and costly supply since it is possible that all the tubes might draw the same sign of grid current. To avoid that, the circuit shown in the diagram was devised, which will supply 1,000-volts bias at currents up to 100 ma.

If bias were developed across an ordinary grid-leak resistor no bias supply would be needed, but the bias would vary with grid current. Replacing the fixed grid-leak resistor with a tube allows the resistance to be varied as the grid current changes thus keeping the bias constant.

In the circuit shown, the type 845 tube is the regulated grid leak. The grids of all the amplifier tubes are connected to the bias bus, $C-$, and the grid currents of all tubes flow to ground through the 845. The grid potential of the 845 is determined by a direct-coupled feedback amplifier consisting of both halves of a cathode-coupled 6SL7. The bias potential of the right-hand grid of the 6SL7 is picked off a potential divider connected from ground (positive) to a point 300 volts below the bias bus as maintained by the two 0A2 tubes. The 25,000-ohm potential divider across the lower 0A2 puts the left half of the 6SL7 in the proper range of its characteristics. The power supply at the lower right serves only thethe 0A2 tubes and the 6SL7.

Failure Protection

As with any grid-leak bias, if the r-f drive on the amplifiers fails, the bias fails and the tubes may be damaged. To prevent this a small back-up supply is provided. It is set with a variable transformer at some value less than the operating bias voltage. Normally, its only load is a voltmeter since the lower 3B24 tube is nonconducting.

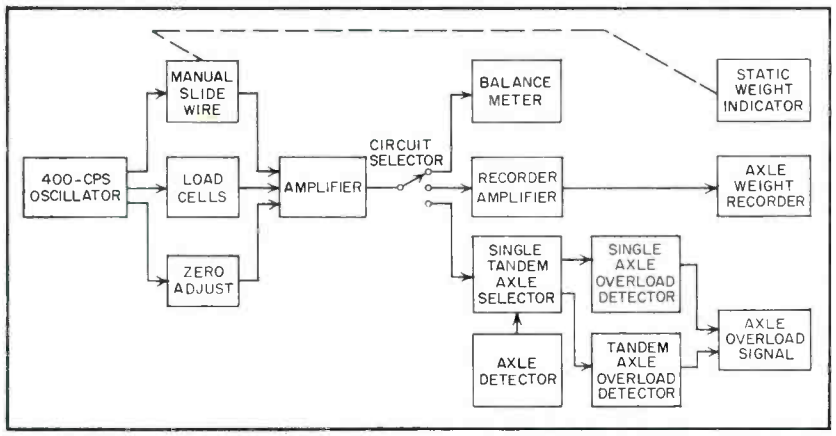
If the r-f drive fails the bias will fall until the 3B24 conducts and then stay at the back-up voltage until the drive is restored. The back-up supply has no load, since no grid currents are drawn.

Scale Weighs Moving

SUMMARY — Highway trucks diverted to lane along edge of road are weighed while traveling at speeds up to 48 mph. Overweight vehicles set off preset alarm. Scale is operated at 400 cps and uses load cells bridge-connected to d-c amplifier. Dead weight is balanced with potentiometer

AN ELECTRONIC highway scale, recently installed on U. S. Highway 1 in Virginia, is capable of detecting overloaded trucks while they are in motion, recording the weight of all passing trucks and accurately weighing stationary trucks.

The scale operates at 400 cycles. Power is fed into the load cells, the zero-adjust potentiometer and the slide-wire circuit as shown in the block diagram. The voltage into the slide wire circuit and the zero-adjust potentiometer are in opposite phase to that fed to the load cells. The zero-adjust potentiometer is used to counterbalance load cell output owing to the dead weight of the scale platform.

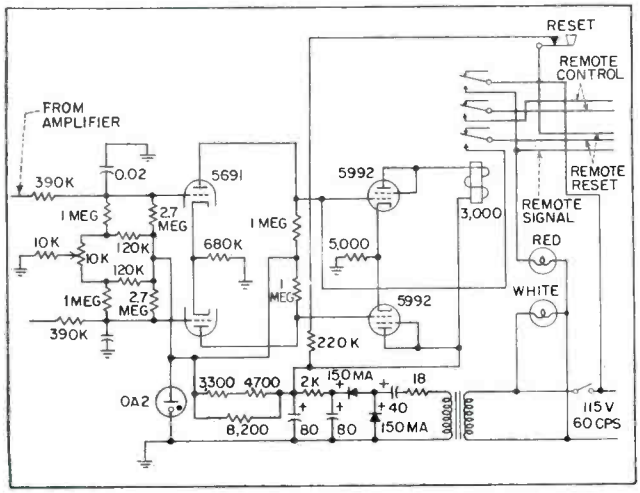


Elements of highway scale that indicates static weight or signals and records overweight on basis of preset alarm

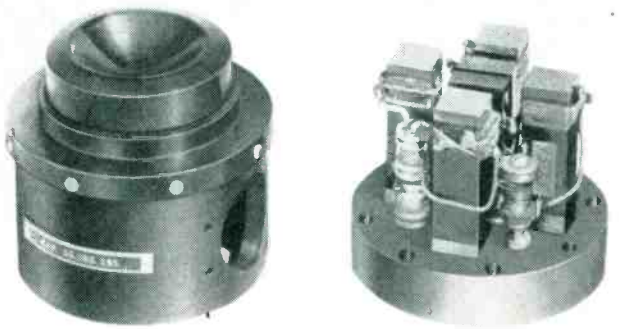
When this equipment is used for static weighing, the circuit selector is connected to the balance meter, which is a zero-center, 100-microampere meter. With no load on the scale and the weight indicator dial at zero, there is no input to the amplifier and the meter shows a zero balance. When a load is placed on the platform, unbalancing the bridge network in the load-cell circuit, a voltage is applied to the amplifier and the meter goes off balance.

Static Weight

By turning the weight indicator dial, a voltage of opposite phase is introduced into the amplifier and this voltage is adjusted until its magnitude is equal to the load-cell output. The resulting amplifier input is zero and the meter returns to zero balance. The actual weight on the scale is indicated by graduations of the weight indicator dial on the shaft of the slide-wire control used to develop the balancing voltage.



Alarm circuit of scale must be reset manually



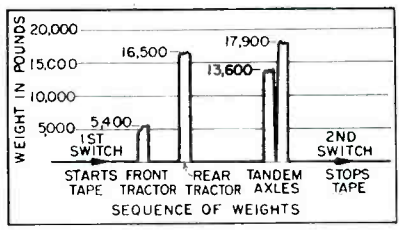
Four load cells of this type are used under weighing platform

Trucks

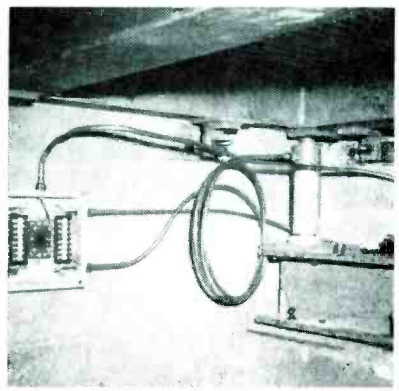
By ARTHUR L. THURSTON

Consulting Engineer
Cox and Stevens Electronic Scales Division
Revere Corp. of America
Wallingford, Conn.

Weighing platform is set into roadway. Equipment is triggered by switch ahead of platform and shut off by another that follows. A permanent tape record shows the weight of each axle



Typical tape record of weights determined by automatic equipment from truck passing at 48 mph



Underside of platform shows support for electronic load cell. Four cells are used, one at each platform corner

When the scale is recording moving weights, the circuit selector switch is turned to the record position. The slide wire is not used and the weight indicator dial remains at zero. In this case, any load placed on the platform develops from the cells an output that is amplified and fed into the paper-tape recorder.

This recorder uses a heated stylus and sensitized paper for low-inertia, high-speed operation. To save tape, because it is used at the rate of 50 millimeters per second, a roadway treadle is placed just ahead of the scale to start the paper drive as a vehicle approaches the weighing platform. A second treadle shuts off the drive after the platform is cleared.

Overload Alarm

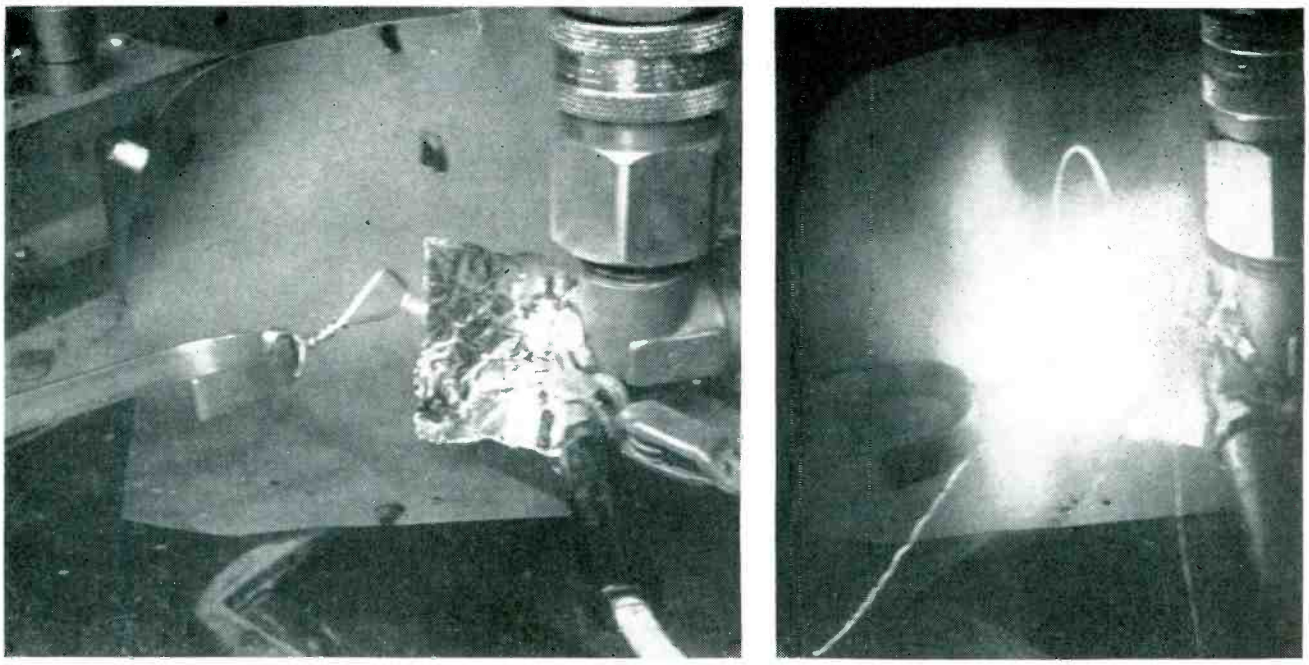
As an overload detector, the manual slide wire is set to the predetermined limit over which excess weights are to be detected. For a signal to trip the overload detector circuit, a voltage must be developed by load cells in excess of that voltage introduced by the slide wire. Any slight excess will trip the detector circuit and set off the alarm signal. In addition to the alarm, there would normally be a sign along the roadway to indicate to the driver of the overloaded truck that he is to pull off the highway and be weighed at a static scale operated by enforcement personnel.

Tandem Detection

As most states allow less weight on a tandem axle arrangement than on two single axles, two treadles are placed on the platform for tandem axle detection. If the contact strips in both treadles are closed at the same instant as by tandem axles, a high-speed switch circuit changes the amplifier output to a detector set to trip on a higher voltage. This detector, adjusted independently of the single-axle detector, is set to trip at a weight near the tandem axle load limit. In either case, the overload signal information is the same.

The oscillator and amplifier employ standard circuits, the amplifier having a gain of approximately 90 db. In addition, the amplifier contains a phase-detection circuit related to the 400-cycle supply, to provide a positive d-c output when the cell voltage exceeds the slide-wire voltage and negative for the reverse condition. The overload detector uses a standard d-c amplifier circuit with a relay in the plate circuit of the final stage. Only when the load cell output exceeds the slide-wire voltage will a grid voltage of the proper polarity be applied to the detector circuit. For the high weight limits of tandem axles, this bias voltage is increased so that a higher cell output to trigger the relay is required.

When the relay closes, a positive voltage from the power supply is applied to the grid of the output tube through the reset button on the panel and an external reset in series, should there be one. This locks in the relay to hold the alarm and roadway signs until the circuit is manually reset.



Spark (left) when 7-kv supply of tv transmitter with electronic-crowbar fault protection is shorted. Neither solder-wire loop nor aluminum foil are damaged. Effects of same test with overcurrent relay-magnetic switch type of fault protection are shown at right

Gas Tubes Protect

By W. N. PARKER and M. V. HOOVER

Tube Division
Radio Corporation of America
Lancaster, Pennsylvania

MOST POWER TUBES are subject at some time to a phenomenon known as the Rocky Point effect, which derives its name from experiences with power tubes in communications transmitters at Rocky Point, Long Island.

Nature of Effect

This phenomenon manifests itself as an internal flash-arc developing with little warning in power tubes which apparently are of good design and are operated in a conservative manner. Triggering sources range from cosmic rays to line-voltage transients, parasitic oscillations, spurious renegade primary and secondary electrons, material whiskers and photoelectrons.

The cause of this effect is not thoroughly understood and thus efforts to find a remedy are hampered. However, techniques have been evolved which protect power-tubes against Rocky Point effect. These circuits detect the development of fault conditions in a power tube and/or its circuitry and trigger a gaseous-conduction device connected in shunt with the d-c power supply, extinguishing the flash-arc in the power tube before serious damage results. The gaseous conduction device bypasses the rectifier output and filter-circuit energy until the rectifier is de-energized.

This protection system is known as an electronic crowbar.

Fault Protection

In the past, the chief technique available for minimizing the effects of flash-arc damage in power tubes has been the addition of resistance in series with the d-c supply to limit surge currents during faults. Figure 1 shows a circuit of this type in which R is the series limiting resistance. In high-power installations this type of circuit dissipates an objectionable amount of power in the series limiting resistance if even marginal protection is to be afforded.[1]

In 1951, it was suggested that an electronic crowbar be built and electronically slammed across the high-voltage-supply bus in event of a fault as a means of shunting the fault currents of a 2,000-kilowatt rectifier from the faulting tube.[2] This device placed a virtual short-circuit across the rectifier output, similar to that placed on the rectifier by the flash-arc, but transferred the short-circuit current to a device which was not damaged

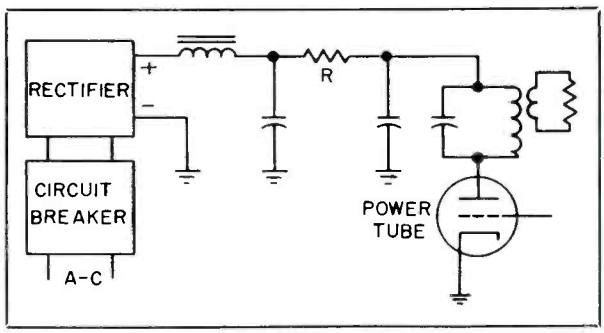


FIG. 1—Simple r-f power amplifier has limiting resistance

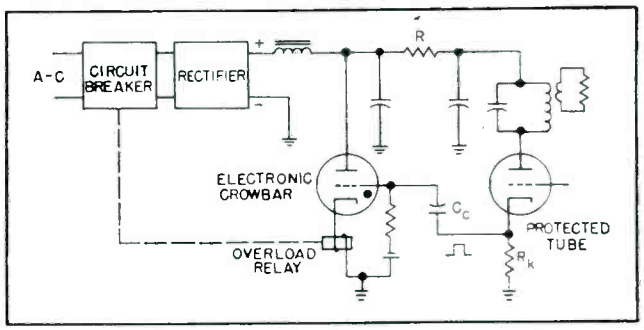


FIG. 2—Basic electronic-crowbar fault-protection circuit

SUMMARY —— Microsecond-response fault-detection and protection circuit minimizes flash-arc damage to power tubes. Gas tube shunted across d-c supply extinguishes flash-arc before serious damage occurs. Systems handling up to 5 megawatts can be protected

High-Power Transmitters

by the momentary short-circuit condition.

Basic Circuit

A simple electronic-crowbar circuit is shown in Fig. 2. A fault in the protected power tube results in a sudden increase in current through cathode resistor R_k, producing a positive voltage pulse which is coupled by C_c to the grid of the thyratron. This impulse ionizes the thyratron and causes it to conduct damaging current away from the faulting tube.

The current through the crowbar tube energizes the coil of the overload relay, causing the circuit breaker to open, thus deenergizing the primary source of a-c power to the rectifier.

In the sequence of these operations, plate voltage across the faulting tube is quickly reduced to a value of 15 to 20 volts, which is the voltage drop across the ionized gaseous-conduction crowbar device. This low voltage starves and extinguishes the flash-arc in the protected tube before serious damage can result. A small series resistor, R, provides adequate voltage across the crowbar tube to insure its conduction despite severe low-impedance flash-arcs in the protected tube.

In a typical large-power-tube installation, the value of the series dropping resistor is only about 5 ohms.

Actuation Time

Measurements have revealed that the electronic-crowbar tube is capable of beginning its protective function within 1 to 5 microseconds after the fault has been detected. When vigorously triggered, hydrogen-thyratron crowbar tubes begin to conduct within approximately 1 microsecond and mercury-vapor devices within about 5 microseconds.

A simplified diagram of a crowbar protection circuit currently in commercial use is shown in Fig. 3. This circuit is employed in the RCA TTU-12, a 12.5-kilowatt uhf television transmitter.[3]

In the arrangement shown in Fig. 3, the series resistance corresponding to R of Fig. 2 consists of series resistors, R_1, R_2 and R_3.

Resistor R_2 also serves as a sensing resistor. In the event of a sudden overcurrent in the load circuit as a result of a fault, a steep-wavefront positive pulse is transmitted through the transformer to the grid of the thyratron crowbar tube, which is normally biased off by the bias source.

This pulse causes almost immediate ionization of the thyratron, which then conducts and forms an effective short-circuit in parallel with the load. Energy stored in reservoir capacitor C_r and that which is subsequently furnished from the power supply is dissipated in R_1 and R_2. Because R_3 has a large value compared to the resistance of the ionized thyratron, very little current flows to the faulting load.

The series resistance of R_1 and R_2 in combination with the impedance of the power supply limits the fault current to a value not exceeding the

peak-current rating of the thyratron. Conduction of the thyratron operates the overload relay, which ultimately interrupts the primary source of a-c power by the circuit breaker. Several other variations of this circuit also give effective protection.

Performance

When a wire having a diameter of 0.003 inch is placed directly across the energized 7,000-volt plate lead of the circuit shown in Fig. 3, the resulting arc is so slight that it produces only a small pit in the wire. However, a tremendous cone of fire results if the plate potential is short-circuited with the protective system disabled.

In another test of effectiveness, the positive power-supply lead is touched to a small sheet of thin metal foil at ground potential. The thin metal foil used in cigarette packages is quite satisfactory. If the protective circuit is operating properly, the foil will show no melting, pitting or burn marks. However, the foil will disappear in a cloud of vapor if the test is performed with the electronic protective circuits disabled. Results of such tests are illustrated in the photographs.

Equipment Installations

An electronic-crowbar system of protection has been employed in conjunction with the 1,700-kilowatt rectifier for part of Navy's Jim Creek million-watt transmitter.[5, 6] More recently, super-power transmitters for the Voice of America have used the electronic crowbar.[7] In these superpower installations, it is not uncommon to find rectifiers having fault-current capabilities of the order of 2,000 amperes.

The effectiveness of fault-protection circuits in these large systems may be demonstrated by a deliberate short-circuiting of the high-voltage bus or tube terminals with a movable horn gap in which one of the electrodes is a piece of conventional 0.060-inch-diameter rosin-core solder. A slight melting and pitting of the solder will result when the electronic crowbar is in operation.

When conventional breaker-protected rectifiers are used, however, the horn gaps will disappear in a frightening display of aural and visual fireworks. Although the use of grid-controlled rectifiers reduces tube damage significantly, experience has demonstrated that such rectifiers are also capable of damaging tubes and circuits.

Another advantage of rapid fault protection is that full power can be restored almost immediately when the damage due to the flash-arc is minimized. Operators of high-power transmitters are familiar with the lengthy aging process demanded by power tubes after a severe flash-arc.

These periods of operation at lower power level may require many hours or days. Furthermore, tubes which have suffered from severe flash-arc damage are often somewhat gassy and may produce a final and fatal flash-arc unless they are adequately protected during reaging.

Out of Service Time

Actual tests of electronic-crowbar circuits in super-power transmitters have demonstrated that full-power operation can safely be restored almost immediately after a flash-arc. When these protective circuits are operated in conjunction with grid-controlled rectifiers, the total down time due to a flash-arc is of the order of 50,000 microseconds, a period almost unobserved in most communications services. The down time is, of course, directly proportional to the severity of flash-arc damage.

High-speed fault protection is not limited to power tubes, but is equally applicable to circuitry associated with the tubes. Capacitors, inductors, insulation and the like can also be damaged by fault currents. Crowbar protection greatly enhances the possibility of survival of circuit components and of early restoration of normal full-power operation.

Fault Detection

The effectiveness of high-speed fault-protection circuits is contingent upon the early detection of a fault in the tube or in its associated circuitry.

In simple fault-detection systems, such as that shown in Fig. 2, the power tube is protected against faults, but the system is incapable of sensing fault conditions in the circuitry associated with the protected tube. This disavantage may be obviated by the use of a fault-detection system such as that shown in Fig. 3. In this system, any d-c fault in the tube or circuit on the load side of sensing resistor R_2 triggers the protection system into action.

Several other fault-detection systems are available.[8] A differential system of fault protection has proven very successful.[9] The operation of the differential fault detector is predicated on the fact that a fault which develops in a vacuum tube operating as an oscillator or an amplifier causes the r-f output to decrease sharply and the d-c input to increase.

In the differential fault-detector circuit shown in Fig. 4, rectifier

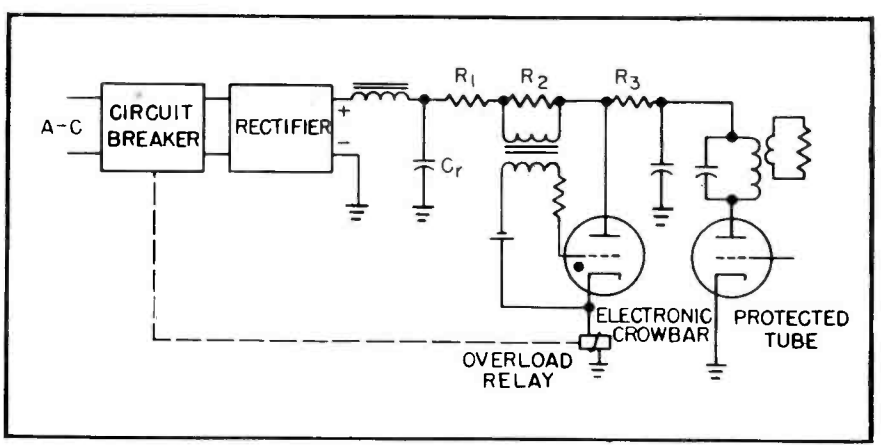


FIG. 3—High-speed protection circuit used in 12-kilowatt ultra-high-frequency television transmitter. Resistor R_2 acts as sensing element

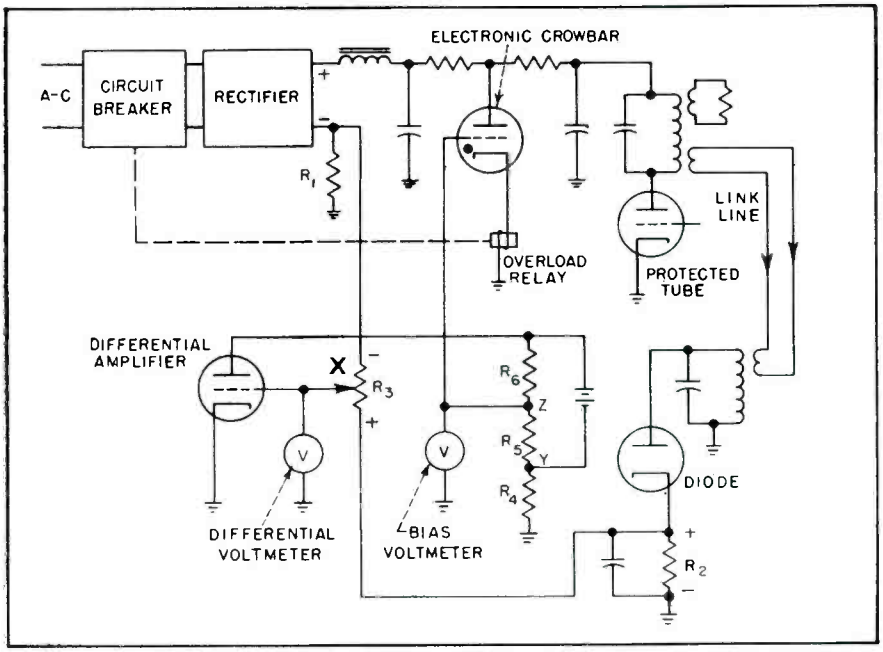


FIG. 4—Differential fault detector in high-speed protection system

load currents manifest themselves as a negative voltage across R_1 in the negative return of the rectifier. A sample of the r-f power output from the protected tube is coupled by a link line from the tank circuit to the parallel resonant circuit in the diode plate circuit. Rectification by the diode develops a positive voltage across resistor R_2 having a magnitude directly proportional to the r-f amplifier output. Resistor R_3 may be adjusted until the differential voltmeter reads zero voltage with respect to ground, indicating balance between the sample of rectified r-f power output and the sample of d-c input from the negative return of the high-voltage rectifier. Because the r-f power output is approximately proportional to the d-c input, the null balance from point X to ground should be approximately maintained at all signal levels, despite 100-percent modulation of the protected tube.

It should be noted that the voltage from point X to ground is zero when the high-voltage rectifier and protected tube are idle. Consequently, under all normal circumstances the differential voltage is zero, resulting in zero-bias operation of the differential amplifier.

This amplifier normally draws plate current through resistor R_4 to produce a negative voltage at point Y with respect to ground. When all the circuit parameters are designed properly, the negative voltage across resistor R_1 is greater than the positive voltage across resistor R_5 produced by the battery. A resultant negative voltage is produced from point Z to ground which biases off the thyratron, as indicated by the bias voltmeter.

Circuit Operation

In the event of a fault, the rectified r-f voltage sample across R_2 decreases rapidly toward zero, while the d-c sample voltage across R_1 in the negative return of the high-voltage rectifier suddenly becomes increasingly negative. Either or both of these sample voltages produce a resultant voltage which is increasingly negative at point X as fault conditions develop. A negative voltage is thus produced from point X with respect to ground and the differential amplifier is biased off, reducing the negative voltage across R_1 to zero.

Point Z, which is positive with respect to ground because of the voltage divider across the battery, then triggers the thyratron electronic crowbar. In addition to its protective function, the thyratron also interrupts a-c power to the rectifier by the overload relay and the circuit breaker.

The tubes employed in electronic crowbar service must be reliable and rugged. They must also be able to conduct heavy surge currents for a short period of time after having been idle for a long period of time.

Tubes for Electronic Crowbar

In high-power installations, the type 5563A mercury-vapor thyratron has demonstrated its effectiveness in commercial equipment[3] with circuits similar to that shown in Fig. 3.

Hydrogen thyratron tubes are also reported to have been used effectively in connection with crowbar applications in super-power transmitters.[7]

From the standpoint of long life, dependability and ruggedness, the ignitron appears to be an ideal choice for super-power crowbar service. Absence of a hot cathode in this tube is an attractive feature.

Ignitrons appear to be almost indestructible in crowbar service. One tube has been in almost daily use in the protective circuits of superpower-tube test equipment for the past seven years. In the course of this activity, the ignitron crowbar has been operated in conjunction with a 5,000-kilowatt grid-controlled rectifier in which fault currents may approach several thousand amperes at output voltages of 27 kilovolts.

Because many flash-arcs are experienced during the early operation and aging of large power tubes, this particular ignitron has been subjected to an unusually rugged life. Since the electronic crowbar has been used, not a single protected tube has been seriously damaged by flash-arcs during testing.

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Digital Presentation

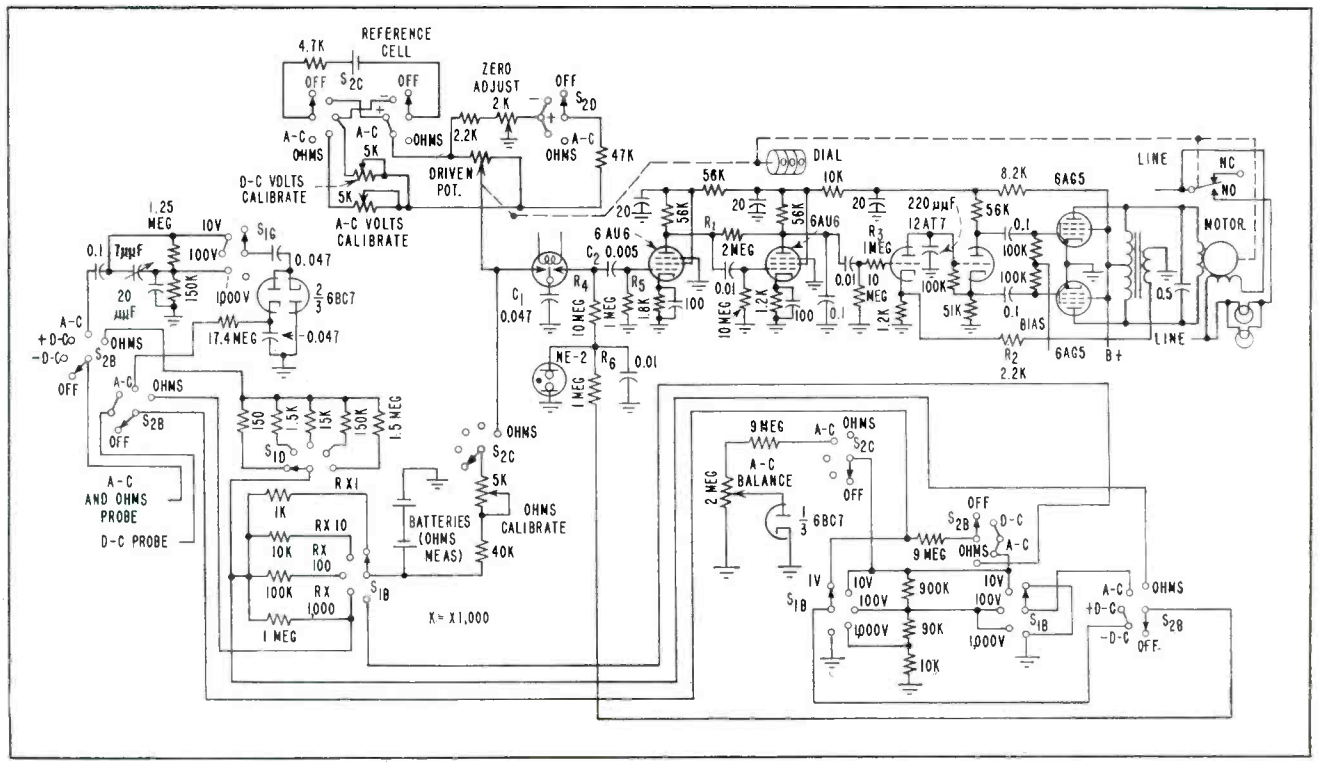


FIG. 1—Resistance-capacitance network in preamplifier grid functions as modulator/mixer, derivative controller and noise filter

SUMMARY —— Servo-driven self-balancing potentiometer with counter coupled to servo shaft provides vacuum-tube voltmeter with digital presentation. Chopper samples potentiometer signal and compares it with input

LARGE-NUMERAL three-digit presentation displayed on the front panel of the vacuum-tube voltmeter avoids parallax errors. Polarity is indicated by a sign before the digits, and the decimal point is indicated in the display. The instrument is insensitive to line-voltage variations, and has no warmup drift when used as a d-c voltohmmeter.

Presentation accuracy for direct voltage is dependent only upon the linearity of the self-balancing potentiometer and the potential of the mercury-cell reference battery, modified slightly by the precision input attenuator. As an ohmmeter, the intrinsic accuracy is limited only by potentiometer linearity.

All measurements are accomplished by a null techique. Voltage measurements employ a self-balancing potentiometer, which has a basic range of 1 mv to 1 volt. High voltages are measured after division in a self-contained voltage divider. Resistance measurements employ a self-balancing Wheatstone bridge.

Alternating-voltage measurements are effected by peak-to-peak detection with a compensated 6BC7 detector, and measurement with the basic direct-voltage servo.

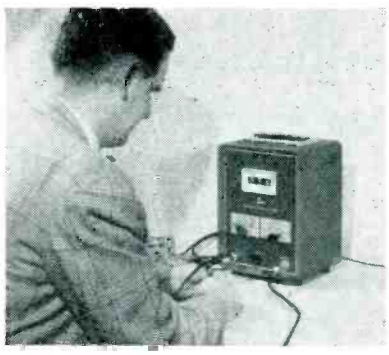
Accuracy

The instrument has a minimum accuracy of plus 1 percent of full scale on direct volts and ohms and plus 2 percent on alternating volts.

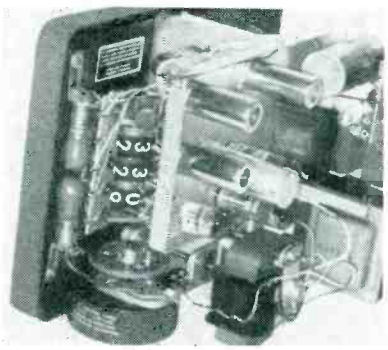
Repeatability of reading is approximately one part in one thousand obtained by high gain without compromising dynamic stablity. A derivative controller in the servo feedback loop, a low-pass filter for attenuating noise and 60-cycle hum, a d-c heater supply for the preamplifier, and means for preventing potentiometer noise from being introduced into the servo amplifier contribute to freedom from zero drift and calibration errors and to critically damped dynamic response. Because of the stability of the servo, no damping control is necessary.

As a d-c voltmeter, the digital presentation permits reading to one millivolt on the one-volt scale and to 1,000 volts with four decade

Vacuum-Tube Voltmeter



Front panel of voltmeter



Chassis and servo gear train

By AUGUST NUUT and CLARENCE MUNSEY

Hycon Manufacturing Company
Pasadena, California

ranges. On all ranges, the input impedance is 11 megohms.

Resistance values range from 1 ohm to 10 megohms. The presentation is linear. Accuracy may be expressed as a percentage of full scale, and compares favorably with laboratory-type resistance bridges.

The digital voltmeter is a servo-driven self-balancing potentiometer with a counter coupled to the servo shaft. The motor is coupled by spur gears to a shaft which positions the mechanical counter through two beveled gears, The potentiometer is operated from this shaft by a worm gear.

The life of the mercury-cell batteries is approximately equal to the shelf life, due to the less-than-50-microampere current drawn. These batteries need to be replaced approximately once a year.

The feedback potentiometer has a linearity of $\frac{1}{4}$ percent and a resolution of $\frac{1}{3}$ digit. Potentiometer noise has little effect on the balancing servo because of the chopper used for sampling the signal and comparing it with the input.

Circuit

Capacitor C_1 (Fig. 1) samples the potentiometer voltage. As a result, spike noise from the potentiometer is eliminated from the input to the low-level preamplifier.

Inverse feedback is used in two places in the servo amplifier for setting and stabilizing gain. Feedback resistor R_1 stabilizes the gain of the second 6AU6, and R_2 stabilizes the gain of the entire phase-inverter and power-amplifier loop in addition to lowering the output impedance of the power amplifier.

The amplifier loop included by R_1 contains a direct-coupled phase amplifier for stability. The direct-coupled phase inverter saturates at a peak swing which is slightly less than that required to cause the 6AQ5's to draw grid current. The only grid-current-limiting resistor used is R_3 at the input of the 12AT7. In spite of the 60-db range of inputs that can be applied, this high-gain amplifier cannot be blocked.

Although the motor is direct-coupled to the 6AQ5 output tubes, no d-c component flows through the motor winding. This reduces motor noise. Little signal power is lost in the transformer. Most of it is absorbed by the motor. Thus a small transformer with the secondary winding used for feedback may be used without compromising efficiency or smooth operation.

R-C Network

The network R_4, C_2 and R_5 when used with the chopper and C_1 functions not only as the modulator and mixer, but also functions as a derivative controller and potentiometer noise filter. Capacitor C_2 is smaller than C_1 and R_4 is much larger than R_5. Thus the voltage of C_1 is constant during the period that the chopper arm is connected to the right-hand contact. Assuming a constant signal input to R_4 and a step change of voltage to the left-hand contact of the chopper; the charging time constant through the choppers and the right-hand contact consists of C_2 and R_5. This time constant is shorter than that of C_2, R_5, R_4, R_6, plus the resistance of the input dividers.

As a result of a step change of the feedback signal, the initial error voltage coupled to the grid of the preamplifier is equal in amplitude to the magnitude of the step change. After a period of time, however, C_2 accumulates a charge which opposes the potential of the step change. The difference potential is smaller and the amplitude of the error voltage to the preamplifier is smaller. Figure 2 illustrates the process.

The counter was designed by Warren White and Warren Malcher. The contributions of coworkers including Edward M. Boughton, Jr., who reviewed the material, are acknowledged.

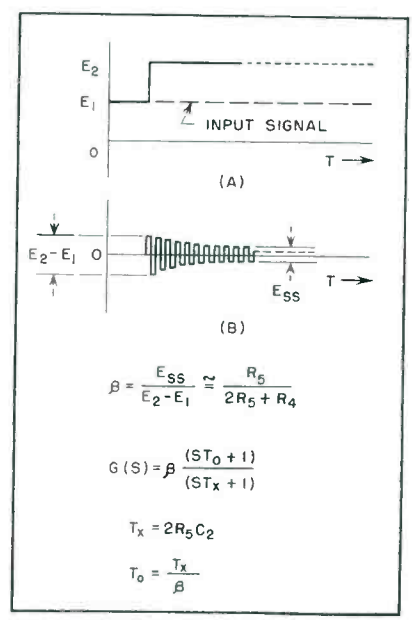
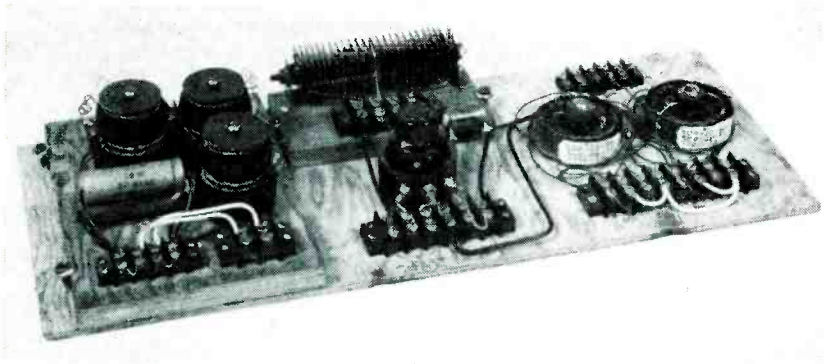


FIG. 2—Simulated potentiometer step function (A), error signal to preamplifier (B) and general form of derivative controller transfer function

Magnetic-Switch

SUMMARY —— High accuracy of response time measurements in testing high-speed magnetic amplifiers is provided by frequency tripler and magnetic switch. Phase shifter permits varying of switch firing point in relation to test voltage waveform



Breadboard model of magnetic-amplifier analyzer. Magnetic switch is on right and magnetic frequency tripler is at left

SYNCHRONOUSLY operated mechanical switches have proved to be a valuable tool for experimental studies on the dynamic properties of high-speed magnetic amplifiers. Application of such equipment is limited to power-supply frequencies where a mechanical switch can be used.

Analyzer performance can be considerably improved by providing a magnetic switch which consists of a saturable-reactor circuit producing an auxiliary current with nearly rectangular waveshape. The amplifier under test is supplied from a magnetic frequency multiplier which produces an exact multiple of the frequency of the a-c power supply.

When applying a frequency tripler, as illustrated in the typical example of Fig. 1, the magnetic switch makes and breaks alternately in a sequence of three half-cycles.

Figure 1 shows an arrangement of operation from a three-phase, 400-cps power supply in connection with a three-phase type of magnetic frequency tripler providing the frequency ratio 400-to-1,200 cps.

The amplifier under test is connected with the 1,200-cps output of the tripler. The 400-cps tripler input is supplied through a phase shifter with the magnetic-switch circuit. This circuit produces an auxiliary current I_s with nearly rectangular waveform and corresponding unidirectional square wave pulses representing the variable signal voltage E_s for controlling the amplifier input circuit.

Magnetic-Switch

The waveform of the output current I_s of an ordinary saturable reactor with high-permeability core material having series-aiding-connected a-c load windings N_1', N_1'' and series-opposing-connected d-c control windings N_2', N_2'' is nearly rectangular. This assumes that the control-circuit loop carrying constant direct current I_A represents a very high impedance (choke coil L_c) with regard to even-harmonic currents. These even-harmonic currents are suppressed and the saturable reactor operates under forced magnetization conditions.

To derive corresponding unidirectional square-wave pulses (signal voltage E_s) from the square-wave alternating-current I_s, a splitting

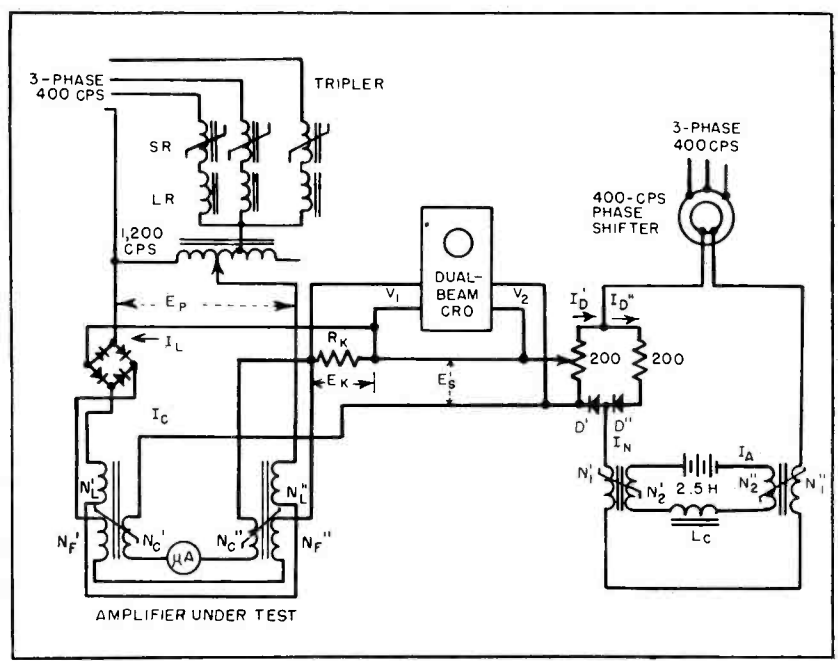


FIG. 1—Transient analyzer using magnetic switch is shown with circuit of high-speed magnetic amplifier under test

Transient Analyzer

By W. A. GEYGER

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circuit is provided which consists of two half-wave-rectifiers D' D'', a potentiometer (first-half-cycle pulses I_D') and a fixed resistor (second-half-cycle pulses I_D'').

Magnetic Frequency Tripler

A simple arrangement for producing third-harmonic frequency power from a three-phase, four-wire power source contains three Y-connected saturable reactors *SR* with series-connected linear reactors, *LR*. The load consists of the magnetic amplifier under test and a variable transformer.

Introduction of the phase shifter offers the possibility of varying the actual time interval between the instant of firing of the saturable-reactor switch and the instant supply voltage E_P of the magnetic amplifier goes through zero.

Choke coil L_C carries the constant direct current $I_A = 0.6$ amp which is supplied from a storage battery or a full-wave rectifier. The splitting circuit consists of 2 rectifiers, each made up of 12 1-sq-in. selenium plates.

Table I—Core and Winding Data for Magnetic Switch and Tripler

Core		Winding			
No.	Material and Size	No.	Function	Turns	Wire Size
Magnetic Switch					
2	¼ in. by 2 mil Orthonol tape coil, 1¼ in. i-d, 1½ in. o-d	1 2	a-c load d-c control	1,700 500	No. 28 No. 28
Frequency Tripler Saturable Reactor					
3	¾ in. by 2 mil Orthonol tape coil, 1⅛ i-d, 1⅜ o-d	1		380	No. 23
Linear Reactor					
3	2-stacked Permalloy dust cores, Western Elect. No. 467585	1		300	No. 23

When supplying a 400-cycle voltage of about 110 to 130 volts rms, the average value of the full-wave-rectified load current is

$$I_N = I_A \frac{N_2}{N_1} = 0.6 \frac{500}{2{,}000} = 0.15 \text{ ampere,}$$

The average value of unidirectional current components is $I_D' = I_D'' = 0.075$ ampere. Thus, the average value of the unidirectional square-wave signal voltage E_S may be varied within the limits of from zero up to a maximum value of $E_{S\max} = I_D'R_D' = 0.075 \times 200 = 15$ volts.

Figure 1 shows the circuit diagram of a high-speed magnetic amplifier of the self-balancing potentiometer type. This single-ended external-feedback circuit contains two equally rated saturable-reactor elements with load windings N_L', N_L'', d-c control windings N_C', N_C'', and external-feedback windings N_F', N_F''. Positive feedback produces an effectively infinite gain and 100-percent negative voltage feedback. Signal voltage E_S is balanced automatically by the opposing average voltage drop $E_K = I_LR_K$, and the average control-winding current I_C flowing through the moving-coil microammeter is substantially zero. There is a linear relationship between I_L and E_S, and $1/R_K$ is the transconductance of the self-balancing magnetic-amplifier circuit.

Voltage drop I_LR_K, produced by load current I_L across compensating resistor R_K, is applied to the one channel of a dual-beam oscilloscope. Meanwhile the square-wave signal voltage E_S, synchronous with supply voltage E_P of the amplifier, is applied to the second channel.

The oscillograms of Fig. 2 show the transient response of the magnetic amplifier circuit of Fig. 1. The lower trace of each oscillogram shows the square-wave signal voltage E_S derived from the magnetic-switch circuit. The upper trace shows the transient response of compensating voltage E_K across compensating resistor R_K.

In oscillogram Fig. 2A, the response time of the amplifier is one half-cycle of the 1,200-cps power-supply frequency. The amplifier reaches 100 percent of its final steady-state output-current value 0.417 millisecond after the transient signal voltage E_S is applied to the control circuit.

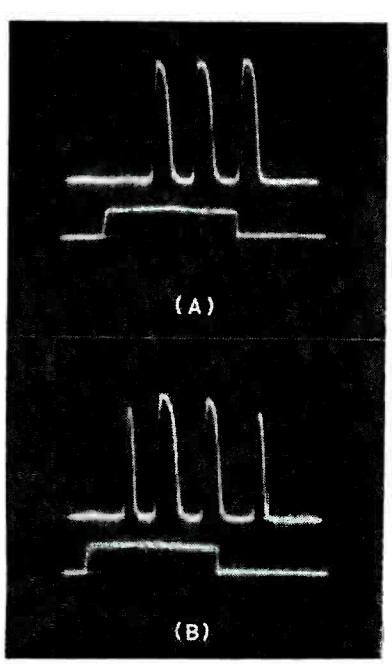

FIG. 2—Oscillograms of magnetic amplifier transient response show effect of changing time interval between firing of magnetic switch and time when magnetic amplifier voltage goes through zero point

Analog-to-Digital

SUMMARY — Gating variable-frequency pulse oscillator into fixed-interval counter converts analog voltage into digital quantity over four-decade range. Output pulses, 20 volts at $\frac{1}{2}$ μ sec into 100 ohms, are suitable for driving counter. Stability and repeatability are better than 0.1 percent of maximum frequency

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Operations Research Office
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ONE METHOD of converting an analog voltage to a digital quantity is to generate a pulse frequency that is proportional to the voltage to be converted. This frequency is then gated into a counter for a fixed time interval. At the termination of the gating interval the number left in the counter is the digital representation of the voltage. This article describes a variable-frequency pulse oscillator possessing a range of over four decades and an accuracy of 0.1 percent. Previous attempts[1] have been limited to about one decade.

The basic mechanism of oscillation is a pair of saw-tooth waveforms produced by integrating a control voltage E_c. Termination of one saw tooth causes the other to start; return to the initial voltage being accomplished during the active time of the other integrator as shown in Fig. 1. Output pulses are emitted at the termination of each saw-tooth waveform. The time between pulses is proportional to the total height of a saw tooth, $E_s - e_g$, and inversely proportional to its slope, $(E_c + e_g)/(RC)$. The pulse repetition frequency, the reciprocal of this time, is

$$f = \frac{(E_c + e_g)}{(E_s - e_g)} \frac{1}{RC} \qquad (1)$$

Hence, a frequency is linearly related to a d-c voltage E_c.

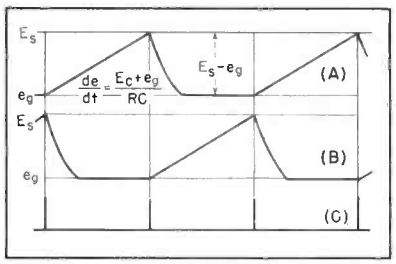

FIG. 1—Saw-tooth waveforms (A) and (B) control output pulses (C)

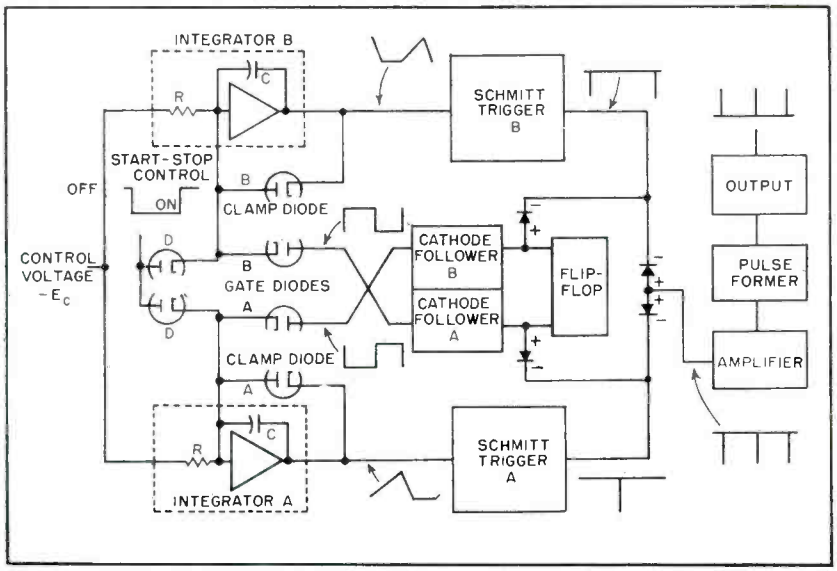

FIG. 2—Variable-frequency pulse oscillator uses Schmitt trigger circuits

Fig. 2 is the block diagram and Fig. 3 the circuit diagram of the converter. The actual d-c input is negative voltage $-E_c$.

Operation

In Fig. 2, assume that gate diode *A* is conducting, sending current into the summing junction of integrator *A*. This causes the output of integrator *A* to integrate downward until clamp diode *A* conducts, passing just sufficient current to make the net current into the junction zero. The cycle of operation is started by reversing the flip-flop which causes gate diode *A* to be cut off.

Output from integrator *A* rises linearly. When this output voltage reaches E_s, Schmitt trigger *A* trips reversing the flip-flop and sending

Data Converter

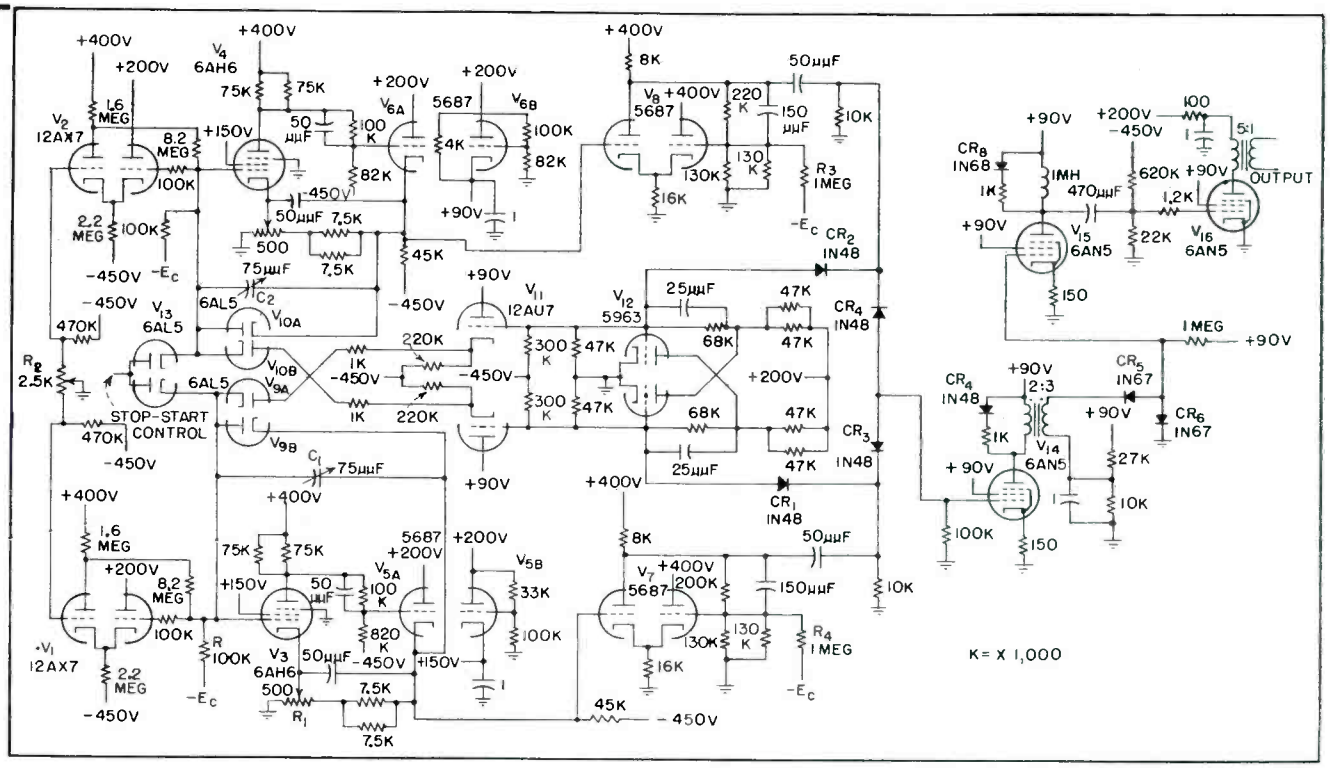

FIG. 3—All supply voltages for converter except two must be regulated to 0.1 percent. The +150 and +90 voltages are derived from voltage regulators V_{5B} and V_{6B}

a pulse into the pulse amplifier. This reversal of the flip-flop causes gate diode *A* to conduct, returning integrator *A* to its initial condition, and also cuts off gate diode *B* which starts integrator *B*. When integrator *B* reaches E_s, Schmitt trigger *B* trips again reversing the flip-flop and sending another pulse to the output circuit via the amplifier, pulse-former and output tubes. The entire circuit can be thought of as a multivibrator with linear timing waveforms.

Diodes *D* in Fig. 2, V_{13} in Fig. 3, are used to send current into both integrator junctions simultaneously to give external start-stop gating control of the pulses. This method is used rather than gating in the output tubes to obtain phase coherence between the pulses and the gating signal.

Integrator

An upper limit of 200 kc on the output pulse frequency implies a square-wave input to the integrators of 100 kc. Significant harmonics of this waveform extend well into the megacycle region. Conventional analog-computer-integrator designs do not even approach this bandwidth.

Theoretical considerations[2] indicate that multiple-tube operational amplifiers cannot be constructed to handle large bandwidths. Hence a single amplifying stage is indicated. However, a large gain is needed to produce the required accuracy of integration.

Positive feedback applied from the output to the cathode of amplifier V_3 is employed. Potentiometer R_1 is adjusted to make the overall gain of the amplifier infinite. This is accomplished by adjusting R_1 for zero amplitude of the triangular waveform at the grid of V_3, as indicated by a oscilloscope. As the proper setting of R_1 depends on the g_m of the tube, it must be readjusted whenever V_3 is replaced. A 50-$\mu\mu$f capacitor provides high-frequency compensation of the feedback network but is not made adjustable since the value is noncritical. Omission of this capacitor produces a square wave at the summing junction.

The transfer function of this integrator obtained from the equivalent circuit of Fig. 4A is

$$\frac{e_o}{E_c} = \frac{1}{RCp}\left\{\sqrt{\left[\left(\frac{C_i}{C}+1\right)C_o p+\left[\frac{C_o}{C}\frac{1}{R}+\left(\frac{C_i}{C}+1\right)\frac{1}{R_L}+\gamma g_m\left(1-B\frac{C_i+C}{C}\right)\right]+\frac{1}{RCp}\left[\frac{1}{R_L}-\gamma g_m B\right]\right\}}\qquad(2)$$

where γ is fraction of V_3 plate swing appearing at the output of the cathode follower, C_i and C_o are input and output parasitic capacitances of V_3, B is fraction of

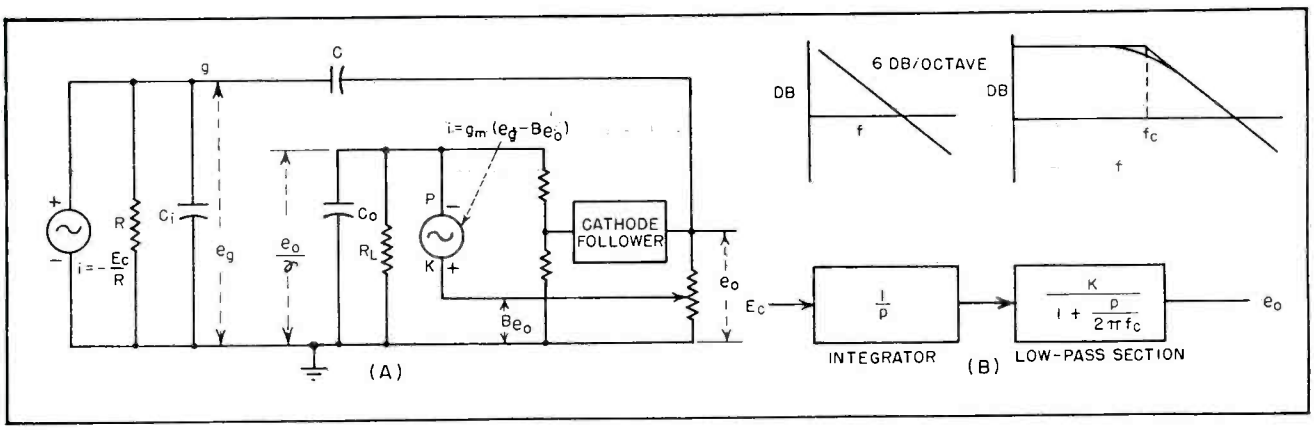

FIG. 4—Equivalent circuit (A) of V_3 and V_{5A} in Fig. 3 and response (B)

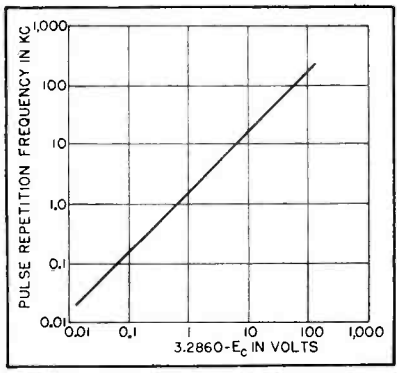

FIG. 5—Converter performance with correction for —3.286 zero-frequency voltage

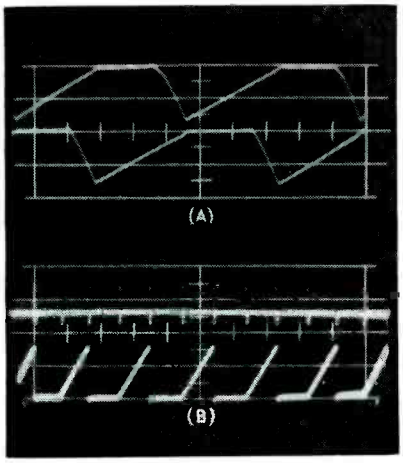

FIG. 6—Saw-tooth waveforms at 88 kc and saw-tooth and output pulses (B) at frequency of 10 kc

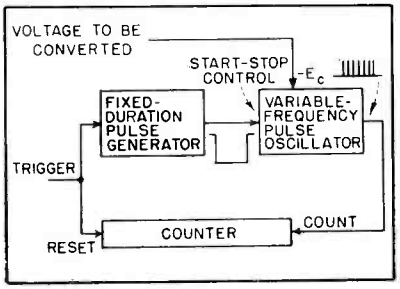

FIG. 7—Analog-to-digital converter includes pulse generator, variable-frequency pulse oscillator and counter

output voltage fed back to the cathode of V_3 and p is $j\omega$. The coefficient of the brace represents pure integration. If the quantity within could be made a constant, the integration would be perfect for all frequencies. By adjusting B to the value

$$B = \frac{1}{(g_m R_L \gamma)} \qquad (3)$$

this is best approximated. This value of B is the critical amount of regeneration, which makes the open-loop gain of the amplifier infinite at d-c. Using this appropriate value of B, Eq. 2 represents a pure integrator followed by a single-section low-pass R-C filter as illustrated in Fig. 4B where the 3-db cutoff frequency is

$$f_c = \frac{\gamma g_m}{2\pi(C_o + \frac{C_o}{C}\, C_i)} + \frac{1}{2\pi R(C_i - C)} \qquad (4)$$

If the output of this integrator were inverted and added in a resistive network to the output of a conventional R-C integrating circuit, the overall effect would be perfect integration at all frequencies.

As with any single-ended amplifier, an equivalent drift of e_g of about 0.3 volt changes the current flowing through R and hence the frequency[3]. This would, if uncorrected, cause excessive frequency drift at the low-frequency end of the range where the current through R is small. Push-pull amplifiers operating at low plate currents maintain grid stabilities of about 0.02 volt.[3] By using such a push-pull amplifier in a negative-resistance circuit V_1 or V_2, the current into the integrator junction is made independent of changes in e_g. The denominator of Eq. 1 also contains an e_g term since the initial clamp point of the integrator output is e_g, which is not corrected by this circuit. However, this represents only a given percentage change in frequency and therefore does not become more troublesome as the frequency is decreased. Better overall stability for both e_g terms in Eq. 1 could be obtained by chopper stabilization of the integrators if accuracy considerations warrant.

Differential adjustment of the bias on drift-compensator tubes V_1 and V_2 with R_2 equalizes the integrating rates of the integrators for low values of E_c. At high values of E_c, the integrating capacitors are adjusted to equalize rates. The setting for R_2 should be readjusted if V_3 or V_4 is replaced.

Other Components

Each Schmitt trigger detects the instant when the integrator waveform reaches the voltage E_s. It then delivers a negative pulse which reverses flip-flop V_{12}. The other Schmitt trigger does the same when the other integrator reaches E_s.

Both Schmitt triggers send negative pulses through mixing diodes CR_3 and CR_4 to pulse amplifier V_{14}. Here the pulse is sharpened and clipped at its most rapidly changing level by biased diode CR_5 in the output circuit of V_{14}. This sharp negative waveform cuts off pulse-forming tube V_{15}. An inductance in the plate of V_{15} rings for one-half cycle, which is about ½ microsecond in duration. Ringing after one-half cycle is damped out by diode CR_8. Pulse output tube

V_{1B} amplifies this shaped pulse and delivers an output to a low-impedance line.

The entire circuit was designed to make stability a function of voltages rather than a characteristic of tubes and passive components. Examination of Eq. 1 will show how far this has been accomplished. Since a basic component of frequency is time, it was necessary to use an R-C time constant. These components must be kept stable, but most of the other components have only secondary effects upon the frequency.

Variations of e_g have been discussed. Variations of E_s must now be considered. Although V_7 and V_8 in Fig. 3 are operated at high currents they are push-pull operated at the tripping point and hence have better voltage stability than single-ended pick-off circuits.[3]

Other major factors affecting E_s are the 400-volt supply for the Schmitt triggers and the resistor-divider ratio supplying the normally conducting triode grid.

The Schmitt triggers are fast but not instantaneous. This delay in starting the saw tooth causes nonlinearity in the frequency-versus-control voltage curve. This is compensated by slightly changing E_s with changes in E_c with R_3 and R_4.

Since most of the important factors have been referenced to voltages it is necessary to regulate the supplies to 0.1 percent if this is the expected accuracy and stability of the overall circuit. However, the +150-volt screen supply and the +90-volt supply are not so critical and hence are derived from cathode-follower regulators V_{5B} and V_{6B}.

Performance

Figure 5 shows the performance expressed as a plot of pulse repetition frequency as a function of the control voltage corrected for the 3.286-volt offset. Although the design goal was about three decades final performance indicates four decades are available. The high-frequency limitation is the rapidity with which the integrators can return to the clamping point. This could be speeded up by increasing the current sent into the integrator summing junctions through gate diodes V_{9A} and V_{10B}.

Figure 6A shows the two saw-tooth waveforms produced by the integrators operating at a frequency of about 88 kc.

Figure 6B shows one saw tooth and the output pulses at a frequency of about 10 kc. The flyback time on the saw tooth is a much smaller percentage of the total cycle because of the lower frequency. Zero output frequency would be at a voltage of −3.286 volts. Hence this offset must be supplied by the device producing voltage E_c.

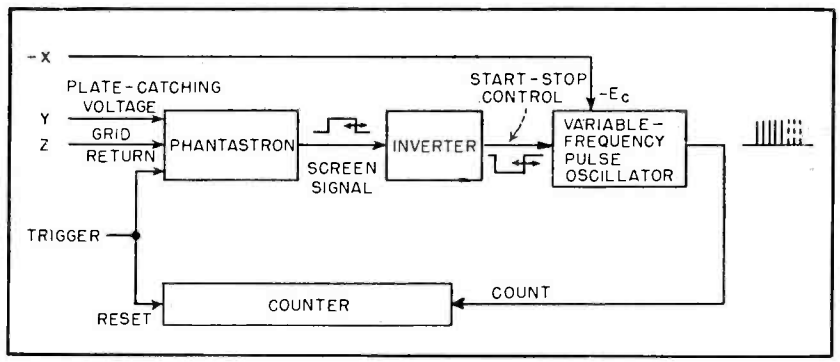

FIG. 8—Setup for converting product of two voltages into digital quantity

Applications

The block diagram of Fig. 7 shows the oscillator used to convert a voltage into a digital quantity.

Sometimes it is desired to convert the product of two voltages X and Y into a digital quantity. This can be accomplished by combining two methods of analog-to-digital conversion. One voltage, X, controls the frequency and the other voltage, Y, controls the time of counting. Figure 8 shows the block diagram. The phantastron[4] produces a waveform proportional to the plate-catching voltage, Y. A trigger resets the counter and starts the phantastron. During rundown a positive waveform appears at the screen, which is inverted and applied as the gating waveform of the variable-frequency oscillator. At the termination of the rundown, the count left in the counter is proportional to the product XY. If the grid return voltage of the phantastron is considered as another variable, Z, this product can be divided by a third voltage. The device then yields the digital conversion of XY/Z. By its nature, the phantastron limits the range of Y and Z to about two decades each.

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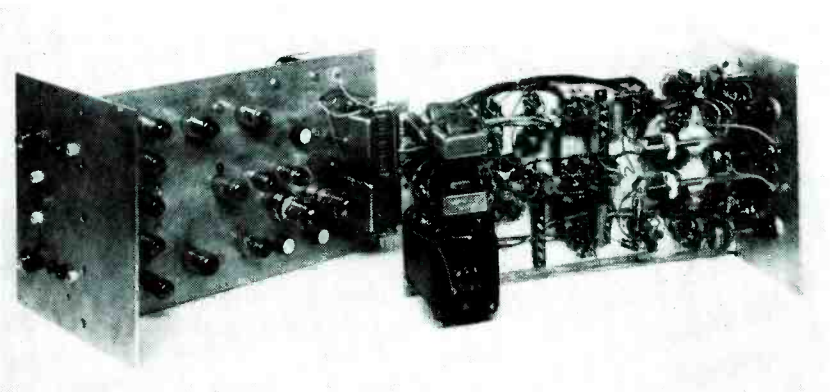

Top and bottom views of variable-frequency pulse oscillator

Phase Shifter Circuits

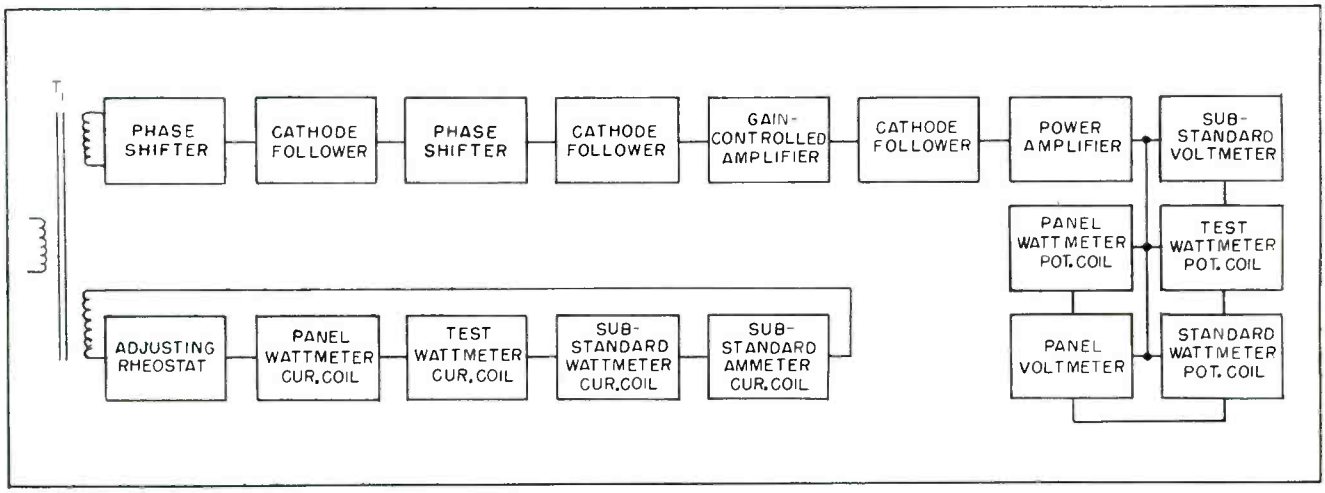

FIG. 1—Components of meter tester. Top row of blocks supplies potential-coil voltage; bottom row supplies current-coil current. Substandard meters have permissible error of less than 0.3 per cent. Input is a-c line voltage

NEED for portable universal equipment for testing meters is keenly felt in the laboratories of engineering firms and utility companies. The electronic meter tester to be described has been designed to fill this need.

Design of the equipment is based on the principle of phantom loading.[1] Test loads are simulated by applying rated voltages to the potential coils and variable current loads to the current coils.

System Theory

A two-stage phase-shifting network provides smooth control of the phase angle between the current and voltage vectors, particularly in the zero and unity-power-factor regions.

In the block diagram of Fig. 1, a low-voltage winding of the transformer supplies the current coil of the meter under test, the substandard wattmeter and a substandard ammeter; the value of the current is adjusted by a limiting resistor. Another secondary winding applies a voltage to a phase shifter capable of shifting the phase of the a-c input voltage up to 360 degrees. To keep the load impedances on the phase-shifting circuits extremely large, cathode followers have been interposed as shown in the diagram.

The final phase-shifted voltage is applied to a cathode-follower power amplifier which drives the requisite current through several meter potential coils ordinarily met with in practice.

Phase Shifting

Voltage AB, shown in Fig. 2, from the secondary of input transformer T_2 is applied to the first phase shifter in Fig. 3 consisting of C_1 and R_1. Voltage CO is applied to cathode-follower V_1, which serves as an impedance-matching device. This voltage is constant in magnitude for any value of R_1 and its position in the vector diagram is fixed by the setting of R_1. The output of the cathode-follower is slightly less in magnitude than, but in phase with, CO and is applied to the second phase-shifting network consisting of C_2 and R_2.

Point E, like O, moves on the second semicircle on CO. The double phase shifter is thus capable of rotating the voltage vector through 360 degrees. The magnitude of the output voltage, however, is a little less than a quarter of the input voltage.

The first phase shifter insures that the voltage and current vectors are in phase with each other. The second phase shifter is calibrated to read the power factor directly on the dial setting.

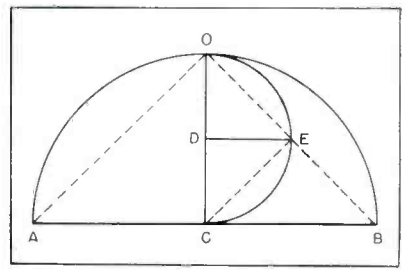

FIG. 2—Vector representation of two-stage phase shifter

The output of the second phase shifter is applied to the primary of T_2, which is used to obtain a grounded signal to the succeeding stages of the meter-testing equipment.

Potentiometer R_3 across the secondary of the interstage transformer provides smooth control of the magnitude of the power-amplifier output. The output of voltage amplifier V_4 is applied to the grid of the triode-connected cathode-follower driver amplifier, V_5.

A small voltage of the order of 9 volts is fed back from interstage transformer T_3 to V_4 to improve stability of operation.

The power amplifier is of the cathode-follower type with two EL37 pentodes in class AB push-pull. The primary of output transformer T_4 is connected between the cathodes and the center tap of

Test Power Meters

SUMMARY —— Device permits testing and calibration of wattmeters, watt-hour meters and power-factor meters at line frequencies of 40 to 60 cps. Actual loads are simulated by phantom loading

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the primary is grounded through the biasing resistors.

To keep the screen-grid voltage constant with respect to the cathode at the quiescent value, a separate winding of the same number of turns as the primary is provided on the output transformer. The ends of this secondary winding are connected to the two screen grids, with the center tap connected to the positive supply of the plates.

This amplifier is capable of delivering about 35 watts of undistorted output at any of its secondary taps.

To permit frequent checking for the correct initial phase alignment, a test wattmeter is incorporated in the equipment.

The first phase shifter is adjusted until a maximum reading is obtained on the wattmeter under test or on the panel wattmeter, when the power factor is set at unity. The phase angle can be smoothly varied through ± 90 degrees by the second phase shifter. In actual testing, the potential coil voltage wave can be smoothly varied through 180 degrees with reference to the current through the current coil of the meter under test. The wattmeter can be compared with a standard wattmeter for calibration purposes.

For the energy meter, however, a standard ammeter and a standard voltmeter are included in the current and potential circuits; power factor is indicated by the setting of R_2 of the second phase shifter.

The author is indebted to C. S. Ghosh for his encouragement and constant help, and to the Director, Indian Institute of Science for his permission to publish this paper. The assistance of G. Krishna is also acknowledged.

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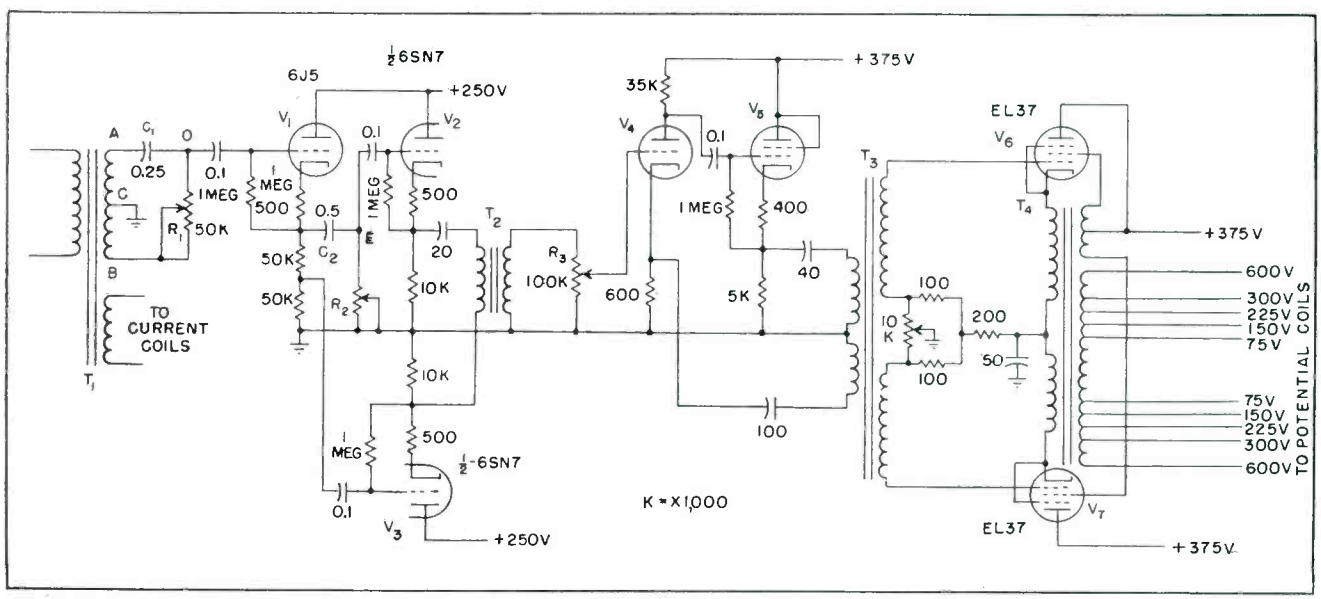

FIG. 3—Phase is shifted over range of 360 degrees by combination of R_1C_1 and R_2C_2. Output voltage is adjusted by variation of R_3

Electrically Variable

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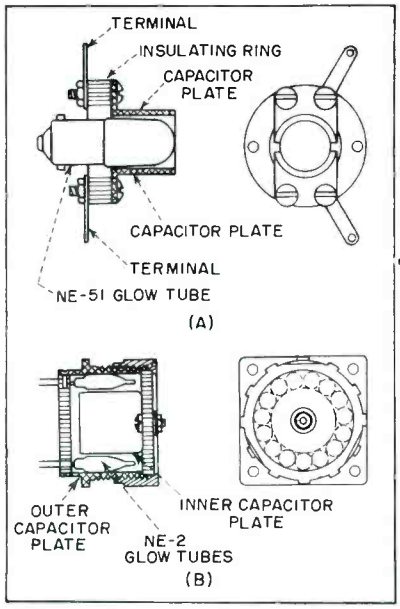

FIG. 1—Experimental variable gas-dielectric capacitor (A) and structure using 15 NE-2 glow tubes (B)

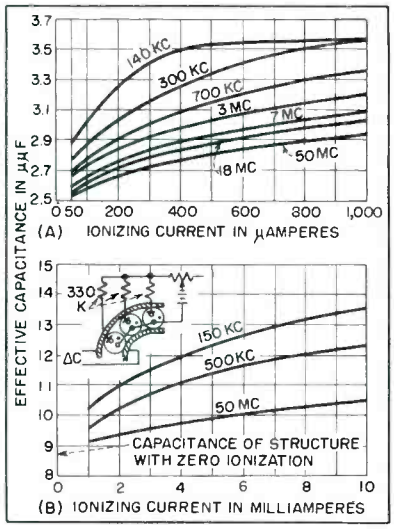

FIG. 2—Capacitance versus ionizing current at various frequencies for the single glow-tube unit (A) and the multiple glow-tube unit (B)

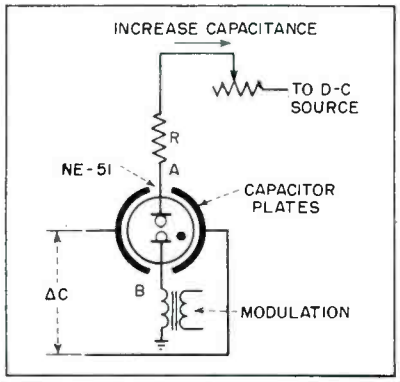

FIG. 3—Schematic of the variable capacitor unit showing circuit simplicity

THIS CONTROLLABLE capacitor exhibits a usably high ratio of capacitance change to total capacitance.

Although its dielectric constant is not appreciably greater than 1, the capacitance change is sufficient to provide frequency modulation and control of self-excited oscillators, see Fig. 1 and 2.

Circuit

A diagram of the capacitor circuit is shown in Fig. 3. The capacitor consists of a pair of plates with a glass envelope placed between the plates. Within the glass envelope are two electrodes and neon gas of suitable density and ionizing characteristics.

The gas within the envelope forms an appreciable part of the space between the two plates. Under the condition of no ionization, the aggregate dielectric constant will be slightly greater than one owing to the glass envelope and the negligible amount of neon.

That portion of the dielectric which is air and that portion which is glass will remain relatively constant, as will the insignificant amount of neon. When an ionizing potential is applied to the electrodes that part of the dielectric which consists of ionized neon will have acted to alter the aggregate dielectric constant.

An increase in capacitance takes place when gas ions are generated between the two electrodes. The greatest capacitance change takes place between the condition of no ionization and maximum ionization. There are applications for such abrupt capacitance changes. However, the use of the capacitor as a frequency modulator or similar proportional control requires that the ionizing current be maintained at some controllable level above the extinguishing point.[1]

With n gas ions present a certain fixed value of capacitance will result and with $n + 10$ or $n - 10$ gas ions a proportional increase or decrease in capacitance will take place. With the standard neon tubes used, the capacitance change for a linearly increasing current change is exponential.

A linear current-controlled variable capacitor should conform to the expression $C = Ik$, where C represents the capacitance and I the ionizing current; k defines the relative current-capacitance sensitivity. For frequency-modulator applications the ideal capacitor should agree with the expression $C = I\epsilon k$ where $\epsilon = 2$ defines conformity to the capacitance change in a resonant circuit to create a frequency change linear with current.

Neglecting inductance and resistance which must necessarily exist in a practical structure, such a capacitor will always appear as a variable capacitance in shunt with a fixed one. If C_s represents the fixed shunt capacitance, the expression becomes $C = Cs + I\epsilon k$.

To make the variable section as effective as possible a maximum

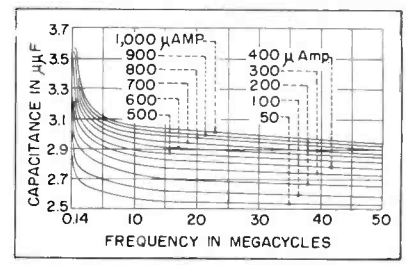

FIG. 4—Effective frequency sensitivity of the assembly using a single NE-51 glow tube. A reduction in Q is noted wherever the current increases

Gas-Dielectric Capacitor

SUMMARY —— Neon diode between plates of air capacitor varies dielectric constant in proportion to diode current, giving variation in capacitance between plates. Applications include frequency control of self-excited oscillators and potential use in other low-power circuits

ratio of variable capacitance to fixed capacitance must be accomplished.

The experimental units were designed to have low inductance and have worked satisfactorily through the test ranges shown. They should work effectively up to field frequencies of several hundred megacycles, although the effective current capacitance sensitivity k for a given current increment decreases as the field frequency increases, as shown in Fig. 4.

Limitations

One might expect the gas tube capacitor to be sensitive to ambient light, heat and stray electrical fields.[2] Such effects are almost negligible once ionization has taken place. The NE-51 and NE-2 bulbs are of the negative-glow type in which light is produced by the ion activity surrounding the cathode. The direct-current flow through such tubes may be considered as closely following statistical laws and might be expected to contribute noise in frequency-modulator applications. A realistic determination of noise contribution was made by utilizing the multiple tube capacitor to modulate an oscillator.

Single-tube capacitor showing NE-51 glow tube glass envelope

The oscillator output frequency was multiplied and applied to an f-m receiver. A modulating voltage was applied to the capacitor sufficient to create approximately 10 percent of the maximum capacitance variation available. The results are shown in Table I.

The rms f-m detector output was measured under conditions of no modulation at the received frequency. It was then compared with the residual noise when the gas capacitor was extinguished. No significant noise change was found.

Two possible ionization modes were noted where a sufficiently strong field exists to create a second ionization independent of the

Table I—Performance Data on the Variable Multiple Glow-Tube Capacitor

Static current	0.005 amp
Static capacitance at 0.005 amp	11.2 $\mu\mu$f*
Maximum capacitance change	± 1 $\mu\mu$f*
Capacitance change for $\pm$ 10% peak current change	± 0.125 $\mu\mu$f*
RMS Level of contributed noise with respect to RMS test receiver output created by $\pm$ 10% peak current change	< -60db**

When multiple glow tubes are used it is desirable to apply the modulation in series in order to eliminate the use of a separate coupling capacitor for each glow tube. Noise measurements were made by substituting this capacitor for the single unit in the circuit of Fig. 5.

* At 1.75 mc
** Audio bandwidth of receiver output held to 10 kc

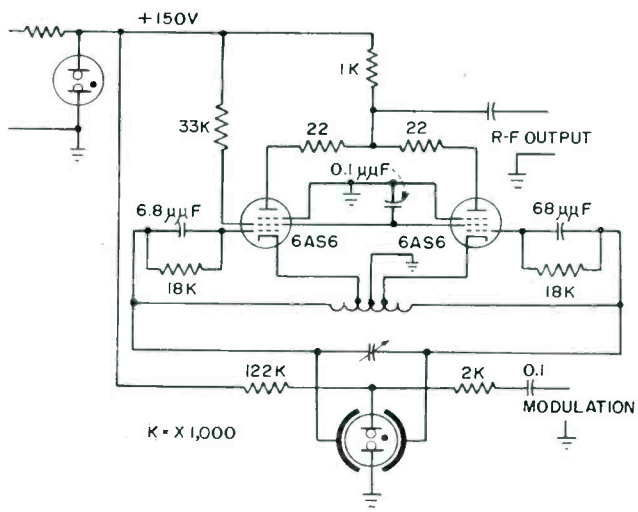

FIG. 5—Frequency-modulated oscillator circuit at right with which modulation measurements of Table I were made

d-c ionization. The first of these modes is the one under which all of the measurements shown were made and is the condition created by the d-c ionizing current with negligible contribution by the field between the plates.

If, under the conditions of this first mode, the field strength between the plates is increased to a high enough value the second additional ionization will take place. This is characterized by the familiar blue-violet glow which diffuses throughout the bulb. A sudden increase in capacitance accompanies this change.

The d-c ionizing current still exhibits some control over the effective capacitance. A different situation exists here since the capacitor can be expected to exhibit a resistive component of impedance which will absorb appreciable energy from the circuit.

If the field strength should increase, so will the extent of this secondary ionization up to the saturation point. If such a condition occurs, where the capacitor is applied as an oscillator control, the amplitude changes will usually degrade the frequency stability and the performance may be erratic.

This difficulty is not present if the field strength is maintained at a low level. The gas-dielectric capacitor should be operated in a sufficiently weak field in frequency modulator use to assure that the second mode will not be triggered by peak-modulation currents.

Frequency Modulator Applications

The circuit of Fig. 5 meets the general requirements for a frequency-modulated oscillator. Ionization is held to the first mode where the field between the capacitor plates is suitably low. The frequency swing versus the rms modulating voltage is uniform throughout the audio range.

An experimental four-band r-f exciter unit was constructed utilizing four separate oscillators each on a different frequency. The NE-51 bulbs were placed behind windows in the front panel and served as indicators of the band selection in addition to their capacitor function.

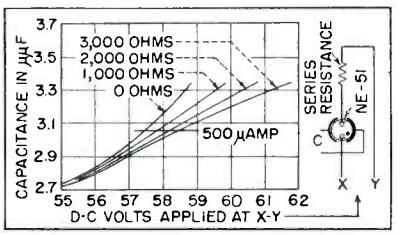

FIG. 6—Curves show linearizing effect of resistance in series with glow lamp

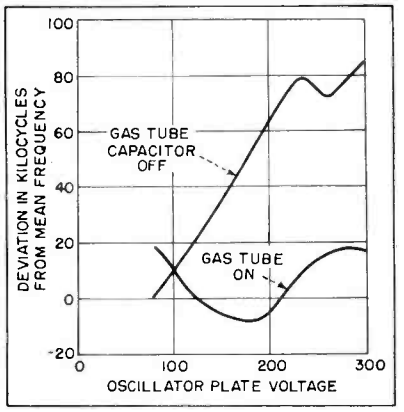

FIG. 7—Curves show frequency stabilizing effect of gas tube on 300-mc oscillator

No measurable degradation of oscillator stability due to the use of the neon capacitors was experienced over the range 3 to 30 mc during 1,000 hours of test service.

The upper effective modulation-frequency limit will occur at the point where the ionization delay reaches a maximum. This takes place well above the audio range, however. It is characterized by a gradual increase in internal gas resistance as the modulating frequency is increased.[3]

Reference to Fig. 2 will indicate that some amplitude distortion of the demodulated wave must occur, since the capacitor does not exactly meet the $C = I\epsilon k$ requirement for a perfect modulator. This distortion will increase with the deviation requirement and will be largely second harmonic in order. It is typical of neon glow tubes that their terminal resistance decreases as the voltage increases.[4]

If one assumes a zero impedance modulating source, a condition will exist where the ionizing current will rise to a higher value during positive voltage increments than would be the case if the glow tube exhibited a constant impedance. This positive nonlinear resistance characteristic may be used to cancel the nonlinear capacitance characteristic. Thus distortion is reduced by placing resistance in series with the modulating source, see Fig. 6, or by suitable choice of modulation-source impedance.

The second mode of operation has been used to advantage experimentally to stabilize a h-f oscillator against changes resulting from plate-supply variations. In this case a circuit similar to that shown in Fig. 5 was used except that no d-c ionizing current was present and the capacitance was controlled by the field strength between the plates.

The test results[5] are shown in Fig. 7. This suggests a means of frequency stabilizing an a-m self-excited oscillator. The multiple-bulb coaxial-type capacitor shown in Fig. 1B provides greater capacitance changes than are possible with the single unit.

The variable gas-dielectric capacitor is a simple, efficient and reliable device having applications in frequency control of self-excited oscillators. It is potentially useful in other low-power circuits where small changes in capacitance are required to be controlled at rates to at least 20 kc.

While the glow tubes shown provide creditable performance, they show considerable variations between individually available commercial types. With particular attention to structure and type of gas, a group of gas tubes may be designed to take fuller advantage of the method described.

The writer wishes to express his appreciation to R. F. Smeltzer of the Bendix Radio Division; A. B. Meador, Melpar Corporation; W. G. Chenoweth and T. C. Fletcher of the Shasta and Beckman Divisions, respectively, of Beckman Instruments, Incorporated.

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Transistor Characteristics for Circuit Designers

SUMMARY —— Tables indicate physical properties, maximum electrical ratings, small-signal low-frequency parameters and average characteristics for grounded-base, grounded-emitter, grounded-collector and switching circuits for 218 transistor types: 106 junction triodes, 46 high-frequency triodes, 6 tetrodes, 23 high-power units, 25 point-contact and 12 phototransistors

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SUCCESSFUL transistor circuit design requires not only familiarity with transistor equivalent circuits and characteristic curves but also an understanding of the behavior of the parameters describing the transistor and the variation of these parameters with bias and temperature. Tables I to VI have been compiled as a systematic presentation of data necessary for transistor circuit design.

Each of the charts presents physical properties, maximum electrical ratings, typical small-signal low-frequency parameters, average characteristics for grounded-emitter, grounded-base and grounded-collector circuits and switching characteristics. Figure 2 illustrates the circuits referenced in Tables II and III.

Small-signal parameters are expressed as resistances. This permits a familiar physical representation of the transistor in circuit design. Box on p 171 enables transformation between h and r parameters.

All the characteristics are for fixed-bias conditions. However, these values vary with operating conditions. Examples of these variations are shown in Fig. 1A, 1B, 1C and 1D.

Figure 1A illustrates how collector capacitance C_c varies with collector voltage V_c. In designing an i-f tuned circuit, the tuning capacitor must be large enough to swamp out the effects of the variation of collector capacitance. If the i-f stage is a grounded-emitter rather than a grounded-base stage, the collector capacitance is magnified by the base-current amplification factor, β.

In i-f stages where neutralization is used to maximize gain by balancing out C_c, instability may occur when the battery voltage decreases. This variation of C_c with V_c permits use of the transistor as a reactance element in f-m applications.

At low current bias, Fig. 1B, 1C and 1D, the noise factor of the transistor decreases and emitter resistance r_e base resistance r_b and collector resistance r_c increase, providing increased power gain and larger values of input and output impedance. This is advantageous in hearing aids where low bias currents are used.

Temperature Effects

In the germanium transistor, noticable changes in α, β and I_{co} take place at approximately 60 C as shown in Fig. 1E. These changes can lead to instability at high temperatures by α becoming equal to or greater than unity or by I_{co} increasing and causing a collector runaway effect due to self heating.

Temperature problems are minimized in silicon transistors as seen in Fig. 1F. The value I_{co} becomes almost negligible in design consideration as the upper limit or temperature range is above 100 C. In such special applications as d-c amplifiers, the slightest change in α over the normal temperature operating range can produce a significant change in d-c current gain of the grounded-emitter stage.

The low-frequency low-power triode junction transistor, Table I, is most commonly used. The majority are utilized in hearing aids audio systems, low-power control systems

ABBREVIATIONS USED IN TABLES

α	Current gain
β	Base-current amplification factor
BW	Bandwidth
C_c	Collector capacitance
$f_{\alpha co}$	Alpha cutoff frequency
g-b	Grounded base
g-c	Grounded collector
g-e	Grounded emitter
I_b	Base current
I_{b2}	Second base current (tetrode)
I_c	Collector current
I_{co}	Collector cutoff current
I_e	Emitter current
I_{eo}	Emitter cutoff current
NF	Noise figure
r_b	Base resistance
r_c	Collector resistance
r_e	Emitter resistance
R_g	Generator resistance
R_i	Input resistance
R_L	Load resistance
R_o	Output resistance
V_c	Collector voltage

TABLE I—JUNCTION TRIODE LOW-POWER TRANSISTORS

Manufacturer	Type No.	Type	Max Coll Power (mw)	Max Coll Volt-age (v)	Max Coll Cur-rent (ma)	Max Am-bient Temp (degC)	Small-Signal Low-Frequency					
							Bias		β	r_e (ohms)	r_b (ohms)	r_c (meg)
							V_c (v)	I_e (ma)				
Amperex Electronic Corp.	OC70	*pnp* fused[1]	25 (45C)	−10	−10	45	−2	0.5	30	39	1,000	1.43
230 Duffy Ave.	OC71	*pnp* fused[1]	25 (45C)	−10	−10	45	−2	3	47	6.5	500	0.625
Hicksville, N. Y.												
CBS-Hytron	2N36	*pnp* fused	50	−20	− 8	50	−6	1	45	30	450	0.95
Danvers, Mass.	2N37	*pnp* fused	50	−20	− 8	50	−6	1	30	30	350	0.55
	2N38	*pnp* fused	50	−20	− 8	50	−6	1	15	25	350	0.5
	HA-1	*pnp* fused	50	−20	− 8	50	−3	0.5	40	24	700	1.7
	HA-2	*pnp* fused	50	−20	− 8	50	−3	0.5	30	35	350	0.8
	HA-3	*pnp* fused	50	−20	− 8	50	−3	0.5	35	30	450	0.6
	HC-1	*pnp* fused	50	−20	− 8	50	−6	1	45	30	450	0.95
Germanium Prod. Corp.	NPN-3/ 2N103	*npn* grown	50 (25C)	35	10	75	4.5	−1	4	25	100	2.0
26 Cornelison Ave.	RD2517A/ 2N97	*npn* grown	50 (25C)	30	10	75	4.5	−1	13.3	25	100	3.0
Jersey City, N. J.	RD2518A/ 2N97A	*npn* grown	50 (25C)	40	10	85	4.5	−1	13.3	25	100	10.0
	RD2521A/ 2N98	*npn* grown	50 (25C)	40	10	75	4.5	−1	40	25	150	5.0
	RD2522A/ 2N98A	*npn* grown	50 (25C)	40	10	85	4.5	−1	40	25	150	10.0
	RD2523A/ 2N99	*npn* grown	50 (25C)	40	10	75	4.5	−1	40	25	150	5.0
	RD2525A/ 2N100	*npn* grown	25 (25C)	25	5	50	4.5	−1	140	25	400	5.0
General Electric Co.	2N43	*pnp* fused	150 (25C)	−45[5]	−50	100	−5	1	49	32	400	1.0
Electronics Park	2N44	*pnp* fused	150 (25C)	−45[5]	−50	100	−5	1	21.2	26.5	300	1.0
Syracuse, N. Y.	2N45	*pnp* fused	150 (25C)	−45[5]	−50	100	−5	1	11.5	20	250	1.0
	2N43A	*pnp* fused	150 (25C)	−45[5]	−50	100	−5	1	43.4	15	575	1.43
	2N43A USAF	*pnp* fused	150 (25C)	−45	−50	100	−5	1	43.4	15	575	1.43
	2N76	*pnp* fused	50 (25C)	−20[5]	−10	60	−5	1	19	17	300	1.0
General Transistor Corp.	GT-14	*pnp* fused	70 (50C)	−25		85	−4.5	1	28	30	800	1.5
95-18 Sutphin Blvd	GT-20	*pnp* fused	70 (50C)	−25		85			45	30	800	1.5
Jamaica, N. Y.	GT-34	*pnp* fused	70 (50C)	−25		85			15	30	800	1.5
	GT-81	*pnp* fused	70 (50C)	−25		85			65	30	800	1.5
	GT-83	*pnp* fused	70 (50C)	−25		85			45	30	800	1.5
	GT-87	*pnp* fused	70 (50C)	−25		85			28	30	800	1.5
	GT-88	*pnp* fused	70 (50C)	−25		85			65	30	800	1.5
	2N34	*pnp* fused	70 (50C)	−25		85	−4.5	1	40	30	350	2.0
	2N36	*pnp* fused	70 (50C)	−25		85	−4.5	1	45	30	850	2.0
	2N37	*pnp* fused	70 (50C)	−25		85	−4.5	1	30	30	600	2.0
	2N38	*pnp* fused	70 (50C)	−25		85	−4.5	1	15	30	400	2.0
	2N39	*pnp* fused	70 (50C)	−25		85	−4.5	1	45	30	850	2.0
	2N40	*pnp* fused	70 (50C)	−25		85	−4.5	1	28	30	600	2.0
	2N42	*pnp* fused	70 (50C)	−25		85	−4.5	1	13	30	400	2.0
Hughes Aircraft Co	HA5001	*npn* alloyed	500 (25C)	30	100	85	5	1	65.6	16.5	900	2
Culver City, Calif.	HA5002	*npn* alloyed	500 (25C)	20	100	85	5	1	27.5	16	400	1
	HA5003	*npn* alloyed	500 (25C)	20	100	85	5	1	99	26	400	1
Hydro-Aire Inc.	J-1	*pnp* fused	150 (25C)	−40	−10	50	−6	1	34	30	400	1.0
Burbank, Calif.	J-2	*pnp* fused	150 (25C)	−40	−10	50	−6	1	15	30	300	0.7
	J-3	*pnp* fused	150 (25C)	−40	−10	50	−6	1	9	30	300	0.5
	HA-1	*pnp* fused	100 (25C)	−20	−10	50	−6	1	40	30	350	0.75
	CQ-1	*pnp* fused	150 (25C)	−40	−10	50	−6	1	9	30	200	0.5
Nat'l Union Electric	2N39	*pnp* fused	47 (25C)	−27	−12	60	−4.5	1	32.4			1 to 2
350 Scotland Rd.	2N40	*pnp* fused	47 (25C)	−27	−12	60	−4.5	1	15.7-32.4			1 to 2
Orange, N. J.	2N42	*pnp* fused	47 (25C)	−18	−12	60	−4.5	1	9			0.5 to 2
	T34D	*pnp* fused[1]	56 (25C)	−27	−12	70	−4.5	1	32.4	20		1 to 2
	T34E	*pnp* fused[1]	56 (25C)	−27	−12	70	−4.5	1	15.7-32.4	20		1 to 2

Parameters				Grounded-Emitter Connection					Grounded-Base				Grounded-Collector			
f_{aco} (mc)	C_c ($\mu\mu$f)	I_{co} (μa)	NF (db)	I_b (ma)	R_i (ohms)	R_L (ohms)	R_g (ohms)	Gain (db)	R_i (ohms)	R_L (ohms)	R_g (ohms)	Gain (db)	R_i (ohms)	R_L (ohms)	R_g (ohms)	Gain (db)
		− 8	10													
		− 8	10													
0.5						30,000	1,000	40								
0.5						30,000	1,000	36								
0.5						30,000	1,000	32								
		−12	12			30,000	1,000	30								
		−12	27			30,000	1,000	30								
						1,200	1,000	35								
0.7		−12				30,000	1,000	40								
0.75	20	5	22	0.25	225	100,000 matched		33	45	250,000 matched		30	2,500	500 matched		7
1.0	19	2	20	0.07	400	100,000 matched		38	35	250,000 matched		32	7,000	500 matched		11
1.0	19	2	15	0.07	400	100,000 matched		38	35	250,000 matched		32	7,000	500 matched		11
2.5	14	2	20	0.025	850	100,000 matched		47	35	250,000 matched		35	20,000	500 matched		15
2.5	14	2	15	0.025	850	100,000 matched		47	35	250,000 matched		35	20,000	500 matched		15
3.5	10	2	15	0.025	850	100,000 matched		47	35	250,000 matched		35	20,000	500 matched		15
5.0	14	2	20	0.007	3,500	100,000 matched		53	45	250,000 matched		35	70,000	500 matched		20
1.0	40	−10	22		1,000	30,000	600	39	60	50,000	100	28	30,000	600	30,000	15
1.0	40	−10	22		700	30,000	600	38	55	50,000	100	28	15,000	600	15,000	12
1.0	40	−10	22		450	30,000	600	36	50	50,000	100	28	7,500	600	7,500	11
1.0	40	− 5	10		1,000	30,000	600	39	60	50,000	100	28	30,000	600	30,000	15
1.0	40	− 5	30		1,000	30,000	600	39	60	50,000	100	28	30,000	600	30,000	15
1.0	40	− 5	18		1,000	30,000	600	38	55	50,000	100	28	15,000	600	15,000	12
0.65		−10	16													
0.65		−10	16													
0.65		−10	16													
0.65		−10	16													
0.70		−10	16													
0.50		−10	16													
1.0		−10	16													
		−15	24													
		−15	24													
		−15	24													
		−15	24													
		−15	24													
		−15	24													
		−15	24													
2.5	15	5														
0.8		12	15													
1.5		10	15													
1.0		−10	11					40								
0.5		−15	22					35								
0.5		−20	33					30								
		−10	20													
0.5		−20	33													
		−10	20			30,000	500	39								
		−10	24			30,000	500	38								
		−20	28			30,000	500	36								
		−10	20			30,000	500	39								
		−10	24			30,000	500	38								

and low-speed computing circuits. Present units are available in the *pnp* and *npn* fused germanium, the *npn* grown germanium and *npn* grown silicon types. Of the fused type of transistor, the *pnp* is more available commercially and consequently has found a wider range of applications. The *npn* fused type is suitable for complementary symmetry circuitry. The grown silicon type is used for high temperature and low I_{co} applications.

The germanium and silicon grown transistors are used in almost the same manner as the fused transistor. Frequently, the grown types, owing to their lower value of collector capacitance and higher value of α cutoff, may be employed as

Table I (cont)

Manufacturer	Type No.	Type	Max Coll Power (mw)	Max Coll Voltage (v)	Max Coll Current (ma)	Max Ambient Temp (degC)	Small-Signal Low-Frequency					
							Bias		β	r_e (ohms)	r_b (ohms)	r_c (meg)
							V_c	I_e				
Nat'l Union (cont)	T34F	*pnp* fused[1]	56 (25C)	−18	−12	70	−4.5	1	9	20		0.5 to 2
Philco Corp.	2N47	*pnp* fused[1]	50 (25C)	−35	−20		−5	1	39	25	600	1.0
4700 Wissahickon Ave.	2N49	*pnp* fused[1]	50 (25C)	−35	−20		−5	1	39	25	600	1.0
Philadelphia, Pa.												
RCA	2N104	*pnp* fused[2]	110 (25C)	−30	50	85	−6	1	44	24.5	750	2.25
Harrison, N. J.	2N77	*pnp* fused[1]	35 (25C)	−25	15	50	−4	0.7	40	36	560	2.3
Raytheon Mfg Co.	CK721	*pnp* fused[3]		−15[6]	−10	70	−6	1	45	25	700	2.0
55 Chapel St.	CK722	*pnp* fused[3]		−22[6]	−10	70	−6	1	22	25	250	2.0
Newton, Mass.	CK725	*pnp* fused[3]		−12[6]	−10	70	−6	1	90	25	1,500	2.0
	CK727	*pnp* fused[3]		− 6[6]	−10	70	−1.5	0.5	35	50	500	2.0
	2N63	*pnp* fused		−22[6]	−10	85	−6	1	22	25	350	2.0
	2N64	*pnp* fused		−15[6]	−10	85	−6	1	45	25	700	2.0
	2N65	*pnp* fused		−12[6]	−10	85	−6	1	90	25	1,500	2.0
Sylvania Electric	2N34	*pnp* fused	50 (25C)	−40	−10		−6	1	40	26	800	2.0
1740 Broadway	2N35	*npn* fused	50 (25C)	−40	−10		6	−1	40	26	800	2.0
New York, N. Y.												
Texas Instruments	200	*npn* grown	50 (25C)	30	5	50	5	−1	9	22	150	0.4
6000 Lemmon Ave.	201	*npn* grown	50 (25C)	30	5	50	5	−1	19	22	170	0.4
Dallas, Texas	202	*npn* grown	50 (25C)	30	5	50	5	−1	49	35	200	0.4
	206S	*npn* grown[1]	50 (25C)	30	5	50	2.5	−0.5	35			
	207S	*npn* grown[1]	50 (25C)	30	5	50	2.5	−0.5	19			
	208S	*npn* grown[1]	50 (25C)	30	10	50	2.5	−10	19			
	300	*pnp* fused	50 (25C)	−30	−10	50	−5	1	9		550	0.4
	301	*pnp* fused	50 (25C)	−30	−10	50	−5	1	19		1,000	0.4
	903	*npn* grown	150 (25C)	30	10	150	5	−1	9–19	150	500	0.5
	904	*npn* grown	150 (25C)	30	10	150	5	−1	19–39	150	1,250	0.5
	905	*npn* grown	150 (25C)	30	10	150	5	−1	≷39	150	2,500	0.5
	904A	*npn* grown	150 (25C)	30	10	150	5	−1	≷19	150	1,250	0.5
	210	*npn* grown	50 (25C)	30[7]	5	50	22.5	−2				
	302	*pnp* fused	50 (25C)	−30	−10	50	−5	1	44			
	350		50 (25C)	−12								
Transitron	2N85	*pnp* fused	750	−45	−100	100	−12	10	40	2.5	300	0.16
407 Main St.	2N86	*pnp* fused	750	−60	−100	100	−12	10	20	2.5	300	0.125
Melrose, Mass.	2N87	*pnp* fused	750	−30	−100	100	−12	10	20	2.5	300	0.125
	2N88	*pnp* fused[1]	25	−12	−10	85	−1.3	0.5	25	50	1,000	0.5
	2N89	*pnp* fused[1]	25	−12	−10	85	−1.3	0.5	25	50	1,000	2.0
	2N90	*pnp* fused[1]	25	−12	−10	85	−1.3	2.5	40	10	600	0.5
	2N91	*pnp* fused	125	−15	−500	85	−3	30	25	1.5	50	2.0
	2N92	*pnp* fused	125	−25	−200	85	−3	5	30	5	500	1.0
	2N34	*pnp* fused	125	−25	−20	100	−6	1	40	18	600	1.0
	2N36	*pnp* fused	125	−25	−20	100	−6	1	45	18	700	1.0
	2N37	*pnp* fused	125	−25	−20	100	−6	1	30	20	500	1.0
	2N38	*pnp* fused	125	−25	−20	100	−6	1	15	20	250	1.0
	2N43	*pnp* fused	375	−45	−50	100	−6	1	33	20	500	1.0
	2N44	*pnp* fused	375	−45	−50	100	−6	1	16	20	300	1.0
	2N45	*pnp* fused	375	−45	−50	100	−6	1	9	20	250	1.0
	2N63	*pnp* fused	125	−25	−20	100	−6	1	20	20	350	2.0
	2N64	*pnp* fused	125	−25	−20	100	−6	1	30	20	700	2.0
	2N65	*pnp* fused	125	−25	−20	100	−6	1	50	18	1,500	2.0
Tung-Sol Electric	DR126	*pnp* fused[4]	50 (25C)	−10[7]		85	−1.5	0.5	24	26	900	1.5
100 Eighth Ave.	DR128	*pnp* fused[4]	50 (25C)	−10[7]		85	−1.5	0.5	49	34	1,400	2.0
Newark, N. J.	DR129	*pnp* fused[4]	50 (25C)	−25[7]		85	−1.5	0.5	32.4	26	1,200	2.0
	DR130	*pnp* fused[4]	50 (25C)	−25[7]		85	−1.5	0.5	13	20.5	650	1.3
	DR154	*pnp* fused[4]	50 (25C)	−25[7]		85	−1.5	0.5	124	55	600	1.2
Western Electric	2N27	*npn* grown	50 (60C)	30	5	85	4.5	−1	19–198	50	700	2.0
120 Broadway	2N28	*npn* grown	50 (60C)	30	5	85	4.5	−1	5–198	125	1,000	1.0
New York, N. Y.												
Westinghouse	2N54	*pnp* fused[1]	200 (25C)	−45	−10	60	−6	1	33	25	400	1.0
Box 284	2N55	*pnp* fused[1]	200 (25C)	−45	−10	60	−6	1	20	20	400	1.0
Elmira, N. Y.	2N56	*pnp* fused[1]	200 (25C)	−45	−10	60	−6	1	13	5	400	1.0

high frequency transistors.

The maximum power ratings on most of the low-power transistors are of the order of 50 milliwatts collector dissipation at room temperature. Some of these units have external heat sinks and are able to dissipate considerably more power.

The rating most commonly em-

Parameters				Grounded-Emitter Connection					Grounded-Base				Grounded-Collector			
$f_{\alpha co}$ (mc)	C_e ($\mu\mu$f)	I_{co} (μa)	NF (db)	I_b (ma)	R_i (ohms)	R_L (ohms)	R_g (ohms)	Gain (db)	R_i (ohms)	R_L (ohms)	R_g (ohms)	Gain (db)	R_i (ohms)	R_L (ohms)	R_g (ohms)	Gain (db)
		−20	28			30,000	500	36								
1.0	49	−10	15		1,000	50,000	matched	42								
1.0	49	−10	12		1,000	50,000	matched	42								
0.7		−10	12		1,200	50,000	matched	43	140	400,000	matched	32.8	500,000	20,000	matched	13.9
0.7		−10	9		1,350	50,000	matched	42.6	130	400,000	matched	33.2	10,000	300	matched	16.2
		− 6	22		1,500	20,000	matched	41	70	100,000	matched	31	600,000	20,000	matched	15
		− 6	25		500	20,000	matched	36	45	100,000	matched	32	200,000	20,000	matched	10
		− 6	20		2,700	20,000	matched	42	110	100,000	matched	30	1,000,000	20,000	matched	16
		− 6	12			20,000	1,000	36		200,000	100	28	540,000	10,000	100,000	14
		− 6	25		800	20,000	matched	39	50	100,000	matched	32	350,000	20,000	matched	13
		− 6	22		1,500	20,000	matched	41	70	100,000	matched	31	600,000	20,000	matched	15
		− 6	20		2,700	20,000	matched	42	110	100,000	matched	30	1,000,000	20,000	matched	16
0.6	15	− 5	18	−0.03	1,200	30,000	500	40					20,000	500	matched	16
0.8	18	5	16	0.03	1,200	30,000	500	40					20,000	500	matched	16
0.9	15	10	26		480	20,000	500	37	35	100,000	60	30	9,500	500	15,000	12
1.1	17	10	23		970	20,000	500	40	40	100,000	60	30	15,500	500	15,000	14.5
1.3	19	10	20		1,250	20,000	1,250	43	45	100,000	60	31	32,000	500	15,000	17
		3	14			20,000	1,000	32								
		3.5	21			20,000	1,000	29								
		4	26			300	1,000	26								
		−10	25													
		−10	20													
3		1 (25C)	23													
3		1 (25C)	23													
3		1 (25C)	23													
≥8		1 (25C)	23													
		50 (25C)				10,000	500	39								
		−10														
0.8		−10	20			1,000	500	30								
0.8		−10	20			1,000	500	26								
0.8		−20	20			1,000	500	26								
0.5		−10	10			20,000	1,000	36								
0.5		−10	20			20,000	1,000	36								
0.5		−10	20			600	1,000	26								
		−15														
		−10														
		−10	20			30,000	1,000	40								
		−10	20			30,000	1,000	40								
		−15	22			30,000	1,000	36								
		−25	24			30,000	1,000	32								
		−15	20			30,000	1,000	40								
		−15	22			30,000	1,000	37								
		−15	22			30,000	1,000	33								
		−10	25			30,000	1,000	38								
		−10	22			30,000	1,000	39								
		−10	20			30,000	1,000	41								
0.9		− 9	14	−0.006		30,000	1,000	33								
0.9		− 8	18	−1.5		300		24								
0.7		−10	18	−0.006		30,000	1,000	35								
0.5		−14	21	−0.006		30,000	1,000	27								
0.7		−10	18	−0.006		30,000	1,000	40								
2	17	10	30													
0.95	25	10	30													
0.5		− 6			700	50,000	700	39.5	125	300,000	125	31	35,000	1,000	35,000	15
0.5		− 6			550	67,000	550	39	125	300,000	125	31	27,000	1,000	27,000	13
0.5		− 6			450	85,000	450	37	125	300,000	125	31	20,000	1,000	20,000	11

All sockets A to H except where otherwise noted
[1] Socket type A
[2] Socket types B to H
[3] Socket types A, I and J
[4] Socket type not given

Characteristics measured at 25 C unless otherwise noted
[5] Characteristics measured at 30 C
[6] Characteristics measured at 27 C
[7] Temperature not given

ployed is the maximum power rating. Maximum current and maximum voltage ratings cannot be achieved simultaneously because the product of these two ratings usually exceeds maximum rating. The maximum voltage rating is set at a value safely below the collector voltage breakdown value while the max-

TABLE II—HIGH-FREQUENCY TRANSISTORS

Manufacturer	Type No.	Type	Max Coll Power (mw)	Max Coll Voltage (v)	Max Coll Current (ma)	Max Ambient Temp (degC)	Storage Temp (deg C)	Typical Small-Signal Bias V_e (v)	Bias I_e (ma)	β	r_e (ohms)	r_b (ohms)
General Electric	2N78	*npn* rate grown	50 (30C)	15	20	100	100 max	5	−1	27.5		
	2N123	*pnp* fused	150 (25C)	−15	150		85	−5	1	30–150		
	2N135	*pnp* alloyed	100 (25C)	−20	−50		85	−5	1	20		
	2N136	*pnp* alloyed	100 (25C)	−20	−50		85	−5	1	40		
	2N137	*pnp* alloyed	100 (25C)	−10	−50		85	−5	1	60		
Germanium Prod.	RD2523A (2N99)	*npn* grown	50 (25C)	40	10	75		5	−1	40	25	150
	RD2525A (2N100)	*npn* grown	25 (25C)	25	5	50		5	−1	100	25	400
	RD2521A (2N98)	*npn* grown	50 (25C)	40	10	75		5	−1	40	25	150
	RD2517A	*npn* grown	50 (25C)	30	10	75		5	−1	13	25	100
Hydro-Aire	HF-1	*pnp* fused	35 (25C)	−15	− 5	55		−4.5	1	25	30	500
	IF-1	*pnp* fused	35 (25C)	−15	− 5	55		−4.5	1	20	30	500
Philco	SB-100	surface barrier[1]	10 (40C)	− 4.5	− 5		−55 to 85	−3	0.5	19	50	
Raytheon	CK-760	*pnp* fused		− 6[3]	− 5		−55 to 85	−6	1	45	22	70
	CK-761	*pnp* fused		− 6[3]	− 5		−55 to 85	−6	1	50	22	70
	CK-762	*pnp* fused		− 6[3]	− 5		−55 to 85	−6	1	60	22	70
Sylvania	2N94	*npn* alloyed	50 (25C)	20	10		−55 to 85	6	−0.5	30	52	500
	2N94A	*npn* alloyed	50 (25C)	20	10		−55 to 85	6	−0.5	30	52	500
Texas Inst.	220	*npn* grown[1]	50 (25C)	30	5	50		22.5				
	221	*npn* grown[1]	50 (25C)	30	5	50		22.5				
	222	*npn* grown[1]	50 (25C)	30	5	50		22.5				
	223	*npn* grown[1]	50 (25C)	30	5	50		22.5				
	904A	*npn* grown	150 (25C)	30	10	150		5	−1	≥19	150	1,250
	224–1											
	2											
	3											
	4											
	5											
	225–1											
	2											
	3											
	4											
	5											
	226–1											
	2											
	3											
	4											
	5											
	227–1											
	2											
	3											
	4											
	5											
Tung-Sol	DR-155	*pnp* fused[2]	50 (25C)	−10		85	−55 to 85	−1.5	0.5	32		
	2N112	*pnp* fused	50 (25C)	−10	− 8	85	−55 to 85	−6	1	32	31	110
	2N113	*pnp* fused	50 (25C)	−10	− 8	85	−55 to 85	−6	1	32	31	110
Western Electric	2N27	*npn* grown	50 (60C)	30	5	85		4.5	−1	20–198	50	700

Socket types A to H unless otherwise noted
[1] Socket type A only
[2] Socket types A and J

Low-Frequency Parameters						H-F Parameters	High-Frequency Circuit Conditions					High-Speed Switching Characteristics			
r_e (meg)	f_{aco} (mc)	C_e ($\mu\mu$f)	I_{co} (μa)	I_{eo} (μa)	NF (db)	$r_b C_c$ ($\mu\mu$ sec)	Application	R_i (ohms)	R_o (ohms)	Power Gain (db)	Circuit	Rise Time (μsec)	Fall Time (μsec)	Reverse Emitter Voltage (v)	Circuit
	5.5	6	1		14		r-f amp	1,000	6,000	20					
							i-f amp	1,500	10,000	30					
	7.5	14	−2	5	10	1,000	switching					0.1	0.2	5	
	4.5	14	5				r-f/i-f amp			29					
	6.5	14	5				"			31					
	10	14	5				"			33					
5.0	3.5	10	2		15		i-f amp unneut	500	10,000	22		<0.2	<0.3		
5.0	5.0	14	2		20		"	750	10,000	23		<0.2	<0.3		
5.0	2.0	14	2		20		"	500	10,000	22		<0.2	<0.3		
3.0	1.0	19	2		20		"	350	10,000	20		<0.2	<0.3		
1.0	5.0	10	−10												
1.0	2.0	10	−10												
0.4	30 (osc)	2.2	−0.5	0.5		800									
1.0	5	14	−2	2	25	1,000									
1.0	10	14	−2	2	25	1,000									
1.0	20	14	−2	2	25	1,000									
2.0	3.5	10	3	−3	15	1,000	i-f (g-b)	80	100,000	25[4]	*C*	0.15	0.15	≥0	*F*
							i-f (g-e)	500	25,000	32[4]	*D*				
2.0	6.0	10	3	−3	15	1,200	i-f (g-b)	80	100,000	25[4]	*C*	0.1	0.1	≥0	
							i-f (g-e)	800	25,000	35[4]	*D*				
							r-f (g-b)	80	15,000	20[5]	*E*				
			50				262-kc (g-e) i-f	750	70,000	31	*A*				
			50				"	750	70,000	33	*A*				
			50				"	750	70,000	35	*A*				
			50				262-kc conv	300	60,000	20	*B*				
0.5	≥8		1												
							neut 262-kc g-e i-f	600	70,000	26	*H*				
										28					
										30					
										32					
										34					
							neut 455-kc g-e i-f	500	50,000	24	*H*				
										26					
										28					
										30					
										32					
							neut 262-kc g-b i-f	65	120,000	18	*I*				
										20					
										22					
										24					
										26					
							neut 455-kc g-b i-f	65	150,000	18	*I*				
										20					
										22					
										24					
										26					
1.0	1.4		−15		28										
1.2	5		−10		28		i-f	600	25,000	32	*G*				
1.2	10		−10		28		i-f	600	25,000	33	*G*				
2.0	2	17	10												

Characteristics measured at 25 C unless otherwise noted

[3] Characteristics measured at 27 C

[4] Bandwidth 12 kc

[5] Bandwidth 25 kc

TABLE III—GROWN *NPN* JUNCTION TETRODE TRANSISTORS

Manufacturer	Type No.	Max Coll Power (mw)	Max Coll Voltage (v)	Max Coll Current (ma)	Max Base-to-Base Current (ma)	Application	Small-Signal Low-Frequency				
							Bias		I_{b2} (ma)	α	r_e (ohms)
							V_c (v)	I_e (ma)			
Germanium Prod.	RDX-302/ 3N23	50(25C)	30	5	5	video amp, switching 10-mc osc	4.5	1	0	0.95	30
	RDX-301/ 3N23A	50(25C)	30	5	5	video amp, switching 20-mc osc	4.5	1	0	0.97	30
	RDX-300/ 3N23B	50(25C)	30	5	5	video amp, switching 35-mc osc 20-mc i-f	4.5	1	0	0.98	30
	RDX-300A/ 3N23C	50(25C)	30	5	5	video amp, switching 50-mc osc, 20 to 30 mc i-f	4.5	1	0	0.99	30
Texas Inst.	700	50(25C)	30	5	5	low-level, low-freq agc	5	−1	0	0.95	30
Western Electric	3N22	30(25C)	12	5	5	video amp, r-f	9	−2	−4.5	0.90	25
							9	−2	0	0.975	25

All sockets A, F, G, H and M

TABLE IV—POWER TRANSISTORS

Manufacturer	Type No.	Type	Max Power Output (w)			Max Coll Power (w)	Max Coll Voltage (v)		Max Coll Current (amp)	f_{aco} (kc)	Small-Signal		
			Class A	Class B (push-pull)	D-C Switch		Circuit				Bias		β
							g-e	g-b			V_c (v)	I_e (ma)	
Amperex	2N115	*pnp* fused[1]	1.5	2.5		2(45C)	−12(B) −6(A)		−1	300			
	2-OC72	*pnp* fused[2]				0.045(45C)	13(B)		0.045	10			
CBS-Hytron	HD-197	*pnp* fused[1]				0.5(25C)	−40			150	−10	50	10
Hydro-Aire	JP-1	*pnp* fused[2]	0.45	0.9	1.5	0.5(25C)		−45	−0.1	50	−22.5	20	9
Minneapolis-Honeywell Regulator Co. 2753 4th Ave. S Minneapolis, Minn.	H-1	*pnp* fused[1]	5	10	40	20(21C)	−30	−60	−0.8	20	−2		
	2N57	*pnp* fused[1]	6	12	48	20(21C)	−30	−60	−1	20	−2		
	H-2	*pnp* fused[1]	8.5	18	68	20(21C)	−30	−60	−1.4	20	−2		
	H-3	*pnp* fused[1]	2	4	16	5(21C)	−30	−60	−0.35	20	−2		
	H-4	*pnp* fused[1]	2	6	16	5(21C)	−30	−60	−0.5	20	−2		
Sylvania	2N68	*pnp* alloyed[2]	0.75	10		4(25C)		−25	−1.5		−6	50	40
	2N95	*npn* alloyed[2]	0.75	10		4(25C)		25	1.5		6	−50	40
	2N101	*pnp* alloyed	electrically identical to 2N68										
	2N102	*npn* alloyed	electrically identical to 2N95										
Texas Inst.	X-2	*npn* grown						35	0.075	225	5	−1	9

Parameters			Typical Operation	
r_b (ohms)	r_c (megohms)	I_{co} (μa)	Freq (mc) Circuit *J*	Power-Gain at 5mc Circuit *K*
70	2	10	10 to 20	12
100	2	10	20 to 35	14
200	2	10	35 to 50	15
300	2	10	50 to 80	17
1,000	1	10		
100	1	10	15	
1,000	1			

Characteristics measured at 25 C

imum current is selected where β has not decreased to too low a value.

Table II, high-frequency transistors, includes *pnp* and *npn* fused junction, *npn* grown junction and *pnp* surface-barrier units. Except for the *npn* grown type, which is of either germanium or silicon, all of these units use germanium.

Physically, one of the main distinctions between these units and the low-frequency units is the closer spacing between emitter and collector junctions. Electrical characteristics are higher alpha cutoff, lower collector voltage breakdown and in many units lower collector capacitance and lower base resistance. The widest application is in radio receivers and high-speed switching circuits.

In selecting a high-frequency transistor for a grounded emitter i-f amplifier, note that the β cutoff frequency of the amplifier is equal to α cutoff frequency divided by β.

Table III lists tetrode junction transistors which are high-frequency triode *npn* grown junction transistors with an extra base lead and a narrower base region. The electrical characteristics of the grown tetrode transistor are almost identical to the grown triode transistor except for a lower value of base resistance and higher value of α-cutoff frequency. The extra base lead makes the tetrode applicable in specialized control circuits and avc applications. Bias for the extra base lead is usually obtained from a bleeder across the main supply.

High-Power Units

The high-power transistor, Table IV, is in most cases the largest of all transistors. One element is attached to the container. In most units the case may be connected to the chassis either directly or

Low-Frequency Parameters						Typical Operating Conditions										
r_e (ohms)	r_b (ohms)	r_c (ohms)	C_c ($\mu\mu$f)	Rise Time (μsec)	I_{co} (μa)	Class & Circuit	Supply Voltage (v)	Coll Current (ma)	Base Current (ma)	Zero Signal Current (ma)	Power Output (w)	Power Gain (db)	Driving Power (mw)	R_e (ohms)	R_L (ohms)	R_g (ohms)
						B(g-e)	−6	−1,280		−5	5[4]	27				
						B(g-e)	−6				0.2[4]	27				
	70	5,000				A		−50				30			5,000	100
2	150	100,000			−500	B(g-b)	−22.5	−40			0.7[4]	20				
				1.5	−8,000	A(g-e)	−28	400	50		5	15	158	20	70	4
						B(g-e)	−28	510		4	10[4]	12	630	100	140	4
				1.2	−8,000	A(g-e)	−28	500	45		6.25	16	156	35	56	4
						B(g-e)	−28	640		4	12.5[4]	13	625	140	128	4
				0.5	−8,000	A(g-e)	−28	600	30		7.5	20	75	40	47	4
						B(g-e)	−28	890		4	17.5[4]	16	440	100	80	4
				1.2	−1,000	A(g-e)	−28	150	15		1.9	16	48	100	187	4
						B(g-e)	−28	220		0.5	4.4[4]	12	278	240	320	4
				0.6	−1,000	A(g-e)	−28	150	10		1.9	21	15	60	187	4
						B(g-e)	−28	318		0.5	6.25[4]	14	250	200	224	4
1	30	100,000	300		−100	A(g-b)	−12	−150			0.6	23		75	100	50
						B(g-e)	−12	−550		−1	5[4]	15		50	12	50
						B(g-c)	−12	−550		−1	5[4]	10		250	12	100
						B(g-b)	−24	−950		−1	10[4]	10		2	24	2
1	30	100,000	300		100	A(g-b)	12	150			0.6	23		75	100	
						B(g-e)	12	550		1	5[4]	15		50	12	
						B(g-c)	12	550		1	5[4]	10		250	12	
						B(g-b)	24	950		1	10[4]	10		2	24	
25	0.75	200,000			25	B(g-b)	22.5	40			0.5[4]	9.5			1,000	
						B(g-b)	22.5	40			0.5	22.7			1,000	

Table IV (cont)

Manufacturer	Type No.	Type	Max Power Output (w)			Max Coll Power (w)	Max Coll Voltage (v)		Max Coll Current (amp)	f_{aco} (kc)	Small-Signal		
							Circuit				Bias		
			Class A	Class B (push-pull)	D-C Switch		g-e	g-b			V_c (v)	I_e (ma)	β
Texas Inst. (cont.)	951	*npn* grown silicon		0.45(25C) 0.3(100C) 0.15(150C)		1(25C) 0.5(100C) 0.15(150C)	50		0.06				
	952	*npn* grown silicon		0.6(25C) 0.4(100C) 0.15(150C)		1(25C) 0.5(100C) 0.15(150C)	80		0.05				
	953	*npn* grown silicon		1(25C) 0.5(100C) 0.15(150C)		1(25C) 0.5(100C) 0.14(150C)	120		0.04				
Transistor Products	X-107	*pnp* fused[1]	1			2(25C)	−30	−60	−1		−24	80	22
241–251 Crescent Ave. Waltham, Mass.	X-120	*pnp* fused[1]	7.5			15(25C)	−30	−60	−4		−28	360	20
Transitron	2N83	*pnp* fused[3]	5	15	40	10(25C)	−30	−45	−1	200	−20	100	8
	2N84	*pnp* fused[3]	5	10	30	10(25C)	−22	−30	−1	200	−20	100	12
Tung-Sol	DR-150	*pnp* fused		1	3.5	5(25C)		−25	−1	250	−15	10	33
Western Electric	2N66	*pnp* fused[1]				5(25C)	−40	−60	−0.8	500	−4.5 −40	100 0	45

[1] Type A sockets

[2] Socket types A to H

TABLE V—POINT-CONTACT TRANSISTORS

Manufacturer	Type No.	Application	Max Coll Power (mw)	Max Coll Voltage (v)	Max Coll Current (ma)	Max Reverse Emitter Voltage (v)	Max Emitter Current (ma)	Max Emitter Power (mw)	Small-Signal			
									Bias		$-\alpha$	r_e (ohms)
									V_c (v)	I_e (ma)		
Hydro-Aire	A-0	amp, osc	0(25C)	−20	−8				−8	0.3	2	425
	A-1	amp, osc	50(25C)	−20	−8				−8	0.3	2	425
	A-2	amp, osc	50(25C)	−20	−8				−8	0.3	2	375
	A-3	amp, osc	50(25C)	−20	−8				−8	0.3	2	350
	S-0	switching	50(25C)	−40	−8	−30						
	S-1	switching	50(25C)	−40	−8	−30						
	S-2	switching	50(25C)	−30	−8	−30						
Sprague Electric	5A	switching	80(25C)	−50	−10	−50			−10	1	3	
Transistor Prod.	2A	amp, osc, sw	120(25C)	−50	−8	−50						
	2C	switching[1]	100(25C)	−50	−8	−50						
	2D	amp, osc[1]	100(25C)	−50	−8	−50						
	2E	amplifier[1]	100(25C)	−50	−8	−50						
	2G	switching[1]	120(25C)	−50	−8	−50						
	2H	amplifier[1]	100(25C)	−50	−8	−50						
	2L	switching[1]	50(25C)	−50	−8	−50						
	2N32	switching[1]	50(25C)	−40	−8	−40						
	2N33	switching[1]	30(25C)	−8.5	−7							
	2N50	switching[1]	50(25C)	−15	−1	−15						
	2N51	sw, osc[1]	100(25C)	−50	−8	−50						
	2N52	amp, osc[1]	120(25C)	−50	−8	−50						
	2N53	switching[1]	120(25C)	−50	−8	−50						
Western Electric	2N21	switching	120(25C)	−100	−60	−100	60	80(25C)[2]	−10	1	2.5[6]	200
	2N21A	amp, osc, sw	120(25C)	−100	−60	−100	60	80(25C)[2]	−10	1	2.5[6]	200
	2N110	switching	200(25C)	−100	−75	−100	75	100(25C)[2]	−10	1	2.5[6]	200
	2N67	hi-speed sw	100(25C)	−100	−60	−100	60	60(25C)[2]	−10	1	3	900

Socket types A to H unless otherwise noted

[1] Socket types A and L

Maximum ambient temperature 50 C unless otherwise noted

[2] Maximum ambient temperature 85 C

Characteristics of A-0, A-1, A-2, A-3, 2N21, 2N21A, 2N110 and 2N67 measured at 25 C

Low-Frequency Parameters						Typical Operating Conditions										
r_e (ohms)	r_b (ohms)	r_c (ohms)	C_c ($\mu\mu$f)	Rise Time (μsec)	I_{co} (μa)	Class & Circuit	Supply Voltage (v)	Coll Current (ma)	Base Current (ma)	Zero Signal Current (ma)	Power Output (w)	Power Gain (db)	Driving Power (mw)	R_c (ohms)	R_L (ohms)	R_g (ohms)
					5	B(g-e)	28	30			0.45(25C)[4] 0.15(150C)	20			1,500	1,000
					6	B(g-e)	45	25			0.6(25C)[4] 0.15(150C)	21			4,000	1,000
					8	B(g-e)	67.5	20			1(25C)[4] 0.15(150C)	23			8,000	1,000
0.85	12	50,000			−120	A(g-b)	−28	−80			1	24	4	1.5	375	
0.65	1	10,000			−200	A(g-b)	−28	−360			5	20	50	0.8	100	
0.3	15	20,000	400	1.5	−100	B(g-e)	−30	−160			2.5[4]	24			600	100
0.3	15	20,000	400	1.5	−100	B(g-e)	−20	−160			2.0[4]	22			400	100
		30,000														
			400		75											
					300											

[3] Socket types A and K

[4] Push-pull connection

Low-Frequency Parameters						Large-Signal Parameters					
r_b (ohms)	r_e (ohms)	f_{aco} (mc)	C_c ($\mu\mu$f)	Nf (db)	I_{co} (μa)	Rise Time (μsec)	Turn-Off Time (μsec)	Off I_c (ma)	On V_c (v)	Emitter Rev Resist. (ohms)	α (at max rise time)
200	13,000	3			−1,200						
200	13,000	2			−1,500						
175	13,000	1			−2,000						
150	13,000	0.3			−2,000						
						0.2[3]		−1	−2	50,000	
						0.5[4]		−1	−2	50,000	
						1[5]		−1	−2	50,000	
		5		43		0.12	0.5				
90	10,000	2		45	−1.1	0.2	1.3	−1.1	−1	200,000	5
90	10,000	2		45	−1.1	0.2	1.3	−1.1	−1	200,000	5
90	15,000	1.5			−0.9	0.3	1.3	−0.9	−1	200,000	4
500	20,000	20			−0.9	0.02	0.9	−0.9	−0.8	2,000,000	7

[3] Fall time = 1 μsec
[4] Fall time = 2 μsec
[5] Fall time = 6 μsec
[6] Large-signal α = 2.4

PARAMETER CONVERSION FORMULAS

$$H_{21} = \frac{R_{21}}{R_{22}} = -\alpha$$

$$H_{11} = R_{11} - \frac{R_2 \cdot R_{12}}{R_{22}} \overset{\bullet}{=} r_e + (1-\alpha)r_b$$

$$H_{12} = \frac{R_{12}}{R_{22}} \overset{\bullet}{=} \frac{r_b}{r_c}$$

$$H_{22} = \frac{1}{R_{22}} \overset{\bullet}{=} \frac{1}{r_c}$$

$$r_c = \frac{1}{H_{22}}$$

$$r_b = r_c H_{12}$$

$$|\alpha| = |H_{21}|$$

$$r_e = H_{11} - r_b(1-\alpha)$$

TRANSISTOR SOCKETS

Code	Manufacturer	Type
A	Solder connections	————
B	Elco Corp.	3-pin polarized 3-pin printed-circuit
C	Cinch Mfg. Corp.	3-pin polarized
D	Super-Ear Prod. Co.	3-pin polarized
E	Mycalex Tube Socket Corp.	3-pin polarized
F	Elco Corp.	4-pin polarized 4-pin printed-circuit
G	Super-Ear Prod. Co.	5-pin
H	Elco Corp.	5-pin 5-pin printed-circuit
I	Super-Ear Prod. Co.	3-pin equal spacing
J	Cinch Mfg Corp.	5-pin
K	Amphenol Co.	————
L	Cinch Mfg Corp.	————
M	Cinch Mfg Corp.	4-pin polarized

TABLE VI—PHOTOTRANSISTORS

Manufacturer	Type No.	Type	Max Coll Voltage (v)	Max Coll Current (ma)	Max Coll Power (mw)	Max dark Current (μa)	Max Ambient Temp. (deg C)	Cutoff Freq. (kc)	Noise (ft-candles)	Sensitivity (μa/ft-candles)
General Transistor	GT-66	fused, 3 lead[1]	12	20	50(25C)	15		750	6×10^{-5}	25
Texas Inst.	800	grown, 2 lead[2]	20	20	50(25C)	250	40	20		35
Transistor Prod.	1N188	grown, 2 lead	100		40(25C)		50		3 to 10 μv	10 μa/millilumen
	1N189	nonrect, 2 lead			30(25C)	20	50			0.08%/ft-candle
	10A	grown, 2 lead	15		100(25C)	500	50		15 to 100μv	4ma for 300 ft-candles
	10B	grown, 2 lead	15		100(25C)	50	50		15 to 100μv	50% for 10 ft-candles
	5B	grown, 2 lead	50		100(25C)	20	50		3 to 10μv	1ma for 300 ft-candles
	5C	grown, 2 lead	50		100(25C)	5	50		3 to 10μv	50% for 40 ft-candles
	11A	nonrect, 2 lead	15		50(25C)	4,000 ohms	50			2,000 ohms for 300 ft-candles
	11B	nonrect, 2 lead	15		50(25C)	4,000 ohms	50			3,000 ohms for 300 ft-candles
	17A	grown, 2 lead							below 1μv	
Western Electric	1N85	grown, 2 lead[1]	90	1	50	20	85	25	$2\times10^{-6}\mu$a	0.35μa/μw

[1] Socket type A
[2] Socket type A to H

through a thin mica spacer. The types used as power transistors are the germanium *pnp* fused and silicon *npn* grown.

The *pnp* fused transistors are usually the high-power units whose larger physical size provides collector power dissipation up to 20 watts. The larger physical size also contributes a higher collector capacitance and lower α-cutoff frequency. Medium power *pnp* and *npn* fused units which retain their smaller physical size and most of the electrical characteristics of the low-power transistors are used in applications requiring collector power dissipation below $\frac{1}{2}$ watt.

The characteristics peculiar to the high-power transistor are the lower values of input resistance, output resistance and α, resulting from the higher values of bias currents employed. Bias stability tech-

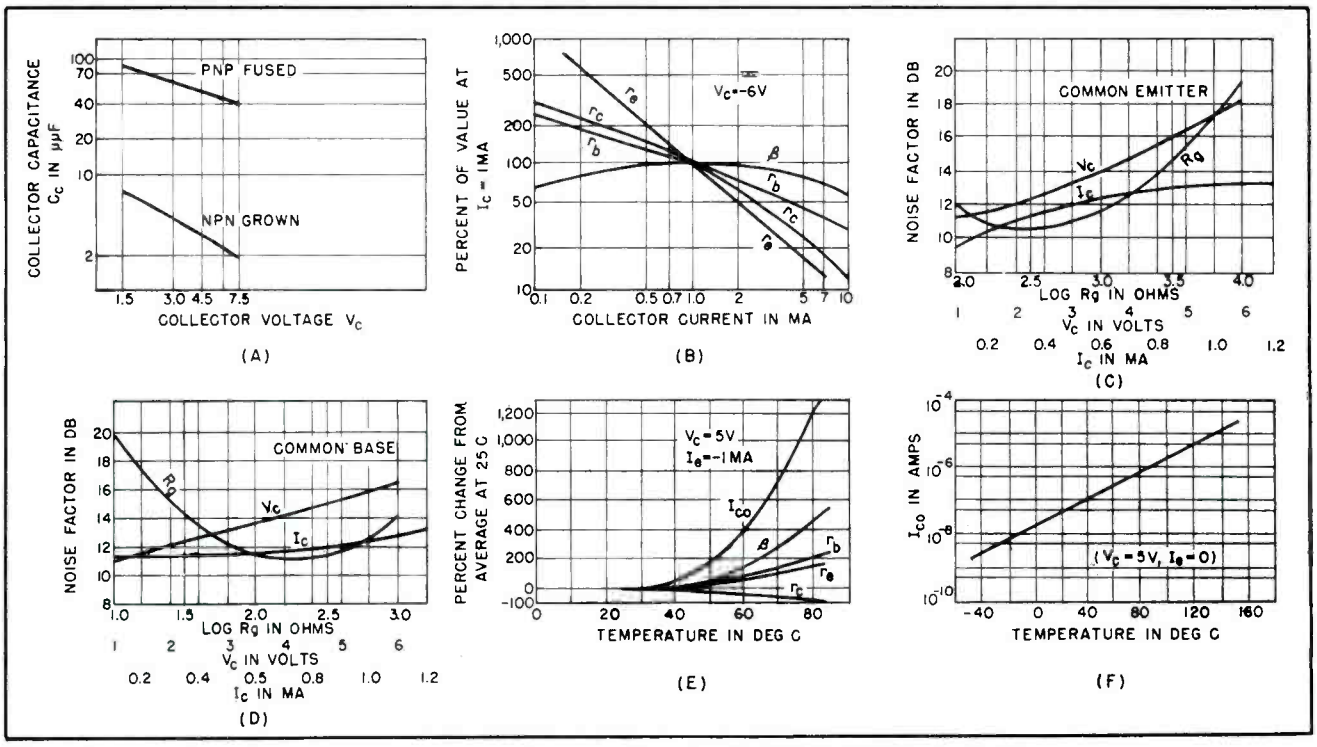

FIG. 1—Variation of transistor parameters with operating point (A to D) and ambient temperature (E, F)

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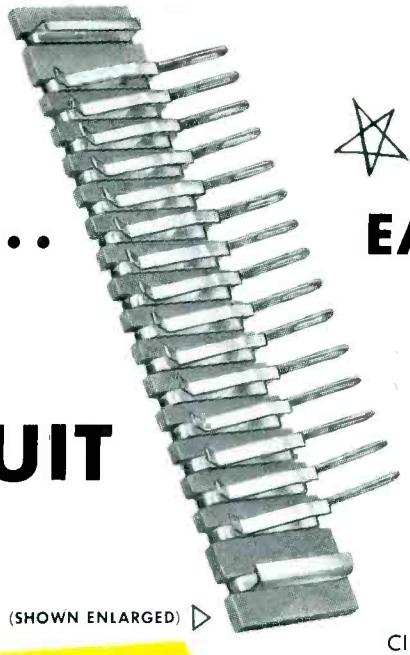

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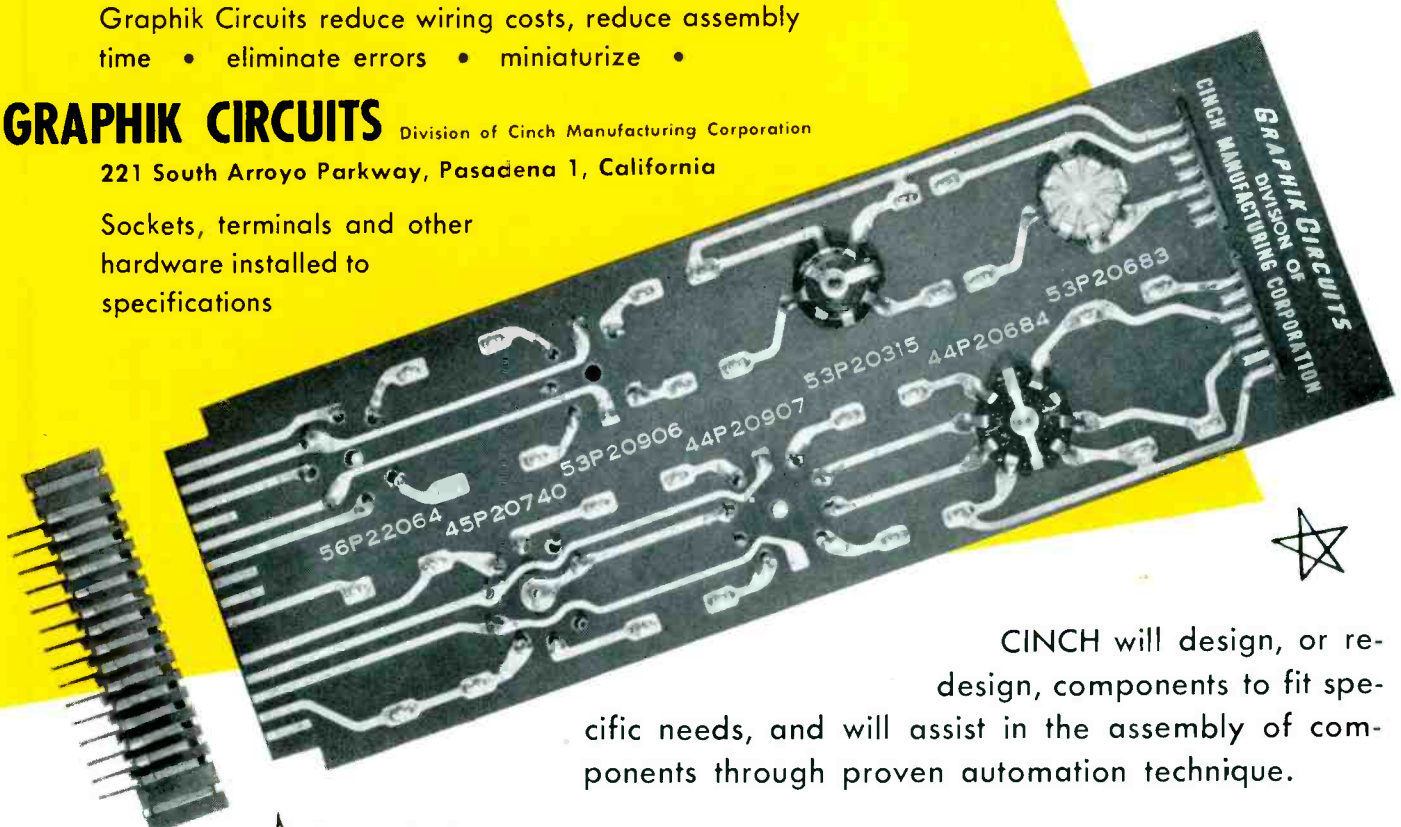

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niques are used to minimize the effect of runaway due to self-heating of the collector.

The point-contact transistor, Table V, is limited to high-speed switching circuitry. Phototransistor devices, Table VI, are divided into two basic types: the two-lead and three-lead devices. In the two-lead unit, one lead is attached to the base and the other to the collector. The three-lead device has leads going to the emitter, base and collector respectively.

The two-lead device is used in circuits providing d-c amplification for unmodulated light while the three-lead device can be used in circuits employing a-c amplification for modulated light.

Acknowledgment is given to Ann M. Field and Elizabeth A. Sewell for their assistance in compiling data.

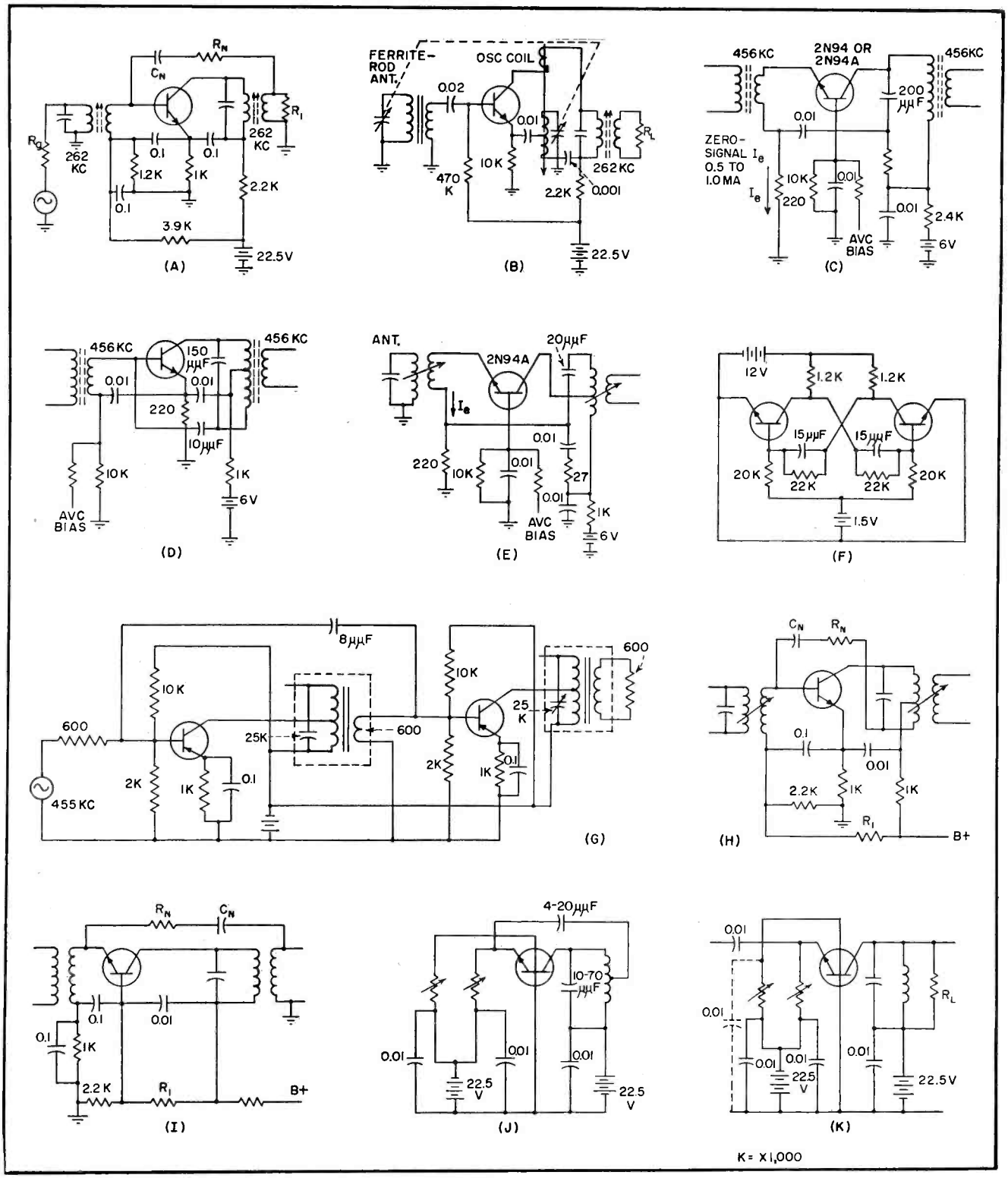
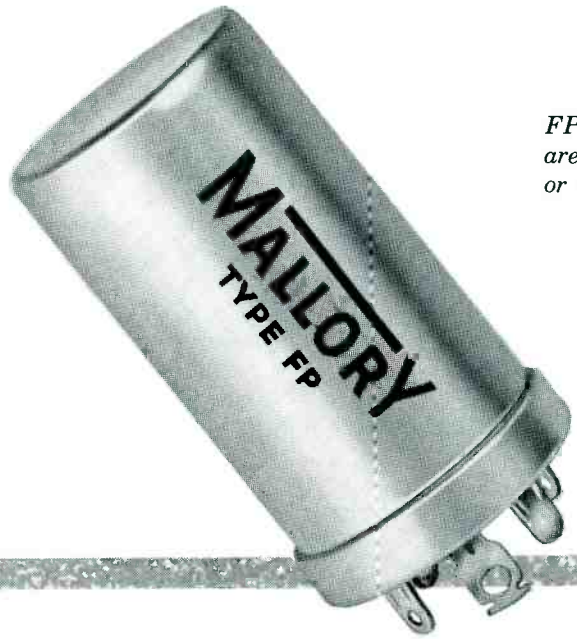


FIG. 2—Typical circuits for high-frequency transistors (A to I) and junction tetrode transistors (J, K) referred to in Tables II and III

MALLORY



FP Capacitors withstand high ripple currents . . . are ideal for use with selenium rectifiers, doubler or tripler circuits, especially at high ambients.

High ripple currents...high temperatures... call for Mallory FP Capacitors

Higher ripple currents in color television circuits emphasize the importance of ripple current rating in choosing electrolytic capacitors.

To see how Mallory FP Capacitors compare in this quality, take a look at the table at the right. The figures are based on extended life tests in our laboratories.

Uniformly higher in ripple current rating than other standard types of electrolytics, FP's often can carry *double* the current rating expected for a given capacitance and voltage rating. The reason for this superiority is the unique FP construction. The fabricated plate compresses a lot of effective area into minimum volume . . . so that more electrolyte and more capacitance can be placed in a smaller size container. This compact construction has improved heat dissipation. In addition, separator, etched cathode, end seal and air space are designed for 85° C. operation.

The same characteristics which give Mallory FP's their superior ability to handle high ripple current also permits them to operate effectively in auto radios, sealed military units and other equipment where high ambient temperatures are a problem.

The Mallory FP is a capacitor that needs no de-rating at 85° C., and that can take heavy ripple current without overheating and with normal life expectancy. A Mallory capacitor specialist will be glad to consult on the use of FP capacitors in your specific circuit . . . or to send you detailed technical data.

Typical Ripple Current Ratings for FP Capacitors

The following ratings represent values obtained by tests on single section units at 85° C. ambient, on 120 cycle ripple.

Capacitance	Voltage	Ripple Current Rating	
		Mallory FP	Usual Industry Expectation
80 mfd	450 VDC	670 MA	480 MA
60	450	620	440
100	350	820	500
200	150	1290	525
150	250	1030	515

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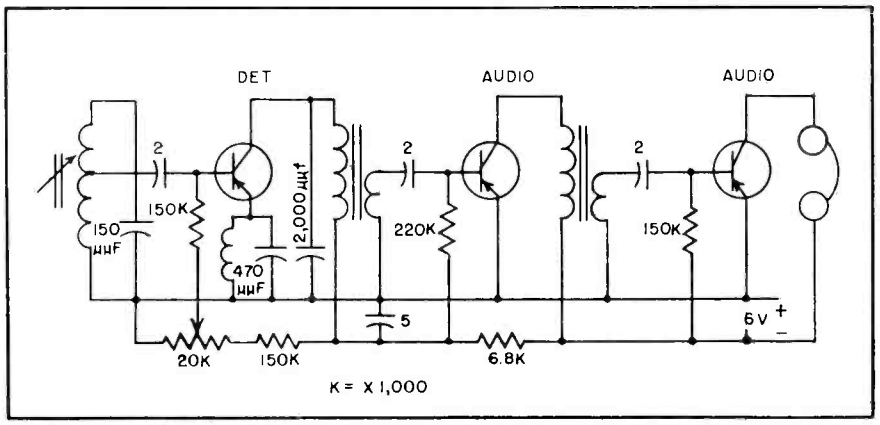
Electrons At Work

Edited by ALEXANDER A. McKENZIE

Wrist Receiver Circuit Uses Three Transistors



Highly efficient detector and two a-f stages comprise the LEL wrist radio

COMPLETE CIRCUIT of the wrist radio receiver (ELECTRONICS, p 10, Dec. 1955) is shown in the diagram.

The tap on the input inductance is adjusted for best impedance match and selectivity. The low loading of the input circuit by the transistor allows a frequency coverage of over 3-to-1 ratio with conventional slug tuning.

Regeneration is provided by the tank circuit in the emitter circuit of the r-f stage. This is tuned to a frequency below the broadcast band, thus presenting a capacitive reactance at all frequencies within the band.

Reduction of the time constant in the base circuit of the r-f stage will result in oscillation when the base current control is advanced beyond the point of stability. In strong signal areas, it is not necessary to operate the base current control close to the point of instability. However, as the distance from the station increases and low signal energy results, it is necessary to operate the control closer to threshold, as is common with regenerative receivers.

The collector circuit of this stage is bypassed to ground by the 2,000-$\mu\mu$f capacitor.

The low base current provides operation in the nonlinear portion of the transistor ΔI_b ΔI_c characteristic, resulting in good detection characteristics. As regeneration is advanced, the input circuit losses are decreased and sufficient signal energy is supplied to the base emitter circuit.

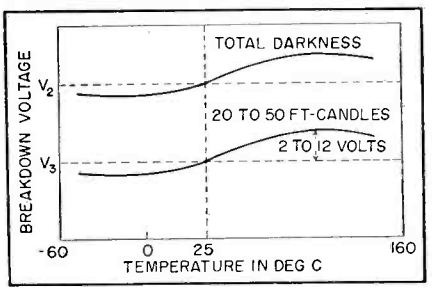
The higher efficiency that results permits reception of much weaker signals than would be possible with a diode detector. The balance of the receiver is a two-stage audio amplifier. The overall signal gain of these stages exceeds 70 db.—V.Z.

Breakdown In Gas Tubes

OF PERENNIAL surprise to young physicists and engineers is the effect of light on the breakdown voltage of glow-discharge tubes. This interdependence is spelled out in an unpublished National Bureau of Standards report on characteristics of cold-cathode glow-discharge tubes by Eugene J. Hebert, Jr., quoted here with permission.

"The d-c breakdown voltage is greatly affected by light or rather the lack of it. Experiments of the present study indicate that the breakdown voltage, after a tube has been in complete and total darkness for 24 hours or more and then fired in complete and total darkness, may vary from 100 to 200 percent of the breakdown voltage at general room illumination (20 to 50 foot-candles).

"The effect is not consistent; a particular tube may display this variation only at intervals and then again may or may not display it for a considerable number of tests. Some tubes show little variation at all. The intensity of the light seems to be of little importance, the main factor being just that some light be present.



Influence of temperature and light on direct breakdown voltage

"The light from a nearby tube is usually sufficient to bring the breakdown voltage back to that under general room illumination. This effect is illustrated in the graph where V_1 is the breakdown voltage under room illumination and V_2 that under total darkness."

One experimenter in early cosmic-ray sounding utilized a neon-bulb relaxation oscillator to key a radio transmitter. When the keying circuit was sealed in a metal can, it failed to operate. With a tiny window set into the wall of the can in the general vicinity of the neon tube, normal operation was restored. This was true when the window passed any degree of daylight or even artificial light from an electric bulb. Intensity of illumination appears uncritical.—A.A.McK.

(Continued on Page 178)

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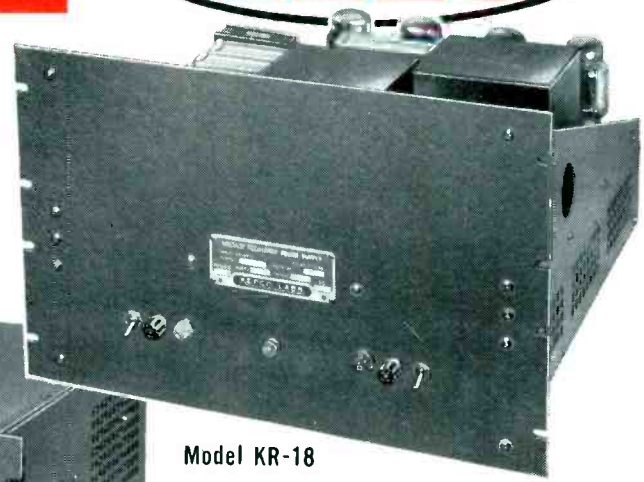

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KR18	195-325	15 Amp.	19"	12¼"	17"	$695
KR19	295-405	outputs	19"	12¼"	17"	$695

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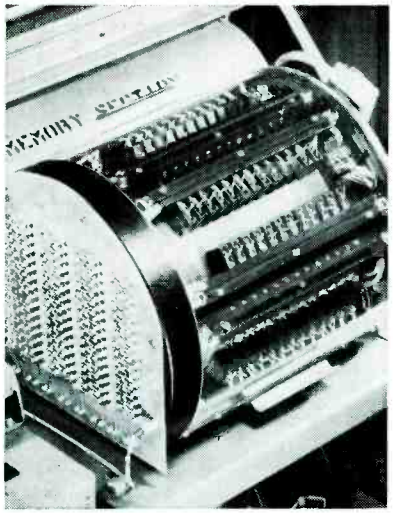
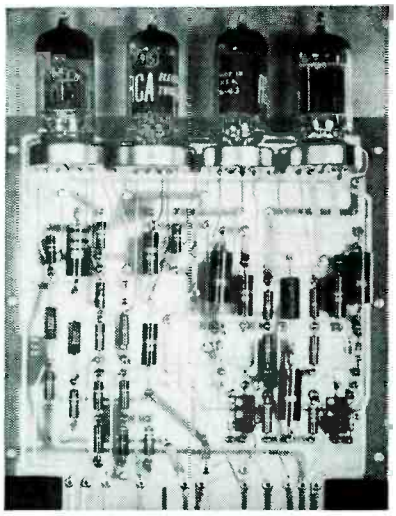
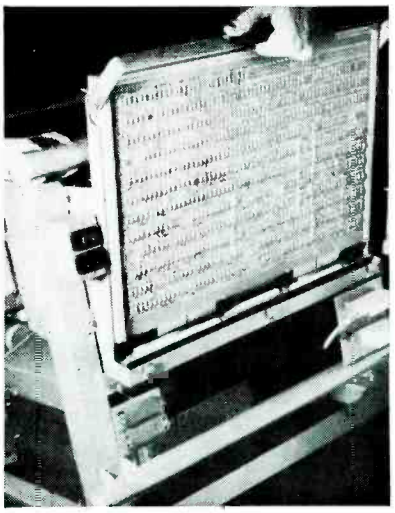
Computer Stored Program Alters Itself



Memory section has space for 4,096 instructions and numbers. Since instructions are stored in the memory, the program can alter itself



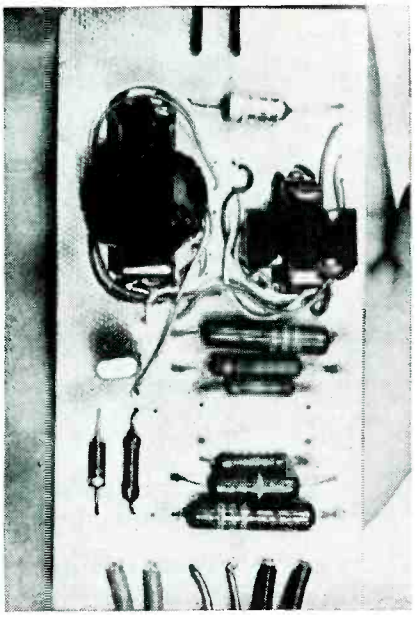
Plug in units based upon mechanized wiring facilitate servicing in new Librascope computer. Logic section (right) can be removed



Total access time is 2 millisec minimum and 17 millisec maximum. Addition time is 0.26 millisec, division and multiplication are 17 millisec

Transistors Lighten Field Telephone Repeaters

Transistorized version of telephone repeater enables a combat soldier to talk more than 30 miles. Total weight of the unit is 3.5 pounds



Amplifier uses transistor shown at the middle left of unit

RANGE of the average Army field telephone line is 6 miles. Repeaters, or amplifiers, increase the talking distance to 30 miles, but normally require 15 vacuum tubes powered by a special 24-volt jeep battery or a small power generator.

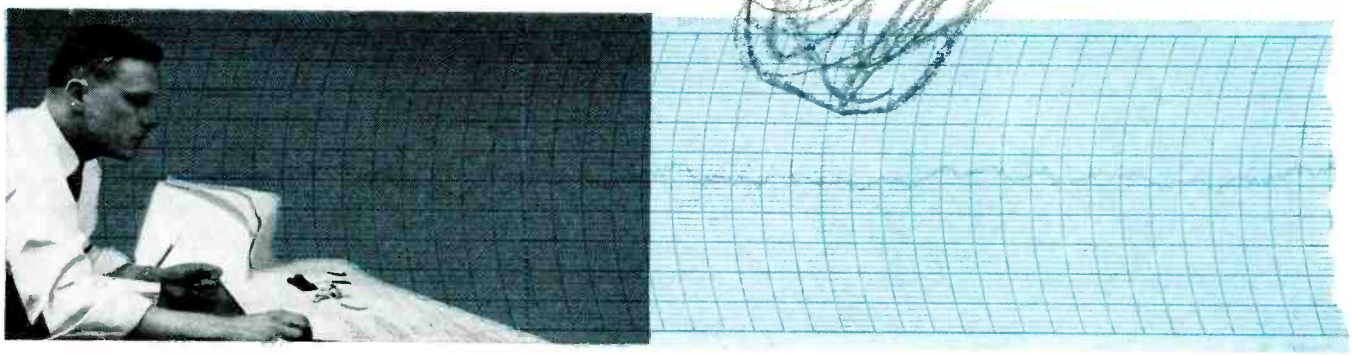
The new repeater, using a transistor audio amplifier, is some 40 times smaller and 20 times lighter than the multitube version of the equipment.

Batteries for the new Signal Corps device last 90 days and cost $6 a year. For an obsolescent World War II repeater, batteries had to be changed every two weeks and cost $105.

The repeater circuit is printed on a card and sealed in a plastic case. It is expected to last 10 to 15 years in field service and needs no adjustment.

(*Continued on Page* 180)

Look mom...no hands!



Mom died a thousand deaths when Junior free-wheeled his two-wheeler down Deadman's Hill... no hands, yet!

Despite dire predictions, Junior grew up... but he didn't change a bit.

True, he's outgrown his bike... more complex machines are his meat today. He's designing industrial indicators, recorders and computers... automatic machine tools... six-figure process controllers. Tomorrow, his dream of automation will come true in the completely automatic factory.

Yes, Junior's grown up, but his war-cry is the same..."look mom, no hands!"

Junior outgrew his bike when he discovered HELIPOT * *precision potentiometers. If you're still riding in circles, join Junior! You'll find that Helipot makes the most complete line... linear and non-linear... in the widest choice of sizes, mounting styles and resistances ...that our engineers will gladly adapt standard models to your requirements... even design entirely new ones for you. For information and specifications... write for data file 101.*

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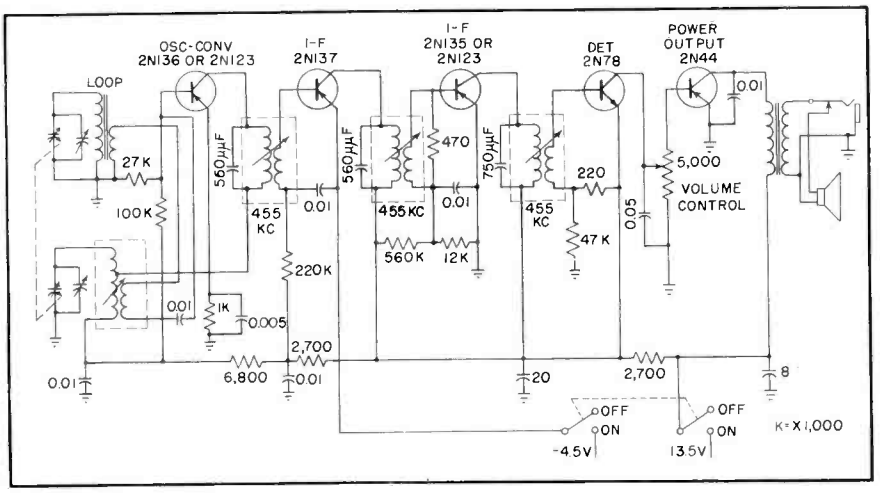
American Transistor Broadcast Receiver

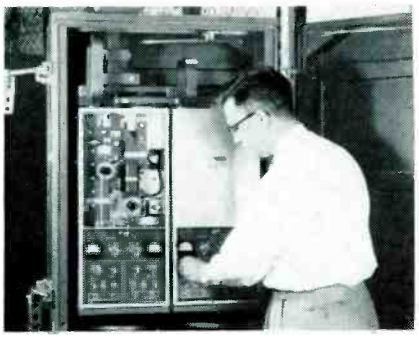


Broadcast receiver employs five transistors

BROADCAST receiver using transistors is being produced by General Electric. It is powered from a d-c supply of 13.5 volts and uses a plated wiring chassis. Tuning between 540 and 1,620 kc, the circuit employs a 455-kc intermediate frequency.

There are five hermetically sealed transistors, including oscillator-converter, detector, audio amplifier and two i-f amplifier stages. Power output is 40 milliwatts at 10-percent distortion.

Frequency Diversity Gives Reliable Signals



Diversity microwave terminal uses two transmitters and two receivers

FAILURE of microwave equipment to furnish consistent communication may be caused, not by malfunctioning of the gear, but by refraction in the atmosphere. Equipment recently developed by Motorola for special applications requiring maximum possible reliability uses two beams at different frequencies.

Two separate transmitters are required as well as two receivers. Only one receiver output is used at a time. Received signal strength of both beams is monitored by a signal comparator circuit. If the level of one beam falls significantly below the other, receivers are automatically switched in a period of only a few milliseconds.

Scatter Symposium

PROPAGATION experts gathered during November for a two-day session in Washington. Their symposium on communication by scatter techniques was sponsored by the Institute of Radio Engineers (acting through professional groups on antennas and propagation, and communications systems) as well as by the George Washington University.

Besides addresses that were essentially nontechnical, 21 formal papers were presented ranging from theory and experimentation to communications practice. Both vhf propagation by ionospheric scattering and uhf beyond-horizon tropospheric transmissions were described.

Commissioner E. M. Webster of FCC discussed the allocations problems inherent in a new technique and pointed out that so far no new allocations have been made to accommodate scatter circuits. Allen B. DuMont reviewed propagation mechanisms and urged the establishment of live television hookups between North America, Europe and South America.

► **Auroral**—H. G. Booker reviewed the propagation phenomenon by which signals are returned from a northerly direction. J. H. Chisholm described wartime propagation anomalies and indicated that diversity techniques in modern transhorizon circuits may increase effective bandwidth as well as improving s-n ratio. Experimental ionosphere scatter paths studied by R. C. Kirby showed a maximum Doppler shift of 6 kc. The role of meteors in extended vhf propagation was discussed by O. G. Villard.

J. R. McNitt, in describing the Maine to Greenland vhf circuits said that the Loring AFB-Goose Bay link, which is too short for satisfactory service, will be extended to 900 miles. K. A. Norton, who discussed the scatter mode, relied upon meteorological data previously presented in a paper by B. R. Bean. F. J. Altman described a simplified diversity system using two planes of polarization to obtain quadruple diversity, and W. E. Morrow presented a plan for parallel connection of equipment to effect greater equipment reliability.

► **By request**—T. J. Carroll of MIT Lincoln Lab, departed from his role as moderator to explain the controversy between two theoretical groups in the field of over-horizon propagation. One camp

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believes in the concept of a blob in which occurs fine scale microturbulence that produces extended-range signals. Carroll himself believes that the mode theory is adequate by which stratified air, affected by gravity, produces something akin to optical twilight.

H. V. Cottony described a series of experiments using rhombic, corner-reflector and Yagi antennas. T. Moreno and F. A. Speaks listed existing and preproduction models of high-power klystrons useful for transhorizon transmitting equipment. J. R. Day outlined the design considerations for Pole Vault and White Alice communications equipment. The ionospheric scatter equipment used at vhf was described by R. M. Ringoen. The Montreal-Riverhead experimental circuit was handled by H. H. Beverage and L. C. Simpson.

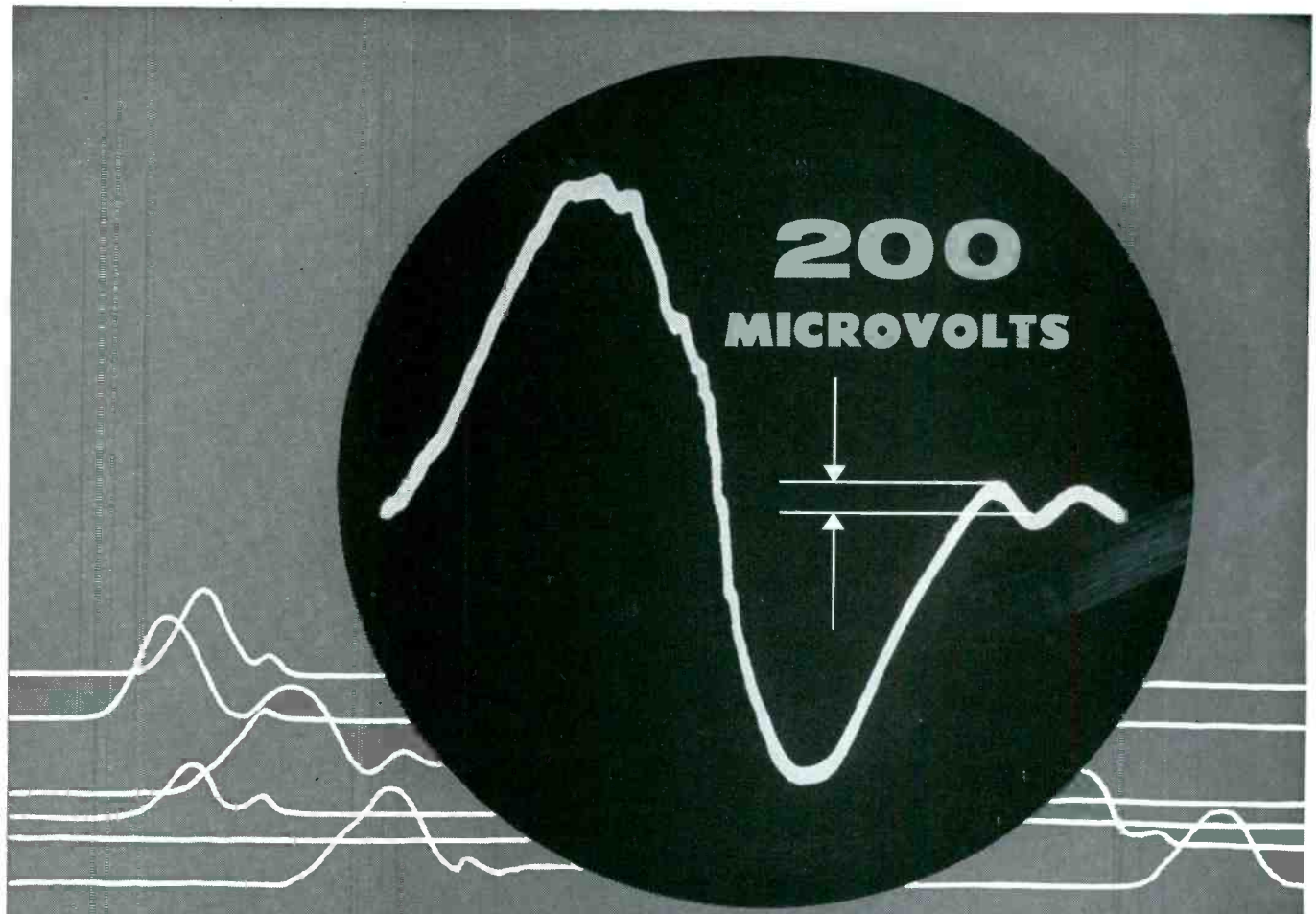
A brief run-down of the Booker-Gordon theory was given by W. E. Gordon. T. E. Rogers commented upon sensible circuit design based upon some 220 mc transmissions over water from Scituate, Mass. Kenneth Bullington reviewed experiments carried out along the coast of Newfoundland using 505 and 4,090 mc. Preliminary measurements over the 468-mc Montreal-Riverhead path were evaluated by G. S. Wickizer. W. A. Whitcraft, Jr. reviewed backscatter and suggested that the technique could be used to communicate between two stations within the skip zone. Signal fluctuations in overwater propagation at 3 and 9 cm received comment from W. S. Ament.

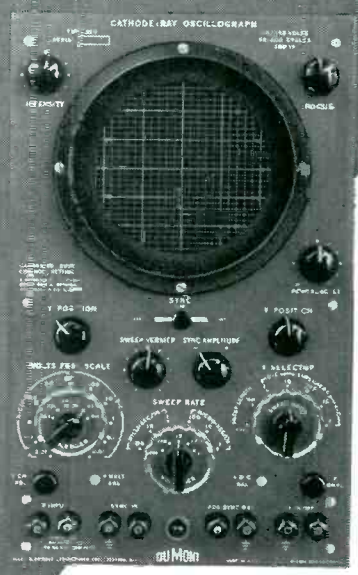
It is expected that transactions of the symposium will be published by IRE.

Interaction Between Antennas

FOR MANY YEARS it has been known that the loop patterns of marine radio direction finders are affected by proximity of other wires, particularly those antennas resonant at, or connected to, equipment tuned to the desired frequency of d-f reception.

It is customary to break up guy wires with insulators so that reradiation of radio signals will occur





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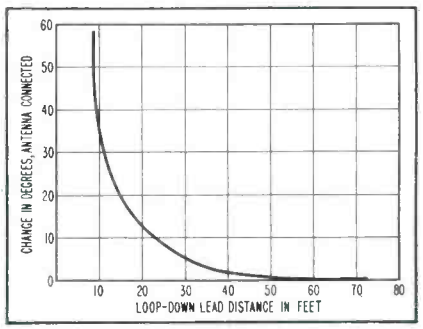


Minimum error occurs when the down lead is 60 feet from the d-f loop

only at frequencies well above those used for direction finding.

Since reradiation on the d-f frequency results in large and unpredictable bearing errors, it is usual to disconnect receiving and transmitting antennas while using the d-f loop. However, the need for maintaining watch on the distress frequency (500 kc) has resulted in a recent evaluation by J. H. Moon in the *Marconi Review*, No. 113.

The errors found among ships with different spacings of antennas is shown in the graph. The spacing shown on the abscissa is that between the d-f loop and the down lead of a ship's main antenna when the latter is tuned to 500 kc. Loop reception is likewise on 500 kc.

The pure quadrantal error that originates in the solid mass of the ship's structure is not considered here.

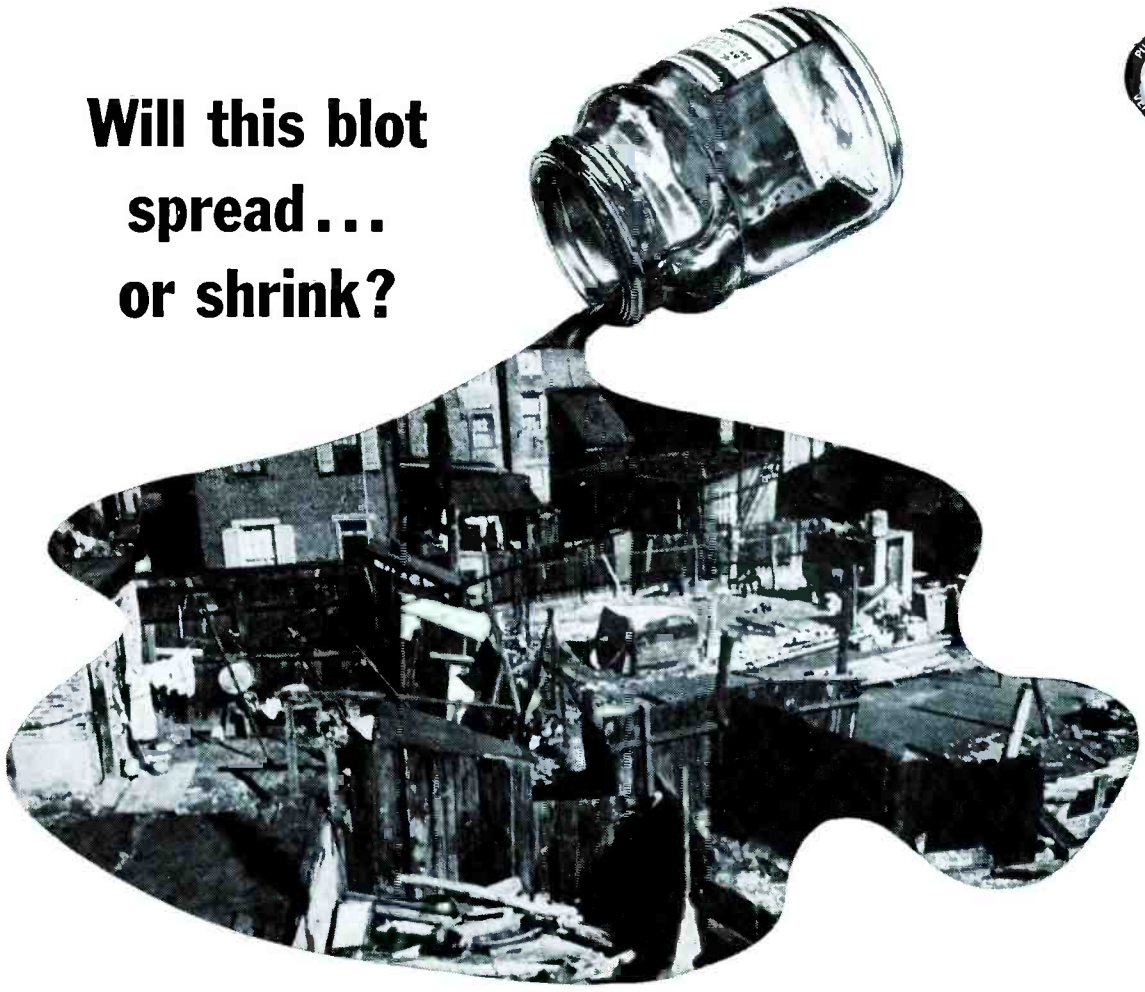
It has been concluded by the author of the original paper that many ships with some 500 feet of separation between antennas might safely use the d-f equipment without isolating the receiving antenna during the operation.—A. A. McK.

Paging Receiver Uses Two Tubes

GROWTH of one-way signaling and also one-way reception of communications signals has led to an increased number of receivers for the purpose. A recent design employs only two tubes and is packaged in a styrene case.

The receiver comprises a superregenerative detector followed by a single audio stage that drives a magnetic speaker. Each stage uses a subminiature pentode, which together with all other parts is

Will this blot spread... or shrink?



NOTHING STRIKES so brutally at human lives as a slum.

Yet of America's many millions of homes, the blot that is a slum covers more than 1 out of every 10 . . . and nearly one-half of all our homes are urgently in need of repair and basic improvements.

Will the blot go on spreading? Or will a concerted, nationwide attack on the causes of slums shrink it, year by year, until it is wiped out? Today, this is a challenge to every American . . . a challenge that *must* be met.

Your community . . . your problem!

A slum reaches across blocks, across miles, to sit on your doorstep and demand a price.

You pay it in the threat of crime and juvenile delinquency to your family. You pay the price in higher personal property taxes to fight the disease and crime and poverty that are slum-bred. You pay personally when the value of your home sinks as community deterioration takes another step closer.

Your *firm* pays when the community where you do business goes downhill. Slums automatically mean lower purchasing power and less effective labor.

Good citizenship is good business

It's good citizenship and good business both for your firm to join efforts to check housing decay . . . to stop slums before they start. In fact, it's the *responsibility* of every business, as it is of every other good citizen, to support community improvement efforts.

Some slums are beyond repair. They should be torn down and a fresh start made. Others can be remodeled, made to conform to better living standards. So it is up to you to get behind every sound program which seeks to provide adequate housing for all our people.

Adding your support to the efforts of the millions already attacking the problem, your firm can help stop slums cold and put America's housing standards at a new height.

How to get into action

A group of Americans from every walk of life has formed a new, non-profit organization to help combat home and community deterioration — The American Council To Improve Our Neighborhoods . . . A.C.T.I.O.N.

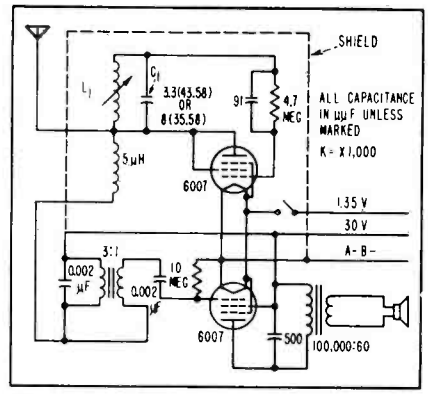
Send for a free copy of "ACTION." It explains what A.C.T.I.O.N. is and proposes to do. It also lists booklets, research reports, check-lists, and other material which can help you protect the housing health of your community. Address P. O. Box 500, Radio City Station, New York 20, N. Y.

ACTION

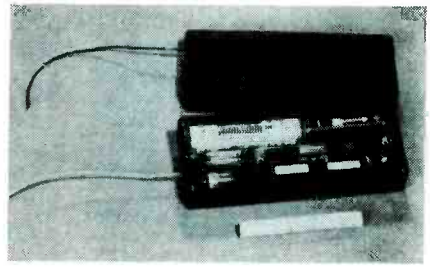
American Council To Improve Our Neighborhoods

AN INSPIRING ADVANCE IN MINIATURE RATE GYRO DESIGN

LEAR



Circuit of the one-way signaling receiver uses a superregenerative detector



Upper model of the receiver shows speaker ports (right)

mounted on a phenolic board.

Gummed aluminum foil is applied to the inside of the case and provides an inexpensive but excellent low-loss r-f shield. The units are pretuned to either 35.58 or 43.58 mc, the standard one-way signaling frequencies, by proper choice of C_1. Final tuning is accomplished with adjustment of L_1.

The unit, with its short, single-wire antenna weighs less than 6 oz. Technical information on this receiver was kindly furnished by the manufacturer, West Coast Electronics Co., of Los Angeles, Calif.

Single-Sideband Mobile Radio

FEDERAL COMMUNICATIONS COMMISSION has gone on record as looking towards establishment of single sideband transmission in radiotelephone stations below 25 mc. Presently, this includes stations in the fixed service except Alaskan and maritime. Because of special technical problems, there are no immediate plans for extension of ssb to mobile, Alaskan and maritime fixed stations.

Radiotelephone stations customarily employ double sideband transmissions on the frequencies in question although ssb has been used for years in international radiotelephone service. Elimination of the extra sideband offers means of reducing bandwidth for each station, probably resulting in additional channels being made available.

FCC expects users, manufacturers and professional groups to conduct tests and studies to serve as technical background for future consideration.

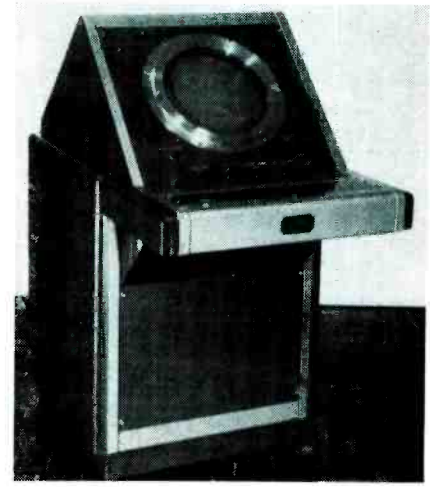
Citizen Radio Evaluation

USE OF Citizen Radio frequencies has failed to live up to early plans, but the facilities are being increasingly employed by those prepared to purchase commercial equipment that can be tuned to frequencies between 460 and 470 mc.

An evaluation recently made has been published as Bulletin No. 9 of the Engineering Experiment Station of the University of Idaho in Moscow, Idaho. Retuned commercial equipment was used in the class A bands, 460-462 and 468-470 mc. Hand portable, class B, equipment was used at 465 mc.

In the Idaho terrain it was found that the class A equipment had a minimum range about 3 miles and maximum range over 60 miles. The class B equipment operates satis-

Radar Data Via Wire



Bandwidth of radar ppi signals is compressed by an optical-electronic scanning device in a ratio of 100 or greater. After transmission over a telephone line or radio link, the signals are used to recreate a facsimile of the original radar picture. The Rafax system is manufactured by Haller, Raymond & Brown

factorily between 300 yards and 10 to 20 miles. Class C equipment used for remote control and utilizing a frequency of 27.255 mc was not tested.

Summaries of a large number of tests are given in the 35 pages.

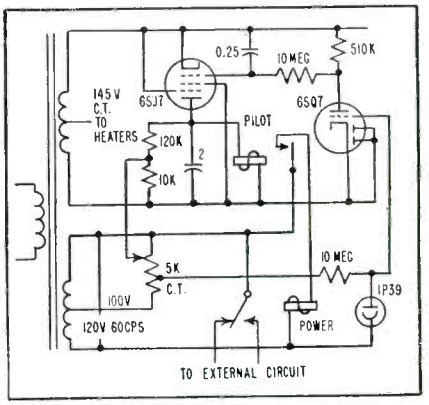
Photocontrol Prevents Motorist Blindness

TUNNEL ENTRANCE lights must be switched to high intensity during periods of bright external sunlight so that drivers' eyes will have necessary time to accommodate to less illumination within the tunnel.

The photoelectric control used for this application differs from the more usual type of device that operates with failing sky light. It is essentially a two-stage photorelay using a 1P39 vacuum phototube, a 6SQ7 buffer amplifier and a 6SJ7 output tube to energize the pilot relay. This relay, in turn, actuates a power contactor.

The phototube directly controls the buffer amplifier. The power amplifier is controlled through a time-delay network that provides a 4 to 6-second delay at turnoff. False operation that might be caused by transient artificial light sources is thus prevented.

A small portion of the p-a output is fed back in series with the phototube-buffer tube signal circuit. This feedback causes a regenerative or trigger action. The circuit becomes unstable and snaps over when the operating points are reached. Because the turn-off point is fixed at a foot-candle value higher than the



Circuit of photocontrol adapted from street-light device

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HU—734:
DIMEN. A—11/16"
DIMEN. B—1 9/32"
LENGTH—1 27/64"

HU—736:
DIMEN. A—3/4"
DIMEN. B—15/16"
LENGTH—7/8"

HU—745:
DIMEN. A—3/4"
DIMEN. B—15/16"
LENGTH—13/8"

HU—750:
DIMEN. A—7/8"
DIMEN. B—1 1/16"
LENGTH—13/8"

HU—796:
DIMEN. A—5/8"
DIMEN. B—1 5/16"
LENGTH—2 1/2"

HU—826:
DIMEN. A—11/16"
DIMEN. B—1 9/32"
LENGTH—1 5/8"

HU—844:
DIMEN. A—11/16"
DIMEN. B—1 9/32"
LENGTH—1 1/4"

STANDARD ROUND SIZES

HU—727:
OUTSIDE DIA.—1 1/4"
LENGTH—1/2"

HU—728:
OUTSIDE DIA.—1 1/16"
LENGTH—2 1/4"

HU—737:
OUTSIDE DIA.—1 15/64"
LENGTH—1 13/32"

HU—760:
OUTSIDE DIA.—21/32"
LENGTH—5/16"

HU—771:
OUTSIDE DIA.—.742"
LENGTH—3/4"

HU—773:
OUTSIDE DIA.—1 1/16"
LENGTH—1"

HU—806:
OUTSIDE DIA.—1 9/64"
LENGTH—1 7/8"

HU—819:
OUTSIDE DIA.—49/64"
LENGTH—2 1/64"

STANDARD SQUARE SIZES

HU—709:
DIMEN. A—1"
LENGTH—2 1/8"

HU—789:
DIMEN. A—1"
LENGTH—1 1/2"

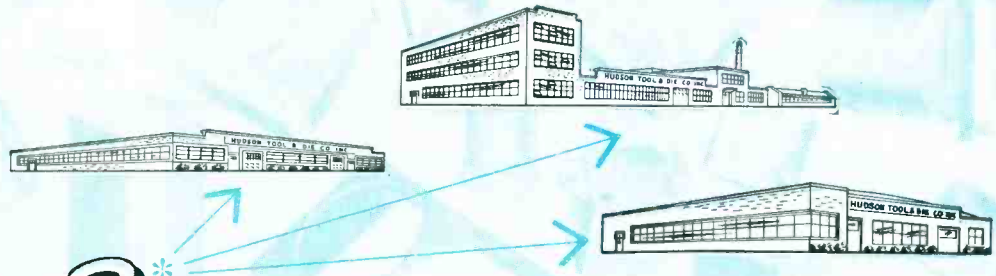
HU—793:
DIMEN. A—1"
LENGTH—1 19/32"

HU—808:
DIMEN. A—1 1/64"
LENGTH—1 25/32"

HU—810:
DIMEN. A—4 5/64"
LENGTH—7/16"

HU—847:
DIMEN. A—1"
LENGTH—2 1/4"

File This Page for Future Reference



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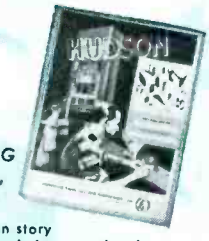

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Want more information? Use post card on last page.

Photocontrol is housed in meter-type glass enclosure

turn-on point, cycling is prevented.

The turn-on point can be adjusted over a range and the turn-off point follows it, but always at a fixed differential. The on and off designations used above refer ultimately to the condition of the pilot relay, which is energized during daylight. The contacts of the power contactor can be used to close or open the external circuit during either daylight or dark periods.

For tunnel applications, the daylight-closed circuit would be used. The information abstracted here comes from a maintenance manual furnished by The Fisher-Pierce Co., Inc., of South Braintree, Mass.

Hawaii Cable Authorized

AUTHORIZATION permitting American Telephone and Telegraph Co. to construct and operate twin submarine cables between the United States and Hawaii has been granted by FCC.

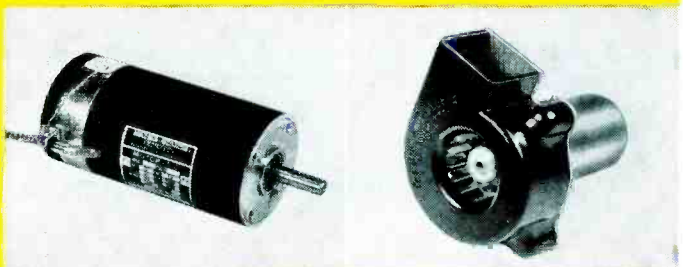
The new cable system, designed for telephone and telegraph communication from Point Reyes, Calif. to Koko Head, Oahu, Hawaii, will cost about $35 million. When completed in 1957 the cable will be the world's longest telephone-telegraph span. With a length in excess of 2,000 miles it will exceed those of the Newfoundland-Scotland and Alaskan cables.

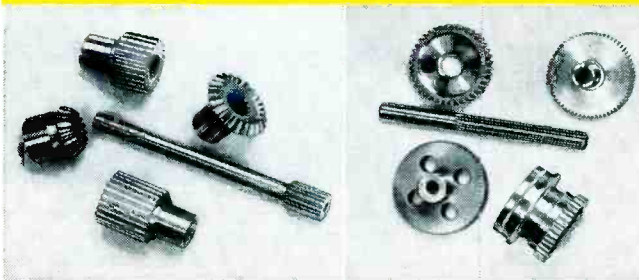
FCC Mobile Monitor

BECAUSE fixed monitoring stations cannot receive distant television transmissions, Federal Communications Commission has developed a

how to reduce costs with WESTERN GEAR rotary electrical equipment

We have more than 50 basic prototype motors, fans, blowers, converters, alternators and generators. Motor designs range from 1/500th to 4 HP, 50 to 1,000 cycles in frequency, any desired voltage. Extensive line enables economic modification to your requirements or special design. Complete engineering service gladly offered for help on any rotary electrical equipment problem. Write for new catalog No. 254-A.





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mobile monitoring unit that will operate in the various field engineering districts where it is needed.

Measurements to be made include frequency of the sound and picture carriers, color subcarrier, line scanning and field scanning repetition rates, modulation percentage and waveform observations. Distribution of the elements of the television signal over the assigned channel will be determined by spectrum emission analysis.

South Africa Time Signals

ESTABLISHED in 1949, station ZUO is now one of the six stations in the world transmitting standard frequency and time signals in accordance with standards of accuracy set up by CCIR (International Consultative Committee for Radio).

Operation is continuous except between the hours 0630 and 0700 Universal Time. Output power is 100 watts on 5 mc from Johannesburg, South Africa.

Modulation for time signals is one impulse a second, each consisting of 10 cycles of 1,000 cps tone (10 milliseconds duration.) The first im-

Microwave Facsimile

Photograph of the Chicago terminal of Texas Illinois Natural Gas Pipeline Co. microwave link to Houston, Texas was sent over the system and the result reproduced above. Copy was scanned at drum speed of 100 rpm with a definition of 100 lines to the inch. A temporary channel 7½ was inserted between two of the 12 channels in regular use. Microwave antenna in foreground has protective cover against weather

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SOME TYPICAL NIXIE APPLICATIONS

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Haydu's 10 digit in-line numerical indicator!

Small, electronic indicating tube uses the direct read-out method which clearly displays the digits at top surface of tube. This method assures the highest readability from a wide angle . . . speeds work, reduces errors, cuts costs in hundreds of diversified applications.

NOTE THESE OUTSTANDING ADVANTAGES:

- Small, simple plug-in tube
- Uses standard sockets
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- Operates directly off Beam Switching Tubes or any voltage source
- Radical Simplification of circuitry
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pulse in each minute is prolonged to about a half second.

Announcements are made ahead of each quarter-hour minute using Morse code. For example, the announcement between 4.14 and 4.15 pm would be sent:

ZUO ZUO ZUO 1615

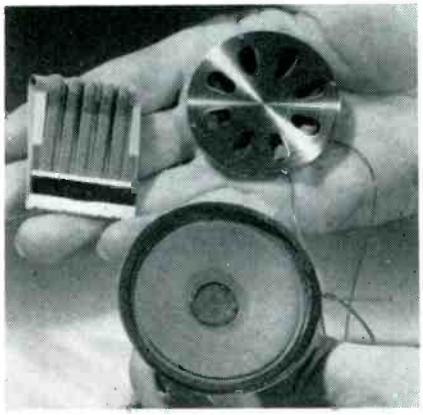
Since the maximum oscillator drift is less than 1 part in 10^8 a month, frequency accuracy is $\pm$ 2 parts in 10^8. If necessary, signals are phased in steps of 20 milliseconds or multiples thereof on the first Monday of the month. The maximum value of steps of frequency adjustment is 1 part in 10^8.

Accuracy of time intervals is $\pm 2 \times 10^{-8}$ ($\pm$ 1 microsecond). A quarterly bulletin is published by The Union Astronomer, Union Observatory, Johannesburg, South Africa.

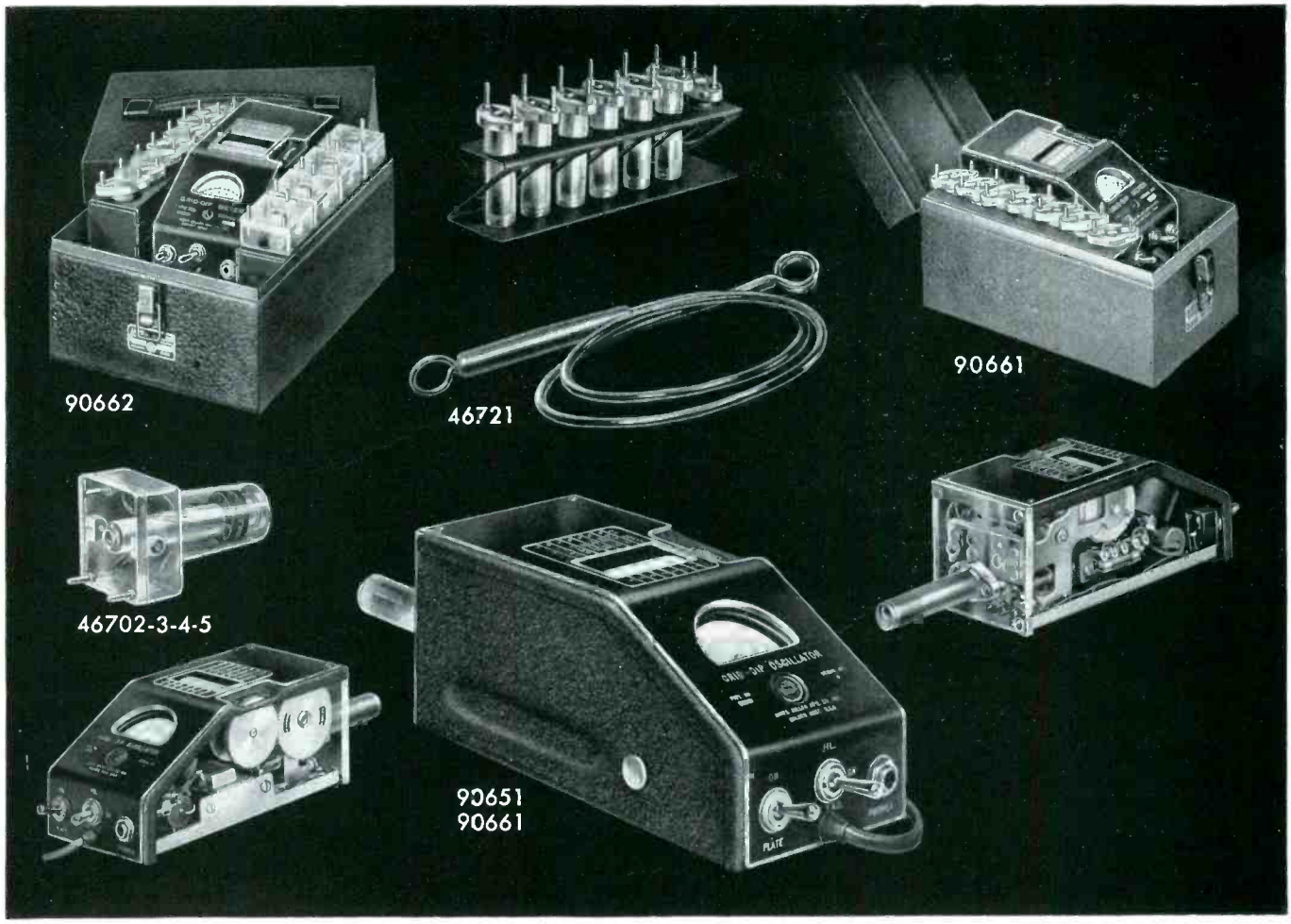
Gamma Rays Preserve Meat

PASTEURIZATION by gamma rays has been suggested as a public health measure for fresh meat and seafoods. It would have the further advantage of making available to the small market the method of packaging cuts of meat in the manner employed in very large markets. The ultimate effect would be to confine the butchering operation to the slaughter and packing house. Gamma radiation might destroy

Tiny Loudspeaker



Small loudspeaker for use in pocket-size transistor radio receivers is only 2⅛ inch in diameter and about a half inch thick. Magnetic structure that projects from the rear of conventional speakers is contained within the shell surrounding the vibrating cone. Unit was developed by RCA engineers



Designed for Application

Grid Dip Meters

Millen Grid Dip Meters are available to meet all various laboratory and servicing requirements.

The 90662 Industrial Grid Dip Meter completely calibrated for laboratory use with a range from 225 kc. to 300 mc. incorporates features desired for both industrial and laboratory application, including three wire grounding type power cord and suitable carrying case.

The 90661 Industrial Grid Dip Meter is similar to the 90662 except for a reduced range o 1.7 to 300 mc. It likewise incorporates the three wire grounding type cord and metal carrying case.

The 90651 Standard Grid Dip Meter is a somewhat less expensive version of the grid dip meter. The calibration while adequate for general usage is not as complete as in the case of the industrial model. It is supplied without grounding lead and without carrying case. The range is 1.7 to 300 mc. Extra inductors available extends range to 220 kc.

The Millen Grid Dip Meter is a calibrated stable RF oscillator unit with a meter to read grid current. The frequency determining coil is plugged into the unit so that it may be used as a probe.

These instruments are complete with a built-in transformer type A.C. power supply and internal terminal board to provide connections for battery operation where it is desirable to use the unit on antenna measurements and other usages where A.C. power is not available. Compactness has been achieved without loss of performance or convenience of usage. The incorporation of the power supply, oscillator and probe into a single unit provides a convenient device for checking all types of circuits. The indicating instrument is a standard 2 inch General Electric instrument with an easy to read scale. The calibrated dial is a large 205° drum dial which provides seven direct reading scales, plus an additional universal scale, all with the same length and readability. Each range has its individual plug-in probe completely enclosed in a contour fitting polystyrene case for assurance of permanence of calibration as well as to prevent any possibility of mechanical damage or of unintentional contact with the components of the circuit being tested.

The Gride Dip Meters may be used as:

1. A grid Dip Oscillator
2. An Oscillating Detector
3. A Signal Generator
4. An Indicating Absorption Wavemeter

The most common usage of the Grid Dip Meter is as an oscillating frequency meter to determine the resonant frequencies of de-energized tuned circuits.

Size of Grid Dip Meter only (less probe): 7 in. x 3 3/16 in. x 3 3/8 in.

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about 99 percent of the microorganisms without developing off-flavors and also increase refrigerator shelf life. Refrigeration would still be necessary.

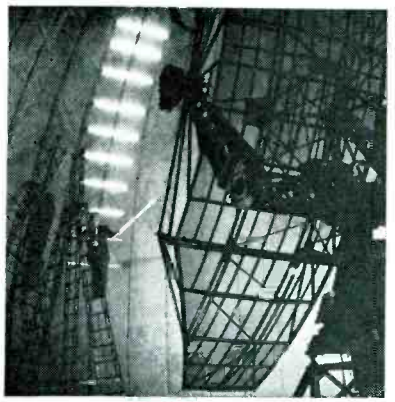
Electrostethograph Measures Heart Sounds

ADAPTATION of a surface roughness measuring gage (ELECTRONICS, p 181, Nov. 1953) to measurement of heart sounds has extended the range of cardiographic equipment. Using a stethoscope diaphragm coupled directly to the anode of a movable anode transducer tube, frequencies as low as one cps can be recorded. The output of the device can be observed on a conventional cro or a recording oscillograph and can also be recorded on tape for reference.

High directional selectivity of the cardiograph pickup head permits observation of the vibrations produced in different areas of the heart. Study of these localized vibrations may lead to more accurate diagnostic techniques. With the accumulation of a large library of recordings from normal and defective hearts, the value of the instrument will be increased as a supplement to conventional electrocardiograph and stethoscope techniques.

Development of the stethograph was done at the Medical College of South Carolina by Dr. Dale Groom,

Multimegawatt Fluorescent



Fluorescent tubes fastened to inside of radome used in arctic service are lighted by power in beam from Air Force FPS-6 height-finder radar on test by General Electric engineers

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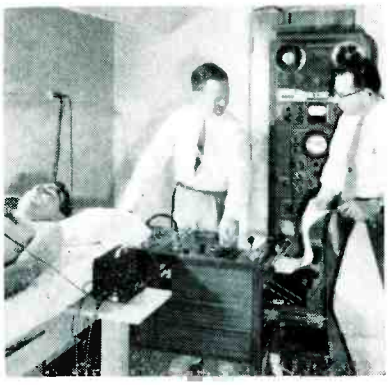
Electronic Components Division

STACKPOLE CARBON COMPANY, St. Marys, Pa.

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



Electronic stethoscope using a movable anode transducer

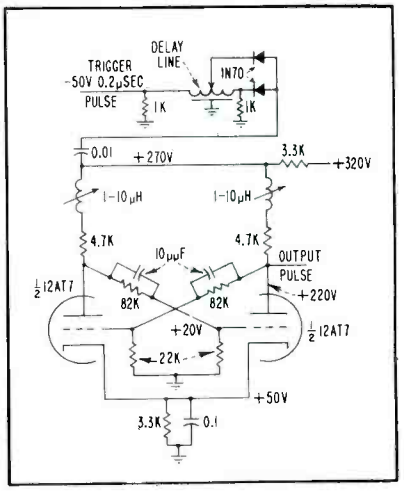
aided by Joseph Bidwell of the General Motors Research Laboratories, where the original surface roughness gage was developed.

Delay-Line Pulse Generator

By IRVING BARDITCH
Baltimore, Md.

A VARIABLE-WIDTH high-precision pulse is simply produced by the circuit shown in the diagram. The width is continually variable, jitter-free and as accurate as the delay-line being used. A trigger pulse is used to initiate one tube of a bistable multivibrator; the same pulse is then passed through a variable delay line and used to initiate the other tube of the multivibrator.

As a consequence, the output pulse is jitter-free, continually variable within the resolution limits of the delay line and independent of any R-C time constant or other source of instability. The rise time and minimum width of the pulse



Simple delay-line circuit can generate pulses of less than 1-μsec duration

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MAGNETICS inc.

DEPT. E-23, BUTLER, PA.

*Manufactured under a license agreement with the Western Electric Co.

are limited only by the capabilities of the tubes. This circuit allows the generation of variable-width pulses below one microsecond, a region in which the cathode-coupled multivibrator will not function.

PERTINENT PATENTS

By NORMAN L. CHALFIN
Hughes Aircraft Co.
Culver City, Calif.

SIGNALING methods and oil prospecting are two diverse but important applications of the electronic technique. Considerable space has been given below to a French invention describing the former, since it appears to have high interest.

Coded Pulse Device

A circuit shown in Fig. 1 defines a "Method and device for decoding groups of coded pulses representing an intelligence wave". This is the invention of A. P. Pages and G. H. L. Dureau of Paris, France. They have assigned their patent No. 2,685,647 to Societé Alsacienne de Constructions Mecaniques of Paris.

This invention, provides a method of translating successive groups of coded recurrent electric pulses of time period T, comprising an integral number n of coded pulses, each of which may be of one or another of two possible signaling conditions, into a variable amplitude intelligence wave. This method comprises the steps of creating, on re-

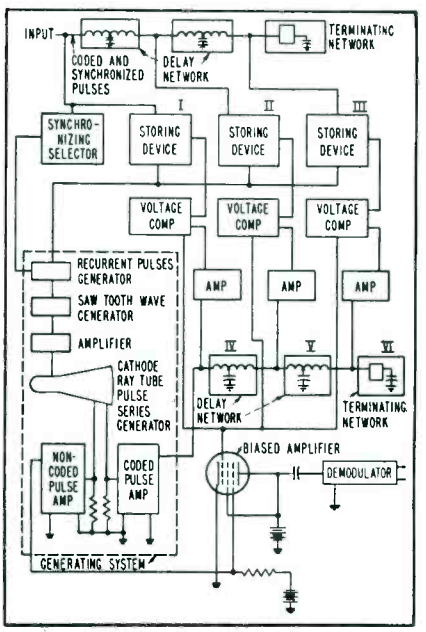
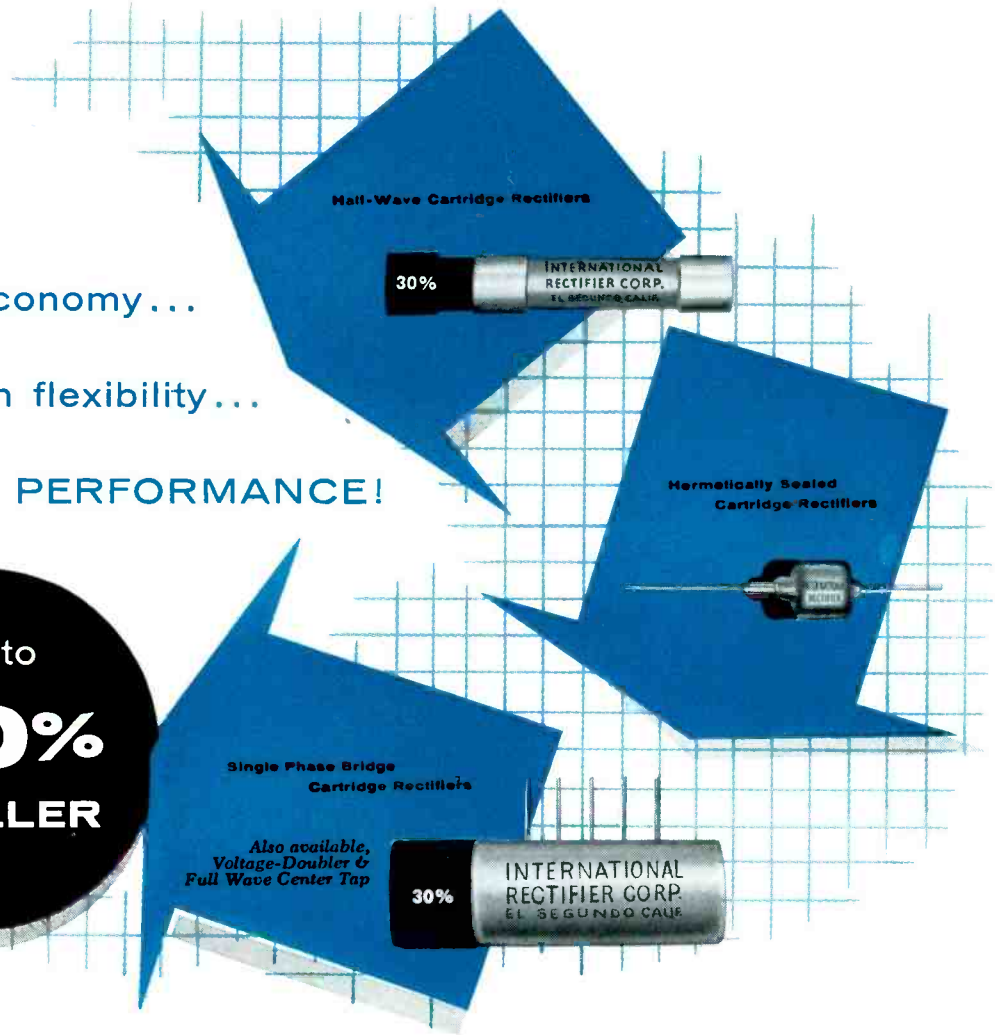


FIG. 1—Successive groups of three coded pulses applied to input



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ceiving each one of the successive groups and storing for a time at most equal to T, a group of n electrical voltages.

Each voltage corresponds to one pulse in one of the groups and has one or another of two predetermined constant values according to the signaling condition of the corresponding pulse, rapidly producing, during a time interval at most equal to T, a sequence of 2^n different permutation groups of n voltage pulses in which each individual pulse has one or another of the two predetermined constant voltages.

All of the permutation groups have the same duration and follow each other at uniform time intervals of duration t. Each of the $(n\text{-}1)$ first pulses in each of the permutation groups is thereby delayed respectively by such an amount that 2^n different groups of n simultaneous pulse voltages successively appear at n terminals at 2^n different instants within the time interval at most equal to T. Each one of the n voltages appearing at said n terminals is then compared with one of the n voltages of the stored-group of n electric voltages.

► **Equal Voltages**—When all compared voltages are equal a derived pulse of short duration is emitted at that instant. The time position of the derived pulse within the time interval at most equal to T thus depends upon the composition of the stored electrical voltage group. Successive derived pulses so obtained from successive groups of coded pulses are demodulated by their time position with respect to fixed reference instants whereby they are transformed into an intelligence wave of variable amplitude.

Another feature of the invention provides a device for translating into a variable amplitude intelligence wave, periodic electric synchronizing signals of period T and recurrent groups of electric coded pulses of recurrence period T including an integral number n of pulses. Each of the integral pulses may be one or another of two possible signaling conditions. The device comprises a generator of periodic voltage pulses of period T, synchronized by the periodic electric synchronizing signals, with

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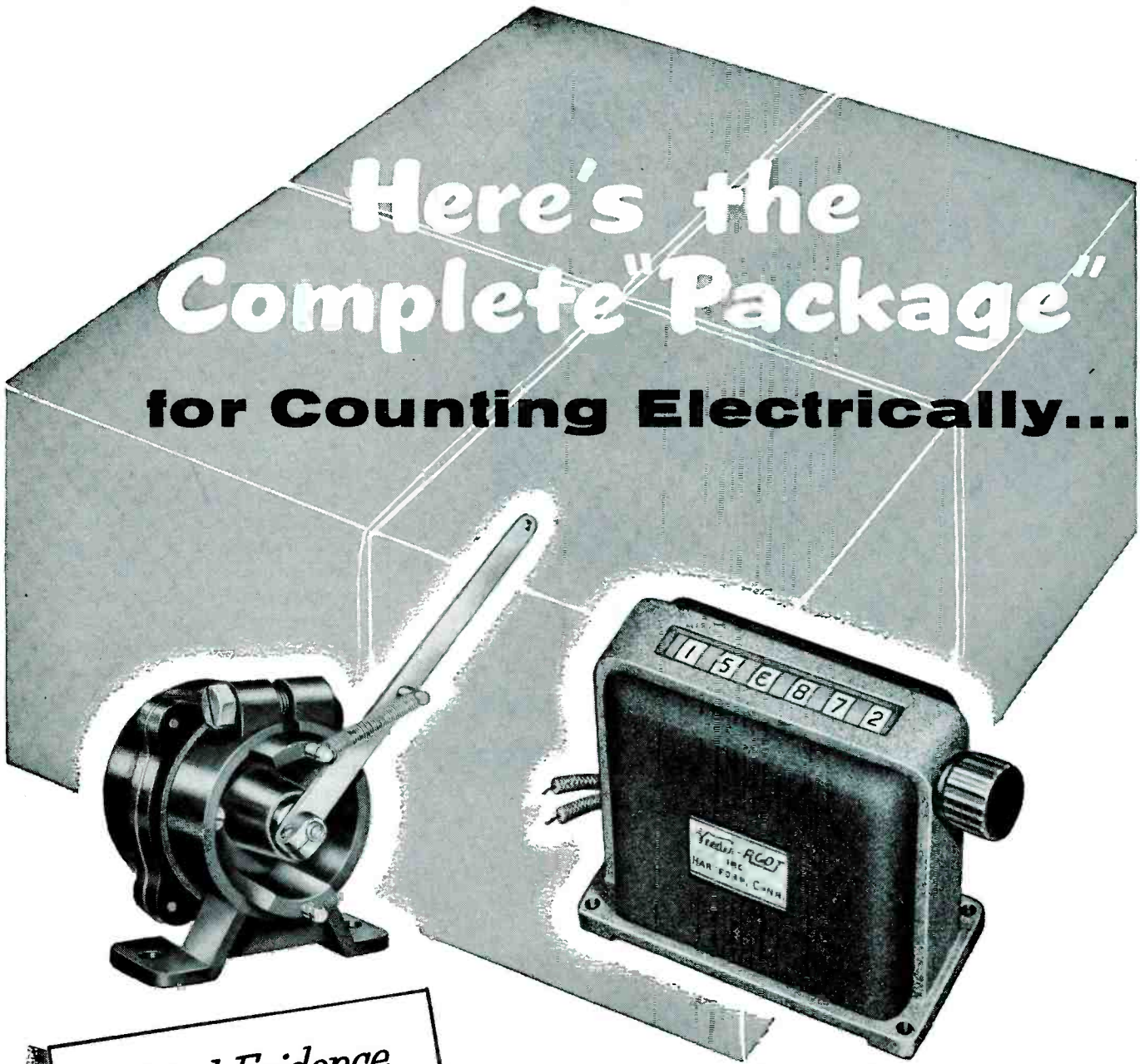

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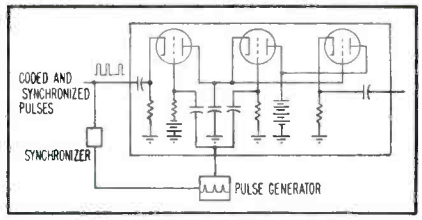


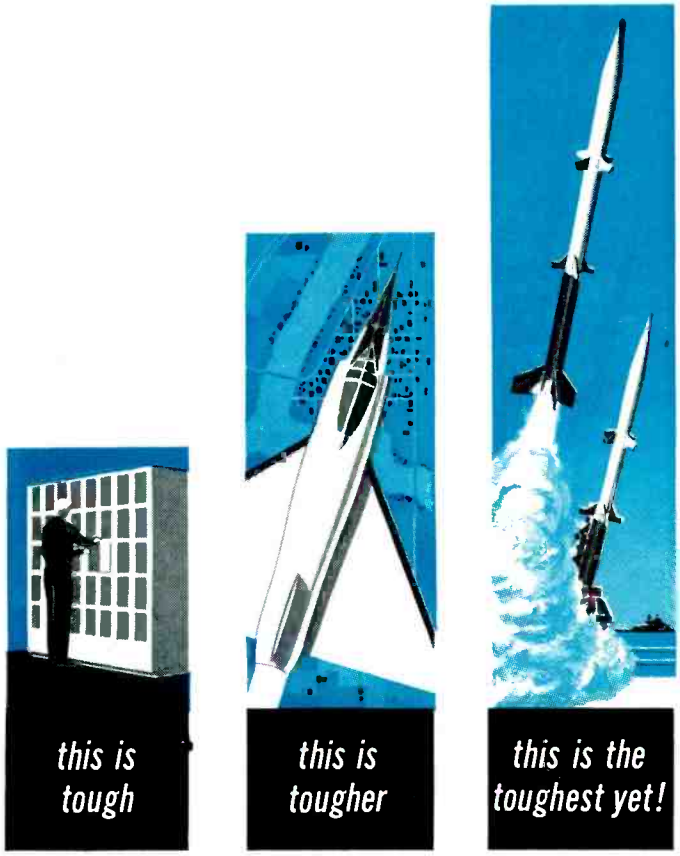
FIG. 2—Voltage storing device is one of three used

provision for creating and storing a group of n electrical voltages on receiving each one of said groups of coded pulses.

Each voltage corresponds to one pulse in one of the groups and has one or another of two predetermined constant values according to the signaling condition of the corresponding pulse. There is also a device controlled by the generator for creating, during a time interval at most equal to T, a series of 2^n electric voltage pulses spaced in time at uniform intervals of duration τ and an arrangement controlled by the generator, which generates at the same time a sequence of coded pulses successively reproducing each one of the 2^n possible permutation groups of n voltages in the form of pulses having one or another of the two predetermined voltage values.

A chain of delay networks in cascade is provided having a total delay time at least equal to $(n\text{-}1)\ \tau$ and with n connection points spaced along the chain in such a manner that the propagation time from one point to the next is equal to said duration τ. There is an arrangement for applying the sequence of coded pulses at one end of the chain and an impedance for terminating the chain at its other end to avoid pulse reflections at that end. A voltage comparator compares each of the n voltages that appear at the n connection points to one voltage of above-mentioned stored voltage group.

The comparator is controlled by pulses from the series of 2^n electric voltage pulses. The comparator controls a generator of a derived pulse when the voltage values in each compared pair are equal. Successive derived pulses are demodulated as derived from successively received coded pulse groups with respect to their time position in relation to fixed reference times established by the generator. Signals received at



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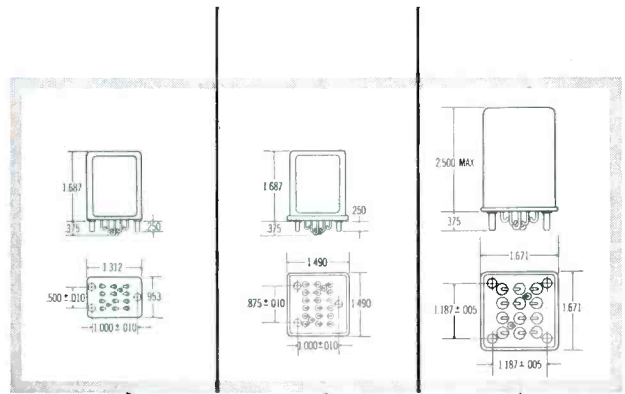

	9220	9226	9230
Contact arrangement	4PDT	6PDT	4PDT
Operating voltage	18-30 VDC	18-30 VDC	18-30 VDC
Contact rating at 28 VDC Resistive Inductive	 5 amp 1.5 amp	 5 amp 1.5 amp	 10 amp 7 amp
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the output of the demodulator are applied to a utilization circuit.

Groups of binary pulses may be arranged in 2^n different ways to represent 2^n different amplitude values. A basic sequence of N bivalent symbols may also be written, provided N be large enough, in such a way that 2^n different groups of n bivalent symbols are successively found at regular intervals in the sequence. A most economical way of doing so is to write $2^n + (n\text{-}1)$ bivalent symbols in such an order that all the 2^n possible permutation combinations are successively found by shifting the rank of the group in the sequence by one unit.

While the application of the principle of the invention is not limited to the use of a basic sequence of the latter type, it will be assumed in the following description that this is the case for greater simplicity and because one of the simplest embodiments of the invention is thus effected.

To simplify the description, there is considered below the particular case when $n = 3$, that is, when the groups of coded pulses each comprise three pulses each capable of assuming two values that will be represented respectively by the figures 0 and 1. It is assumed that one of the values of the pulses is effectively zero—the pulses may each be either absent (value 0) or present (value 1).

Groups of three binary pulses may be arranged in eight different ways and consequently represent eight distinct amplitudes. For instance, to represent eight distinct amplitudes of an intelligence wave, corresponding to the integral numbers from 1 to 8, the eight groups may be 000, 001, 011, 111, 110, 101,

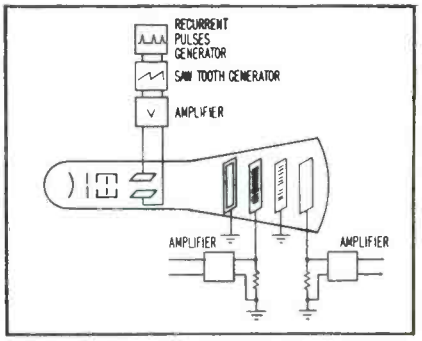
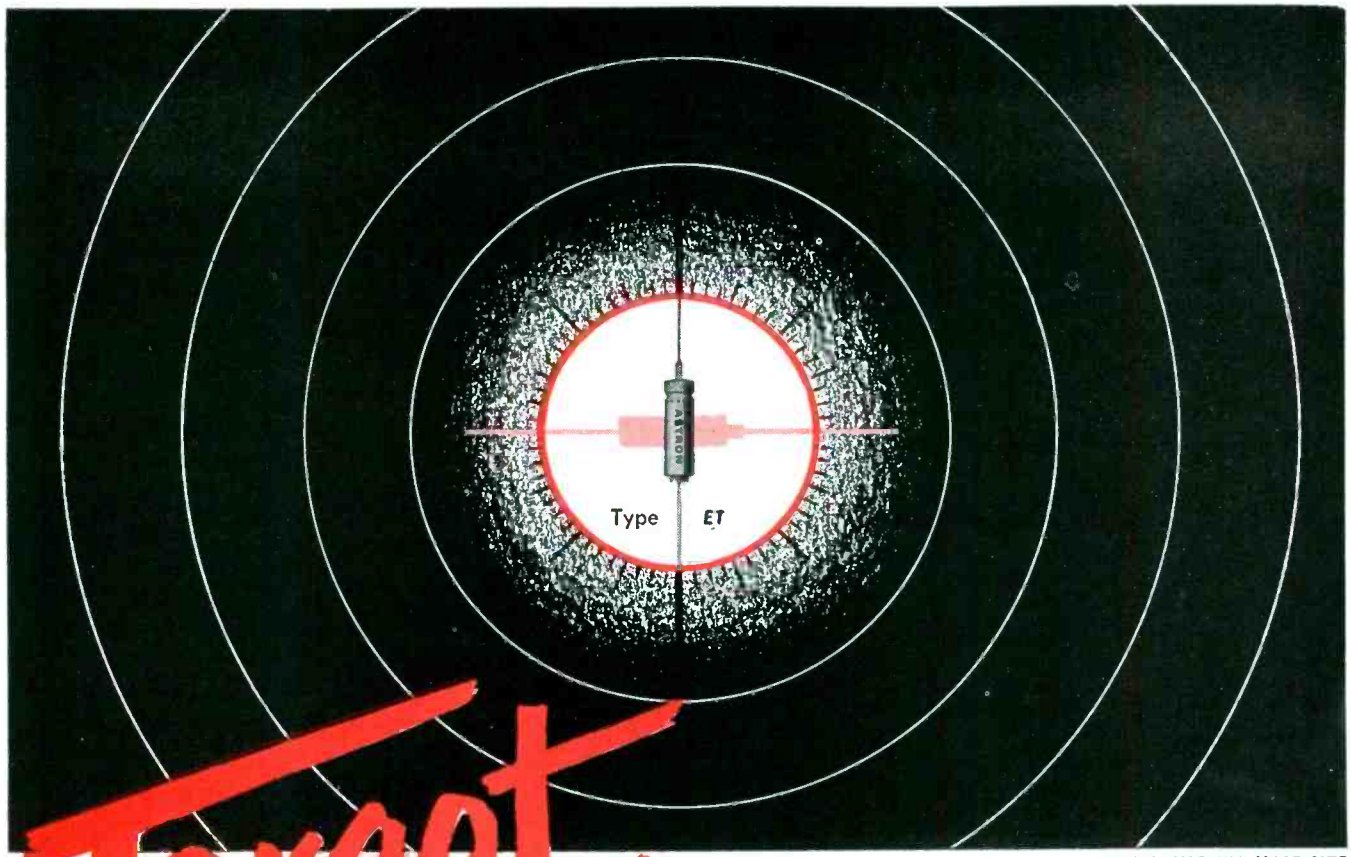


FIG. 3—Pulse generating system produces coded and noncoded signals



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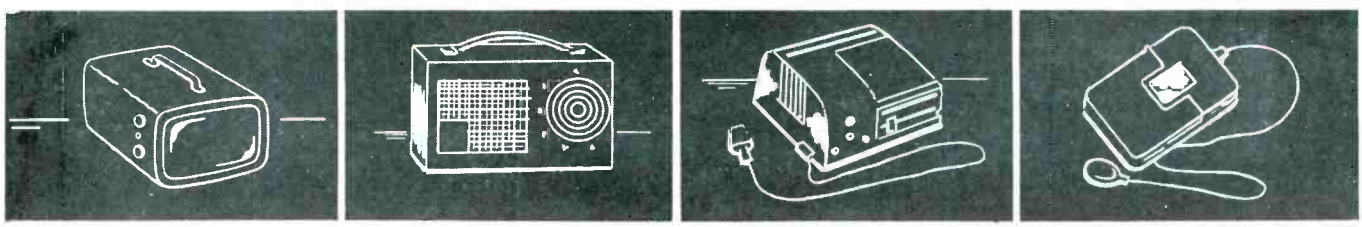

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010, 100. These groups may be formed by extraction, from the sequence 0001110100111 . . . successive three-figure groups obtained by shifting one figure from one group to the next one.

If there is produced, by any means, a series of ten two-valued pulses, the composition of which is represented by the basic sequence, all possible permutation groups will be successively found in each permutation group appearing once. This occurs if it is assumed the production of the sequence begins at a time that varies according to the particular composition of the considered group.

► **Sequence**—In the practice of the invention, the above-mentioned series of at least 2^n pulses and the whole sequence of N coded pulses will be produced during a time interval at most equal to and preferably slightly less than T. Designating the repetition period of the pulses in the series by τ, such arrangements will be taken that the product $2^n\tau$ be less than T and that changing from one coded pulse group (permutation combination) to the next different group will be effected in a sequence at regular time intervals also equal to τ.

Circuits can be arranged such that, at 2^n recurrent instants separated by time intervals equal to τ and defined by the pulses of the abovementioned series, a received coded pulse group may be compared with every possible group present in the sequence, any one of the comparisons will show identity. The received group is thus identified by the rank of the identical group of the sequence; 2^n comparisons will thus be made during each time interval T, at 2^n instants corresponding to 2^n pulses of the series. Some of the pulses may possibly be unused if, as in certain embodiments of the invention, the series includes more than 2^n pulses.

As already mentioned, it is possible to build a sequence of coded pulses fulfilling the required conditions by taking N equal to $2^n + (n-1)$.

Figure 1 illustrates an arrangement wherein successive groups of three coded pulses are applied to

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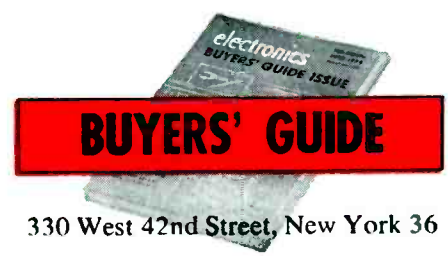

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the input from an external source. This may be a card or other system. They follow through a chain of delay networks with time delays equal to that occupied by a complete group of coded pulses divided by a number n of pulses that are received by and fully dissipated in a terminating network.

Three voltage-storing devices such as shown in Fig. 2 are timed at a recurrent rate T by appropriate

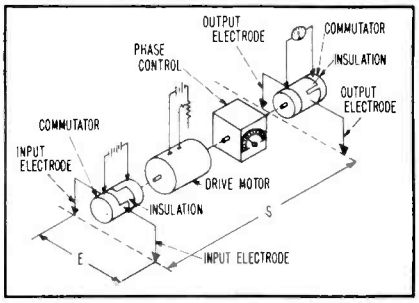

FIG. 4—Output and input devices are connected through phase control

control pulses and separated from the coded groups by a synchronizing selector.

A generating system shown in Fig. 3 produces the series of $2^n + (n\text{-}1)$ noncoded and two sequences of $2^n + (n\text{-}1)$ coded pulses, using the same recurrent pulse generator as supplies control pulses T, which are used as directing pulses for the system. The noncoded pulses are applied to a second system of delay networks as described above having delay times such that they are totally dissipated in the termination device.

It will be assumed that pulses representing the combination 101 are received at the input of Fig. 1.

These three pulses are propagated in the first delay networks and are positioned in the storage devices according to the delays at the same instant when the recurrent pulse generator puts out a pulse. This pulse is under the control of the synchronizing selector to allow only the synchronizing pulses through. The synchronizing pulse turns on the storage devices to receive a present pulse and an absent or no pulse. The present pulses are in devices I and III while the absent pulse is in device II. They thus store the 101 input.

During the next phase of the operation the generating system supplies a sequence of 10 coded

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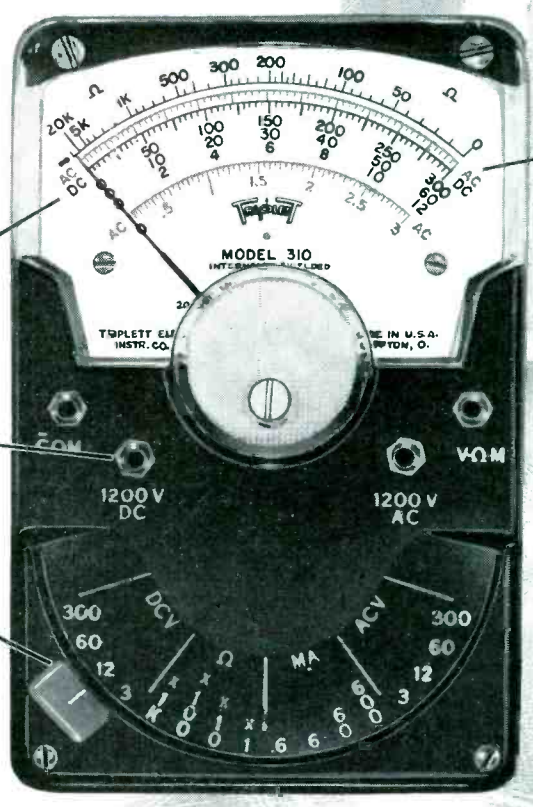

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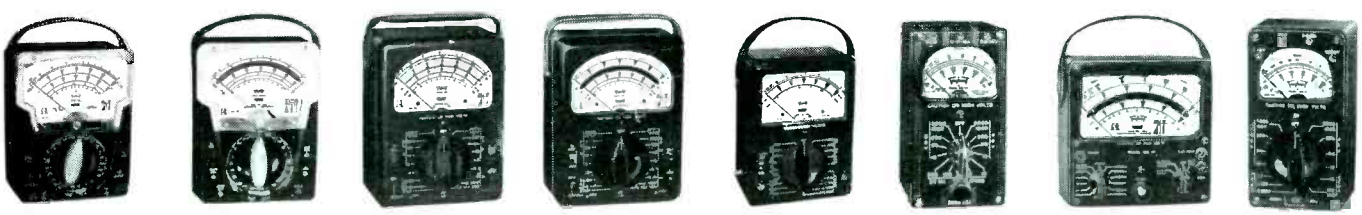

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pulses, 000, 111, 01, 00, which are applied to a chain of delay networks IV, V and VI. At the appropriate times these pulses are applied to the three amplifiers and to the voltage comparators.

The amplifier supply to the comparators a present or absent pulse in accordance with the code. Only one of the eight possible groups will coincide with the stored information in storage units I, II and III or 101. When this group passes, the voltage comparators are balanced and no output appears at the grid of the nonconducting biased amplifier tube.

While the coded sequence is being applied from coded pulse amplifier to delay networks IV, V, VI noncoded pulses are being applied to another grid of the biased amplifier tube and tend to make it conducting except that when noncoincident pulses from the comparator devices are applied this conductive condition is inhibited.

Thus when the coincidence of the 101 of the coded sequence occurs and no signal appears at the grid of the biased amplifier, a pulse appears at the anode, is detected and may be used to control other circuits. A similar condition would occur for any other coincidence.

Pulse Prospecting

A technique for "Geophysical Exploration by Electric Pulses" has resulted in the grant of patent 2,685,058 to W. J. Yost of Dallas, Texas. The patent is assigned to Socony-Vacuum Oil Company, of New York.

According to Yost's patent as illustrated in Fig. 4, when a commutated d-c potential e of alternate polarity is applied through input electrodes to a particular ground area, at a distance s a particular signal will be picked up that it has been found varies in phase and amplitude in accordance with the geophysical conditions of the ground. The electric field picked up at the output electrodes depends upon the resistivity of the earth.

The field decreases with increasing values of distance s as the cube of s. In practice, s is a great distance and so this factor is ignored since there will be only the minutest field owing to direct flow between

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input electrodes and output electrodes. If the earth is considered homogeneous the signal at the detecting electrodes may be only boundary wave energy traveling at speeds approaching the speed of light.

Where the earth is not homogeneous, detecting electrodes will

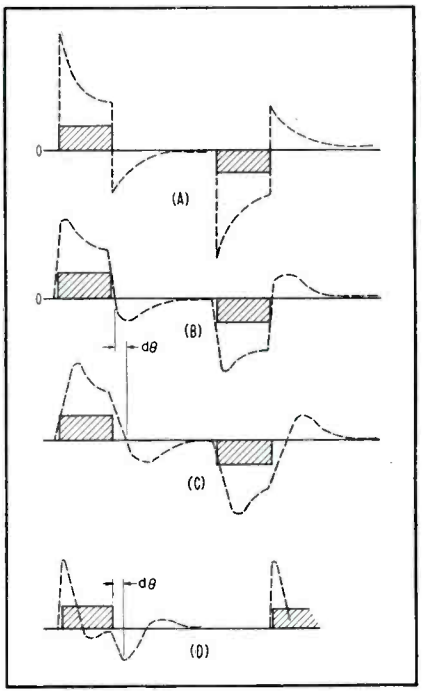


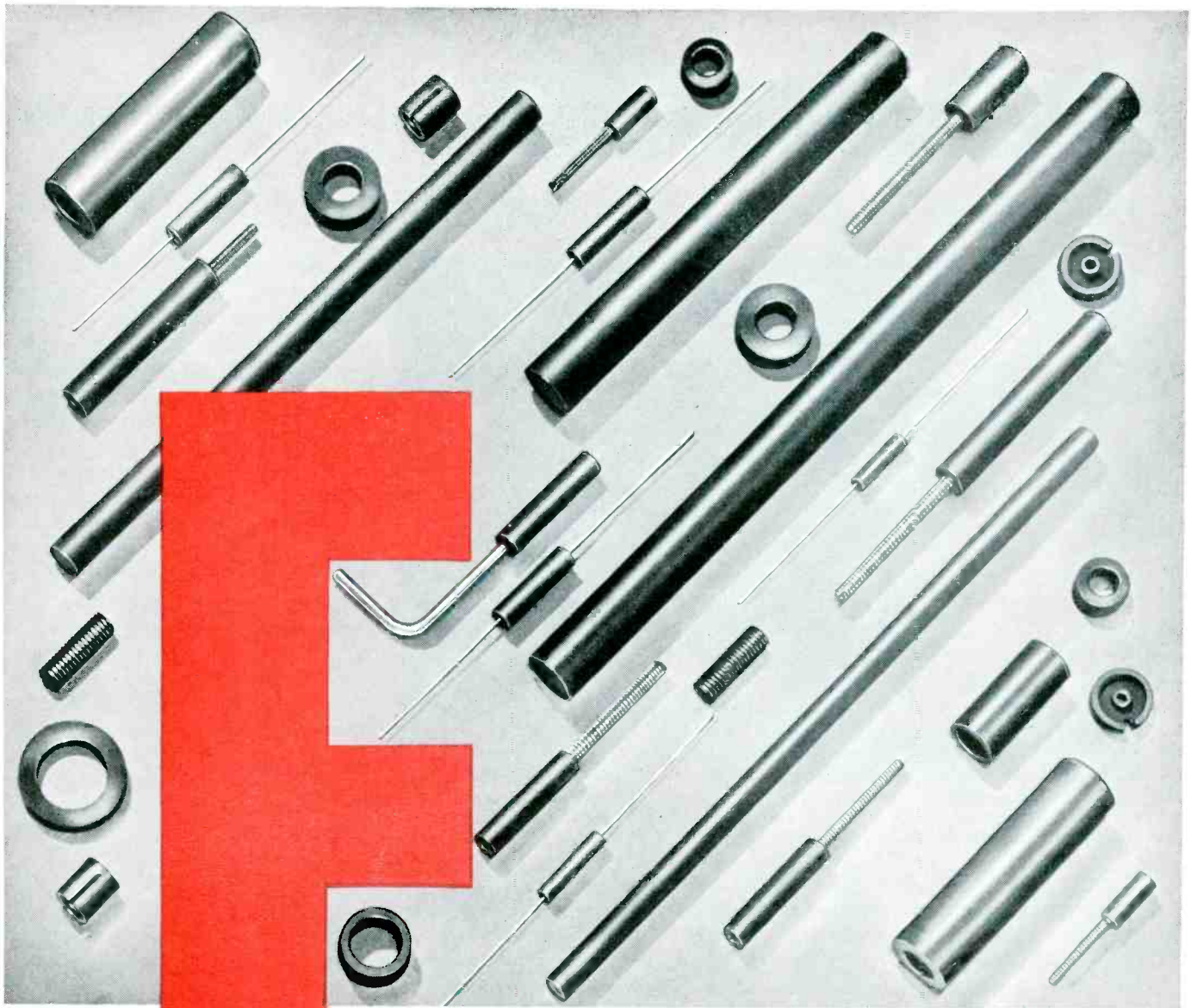
FIG. 5—Typical signals resulting from geophysical soundings

pick up a combination of the signal of the air-earth boundary wave and subsurface reflections from discontinuities and resistive interfaces. At the detector a commutator similar to that at the transmitter is employed. In the presence of discontinuities an original signal as shown at (A) in Fig. 5 is received as at (B) or in the presence of severe discontinuity as at (C).

Considerable subsurface structure results in a received pattern such as shown at (D).

A phase shift of 40 deg in a tangential received wave is reported from certain subsurface interfaces compared to others. These measurements may be made by the technique shown to depths greater than 1,000 feet.

By standards developed from measurements made in areas well-known as to the subsurface geophysical structures, the invention has provided means for prospecting as yet untapped areas.



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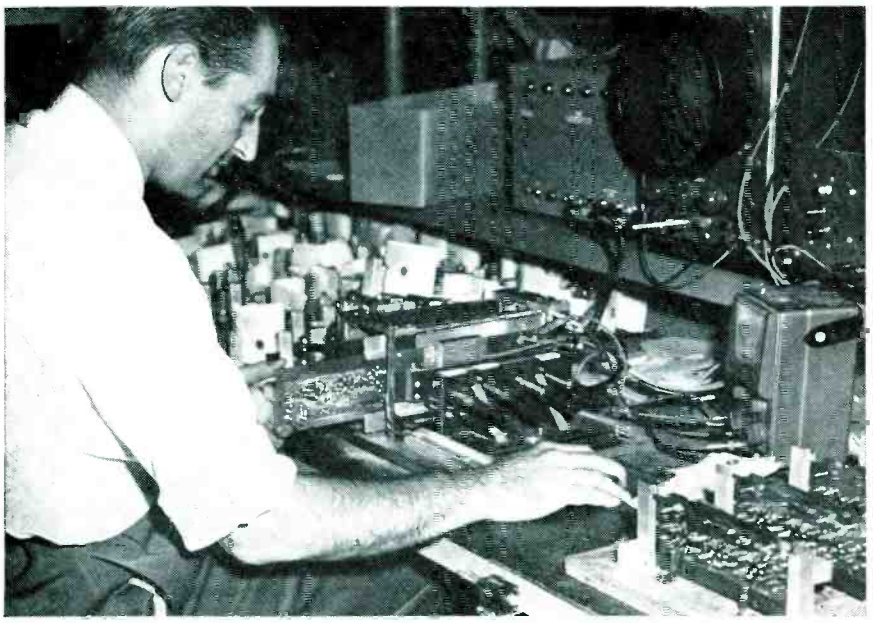


Method of sliding finished board into alignment fixture. Right hand of operator is on lever attached to cam that moves contacts up to board, making test connections for energizing all circuits on board automatically

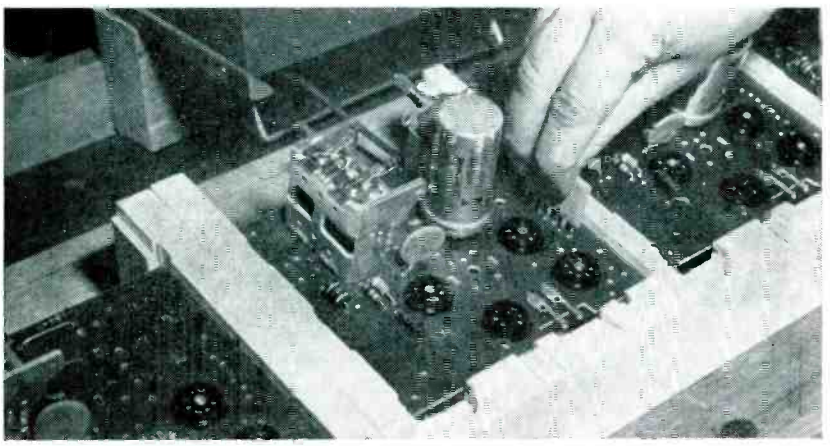
ETCHED wiring boards serving as video i-f amplifiers in Westinghouse television receivers are accurately aligned with the aid of a bench fixture that automatically makes all necessary connections and provides the required aligning tools. The operator merely slides a board vertically into the fixture, up against a stop, then pulls a lever to press spring-loaded contacts against the required terminals on the dip-soldered wiring pattern.

Using both hands, the operator then adjusts captive screwdrivers for each of the four transformers in turn, while watching indications on the scope over the bench. The screwdrivers are spring-loaded so that they move back out of the way automatically when released. A pushbutton under the left wrist of the operator is pressed between transformer adjustments, to actuate a five-position attenuator controlled by a stepping switch. After the fourth and last transformer on a board is aligned, the next push on the button brings the attenuator back to its original setting in readiness for the start of the next board.

Boards awaiting alignment are placed in a rack at the right of the operator for preheating tube filaments, so that no time is lost in waiting for them to warm up in the alignment fixture. After a board is taken from the preheating rack and transferred to the alignment fixture, the operator places a cold board in the empty position. The time for this operation is sufficient for the tubes to recover the heat lost during transfer.

FOR most work with etched wiring boards in Convair's Pomona, Calif. missiles plant, three sizes of holes have proved adequate for leads of components, namely 0.053, 0.063 and 0.094 inch. Clinching of leads against the etched wiring permits considerable clearance of leads in these holes, simplifying assembly operations.

Wood Pallet Aids Insertion of Parts in Wiring Boards



Inserting seven-terminal Couplate in etched wiring board for radio. Tuning capacitor and volume control have special terminals that permit manual insertion in much the same manner, for automatic anchoring and connecting by dip soldering

MANUAL insertion of components in four-tube radio etched-wiring boards is accomplished efficiently on moving conveyor lines in the Metuchen, N. J. plant of Westinghouse Electric Corp. with the aid of simple wood pallets, each holding three wiring boards. The three-up arrangement of pallets gives sufficient weight and bulk so that the relatively light boards do not move around on the belt during assembly work.

Pallets are loaded simply by dropping the boards into position on sawed-out shelves. Each operator on the line inserts her assigned

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quota of parts. Punched holes are almost double the lead diameter in most cases, making manual insertion easy. Leads are not clinched. When all parts have been inserted, the board is carefully lifted out without tipping and transferred to a metal pallet for dip soldering.

Cutouts along the front edge of the wood pallet enable the operator to grip the front of the board readily when lifting it out of the pallet.

Machines Speed Cutting of Resistor Leads for Etched Wiring

ALTHOUGH intended for handling individual components, the motor-driven lead cutter developed in Emerson's Jersey City plant (ELECTRONICS, page 258, May 1952) has been found suitable for cutting two or three ½-watt resistor leads at a time. Because of their small body diameter, these resistors can be readily loaded into the slots of the projecting sprockets on the endless chain. The chopping blades can cut two or three leads just as readily as one while moving up and down under cam action.

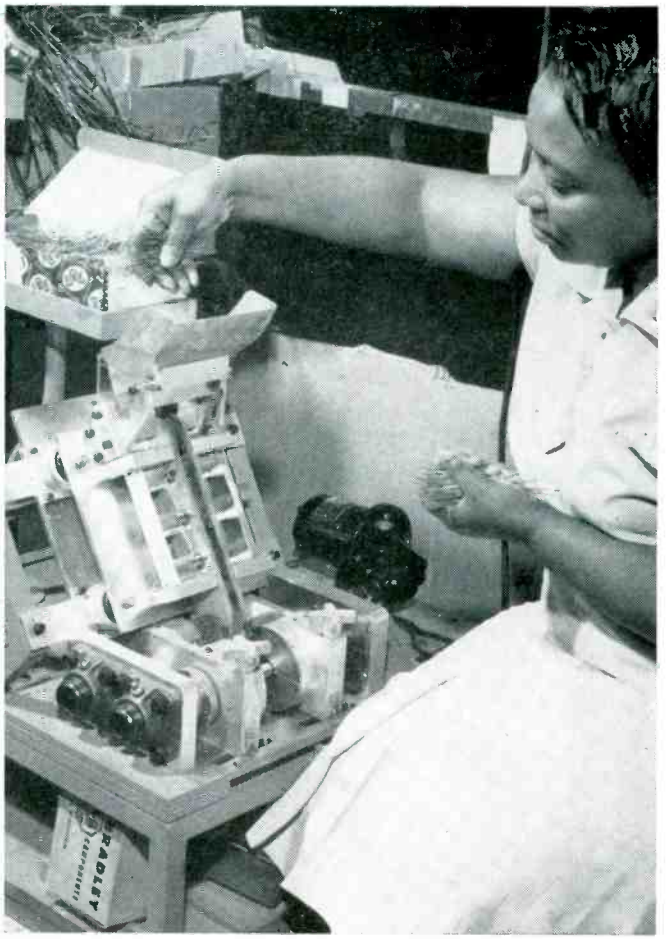
This type of machine has stood up well in actual use now for over 3 years. Its settings can be changed to provide different equal or unequal lead lengths simply by loosening two captive Allen wrenches at the rear. The only drawback is the necessity for hand loading, though this is at the same time an advantage because a human operator can load bent leads just as easily as straight leads.

The loading problem is partially solved by the IRC automatic lead cutter, an early version of which has been under test in the Emerson plant for a number of months. This does not have the latest automatic feed and hence the resistors must be dribbled down into the hopper a handful at a time by the operator. Though giving many times the cutting speed of an individual-resistor-loading setup, this machine does not begin to approach the ultimate cutting capacity of 60,000 resistors per hour that can be achieved with fully automatic feed of the hopper.

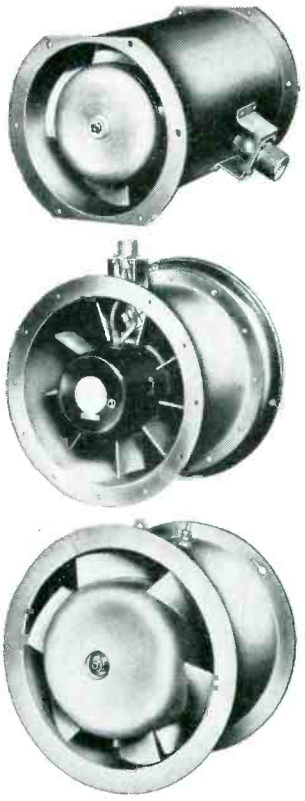
From the hopper, the resistors drop down a zig-zag path, achieved by having zig-zag slots for the leads in the two vertical side-plates between which the bodies of the resistors pass. This prevents the resistors from cocking at too great an angle and jamming as they go down. A Syntron electric vibrator bolted to the back of this slide-down plate helps to keep resistors moving without jamming.

At the bottom, the resistor leads pass between two pairs of rotating cutters, each pair individually adjustable as to position, to give any desired equal or unequal lead lengths. The cutters are geared together and driven by an electric motor through a reduction gear ar-

Loading resistors manually two at a time on motor-driven cutter



Loading resistors a handful at a time into IRC lead cutter



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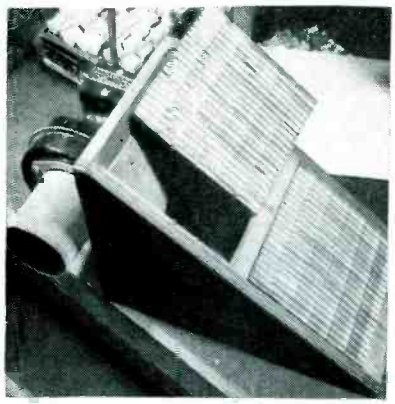
rangement. The rear cutter of each pair has small gear teeth so as to grip resistor leads, while at the same time serving as a shearing anvil against which the sharply beveled front cutter can work to give a shearing cut.

In the fully automatic version of the machine, the box of resistors is unloaded automatically under photoelectric feed control, so that the operator needs only to remove empty boxes and put in full boxes from time to time.

Blower-Cleaned Tote Trays for Tube Grids



Construction of dust-repelling trays for small and critical grids used in miniature tubes

SPECIAL perforated metal trays are used for tube grids in the Bloomfield, N. J. tube plant of Tung-Sol Electric Inc. to insure cleanliness during assembly. Loaded trays are placed in recesses in a slanting box, at the rear of which is mounted a small centrifugal blower. The blower keeps a steady stream of air coming up through the trays past the grids to keep dust from settling on them.

The nickel-plated trays are designed to be self stacking. The slots also permit quick drainage of degreasing solution when entire trays of grids are immersed for cleaning.

Fluorescent Lamps Aid Inspection of Wiring

SHIELDED fluorescent lamps mounted directly on the rails of a pass-along assembly line provide glareless low-angle lighting that aids inspectors in detecting and repairing defects in dip-soldered wiring for a large etched-wiring board used in Westinghouse tv sets. Bad joints and shorts between wiring lines are easily detected. Shorts are cleared immediately with the tool used for probing joints. Locations requiring hand soldering are marked for later correction by putting on a small

Clearing short between leads with probe tool at inspection position illuminated by fluorescent lamps above and below wiring board. Operator's right hand rests on shield of lower lamp while holding etched wiring board in pass-along line

alligator clip to serve as indicator.

The 18-inch fluorescent lamps are mounted in plain white fixtures of the type having an adjustable metal shade. This shade is covered with black tape to eliminate reflections from overhead lighting. The inspector adjusts each shade so looking directly at the lamps will be avoided.

To prevent warping of such a large wiring board during dip soldering, a heavy punched metal stiffening strip is plugged into the center holes of the six-in-line tube sockets running across the center of the board. Three of the punched pegs on the strip, one at each end and one at the middle, are undercut. The operator crimps the socket tubulations over these to give the mechanical holding required to prevent the board from curling when immersed in the molten solder. The solder itself provides increased holding ability afterward, so there is no give when tubes are plugged in or removed.

Conveyorized Oven Bakes Resist on Boards

Silk-screen printing setup for etched wiring boards, with inspection position at right

SILK-SCREEN stenciling positions are located on both sides of a moving-belt conveyor running through a baking oven in RCA's Indianapolis plant. After placing a sheet of XXXP copper-clad phenolic in position on the worktable, the operator brings down the hinged silk-screen holder and forces the etching resist through the screen with one slow movement of a wide rubber squeegee. This applies the resist to protect the copper in regions where a wiring pattern is desired. The operator then transfers the board carefully to the conveyor, for transport through the oven to bake the resist.

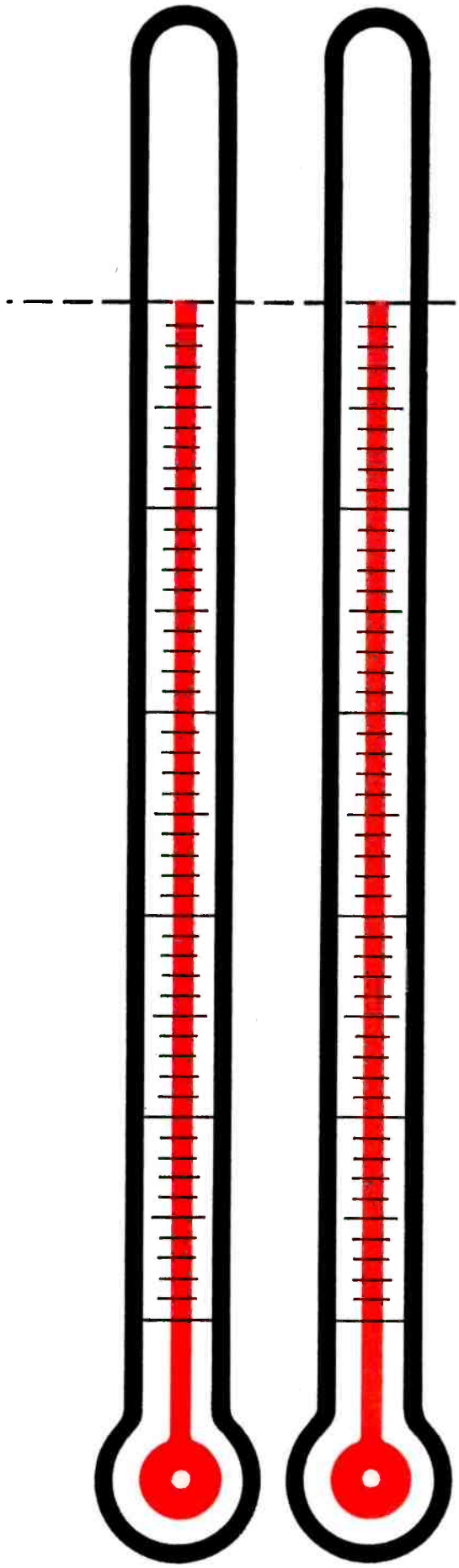
Fiber Tote Tray Is Experimental Chassis

By GEORGE H. AMBER

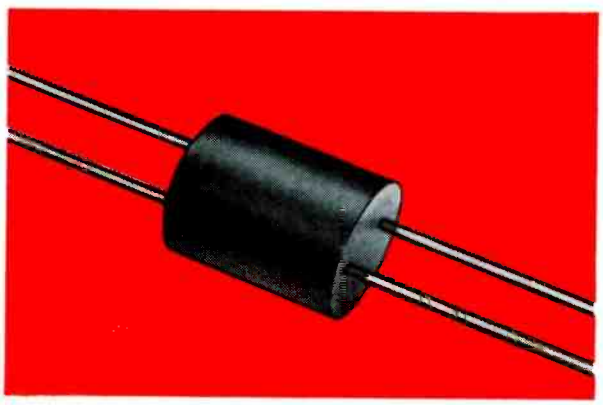
Professional Engineer
Jam Handy Organization, Inc.
Detroit, Mich.

SMALL fiber tote trays reinforced with metal-edge corners have proved ideal as bases for day-to-day breadboard setups and for experimental lab checkouts of analytical designs. The inexpensive and expendable trays serve the same function as a metal chassis but are much easier to prepare.

Conventional metal-working techniques were applied to the fiber box at first, these being drills, a socket punch and a key-hole hacksaw for large rectangular holes. However, it was soon found that drills were not needed, for screw and wire holes could be readily pierced through the fiber with a scriber or awl. For potentiometer shafts and switch barrels, a small hole could be worked up in size with a center punch or screwdriver. Also, aviation-type



Thermally Similar



RESISTOR ASSEMBLIES BY CLAROSTAT

Another example of *imagineering* at Clarostat – Two or more deposited carbon resistors encapsulated in a common potting compound to provide highly similar thermal conditions.

Designed to fill the needs of critical circuitry, the Clarostat thermally similar resistor assemblies are made up of deposited carbon resistors approved under MIL-R-10509A specifications. Resistance, or voltage ratio change from that of room temperature is less than 0.1% throughout the range of −55° C to +85° C.

Write for complete technical information on this latest product of the House of Resistors.

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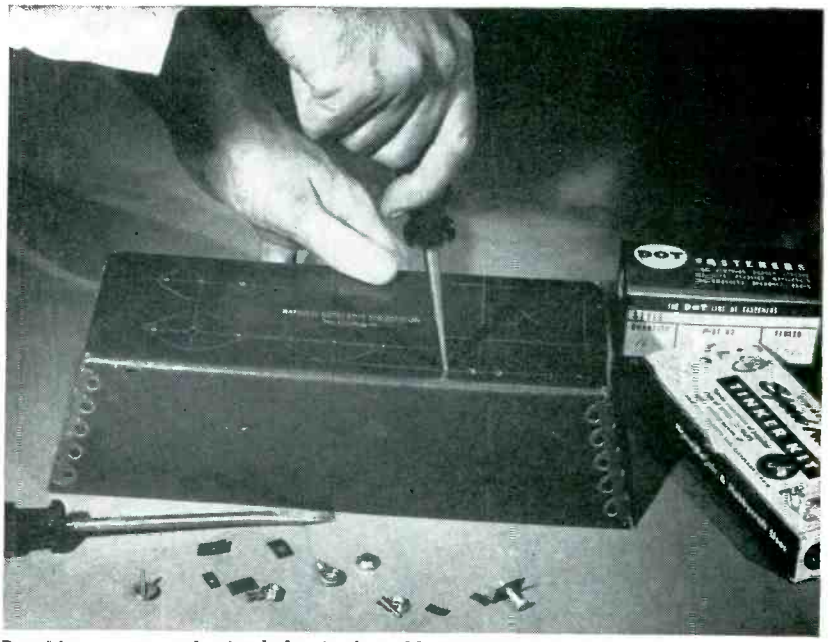


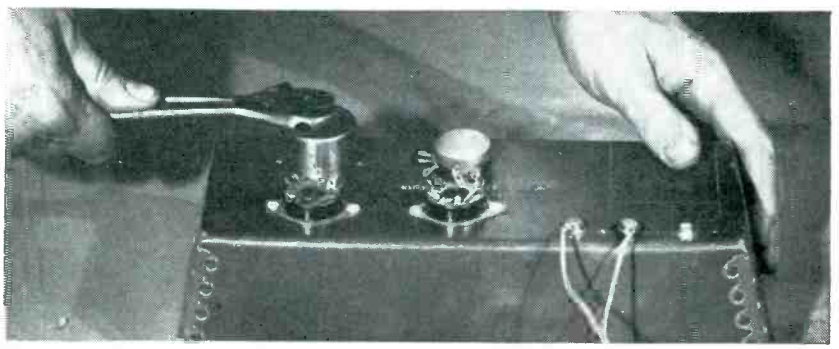
Punching screw and wire holes in 4 × 10 inch tote tray with ordinary awl

sheet metal snips replaced the hacksaw for rectangular holes.

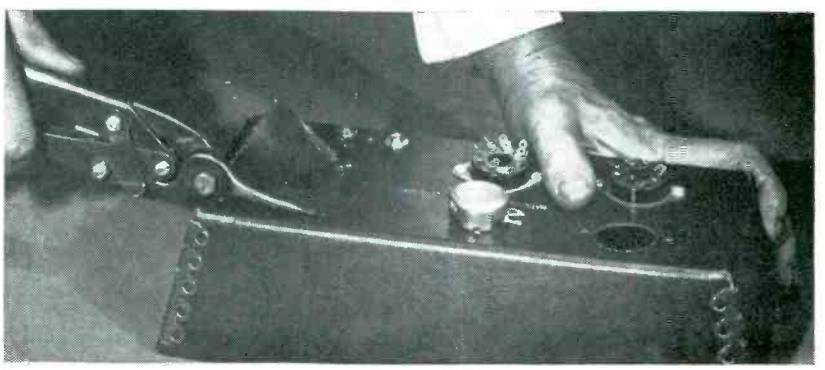
The fiber tote trays are manufactured by National Metal Edge Box Co., Philadelphia, Pa. The two smallest sizes of trays (5.5 × 5 × 2.75 inches deep and 11.25 × 5 × 2.75 inches deep) are most frequently used as a chassis. Cost in quantities of twenty-five or more is under 20¢ each.

In working on the fiber chassis, a yellow china marking pencil makes a contrasting layout on the blue surface. Binder-head sheet metal screws and flat speed nuts are used instead of machine screws when mounting components, brackets, sockets or clamps. The pointed screw is compatible with a pierced hole, and the broad speed-nut offers ample backing to resist pull.

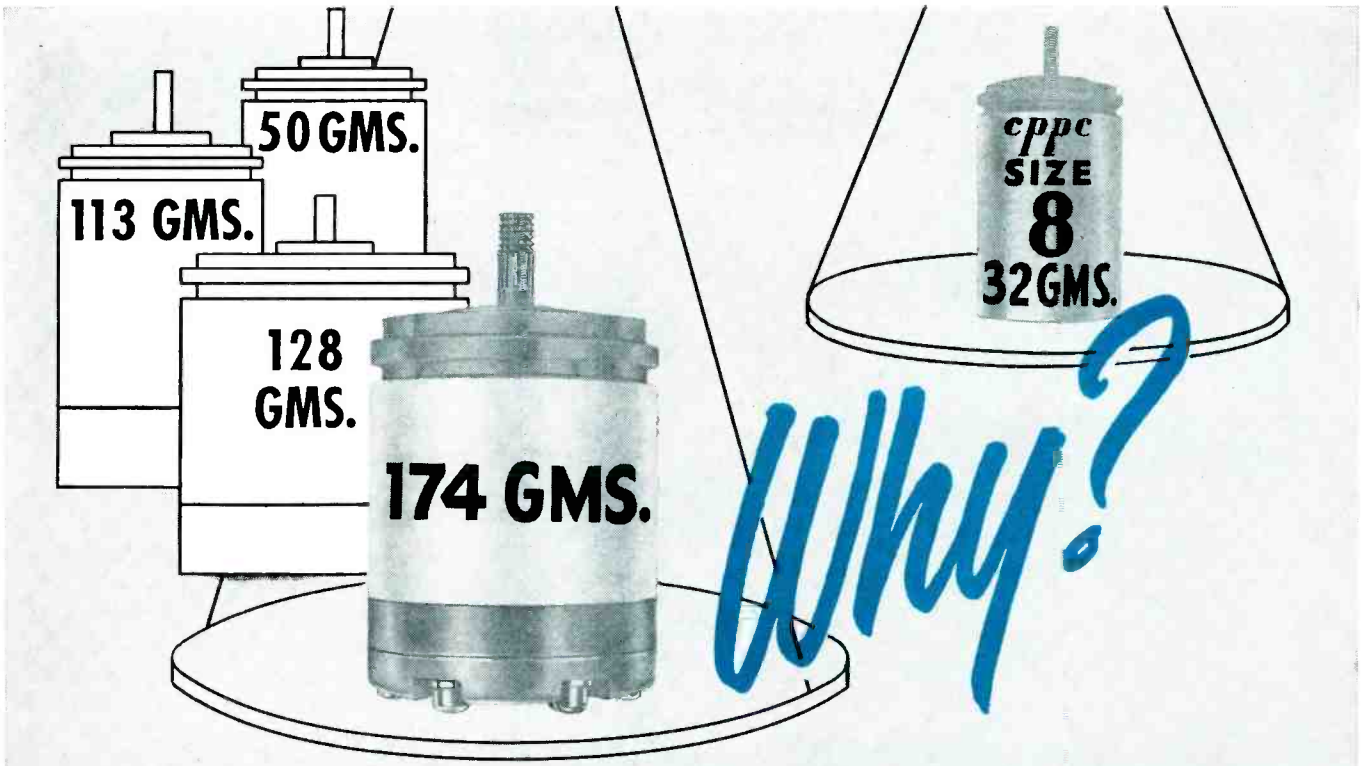
United-Carr snap fasteners are used as electrical lead connectors



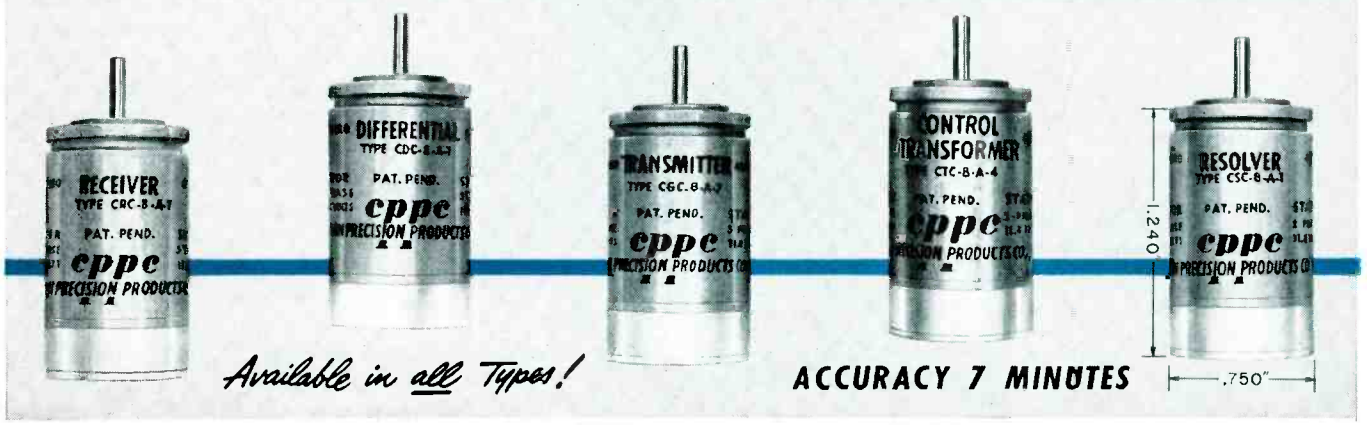
Making socket hole with Greenlee punch after making pilot hole with awl and enlarging with center punch



Cutting transformer hole with aviation-type metal snips



WHY USE 1945 SYNCHROS IN 1956 DESIGNS?



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Transmitter	CGC-8-A-7	Rotor 1 Phase	26.0	100	.50	54+ j260	37.0	Stator 3 Phase	11.8	12+ j45	15+ j3.5	11.8	8.0	200	7
Control Transformer	CTC-8-A-1	Stator 3 Phase	11.8	90	.23	28+ j110	24.7	Rotor 1 Phase	23.6	220+ j740	246+ j60	143	8.5	400	7
Control Transformer	CTC-8-A-4	Stator 3 Phase	11.8	37	.09	67+ j270	59.5	Rotor 1 Phase	24.0	508+ j1680	640+ j190	381	9.2	400	7
Resolver	CSC-8-A-1	Stator 2 Phase	11.8	84	.27	38+ j136	27.0	Rotor 2 Phase	23.2	280+ j600	344+ j75	230	11	400	7
		Rotor 2 Phase	26.0	39	.43	280+ j600	230	Stator 2 Phase	10.6	38+ j136	70+ j29	27.0	20	180	7
Repeater	CRC-8-A-1	Rotor 1 Phase	26.0	100	.50	54+ j260	37.0	Stator 3 Phase	11.8	12+ j45	15+ j3.5	11.8	8.0	200	30*
Differential	CDC-8-A-1	Stator 3 Phase	11.8	85	.21	27+ j120	25.0	Rotor 3 Phase	11.8	38+ j122	47+ j14	36.0	9.0	200	7 Rotor 7 Stator

Total Null max. 30mv for each unit

*Torque 2500 mg.-mm./degree from CGC-8-A-7

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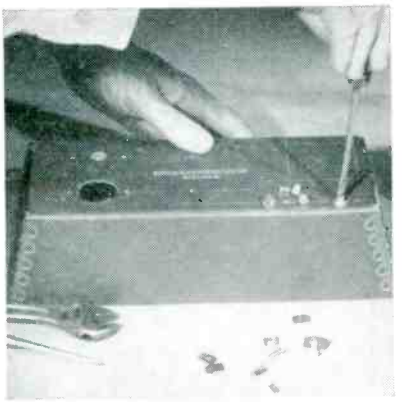


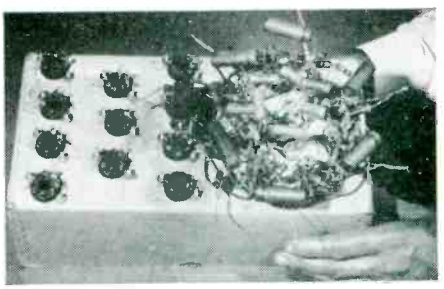
Mounting United-Carr snap fastener on top of fiber chassis for use as battery connection

and to connect separate units together. For example, a power supply is snapped onto one side of a summing amplifier chassis and a 6.3-v filament transformer is snapped onto the opposite side of the summing amplifier. Some B batteries, such as the 67½-v size, come with snap terminals so they can be snapped directly to a fiber chassis.

The fiber chassis is tough and strong, so that it springs back from a severe stress rather than becoming permanently deformed. Heavy components, such as magnetic amplifiers and transformers, are best mounted at a corner for stiffness.

While tubes can be mounted upright in a conventional manner, the trend in the test laboratory is to mount the tubes upside down. This permits components to be readily changed, and makes readily available all tube socket pins for point-to-point measurements and waveform checks. Most GT series tubes, such as the 6SN7 type, and all miniatures can be mounted upside down in any of the trays. Hot tubes, such as rectifiers and power pentodes, belong on top.

In addition to the tangible advantages of reduced shop time and



Appearance of ring oscillator as wired on fiber chassis for experimental work

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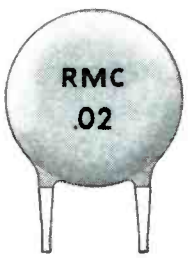
RMC Type B "Heavy-Duty" DISCAPS are designed for all by-pass or filtering applications and meet or exceed the RTMA REC-107-A specifications for type Z5Z ceramic capacitors. Rated at 1000 V.D.C.W., Type B DISCAPS cost no more than lighter constructed units. Available in standard capacities between 470 MMF and 40,000 MMF.

Type JL

Type JL DISCAPS afford exceptional stability over an extended temperature range. They are especially engineered for applications requiring a minimum capacity change as temperature varies between −60°C and +110°C. The maximum capacity change between these extremes is only ±7.5% of capacity at 25°C.

Wedg-loc



The exclusive wedge design of the leads on these DISCAPS lock them in place on printed circuit assemblies prior to the soldering operation. "Wedg-Loc" DISCAPS are available in capacities between 2 MMF and 20,000 MMF in TC, by-pass and stable capacity types. Suggested hole size is an .062 square.

High Voltage

Special high voltage DISCAPS are available in a wide range of capacities for color television and other electronic applications. RMC DISCAPS for deflection yokes insure the voltage safety factor required in this application. They are available in all capacities between 5 MMF and 330 MMF.

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RMC Plug-in DISCAPS will speed up production time in printed circuit operations. Leads are constructed of No. 20 tinned copper (.032 diameter) and are available up to 1½" in length. Manufactured in TC, by-pass and stable capacity types, Plug-in DISCAPS have all the electrical and mechanical features of standard DISCAPS.

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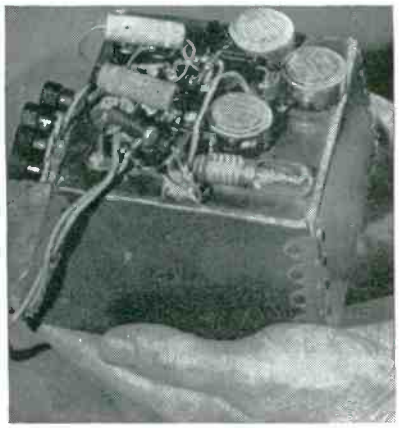
reduced chassis cost, these simplified fiber-chassis experimental techniques brought about unexpected intangible advantages at the Jam Handy Organization. Most electronic engineers are eager to prove out their paper designs, but are intimidated at times by the prospect of the time and metal work involved



Wien-bridge oscillator mounted on bottom of small fiber tote tray

Underside of Wien-bridge oscillator, showing potentiometers and tube

in working up a conventional chassis. Many a good idea thus cools off and many a poor one is carried into the prototype and pilot model, because it was never adequately breadboarded.

Designers are less reluctant to try out a circuit idea when it is easy to whip together functional hardware. Checking out each design change saves engineering time and reduces the need for last-minute re-designs and field modifications.

A shielded chassis is often desirable for high-frequency applications. It is planned to try out a copper-laminated fiber chassis that would permit point soldering of brackets and ground return leads.

A further experiment would in-

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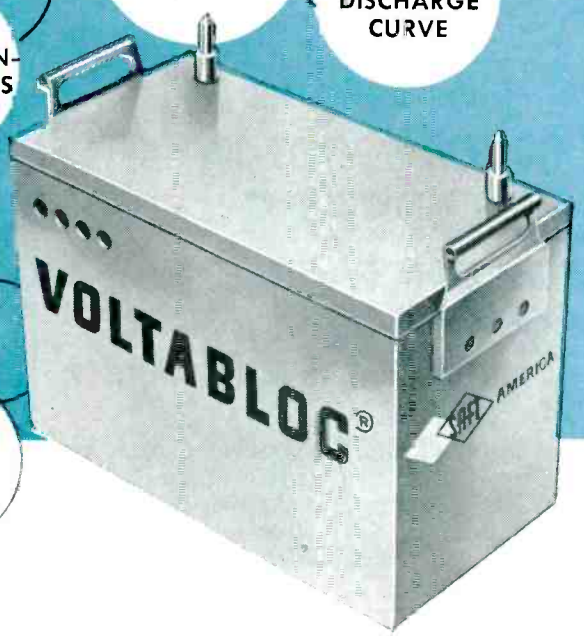

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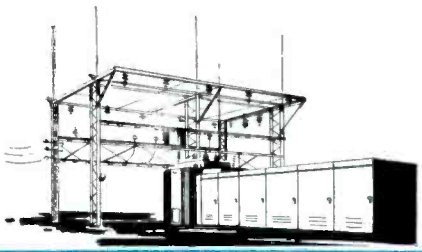

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volve combining etched circuit techniques with the fiber chassis. In this way, the advantages of low cost, easy workability, shielding and printed circuit simplicity may all be possible at the same time.

The fiber chassis is even being seriously considered for use as a permanent chassis. Its resilience makes it extremely resistant to shock damage and the inherent internal damping of the fiber resists vibration.

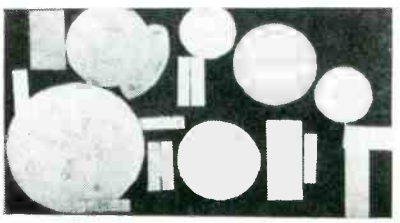
Producing Inkless Drawings for Etched-Wiring Patterns

By Donald F. Pennie
Electrical Engineer
Minnesota Engineering Co.
Minneapolis, Minn.

In testing various units of automatic assembly systems, etched-wiring layouts are often needed for test purposes. Where high accuracy is not necessary, engineers themselves can produce a satisfactory master drawing by applying Scotch electrical tape to a sheet of glass. This eliminates a costly drafting operation and saves considerable time. Furthermore, changes can be made in a few seconds, as compared to the hours required to move ink blots around on Bristol board or make new drawings.

To make a typically simple circuit by the tape method, the necessary tools are several sheets of ⅛-inch to ¼-inch plate glass, a few china marking pencils, Scotch tape (No. 471 and No. 33 work satisfactorily), a sharp cutting edge such as a razor knife and a paper punch. Even more convenient are the strip and circle preforms recently made available for this purpose by W. H. Brady Co. of Milwaukee.

A scale is selected (usually two times actual size). Paper cut-outs

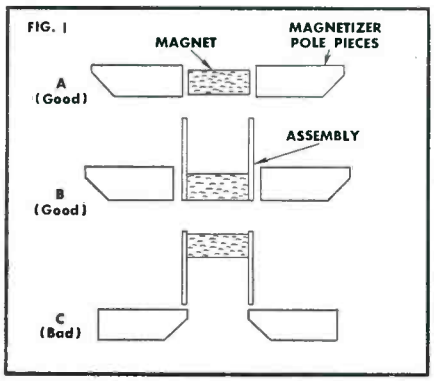


Example of paper cutouts for three-tube amplifier having power transformer and selenium rectifier

INDIANA PERMANENT MAGNET DESIGN INFORMATION

published for industrial and consumer product engineers and designers

HOW TO MAGNETIZE PERMANENT MAGNETS



Magnetizing permanent magnets after assembly into the product offers several advantages. Higher field strengths are obtainable. The magnetic field produced in a loudspeaker, for example, using an Alnico V permanent magnet that has been magnetized after assembly, is about three times as great as the field obtained when the same magnet is magnetized before assembly.

The unmagnetized magnets are easier to handle and to assemble with other parts of the assembly. There is less contamination due to pick-up of magnetic particles.

Magnetizing after assembly is also advantageous in such applications as watt hour meters, polarized relays, and permanent magnet motors.

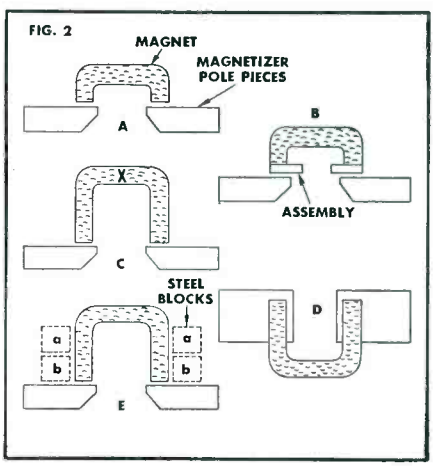
Using the Magnetizer

Most commonly used magnets are of simple bar or "U" shapes, which may be magnetized with an electromagnetic magnetizer in the user's plant.

Fig. 1-A shows how a bar magnet should be positioned between the magnetizer's pole pieces. The square ends of the pole pieces are used toward the gap. The space between the pole pieces is adjusted so the magnet can be easily inserted and removed. Normally, only one to two seconds are required to fully magnetize the magnet.

An assembly consisting of a bar-type magnet and soft-steel pole pieces should be placed with the magnet between the magnetizer pole pieces as shown in Fig. 1-B. Positioning the assembly as shown in Fig. 1-C will not fully saturate the magnet.

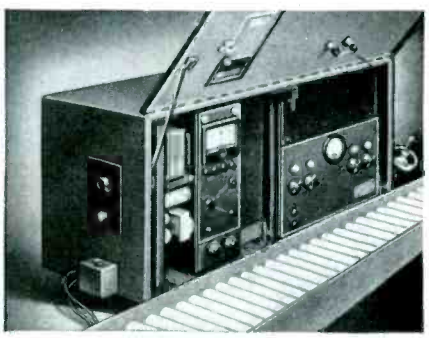
"U" shaped magnets and assemblies should be positioned as shown in Fig. 2, with the tapered ends of the magnetizer pole pieces used toward the gap. A meter or separator assembly would be placed on the magnetizer as shown in Fig. 2-B.



When a "U" shaped magnet is tall or larger than the generally accepted setting of the magnetizer, the field produced at point "X" (see Fig. 2-C) may not be sufficient to saturate the magnet. In this case there are two acceptable methods of magnetization. One is to place the magnet with its side on the pole pieces as shown in Fig. 2-D. This allows the yoke of the magnet to become magnetized. The magnet is then raised to the position in Fig. 2-C and again magnetized.

The other procedure is to stand the magnet on the magnetizer pole pieces with one or two steel blocks against each of its legs as shown in Fig. 2-E. The magnet (or assembly) is then magnetized three times: first, with both pairs of blocks in place; second, with blocks (a) removed; and third, with blocks (b) also removed.

For a complete discussion of how to magnetize permanent magnets by the electro-magnetic method, write for a copy of *Applied Magnetics*, Vol. 2, No. 3.



Chesterfield?

Cigarette manufacturers invest a great deal of time and money to bring you the best smoke possible.

Chesterfield is no exception . . and strangely enough, behind some of their recent efforts is an Indiana Permanent Magnet. You've probably read dozens of ads which say, "Chesterfield . . made the modern way . . with AccuRay."

AccuRay is a machine, made by Industrial Nucleonics Corp., that checks and controls the making of Chesterfields. One of the basic parts of this machine is a contact meter-relay, manufactured by Assembly Products, Inc. And the heart of this relay is an Indiana Hyflux Alnico V magnet!

Report on Indox I Ceramic Permanent Magnets

This recently published four-page technical bulletin, "Indox I Ceramic Permanent Magnets," suggests factors to be considered during design calculations, and discusses possibilities for new applications or improvements of existing ones.

Also discussed are some 30 representative sizes and shapes available in sample quantities for immediate shipment. Ask for price list and Catalog 15-A-1.

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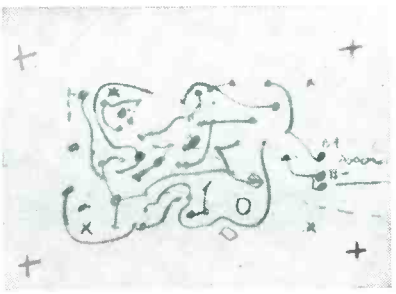
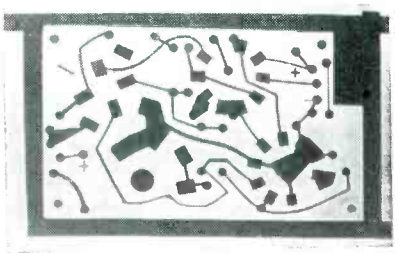
INDIANA PERMANENT MAGNETS



Crayoned wiring layout on glass



Taped wiring layout on glass

of the components are made to this scale and shifted about on a flat surface within the limits of the desired board size until an optimum arrangement is achieved. The cutouts are then tacked to the drafting board surface with masking tape, a clean plate of glass is placed over them and a china-marking pencil is used to sketch possible wiring routes. Different colors are sometimes helpful for signal, d-c and 60-cps paths. The work then becomes a game of moving or rotating tube sockets and shifting resistors and capacitors to minimize the number of jumpers. The pencil lines are easily wiped off with cleaning tissue to make changes.

When satisfied with the component positions and interconnections, the penciled plate glass is removed and a fresh glass placed over the paper cutouts. Component terminations cut from plastic tape (or preforms) are now placed on the fresh glass over the final component layout. For example, $\frac{1}{4}$-inch terminal circles of No. 33 Scotch tape are placed over the ends of all resistor, capacitor and other axial-lead components. Small resistor and capacitor terminations are spaced on centers $\frac{1}{2}$-inch apart or more, as required for Minn-A-Matic insertion machinery. Squares or rectangular terminations are used for larger parts such as potentiometers and transformers.

When all tape terminals are in place, the connecting strips are cut

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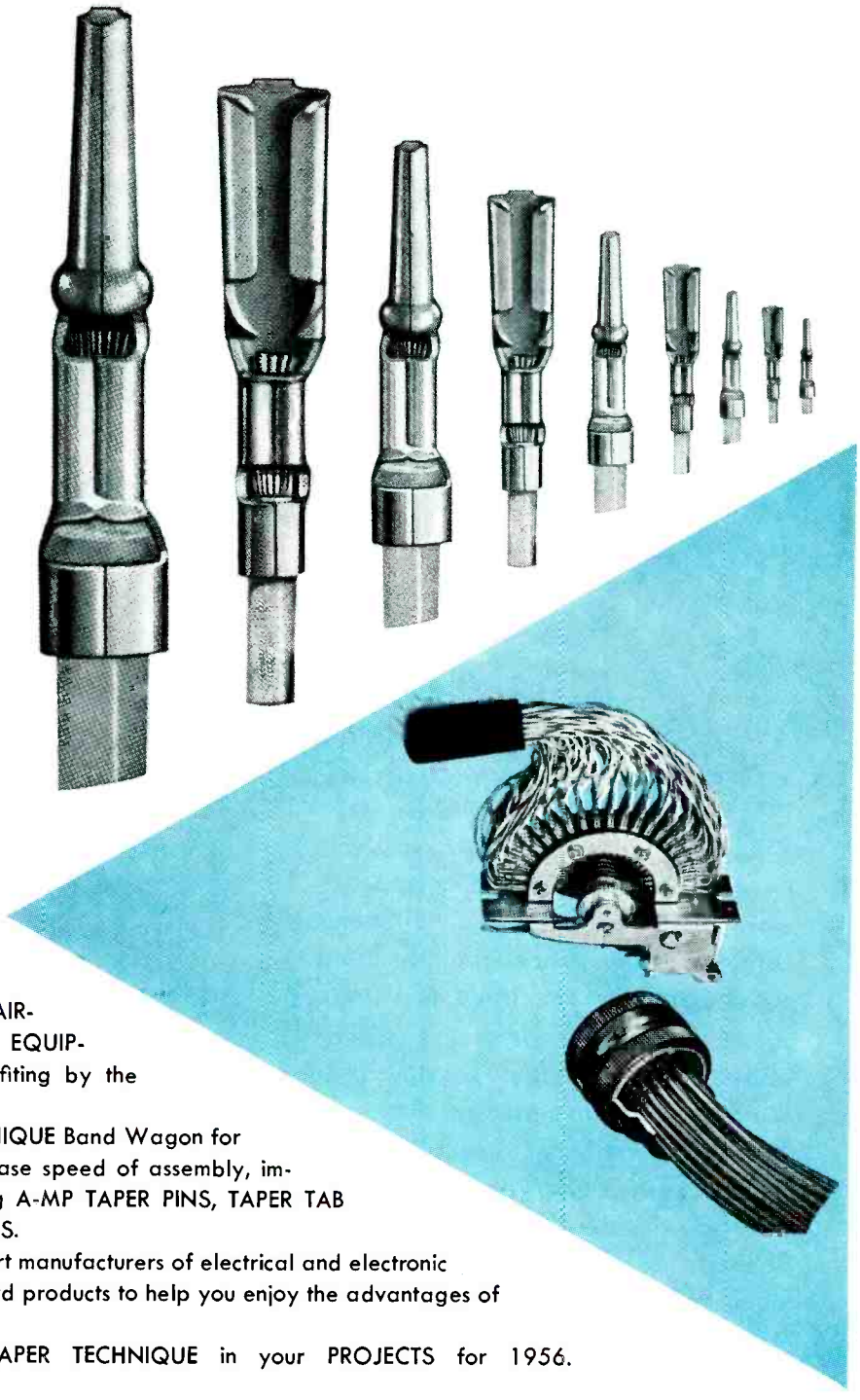

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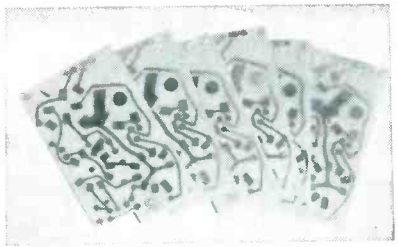
from tape with the razor and added. Spacing and minimum width of these strips of tape depend on the current to be passed, coupling, efficient use of resistors for bridging and the necessary spacing to avoid bridging in the solder-dip operation.

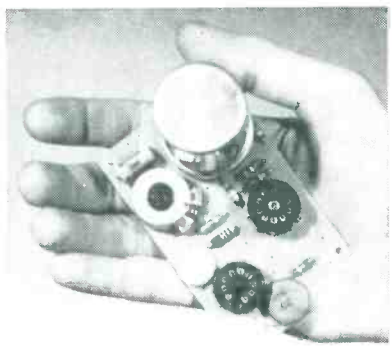
Scotch No. 33 electrical tape is easy to cut and work with, but is



Examples of finished boards

too stiff for sharp radii. Scotch No. 471 tape may be easily used for sharp radii, but bleeds if the tape is allowed to get too warm and may slip on the glass plate if laid down in a stretched position.

During the final routing of cir-

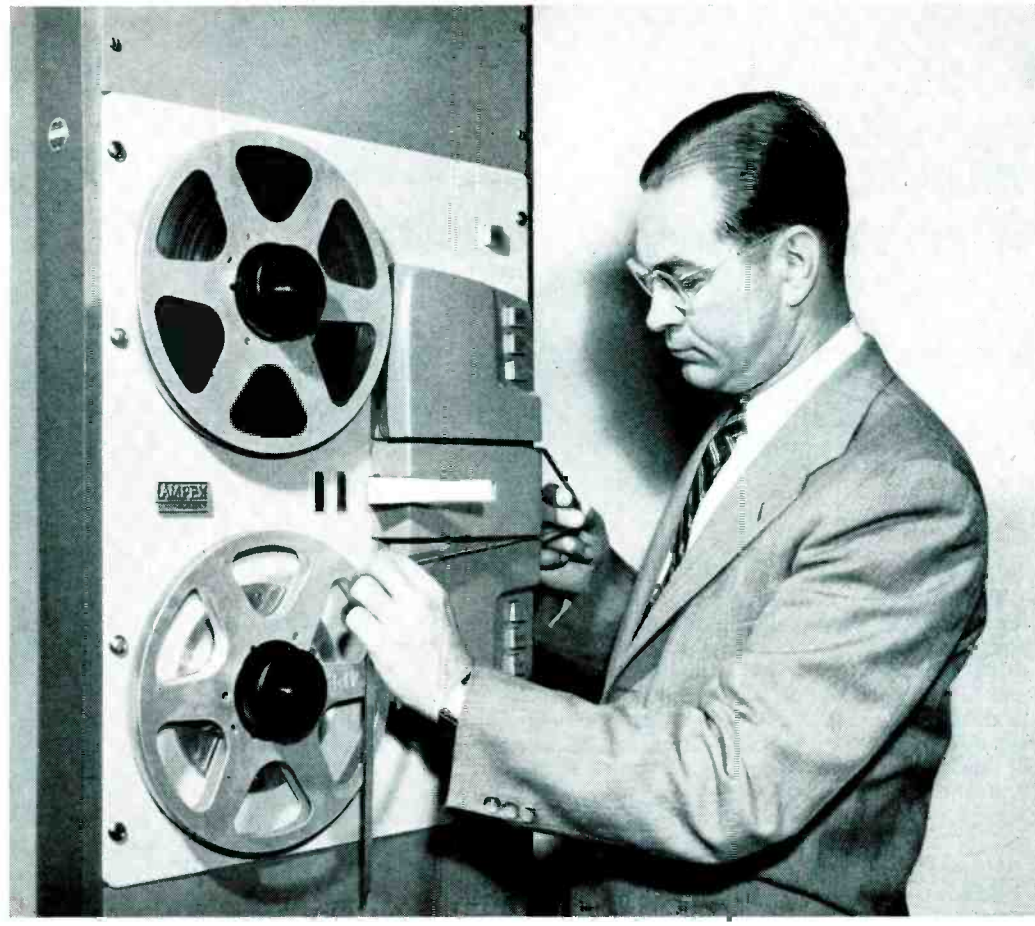


Finished amplifier after soldering

cuits the china-marking pencil sketch serves as a good guide. It will be found that a ½-watt resistor will nicely bridge two or three ⅛-inch parallel conduction paths. Ground paths serve as fairly good shields and unfortunately also as efficient ground loops. If the china-marking pencil sketch has been correctly drawn, rotation or shift of components rarely needs to be made in this third step.

When conduction paths are complete, extra tape can be added where grounding is thought to be necessary or to widen areas which might become points of poor pattern adhesion. Tape wiring is

new digital magnetic tape transport →



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On the Ampex FR200 the tape attains full speed or full stop within less than 5 milliseconds to provide high information storage density. A remote control provision is provided, as well as pushbuttons on the topplate.

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FULL SPECIFICATIONS ON THE FR200 *and description of its features and accessories are given in descriptive literature. For your copy, write Dept. E 2539.*

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easily removed or added at this stage.

The finished drawing is removed, clamped in a frame against a white background and photographed conventionally for the production of etched wiring boards.

Under-Bench Wire Bins

Floor-level view of under-bench wire-storing tubes

METAL tubes holding a complete selection of wires needed in Martin electronic assembly operations are fastened under the work tables. They provide a conveniently available stock of wire for the operators on both sides of the tables. These simple aids have saved operators many useless trips to stock bins.

Pre-Tinning Techniques for Etched Wiring

By L. J. MARTIN and M. J. VAVRA
Weapon Systems Development Laboratories
Hughes Aircraft Co.
Culver City, Calif.

ONE operation which subjects an etched wiring board to chemical contamination is that of plating the etched circuit. Gold, nickel, rhodium and solder plating have been used on etched circuits to facilitate soldering or improve contacts.

As a test of the effect of plating, comb test patterns were prepared on phenolic boards and subjected to solder plating in a lead-tin-fluoroborate bath, followed by normal washing. After exposure to humidity, resistivities were similar to those of unplated control samples, indicating negligible contamination from plating. It should be pointed

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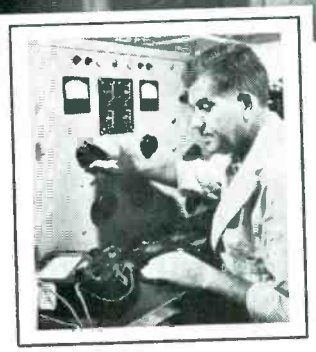

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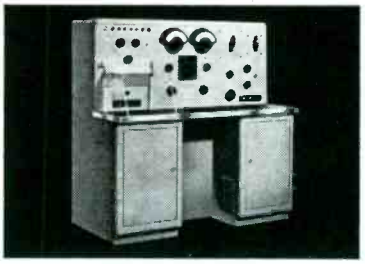
The advantage gained by in-plant calibration of electrical instruments using these console type Standards, which encompass the full range of testing instruments, under controlled laboratory conditions, goes beyond mere convenience. Their ease of operation, consistent calibration and high accuracy over wide current and voltage ranges are impossible to duplicate using individual testing equipment which must be moved from job to job throughout a manufacturing plant.

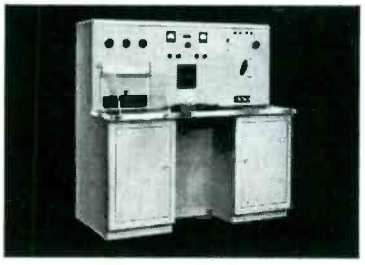
In addition to accuracy, each RFL Standard has many features which make rapid calibration procedure possible. Where many instruments must be tested, it can be demonstrated that an appreciable cost saving over older calibration methods will soon result.



Model 260C

Calibrates DC electrical measuring instruments to direct reading accuracies of 0.5% (0.25% using calibration charts) through voltages ranging from 1 millivolt to 1500 volts and currents ranging from 1 microampere to 150 amperes.

Net price $8,975.00 f.o.b. Boonton.



Model 261B

Calibrates all types of AC meters to direct reading accuracies of 0.5% (0.25% using calibration charts) over frequency range of 50 to 1600 cps. Current range from 1.5 milliamperes to 200 amperes; voltage range from 75 millivolts to 1500 volts. Output of electronic power oscillator has less than 5% total harmonic content at 60 cycles.

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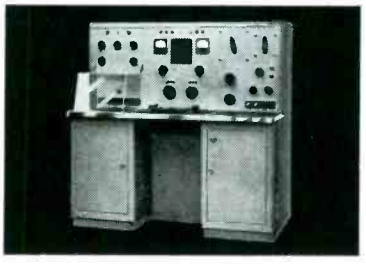

Model 262B

Calibrates DC electrical measuring instruments to direct reading accuracies of 0.1% (0.05% using calibration charts) through voltages ranging from 1 millivolt to 1500 volts and currents ranging from 1 microampere to 150 amperes.

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Write for technical data and application information.

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out, however, that these boards did not have holes drilled in them which might have permitted entry of the electrolytes. The only machined surfaces were the outside edges, far removed from the circuit.

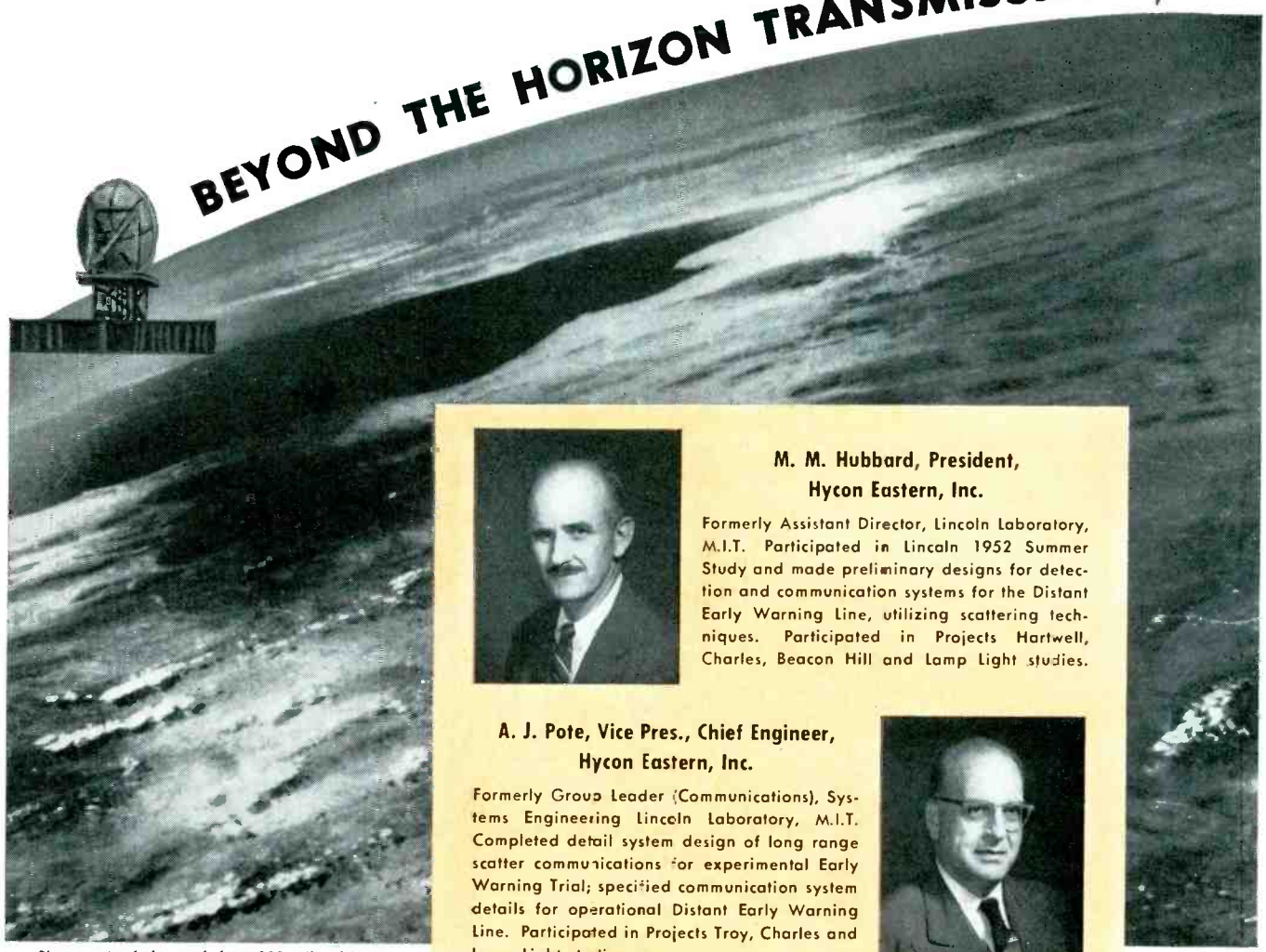
► **Dip-Soldering Isn't Easy**—One naturally thinks of dip-soldering in connection with etched wiring as a means of soldering many connections at once, without dependence upon a girl with an iron, as an attractive economic prospect. Reliable dip-soldering, though, is easier talked about than done. One can't just stick component leads into an etched circuit with partially oxidized copper conductors, apply a safe flux, dip it in solder and hope for 100 percent reliable joints. Either a dangerously active flux must be used or other steps to insure wetting the etched conductors must be taken, such as pretinning or plating.

Some workers have found a thin gold plate, a flash, to be adequate to insure tinning. Others prefer solder plating at least 0.001 inch thick. Though it has been shown that adequate washing avoids contamination from plating electrolytes, plating tends to be objectionably expensive, if for no other reason than the difficulty of interconnecting the many isolated conductors on a board.

► **Fluxing Problems**—Pretinning with molten solder has obvious advantages over plating, but fluxes are required and so must be considered as possible contaminants. The important differences between using fluxes for pretinning or for soldering components directly to untinned conductors are: the pretinning may be done with a heated roller or other similar applicator, which aids in breaking through the oxide better than with dipping; flux residues may be washed away more effectively after simple tinning than after covering a board with components.

In general, the more active the flux the greater is its help in soldering. However, unless the residues of active fluxes can be removed, their corrosive effects are intolerable. Many so-called noncorrosive fluxes have been tested. In one set

BEYOND THE HORIZON TRANSMISSION



Photograph of the earth from 100 mile altitude — Courtesy U. S. Air Force

M. M. Hubbard, President, Hycon Eastern, Inc.

Formerly Assistant Director, Lincoln Laboratory, M.I.T. Participated in Lincoln 1952 Summer Study and made preliminary designs for detection and communication systems for the Distant Early Warning Line, utilizing scattering techniques. Participated in Projects Hartwell, Charles, Beacon Hill and Lamp Light studies.

A. J. Pote, Vice Pres., Chief Engineer, Hycon Eastern, Inc.

Formerly Group Leader (Communications), Systems Engineering Lincoln Laboratory, M.I.T. Completed detail system design of long range scatter communications for experimental Early Warning Trial; specified communication system details for operational Distant Early Warning Line. Participated in Projects Troy, Charles and Lamp Light studies.

A TECHNOLOGICAL BREAKTHROUGH

Not since the end of the 19th century when Marconi signalled a few miles over a radio circuit has any development in the field of communications had the far-reaching significance of ionospheric and tropospheric "Scatter" transmission . . . "Beyond the Horizon" circuits. Signals as far as several hundred miles beyond the horizon exhibit properties which make possible in long distance radio circuits, for the first time, degrees of reliability equal to or better than wire circuits afford.

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Within the areas of Hycon Eastern, Inc. and its associates, Hycon Manufacturing Company and Hycon Aerial Surveys, Inc. can be found complete facilities not only to design, engineer and specify equipment for Beyond the Horizon Transmission Systems, but to design Central Offices, Connecting Wire Networks, perform Communication Traffic Density Surveys, Aerial Surveys and Mapping to determine the most efficient routes for land lines and for various radio links such as UHF/SHF line of sight. After the necessary facts have been gathered there further exists the experience to evaluate them and to specify practical equipment with complete independence of judgment necessary to create a complete communications system capable of fulfilling present and projected needs.

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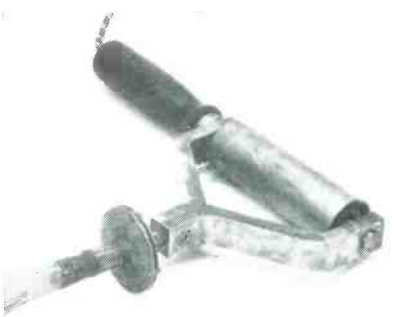
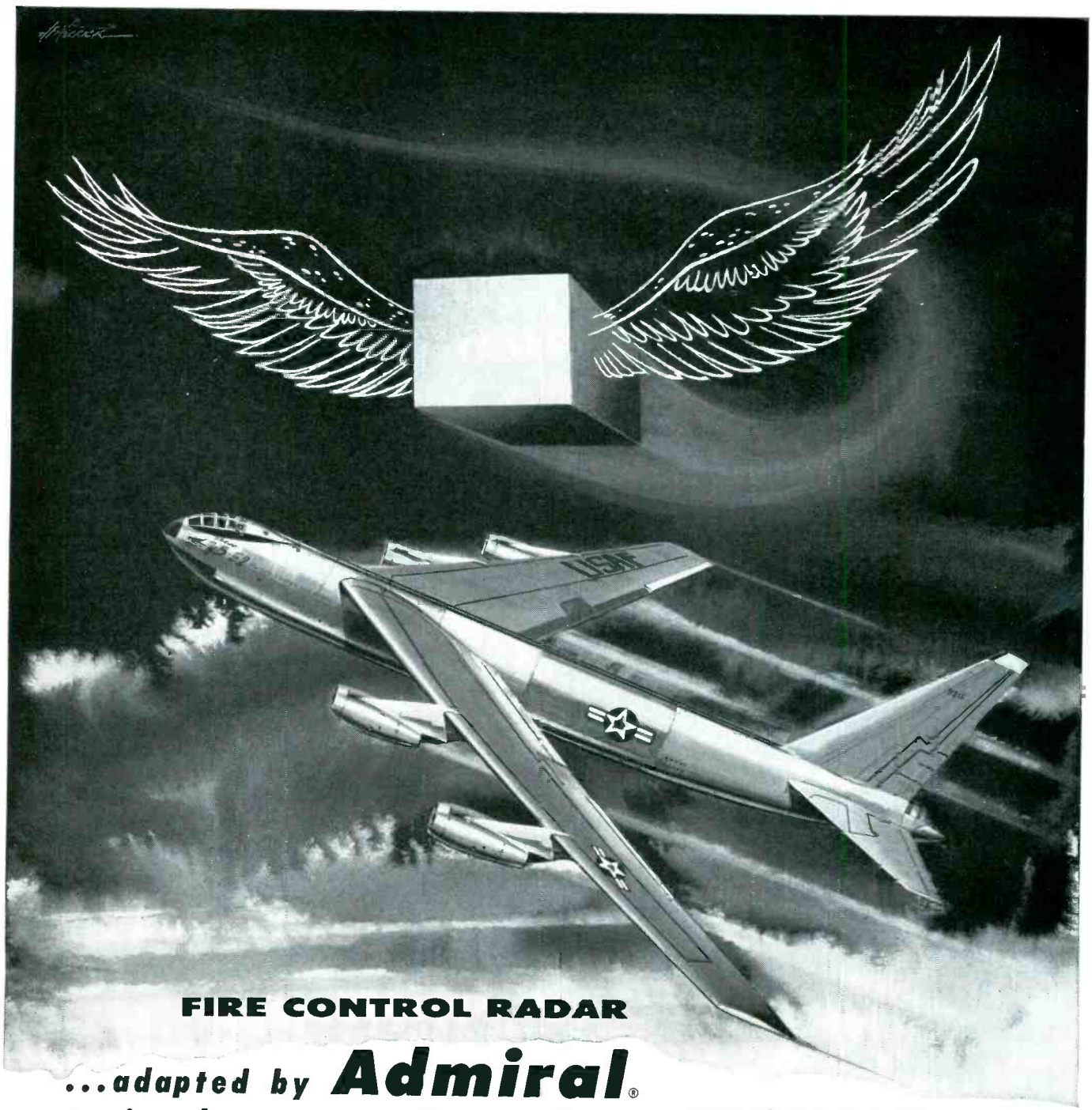
of experiments these fluxes were applied to comb pattern test boards, a dip or roll tinning performed and the boards subjected to humidity exposure. Except when these boards were thoroughly cleaned after tinning, serious insulation leakage was measured and visible corrosion generally was evident. This indicated, contrary to a general belief, that these fluxes are not completely volatilized or decomposed to noncorrosive residues by the heat of soldering. Accelerated corrosion tests also were made by applying the fluxes to parallel windings of bare copper wire on glass rods and subjecting these to direct voltages and humidity. Corrosion was evidenced by the formation of copper salts.

Stearic acid-toluene and rosin-alcohol were found to be free of contaminating residues and therefore safe to use without subsequent cleaning to remove all traces of their residues. Though the residues of corrosive fluxes can be removed by thorough washing, one is inviting trouble from careless work. One also should beware of using these active fluxes with eyelets because of the danger of trapping corrosive residues beneath their heads.

► **Roller-Type Soldering Iron**— Pretinning may be performed with a heated solder-coated roller, either used manually or mechanized for volume production. The construction of a hand-roller containing a regulated heating element is shown. A thin uniform film of solder is applied and rolled onto the fluxed boards, the conductors picking up this solder film as they are heated



Hand roll tinner. Cord does not kink because soldering iron is locked in fork of handle; copper roller rotates on and is heated by heating element of iron



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by the roller. This tinning operation should be performed as soon as possible after the boards have been etched, cleaned and dried, so as to minimize oxidation prior to tinning. Subsequently, the tinned boards may be dipped in stearic acid, to provide flux for subsequent dip-soldering and to protect the tinned conductors from oxidation, if stored.

For successful dip-soldering, it is essential that the solder wet the component leads, as well as the board conductors. Consequently, it is desirable to have these leads tinned with an eutectic solder and then coated with stearic acid. Component leads thus treated have dip-soldered well, even after two years of open storage.

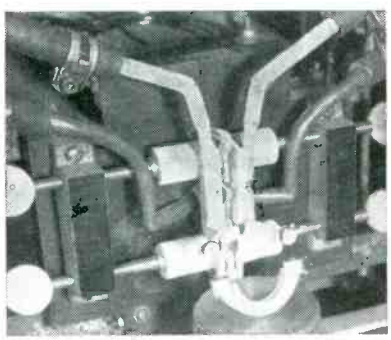
Split Induction Coil Heats Silicon Crystals

By J. Soled

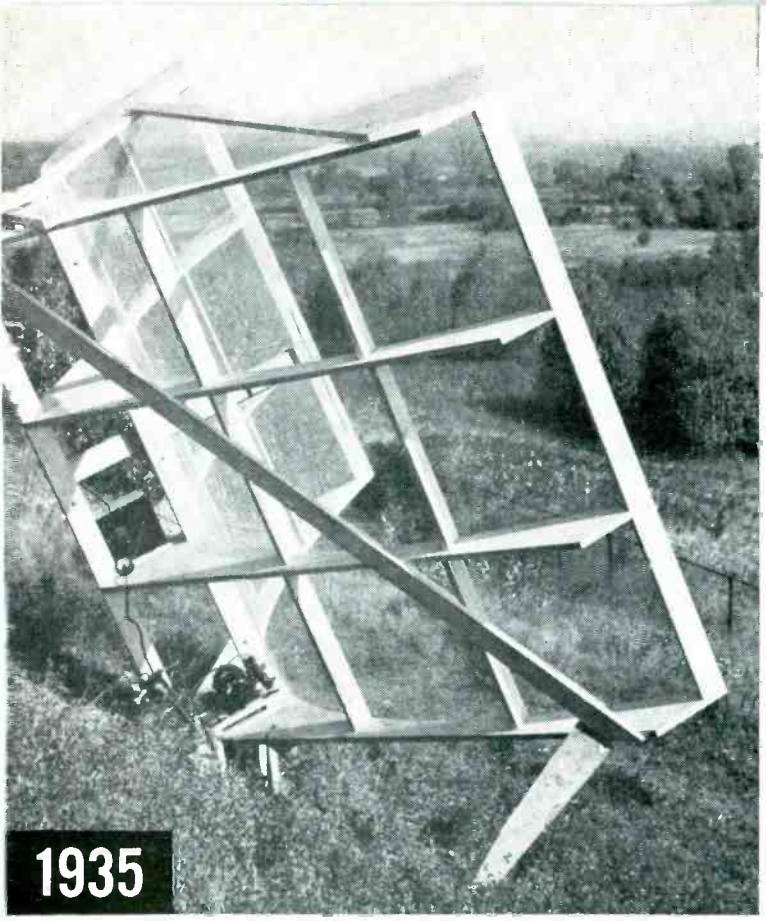
Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey

Split induction coils are needed when the work piece is so shaped that it cannot be inserted into the coil. The usual design utilizes separate water cooling paths for each half, with a rubber connecting tube joining them. The halves are hinged to facilitate opening and closing. Such a design results, however, in a heavy assembly.

▶**Construction Details**—The split induction coil was designed to maintain the close coupling and narrow heating zone of the regular single-turn coil. A three-piece inner copper ring, silver-soldered to the split copper tubing, supplies the current path. A slight bowing out of the copper tubing at both sides provides room for sleeve joints, which take $\frac{1}{16}$ inch thick, $\frac{3}{8}$ inch



Disassembled work coil, with O-ring seals attached to fixed ends



EARLY RESEARCH AND DEVELOPMENT EXPERIENCE with electronic location equipment at G.E. began in 1935 when this first system, with an output of 1½ watts, located planes up to five miles away.

IN USE TODAY, this huge nodding height finder was designed and developed by General Electric to be used with powerful search radar systems and is a major contribution to long-range aircraft location.

How G.E.'s 20-year antenna background can help make your radar system more effective

6 examples show experience in all areas of land- and ship-based antenna work

To give you an outstanding source for reliable, precision radar antenna equipment, General Electric backs modern facilities with the know-how that comes from many years of research, engineering, and manufacturing experience.

For example, early research in electronic location equipment at G.E. began in 1935 and engineering and manufacturing experience includes these six major areas:

1. **Stabilized bases** to compensate for ship pitch and roll were built in large quantity with Navy antennas in World War II.
2. **Small, portable systems** for weather balloon tracking were developed and produced for the Army and Navy in 1948.
3. **Powerful heightfinding antenna,** FPS-6XW1, developed by G.E. for USAF in 1949, was an advancement in long-range detection.
4. **Giant shipboard search antenna,** largest in use today, was G-E developed and produced for Navy early-warning ships.
5. **Long-range search antennas** (FPS-7) were designed and built by G.E. using advanced construction techniques.
6. **One of the first combination antennas** (allows both search and elevation detection), the Navy's SPS-8 was designed and produced to give a precise beam pattern.

This extensive background enables clearer perception of special engineering and manufacturing problems. It is the element that helps give G-E precision antenna equipment the efficiency and reliability to help make your radar system more effective. For more information, contact your G-E Apparatus Sales Office or use coupon below.

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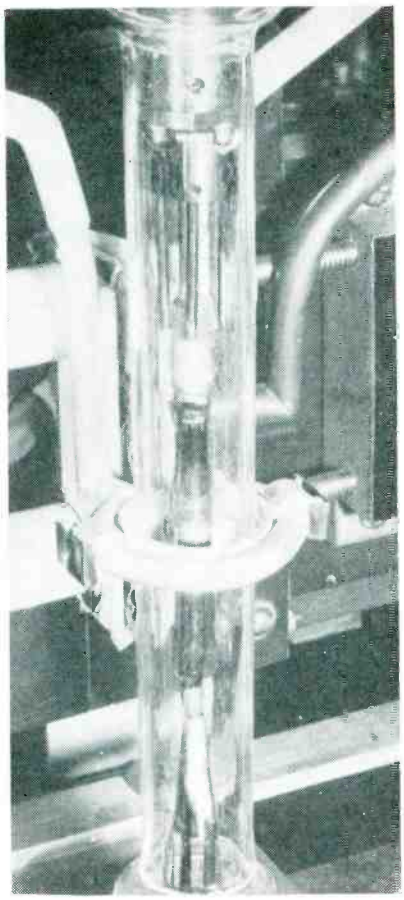
GENERAL ELECTRIC



Coil in operation on floating-zone equipment for growing silicon crystals

outer-diameter rubber O rings for effective water sealing.

In the floating-zone technique for growing single crystals of silicon a necked quartz tube is employed, around the necked section of which a separate induction coil was formed.

Small triangular copper projecting ears are gripped by beryllium copper clips to develop pressure contact of the inner silver-plated conducting path. These clips slide on and off with finger pressure.

The heating characteristics of the split coil are equal to that of the original single-turn coils. The prin-

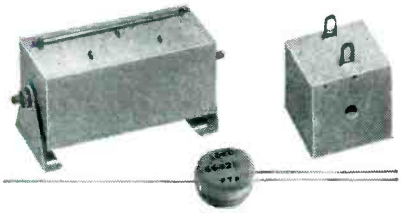
Twisting Insulated Wire

A MECHANICAL wire twister which can be operated by one worker is used in Martin's Baltimore plant. The device consists of a driving head powered by a slow-speed motor, a stationary head with rotating pins for attaching the wires and a comb for leading the wires as they are being twisted.

One end of each wire to be twisted

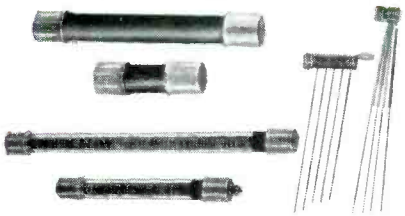
Extremely long life . . . with no maintenance problems. Thousands of voltage/amperage combinations available. Sizes from 11/16" square cells to giant 6" x 10" plates . . . Federal can provide a power rectifier for almost every type of industrial and military equipment.

Encapsulated Rectifiers



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

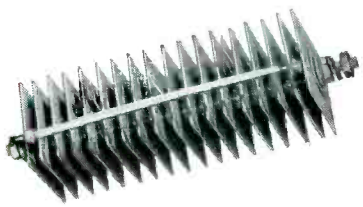
High-Voltage Stacks



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

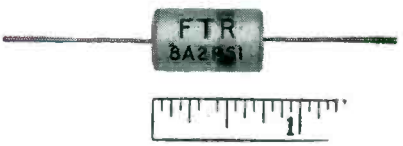
Why INDUSTRY and DEFENSE LOOK TO Federal FOR THE FINEST IN SELENIUM RECTIFIERS

High-Temperature Stacks



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

Selenium Contact Protectors



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

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

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

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

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

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

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Operator holds motor switch in left hand and comb in right hand as she walks ahead of twists

is attached to the driving head. The other end is fed through the comb and attached to the pins on the stationary head. The operator starts the mechanism with a remote-control switch carried in one hand and leads the wires with the comb held in the other hand while walking ahead of the twists. At the end of the wire the motor is turned off and the twisted group removed from the machine.

The device has saved 75 percent of production costs over hand-twisting operations.

Self-Insulating Aluminum for Transformer Coils

DEVELOPMENT of a method of winding coils with aluminum foil or sheet which is insulated only with aluminum oxide has been announced by Reynolds Metals Co., Louisville, Ky. A special anodizing process provides excellent insulation, making possible the new system of winding coils for use in power transformers and solenoids.

The coils are wound spirally with the anodized aluminum foil or thin aluminum sheet instead of with conventional wire. Minimum winding radius recommended is ½ inch. Sheet thicknesses currently being considered are 0.008 inch and 0.015 inch, with 0.004 inch as a minimum for anodized insulation.

In addition to cost savings, the method offers important advantages in reduction of size, weight and resistance to heat.

Aluminum can now be used as a conductor with no increase in equipment size. Spiral winding of the coils subjects the conductor in-

ANOTHER FIRST BY Amperex®

High-Power RF Oscillator Triodes SPECIFICALLY DESIGNED as INDUSTRIAL POWER OSCILLATORS

for INDUCTION HEATERS
for DIELECTRIC HEATERS

Designed to end the practice of forcing communications-type oscillator tubes into heavy-duty industrial service, these new AMPEREX triodes are engineered from the ground up to the specific requirements of RF power oscillator circuitry in industrial induction and dielectric heating installations. Their performance is virtually independent of the wide variations in load impedance encountered in industrial applications.

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- **low plate impedance**
- **low mu**
- **hi h transconductance**
  fo . .
  . . superior "loadability"
  . . . high efficiency under all loaded conditions
  . . . greater power into hard-to-heat loads
  . . . simpler circuitry eliminating special grid-current regulation devices

Outstanding Physical Characteristics—

- **thoriated tungsten filament . .**
  . . . for maximum life
- **extra-heavy-wall copper anode . . .**
  . . . to absorb short-term overloads of double the maximum ratings
- **platinum-clad grid . . .**
  . . . for stable grid-current operation
- **coaxial grid construction and powdered-glass stem . . .**
  . . . for maximum mechanical strength
- **permanently bonded, flexible, heat-dissipating filament leads**
  . . . to eliminate failures due to contact resistance at terminals

FOR OPTIMUM PERFORMANCE WITH FLUCTUATING LOADS

Type 6756
WATER-COOLED
20 kw dissipation
$435.00
Grid Connector included
Accessory: Water Jacket (Type S-15096)

Type 6757
FORCED-AIR-COOLED
15 kw plate dissipation
$535.00
Grid Connector included
($75.00 allowance for return of radiator with order)

TYPICAL OPERATING CONDITIONS
TYPES 6756 and 6757

Oscillator, Class C — Three-Phase, Full-Wave Supply (Per Tube)

	CCS Full Load	CCS 2A Load	CCS No Load	
DC Plate Voltage	12000	12000	12000	volts DC
DC Plate Current	3.5	2.0	0.430	amps DC
DC Grid Voltage	—1220	—1380	—1710	volts DC
RF Grid Voltage	2050	2030	_____	volts
DC Grid Current ✻	**0.210**	**0.238**	**0.295**	**amps DC**
Grid Resistor	5.8	5.8	5.8	kilohms
Plate Input	42.0	24.0	5.16	kw
Plate Dissipation	11.25	4.9	_____	kw
Efficiency	73.30	79.4	_____	percent
Load Impedance	1755	3120	_____	ohms
Plate Power Output	30.75	19.1	_____	kw

✻ Note flat grid current characteristics, no load to full load, without external grid stabilization circuitry

Detailed data sheets and application information available on request.

***Retube with* Amperex**

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sulation to turn voltage only, and accordingly normal layer insulation can be eliminated. This saving in space, coupled with that derived from the use of the very thin anodic films for insulation and the lack of voids in the completed windings, accounts for the compactness of the coils.

Further space savings are afforded by the excellent heat transfer characteristics of the coils. Since every turn of the coil is exposed to the outside, no hot spots are encountered and cooling ducts can be eliminated.

The anodic coating, consisting of aluminum oxide—a chemically inert material and an excellent electrical insulator—reduces the possibility of a coil's burning out, since the melting point of the anodic coating is higher than that of aluminum itself.

Appreciable weight savings also are afforded by the new aluminum coils. In most cases, the coil weight is approximately one-half that of a comparable copper unit.

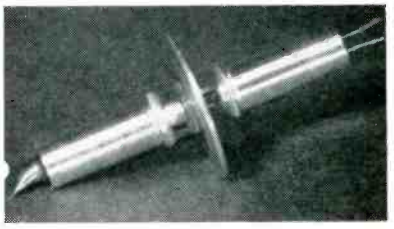
Basing Pencil Triodes with Epoxy Resin

By David Lichtman
and
Byron G. Wells

Applied Physics Staff
Airborne Instruments Laboratory
Mineola, N. Y.

Flexible wire filament leads on various uhf triode tubes were found to break easily and required soldering or elaborate terminations in order to connect to them. Leaving the leads too long resulted in the possibility of short circuits; on the other hand, clipping them short caused difficulty in making connections. For these reasons it was decided that a means of basing these tubes be devised.

▶ **Use of Sleeving as Mold**—The first attempts consisted merely of

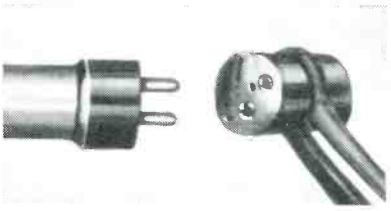


Example of unbased tube

slipping a piece of Teflon sleeving over the end of the tube and filling the sleeving to the proper level with Araldite No. 502 (CIBA Co.). After the Araldite had set, the Teflon sleeving was removed, leaving a plastic base with the two filament leads projecting beyond it. Clipping the leads to a suitable length and tinning added to their rigidity.

Better rigidity and mechanical strength were obtained when a pair of specially constructed tube pins were spotwelded to the shortened filament leads before basing. The heavier pins were stronger and looked better.

▶**Use of Brass Mold**—When it was decided that the overall appearance and strength would be improved by the addition of a shoulder on the base, a new mold was designed. The new mold, which incorporated the shoulder design, had to be made of



Based tube, with matching socket alongside

a flexible material that could be slipped over the base once the base had hardened. The mold material decided upon was Arcoflex-B (Applied Resins Co.). A brass mold was prepared to cast the Arcoflex mold.

It was found that careful handling of the Arcoflex was required; furthermore, to secure a clear, bubble-free mold, the Arcoflex had to be subjected to partial vacuum before it was poured.

▶**Pouring Precautions**—In pouring the liquid from the can to a suitable container for pumping, care must be taken to pour it down one side of the container to avoid trapping any air. After pumping, the same care should be exercised when pouring the liquid into the mold. A slow, careful curing process will result in a mold that can be used again and again.

The new Arcoflex mold was set in place over the filament end of the

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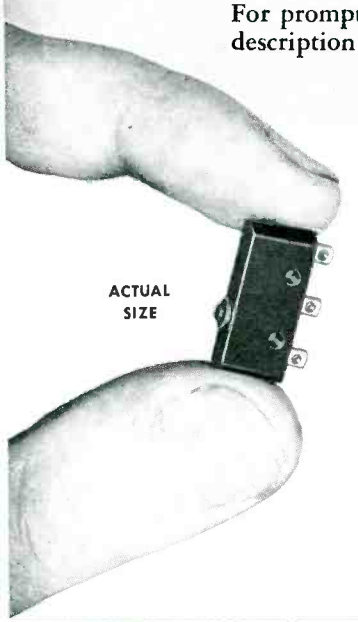
For prompt action on your switching problems, send us a brief description and rough sketch of the switch you need.

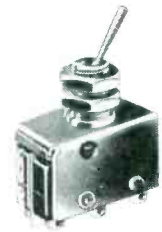


SUB-MINIATURE SWITCHES TYPE E-4

S.P.D.T., 1 circuit; 5 amps, 125/250 v. AC
Operating force 150 grams max.
Exceptionally vibration-resistant.
Special model E4-7 is stabilized for — 65° to + 350° F. operation.


Push Button Actuator

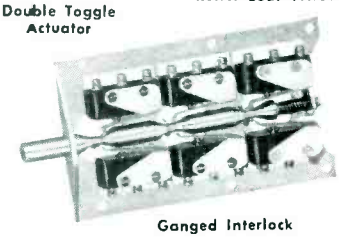

Toggle Actuator (Momentary or Constant Contact)


Double Toggle Actuator

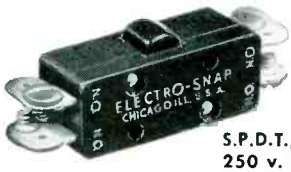

Roller Leaf Actuator


Leaf Actuator


Extension Leaf Actuator

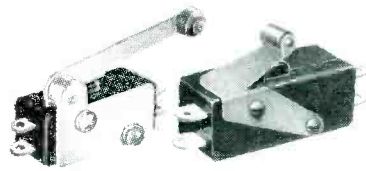

Ganged Interlock

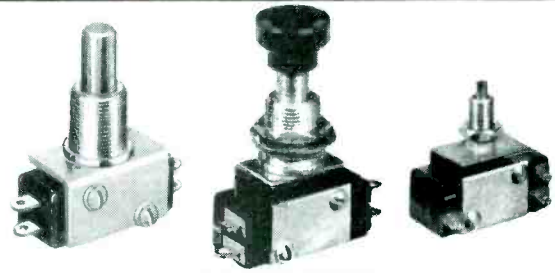
TYPE S SWITCHES Series S1

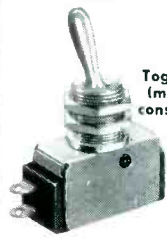


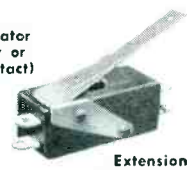
S.P.D.T., 2 circuit; 10 amps, 125/250 v. AC/ 30 v. DC. Ind. Screw or solder terminals on ends or one side of switch. Also available with reset button at bottom of switch or in Type S-100 Make-Before-Break Series where switch completes a new circuit before interrupting old one.

Write for Data Sheet STN-1

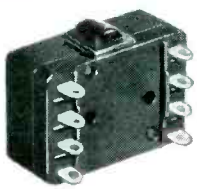

Roller Lever Actuator — Roller Actuator


Push Button Actuators (Various button sizes available)


Toggle Actuator (momentary or constant contact)


Extension Leaf Actuator


Special Push Button Actuator designed for fire control system



DOUBLE-POLE SIMULTANEOUS ACTION TYPE D-8

D.P.D.T., 4 Circuit
15 amps, 125/250 v. AC.
10 amps, 30 v. DC Ind.
Eight terminals and four separate circuits which operate simultaneously permit switch to reverse 3-phase motors, replace expensive relays, etc.

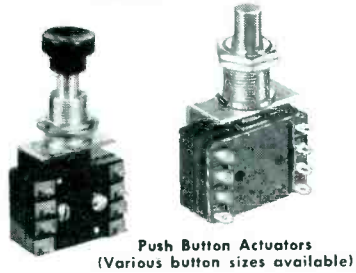
Write for Data Sheet DN-1


Roller Leaf Actuator


Roller Lever Actuator

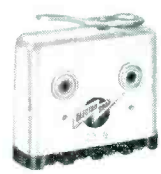

Leaf Actuator


Extension Leaf Actuator


Push Button Actuators (Various button sizes available)

HERMETICALLY-SEALED DOUBLE-POLE SWITCH

Write for Data Sheet HJN-1


Type J2-4


Toggle Actuator for J2-4

D.P.D.T., 4 circuit 10 amps, 125/250 v. AC/30 v. DC.

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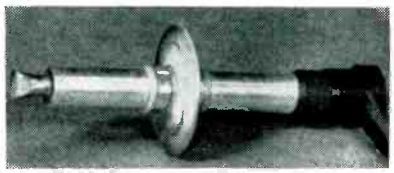


Tube in socket

tube. The tube was then mounted, anode down. The Araldite was weighed out with 1-percent black coloring (No. E-340) and allowed to set at room temperature until all trapped air bubbles worked their way to the surface. Then, 10-percent hardener (HN-951) was added and carefully stirred into the Araldite mixture, in order not to induce further bubbling.

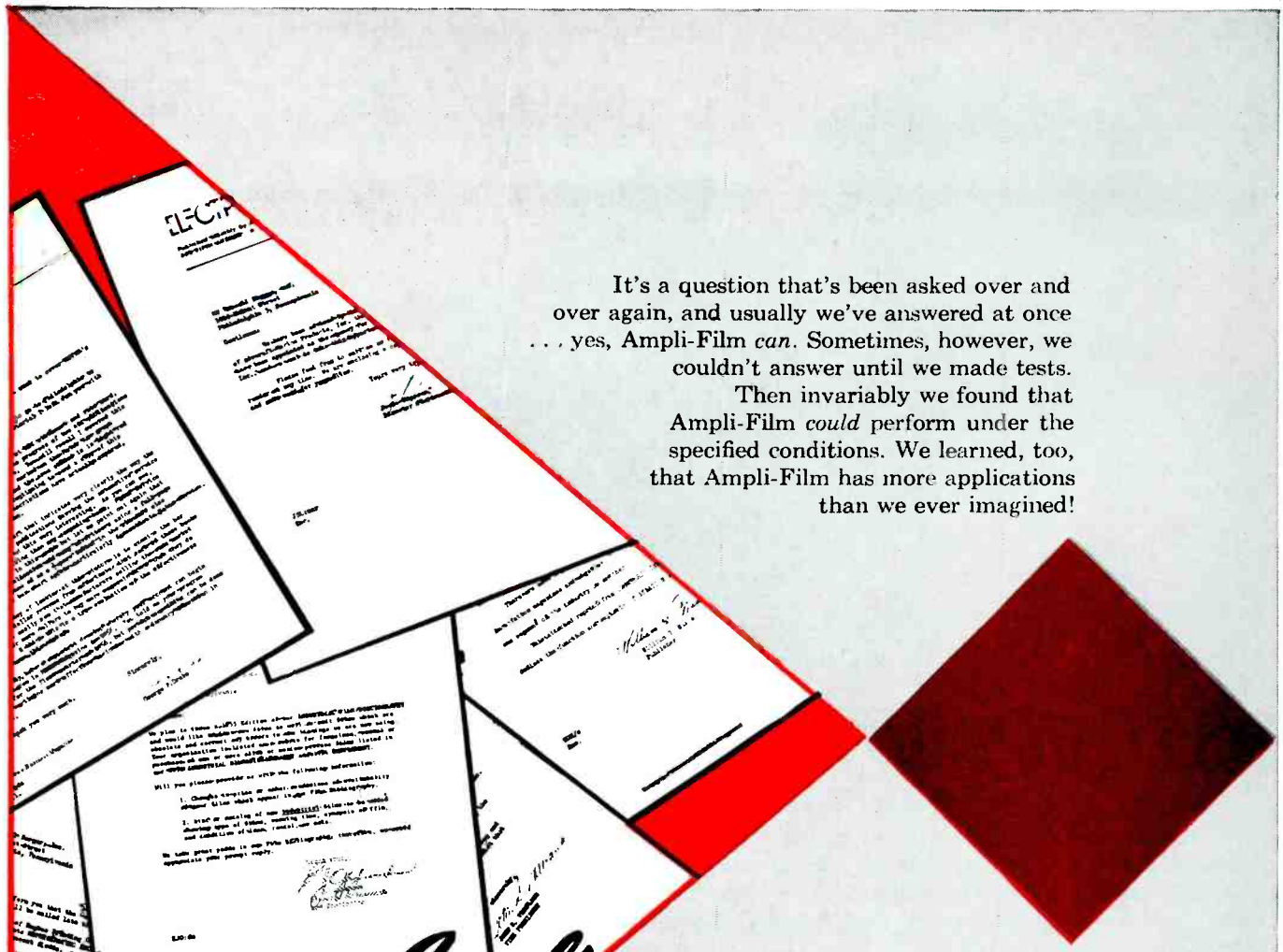
The Araldite mixture was then poured carefully down one side of the mold (again, to avoid trapping air); when the desired level was reached, the tube and mold were baked at 70 C for one-half hour. The unit was then removed from the oven and allowed to cool to room temperature. Gentle probing with a small scribe helped to determine the state of hardness.

The Arcoflex mold was gently separated from the Araldite by stretching it away with the fingers. When the mold was completely free from the Araldite, it was slid carefully off the tube and the rough edge was trimmed off the tube with a sharp razor blade. The hollow that remained was then filled with a few drops of the Araldite mixture, leaving a professional appearance.

►**Socket Molding Technique**—Having manufactured the tube bases, it was necessary to make a socket to match.

Special small pins, with a turret-type soldering connection on one end and spring contacts on the other, were made up. These were silver-plated and rhodium-flashed.

A mold was constructed from Teflon block and aligning pins were mounted in one part to support and align the other. Lead wires of No. 20 plastic-covered wire were soldered to the pins before they were set in the mold and two small pieces of Teflon tubing were set over the contact ends to keep the pins free from the surrounding Araldite. The entire mold was greased with a thin film of Dow Corning No. 7



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Ampli-FILM IS THE ALL-PURPOSE DIELECTRIC

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Write for the Ampli-Film Handbook for further details on the Dielectric and how it is used in A-MP'S Capitron® Capacitors, Pulse Forming Networks, Power Packs and Pulse System Packages.

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silicone grease. This permitted removing the base easily when the Araldite had set.

In using this mold, additional precautions must be taken to avoid the formation of air bubbles. While mixing the Araldite, the mold was preheated at 70 C for about one-half hour. The Araldite was then poured in slowly down one side of the mold to avoid air pockets.

After the unit was baked at 70 C for one-half hour, it was allowed to cool to room temperature. The mounting screws were removed from the mold, and the upper portion of the mold was lifted away. By applying downward pressure against a hard surface, the aligning pins exerted a similar pressure on the socket pins, causing the tube base to rise out of the mold. The aligning pins and the small Teflon sleeves were then removed and the remaining kerf (or flash) was removed with a sharp razor blade.

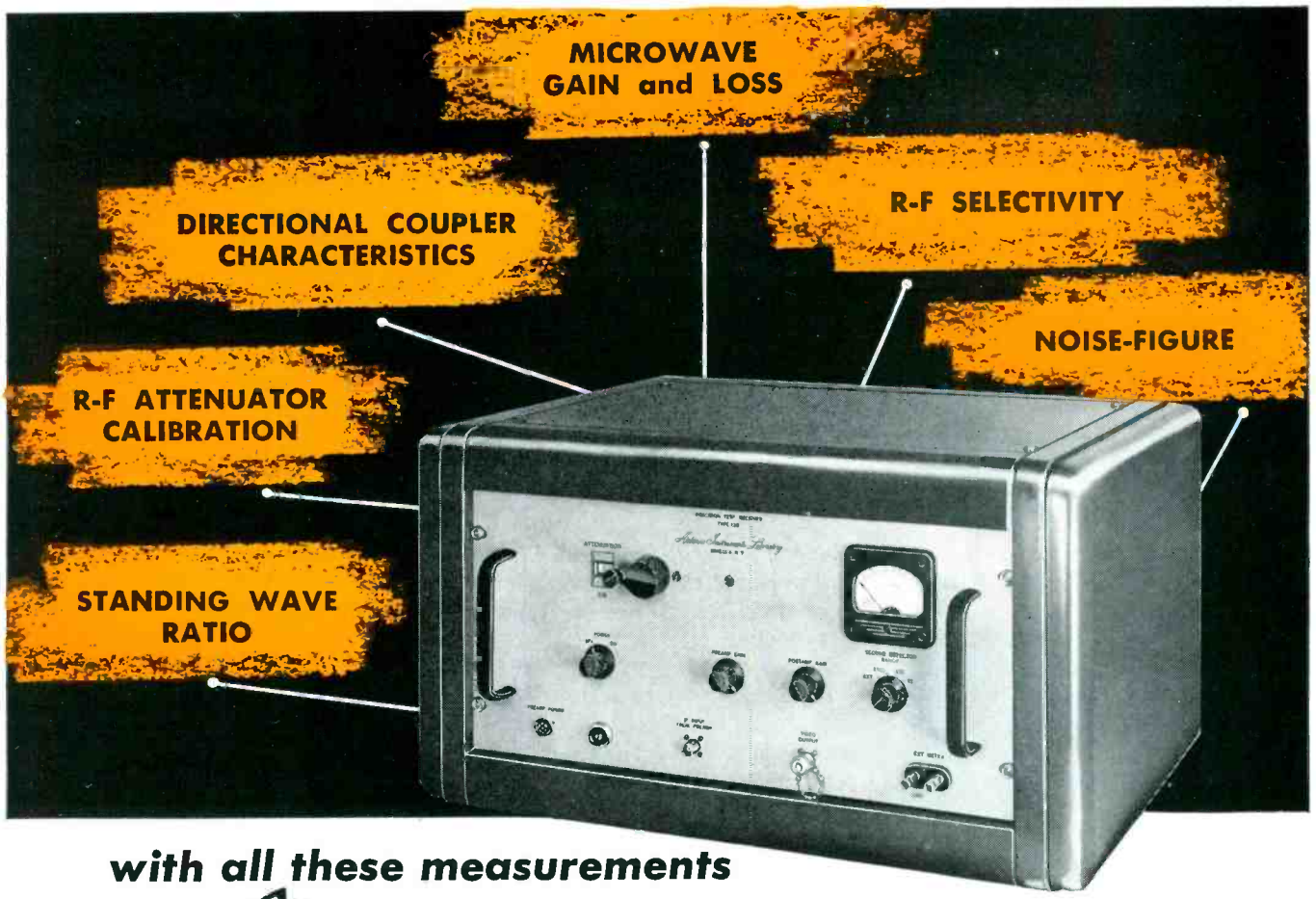
Because of the design of the mold, the pins are recessed into the socket. Thus, when the tube is plugged into its socket, there is no exposed metal and complete insulation as well as handsome appearance are achieved. Tubes having these bases have been used at frequencies up to 1,000 mc with no deterioration of operation.

Aluminum Hole-Filler

A PUTTY consisting of approximately 80-percent powdered aluminum and 20-percent plastic, known as Devcon F, can be used for filling undesired holes in aluminum and steel castings, as well as to build up worn sections.

Adherence to aluminum, steel, bronze, brass and cast iron is excellent. It will bond to a flat surface and can be machined to a feather edge. It is not necessary to undercut the metal or treat it in any special way. No volatile solvents or thinners are used, hence there is no shrinking or pulling away during the 2-hour hardening time in air.

The hardener furnished with the material is simply added and mixed with a screwdriver or a nail. The manufacturer is Chemical Development Corp., Danvers, Mass.



with all these measurements

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offers complete versatility

How often have you put together a breadboard setup of a pre-amplifier, post-amplifier, attenuator, power supply, output indicator, bias control and the rest of the haywire needed to make the multitude of measurements which require an intermediate frequency receiver?

AIL's engineers did it often enough to force the design of a single package for their own use. As a result, the type 130 Receiver is an engineer's design for engineers' use.

The AIL Type 130 Precision Test Receiver is a versatile instrument combining a high-gain, low-noise-figure i-f receiver and a secondary standard of attenuation. It is designed to operate from the i-f output of a wide variety of standard microwave mixers. In combination with such mixers and a suitable local oscillator, the Receiver becomes a sensitive detector of microwave energy. It can be used wherever accurate measurements of the differences of r-f or i-f power levels are required.

The complete AIL Type 130 Precision Test Receiver is priced at $1,350.00. The standard model is available for 30MC use. Prices on models operating at other frequencies will be provided on request. F.O.B. Mineola, N. Y.

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New Products

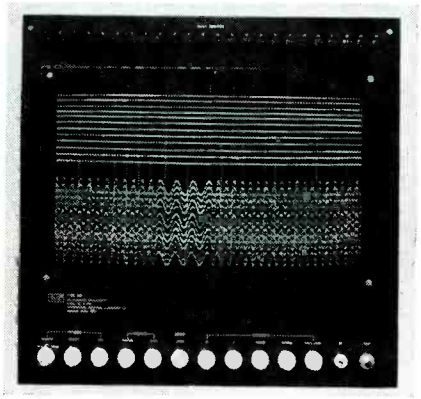
Edited by WILLIAM P. O'BRIEN

74 New Products and 70 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

TRACE CRO

presents multichannel data

SOUTHWESTERN INDUSTRIAL ELECTRONICS Co., 2831 Post Oak Rd., Houston, Texas. Model MO24 trace cro presents multichannel information on a 21-in. picture tube for direct viewing.



▶ **Method of Presentation**—Information is presented by intensity modulation of a 5,000-cps raster. The raster method results in frequency response useful to 500 cps on all 24 traces with only a single electron gun. Each trace may cross over other traces, and is limited in amplitude only by the size of the crt. A position control is provided for each trace. A special window control permits a portion of the sweep to be accelerated for careful examination.

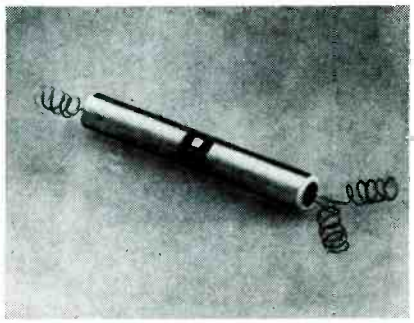
▶ **Auxiliary Unit**—The event preselector puts 0.1 and 0.01-sec timing lines over the scope, and triggers the sweep after an adjustable delay period following the initial pulse. This feature is especially useful when the MO is used as a monitor for 24-channel magnetic tape recordings, such as those used in seismograph work.

▶ **Prices**—The oscilloscope, complete with power supply, is $6,000. The event preselector sells for $1,500.

DELAY LINES

are hermetically sealed

PCA ELECTRONICS INC., 2180 Colorado Ave., Santa Monica, Calif., has released a complete range of standard single-stick hermetically sealed delay lines. The units are in round, 0.4 in. o-d, brass tubing with capacitor end-seals. They are commonly mounted in a fuse-clip or with a cable-clamp.



▶ **Designs**—Three general designs are available in each impedance level and delay time. One design emphasizes maximum delay per cu in., with a fair rise time. The second combines moderate delay per cu in. with good rise time. The third emphasizes fast rise time, with a low delay per cu in.

All designs are miniaturized and are commonly used for delaying video pulses, pulse shaping, gating, storage of information in computers, time standards in count-down circuits, synchronization of waveforms, time-modulation, generation of waveforms, and high-impedance connecting cables.

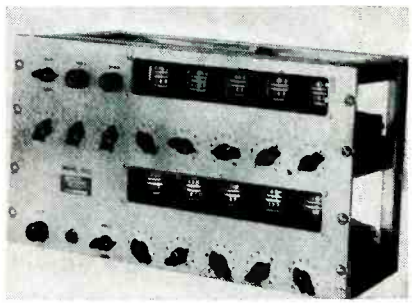
Prices range from $10 each to $7.10 each, depending on quantity ordered.

DIGITAL UNIT

interval timer and counter

RANSOM RESEARCH, P. O. Box 382, San Pedro, Calif. The functions of several digital instruments have been combined into one portable instrument in the Digitac model 1500 digital interval timer and counter.

The instrument contains 10 plug-in decade counters arranged in two banks of five each. It will count up to 10 billion at a rate not exceeding 100,000 per sec. Timing capacity is 10 μsec to 100,000 sec and timing increments may be preset

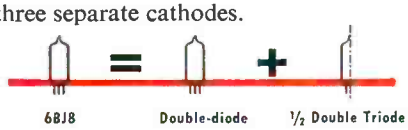


NEW COLOR TV TUBE

Does the work of 1½ tubes

—combines phase splitting with other color circuit functions

Here's a Sylvania tube development that can make an immediate improvement in your color TV chassis tube complement and layout. The 6BJ8 has two diodes and a low mu triode with three separate cathodes.



Thus, with a single miniature package, you can achieve phase splitting plus horizontal oscillation, or any other low mu triode function. Prior to the development of the 6BJ8 the need for independent cathodes in phase splitting called for at least a double diode with separate cathodes and half a double triode to accomplish this same work.

In some circuits the diodes may be used for phase comparison. For applications where two diodes and a high mu triode are needed Sylvania offers the type 6BN8 which also has the three-cathode construction of the type 6BJ8. The versatility of these tubes can introduce improvements in new black and white TV designs as well as color.

Sylvania can supply all your color TV tube needs with these important types.

3A2.....**miniature half-wave rectifier**
3A3.....**T-9 half-wave rectifier**
5V3.....**full wave vacuum rectifier**
6BK4.....**sharp cutoff beam triode**
6CL5.....**T-12 Beam power amplifier**
6CL6.....**miniature pentode video amplifier**

Write for complete details

SYLVANIA®

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., Montreal

LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

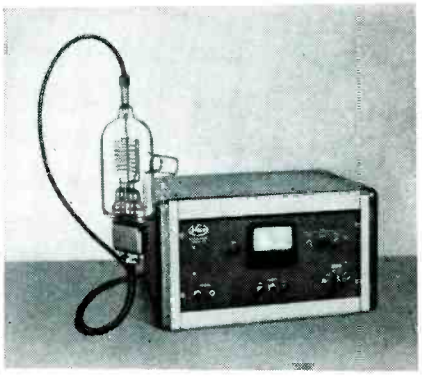
at any value in 10 μsec steps within that range.

▶ **Uses**—Model 1500 may be used as a lab instrument to measure time, frequency or events; as a counting or measuring device in process control and other types of automation; as an integral part of a computer; and as a test instrument for maintenance of telephone carrier and other communications and electronic equipment.

Weight is 25 lb, and the unit sells for $795.

GAGE CONTROLS
employ no bridge circuits

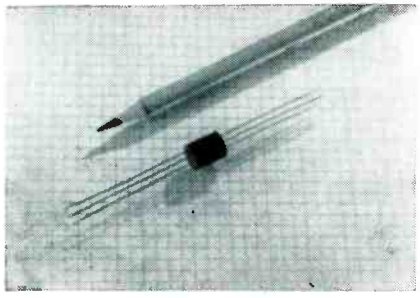
VACUUM ELECTRONIC ENGINEERING Co., 86 Denton Ave., New Hyde Park, N. Y. Types RG-2 and RG-3 ionization gage controls measure pressures from 1 micron to 2×10^{-10} mm Hg. Performance is due mainly to an ion current amplifier, employing 100 percent negative feedback, similar to those used in electrometer amplifiers. Amplification is independent of variations in tube and component characteristics and as a result, periodic adjustment of circuit calibration is entirely unnecessary. Constant checking of



zero is also eliminated. The feedback insures linearity through the entire pressure range.

▶ **Prices**—Catalog RG2-R gage control (smallest reading 2×10^{-9} mm Hg) sells for $397; and the RG21-R (smallest reading 2×10^{-10} mm Hg), $447. These prices are for panel units suitable for mounting in standard racks. The same units in a cabinet are priced at $28 more. The RG3-R and RG-31-R circuits are similar to the RG2-R and RG21-R, respectively, but are provided with a two-station thermocouple gage control, with separate output meter. Prices for these two units are $502 and $552. Again, cabinets are $28 extra.

PULSE TRANSFORMERS
with ferrite cup cores



TECHNITROL ENGINEERING Co., 2751 N. Fourth St., Philadelphia 33, Pa. The new M series of pulse transformers measure only 0.44 in. in diameter by 0.56 in. long. They can be wound to cover a range of pulse widths from 0.05 μsec to 2.0 μsec. The transformers weigh only 4 grams and are completely encapsulated for protection.

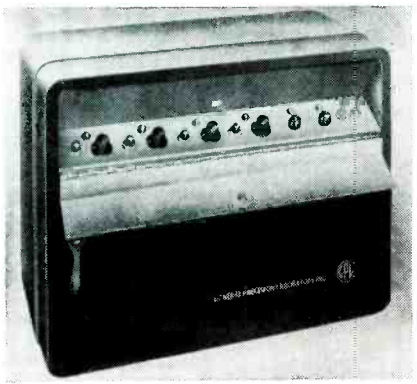
Specially designed ferrite cup cores make it possible to wind transformers of this size covering a wide range of applications in transistor and tube circuits.

▶ **Prices**—For three winding and two winding types prices are $8.50 and $8 each, respectively, for quantities of 1 to 3; $7.50 and $7.15 each for lots of 4 to 10; $6.75 and $5.85 each for 11 to 50; and $6.25 and $5.45 each for 51 to 100.

CAMERA SWITCHER
for industrial tv systems

GENERAL PRECISION LABORATORY, INC., 63 Bedford Rd., Pleasantville, N. Y. Model PD-133 camera switching unit permits operation of four PD-150 tv cameras from a single camera control unit. Switching units may be cascaded to provide pushbutton selection of any number of cameras. Price of the PD-133 is $1,430.

▶ **Automatic Sequential Switching**—With the addition of a motor driven timer or a series of thermal activated relays, it is possible to provide automatic sequential switching of any number of GPL cameras thus providing completely automatic remote surveillance of an automated production line.



Preset control of gain, blanking, beam, target and focus for each camera, plus current regulation of electrical focus and camera heater circuits, makes reliable pushbutton or automatic sequential switching of a multiple camera system possible.

CAPACITORS
miniature and subminiature

CAPCON, INC., 25 Willett St., New York 2, N. Y., is now producing a complete line of miniature and subminiature capacitors of all types. They are ideal for applications

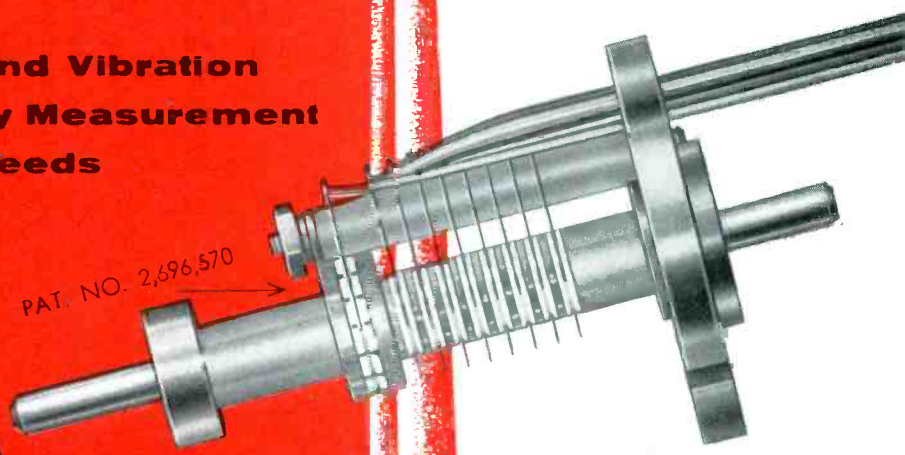
For ACCURATE HIGH SPEED SWITCHING..

Specify ELECTRO TEC

miniature ultra-low torque Precision Selector Switch

- Withstands Shock and Vibration
- Offers High Accuracy Measurement
- Operates at High Speeds

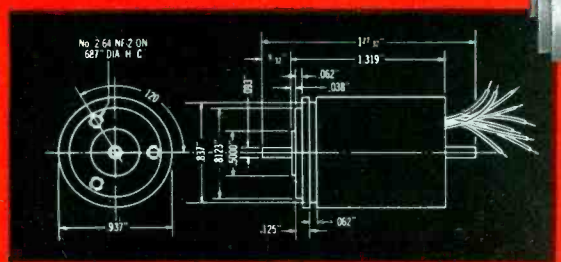
This new Electro Tec Precision Selector Switch is ideal where miniature size, low friction torque, high accuracy, and low electrical noise at high speeds are requirements. Simplified circuits and long service life recommend it for a wide variety of uses including sampling, pulse generation for precision measurement, telemetering and strain gage applications, in aircraft, missiles, servos, computors, etc. Switch design incorporates many exclusive features that have gained industry-wide acclaim for Electro Tec precision slip rings, commutators and brush blocks.



CALL OR WRITE FOR ILLUSTRATED BROCHURE

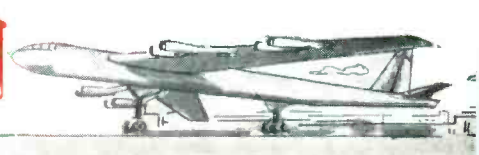
8 or 10 position switches in standard size 10 synchro housings are available for immediate delivery; other circuit combinations supplied to specifications.

ACTUAL SIZE



Electro Tec Corp.

SO. HACKENSACK
NEW JERSEY
Tel.: HUbbard 7-4940



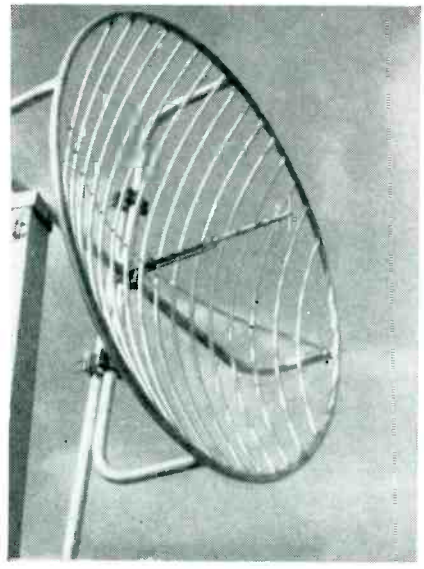
where space is severely limited.

► **Available**—The tiniest capacitor most suitable for any given application can be supplied by the company. This includes the following types: paper, metallized paper, electrolytic, mica, ceramic, and all the film dielectric capacitors such as Mylar, Teflon and polystyrene.

The capacitors are available in all capacitances from 0.1 $\mu\mu$f to 500 μf, and in capacitance tolerances from 0.1 percent to 20 percent. Units are furnished in voltages from 3 v to 1,000 v. Operating temperature ranges are available as specified, from −65 C to +200 C, without derating.

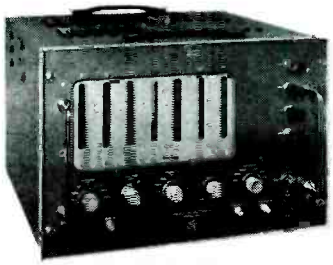
Units can be supplied cased or uncased, flat or round. Leads can be positioned radially, axially, for plug-in or in any other required position.

Prices are determined by quantities ordered of a particular rating and tolerance required.



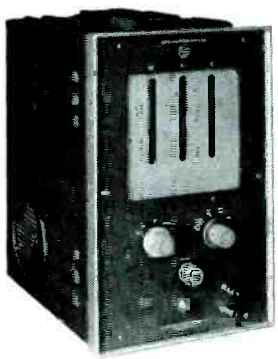
PARABOLIC ANTENNAS with multi-element grid

MARK PRODUCTS CO., 6412 W. Lincoln Ave., Morton Grove, Ill., announces a new series of parabolic antennas for the 890-960 mc and 450-470 mc regions. At 960 mc three models are available: P-942, P-972 and P-9120 are 42 in., 6 ft and 10 ft in diameter and produce gains of 15, 20 and 25 db respectively over a dipole. At 460 mc two units are available: P-472 and P-4120 are 6 ft and 10 ft in dia-

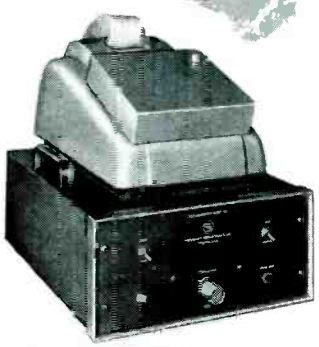


501: TIME-RATE INDICATOR
Frequency Measurements 0 cps to 10 mc.
Period Measurements 10μ sec to 28,000 hours.
Recorder Output; Timing Pulse Output; Heterodyne Outputs.

502: PREDETERMINED COUNTER
Input Sensitivity
A.C: 120 millivolts rms.
D.C: 3.5 volts.
Predetermined Pulse Output.
Pulse Train Output.
100 kc Oscillator Output.



503: DIGITAL MULTITESTER
DC Ranges: ±.01 to ±1000 v.
Relative Accuracy: ±0.15% of full scale.
AC Range: .01 to 1000 V RMS.
Relative Accuracy: ±1% of full scale.
Resistance Range: 10 ohms to 10 MEG.
Relative Accuracy: ±2% of full scale.
Measurement Rate: 10 per second.



504: DIGITAL RECORDER
Decimal Digits per Line: Seven.
Printing Rate: Variable from approximately 4 to 60 per minute, or manual.
Input Requirements: Normally wired to accept code voltage outputs from LFE scalers in the following order:

THE ANSWERS ARE AT YOUR FINGERTIPS

Here are four late model precision instruments from LFE to help you solve your problems in research, production, test and development.

The Model 501 **Time-Rate Indicator,** a 10 megacycle digital frequency meter. Also measures time interval periods, ratio and totals at the turn of a switch. The Model 502 **Predetermined Counter** counts to a predetermined number of pulse and gives a control signal output. Useful for automatic packaging, control of machine tools, generation of precision delays and so forth. The Model 503 **Digital Multitester,** the challenging digital meter which measures ac and dc voltages and resistances to new accuracies. The Model 504 **Digital Recorder,** designed for use with Models 501 and 503 and LFE plug-in scalers, records readings continuously -- up to 1 reading per second.

For more specifications and details about each of these four outstanding performers, write for our free informative bulletins and the name of the LFE Engineering Representative nearest you.

LABORATORY FOR ELECTRONICS, INC.
75 PITTS STREET • BOSTON 14, MASSACHUSETTS

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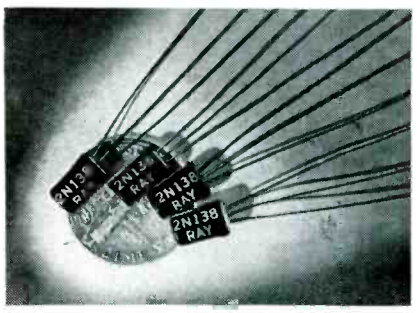
meter and produce gains of 15 and 20 db respectively over a dipole.

▶ **Construction**—The multielement grid construction affords many economies in production allowing for lower costs especially in the larger sizes as compared with spun or mesh type reflectors. The low weight and wind loading allow for great savings in tower and installation costs as well as the possibility of utilization of these parabolas on existing towers where wind loading caused by conventional spun parabolas would be prohibitive. Adjustable mounts are also available to allow for tilt in elevation where necessary.



SMALL TRANSISTOR
is *pnp* fused junction type

RAYTHEON MFG. CO., 55 Chapel St., Newton 58, Mass., announces a new *pnp* fused junction germanium transistor for push-pull class B audio output applications. The 2N138 is sold only in pairs matched for optimum output and minimum distortion.

In a typical class B application using a 4.25-v supply the average power output is approximately 50 mw with a power gain of 30 db. The small physical dimensions are identical to those of the 2N130 series of miniature transistors.

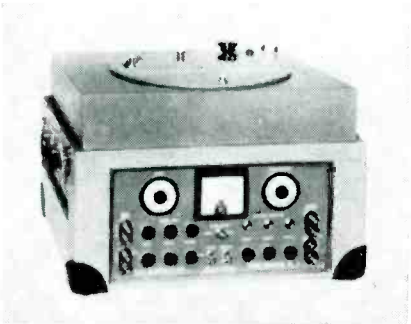
ALL-PURPOSE RELAY
with wide application

OHMITE MFG. CO., 3681 Howard St., Skokie, Ill., has announced the Amrecon model DOS relay. Specially designed to meet the rigorous standards for aircraft relays, model DOS meets industrial needs for a compact, lightweight relay capable of handling power loads usually

demanded of much larger and heavier relays.

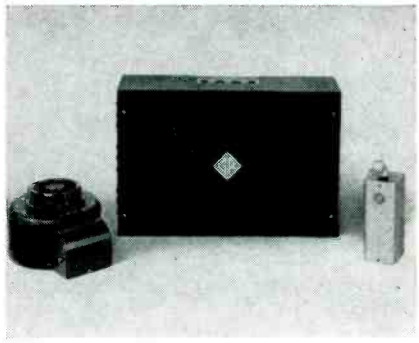
▶ **Insulation**—The insulation is of high grade, molded phenolic material.

Contact rating is 15 amperes at 115 v a-c or 32 v d-c noninductive load. The relay is available from stock in a wide range of coil operating voltages for either a-c or d-c. Write for catalog R-26.



TIME DELAY UNIT features controlled amounts

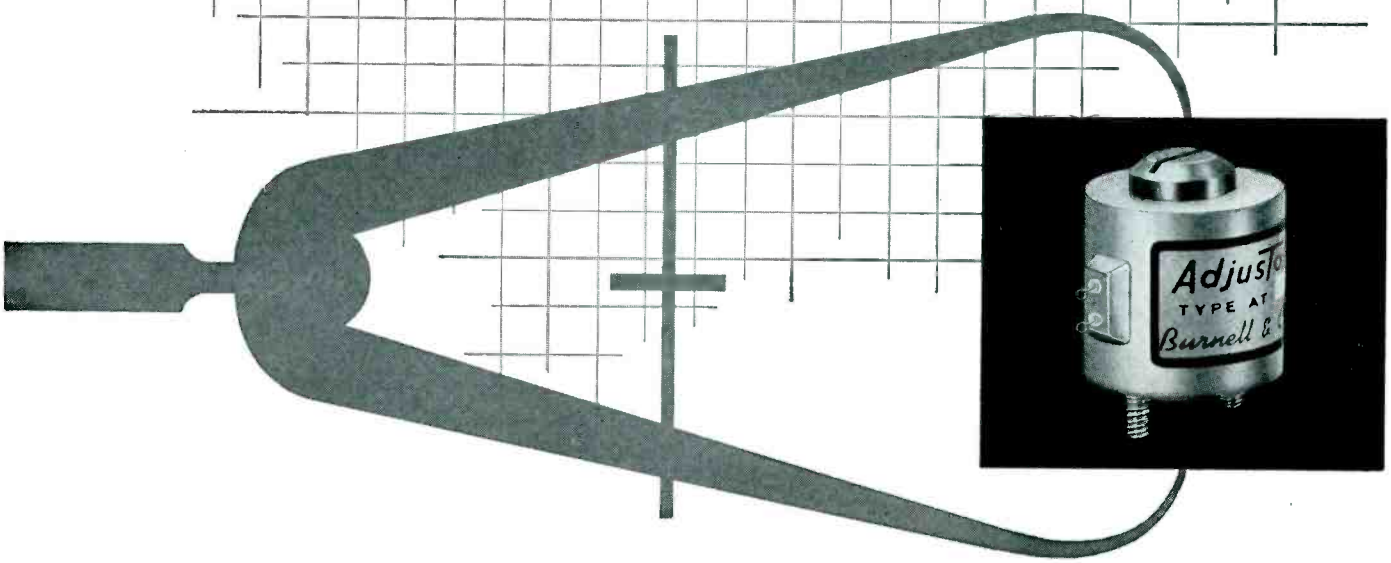
KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N. J., has announced the Auto-Vox, a variable time delay instrument designed to introduce controlled amounts of delay into an audio system. It provides one output as a reference and a second output with variable delay in two ranges. The unit permits two signals to be developed in two independent channels with separate or mixed output. Price is contingent on ranges specified.



SPEED CONTROLS in 1 and 1½ h-p ratings

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. A small, rugged, and inexpensive drum controller is used in place of magnetic contactors as the switch-

AdjusToroiD®



A LOW-COST ADJUSTABLE TOROID

- precise, instant adjustment
- inductance variation of 10%
- eliminates critical close tolerance capacitors
- high Q
- no external power supply
- truly hermetic sealing
- temperature coefficients same as fixed toroids
- no increase in case diameter
- developed by Burnell, creators of the Rotoroid®

Write for Adjusteroid Technical Brochure A-55

LET BURNELL ENGINEERS SHOW HOW USE OF ADJUSTOROIDS REDUCES EQUIPMENT COSTS

Many types of Adjustoroids and Rotoroids now available from stock.

Teletype: Yonkers, N. Y. 3633

BURNELL & CO., INC.

45 Warburton Avenue
Yonkers 2, New York
Pacific Division: 720 Mission St., S. Pasadena, Calif.

ing unit for forward, reverse and stop operations. The controller and the speed-adjusting Variac are separate from the main chassis which can therefore be mounted in any out of the way location.

► **Protection**—A dynamic braking resistor is included for use where quick stopping is required. Overload protection of the Klixon type with appropriate time-delay characteristics is incorporated in the Variac.

► **Prices**—Type 1704-B 1 h-p control is priced at $330 complete, and at $308 without the drum controller; type 1705-B 1½-h-p control is priced at $380 complete and at $358 less the controller.

D-C AMPLIFIER
uses new chopper circuitry

KAY LAB, Box 16, San Diego 12, Calif., has announced model 110 chopper stabilized broadband d-c amplifier.

► **Performance** — Longtime drift (40 hr) of ±2μv is assured by the use of radically new chopper circuitry. Equivalent input noise is less than 5μv peak to peak for 3-cycle bandwidth, less than 5μv rms for 750-cycle bandwidth, and less than 12μv rms for 50-kc bandwidth. Variable gains of 0, 20, 30, 50, 70, 200, 300, 700, 1,000 accurate to 1 percent are provided. Bandwidth is flat within 3 db from d-c to 30 kc.

A unique output circuit with 4 tubes arranged symmetrically with multiple feedback loops provides a damage-proof circuit which recovers rapidly from overloads. Output

of the amplifier is 25 v with a 1,000-ohm load. Linearity is better than 0.1 percent.

Modular plug-in construction is used so that 3 amplifiers can be housed in a standard 19-in. rack adapter. The amplifier is extremely useful for multiple strain gage testing and as a recorder amplifier.

Price, complete with cabinet or rack adapter, is $550.

MILLIAMMETERS
for industrial panel uses

HOYT ELECTRICAL INSTRUMENT WORKS, 42 Carleton St., Cambridge 42, Mass. Model 649 d-c milliammeter provides a 2½-in. scale. Antistatic treated, virtually dust tight and with standard mounting dimensions, it is designed to provide accuracy and legibility in modernized industrial panel installations.

Identical in appearance and mounting dimensions, the companion a-c meter, No. 650, has an accurate, air-damped jeweled repulsion movement. Both meters are available in quantity only.

VOLTAGE SOURCE
constant from —55 to 100 C

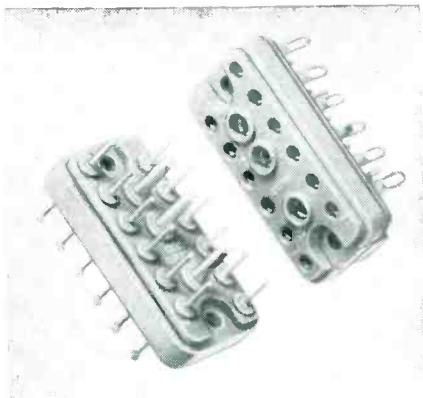
AVIEN, INC., 58-15 Northern Blvd., Woodside 77, N. Y., has announced

For additional information on all items on this page, use post card on last page.

a new high-stability voltage source that provides constant d-c output through ambient temperatures as low as —55 C and up to 100 C. Known as the k-volt standard, the unit is designed to replace the chemical cell and v-r tube as an absolute reference, constant output working supply or precision voltage regulator in airborne, lab, and other instrumentation requiring extreme stability over widely varying environmental and operating conditions.

▶ **Design**—The unit utilizes a voltage regulating network based upon special types of double anode silicon diodes selected for stability of conduction characteristics. Using neither tubes nor moving parts, it is unaffected by position, vibration or mechanical shock, and conforms to MIL-E-5272A. Uniformity of output is maintained through repeated on-off switching.

The unit, which measures 1½ in. high and 1¼ in. diameter, weighs less than 3 oz. It is available for operation from 26.5 v d-c, or 117 v a-c, with d-c output of 6 v or 1 v, at 1 ma or 10 ma. Power consumption is less than 1.8 w. Case is hermetically sealed and employs a 7-pin miniature plug-in base.

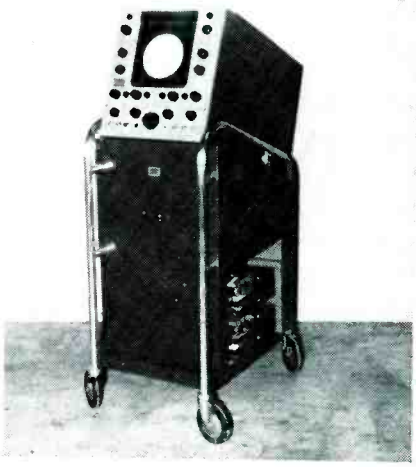


PRECISION CONNECTOR features 15 contacts

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City, N. Y. The plug of the GS series has twelve 0.040-in. diameter pin contacts and three 0.090-in. diameter center polarizing contacts molded into a mineral filled mica phenolic body. Pin contacts are phosphor bronze and gold plated. Floating socket contacts are Beryllium cop-

per, gold plated 0.0002 in. thick. Soldering lugs are annealed to prevent breakage.

Technical information, specifications and diagrams are available free on request. Write for bulletin GS.



VIDEO SIGNAL SCOPE
10 test functions in 1 unit

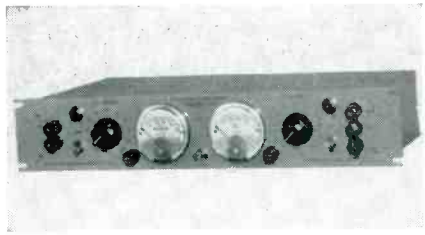
TARC ELECTRONICS, INC., 48 Urban Ave., Westbury, N. Y., has developed Colorscope which combines the functions of seven bulky test units in one compact instrument. The new unit occupies a space of only 14 in. by 16 in. by 24 in., plus power supply, and can be set up for dolly carry or rack mounted.

▶ **Displays**—By means of a function switch, 10 displays are seen in sequence on the crt face: picture monitor, pulse cross monitor, two line horizontal time, two fields at vertical time, NTSC vectorscope presentation, external vertical signal at horizontal or vertical time, external horizontal and vertical amplifier, phase demodulator scope, and quadrature phase demodulator scope.

The unit is presently priced at less than $5,000.

POWER PACK
for transistor operation

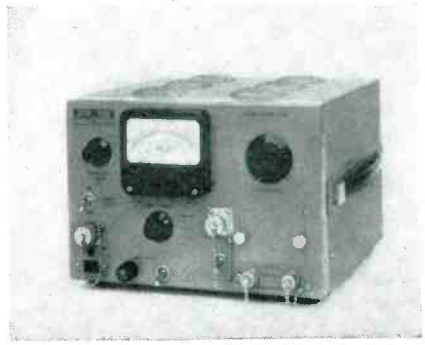
ELECTRONIC MEASUREMENTS CO., Lewis St., Eatontown, N. J. Use of new circuit techniques in the 212-A transistor power pack results in a unit 3½ in. tall, weighing 14 lb, to provide 0 to 100 v d-c at 100 ma. Two approximately calibrated con-



trols sweep 0 to 100 v and 0 to 10 v respectively, to permit precise adjustment from 0 to 100 v. A modulation unit is provided to permit measurement of transistor parameters by the small-signal method.

► **Features**—Remote control connector is provided whereby the unit may be controlled from a distance by inserting resistance across a two-terminal line. Voltage is controlled according to $E_0 = KR$ where K is a constant and R is the inserted resistance. A typical application would be tube testing with automation.

Other features include 0.1-percent regulation, 0.15-percent stability, ½ mv ripple and polarity reversal with a switch.



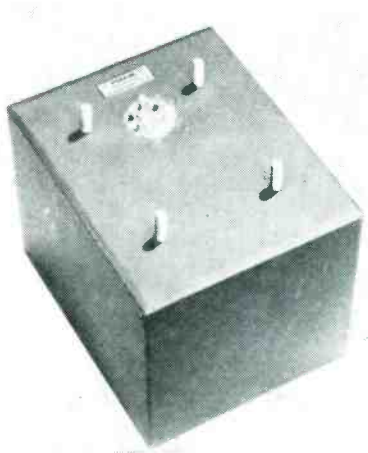
NOISE GENERATOR is a well-filtered unit

R S ELECTRONICS CORP., 435 Postage Ave., Palo Alto, Calif., has produced a noise generator designed to measure i-f amplifier and other receiver noise figures by providing a known amount of random noise to the amplifier under test. It features diode current indication within 1.0 percent accuracy and BNC connectors for use with single or double-ended receiver inputs.

Plug-in precision resistors (±1 percent) permit selection of resistance while adjustable capacitors permit adjustment of capacitance, to simulate various types of mixers. The noise diode operates on rectified

filament power to eliminate line voltage ripple and harmonics.

►**Shielding**—Extremely well filtered, the noise generator has double and triple shielding to eliminate danger of pickup. Under certain conditions the unit is useful up to 500 mc. Provisions include a remote control, so that the noise output may be automatically turned on and off by the attenuator switch in RS post amplifier.



POWER SUPPLY
for operating strain gages

PERKIN ENGINEERING CORP., 345 Kansas St., El Segundo, Calif., has developed a hermetically sealed strain gage power supply for operation of strain gages and telemetering equipment in aircraft systems.

►**Specifications**—The d-c output is 5 v at 1 ampere; a-c input, 105 to 125 v, single phase, 380 to 420 cps; duty cycle, continuous; controls, potentiometer, externally mounted; dimensions 5 in. by 5 in. by 4 in.; and weight, 6½ lb.

Bulletin M562 is available on request describing and illustrating this unit in detail.

SIGNAL GENERATOR
a multipurpose unit

BYRON JACKSON DIVISION, Borg-Warner Corp., 492 E. Union, Pasadena, Calif., announces the AN/USM-16 standard signal generator. Over its range of 10 to 440 mc it can be tuned to within less than 1,000 cps of the desired frequency,

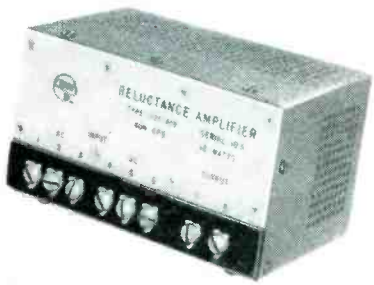
with reference to a two-stage temperature-controlled crystal calibrator, without charts or auxiliary equipment.

Stability is assured by automatic frequency and automatic level control.

▶ **Outputs**—Available outputs are c-w, a-m, f-m, pulse modulation (with or without video pulse of variable rate, width, and delay and a sync out pulse through separate connectors), or swept frequency with marker pip.

The instrument has an output of 0.1 μv to 0.224 v (—127 to 0 dbm) into a 50-ohm load with the selected output remaining constant over the full frequency range.

Price of the unit is $5,000.



SERVO AMPLIFIER
with instantaneous response

SERVO CORP. OF AMERICA, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y. Type 1121-A18 reluctance servo amplifier accepts two a-c inputs and one d-c input in any combination. With instantaneous response (time lag is negligible compared to one cycle of supply frequency), it produces proportional and reversible power circuit output for most 115-v 400-cycle servo motors rated at 18 w or less.

▶ **Features**—Operating directly from the power line, total power consumption is low for small input signals and less than half plate dissipation is required at no load. Featuring built-in power supply and built-in preamplifier, the amplifier is compact—the factor of output vs weight is over 5 w per lb.

The unit has no tuned elements. Supply voltage variations will nat-

urally affect peak power output correspondingly, but with little effect on the amplifier's gain.

VOLTAGE REGULATORS
are ± 0.25 percent accurate

MAGNETIC RESEARCH CORP., 200 Center St., El Segundo, Calif. Stablvolt magnetic a-c line voltage regulators perform with ±0.25 percent regulation accuracy with load variations from 0.3 to 3 kva. Output voltage is stabilized within a band of 0.25 v rms for line voltage variations from 100 to 130 v and line frequency variations from 57 to 63 cps. Control of voltage output is continuously adjustable between 110 and 120 v rms.

▶ **Long Life**—Magnetic amplifiers replace tubes in the new regulators to provide a long-life a-c power source of extreme reliability. There are no fragile elements to burn out, no parts to wear out.

Price is $785.

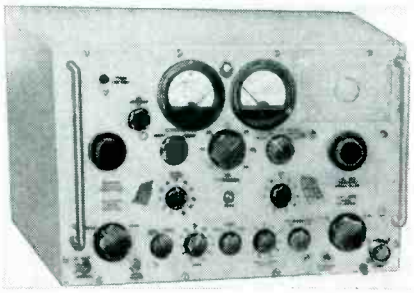
PROTECTIVE COATING
for printed circuitry

PHOTOCIRCUITS CORP., Glen Cove, N. Y. A new, noncorrosive film protects and prolongs shelf life of etched circuit boards that are inventoried prior to assembly and dip soldering. The film is applied after etching the printed circuitry.

Trade-named "Photofinish No. 4," the coating is an inexpensive colorless special plastic film applied thin enough to be hardly perceivable. The film vaporizes upon contact with hot solder leaving no disagreeable residue or contamination

of the solder pot when dip soldering.

Photofinish No. 4 has excellent electrical characteristics. It is easy to handle both during and after application. The film will be applied by the company prior to shipment of printed circuit boards upon specification.



FIELD STRENGTH METER
for 19 to 125 mc range

TELECTRO INDUSTRIES CORP., 35-18 37th St., Long Island City 1, N. Y. Model 728 radio field strength meter makes field strength measurements in the range of 19 to 125 mc and will accurately measure intensities ranging from 2 μv to 2.5 million μv per meter. It can be used to measure the field intensities of both a-m and f-m transmitting stations.

Provisions for linear or logarithmic output indications for recording meter use are included. Readings in db above 1 μv per meter are made by the simple addition of three values. Measurement of noise intensities can be made by means of accessory probes.

Net price is $2,200.

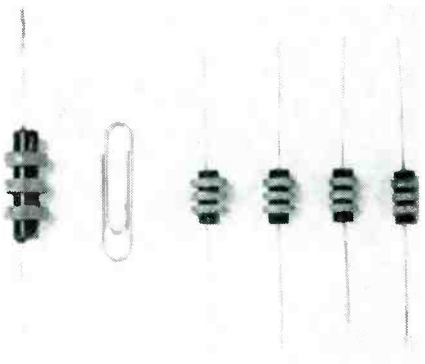
SINE-WAVE GENERATOR
0.9 cps to 510 kc in 5 ranges

ALLEN B. DUMONT LABORATORIES, INC., 760 Bloomfield Ave., Clifton, N. J. A new sine-wave generator for magnetic amplifier, servomechanism and computer development, for laboratory testing or field maintenance, and for measurements of frequency response, bandwidth or distortion has been introduced.

► **Features**—Type 348 sine-wave generator features an extended l-f range, high output power, low distortion and a calibrated output control including a 4-step decade attenuator. Frequency accuracy is

±2 percent, with vernier tuning and a scale length of 14 in. on each range. Five decade tuning ranges and an additional band-spread h-f range are provided.

Price is $325.



TINY FERRITE CHOKES
have Q to 100

SUPEREX ELECTRONICS CORP., 4 Radford Place, Yonkers, N. Y. Illustrated are the new microminiature ferrite cored chokes. An idea as to the size of these components can be had by their comparison to a paper clip and the 2.5-mh ferrichoke. The Mini-Choke is available from stock, in values of: 500μh, 1 mh, 2.5 mh, and 5 mh.

A 4-page inductor catalog, covering specifications of Mini-Chokes, as well as other types of inductors, is available.

PRECISION POT
accurate voltage divider

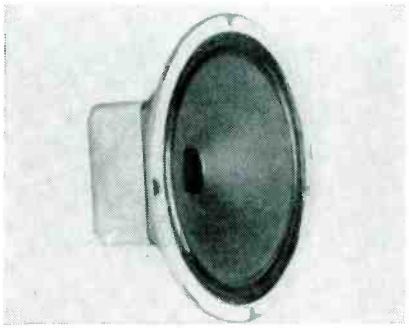
NIPPON ELECTRIC CO. LTD., 1753, Shimonumabe, Tamagawamukai, Kawasaki City, Japan. Type A precision potentiometer is intended to subdivide any audio or d-c voltage with an accuracy which is better than 8 parts in 100,000. A built-in

sinusoidal-voltage generator is incorporated.

The unit is designed to be used for model measurements of electron trajectories within a vacuum tube by an electrolytic trough.

► **Makeup**—The unit essentially consists of two parts: the a-f oscillator and the voltage divider. The a-f oscillator is a Wien-bridge resistance-capacitance oscillator of purely sinusoidal waveform operating at around 550 cps. The output voltage of the oscillator is around 5 v.

The voltage divider consists of 4 resistance elements. The first 3 have a total resistance of 200 ohms each and are capable of dividing the oscillator voltage in 100 divisions. The fourth element has a total resistance of 20,000 ohms and the same voltage can be divided into 1,000 divisions.



LOUDSPEAKER
an 8-in. industrial unit

ALTEC LANSING CORP., 800 Hollywood Blvd., Hollywood, Calif. Model 401A loudspeaker is an 8-in. industrial all-range type designed to meet the requirements of public address and various types of commercial sound systems.

It has a power capacity of 14 w, impedance of 8 ohms, with resonance 75 cps. The voice coil diameter is 1 in., and the depth $3\frac{5}{8}$ in. Price is $13.20.

DATA RECORDER
a 5-channel, 3-speed unit

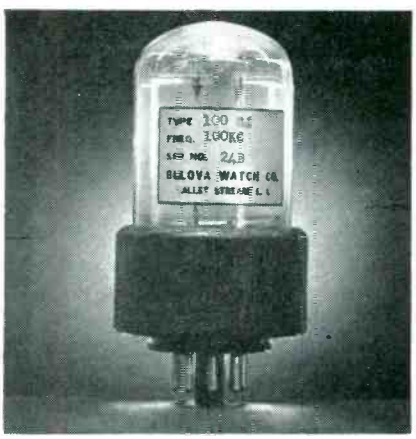
TELECTRO INDUSTRIES CORP., 35-18 37th St., Long Island City 1, N. Y. Model TR-150-5 magnetic tape recorder-reproducer is designed specifically for recording and repro-

ducing data from telemetering channels. Data are recorded on and reproduced from a 2,400-ft magnetic tape moving at 15 ips, 30 ips or 60 ips.

► **Response**—The frequency response is 200 to 20 kc ± 3 db at 15 ips; 200 to 40 kc ±3 db at 30 ips; 100 to 80 kc ±3 db at 60 ips. Rewind time is less than 1 minute for a full reel of tape.

The model TR-150-5 is supplied as 5 separate units, each suitable for mounting in a standard relay rack. The separate units comprise a low and high-voltage power supply; filament and bias supply, recording amplifiers, playback amplifiers and tape-transport mechanism.

Price of the machine is $5,500; delivery, 120 days.



CRYSTAL UNIT
measures 4⅛ in. by 2 in.

BULOVA WATCH CO., INC., Valley Stream, L. I., N. Y., has added model GA-100 to a line of high-stability crystal units. It contains

a 100-kc GT high precision quartz element in an evacuated glass bulb fitted with a standard octal base. The overall dimensions are $4\frac{1}{8}$ in. by 2 in.

► **Other Features**—The unit exhibits a frequency shift of less than $\frac{1}{2}$ cycle over a temperature range of 25 C to 70 C. Aging characteristics average less than one part in 10^8 per week. Readily attainable are Q's in the order of one million.

LONG-LIFE BATTERIES
for transistor applications

RADIO CORP. OF AMERICA, Harrison, N. J., has developed two new battery types, specifically designed for transistor applications. Both the VS300 and VS301 are being recommended as power supplies in new transistorized portable receivers. The VS300 is a 9-v unit designed for transistorized portables. The battery is approximately 2 in. long and 1 in. in diameter. The VS301 was designed for applications requiring long-life operation and low cost-per-hr playing time. Its dimensions are 8 by $1\frac{9}{16}$ by $2\frac{13}{16}$ in. Voltages of 3, 6 and 9 v may be obtained from a small 4-hole socket mounted flush with the battery case.

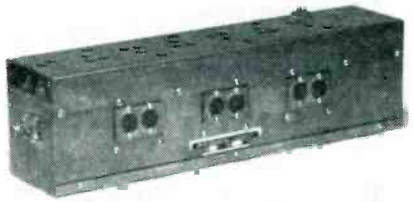
► **Assemblies**—Both battery assemblies consist of 15 separable 1.4-v alkaline-type dry cells enclosed in a plastic sleeve. The voltage required for any experimental transistor application is obtained by slicing off the number of cells needed.

FASTENERS
with spring-steel coil form

TINNERMAN PRODUCTS, INC., P. O. Box 6688, Cleveland 1, Ohio, is producing a new spring steel coil form fastener that accommodates

0.218-diameter electronic tubes. It overcomes the problem of holding close tolerances during high-speed mass production.

▶ **Assembly**—To assemble, coil screw is threaded into fastener where sheared prongs provide correct tensioning on screw. Coil tube is then inserted into fastener and retained by four small barbs on inside. Assembly is then snapped by hand into chassis where tab on leg of fastener fits into small hole in panel to prevent it from turning.



UHF AMPLIFIERS
are wide-band units

APPLIED RESEARCH INC., 163-07 Depot Road, Flushing, N. Y. Models UH-4(A) and UH-6(A) amplifiers feature a center frequency of 400 mc and a bandwidth of 50 mc. They incorporate the GL6299 vacuum tube in lumped constant, triple-tuned circuitry. All efforts have been made to maintain a low peak-to-valley ratio to preserve phase linearity in the passband.

▶ **Specifications**—Both models have an input and output impedance of 50 ohms. Power gain for the UH-4A is 35 db; for the UH-6A (illustrated), 50 db. Noise figure for each is $\leq$ 7 db, and peak-to-valley ratio, $\leq$ 2db.

COIL CEMENT
available in two viscosities

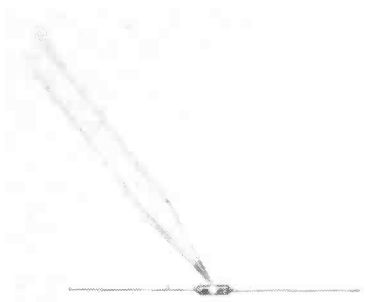
BARRETT VARNISH CO., 1532 S. 50th Court, Cicero 50, Ill., has introduced Gripo, a new cement especially recommended for use on electronic coils. It provides a firm bond to overcome fragile coil conditions and has excellent insulating properties as well.

▶ **How Applied**—Gripo may be applied by dipping, spraying or brushing, and since it is thermo-

setting, must be cured at high temperatures. Television coils should be dipped after assembly and baked at a temperature of 275 to 300 F for 30 to 45 minutes. Large coils will require higher temperatures and longer baking time.

Gripo is available in two viscosities. Gripo X is heavier bodied, corresponding to X on the Gardner scale, while Gripo C is lighter, corresponding to a reading of F. Price of the former is $3.70 per gallon in drums, and the latter, $3.50 per gallon in drums. There is an additional charge per gallon for smaller quantities.

The cement has a minimum dielectric strength of 2.500 v per mil d-c.



COMPACT RESISTORS
are wire-wound type

PRECISION RESISTOR CO., INC., 107 U. S. Highway No. 22, Hillside 5, N. J., has available a line of precision wire-wound resistors designed especially for subminiature and transistor requirements where physical size, weight and simplicity are of prime importance.

► **Varieties**—They are supplied in either inductive or noninductive windings in varying sizes from ¼ in. up to ¾ in. lengths in any resistance values desired, 0.10 ohm through 0.50 megohm, and in a choice of standard tolerances of ±1, 0.5, 0.26 and 0.1 percent including precision tolerances. All have temperature-coefficient of resistance of 20 ppm per deg C.

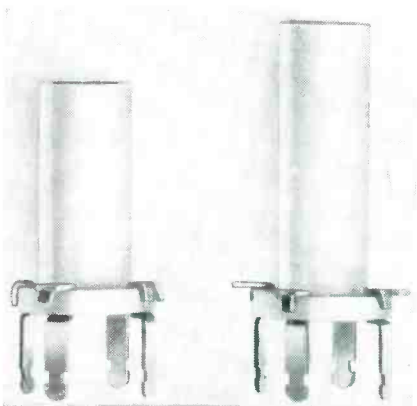
F-M WAVE TRAP
is precision tunable

BLONDER-TONGUE LABORATORIES, INC., 328 North Ave., Westfield,

N. J., has announced a precision tunable trap to eliminate f-m interference in master tv systems and individual tv sets. The weather-protected unit, called MWT-1, may be mounted on the antenna mast, at amplifier inputs or at tv set terminals.

▶ **F-M Aid**—Any f-m channel from 88 to 108 mc may be attenuated more than 20 db. Two trimmer screws tune out the interfering frequency. Rejection ranges from 35 db at channel center to less than 3 db 1.5 mc on either side. The feed-through circuit insures excellent 75-ohm impedance match on all vhf tv channels. Standard uhf connectors are used.

Price is $23.



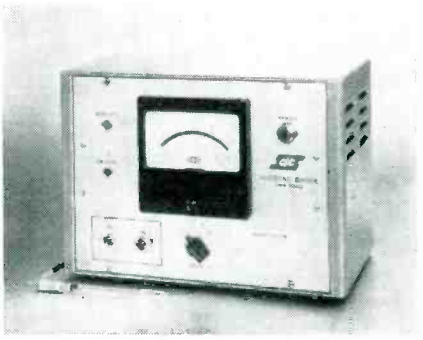
CERAMIC COIL FORMS used with printed circuits

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge, Mass., announces two new printed circuit coil forms, the SPC-11 and SPC-12, made of grade L-5 ceramic. One has a mounted height of $\frac{5}{8}$ in. and the other $\frac{13}{16}$ in. Both have an o-d of $\frac{1}{4}$ in. and have a $\frac{19}{32}$ in. threaded powdered iron core and silicone Fiberglas collar.

▶ **Other Features**—The coil forms are available with 2 to 4 solder lugs and feature a design which allows the units to be dip soldered after mounting. They are available as a form alone or wound to the required specification of the user. They come complete with threaded slug and the terminal collar of silicone Fiberglas is securely fastened to the form.

▶ **Prices**—In quantities of 1 to 49 they sell for 0.174 each; 50-249,

0.154 each; 250-499 0.134 each; and 500-999, 0.119 each.

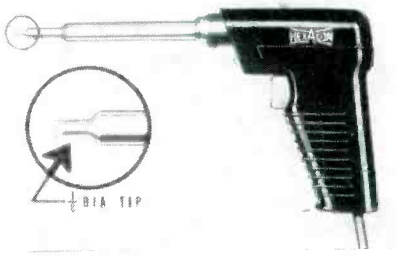


VACUUM GAGE
a 1 to 4-station unit

CONSOLIDATED ENGINEERING CORP., 300 N. Sierra Madre Villa, Pasadena 15, Calif., has announced the Autovac, a 1 to 4-station vacuum gage which gives continuous pressure readings from 100 mm. Hg to 1 micron Hg. It covers substantially all laboratory and industrial applications now using Pirani and similar gages.

► **Features**—A special range-selection circuit provides automatic switching from the millimeter range (100 to 0.1 mm Hg) to the micron range (100 to 1 micron Hg). Other features include (1) wide measuring range, (2) its ability to actuate an external relay circuit for various purposes, and (3) connection for 4 gage tubes.

The single station gage is priced at $275. Each additional station increases price by $25. Thus a 3-station gage is $325.



INSTANT SOLDER GUN
features tiny tip

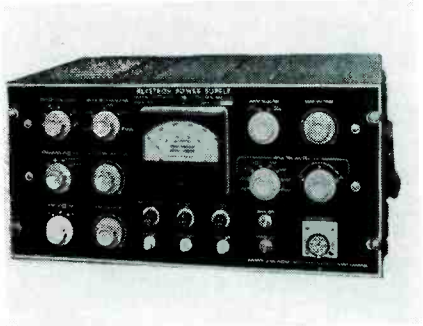
HEXACON ELECTRIC CO., 130 W. Clay Ave., Roselle Park, N. J., announces an instant solder gun with ⅛-in. tip. The gun is soldering-hot in a few seconds, without the use of heavy

transformer or fragile thermostats.

Trigger control gives any degree of heat required without danger of overheating. The gun has more heat capacity than size indicates because the heating element is right in the $\frac{1}{8}$-in tip.

▶ **Applications**—It is recommended for printed circuits, subminiature assemblies, radio, telephone, tv, laboratories and the like.

Rated at 150 w and available for 120 v, it operates identically on d-c as well as a-c, any cycle. List price is $7.95.



KLYSTRON POWER SUPPLY
up to 75 ma beam current

BROWNING LABORATORIES, INC., 750 Main St., Winchester, Mass. Model TVN-11B universal klystron power supply provides up to 75 ma beam current at voltages from 225 to 500 v, with both beam and reflector voltages being continuously variable. Price is $425.

▶ **Also Featured**—It has both square wave and saw-tooth modulation, the square wave with minimum overshoot and the saw tooth with good linearity for driving an external instrument; reflector voltages from 25 to 875 v with less than 1-percent regulation and better than 2.5-mv ripple content on both beam and reflector voltages.

A large illuminated panel meter indicates beam voltages and currents, and accurately calibrated panel controls give rapid readings of reflector voltage and current.

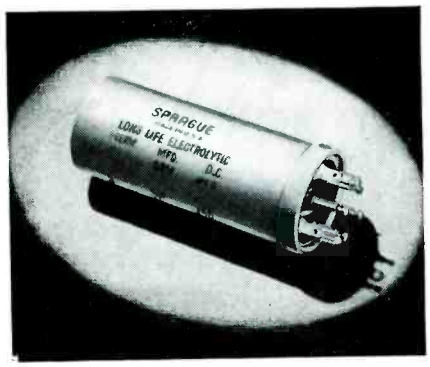
CODING SYSTEMS
digitize analog data

WANG LABORATORIES, INC., 37 Hurley St., Cambridge 41, Mass., an-

nounce their angular position coding systems, a complete line of compact units for converting analog data which is in the form of a shaft position into digital form.

The systems are available in two types—a nonambiguous coded type which can be read out on demand, either on the fly or at static shaft positions, and the incremental coded type which registers the instantaneous position of the shaft and each incremental change.

► **Cost**—The price of the coder units type 3A (1,000 parts per 360 deg) is $395; type 13A (10,000 parts per 3,600 deg) is $745; and the price of the translation matrix which will accommodate static as well as on the fly readout (type 3AT) is $700. A translation matrix providing static readout only is $500.



CAPACITORS
of the electrolytic type

SPRAGUE ELECTRIC CO., 35 Marshall St., North Adams, Mass. Type 17D electrolytic capacitor is now applicable to other electronic equipment. Long life and faultless performance require this series to use specially high-purity materials and the utmost care in manufacture.

Turret-terminal and mounting lugs and a special vent construction are molded right into the cover of the capacitor as are the numbers which identify each terminal. The seal, made by crimping the aluminum can on to a gasket, has been long proven for dependability. The cans themselves are covered with a corrosion-resisting insulating coating.

► **Ratings**—Nineteen standard ratings covering a wide range of appli-

cations in single, dual and triple section units are available in the series. All are characterized by low maximum leakage current and remarkable life test capabilities.

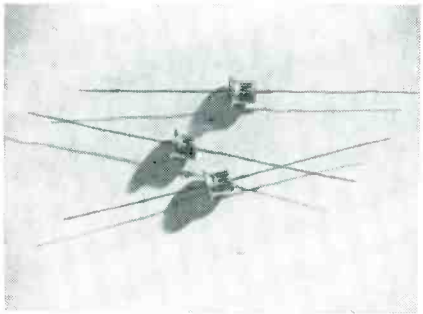
Complete technical data are provided in engineering bulletin 340.

FREQUENCY METER
with built-in calibrator

VARO MFG. CO., INC., 2201 Walnut St., Garland, Texas. Model 6501 frequency meter features a built-in precision calibrator using the Varo temperature-compensated tuning fork. Output terminals permit using the 400-cps reference frequency in laboratory applications, or as a secondary frequency standard.

▶ **Versatility**—Model 6501 has two scales for extra versatility. These scales cover the range 395 to 405 cps, and 350 to 450 cps. The unit will measure signals of 2 to 200 v rms.

Overall accuracy is better than 0.1 percent, and the accuracy of the calibrator reference frequency is 0.05 percent or better. Dimensions are 5¾ in. wide, 7⅞ in. high and 4½ in. deep. Price is $345.

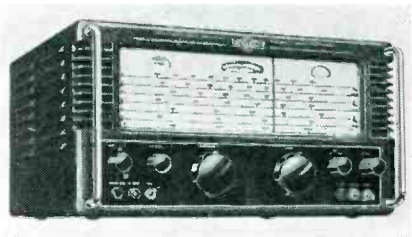


POWER DIODES
miniature, highly efficient

CLEVITE TRANSISTOR PRODUCTS, a division of Clevite Corp., 241-257 Crescent St., Waltham 54, Mass., have announced germanium junc-

tion power diodes types 1N91, 1N92 and 1N93. They are designed for use in high-level modulation and detection in communications and control, a-f switching applications and rectification in the power range up to 25 w.

▶ **Specifications**—The diodes feature peak inverse voltages up to 300 v; peak forward currents up to hundreds of ma; low full load voltage drops (approximately 0.5 v); operating frequency, 50 kc; and storage temperature, 85 C.



F-M/A-M RECEIVERS cover 19 to 500 mc

MARCONI INSTRUMENTS, 44 New St., New York 4, N. Y., has available two new f-m/a-m Eddystone receivers for measurements in the range of 19 to 500 mc.

Model 770R (covering 19 to 165 mc) is a superhet with a 5.2-mc i-f. Narrow-band a-m and f-m operation is augmented by a wide-band f-m position for use with high-quality transmissions. Deviation ranges are 15 and 75 kc. Sensitivity is better than 5 μv for 50 mw output and 15-db signal-noise ratio. A maximum of 2½ w audio is available from the push-pull low-distortion output stage.

The 770U (covering 150 to 500 mc) is a double superhet with i-f frequencies of 50 and 5.2 mc designed for a-m and f-m operation. Sensitivity is better than 10 μv for 50 mw output and a signal to noise ratio of 15 db. The bandwidth is 15 kc and image rejection is 25 db down at 400 mc and 10 db down at 200 mc.

MAGNETIC AMPLIFIER low-level, push-pull unit

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. Type R6A5M1 low-level push-pull d-c magnetic am-

plifier is designed to amplify the output of low level devices such as thermocouples, strain gages, thermistor bridges phototubes or crystal detectors so as to operate an insensitive relay or meter. The amplifier is self-contained and requires no external rectifier.

▶ **Specifications**—The unit has a power gain of 60, a low drift of 1 μa and will give 5 mw output with a 300 mv input. Stability and linearity are excellent within the ambient temperature rating of —55 C to + 85 C.

Units can be cascaded for increased gain. The R6A5M1 is hermetically sealed and highly resistant to shock and vibrations.

CRT TEST SET
operates automatically

RESEARCH ELECTRONICS LABORATORIES, Roslyn, Pa. Model 808 Autotester (for manufacturers' use) is a crt test set with one meter to read and one button (on tube socket) to push. Two small meters are for calibration purposes only.

▶ **How It Works**—The operator merely places socket on the tube under test. This automatically starts a timer (adjustable to your own specifications) for warmup

check. If within time (usually 30 seconds) tube emission is not standard (usually 0.5 ma, also adjustable) all further tests are locked out, and an indictor lamp shows SLOW WARM-UP. But a good tube, as soon as it reaches specific emission, automatically changes over to the next position, the standard two neon lamp short and leakage test, which indicates leakages up to 100,000 ohms—and the tube can be bounced in this position. Then gas is read by pushing a button on the crt socket, which automatically regulates all conditions for authoritative gas ratio test. No resetting is necessary—merely pull the socket off and on to the next tube immediately.

Price of the model 808 Autotester is $240.

LAB-TYPE OSCILLATOR covers from 18 cps to 1.1 mc

ALLEN B. DUMONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J. Type 347 extended-range oscillator covers from 18 cycles to 1.1 mc in 5 overlapping ranges. It costs only $150. It weighs 6 lb and measures 6 in. deep, 6½ in. high and 4½ in. wide. Output voltage is 10 v open circuit and distortion is less than 0.2 percent over most of its useful range.

► **Applications**—The combined advantages of the type 347 make it an ideal instrument for testing of sound and high fidelity systems and for work in ultrasonics. The unit's ability to operate on power supplies of 50-400 cps permits it to be used in airborne applications such as

testing of intercom installations and other aircraft electrical systems.

For application where it is necessary to operate the type 347 with balanced output, a new matching transformer, type 2624, is available. This provides the maximum output of +8 dbm.

PRECISION WATTMETER
is a low-power unit

PHYSICS RESEARCH LABORATORIES, INC., 507 Hempstead Turnpike, West Hempstead, N. Y., announces the Goerz (Vienna) low-power precision wattmeter.

▶**Ranges and Accuracy**—With current ranges of 10 ma and 50 ma and voltage ranges of 150, 300 and 450 v at a full-scale accuracy of 0.5 percent, this wattmeter is particularly well adapted to the measurement of power consumption in relay coils, voltage coils and the like.

TELEPHONE AMPLIFIER
uses magnetic induction

REMLER CO., San Francisco, Calif. A new 3-oz telephone amplifier powered by dime-sized batteries is now available for those who use telephones in noisy locations and for

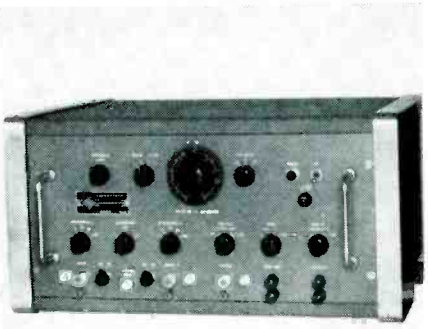
the hard of hearing. The phone aid clips over any style telephone receiver.

The pocket-size electronic device is a reproducing receiver and a 3-stage amplifier with transistors taking the place of tubes. It increases the acoustic output of telephones by 49 db.

▶ **Magnetic Induction**—The phone aid picks up speech from the telephone by magnetic induction which cuts out all room noise. An ingenious circuit shuts out disturbances created by electrical circuits and appliances.

No warmup is necessary. Volume is adjusted while in use and the unit automatically shuts off when removed from the telephone.

Price, including batteries, is $49.50.



ELECTRONIC SWITCH
for wide-band operation

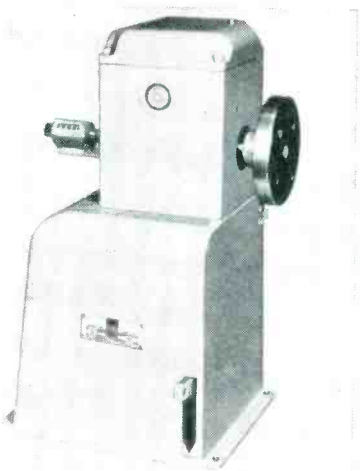
TELETRONICS LABORATORY INC., 54 Kinkel St., Westbury, L. I., N. Y. Model ES-180A wide-band electronic switch provides d-c to 15 mc dual trace oscilloscope presentations on any conventional oscilloscope at switching rates up to 400 kc.

A movable horizontal index and provisions for introducing time markers make extremely rapid and accurate amplitude and time measurements possible. A control dial, calibrated in both volts and percent, allows absolute and relative amplitude measurements to within 2 percent accuracy.

▶ **Specifications** — The amplifier rise time is 0.023 μsec; input impedance, 1 megohm; and output impedance 93 ohms.

Unity gain, negative feedback

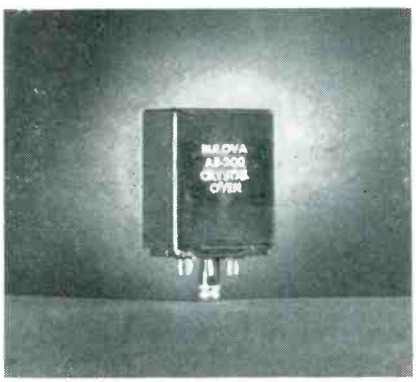
and regulated power supplies are provided for maximum linearity and stability. Price is $495.



COIL WINDER DRIVE
a compact bench-type unit

CROWN INDUSTRIAL PRODUCTS CO., 713 Amsterdam St., Woodstock, Ill. The series 50 coil winder drive handles everything from solenoid coils up to 5-hp winding field, mush, armature and similar types of coils. The gear arrangement is designed for smooth operation and constant torque with no backlash, giving the operator precise control.

Price is $198 without motor, $225 with ½-hp 120-v motor.

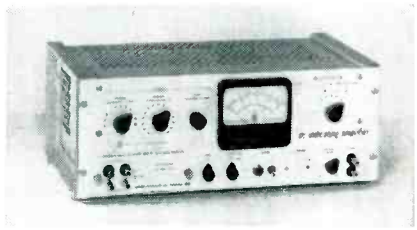


TINY CRYSTAL OVEN
for military communications

BULOVA WATCH CO., INC., Valley Stream, L. I., N. Y. Model AB-200 miniature precision crystal oven is designed primarily for use in military communications equipment. Fitted with an octal base, the unit features a patented heater design which eliminates the necessity for

two thermostats. Long trouble-free service is claimed.

Operating temperature of the unit is preset to customer's requirements; the heater voltage, either 27 or 110 v.



D-C AMPLIFIER
has 160,000 maximum gain

KEITHLEY INSTRUMENTS, INC., 3868 Carnegie Ave., Cleveland 15, Ohio. Model 303 d-c indicating amplifier has an input impedance of over 1 million megohms, a maximum gain of 160,000, and a frequency response of d-c to 100 kc.

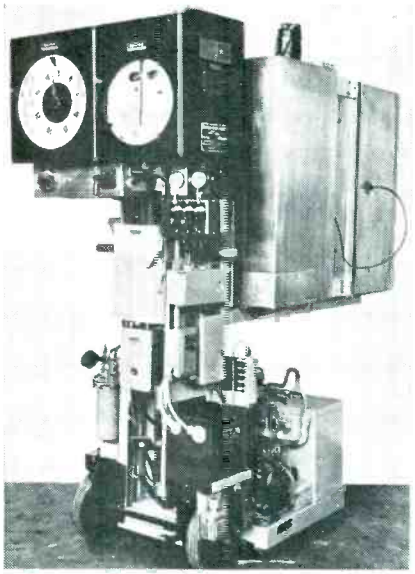
▶ **Other Features**—The unit has an accurate meter, with ranges of 2 to 2,000 mv full scale, a power amplifier for driving all common direct-writing recorders, a differential input, and a zero drift of less than 2 mv per hour on any range or gain setting.

Input terminals are mounted on a small plug-in panel which can be interchanged with plug-in multipliers that extend the voltage range to 800 v full scale, or a plug-in decade shunt that converts the instrument to a direct-reading micromicroammeter.

▶ **Uses**—The amplifier may be used to measure voltages as low as 200 μv, currents down to 10^{-12} amperes, and resistances up to 10^{14} ohms. It is suited for measuring transistor, piezoelectric crystal, and capacitor potentials, and currents in semiconductors, photocells and ion chambers.

HOT-COLD CABINET
primarily for aircraft use

ATMOSPHERE CONTROL CO., INC., 5315 Chester Ave., Philadelphia 43, Pa., has announced a hot and cold cabinet that is used primarily by aircraft component producers. It is

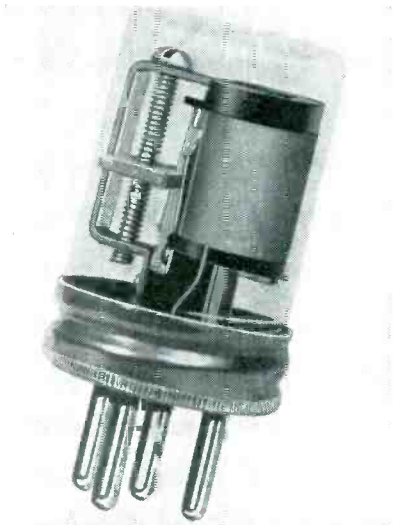


available in a choice of two models —stationary and movable—and can be used efficiently in any part of the laboratory in conjunction with breaking-strength and tensile-strength testing machines.

Range of temperature is from −100 to +600 F.

► **Control Specifications** — Either model can be equipped with various types of controls from vapor-pressure type to the electronic type, depending upon the degree of accuracy demanded, and same may be either the indicating or recording.

Air circulation is according to customer specifications.



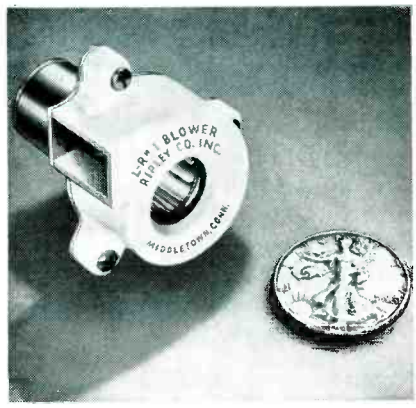
FREQUENCY RELAY
a low-cost series

POTTER AND BRUMFIELD, INC., Princeton, Ind., announce a new

low-cost series TR frequency relay.

►**Range**—It features a range of frequency from 40 to 170 cps with a 400-ohm coil as standard. Other frequency ranges are available for special applications.

A maximum of 10 standard relays may be installed in a control panel each operated by a signal to which it has been tuned. Each in turn will operate an auxiliary relay for closing or opening any circuit.



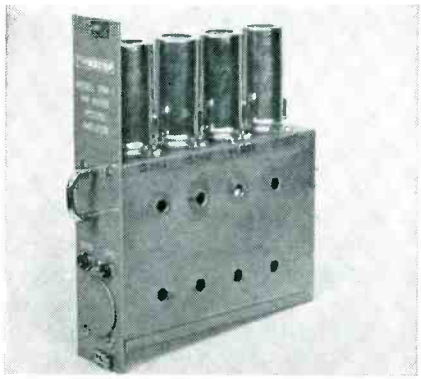
SMALL BLOWER
for space-conscious designs

RIPLEY CO., INC., Middletown, Conn. The L-R No. 1 subminiature self-contained motor blower is engineered for space-conscious designs.

Using a 1-in. diameter impeller, this unit will efficiently move 8 cfm at 1-in. static pressure when running at 20,000 rpm. Total weight of blower and motor unit is less than 2¾ oz. Designed to meet military specifications, it is available in ccw and c-w rotation. High efficiency and long life under the most rigorous conditions are assured.

P-W AMPLIFIER
for keying and recording

APPLIED SCIENCE CORP. OF PRINCETON, P.O. Box 44, Princeton, N. J., announces a new model DKA-1 p-w keyer-record amplifier unit used for p-w multi coding and direct recording of numerous data channels onto single track of an Ampex magnetic tape recorder. The unit combines a standard 900

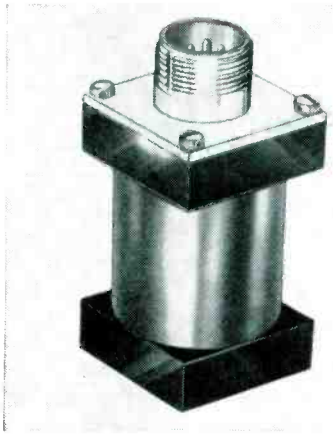


sample-per-sec pulse width keyer and a record amplifier in a single unit which is interchangeable with the f-m or pwm/a-m record strips in the record electronics assembly of any of the Ampex 800 series airborne recorders.

For each track of p-w recording required the DKA-1 and any standard ASCOP p-w commutator producing timing signals and 900 data samples per sec in the 0 to +5-v range achieve the desired result with a minimum of equipment.

The unit meets all essential functional requirements of MIL-E-5400.

► **Measurements**—Model DKA-1 is 1.484 in. wide by 6.718 in. high by 6.522 in. deep. Weight is 1 lb 3 oz.



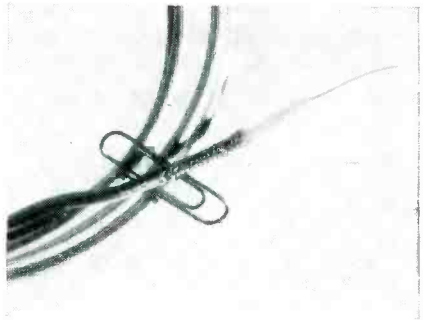
ACCELEROMETERS
for aircraft applications

CEDAR ENGINEERING, INC., 5806 W. 36th St., Minneapolis 16, Minn. A series of new accelerometers offer a wide selection of single and multi-axis devices that have been fully qualified for yaw damping, acceleration limiting, turning rate, and sim-

ilar aircraft applications, as well as industrial automation. They measure accelerations from $\frac{1}{10}$ g to 50 g.

► **Response Element**—A nonpendulous, turly linear response element eliminates crosstalk and provides a completely basic linear output. The response elements can be housed in a variety of frames to meet mounting conditions and are available with potentiometer pickoff, inductive pickoff, or switches with manual or automatic reset.

Potentiometer life for most models is in excess of 8 million cycles.



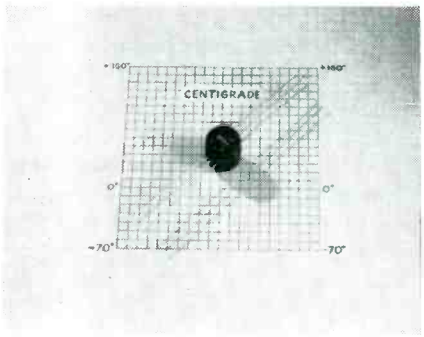
TINY COAX CABLES
are Teflon insulated

HITEMP WIRES, INC., 26 Windsor Ave., Mineola, N. Y., introduces a new line of miniature coaxial cables. These Teflon insulated cables are available in 3 standard types, 50, 70 and 93 ohms. Each type of cable can be obtained with an outer covering of Vinyl, Nylon, Kel-F, Teflon or a glass-fiber braid. Special low noise types are also available in any of the aforementioned types. Prices range from $125 to $382.50 per 1,000 ft, depending on the conductor, outer covering and type of cable.

► **Uses**—Because of their small diameter and light weight, these cables are excellent for aircraft and telemetering applications.

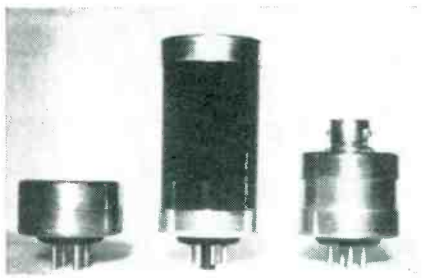
PULSE TRANSFORMERS
withstand severe conditions

TECHNITROL ENGINEERING CO., 2751 N. Fourth St., Philadelphia 33, Pa., announces availability of MIL grade and X grade pulse transformers in the same sizes as the



standard TE and TP types. They exceed MIL T-27A specifications for temperature cycling. MIL grade units safely withstand temperatures from — 70 C to + 105 C, and X grade units from — 70 C to + 150 C.

▶ **Other Features**—The new encapsulating material renders these transformers nonflammable and impervious to humidity, salt spray and other severe conditions. A special phosphor bronze alloy now used for the pig tail leads enables the units to far surpass the bending and twisting requirements of military specifications.



PLUG-IN UNITS
in varied lengths, materials

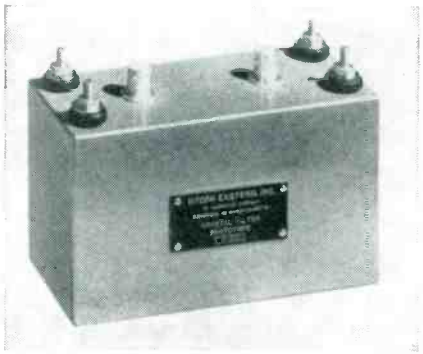
STAMCO INSTRUMENT CORP., Larkin St., Springdale, Conn. Plug-in units made of heavy gage (0.060) aluminum are available in stock lengths from 1 in. to 12 in. in steps of ½ in. Standard diameter is 1⅞ in. o-d. Other materials may be substituted for aluminum according to requirements, including steel, stainless and others.

▶ **Special Requirements** — Opening at both ends, the units are applicable to many special requirements including potting. The end caps are made to close tolerance making a friction closure strengthened by screws. Terminal-strip circuit mountings are included in the assembly in all lengths upon request.

Standard plugs are octal or mini-

ature. Upon request, octal or miniature sockets may be mounted on top to accept tubes or facilitate stacking.

Complete descriptive literature is available. Information concerning diameters other than the standard 1⅞ in. will be furnished upon request on company letterhead.



CRYSTAL FILTERS
produced by new technique

HYCON EASTERN, INC., 75 Cambridge Parkway, Cambridge 42, Mass. A new technique for the synthesis of quartz crystal filters resolves many of the problems heretofore associated with their design and production. Filters can be produced on short notice in large or small quantities to meet exact performance requirements.

▶ **Characteristics**—Quartz crystal filters can be realized to any frequency from 10 kc to 10 mc. Throughout this range the attenuation characteristic can be tailored to meet almost any desired specification within the bandwidth limits from 0.01 percent to 14 percent of center frequency.

For applications where absence of phase distortion is essential, crystal filters can be designed with a high degree of phase linearity. Stable band-pass delay lines may be produced in this manner.

For a given filter specification, information on the most economical values can be provided.

COMMUTATOR
drum type coded-switching

ELECTRO-MINIATURE CORP., 205 Lafayette St., New York, N. Y., has developed and is in production on a new drum-type coded-switching

commutator. The commutator in drum form gives dependable, trouble-free performance in the smallest possible space. All switching combinations are attainable.

▶ **Purpose of Drums**—These drums are particularly well suited to cascade operation. Solid, precision made, precious metal or alloy segments and Nylon or Kel-Fallow extensive ranges of operating conditions, insure long shelf life and give stable operation in service.

Simple registration techniques make possible highly accurate angular resolution as well as exceptionally small segments. Size and weight for airborne and military applications are minimal.

PULSE HEIGHT VTVM
for development engineers

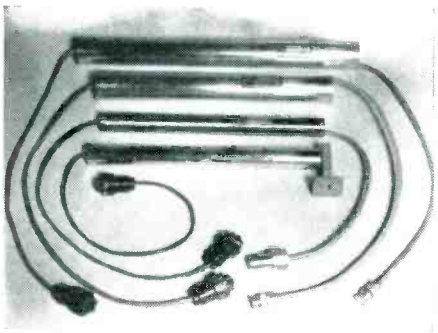
TELEVISION ACCESSORIES CO., 1412 Great Northern Bldg., Chicago 4, Ill. The PV-812 pulse height vtvm measures repetitive pulse heights with an accuracy of better than 2 percent of full-scale deflection.

Readings are entirely independent of pulse width from 0.01 μsec upward.

▶ **Ranges**—The unit provides ranges of 0 to 10, 0 to 30, and 0 to 100 v; and the 5-in. meter is equipped with a knife-edge pointer and mirror scale.

OSCILLATORS
are voltage tuned

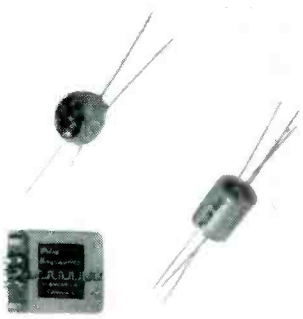
HUGGINS LABORATORIES, INC., 711 Hamilton Ave., Menlo Park, Calif., has available a series of backward-



wave oscillators featuring electronic tuning across their respective frequency ranges. Tuning is accomplished by varying or sweeping a single voltage without any complementary mechanical adjustments. The frequency band may be traversed at μsec rates.

▶ **Applications**—This type of oscillator should find its greatest use as a swept signal source for microwave instrumentation and testing, as a swept local oscillator in superheterodyne receivers, and as a master oscillator in variable frequency transmitters.

▶ **Characteristics**—The four tubes span the frequency ranges of 2 to 4 kmc, 3.75 to 7 kmc, 7 to 14 kmc, and 12.4 to 18 kmc with power outputs of approximately 100 mw, 100 mw, 50 mw and 10 mw respectively. Tuning voltage in all cases is within the range of 300 to 3,300 v.

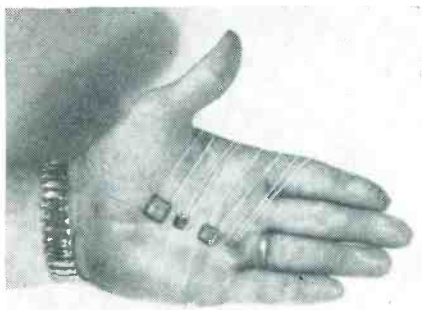


TRANSFORMERS
missile and computer types

PULSE ENGINEERING, 2431 Spring St., Redwood City, Calif. A complete range of designs in miniature wide-band transformers are available from this firm for application in pulse and computer circuitry. Type ES6 and ES7 performance ratings extend from 0.2 μsec to 20 μsec pulse width in blocking oscil-

lator and pulse coupling circuits. They are also provided as wide-band step-up step-down transformers for tape and computer circuits up to 10-to-1 turns ratio. High potential ratings of 2 kv d-c may be called out on ES6 designs.

▶ **Military Requirements**—All units are epoxy impregnated and will withstand environmental requirements of MIL-T-27A including shock, temperature cycling, humidity, salt spray and vibration.



L-V CAPACITOR
for transistor use

GLENCO CORP., 212 Durham Ave., Metuchen, N. J., is producing a new series of Ceramistor low-voltage capacitors, particularly well-suited for use in transistorized circuits for bypass and coupling applications.

▶ **Construction and Size**—Rated at 75 v maximum, this subminiature component features rectangular plate construction and the patented thin-sheet process of manufacture for obtaining maximum capacitance in minimum space. Sizes vary from $\frac{1}{8}$ to $\frac{1}{2}$ in. sq, with capacitance range from 0.001 μf to 0.1 μf. Ceramistor capacitors of other values and sizes can be built to specification.

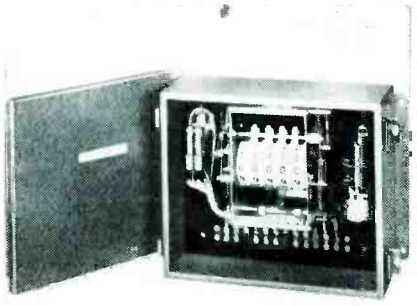
TEST EQUIPMENT
inspects bars and tubing

MAGNETIC ANALYSIS CORP., 42-44 Twelfth St., Long Island City, N. Y., has developed new electronic testing equipment designed for the metal-producing and metal-working industries to inspect nonmagnetic

stainless steel bars and tubing—both seamless and welded.

▶**Warning System**—An audio-visual warning system indicates external mechanical defects in bars, such as cracks, seams and slivers. In seamless and welded tubing, it indicates mechanical defects both on inside and outside diameters, as well as imperfect welds. Differences in chemical composition and cross-sectional dimensions are likewise detected.

A meter and an oscilloscope are provided in addition to the audio-visual warning system to give more complete information. Testing speed is approximately 200 ft per minute.



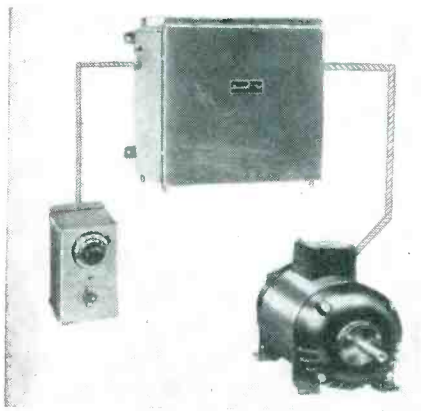
BATCH COUNTER
operates indefinitely

SPENCER MFG. CO., 3253 N. Cicero Ave., Chicago 41, Ill. The batch counter has been developed for controlling the number of items in a batch to be counted or measured with control of quantity before or after an operation, as desired. The control function—ringing of a bell or stopping of a machine, can be

made on a conveyor or at a machine or press.

▶ **Performance**—This counter can be preset at any figure within the range of 5 digits (specials available). At each impulse a subtraction of one is made from the preset figure until the counter reaches zero. The counter then performs the control function. As further impulses are received, the counter adds one for each impulse until it reaches the original preset figure, then it again performs the control function and then starts the subtracting operation over again.

This counter requires no resetting at the end of each cycle and will continue to operate indefinitely until the preset figure is changed. Electrical control panel with release are built in. Size is 5 in. deep by 10 in. high by 12 in. wide.



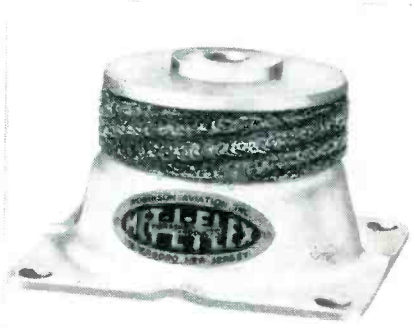
DRIVE MOTOR
with adjustable speed range

SERVO-TEK PRODUCTS CO., INC., 1086 Goffle Road, Hawthorne, N. J. The 100 series of drive motors permits a precise adjustment of speed over a 100-to-1 speed range. Any given speed setting can be repeated and held to better than 0.5 percent of full-rated speed in spite of wide changes in line voltage, temperature or torque load. Both ¼ and ½-hp models are available, either of which can be adjusted for any speed between 36 and 3,600 rpm.

▶ **Encapsulation**—Of particular note is the use of a concrete-like epoxy resin to fully encapsulate all resistors, capacitors and the like, within easily removed plug-in assemblies. A screwdriver is the only

tool necessary to replace any part within a few minutes.

▶ **Uses**—The precise nature of speed adjustment on these drives permits their use with proportioning pumps or feeders and tachometer test stands, as well as with rewinders and machine-tool drives. These units utilize a d-c tachometer generator, which can be remotely mounted, and are particularly adaptable for various automation devices.



SHOCK MOUNT
protects electronic tubes

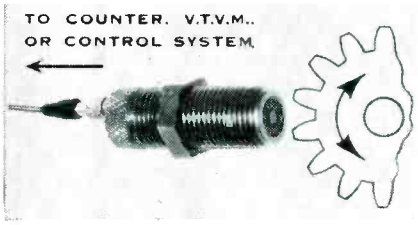
ROBINSON AVIATION, INC., Teterboro, N. J. Miniaturized mounting, as in model K271, is the best insurance against shattered tubes and waveform distortion during important operations, whether airborne, mobile or otherwise.

▶ **Design**—Integral in the mounting system is a metal sleeve, serving as a brace and support for the tube, which may be adjusted with a screw clamp. Met-L-Flex spring-enclosed cushions, fabricated of stainless steel (in projecting cups), attenuate shock and vibration between the sleeve and the outer support.

Performance is unimpaired from heat because of resistance extending to 375 F throughout the all-metal system. Cold to −130 F does not hamper its resilient action. Flexible electrical leads are securely connected at the base of the tube and do not interfere with the free action of the mounts.

These types of mountings utilize every available portion of space in small chassis and electronic sets. They are designed for any shape to

fit all varieties of circuit configurations.



SMALL GENERATOR
proximity impulse type

MINATRON CORP., 14 Cliveden Place, Belle Mead 14, N. J. Model 50A miniature proximity impulse generator provides a self-generated output voltage proportional in amplitude and frequency to the velocity of magnetic material moving in proximity to the sensitive end of the pickup.

The device, when used with commercially available electronic counters, provides an accurate means of measuring, counting or detecting movement, vibration, or speed of a shaft or other part.

► **Construction**—Stock units are encapsulated in a stainless steel housing, which is ⅝ in. diameter by 1¾ in. long. Construction is such as to withstand extreme conditions of shock, vibration and operating temperatures to 500F.

Literature

Broadband Cavity Wavemeters. DeMornay-Bonardi, 780 S. Arroyo Parkway, Pasadena, Calif., has announced a 4-page, illustrated folder on precision broadband cavity wavemeters. It describes the sealed construction which maintains a dielectric constant, and explains the extremely high accuracy of the units. Eleven sizes are listed, covering frequencies from 2.6 kmc to 90 kmc. Applications, specifications and ordering information are provided.

Dip Soldering of Printed Circuits. Hi-Grade Alloy Corp., 1236 S. Talman, Chicago, Ill. Bulletin No. 14 describes the application of

several new products in the dip soldering of printed circuits.

HG No. 19 flux lacquer applied to the circuit immediately after etching protects it from oxidation and acts as an efficient flux during soldering. HG No. 27 rosin flux used hot serves the double purpose of fluxing and preheating ceramic patterns so as to prevent cracking during soldering.

Bulletin No. 14, in addition to describing the above products, provides a complete guide to the techniques of fluxing, choice of soldering equipment and methods of soldering.

Electro - Pneumatic Controllers. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. A 4-page data sheet gives complete information about the new Speedomax H electro-pneumatic controllers, current-adjusting type. Included in the sheet is a full description, complete with line drawings and photographs, of the controller and its associated converter. Specifications and standard ranges for all models are conveniently tabulated along with equipment for the complete control system. Ordering instructions complete the sheet. Ask for data sheet ND46-33(106).

Beacon Telemetering System. Stavid Engineering, Inc., U. S. Highway 22, Plainfield, N. J., has prepared a technical brochure on the Beacon telemetering system developed for the U. S. Army Signal Corps. The system described uses ppm with time separations of 25 to 125 μsec employing 0.8-μsec pulses corresponding to telemetered data signal inputs of 0 to 5 v d-c. Complete information is included on the system's three groups of equipments: airborne equipment (transmitting), ground equipment (receiving) and test equipment (calibration).

Phase Measurement. Berkeley Division, Beckman Instruments, Inc., 2200 Wright Ave., Richmond 3, Calif. Data file 107 describes the company's digital method for fast, precise phase measurement. The procedure discussed reads directly in degrees, mils, or any other unit

of angular measure, and banishes interpolation. Accuracy is 0.1 deg.

Basically, the procedure simply measures the time interval between the zero crossover point of a reference signal and the zero point of the shifted signal. Comparing the time interval with one period of the signal frequency determines the phase-lag magnitude.

Closed Circuit TV Systems. Dage Television Div., Thompson Products, Inc., Michigan City, Ind. A 16-page booklet covers the company's complete closed circuit TV systems. It discusses models 60 and 101 cameras, the 600-B video monitor, an amplifier, audio-video mixer, remote control, remote pan and tilt, and lens turrets.

Illustrations and specifications are included.

Photographic Printing Process. LogEtronics Inc., 1177 New Hampshire Ave., N.W., Washington 7, D. C. A colorful, descriptive folder outlines some of the types of problems already being solved by a new photographic printing process with automatic dodging and automatic exposure control.

Much discussion has centered around this new principle which brings electronic automation to the photographic darkroom. The folder answers many of the questions being asked, and is available upon request.

Dynamic Accuracy Tester. General Electric Co., Schenectady 5, N. Y. Bulletin GEA-6345 describes DYNAT, a dynamic accuracy tester developed for ground testing complete aircraft armament systems under fully simulated flight conditions. The 4-page bulletin describes the operation of the tester, its capabilities, and its advantages in speeding delivery of future armament systems.

Synthetic Micas. Mycalex Corp. of America, Clifton Blvd., Clifton, N. J., has available literature describing its compression-molded Supramica 500 and precision-molded Supramica 555 Ceramoplastics. Type 555, made with synthetic mica, provides all of the desirable properties of Mycalex 410 glass-bonded mica, plus tempera-

ture endurance up to approximately 950 F. Supramica 500 offers temperature endurance up to 1,000 F.

Prices range according to thickness, from $6.84 to $26.88 for sheets 14 in. by 18 in.; from $1.08 to $4.02 for 18-in. rods. Quantity discounts are available.

Operational Amplifier. George A. Philbrick Researchers, Inc., 230 Congress St., Boston 10, Mass. Complete data on a new operational amplifier, model K2-X is described in a new technical bulletin. General characteristics, operational details, applications, internal circuitry and suggested methods of applying bias are presented.

Radio Interference Filters. Televiso Corp., 1415 Golf Road, Des Plaines, Ill. A 4-page folder illustrates and describes radio interference filters to specification MIL-I-6181. Included is information on the company's interference laboratory facilities and field testing operations.

Electronic Wire. Alpha Wire Corp., 430 Broadway, New York 13, N. Y., has announced publication of catalog 55 of electronic wire, which contains complete descriptions, specifications and illustrations of the company's in-stock line of 1,373 items. The catalog lists 487 new items, full Government and MIL specification data, and special engineering cross-reference charts for easy determination of individual wire needs.

Thermistor Data. Victory Engineering Corp., Union, N. J., has prepared a new edition of the VECO thermistor data book with information on the historical background, operating characteristics, typical applications and engineering data. A new section on varistors is now included, with graphs showing typical curves. Priced at $1, it may be obtained free if requested on company letterhead.

Electronic Generators and Test Equipment. Communication Measurements Laboratory, Inc., 350 Leland Ave., Plainfield, N. J. A 16-page booklet contains illustrated

information on 7 electronic generators, a group of 3 phase and master units, and such test equipment as a Rotobridge and its accessories, a stroboscope, megohm meter and vtvm. Specifications and prices for all are included.

Relays. AEMCO, Inc., Mankato, Minn., has released a 4-page bulletin covering a wide variety of relay types. Complete specifications are given for each relay. The bulletin contains valuable mounting information, type enclosures available, and basic size information. Each relay type is pictured and platings, insulation grades and finishes are described.

Laminations Catalog. Magnetics, Inc., Butler, Pa., has issued a greatly expanded magnetic laminations catalog, describing the company's standard lines of laminations, laminated cores and dies. Catalog ML201 includes 16 pages of lamination specification sheets, showing both the individual laminations to actual scale, as well as properties of square cross-section core stacks, and weights and counts for different materials.

Catalog sections are devoted to laminated core assemblies, mechanical and magnetic parameters and lamination tolerances.

Instrument Type Switches. Cinema Engineering Co., Aerovox Div., Burbank, Calif., has available an 8-page catalog describing instrument-type switches. Illustrations, a complete code system outline and complete specifications are included in the data. Production switch parts discussed are prefabricated to insure speedy production, but all switches are precision made custom-built.

Information is also available on other CES switches with special terminal boards, dust-covers, ball-bearings, stainless steel shafting, coin silver contacts, special detent positions and h-v construction.

Industrial TV Cameras. Taller & Cooper, Inc., 75 Front St., Brooklyn 1, N. Y. Descriptive literature deals with three new products recently placed on the market. Bulletin 508 covers industrial tv cameras,

a private tv system for supervising plant and traffic operations. Bulletin 507 discusses an automatic camera with which it is possible to record picture and pertinent data simultaneously on the same frame. Bulletin 503 has to do with remote control systems for the automatic operation of municipal water supply systems.

Cabinet Racks. California Chassis Co., Lynwood, Calif., has issued a supplementary catalog sheet on its cabinet racks for electronic uses. Another item listed is the C.C.C. miniature cabinet. The new catalog sheet is a supplement to the annual Cal Chassis illustrated catalog for its chassis, brackets, panels, cabinets, bottom plates and other production items. Dealer's price sheet is included.

Regulated Power Supply. Deltron Inc., P.O. Box 192, Glenside, Pa. A single-page bulletin covers a new regulated power supply that features low cost wide voltage range, large current output, excellent regulation, low ripple, relay-controlled preset voltage and heavy duty filament supply. Complete specifications are given.

Two models are illustrated in the bulletin. Model 900 is priced at $340, and model 900R $330.

Sprayed Metals. Metallizing Engineering Co., Inc., 1101 Prospect Ave., Westbury, L. I., N. Y. Bulletin 120 illustrates and describes a wide range of applications of metallizing—sprayed metal—in the production of electrical and electronic equipment. Originally used to provide a soldering base on nonmetallic materials, the use of this metal-spraying process has spread to applications in shielding, the production of other types of electrically reflective surfaces and in the replacement of wired circuits.

The bulletin provides engineering data on bond strength, conductivity characteristics, permissible coating thicknesses, circuit tests, surface preparation and spraying methods.

Delay Lines. Epsco, Inc., 588 Commonwealth Ave., Boston 15, Mass. Bulletin DL55 covers new delay lines designed particularly for tele-

metering, digital or analog computers, pulse circuits, coders and decoders, navigation systems and stable time reference units.

► **Standard Units**—It covers units with the following characteristics: Temperature coefficient of delay is less than 50 parts per million per deg C; operating temperature range of —55 C to +125 C; delay tolerance, 3 percent; attenuation in db, approximately 0.1 to 0.2 times delay-to-rise-time ratio.

The bulletin presents design data on the following elements: precision audio delay lines; custom designed units; standard series and special applications; design formulas; characteristic impedance; attenuation; delay time, rise time, delay-to-rise-time ratio; bandwidth; phase linearity; spurious signals; operating temperature range; and typical circuits.

Gear Boxes and Precision Gears. Southwestern Industries, 5880 Centinela Ave., Los Angeles 45, Calif. A 4-page brochure illustrates and describes a line of miniaturized gear boxes for electronic and instrument applications, servomechanisms, computers, small actuators and electronic components. Also included is information on the company's miniaturized, vibration-resistant pressure switches for aircraft and missile systems applications.

Servo Amplifiers. Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y. A 4-page brochure fully describes Servoflex amplifier models 1120, 1121, 1123 and 1124. Each of the models discussed features instantaneous response, built-in preamplifier, built-in power supply, compact assembly, standard tubes and stability.

Printed Wiring Boards. General Electric Co., Electronic Components Dept., W. Genesee St., Auburn, N. Y. A new 6-page, 3-color brochure with technical data and circuit design pointers for G-E Thru-Con printed wiring boards is now available. The brochure includes layout and design information, specifications on base and conductor materials, use characteristics, and

other customer information. The Thru-Con boards described are made by an additive process which plates the copper through the component lead holes.

Pressure Transducers. Statham Laboratories, Inc., 12401 West Olympic Blvd., Los Angeles 64, Calif., has available bulletins on the P130 absolute pressure transducer, the P131 differential pressure transducer, the P132 gage pressure transducer and the Type A pressure adapters. Price of the units described in the order listed are $200.00, $175.00, $175.00 and $5.00.

Doppler Data Translator. Potter Instrument Co., Inc., 115 Cutter Mill Road, Great Neck, N. Y. The first in a series of data sheets illustrating custom designed equipment manufactured by the company is available. The first sheet covers the Doppler data translator and describes in some detail the device and its application. The DDT takes Doppler data such as that obtained from radar tracking of a guided missile, digitizes it into a binary code and stores this information onto a magnetic tape suitable for playback into a conventional computer from which velocity and acceleration figures can be determined. The data sheet serves to illustrate the type of custom-designed equipment which the company is presently engaged in manufacturing.

Single Sideband. Eitel-McCullough, Inc., San Bruno, Calif. Application bulletin No. 9, "Single Sideband", is now available. The 24-page bulletin gives single sideband ratings for Eimac tubes and discusses other technical topics in this increasingly popular field.

Germanium Rectifiers and Stacks. Federal Telephone and Radio Co., 100 Kingsland Rd., Clifton, N. J. Two catalog inserts are now available covering the new germanium product line.

The first is a 4-page folder—"Federal Germanium Diffused Junction Power Rectifiers"—describing the 1N91, 1N92, 1N93 and 1N368 series. These tiny rectifiers are over 95 percent efficient, with electrical ratings ranging from 75 to

150 ma d-c output.

The second is a 12-page booklet—"Federal Diffused Junction Power Stacks." It describes a series of over 100 germanium stacks employing the diffused junction rectifiers to obtain higher power. The stacks are approximately ⅓ smaller than existing types and are rated electrically up to 565 v and 6 amperes d-c in configurations of 1 to 12 fins.

Miniature Electromagnetic Clutches and Brakes. Dial Products Co., 7 Bergen Court, Bayonne, N. J. An 8-page catalog describes the company's line of electromagnetic clutches and brakes with o-d from 0.920 in. to 1.500 in. and torque values up to 200 in. oz. All dimensions and specifications are shown. Graphs on power-input, torque and heating relationship are included. Also given is a new design for slip and tension-control application. Prices for 4 models of dial clutch range from about $25 to $52; for 3 models of dial brake, from about $20 to $24. Discounts are available for quantities over 10.

TV and Broadcast Microphones. Electro-Voice, Inc., Buchanan, Mich., has issued a complete, colorful and illustrated catalog on professional microphones for tv and broadcast applications. The 32-page catalog No. 120 gives detailed application information, features and specifications on each Electro-Voice microphone used in telecasting and broadcasting. It shows how the microphones work and includes polar patterns, frequency response curves and wiring diagrams.

Information on the relation of the particular microphone to the overall station operation is included. Development and manufacture of the microphones are explained in a special section of the catalog. E-V accessories are also illustrated and described.

Interference Locator. Sprague Electric Co., North Adams, Mass. A 4-page brochure completely describes the model 400 interference locator which provides tuning from 500 kc to 220 mc in six bands, thus covering the standard broadcast, short wave, f-m broadcast and vhf-tv spectrums. Illustrations, per-

formance data and specifications are included. Net price of the unit described is $369. A page is devoted to accessory items, and their individual prices are also given.

Power Supply. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena, Calif. Bulletin 1562 deals with the type 3-120A power supply, a d-c to a-c converter which provides 115 v at 60 cycles, from 26-v d-c input. Price of the unit described is $335. Prices for replacement parts are as follows: The B-36231 meter, $8.25; the B-36232 meter, $8.25; the A-34072 Variac, $17.25; and the 16656-16 fuse, $0.20.

Deposited Carbon Resistors. Electroseal Products, Inc., 22 E. 40th St., New York 16, N. Y. Technical information bulletin 100 describes the company's line of deposited carbon resistors for use in electrical and avionic applications.

Printed in two colors and illustrated with h-f response and temperature coefficient curves, the bulletin gives resistance values and specification data on both type B (axial lead) and type A (radial lead) resistors. It includes such information as tolerance, noise, temperature coefficient, construction and wattages.

Coaxial Transmission Line. Prodelin Inc., 307 Bergen Ave., Kearny, N. J., has announced a 2-color, 8-page catalog bulletin describing coaxial transmission line used for conducting tv transmitter signals to the transmitting antenna. Rigid type lines with RETMA flange connectors are described in 1⅝ in., 3⅛ in. and 6⅛ in. sizes.

Bulletin 431 fully describes lines and accessories complete with photographs, outline drawings, efficiency graphs and charts showing attenuation, velocity, voltage breakdown, diameters, weights and bead spacing.

Pressure Resistors. Clark Electronic Laboratories, Box 165, Palm Springs, Calif. Bulletin 269 illustrates and describes the company's line of pressure resistors. It discusses Celab resistance material as a variable resistance means capable of such wide range that a quarter

of a thimblefull of the powder will be an excellent insulator at 1-lb pressure, but will be a good conductor at 12 to 20-lb pressure.

A sample pressure-adjustable device which can be taken apart (suitable for design engineers) is available in the 15-w size for $15. The powder is available in ½-oz size for $5.

High-Speed Potentiometer. The Bristol Co., Waterbury 20, Conn., has released bulletin P1270 describing the new high-speed recording Dynamaster potentiometer. This recorder has full-scale pen-travel across its 11-in. calibrated chart of only 0.4 sec, without overshot on long or short traverses.

The 2-color bulletin features a full-size reproduction of a sample chart which shows the dynamic characteristics of the new recording potentiometer.

Quartz Crystal Filters. Hycon Eastern, Inc., 75 Cambridge Parkway, Cambridge 42, Mass., has just released a new bulletin on quartz crystal filters. Complete data, including selectivity curves and specifications, are presented.

Lower Manufacturing Costs. Magnaflux Corp., 7300 W. Lawrence Ave., Chicago 31, Ill. A booklet, entitled "Lower Manufacturing Costs", discusses various uses for testing. It indicates how a nondestructve testing program can be instituted in the production departments, as a cost-reducing, money-saving tool. It outlines how inspection should be considered productive machinery. Ask for Form No. 148-2, an 8-page, well-illustrated booklet.

Scintillation Counter. Chatham Electronics, Division of Gera Corp., Livingston, N. J. Model SC-102 scintillation counter is illustrated and described in a single-sheet bulletin. The unit discussed offers extreme sensitivity for uranium and oil prospecting. Specifications are included.

Hermetically Embedded Circuitry. Alcor Electronics Corp., 180 Lafayette St., New York 13, N. Y. A 4-page folder covers the Encapsor, a plug-in electronic circuit hermeti-

cally embedded in the new thermosetting plastic, Alcorite. Included is a full description of Alcorite. The bulletin tells where and why to use Encapsors, discussing dependability, reduced engineering, simplified production, faster equipment checkout, easy maintenance and smaller inventory.

H-V Control Tube. CBS-Hytron, A Division of Columbia Broadcasting System, Inc., Danvers, Mass. Bulletin E-258 gives complete data on the CBS 6792, a multipurpose beam tetrode for voltage stabilization service from 3,000 to 25,000 v. The tube described can solve h-v control problems as a regulator, gating tube, variable resistor or amplifier. Internal structure of the tube discussed is unusual in that, to attain high efficiency and dependability, it embodies the principle of the electron-beam gun found normally in crt's.

Equipment Bulletins. Adler Communications Laboratories, One LeFevre Lane, New Rochelle, N. Y., has announced 5 new equipment bulletins enclosed in a file folder. All are illustrated with photographs and schematic diagrams, and they explain the features, uses, electrical and mechanical specifications, and equipment supplied in each case.

Bulletin VS-5 describes an electronic video switcher; bulletin VA-18, a video distirbution amplifier; bulletin VA-19, a video clamp amplifier; bulletin UST-150, a 150-w uhf tv transmitter; and bulletin VST-150 , a 150-w vhf tv transmitter.

Electronic Relay. Automatic Switch Co., 391 Lakeside Ave., Orange, N. J. Bulletin 585 covers the company's new electronic relay. The relay described is capable of: (1) complete follow-through action —brushing of contacts even momentarily effects immediate operation of controlled device; (2) responding to controls from a highly sensitive, essentially a fine-wire contact; (3) no arc operation—only microamperes are drawn by the grid circuit; and (4) direct control of the load operating solenoid. The literature provides design and application information, circuit de-

scription and complete dimensional and pricing data.

Modulized Standard Circuits. Aerovox Corp., 1200 Jefferson Davis Highway, Arlington, Va. A 12-page illustrated bulletin covers modulized standard circuits for the design engineer.

Standard circuits described include a video limiter, low-level cathode follower, common cathode mixer or dual cathode follower, cascade intermediate video amplifier, triode video driver amplifier, prf multivibrator and d-c regulator for +300 volts.

Precision Selector Switch. Electro Tec Corp., South Hackensack, N. J., has available a 4-page folder describing a miniature ultra-low torque precision selector switch for high-speed operation. Included are illustrations, a parts list, general description, design features and specifications. The switch described is available in both 8 and 10 positions.

Oscillographic Recording Equipment. Sanborn Co., 195 Massachusetts Ave., Cambridge 39, Mass. All of the company's 150 series oscillographic recording systems, components and associated equipment are fully described in a new 16-page illustrated catalog. Basic systems, in 1, 2, 4, 6 and 8-channel models, as well as the 11 currently available plug-in preamplifiers, are described in detail. Performance data for these interchangeable front-ends, as well as frequency response characteristics of galvanometer with driver amplifier, are also provided.

Technical details are included on the model 150-1900 master oscillator power amplifier, and model 150-300/700 wide-band driver amplifier and power supply.

► **Prices**—Equipment users will also find complete price lists covering basic assemblies, complete systems, preamplifiers, amplifiers, recorders, cabinets, cases and accessories.

Analog Computer. Electronic Associates, Inc., Long Branch, N. J. A 16-page booklet illustrates and describes the type 16-31 R computer group, featuring 20 operational

amplifiers, 32 attenuators, 4 free diodes, 3 function switches, full system monitor, audible overload alarm, temperature-controlled oven, shielded patch plugs and coaxial patch cords. Section 2 of the booklet features a building block method simplifying expansion by the addition of standard component groups.

Rectangular Connector. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y., has available a 2-page illustrated color bulletin with special features, electrical and mechanical ratings, mounting and clearance dimensions, and diagrams of the new 15-contact rectangular connector with aluminum hoods. Write for bulletin GS.

Time Delay Relay. Elastic Stop Nut Corp. of America, Elizabeth, N. J. A 4-page bulletin, SD-1, contains selection information for the Agastat time delay relay models. The correct Agastat model for a particular time delay or combination of time delays in an electrical circuit may be chosen from a selection chart there. The chart presents method of adjustment, operating voltage, type of operation, contact arrangement, type of contact, dimensions and weight for each Agastat model. Various Agastat mountings and enclosures are shown in 6 diagrams.

Switchboards With Basic Circuits. General Electric Co., Schenectady 5, N. Y. The company's building-block concept as applied to switchboards is described in a 4-color 40-page bulletin, GEA-4127B. The publication shows how 8 classifications of standard switchboards are constructed, operated and tested. A complete discussion of basic circuit specifications in duplex switchboards is included.

Data Processing Systems. Logistics Research, Inc., 141 S. Pacific Ave., Redondo Beach, Calif. The Alwac III data processing systems are described in an 8-page, illustrated brochure. The data processing system described consists of the ALWAC III electronic digital computer, a punched card converter, magnetic tape storage, automatic typewriter and punched paper tape. The computer can read or punch

cards at the rate of 8,000 alphanumeric characters per minute and read from or record on magnetic tape at the rate of 60,000 characters per minute. The system's memory drum has a capacity of more than 16,000 single-address instructions.

The brochure contains data on the magnetic drum memory, speed of operation, programming, input-output, controls and indicators, physical characteristics, reliability, and a summary of instructions.

H-V Generator. Lintronic Ltd., 32 Lockwood Terrace, West Hartford 7, Conn. A 4-page bulletin covers a portable power unit featuring a generator-mains-transformer combination. Included are two sets of curves, an illustration and instructions for operation.

A-C Potentiometer. Perkin-Elmer Corp., Norwalk, Conn. A 4-page illustrated folder covers the 400-cycle Vernistat a-c potentiometer with this combination of features: high linearity, high resolution and low output impedance. Design principle and specifications are given.

Precision Panel Instruments. DeJUR-Amsco Corp., 45-01 Northern Boulevard, Long Island City 1, N. Y., has available a 2-page illustrated bulletin with diagram describing all special features, general specifications and mounting dimensions of the two new v-u and db meters including photographic representations of both. Write for bulletin VU133. Ordering information is included.

Miniature Wideband Transformers. Pulse Engineering, 2431 Spring St., Redwood City, Calif., has available a bulletin on its miniature wideband transformers (missile and computer types). Types ES6 and ES7 performance ratings extend from 0.2 μsec to 20 μsec pulse width in blocking oscillator and pulse coupling circuits. They are also provided as wideband step-up step-down transformers for tape and computer circuits up to 10 to 1 turns ratio. High potential ratings of 2 kv d-c may be called out on ES6 designs.

All miniature transformers described are epoxy impregnated and

will withstand environmental requirements of MIL-T-27A including shock, temperature cycling, humidity, salt spray and vibration. Miniature units are normally supplied form-encapsulated but may be obtained hermetically sealed in a metal can.

▶ **Ordering**—Prices on the company's designs in 50 to 500 units are approximately as follows but will vary somewhat depending upon complete specifications: ES6 and ES7—$3.12 each; EF8, $6 each; H9 and H10, $11.80 each; H11, $18.50 each, and H12, $22 each. Ordering information is available.

Instruments. Radio City Products Co., Inc., Centre and Glendale Sts., Easton, Pa. An 8-page 8½ in. by 11 in. brochure includes the latest instruments that have been announced by the company and also includes some lower prices on several models. Ask for catalog No. 139.

Rectilinear Potentiometer. Markite Corp., 155 Waverly Place, New York 14, N. Y. Bulletin C54-1 covers the type 2064 dual-element rectilinear-motion potentiometer. Application advantages, typical performance, design features and prices are given.

Camera Tube Manufacturing. General Electric Co., Schenectady 5, N. Y. A 16-page booklet describes the company's camera tube manufacturing facilities. It illustrates how GE's power tube subdepartment has established extensive facilities with advanced equipment, and assembled engineering and technical skills for the manufacture of image orthicons, Vidicons and other pickup tubes for military and commercial applications. Ask for booklet ETD-1192.

Precision Voltage Divider. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa., has available complete information about a precision voltage divider, which provides a ratio as small as 1 to 100,000 and is correct within ±1 part of 0.001 percent of the total.

Data sheet E-51(4) describes how the divider is being used (1) for calibrating analog computing

elements such as potentiometers, slidewire components or other elements involving linear, nonlinear, trigonometric, or exponential d-c voltage functions; (2) for testing d-c output of power packs; and (3) as a calibrated potentiometer. Included in the sheet are photographs and a line drawing of the voltage divider and its circuit. A listing of specifications, accessories and special voltage dividers completes the sheet.

AN-Type Connector. DeJUR-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. A 4-page illustrated bulletin with diagrams, describes features, specifications and mounting dimensions of AN-type series 1300 miniature connectors. Write for bulletin AN.

High-Temperature Selenium Rectifiers. Sarkes Tarzian Inc., 415 N. College Ave., Bloomington, Ind. A 4-page folder, Form HT1, illustrates and describes high-temperature selenium rectifiers that are practical not only on application considerations but are adaptable to mass production techniques. The company's research departments have developed a compatible barrier layer and counter electrode that when combined with selenium produce a rectifier capable of operating at all temperatures of 150 C. Characteristics charts and tables are included in the folder.

Relays. Magnecraft Electric Co., 3352 W. Grand Ave., Chicago 51, Ill. Engineering catalog No. 55 is a 12-page booklet containing illustrated descriptions of the company's Class 11, Class 33 and Class 22 reliable relays for exacting requirements. Coil data as well as information on contacts and mounting are included.

Radio Interference Measurement. Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif. A new 37-page bulletin describes the application of radio interference-field intensity measuring equipment in accordance with MIL-I-6181B. Specific instructions and practical examples are cited, including a

perspective illustration of a typical equipment setup.

An appendix includes important data on bandwidth concepts in interference measuring equipment. It explains that despite the fact that selective circuits may display the same maximum response and the same selectivity, they can still exhibit different sensitivities to noise. This must be taken into consideration to prevent erroneous indications.

Electronic Equipment. Specialty Engineering & Electronics Co., 79 Clifton Place, Brooklyn 38, N. Y. Bulletin No. 60 covers the company's line of r-f signal generators, precision attenuators, vtvm's, radiation detection instruments, electronic communication equipments, electronic navigation aids and Radiac equipments. Illustrations, chief features and specifications are shown.

Ceramic Magnets. The Indiana Steel Products Co., Valparaiso, Ind. The characteristics, design and application of Indox I—a lightweight, low-cost, nonmetallic ceramic permanent magnet—are described in a 4-page catalog.

The lightweight and high coercive force of this magnet described make it especially suitable for indicating gages, magnetic couplings, magnetic filters, special instrumentation and miscellaneous holding applications.

Its high coercive force also makes it well adapted for generators, motors, tv focusing units, polarized relays, and in applications where the magnetic length is limited or magnetization prior to assembly is necessary.

Sensitive Relays. Electronics Division of Iron Fireman Mfg. Co., 2838 S. E. 9th Ave., Portland 2, Ore. A comprehensive catalog on high speed and sensitive relays is available. The 12-page catalog describes relays especially designed for precision aircraft electronic equipment conforming to highest standards of inspection with excellent military ratings in quality control.

Operational charts and instructions for their use are included. The

charts provide a means of predicting the behavior of special values of coil resistance and other operating characteristics. Dimensional and wiring diagrams are also shown in the catalog.

Hermetic Seal Plugs. Seals, Ltd., 1010 Mission St., South Pasadena, Calif. A 2-color, 4-page brochure introduces the type S line of glass insulated connectors. It presents design drawings and specifications covering 48 products, and also includes discussions of general use, available finishes and standard characteristics, copper brazing service, and special customer design services. For a copy, write on company letterhead.

AN Connector Chart. The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif., has prepared a new wall chart to assist engineers to quickly specify AN connectors for a wide range of applications. Items shown for ready reference on the chart are: "How to Select the Right AN Connector" which includes number of contacts, contact size, voltage rating, creepage distance and spacing information; and "How to Specify the Complete Connector Assembly" covering special insert insulation materials and shell finishes.

Other features covered are the code of contact sizes, shell dimensions and an availability check list and shell data. The chart, measuring 22 in. by 27 in. and printed in 3 colors, is available at no charge. Additional data are available on hermetic and quick-disconnects as well as on AN connectors.

Magnetostriction Transducers. The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y. A 38-page booklet covers the design of nickel magnetostriction transducers. It was prepared to guide the engineer toward a workable design in exploring new fields in the sonic and ultrasonic regions.

The booklet, consisting of an article by Boyd A. Wise of Battelle Memorial Institute, contains diagrams, charts and illustrations, as well as a 2-page bibliography. It is available to engineers requesting it on their letterhead.

Plants and People

Edited by WILLIAM G. ARNOLD

Industry societies elect new officers, honor engineers for technical accomplishments. Manufacturers continue to expand plants and facilities for future growth. Engineers are promoted and move to new positions in the industry

IRE Elects Officers For 1956, Announces Awards

Arthur V. Loughren

Herre Rinia

Frank J. Bingley

ARTHUR V. LOUGHREN, vice-president in charge of research of the Hazeltine Corp., was elected president of the Institute of Radio Engineers for 1956. He succeeds John D. Ryder, dean of the school of engineering of Michigan State University, as head of the international society of 44,000 members.

Herre Rinia, director of research of the Philips Research Laboratories in Eindhoven, Holland, will succeed Franz Tank, professor at the Swiss Institute of Technology, Zurich, Switzerland, as IRE vice-president.

Elected as directors for the 1956-1958 term are E. W. Herold, director of the electronic research lab, RCA Laboratories, Princeton, N. J. and J. R. Whinnery, professor of electrical engineering, University of California, Berkeley, Calif.

Regional directors elected for 1956-1957 are: Region 1 (North Atlantic), C. R. Burrows, director of the school of engineering, Cornell University, Ithaca, N. Y.; Region 3 (Central Atlantic), J. G. Brainerd, director of the Moore school of electrical engineering, University of Pennsylvania, Philadelphia, Pa.; Region 5 (Central), J. J. Gershon, director of resident instruction, DeVry Technical Institute, Chicago, Ill.; Region 7 (Pacific), C. F. Wolcott, technical director of Gilfillan Brothers, Los Angeles, Calif.

IRE also announced two annual awards for 1956. Frank J. Bingley, executive engineer of the Philco Research Labs, has been named to receive the Vladimir K. Zworykin Television Prize Award for 1956. He will receive the award for his study of the relationship between the science of colorimetry and the NTSC color signal.

The Browder J. Thompson Memorial Prize for 1956 will be awarded to Jack E. Bridges, research engineer of the Zenith Radio Corp., for his paper, Detection of Television Signals in Thermal Noise.

Seventy-five radio engineers and scientists from the U. S. and other countries were named Fellows of the IRE. The complete roster is published in this issue of ELECTRONICS beginning on page 346.

RCA Expands For Hi-Fi, Promotes Three

A $2.7 MILLION addition to the RCA plant at Cambridge, Ohio, will be constructed for increased production of tape recorders and high fidelity instruments.

The addition will add more than 210,000 sq ft of floor space to the present 135,000 sq ft at the Cambridge plant—now used for the manufacture of fabricated parts for record players, radios and television receivers as well as the assembly of record changers and phonographs.

Approximately 1,400 persons are now employed at the plant under the direction of T. F. Whitten, plant manager.

Work on the new addition will get under way immediately and is expected to be completed in 1956.

RCA also announced the election

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ploy about 115 persons, will be responsible for the engineering, manufacture and sale of induction heating equipment, power line carrier equipment and a variety of other industrial electronic devices.

Cheek joined Westinghouse in 1939. From 1942 until 1951, he was a consultant on power systems problems and subsequently acted as a specialist in carrier and microwave applications. In 1951, he was transferred to Baltimore as assistant sales manager for the electronics division. He was appointed assistant division engineering manager in 1953.

Airborne Instruments Appoints Dunning

ORVILLE M. DUNNING has been appointed director of the engineering and production division of Airborne Instruments.

He was formerly vice-president in charge of engineering for Hazeltine Electronics Corp. of Little Neck, New York.

Dunning brings to his new position over thirty years of experience in management, production and engineering. His work at Airborne will be to direct all of the activities of the division.

Van Norman Acquires Insuline And Transitron

INSULINE CORPORATION OF AMERICA of Manchester, New Hampshire, manufacturer of electronic parts and equipment, has become a subsidiary of the Van Norman Co. of

Springfield, Mass., a machine tool firm. Van Norman also acquired Transitron of New York, N. Y.

No change in officers or personnel will be made at Insuline. Samuel J. Spector continues as president and chief executive officer; Bernard L. Cahn, vice-president for sales; Myles Spector, vice-president for manufacturing; William J. Schoenberger, assistant to the president and Augusta S. Spector, secretary.

Transitron, which will be operated as a wholly-owned subsidiary of Van Norman, currently operates two plants in New York City. However, present plans call for moving to Manchester, New Hampshire, where plant space of approximately 100,000 sq ft will be available. Entire engineering staff of Transitron is being retained and will move with the operation to Manchester. Insuline Corporation of America is located there.

Management of Transitron will consist of Samuel Lackoff, president and Samuel J. Spector, vice-president, who will act as directors with J. Y. Scott, president of Van Norman. Herbert I. Segal, chairman of the executive committee of Van Norman will also hold this position with Transitron. R. W. Porter is treasurer of Van Norman and also of the new subsidiary.

GE Sets Up New Sections, Selects Engineers

IN the General Electric light military electronic equipment department, William J. Kuehl was named manager of the communication and navigation subsection; Russell I. Mason was named manager of the airborne early warning systems and sonar subsection and Donald E. Uren was named manager of the special project subsection.

Establishment of the new subsections resulted from growth of the weapons system concept in some of the department's product lines, according to GE.

Robert R. Johnson has joined the communications and computer subsection of GE's Electronics Laboratory.

He previously was on the staff of Hughes Aircraft Co. at Culver City, Calif., where he spent four years as

a research physicist working on design of digital airborne computers, business data systems and machine tool automation projects.

GE also announced that William Jan van der Grinten has joined the company as a physicist in the semiconductor and solid state sub-section of the Electronics Laboratory.

Dr. van der Grinten has been with GE since 1940. He was with the Kaiser Wilhelm Gesellschaft, a research foundation, in Berlin, Germany from 1935 to 1940 and was a research associate at the GE Research Laboratory in Schenectady from 1940 to 1943.

From 1943 to 1945, Dr. van der Grinten was an assistant professor in the physics department of the University of Rochester. He returned to GE at Schenectady in 1945 and remained there until his present appointment.

Also in the Electronics Lab, W. Crawford Dunlap, Jr., has been named a consultant in the semiconductor field.

Dr. Dunlap has been engaged in the field of semiconductors since 1945.

During World War II, he was an assistant physicist in the western regional research laboratory of the U. S. Department of Agriculture. He joined the physics staff at GE's Research Laboratory as a research associate in 1945. He was appointed to the Laboratories Department of the Electronics Division in 1954.

Keller Appointed Panellit Research Head

ERNEST A. KELLER has been appointed director of research of Panellit of Skokie, Ill. The firm

designs, engineers and builds control and data handling systems. Dr. Keller will lead an expanded research program which includes development projects in data handling, automation and computer technology.

A native of Switzerland, Dr. Keller came to the United States in 1950 as a technical executive to evaluate markets for Oerlikon Machine Tool Works, Zurich. Later he joined Daystrom Electric Corp. as physicist in charge of tape recorder development and high-fidelity sound equipment.

Until coming to the U. S. he served as research director with Oerlikon, devoting himself to applied research in the fields of ballistics, electronic and mechanical test equipment, magnetic recording, telephone switching circuits and automatic production techniques.

Sylvania Builds More Plants, Names Engineers

SYLVANIA ELECTRIC will construct a multimillion dollar plant in Altoona, Pa. for the production of receiving tubes.

The new 110,000 sq ft single-story plant will ultimately replace an existing smaller plant and leased warehouse space in Altoona. It will be built on a 15-acre site which has already been acquired by the company. In the plant 100,000 sq ft will be for manufacturing. The remainder will contain offices and a cafeteria.

Employment is expected to remain at its current level of approximately 800 for the foreseeable future, since the new project will be a consolidation of existing production and warehousing facilities.

Sylvania also announced plans to build a new 76,000 sq ft warehouse and sales office in Atlanta, Ga.

Construction is already under way and completion is scheduled for March, 1956.

A single story building, the new warehouse will include 8,000 sq ft of office space. Located on six and a half acres, the building will have a storage capacity of approximately twice that of the present Atlanta warehouse facility.

In the firm's new Waltham Labs Richard M. Osgood has been ap-

pointed manager of equipment fabrication.

He will direct the manufacture of prototype equipment developed by the avionics and guided missiles research staff.

Before joining Sylvania, Osgood was chief of the electronic systems division of the Air Materiel Command, U. S. Air Force. He was responsible for coordination of the design, production, and installation of a semiautomatic air defense system for the continental United States and the Distance Early Warning radar line at the northern edge of North America. Also, Heinz K. Henisch has been appointed a visiting scientist at the physics laboratory of Sylvania.

On leave of absence from the University of Reading, England, Dr. Henisch is serving in the Sylvania post for one year, working on semiconductor and electroluminescence research. At Reading, Dr. Henisch heads a group currently engaged in advanced research on transistor physics, in collaboration with Dr. P. C. Banbury. Engaged in this field since 1945, Dr. Henisch has been on the teaching staff of the University for eight years.

Beckman Builds New Plant, Promotes Managers

CONSTRUCTION has started on the new $250,000 plant in Richmond, Calif. of the Berkeley division of Beckman Instruments.

The new 55,000 sq ft building,

Donald C. Duncan

situated on a 4½-acre site adjacent to the present Berkeley division facility, will approximately double plant capacity. The new building will be used to house the systems engineering department, substantially increase the research and development facilities and add to the overall manufacturing capacity.

Beckman also announced that Donald C. Duncan has been appointed general manager of the Berkeley division.

Thomas Allinson was named manager of the division. He will report to Duncan who will continue to serve as general manager of the firm's Helipot and Arga divisions in South Pasadena, Calif.

Duncan was an industrial control test engineer for GE in 1940, and from 1941 to 1945 served with the Navy's Bureau of Ships in Washington, D. C. as an electrical engineer.

Allinson joined Berkeley in 1951 as plant manager. In 1954 he was named marketing manager directing advertising and sales promotion, market research and sales activities.

Before joining Beckman he was plant manager for the Marchant Calculating Machine Co., in Emeryville, Calif.

Varian Dedicates Canadian Plant

VARIAN ASSOCIATES of Palo Alto dedicated a new $400,000 manufacturing and research plant in Georgetown, Ontario. It has 10,000 sq ft of space. The new plant will be operated by Varian Associates of Canada Limited, a wholly owned subsidiary of the California firm. It will produce microwave vacuum tubes and related devices for the Canadian government and commercial customers. It will also provide a second manufacturing source under several of the parent company's United States defense contracts.

The new plant's manager, C. W. Carnahan, was appointed vice-president and general manager. He was previously engaged in engineering management in the Varian Associates Palo Alto headquarters. Before that, he served five years as

manager of electronics research at Sandia Corp., Albuquerque, New Mexico.

B. A. Breckenridge, assistant treasurer, was appointed assistant secretary and business manager. Before joining Varian Associates of Canada, he was with Fleet Manufacturing of Fort Erie, Ontario.

Associated Missile Promotes Two

Earl R. Skaggs

EARL R. SKAGGS, vice-president and former director of product engineering, has been named to the newly created post of assistant general manager of Associated Missile Products Corp. of Pomona, Calif. Joseph Tampico, vice-president and former director of research and development, has been made the firm's director of engineering.

Modification of the AMF subsidiary's 55,000 sq ft plant has been completed. A personnel group of over 200 is anticipated by the end of 1955.

Mallory Opens Plant, Plans Another

A NEW manufacturing plant for the production of electrolytic capacitors has been opened in Huntsville, Alabama, by P. R. Mallory, (Huntsville), an affiliate of P. R. Mallory & Co. of Indianapolis.

The company chose Huntsville as its location because of the availability of power, an excellent water supply and ample labor.

Located on a twenty-one acre site, and completely equipped, the

plant represents an investment of $2 million.

Paul R. Hufnagel is vice-president and general manager of the Huntsville corporation.

In another move, Mallory with Schwarzkopf Development Corp. formed Mallory-Schwarzkopf Metals. The jointly-owned new company will produce and fabricate refractory metals principally for the electronic, chemical and aircraft industries.

Dr. Paul Schwarzkopf has been named chairman of the board and P. R. Mallory, president. Richard L. Hopkins is executive vice-president.

A new plant is planned for Huntsville, Alabama, with initial operations scheduled for late 1956.

Litton To Build New Plant

LITTON INDUSTRIES' power tube division in San Carlos, Calif. will build a 40,000 sq ft plant adjacent to its present facilities. It is to be completed by early 1956 on a recently purchased 11-acre site.

The present plant at San Carlos has 60,000 sq ft of space.

The firm will have a total plant area of 350,000 sq ft at its seven locations when the new plant is completed.

Lenkurt Elects Vice-President

WILLIAM H. HEFLIN has been elected vice-president and general manager of Lenkurt Electric Co. of Canada.

The Vancouver company, an affiliate of Lenkurt Electric Co. in San Carlos, Calif., produces carrier telephone and telegraph systems and other electronic equipment.

Heflin has been with Lenkurt in San Carlos for seven years during which time he has held various positions in sales, engineering and production. He had been manager of the procurement division since 1953. Before that he was factory manager of the special equipment division.

Division managers for Lenkurt of Canada are J. S. Agnew, account-

ing; C. W. Hunter, sales engineering; C. E. Whaley, applications engineering; M. O. Swailes, production and H. R. Herron, quality control.

Raytheon Rents Plant Space

RAYTHEON leased 65,000 sq ft of space in the former Assabet Mills of Maynard, Mass.

The space will be used for the development and engineering activities of the radar-system group attached to the missile and radar division.

Raytheon will open a new, multi-million dollar engineering laboratory in nearby Wayland. The Wayland plant has approximately 225,000 sq ft of floor space and will employ approximately 1,000 engineering personnel.

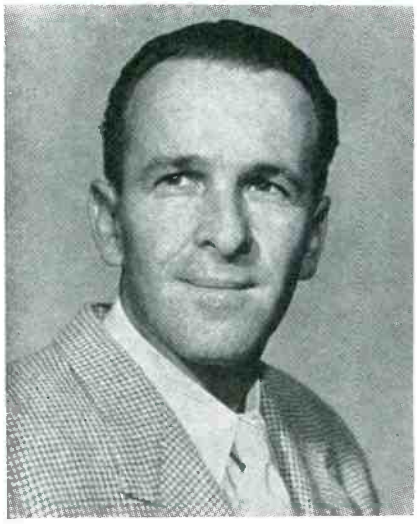
Eimac Names Production Heads

FRANCIS MIGGE has been named to the newly-created post of manager of manufacturing for Eitel-McCullough.

Robert Herdman will assume the duties of production manager, the position formerly held by Migge.

As manager of manufacturing, Migge will direct all phases of Eimac manufacturing activity at both the San Bruno and Salt Lake City plants.

He joined the firm in 1940 and served as head of various pro-



Francis Migge

duction departments until his appointment as assistant production manager in 1950. He was named production manager in 1951.

Herdman, who moves up from his position as assistant production manager, also joined the firm in 1940. He became assistant production manager in 1951.

Corning Glass Expands Parts Plant

CORNING GLASS plans to enlarge its facilities for manufacturing glass electronic components in Bradford, Pa.

The plant expansion will include the eventual installation of automatic resistor and capacitor production equipment. The expansion was required to meet increasing demand, especially from radio and television set manufacturers, according to the company.

The firm's low-power resistor line has been purchased by 13 television set manufacturers.

Additional space has been obtained that will nearly double the present Corning plant area in Bradford. While necessary alterations to the newly-acquired area are now being carried out, the expansion, which will include eventual consolidation of all the company's major electronic manufacturing operations, will be carried out gradually during 1956 to avoid disruption of delivery schedules.

Hupp Acquires Pioneer Electric

THE HUPP CORP. of Detroit, Mich. has acquired the business and assets of the Pioneer Electric and Research Corp. of Chicago, an electronics firm engaged in both manufacturing and research operations.

Hupp will issue approximately 16,000 shares of its common stock in payment for the business and assets of Pioneer. This stock is to be distributed to the Pioneer stockholders.

Pioneer Electric and Research has developed and is now manufacturing electronic remote control equipment. This equipment, which is primarily being used in teletype-

writer communication facilities, also permits central control of remotely located teletypewriters on a common circuit.

Sperry Selects Four Engineering Heads

W. L. BARROW has been named vice-president for research and development, and George A. Richroath has been named vice-president for manufacturing of Sperry Gyroscope Co.

Dr. Barrow, vice-president and chief engineer since 1952, joined Sperry in 1943. He directed a number of projects in fire control and armament engineering with the company during the war, and for 14 years has served in various advisory capacities to the armed forces. Before joining Sperry he was an associate professor at M.I.T.

Richroath, formerly vice-president and works manager, will develop long range manufacturing goals in his new post. Upon joining Sperry in 1941, he supervised production preparations at the 2-million sq ft plant then being built at Lake Success, Long Island. During World War II and subsequently he managed various production phases at the plant.

The firm also announced that L. L. Wheeler has been named chief engineer, and Samuel Agabian has been named works manager.

Dr. Wheeler, since joining Sperry in 1942, has spent a decade in

W. L. Barrow

George A. Richroath

weapon system engineering with emphasis upon armament and bombing equipment. In 1951, he became assistant chief engineer.

Agabian, former assistant works manager, is a graduate of the U. S. Naval Academy. Since joining Sperry in 1940, he has held a number of research, development, engineering and production assignments. Prior to his appointment as assistant works manager in 1953, he was director of surface armament engineering.

Thomas Industries Acquires White

The White Corp. of Milwaukee, Wis., has been acquired by Thomas Industries of Louisville, Ky. White is engaged in electronics research and development, mostly on contracts from the U. S. Government. Thomas Industries is engaged in several fields including residential lighting fixtures and power saws.

All outstanding stock of the White Corp., headed by H. Louis White, president, was acquired in exchange for 10,000 shares of Thomas Industries class A common stock. White becomes a wholly-owned subsidiary of Thomas Industries.

Daven Moves To New Plant

THE DAVEN CO., manufacturers of attenuators, precision wire wound resistors, rotary switches and electronic test equipment, opened a new

plant in Livingston, New Jersey. The building occupies over 65,000 sq ft of space.

Bendix Pacific Expands Plant

A LARGE addition to the engineering building of the Pacific division of Bendix in North Hollywood, Calif., is nearing complection. The new building will centralize and consolidate all engineering activities formerly housed at three separated locations in the San Fernando Valley. It will provide more space for increased engineering activity in the fields of radar, missile guidance, instrumentation, sonar and aircraft hydraulics.

The new addition will increase floor space from 23,000 sq ft to over 100,000 and will house both engineering and development activities. Total floor space devoted to engineering, development and test is equivalent to 50 percent of total manufacturing space.

Emerson Selects Engineering Head

MAURICE L. LEVY, technical assistant to the vice-president in charge of manufacturing at Emerson Radio, has been advanced to the post of director of the commercial engineering division. W. A. Auerbacher continues as director of the government project engineering division.

Levy joined Emerson in 1943 as chief engineer, special products, resigning in 1949 to become engineering consultant to various electronics organizations. In May, 1953, he rejoined Emerson and was named technical assistant to the vice-president in charge of manufacturing.

Consolidated Changes Name, Appoints Jones

CONSOLIDATED Engineering Corp. changed its name to Consolidated Electrodynamics Corp.

The change was made because the previous name did not adequately describe the broad scope of business in which the company is

engaged.

Also, Consolidated had been unable to qualify for intrastate business in certain key states under its previous name, which forced creation of a special subsidiary, CEC Instruments, to operate in such states. This unit is now being dissolved.

Consolidated Vacuum Corp., the Rochester, New York, high-vacuum subsidiary of Consolidated, has also been dissolved and its activities combined with those of the parent firm. It will be known as the Consolidated Vacuum division.

Consolidated also announced that Howard C. Jones has been appointed director of manufacturing of its vacuum division.

In his new position, Jones will direct all manufacturing phases of high-vacuum equipment. He will also direct traffic, purchasing, quality control, and plant engineering operations.

Jones joined the North East Electric Co. in 1921 as an equipment engineer. He became plant engineer, chief engineer, and works manager for the firm's successor, Delco appliance division, General Motors Corp. He was works manager there for eight years.

Navy Dedicates Atomic Lab.

THE NEW $8,500,000 main building of the U. S. Naval Radiological Defense Laboratory was dedicated in San Francisco.

The laboratory is devoted to the

Electronic equipment in new Navy Lab includes 40-channel gamma-ray analyzer

study of nuclear radiation effects. The studies center around the harmful effects of radiations resulting from nuclear reactions, and developing means of preventing or minimizing the hazards of those effects.

The new building is a six story structure of reinforced concrete. Specially designed for use as a research laboratory, it is windowless to provide protection from atomic detonations.

Frank Cook Acquires Hart

HART MACHINE & MANUFACTURING CO., a tool and die machine shop at Denver, has been acquired by the Frank R. Cook Co., incorporated in Denver last July. Cook specializes in the design and manufacture of aeronautical and electronic equipment for military and commercial use. Cook said Hart's operations would be expanded to include production of devices designed by Cook and others.

The Hart firm, which will be a division of Cook, will be managed by Walter N. Lundahl, until recently chief of the advanced flight control design section of the aeronautical division of Minneapolis-Honeywell Regulator Co. Frank M. Hart, who headed the Hart firm the past 20 years, is retiring from business.

Furnas Appointed To Defense Post

CLIFFORD C. FURNAS, chancellor of the University of Buffalo, was appointed by President Eisenhower to be assistant secretary of defense (research and development). He succeeds Donald A. Quarles who became Secretary of the Air Force. Dr. Furnas will be on leave of absence from the University of Buffalo.

From 1946 until 1955, when he became Chancellor, Dr. Furnas was director of the Cornell Aeronautical Laboratory, Buffalo, New York. He has been serving the Department of Defense research and development organization that he will now head in a consultant capacity and had

been associated with its predecessor organization, the Research and Development Board, in various capacities since February 1948.

Clevite Adds Firm, Names Engineers

CLEVITE CORP. has acquired full ownership of Transistor Products and has changed its name to Clevite Transistor Products.

Clevite purchased a majority interest in the company early in 1953, as part of its expansion into the field of electronics.

Dr. R. B. Holt, founder of Transistor Products and former director of Harvard University's nuclear research laboratory, will continue as president of the unit.

Clevite also announced that John H. Harris has been appointed as vice-president in charge of planning, and Wallace T. Gray as general works manager of Brush Electronics Co. in Cleveland.

Harris has been vice-president and general works manager for the Clevite firm since 1948.

Gray was formerly works manager for the Leece-Neville Co. Prior to joining Leece-Neville, he served as plant manager for RCA and as factory manager for the Thomas A. Edison instrument division.

In another move, Clevite combined the Brush Laboratories Co. and Clevite-Brush Development Co. into a single organization, the

John H. Harris

Clevite Research Center in Cleveland, Ohio. A. L. W. Williams is president of the center. Dr. C. B. Sawyer, former president of Brush Labs, is now a consultant to Clevite Corp. on special scientific projects.

Stromberg Selects Operations Analyst

WILSON P. COGSWELL, Captain, U. S. Navy, Ret., has been appointed staff assistant for operational analysis—military, in the engineering and research department of Stromberg-Carlson.

At the time of his retirement from the Navy, Captain Cogswell was serving as director of the Electronic Production Resources Agency. From 1952 to 1954 he was a staff member and consultant at the Lincoln Laboratories of MIT. For the past two years he has been serving Stromberg-Carlson as a part-time consultant.

Texas Instruments Names Maj. Gen. Born

MAJOR GENERAL Charles F. Born, USAF, has joined Texas Instruments as director of service engineering of the apparatus division.

Gen. Born was commander of the crew training air force at Randolph Air Force Base until his recent retirement.

As director of service engineering, he will be responsible for engineering liaison with the Department of Defense and with other defense equipment manufacturers. He will be in charge of the division's service engineering group. The company also announced that an Eastern region marketing office has been opened in New York City. A Los Angeles office was opened in June and a Chicago office in August.

Computer-Measurements Appoints Lovejoy

R. E. LOVEJOY has been appointed director of research for the counting and computing instrument division of Computer-Measurements Corp., North Hollywood, Calif.

He has held executive positions

with several industrial companies and governmental agencies. During World War II, he was employed by the Naval Research Laboratory in Washington.

Prior to joining Computer-Measurements, Lovejoy was employed as instrumentation engineer with AiResearch Manufacturing of Los Angeles.

Condenser Manufacturers Changes Control

THE controlling interest in Condenser Manufacturers of Nashville, Tenn., has been acquired by E. W. Carmack of Murfreesboro, Tenn., and J. W. Hart, president.

Howard W. Gates will remain with the company as chief engineer and vice-president.

The company manufactures miniature and subminiature electrolytics. It also manufactures regular type electrolytics for 150v and less.

Electronic Engineering Adds Space

TOTAL of 6,300 sq ft of space has been added to the fabrication facilities of the Electronic Engineering Company of California. As the result of the addition, the company's Los Angeles laboratory facility now encompasses 26,000 sq ft.

Fairchild Camera Expands In Nucleonics

FAIRCHILD CAMERA AND INSTRUMENT CORP. established a nuclear instrumentation department headed by Harold E. DeBolt.

Dr. DeBolt comes to Fairchild from the nuclear power division of the Navy's Bureau of Ships and the naval reactor branch of the reactor development division of the Atomic Energy Commission. Prior to that time he was associated with the Westinghouse atomic power division in Pittsburgh.

Products under consideration for development and manufacture include radiation monitoring equip-

ment, control rod drive mechanisms for atomic reactors, neutron detectors and associated temperature, pressure and flow controls.

ElectroData Promotes Meyer

RAYMOND MEYER has been named supervisor of manufacturing for ElectroData Corp.

Meyer, who previously was administrative assistant to the vice-president, will have charge of production, purchasing, plant maintenance and production and materials control.

Prior to joining ElectroData last spring, he was general manager of quality control for Hoffman Radio Corp. Prior experience includes managerial and engineering positions with RCA and Permoflux Corp.

Librascope Re-Groups Engineering Division

LIBRASCOPE, Glendale, Calif., manufacturers of computers and control devices has reorganized its engineering divisional structure into five departments. Each department will conduct its own research and development in specific fields.

The five departments, each functioning under a director responsible to chief engineer, D. C. Webster, are: commercial; special devices; airborne equipment; shipboard equipment, and administration. In each of the first four departments, teams of engineers, designers and technicians will work as self-sufficient units under the immediate direction of a project manager.

Clegg Triples Plant Facilities

EXPANSION of physical facilities and production capacities to three times their former size is being completed by Clegg Laboratories, at Morristown, N. J.

The company specializes in custom built electronic and microwave equipment and in the production of electronic scanning and control devices.

President of the firm is Edward

T. Clegg. Secretary and chief engineer is George Antanelis. They have been associated since World War II in radar work and in the development and application of thyratron tubes. Anthony Gerson is treasurer and plant manager.

Gertsch Products Promotes Hood

ROBERT S. HOOD has been appointed vice-president in charge of manufacturing of Gertsch Products of Los Angeles.

Hood has been with Gertsch Products for the past six years. He started as mechanical engineer, then moved to the position of production manager and in his new position is vice-president in charge of production, maintenance, and plant operation.

Corey Elected NEMA President

J. W. COREY, president of The Reliance Electric & Engineering Co. of Cleveland, Ohio, manufacturers of motors and generators, was elected president of the National Electrical Manufacturers Association.

Corey, former vice-president of NEMA, and a member of the board of governors since 1951, succeeds Albert F. Metz, chairman of the board and chief executive officer of the Okonite Co. of Passaic, N. J.

Kelly & Radley Honored In Italy

MERVIN J. KELLY, president of Bell Telephone Laboratories and Sir Gordon Radley, director general of the British Post Office, were recently awarded the first Christopher Columbus International Communication Prize at ceremonies in Genoa, Italy.

Dr. Kelly and Sir Gordon Radley received the prize in recognition of "the planning, now being placed into practice, of the submarine telephone cable which will make it possible to establish 36 telephone circuits across the Atlantic between

Scotland and Canada with extension to New York, intending furthermore to reward hereby the numerous scientists, research workers and engineers who have contributed in the planning, production and placing in operation of the intercontinental submarine telephone line."

In the section of the cable lying on the ocean's bed, there are, at intervals of 40 miles, electronic repeaters. In these repeaters there are some 300 thermionic, high vacuum amplifying tubes and more than 7,000 associated circuit components. The tubes and components have expected lives without failure of more than 20 years.

Dr. Kelly said that the time is not too far distant when cables with band widths sufficiently broad for television transmission will be possible.

The Christopher Columbus International Communication Prize was instituted recently in Italy, under the auspices of the City of Genoa, as a memorial to Christopher Columbus, a native of Genoa. The annual prize is intended to honor any outstanding discovery or research work completed in the previous four years to aid communications among men.

New Firm Formed In Los Angeles

A NEW electronics company, Fenske, Fedrick, Miller, Inc., has been established in Los Angeles. The firm is developing electronic testing equipment and analyzers. Don Fenske is president, Jack Fedrick is secretary and treasurer and Robert Miller is vice-president.

IRE Makes Fellow Awards For 1956

SEVENTY-FIVE fellow awards were made by IRE for 1956. The grade of Fellow is the highest membership grade offered by the Institute and is bestowed only by invitation on those who have made outstanding contributions to radio engineering or allied fields.

Presentation of the awards will be made by IRE Sections all over

the world wherever the recipients reside. Recognition of the awards will be made by the president of the IRE at the anual banquet on March 21, 1956, at the Waldorf-Astoria Hotel in New York City during the 1956 IRE National Convention.

The recipients of the Fellow award, which takes effect January 1, 1956, are as follows:

H. E. M. Barlow, Pender professor of electrical engineering, University of London, London, England
Leslie C. Jesty, chief of television research group, Marconi's Wireless Telegraph Company, Essex, England
Rolf Moller, c/o Fernseh GMBH, Darmstadt, Germany
Lothar Rohde, co-partner, Rohde and Schwarz, Munchen, Germany
M. J. O. Strutt, professor, director, Swiss Federal Institute of Technology, Zurich, Switzerland
Samuel N. Alexander, chief, data processing systems div., National Bureau of Standards, Washington, D. C.
Nicholas G. Anton, president, director of research and engineering, Anton Electronics Labs., Brooklyn, N. Y.
William S. Bachman, director, engineering and development, Columbia Records, New York, N. Y.
George W. Bailey, executive secretary, Institute of Radio Engineers, New York, N. Y.
William J. Barkley, c/o Rust Industrial Co., New York, N. Y.
Loy E. Barton, research engineer, RCA Laboratories, Princeton, N. J.
Robert E. Beam, professor of electrical engineering, Northwestern University, Evanston, Ill.
James E. Beggs, research associate, General Electric Co., Schenectady, N. Y.
Willis H. Beltz, Capt., (USN, retired), Sheraton Park Hotel, Washington, D. C.
William R. Bennett, Bell Telephone Laboratories, Murray Hill, N. J.
Enoch M. Boone, professor of electrical engineering, Ohio State University, Columbus, Ohio
Wilson P. Boothroyd, chief development engineer, Philco Corp., Philadelphia, Pa.
Paul N. Bossart, section engineer, Union Switch and Signal Div., Westinghouse Air Brake Co., Pittsburgh, Pa.
Arthur B. Bronwell, president, Worcester Polytechnic Institute, Worcester, Mass.
Archibald S. Brown, special assistant to director of research, Stanford Research Institute, Stanford, Calif.
Horace T. Budenbom, Bell Telephone Laboratories, Whippany, N. J.
R. D. Cahoon, prairie regional engineer, Canadian Broadcasting Corp., Winnipeg, Canada
Herbert J. Carlin, research professor, Microwave Research Institute, Brooklyn, N. Y.
Alva B. Clark, (vice-president of Bell Telephone Laboratories, retired), Washington, D. C.
George F. Corcoran, professor and chairman, electrical engineering dept., University of Maryland, College Park, Md.
Thomas M. Davis, head, radio techniques branch, U. S. Naval Research Lab., Washington, D. C.
Edward N. Dingley, Jr., special assistant to the chief, office of research and development, National Security Agency, Washington, D. C.
Ora S. Duffendack, president and director of research, Philips Labs., Irvington-on-Hudson, N. J.
J. Presper Eckert, Jr., vice-president, Remington Rand, Philadelphia, Pa.
Harold E. Edgerton, professor, Massachusetts Institute of Technology, Cambridge, Mass.
George A. Espersen, section chief, microwave tube and electron optics sections, Philips Labs., Irvington-on-Hudson, N. Y.
Clifford E. Fay, Bell Telephone Laboratories, Murray Hill, N. J.
W. G. H. Finch (USN, retired), Newton, Conn.
A. Gardner Fox, research radio engineer, Bell Telephone Laboratories, Red Bank, N. J.
Alan M. Glover, manager, semiconductor operations dept., RCA Tube Div., Harrison, N. J.

Stanford Goldman, professor of electrical engineering, Syracuse University, Syracuse, N. Y.
Ladislas Goldstein, professor of electrical engineering, University of Illinois, Urbana, Ill.
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Maurice E. Kennedy, director and chief engineer, department of communications, Los Angeles County, Los Angeles, Calif.
Glenn Koehler, professor of electrical engineering, University of Wisconsin, Madison, Wis.
N. I. Korman, manager, systems engineering group, RCA, Moorestown, N. J.
Kurt Lehovec, supervisory engineer and head, transistor lab., Sprague Electric Co., North Adams, Mass.
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Robert L. Wallace, Jr., Bell Telephone Laboratories, Murray Hill, N. J.

New Books

Electronic and Radio Engineering

By Frederick E. Terman. *McGraw-Hill Book Co., Inc., New York,* 1955. 1,078 *p,* $12.50.

Each passing year adds to the multitude of electronic engineers who have cut their professional eyeteeth on Terman's "Radio Engineering." Now in his fourth edition, the author recognizes in the title that radio is only a part of the rapidly expanding field of electronics.

▶ **Content**—The book provides a thorough treatment of electronic fundamentals with a considerable portion devoted to ramifications of the electron-tube amplifier. The author has made a highly commendable effort to keep the book timely.

There is a fairly long chapter on microwave tubes that will give the student a good qualitative understanding of the traveling-wave tube and other devices for microwave frequencies. It is a convenience to have the admittance-spiral discussion of the klystron within such a general book. This avoids the necessity for an outside reading assignment.

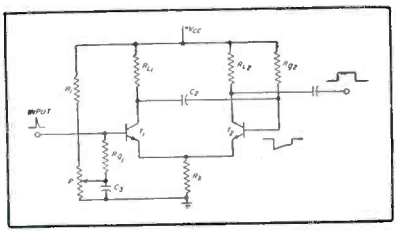
Another fairly long chapter discusses the transistor. This discussion will provide a firm basis for work with semiconductor circuits. Undoubtedly, subsequent editions will devote even more space to this extremely useful device—especially from the application standpoint.

The material on television has been completely revised from previous editions and includes a thorough coverage of modern practice including color television.

The chapter on aids to navigation provides an introduction to radar which is so important in the military end of the electronics business. Appropriate emphasis is placed on newer radar features such as moving target indication.

In his coverage of radio propagation, the author has anticipated the current interest in propagation beyond the horizon through the mechanism of forward scatter.

▶ **Evaluation**—The book is excellent as a general text on the under-



One-shot multivibrator using junction transistors

graduate level. The author gets his material across with a minimum of high-powered mathematics such as transform analysis and partial differential equations.

The specialist will have to look elsewhere for the answers to his special problems. Nevertheless, the material is here for a basic understanding of electronic and radio engineering together with a comprehensive view of the current electron art.—J.M.C.

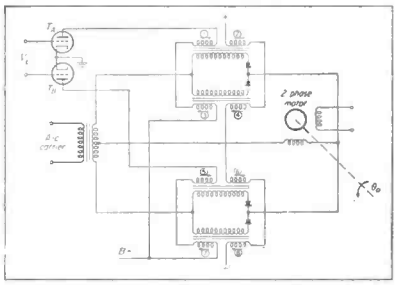
Analysis of Feedback Control Systems

By ROBERT A. BRUNS and ROBERT M. SAUNDERS.
McGraw-Hill Book Co., New York, 1955, 383 *p*, $7.50.

THE past two years have seen an increasing number of books published on the subject of feedback control systems. This text is different, however, in that it not only deals with the analysis of such systems but also includes a good, extensive treatment of the individual components of which the system is composed. Especial emphasis is placed upon deriving the transfer function for each component since this constitutes the essence of the frequency response method of analyzing system behavior to applied disturbances.

The book was written primarily for the benefit of the scientist and/or the practicing engineer who is new to the field of feedback control systems and who desires to gain a knowledge of the subject matter and an appreciation of its limitations. It is also intended as a text for a senior-level engineering course. The required preparation consists of a-c circuit theory and some familiarity with dynamics and differential equations.

Basically the book is divided into two parts. Part I, which covers 222



Magnetic-amplifier motor control

pages, deals with components. Part II, which spans the remaining 150 pages, treats the subject of feedback system theory. The authors chose to present the material on components first since they felt this would make understanding system behavior easier.

In presenting the material of the book the authors frequently resort to the use of instructive, illustrative examples. Moreover, the text is considerably annotated with well-chosen references. Another worthwhile feature is the termination of each chapter with a summary section in which the salient points of the chapter are condensed. There is also an abundance of problems after each chapter.

This is a book which has a definite contribution to make to the literature on feedback control systems. It should be well received.—PROF. V. DELTORO, C. C. N. Y. *School of Technology, The City College, New York, N. Y.*

Transistors and Other Crystal Valves

BY T. R. SCOTT. *Essential Books, Inc., Fair Lawn, New Jersey,* 1955, 258 *p,* $7.20.

MANY books about transistors concentrate heavily on how to design the units into electronic circuits. This book emphasizes fundamental behavior of transistors and thereby indicates broadly their potentialities.

► **Content**—The book starts off with a brief discussion of early Bell Labs work with transistors and a chapter on imperfections in crystals from which the transistor derives its amplification properties.

There follows a fairly comprehensive coverage of the *p-n* junction. This topic provides a jumping off point for discussions of various

junction transistors and diodes of U. S., British and European manufacture.

Material on high-frequency semiconductor devices covers the *pnip* trabsistor and the field-effect transistor.

►**Evaluation**—Of special merit is the appendix which discusses transistor action from the quantum mechanical viewpoint. This material serves to integrate the behavior of the transistor into the overall physical concept of matter and energy. There is also a useful appendix devoted to testing techniques.—J.M.C.

Thumbnail Reviews

Application of Transistors to Electronic Counting Equipment. By R. E. Kimes. Report to Signal Corps Supply Agency. Available from OTS, Washington, D. C., 71 p, $2.00 (paper). Design and development of a transistorized frequency meter. Circuit details are presented.

Coyne Technical Dictionary. Howard W. Sams & Co., Inc., Indianapolis, Indiana, 160 p, $2.00. Defines 4,000 expressions used in television, radio and electronics. A data section is included.

Repairing Record Changers. E. Eugene Ecklund. McGraw-Hill Book Co., Inc., New York, 1955, 278 p, $5.95. Treats mechanical operation of record changers; discusses pickups, amplifiers, also magnetic-tape recorders.

Physical Mathematics. Chester H. Page. D. Van Nostrand, Inc., New York, 1955, 329 p, $7.50. Nicely groups the mathematics required for a first-year graduate-level course in theoretical physics. Considers eigenfunctions, transform analyses, partial differential equations and other important topics.

Powder Metallurgy. Organization for Europeon Economic Cooperation, Washington, D. C., 1955, 309 p, $3.00 (paper). Contains material on the properties and preparation of powdered metal magnets and ferrites.

A Study of the Double Modulated F-M Radar. Mohamed Abd-El Wahab Ismail. Berlag Leemann, Zurich, Switzerland, 112 p, 10.40 Swiss francs. Highly mathematical discussion of the technique of double-modulated f-m radar. Advantages are given. Conventional f-m radar is also discussed.

An Introduction to Automatic Computers. Ned Chapin. Technology Center, Chicago, Ill., 245 p. $9.00 (binder). Discusses design and programming of automatic digital computers and gives data sheets for available units, that provide technical and operating data.

Backtalk

Automatization

DEAR SIRS:

ON the article "Automatics" which appeared in UNESCO's Monthly Bulletin of the International Advisory Committee on Documentation and Terminology in Pure and Applied Science, 1955. 08,14, commenting on editorials and letters published, I think it useful to bring to the notice of interested scientists the following:

In the English language there is the verb "automatize" which is accompanied by many derivatives and related words.

The verb "automatize" and the connected words are of Greek origin and in use from ancient times . . .

The word "automation" means self acting or presenting a reflex action. It derives from Greek words meaning to act, to move, to attempt, to desire, to hurry, to be eager. The resultant of all these ancient meanings of "maomai" with the prefix "autos" is the modern meaning of the combined word "automation" . . .

There is no need for scientists to invent a verb of Latin appearance or origin, as has been suggested, because Latin has nothing to do with those completely Greek words. It seems necessary to emphasize that words like automation, automacy, automate, and who knows what else, are altogether out of the rules governing the mother root: "automat—", either in English or in Greek and in consequence they are erroneous . . .

As a technical man, I could say that those words: "automation, automacy, automate etc." do not bring any new conception in the technical field, which might justify their introduction in the technical vocabulary. They are intended to have the same meaning as the correct ones but they are wrongly formed.

The Oxford English Dictionary, besides the correct terms, gives: Automate (a substantive and adjective, obsolete, from French "automate"), Automacy (name indicating the "automatic quality", probably from French "automatie"). So, we see their formation

comes from French instead of from Greek.

In conclusion, the expressed useful idea that we need a verb from which the abstract noun could be easily recognized, I think, is fully satisfied with the use of the existing Greek root: "automat—", which gives so many, so precise and so easily recognizable derivatives.

DIONYSIUS J. BATAIMIS
Athens, Greece

Television Pioneer

DEAR SIRS:

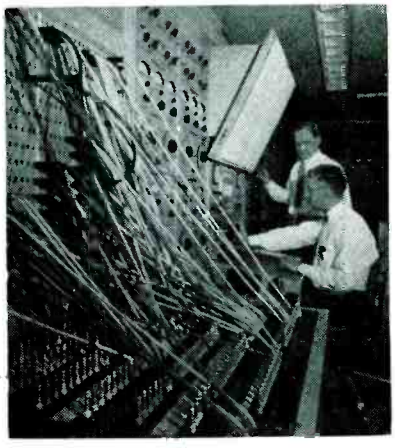
TWENTY-FIVE years ago Manfred Baron von Ardenne succeeded for the first time at his laboratory in Berlin Lichterfelde to transmit electron pictures in half-tones. This was encouraging, giving hope of further development of electron picture transmissions.

I wish to call your attention to the fact that these experiments caused the conversion from the generally used mechanical television technique to the modern electronic television technique.

The historical date of this experiment was December 14, 1930.

HANS KOEPPEN
Berlin, Germany

Network Analyzer



Example of industry-education teamwork, this $430,000 network analyzer presented to Syracuse University by two power companies and GE will solve power-distribution problems while training network analysts. The 20-ton machine consists of 16 generator units, 200 line units, 150 capacitor units, 64 load units, 32 autotransformer units, 50 mutual transformer units, two operating consoles and a recording table. It uses 25 miles of hookup wire, 3,500 resistors, 2,500 switches, 800 transformers and reactors and 800 relays

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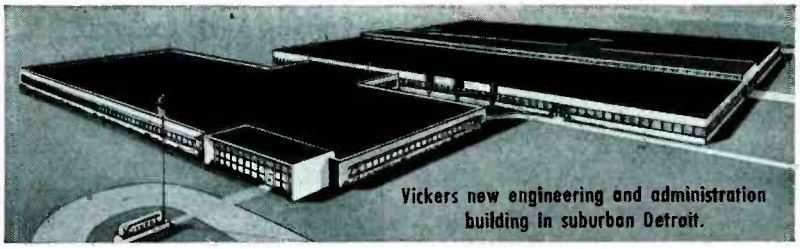

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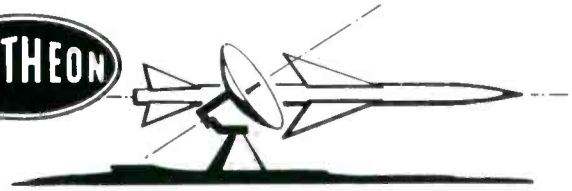

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		Electrical Engineers			Mechanical Engineers			Physical Science			Chemistry Ceramics Glass Technology Metallurgy		
		1-2	2-3	4-15	1-2	2-3	4-15	1-2	2-3	4-15	1-2	2-3	4-15
SYSTEMS *(Integration of theory, equipments and environment to create and optimize major electronic concepts.)*													
AIRBORNE FIRE CONTROL				W M			M			W M			
DIGITAL DATA HANDLING DEVICES	M C			C			C			C			
MISSILE ELECTRONICS • RADAR	M			M X			M			M			
INERTIAL NAVIGATION	M			M			M			M			
COMMUNICATIONS				C I						C I			
DESIGN • DEVELOPMENT													
KINESCOPES (B & W and COLOR), OSCILLOSCOPES—Electron Optics—Instrumental Analysis—Solid States (Phosphors, High Temperature Phenomena, Photosensitive Materials and Glass to Metal Sealing)		L	L	L	L	L	L	L	L	L	L	L	L
RECEIVING TUBES—Tube Design—Test and Application Engineering—Chemical and Physical Development—Methods and Process Engineering—Advanced Development		H	H	H		H	H		H	H		H	H
SEMI-CONDUCTORS—Transistors—Semi-Conductor Devices—Materials		H	H	H	H	H	H	H	H	H	H	H	H
MICROWAVE TUBES—Tube Development and Manufacture (Traveling Wave—Backward Wave)	H		H	H		H	H		H	H		H	H
GAS, POWER AND PHOTO TUBES—Photosensitive Devices—Glass to Metal Sealing		L	L	L	L	L	L	L	L	L	L	L	L
AVIATION ELECTRONICS—Radar—Computers—Servo Mechanisms—Shock and Vibration—Circuitry—Remote Control—Heat Transfer—Sub-Miniaturization—Automatic Flight—Design for Automation—Transistorization	M C	M C X	M C X	M C X	M C	M C X	M C X	M C X	M C X	M C X			
COMPUTERS—Systems—Advanced Development—Circuitry—Assembly Design—Mechanisms—Programming		C	C X	M C X	C	C X	M C X	C	C	M C			
RADAR—Circuitry—Antenna Design—Servo Systems—Gear Trains—Intricate Mechanisms—Fire Control	M C	M C X	M C X	M C X	M C X	M C X	M C X	M C X	M C X	M C X			
COMMUNICATIONS—Microwave—Aviation—Specialized Military Systems		C	C	C		C	C		C	C			
RADIO SYSTEMS—HF-VHF—Microwave—Propagation Analysis—Telephone, Telegraph Terminal Equipment		I	I	I									
MISSILE ELECTRONICS—Systems Planning and Design—Radar—Fire Control—Shock Problems—Servo Mechanisms	M	M	M	M	M	M	M	M	M	M			
COMPONENTS—Transformers—Coils—TV Deflection Yokes (Color or Monochrome)—Resistors		C	Z C	Z C	C	Z C	Z C	C	C	C		Z	Z
MACHINE DESIGN Mechanical and Electrical—Automatic or Semi-Automatic Machines			L	L		L H	C L H		L	L			

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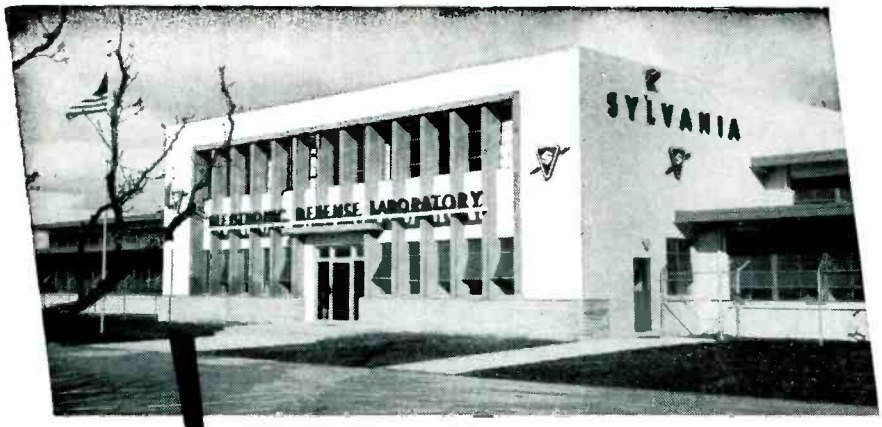

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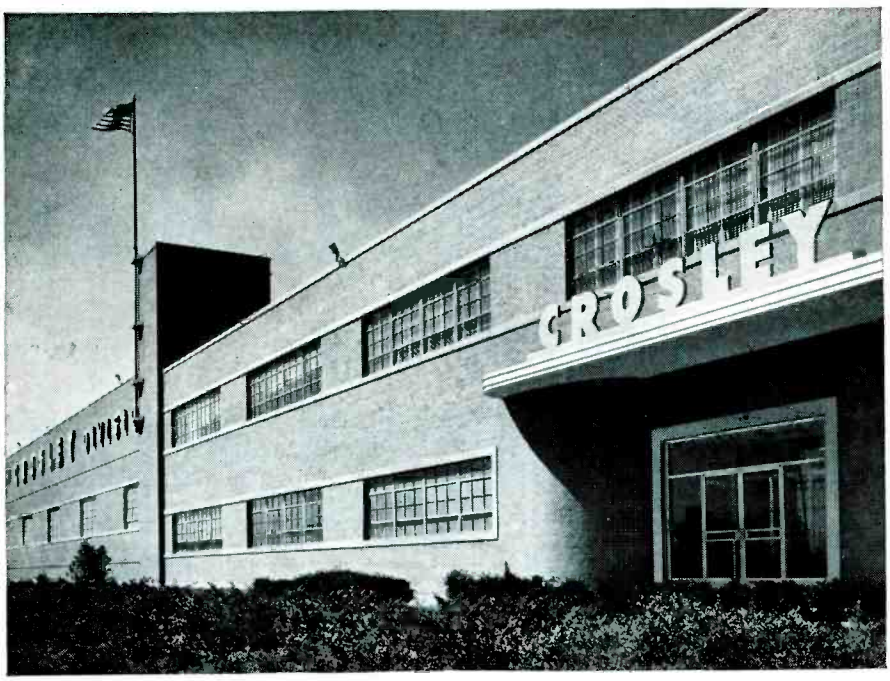

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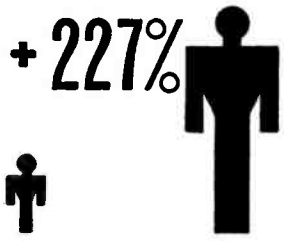

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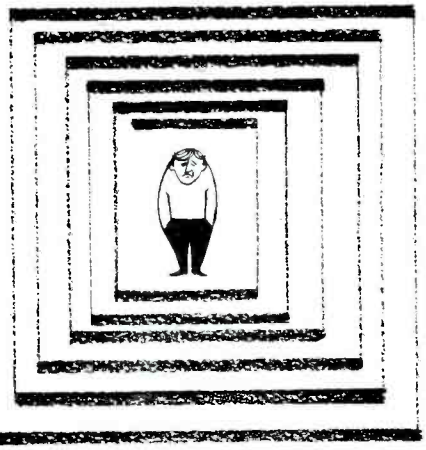

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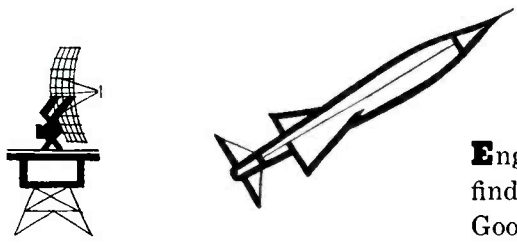

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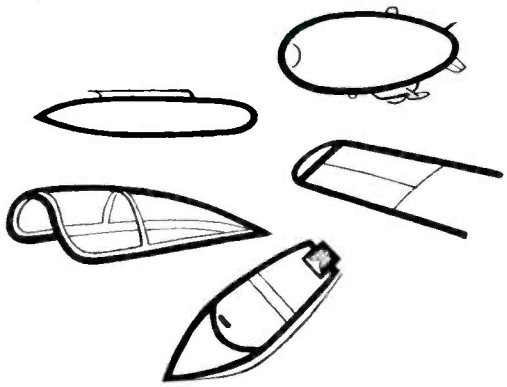

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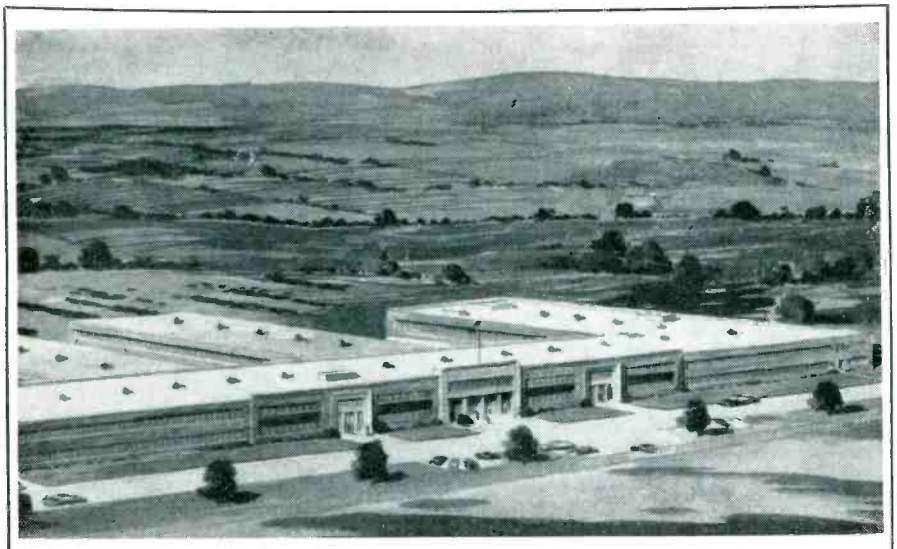

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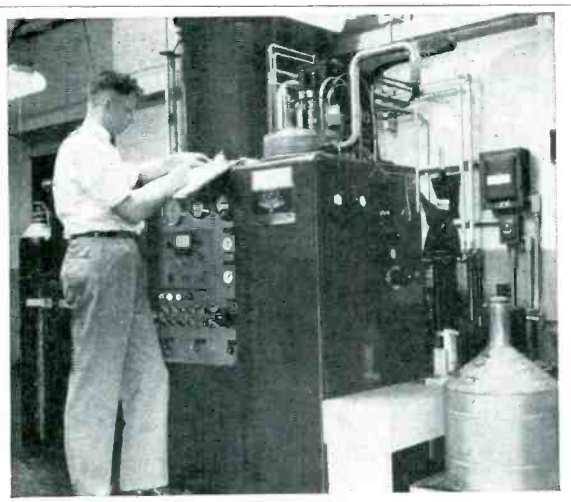

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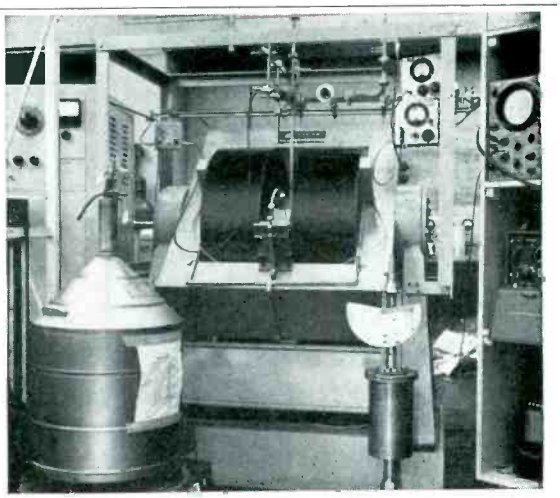

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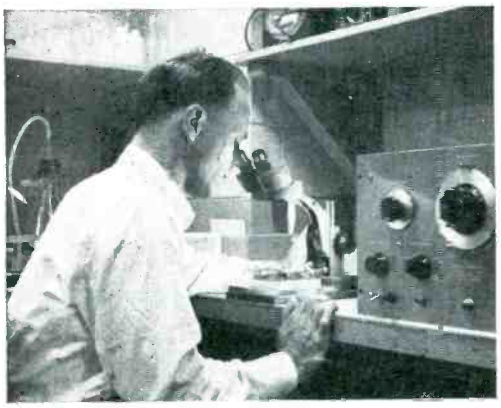

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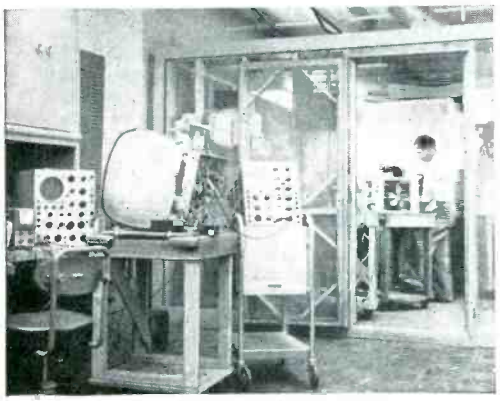

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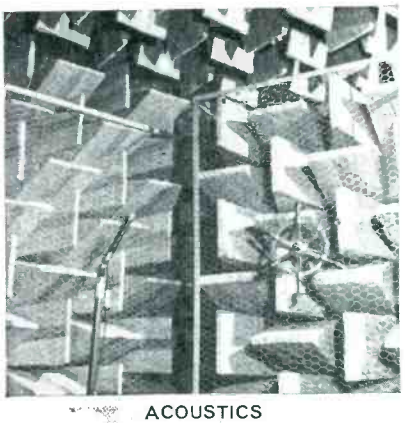

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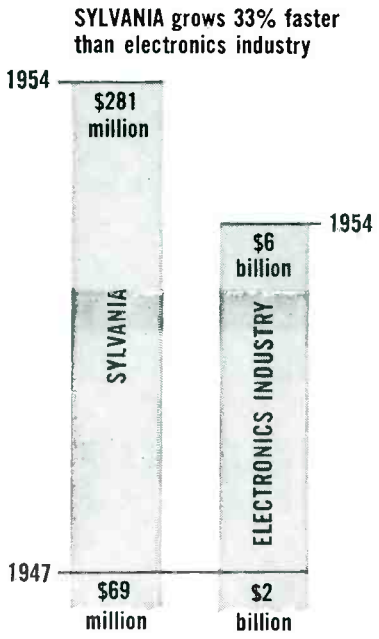

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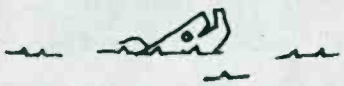

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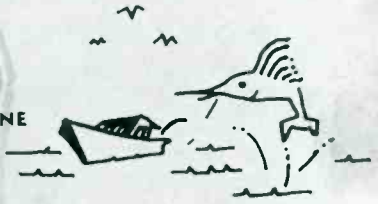

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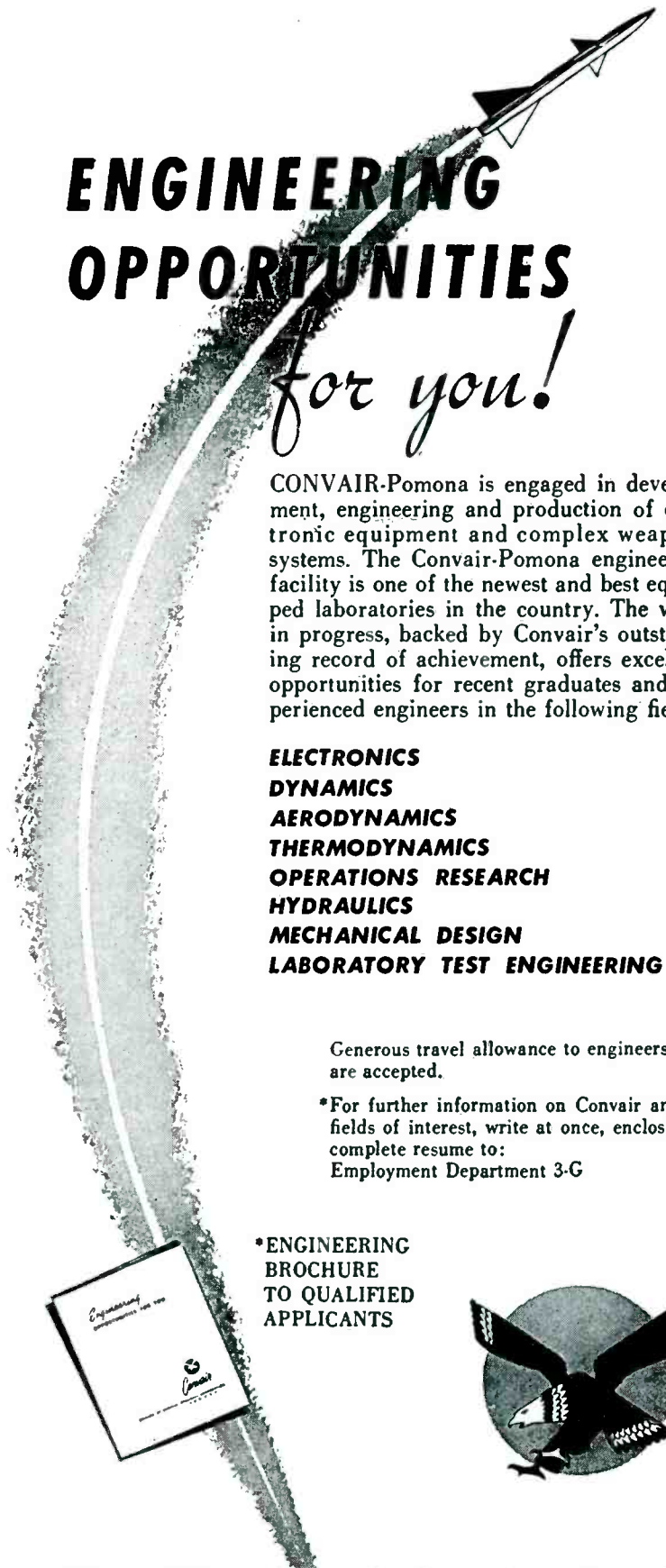

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CONVAIR-Pomona is engaged in development, engineering and production of electronic equipment and complex weapons systems. The Convair-Pomona engineering facility is one of the newest and best equipped laboratories in the country. The work in progress, backed by Convair's outstanding record of achievement, offers excellent opportunities for recent graduates and experienced engineers in the following fields:

ELECTRONICS
DYNAMICS
AERODYNAMICS
THERMODYNAMICS
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Generous travel allowance to engineers who are accepted.

*For further information on Convair and its fields of interest, write at once, enclosing a complete resume to:
Employment Department 3-G

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CONVAIR
A DIVISION OF GENERAL DYNAMICS CORPORATION
POMONA, CALIFORNIA

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Creativity

is encouraged and prized

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The Foundation was created some twenty years ago to provide research and development services to industry and government. How well it has fulfilled this purpose is reflected in its remarkable growth.

One of the key factors in Armour Research Foundation's success has been engineering and scientific teamwork. Intensive collaboration, utilizing highly skilled and diversified talents, is focused upon a particular problem to reach a solution.

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These also are the reasons why more and more scientists and engineers are looking to Armour Research Foundation as the place to build their careers. Write to the Personnel Manager if you are interested in openings as:

Aeronautical Engineers
Ceramists
Chemical Engineers
Chemists
Structural Engineers
Design Engineers
Electrical Engineers
Electronic Engineers
Mathematicians
Mechanical Engineers
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ARF

ARMOUR RESEARCH FOUNDATION OF ILLINOIS INSTITUTE OF TECHNOLOGY

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Employment Manager

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OLIN MATHIESON CHEMICAL CORPORATION

P.O. Box 906

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WHEN there are many applicants for a single position it frequently happens that the only letters acknowledged are those of the most promising candidates. Others may not receive any indication that their letters have even been received by a prospective employer much less given consideration. These men often become discouraged, will not respond to future advertisements, and sometimes question their bona fide character.

Every advertisement printed in the Employment Opportunities Section is duly authorized.

It will help to keep our readers interested in this advertising if you will acknowledge every application received, even if you merely return the letters of unsuccessful applicants with, "Position filled, thank you" written or stamped on them.

We suggest this in a spirit of cooperation between employers and the men replying to Positions Vacant advertisements.

★

"Put yourself in the other fellow's place."

★

Classified Advertising Division

McGraw-Hill Publishing Co., Inc.

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Got here o.k. today. Couldn't wait to tell you what I think of Farnsworth and Fort Wayne. It's more than a place to work .. it's a way of life! Most of the folks here own their own homes. There are no row houses and that cottage in the country is real and only 10 minutes from everywhere.

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There's also a full size, full season symphony orchestra ... World championship basketball and hockey in a new 3 million dollar coliseum that's out of this world. (Are you listening, Jackie?)

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I can't wait until you and the kids get here ... I know you'll love it. And, like they say at Farnsworth, "Very, very few ever leave it."

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ENGINEER, M.E.

ADVANCED DESIGN, RADAR ANTENNAS

A chance to use the latest techniques and methods in lightweight construction. You will direct new work in the field and can make original contributions in structural design and stress analysis involving advanced design.

Experience in radar antenna design plus additional study a "must." Training and experience should indicate ability to undertake leadership in study, application and use of latest techniques and methods.

Especially attractive working location in Berkshire mountains of Massachusetts plus advantages of proper atmosphere planned to assist creative thinking. Extensive company-paid benefit plans. Excellent salary commensurate with ability.

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CALTECH
JET PROPULSION LABORATORY
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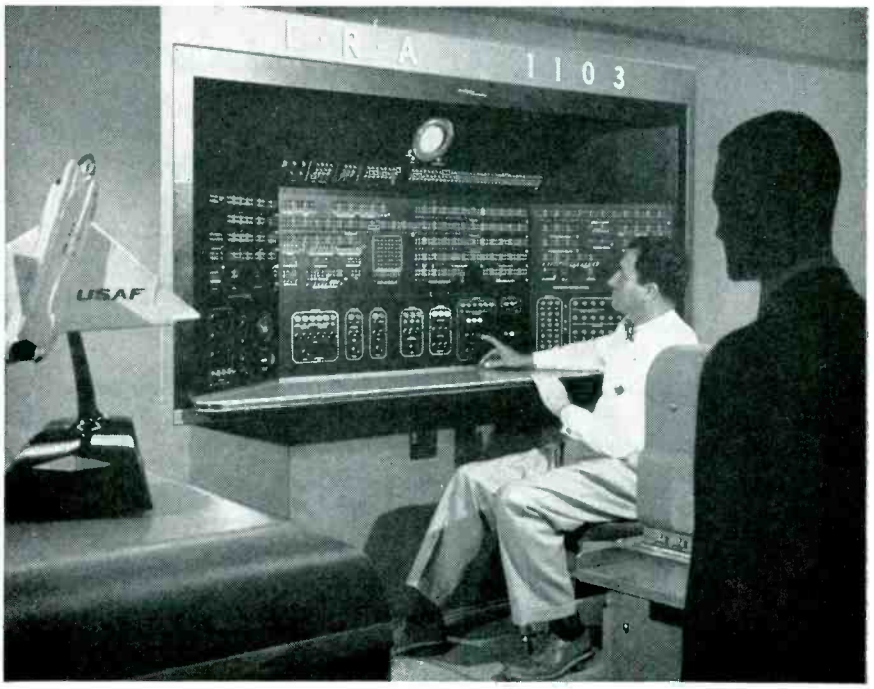
SEEKING THE CHALLENGING PROJECTS IN



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ERCO now needs Electronic Engineers (all levels with some overseas positions available). Aerodynamicists, Analog Computer Engineers, Mechanical Design Engineers, and supporting personnel. Send resume or request for additional information to:

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Research facilities that enable you to test out your most revolutionary ideas and encouragement to publish original work available to the engineer experienced in precision gyroscopic equipment.

Assignments in the field of missile guidance systems will include both mechanical and electrical problems involving lubrication, temperature control, bearings, vibration and shock mounts, development work in components such as pickups, accelerometers, amplifiers and computers, plus project work on complete gyroscopic systems.

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- Friendly and Personable — Must Deal Extensively with Stromberg-Carlson and Military Engineering Personnel

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Charles W. Finnigan, Chief Electronics Engineer

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A DIVISION OF GENERAL DYNAMICS CORPORATION
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Personnel Department
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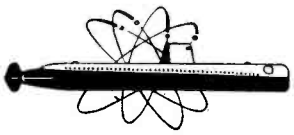
3rd Ave. Alpha, N. J.

ELECTRONIC ENGINEERS

What Should an EE Know About Atomics?



Quite a bit these days, with so many companies getting into the field. While many new firms are now starting to explore the field, Electric Boat Division of General Dynamics Corporation led the way with the building of the first nuclear powered submarines, Nautilus and Sea Wolf.

In addition to increasing its engineering force for work on new and greatly advanced nuclear submarines, Electric Boat is expanding Research and Development operations to include the development of additional practical uses for nuclear energy.

Right now Electric Boat has interesting positions for EE's versed in servo-mechanisms, circuitry, motors and generators, radar & sonar, or electro-mechanical systems.

Study for bachelor's or advanced degrees is encouraged at Electric Boat, with courses in mathematics, naval architecture, nuclear engineering and nuclear submarine systems offered within the plant, and tuition paid by the company for study in these or other fields at leading colleges and universities.

Men interested in these openings should write complete details of background and experience including initial salary requirements. Interviews will be arranged promptly for qualified applicants. Address Mr. Peter Carpenter.

Electric Boat Division
GENERAL DYNAMICS CORPORATION
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AMF

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To design or supervise the design of Radio Frequency components for radar, radio equipment, antennas, horns, mixers, directional couplers, rotating joints and radomes. Must know cost estimating of this equipment and be able to advise shops on the best fabrication methods. Should be capable of setting up RF section. Approximately 10 years experience in design of RF components and systems.

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Product Design, Production liaison on electronic packaging and mechaniams. Involves gear trains, printed circuits and electronic layout work. Knowledge of military specifications. Minimum 6 years experience in electronic equipment design and manufacture.

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Experienced in Product Design and Production. Production liaison requires wide knowledge of electronic circuits and packaging. System and Component Testing. Some experience in cost estimating and project administration. Familiarity with all types of military specifications.

And remember that AMF is well-known for its liberal benefits program.

Please send complete resume to:
Personnel Manager, Electronics Division

American Machine & Foundry Co.

1085 Commonwealth Ave — Boston, Mass.

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To conduct pattern studies, design prototype antennas and supervise flight tests of new antenna installations. College graduate in Physics, Math or E.E.

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Three to five years aircraft instrumentation experience required. Knowledge of transducers, amplifiers and recording equipment used in experimental research testing of hi-speed jet aircraft is essential. Knowledge of servo loop theory as applied to aircraft systems coupled with ability to properly instrument, record and analyze is desirable. Graduates with E.E. degree preferred.

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Staff position available for qualified Aeronautical or Electrical Engineer with heavy experience in the design and installation of automatic flight control systems. Servo-mechanism background is essential while flight test experience is desirable. Must be capable of evaluating automatic control systems and monitoring design by outside vendors.

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MR. R. L. BORTNER

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We are looking for outstanding young engineering graduates with 5 to 10 years' experience in one or more of the above fields.

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Unusual Opportunity in Western N. Y. State. Must have experience in the Design of Audio Power, Pulse & Toroidal Transformers for use in commercial & government applications. Please send resume to

P-8651, Electronics
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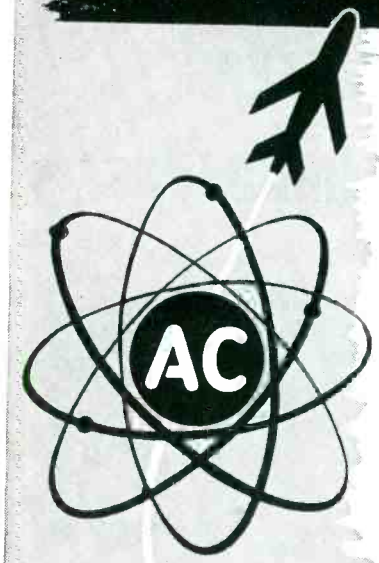

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- Experimental Engineering
- Development Engineering
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$30,000

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Nationally known manufacturer, a recognized leader in the field, offers an exceptional opportunity for an experienced sales manager capable of directing a well-trained sales organization . . . as well as assuming responsibility for advertising, sales promotion and all other phases of marketing.

Sales are direct to industrial users.

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P-8548, Electronics
330 W. 42 St., New York 36, N. Y.

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AUDIO • ACOUSTICAL • MICROWAVE ENGINEERS

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Here's a highly respected firm—one of the fastest growing in the fabulous electronics industry, and a member of the headline-making General Dynamics family.

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Stromberg-Carlson, at Rochester, N. Y., is in the heart of the lovely Finger Lakes region. This medium-sized progressive city offers unusual recreational and educational facilities, and fine residential areas within a mile of the plant.

With its varied product line (divided almost equally between civilian and military) and its 61 years of prominence in the field of communications, Stromberg-Carlson offers you stability along with a chance to grow. For further details, write immediately to:

CHIEF ENGINEER, SPECIAL PRODUCTS DIVISION

STROMBERG-CARLSON COMPANY

A DIVISION OF GENERAL DYNAMICS CORPORATION

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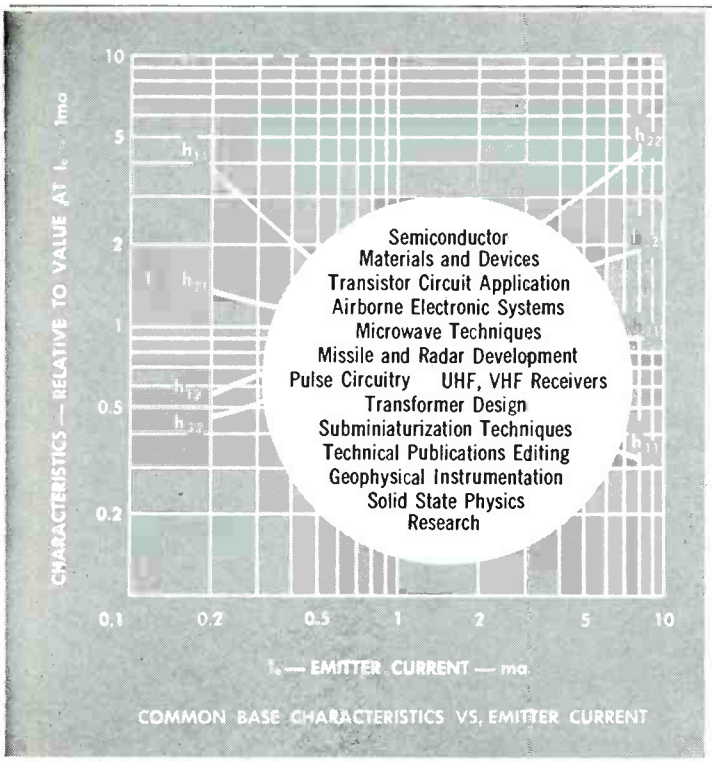

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Stromberg-Carlson, a Division of General Dynamics Corporation, is located in the Finger Lakes region of upstate New York. In addition to providing a wide variety of challenging engineering opportunities, excellent salaries are offered with the finest working conditions in a modern electronics laboratory. Unusual recreational and educational facilities are available in this medium-sized progressive city, and fine residential areas are located within a mile of the plant. Because of the variety of its product line, which is approximately equally divided between military and civilian, Stromberg-Carlson offers a degree of stability and an opportunity for advancement unequalled in the industry.

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Communications
Infrared
Digital Techniques
Microwave Circuits
Mechanical Design Engineering
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Radar
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For further information please write or call—

Mr. C. W. Finnigan, *Chief Electronics Engineer*

STROMBERG-CARLSON COMPANY
A DIVISION OF GENERAL DYNAMICS CORPORATION
Rochester 3, New York

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To coordinate and supervise a group of engineers and mathematicians in systems analysis and design.

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About

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Sales organizations or individuals geared to sell laboratory grade test equipments to electronic, aircraft, and industrial concerns.
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SW-8665, Electronics
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Philadelphia and Chicago area.

RW-8686. Electronics
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INVITES INQUIRIES FROM ELECTRONIC ENGINEERS INTERESTED IN JOINING A MODERATE SIZED RESEARCH AND DEVELOPMENT ORGANIZATION OPERATED BY SCIENTISTS FOR SCIENTISTS.

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More and more these days you hear top engineers talk about the many growth opportunities at Melpar. With an increasing number of significant electronic projects, an enlarged staff and facilities, Melpar provides many opportunities for professional growth and advancement. Our new laboratory is an engineer's dream come true; a building conceived by and constructed for the ENGINEER – 265,000 sq. ft. of complete engineering facilities.

We are located in Fairfax County of northern Virginia where housing is reasonable and plentiful—whether you desire a private home or an apartment. Although we are in a truly suburban atmosphere, we are only 10 miles from the nation's capital with all its recreational and social advantages. Here you and your family can grow in an environment to match your professional growth.

Send resume to Technical Personnel Representative,

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Position with technical and managerial responsibility in the design of antennas for the UHF through the microwave region. A degree in Elect. Eng. or Physics is required with at least 2 years experience if PhD or 5 years if B.S.

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WAYLAND LABORATORY WAYLAND, MASSACHUSETTS

For information on this new laboratory, see our ad on page 372 of this issue.

PRODUCTION ENGINEER
TRANSFORMERS

2 years minimum experience in design, fabrication and processing of precision, specialty inductive components. Prefer graduate E.E. or B.Sc. Physics.

CAPACITOR ENGINEERS

Engineering of Mica and Paper capacitors. Prefer graduate E.E. or B.Sc. Physics. Will consider 2 years college, plus minimum 2 years experience.

Mail complete resume to Employment Manager,
SANGAMO ELECTRIC COMPANY,
Capacitor Division, Marion, Illinois.

PROJECT ENGINEERS
Electro-Mechanical

Opportunities are available in controls engineering department of leading aircraft accessories manufacturer. These are responsible positions requiring men with 7-10 years experience in electro-mechanical engineering. The work is related to precision control of relatively large high speed turbine driven devices. Previous supervisory experience necessary. Openings exist in the following areas:

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These are permanent positions with excellent opportunities for advancement under excellent working conditions.

Submit complete resume, including past earnings and availability for interviews in first letter to:

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Operations Research Office of The Johns Hopkins University offers exceptional opportunities for scientists who prefer the challenge of operational problems of unusual scope and diversity to routine design and development work.

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- Military communications systems planning, analysis and evaluation
- Electronic Countermeasures Analysis

Please send your resume to Research Personnel Officer

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EXPERIENCED IN:

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Development
Design
Instrumentation
Servomechanisms
Missiles
Audio Systems
Control Systems
Radar
Computers
Transistors

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Employment Opportunities

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ASCOP announces opportunities for ENGINEERS at Princeton, N. J.

POTENTIOMETER ENGINEER

Experience in the electrical design and performance of potentiometers, qualified in setting up accurate noise measuring circuits at low levels, simulating attached circuitry of customers, carrying out life, performance and environmental evaluations. To work with the Company's rapidly expanding Switch Division. Supervisory abilities highly desirable. Knowledge of MIL specs desired but not mandatory.

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Five years experience in electrical circuitry, specializing in VHF, UHF and microwave design engineering. Some background in high altitude propagation study desirable. Record of successful equipment design as well as experience in production designing and planning. Experience or knowledge of instrumentation and telemetry is desirable.

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Senior electronics engineer or physicist with five to ten years experience in electronic product design, preferably instrumentation, including a minimum of two to three years experience in transistor circuit work. Familiarity with MIL specs required. Will consider electronics engineer with three to five years in electronic design with some transistor work as assistant to senior transistor man.

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Comprehension of the concepts and applications of data systems, preferably with several years experience in Pulse Width Telemetry use or four years of telemetering or instrumentation experience in missiles, aircraft, or similar field. Must be willing to travel up to 40% of the time, usually not in stretches longer than two (2) weeks at a time. Sales experience not necessary but desirable.

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Applied Science Corp. of Princeton
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55 Chapel St. Newton 58, Massachusetts

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Complete laboratory for sale including laboratory model sub-miniature toroid coil winding equipment (modified), formvar insulated wire, many ferrite and permalloy cores, new inductance bridge, etc.

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Must be new, boxed, and fully guaranteed. Address quotation for full or partial quantity to:

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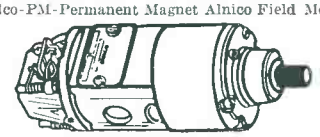

#5071895 1/4 SHAFT or 11/16 GEAR.... $17.50
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6v—1½ amps
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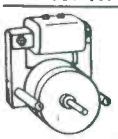

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4 RPM on 50cy or 4¾ RPM on 60 cy. $2.85	3.6 RPM. 3.15
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HAND WOUND 10 Sec. to 24 Min. TIMER SWITCH..$1.25

6 Watt Most POWERFUL TELECHRON 1 RPM
110 v. 60 cy.....$6.50
10 for $50.00

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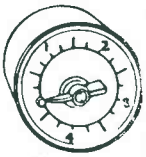

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Also available in 15 min., or 30 min. or 1 hr. at....$6.50

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110v 60 cycle 30 RPM	$2.60
110v 60 cycle 1 RPM..	2.60
230v 1 RPM.....	1.00
60cy 2 RPM.....	1.00

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ARC-3 Complete $185.00	BC-312 Receiver $40.00
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WANTED

ART—13; type ATC, T-47, T-47A—transmitters
BC—348—342—312—224—receivers
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Complete units and all component parts regardless of condiiton. Any quantity large or small

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that other readers can supply
OR . . . something you don't want—
that other readers can use—
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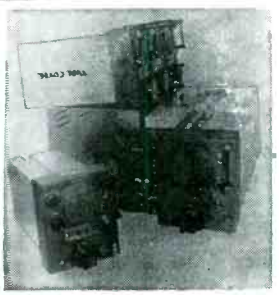
SEARCHLIGHT SECTION



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19 Haseltine 1030 TS/13AP-UHF Signal Generators—
Synchroscopes—
Dumont #241-UPM-1
56 Frequency Meters
OAO 2

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1500 Slide Rules—
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and
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Tubes

20,000 NEW

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538 COMPLETE TRANSMITTERS RECEIVERS

ARC—TBY—TCS
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SCR-522—RTA-1
Walky Talky
BC-459a—BC-357
BC-611—BC-733
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APS-3

200 REGAL 5 TUBE RADIOS (ac & dc)
150 SETS Complete FLUXGATE COMPASS
25 Sets Complete MAGNESYN COMPASS
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DYNAMOTORS 14 and 28 Volts
283 RECTIFIERS and VARIAC s/9r
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SCR-545 RADAR VAN L/PS

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For SCR-508 and 608. 100 Complete Sets for SCR-543

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150 Stromberg Carlson Telephone Sets with Dial. EE-8 Phone Sets.
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Jan. 12 until Day of Sale

BLOWERS:

12/24 VDC—AC CAST ALUMINUM BLOWER (Pictured at left)—100 CFM: 3" intake; 2" outlet, Shunt Motor 4"x2"; 3000 RPM @ 24 VDC..$5.95

6 VDC SINGLE—100 CFM—No. 6100. Used....$4.95

6 VDC FLANGE—150 CFM—No. 6150.

24 VDC DUAL—20 CFM—Min—No. 2420.....$7.95

10 CFM BLOWER (Pictured—right) 27.5 VDC; 1/100 HP.; 7000 RPM; Oster Motor C2BP-1A; L-R Mfg. Co. Bakelite Blower #2, overall size: 3-½" x 4-½". Price $5.95
Same as above, 12 VDC operation: Price $5.95

115 V. 400 CYCLE—10 CFM—Eastern Air Devices Motor J31A—7200 RPM. 1/100 HP. L-R #2 Blower Assy. Overall Size: 4-½" x 3-½". No. 3110....$5.95

10 CFM BLOWER (Pictured at left)—28 VDC—.6 A; 5000 RPM. Pioneer Motor SS-2345. Aluminum Blower Housing; Overall Size: 4-½" x 3-¼". Price $5.95

115 V. 60 CYCLE BLOWERS:

115-VAC 60 cycle SINGLE TYPE—100 CFM; 2-¼" intake: 2" outlet. Complete size: 5" x 6" —No. 1C939 ..... **$8.95**

115 VAC 60 cycle DUAL TYPE—100 CFM: 4" intake: 2" Dis. Each side. Complete size: 8" x 6" —No. 1C880 ..... **$13.95**

115 VAC 60 cycle COMPACT TYPE—108 CFM; Motor built inside quirrel cage; 4-½" intake; 3⅝" x 3" Dis. Complete size: 4-½" W x 8-⅜" H x 8-⅛" D—No. 2C067 ..... **$14.95**

115 VAC 60 cycle FLANGE TYPE—140 CFM; 3-½" intake; 2-½" Dis. Complete size: 7-½" W x 7-¼" H x 6-¾" D—No. 1C807..... **$13.95**

115 VAC 60 cycle FLANGE TWIN—275 CFM; 4-½" intake; 3-¾" x 3" Dis. Complete size: 11-¾" W x 3-⅜" H x 8-1/16" D— No. 2C069 ..... **$21.95**

115 VAC 60 Cycle BLOWER—200 CFM; 4" intake: 3" x 5" outlet. Overall size: 8" x 7" x 6". Bodine Motor NSI-33. Removed from New Equipment. #ROD-200 ..... **$14.95**

115—VAC 60 Cycle BLOWER—100 CFM; 3-¾" intake; 2" outlet; Rd. Flange with Flap Director. Overall size with bracket; 8" L x 6-½" W x 7" H. Removed from New Equipmet. Diehl Motor FB-2106-6 No. FDBL-2106..... **$6.95**

Same as above, but with 12- Curved Director. No. CDBL-2106 ..... **$7.95**

Previously Adv. Items Still Available. Please Write!

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(Illustrated) Galvanized Steel Tower, 12½" Base, 30 Ft. High—in 10 Ft. Sections. Knocked down. Complete with Hardware, two 50 Ft., one 80 Ft. Guys; three 5 Ft. Anchors, and Base Plate. Each section weighs 45 lbs. Complete with Erection Manual. Shipping Weight: Approx. 350 lbs. F.O.B. Ky.—Price..... **$31.95**

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MP-S-33 BASE—Ins. type with heavy coil spring and 5" dia. Ins. Requires 2" hole for mounting. Weight: 9 lbs. $5.95
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MAST SECTIONS FOR ABOVE BASES:

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. Larger Dia. Section MS-54 75¢ Ea.

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INPUT VOLTS:	OUTPUT: VOLTS:	MA.	STOCK No.	PRICES: USED:	NEW
12 VDC	625	225	DM-35	$8.95	$12.95
12 or 24	230	100	DA-12		8.95
12 or 24	540	450	DA-14		14.95
12 or 24	500	50	USA/0515		4.95
24	250	60	PE-86		8.95
14 VDC	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	275	110	USA/0516		4.95
12	230	90	PE-133	4.95	6.95
14 VDC	375	150	BD-83	3.95	4.95
12 VDC	220	80	DM-34	2.95	4.95

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CRP-72	.79
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E-1148	.39
EC1	.39
EM34GA	39.99
F123A	5.99
F128A	19.50
FG-105	14.44
FG-154	16.99
HF-100	6.99
HF-150	15.99
HF-200	10.99
HF-300	19.99
HK-24	3.99
HK-54	3.49
HY-114B	.69
HY-615	.29
KU-610	4.99
QK-59	39.50
QK-61	63.60
QK-62	69.00
QK-185	110.00
RK-34	.29
RK-38	5.89
RK-59	1.89
RK-60	2.49
RK-65	9.95
RX-21A	5.99
UH-50	1.99
10S/VT-25A	.29
VR-78	.89
VR-90	.82
VR-105	.89
VR-150	.80
VT-52	.29
30S/VT-67	.39
VT-127A	2.99
VT-158	15.99
VU-111	.89
OA2	.84
OA3	1.10
OB2	.86
1B22	1.49
1B24	5.99
1B26	1.19
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1B32/532A	.99
1N21	.69
1N22	.69
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2E22	2.49
2E24	3.29
2E36	1.19
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2J-32	15.99
2J-33	16.99
2J-34	16.99
2J-38	16.50
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2K49	53.50
2K52	59.50
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2K55	29.95
2x2/879	.59
2V3	1.29
3AS	.59
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3B28	4.69
3C21	.94
3C22	64.95
3C23	4.59
3C24	1.69
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4C35	14.99
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4D32	19.89
4E27	9.99
4J22	34.50
4J23	34.50
4J24	34.50
4J25	34.50
4j26	59.50
4J27	59.50
4j28	59.50
4J29	59.50
4J30	49.50
4J31	49.50
4J34	49.50
4J36	69.50
5AP1	4.99
5BP1	2.99
5BP1A	4.99
5BP4	2.99
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5CP7	8.99
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446A	1.49
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704A	1.59
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812	2.99
813	10.99
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833A	37.49
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838	1.99
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843	.49
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849	32.50
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865	1.19
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869B	15.99
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874	.74
876	.96
878	1.29
884	.99
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927	1.65
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954	.26
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957	.59
958	.59
959	1.99
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1LD5	.94
1L4	.84
1T4	.69
1A5	.79
1H5	.69
1N5	.89
1R5	.69
1S4	.84
1S5	.69
1U4	.69
1U5	.65
1X2A	.89
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2A3	.99
2A4	.99
3B7	.39
3D6	.39
3V4	.73
3Q4	.83
3S4	.69
5U4	.59
5Y3	.50
5T4	.91
5V4	.89
5Z4	1.19
5W4	.89
6AC7	.89
6AC7W	1.12
6AB7	.99
6AF4	1.29
6AG5	.84
6AG7	1.19
6AH6	.89
6AL5	.59
6AJ5	1.69
6AK5	.74
6AK6	.78
6AN4	1.35
6AQ6	.59
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6AS7G	2.99
6AX4	.79
6B4G	.99
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6B8	.69
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6BH6	.79
6BE6	.69
6BJ6	.69
6BK7A	1.21
6BL7	1.10
6BM6	35.99
6BN6	1.24
6BQ6	1.19
6BQ7A	1.19
6BX7	1.24
6CD6	1.72
6CB6	.69
6C4	.40
6C5	.49
6C6	.49
6C8G	.99
6D4	2.75
6E5	.79
6F5	.49
6F6	.99
6F8G	1.49
6J4	3.29
6J6	.72
6J7	.94
6J8	.96
6K4	2.65
6K5	.79
6K6	.69
6K7	.79
6K8	1.19
6L6M	1.49
6L6G	.99
6L7	.99
6N7	1.10
6R7GT	.69
6S4	.59
6SC7	.74
6SF5	.74
6SG7	.69
6SH7	.79
6SK7	.64
6SL7	.79
6SR7	.59
6SS7	.79
6W4	.69
6W6	.84
6V6GT	.66
6X4	.49
6X5	.49
6T4	1.44
6T8	.99
7A5	.95
7A6	.85
7A7	.79
7A8	.79
7B5	.66
7C4	.39
7C5	.79
7F7	.89
7G7	.89
7H7	.69
7N7	.89
7Q	.99
7Y4	.69
7Z4	.69
12A6	.59
12AT6	.49
12AU7	.79
12AT7	.99
12AV7	.94
12AX4	.83
12AX7	.79
12AY7	1.31
12BA6	.64
12BA7	.64
12C8	.69
12SC7	.89
12SQ7	.59
12SR7	.59
12SF7	.82
12SG7	.85
12H6	.65
12SH7	.69
12SJ7	.69
12K8	.69
12SK7	.69
12SN7	.79
12SL7	.89
12Z3	.49
14A7	.79
14B6	.69
12BH7	.79
12N7	.99
14R7	.99
14W7	.99
19T8	.99
25L6	.64
25Z6	.61
28D7	1.21
77	.49
78	.59
80	.49
83V	.99
5651	1.39
5654	1.10
5656	8.25
5670	2.25
5686	1.79
5687	3.40
5702	1.49
5702WA	1.99
5703	1.19
5725	1.99
5744	.99
5751	2.15
5763	1.39
5796	7.99
5814	1.27
5879	1.29
5915	1.09
5963	.99
5964	1.30
5972	3.89
6080WA	3.99
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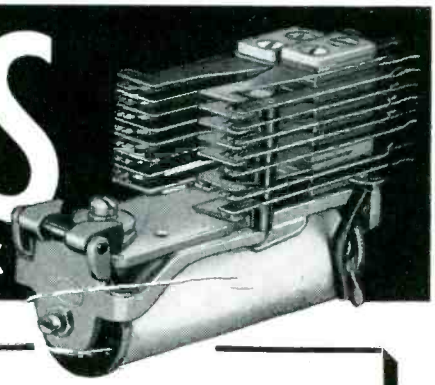

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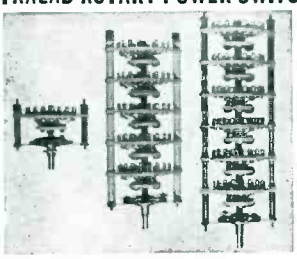

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OA3/VR75	1N76	2J56	4J50	6SK7W	252A	575A	878	5644	5915
OA4	1N78	2J61A	4J51	6SL7W	253A	592	879	5645	5931
OA5	1N81	2J62A	4J52	GT	258A	615	880	5646	5932
OB2	1N91	2K22	4J58	6SN7W	259A	KU627	884	5647	5933
OB2WA	1N93	2K23	4PR60A	GT	266B	685	885	5651	5948
OB3/VR90	1N126	2K25	4X-150A	6S117	274B	648-P1	889RA	5651WA	5949
OB4	1N127	2K26	4X-150G	GTY	QK284	HK654	891	5654	5962
OC3/VR105	1N128	2K29	4X-500A, F	6X4W	290A	700B	892	5657	5963
OD3/VR150	1N158	2K30	C5B	7AK7	HF300	703A	892R	5659	5965
OD3W	1N198	2K33A	EL5B	7BP7, A	300B	704A	893A	5660	5977
OZ4	1P23	2K39	5AP1	7CP1	304B, L, TH, TL	705A	898	5661	5980
REL1	1P24	2K41	5AP4	7UP7	706	902P1	5663	5987
1A2D	1P30	2K42	5BP1	8D21	GG305	SERIES	920	5667	5993
1B24	1P31	2K43	5BP4	CE306	707A, B	923	5670	5995
1B24A	1P32	2K44	5C22	9LP1	307A	708A	929	5672	5998
1B27	1P36	2K45	5CP1	9LP7	310A	710A	930	5677	6002
1B35	1P37	2K46	5CP2A	10E/13	311CT	713A	931A	5684	6095
1B35A	1P39	2K47	5CP7	10E/222	314A	714A, AY	CW-931A	5685	6012
1B36	1P40	2K48	5D21	10KP7	316A	715A, B, C	954	5686	6021
1B37A	1P42	2K50	5FP7A	10KP17	ML-322	717A	955	5687	6028
1B38	1P44	2K54	5FP11A	A-11	T327A	719A	956	5687WA	6044
1B40	1Z2	2K55	12AT7	C-33S	720	957	5691	6045
1B42	2A1	2K56	5GP1	WA	337A	SERIES	958A	5692	6050
1B44	2A2	2K57	5HP4	12AU7	342A	721A	959	5693	6072
1B46	2A3	2K58	5J23	WA	348A	CE-722A	991	5696	6073
1B47	2A5	2K59	5J24	15E	350A, B	CK-722	1003	5702	6074
1B50	2A6	2K60	5J26	15GP1	354C, F	723A/B	CK1005	5702WA	6080
1B51	2A7	2K61	5J29	FG17	359A	724B	CK1009	5703	6080W
1B52	2A8	2K62	5J30	RX21	371A, B	724A	TR1032K	5703WA	6082
1B53	2B7	2K63	5J32	HK24	394A	726A, B, C	VC-1258	5704	6087
1B54	2B10	2K64	5J51	24G	MIL-381	SERIES	CK-1301	5718	6088
1B57	2B22	2K65	5JP1	RK20A	388A	728	DG-1295	5719	6096
1B58	2B24	2K66	5JP7	RK25	393A	SERIES	CK-1301	5719	6096
1B59	2B25	2K67	5NP1	25T	395A	750TL	1603	5721	6097
1B60	2B26	2K68	5R4GY	25Z6W	397A	800	1611	5722	6100
1B63A	2B29	2K69	5R4WGY	GT	401A	801A	1613	5725	6101
1B98	2B31	2K70	5RP11A	26Z5W	403A, B	802	1614	5726	6110
1B100	2B32	2K71	5V3W	GTA	404A	803	1616	5727	6111
1C	2B35	2K72	5Y3WGT	28D7W	407A	804	1619	5732	6112
1C21	2B46	2K73	5Z3	31Z	408A	805	1620	5734	6136
1D	2B47	2K74	5Z4	RK-34	409A	806	1622	5744	6140
C1K	2B48	2K75	6A3	35T, TG	412A	807, W	1624	5749	6141
1N21, ABC	2B50	2K76	6AG7Y	RK-39	415	808	1625	5750	6146
1N22	2C21	2K77	6AH4	T-40	416A, B	809	1626	5751	6147
1N23, A, B, C,CR	2C22	2K78	6AH6	TZ-40	417A/5842	810	1629	5763	6143
1N25	2C26	2K79	6AJ5/CK5654	RX-47	418A	811, A	1630	5764	6186
1N26	2C27	2K80	6AK5	RK-49	419A	812, A	1631	5765	6188
1N28	2C28	2K81	6AL5	V-50	420A	813	1632	5783	6189
1N31	2C29	2K82	6AN5, WA	52HAP7	421A	814	1633	5783WA	6199
1N32	2C31	2K83	6AN6	RK-65	422A	815	1635	5784	6201
1N34, A	2C32	2K84	6AQ5W	HY-65	423A	816	1641	5787	6205
1N35	2C33	2K85	6AR6	HY-69	427A	825	1642	5792	6216
1N38A	2C34	2K86	6AS6W	RK-72	428A	826	1644	5793	6246
1N39	2C35	2K87	6AS7G	RK-73	429A	828	1654	5794	6247
1N41	2C36	2K88	6BA6W	RK-75	431A	829B	1754	5797	6249
1N42	2C37	2K89	6BA7	75T, TL	438A	830B	1850A	5798	6280
1N43	2C39, A	2K90	6BE6W	BR-90	446A, B	832A	1907	5800	6293
1N44	2C40	2K91	6BF5	CV-92	ZP-449	833A	1961	5803	6336
1N45	2C42	2K92	6BF7, W	C-100A	450TH, TL	834	2050	5812	8002
1N46	2C43	2K93	6BL6	HF100	451A	836	2051	5814	8005
1N47	2C44	2K94	6BM6	100TH, TL	454H	837	4210	5814A	8008
1N48	2C45	2K95	6C	101D	464A	838	4330	5819	8011
1N53	2C46	2K96	6C4W	FG105	471A	841	4340	5820	8012, A
1N55	2C48	2K97	6C21	WE121A	502A	843	4350	5823	8013, A
1N56A	2C49	2K98	6D4	VT127, A	506AX	845	5269	5825	8014A
1N58	2C50	2K99	6F4	151N	507AX	845W	5516	5829	8016
1N60	2C51	2L1	6H6WGT	F-124A	508	850	5517	5840	8020
1N69	2J53	4J33	6SG7Y	FG154	510	851	5527	5841	8025A
1N70	2J54	4J34	6SG7Y	QK155	511X	852	5528	5842	9001
				183	512AX	854	5586	5844	9002
				4J4WA	526AX	857B	5588	5845	9003
				6J5WG1	527	858	5590	5847	9004
				6J6WA	518AX	860	5591	5851	9005
				6L6WGA, GB	522AX	862A	5610	5853	9006
				C6M	532A	865	5635	5876	38111A
				6SA7W	533AX	866A	5636	5879	D96475
				GT	535AX	868	5637	5881	D164696
				6SA7Y	220B, C	869B	5639	5886	D178461
				6SB7Y	RX233A	872A	5640	5894	199698
				6SC7GTY	235A	874	5641	5896	8651860-G1
				6SG7Y	249A, B, C	572AX	875	5642	5899

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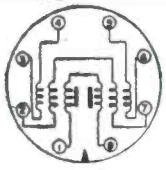
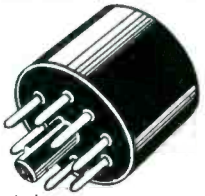
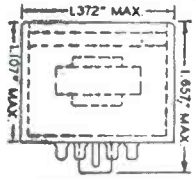
PULSE TRANSFORMER PT-3

TUBE BASE PLUG-IN TYPE



Similar characteristics to UX 7350. Precision-made. Two 100-turn and two 50-turn coils wound on high quality hypersil cores. Built into octal bakelite tube bases. Completely impregnated and sealed—humidity-resistant. Diagram on end disc of each unit provides versatility of application.





THESE PT-3 TRANSFORMERS may be used

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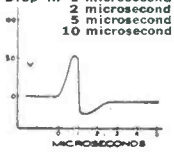
- For Interstage coupling, impedance matching and isolation.
- Wherever accurate timing and triggering are essential.
- In circuit applications requiring the generation of low power and low voltage pulses.
- In circuits utilizing repetition rates from 0 to well over 1 MC and pulse widths from .03 microsecond.

CHARACTERISTICS
Impedence, ohms 120
Rise time, microseconds .03
Drop in 1 microsecond 20%
2 microsecond 40%
5 microsecond 55%
10 microsecond 75%



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Experience or formal training and a record of successful accomplishment essential.

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Employment Opportunities

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Experience in the electrical design and performance of potentiometers, qualified in setting up accurate noise measuring circuits at low levels, simulating attached circuitry of customers, carrying out life, performance and environmental evaluations. To work with the Company's rapidly expanding Switch Division. Supervisory abilities highly desirable. Knowledge of MIL specs desired but not mandatory.

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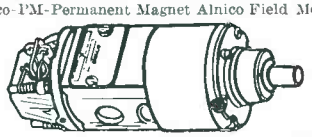
Delco-PM-Permanent Magnet Alnico Field Motor



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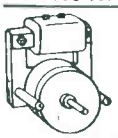

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4 RPM on 50cy or 4¾ RPM on 60 cy. $2.85	3.6 RPM. 3.15
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REDMOND 5" 18 watts....$8.95
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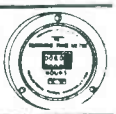

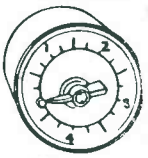

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230v 50cy 1 RPM.....	1.00
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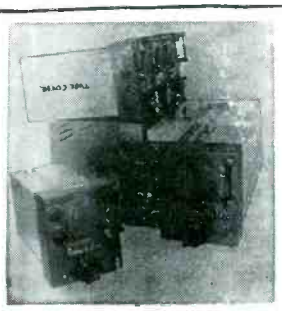

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10 CFM BLOWER (Pictured at left)—28 VDC—.6 A; 5000 RPM. Pioneer Motor SS-2345. Aluminum Blower Housing; Overall Size: 4-½" x 3-¼". Price $5.95

115 V. 60 CYCLE BLOWERS:

115-VAC 60 cycle SINGLE TYPE—100 CFM; 2-¼" intake; 2" outlet. Complete size: 5" x 6" —No. 1C939 ..... **$8.95**

115 VAC 60 cycle DUAL TYPE—100 CFM; 4" intake; 2" Dis. Each side. Complete size: 8" x 6" —No. 1C880 ..... **$13.95**

115 VAC 60 cycle COMPACT TYPE—108 CFM; Motor built inside quirrel cage; 4-½" intake; 3⅝" x 3" Dis. Complete size: 4-½" W x 8-⅜" H x 8-⅜" D—No. 2C067 ..... **$14.95**

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115—VAC 60 Cycle BLOWER—100 CFM; 3-¾" intake; 2" outlet; Rd. Flange with Flap Director. Overall size with bracket; 8" L x 6-½" W x 7" H. Removed from New Equipmet. Diehl Motor FB-2106-6 No. FDBL-2106..... **$6.95**

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803	2.99
804	8.99
805	4.25
806	10.50
807	1.31
808	2.45
809	3.49
810	9.99
811	3.39
812	2.99
813	10.99
814	2.99
815	2.99
816	1.39
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927	1.65
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954	.26
955	.49
956	.59
957	.59
958	.59

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5V4	.89
5Z4	1.19
5W4	.89
6AC7	.89
6AC7W	1.12
6AB7	.99
6AF4	1.29
6AG5	.84
6AG7	1.19
6AH6	.89
6AL5	.59
6AJ5	1.69
6AK5	.74
6AK6	.78
6AN4	1.35

Type	Price
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6AR6	1.69
6AS5	.76
6AS7G	2.99
6AX4	.79
6B4G	.99
6BA7	.89
6B5	.99
6B8	.69
6BG6G	1.99
6BH6	.79
6BE6	.69
6BJ6	.69
6BK7A	1.21
6BL7	1.10
6BM6	35.99
6BN6	1.24
6BQ6	1.19
6BQ7A	1.19
6BX7	1.24
6CD6	1.72
6CB6	.69
6C4	.40
6C5	.49
6C6	.49
6C8G	.99
6D4	2.75
6E5	.79
6F5	.49
6F6	.99
6F6G	.69
6J4	3.29
6J6	.72
6J7	.94
6J8	.96
6K4	2.69
6K5	.79
6K6	.69
6K7	.79
6K8	1.19
6L6M	1.49
6L6G	.99
6L7	.99
6N7	1.10
6N7GT	.69
6S4	.59
6SC7	.74
6SF5	.74
6SG7	.69
6SH7	.79
6SK7	.64
6SL7	.79
6SN7	.59
6SS7	.79
6W4	.69
6W6	.84
6V6GT	.66
6X4	.49
6X5	.49
6T4	1.44
6T8	.99
7A5	.95
7A6	.85
7A7	.79
7A8	.79
7B5	.66
7C4	.39
7C5	.79
7F7	.89
7G7	.89
7H7	.69

Type	Price
7N7	.89
7Q	.99
7Y4	.69
7Z4	.69
12A6	.59
12AT6	.49
12AU7	.79
12AT7	.99
12AV7	.94
12AX4	.83
12AX7	.79
12AY7	1.31
12BA6	.64
12BA7	.64
12C8	.69
12SC7	.89
12SQ7	.59
12SR7	.59
12SF7	.82
12SG7	.85
12H6	.65
12SH7	.69
12SJ7	.69
12K8	.69
12SK7	.69
12SN7	.79
12SL7	.89
12Z3	.49
14A7	.79
14B6	.69
14B8	.79
12N7	.99
14R7	.99
14W7	.99
19T8	.99
25L6	.64
25Z6	.61
28D7	1.21
77	.49
78	.59
80	.49
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5651	1.39
5654	1.10
5656	8.25
5670	2.25
5686	1.79
5687	3.40
5702	1.49
5702WA	1.99
5703	1.19
5725	1.99
5744	.99
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5763	1.39
5796	7.99
5814	1.27
5879	1.29
5915	1.09
5963	.99
5964	1.50
5977	3.89
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8012	1.94
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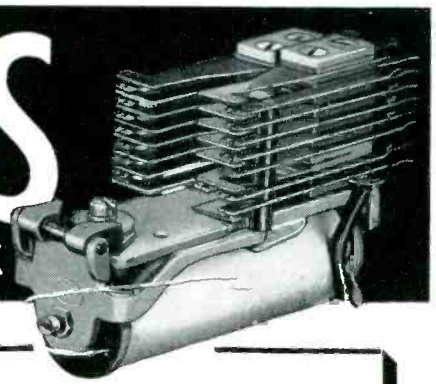

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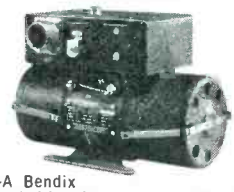

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Output: 125.5 VAC; 1.5 amps. 400 cycles single phase, 141 VA. Input: 20-30 VDC. 18-12 amps. Voltage and frequency regulated. **$49.50**

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12143-2-A Bendix
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778 Bendix
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10339 Leland
Output: 115 volts; 190 VA; single phase; 400 cycle; .90 pf. and 26 volts; 60 VA; 400 cycle, .40 pf, Input: 27.5 volts DC, 18 amps cont. duty, voltage and freq. regulated. **$49.50**

10486 Leland
Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 pf. Input: 27.5 DC; 12.5 amps; cont. duty. **$70.00**

10563 Leland
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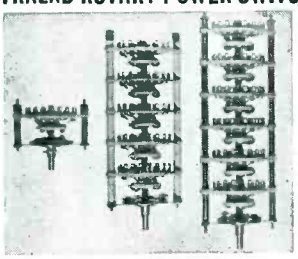

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OA3/ VR75	1N76	2J56	4J50	6SK7W	252A	575A	878	5644	5915
	1N78	2J61A	4J51	6SL7W	253A	592	879	5645	5931
OA4	1N81	2J62A	4J52	GT	258A	615	880	5646	5932
OA5	1N91	2K22	4J58	6SN7W	259A	KU627	884	5647	5933
OB2	1N92	2K23	4PR60A	GT	265B	631-P	885	5651	5948
OB2WA	1N93	2K25	4X-150A	6S117	274B	648-P1	889RA	5651WA	5949
OB3/ VR90	1N126	2K26	4X-150G	GTY	QK284	HK654	891	5654	5962
	1N127	2K28	4X250B	6X4W	290A	700B	892	5657	5963
OB4	1N128	2K29	4X-500A, F	7AK7	HF300	703A	892R	5659	5965
OC3/ VR105	1N158	2K30		7BP7, A	300B	704A	893A	5660	5977
	1N198	2K33A	C5B	7CP1	304B, L, TH, TL	705A	898	5661	5980
OD3/ VR150	1P23	2K39	EL5B	7UP7		706	902P1	5663	5987
	1P24	2K41	5AP1	7YP2	GG305	SERIES	920	5667	5993
OD3W	1P30	2K42	5BP1	8DP1	CE306	707A, B	923	5670	5995
OZ4	1P31	2K43	5BP4	9LP1	307A	708A	929	5672	5998
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1A2D	1P36	2K45	5CP1	10E/13	311CT	713A	931A	5684	6095
BG1A4B	1P37	2K46	5CP2A	10E/222	314A	714A, AY	CK-931A	5685	6012
BG1A4C /1B67	1P39	2K47	5CP7	10KP7	316A	715A, B, C	954	5686	6021
	1P40	2K48	5D21	10KP17	ML-322	717A	955	5687	6028
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1B46	2C42	3C33	5ZP16	31Z	407A	804	1619	5732	6112
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1N23, A, B, C,CR	2J21	4-400A	6BL6	100TH, TL	451A	836	2051	5814	8005
	2J22	4-1,000A	6BM6		454H	837	4210	5814A	8008
1N25	2J23	4B22	6C	103D	464A	838	4330	5819	8011
1N26	2J24	4B23	6C4W	FG105	471A	841	4340	5820	8012, A
1N28	2J25	4B24	6C21	WE121A	502A	843	4350	5823	8013, A
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1N32	2J27	4B26	6F4	151N	507AX	845W	5516	5829	8016
1N34, A	2J29	4B27	6H6WGT	F-124A	508	850	5517	5840	8020
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1N53	2J42	4C36	6SA7W	212D	532A	865	5635	5876	38111A
1N55	2J48	4D21	6SA7Y	217C	533AX	866A	5636	5879	D96475
1N56A	2J49	4D32	GT	218	535AX	868	5637	5881	D164696
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1N60	2J51	4J31	6SB7Y	RX233A	559	872A	5640	5894	139658
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PULSE XFMR .3mu Sec. 1000 cy. 12.5 kv, 9.5A; 3kv 64A; 200V. 8"x3"x5" o.a. $14.50.
FEEDBACK DIPOLE ⅞" coax. 11¾" o.a. $14.50
60MC. **IF STRIP** uses (6) 6AK5, $9.50

X BAND

CUTLER FEED DIPOLE. 1"x½" slvr pl. $4.75.
E PLANE BENDS UG39/40 std Radius, pl. $4.75.
MITRED BEND. Vy Short Radius. E plane, $10.00.
TRANSITION, 1"x½" to 1¼"x⅝" Lgth 3½", $6.50.
TWIST 90 DEGREE, UG39 to UG40, Silved plated. $6.50.
CRYSTAL MOUNT. Hold any 1N23 type xtal, 1" x ½" guide and coax output. UG40 flg. input, $15.00.
AS 24/APS 6 ROTARY JOINT SET $75.00.
DIRECTIONAL COUPLER "Airtron" 20 db. pressurized cross guide type. Aluminum. $18.50.
DUPLEXER, latest type incl. ATR switch tube mount, directional coupler, etc. 1"x½" guide, $27.50.
LINE STRETCHER, VSWR matching device for XMSN Lines, $34.50.

K BAND

DIRECTIONAL COUPLER bi-dir. UG-115/U flanges, $22.50.
KLYSTRON OUTPUT COUPLING for 2K50, RG 66/U guide, $6.50.
H BEND 90 deg. CG346/U. $12.50.
E BEND 90 deg. CG345/U. Cplg. UG-117 to UG-116. RG66 guide, $12.50.
ADAPTERS 1¼" lg UG116 to UG116, UG117 to UG117 ea. $5.00

TEST EQUIPMENT

MIT type TS155 Signal Gen. 2C40 lighthouse cavity 2700-2900mc, wg below cutoff atten., thermistor bridge, 115vac reg. pwr. supply, $325.00.
OAP WAVE METER, freq. meter 100-200mc band, $85.00.
10CM THERMISTOR BRIDGE — Power meter, direct reading, complete. Western Electric. $65.00.
ECHO BOX, TS-207/UP 2700-2900mc. $64.50.
ECHO BOX, OBU-3, Precision w/detector and meter, $325.00.
TTX 10RH 3 CM FM TEST SET. Sig. Gen., Freq. meter, calib. attenuator, Thermistor Bridge. 115v. 60 cy ac. $175.00.

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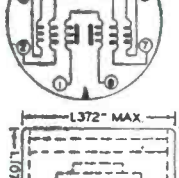
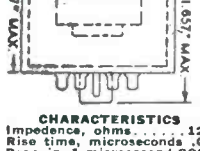
McNEAL ELECTRIC & EQUIPMENT CO.
4736 Olive St., Dept. E-12, St. Louis 8, Mo.

PULSE TRANSFORMER PT-3

TUBE BASE PLUG-IN TYPE



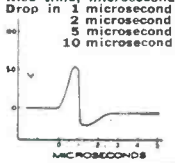
Similar characteristics to UX 7350. Precision-made. Two 100-turn and two 50-turn coils wound on high quality hypersil cores. Built into octal bakelite tube bases. Completely impregnated and sealed—humidity-resistant. Diagram on end disc of each unit provides versatility of application.



THESE PT-3 TRANSFORMERS may be used

- In Blocking Oscillator, Multivibrator and Scope Circuits.
- For Interstage coupling, impedance matching and isolation.
- Wherever accurate timing and triggering are essential.
- In circuit applications requiring the generation of low power and low voltage pulses.
- In circuits utilizing repetition rates from 0 to well over 1 MC and pulse widths from .03 microsecond.

CHARACTERISTICS
Impedence, ohms 120
Rise time, microseconds .03
Drop in 1 microsecond 20%
2 microsecond 40%
5 microsecond 55%
10 microsecond 75%



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INPUT TRANS: Amertran #31136. Response: 10 cy.—100 cy. Primary—500/125 ohms. Secondary 6800/1700 ohms. Level 43VU. $27.50

Output Trans: Amertran #31138. Response: 10 cy.—100 cy. at 58 V.U. Level. Primary: 3600/900 ohms. Secondary: 30/40/50/60 ohms $38.45

Set of input and output $57.50

PULSE TRANSFORMERS

4P37: Primary, 50 Ohms 750V, .001 Duty. Sec. 15KV, 1000 Ohms Impedance. Bifilar 12.6V/2.5A $32.50

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC. 16KV-16 AMP DUTY RATIO: 001 400 CYCLE FIL. TRANS. "BUILT-IN" $42.50

WECO: D-163247 For Modulator of SCR 720 ..... $22.50

GE #K-2449A
Primary: 9.33 KV, 50 ohms Imp.
Secondary: 28 KV, 450 ohms.
Pulse length: 1.05/5 usec @ 635/120 PPS, PK Power Out: 1,740 KW.
Bifilar: 1.5 amps (as shown) $62.50

GE #K-2748-A, 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar rated at 1.3 Amp. Fitted with magnetron well. $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. Bifilar: 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. Bifilar 1.3 Amp. Fitted with magnetron well. $29.50

K35145—Pulse inversion: PRI: 5 KV PK. Pulse Negative. Sec: Pos. Pulse, 4 KV; 1 usec. and .001 DUTY RATIO $6.50

54J318-1—3 wdgs. Ratio: 1:1:1, 1.10 uh. /wdg., 2.5 ohms DCR $3.50

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UTAH X-150T-1: Two sections, 3 Wdgs. per section, 1:1:1 Ratio, 3 MH, 6 ohms DCR per Wdg. $5.00

68G711 Ratio: 4:1 ri: 200V, Sec. 53V, 1.0 usec Pulse @ 2000 PPS, 0.016 KVA $4.50

TR1049 Ratio 21 Pri. 220 MH, 50 Ohms, sec. 0.75 H. DCR 100 Ohms $6.75

K-904695-501: Ratio 1:1, Pri. Imp. 40 Ohm. Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise $8.95

RAYTHEON, UX-7350, UX-7307 ..... $5. ea.

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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. 25E5-1-250-50 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

H-605: 25 KV, "E" CKT. 1.5 usec. 400 PPS. 50 Ohms Impedance. 5 sections $62.50

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

Airborne RF head, model A1A, delivers 50 Kw peak output at 9000 mc. at .001 duty. Complete with pulser unit and all tubes $185.00

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D-168184: 0.5 usec. up to 2000 PPS. 1800 Ohms. ..$4.00

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D-165997 Delay 1.25 usec ..... $ .50

RCA #255686-502: 1.7 usec. 1400 ohm impedance $2.00

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4-172578. 416 ohms imp., 0.22 usec. Delay $4.75

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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	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	350-0350V/50MA, 5VCT/2A, 2.5VCT/7.5A	3.65
CT-479	7000V/.018V, 2.5V/5A/17,800 V. Test	22.50
CT-013	450-0450V @ 200MA, 10V/1.5A, 2.5, 3.5A, 5V/3A	4.35
CT-403	350VCT .026A 5V/3A	2.75
CT-331	585VCT .086A 5V/3A, 6.3V/6A	4.25

PLATE—115V/60~INPUT

PT- 07	400VCT/4.0 AMPS For RA43	17.50
PT 034	125V/45MA (For Preamp)	1.15
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-38-2	37.5/40V AT 750 MA	2.15

FILAMENT—115V/60~INPUT

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	6.3V/2.5A, 2x2.5V/7A 5KV Test	2.79
FT-521	2.5V/10A-3KV TEST LO-CAP	7.50
FT-025	2.5VCT/10A, 10KV TEST	6.95

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Stock	Description	Price
CH-914	12HY/250 MA 2500 V. Test	53.25
CH-CEC	117: 9-60H/.05-400 MA. 10 KV Test	$14.95
CH-113	2.5H/700 MA, 2.5 KV Test 18 Ohms	5.75
CG-044	8.5H/350 MA, 3.5 KV Test 50 Ohms	6.35
CH-291	0-1H/12 A, DCR: 0.3 Ohms	12.50
CH-291	0-1H/12 A, DCR: 0.3 Ohms	12.50
CH-322	.35H/350 MA—10 Ohms DCR	2.75
CH-141	Dual 7H/75 MA. 11H/60 MA	4.69
CH-69-1	Dual 120H/17 MA	2.35
CH-776	1.28H/130 MA/75 ohms	2.25
CH-344	1.5H/145MA/1200V Test	2.35
CH-366	20H/300 MA.	6.95
CH-999	15HY/15 MA—400 ohms DCR	1.95
CH-445	0.5HY/200 MA, 32.2 ohms, 3000 V.T.	1.39
CH-170	2x0.5H/380 MA, 25 ohms	2.79
CH-533	13.5H, 1.0 AMP DC. 13.5 KVINS.	29.95

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. 2.5/.75A. 6.4V/3.9A. 5V/2A. 6.5V/.3A, P/O ID-39/APG-13	4.95
352-7039	640 VCT @ 380MA. 6.3V/.9A, 6.3V-6A 5V/6A	5.49
702724	9800/8600 @ 32MA	8.95
KS9584	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	13V9A	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, 63V/2.9A, 1.25V/.02A	2.59
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
KS9445	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
70G30G1	600VCT/36MA	2.65
M-7474318	2100V/.027A	4.95

VHF TEST SET

The signal generator is designed to serve as an aid in aligning 152-162 megacycle FM receivers. It consists primarily of a temperature controlled crystal oscillator, the plate circuit of which is tuned to the 48th harmonic of the crystal frequency. The generator provides an extremely stable output which can be varied continuously from zero to well over a hundred microvolts. Provision has been made for two-frequency output provided that is utilized.

a dual crystal

New, Less Crystal $32.50

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TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Prl
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35X-059	19	3.8	405	.095	4.35
POSX-15	14	2.8	220	.08	8.95
DM33A	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	3.95
			150	.010	
			14.5	5.	
PE73CM	28	19	1000	.350	10.50
BD 69‡	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	2.50
BDAR 93	28	3.25	375	.150	6.95

‡Less filter *Replacement for PE 945

PE 94-, Brand New 5.95

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800-1B Input 24 vdc, 62 A. Output: 115 V. 800 cy. 7A. 1 phase. Used, excellent $18.75

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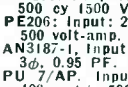
X BAND — 1" x ½" WAVEGUIDE



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PARABOLOID DISH, 18" diam. Spun Aluminum. 8" Focus. For AN/APS-6 ..... $4.95

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3CM. DIPOLE FEED, 15" L. for APS-15 10½" Focus $14.50

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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. Tit: 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 $22.50

RG52/U Waveguide in 5' lengths, fitted with UG 39 flanges to UG40. Silver plated ..... **per length $5.00**

Rotating-Joints supplied either with or without deck mountings. With UG40 flanges ..... **each $17.50**

Bulkhead Feed-thru Assembly $15.00

Pressure Gauge Section with 15 lb. gauge $10.00

Directional Coupler, UG-40/U Take off 20db. $17.50

MAGNET AND STABILIZER CAVITY For 2J41 Magnetron $24.50

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.

JAN WAVEGUIDE FLANGES

UG 39/U	$1.10	UG 51/U	$1.65
UG 40/U	$1.25	UG 52/U	$3.40
UG 40A/U	$1.85	UG 52A/U	$3.40

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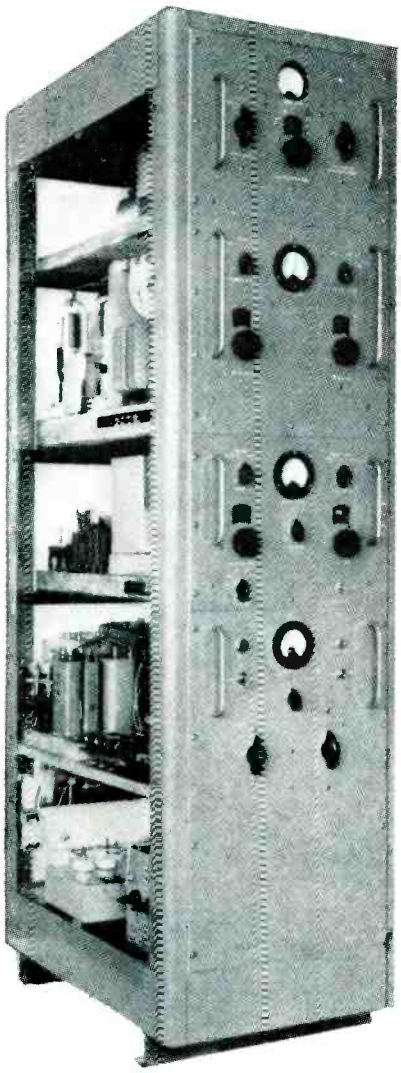

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T-350XM

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- 2,000—20,000 KCS
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- 250 Watts—A3 Output
- Built in Master Oscillator
- 5 Crystal Positions.
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- Manual or High Speed Keying
- Uses 2—813 P.A. and 2—805 Modulators Hi-Level Class B.
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- Size 59" X 16" X 24"
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- Power Input: 210/250 Volts Single Phase 50/60 Cycles
- Brand New—Complete—Unused

This modern precision built point-to-point transmitter is now available for delivery singly or in quantity to interested users at an attractive price. This transmitter is similar in characteristics to the RCA Model ET-4336.

The T-350XM was manufactured by Technical Radio Corporation, San Francisco, California, for the U. S. Signal Corps. All are new, unused and export cased. Each transmitter carries our guarantee. Spare parts available. Quotations on request.

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3600—6 PDT—Struthers Dunn, type 220XFX100, 26.5 VDC, hermetically sealed.
$2.95 ea.—10 for $25.00—100 for $200.00

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Sarkes Tarzian miniature rectifier, ½ wave, bridge embedded selenium, 52VAC input, 21 VDC output at 5 milliamps, axial wire leads.
$1.00 ea.—10 for $8.50—100 for $70.00

DELAWARE EQUIPMENT COMPANY
124 N. 3rd St. Phila. 6, Penna.
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ALLIED ELECTRONICS SALES

POPULAR RUGGEDIZED and SUBMINIATURE TUBES AT SUBSTANTIAL SAVINGS
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5636	4.00	5721	150.00	5829	1.80	6021	4.95
5640	9.00	5722	5.95	5840	5.00	6073	1.65
5641	6.00	5725	1.85	5879	1.25	6082	3.25
5647	7.50	5726	.75	5881	2.50	6097	1.25
5654	1.35	5744	.90	5899	5.25	6098	5.00
5663	1.25	5751	2.20	5899A	5.25	6111	6.75
5687	2.75	5755/420A	8.50	5902	7.90	6130/3C45	9.95
5696	1.00	5783	3.50	5933/807W	3.50	*WRITE FOR NEW PRICE LIST*	
5702	1.40	5814A	1.95	5964	.75		

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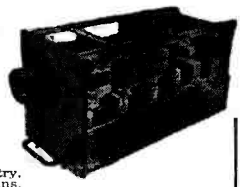
RCA TV CAMERA



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Ideal for labs, industry, prisons, TV technicians, swim pools, medics—"mechanical eye" for closed circuit TV. 1846 Iconoscope, 6-stage video amplifier and clipper. THE REAL THING! Send for new, free, complete technical data. SOLD AT FRACTION OF REAL VALUE!

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SCR-682-A
AIR SEARCH AND WEATHER RADAR

This is a 10 cm 3000mc ground based high power air surveillence, search and weather radar, using a 7" PPI. These sets will give excellent SERVICE IN A TORNADO OR STORM WARNING NETWORK OR AT AN AIRPORT for air surveillence up to 135 miles. Ease of operation and service will allow relatively inexperienced personnel to use this equipment with ease. The set consists of three major units as follows: 1—The paraboloid antenna system which includes the pedistal, reflector, dipole and RF section mounted on rear of reflector. 2—Modulator which includes the control panel for modulator, power supply and modulator unit. 3—P.P.I. Indicator. This unit is a desk type plan position indicator utilizing a 7" screen and operating controls. All units have pull out decks that enable the set to be serviced without the entire set being taken out of use and are fully safety interlocked.

The technical specifications are as follows:

1—Oper. Freq.—3000 mc 10mc
2—Power output—225 kw
3—Pulse width—1 micro second
4—ranges—500-240,000 yds in four ranges. 10,000 yds. 40,000 yds. 160,000 yds. 240,000 yds.
5—360° scan.
6—azimuth accuracy 1° ±
7—7" PPI indicator
8—⅞" coax transmission line.
9—6° antenna beam width.
10—110 v 60 cyc power input.

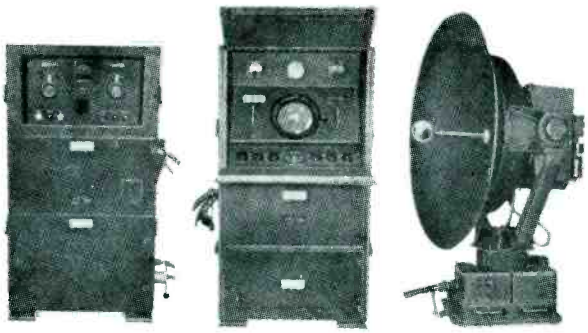


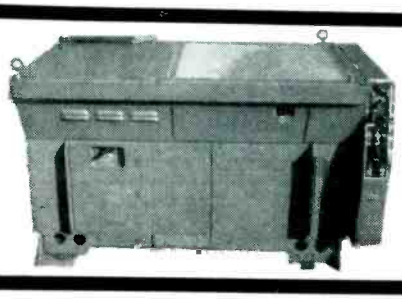
Figure 1. Radar equipment SCR-682-A.

We can supply these sets for use in a building, or mounted in a shelter for transportation in a 2½ ton truck. These radars are supplied completely overhauled tested and guaranteed. Test equipment is available to maintain and test this radar. Complete line of spare parts in stock. Write for price.

This SCR-682-A is Avail. for Inspection in Operation by Qualified Buyers on Appointment. Write or Call.

AN/ART-23 — AN/SRR-1 Radar relay equipment

The ART-23 is an air to ground and ground to ground and air to air VHF radar relay link set. The set operates on a freq. range of 78-102 mc. This equipment will accept video, synch pulses from an airborne or ground radar and relay them to the SRR-1 receiving equipment to be displayed on a remote radar indicator such as the VE, VE, VG, etc. The set will transmit a band width of 300cyc to 2 mc. The power output of the transmitter is 100 watts and has a range of app. 150 miles. This is the type of equipment used in the radar picket plane to relay information to a ground station. The ART-23 operates from 110v 400cyc. The SRR-1 input is 110v 60 cyc. Write for prices.



VG-1, 2, 3—24" P.P.I. repeater indicator

The type VG remote plan position indicator is an elaborate projection type radar repeater using a skiatron tube to project a radar image to the top of the console, which is a transparent 24" screen used as a plotting table, enabling the operator to make a tracing on a sheet of paper stored in the unit on a roll. This set will operate very well with the SCR-682 at an airport or weather observing station. Five scanning ranges are provided 4, 10, 20, 80, and 200 miles. Electronic range marks are also provided. This set will operate with any radar set with a pulse repetition rate of from 60-1000cyc per second. The VG operates from a power input of 110v 60cyc. A very bright image allows use in a well lit room. Complete line of spares for this equipment are in stock. Other repeaters in stock: VC, VD, VE, VF, VK. Write for prices.

AN/APN-3 — AN/CPN-2 — SHORAN

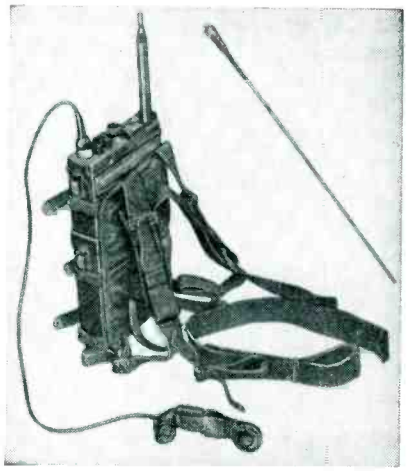
The AN/APN-3 and AN/CPN-2 are airborne and ground precision distance measuring and navigation installations respectively. This equipment operates on 250mc and provides an extremely accurate distance measuring system in relation to two ground beacons. The range is app. 250 miles with an accuracy of plus or minus 25 feet. This is probably the most accurate distance measuring equipment built to date. The AN/APN-3 used in conjunction with the K-1 computer (also available) will permit taking an aerial photograph or drop a bomb up to 250 miles distant from the CPN-2 beacons completely automatically. The AN/APN-3 can be fed into the auto pilot of the airplane to fly it if desired, to the drop point. This equipment is very widely used by geological survey companies for oil prospecting and mapping. Power input is 110v 400cyc and 28v DC. Write.

AN/GRC-3 thru 8
Late model field radios.

The GRC series are the new field and mobile military communications sets. These sets cover 20-58.4 mc depending on the transceiver used. These sets replace the SCR-508, 608 etc as the standard high freq. communications sets. The transmitter output is 15 watts. The transceiver are tuneable or fixed tuned. Input powers are 12 or 24v DC. Components are miniaturized and hermetically sealed. Complete installations are avail. Write.

AN/PRC-8, 9, 10

The PRC series of radio sets are the new F.M. high freq. back pack walkie-talkies superceding the SCR-300. These sets are completely miniaturized and weigh app. 18 lbs. complete, with battery. The PRC-8 covers 20-27.9 mc, PRC-9 covers 27 to 38.9 mc, PRC-10 covers 38-54.9 mc. The set has 16 tubes. The receiver is A.F.C. controlled and has a sensitivity of .5 microvolts. The transmitter power output is app. 1 watt F.M. A crystal calibrator is provided to check and calibrate the set. The receiver is equipped with a squelch control. This set can be used with the AN-GRA-6 to provide remote operation and automatic relay. We can supply spare parts for these sets. Write for prices.



AN/ASQ-1—Airborne Magnetometer

The AN/ASQ-1 is an airborne chart recording magnetometer. The set consists of an amplifier, oscillator, detector head, chart profile recorder, power supply, etc. The equipment has a sensitivity of 2 gamma or better. The AN/ASQ-1 will record on an Esterline-ANgus recorder disturbances in the earths magnetic field caused by an ore deposit or a sunken boat or submarine. A bearing indicator is also provided that gives a left right bearing on a magnetic disturbance. Power input is 28v. DC. Weight about 130 lbs.

OTHER EQUIPMENT

AN/URC-4 U.H.F. airsea rescue set.
AN/ARC-12 and higher.
AN/APC-15 and higher.
AN/APS-15 and higher.
AN/APR-4 and higher.
AN/TC-1 facsimile.
TS-587-U.
AN/TRC-7
AN/ART-18, 23, 24 relay equip.
AN/APN-19
AN/APN-12
AN/CPN-6, 8 beacons.
AN/UPN, 1, 2, 3, 4, beacons.
Test sets, field radios, radar, special equipment. Write.

9 CONDUCTOR CABLE

Army spec. CO-215 Weatherproof 9 Cond. No. 20 AWG stranded tinned copper, plastic ins., colored coded, double vinyl jackets with tinned copper braid between Dia. 9/16" made by G.E. Available 1000, 1500, 2000 ft. reels. Price 10¢ per foot. Sample 100 ft. Coil $10.00

NEW SCR-522A 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.

NEW REPAIR PARTS FOR BC-348

(Models H, K, L, R only)

4 gang tuning capacitor ..... $ 3.95
Aluminum front panel ..... $ 3.75
1st, 2nd, 3rd. and 4th I.F. transformer assy. ..... Each $ 2.00
Crystal filter assy inc. 915 Kc. Crystal ..... $ 6.50
C.W. Oscillator assembly ..... $ 2.00
R.F. Unit Assembly in can $12.50
Dual Volume Control ..... $ 2.75
Spring tuning knob ..... $ .50
Ant., RF., Det. and Osc. coils for bands 1 to 6. Per Band ..... $ 2.00

RADAR ANTENNA ASSEMBLIES

SO-1 (10CM) assembly with reflector, waveguide nozzle and drive motor $279.50
SO-3 (3CM) Surface Search type with reflector and drive motor, but less plumbing $99.50
SO-13 (10CM) Complete assembly with 24" dish, dipole, drive motor and gearing $49.50
ASD (CS-66ACN-1) Complete with dish, 24 volt drive mechanism, waveguide plumbing, etc. New $39.50

HIGH POT TRANSFORMER

Westinghouse. Pri: 115, 60 cy. Sec: 15,000V C.T., @ .060A, C.T. ungrounded. Excellent for high potting tests. Size OA 12H x 8½W x 9¼D. Weight 67 lbs. Fully enclosed steel case. Price $29.50

6 KVA. STEPDOWN TRANSFORMER

G. E. Step-Down. 6KVA. Pri: 230/460. Sec: 115/125, 60 Cy. Size: 20" x 11" x 9½". Weight 225 lbs. Navy grey finish, integral junction box and mounting brackets $49.50

AMPLIDYNES

5AM21JJ7. Input 27 VDC @ 15 A. Output 60 VDC @ 2.5A. 4600 RPM. New $34.50
5AM31NJ9A. Input 27 VDC @ 44 A. Output 60 VDC @ 8.8 A., 7500 RPM. New $23.50
5AM31NJ18A. Input 27 VDC @ 44 A. Output 60 VDC @ 8.8 A., 8300 RPM. New $12.50

INVERTERS

Leland Elec. C. PE206A. Input: 28DC at 38 Amp. Output, 80V, 800 Cy., 1 Ph., 485W. New ... $16.50
PE218H. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5 KVA. New $32.50
G. E. 5AS13IJJ11A. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5 KVA. Regulated New $89.50

DYNAMOTORS

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

SMALL DC MOTORS

G.E. 5BA50LJ2A. Armature 60 VDC at 8.3 Amps. Field 27.5 VDC at 2.3A RPM 4000. H.P. 0.5. New $27.50
Oster E-7-5. 27.5DC. 1/20 HP. 3600 RPM. Shunt Wound. New $9.50

HI-VOLT OIL CAPACITORS

Mfd.	KV	Price
.001	50	22.95
.01	5	2.50
.02	20	6.75
.025	50	17.95
.025/.025	50	34.50
.1	3	1.75
.1	4.5	3.50
.135	7.5	6.95
.2	50	29.50
.25	15	9.95
.25	20	15.95
.25	50	44.50
.5	25	39.50
1.	7.5	6.95
1.	15	29.50
1.	20	42.50
2.	5.5	9.50

SPECIAL!

PYRANOL FILLED CAPACITOR Cat. No. 26F681 *ONLY* $6.95

.02 mfd. 20,000 volts. 10½x2½ dia. in. A real value at only. $6.75

TEST EQUIPMENT

FLUX-METER. Measures flux of magnetron magnets from 500 to 4000 gauss. New $14.95
FREQ.-METER. TS-127/U. Range 375-725 Mcs. New with spare tubes and manual $34.50
PANADAPTER. AN/APA-10. For 115v., 60 cy. New with 80 page tech manual $97.50
40-500 Mc TEST OSC. TS-47/APR. New.. $149.50
RECEIVER. 158-210 Mc. BC-1068A. 60 cy.. $29.50
RECEIVER MX-24/APR-1 ..... $97.50
PULSE TIMER. CUZ-50AGD. For 115/60/1. $65.00
OSCILLATOR 300-1600 Mc. AN/APT-5. New with cables, etc. Power supply $169.50
OSCILLATOR 450-710 Mc. AN-APT-2. New $29.75
MODULATOR BC-1203. For 115v., 60 cy... $125.00
MODULATOR BC-423B. Radiates 205Mc. pulsed sig. at 4,098 cps. New 60 cy. $19.50
PULSE ANALYZER. Airborne counter-measures model ID-59/APA-11. New $149.50
FREQ.-METERS. LINK 230-D2. For testing mobile equip. One each 152.270-157.530, 152.390-157.650, 152.510-157.770, 152.630-157.890, 35.420-43.420 Mc. Price per set $49.50
SIG GEN. I-222A, 115-230 Mc., 8-15 Mc.... $89.50
20-250 Mc. FREQ-METER TS-174 ..... P.O.R.
SIG. GEN. SG-13/ARN. AM-PM 105-138 Mc. for aircraft loc. and glide slope tests ..... P.O.R.

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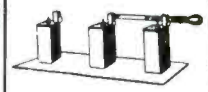
OIL FILLED CAPACITORS

VOLTS	MFD	Price	VOLTS	MFD	Price
25KV	1.0	★49.95	2KV	.25	.89
25KV	0.5	★39.95	1000	28.0	5.50
25KV	0.1	14.95	1000	2.0	.69
7.5KV	0.5	4.25	600	10.	1.29
6KV	0.25	1.09	600	8	1.19
3KV	0.5	1.59	600	4	★ .69
3KV	0.1	★1.19	600	2	★ .39
2.5KV	2.0	★2.95	600	1	★ .19
2KV	5.0	2.95	660AC	5	2.95
			330AC	5	1.29

SPECIAL SWITCHES

SW 141 ( ) DPST normally open with or without lock-in position on push button, part of CD-318 cord set suitable for 115 V. AC SPECIAL ★.19¢



SW 224 SPDT Antenna change switch Square D Cat. No. 9320-962 SC #3ZK-9503 - 20 Bakelite Base 2x8x¼ ★.49¢

Sensitive MU-Switch 15A. 125 V. AC 15/32-32 threaded bushing. SPDT—69¢

MULTIPLE SECTION OIL CAPACITORS

10 Mfd 400 volts ★59c
Dual 5 mfd 3 term. bottom mount. Meets specs for 600 V operation at 40°C. 3¾x3⅜x2

9½ Mfd 600 volts ★59c
8 Section 2-2-2-1-1-.5-.5-.5 Rated by Western Electric at —50 to +85C will pass 1000 V. test at 40°C 4¾x4¾x1½

Molded, Upright and Ceramic-Cased Mica Capacitors

.01	4LS	600WV	CM45B103J	.32
.02	4LST	600WV	CM50B203G	★.45
.001	A2L	2500WV	Thickness 7/16"	.49
.02	6S	2000WV		1.65
.0068	F2	3000WV		★1.35
.00015	Type 59	10,000WV	3Amp @ 1MC	★9.95
.0002	Type 50	10,000WV	1.6Amp @ 1MC	9.95

PULSE NETWORK SPECIAL ★$2.95

Sprague 15-1-400-50 15 Kv 1.0 usec 400 P.P.S. 50 Ohm Z

Variable Transmitting Capacitor: 19 to 116mmfd 27 plates, .085" air gap. O/a dim. 4¾Lx3½x2¼ SC# 3D 9019V-1 P/o Tuning Units TU-7A a TU-79 ..... ★98c

OCTAL SOCKETS ★$5.00 C

Johnson 122-128 steatite sockets; Amphenol 49-558, steatite ring mounting; Amphenol ceramic and mica filled 1⅞ and 1½ mounting centers.

RELAYS

Allied BJ6D36 DPDT, 24VDC coil contacts rated 5 Amp @ 24VDC, or 115V AC. ..... ★.59¢
Allied BO 13D35 SPST Double break normally open 24V DC. Coil Silver contacts each rated 15 Amp @ 24V DC or 115V AC. ..... ★.98¢
Autelco Jr Type 16 115V AC coil DPDT Snap Action contacts rated 15 Amp 115V, 5 Amp 230V 2.95
Cook #773 Standard Telephone Relay 900 ohm DC coil double arm 14 contacts 11A-1B-1C-1D 4"Lx1½Wx 2½H ..... ★1.09
AMPERITE 6NO-110 ..... ★99¢

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RG 9 B/U ..... ★15.00 C. FT
PL 259 Plug ..... ★29¢
M 359 Angle Adapter ..... ★23¢

Power Rheostat famous make Model J 3000 Ohm 50 Watts ..... ★.79¢
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TYPE "J" POTENTIOMETERS

Type "J" .95 Type "JL" $1.10
Type "JJ" $2.95 Type "JJJ" $4.95

Ohms	Ohms	Ohms	Ohms	Ohms	Ohms
50	2000	50K	60-60	10K-100K	250K-250K
100	2500	100K	600-600	25K-400K	300K-300K
150	3000	150K	2K-2K1	40K-40K	500K-500K
200	4000	200K	2K-25K	100K-100K	1meg-500K
250	5000	250K	7K-1meg	100K-200K	1meg-1meg
300	10K	500K	10K-10K	150K-150K	2meg-2meg
400	15K	1meg	ohms		ohms
500	20K	2meg	60-1K-5K		700K-700K-700K
1000	25K	3meg	20K-200K-15K		800K-800K-800K
1500	30K	5meg	45K-27K-2500		1meg-1meg-1meg

Specify Screwdriver Slot or Knob Type Shaft

15. MFD 600 VOLTS D.C.

Famous Make Oil Filled Condenser 3" wide & 2-½" thick x 4-½" high, 3-½" mounting centers.

ea. 89¢ lots of 1000
$1.19 ea. lots of 100
$1.49 ea. smaller lots

MEDIUM POWER TRANS. MICAS

MFD	VDCW	Type	Each
.00005	3000	F1	3.15
.00005	5000	F2	4.33
.00009	3000	F1	3.15
.0001	3000	F1	3.15
.0001	9000	F3	8.81
.00015	5000	F2	4.33
.0002	5000	F2	4.33
.00022	3000	F1	3.15
.00025	5000	F2	4.33
.00025	8000	F3	8.81
.0003	3000	F1	3.15
.00035	3000	F2	4.33
.0004	3000	F1	3.15
.0004	6000	F2	4.33
.0005	8000	F3	8.81
.0006	2500	F1	3.15
.00062	3000	F1	3.15
.0007	6000	F2	4.33
.00072	5000	F2	4.33
.00075	2500	F2	4.33
.0008	1000	F2	4.33
.0008	5000	F2	4.33
.00085	2000	F2	4.33
.0009	5000	F2	4.33
.001	3000	F1	3.15
.001	3000	F2	4.33
.0011	5000	F2	4.33
.00125	2000	F1	3.15
.0016	1000	F2	4.33
.0016	2500	F1	3.15
.002	3000	F1	3.15
.002	3000	F2	4.33
.002	5000	F2	4.33
.0025	2000	F1	3.15
.003	3000	F2	4.33
.004	3000	F2	4.33
.005	3000	F2	4.33
.005	8000	F3	12.15
.006	2000	F1	3.15
.0075	1500	F1	3.15
.008	3000	F2	4.33
.01	8000	F3	13.80
.02	2000	F2	4.33
.024	1500	F2	4.33
.025	1200	F2	4.33
.025	1500	F2	4.33
.033	1500	F2	4.33
.062	1000	F2	4.33

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Large Quantities

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New, Used and Rebuilt Leeds & Northrup Micromax and Speedomax, M. H.-Brown ElectroniKs, and others. Sold on Trial Basis.

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TIME DELAY RELAY

Haydon 115v 60 cy. adj. In 5 sec. steps to 40 sec. spdt mu sw. $5.95. With 2 arms & 2 sw.... $9.95
PULSE xfmr Utah 1059-AA, 3-50T Windings $3.95

Hundreds of other items, see ad in Buyers Guide Issue, write for listings.

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SPECIAL–PURPOSE?

OA5	4.50
R1111	4.00
R4340	25.00
5556/PJ8	7.00
5740/FP54	35.00

Especially our purpose

PAGE ELECTRONICS

CONDENSERS

16 mfd.—600 V $1.39
Dual 8 mfd oil filled cond. hermetically sealed and packed. Tobe type PT-SC-11 measuring 3¾"x2⅝"x2⅝". Stud mntg. centers 2". Plugs into standard four prong socket. *Quantity discount.*

1 mfd.—7500 V . . . $14.50
Dykanol—Ind. Cartoned

1 mfd.—15 KV $26.95
Pyranol—Qua. Disc.

Mfd	Volts	Price	Mfd	Volts	Price	Mfd	Volts	Price
.001	50KV	24.94	.5	3000	2.39	4	4000	15.95
.0023	16KV	6.95	.5	5000	3.09	4	5000	24.95
.01	5000	.79	.5	7500	6.25	4	7500	39.95
.01	10KV	4.95	.5-.1	2000	.39	4	10KV	65.95
.012	25KV	12.95	2x.5	600	.69	5	220AC	1.19
.02	8000	4.75	2x.5	9000	12.95	5	330AC	1.39
.02	10KV	5.25	2	15KV	69.50	5	600	1.19
.02	20KV	10.95	3	4KV	8.75	5	1000	1.89
.025	50KV	22.95	.5	25KV	45.95	5	1500	1.98
2x			.65	12.5KV	13.95	5	5000	27.50
.025	50KV	34.50	1	500	.55	2x5	400	.89
.03	7500	4.50	1	1000	.69	2x5	600	1.19
.03	16KV	8.50	1	1500	.99	3x5	400	1.29
.035	10KV	5.95	1	2000	1.85	6	600	1.69
.05	7500	2.95	1	2500	2.20	6	1000	2.30
.08	12.5KV	8.95	1	3000	2.95	6	1500	2.95
.1	1250	.29	1	5000	6.25	7	110AC	.79
.1	1500	.39	1	6000	5.95	7	600	.98
.1	2000	.45	1	6000	7.50			
.1	2000	.89	1	7500	8.95			
.1	2500	.98	1	7500	14.50	7	600	1.35
.1	3000	.69	1	10KV	23.50	7	800	1.75
.1	3000	1.19	1	15KV	26.95	7	5000	29.95
.1	4000	1.29	1	20KV	45.95	8	110AC	.75
.1	7500	.85	1	25KV	49.50	8	500	.99
			1	25KV	65.00	8	600	1.49
.1	7500	4.25	1	25KV	75.00	8	660AC	4.25
.1	10KV	6.35	1.75	330AC	.69	8	800	1.89
.1	12KV	6.95	2	600	.55	8	1000	2.78
.1	50KV	42.50	2	600	.65	8	1400	3.05
2x.1	2000	.89	2	1000	.79	8	1500	3.65
2x.1	7000	3.50	2	1000TLA	1.29	8	2500	6.50
2x.1	6000	2.29	2	1500	1.15	2x8	600	1.89
.2	10KV	8.50	2	2000	2.80	10	400	.89
.2	13KV	10.50	2	2500	3.45	10	600	1.19
.2	15KV	13.90	2	3000	4.25	10	600	2.25
.2	50KV	39.50	2	4000	7.50	10	1000	3.75
3x.2	4000	2.85	2	5000	12.50	10	1500	4.25
.25	1500	.88	2	7500	21.95	10	2000	5.95
.25	2000	.98	2	10KV	35.95	10	6000	59.50
.25	3000	1.45	2	12.5KV	59.50	12	660AC	3.75
.25	4000	1.98	2	20KV	89.75	15	330AC	3.50
.25	6000	.85	2x2	600	.85	15	400	1.29
.25	15KV	14.95	3	1000	.98	15	440AC	3.85
.25	20KV	18.95	3	2000	2.50	15	1000	3.95
.25	25KV	40.95	3	4000	0.00	15	1500	5.40
.25	32KV	49.50	3x3	400	.68	15	5000	59.50
.25	50KV	62.95	4	500	.59	20	330AC	3.35
.3	2000	.59	4	600	.79	20	600	1.69
2x.25	2000	1.10				24	500	1.89
.4	10KV	10.90	4	600TLA	.98	28	1000	5.95
2x.4	7500	5.25	4	1000	1.89	30	330AC	5.25
.5	600	.39	4	1500	2.65	30	600	3.95
.5	1500	.59	4	2000	2.95	50	330AC	6.50
.5	2000	1.19	4	2500	4.95	70	220AC	6.50
.5	2500	1.49	4	3000	6.99	80	4000	45.50

PILLAR MICA CONDS

Mfd	Volts	Price	Mfd	Volts	Price
.000028	35KV	42.50	.0008	20KV	36.95
.000051	6000	7.95	.0008	30KV	52.50
.0001	6000	9.95	.001	6000	11.95
.0001	10KV	14.95	.001	10KV	19.95
.0001	20KV	32.95	.001	20kV	39.50
.0001	30KV	52.50	.001	25KV	55.95
.00015	6000	9.95	.00124	15KV	28.95
.00015	10KV	9.95	.002	6000	11.95
.00015	10KV	13.95	.002	15KV	38.95
.0002	6000	9.95	.002	20KV	54.50
.0002	10KV	14.95	.0025	25KV	57.50
.0002	20KV	32.95	.003	6000	15.00
.00024	6000	9.95	.003	8000	19.95
.00025	6000	9.95	.004	8000	19.95
.00025	10KV	15.95	.005	6000	12.85
.00025	20KV	32.95	.007	12kV	59.50
.0003	10KV	15.95	.008	15KV	62.50
.00032	10KV	47.00	.01	5000	10.95
.00035	20KV	33.95	.01	5000	20.95
.0004	20KV	33.95	.02	3000	8.95
.0005	6000	10.95	.03	2000	14.95
.0005	10KV	15.95	.04	1000	6.95
.0005	20KV	32.95	.09	1500	6.50
.0005	35KV	52.50	.1	4000	72.50
.0006	10KV	16.95	.115	2000	5.15

OIL CONDENSERS

.04 mfd	17KV	14.95	DUAL .05	12KV	9.95
1.5	15KV	49.50	.005	15KV	9.75
.25	35KV	55.00	.05	20KV	12.95
.005	25KV	22.95	.002	35KV	13.65
.15	65KV	73.50	.05	25KV	16.50
.01	25KV	19.95	.015	16KV	14.50
.3	35KV	57.50	.005	50KV	19.95
.03	30KV	25.50	DUAL .5	25KV	59.50

MICA CONDENSERS

6, 10, 15, 27, 30, 34, 39, 50, 51, 60, 70, 75, 85, 100, 140, 150, 200, 230, 240, 250, 300, 350, 390, 400, 500, 510, 600, 650, 750, 1000, 1200, 1400, 1600, 2000, 2400, 2500, 3000, 3300, 3700, 3900, 4000, 4700, 5000, 5100, 6000, 6200, 6500, 7900, 8000, & 9100 mmfd

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1000 to 4700 mmfd 5c — **9100 to 10000 mmfd 10c**

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OC3/VR105	.85	3BP11	7.00	V45		417A w/wv.		
OD3/VR150	.85	3DP1	3.00	Klystron	525.00	guide	2.75	
1B24	4.95	3X2500A3		53	1.10	429A	8.75	
1B24A	15.00	(Surp)	88.00	QK-60	25.00	464A	2.55	
1B26	1.50	4B24	5.00	RK60	1.00	CK503AX	1.00	
1B32	2.00	4B28 6 Amp		QK61	25.00	GL559	.50	
1B35	3.50	Rectigon	3.00	RK61	2.75	GL562	50.00	
1B45	37.00	4E27	9.50	RK-65	9.50	575-A	12.00	
1B63A	22.50	4J21	77.50	FG67	12.00	WL651/5552	50.00	
1B85	8.95	4J30	39.50	RKR-72	.35	WL-653B	110.00	
1B86	7.75	4J36	75.00	RKR-73	.50	GL673	13.00	
1N21	.04	4J37	75.00	90-NB		703A	1.25	
1N21B	1.50	4J63	7.00	Amperex	7.00	705A	.85	
1N23B	1.50	4-65A(Surp)	13.50	FG95/5560	18.00	707A	4.00	
1N34	.44	4-125A Surp	19.00	FG98A	20.00	707B	5.00	
1N34A	.65	4PR60A		100R Surplus	5.00	708A	2.00	
1N48	.40	(Surp)	50.00	100TH Surp.	6.75	709A	1.75	
1N54	.55	4X150A		100TL Surp.	8.50	715B	3.95	
1N56	.85	Surp	22.50	FG105	15.00	717A	.35	
1N64	.70	4X150G	32.50	VT127A	2.50	721A	.75	
1N65	.75	4X250B	42.50	VXR130	1.75	723A/B	9.50	
1N67	.45	4X500A		FG172	45.90	726A	4.50	
1N69	.60	(Surp)	80.00	HF201A	27.50	726B	25.00	
1N70	1.20	4X500FSurp	65.00	QK181	35.00	726C	35.00	
1N81	.90	4-750A		203A	2.50	750TL(Surp)	75.00	
1P23	1.90	Surp	50.00	207	45.00	800	.90	
1P30	2.00	4-1000A		211/VT4C	.50	803	2.00	
WL1P41	1.25	Surp	85.00	227A	2.00	807	1.20	
2C39A	11.00	5BP1	3.75	FT-231	12.50	807-W	4.50	
2C43	9.00	5BP4	3.95	245A	15.00	808	1.50	
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2D21W	2.00	5D21	7.95	249A	3.50	810	9.95	
2E30	1.60	5FP7	1.20	HK253	5.00	811	3.00	
2E35	1.95	6D21	7.75	266B	45.00	812A	3.50	
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2J54	35.00	5MP1	10.00	276G	8.50	829B	9.95	
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3B24/W	5.00	CL-6(West)	19.90	304TH Surp.	8.75	845	5.00	
3B25	5.00	6C21	17.00	304TL Surp.	10.75	851	9.50	
3B27	3.50	6F4	1.90	310-A	3.00	860	3.50	
3B29	6.00	6J4	3.00	311C	2.50	856A	1.25	
3C31/C1B	2.25	6K4	2.25	347A	3.25	872A	1.25	
3C45	7.05	6SN7W	1.50	350R	2.75	872A(G.E.)	2.75	
3D21A	3.00	7C30	65.00	391A	3.50	874(RCA)	.60	
						878(RCA)	.85	

891	125.00	5751	1.50					
902	902P1	6.00	5763	1.10				
918		2.25	5783	4.50				
931A		3.00	5787	5.75				
932		1.25	5794	7.75				
958A		.40	5814	.80				
CK-1007		.90	5814A	2.00				
1000T		137.50	5819	RCA 37.50				
1500TSurp		120.00	5820(Icon)	500.00				
1503		3.00	5829	1.35				
1519		.30	5840	4.50				
5517		2.15	5844	1.00				
GL5551/			5879	1.25				
FG271		47.50	CK-5886	3.25				
5553/655		95.00	5890	35.00				
5633		8.00	5894/					
5634/SD828E		7.00	AX9903	16.00				
5636		2.95	5896	4.50				
5637		5.50	5902	6.00				
5638		8.00	5906	15.00				
5639		9.50	5915	1.00				
5641		6.00	5932	6.50				
5642		1.00	5955	1.45				
5643		6.00	5993	10.00				
5644		8.50	6021	4.50				
5647(Sylv.)		4.00	6073	1.65				
5651		2.25	6080WA	3.00				
5654		1.55	6095	.95				
5655		6.50	6096	1.50				
5670		1.10	6097	1.50				
5672		1.25	6098	1.90				
5675		.65	6099	1.40				
5676		39.50	6100	4.75				
5678		.90	6113	1.85				
5686		.65	6161RCA-					
5687		3.00	Jan	70.00				
5691		5.50	6183	275.00				
5692		5.25	6186	4.00				
5693		4.75	6189	2.25				
5696		.90	6263	11.50				
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5704		1.90	8000	9.50				
5718		4.24	8002-R	18.35				
5718-A		5.00	8005	4.10				
5719		4.00	8029 Surplus	1.25				
5726/6AL5W		.60	8008/					
5732		3.00	RCA872A	4.00				
5744		.75	8013A	3.95				
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			9006	.20				

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Large GT white	" " "	1500	20.25	1.50
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6	4.00	7.75	12.85	17.30	29.75
10	5.90	11.45	19.50	24.80	41.35
12	7.25	14.35	22.10	29.75	44.25
20	13.05	25.05	37.25	48.75	78.50
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SKF Rigid Type EL4—4 mm. int.—13 mm. ext. —5 mm. thick one range of balls—net price: **Belg. francs 10.- or $. 0,20.**

Type 126—6 mm. int.—19 mm. ext.—6 mm. thick two ranges of balls—rotule rolling net price:

Belg. francs 7.50 or $. 0,15

F.O.B. Antwerp, export packing included.

SOCIETE INDUSTRIELLE ALFA Soc. Anon.
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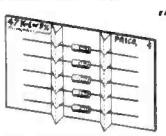

"PACKAGED" RESISTORS

Buy your odd-size resistors by the "package." All sizes, 5 & 10 on a card. Half, one & two-watts—5% —10%.

Write to
GOULD GREEN
252 Greenwich St. New York 7, N. Y.

ART-13 APR-4 BC-610-E

BC-348, BC-312, BC-342, TCS-12, BC-221, ARC-1, Dumont #241 Scope DY-17, Teletype, Boehme Keyers

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Richmond 2-0048

BELVISION'S COMPONENT BARGAINS

TUBES

6J6 — 6AQ5 — 3A5	25¢		
6F8	15¢	316A	12¢
3BP1 — WITH SOCKET	75¢		

INSULATED CARBON RESISTORS

½ Watt — $10.00 per M • 1 Watt..$15.00 per M
2 Watt..$25.00 per M • Minimum 250 of a number

Ceramic Condenser.....$20.00 per M. All Sizes

And Many Other Items
We Also Purchase Your Surplus Inventory

INSULATED CARBON RESISTOR KITS

100 Pieces/ In Plastic Bag—All Tolerances 85 are ½ watt, 10 are 1 watt, 5 are 2 watt **$1.45**

TERMINAL STRIPS—ALL SIZES—$7.00 per M
KIT OF 50 STRIPS—10 SIZES.....45¢

Condensers—20/20 mfd. 350 V. F.P. (Plug-in) 15¢

BELVISION, INC.
254 Greenwich St., N. Y. 7, N. Y. BA 7-6063

"TAB"

THAT'S A BUY

HI-FI HDQTS

COMPLETE LINE OF HI-FI
Speakers, Tuners, Amplifiers, Record Changers & Components,
GET OUR PRICE B-4-U-BUY
NEW G.E. PHONO CARTRIDGES
Original Boxed, $, $, $, Back Gtd

RPX050A .001 & .003 .... $6.98
RPX052A Gold Treasure 19.98
RPX053A Gold Treasure 28.98
RPX040A Single (S) .003 ...... 5.25
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Replc'ment Needles "TETRAD" Diamond†

RPJ010A Dual (S) .001 & .003 **GE** $1.98
RPJ012A Dual (D) .001 & .003 **Tetrad†** .. 18.99
RPJ013A Dual (DS) .001 & .003 **Tetrad†**. 10.99
Replc'mts for New A Cartridge Only
RPJ01D or RPJ03D Single (D) **Tetrad†** ... 9.99
RPJ01S or RPJ03S Single (S) 1.15
Replc'mnt Styli for RPX040 & 041 Only
RPJ001 or RPJ005 Single (S) **GE** 1.35
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Complete Stock of Replc'mnt Needles
Send Cartridge Name and Number

New Collaro RC-54 Changer with Hi-Fi Crystal Pickup $39.75

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Inbuilt network 2 wires needed for **HF & LF** Response. **Famous Hi-FI mfg. 15" Coaxial** PM & 5" Tweeter. 25W/20-17500 cy Model **P25CO** $19.50
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8" Coaxial PM & 2½; TW. 8 Watts/70-15 KC **Model P8CO** $7.75

HI-FI RECORDING TAPE

Finest, $, $, $, Back Gtd

PRECISION COATED & SLIT
Gtd Splice free. Quality Controlled. Plastic Base. Gtd. Constant Output. Freq. 7½ IPS 40-15KC Oxide Wnd. In 7½" reel; **1200** ft. per reel.

"TAB" @ $1.68 ea; 3/$4.85; 12/$18; 24/$36

WRITE FOR OUR NEW
BONUS HI-FI GRAM

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Heinmann Magn. Bkrs. Amps: 3, 5, 7, 8, 10, 12, 40, 80, @ **$1.98 ea; 12/$20; 50/$75**
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Klixon Therma Push Button Bkrs. Amps: 10, 15, 30, 35 @ .89; **10/$7.98** .... **50/$34**
Asst'd One Each Twelve Types @ $9

TRANSFORMERS

ALL 115V 60 CYC INPUT
2500V/20MA, 6.3V/6A, 2.5V/1.75A 4/BC412 Scope Replmnt **$7.98**
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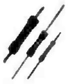
1% Accuracy Gtd
No Mfg Choice . . .
We Ship Types in Stk



0.116	240	1924	7320	42000	270000
0.42	250	1980	7500	47000	275000
0.7	270	2000	7717	50000	294000
1.03	300	2080	7900	51000	300000
2.5	320	2150	8000	52000	314000
3	350	2187	8200	55000	316000
3.83	360	2195	8500	56000	325000
4	390	2200	8770	57065	330000
5	426.9	2250	9100	60000	350000
7	430	2300	9900	61430	360000
7.8	470	2400	10000	62000	375000
8	500	2500	10500	64000	380000
10.38	520	2600	11000	68000	390000
12	540	2700	11600	70000	400000
14.2	560	2860	12000	80000	420000
16	580	2900	12500	82000	425000
17	588	3000	13000	84000	430000
20	620	3290	14000	85000	450000
23	750	3300	14400	88000	458000
25	800	3333	15000	90000	470000
28	820	3500	16000	91000	478000
30	850	3600	16500	93000	500000
48	910	3730	18000	95000	510000
50	917	3760	19000	100000	520000
51.78	978	3900	20000	110000	543000
55	1000	4000	21500	120000	550000
56	1056	4220	22000	130000	560000
62	1100	4300	23000	135000	570000
68	1110	4440	24000	145000	575000
74	1200	4500	25000	150000	600000
75	1225	4700	26000	160000	660000
82	1260	4900	27000	169000	680000
95	1300	5000	28000	175000	690000
100	1488	5100	29000	180000	700000
110	1500	5600	29990	190000	750000
120	1518	5730	30000	200000	800000
125	1600	5770	31000	205000	813000
130	1640	6000	32000	215000	820000
134	1800	6100	33000	220000	850000
150	1850	6200	35000	225000	900000
180	1892	6300	36000	229000	910000
200	1900	6500	37000	230000	930000
210	1905	6800	39000	240000	950000

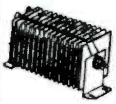
MEGOHMS

1	1.5	1.8	5.6	8.5	12
1.1	1.57	2	6	9.05	12.89
1.2	1.6	3	6.6	9.5	13
1.3	1.65	3.5	7	10	13.85
1.35	1.75	5	8	11.55	51

"TAB" Special
10 of One Value ......ea 10¢
100 of One Value $8.00
10 Assorted Values $1.50
Write for Complete Listing

NEW "TABTRON" SELENIUM RECTIFIERS

ENGINEERED *for* INDUSTRY



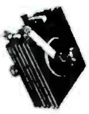
"Technical Apparatus Builders" mfgrs. Power Rectifiers to your specs. From one amp up to and above 1000 amps, convection or fan cooled, single or 3 phase. "NEMA" & JAN. Specs. Write for catalog.

FULL WAVE BRIDGE • DATED & ONE YEAR GTD

Max Amp	18VAC* 14VDC	36VAC* 28VDC	54VAC* 42VDC	72VAC* 56VDC	130VAC* 100VDC	266VAC* 217VDC	Ctr Tap AC*DC 30/12	3 Phase 120VAC 150VDC	Bridge 240VAC 300VDC
1	$1.60	$2.70	$4.30	$5.15	$9.45	$25.25	$2.40	$17.10	$33.25
2	2.40	3.40	6.15	6.75	11.50	33.15	2.70	18.25	35.50
3	3.45	4.75	6.70	9.00	14.65	42.35	3.05	20.00	38.50
4	4.25	8.45	13.05	16.50	28.45	44.65	3.40	21.70	42.45
6	5.10	10.05	14.75	19.85	36.80	63.05	3.70	24.00	45.90
10	7.50	14.35	22.40	28.50	47.55	97.55	5.45	42.40	82.70
12	9.20	18.10	25.40	34.20	50.85	114.80	6.80	48.15	94.20
20	15.00	28.80	42.80	56.05	90.25	184.95	9.15	58.50	112.60
24	18.40	36.74	51.15	66.30	97.75	219.45	11.45	103.35	183.90
30	22.70	38.50	64.95	81.65	125.35	271.20	Q	135.55	259.80
36	28.45	54.60	74.75	100.00	154.10	340.20	17.20	155.10	310.40
50	33.90	62.50	111.95	122.30	200.10	466.15	27.50	206.85	413.90

SELENIUM IS WORTH $ $ $
RETURN YOUR OLD DUD RECTIFIER—DEDUCT 5% FROM PRICE
DISCOUNT TO INDUSTRIALS, SCHOOLS & COLLEGES

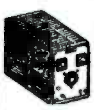
Heavy Duty Battery "Fast" Charger Rectifier



13-0-13V(CT) 100 Amp Fan Cooled or 34 Amp Air Cooled. Rep'mt 6V Booster Charger.
Model CR16 .... $12.00
16-0-16V(CT) Fan Cooled for 12V/60A and 6V/100A Booster Charges.
Model CR30 .... $14.00

New Variable 0 to 6 & 12 Volt/12 Amp

DC POWER SUPPLY



Battery Eliminator Charger Model RR Plater Aircraft Marine or any DC Reg. Extra Hvy Duty Selenium Rectifier, 2 Meters V. & A. Dsgnd for Cont. Service and up to 20 Amp intermittent overload. **New Model T612V12AC SPECIAL** $29.95

New! *Quality* VOLTAGE REGULATOR

$ $ Popularly Priced $ $
ONLY $16.98

Line Voltage Stabilizer
Stabilizes line voltage within plus or minus 3% regardless of **VOLTAGE & FREQ.** Shift. Ideal for **INDUSTRIAL, LAB** or **TV & RADIO** use. Insures full suze, strength, & sync of TV picture regardless of line voltage. Automatically operated . . . regulator turns on & off with set or Equipment. **TROUBLE FREE, QUIET,** needs no adjustment. Universal Use—from 100 to 300 Watts. Input 190-125V/Output 115V plus or minus 3% 50/60 cycles—. **Sold on "TAB" Money Back GUARANTEE. ORDER SIX ADDITIONAL 10% DISCOUNT.**

FILTER CAPACITORS

CE156M 6000MFD 15V .....98c; 2/$1.50; 10/$5
CE603M 3000MFD 60V .... $3.98; 2 for $7

230 to 115V Autoformers

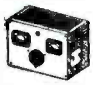
For 220V/50cy Input. To 110-120V or Step up. † With Cord, Plug & Receptacle.
TPA050/50W.* $2.55
TPA075/75W.† 3.65
TPA100/100W.† 4.00
TPA200/200W.† 5.75
TPA250/250W.† 6.75
TPA500/500W.† 8.25
TPA750/750W.† 11.79
Model TPA1000 Watts'1 KW † 16.95
TPA1500/1500W †. $22.50; TPA2000/2KW ... $34
* Less Cord, Plug & Receptacle.

DC Power Supply

6 or 12V DC Power Supply Full Wave Rectification 6000MFD Condenser Filter Ready to operate Input 115V 60cy Output 6.3 or 12.6V.
Model 2DCF (2 amp) $12.98
Model 5DCF (5 amp) 29.95
5DCF ACC/5 amp/1% Ripple 38.95

High Current Power Supplies

ONE YEAR GTD



Variable 0-28VDC. Completely Built. Ready to Go. Full Wave Selenium Rectifier Transformer, Variac. Volt & Amp Meters. Switch. Terminals & Fuse. Hvy Duty Steel Cabinet Std 115V/60 cy Input or 220V † (3 phase) to order.

Stock Number	Continuous Rating	With Meters
T28V5A	0-28 WVDC at 5 Amp	$50
T28V5ACC	5 Amp (1% Ripple)	85
T28V5A2CC	5 Amp 0.01% Ripple	145
T28V12A	0-28 VDC at 12 Amp	125
T28V12ACC	12 Amp (1% Ripple)	160
T28V12A2CC	12 Amp0.01% Ripple	220
T28V24A †	0-28 VDC at 24 Amp	155
T28V24ACC †	24 Amp (1% Ripple)	225
T27V24A2CC †	24 Amp 0.01% Ripple	310
T28V50A †	0-28 VDC at 50 Amp	285
T28V50ACC †	50 Amp (1% Ripple)	410
T28V100A†	0-28 VDC at 100 Amp	500
T28V100ACC †	100 Amp (1% Ripple)	700

Variable 75 to 135 VDC Completely Built. Ready to go. Includes F. W. Selenium Bridge Rectifier 4" Rectangular Volt & Ammeter Over-Load output Dsgnd for cont. service.
Specify for 115 or 230 VAC 1 phase, 60 cy Input

T120V5AC	75 to 135 WVDC at 5 Amp	$190
T120V5ACC	5 Amp (1% Ripple)	240
T120V10AC	75 to 135 VDC at 10 Amp	245
T120V10ACC	10 Amp (1% Ripple)	295

POWER SUPPLIES TO YOUR SPECS
WRITE US YOUR REQUIREMENTS

New Variable Voltage X-fmrs

SUPERIOR-GR-STACO-UTC
0-132V-1.25A * $7.23
0-135V/3A * 10.63
Cased/0-135V/7.5A. * 19.55
Uncased/0-135V/7.5A * .. 15.30
Cased/0-270V/3A * 22.10
Uncased/0-270V/3A * 17.00
Cased/0-135V/15A * 39.10
Cased/0-270V/9A * 39.10
Uncased 0*27V/7.5A † ... 51.64
Cased 0-270V/9A * 81.60
Cased 0-270V/12A † 107.10
Cased 0-270V/15A † 124.95
Cased 0-270V/30A 154.70
GR50B/0-270V/31A/LN 115.00
LN, Like New (*) **New** (†) **3 Phase New**

"TABTRAN" Rectifier Chokes

CR6001/1 Amp/0.1 HY/1.4 Ohm **$4.50; 2 for $8**
CR6002/2 Amp/0.1 HY/.67 Ohm **$5.75; 2 for $11**
CR6003/5 Amp/07 HY/6 Ohm **$7.90; 2 for $15**
CR6004/12 Amp/.01 HY/.1 Ohm **$14.50; 2for$28**
CR6005/24 Amp/.004 HY/025 Ohm **$29.50; 2/$58**

"TABTRAN" Rectifier Xfmrs

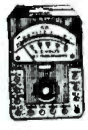
Sec'd Volts (DUAL†) 18-15-9-0:0-9-15-18V.

TR5007 1 Amp† $5.65; 2/$10.50
TR5008 2 Amp† $6.65; 2/$12.25
TR5001 5 Amp† $8.65; 2/$15.75
TR5002 12 Amp† ..$16.50; 2/$32
TR5003 24 Amp† ..$35.50; 2/$70
TR5004 50 Amp* .... **$58.50; 2/$115**
TR5005 100 Amp* .... **$107; 2/$210**
18 Volt 2 Amp .... **$1.98; 2 for $3.50**
† Wndgs in Series at Ratings shown; Parallel 2/Amps; Voltage one half max.
*** Dual Pri 115 & 220V 60cy; Tapped 36VCT**

"TAB" NEW YORK DISTRIBUTOR

Write for Discounts and Rectifier Catalog PR156

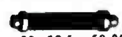
POCKET AC-DC *Multitester*



"TAB" 27C $7.75 ea

Hi-accuracy precison VOM 1000 Ohms per V. Reads AC & DC Volts 0, 5, 25, 250, 1000V. DCMA: 0, 1, 10, 100MA. Ohms 0, 10, 100K. Size 1¾D. 4⅝L 3¼ W. Test Leads **(Plus 40c ship in U. S. A.)**
Dealers Distributor Write for Discounts

HI-MEG HI-VOLT RESISTORS



2 MEG 5W/10KV .... **89c 12 for $9.00**
7 MEG "MVP" 10W/10KV .. **$1.00 12 for $10.00**
12 MEG 10W/10KV .... **$1.50 12 for $16.00**
20 MEG "MVO" 15W/50KV. **$2.00 12 for $20.00**
50 MEG "MVE" 25W/40KV. **$2.50 12 for $25.00**
10 MEG "MVP" 10W/10KV. **$2.00 12 for $20.00**
Lots Fifty 20% Disc.; Lots 100 Disc. 40%

NEW MINIATURE METER

0-1 Milliamp

Precision Jeweled D'Arsonval Mvt. Better than 2% accy. Readable long 1⅝" scale 20 divisions. Rugged. Well damped. Bakelite cased. Front Sq. or Rear Round Face mtg. Mounts 1½; hole. 4 screws 1¼" ctrs. Not surplus
Milliamp Shunts each .... .35
"TAB" SPECIAL ...... $3.85; 2 for $7.00

INFRARED SNOOPERSCOPE

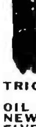
SEE IN DARK TUBE

Selected, GTD Image-Converter Tube Hi-Sensitivity simplified design 2" dia. Willemite screen—Resolution up to 350 lin'in. Tube & Data **"TAB" Special** .... **$3.90; 2/$7.50**
Snooperscope Pwr Supply ....**4500VDC/35MA.** Using Dual Doubler Crkt. Transformer, Rectifiers Sockets, Resistors, Capacitors and Diagram 115V/60cy Oper. . **$13.50**

PRECISION POTENTIOMETERS

Helipot 1000 Ohms/0.5%/3 Turn
Helipot 2000 Ohms/0.5%/10 Turn
Helipot 20K Ohm/0.5%/10 Turn
Helipot 50K Ohm/0.5%/3 Turn
Special Buy @ .... **$6.49 ea; 6 for $24**
$100 or more 20% Discount

PHOTOFLASH & STROBE LAMPS



"TAB" No.	Replaces	W-Sec Max	Each
TWL	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 & FA100	150	9.00
TDX	DXC/250-350	150	10.00
353GTQ	FT 503	2000	49.98

TRIGGER COIL LO VOLT FLASH **$1.47**
Write for Complete Listing
OIL COND-525 MFD/450VDC/53 Watt sec'ds
NEW low leakage famous mfgr .... **$8; 2/$15**
FIVE-90 Volt (N60) Batteries **$12.50**

TUBES

1st Quality
TESTED — GUARANTEED

OA2	$ .74	388A	1.99	GL5727	1.77
OA3	.98	394A	1.96	5732	3.94
OB2	.64	434A	3.94	5736	159.95
OB3/VR90	.84	446B	2.98	5744	2.39
OC3/		450TH	75.49	5749	1.72
VR105	.82	502AX	2.05		
OD3		512AX	1.35	5750	3.10
VR150	.78	531DX	1.89	5751	3.09
1AD4	3.95			5764	55.99
1AG4	1.35	536AX	1.55	5765	55.99
1AX2	1.25	538DX	.98	5769	298.00
1B3	.66	539DX	2.50	CK5783	5.55
		544DX	2.50	CK5787	4.95
1B24	4.98	571AX	4.45	5794	8.99
1B46	1.88	608CX	.97	5812	2.99
1B63A	42.50	HY615	.46	5814	1.28
1D21	3.49	703A	1.48		
1Q23	150.00	704A	.98	5819	49.99
1X2A	.62	705A	.98	5820	45.00
2C39A	16.90			5823	1.29
2D21	.75	710A	1.68	5825	11.99
2E22	1.89	715B	11.90	5828	6.70
2E24	2.48	717A	.46	5840	5.05
		721A	.98	5841	7.98
2E26	3.78	723AB	9.98	5842	12.00
2E32	2.07	724A	2.94	5844	4.48
2E43	1.49	724B	.96	5852	7.57
2J30	50.50	725A	4.49		
2J42	99.50	807	1.19	5857	59.50
2K25	23.88	807W	4.98	5863	49.94
2K28	29.50			CK5875	2.05
2K29	27.59	814	2.48	5876	12.49
2K30	130.00	815	3.98	5879	1.59
2K33	219.48	829B	8.49	5881	2.70
		832A	5.49	5893	7.55
2K41	175.00	864	.34	5910	.74
2K42	149.55	927	1.36	5927	89.45
2K43	130.00	954	.18	5932	5.00
2K48	110.00	955	.65		
2K50	315.00	956	.32	5950	6.45
2P23	298.00	957	.51	5959	37.25
3B24W	8.48			5965	1.75
3C22	72.50	CK1005	.56	6027	179.95
3C24	3.98	1612	1.98	6072	3.99
3D21A	7.99	1613	1.27	6080	5.99
		1616	.79	6099	1.55
4-65A	19.49	1619	.34	6101	1.55
4-125A	19.09	1620	5.01	6110	6.55
4B23	16.98	1625	.44	CK6111	8.95
4B27	4.98	1626	.16		
4C35	16.95	1629	.22	6119	6.45
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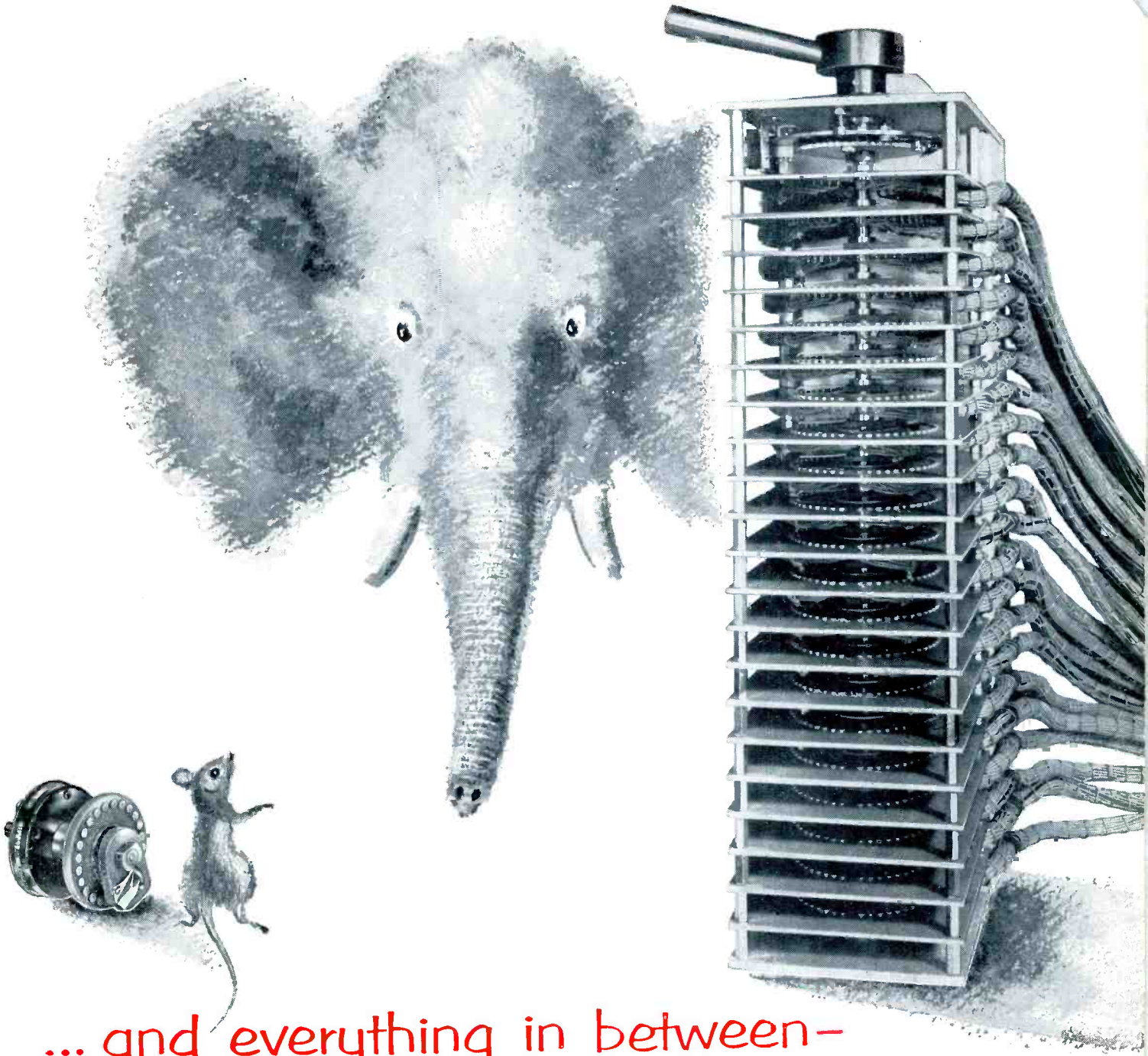

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